XII. ECONOMIC AND FINANCIAL EVALUATION

Approach to Evaluation

69 The proposed Project is planned to be a multi-purpose dam serving for power generation, irrigation, and flood control. Three types of power benefits were considered, i.e. the benefits derived from avoided thermal, the Long Run Marginal Cost (LRMC) as benefits, and the benefits derived from consumer surplus.

The financial analysis was carried out to answer (1) whether the overall Project is profitable, (2) whether the potential investors, private or public, or joint efforts, will see the incentives attractive enough for them to forgo the investment opportunities, and (3) whether the Project could bring reasonable level of income to the government, federal and provincial, through dividends distribution, taxes, water charges, and other charges and duties, with focusing power generation alone (using the separable cost - remaining benefits)

Three modalities of financing schemes were tested assuming private investment (BOT), public investment, and joint ventures (BOT).

Major Assumptions and Conditions

70 A discount rate of 10% was used in economic analysis to reflect the opportunity cost in Pakistan and 12% was tested for financial analysis. An exchange rate of US$ 1 for Rs. 50 was used in the analyses. The service life of civil works was assumed at 50 years and the electrical and mechanical components are assumed to be replaced during the life of the Project. The cost estimate reflects the mid-1999 constant price. Price escalation is taken into account up to the year 2009 when the dam construction is completed, with an international inflation rate of 2.4% per year. In financial analysis, a US¢ 0.23 per kWh water charge is levied on independent power producers (IPPs). The total capital cost on the Munda Project was estimated at US$ 1,148.9 million (including US$ 120.0 million in tax and duties), of which US$ 611.8 million, or 53% is in foreign cost. The construction period was assumed to start from the year 2002, and last to the year 2009. The date of commissioning was assumed in the year 2010. The average rate for O&M was assumed at 0.5% per annum of the total capital cost, and average auxiliary rate and line loss to delivery point were assumed to be 1.3% of the total generation.

Valuation of Benefits

71 Avoided Cost: The avoided thermal units assumed is a mix of gas turbine for peak power generation and combined cycle generators for off-peak. The off-peak

energy contributions result in avoided fuel and O&M cost of the thermal power plant.

72 Long Run Marginal Cost (LRMC): LRMC was calculated in a study conducted by HEPO in 1994/95, and updated to a level of September 1999. The LRMCs at peak and off-peak are estimated to be US$ 0.061/kWh and US$ 0.056/kWh, respectively. Energy output at power plant is 847 GWh at peak and 1,560 GWh at off-peak, totaling in 2,407 GWh. The multiplication of the LRMC with energy generation makes power benefits consisting of primary energy benefit as US$ 51.1 million and the secondary as US$ 85.5 million.

73 Consumer Surplus: WAPDA's average tariff as per April 1999 was calculated to be about Rs 3.76/kWh or equivalent to US¢ 7.52/kWh. Consumer surplus is the method usually used in estimating consumer's willingness to pay (WTP). In this Study, consumer surplus is assumed to be conservative, around 50% over the prevailing tariff. The tariffs with consumer surplus at peak and off-peak are estimated to be US$ 0.1094/kWh and US$ 0.0547/kWh. The multiplication of these tariffs with energy to be generated makes the consumer surplus-based benefits consisting of US$ 91.4 million for primary and US$ 84.3 million for secondary energy.

74 Agricultural/Irrigation Benefits: The evaluation of the agricultural and irrigation costs and benefits is based on with and without scenarios. Three irrigation benefits, i.e., for new command area, for additional water supply, and for stable and sufficient water supply, were considered here, thereby being US$ 5.79 million (Rs 289.7 million).

75 Flood Mitigation Benefits: Economic and financial benefits were calculated as US$ 0.92 million and US$ 1.03 million, respectively.

