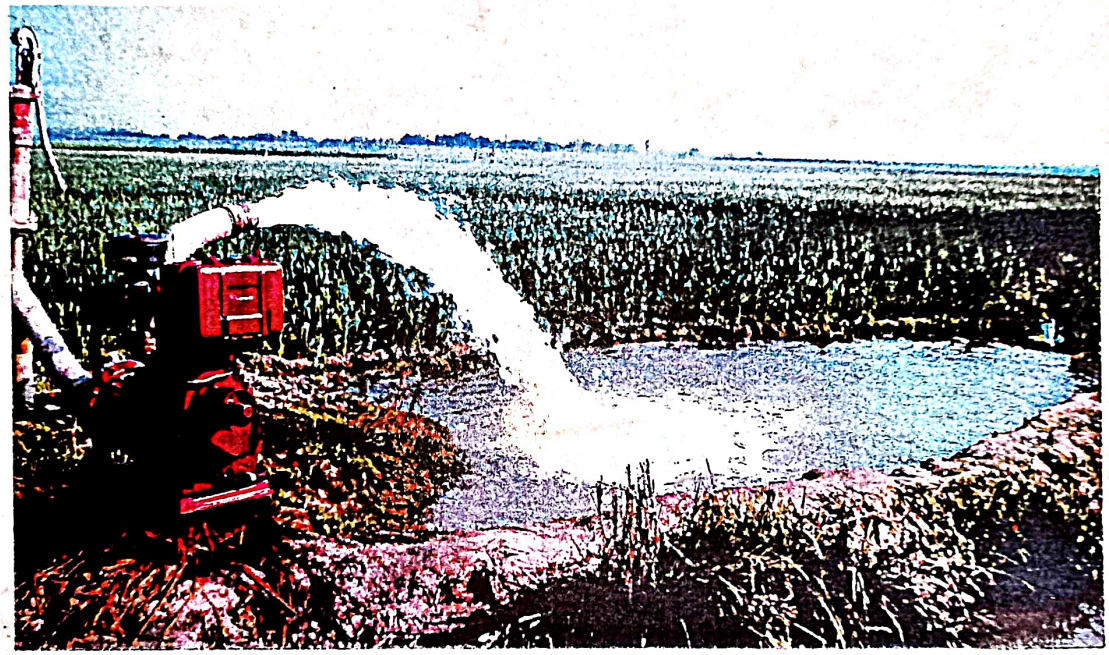
Asian Development Bank
His Majesty's Government of Nepal
Department of Irrigation

Community Groundwater Irrigation Sector Project (TA 2589 - NEP)



Final Report

Volume 1
Main Report

October 1997

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Cambridge, United Kingdom

in association with

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Asian Development Bank
His Majesty's Government of Nepal
Development of Irrigation

Community Groundwater Irrigation Sector Project
(TA 2589 - NEP)

Final Report
October 1997

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COMMUNITY GROUNDWATER IRRIGATION SECTOR PROJECT

FINAL REPORT

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2 The Groundwater Irrigation Sector
3 Review of Past Performance and Lessons Learned
4 Agriculture and Irrigation
5 Hydrogeology, Drilling Technology and Pumps

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DRAFT FINAL REPORT

MAIN REPORT

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PREFACE

On 22 April 1997 the Consultant submitted the Draft Final Report of this Community Groundwater Irrigation Sector Project (CGWISP) Preparation Study to the Asian Development Bank (the Bank) and the Department of Irrigation (DOI) of His Majesty's Government of Nepal (HMGN). At the Final Tripartite Meeting, which was held in Kathmandu on 9 May 1997, the report was briefly discussed, although the main emphasis at the meeting was on Project strategy, scope and components. The timetable in the Consultant's contract stipulated submission of the Final Report one month after the Final Tripartite Meeting, with the implication that written comments on the Draft Final Report would have been received from the Bank and HMGN before or at the time of the Final Tripartite Meeting. Since formal comments had not been received by this time, it was not possible to keep to this timetable.

A Bank Fact Finding Mission visited Nepal from 7 May 1997 until early June. At the 9 May 1997 Final Tripartite Meeting the Mission conveyed to HMGN several policy decisions concerning the Project which had been taken recently in Manila. These were as follows:

(a) The Bank stipulated that, as a loan condition, the HMGN shallow tubewell (STW) subsidies should be phased out by July 1999;

(b) The Bank was unwilling for the Agricultural Development Bank of Nepal (ADBN) to be a supplier of Project credit during at least the initial stages of the Project, primarily because it was not satisfied with ADBN's loan recovery performance;

(c) Deep tubewells should be excluded from the Project, which should then be concerned solely with shallow tubewells.

Clearly, these policy decisions implied major changes in Project design, especially with regard to credit supply. During its visit, the Bank Fact Finding Mission, in consultation with HMGN, prepared a Project proposal taking account of these changes. As part of this preparation work, the Bank commissioned the Consultant to carry out the following additional work for the Project in May and June 1997:

(a) A brief pre-appraisal of 30 potential Village Development Committee areas (VDCs) for group STWs, to ensure that there will be additional VDCs who would wish to enter the Project in the second and third years of the Project. This was undertaken by CEAPRED, an NGO, under sub-contract to the Consultant.

(b) A Credit Study to formulate detailed proposals for the credit supply system for group STWs (GSTWs), given the requirement that subsidies should be eliminated in the next two years and that the Bank has decided that ADBN should not be involved in credit supply for the Project initially.

(c) The organisation and running of a Farmers' Workshop at Biratnagar with participants from the Mrigauliya sample site, involving both existing GSTW farmers and members of the would-be GSTW groups which had been identified in the social mobilisation work undertaken by the NGO Grameen Bank Biratnagar at the site.

It was agreed with the Bank, on 9 May 1997, that the reports on the above additional work would be separate from (supplementary to) the Final Report. In particular, the Final Report would refer to the Credit Study but its findings would not be incorporated in the Report, the credit aspects of which would be based on the credit findings and proposals presented in the Draft Final Report. The reports on these three supplementary assignments are thus presented in a separate volume, Volume 6, of this Final Report.

In July 1997 a Bank Pre-appraisal Mission visited Nepal to continue the process of preparing the Project for Bank financing. This was to be followed by an Appraisal Mission in September.

HMGN's comments on the Draft Final Report were passed to the Consultant by the Bank in mid-July, and the Consultant's response to these comments was sent to HMGN and the Bank in August. Following informal discussions between the Bank and the Consultant in July, in Mid-July the Consultant presented his proposals for the preparation of the Final Report. These were accepted by the Bank and the Bank gave approval for the Report to be printed on 16 October 1997.

The function of the Final Report of a project preparation consultancy study such as this is to present the study findings in their final, agreed, version, based on those presented in the Draft Final Report but with modifications made in the light of comments received. It can then provide the basis for the Project to be implemented. In this case, however, the Final Report cannot fulfil this role, because of the substantial changes which have been made to the proposed Project since submission of the Draft Final Report, and the preparation work which has been and is being undertaken by the Bank and HMGN during and after the two Bank Missions.

Thus the CGWISP Preparation Study Final Report has, to a considerable extent, now been superseded by subsequent events. Nevertheless, it is important that a final version of the Draft Final Report is produced, as a record of the work undertaken and the findings and Project proposals produced by the consultancy study. This Final Report follows the same structure as the Draft Final Report, with a Main Report and four volumes of Appendices, but also includes the volume of supplementary reports mentioned above. At the request of the Bank, the Appendices as well as the Main Report follow the standard Bank format, with numbered paragraphs. In view of the size of the Report, and at the request of the Bank, a 'quick reference' guide has been prepared, so that readers can rapidly locate the volumes, appendices and sections covering the particular aspects about which they wish to read.

ACRONYMS AND ABBREVIATIONS USED IN THE REPORT

ADB	:	Asian Development Bank
ADBN	:	Agricultural Development Bank Nepal
AIC	:	Agricultural Inputs Corporation
APP	:	Agricultural Perspective Plan
APROSC	:	Agriculture Project Service Centre
AREP	:	Agricultural Research and Extension Project
ASC	:	Agriculture Service Centre
BLGDP	:	Bhairahawa Lumbini Groundwater Development Project
CDR	:	Central Development Region
CGWISP	:	Community Groundwater Irrigation Sector Project
DAC	:	District Agriculture Committee
DADO	:	District Agricultural Development Office
DC	:	Direct Circulation
DDC	:	District Development Community
DDT	:	Dichloro-diephynye Trichloro-ethene
DIN	:	German Industry Norms
DIO	:	District Irrigation Office
DOA	:	Department of Agriculture
DOI	:	Department of Irrigation
DPPIF	:	Division of Plant Protection and Industrial Technology
DSSTW	:	Deep Set Shallow Tubewell
DTW	:	Deep Tubewell
DWRC	:	District Water Resources Committee
EDR	:	Eastern Development Region
FAO	:	Food and Agricultural Organisation
FIRR	:	Financial Internal Rates of Return
FMIS	:	Farmer Managed Irrigation Scheme
FO	:	Farmer Organiser
FWDR	:	Far Western Development Region
GDC	:	Groundwater Development Consultants
GFO	:	GWRDP Field Office
GID	:	Groundwater Irrigation Division
GTZ	:	German Society of Technical Co-operation
GUG	:	Groundwater User Group
GWRDB	:	Groundwater Resources Development Board
GWRDP	:	Groundwater Resources Development Project
HDPE	:	High Density Polyethylene
HMG(N)	:	His Majesty's Government (Nepal)
IBRD	:	International Bank for Reconstruction and Development
IDA	:	International Development Agency
IFAD	:	International Fund for Agriculture Development

IIMI	:	International Irrigation Management Institute
ILC	:	Irrigation Line of Credit
INGO	:	International Non-Government Organisation
IP	:	Irrigation Policy
IPM	:	Integrated Pest Management
IRRI	:	International Rice Research Institute
IUCN	:	International Union for Conservation of Nature
JADP	:	Janakpur Agriculture Development Project
JICA	:	Japan International Co-operation Agency
JT	:	Junior Technician
LCB	:	Local Competitive Bidding
LLDPE	:	Linear Low Density Polyethylene
LRMP	:	Land Resources Mapping Project
LWC	:	Lower Well Casing
MLD	:	Ministry of Local Development
MOA	:	Ministry of Agriculture
MOWR	:	Ministry of Water Resources
MPIDN	:	Master Plan for Irrigation Development Nepal
MTW	:	Medium Tubewell
MUV	:	Manufacturing Unit Value
MWDR	:	Mid-Western Development Region
NARC	:	National Agricultural Research Council
NEA	:	Nepal Electricity Authority
NGO	:	Non-Government Organisation
NISP	:	Nepal Irrigation Sector Project
NMIDP	:	National Minor Irrigation Development Project, Bangladesh
NZIDP	:	Narayani Zone Irrigation Development Project
PRA	:	Participatory Rural Appraisal
PVC	:	Polyvinyl Chloride
PWL	:	Pumping Water Level
RADO	:	Regional Agriculture Development Office
RATC	:	Regional Agriculture Training Centre
RC	:	Reverse Circulation
RRA	:	Rapid Rural Appraisal
RRP	:	Report and Recommendation of the President
Rs	:	Nepalese Rupees
SC	:	Specific Capacity
SCO	:	Savings and Credit Organisations
SFCL	:	Small Farmers Co-operative Ltd
SFDP	:	Small Farmer Development Programme
SIRDP	:	Sagarmatha Integrated Rural Development Project
SISP	:	Second Irrigation Sector Project
SPIN	:	Special Programme on Food Production In Support of Food Security in Nepal

STW	:	Shallow Tubewell
SWL	:	Static Water Level
TOR	:	Terms of Reference
TW	:	Tubewell
UNDP	:	United Nations Development Project
UP	:	Uttar Pradesh, an Indian State
UPVC	:	Ultra Polyvinyl Chloride
USAID	:	United States Aid for International Development
UWC	:	Upper Well Casing
VDC	:	Village Development Committee
WRA	:	Water Resource Act
WRR	:	Water Resource Regulation
WUA	:	Water User's Association
WUG	:	Water User's Group

CURRENCY EQUIVALENTS

1 Nepalese Rupee (Rs)	=	US$ 0.018
Rs 56.75	=	US$ 1.00
Rs 92	=	1 pound sterling
Rs 1.60	=	1 Indian Rupee

UNIT CONVERSIONS

1 metre (m)	=	3.28 feet
1 kilometre (km)	=	0.62 miles
1 hectare (ha)	=	2.47 acres
	=	1.50 *bighas*
	=	30 *khatas* (kattha)
1 metric tonne (t)	=	2 205 pounds
1 *maund*	=	37.324 kilograms (kg)
1 *quintal*	=	100 kilograms (kg)
1 litre (l)	=	0.22 imperial gallons
1 cubic metre per second (m^3/s)	=	35.31 cubic feet per second
1 cubic foot per second (cusec)	=	28.3 litres per second (l/s)
1 cubic metre per hour (m^3/h)	=	0.28 litres per second (l/s)
1 kilowatt (kW)	=	1.34 horsepower (hp)
	=	1 kilovoltamp (kVA)
1 megawatt (MW)	=	1 000 kilowatts (kW)
1 gigawatt (GW)	=	1 000 000 kilowatts (kW)

FISCAL YEAR

July 16 - July 15

RECENT NEPALESE : GREGORIAN YEAR EQUIVALENTS

Nepalese year	Gregorian Year
2050	1993/94
2051	1994/95
2052	1995/96
2053	1996/97
2054	1997/98

QUICK REFERENCE GUIDE

In view of the size of this Final Report, and at the request of the Asian Development Bank, a 'quick reference' guide has been prepared, so that readers can rapidly locate the volumes, appendices and sections covering the particular aspects about which they wish to read. A guide rather than index has been prepared because, with such a large report, a full index would be so large as to be very difficult to use.

For each subject, its location within the Main Report and the Appendices has been shown. Location within appendices has been specified in terms of section numbers (I, II, III, IV etc), following the Bank report format system. Thus, for example, the location 18 IV means Section IV in Appendix 18. For Main Report references the locations have been specified to the next tier of format, sub-sections A, B, C etc. So the location IIIA means Sub-Section A in Section III of the Main Report.

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COMMUNITY GROUNDWATER IRRIGATION SECTOR PROJECT

EXECUTIVE SUMMARY

Project Background

1 Over the past two decades there has been a substantial development of groundwater irrigation in the Terai, largely in the form of shallow tubewells (STWs) installed by private farmers. By 1994 the total groundwater irrigated area had reached 0.14 million ha, but this is only a fraction of the total potential. There is an estimated 0.72 million ha with high potential for STW irrigation, and another 0.30 million ha with marginal potential, plus a further 0.05 million ha with potential for deep tubewell (DTW), but not STW, irrigation. Tubewell irrigation, principally with private sector STWs, is now regarded by Government as the centrepiece of future irrigated agricultural development in the Terai. Under the Agricultural Perspective Plan it is intended that by the year 2015 the total tubewell-irrigated area will have reached 0.61 million ha, of which at least 85% will be irrigated by private STWs.

2 At present, virtually all the Terai's STWs are under individual ownership, with less than 5% being owned by farmer groups rather than individuals. Few small farmers have the land or financial resources to install STWs on their own. As a result, the poorer members of the farming community have largely missed out on the opportunities available for raising agricultural output and incomes by developing groundwater irrigation. Experience with both surface and groundwater irrigation has demonstrated that Nepali farmers are capable of working together effectively in farmer groups. Relatively little emphasis has, however, been given to stimulating group STW irrigation. The aim of the Project will be to repair this omission and to bring about a rapid expansion of group STWs, while at the same time stimulating a more general growth of STW numbers and productivity through provision of advisory and support services and technology improvements.

3 The Project area comprises the 12 Terai districts of Central and Eastern Development Regions. Its total 1991 population was 5.7 million, in 1,002 Village Development Committee (VDC) areas, and total cultivated area is approximately 0.86 million ha. In common with the country as a whole, living standards are low and many people live below the official poverty line.

Project Objectives and Scope

4 The Project's objectives are to (i) increase agricultural productivity on a sustainable basis and thereby (ii) improve the income of small farmers. These objectives will contribute to

the achievement of HMGN's goals of reducing poverty and increasing employment in rural areas. To achieve these objectives, the Project will comprise the following four components:

(i) **Groundwater Irrigation Development:** This involves the installation of 13,500 group STWs and 1,500 individual STWs, all of the simple ADBN type, in some 300 VDCs in those parts of the regions with high STW potential; the installation of 67 new DTWs and the rehabilitation of 33 existing DTWs in areas of no STW potential; and the mobilisation, preparation and training of farmer groups by NGOs contracted specifically for this purpose. It will be entirely demand-based, STWs being installed by farmer groups and individuals, using private sector drillers and suppliers. STW improved irrigation distribution systems and pumphouses are not included in the Project, because analysis has shown them to be uneconomic. To provide a focus and an appropriate field operating unit, implementation will be based on individual VDCs. Government's role will be primarily that of facilitator rather than direct implementer of the development.

(ii) **Supportive Infrastructure Development,** comprising the improvement of rural access and village roads in the 300 VDCs in which the Project is expected to operate and the provision of a lump sum of Rs 227,000 (US$4,000) to each VDC for the improvement of social infrastructure and services. In view of its high cost, the roads improvement will be undertaken on a highly selective basis, to relieve obvious bottlenecks, the total programme covering an estimated 600 km of access roads and 240 km of village roads.

(iii) **Project Management and Groundwater Support Services,** Agricultural Extension services in the beneficiary VDCs, Monitoring and Evaluation and Technical Assistance (the Project Consultants) for Project implementation.

(iv) **Technology Improvement and Dissemination.** This involves: Agricultural and Irrigation Research to develop and implement a needs-based research programme; Engineering Research and Development, to improve STW and, a lesser extent, force mode MTW, drilling and design; two Technology Transfer Centres, one in each region, for the promotion and dissemination of the technology improvements generated; Technical Assistance (the Technology Consultants); and Dissemination activities to farmers and the private sector through the media.

Cost Estimates and Financing Plan

5 Over the seven year implementation period the total cost of the Project, including contingencies, is estimated at Rs 3,370 million (US$ 59.4 million), including the farmer-financed portions (part of the tubewell costs). Details are as follows:

Summary of Project Costs (Rs million)[1]

Project Component	Foreign Exchange Cost	Local Cost	Total Cost	%
Groundwater Irrigation Development	707	594	1,301	47
Supportive Infrastructure Development	103	685	788	29
Project Management and Groundwater Services	217	261	478	18
Technology Improvement and Dissemination	91	70	161	6
Total Base Cost :	1,118	1,610	2,728	100
Physical Contingencies	107	170	277	
Price Contingencies	144	211	365	
Total Project Cost :	**1,369**	**2,001**	**3,370**	

Note 1: 1 Rs 56.75 = US$ 1.0

6 A summary of the financing plan for the Project is given below:

Summary of the Proposed Financing Plan (000 US$)

Financier	Foreign Exchange Cost	Local Cost	Total Cost	%
Bank Loan	24,133	20,401	44,534	75
HMGN	-	9,628	9,628	16
Farmers	-	5,224	5,224	9
Total :	24,133	35,253	59,386	100
%	40.6	59.4	100.0	

Implementation Arrangements

7 The Project will be implemented over seven years from 1998 to 2004. During the first two years attention will be concentrated on the development of the six sample site sub-projects and some expansion into other VDCs in the same districts, on building up DOI's administrative and technical capability to implement the Project, with the accompanying institutional changes, staff recruitment and training, and on the establishment of the Technology Improvement and Dissemination programme. In Year 3 a mid-term review will be undertaken, in order to evaluate the progress and performance achieved on the six sub-

projects. Based on this evaluation and other work carried out (e.g. the roads assessment in the priority areas) and on any major policy changes which may have occurred, especially concerning subsidies, the programme for the remaining four years of the Project will then be drawn up.

8 The Project organisational structure will, as far as possible, be based on existing institutions and units, creation of new units being kept to a minimum. The executing agency for the Project will be the **DOI**, under the Ministry of Water Resources. DOI will have overall responsibility for supervision, implementation, co-ordination, and monitoring and evaluation of Project activities. At DOI headquarters the **Groundwater Irrigation Division (GID)**, under its Deputy Director-General, will be the Division responsible for the Project. It will establish a **Project Implementation Unit**, which will run the Project through the four existing GWRDP Groundwater Field Offices. To ensure adequate co-ordination at the central level between the principal agencies involved (DOI, DOA, NARC, the credit agencies etc.) a **Project Co-ordination Committee** will be set up, with the DDG of the GID as Chairman and the Project Co-ordinator as Secretary. A consulting firm will be employed to provide the technical assistance required for project implementation (the 'Project Consultants').

9 In operational terms Project activities will be divided into two, **Tubewell Irrigation Development and Associated Infrastructure** and **Technology Improvement and Dissemination**. Under the direction of the Project Co-ordinator close liaison will be maintained between the two, so that technology improvements are disseminated rapidly to STW users, drillers and others and feedback from these customers is passed back to the originators of the improvements. The **Department of Agriculture** will provide the agricultural extension services. **NARC** will carry out the irrigated agriculture research and development, with assistance where necessary from the **Research and Technology Section of DOI's Irrigation Management Division**, and GWRDP will be responsible for technology improvement in drilling and tubewell design. International and local consultants (the 'Technology Consultants') will play an important role in the technology development process.

10 In each participating VDC a **Groundwater Development Committee** will be set up within the main VDC Committee, to facilitate effective liaison between the STW groups, the Project and the service providers, working especially through the **NGO** Social Mobiliser. NGOs will be contracted by the Project to provide one **Social Mobiliser** per VDC, normally for a period of two years, backed up by a mobile team of three specialists per 10 VDCs.

Project Benefits and Justification

11 Project benefits will comprise mainly the increase in agricultural production and incomes resulting from the development of new irrigation tubewells and the expected improvement in the performance and productivity of existing tubewells in the Project area. There will also be substantial non-quantifiable social benefits resulting from the alleviation of poverty,

improved drinking water supplies from the tubewells and the VDC infrastructure and services improvements to be financed by the Project. A much wider area of the Terai beyond the 300 VDCs should in fact benefit from the Project, due to the beneficial impacts of the Technology Improvement and Dissemination component and the general impetus which the Project should give to group STW development. The value of such impacts has not been included in the economic analysis.

12 If group STW uptake reaches the assumed level, the total number of direct beneficiaries of the Project is expected to be some 490,000 persons in 82,000 households in the 12 Terai districts of the Central and Eastern Development Regions. Total tubewell irrigated area would increase by 60,700 ha. The financial analysis results indicate that investment in STWs should bring high returns to STW groups and, though to a somewhat lesser degree, to individual well owners, even if there were no STW subsidy. Social impacts will be highly positive and there will be no substantial adverse environmental impacts.

13 Economic returns to investment would also be high. Economic internal rates of return (EIRRs) for single tubewells would be very high for STWs but less satisfactory for DTWs, although DTW EIRRs will be adequate provided that improvements in productivity are achieved. Four of the six sample site sub-projects would give very high economic returns even at present levels of productivity. As long as existing tubewell productivity levels can be appreciably increased which, given the investment to be made by the Project in raising productivity, is a reasonable expectation, the other two sub-projects would also be economically feasible, with EIRRs of 39% and 50% respectively.

14 The EIRR for the overall Project, taking account of agricultural benefits only, is a very attractive 35.9%. For the rural roads improvement component the EIRR is 13.6%. Sensitivity analyses carried out to test the effects of major shortfalls in benefits, including lower than projected uptake of STWs, productivity improvements and STW command areas, show that the Project is highly robust in economic terms and can withstand quite severe changes in benefit parameters without becoming uneconomic.

Project Risks

15 The Project has set ambitious targets in terms of the number of STWs to be developed and the number of VDCs to be covered. There are several major risks and uncertainties which may affect the Project's levels of activity, expenditure and impact. These concern the future levels (rates) of farmer uptake of STWs, HMGN's ability to fund tubewell subsidies, public sector institutional capabilities and capacity for change, and credit supply for group STWs after the present high levels of subsidy are reduced. Of these, the first two are considered to be the most serious.

16 During its seven year implementation period the Project envisages an increase of 70% in the total number of STWs in the two regions and a massive, almost seven fold, expansion in the number of group STWs. Over the past 15 years the rate of STW development in the Terai has been disappointingly slow. The proposed Technology Improvement and Dissemination component and the increased emphasis on extension and advisory services should increase STW returns and attractiveness, but at this stage there is no guarantee as to the overall impact of the improvement activities. The uncertainties with regard to the future expansion of group STWs are especially great. Existing experience in the Terai indicates that group STWs out-perform individual STWs in agricultural, economic and social terms, but the land tenure and other constraints involved tend to limit the numbers of group STWs. A major Project task will be to overcome such constraints by means of the proposed social mobilisation, awareness raising and other activities.

17 At present (1996/97), the budgeted sum for private sector STW subsidies (those provided through the Agricultural Development Bank of Nepal (ADBN), and excluding subsidies on public sector tubewell projects) is Rs 44 million, having come down from the 1992 / 93 peak of Rs 64 million. This sum is for all five regions of the Terai. Each year the subsidy funds are fully drawn down, there being an excess of demand. Under the Project, the projected funding required at present subsidy levels will rise from Rs 10 million in Year 1 (1998) and Rs 31 million in 1999 to Rs 110 million in 2000 and Rs 161 million per year between 2002 and 2004. This is, of course, for only two of the five Terai regions. Given HMGN's financial constraints, it is by no means certain that such increased funding can be provided. On the other hand, financial analysis has clearly demonstrated that returns from STW investment would still be very attractive even if there were no subsidies.

I INTRODUCTION

1 Over the past two decades there has been a substantial development of groundwater irrigation in the Terai, largely in the form of shallow (suction mode pumped) tubewells (STWs) installed by private farmers. By 1991/92 the total groundwater irrigated area had reached 107,000 ha. With the highly favourable groundwater resource base this is only a fraction of the total potential, which has been estimated as comprising 725,000 ha of high potential for STWs, another 305,000 ha of marginal potential for STWs and a further 51,000 ha suitable for deep (force mode pumped) tubewells (DTWs) but not STWs.

2 In Nepal's Agricultural Perspective Plan (APP), completed in 1995 and endorsed by the Government (HMGN) as the basis for future agricultural development, groundwater irrigation has been selected as the centre piece of the Terai irrigation development strategy. Emphasis will be given primarily to private sector STW irrigation. Experience has shown that this is the most economic and practicable form of tubewell irrigation development. The APP calls for an average of 24,000 ha per year to be added to the groundwater irrigated area (STWs 22,000 ha, DTWs 2,000 ha), so that by the year 2015, at the end of the APP period, this will have reached a total of 612,000 ha. At the assumed 2.5 ha per STW and 50 ha per DTW, this translates to 8 800 STWs and 40 DTWs per annum respectively.

3 At present, virtually all the Terai's STWs are under individual ownership, with less than 5% being owned by farmer groups rather than individuals. Few small farmers have the land or financial resources to install STWs on their own. As a result, the poorer members of the farming community have largely missed out on the opportunities available for raising agricultural output and incomes by developing groundwater irrigation. Experience with both surface and groundwater irrigation has demonstrated that Nepali farmers are capable of working together effectively in farmer groups. Relatively little emphasis has, however, been given to stimulating group STW irrigation in the private sector, apart from some limited efforts under the Small Farmer Development Programme (SFDP).

4 In recognition of the high potential and strong need for such development, in 1996 HMGN requested the Bank to formulate a community groundwater irrigation sector project for the Central and Eastern Development Regions (CDR and EDR) of the Terai. In September 1996 Groundwater Development Consultants Ltd of UK, in association with Hunting Technical Services Ltd of UK and EastConsult (P) Ltd of Nepal, were contracted by the Bank, under a Project Preparation Technical Assistance, to prepare the Project. Work began at the end of October 1996. From mid-November 1996 until the end of March 1997 the study team was based in the Project area, in Biratnagar, the EDR capital, before moving to Kathmandu for final report completion in April 1997. In December 1996 a First Workshop was held in Nagarkot, its main objectives being to agree the project concept, strategy and policies, and was followed by submission of the Inception Report in the same month. The Interim Report, which was concerned primarily with the six sample site sub-projects, was submitted in

February 1997. It was followed in March by a Second Workshop, the principal aims of which were to discuss technical and practical aspects of Project design and implementation. The Draft Final Report was submitted on 22 April 1997.

5 The project area is shown in Figure 1. It covers the 11 Main Terai districts of the Central and Eastern Development Regions (Parsa, Bara, Rautahat, Sarlahi, Mahottari and Dhanusha in CDR and Siraha, Saptari, Sunsari, Morang and Jhapa in EDR) and the Inner Terai district of Chitwan. Its total length in the 11 Main Terai districts is almost 400 km and its width varies between about 20 km and 45 km. It is traversed by the East-West Highway; road communications are better than in most other areas of Nepal. Total cultivated area is approximately 864,000 ha. The area has 1,002 Village Development Committees (VDCs) covering the 12 districts.

6 Total population of the 12 districts in 1991 was 5.7 million. Average household size is 5-6 persons. The population is ethnically mixed, but conflict between ethnic groups is not a problem. In common with the country as a whole, living standards are low and many people live below the official poverty line of Rs 4,140 (US$ 73) per annum. At the national level 49% of the economically active population (the 16-59 age group) is considered to be below this income level.