76 Environmental Benefits: Environmental benefits of avoided thermals units were tested, using the internalized environmental cost of thermal units. In the present feasibility study, the environmental cost for gas turbine is assumed for peak power generation at US¢ 1.32 per kWh and for combined cycle for off-peak generation, at US¢ 0.86 per kWh based on a World Bank study in 1994.

Cost Allocation

77 The Munda Dam is a multipurpose project and the method called Separable Cost Remaining Benefits is used for cost allocation.

Economic Viability of Project

78 The economic viability of the Project was assessed by the economic internal rate of return (EIRR). Economic construction cost is estimated to be US$ 744.0

million. Benefits consist of power generation, irrigation and flood control, out of which power benefits are separately estimated by i) avoided cost, ii) LRMC, and iii) consumer surplus. EIRRs for three methods are:

Avoided cost	13.7%
LRMC without environmental benefit	13.3%
LRMC with environmental benefit	14.9%
Consumer suplus	15.8%

On the other hand, EIRRs by purposes are:

Description	EIRR
Power	13.4%
Irrigation	9.7%
Flood control	24.2%

Financial Viability of Project

79 The financial viability of the Project was assessed by financial internal rate of return (FIRR). Financial construction cost is estimated to be US$ 1,148.9 million. The results of FIRRs are summarized as follows:

Description	FIRR
The Project as a whole	12.7%
Power	13.2%
Irrigation	4.1%
Flood control	19.7%

Financial Analysis

80 The financial analysis of the Munda Project was based on the assumption that the scheme (Power Only) will be owned and operated by an independent company (Private, or Public, or Joint Venture) that will supply all the energy generated to the national grid. The grid was assumed to be operated by WAPDA or the future transmission company, which will purchase all the energy at a technically and economically acceptable point. The tariff, as well as other relevant parameters for financial analyses, was determined based on two principles: a) the Project must be profitable, and b) the tariff level should be lower than Rs 3.9/kWh or US¢ 7.8/kWh which was paid to IPP in 1997/98.

Three scenarios are envisioned under BOT; i) 100% publicly-owned, ii) 100% privately-owed, and iii) Public-Private joint ventures. Prices used in the analyses are market prices. The analyses were carried out in fixed prices, at the mid-1999 level. A 25-year life time after commissioning of Munda was assumed and at the end of the 25 years, the Project will be transferred to the Government free of charge.

81 Public-Private Investment Model: The public-private model assumes a joint venture between GOP and a consortium of private sector. An independent power development company under BOT schedule was assumed in this model and the

debt-equity ratio of 70-30 was used. GOP would be responsible for 25% of equity investment, and the GOP equity was assumed to come from an international soft loan, with an interest rate of 1.8%, a 30-year repayment including a grace period of ten years. The prevalent interest rate of commercial loans in Pakistan was assumed at about 12.5%. The international soft loan, in this model, was assumed to cover 25% of the total loan to correspond to the proportion of the government ownership of the Project. However, Japan Bank of International Corporation (JBIC - Previous OECF) loan can actually cover up to 75% of the total project cost. A flat, 25-year depreciation rate was assumed. The concession period is 25 years and after 25 years, the Project will be reverted to GOP. The results for the Public-Private Investment Model are as follows:

	Public-Private Investment Model	FIRR
1.	FIRR on Project	12.8%
2.	FIRR on equity	15.2%
3.	FIRR on GOP receipts, including Dividends, Water Charge and others	17.4%
4.	FIRR on GOP (Dividends only)	15.2%
5.	NPV at 12%, Million US$ of Total GOP Receipts	86.7

82 Private Investment Model: This model assumes 100% of private investment in the Project. The debt-equity will still be 70-30%, yet the loans will all come from commercial loans with higher interest rate, at a weighted average of 12.5%, and short repayment period, in most cases, without grace period.

In the 100% Privately-owned Model, the government's income will come from water charge only. The results are summarized below:

	100% Private Investment Model	FIRR
1.	FIRR on Project	12.8%
2.	FIRR on equity	11.1%

83 Public Investment Model: In this model, the power company will pay no tax and the project cost will be covered by an assumed international soft loan at an interest rate of 1.8% per annum, 30-year repayment period and 10-year grace. The results are shown as follows:

	100% Public Investment Model	FIRR
1.	FIRR on Project	12.8%
2.	FIRR on equity	26.2%
3.	NPV at 12%, Million US$ in water charge and dividends	562.7

Sensitivity Analysis of FIRR

84 Risks in investing in hydropower projects in Pakistan, from a developer's point of view, include external and project risks. External risks are foreign exchange risks (convertibility and devaluation) and inflation. Project risks are the possibility that the sales price agreed in the Power Purchase Agreement fails to be honored and unexpected tax increase. Other risks include cost and time overrun, power production short of projection for hydro and other reasons, O&M cost increased

by 20% of the total project cost, commissioning date delay by one year, and unexpected increase of water charge and corporate income tax.

Sensitivity analysis of FIRR was carried out on the 100% publicly owned model to test the risks involved in the Project. The results are favorable, except the return on Project is somewhat sensitive to the delay and investment cost increase, implying the lengthy duration of project construction.

	Risk Analysis	FIRR on Project	FIRR on Equity
1.	GOP Investment Base Case	12.8%	26.2%
2.	O&M Cost Increased by 20%	12.8%	26.1%
3.	Water Charge Up by 20%	12.7%	26.1%
4.	10% Increase in Investment Cost	10.9%	23.1%
5.	10% Decrease in Total Energy Sales	11.6%	24.1%
6.	Project Delay by One Year	11.7%	22.9%

Loan Repayability

85 At this stage, no sponsor for this Project has been identified, and the allocation of fund resources was roughly estimated based on experience. Loan repayability was tested using Debt Service Current Ratio (DSCR) for the three financial models:

Model	Average Interest	Repayment Period	Grace Period	DSCR
JV	9.8%	25 years	0	1.4
Private	12.5%	25 years	0	1.1
Public	1.8%	25 years	10 years	5.0

As is seen above, the minimum DSCR for publicly owned model is 5.0 times, showing a very strong loan repayment ability while that for privately-owned is 1.1 times which are below the usually required 1.5 times by international development agencies, thus being not easy for repayment.

Note: DSCR means (Net after tax profit excluding depreciation, interest and repayments) / (Principal and interest payments).

Summary of the Economic and Financial Analyses

86 Since the Munda Project is a multi-purpose project, the estimated cost was allocated into three different portions, power generation, irrigation, and flood control, using Remaining Benefits Method. Both economic and financial analyses, simple methods, were tested on total project, (1) power generation only, (2) irrigation only, and (3) flood control only. The results of the economic and financial analyses are shown in the following table:

Unit: Million US$

	Total Project*	Power Only*	Irrigation Only	Flood Control
EIRR in 50 years	13.2 %	13.4 %	9.7 %	24.2 %
Total Project Cost (Economic) in Mil US$	735.6	687.9	45.7	2.0
NPV of Benefit at 10% Discount rate (Economic)	194.17	193.2	(1.0)	3.05
* Using LRMC cost at 500 kV				
FIRR in 50 years	12.7 %	13.2 %	4.1 %	19.7 %
Total Project Cost (Financial) in Mil US$	1,148.9	1,074.5	71.3	3.1
NPV of Benefit at 12% Discount rate (Financial)	55.1	83.0	(27.2)	1.75

The economic benefits of power is based on LRMC. EIRR of irrigation is below 10%, which shows low economic viability while the FIRR is as low as 4.1% and hence irrigation would not be objective of investment. FIRR of the total project is 12.7%, slightly higher than the opportunity cost of capital (12%).