7 The soils are alluvial and capable of high levels of productivity. Total mean annual rainfall is between 1,500 and 3,600 mm. With hot summers and cool winters, the climate is suitable for a wide range of crops and, provided that irrigation is available, is not a significant constraint on local agriculture. Abundant scope exists for a major intensification of agriculture. Rice is the main crop, other important crops being wheat, maize, oilseeds, pulses, sugarcane, jute, potatoes and vegetables. Livestock are the main source of farm power and are important for their output of milk, meat and other products.

8 Average holding sizes in the 11 districts other than Chitwan range from 1.04 ha to 1.47 ha. Landlessness is widespread. The degree of fragmentation of holdings is high, with holdings having as many as 5 or 6 different parcels. Tenancy is common and many small farmers are both owner-cultivators and tenants. There are two main types of tenants, Legal Tenants with well-defined rights under formal tenancy agreements, and tenants operating under the sharecropping system found in many parts of South Asia.

9 An important part of the study was the detailed investigations and planning carried out at the six sample sites, three in each region, culminating in the preparation of six proposed Sub-Projects to be implemented in the first stage of the Project. These have been used in models for the more extensive planning required for the Project area as a whole. Each sample site covers one VDC area, ranging in size from 660 ha to 3,729 ha. Five of the sites are suitable for STWs and one partly for DTWs and partly for STWs. Specific work undertaken at the six sites included the following:

- Social mobilisation and assessment activities by two NGOs (Non-Government Organisations) contracted specifically for this purpose. This included the identification of prospective STW groups.

- A questionnaire-based sample survey of existing tubewells, covering 123 individually owned STWs, all 26 group STWs and the four existing DTWs, to provide reliable field data on existing tubewell irrigation.

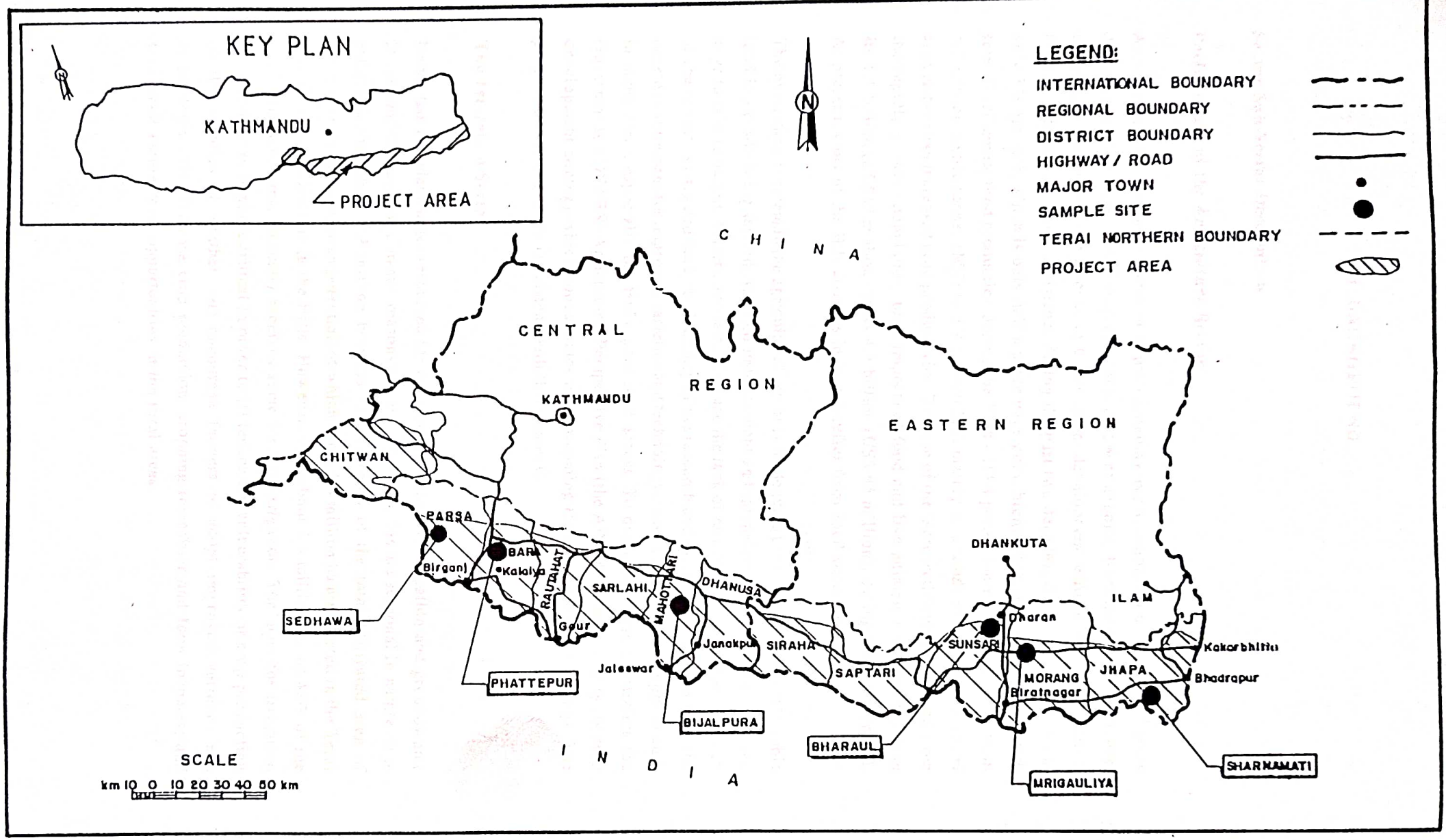
- Other detailed field investigations required for Sub-Project planning purposes.

At the Bank's request, a further sample survey of existing STWs, covering the whole of Bara and Morang districts, was undertaken on a sub-contract basis by one of the two NGOs working in the sample sites, and was completed by the end of April 1997.

10 In addition to the Main Report, this Final Report comprises 18 appendices, which are published in four supporting volumes, and the volume of supplementary reports on the additional work undertaken separately after submission of the Draft Final Report, as explained in the Preface above. At the request of the Bank, the structure of the Report follows the standard format of the Report and Recommendation of the President (RRP) to the Board of Directors which is produced within the Bank as a loan application for each project.

THE PROJECT AREA AND THE LOCATION OF THE SAMPLE SITES

Figure 1



II BACKGROUND

A Sector/Sub-Sector Description

1 Performance of the Agriculture Sector

11 Agriculture is the dominant sector in Nepal's economy and accounts for about 44% of gross domestic product, 80% of total employment and 15% of exports. Because of its importance, agriculture continues to be a focus of Government development efforts and expenditures. Despite substantial foreign assistance during the past two decades, the sector has grown at only 3% per year, which is only half a percentage point higher than the population growth rate. Total annual food production during the 1988 - 1994 period increased marginally from 5.5 million metric tonnes (MT) to 5.9 million MT, mainly as a result of increased cropped area rather than increased crop productivity. Because of the increased demand for food from the rapidly growing population, total imports of food and live animals rose rapidly, from Rs 1.5 billion (US$30 million) to Rs 4.3 billion (US$ 85 million), during the same period. At present, most of the Hill districts in Nepal suffer from food shortages.

12 The overriding problem in the agricultural sector is inadequate productivity. Most cultivable land is already being farmed, so yield improvement and intensification of cropping are the keys to raising output. Major constraints include the lack of reliable water supplies on much of the country's irrigated land, the inability of the research and extension system to meet the urgent requirement for improved varieties and technology, inadequate fertiliser supplies and, in many areas, especially the Hills, poor road access. To overcome these constraints the Government's (HMGN) Agricultural Perspective Plan (the APP) proposes a highly focused development strategy which concentrates on overcoming these critical shortcomings. The proposed Project is fully consistent with this strategy.

2 The Irrigation Sector

13 Nepal has abundant water resources for both surface (gravity) irrigation and groundwater irrigation, although for climatic reasons surface water supplies are seasonal in nature. It is estimated that about 1.8 million hectares (ha) or 69 % of the total cultivated area of 2.6 million ha has irrigation potential, of which about 1.4 million ha are located in the Terai and about 0.4 million ha in the Hills. However, only about 1.1 million ha, or 42% of the total cultivated area, currently receives some form of irrigation. The need for irrigation development in Nepal is critical in order to (i) reduce the vulnerability of crop production to the vagaries of weather; (ii) encourage farmers to adopt improved varieties and technologies; (iii) increase crop production, cropping intensities and farm incomes; and (iv) create employment opportunities in the rural areas.

14 The irrigated area in Nepal can be broadly categorised according to ownership of management (public versus private schemes), location (Hills versus Terai), and source of water (surface versus groundwater). On the basis of these classifications, about 26% or about 258,000 ha has been developed and managed by the Department of Irrigation (DOI), while the rest (74% or 746,000 ha) is classified as Farmer Managed Irrigation Schemes (FMISs). About 71% of the irrigated area is located in the Terai and the remainder in the Hills. All the irrigated areas in the Hills are under surface water schemes, while those in the Terai comprise both surface water schemes (80%) and groundwater development (20%). In 1994 the total groundwater irrigated area was estimated in the APP to be some 141,000 ha.

15 In comparison with many countries, Nepal has an enviable record in the development and management of FMISs. For centuries, Nepalese farmers have been involved in irrigation development using their own resources, mainly for the purpose of providing supplementary irrigation for the monsoon paddy crop, and to some extent also for dry season crops. The main strengths of FMISs are that (i) the farmers are able to mobilise local resources to finance the costs of investment and operation and maintenance (O&M), (ii) O&M of the completed schemes is carried out by the beneficiaries themselves, to ensure a rapid response to O&M problems; and (iii) the beneficiaries are organised into viable water users' associations (WUAs), which have been developed according to the needs of the farmers. Over the past two decades this 'self-help' form of irrigation development has been extended into the groundwater sub-sector, with the expansion of low cost shallow tubewells (STWs) installed by private farmers, mainly with funding from the Agricultural Development Bank of Nepal (ADBN). The relative success of FMISs is a tribute to the marked ability of Nepalese farmers to undertake group operations and management together on a sustainable basis.

16 During the 1955 to 1987 period DOI directed most of its efforts toward developing medium- and large-scale irrigation schemes. Because of their complexity and high cost, large-scale schemes have been the major focus of technical and financial assistance by external agencies on a project basis. In these schemes, the need for farmers' participation in planning, design and construction and their potential for active involvement in O&M activities were often not explicitly incorporated in the project design. Lack of farmers' participation has partly contributed to the poor O&M of the completed schemes. Studies have indicated that only 57% of the total planned command area of 258,000 ha managed by DOI was irrigated during the wet season and as little as 23% during the dry season. The fact that many private STWs have been installed within DOI surface schemes reflects these irrigation supply shortcomings.

17 HMGN has recognised these problems and, since 1988, has taken a number of important measures to enhance the efficiency of the public irrigation schemes. The key initiatives have been (i) introducing a working policy on irrigation development in 1988 that emphasises the importance of farmer participation at all stages of project implementation and O&M activities; (ii) launching the Turnover and Joint Management Programme (TJMP) in 1990,

under which small and medium-scale public schemes are turned over to the WUAs, while large-scale schemes are jointly managed by DOI and the relevant WUAs; (iii) issuing the Irrigation Policy of 1992, which incorporates and adds to the 1988 working policy and provides a policy framework for irrigation development, and (iv) reorganising DOI in 1993 and creating a new Irrigation Management Division, which is responsible for the effective implementation of the new irrigation policy on O&M. The emphasis on farmer participation and handover has been applied on public sector groundwater irrigation projects as well as the DOI surface schemes. There has been little change in the rather hands off approach to the private STW sub-sector, HMGN's role there being confined largely to providing capital cost subsidies and loan funds for ADBN, rather than providing extension and supporting services as well.

18 As indicated above, the groundwater irrigation sub-sector comprises two distinct elements, the public sector-implemented tubewell projects and the ADBN-type private STW development. In 1993 GDC estimated that there were 568 deep tubewells (all based on force mode pumping) and 46,014 STWs (suction mode pumping) in the five Terai regions. Of the latter, 7,959 had been installed by government projects, principally the Janakpur Agricultural Development Project (Department of Agriculture), the Groundwater Resources Development Project (GWRDP) and the Sagarmatha Integrated Rural Development Project. Virtually all of these were machine drilled. The remaining 38,055 STWs were low cost manually drilled ADBN-type wells installed privately, 76% with ADBN loans and 24% funded by the owners themselves. Formerly, the public sector DTW projects such as the Bhairahawa-Lumbini Groundwater Development Project (BLGWP) had been managed directly by DOI but, with the change of HMGN policy, all such projects, both existing and new, are now based on the principle of handover to farmers.

19 As is clear from the above figures, most of the Terai's tubewell-irrigated land has been developed by the private sector. Even with the low well utilisation rates and command areas achieved (the average STW command area is estimated to be only some 2.5 ha, well below the potential), at least two thirds of the total groundwater irrigated area is supplied by privately installed ADBN-type STWs. Despite considerable expenditure on HMGN projects like BLGWP and JADP, their contribution to the expansion of the groundwater irrigated area has been somewhat limited.

3 Irrigation Sector Programme

20 Until 1987, HMGN did not recognise the advantage of involving farmers in irrigation development. With the adoption of the Working Policies on Irrigation Development in 1988, the Government changed its development priorities and strategies for irrigation investments. The policies stressed the importance of farmers' participation in the identification, design, construction and O&M of irrigation schemes. Both beneficiaries and the Government share the capital cost and the O&M cost of the schemes. The cost sharing formulas for small, medium, and large surface irrigation schemes and for shallow and deep tubewell are

specified in the policies. The policies also emphasise the importance of institutionalising coordination between the agencies involved in irrigation development and the agencies that provide agricultural support services, so that crop yields and cropping intensities in the irrigated areas can be increased.

21 In the mid-1980s, HMGN established new priorities in irrigation development by laying emphasis on quick-yielding and short-gestation projects. The strategy for achieving this target includes (i) rehabilitation and upgrading of existing FMISs where WUAs are already in place, (ii) construction of new small and medium-scale gravity irrigation schemes, (iii) development of STWs, and (iv) improving management and O&M of completed public schemes. In 1987 the Government adopted a sector programme approach in irrigation development, under which better integration of planning, design, and implementation capacities of DOI and a more flexible funding approach were adopted by both the Government and the external funding agencies. Under the Irrigation Sector Programme HMGN envisaged developing a total irrigated area of 464,000 ha during 1987-2000.

4 The Groundwater Irrigation Sector in Central and Eastern Development Regions

22 **Groundwater Irrigation Potential:** With its favourable aquifer conditions and groundwater quality, high annual recharge and fertile alluvial soils the Terai has excellent groundwater irrigation potential. It is one of the last remaining under-exploited irrigation fresh groundwater resources in South Asia. The Project area can be divided into three hydrogeological units, the Bhabar Zone in the northern part of the Terai plain, the main Indo-Gangetic flood plain in the southern part and the Inner Terai Unit in which Chitwan District is located. There is a well-defined shallow aquifer zone of 50-60 m depth and a generally confined deeper zone. Watertable depths decrease in a southerly direction. A large proportion of the area has watertable depths of 5 m or less, the critical depth below which the suction mode pumping used by the typical STWs of the Terai becomes problematical. Aquifer lithology is generally favourable for high levels of well discharge. Despite this favourable overall picture, there is widespread variation in groundwater conditions and tubewell irrigation potential at the local level, more so than is often thought.

23 Annual groundwater recharge, for which the Bhabar Zone is the largest single source, is relatively high, as would be expected with the Terai's average annual rainfall of 1,500 - 3,600 mm. No more than 10% of the available recharge is being exploited at present, and the groundwater resource is sufficient to support a massive expansion in tubewell irrigation.

24 In the study a detailed assessment was made of the tubewell development potential for the six sample sites and the 12 Project Area districts, particular emphasis being given to suitability for manually drilled STWs and for the two main manual drilling techniques, the Sludge (Dhikuli) and Hammer (Thokuwa) methods. Three categories of potential were identified, as follows:

Category	Description
I	Feasible for DTWs only, because water levels are too deep for suction mode pumping.
II	Feasible for STWs, but only for the hammer (Thokuwa) manual drilling method.
III	Feasible for STWs using the sludge (Dhikuli) method, the easiest manual method.

25 Within this overall categorisation, STW High Potential Areas were also identified. These are areas with high transmissibility and shallow watertables where conditions for STW development are unusually favourable and high well discharges can be obtained at a relatively low cost. Table 1 shows the areas of each category and the High Potential areas for each district of the Project area. The conclusions are as follows:

(i) In all of the 12 project area districts except Chitwan there is abundant physical potential for manual drilled STWs. There are 775 VDCs with potential; this is over three quarters of all the VDCs in the 12 districts. The total STW-feasible areas are 262,000 ha in CDR and 273,000 ha in EDR, giving an overall total of 535,000 ha.

(ii) The great majority (77%) of this STW-feasible area is suitable for the Sludge method. In nine of the 12 districts, including all those in EDR except Sunsari, 70% or more of the STW feasible area is suitable for this method. Even in Dhanusha District of CDR, that with the highest percentage where the Hammer rather than Sludge method has to be used, the percentage of area suitable for Sludge drilling is 58%.

In the project area as a whole the physical resource base for an expansion in STW irrigation is thus highly favourable. In the Project, priority will be given to the more than 300 VDCs in the High Potential Zone. Since, however, development will be demand-led, with VDCs or groups of VDCs putting in applications to join the Project, precise definition of priority areas can be no more than a prediction at this stage, rather than a confirmed plan.

TABLE 1

STW Irrigation Potential Area by districts in EDR and CDR

Region/ District	Total Terai area ('000 ha)	Terai cultivated area ('000 ha)	STW Feasible Areas[1]					Potential Areas for Intensive STW Development			Feasible Area for DTW Only[2]	
			Cat.III Sludge (Dhikuli) ('000 ha)	Cat. II Thokuwa (Hammer) ('000 ha)	Total Area ('000 ha)	% of Terai cultivated area	No. of VDCs	Area ('000 ha)	% of Terai cultivated Area	No. of VDCs	Area ('000 ha)	% of Terai cultivated area
CENTRAL												
Chitwan	189.9	43.4	9.4	3.8	13.2	30	11	13.2	30	11	11.3	26
Parsa	90.4	48.9	23.0	7.9	30.9	63	74	8.9	18	13	14.5	30
Bara	112.1	61.8	27.5	8.4	35.9	58	87	16.0	26	26	21.0	40
Rautahat	95.9	58.0	24.2	11.9	36.1	62	92	19.1	33	37	10.2	18
Sarlahi	108.8	74.6	34.4	12.8	47.2	63	76	24.9	33	49	21.1	28
Mahottari	83.2	61.7	33.5	4.5	38.0	62	62	10.2	17	12	6.1	10
Dhanusha	89.9	74.4	35.1	25.7	60.8	81	96	19.1	26	35	6.9	9
Total	770.2	422.8	187.1	75.0	262.1	60	498	118.8	29	183	91.1	23
EASTERN												
Siraha	95.0	79.3	41.5	18.0	59.5	75	95	18.8	24	30	12.0	15
Saptari	104.3	79.0	28.9	-	28.9	37	50	23.3	29	36	38.7	49
Sunsari	115.9	72.6	20.5	12.0	32.5	45	45	15.0	21	21	7.5	10
Morang	149.3	102.0	66	10.6	76.6	75	45	41.6	41	30	22.9	22
Jhapa	146.6	107.5	69.3	6.6	75.9	71	42	39.8	37	20	3.1	3
Total	611.1	440.4	226.2	47.2	273.4	62	277	138.5	30	137	84.2	19
OVERALL TOTAL	1,381.3	863.2	413.3	122.2	535.5	61	775	257.3	30	320	175.3	21

Note: [1] Area includes Potential Area for Intensive STW Development

[2] Includes some areas with watertables below >15 m, where DTWs may not be feasible.

26 **Existing Tubewell Numbers and Development:** In 1996 there were 27,968 STWs and only 209 DTWs in the Project area. Over threequarters of the STWs are private sector and, of these, approximately two thirds were funded by ADBN loans and one third were financed by the farmers themselves from informal sources. The precise number of group-owned STWs within the overall STW population is not known but is estimated to be about 2,000. Thus the concept of group STW irrigation is already well established. Thirty-one of the 445 STWs on the six sample sites are group wells (six of these have been installed recently by HMGN under the IFAD Community STW Irrigation Project).

27 Virtually all STWs are diesel-powered. The typical well is less than 20 to 30 m deep, has a 4 inch diameter, a mild steel, PVC or bamboo casing and screen without a gravel pack, and a discharge of 10 to 15 l/s. It is relatively crude but reliable. Typically capital cost is Rs 40 000-60 000, including the diesel pumpset. Annual utilisation rates are low, typically around 200 hours per annum, with an average command area of only 2 to 3 ha (group STWs, however, have larger command areas of 4 ha or so). Many farmers use their STWs more as a form of insurance against drought than as a means of maximising their farm incomes. Thus there is considerable unexploited potential amongst the existing tubewell population.

28 TW irrigation is used mainly for wheat and paddy and, to a lesser extent, sugarcane, vegetables and spring maize. Pulses and oilseeds often decline in importance once TW irrigation is introduced. In many areas spring paddy increases substantially and paddy double cropping is common. Boro (winter) paddy, a promising crop for TW irrigation, is not yet grown on any scale. In some areas where road communications are good and marketing is thus not a problem vegetables are an important irrigated crop.

29 Financial analyses made of STWs in this study and elsewhere have all shown high returns to STW farmers. Most of the numerous farmers interviewed in the sample sites STW survey expressed satisfaction with their investment. So far, however, the type of rapid STW take-off seen in other South Asian countries has not occurred in Nepal. Possible reasons include:

- The small size of land holdings and their fragmentation. In many areas (e.g. Phattepur VDC, where there are 110 individual STWs) most of the farmers who have sufficient land to justify installing their own well may well already have done so, demand for individual wells having therefore declined. In such areas group STW development, by enabling the smaller farmers to combine their land together to form command areas of sufficient size, may be the only means of accelerating STW expansion.

- Socio-economic factors, including many farmers' shortage of cash and their unwillingness to take the risks involved in STW investment and, with tenanted land, the difficulties of providing collateral for loans, the uncertainties of tenure and landowners' possible reluctance to make the investment when they have to share the benefits with their tenants.

- Despite the general high returns from STW irrigation, the inadequate returns obtained by some farmers and the absence of a really high return irrigated crop like boro rice which can be grown on a large scale. Boro has been the engine of STW growth in Bangladesh. A key factor here is whether soil, transport access and market conditions enable the farmers to grow higher return crops like spring rice, vegetables and sugar cane. Shortage of fertilisers may act as a constraint on irrigated crop yields in many places. Sandy soils in certain areas (e.g. Sharnamati, the Jhapa sample site) result in excessive infiltration losses and thus higher pumping costs.

- Despite the existence of STWs at all sample sites, a lack of information amongst many farmers as to STW installation, operation and maintenance and income-earning potential, how to go about obtaining loans from ADBN/SFDP, group formation and organisation etc. Many farmers interviewed expressed such problems. Lack of agricultural extension services was often mentioned.

- In some places (e.g. at Mrigauliya) problems experienced with unsatisfactory well performance or even failure has made farmers wary of installing STWs themselves. Groundwater and aquifer conditions vary considerably over even small distances (e.g. within a VDC ward), making STW development a more risky undertaking than might otherwise be thought.

- The present high levels of STW subsidy may, paradoxically, hold back expansion. Each year the subsidy budget is fully used, there being excess demand. Some farmers may delay installing STWs using alternative, unsubsidised, sources of funding if they feel that, by waiting, they may obtain a subsidised loan some time in the near future.

These problems are not insuperable. With its emphasis on social mobilisation, technology improvement, information dissemination and much stronger support and advisory services at the VDC level, the Project is expected to alleviate many of the above constraints and thereby bring about a major expansion in STW development.

30 **Existing Groundwater Irrigation Projects:** As part of the study a review was made of existing groundwater irrigation projects in the Terai. The main projects of possible direct relevance to the Project are the IFAD Community STW Irrigation Project and the World Bank - funded Irrigation Line of Credit (ILC) Project.

31 **The IFAD (CTWIP)** six year project started in 1995 and covers five districts of CDR and EDR (Rautahat, Sarlahi, Siraha, Saptari and Sunsari). It involves the construction of 800 group STWs, for handover to farmer groups, to irrigate a total of 4,800 ha in clusters of tubewells. Implementation is by the DOI's Groundwater Resources Development Project (GWRDP). All wells are machine-drilled. Other features of the IFAD project are as follows:

- The minimum permissible group size is seven members, there being no maximum. The overall average has been 12 to 13. Seventy-five percent of members must have holdings of less than 0.5 ha. Tenants as well as owner-cultivators can become members. The groups formed so far appear to be functioning satisfactorily.

- Command areas range from 6 ha to 8 ha; the target is 6 ha.

- For cost and logistical reasons the project aims to develop the STWs in clusters of 10 wells or more. So far, however, this has proved to be difficult to achieve, due to the scattered nature of the demand for wells from farmers.

- An irrigation distribution system is provided as a standard part of the STW package, with farmers being given a choice of open channel or buried pipe systems. Including pumphouse, the typical cost is Rs 250,000 to Rs 280,000. Taking an average command area of 7 ha, total capital costs per hectare, including the well, are high, at Rs 55,000 to 60,000.

32 Implementation progress has been somewhat behind target. As at March 1997, 149 wells had been drilled but there have been delays in pumpset procurement and only 54 distribution systems had been completed; i.e. no more than 54 wells are in full operation. Other problems have been the absence of the intended technical assistance from local consultants, due to procurement difficulties, and the fact that there has also been no NGO involvement so far. As a result, interaction with farmers has not been as thorough as intended and the necessary social mobilisation and preparation has been somewhat lacking.

33 **The ILC Project:** Like the IFAD Project, the groundwater component of the World Bank-funded ILC Project is based on group tubewells (in this case, both DTWs and STWs) installed in response to farmer demand, on a cluster basis to reduce costs. The project target is the irrigation of 14,202 ha in seven districts of the three western regions. Of the total of 527 TWs, 239 are to be STWs, 44 medium-deep TWs and 244 DTWs. Implementation is through four GWRDP Field Offices. The Project started in 1989 and, as of mid-1996, the area irrigated had reached 4,216 ha, 30% of the target, the implementation rate thus being about 600 ha per annum. Like the IFAD Project, therefore, implementation progress has been relatively slow. On the other hand, the project has been successful in developing and implementing group TW irrigation in a participatory manner, with farmer groups being built up on a sustainable basis. Limited data are available on project impact.

34 The DTW component of the Project will be based on the ILC DTW model, as regards technical as well as organisational aspects. The forthcoming World Bank-funded Nepal Irrigation Sector Project (NISP), due to start in 1997/98, will in effect be the follow-up project to ILC. Like the ILC, it will involve both surface water and groundwater irrigation. Apart from the Sunsari Morang Irrigation Project, it will be confined to the three western regions.

35 **Comparative Tubewell Costs:** Typical capital costs of alternative tubewell types and development modes are as follows :

Type/Mode	Rs/ha
ADBN diesel STW, 10-15 l/s, cost Rs 55,000	
• 4 ha command	13,750
• 2.5 ha command	22,000
IFAD STW, including distribution system on 7 ha	55-60,000
ILC DTW, including distribution system*	
• 29 ha command	50,600
• 63 ha command	38,170

* Figures from the ILC July 1996 Status Report.

The large capital cost advantage of the ADBN STW development mode is clear. For such small command areas a lined or buried pipe distribution system is not necessary. Moreover, its HMGN overhead costs are lower, because implementation is largely by the private sector.

36 **Performance and Impact of ADBN - Type STW Development:** A detailed assessment was made of the performance and benefits of group and individual STWs, based on the STW survey on the sample sites, the Shrestha/Uprety 1995 survey of 26 group wells and 17 individual wells in Mid- and Far-Western Terai, the Integrated Development Consultants Nepal 1996 Evaluation of the ADBN STW Programme in CDR and EDR and a December 1993 report by Consolidated Management Services Nepal (P) Ltd on eight ILC and eight ADBN STWs in two districts.

37 General conclusions from these surveys were as follows:

- Most group STWs were operating satisfactorily, without significant internal dissension.
- Average command areas of individual STWs were normally in the 2 to 3 ha range, whereas those of groups STWs were in the 3.3 to 5.9 ha range, and typically around 4 ha.
- The average number of members per group well was between 4 and 5.
- There was general satisfaction with the STW development amongst beneficiaries. The STWs themselves were considered to be reliable. Since the median age of the wells

was between 4 and 6 years the implication is that they have a reasonable length of working life.

- Lack of agricultural extension and other advisory and support services was a widespread complaint.

- Based on the respondents' answers, most groups and individuals were up to date with their loan repayments.

- Water selling is widespread, but more amongst individual well owners than groups (presumably because of their smaller command areas and thus greater spare capacity). Typical sales prices are Rs 50 - 60 / hour, including fuel. Most of the out-sale areas receive just occasional emergency irrigations rather than a regular supply. Many groups use the receipts from water sales as a fund to pay for repairs and maintenance.

- Many of the group wells, not just the individual wells, were funded by ADBN.

- Lastly, since they irrigate considerably more land, produce similar crop benefits per hectare and have many more beneficiaries per well, group STWs clearly outperform individual STWs in economic and social terms.

38 **Results from the Sample Sites STW Survey:** Since this survey covered a much larger sample, and in the Project area, more details of the results of this particular survey are given here. Particular findings not already covered above were as follows :

- The overall average command areas of the 26 group wells (excluding the IFAD wells) was 4.3 ha, compared with 2.8 ha for the 123 individual wells.

- 125 (84%) of the 149 STWs had their own pumpsets. Only at one site, Sharnamati (Jhapa District), was there a significant number of well owners without pumpsets.

- Two thirds of the individual well owners said that they would have installed their wells even if there had been no STW subsidy. It is, of course, impossible to check the veracity of this statement, but it is nevertheless encouraging.

- There were not large differences in agricultural performance between group and individual STWs. Cropping patterns and intensities and crop yields were broadly similar.

- Cropping patterns: STWs produce substantial crop area expansion benefits, principally in wheat and early rice, and in sugarcane where market opportunities exist. For analysis purposes the increase in annual cropping intensity resulting from STW development in CDR and EDR could be taken to be between 30% and 50%.

- Crop yield improvements resulting from STWs in CDR and EDR can be expected to be in the range of 0.7 to 0.9 t/ha for early paddy, rather less for main paddy and 0.4 to 0.6 t/ha for wheat.

39 **Bangladesh Experience:** Bangladesh is further advanced along the tubewell irrigation (TWI) development path than Nepal. Since there are considerable similarities in conditions between the two countries (e.g. a good alluvial aquifer, a rice-based farming system and small and fragmented holdings), there may be valuable lessons to be learned from Bangladesh experience. Particular findings from the review made were as follows :

- Bangladesh STWs have been extremely successful, with total STWs in operation reaching 223,000 by 1989. Major reasons for the greater success achieved in Bangladesh are the ability to grow boro paddy and, possibly, the slightly better well performance resulting from the somewhat higher technical specifications of the Bangladesh STWs (e.g. greater well depths) and the easier aquifer conditions.

- By contrast, the performance of the Bangladesh DTW sector has been much less impressive and DTW expansion has been severely hampered by low farmer demand; demand has now almost dried up. Farmers have been unwilling and/or unable to afford the higher DTW capital and pumpset maintenance costs, given the risks involved with the higher technology of force mode pumping and the practical difficulties in setting up and managing groups with the large numbers of farmers and large command areas required to make DTWs financially viable.

- Bangladesh experience clearly demonstrates that, where STWs are feasible, they can be expected to be a much more successful form of farmer-operated TWI than DTWs. The most important constraint on DTW success is the organisation and management difficulties inherent with large farmer groups. Frequent breakdowns due to engine and pump line shaft problems were another contributory factor.

- DTW water distribution in Bangladesh is by poorly constructed and maintained earth channels and water management is often disorganised, but farmers are considered to operate their unimproved systems quite well. They were found to be unwilling to finance improvements. Analysis showed that installation of buried pipe systems and lined channels was financially marginal, except where such systems can enable topographic obstacles to be bypassed and command areas thereby to be increased. Improvement of irrigation distribution was therefore not considered a high priority and improved systems should be confined to specific conditions (e.g. sandy soils) where they are clearly justified.

B Government Policies and Plans

40 The Government revised the Working Policies on Irrigation Development of 1988 by publishing the Irrigation Policy of 1992. The objectives of the new policy were to (i) carry out irrigation development in a cost-effective way that is also sustainable from the technical, financial, institutional and environmental perspectives; (ii) bring uniformity into the implementation process of all organisations involved in the irrigation sector; (iii) reduce Government involvement in the construction and O&M of irrigation schemes by involving beneficiary participation; (iv) strengthen farmers' WUAs to enable them to continue the O&M of improved FMISs; (v) continue reforming the institutional structure and management system of public agencies to increase the effectiveness and efficiency of government services involved in irrigation development; and (vi) increase research on irrigation technology and management.

41 The 1992 Irrigation Policy was amended in January 1997. The latter contains no major changes, but the STW subsidy rates have been rationalised so that a single rate, 80%, applies for both project (ILC, IFAD etc.) and other group STWs.

42 To guide the implementation of the Irrigation Policy of 1992, the Government has enacted the Water Resources Act, 2049 (1992) and the Water Resources Regulation, 2050 (1993). These actions have given WUAs the status of an autonomous and corporate body having perpetual succession, and have prioritised the utilisation of water resources such that irrigation is given second priority following the top priority, for drinking and domestic uses.

43 **The Nepal Agricultural Perspective Plan (APP),** finalised in 1995 and endorsed by the Bank, provides a sound and well-focused framework for future agricultural development. The Project has been designed to be consistent with APP policies and plans. The APP's main points which are of relevance to the Project can be summarised as follows:

- Four 'input priorities' are proposed, namely STW irrigation in the Terai, rural roads, fertilisers and the Technology system of research and extension. Apart from the first, which can be regarded as the core feature of the Project, rural roads development has been included, as well as strengthening of agricultural extension activities in support of tubewell irrigation. Farming systems research for intensive cropping systems for tubewell irrigation was regarded as a research priority. The Project includes provision for research and development in irrigated cropping. The forthcoming World Bank-funded Agricultural Research and Extension Project (AREP) could also make an important contribution here.

- Expansion of high value crop production (horticulture, sericulture, etc.) should be concentrated in the Hills, whereas in the Terai the priority must be to increase output of the basic food crops.

- Rural electrification on a large scale should be postponed to the second five year period of the APP, because of the shortage of generating capacity, but the Terai should be fully electrified in the subsequent 15 years (analyses made during the current study indicate, however, that, when full economic costs are applied, electric STW pumping is less economic than diesel pumping).

44 At present, HMGN provides large subsidies for STWs and DTWs (80% for group STWs, 40% for individual STWs and 90% for DTWs), and also for fertilisers, especially urea. There has been considerable discussion between HMGN and donors as to the affordability and desirability of such subsidies, and the STW subsidy question has been addressed in the current study. Currently, Government policy is to continue the subsidies at their present levels. Another policy matter concerns procurement of fertilisers, the importation of which is handled solely by the Agricultural Inputs Corporation (AIC). Fertiliser shortages, especially of urea, are a serious problem throughout Nepal and a major constraint on agricultural growth. Such factors can reduce farmers' returns and thus the attractiveness of tubewell irrigation.

C External Assistance to the Sector

45 The Bank and the World Bank (WB) have been the major external agencies providing assistance to Nepal's irrigation sector. Considerable assistance has also been provided by UNDP and USAID for institutional strengthening, and from other bilateral donors for equipment and specific grants. In the past, the Bank and the WB focused assistance on constructing medium- and large-scale irrigation schemes, but recently their assistance has shifted to include rehabilitation and construction of small-scale FMISs.

46 To deal with the large number of small-scale FMISs, a new 'sector lending' approach was required to replace the traditional project approach. The development of small- and medium-scale irrigation schemes including FMISs and STWs has been included in the Government's Irrigation Sector Programme. Under this programme, a more integrated approach to planning, design, and implementation has been adopted by DOI and a more flexible funding approach has been adopted by the external agencies. Both the Bank and WB have supported the sector lending approach since 1988, and there has been additional support from UNDP in the form of grants for institutional strengthening to DOI, and recently also from the Bank. While the Bank-financed Irrigation Sector Project (ISP) has supported the implementation of the Irrigation Sector Programme in the Central and Eastern Development Regions, the WB-financed Irrigation Line of Credit Project has focused its efforts on the three other development regions (Western, Mid-Western, and Far-Western Development Regions). This assistance has helped put in place the appropriate conditions for further sector lending programmes including (i) an established process of demand-driven irrigation sector planning, (ii) establishment of the Irrigation Policy of 1992 to guide irrigation sector programme development, and (iii) increased capacity of DOI for irrigation sector programme implementation. In the near future the World Bank Nepal Irrigation Sector Project (NISP),

the successor to the ILC Project, is expected to begin implementation. This will build on the experience gained with the ILC Project.

D Lessons Learned

47 Groundwater irrigation in the Terai has proved to be capable of giving high returns to investment and making a significant contribution to increasing economic growth and social welfare. Despite the fact that current STW utilisation and agricultural productivity are far below their potential, STWs, which use suction-mode pumping, clearly outperform force mode pumping-based tubewell irrigation (deep and medium tubewells (DTWs and MTWs)), due primarily to their much lower capital costs per hectare and their more rapid rate of implementation. In its September 1994 Impact Evaluation the Bank estimated that, despite their under-performance, investment in the basic ADBN-type STWs yielded positive rates of return ranging from 10% to 38%. Other analyses of STW returns all come to the same conclusion, namely that the ADBN-type private sector STW development gives attractive returns and outperforms other forms of groundwater irrigation development; hence the emphasis in the Agricultural Perspective Plan on this tubewell type.

48 Private sector-based groundwater development outperforms public sector-based groundwater development even where the latter involves STWs rather than DTWs / MTWs. Public sector STW projects, as exemplified by the IFAD-funded Community STW Project in CDR and EDR and the ILC Project in the three western regions, are characterised by high capital costs and relatively slow rates of implementation. Over the past four years ADBN has funded the installation of between 3,000 and 5,000 STWs per annum, irrigating, say, between 7,500 ha and 13,000 ha, with little public sector involvement other than the operation of the ADBN itself and the provision of the necessary funds for the STW subsidies. This is a much higher rate of implementation, in terms of the number of hectares brought under irrigation each year, than the total achieved by the public sector groundwater irrigation projects.

49 On the other hand, the great majority of the STWs are individually owned and, since small farmers do not have the collateral and other resources required for individual ownership, the direct benefits of the STWs go mainly to the better-off sections of the farming community. This is rarely the case with the public sector tubewells, which normally serve substantial blocks of land occupied by small as well as larger farmers. This drawback of the ADBN STW development mode can, however, be overcome if the STWs are group-owned rather than individually owned. No change in technology or costs is required. Group ADBN-type STWs, the focus of the project, can achieve the same social benefits as current public sector groundwater projects, but at a lower cost.

50 Previous Bank reports have identified a number of problems with previous Bank projects in the irrigation sector in Nepal, of which the following two are relevant to the current project:

(i) Relegation of concern with crop production to the post-construction phase, and inadequate attention to agricultural supporting services;

(ii) Government budgetary constraints.

51 In the December 1995 preparation report for the NISP the following points of importance were identified :

(i) Farmers need technical support and advice to enable them to exploit the opportunities for increased production which are created by new projects. Provision of the support services required has been inadequate in the past.

(ii) The DOI technical staff need continuous orientation on participatory irrigation development.

(iii) The role of Associate Organisers (these are the Social Mobilisers/Group Organisers employed directly by the ILC Project) needs to be revitalised or NGOs need to be employed to facilitate the participatory development process and to develop the capabilities of farmer organisations such as Water User Groups.

52 These lessons learned have been taken into account in the design of the current project wherever possible. Specifically :

- The Project includes the provision of agricultural extension and other technical support services to the VDCs involved in the Project. This will benefit both new STW groups and existing STW owners.

- Project costs include a generous provision for the contracting of NGOs to carry out the social mobilisation and farmer organisation activities required for the successful development of the group STWs and the limited number of DTWs to be installed.

- A participatory approach will be a key feature of Project implementation and the DOI staff involved will include sociologists/community development specialists and agriculturists/agricultural engineers as well as hydrogeologists and irrigation engineers. Training will be provided in participatory development; such training already forms part of DOI's regular training programme.

- With regard to public sector funding constraints, the tubewell development will be implemented by the private rather than public sector, except for the small number of DTWs, the public sector's role being essentially that of providing planning and support plus the tubewell subsidies. It is recognised that there is a danger of inadequate government funding for the STW subsidies.

E The Bank's Sectoral Strategy

53 The Bank's Country Operational Strategy for Nepal has identified poverty reduction as the major goal for Bank operations, because poverty is both extreme and widespread. Flowing from this, the Bank's sectoral objectives for agriculture in Nepal have been identified as (i) reducing poverty by generating income and employment for the rural poor, (ii) enhancing agricultural productivity and production in the Terai and accessible areas in the Hills, (iii) protecting the ecologically sensitive environment of the Hills and Mountains and promoting sustainable development, and (iv) reducing regional imbalances and promoting equitable incomes and access to resources. As noted above, the Bank has endorsed the Agricultural Perspective Plan.

54 In pursuit of its sectoral objectives, the Bank has identified a number of key strategic approaches to support, as follows: (i) income and employment-generating activities in the Hills to reduce poverty-induced degradation of the environment; (ii) rural road and irrigation infrastructure, particularly in support of small-scale FMISs and STWs, to increase productivity; (iii) liberalisation of trade and phasing out of import and export restrictions and of subsidies for fertiliser and credit; and (iv) capacity building to increase resource utilisation and productivity. Other identified strategic approaches relate to employment generation in rural areas, including the promotion of credit and support to small rural enterprises, privatisation of public sector enterprises, and support for community-based programmes for access roads and water supply as part of integrated rural development activities. Beneficiary participation in the design and implementation of all Bank-supported activities in the sector is an integral part of the Bank's strategy. In this context, the Project accords fully with the sectoral strategy and is consistent with the Bank's operational strategy for Nepal and the Government's Ninth Plan.

55 The forthcoming NISP will concentrate on surface and groundwater irrigation development in the three western regions while the Bank's ongoing Second Irrigation Sector Project (SISP) provides sector support in the other two regions, but only for surface irrigation. By introducing support to the groundwater irrigation sub-sector in these two regions, the Project will complement the efforts of the NISP and SISP. The Bank has provided long-term support to private STW development through its participation in six successive Agricultural Credit Projects, which provided funding and institutional strengthening to ADBN. Even though the Project will concentrate on group rather than individual STWs and will be based on a diversity of institutional credit sources rather than just ADBN it will still be continuing, in a somewhat different form, the Bank's long-term support to STW development in the Terai.

III THE PROJECT

A Rationale

56 With its generally fertile alluvial soils, favourable climate for double and even triple cropping and abundant high quality groundwater resources the Terai has excellent prospects for major increases in irrigated agricultural production. The scope for further expansion of cost-effective surface irrigation is limited by water resource and engineering constraints. Groundwater irrigation will therefore be the main engine of future growth in irrigated crop output. To feed Nepal's growing population and relieve its widespread poverty it is essential that this potential is exploited as fully and rapidly as possible.

57 Experience has shown that the ADBN-type STW offers a highly effective means of developing groundwater irrigation. At a cost of, at most, Rs 60,000 per well and a potential command area of 4 ha or more, it is the least expensive form of irrigation development. The typical 4 inch diameter STW has proved to be easy for private drillers to install and for farmers to operate. An extensive network of private drillers, pumpset suppliers and mechanics is available throughout the Terai. Credit for STW installation is provided through ADBN's well-developed branch network, although this caters mainly for individuals rather than groups; improvement of the credit system for group STWs will be an important Project objective. Being a largely private sector operation, the STW Sub-sector imposes few demands on the public sector, except for the provision of the subsidies on capital costs. With Nepal's growing population, markets for increased crop output from the Terai are readily available. Numerous analyses undertaken by the Bank and others have shown that, even at the currently modest levels of well utilisation and crop yield, STWs provide satisfactory financial and economic returns.

58 STWs thus offer excellent opportunities for agricultural growth and poverty reduction, as is recognised by the priority they are being accorded in HMGN's Agricultural Perspective Plan. Despite the favourable factors listed above, however, the sub-sector is operating at far below its potential in terms of STW numbers, utilisation and crop productivity. As yet, the STW 'take-off' experienced in other parts of South Asia has not taken place in Nepal. Given the fact that STWs are now found throughout the Terai, there is a surprising lack of technical knowledge and awareness about them amongst local farmers, as was found in the sample site studies. As yet, few small farmers have been able to enjoy the benefits of STW irrigation. They do not possess sufficient land and financial resources to install a well on their own and relatively little attention has been given to stimulating the group approach which is necessary to enable the smaller farmers to overcome the holding size constraint by combining together for joint STW ownership.

59 The Project will address the above issues by:

(a) Stimulating a major expansion of group-based groundwater irrigation through a programme of intensive social mobilisation activities amongst prospective STW group members in VDCs where physical and socio-economic conditions are suitable and the local farmers are enthusiastic. This will be supported by the necessary extension, credit and other services and by a selective programme of rural infrastructure improvement in the VDCs.

(b) Improving the performance and productivity of both new and existing STWs through a major strengthening of support services in the Project area and an ambitious programme of technology improvement and dissemination.

60 As at present, the STW development will be demand-driven and will be essentially a private sector activity. HMGN's role will be that of facilitation and support rather than direct implementation.

61 With its strong emphasis on group STW development and the provision of effective support services to the STW Sub-sector the Project is innovatory in character. Nevertheless, it has been designed on the basis of the results and achievements of the ADBN and SFDP shallow tubewell programme. Its technical, economic and financial feasibility has been determined on the basis of the feasibility studies made of the six sample site sub-projects. Between them, these represent the range of conditions prevailing in the large areas of the CDR and EDR which are suitable for STWs.

62 DTWs are recognised to be less economic than STWs and also involve direct implementation, rather than just facilitation, by HMGN. Nevertheless, there are substantial areas on the northern fringes of the Terai, in the Bhabar Zone, where the social need for irrigation is high and DTWs are the only feasible form of irrigation. A limited provision for DTW development in this zone has therefore been included in the Project.

63 A sector approach for the Project is justified because DOI has adequate capacity to execute and facilitate groundwater irrigation, as has been demonstrated by its successful implementation of the ILC Project and the IFAD Project (re-orientation of DOI groundwater staff towards a facilitating rather than implementing role will form part of the Project's activities). Through the Second Irrigation Sector Project (SISP) the Bank is already funding a surface irrigation sector project for CDR and EDR. There is considerable, and growing, NGO capacity available for the preparation of beneficiaries and the provision of assistance for the implementation of group STW development. Private sector capability in well installation and the supply of pumpsets and supporting services is adequate. Various sources of institutional credit are available, principally ADBN and SFDP but also increasing numbers of Saving and Credit Organisations (SCOs) and NGOs, and measures to improve rural finance services are due to be taken under the forthcoming Bank-supported Rural Finance Project. HMGN's polices and commitments are favourable for Project success and the Government has formulated, in the APP and Ninth Development Plan, a long-term

groundwater sector programme which is one of the four key elements for the rapid agricultural growth envisaged in the APP.

64 The Project's initiatives in group STW development, technology improvement, and the provision of effective supporting services to the private/group STW Sub-sector should have a demonstration effect extending beyond the two Project regions. In other Terai regions it could provide a model for future actions to stimulate private sector STW development. During the preparation study consultations were held with credit agencies, the private sector, intended beneficiaries, the government, NGOs and aid agencies. During the feasibility study for the project, two Participatory Planning Workshops - attended by farmers, VDC representatives, NGOs, Government officials, Bank staff and consultants - were held to discuss the Project. The results of the workshops have been incorporated in the design of the Project.

B Objectives and Scope

65 The Project's objectives are to (i) increase agricultural productivity on a sustainable basis and thereby (ii) improve the incomes of small farmers. These objectives will contribute to the achievement of HMGN's goals of reducing poverty and increasing employment in rural areas. It is intended that the Project will provide the catalyst for accelerated tubewell irrigation development in the 12 Terai districts of CDR and EDR. The total number of direct beneficiaries on the 60,000 ha to be developed for STW and DTW irrigation is estimated at 490,000 people in 82,000 households, a large proportion of whom have incomes below the National Planning Commission's official poverty line of Rs 4,140 per annum. In addition, other STW farmers should benefit from the dissemination of the technical improvements brought about by the Project.

66 To achieve these objectives, the Project will comprise the following four components:

(i) **Groundwater Irrigation Development**, involving the installation of 13,500 group STWs and 1,500 individual STWs, all of the simple ADBN type, in some 300 VDCs in those parts of the regions with high STW potential, plus the installation of 67 new DTWs and the rehabilitation of 33 existing DTWs in areas of no STW potential. The Groundwater Irrigation Component includes the mobilisation, preparation and training of farmer groups by NGOs contracted specifically for this purpose.

(ii) **Supportive Infrastructure Development,** comprising the improvement of rural access and village roads in the 300 VDCs in which the Project is expected to operate and the provision of a lump sum of Rs 227,000 (US$4,000) to each VDC for the improvement of social infrastructure and services. In view of its high cost, the roads improvement will be undertaken on a highly selective basis, to relieve obvious bottlenecks, the total programme covering an estimated 600 km of access roads and 240 km of village roads.

(iii) **Project Management and Groundwater Support Services,** Agricultural Extension services in the beneficiary VDCs, Monitoring and Evaluation and Technical Assistance (the Project Consultants) for Project implementation.

(iv) **Technology Improvement and Dissemination,** involving Agricultural and Irrigation Research to develop and implement a needs-based research programme, Engineering Research and Development, to improve STW and, to a lesser extent, force mode MTW drilling and design, two Technology Transfer Centres, one in each region, for the promotion and dissemination of the technology improvements generated, Technical Assistance (Technology Consultants) and Dissemination activities to farmers and the private sector through the media and other means.

1 Groundwater Irrigation Development

67 The tubewell development programme will be entirely demand-based, STWs being installed by farmer groups and individuals where they wish, provided that certain simple criteria (e.g. a minimum group STW command area of 4 ha in contiguous plots) are met and the farmers are prepared to meet their due share of the tubewell cost. To provide a focus and an appropriate field operating unit for the Project, implementation will be based on individual VDCs. VDCs, through their prospective STW farmers, will apply to join the programme and, if the application is accepted, the Project will then provide the staff and services required and, in collaboration with the VDC staff, the farmers, the credit agencies (where farmers are taking out loans) and the private sector contractors and suppliers, implementation will then begin.

68 To enable farmer-beneficiaries to participate actively in planning, designing and implementing and operating group STWs, the Project will support the establishment of GUGs (Groundwater User Groups). The Project will support the GUGs through training in administration, gender awareness, environmental concerns, construction quality, and O&M of the STWs. The Project will also assist the registration of the GUGs with the District Water Resources Committee to confer on them legal status and help write appropriate rules and regulations, including those relating to the democratic selection of office bearers from among the beneficiaries. These will be standardised to the extent appropriate. Women beneficiaries will be encouraged to be involved in the work of the GUG committees.

69 Suitable NGOs will be contracted to undertake and assist with, within each VDC, social mobilisation, GUG formation, training and monitoring, providing effective linkages with agricultural supporting services (credit, farm inputs, marketing etc) and stimulating the formation of further viable STW groups in addition to those already included in the VDC application. Wherever appropriate, farmer organisers (FOs) will be engaged under the NGO contracts to assist the work of the AOs. FOs will be recruited by the NGOs from among farmers of the same VDC where they will be expected to work. The training of GUG office bearers and members will be undertaken by trainers also to be included in the team of the

NGOs. In each VDC this development process is expected to take two years, after which the NGO Social Mobiliser, and also the agricultural extension worker, the JT, will be withdrawn.

70 Drilling, well installation and pumpset supply and maintenance support will be undertaken by existing private sector contractors and suppliers, who have adequate capacity to handle the increased demand resulting from the Project. Field investigations and interviews have shown that local drillers are fully aware of the methods and techniques available to improve well performance but are constrained from using them by the inadequate cost ceilings applied by ADBN for STW construction work and farmers' reluctance to pay the necessary additional sums to secure better well performance. Persuading STW farmers of the benefits of slightly more expensive wells will form part of the Project's extension activities, as will training and advice in pumpset maintenance. Pumpset maintenance and repair services are generally adequate, but the farmers themselves lack the necessary knowledge and skills required for routine day-to-day pumpset care.

71 In parallel with the NGO activities, strong efforts will be made to improve irrigated crop husbandry and water management through the posting of one JT to every two VDCs. Technical advice to farmers will also be provided by GWRDP groundwater and other staff, who will be given special training under the Project to enable them to fulfil this new role.

72 A limited provision has been made in the Project for individual STW development. Individual well owners would require little attention from the NGO staff but would benefit from the agricultural extension and other groundwater support services provided. Individual STWs will be developed under the existing ADBN credit and supervision system, except in those cases where the owner decides to finance the well himself.

73 The Groundwater Irrigation Development programme will start with the six sample site sub-projects in Year 1 and will then be progressively extended to the 300 priority VDCs which have been identified as having the highest STW potential. In the social assessment and mobilisation work carried out by NGOs on the six sites a total of 108 would-be STW groups had been identified by mid-March 1997, with a further 57 being identified between then and the end of April, making an overall total of 165 would-be groups so far. Their details are given in Annex A. Progress and achievements on these sub-projects will be closely monitored, to provide information and guidance for the subsequent more extensive Project groundwater activities. Given the demand-based nature of the Project, the precise number of VDCs to be included and the number of STWs which will be installed in each year cannot be predicted with certainty. A highly flexible, process project, approach, will be essential for Project implementation. Areas and VDCs which are considered to have good STW potential were identified in the Project Preparation study. Except for Chitwan District, where there are insufficient priority VDCs to justify a substantial Project involvement, all the CDR and EDR districts have substantial numbers of priority VDCs, the largest priority areas being located in Bara, Rautahat, Sarlahi and Dhanusha districts of CDR and Siraha,

Saptari, Morang and Jhapa districts of EDR. The total cultivated area in the 300 VDCs is some 230,000 ha.

74 The criteria which were applied in this initial selection of priority areas and should be applied during Project implementation include the following:

- By far the most important, the groundwater potential for STW irrigation. Criteria applied include a minimum STW yield of 10 l/s, as compared to the 6l/s minimum applied by ADBN at present, and minimum transmissibility usually of over 750 m^3/day, as compared with the normal 500 m^3/day. Watertable levels of well above the 5 m minimum in May-June should also be regarded as a major plus factor.

- The level of interest in and demand for group STW irrigation development, as far as this can be gauged. For example, a Groundwater Field Office (GFO) may have been receiving numerous and repeated requests for group STWs from certain parts of its districts, in which case their priority should be upgraded.

- Ease of access, in terms of road communications and travel time.

- Whether other projects, such as the Janakpur Agricultural Development Project (JADP), which include STW development, are active in the area. If so, priority would be somewhat reduced.

- The relative development need of the area in socio-economic terms, as far as this can be assessed.

Analysis has shown that areas should not be downgraded just because they are within DOI perennial irrigation schemes. Surface supplies in many parts of these schemes are not sufficiently reliable to justify excluding VDCs within them from Project STW development, as is demonstrated by the fact that existing STW numbers are high in many DOI command areas.

75 All STWs will be manually drilled using the existing cheap but effective Sludge (Dhikuli) or Hammer (Thokuwa) methods, according to local aquifer conditions. Most will be of the standard 4 inch diameter suction mode ADBN-type, with 5 to 8 HP diesel pumpsets, the total cost per well being Rs 50,000 to 60,000. Smaller (3 inch) wells may be installed by some farmers, although demand for these smaller wells has so far been low. A standard STW irrigated command of 4 ha has been taken for group wells, as compared with 2.8 ha for individual wells. With these small command areas, the simple earthen irrigation distribution systems used at present are perfectly adequate, although farmers will be encouraged to adopt simple, low cost, improvements. Since technical and economic analysis has shown that investment in more elaborate distribution systems (e.g. lined channels or buried pipes) would not be justified, they will not be included in the Project.

76 Assessment of existing STW technology has indicated that the existing standard STW is rugged and dependable but that there is scope for improvement. Specific measures to be encouraged under the Project will include: deeper well depths, an increase in screen length to 9 m, with a minimum 9 m to 12 m of blank casing, the use of PVC rather than mild steel or bamboo screen wherever possible, increased use of the more costly bogi/manual percussion drilling technique in areas which are too hard for the Thokuwa method, the increased use of the manual rotary method, with gravel packing, and a short formal completion test for all wells. More careful selection of slot size and better well development will also be promoted. Adoption of most of these improvements will, however, involve some increase in cost, in which case they are dependent on the farmers and the credit agencies being willing to pay slightly more for the wells. In places where watertable depth becomes a problem in the dry season the 'pitting' of STWs, as deepset STWs (DSSTWs), should become standard practice, as is the case throughout Bangladesh. Some Terai farmers are already using DSSTWs. Given the lack of knowledge of STWs amongst many farmers, an information pack for farmers will be prepared by the Project. As part of the Technology Improvement process, a low cost (US$ 20,000) machine bogi/percussion drilling rig will be purchased and tested.

77 Tubewell irrigation farmers are well aware of the choice of irrigated crops available to them, as determined by soils, marketing and other factors. Higher value crops like sugarcane and vegetables are grown wherever market conditions permit, as has been demonstrated on the sample sites. Paddy and wheat are by far the most widely grown crops and, given market prospects and circumstances, this is expected to continue in the future. Financial and economic analyses, and also farmer opinion from the sample sites, have demonstrated the profitability of irrigated paddy, especially spring paddy. Particular emphasis will be given to raising the yield of this and other crops and to encouraging the adoption of 'boro' paddy, if this crop proves to be widely suitable for the Project area.

78 Construction and rehabilitation of the 100 DTWs in the Project will be undertaken by DOI, which will employ private contractors for the purpose. The wells will then be handed over to the participating farmers, who will assume responsibility for their operation and maintenance. Technical specifications and administrative arrangements will be based on DOI's successful ILC Project model. Average command area will be only 25 ha, to facilitate effective farmer management. A lined distribution system will be installed. Estimated capital cost per DTW is just under Rs 2.0 million. The first three DTWs will be developed at the Bijalpura sample site Sub-Project.