XIII. RECOMMENDATIONS

87 The Feasibility Study has concluded that the Munda Dam Multipurpose Project is feasible technically and viable economically and environmentally. Recognized as being in a state that the detailed design can commence whenever the fund becomes available, the Feasibility Study recommended that the field investigation and studies required for the detailed design as described below be conducted, provided that depending on the fund available, a part of the items therein could be advanced prior to full scale detailed design.

Field Investigations for Munda Dam

88 Topographic Survey: A series of detailed topographic survey will be required for the detailed design of the structures and locations where no topographic survey could be done in this Feasibility Study, i.e. the re-regulation weir, contractors' site installation area, the proposed quarry sites with access road routes thereto, the borrow area for concrete aggregate and earth embankment materials, all being in a scale of 1:1,000 or larger.

89 Geological Investigation: A detailed geological investigation will further be required for the detailed design in the future, for confirmation of the foundation condition at exact locations of the structures to meet the finally determined layout, the confirmation of the rock mechanical characteristics, the detailed confirmation of the quarry sites, especially about Todobo Banda quarry, and the detailed confirmation of the borrow area at West Sadar Garhi.

90 Hydrological Investigation: The following hydrological investigations are recommended:

1) Observation of the new hydrological gauging stations established at Zulam and Munda during the feasibility study stage should be commenced and continued.
2) Rainfall observation network in the Swat River basin should be improved by adding rain gauges especially in the western side including Panj Kora River basin and Ambahar River basin.
3) River gauge network should be strengthened by adding at least a gauge in Panj Kora basin and a gauge in Ambahar basin.

91 Hydraulic Model Studies: Hydraulic model studies are recommended for the spillway, power intake, and river outlet in order to evaluate:

1) Required shape of the spillway forebay
2) Discharge capacity of both the gated and non-gated overflow sections
3) Flow behaviors in the headworks, chute, and energy dissipator
4) Selection of shape and locations of aeration system within the chuteway
5) Required shape of power intake in respect of bellmouth and anti-vortex device
6) Required shape and length of river outlet facilities

Field Investigations for Irrigation Facilities

92 Topographic Survey: A detailed topographic survey will be required for detailed planning and design for the new command area at both left and right banks at a scale of 1:5,000, along the feeder tunnel and its outlet area at the right bank, the pumping station area and the locations of major structures such as river crossing, aqueducts, road culverts, superpassages at a scale of 1:1,000 or larger. In addition, cadastral maps over the command area should be compiled.

93 Geological Investigation: A detailed geological investigation will be required for the detailed design of the feeder system at both banks. The investigation would include such items as, but not limited to, core drillings at the intake and outlet of the feeder tunnel and pump station, and seismic refraction along with the feeder tunnel.

Items of Field Investigation and Studies Prior to Full Scale Detailed Design

94 During and prior to arrangement of full scale fund for the Project, some of field investigation and studies may be advanced with fund available or arranged by the Government of Pakistan. Those are:

1) Topographic survey and geological investigation over the re-regulation weir.
2) Preliminary study on hydropower plant at the re-regulation weir.
3) Preliminary study on mini hydropower plant utilizing the irrigation water for the left bank and head available in the feeder tunnel.
4) Topographic survey and geological investigation for the command area at the right bank where development of the lift irrigation scheme may be considered even prior to implementation of the Munda dam.

Environmental Assessment

95 The following issues will need detailed analysis to be carried for the next phase of Environmental Assessment.

1) An EIA for the route of the transmission lines selected for the Project.
2) Detailed studies of fish for fragmented populations and other aquatic life will be carried out. Community participation and evaluation of the economic benefits will also be carried out.
3) Detailed plans for rescue and retrieval of archeological sites, establishment of a museum, and a plan for the promotion of tourism.
4) A master plan will be developed for wildlife conservation, range management, social forestry, medicinal plants and erosion control.