2 Supportive Infrastructure Development

79 At a road density per cultivated area of 0.25 km/km^2 for all-weather roads and 0.395 km/km^2 for all classified roads, the CDR and EDR are relatively well-served in comparison with other, more mountainous, regions of Nepal. In general, accessibility to VDCs is reasonable. Nevertheless, from investigation of the internal road network of the sample site VDCs it is

clear that some investment could significantly assist in ensuring that farm productivity and marketing opportunities are optimised. The internal road networks of the VDCs are extensive (a density of 1.25 km/km^2 is not uncommon) and have been developed over many years by the farmers with only modest outside assistance. Principal access roads (to VDC headquarters) are often already largely built to gravel standards, ensuring all-weather access, although in some instances there are gaps where gravelling and culverts have not been provided or where lack of maintenance over the years has caused intermittent road failures. It would be desirable to ensure that such access roads are upgraded and maintained to all-weather standards.

80 The lowest standard of road in the network hierarchy is the VDC village road, or farm track. These roads are almost entirely constructed of earth (by the villagers themselves) and have very few properly installed culverts. The result is that they become impassible to vehicle traffic in the rainy season, particularly where there is a need for proper cross-drainage. Consequently, although once on the main access road journeys can proceed with relative case, during the monsoon season the initial (or final) stages of the journey can be impossible, or extremely difficult at best. It would not be financially possible to upgrade the many hundreds of miles of VDC village road to all-weather standards. However, by some modest investment in the provision of culverts where they are most needed, transport problems within the VDCs could be significantly alleviated.

81 Investigations in the six sample site VDCs and a wider examination of VDC access roads in the 300 VDCs indicated that investment in bringing to gravel standards an average of 0.5 km of access road per VDC, together with provision of an average of eight culverts per VDC on village roads and a few critically needed causeways on both access and village roads, will provide a significant improvement to the standard of the VDC road network at an acceptable cost. Improvement works in the 300 VDCs will cover a total of 619 km of access roads, together with the provision of about 70 culverts and 32 causeways, plus some 240 km of village road improvements associated with the provision of proper approaches to some 2,400 village road culverts. Estimated cost per VDC is Rs 2.18 million (US$ 38,000). Contractors will normally be employed for the access roads and the installation of the culverts, but self-help (people's participation) construction should be used for the earthworks approaches to the culverts. A condition of any such investment should be that steps are taken to ensure that the various beneficiary groups undertake the future maintenance of the roads.

82 The above proposals are based largely on detailed studies of the six sample sites. As these studies show, road improvement needs vary greatly from VDC to VDC. As part of the Project, therefore, an assessment of the access road and village improvement requirements of other priority VDCs will be carried out early in the implementation process.

83 The Village Advancement Sub-Component will involve the improvement of village social infrastructural facilities by the VDCs, to increase social welfare. Activities undertaken will

be on a demand-driven basis and will be based on a list of development needs prepared by the VDC. An informal needs assessment was carried out by the NGO Social Mobilisers at each of the six sample sites. Irrigation, roads, agricultural extension, credit and inputs, and electricity, rather than social facilities and services, were the items most frequently mentioned, but subsequent investigations identified other specific needs, mainly concerning education, health and drinking water supplies. The Project will contribute funds for such works in conjunction with VDC funds and beneficiary labour, the Project's contribution not to exceed 50% of the cost of any particular component. It should be noted that, in fact, HMGN, through the Ministry of Local Development, has a Self-Reliance Programme (formerly Self-Help Programme) under which each VDC receives an annual grant of Rs 500,000 for such activities. The Project contribution will be incremental to this. Usually the local beneficiaries are required to contribute between 25% to 40% of the total cost of any activity taken up by the VDC using such funds, which is normally almost entirely in the form of labour.

84 Rural electrification has not been included except for the provision made for electricity supply to some DTW clusters. Quite apart from the constraints imposed by the nation-wide shortage of generation capacity, a cost comparison of diesel and electric STW pumping, based on the two sample sites which already have electricity, showed that electric pumping is more expensive than diesel pumping in economic terms.

3 Groundwater Support Services

85 The role of NGOs in providing support to tubewell development is described in Section B1 above. DOI services and agricultural extension are the other two principal support services. Proposed credit arrangements are described in Section F3. As Executing Agency, DOI's role and responsibilities are detailed in Section F1 and will be concerned primarily with implementing the Project. Its staff will, however, provide extension advice in tubewell-related matters to drillers, STW farmers and others involved in groundwater development and will help to disseminate technology improvements generated by the Project.

86 Existing agricultural extension services in the Project area are weak. Of the many farmers interviewed in the STW sample survey carried out on the six sample sites, 95% had not had contact with an extension worker in 1996. A more effective extension service is essential for the improvement of tubewell irrigated agriculture. In addition to the provision of JTs for each Project VDC, each District Agricultural Development Office, and the respective Agricultural Service Centres (usually seven per District), will provide support as required. To ensure effectiveness, funds for the stationing of the JTs in the VDCs will be controlled by DOI. It is proposed that the four Groundwater Project Field Offices will provide a catalytic role in bringing research and extension staff together to address short- and long-term problems associated with irrigated agricultural production in the Terai. The proposed institutional arrangement will involve DOI, the Department of Agriculture and the National Agricultural Research Council (NARC) as the main organisations.

4 Technology Improvement and Dissemination

87 This Project component will concentrate on irrigated crop husbandry and tubewell drilling and design. Low-cost farmer-implemented improvements in STW irrigation distribution systems, such as better compaction of earth channels and trials of alternative channels lining materials, will also be investigated. Agricultural aspects to be covered will include:

- **Expansion of 'boro' (winter) rice cropping** in the Terai, the work to be undertaken including: mapping of the areas currently cropping winter rice; identification of potential areas for expanding production of winter rice; supporting study tours of research and extension staff to India and Bangladesh to study the boro production systems there; supporting farmer exchange visits in the Terai to sites which are being cropped with boro (e.g. Rangely, near Biratnagar); and research into selection of winter rice varieties with tolerance to cold at the seedling stage.

- **Fodder crops and fast-growing crops for firewood.** Provision of an alternative fuel source to cow dung would ensure that dung could be returned to the land rather than burnt. There is a scarcity of good fodder during March and April in the Terai. A leguminous fodder such as berseem, and forage oats, are possibilities. The current constraint to testing of these interventions is lack of seed. The Project will support the collection and distribution of seed for testing and follow this up with a programme to encourage farmers to multiply and save their own seed stocks.

- **Integrated pest management (IPM)** practices are not widely used in Nepal at present. The Project will specifically promote IPM during implementation, following the 'field school' model which has been successfully used in Indonesia.

- **Farmer-saved seed**: By adopting simple procedures, farmers are able to improve the quality and quantity of seed saved by themselves. The Project will support a farmer-saved seed programme, concentrating on the following aspects: sowing good quality seed; demarcating areas for seed production and introduction of the necessary isolation; removal of off-types and diseased plants (rogueing); prior to harvest, selection of plants with preferred characteristics; and post harvest, to select good quality seed, and clean, dry and store it separately from crops to be consumed.

88 Tubewell drilling and design aspects to be covered will include:

- **Tubewell Design Standards:** The minimum standards proposed for Project STWs will be reviewed during implementation to ensure that the expected gains in specific capacity, sand control and working life are being achieved. Some applied research is also required on the use of even longer screen lengths, different open areas with or without gravel packs and different screen materials. This applied research could be implemented by construction of up to 10 experimental STWs within 1 or 2 VDCs. The

experimental STWs would be built instead of standard Project STWs, provided that the group owners agree. The Project would then bear the cost of any special features of each STW and might have to bear the cost of eventual replacement with a standard STW.

- **STW Drilling:** The Project will investigate possible improvements in manual drilling methods and seek to disseminate these improvements to drillers. Improvement to existing technologies could cover areas such as the use of correctly formed drilling bits, uprated circulating pumps, parallel tube wash boring and different development techniques. The cost-effectiveness of uprating manual percussion rigs with a power winch or manual rotary rigs with a swivel should also be investigated. Innovative drilling techniques such as the use of a suction pump instead of the hand bailing method for sludge/Dhikuli could also be attempted. A machine Bogi/percussion rig will be purchased and tested for the installation of STWs in areas too bouldery for the Thokuwa or manual Bogi/percussion techniques. A tripod rig (Dando 1.5 tonne or similar) with cable clutch/hoist will be procured.

- **MTW Construction:** In the longer term, the scope for using force-mode pumps in 15 l/s to 30 l/s medium tubewells needs to be examined further. The objective will be to find ways of delivering an STW range of discharges in areas where the watertable is too deep for DSSTWs. These MTWs would be suitable for a small, easily managed, farmer group without incurring the huge jump in costs associated with the switch to an ILC-type MTW/DTW.

- **Pumpsets:** No medium-term investigation of STW pump design is proposed, but the use of electro-submersible pumps in both MTWs and DTWs should be investigated by evaluating performance in ILC/IFAD tubewells and Project tubewells. Key areas of concern are the time-to-failure given the fluctuations and transient voltages expected in electrical supplies on the Terai. Alternative forms of electrical control and protection systems should also be evaluated, since failure of electric motors is influenced strongly by these systems.

89 There is currently no specific mechanism which provides a focus for training and dissemination of technology relevant to increased agricultural production through groundwater irrigation in the Terai. The Project would therefore address this shortfall by establishing Technology Transfer Centres (TTCs) at the two existing Groundwater Field Offices in Biratnager and Parwanipur. It is intended that the TTCs would provide a catalytic role in compiling existing technology in the fields of irrigation agronomy, water management, seed selection and storage and IPM, as well as improved drilling skills. In addition to these technical components, the TTCs would provide training on social mobilisation and credit facilitation.

90 A vital role of the TTCs will be in ensuring linkage with the following organisations: Department of Agriculture, National Agricultural Research Council (Tarahara in Eastern Terai and Parwanipur in Central Terai), NGOs and the credit agencies. The TTCs will also link closely with other training institutions within Nepal to facilitate sharing of materials and ideas. Special attention will be given to establishing contacts with the Regional Agricultural Training Centres (RATCs) of the Department of Agriculture in the EDR (Jhumka, Sunsari) and CDR (Janakpur, Dhanusa).

91 The establishment of the TTCs will involve the physical development of the sites and will then focus on clearly identifying the target training audience, their information needs and the most effective way of presenting the required information. The TTC will provide training at a number of different levels, firstly, as a means of training a cadre of trainers to support the technical and social mobilisation programmes, secondly, to provide in-service training to staff from the implementing agencies and, thirdly, to provide specific technical training and demonstrations to community groups.

Course Development and Approach

92 The course content will be based on a comprehensive training needs analysis and will concentrate on the practical aspects of groundwater technology transfer. The training needs analysis will be based on survey results from the sample sites and the targeted priority development areas. The courses will stress the importance of costing technology inputs and enabling farmers to choose from a menu of technology options. The successful field-based methods of community communication piloted by the IPM farmer field schools will be explored by the two TTCs. The course content will draw on available costed technology as well as proven methods for community organisation. Close linkages with the two Groundwater Field Offices nearby will ensure that up-to-date aspects of drilling technology are addressed and each of the two centres will be in close contact with the relevant NARC centres in Parwanipur and Tarahara for up-to-date information on crop technology. The TTCs will play an important role in bringing together available information and making this readily available not only though the training courses but through the range of media available, including radio and video.

C Technical Justification

93 During the design of the Project a number of technical alternatives were assessed and compared, including: the scope for 'high value' crops under tubewell irrigation, especially with regard to market prospects and marketing; linked with this, alternative crops and cropping patterns; the feasibility of STW electrification; alternative sizes of STW; alternative irrigation distribution and application technologies; and the 'conjunctive use question', whether lower priority should be given under the Project to areas within DOI surface irrigation schemes;

94 **Crop market prospects and marketing:** Detailed studies were undertaken, including field studies in and around the six sample site VDCs, the conclusions reached being follows:

- With a national deficit of some 1 million tonnes per annum and Nepal's rising population, market prospects for rice are good. Wheat, the other major irrigated foodgrain, also has reasonable market prospects;

- Sugarcane has good prospects in those areas within easy reach of the two regions' five sugar mills. A new sugar factory being built near Biratnagar offers attractive prospects for expansion of irrigated sugarcane in that area.

- The market for vegetables and potatoes produced under tubewell irrigation in the Terai will certainly grow, but the scope for a major expansion in the project area in general are limited. The problem is that the opportunities for taking advantage of the market for summer vegetables, which is the attractive market, are limited by climatic constraints, the Terai summer being too hot for the most popular types of vegetable. Indian vegetable production is low cost, so there are only limited opportunities for export to India. Winter vegetables already often suffer from over-production and market gluts in the April to July period.

- The suggestion has been made that off-season production of vegetables could be an attractive proposition for tubewell irrigators in the Terai. Off-season production by small farmers who cannot invest in high cost facilities such as glasshouses depends essentially on growing seasons (climatic conditions) in the area being substantially different from those in other producing areas, so that local farmers can produce vegetables when other areas cannot. Off-season vegetable production opportunities are already being exploited in the Terai (e.g. at the Mahottari sample site) with the export of vegetables to the Kathmandu market in those months when they cannot be produced in the Kathmandu region. There is, however, little possibility of off-season vegetable exports to the other main potential market, India, because the climatic conditions (growing seasons) there are so similar to those in the Terai. As noted in the APP, it is the Hills rather than the Terai where the major opportunities for increased production of high value crops like off-season vegetables lie.

- In conclusion, therefore, the market for non-staple food crops and 'high value' crops is not sufficient to support any major departure from the present paddy-based farming system used for tubewell irrigation. It should be noted, however, that the two most widespread high value crops, sugarcane and vegetables, are already grown in those places where marketing and agronomic conditions permit. For example, sugarcane is grown on a significant scale on three of the six sample sites (Sedhawa, Phattepur and Bijalpura), and will soon start to be produced at Mrigauliya, to supply the new sugar factory near Biratnagar, and potatoes and/or vegetables are also grown on a

significant scale, though less so than sugarcane, at three sample sites (Bijalpura, Phattepur and Mrigauliya).

- In overall terms, the existing marketing system in the rural Terai is considered to function satisfactorily. This was the opinion of the sample site farmers. It was also confirmed by the farmers who attended the study's Second Workshop. This is not say, however, that farmers do not experience difficulties selling their produce at satisfactory prices, only that the constraints lie principally not in the marketing system itself but in other factors, above all the transport problems in certain areas resulting from inadequate rural roads. This was the major marketing constraint reported in the Project area. Even then, it affects mainly the perishable crops like vegetables and sugar cane rather than the staple food and cash crops like cereals, oilseeds and pulses.

95 **Alternative Crops and Cropping Patterns:** Analysis was made of the financial and economic returns for major tubewell irrigated crops for two productivity levels, Present Performance, based on the productivity levels being achieved by STW farmers at present, and the other being an Improved Performance scenario, whereby, as a result of Project activities, there is an increase in productivity over present levels. The input and output data are those for the Project Area Representative STW Model. The main conclusions from the comparison of the various crops were the following:

(i) At present irrigated yield levels paddy, sugarcane and potatoes/vegetables all give satisfactory financial returns, with paddy giving the highest returns to labour, whereas wheat and early maize are significantly less profitable. This conclusion mirrors the view of many Terai farmers, early paddy being a particularly popular crop under irrigation. In economic terms paddy gives the best returns, higher than sugarcane or potatoes/vegetables, because of its high import parity price (import substitution value). The same conclusions hold true at Improved Performance levels, those which are expected to be achieved under the Project in the future, except that, with the increased yields, potatoes/vegetables become the most profitable crop in terms of financial returns per hectare.

(ii) It is sometimes thought that the adoption of high value crops is necessary for the expansion of STW irrigation in the Terai. The high returns obtainable from irrigated paddy (including supplementary irrigation of monsoon paddy) indicate that this is not the case, and the farmers' opinions expressed on the sample sites and elsewhere confirm this. Moreover, as discussed above, the market for non-staple food crops and 'high value' crops is not sufficient to support any major departure from the present paddy-based farming system used for tubewell irrigation.

(iii) With regard to this point about high value crops, it should be noted that the massive development of tubewell irrigation that has taken place in South Asia in the last 30 years has been based on the major field crops of the region (wheat, cotton and rice)

rather than more specialised high value crops. Due to the relatively low costs of shallow tubewell irrigation, the returns from such 'broad acre' crops are quite sufficient to make investment in tubewells highly attractive. Analyses made of the returns from STWs at the sample sites support this conclusion. Probably the single most important cropping innovation which would stimulate STW expansion in the Terai would be the widespread adoption of boro paddy. Boro paddy has started to be grown in certain parts of the Eastern Development Region. Testing and, hopefully, expansion of boro paddy growing will be one of the main activities of the Project's Technology Improvement and Dissemination component.

(iv) The above conclusions are supported by the results of the analysis of financial and economic returns per hectare of TW-irrigated land, and the financial returns per labour day, from alternative cropping patterns at Improved Performance levels. Returns from cropping patterns with above average proportions of sugarcane or vegetables would be similar to those from cropping patterns with a high proportion of rice.

96 **Diesel Versus Electric Pumping for STWs:** An analysis was made of the costs of electrifying all the expected new STWs (60 and 55 respectively) at the Mrigauliya and Phattepur sample sites, the two sites which already have electricity. The average capital cost per STW was calculated to be Rs 163,000 and Rs 165,000 respectively, very largely for the electricity distribution system. Taking account also of the respective capital and O&M costs per STW of electric and diesel pumpsets, the cost of the electric option in present value terms at a 10% discount rate was calculated to be nearly three times the cost of the diesel option.

97 The economic cost of electricity in Nepal is estimated by WECS to be about Rs2.88/kWh, little different from the financial cost used in the above analysis. However, NEA (Nepal Electricity Authority) quotes a long-run marginal economic cost of Rs 5.20/kWh for irrigation, which would make electric drives economically extremely unattractive.

98 **Alternative Sizes of Shallow Tubewell:** The standard STW in the Terai is the ADBN-type 4 inch (100 mm) well equipped with a 7 to 8 BHP, or sometimes 5 BHP, diesel pumpset; where the farmer does not wish to use his diesel engine for other tasks like wheat threshing the 5 BHP size is perfectly adequate. For smaller command areas it might be desirable to use smaller STWs. Alternative designs for 3 inch (10 l/s) and 2 inch (4.3 l/s) wells have therefore been prepared and a cost comparison has been made. This has been based on diesel power rather than electricity, because electricity for TW connections is not widely available. The minimum size of diesel pumpset available is 3.5 BHP.

99 The analysis shows that, at typical existing low rates of STW pumpage and a discount rate of 10%, the cost per m^3 pumped is Rs 1.15 for a 4 inch well, Rs 1.25 for a 3 inch well and Rs 2.14 for a 2 inch well. Although this smallest size is clearly uneconomic, the 3 inch well is not much more expensive than the 4 inch well in terms of cost per m^3 delivered, and may

have potential for farmers with limited command areas. ADBN already has available for farmers the smaller pumpsets of the 3 inch size analysed above, although uptake by farmers has been low so far. Under the Project the choice of pumpset size will continue to be the farmer's. The important point is to ensure that farmers are aware of the selection available.

100 **The Conjunctive Use Issue:** It could be argued that areas which are within DOI irrigation schemes should be given a lower priority, even if they are of high STW potential. This is because the STW benefits in such areas may be reduced by the fact that the potential STW areas already receive perennial irrigation supplies. However, this approach is not considered to be justifiable, for the following reasons:

- The reliability of irrigation supplies on the existing DOI surface schemes is variable. For example, many parts of the CDR and EDR schemes do not have reliable supplies throughout the winter season, and very little land has adequate supplies for spring rice, one of the most profitable irrigated crops. Thus, economic benefits from STWs installed in such areas can still be high, as the analysis made of the Project Area Conjunctive Use STW Model shows.

- Moreover, even in those schemes with better supplies, irrigation distribution within the schemes is very often unsatisfactory, especially in the tail reaches.

- The validity of the above argument is demonstrated by the fact that existing STW numbers are substantial in many of the DOI command areas.

101 **Alternative Irrigation Distribution and Applications Technology:** Although the most common irrigation distribution system used in the Project area is that of earthen channels, several alternatives are also in use, promoted by projects such as the IFAD Community STW Irrigation project. These alternatives, including masonry-lined channels and buried pipe systems, are more expensive than earthen channels but improve water distribution efficiencies. An analysis was undertaken to determine whether these alternative systems should be promoted by the Project. The main conclusions were:

- the farmer-constructed earthen channels are the most appropriate (technically and economically) for the Project, although minor improvements could be made, such as better compaction of embankments and the stopping up of animal burrows;

- masonry-lined channels and buried pipe systems are unjustified economically;

- trials should be undertaken with cheap alternatives, such as plastic lining and truncated precast concrete pipe;

- the use of a canvas hosepipe looks promising, and was tested on two sample sites. It allows flexibility in the layout of the tubewell and distribution system and overcomes

the problem of channels taking up valuable agricultural land. The knowledge of this technique should be disseminated to farmers. However, given the cost of the hosepipe, it is likely that it will only be adopted by farmers in selected circumstances.

102 The study concluded that, for STWs, no subsidies should be given for distribution systems and that the construction of these systems should be left to the farmers, although the Project would provide guidance (through the agricultural extension workers) about channel layout. With DTWs, on the other hand, the Project would support the currently accepted ILC practice of providing a lined channel system.

103 With regard to irrigation application technology, the study found that the farmers are using the most appropriate technique, namely surface basins and furrows. However, they need to be trained in how to maximise the efficiency and timing of irrigation application. Sprinkler and drip irrigation systems were investigated but were found to be entirely inappropriate for use within the Project, from both a technical and economic point of view.

D Cost Estimates

104 Over the seven year implementation period the total cost of the Project, including contingencies, is estimated at Rs 3,370 million (US$ 59.4 million), including the farmer-financed portions (part of the tubewell costs). The local and foreign exchange portions of the total are estimated to be Rs 2,001 million (US$ 35.3 million) and Rs 1,370 million (US$ 24.1 million) respectively. Taxes and duties are estimated to comprise about Rs 231 million (US$ 4.1 million), or 12% of the total. Table 2 summarises the Project costs and Annex A gives more details.

TABLE 2

Summary of Project Costs (Rs million)

Project Component	Foreign Exchange Cost	Local Cost	Total Cost
Groundwater Irrigation Development	707	594	1,301
Supportive Infrastructure Development	103	685	788
Project Management and Groundwater Services	217	261	478
Technology Improvement and Dissemination	91	70	161
Total Base Cost:	1,118	1,610	2,728
Physical Contingencies	107	170	277
Price Contingencies	144	221	365
Total Project Cost	1,369	2,001	3,370

E Financing Plan

105 A summary of the financing plan for the Project is given in Table 3. It is proposed that the Bank will provide a loan equivalent to US$ 44.53 million, comprising the foreign exchange cost of US$ 24.13 million and local costs of US$ 20.40 million. HMGN would finance the equivalent of US$ 9.63 million, most of which would be for tubewell subsidies, apart from the duties and taxes of US$ 4.07 million. The farmers' contribution would be US$ 5.22 million, this being their share of the tubewell capital costs.

TABLE 3

Summary of the Proposed Financing Plan ('000 US$)

Financier	Foreign Exchange Cost	Local Cost	Total Cost	%
Bank Loan	24,133	20,401	44,534	75
HMGN	-	9,628	9,628	16
Farmers	-	5,244	5,224	9
Total :	24,133	35,253	59,386	100
%	40.6	59.4	100.0	

F Implementation Arrangements and Schedule

1 Project Components and Activities

106 In operational terms Project activities can be divided into two, the Tubewell Irrigation Development Component and the Technology Improvement and Dissemination Component. In broad terms, the main activities within the first component, which strongly focuses on group STWs, will be:

- selection and approval of the VDCs wishing to participate in the Project;
- formation and development of STW groups;
- provision of credit for STW installation;
- installation of STWs;
- agricultural extension and STW training;
- DTW implementation;
- rural roads improvements;
- other village infrastructure improvement;
- monitoring and evaluation.

Under the second component, the main activities will be:

- technology improvement;
- technology dissemination;
- co-ordination.

107 Since the Project will be demand rather than supply-driven, it will be implemented on the basis of a participatory and bottom-up approach. The function of the Executing Agency (DOI) and the other organisations involved will be to respond to these demands as efficiently as possible. VDCs will apply to the Executing Agency to participate in the Project, for the development of group STWs and, where justified, supportive infrastructure. A brief description of the sequence of operations at the field level (i.e. development activities in the VDCs) is given in the following sections, because the project organisational set-up must be formulated so as to meet the requirements of the field implementation programme. The implementation programme is applicable for the sample site VDCs as well as the main Project VDCs.

2 Activities Under the Tubewell Irrigation Development Component

(a) Selection of VDCs For Inclusion in the Project

108 A staged process will be followed for inclusion of VDCs as sub-projects. The essential requirements are that there should be a real demand for group shallow tubewells from the VDC and that implementation should be technically feasible. In addition, there should be an agency through which credit can be provided locally. The sequence of operations for the development of **group STWs**, the core Project activity, in the VDCs is given below (DTW development is discussed separately):

(i) Details of the Project will be published in the Project area, especially in the priority or target areas discussed in Section III, by means of radio and written material and through the DOI and the GWRDP Field Offices (GFOs) and staff. The publicity will include details of the Project scope and objectives, what it has to offer to participating farmers (the beneficiaries) and how VDCs should apply to 'join' the Project. Standard applications forms will be distributed to the GFOs, the District Irrigation Offices (DIOs) and the proposed District Groundwater Development Units (DGDUs - these will be set up under the Project) offices, from where they can be collected by VDC staff and farmers.

(ii) The team from the DGDU will make 2 or 3 visits over a 2 month period to publicise the Project, answer any queries, and encourage group formation. Where possible, this team will include the Social Mobiliser or STW group members from adjacent VDCs where group STWs have already been installed under the Project.

(iii) Interested groups will apply for STWs through the VDC; no formal application is required at this stage, but applicants must name the members of the group and give details of their land holdings and request assistance from the Project.

(iv) Once at least 15 farmer groups have expressed interest to the VDC, a VDC wishing to join the Project will send in its application form to the respective DGDU, or, if necessary, through their respective DIO if the VDC is far from the nearest Field Office.

(v) The DGDU concerned would screen the application, in the light of their knowledge of the area and other factors, as an initial check to ensure that the VDC was worth considering for implementation, before initiating the next step in the process.

(vi) If the screening results are positive, a brief feasibility study will then be undertaken by the consulting firm which is providing technical assistance to the Project, on behalf of the DGDU. It would include an assessment of the technical, social and economic feasibility of the proposed group STW development and a costed plan in sufficient detail to provide a sound basis for the funding of the STWs and of any necessary supporting infrastructure (e.g. rural roads) required.

(vii) If, on the basis of the feasibility study, the DGDU considers that the VDC should be included in the Project, it would then be submitted for approval to the existing District Appraisal Committees (DACs) which have been set up under the ADB-funded Irrigation Sector Project (now the Second Irrigation Sector Project). Their membership would be expanded to include the necessary groundwater expertise, from the respective GWRDP Field Office.

(viii) Once approved by the DAC, implementation would begin as described below.

(b) Formation and Development of STW Groups

109 The following stages would be involved in the formation and development of STW groups:

(i) The contracting of an NGO to carry out the necessary social mobilisation and group formation and organisation work. The NGO would provide one Social Mobiliser (SM) per VDC for a period of two years.

(ii) Social mobilisation by the NGO, helping the farmers to form the STW user groups (STWUGs). The role of the SM during this step would include helping with initial group formation, preparing the group's constitution, assisting with the registration of groups. These activities would be carried out for batches of STWUGs, say 15 at a time.

(iii) As part of the preparation process, raising the future STW farmers' level of awareness and knowledge about group functioning, access to credit, and tubewell irrigation. The SM will arrange for initial training, which will mostly be carried out within the VDC in the form of workshops, but may draw on the facilities at the Technology Transfer Centres and include visits to other, successful, STW groups.

(iv) Making arrangements, with the help of the NGO staff, for credit provision for those groups which wish to finance their STWs by loans.

(v) Arrangements will also be made, again with NGO assistance, for the provision of other supporting services required at the VDC level. These could include, for example, agricultural extension, and technical assistance in pumpset operation and maintenance.

(vi) Encourage the formation of a Groundwater Development Committee under the VDC (to provide links between STWUGs and the Project, drillers, service providers, etc);

(vii) provide links between STWUGs and the Project (DGDU).

(c) Installation of STWs

110 There are two options for the procurement and installation of STWs: first, centralised procurement, whereby the Project procures STWs and pumpsets on behalf of the groups in a VDC; and, second, the groups do this themselves, with assistance from the NGO staff if necessary. For the reasons given in Appendix 18, centralised procurement is not recommended. Instead, the groups would procure the STW goods and services directly from the private sector suppliers, as with the present ADBN system. Drillers and suppliers will be prequalified through the GFO, using the existing ADBN lists as the starting point.

111 The installation of STWs will be the responsibility of the STWUG, but the Social Mobiliser will provide support and liaison, together with the DGDU, credit agencies, drillers, suppliers etc. as required. The various stages would be as follows:

(i) the DGDU will issue coupons to the STWUG group leader for the subsidy element for drilling, well materials and pumpset supply;

(ii) from the approved list of drillers and suppliers the STWUG will then select their preferred drillers and suppliers and request them to provide the goods and services required.

(iii) the driller will sink a pilot hole first, to check that the proposed position of the STW will produce the minimum yield necessary (it is proposed that this is raised from the present 6 l/s to 10 l/s), and to select the drilling method, so that he can propose the

required STW design. If the pilot hole fails, the STWUG will have to pay for it (approximately Rs 2,000). However, if the pilot hole is successful, the driller will then become liable should the STW not produce the water yield required;

(iv) the driller will then drill the main borehole, install the screen/casing, undertake well development, and then carry out the acceptance testing, which will include yield, sand content and dynamic water level;

(v) After the well has been drilled and the pumpset installed to the group's satisfaction, the group will hand over the coupons to the respective suppliers, who will then present them to the DOI (probably the proposed District Groundwater Development Unit) and receive reimbursement. The Group will also pay the balance of costs from their own funds.

112 Inspection and monitoring by DOI would be essential for the proper administration of this system, just as it is with the present ADBN system. Apart from the initial feasibility assessment, key tasks will include spot checks on wells at the time they are being commissioned, to ensure that their specifications and performance are adequate, and subsequent spot checks, for monitoring and follow-up purposes, especially to ensure that the pumpsets and/or well materials have not been removed for sale or ineligible uses elsewhere. Appropriate rules, legally enforceable, should be drawn up by HMGN before implementation begins.

(d) Agricultural Extension and STW Training

113 In additional to the NGO staff, a DOA extension worker (JT) would be stationed in the VDC (one JT for every 2 VDCs) during the implementation period and technical advice on STWs would be provided by GWRDP staff on a periodic basis. The JTs will be supported by the NGOs and local consultants contracted by the Project. Normally the length of time from start of implementation until when the STW development is completed and has attained a stable and sustainable basis, so that the Project can withdraw from the VDC, would be two years. In practice, it may be found that the process can be completed in less than two years.

114 Specific Project activities will be to:

- produce a set of training materials for extension staff based on existing recommendations;
- produce farmer training materials for use by extension staff at the DVC level. The messages would be supported by a range of media initiatives (radio, television and signboards);

- assign a JT or JTA to a VDC, one JT for 2 VDCs over 2 years. The JT would be resident in the VDC, to ensure maximum contact with the farmers;

- establish farmer field schools on the use of IPM through NARC and DOA in areas of high concentration of pesticide use, following the model that has already been piloted;

- undertake farmer saved seed programmes at the VDC level.

115 Technical advice to farmers on the operation and maintenance of their STW will be provided by the DGDU, who will liaise with the farmers through the SM and JT.

(e) DTW Implementation

116 For the DTWs the implementation process will be somewhat different because there will be a greater public sector (GWRDP) role. Given the higher level of technology involved (force mode pumping, and much larger wells) and the much larger command areas; the GWRDP will be directly involved in well and irrigation distribution design and construction, and also in well siting. In the case of well rehabilitation, of course, this will be particularly true, because these are owned by GWRDP. Given this situation, for DTWs the basic unit for field operations will be the DTW cluster rather than the VDC, especially as the DTWs will be in non-STW feasible (deeper watertable) areas. There will thus be very few VDCs with a mixture of STWs and DTWs. Bijalpura, one of the six sample sites, is one exception. DTW implementation will follow the well-proven system developed for the ILC DTWs. It will still be demand-driven, but the need to cluster does introduce a supply-driven element into the system, with the need to find several would-be DTW groups within a reasonable distance of each other.

(f) Rural Roads Improvements

117 The VDC Groundwater Development Committee (GDC) will be responsible for planning road improvements, with the assistance of the MLD District Engineer and the District Engineering Cell (DEC). The Social Mobiliser will help farmer groups participating in the Project to articulate their views and needs. The activities will involve:

(a) the Groundwater Development Committee of the VDC will make preliminary lists of the access and village road improvements which they consider are necessary;

(b) a feasibility study will be carried out by the DEC, or the Project Consultants, during which time the villagers will be helped to prioritise the works proposed within budgetary constraints. The DEC will liaise with other road improvements being carried out under the District roads programme;

(c) designs, costing and necessary documentation will be carried out by the DEC/ Project Consultants. Standard designs and proformae from the Project will be used.

(d) The road improvements will be implemented. The DEC will assist in deciding on the works to be done and planning the method of implementation. The most likely methods to be used will be either a 'user contract' by the GDC, or through a local petty contractor. The DGDU will supervise the works in conjunction with the GDC.

(g) Other Village Infrastructure Improvements

118 A fund has been provided for general village advancement activities which are not necessarily related to the STW installation. It is proposed that groups of women whose husbands are members of STWUGs should form a separate group to decide how the fund will be spent. The group will be encouraged to spend the money on village infrastructure improvements. It is proposed that the Project and the beneficiaries should each contribute 50% of the costs of such activities.

(h) Institutions Involved

119 The principal organisations which will be directly involved in the activities described above include the following:

- DOI, including the Groundwater Irrigation Division and the District Irrigation Offices (DIOs);
- GWRDP;
- DOA;
- Credit agencies such as the Small Farmer Development Programme (SFDP) and its privatised SFCLs (Small Farmers Co-operative Limited), ADBN and new rural finance institutions;
- The selected NGOs;
- Private drillers and pumpset suppliers.

120 Other institutions involved, though less intensively, will include the District Development Committees and their District Engineering Cells, and the Ministry of Local Development (MLD), with regard to rural roads and village infrastructure improvements, the Agricultural Inputs Corporation (AIC), for fertiliser, seeds and other inputs, and the Nepal Electricity Authority (NEA), for tubewell electrification.

3 The Technology Improvement and Dissemination Component

121 The institutions responsible for the Technology Improvement and Dissemination activities described in Section III B4 would be the National Agricultural Research Council (NARC), the DOA, the Research and Technology Development Section of DOI's Irrigation

Management Division and the GWRDP itself. The research and development activities would primarily be carried out at the two existing research stations at Parwanipur (Bara District) and Tarahara (Morang District). The Project would establish Technology Transfer Centres (TTCs) at the two existing Groundwater Field Offices in Biratnagar and Parwanipur. These would ensure effective linkage with the DOA, NARC, NGOs and RATCs and maintain close links with the Project;

Co-ordination

122 A national-level workshop involving DOI/DOA and NARC would be held once each year to review progress and finalise the content and budget for the following year's programme, based on district level research and extension requirements. The workshop would be held well before the end of the financial year (July) to enable recommendations to be incorporated into the overall budgets and workplans of DOI, DOA and NARC. Regional-level workshops would be held on a seasonal basis (Summer and Winter) to present findings and to plan for the coming season. These workshops would be timed so that recommendations and programmes would be forwarded to the national co-ordination workshop.

4 Organisational Structure

(a) Structure and Responsibilities

123 The Project's proposed organisational structure is shown in the Project Organisation Chart at the back of this Main Report. DOI will be the executing agency and GWRDP the implementing agency. The organisational structure will, as far as possible, be based on existing institutions and units, creation of new units being kept to a minimum. The executing agency for the Project will be the **Department of Irrigation** (DOI), under the Ministry of Water Resources. DOI will have overall responsibility for supervision, implementation, co-ordination, and monitoring and evaluation of Project activities. At DOI headquarters the **Groundwater Irrigation Division** (GID), under its Deputy Director-General, will be the Division responsible for the Project. It will establish a **Project Implementation Unit**, which will run the Project through the four existing GWRDP Groundwater Field Offices. Since the Project covers two rather than only one Region, it is suggested that the PIU should be located in the DOI headquarters, or elsewhere in Kathmandu, rather than in the Terai. To ensure adequate co-ordination at the central level between the principal agencies involved (DOI, DOA, NARC, the credit agencies etc) a **Project Co-ordination Committee** will be set up, with the DDG of the GID as Chairman and the Project Co-ordinator as Secretary. A consulting firm will be employed to provide the technical assistance required for project implementation (the **Project Consultants**).

124 A **Monitoring and Evaluation Unit** will be set up within the Project Implementation Unit, staffed by a full-time Monitoring Officer and an assistant. All professional staff working on the implementation of the project will be involved in monitoring to some degree, in order that the information required can be supplied by those who are most in contact with events in the field.

125 Close liaison will be maintained between the two Project components (the Tubewell Irrigation Development Component and the Technology Improvement and Dissemination Component), under the direction of the Project Co-ordinator. This will ensure that technology improvements are disseminated rapidly to STW users, drillers and others and feedback from these customers is passed back to the originators of the improvements.

(i) Tubewell Irrigation Development Component

126 Day-to-day management of the Tubewell Irrigation Development Component, which is by far the larger of the two project components, will lie with the four **Groundwater Field Offices** (GFOs). They will liaise closely with the Regional and District DOA units, with the District Appraisal Committees, the DDCs and the District and Regional Offices of other line agencies. In addition to their management functions, the GFO technical staff will be responsible for providing technical advice and support in tubewell and groundwater-related matters to tubewell users, drillers, pumpset suppliers and mechanics, in cooperation with the DGDU technical staff. This extension function will be a new role for the GFO and DGDU staff, but they are the best equipped, by training and expertise, to undertake it.

127 In all districts where there is a substantial level of VDC STW development Project activity temporary **District Groundwater Development Units** (DGDUs) will be set up at the district level under the control of the GFO. They will be located in the districts and will be responsible for implementing Project activities at the sub-project (VDC) level.

128 In each participating VDC a **Groundwater Development Committee** will be set up within the main VDC Committee, to facilitate effective liaison between the STW groups, the Project and the service providers, working especially through the NGO Social Mobiliser.

129 **NGOs** will be contracted by the Project to provide one Social Mobiliser per VDC, normally for a period of two years, backed up by a mobile team of three specialists per 10 VDCs, comprising a Community Development Specialist, an Agriculturist with irrigation experience and a Credit / Finance Specialist. Contracts with NGOs will be awarded by the Project on a 'term basis'; ie. they will be awarded a contract for social mobilisation in a certain number of VDCs, but the actual VDC names and start dates will be variable and will only be decided as VDCs are approved by the DAC. The Project will provide standard information packs to each NGO staff member and will provide short training to them. The NGOs' responsibilities will include:

- Helping build up the STW user groups on a sound footing;
- Promoting the expansion of group STWs amongst other interested farmers;
- Helping the farmers to articulate their needs for assistance;
- Providing effective linkages between the STW groups and the main service agencies and suppliers, including credit agencies, the DOA, input suppliers, pumpset suppliers and mechanics, and drillers;
- In the case of the Agriculturist, promoting the adoption of improved agricultural and irrigation practices and technology;
- Assisting with the benefit monitoring and evaluation work when required.

130 The social mobilisation and other tasks to be undertaken by NGOs will place a substantial burden on the available NGO capacity, with NGO staff (the Social Mobilisers plus the 3 person support teams) operating in up to 100 VDCs in any one year from Year 3 onwards. Peak NGO staff requirements would thus be 100 SMs and 30 mobile team specialists. It is envisaged that national rather than international NGOs will be used. Probably the largest of these is CEAPRED, which successfully carried out the social mobilisation work on the three CDR sample sites. With over 140 staff and seven ongoing major projects CEAPRED has substantial capacity for the type of work required for the Project and can undertake large-scale assignments. For example, it is currently running a National Forestry Survey for IFPRI, with 15 supervisors with 5-7 enumerators each. For major assignments such as the CGWISP, CEAPRED operate partially on a decentralised basis, by setting up regional project offices. Another major suitable NGO is SAPPROS, which has 40 plus staff and operates in similar fields to CEAPRED. Given the fact that there will be at least a two-year build up to full Project activity, NGO capability and capacity is not considered likely to be a future constraint on Project implementation, provided that an early start is made on identifying suitable NGOs and helping them to get prepared for their intended role and activities in the Project. Given the wide geographical spread of the 12 Project districts and the scale of staffing involved, separation of the NGO work into at least three contracts would be desirable.

131 In the case of group STWs, the **Beneficiaries** will be required to form a **Shallow Tubewell User Group (STWUG)** under the standard legal arrangements specified for Water Users Associations under the Water Resources Act and its regulations. Ultimately the beneficiaries carry the responsibility for installing and operating the STWs and DTWs – the Project will only provide assistance in response to requests from the farmers.

132 As noted above, approval for the entry of a VDC into the programme will rest with the **District Appraisal Committees.** For Project activities (as opposed to the Second Irrigation Sector Project surface irrigation activities) the Chief of the respective GFO will chair Project-related meetings.

133 Apart from linkages with their VDCs, the **District Development Committees** (DDC), through their District Engineering Cells, will be involved in the design and construction supervision of access and village roads, as noted above.

134 The **Agricultural Extension Services** will be provided by JTs and JTAs from the Department of Agriculture. DOA will be involved in project coordination meetings at National, Regional and District levels. Key DOA staff will also receive training at the proposed Technology Transfer centres.

135 Private **STW Drillers and Pumpset Suppliers** will have particular responsibility for providing tubewells which meet the improved STW specification that the Project will require. Failure to meet this specification will result in them being removed from the list of approved Project suppliers.

136 During the initial stages of the Project the main role of the **Credit Agencies** will be in providing loans for production inputs, in the same way that they do as present. Should the STW subsidy levels be reduced, and the credit requirements be increased as a result, the credit agencies will play a more significant role in the Project's initial stages.

(ii) Technology Improvement and Dissemination Component

137 The **National Agricultural Research Council** (NARC) will carry out the irrigated agriculture research and development, with assistance where necessary from the Research and Technology Section of DOI's Irrigation Management Division, and GWRDP will be responsible for technology improvement in drilling and tubewell design. International and local consultants (the '**Technology Consultants**') will play an important role in the technology development process. The Project will make use of two existing **Regional Agricultural Research Stations.** The national rice research station is located at Parwanipur near Birgunj and it is proposed that the whole programme would be co-ordinated through Parwanipur, which would also have special responsibility for the CDR. Conveniently, the Groundwater Field Office at Birgunj is located on the same site as the rice research centre at Parwanipur. Tarahara Research Farm, based in the Eastern Region north of Biratnagar, would be responsible for the EDR programme and would be supported by the Biratnagar Groundwater Field Office. As noted above, the Project will support the dissemination of technologies to support irrigated crop production and improve STW technologies through the establishment of training courses at two new **Technology Transfer Centres**, in the CDR (Parwanipur) and the EDR (Biratnagar).

(b) Project Staffing

138 Excluding NGO staff, the Project will require at its peak 31 professional technical staff, one Accounts Officer, 23 sub-professional technical staff, four Accounts Assistants and the necessary lower grade support staff. This large requirement of staff is based on the assumption that there will be a strong demand for group STWs from all 12 districts in the region and that the Project tubewell development programme will operate in approximately 300 VDCs so at least 19 of the professional staff are assumed to be hydrogeologists. At present DOI has a total of 34 hydrogeologists. Fortunately, the Project staff numbers will not reach their full complement until Year 4, so there is time to take the necessary measures to ensure that adequate staff are available. Eleven of the 19 hydrogeologists would be the Officers-in-Charge of the 11 DGDUs. Provided that adequate technical back-up is available from the four GFOs, it is not essential that the Officers-in-Charge are hydrogeologists. Some could instead be DOI irrigation engineers - their training and experience are such that, with the necessary initial Project orientation, training and supervision, irrigation engineers could run the DGDUs. Since there are many more irrigation engineers than hydrogeologists in Nepal, this would overcome any potential staff availability problem.

5 Selection Criteria for VDC Sub-Projects and STW Groups

139 Selection of VDCs for inclusion in the Project will be based on the following criteria:

(i) The number of proposed group STWs included in the VDC's application is at least 15, with an average command area of at least 4 ha each. Substantial numbers of requests can be expected to be received only at a later stage, after the first few group STWs have been brought successfully into operation and doubts about their viability amongst local farmers have been allayed, the final number of group wells thus being well above the number in the initial application.

(ii) Groundwater conditions must be favourable for STWs, as evidenced by there being a substantial number of existing STWs in the VDC (these will usually be largely individually owned). Existing STWs are also a source of project benefit, in that they will usually have considerable potential for improved performance and productivity.

(iii) The agricultural potential, especially in terms of soils, is favourable.

(iv) The VDC farmers are willing to mobilise and contribute resources (cash, labour or in kind) for the implementation of accompanying project activities such as rural roads improvement.

(v) The potential group members are willing to form formal Groundwater User Groups for each STW and enter into the necessary agreement with the District Groundwater Development Unit for implementation.

(vi) The VDC has adequate access to markets, credit agencies, input suppliers and other essential services.

(vii) Each proposed group STW is institutionally, technically and economically feasible and is estimated to give an economic internal rate of return of at least 15%.

(viii) The VDC sub-project is environmentally sound and poses no direct and indirect threat to ecologically sensitive areas or to assets of high historical, archaeological, cultural or aesthetic value.

Group Selection Criteria

140 The aims of the criteria for group selection are to ensure that the programme reaches its intended beneficiaries and that the groups function well. In order to ensure maximum agricultural impact but also that the maximum number of potential beneficiaries derive benefit from the project, the criteria should be more liberal than those of the IFAD Community STW Irrigation Project. Proposed criteria are as follows:

(i) The group size should be more than two and the irrigable area should be at least 4 ha.

(ii) Priority should be given to areas where there is demand from small and marginal farmers. Each farmer should have a maximum of 1 ha within the proposed STW command area.

(iii) The land proposed for STW irrigation should be in contiguous plots.

(iv) The extent of the would-be members' knowledge and understanding of group activities.

(v) The scope for intensive farming - two crops or more per annum.

In order to avoid the problem of 'fake' groups, the VDC Groundwater Development Committee should carefully scrutinise each application before recommending it for inclusion in the programme.

6 Credit and Cost Sharing Arrangements

141 Under the current 1992 Irrigation Policy, amended in 1997, group STWs receive a subsidy of 80% (recently raised from 75%) of investment costs, for the drilling, well materials and pumpset. For individual STWs the subsidy is 40% and for DTWs it is 90%. In the case of

STWs the subsidy is only payable through ADBN / SFDP and this is not received by farmers who do not take out a loan. Project total estimated STW capital costs are Rs 853 million but, at current subsidy levels, Rs 646 million of this would be met by HMGN as subsidies, the balance which might require to be funded by credit thus being Rs 207 million.

142 Credit provision for the Project must be considered within the context of credit supply for the agricultural sector as a whole. Rural credit in Nepal is now in a period of change, with major developments occurring or planned in the diversification of financial markets, the growth of micro-finance and savings and credit schemes, privatisation of the SFDP, and a continuing tightening up of the financial management of the ADBN. A Rural Finance Project is being launched, with the assistance of the Bank, which is due to commission a Project Preparation Technical Assistance (PPTA) in late 1997. The NGO Financial Intermediary Act is due soon. In the past few years there has been a spectacular expansion in the number of savings and credit groups (Savings and Credit Organisations (SCOs)) and a resultant greater diversity of rural credit sources. Formulation of detailed credit proposals for the Project is thus subject to an unavoidable degree of uncertainty stemming from the changes that can be expected to take place in the near future. At this stage, therefore, a particular concern is with credit supply for the first two years or so, before the changes take effect.

143 **Group STWs credit demand:** For a typical group installing a well and pumpset and with, say, five members and 4 ha, the 20% balance to be funded by members would be Rs 12,000, or Rs 2,400 per member. With this relatively low level of investment required, it is probable that most groups could, in fact, finance their 20% share of the STW themselves, without needing to take out a loan. Experience with the Micro-Credit for Rural Women, Production Credit for Rural Women, IFAD Community STW Irrigation and ILC projects, and with rural Savings and Credit Organisations, has demonstrated that many farm households are capable for raising such sums from their own resources if they really wish to. As an example, in a written application received in March 1997 from the Bijalpura VDC, for development of 40 group STWs, the applicants clearly stated that they were willing to do this. Doing so has the major advantage of their not having to go through the administrative process of taking out a loan. A substantial proportion of the IFAD Project groups have also taken up this option. Raising the necessary cash may be a problem for the smaller farmers, but, on the other hand, the smaller their land holding in the proposed STW command, the less money they have to raise. It is therefore unlikely that, at the current high level of group STW subsidies, a substantial amount of credit will be required for STW group loans. Since suitable institutions to handle such loans are not at present operating in many parts of the Project area, the Project will make every effort to encourage groups to fund their 20% share themselves.

144 This situation will, however, prevail only while the current high subsidy rates prevail. Once they are reduced, group STW credit requirements will become very much greater.

145 **Individual STWs credit demand:** Due to the lower subsidy rate, demand for loans from farmers installing individual STWs is likely to be higher than that for group wells. With a typical required investment, net of subsidy, of Rs 24,000 to Rs 36,000 most such farmers can be expected to wish to take out loans. A well-established system for individual STW credit already exists, in the form of the ADBN. Numerous individual STW owners do, however, fund their wells themselves. In the STW survey carried out at the six sample sites, 29% were found to have done so.

146 **Deep Tubewells credit demand:** After deducting the 90% subsidy contribution, the net cost of a typical new DTW is Rs 200,000 or, say, Rs 8,000/ha. A typical DTW farmer with a holding of, say, 0.8 ha, would have to contribute Rs 6,400. In addition, participating farmers in the ILC and IFAD projects are also required to make an up-front 'earnest payment' equivalent to 0.5% of the total cost in cash. This is counted as part of their 10% contribution. This total sum is too much for a small farmer with only 0.8 ha to raise from his own resources. However, in the ILC Project this problem is usually overcome to a large extent by the group members providing much of their contribution in the form of labour for construction of the irrigation distribution system and other tasks. Where this labour contribution is not sufficient to pay the farmer's contribution there is provision for the farmers to take out ADBN loans to fund the balance. A similar system could be adopted for the Project deep tubewells. Often, however, the farmers manage to avoid taking out a loan through a combination of raising cash from their own resources and providing the labour contribution.

147 **Potential Sources of STW financing:** Potential institutional sources of STW credit include the following:

(i) Individual STWs: ADBN
Commercial banks

(ii) Group STWs: SFDP and its privatised SFCLs (Small Farmer Cooperative Limited)
Commercial banks
NGOs and the Grameen Banks
Micro-Credit institutions, principally SCOs

148 **Agricultural Development Bank of Nepal:** Since its establishment, ADBN has been the chief provider of credit to the agricultural sector, especially for STWs, and has a well-established network of branches throughout the Project area. This comprises four Supervision and Control Offices, four Main Branches, 22 Branches, 10 Sub-Branch Offices and two Regional Training Centres. All parts of the CDR and EDR with STW potential are within 15 to 20 km of an ADBN branch or office of some kind. On average, one branch office covers 15 to 20 VDCs. The bank also has a significant technical capacity in the STW field, as part of its inspection and supervisory role, although this has tended to be reduced

in recent years, as part of the drive to reduce non-banking costs and improve financial performance. ADBN has a well-tested and workable STW loans procedure. Although there are shortcomings, the overall view of the many STW owners interviewed in the STW sample survey was that the system works satisfactorily. Two thirds of borrowers were granted their loans within two weeks of application and only 8% had to wait more than one month.

149 For each of the six sample sites, an assessment was made of the staffing and facilities at the nearest ADBN outlet. It was concluded that five of the six offices were well staffed and could handle an increased volume of lending. This was less true of the respective SFDP offices (SFDP is run by ADBN and handles group lending only).

150 In terms of coverage and capability, ADBN could undoubtedly supply the individual STW credit required under the Project. It also provides group STW loans, where one member is willing to take out the loan in his name. There is, however, considerable concern, especially from the Bank, about ADBN's financial performance, particularly with regard to inadequate loan recovery. In 1990/91 this was only 32.4%. Since then, however, the Bank's loan recovery rate, and other indicators of financial performance, have improved markedly. The present recovery rate is reported to be 62%. This still, of course, leaves 38% unrecovered, or at least overdue. A February 1996 ADB report concerning the Third SFDP and Sixth Agricultural Credit Projects provides an excellent summary of ADBN's financial performance and demonstrates the substantial improvements which have been made.

151 ADBN strongly contends that loan recovery rates with STW lending are well above its overall average recovery rate. In order to assess the validity of this assertion, an analysis was made of the loan disbursement, collection and loan recovery records for STW lending for the 12 Project Districts from 1993/94 to 1995/96, using data provided by ADBN. The loan repayment ratios quoted were based on the former ADBN method of measuring loan recovery rates, whereby only the principal, not the interest, is considered. The conclusions are as follows:

(i) At 71 to 72%, STW loan recovery rates in the 12 Districts as a whole do, indeed, appear to be well above the overall average for ADBN loans (62%, under the new method of calculating loan recovery rates). This difference is somewhat more marked for the country as a whole, the STW loan recovery in the three years being 74% to 77%;

(ii) Though clearly still well below the level necessary to guarantee financial sustainability, STW loan recovery rates are considered to be sufficent to suggest that, with some further improvements in efficiency and loan recovery, ADBN's STW lending operations could be brought up to a financially viable level. Certainly, given ADBN's other merits, it would seem inadvisable to exclude it from participation in CGWISP lending operations on the basis of its overall STW loan recovery rates of 71 to 72% in the Project area;

(iii) There are substantial differences in STW loan recovery rates between districts, with Chitwan, and also Morang, consistently performing best and Siraha being the worst performer by a considerable margin. The differences between individual ADBN branches are, however, much greater than those between districts. Such differences could be taken into account when assigning priorities to different parts of the Project area in the implementation programme.

152 Thus the data that are available do support ADBN's contention that the STW loan recovery performance is significantly better than the overall average. Given the fact that ADBN's general financial management and loan recovery is improving, and its extensive branch coverage and lending capability in the Project area, the Consultants consider that it should be involved in STW credit provision under the Project.

153 **The Small Farmer Development Programme:** SFDP is a separate unit within ADBN which, through Sub-Project Offices, and their Group Organisers, works with VDCs in encouraging small farmers (generally, farmers with less than 0.5 ha and an annual income of less than Rs 2,500) and the landless to formulate community income generating schemes and socially valuable undertakings. In the 11 years that SFDP has been involved in irrigation development in eastern and central Terai, it has assisted in the installation of more than 1,700 STWs in seven districts. In theory, collateral is not required on loans, group guarantees of repayment being used but, in practice, most SFDP loans are now collateralised. Under the ADBN Act moveable assets (e.g. pumpsets) are not acceptable as collateral. On the whole, SFDP's loan application and disbursement procedures are adequate but, like ADBN, its loan recovery rates have not been satisfactory. There are 100 SFDP offices in the Project Area, covering 144 VDCs, including 13 privatised SFCLs. Thus its coverage is only partial, unlike ADBN's.

154 The process of privatising some SFDP Sub-Project Offices began only in 1993/94, in Dhading District, with GTZ assistance; the process is now accelerating. SPOs are converted into registered cooperatives under the Cooperatives Act. So far, the programme has been relatively successful. At present, SFCL funds come from members' own savings and from ADBN loans. In future, funding may also be obtained from the commercial banks. Many SFDPs and SFCLs in fact have substantial sums of savings. There are now 34 SFCLs in operation in the country as a whole, including 13 in the Project area. A further 76 existing SFDP Sub-Project Offices have been selected for conversion into SFCLs, of which 30 are in the Project area. One of these, Gothgaun, is in Mrigauliya sample site.

155 **Commercial Banks:** The Nepal Bank Limited (NBL) and Rastra Banijya Bank (RBB) have numerous branches in the Project area, with 62 NBL branches and 40 RBB branches. Many are involved in rural banking through the Intensive Banking Programme (NBL 56, RBB 39), the Production Credit for Rural Women Project (NBL 10, RBB 4) and the Micro-Credit for Women Project (NBL 1, RBB 1). Despite this, the commercial banks are essentially urban-biased and no examples of their lending for STWs were found during the study. Their main

role in credit provision in the Project is likely to be that of providing funds for programmes such as PCRW and MCW, if these become involved in STW financing. If they were to do so, the commercial banks' extensive branch network provides a good basis for their operations in the Project districts.

156 **Grameen Bank Nepal, Biratnagar:** Modelled on the well-known phenomenon of small-scale banking and credit in Bangladesh, two regional Grameen banks were established in Nepal in 1992. Both were created under the initiative of the Nepal Rastra Bank (the Central Bank), which holds 58½% of the total share capital of each (of about Rs 67 million). There are seven area offices and 32 unit (branch) offices in the five EDR Terai districts, covering 188 VDCs in late 1996 and with about 29,500 female borrowers taking group credit. At present, Grameen lends only short term (up to one year) and only to women in households with less than one bigha (0.67 ha) of land. Maximum loan size at present is Rs 15,000. Loan recovery rates are reported to be virtually 100%.

157 In February 1997 the Consultants were given to understand that Grameen would not be involved in lending operations for the Project. Despite this, at the Second Workshop, held at Biratnagar in mid-March 1997, the Grameen representative said that the Bank might well be willing to give medium-term loans of up to Rs 100,000 for STWs. This possibility will need to be explored further in the early stages of the Project, because Grameen could be a useful source of group STW credit for the EDR. Under a sub-contract with the Consultants Grameen successfully carried out the social mobilisation and related activities undertaken on the three EDR sample sites as part of the Project Preparation Study.