Others

96 In relation to the development of new command area, the following issues should be settled with the local administration during the detailed design stage or prior to the decision of the implementation:

1) Issues related to the development of new command area be settled first with Indus River System Authority (IRSA).
2) The issue on the Palai small dam scheme which is pending should be settled and decision on resumption of its construction should be made.
3) The issue on the existing Tangi lift irrigation scheme should be settled and agreement with the farmers as to what the scheme becomes a part of the new command area should be arrived at.
4) The issue on the existing Warsak left irrigation scheme should be settled so that a part of the command area be incorporated in the new command area.
5) Formation of farmer's association should be initiated within the new command area, together with the explanation campaign to the concerned farmers and/or residents.

6) Field investigation should be conducted as to the details of the existing tube wells owned by the privates within the new command area and confirmation should be made if the owners are ready to participate in the new irrigation system.

TABLES

Table S1 Statistics at a Glance of Country (WAPDA + KESC)

Fiscal Year Ending 30th June		1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Installed Capacity (MW) excl. KANUPP	Hydel	2547	2897	2897	2897	2897	2897	2897	2897	3329	3761	4725	4825	4825	4825	4825
	Thermal	2335	2580	3190	3560	3760	4160	4830	5879	5902	6129	6694	7506	8026	6645	6855
	Total	4882	5477	6087	6457	6657	7057	7727	8776	9231	9890	11419	12331	12851	11470	11680
Addition during the year (MW)			595	610	370	200	400	670	1049	464	668	1529	912	520	-1381	210
Energy Generation (GWh)*	Hydel	12822	12245	13804	15251	16689	16974	16925	18298	18647	21111	19436	22858	23206	20858	22060
	Thermal	8749	10386	11362	12960	16173	17613	20456	22388	26375	27052	31241	31820	34741	28420	24437
	Private (HUBCO+KAPCO+KEL)													161	10740	13580
	Total	21571	22631	25166	28211	32862	34587	37381	40686	45022	48163	50677	54678	58108	60018	60577
Maximum Demand (MW) (Undiversified)**		4027	4588	4805	5270	5996	6500	6803	7310	7805	8860	9489	9697	9791	10081	10554
Maximum Demand (MW) (Diversified)***		3948	4498	4711	5167	5878	6373	6670	7167	7652	8686	9303	9507	9599	9883	10347
Energy Sales (GWh)*		15740	16934	19076	21684	25144	26715	28931	31513	34296	36635	37867	40456	42648	44078	45807
No. of Consumers		4881316	5225446	5642209	6102422	6658910	7345623	7857377	8351432	8845100	8291984	9843365	10367886	10768265	11205948	11651822
* Export by KESC to WAPDA excluded & included Import from KESC		37	674	471	191	116	32	264	41	463	517	351	208	298	91	161

** Addition of Computed Demand of WAPDA & KESC

*** Undiversified Demand has been divided by 1.02 factor

Source: WAPDA Power Systems Statistics

Table S2 Load Forecast (Country)

(Without Captive Power)