158 **The Micro-Credit for Women and Production Credit for Rural Women Projects:** The Production Credit for Rural Women (PCRW) Project, which comes under the Ministry of Local Development, has been in operation for 14 years and covers 67 districts. Its target group is the Below Poverty level, women with an annual income of below Rs 2,511 and a land holding not exceeding 0.5 ha. It provides medium- as well as short-term loans, the maximum being Rs 30,000. No collateral is required.

159 The Micro-Credit for Rural Women Project, which is supported by the Bank, started 2½ years ago. So far it has lent some US$ 1.2 million and covers 12 districts, including three in the Project area (Chitwan, Siraha and Saptari). It provides micro-credit loans of up to Rs 40,000, medium term as well as short term, for micro-enterprises. No collateral is required. Small Business Loans (Rs 50,000 to Rs 250,000) are also made, but these are collateratised. Like the PCRW Project, the MCW Project is based on groups. Each group member borrows individually, as with the SFDP, on a group collateral basis. Loan recovery performance has been excellent, at virtually 100%. Group development, with literacy training, health and other activities, is a key part of the package. Saving is a required part of group activity. NGOs play a major role in project execution. Funding comes from the NRB and is channelled through NBL and RBB, mainly the former, with a spread of interest rates sufficient to provide adequate margins.

160 The MCW-type group saving and lending operation provides one potential model for group STW lending in the future. STW-orientated saving and lending groups would, however, involve men rather than only women, and men are generally considered to be poorer credit risks than women. At present, virtually no suitable group credit operations of this type for group STW lending are in existence but, if developed successfully, they could begin to play a useful role after, say, the first 2 to 3 years of the Project.

161 **Other Savings and Credit Organisations:** Most voluntary NGOs are engaged in social and welfare projects at village level and do not engage in savings and credit operations. SCOs are essentially cooperatives registered under the Cooperatives Act. Most do only short-term lending (6 to 12 months), although a few also provide medium-term credit. Many are unregistered, are not subject to supervision or regulation, and are limited in their activities by their restricted geographical coverage. Few would be suitable to act as financial intermediaries for STW loans at present, but with the rapid growth of SCOs and the forthcoming NGO Financial Intermediary Act there may be more of a role for them in the future.

162 There are two major drawbacks with the **SFDP**. First, many would-be STW groups and group members would be ineligible, because their members' farm holding sizes and per capita incomes are too high. Second, with only 144 VDCs covered in the 12 districts, its existing geographical coverage is insufficient to reach many of the VDCs which have promising potential for group STW development. Thus, the SFDP is not envisaged as a major credit provider under the Project, although in certain VDCs it can play a role.

163 Although their development is still in its initial stages, **SFCLs** are a promising source of group STW credit. Being self-governing, as members' co-operatives, they will be able to set their eligibility criteria as they think fit. Those covering VDCs in the Project's Priority Areas can be encouraged to set these so as not to exclude genuine group STWs, where farmers' incomes or holding sizes are above SFDP maxima, especially given the fact that loan recovery rates for STWs are generally better than for agricultural lending as a whole. However, there are at present only four existing SFCLs available to provide group STW loans under the Project, with a further nine in the pipeline. Given the limited coverage of SFDP offices in the area, SFCLs founded from handed-over SFDP offices will only ever cover a minority of the Project VDCs. If this type of organisation is to become the major source of group STW credit, many new SFCL-type units will need to be created. These could be Savings and Credit Organisations, with a strong NGO involvement. Formation of such groups will be a major component of the new rural finance development programme which is now evolving.

164 As noted above, if they really are willing to change their procedures so to provide medium-term loans for group STWs, these groups containing men as well as women, **Grameen Bank Biratnagar** could be a useful credit source, as could its Central Development Region

counterpart, CRRDB. As the number of NGOs providing credit expands, numerous other NGOs could also be involved.

165 **ADBN** is not considered to be a major source of group STW credit but, as described above, can provide loans where a member of the group is willing to take the loan in his name. There is no reason why this should not be done in the cases where it arises.

166 The best option however, for the immediate future (at least the first two years of the Project), while the very high 80% group STW subsidy remains in force, is **self-financing by group members.**

167 Given the range of credit sources available, the differences in their availability between different parts of the Project area and the likelihood of substantial changes in the rural finance sector in the near future, a flexible approach to credit provision for group STWs should be adopted for the Project, with a variety of sources being used. Within this overall strategy, a two phase STW financing arrangement for the Project is proposed, as follows:

Phase 1 (while the subsidy remains at 80% or not far below): Primarily self-financing by group members, although members could take out loans from SFCLs, Grameen Bank, ADBN and other appropriate organisations if they so wish.

Phase 2 (after the subsidy is reduced): SFCLs and other savings and credit organisations, ADBN, NGO credit agencies where available.

168 At present, the subsidy element of the STW cost is channelled to beneficiaries through the lending agency (ADBN/SFDP) and is not available to farmers unless they take loans from the agencies. To enable groups, and also individuals, to still receive the subsidy even when they finance their share of STW cost themselves, the Department of Irrigation (DOI) will act as the channel for the subsidy funds for those cases where loans are not being provided. Details of the administrative arrangements for this proposed system are given in Appendix 18. Essentially, DOI will adopt the present ADBN system, with the use of coupons, lists of approved suppliers and inspection procedures.

169 **Credit for Individual STWs:** The commercial banks are not considered likely to be a significant source of individual STW credit. It is proposed that ADBN should continue to provide the individual STW loans required. With its large financial resources, extensive branch network and long experience in this field, ADBN is clearly the organisation with the absorptive capacity and administrative and technical capacity to fulfil this role. Every effort should, however, be made to encourage would-be STW owners to fund their STW development themselves. An important step in achieving this aim will be the introduction of the facility for them to obtain the 40% STW subsidy from DOI, rather than having to take out an ADBN loan to secure it.

170 **Credit for the Six Sample Site Sub-Projects :** Implementation of these sub-projects will start soon. Thus, credit arrangements, if credit is required, should be put into place rapidly. For the three CDR sub-projects, options to be explored are the Central Region Rural Development Bank (a Grameen Bank), other NGOs, and the nearest SFDP offices and ADBN branches, which are listed in Appendix 8. For the three EDR sub-projects options to be explored are the Grameen Bank Biratnagar, other NGOs and the nearest SFDP offices and ADBN branches, including the Gothgaun SPO (Sub-Project Office) at Mrigauliya, which is to be converted to an SFCL.

7 Institutional Change and Training

171 HMGN's and DOI's role in the Project will be essentially that of facilitator rather than implementor. In recent years, a more participatory and facilitating approach has been developed within the DOI, in line with the 1992 Irrigation Policy (amended 1997). This includes the GWRDP, through its involvement in the ILC and IFAD projects, both of which are based on group rather than individual tubewells. The DOI has progressed a long way from the traditional top-down development approach applied up till the 1980s. GWRDP has become increasingly farmer-orientated, through the participatory approach adopted for the above projects. Nevertheless, its normal role in TW projects is still essentially that of a construction and implementing agency rather than as a technical support agency. It has little experience, for example, in providing technical advice and training to the vast mass of STW farmers who have installed ADBN wells or to the drillers who installed them and the pumpset dealers and mechanics who help maintain them. Unless such support can be provided the Project will not achieve its full potential.

172 Apart from its position as overall implementing agency, GWRDP's role for the STW component will be the new one of providing technical assistance and support to farmers, drillers and pumpset suppliers and facilitating, but not actually implementing, the STW development. This will require a different approach and attitude from that needed for the DTW component, and thus a considerable re-orientation amongst the staff involved. GWRDP staff have a sound technical grounding, and there are existing training courses which seek to enhance this. However, additional intensive training will be required, in order to re-orientate GWRDP fully for their new facilitating role. At the start of the Project a Training Needs Assessment of GWRDP staff will carried out by a Training Specialist from the Project Consultants, and a training plan will drawn up. It is envisaged that the training programme will focus on the following five aspects:

- The Project Concept.
- ADBN-type Tubewell Technology; many GWRDP staff have little experience with this type of well and with manual drilling.

Figure 2

Typical VDC Implementation Schedule

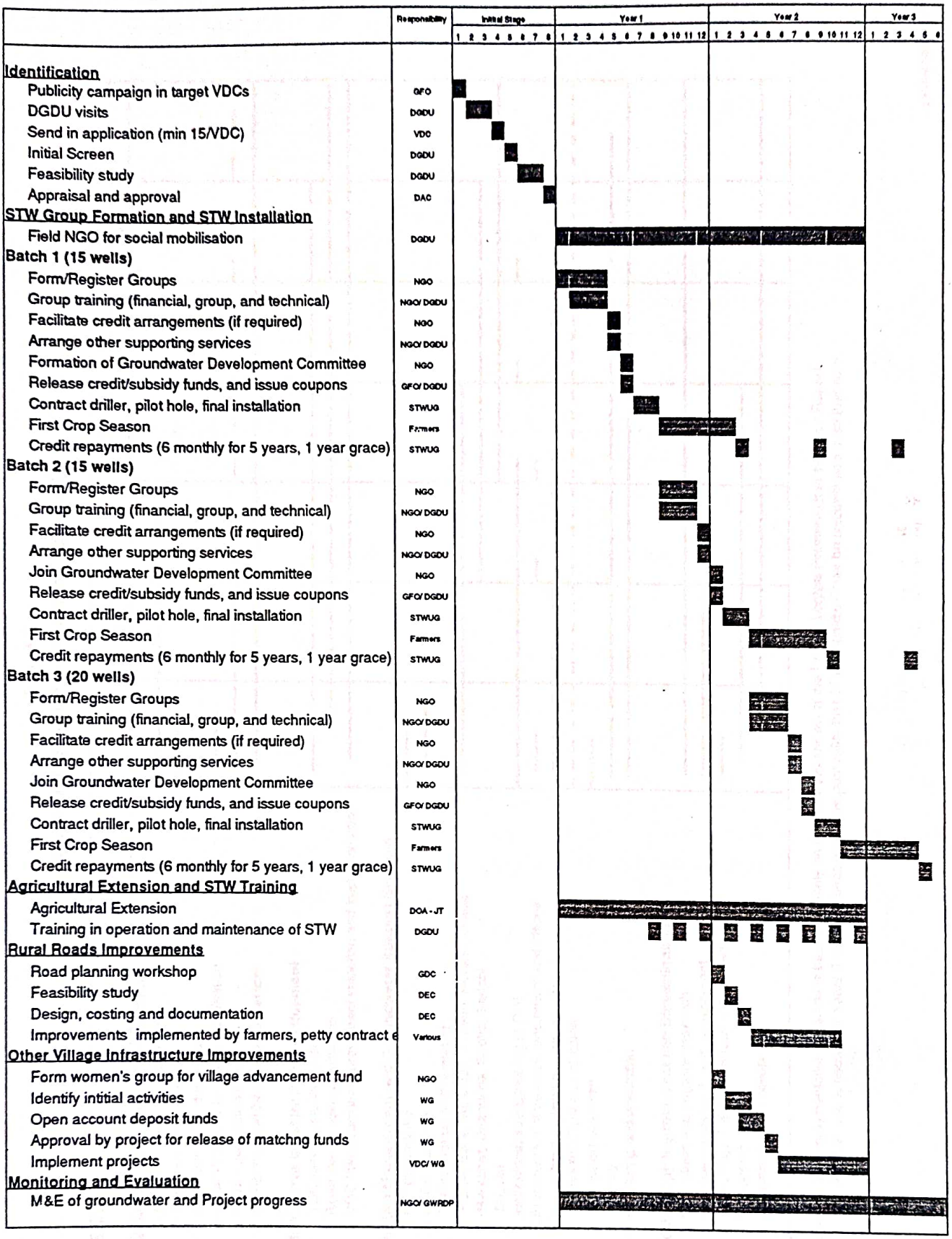
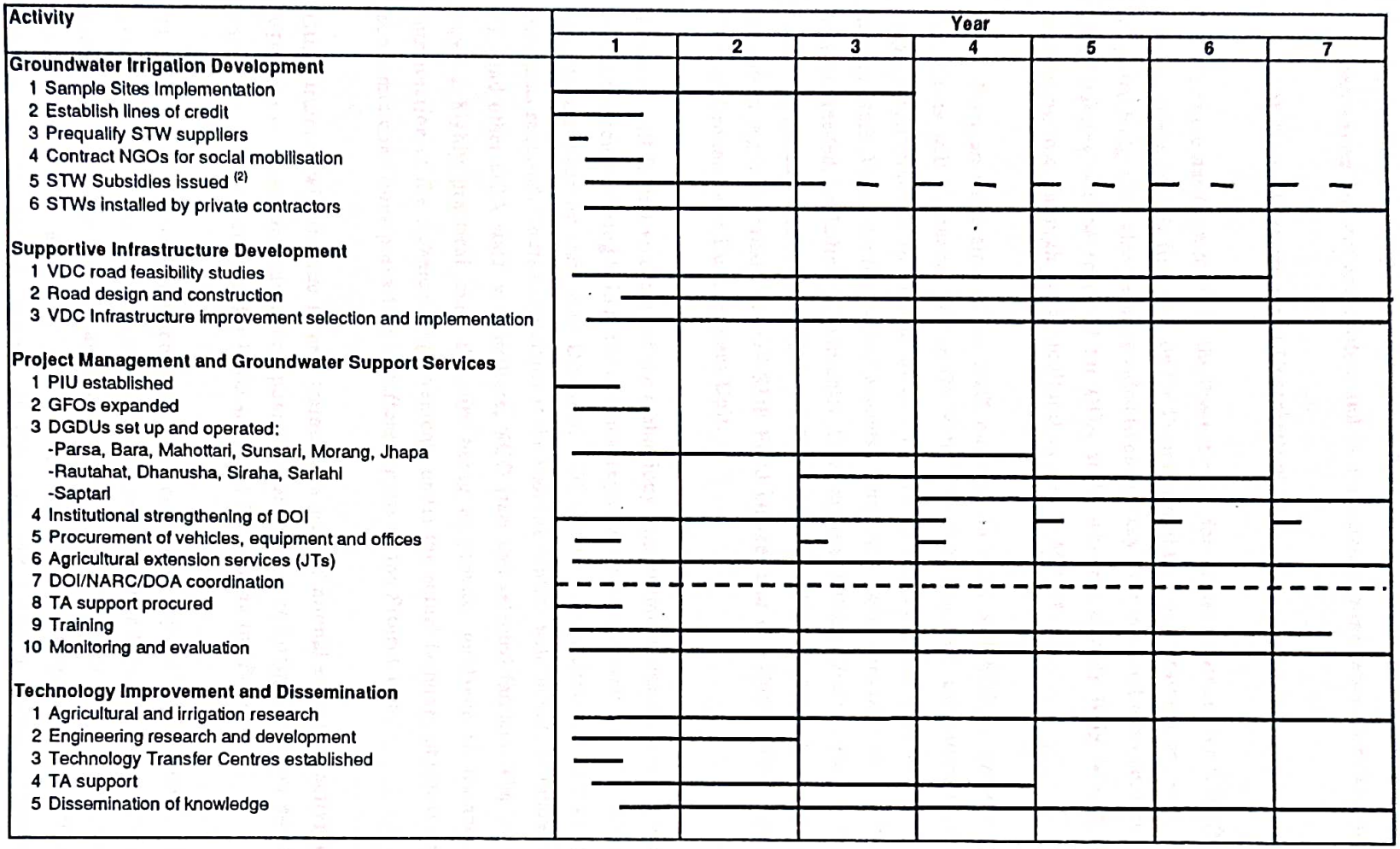


Figure 3
Proposed Project Implementation Schedule[1]



Notes: 1. The implementation schedule is based primarily on the activities shown in the Project Logical Framework in the Main Report
2. A dotted line is shown for Years 3 onwards because of the possibility that STW subsidies may be discontinued from that time.

q:\hen\projects\39191\schedule.xls

- Attitudinal Change, to help staff make the transition to being facilitators rather than implementers, the idea being that the Project should provide an extension-type service to the beneficiaries.

- Provision of an Extension Service to Farmers. Staff will be trained in how to assist and advise farmers and drillers and in understanding the research-extension link.

- STW Group Formation and Organisation.

173 An allowance has been made in the Project costs for 15 days training for GWRDP Project team members in their first year on the Project and then 5 days training per year thereafter. A limited budget has also been provided to enable key staff to attend short courses overseas. Little training will be required for DOA staff, who are already fully familiar with the facilitating role, through the agricultural extension service.

174 Apart from an expansion of its staff numbers in CDR and EDR, a greater spread of disciplines will be needed in the GWRDP. The DOI Regional and District offices now employ agriculturists in district offices and an agriculturist and sociologist at regional headquarters. To handle the 'softer' aspects of the Project activities adequately, similar staff will be needed, including: Community Development Officers/Sociologists to direct and supervise the activities of the NGO mobilisers which will be employed by the Project; one Irrigation Agriculturalist per GWRDP Field Office; and one Community Organiser per District Groundwater Development Unit.

175 Training will form a vital part of the technology improvement dissemination process, with numerous courses being held at the two new regional training centres and an active outreach programme whereby staff visit Districts, VDCs, Agricultural Services Centres and other places as required. Course attendants at the training centres will include groundwater staff, JTs and other DOA staff, well drillers, NGO staff and selected farmers. The courses will have a highly practical bias, the aim being to provide guidance to trainees for the introduction of the technical improvements under the actual farming, physical and socio-economic conditions prevailing in different parts of the Project area.

176 Other training will include farmer training, as part of normal extension activities in the VDCs, in irrigated crop husbandry, pumpset maintenance and irrigation water management, and short induction courses for NGO staff and JTs joining the Project.

177 The proposed Sub-Project Implementation Schedule for a typical VDC is shown in Figure 2 and the overall Project Implementation Schedule is shown in Figure 3. In the case of the six sample sites, all stages prior to approval by the DAC have been completed, but a short stage of confirmation of interest by would-be groups and formal application by them to the Project will be needed because of the time lag between project preparation and implementation. The programme is based on 50 STWs per VDC installed in three batches

(15, 15 and 20 STWs), installed at six month intervals. In practice, however, the number of wells and batches per VDC will vary according to actual demand.

8 Project Implementation Schedule

178 The overall Project is expected to take seven years to implement, starting in 1998 and ending in 2004. During the first two years attention will be concentrated on the development of the six sample site sub-projects, on building up DOI's administrative and technical capability to implement the Project, with the accompanying institutional changes, staff recruitment and training, and on the establishment of the Technology Improvement and Dissemination programme. The Project and Technology Consultants will be recruited as soon as possible. Apart from the sample site sub-projects, STW development in other VDCs in the six districts in which the sub-projects are located (Sedhawa, Bara, Mahottari, Sunsari, Morang and Jhapa) will be initiated during this first two year period.

179 In Year 3 a mid-term review will be undertaken, in order to evaluate the progress and performance achieved on the six sub-projects and elsewhere. Based on this evaluation and other work carried out (e.g. the roads assessment in the priority areas) and on any major policy changes which may have occurred, especially concerning subsidies, the programme for the remaining four years of the Project will then be drawn up. During Year 3 the STW programme will be extended into Rautahat, Dhanusha, Siraha and Sarlahi districts. Implementation of the Project DTW construction and rehabilitation programme will start in the same year. In Year 4 the STW programme will be extended into Saptari District (this has lower STW potential than those listed above). Training activities will continue throughout the Project implementation period.

9 Procurement of Goods and Services

180 The procurement of all goods and services will be carried out in accordance with the Bank's *Guidelines on Procurement*. For the DTWs, which will be implemented by DOI, the Department will engage contractors under the same system as is used for the ILC project. For the STWs, two options are available:

(i) The present well-established ADBN system, whereby farmers 'purchase' the goods and services directly from their choice of private sector supplier, from the ADBN list of approved suppliers. Payment is effected by means of a coupon system, whereby farmers are issued with coupons and suppliers are reimbursed directly by ADBN upon submission of the coupons which the farmers have handed to them after receiving the goods and services.

(ii) Procurement by DOI on the farmers' behalf, by means of a tendering system, as in the IFAD Project. To obtain the potential cost reduction benefits of this system, the

minimum size of tender would have to be at least one VDC (i.e. say, 15 to 30 or more STWs) or even a group of VDCs.

181 In theory, the tendering system has the advantage of reducing the STW 'price' paid by the farmer, because of the competition and quantity discounts resulting from the tendering process. In practice, however, the system has several disadvantages. It eliminates the scope for farmer choice. With public sector tendering and procurement procedures, delays in delivery of the goods and services selected are common and lastly, the work involved increases the administrative workload of DOI, which could be greatly reduced if procurement were left entirely to the farmers and the private sector. In view of the above factors, STW procurement should be based on the present ADBN system. This is very much in keeping with the private sector orientation of the Project and DOI's role being that of facilitator rather than implementor.

10 Consulting Services

182 Consultancy services will be required for the following reasons:

(i) The Executing Agency, DOI, has limited experience with this type of demand-led, private sector-oriented, development and with undertaking the primarily facilitating rather than direct implementation institutional role which it involves. Provision of appropriately qualified consultants will bolster its ability to execute the Project to ensure effective Project implementation.

(ii) The Project Consultants will provide certain specialist skills and expertise which DOI does not possess in sufficient degree at present (eg training).

(iii) The Project will involve a major expansion in DOI's level of activity in groundwater irrigation in Central and Eastern Development Regions, which is likely to place some strain on the Department's staff and implementation capacity in the initial years. Provision of suitably qualified and experienced consultants will bolster its staff resources and thereby ensure that sufficent implementation capacity is available. This is a temporary measure, required only until DOI has built up its own capability sufficiently. In line with this approach, the International Consultants' input will be almost entirely in the early years.

(iv) The Project will require a major institutional change within DOI's Groundwater Irrigation Division, with a re-orientation towards the facilitating role. Technical assistance is required in order to help effect this re-orientation.

183 The proposed consulting services have been split into two packages, the Project Consultancy (90 international and 408 local person-months) and the Technology Consultancy (66 international and 150 local person-months), in case bilateral grant aid funds are to be sought

for the latter. In fact, the two packages could easily be combined into a single overall package, if required. The Project Consultants will provide technical assistance to DOI in all aspects of Project implementation, including the execution of the VDC feasibility assessments. For the Technology Improvement and Dissemination component an international firm with experience in groundwater irrigation development will be required, but both consultancies will be undertaken by a mixed international/local team. Recruitment and appointment of the consultants will be in accordance with the Bank's *Guidelines on the Use of Consultants*. The NGOs will be recruited on the same basis.

11 Benefit Monitoring and Evaluation

184 Benefit monitoring and evaluation will be carried out in accordance with the ADB's *Benefit Monitoring and Evaluation Handbook*. A Monitoring Section will be set up within the Project Implementation Unit, staffed by a full-time Monitoring Officer and an assistant, but all professional staff working on the implementation of the Project will be involved in monitoring to some degree, in order that the information required can be supplied by those who are most in contact with events in the field. A simple and cost-effective BME system will be set up, concentrating on key aspects and parameters and keeping data collection to the minimum required to meet Project needs, in order to avoid data overload.

185 Two categories of BME will be undertaken on the project, progress and technical monitoring and ongoing evaluation, and performance and impact evaluation.

(i) **Progress and Technical Monitoring and Ongoing Evaluation:** Aspects and parameters to be covered will include:

- **Assembly of benchmark data**, to provide the baseline for all future evaluation work. For each VDC these data would have been collected during the feasibility assessment.

- **Progress monitoring:** At the VDC level this will cover a wide range of parameters, including NGO and extension staffing, the number of STW groups formed and number of group STWs installed, and their approximate cost, roads and other infrastructure works undertaken, credit disbursements, other, related, group activities undertaken (e.g. formation of saving and credit groups) and particular problems and constraints encountered by the Project staff and farmers in the implementation process, and suggested solutions. The information will be collected by the NGO staff in collaboration with the VDC Groundwater Development Committees. Brief reports will be prepared every six months and sent to the District Groundwater Development Units and the Monitoring Section in the PIU.

- At the District level most of the progress data to be reported from the District Groundwater Development Units will be the VDC data listed above. With regard to Technology Improvement and Dissemination, regular (probably six monthly) progress reports should be prepared by the Technology Consultants and the PIU, covering, in particular, research and development work undertaken, viable technological improvements identified and development training courses run at the two Regional Training Centres and elsewhere, and other dissemination activities undertaken. Groundwater regional monitoring will continue to be based on GWRDP's existing system, but there will be additional requirements for monitoring by the Project. These include special monitoring of springs which flow into the VDC areas, and the measurement of watertable depths at the time of TW construction. Provision has been made in the Project cost estimates for some rehabilitation of existing GWRDP monitoring wells.

- **Ongoing evaluation** will be carried out in order to maintain an up-to-date picture of Project performance and impact and to provide part of the data which will eventually be required for the more detailed impact studies to be undertaken at the mid-point (in Year 3) and end of the Project. Part of the information required for ongoing evaluation will already be available from the progress monitoring (e.g. rates of group formation and STW installation). For ongoing evaluation additional data will be collected, principally concerning benefit parameters (e.g. cropping patterns and intensities, crop yields, STW command areas) and Project impacts. Such information will be reported once per year by the NGO staff. For each parameter and aspect covered it will comprise an overall assessment for the VDC, backed up by records maintained by a small number (say, 4 or 5) of carefully selected new STW groups spread over 1 or 2 VDCs. With regard to Technology Improvement and Dissemination, ongoing evaluation of the performance and impacts of the improvements developed and disseminated will form a central part of the work and will be part of standard procedures.

(ii) **Performance and Impact Evaluation:** An impact study will be carried out at the end of the Project, and also possibly at the mid-term stage, by an independent external agency such as a consulting firm. It will cover all the aspects listed above but will also consider the impact on STW performance and productivity in the 12 districts as a whole. For such a study a limited amount of sample survey work will be required.

12 Accounts, Audit and Reports

186 The DOI will establish, within three months after the effective date of the Loan Agreement, an imprest account to facilitate the timely disbursement of loan proceeds to finance incremental administrative and operating costs, and activities carried out under the Project

components. Advances will be made annually on the basis of the anticipated expenditures for the next 12 months. The imprest account will be established, managed and liquidated in accordance with terms and conditions satisfactory to the ADB and in accordance with the ADB's *Guidelines on Imprest Accounts*. The PIU will submit to the ADB every six months a certificate of liquidation of the advance, supported by a Statement of Expenditure.

187 The DOI will maintain separate accounts and financial statements for the Project, which will be audited annually by the Auditor General of Nepal. Unaudited accounts and financial statements for the Project will be provided to the Bank within six months of the end of the fiscal year to which they relate, and certified copies of the audited accounts and financial statements will be provided within 12 months of the end of the relevant fiscal year.

188 The PIU will furnish the Bank with semi-annual progress reports on overall Project implementation. Within three months after Project completion, the Project Coordinator will submit a Project Completion Report that will review the utilisation of the loan proceeds and the impact of the Project on the beneficiaries.

G The Executing Agency

189 Implementation arrangements for the Project are described in Section III F4. DOI, through its Groundwater Irrigation Division, will execute the Project through a specially established Project Implementation Unit. Provision has been made in the cost estimates for the necessary temporary offices for the District Groundwater Development Units, with furniture and equipment. To ensure adequate mobility, 23 four-wheel drive vehicles and 36 motorcycles will be procured under the Project.

H Environmental and Social Effects

190 The Consultants have carried out a Summary Initial Environmental Examination (SIEE) in accordance with the prescribed ADB '*Environmental Assessment Requirements and Environmental Review Procedures*'. To complete the SIEE, desk research was undertaken with the help of various published materials and unpublished reports, field visits were made to the six selected sample sites and knowledgeable persons and farmers were contacted so that information could be obtained through direct observation and person-to-person interviews as well as group discussions. At the same time, inspections were also made of the immediate watershed conditions upstream of the sample sites, to obtain an understanding of the human activities on the ground which were likely to affect the project components and to ascertain the potential impact of project activities on the environmental resources, notably the groundwater reserve and any possible change in soil properties.

191 The Project area has two National Protected Areas, namely (i) Parsa Wildlife Reserve and (ii) Koshi Tappu Wildlife Reserve, in Sunsari District. The former is noted for tigers and the latter for wild buffaloes. Koshi Tappu is also an important wetland area. The Royal

Chitwan Park lies is the most western District in the Project area (Chitwan), although little Project activity is proposed in that District.

192 Following the usual guidelines for groundwater irrigation projects in the water resources sector (Environmental Impact Assessment Guidelines for the Water Resources Sector, NCSIP / NPC, 1994) the following five issues were identified as the most pertinent to be investigated: safe aquifer yields; water quality and salinisation; effects on spring discharges; possible interference with existing uses of groundwater (e.g. existing dug wells, tubewells and drinking water sources); and use of agro-chemicals.

193 Less than 10% of the annual recharge of the aquifer will be abstracted by groundwater irrigation schemes in the Terai, even with this Project. Furthermore, the abundant monsoon rainfall means that any deficit in groundwater levels at the end of the (dry) winter season will be readily replenished. The use of the aquifer is therefore sustainable and is well within its safe yield. Tests carried out in Project areas in the Terai (e.g. the Bhairahawa Lumbini Groundwater Project) have clearly shown that groundwater salinity is low and the overall quality is very good. At the same time, because of the heavy monsoon rains, any salt build-up as a result of irrigation will be naturally leached out. Salinity has not been reported as a problem with any of the existing tubewells that were sampled as part of the Project.

194 Extraction of water from shallow aquifers may in some places affect spring discharges. This may cause detrimental effects on existing surface irrigation schemes depending upon the springs for their source of water. Similarly, nearby ponds and other water bodies may be affected, with the consequent impact on spawning areas, feeding grounds and nursery habitats of aquatic species. The Project has proposed that land is carefully surveyed before the installation of tubewells, that protection zones are established around the springs, and that proper precaution is taken regarding the spacing of the wells. These measures will ensure that this slight adverse effect can be eradicated or mitigated to a great extent.

195 Extensive withdrawals may lower the water level in the upper aquifer sufficiently by the end of the winter season to temporary dry out some dug wells, STWs and drinking water hand pumps (or lower the watertable beyond the pump suction limit). Although no drastic change in groundwater level has been reported from any sample site, there were slight indications of temporary loss of water in some shallow wells. The problem will be averted by spacing the wells judiciously, further deepening of existing boreholes and lowering the pumps. Furthermore, domestic supply of water would always be available, in the extreme case from the STWs. Watertable monitoring will be carried out on a regular basis (see Section IV B).

196 With the potential of accelerated irrigated agriculture, a more favourable environment will be created for pests. Intensive cultivation of high yielding varieties and multiple cropping will be promoted, thereby establishing conditions for pests to thrive. Current levels of agrochemical application are rather low but pesticides such as Methyl Parathion (metacid), Thiomet and Endosulfan are in use. These pesticides have a broad spectrum effect causing

incidental damage to a wide array of wild life, plants, water organisms and also humans. This situation is expected to be aggravated further in the future, since heavier use of fertilisers and pesticides has been recommended very strongly by the APP. The Project will tackle the problem by raising farmer knowledge about the risks and by disseminating amongst the farmers the concepts of Integrated Pest Management (IPM).

197 The Consultants have considered the social effects of the Project using the *Handbook for Incorporation of Social Dimensions in Projects* (ADB 1994) as the guide. The checklist followed was the one for irrigation, with changes having to be made because that checklist was written for surface irrigation and this Project deals with groundwater. The principal social effects of the Project will be increased employment, improved farm food sufficiency, a reduction in poverty, and minor impacts on women. The first three issues are addressed by considering the various social groupings affected by the Project.

198 **Landless people and near landless people** make up from 30% to 50% of the total Terai population. Where they have no access to land as tenants (see below), they have to subsist on daily wage labouring work which they try to find on others' farms, seasonally in factories, or on infrastructure building activities. In all these kinds of daily work, the wages are low and can only support a nutritionally deficient, hand-to-mouth existence. As tubewell irrigation spreads under the Project, more farm labouring work will become available to them. The project also plans infrastructure building (access roads) on which there will be paid labouring work. However, the border with India is open and the poor of Bihar can come across at will. This means that, even with more work available, wage rates probably will not rise significantly.

199 **Tenant farmers** make up about 30% of the population, although this varies from place to place. The largest percentage of these are sharecroppers (the 50:50 sharing system) operating on the basis of verbal agreements. A smaller percentage are Legal Tenants with recorded agreements and long-term rights in the land they are working, and a very small percentage have fixed cash rental agreements. Depending on how much land such persons are cultivating and the nature of the tenancy agreements, such households may currently get up to six months of their subsistence from the land. Persons in this group currently need to find wage labouring work to cover the balance of their subsistence needs. Tenant farmers will benefit from group STWs found under the Project in two ways: (i) they can install STWs, with the consent of their landlords, (ii) or, more likely, the landlords can get the boring and pumpset, the water from which is used by the tenants. In either case tenants may be able to double their subsistence off-take from the land.

200 **Small landholders** own perhaps one bigha (0.67 ha) or less land. Such persons currently get from three to six months of subsistence off their land and will tenant others' land, if they get the opportunity, and work at daily wage labour to cover their subsistence needs. These smallholders form about 30% to 40% of the population. They are the main target group for the Project and will be able to get up to 12 months' subsistence from the land they

cultivate with irrigation from STWs. With an STW installed they will require less off-farm employment.

201 **Medium and larger landholders**, owning more than one bigha, make up perhaps 15% of the population. At the high landholding end of this category, with average family size, they are food-sufficient and can market some grain. People in this category do little labouring work for others. Some may install an individual STW through the Project and they will be able to market even more output than before. Many of the would-be group STW members identified on the sample sites are medium land holders but at the lower end of the size range.

202 Throughout the Central and Eastern Terai non-Hill Migrant women represent a backward social sub-community almost regardless of ethnic group. They leave school early, if they have attended at all; their literacy rate, generally, is much lower than that of males; they marry at a young age and have low rates of use of family planning methods. Very few will be members of STW groups, rather their husbands will be the members. Their workload will increase, mostly in the dry season, when fields would otherwise either be fallow or growing crops not requiring much water or work, but the women say that their family welfare will be better, so they do not mind the extra work.

203 There are no groups which will be disadvantaged by the Project through, for example, relocation, loss of rights to use land, loss of income or loss of cultural properties (e.g. ancestral land, burial ground, etc.). All the direct and indirect impacts of the project are seen to be either neutral or positive.

I Policy Issues

204 There are two principal policy issues facing the Project, that of subsidies (on tubewells and on fertiliser) and that of groundwater regulation. At 80% of capital cost the subsidy rates for group STWs are extremely generous and even the rates for individual wells are generous in comparison with many other parts of South Asia. It is probable that the rates are higher than Nepal can afford and must eventually be reduced, but HMGN has decided that tubewell subsidies are to be maintained at the current levels for at least the immediate future. Table 4 shows the subsidy funding that HMGN will need to provide given the present subsidy rates and assuming the projected numbers of tubewells are installed.

TABLE 4

HMGN Tubewell Subsidy Funding for the Project Based on Present Subsidy Rates (Rs million)

Project Year	Group STWs, at 80% of Rs 55,000 per well	Individual STWs, at 40% of Rs 55,000	DTWs, at 90% of Rs 1.99 million	Total
1	9.9	0.5	-	10.4
2	29.7	1.6	-	31.3
3	79.2	4.4	26.8	110.4
4	118.8	6.6	44.8	170.2
5	118.8	6.6	35.8	161.2
6	118.8	6.6	35.8	161.2
7	118.8	6.6	35.8	161.2

205 In comparison with these annual totals for STWs of up to Rs 125 million, at present HMGN is paying out some Rs 40-50 million per annum in STW subsidies, but this is for all five regions of the Terai. If Project STW uptake reaches the levels assumed, it will raise the total STW subsidy bill to a probably insupportably high level, unless external funding is obtained. Since financial analyses demonstrate convincingly that STW returns are more than sufficient even if there is no subsidy, the case for at least greatly reducing, if not completely eliminating, the STW subsidy is clear. The extent and pace of subsidy reduction will, however, be a political decision which will be made by HMGN, with donor agency influence.

206 It is recommended that no subsidies should be granted for STW pump houses and STW distribution systems. Alternative improved distribution systems (eg masonry-lined channels and buried pipes) are not economically justified, so it would be entirely inappropriate to offer subsidies on these elements. It is accepted that there is a strong preference expressed by DOI and farmer groups to construct buried pipe or line channel distribution systems for DTWs. While it is difficult to justify such systems economically, the Project does not propose to challenge or change the existing accepted approach (i.e. that of the ILC Project) of providing these distribution systems, especially since it is a minor component of the Project.

207 It is anticipated that in the immediate future, say, during the first two years of the Project, subsidy levels will continue at the present levels. This would be advantageous to the initial implementation of the Project, for two reasons. First, it will encourage rapid initial uptake of tubewells, due to the relatively low investment costs required by the farmers. Second, should there be delays in establishing an effective and acceptable credit system, Project implementation will not necessarily be delayed, because most farmer groups should be able to fund their 20% contribution from their own resources, without resorting to credit.

208 Evidence suggests that an eventual reduction in the level of subsidy would have no detrimental effect on Project implementation, and could even have a positive influence. In summary, the arguments are: experience from other countries (eg Bangladesh) shows that subsidies are not required to encourage STW 'take-off'; high subsidy levels could slow down the rate of STW installation because annual subsidy budgets are always exhausted; financial analysis shows that STWs would still be attractive to farmers even if subsidies were completely abolished; and farmers may delay installing STWs using alternative sources of funding if they feel that by waiting for a while they may subsequently obtain a subsidised loan.

209 If HMGN opts to reduce subsidies, there are strong arguments for reducing subsidy levels on pumpsets in preference to borings. The pumpsets are mobile, and can easily be sold on by the farmer groups at a profit. Borings are fixed assets, and the probability of farmers being able to sell on parts of the boring are relatively small. A second argument for reducing subsidies on pumpsets in preference to borings is that it would continue to encourage smaller/poorer groups to install a boring and to hire a pumpset as and when required.

210 Indirect operation and maintenance (O&M) subsidies already exist, in that HMGN supports agricultural and irrigation research and extension. The results of the sample site surveys have shown that government provision of these services is in great demand by farmers, and is perceived as an effective way of promoting increased agricultural production. It is recommended that these indirect subsidies are continued. Transferring the direct STW subsidy from capital costs to O&M costs, on the other hand, is not recommended.

211 Fertiliser subsidies in Nepal are substantial, especially for urea. HMGN's expenditure on fertilisers is very large, and much higher than that on tubewells. Total fertiliser subsidy costs were Rs 600 million per annum in 1991/92 and 1992/93 and Rs 350 million in 1993/94. Clearly, these subsidies apply to the whole agricultural sector rather than just the TW irrigation sub-sector. Unlike the group TW subsidy, there is little social justification for them and, from the economic viewpoint, they should be eliminated, so as to obtain thereby a more optimal crop input mix in economic terms. Again, however, their reduction is essentially a political matter. It is complicated by the fact that fertiliser subsidies in India are high. Thus HMGN does not have complete freedom of action with regard to fertiliser subsidy policy. Financial analysis of STW farmer incomes shows that the effects of fertiliser subsidies being completely withdrawn would not be large, mainly because levels of fertiliser use by Nepali farmers are not high and, of the fertilisers widely used in the Terai, only urea is heavily subsidised.

212 Under existing legislation, specifically the Water Resources Act, 1992, and the Water Resources Regulation, 1993, provision has been made for the establishment of a groundwater regulatory system. As of now, no regulatory system has been put in place.

However, no widespread groundwater regulation is required for the successful implementation of the Project. The reasons for this are that:

- In terms of water quantity, there is a plentiful annual recharge, from the high annual rainfall, and water abstraction is relatively low. Monitoring has shown that less than 10% of the annual recharge is being abstracted at present.

- In terms of water quality, there is generally not a pollution problem, although around factories, particularly in Biratnagar, groundwater pollution is becoming significant. This will not directly affect the Project.

- There is also the 'Red Tape Effect' argument. The Project is seeking to stimulate a major take-off in the numbers of group STWs. Some farmers already express concerns about the difficulties of obtaining credit. To create further formalities to be completed, other than the minimum necessary, could reduce farmers' willingness to install tubewells and hence reduce the numbers of tubewells installed.

213 As more tubewells are installed in the Terai and the needs of the population and industry grow, at some time in the future HMGN will have to think of conservation and sustainable development of groundwater. Since, however, the exact nature of the problem that might be posed in the future cannot be anticipated at present, it would be premature to design a regulatory system in detail now.

214 Whilst a global groundwater regulatory system is not required, the Project will exercise some control over the location and density of tubewells in two respects. First, DTWs will not be installed in areas which would otherwise be suitable for STWs. Secondly, intensive STW development will not be permitted immediately around springs, to protect their flow. These controls will be exerted by withholding subsidies in these situations.

IV PROJECT JUSTIFICATION

A Financial and Economic Analysis

215 The financial and economic analysis of the Project is based on data derived from the detailed studies of the six sample site sub-projects, principally the questionnaire survey of 149 existing STWs, including all the group wells and the four existing DTWs at Bijalpura sample site. Since these data are derived from actual performance and productivity levels being achieved on TW-irrigated farms at present they provide a sound basis for the benefit estimates.

216 These data have been used to formulate representative TW (farm) models for the overall Project area, for two levels of technical performance, namely :

- **Existing Performance**, as represented by the cropping patterns, intensities and crop yields being achieved by STW farmers on the six sample sites at present.

- **Improved Performance**, with higher well utilisation, somewhat improved cropping patterns, higher cropping intensities and crop yields and some reduction in pumping costs per unit of water pumped. This scenario has been taken as the standard (the Base Case) for the benefit estimates. There is clear scope for a substantial improvement in STW performance and irrigated crop productivity. To achieve this, the Project provides for major investments in support services to the STW sub-sector and in technology improvement. In the benefit estimates, therefore, it is logical to assume a significant increase in STW productivity over existing levels. The increases assumed are not high.

1 Benefits and Beneficiaries

217 The Project benefits will comprise mainly the increase in agricultural production and incomes resulting from the development of new irrigation tubewells and the expected improvement in the performance and productivity of existing tubewells in the Project area. There will also be substantial non-quantifiable social benefits resulting from the alleviation of poverty, improved drinking water supplies from the tubewells and the VDC infrastructure and services improvements to be financed by the Project. A much wider area of the Terai beyond the 300 VDCs should in fact benefit from the Project, due to the beneficial impacts of the Technology Improvement and Dissemination component and the general impetus which the Project should give to group STW development. The value of such impacts has not been included in the analysis.

218 If group and individual STW uptake reaches the assumed level and the 100 DTWs are installed/rehabilitated, the total number of direct beneficiaries of the Project is expected to

be some 490,000 persons in 82,000 households in the 12 Terai districts of the Central and Eastern Development Regions. Total TW irrigated area would increase by 60,700 ha. There will be four categories of direct farmer beneficiary:

- The largest group, **group STW members installing a new well.** This category is the main target of the project. There will be 13,500 such STWs, with an average command area of 4 ha. With an average of 5 members per group and 6 persons per household, total beneficiaries will be 30 per STW and 405,000 overall, with 54,000 irrigated ha.

- 1,500 **individual STW owners installing a new well**, with an average command area of 2.8 ha. With an average household size of six, total beneficiaries will be 9,000.

- **Existing STW owners, both groups and individuals, whose productivity and returns will increase as a result of the technical improvements brought about by the Project.** Based on the existing STW densities found on the sample sites, an estimated 9,640 such wells will benefit in the 300 VDCs. If there are six beneficiaries per STW (most existing STWs are individually rather than group owned) the total would be some 58,000 persons.

- **New DTW farmers**, on the 100 new and rehabilitated DTWs. With an average command area of 25 ha, 0.8 ha per member and a household size of six, beneficiaries would total about 19,000.

219 The Project will increase crop output by about 139,500 tonnes of paddy, 53,000 tonnes of wheat, 97,000 tonnes of sugarcane and 17,000 tonnes of potatoes and vegetables. The foreign exchange value of the savings in rice, wheat and sugar imports will be US$ 41.4 million (Rs 2,351 million).

220 Agricultural labour requirements in the Project area will be increased by 1,017,000 days per annum. These will be met very largely from within the farm households themselves, although the individual STW owners, with larger holdings than group STW members, will hire more labour.

221 Annex A give details of the group STW beneficiaries for the 108 would-be groups identified by the NGO Social Mobilsers on the six sample sites up to mid-March 1997. A further 57 would-be groups were identified by the NGO staff between then and the end of April, making the total up to 165, but fewer details were presented about these groups. Particular features of the beneficiary groups can be summarised as follows:

- Average would-be group size per sample site is between 5 and 8, except at Sedhawa, where it is 13. Average holdings per member within the proposed STW commands are 0.7 to 0.8 ha, except for the 1.5 ha figure at Mrigauliya, which is for only eight groups. There is, however, a very wide range of values around these averages.

- Average household size per would-be member is 5 to 7 persons, of whom around 3 are available for farm work. This suggests that family labour availability for STW irrigated agriculture is unlikely to be a major constraint. A high proportion of households are reported to have significant levels of off-farm income, especially at Bharaul (91%) and Bijalpura (68%).

- Tenants (wholly tenants or tenants-cum-owner-cultivators) form a substantial proportion of the would-be memberships at all sample sites except Bijalpura and Bharaul, with between 30% and 41% of the total members at the other four sites being whole or part tenants.

- Reported levels of per capita income amongst would-be members and their households are relatively low, with those at Phattepur and Bharaul being significantly below the Nepal official poverty line of Rs 4,140 per annum, although average incomes are significantly above this level in Bijalpura and Mrigauliya. By Nepalese standards the average total holding sizes per would-be member are not particularly small, at 0.9 ha to 2.2 ha, but within these averages there are many farmers with holdings below the official poverty level of 0.5 bigha (90.33 ha).

222 Detailed data on the land ownership were collected for the 17 Bharaul and 5 Mrigauliya would-be groups identified between mid-March and the end of April 1997, in terms of the proportion of would-be group members in each land ownership size. This showed that, in terms of land ownership, one third of the Bharaul 117 members and one quarter of the Mrigauliya 28 members are below the poverty line, because they own less than 0.5 bighas. Just over one half of the members at each site own between 0.5 and 2.0 bighas (1.33 ha) and there is a significant proportion (11% at Bharaul and 22% at Mrigauliya) owning more than 2 bighas, with 11% at Mrigauliya owning 4 bighas or more. Even by Terai standards, however, this is not a large farm, and the members from this sample can be considered to comprise a mixture of marginal, small and medium farmers. It is interesting to note that none of the members was landless; ie although there are tenants, all of them in these two samples of would-be members also owned at least some land.

2 Financial Analysis

223 Calculation of farm production and farmer incomes has been based on farm model analyses using the FARMOD programme. The following financial analyses have been undertaken:

- For an individual member of a STW group, the net annual income from his STW-irrigated land, the increase in income over his Before STW (ie without Project) income from this land and the incremental returns per incremental day of labour input. These results are presented for each of the six sample site Sub-Projects and for the Project Area Representative Group STW model.

- The financial internal rates of return (FIRRs) for each of these models, if the members were to finance the investment themselves, without subsidy, rather than take out a loan. The FIRR for an individual rather than group STW is also presented, for the Project Area Representative STW Model.

- For a tenant operating under the sharecropping system, his increase in net annual income with STW development, for the Sedhawa and Phattepur sample site Sub-Projects, where there are numerous tenants, and for the Project Area Representative STW Model.

- For a DTW at Bijalpura, the one sample site Sub-Project which will include DTWs, a farmer's net annual income from his TW-irrigated land and the increase that this represents over his Before TW income from that land.

224 The analyses of income effects have been undertaken for two subsidy situations, with the present 80% subsidy and with no subsidy, and for Existing Performance and Improved Performance. Table 5 shows the results.

TABLE 5

Financial Returns to Group Tubewell Members (Rs per annum)[1]

Sub-Project	Holding size (ha)	IMPROVED TW PERFORMANCE			EXISTING TW PERFORMANCE		
		With TW annual income	Increase over Before TW situation	Incremental returns per incremental labour day	With annual income	Increase over Before TW situation	Incremental returns per Incremental labour day
NEW GROUP STWs (4 ha)							
(a) With 80% STW Subsidy							
Sedhawa	0.8	13,360	8,986	125	9,567	5,193	118
Phattepur	0.7	17,502	7,703	175	15,235	5,136	128
Bijalpura	0.8	10,626	5,977	87	7,406	2,757	71
Bharaul	0.8	24,183	7,128	107	20,956	3,901	83
Mrigauliya	1.5	32,962	10,972	115	24,067	2,077	51
Sharnamati	7	15,209	7,454	112	12,352	4,597	88
Projects Area Representative	0.8	19,074	9,285	126	13,950	4,160	80
(b) With no STW Subsidy							
Sedhawa	0.8	11,992	7,618	109	8,198	3,824	84
Phattepur	0.7	16,359	6,560	150	14,092	4,293	100
Bijalpura	0.8	9,183	4,534	62	6,010	1,360	38
Bharaul	0.8	22,615	5,560	80	19,388	2,333	49
Mrigauliya	01.5	30,351	8,361	84	21,453	(536)	-
Sharnamati	0.7	14,099	6,344	93	11,396	3,641	63
Project Area Representative	0.8	17,706	7,916	106	12,581	2,791	52
NEW DTW (25 ha) BIJALPURA SUB-PROJECT[2]							
	1.0	18,351	11,127	61	11,518	4,294	58

Note: 1 These are annual equivalent values, based on the FARMOD Cash Flows after Financing, discounted at 10%.

2 Unlike the STW analyses, this analysis does not include the TW capital costs.

225 In general, group STW development can be expected to yield very attractive returns to farmers, with major increases in net farm income and with high returns per family labour day input, above the typical rural wage of Rs 50 to 70/day prevailing in the Project Area. Even at Existing Performance levels, for the Project Area Representative Model farm incomes from the land commanded would increase by 28% (Rs 2,800) if there were no STW subsidy and by 42% (Rs 4,200) if the existing subsidy were maintained. With Improved Performance (the Project Base Case) the increases in income would be much greater, at 95% (Rs 9,300) with the subsidy and 81% (Rs 7,900) without the subsidy.

226 For the six sample site Sub-Projects, the results also indicate very favourable income effects for group STW members, the only exception being for Mrigauliya Sub-Project at Existing Performance levels (here the Before STW incomes are relatively high, because much of the VDC already has perennial or semi-perennial surface irrigation). Thus the Project will have a major poverty alleviation impact on the participating farm households. At the three sites with the lowest reported incomes (Sedhawa, Phattepur and Bharaul), with the Improved level of productivity but no subsidy, the beneficiaries' total household incomes would rise by, on average, between 24% and 35%, or Rs 5,600 and Rs 7,600.

227 For a sharecropping tenant with a 0.8 ha STW irrigated holding, net farm income would increase by between Rs 3,600 and Rs 5,500 per annum. The landlord's income increase would be somewhat less but the financial internal rate of return from his investment would be attractive, at 43% if there were no STW subsidy.

228 FIRRs for a group or individual investing in an STW, without taking out a loan or obtaining any subsidy, are shown in Table 6.

TABLE 6

Financial Internal Rates of Return from STWs (%)

Sub-Project/Project	Improved Performance Levels	Existing Performance Levels
Sample Site Sub-Project		
Sedhawa	77	48
Pattepur	82	57
Bijalpura	49	24
Bharaul	54	31
Mrigauliya	52	-1
Sharnamati	77	53
Project Area Representative STW Model		
- 4 ha group well	79	39
- 2.8 ha individual well	46	18

229 These results indicate that investment in STWs should bring high returns to STW groups and also, though to a somewhat lesser degree, to individual well owners, even if there were no STW subsidy. Analysis of the income effects of withdrawal of the fertiliser subsidy, for the Project Area Model at Improved Performance levels with no STW subsidy, indicated that incomes would be reduced by between 2% and 5%. The implication is that the farming community could absorb the elimination of fertiliser subsidies without too much difficulty.

230 Given these highly favourable financial results which, as noted elsewhere, are considered to be based on realistic crop area and yield estimates, the question then arises as to why STW irrigation is not expanding more rapidly in the Project area. Possible reasons have been given in Section II.A.4.

Poverty Alleviation Aspects

231 Table 7 shows income, household size and holding size details for the 108 would-be groups identified up to mid-March 1997 on the six sample sites. The accuracy of the income estimates, which are based on farmer interviews, may be variable.

TABLE 7

Income, Household Size and Holding Size Details of 108 Prospective STW Groups at the Six Sample Sites

Sample site	Household size (median)	Reported annual income (median in Rs)	Holding size (ha)	
			Total	Proposed STW area
Sedhawa	5	21,500	1.9	0.8
Phattepur	7	23,800	1.3	0.7
Bijalpura	7	44,700	2.2	0.8
Bharaul	6	22,800	0.9	0.8
Mrigauliya	6	30,000	1.5	1.5
Sharnamati	5	NA	1.0	0.7

Source: Consultant's field studies.

232 At each site there was a substantial variation around the holding size and income average or medians shown. It is clear, therefore, that a significant proportion of the would-be STW beneficiaries have incomes below the HMGN official poverty level income of Rs 4,140. The land ownership data presented in paragraph 222 indicate that 25% to 33% of the sample of would-be STW group members at Bharaul and Mrigauliya are living below the poverty line,

as represented by a land holding of 0.5 bigha owned. Most of these farmers are, however, in the upper half of the 0 to 0.5 bigha holding range, owning between 0.25 and 0.5 bighas. Thus they are not the 'poorest of the poor', in that they do at least own some land. If the average ownership of the 0 to 0.5 bigha group were taken to be, say, 0.35 bigha and their farm incomes per hectare were the same as for the Project Area Representative Model in Table 5, their incomes from this owned land would be as follows:

Item	Rs per annum from 0.35 bigha (0.235 ha) owned
Income before (without) STW	2,876
Increases in income due to STW development	
(a) Existing STW performance:	
• with 80% subsidy	1,222
• without subsidy	820
(b) Improved STW performance:	
• with 80% subsidy	2,727
• without subsidy	2,325

233 Depending on subsidy and productivity (STW performance) levels, the Project could thus be expected to raise net incomes from the small areas of land owned by the smallest landowner group by Rs 800 to 2,700 per annum. This would improve, but certainly not transform, their living standards. However, most such small landowners have either additional land rented in or off-farm sources of employment and income, or both. Given these other factors, it is difficult to quantify the precise impact of the Project STW development on rural proverty. The key parameter is that, as explained in paragraph 225, it will raise farm incomes from land brought under group STW irrigation by 28% to 42% (Rs 3,500 to 5,200/ha) at Existing Performance levels and 81% to 95% (Rs 9,900 to 11,600/ha) at Improved Performance levels. Such an improvement is bound to have a major poverty alleviation impact.

3 Economic Analysis

234 Economic analyses have been undertaken for the following:

(i) A single group or individual STW at each of the six sample sites and for the Project

Area, without inclusion of the non-tubewell Project or Sub-Project costs. Analyses for a DTW at Bijalpura sample site and for the Project Area have also been presented.

(ii) Each of the six sample site Sub-Projects.

(iii) The overall Project as a whole, with sensitivity tests to cover major areas of uncertainty such as the overall rate of STW uptake and the percentage of group versus individual STWs in that uptake. With their smaller command areas individual STW give lower economic returns than group STWs.

235 **Analysis of single tubewells:** The analyses undertaken showed economic internal rates of return (EIRRs) exceeding 50% for all the Base Case (Improved Performance) STW models and exceeding 21% at Present Performance levels for all cases except for an individual STW at Mrigauliya. In virtually all the situations and Sub-Projects analysed STWs should thus produce very high economic returns to investment for both groups and individuals, even if there is no improvement in well performance and crop productivity over present STW levels. Even where perennial or semi-perennial surface irrigation supplies are already available (the Conjunctive Use Model) STW installation is still very worthwhile.

236 As would be expected, with their much higher capital costs, the economic performance of DTWs is much less satisfactory. If present levels of irrigated agricultural productivity can be substantially improved, investment in DTWs can be economically justified but, if not, they do not provide adequate EIRRs In this case their development can only be justified on social grounds.

237 **Economic analysis of the six sample site Sub-Projects:** Table 8 summarises the results of these analyses.

TABLE 8

Economic Analysis of the Six Sample Site Sub-Projects (Rs '000)

Sub-Project	Total financial capital cost	Improved Performance (EIRR) (%)	Present Performance (EIRR) (%)
Sedhawa	5,620	55.9	28.6
Phattepur	10,298	63.3	37.5
Bijalpura	13,770	38.8	7.1
Bharaul	4,781	41.0	19.3
Mrigauliya	7,601	50.4	5.6
Sharnamati	13,330	98.1	63.5

Four of the six Sub-Projects would give very high economic returns even at Present Performance levels of productivity. The best performance is at Sharnamati, where groundwater and aquifer conditions are excellent, Before STW annual cropping intensities are low (no more than 100%), due to the general lack of surface irrigation, and enthusiasm for STW development is particularly strong. In this VDC 59 would-be STW groups have been identified, over three times more than on any other Sub-Project.

238 Provided that existing TW productivity levels can be appreciably increased which, given the investment to be made by the Project in raising productivity, is a reasonable expectation, Bijalpura and Mrigauliya Sub-Projects would also be economically feasible, with EIRRs of 39% and 50% at Improved Performance levels respectively. In the unlikely event of no such improvement being achieved, neither would be economically viable.

239 **Economic Analysis of the Overall Project:** For analysis purposes the Project benefits are taken to be only the agricultural benefits from tubewell irrigation. A substantial part of the costs are for supporting infrastructure, mainly rural roads improvement. It is debatable whether the whole of these costs should be charged against the agricultural (Project) benefits but, to avoid the danger of over-estimating economic returns, they have been included. The results of the main analysis are as follows :

EIRR	35.9%
Net Present Value at 10%	Rs 4,894 million

Thus the Project gives very attractive economic returns.

240 **Economic Analysis of the Proposed Rural Roads Improvement Works:** The average cost per VDC of the road improvement works proposed is Rs 2.17 million. To establish the benefits arising from these investments a producer surplus approach was used, it being impracticable to use a more conventional user benefit-based traffic model. Based on the average returns per hectare in the existing production condition (that is, before the proposed investment in STWs) it was considered that if both access road and village road improvements were undertaken a total benefit equivalent to an additional 3% per annum in net income per hectare would be realised. This was considered to be likely from:

- A 1% increase in income from improved marketing opportunity and sales;
- A 1% increase in income from improved productivity, in response to better marketing conditions; and
- A 1% increase in income as a result of reductions in the farm to market transport costs.

241 For the six sample sites taken in aggregate the EIRR is 18.6%. For the Project as a whole, utilising the net income figure per hectare for the whole Project area as calculated by the Project Area STW model, an EIRR of 13.6% was obtained. Given the social and other non-agricultural benefits from road improvement, the proposed programme is clearly worthwhile. The proposed investments have deliberately been limited to cases where bottlenecks exist, principally due to inadequate cross drainage.

4 Sensitivity Analysis

242 In view of the uncertainties concerning the future demand for (uptake of) STWs and the future productivity of STW and DTW irrigation, the following sensitivity analyses have been carried out:

(i) TW irrigation productivity remains only at Existing Performance levels. Apart from the lower benefits from the new STWs, this means that there will be no benefits from the assumed 9,640 existing STWs in the 300 VDCs, because their productivity will remain at its present levels.

(ii) Demand for new STWs in the 300 Project VDCs is only half that predicted, at 25 rather than 50 per VDC, so only 7,500 rather than 15,000 new STWs are installed under the Project.

(iii) STW command areas do not reach the predicted 4.0 ha average for group wells, but instead average only 2.8 ha, the present average for individual STWs.

243 Sensitivity analyses to cover the possibility of cost overruns have not been undertaken. The dangers of substantial cost overruns with STWs and DTWs, the largest single cost items, are minimal, and the Project involves no major construction works which carry a substantial risk element in terms of costs. The risk element is much greater with the Project benefits, which is why three sensitivity analyses of relatively 'severe' benefit scenarios have been carried out.

244 The EIRRs for the three sensitivity tests are as follows :

	%
• Productivity at Present Performance levels only	16.1
• Only 7,500 new STWs installed	23.1
• Average new STW command is only 2.8 ha	29.1

Given these high EIRRs, the Project is clearly highly robust in economic terms and can withstand quite severe adverse changes in benefit parameters without becoming uneconomic.

5 Project Risks

245 The Project has set ambitious targets in terms of the number of STWs to be developed and the number of VDCs to be covered. There are several major risks and uncertainties which may affect the Project's levels of activity, expenditure and impact. These concern the future levels (rates) of farmer uptake of STWs, HMGN's ability to fund tubewell subsidies, public sector institutional capabilities, and credit supply for group STWs after the present high levels of subsidy are reduced.

246 **STW Uptake:** At present, there are some 21,400 existing ADBN-type STWs in the Project area, of which around 2,000 are group wells. During its seven year implementation period the Project envisages an increase of 70% in this total, and a massive, almost seven fold, expansion in the number of group STWs. Over the past 15 years the rate of STW development in the Terai has been disappointingly slow, and no fully convincing explanation for this phenomenon has yet been found. If the Project is unable to accelerate the STW uptake rate its scale of operations will be unavoidably reduced. The proposed Technology Improvement and Dissemination component and the increased emphasis on extension and advisory services should increase STW returns and attractiveness, but at this stage there is no guarantee as to the overall impact of these improvement activities. The uncertainties with regard to the future expansion of group STWs are especially great. Existing experience in the Terai indicates that group STWs out-perform individual STWs in agricultural, economic and social terms, but the land tenure and other constraints involved tend to limit the numbers of group STWs. A major Project task will be to overcome such constraints by means of the proposed social mobilisation, awareness raising and other activities.

247 **HMGN STW Subsidy Funding:** At present (1996/97) the budgeted sum for private sector STW subsidies (those provided through ADBN/SFDP, and excluding subsidies on public sector TW projects) is Rs 44 million, having come down from the 1992/93 peak of Rs 64 million. This sum is for all five regions of the Terai. Each year the subsidy funds are fully drawn down, there being an excess of demand. Under the Project, the projected funding required at present STW subsidy levels will rise from Rs 10 million in Year 1 (1998) and Rs 31 million in 1999 to Rs 84 million in 2000 and Rs 125 million per year between 2002 and 2004. Given HMGN's financial constraints, it is by no means certain that such increased funding can be provided. Moreover, the Agricultural Perspective Plan also envisages a massive increase in STW subsidy funding, to reach Rs 160 million in 2000/1 and Rs 200 million in 2001/2. This estimate is based on the individual STW subsidy of 40%, not the group rate of 80%. Although there will be some overlap (duplication) between the two sets of figures, the overall total would clearly be at least Rs 250 million in 2002, if the projected rates of STW expansion are achieved. The affordability of such large subsidy sums is doubtful. If subsidy rates are reduced, as they should be, this will increase group STW credit requirements. As noted elsewhere, at present subsidy levels most groups should be able to install wells without loans, but this will cease to be the case once subsidy rates are reduced significantly. At present, the basis for a large increase in institutional lending for

group wells is shaky, although, with the upcoming Rural Finance Project and other measures, this situation should improve in the future.

248 **Public Sector Institutional Capabilities:** The Project will place heavy demands on the Groundwater Irrigation Division of DOI, in terms of a greatly increasing level of activity in the two regions, the large increase in the number of hydrogeologists and other staff employed there and a major change in GID's and GWRDP's role and modus operandi. The change from an implementing role to a facilitating role will be particularly challenging. Appropriate measures to enable these demands to be met and these changes to be made have been included in the Project. Another uncertainty concerns the future effectiveness of DOA extension services in the Project VDCs. At present, their presence and impact are slight. To overcome this problem, the Project contains generous financial provision for the posting of JTs to the VDCs and mechanisms to ensure good coordination between DOI, DOA and NARC.

249 **Credit Provision for Group STWs:** Provision of institutional group STW credit on a financially sustainable basis is another area of uncertainty, as mentioned above. Fortunately, time is likely to be available for the development of the necessary capacity, before the subsidy rate is reduced, but rural lending is often an area of difficulty, and the risks involved should not be under-estimated. A key requirement for the Project will be diversity of credit sources, including SFCLs and other Savings and Credit Organisations, ADBN and NGOs.

B Environment

250 The results of the Initial Environmental Examination showed that no significant adverse environmental impacts are anticipated, other than the impact of slightly lower groundwater levels at the end of the dry season (groundwater levels will recover completely during the monsoon) and the hazards of the wider use of agrochemicals as a result of agricultural intensification. These minor adverse effects will be monitored, and training will be undertaken to mitigate their effects. The main objective of the Environmental Monitoring Programme will be to provide the GWRDP offices and DOI with practical control standards for monitoring and evaluating environmental issues concerning the project. The overall goal of the monitoring plan will be to ensure the continuity of important environment functions and resources of the project area and hence the sustainability of the project. DOI will be responsible for the implementation and execution of the environmental monitoring plan.

251 Groundwater level changes and impact will be monitored by measuring the depth to watertable in selected wells and measuring the water discharge from wells and springs. The monitoring will be carried out every month of the dry season (November - May). The results will be interpreted by comparing the findings with the situation during the monsoon period.

252 The application of agro-chemicals will be monitored to determine whether the recommended application prescriptions have been strictly followed, whether prohibited chemicals have been applied (e.g. those listed by HMGN) and any evidence of toxicity. Sampling will be carried out on a quarterly basis on a sample of farm plots (a minimum of 10 in each district). The results will be interpreted by comparing the findings with the baseline situation.

253 On the basis of the visits made in connection with the study of existing environmental conditions and the potential environmental effects of increased groundwater irrigation on the sample sites, the finding was that the positive impacts on job opportunities and social income are expected to occur to a more satisfactory extent and the few adverse impacts that are likely to occur can be removed or mitigated by taking certain simple measures. From the environmental viewpoint the Project can be implemented quite safely. The two likely adverse effects can occur only as a result of human negligence and hence can be easily avoided with strict vigilance, as suggested in the monitoring plan. Proper guidance and training by well trained extension workers will reduce such adverse impacts to a minimum. Hence no subsequent EIA study needs to be done before Project implementation.

C Social Dimensions

254 The primary objective of group-based tubewell development is to encourage farmers to undertake STW installation and other improvements in agriculture which can directly benefit them. It is widely believed that the presently subsidised programmes which are targeted to benefit the poor do not always reach them, because political, social and economic factors restrict their access to these programmes. Helping farmers to organise themselves into groups and training them will help in overcoming such problems, since it will build their capacity for interaction with the programmes.

255 Another important objective is to create viable institutions at the local level. This is in line with the Irrigation Policy 1992 (amended January 1997), which envisages encouraging irrigation users' group federations to develop as multi-purpose institutions. This is considered important in order to develop farmers' capabilities to fulfil some of their needs on their own, thereby reducing their dependence on public institutions. Such farmers' groups, as a result of the development of their capabilities, could put pressure on public offices/officers to increase their responsiveness in helping farmers meet those needs which they cannot meet on their own.

256 During Project preparation, extensive social analysis and mobilisation was undertaken at the six sample sites of the CDR and EDR. This included a baseline assessment of the existing socio-economic situation, a survey of 153 STWs and DTWs in the Project area, and social mobilisation of potential STW groups. These activities formed a vital step in developing an appropriate framework for establishing viable STW groups. The baseline socio-economic assessment showed that the population in the Project area is ethnically mixed, with good

relationships between ethnic groups. Some community initiatives have already been taken at some sites, such as the improvement of village roads, and effective group action is widespread in activities such as surface irrigation. These factors bode well for the formation of viable community STW groups. A high proportion of the population are indigenous Tharus and Mushahar, who tend to be landless and poor. This was borne out by the low level of farm food sufficiency (less than six months for many of the people) and by the fact that half of those households surveyed had individual incomes substantially less than the official poverty level of Rs 4,140 per year.

257 The survey of the STWs and DTWs was carried out by social mobilisers from two NGOs, Grameen Bank Biratnagar and CEAPRED. All existing STW groups in the six sample sites were interviewed, and 25% of the individual STWs. The questionnaire covered STW group structure and function, and technical aspects regarding well construction and operation, agriculture and irrigation. The results from the questionnaire have been incorporated into the Project design. The majority of the STW groups were ethnically homogeneous (64%), and only 11% had trouble functioning. The most common group size was four, with 86% of group sizes falling in the range two to six.

258 Each NGO social mobiliser spent six months in a sample site, getting to know the villagers, explaining the rationale of the project and helping interested STW groups to form. At the end of this relatively short time, 165 would-be STW groups had been formed (108 by mid-March 1997 and the other 57 between mid-March and the end of April), an average of 27 per VDC. Details of the 108 groups are summarised in Annex A. This level of response is encouraging, since it indicates that there is a significant level of interest in STW groups in the Project area. A much greater response is expected from each VDC when the Project is under way, since there will be certainty of Project funds being available (unlike the present situation in the VDCs), the Social Mobiliser will be placed in each VDC for two years rather than six months, and farmers will be motivated to form groups by seeing other groups established and functioning.

V PROJECT LOGICAL FRAMEWORK

Design Summary	Targets	Project Monitoring Mechanisms	Risks/Assumptions
1 Goal Increased contribution of tubewell irrigated agriculture to GDP	Contribution of tubewell irrigated agriculture rises by Rs 1,490 million by 2004	Government statistics • National Planning Commission Annual Reports • Ministry of Finance Economics Survey Annual Reports	
2 Purpose Increase tubewell irrigated agricultural production in the East and Central Terai on a sustainable basis to improve the income of small farmers.	• Area of tubewell irrigated agriculture increased by 60,700 ha by 2004 • Output of major irrigated crops increases by 300,000 tonnes by 2004 • Small farmers' incomes from irrigated agriculture increase by 80% to 95% by 2004	• GWRDP monitoring • District Agriculture Extension Service crop census • GWRDP monitoring	Assumes existing policies (APP), subsidy environment, fertiliser availability, and credit facilities available
3 Components/Outputs 3.1 Groundwater irrigation developed	• 13,500 group STWs installed • 1,500 individual STWs installed • 67 new DTWs installed • 33 DTWs rehabilitated	• GWRDP monitoring, subsidy disbursement records	Assumes demand-driven approach within broad 'priority areas' for both individual and group STWs
3.2 Infrastructure developed to support groundwater irrigation development	• 619 km of access roads improved by 2004 • 240 km of village road surface improved and 2,400 culverts installed by 2004 • Village infrastructure upgraded according to need in 300 VDCs by 2004	• Project monitoring • Disbursement records • VDC reports	
3.3 Project management and groundwater support services established for tubewells.	• Project management by DOI established and supported by TA • 150 agricultural extension workers placed for 2 years covering 2 VDCs each by 2004 • Monitoring and evaluation procedures established by 1998	• DOI reports • DOI organogram • Staffing and training records	Reflects high priority accorded by HMGN to groundwater development

Design Summary	Targets	Project Monitoring Mechanisms	Risks/Assumptions
3.4' Technology improved and disseminated to end users	• Agricultural Research - Boro rice and other irrigated crops • fodder crops and crops for firewood • IPM • farmer-saved seed • Irrigation Research • distribution systems • water application • Engineering Research and Development - tubewell design • drilling methods • MTW construction • pumpsets	• Groundwater project monitoring • DOAD monitoring • NARC monitoring	
4 Activities 4.1 Groundwater Irrigation Development • Lines of credit established through rural finance institutions, procedures for credit disbursement streamlined and monitored • Prequalification of STW suppliers • NGOs contracted to undertake social mobilisation of STWUGs • Subsidies issued • STWs installed by private contractors • DTW feasibility studies undertaken, DTWs designed and constructed • Electrification of selected DTW clusters	**5 Inputs** US$ 22.9 million	Project Progress Reports and Review Mission	Assumes use of broad range of available rural finance institutions
4.2 Supportive Infrastructure Development • Road feasibility study as part of VDC feasibility study • Road design, construction and supervision • VDC advancement selection, construction and monitoring	US$13.9 million	Project Progress Reports and Review Mission	

Design Summary	Targets	Project Monitoring Mechanisms	Risks/Assumptions
4.3 Project Management and Groundwater Support Services • Institutional strengthening of DOI • Procurement of vehicles, motorcycles, equipment and offices • Agricultural extension support services procurred • DOI/NARC/DOA coordination • TA support procured • Training • BME and EMP, monitoring wells rehabilitated	US$ 8.4 million	Project Progress Reports and Review Mission	DOI staff available,especially hydrogeologists JT agricultural extension staff available
4.4 Technology Improvement and Dissemination • Agricultural and irrigation research programme • Engineering research and development programme • Technology Transfer Centres established • TA support procured • Dissemination of knowledge	US$ 2.8 million	Project Progress Reports and Review Mission	
	Total base cost US$ 48.1 million Contingencies US$ 11.3 million **Total cost US$ 59.4 million**		

ANNEX A

ANNEX A

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Details of the Would-be STW Groups at the Sample Sites Identified by Mid-March 1997

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ANNEX A

DETAILS OF THE WOULD-BE STW GROUPS AT THE SAMPLE SITES IDENTIFIED BY MID-MARCH 1997

Item	Sedhawa Parsa	Phattepur Bara	Bijalpura Mahottari	Bharaul Sunsari	Mrigauliya Morang	Sharnamati Jhapa
Nr of would-be groups	13	15	12	9	8	51
Household size						
• Average	5	7	6.5	6	6	5.5
• Range	2 - 12	2 - 23	1 - 18	1 - 20	1 - 12	1 - 13
Numbers of members						
(a) Total	174	134	87	67	43	328
(b) % of total who are part or whole tenants	41%	40%	18%	12%	37%	30%
(c) Members per group						
• Average	13	8	7.5	7	5	6
• Range	9 - 23	4 - 18	5 - 10	5 - 13	3 - 9	4 - 12
Persons available for farm work per member's household						
• Average						
• Range	2.8 1 - 9	3.4 1 - 12	2.8 1 - 7	3.5 1 - 9	NA NA	3.0 1 - 13
Number of groups which include tenants	6	12	9	6	3	25
Average % of tenants in these groups	86%	80%	75%	67%	38%	49%
Land holding per member (ha)						
(a) Total handling						
• Average	1.9	1.3	2.2	0.9	1.5	1.0
• Range	0.3 - 21.4	0.1 - 16.7	0.2 - 16.7	0.1 - 4.0	0.2 - 4.0	0 - 10.0
(b) Holding Within proposed STW command						
• Average	0.8	0.7	0.8	0.8	1.5	0.7
• Range	0.1 - 2.7	0.1 - 2.70	0.1 - 3.3	0.1 - 3.8	0.2 - 4.0	0.1 - 6.7
Median reported household income per head (Rs)	4,300	3,400	5,800	3,800	5,000	NA
% of households having off-farm income	54%	43%	68%	91%	26%	16%

Source: Consultant's/NGO staff working on the sample sites.

Note: These are the would-be groups identified up to mid-March 1997. More groups were subsequently identified by the NGO staff, although fewer data were presented about these groups.

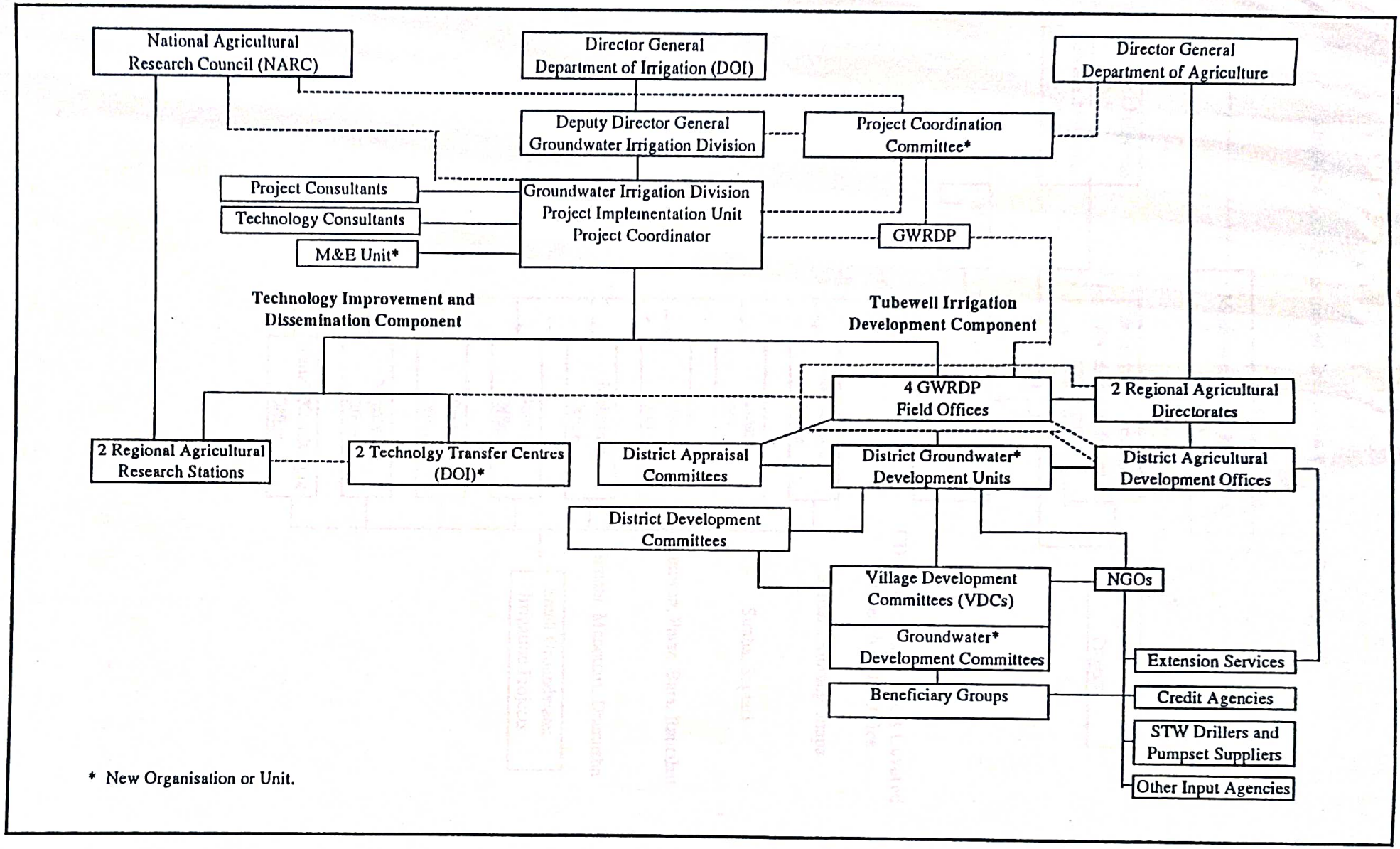
Nepal
Community Groundwater Irrigation Sector Projec
Components Project Cost Summary

	(Rs Million)			(US$ '000)			%	% Total
	Local	Foreign	Total	Local	Foreign	Total	Foreign Exchange	Base Costs
A. Groundwater Irrigation Development								
Shallow Tubewells	275.90	597.31	873.22	4,861.74	10,525.32	15,387.07	68	32
Mobilizing and Training Beneficiaries	200.72	2.03	202.75	3,537.00	35.73	3,572.72	1	7
New Deep Tubewells	84.74	82.08	166.83	1,493.26	1,446.41	2,939.66	49	6
Rehabilitation of Existing Deep Tubewells	32.86	25.43	58.29	579.08	448.08	1,027.16	44	2
Subtotal Groundwater Irrigation Development	594.23	706.85	1,301.09	10,471.08	12,455.53	22,926.61	54	48
B. Supportive Infrastructure Development								
Access Roads	353.03	58.93	411.96	6,220.79	1,038.35	7,259.14	14	15
Village Roads	262.75	43.84	306.59	4,629.92	772.47	5,402.39	14	11
Other Village Infrastructure	69.73	-	69.73	1,228.80	-	1,228.80	-	3
Subtotal Supportive Infrastructure Development	685.51	102.76	788.28	12,079.52	1,810.81	13,890.33	13	29
C. Project Management and Groundwater Support Services								
Project Management and DOI Support Services	81.12	98.52	179.64	1,429.44	1,735.96	3,165.40	55	7
Agricultural Extension	100.92	6.60	107.52	1,778.24	116.38	1,894.63	6	4
Monitoring and Evaluation	20.10	7.44	27.54	354.18	131.06	485.24	27	1
Technical Assistance - Project Consultants	58.49	104.60	163.09	1,030.68	1,843.20	2,873.88	64	6
Subtotal Project Management and Groundwater Support Services	260.63	217.16	477.79	4,592.53	3,826.60	8,419.14	45	18
D. Technology Development and Dissemination								
Agricultural and Irrigation Research	18.19	1.68	19.87	320.46	29.59	350.05	8	1
Engineering Research and Development	1.62	3.71	5.32	28.51	65.32	93.83	70	-
Training Centres	22.81	8.61	31.41	401.88	151.64	553.52	27	1
Technical Assistance - Technology Consultants	21.50	76.71	98.21	378.93	1,351.68	1,730.61	78	4
Dissemination	5.48	0.61	6.09	96.63	10.74	107.36	10	-
Subtotal Technology Development and Dissemination	69.60	91.31	160.91	1,226.40	1,608.97	2,835.37	57	6
Total BASELINE COSTS	1,609.97	1,118.08	2,728.05	28,369.53	19,701.92	48,071.45	41	100
Physical Contingencies	169.21	107.32	276.53	2,981.69	1,891.16	4,872.85	39	10
Price Contingencies	221.40	144.16	365.56	3,901.31	2,540.19	6,441.51	39	13
Total PROJECT COSTS	2,000.58	1,369.56	3,370.14	35,252.53	24,133.28	59,385.80	41	124

Nepal
Community Groundwater Irrigation Sector Pr
Disbursement Accounts by Financiers
(US$ '000)

	Asian Development Bank		The Farmers		Bilateral Agency		His Majesty's Government of Nepal		Total			Local (Excl. Taxes)	Duties & Taxes
	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%	For. Exch.		
Tubewell Works	11,345.13	46.8	5,223.66	21.6	-	-	7,670.27	31.6	24,239.06	40.8	15,552.78	6,573.28	2,113.02
Infrastructure	15,712.07	91.5	-	-	-	-	1,456.41	8.5	17,168.48	28.9	2,238.78	13,473.28	1,456.41
DOI Costs	4,019.29	93.8	-	-	-	-	267.80	6.2	4,287.09	7.2	2,191.32	1,827.97	267.80
Agricultral Contract Packages	2,646.18	100.0	-	-	-	-	0.00	-	2,646.18	4.5	173.91	2,472.27	-
NGO Contracts	4,201.10	95.0	-	-	-	-	221.11	5.0	4,422.21	7.4	44.22	4,156.87	221.11
Monitoring and Evaluation	578.74	98.7	-	-	-	-	7.34	1.3	586.08	1.0	151.33	427.41	7.34
Specialist Services	5,504.54	100.0	-	-	-	-	-	-	5,504.54	9.3	3,723.99	1,780.55	-
Training Centres	395.00	98.6	-	-	-	-	5.61	1.4	400.61	0.7	43.80	351.20	5.61
Media Expenses	131.56	100.0	-	-	-	-	0.00	-	131.56	0.2	13.16	118.40	-
Total	44,533.61	75.0	5,223.66	8.8	-	-	9,628.54	16.2	59,385.80	100.0	24,133.28	31,181.25	4,071.28

Project Organisation Chart



* New Organisation or Unit.

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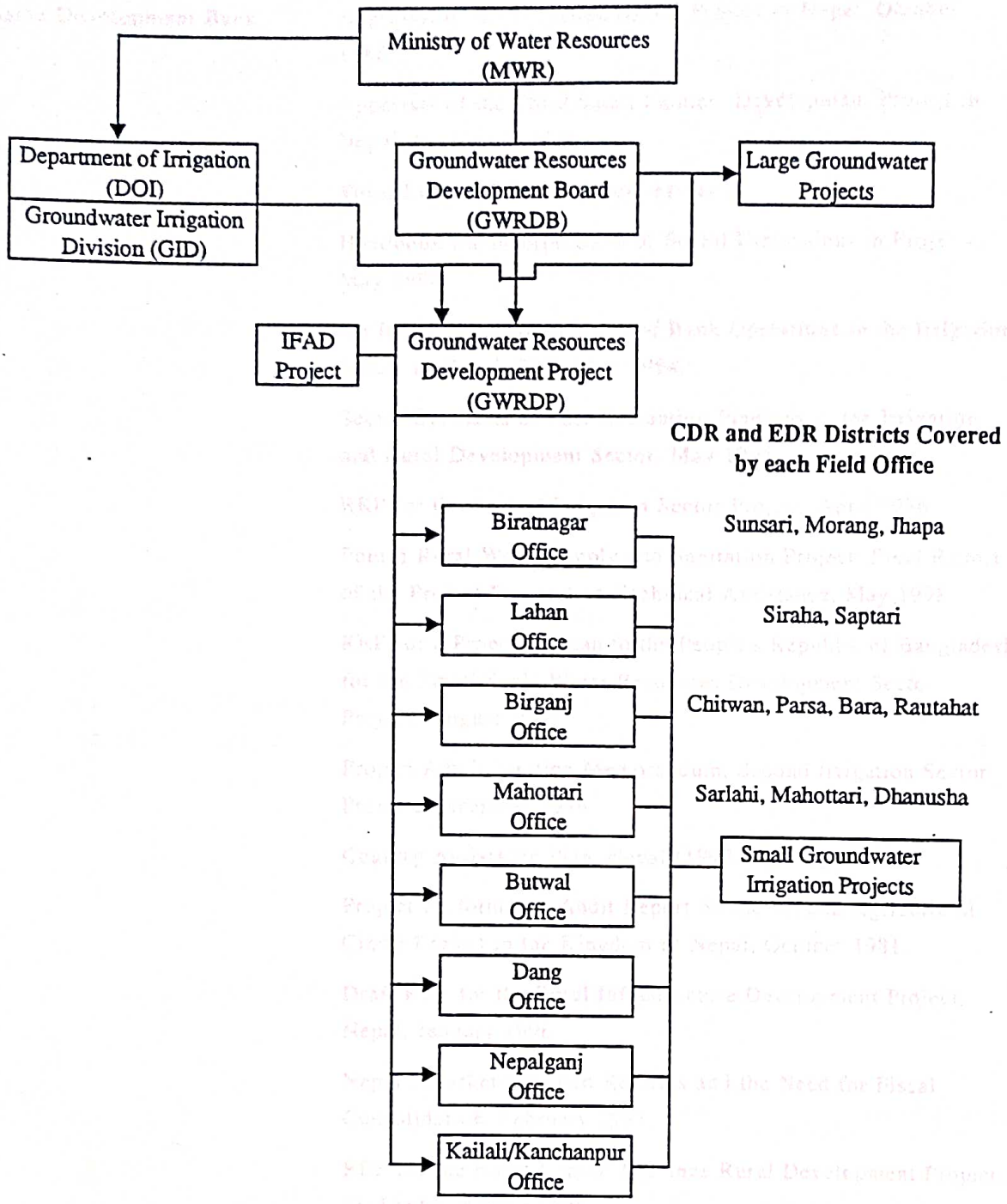
Organisational Structure of Groundwater Irrigation Development



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