Based on Normal Growth Assumption of Energy Consumption

Year	Energy Sales (GWh)	Growth Rate (%)	Losses			Energy Generated (GWh)	Load Factor (%)	Peak Demand (MW)
			T & D (%)	Auxiliary (%)	Total (%)			
1997-98	45,035	4.24	25.79	2.75	28.54	63,024	69.8	10,308
1998-99	47,737	6.00	24.54	2.68	27.22	65,595	68.9	10,872
1999-00	51,078	7.00	23.17	2.66	25.83	68,867	68.3	11,515
2000-01	55,165	8.00	21.81	2.65	24.46	73,026	67.7	12,319
2001-02	59,578	8.00	20.48	2.63	23.11	77,482	67.1	13,186
2002-03	64,344	8.00	19.16	2.61	21.77	82,253	66.5	14,122
G.R(1998-03)	7.4%					5.5%		6.5%
2003-04	70,135	9.00	18.60	2.61	21.21	89,011	66.2	15,348
2004-05	76,447	9.00	18.02	2.61	20.63	96,313	66.0	16,670
2005-06	83,327	9.00	17.44	2.60	20.05	104,221	65.8	18,087
2006-07	90,827	9.00	16.87	2.60	19.47	112,786	65.6	19,625
2007-08	99,001	9.00	16.30	2.60	18.89	122,062	65.4	21,296
G.R(2003-08)	9.0%					8.2%		8.6%
2008-09	107,911	9.00	15.72	2.59	18.32	132,108	65.3	23,111
2009-10	117,624	9.00	15.58	2.59	18.17	143,734	65.1	25,214
2010-11	128,210	9.00	15.44	2.58	18.02	156,389	64.9	27,509
2011-12	139,749	9.00	15.30	2.57	17.88	170,166	64.8	29,975
2012-13	152,326	9.00	15.17	2.57	17.73	185,163	64.8	32,618
G.R(2008-13)	9.0%					8.7%		8.9%
2013-14	166,035	9.00	15.15	2.57	17.72	201,783	64.8	35,547
2014-15	180,978	9.00	15.15	2.57	17.72	219,943	64.8	38,746
2015-16	197,266	9.00	15.15	2.57	17.72	239,738	64.8	42,233
2016-17	215,020	9.00	15.15	2.57	17.72	261,315	64.8	46,034
2017-18	234,372	9.00	15.15	2.57	17.72	284,833	64.8	50,177
G.R(2013-18)	9.0%					9.0%		9.0%
Av. G.R. (1997-2018)	8.4%					7.8%		8.0%

Source: WAPDA

Table S3 Generating Capacity Addition During 9th Five-Year Plan (1998/99 to 2002/03)

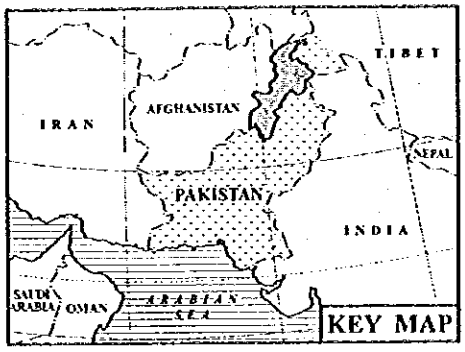
Name of Power Station/ Fiscal Year ending 3th June	9TH FIVE YEAR PLAN					
	1998	1999	2000	2001	2002	2003
A. PUBIC SECTOR						
1 Chashma Nuclear	0	0	325	325	325	325
2 Chashma Low Head Hydel	0	0	184	184	184	184
3 Ghazi Barotha Hydel 1-5	0	0	0	0	1160	1450
Subtotal (A)	0	0	509	509	1669	1959
Addition during the year	0	0	509	0	1160	290
B. PRIVATE SECTOR						
1 AES Lal Pir Ltd.	362	362	362	362	362	362
2 Southern Elec. Power Co. Ltd.	117	117	117	117	117	117
3 AES Pak Gen: Ltd.	365	365	365	365	365	365
4 Habib Ullah Energy ltd.	140	140	140	140	140	140
5 Liberty Power Project	235	235	235	235	235	235
6 Japan Power Gen. Ltd.	0	120	120	120	120	120
7 Rousch Pak Power Ltd.	0	412	412	412	412	412
8 Uch Power Project	0	586	586	586	586	586
9 Fauji Kabirwala	0	157	157	157	157	157
10 Altern Energy Ltd.	0	14	14	14	14	14
11 Ecshatech Ltd.	0	20	20	20	20	20
12 Davis Energon	0	10	10	10	10	10
13 Power Gen. System	0	116	116	116	116	116
14 Saba Power Co.	0	114	114	114	114	114
15 Northern Electric Co.	0	6	6	6	6	6
Subtotal (B)	1219	2774	2774	2774	2774	2774
Addition during the year (Thermal)	1219	1555	0	0	0	0
Total (A+B)	1219	2774	3283	3283	4443	4733
Total Addition during the year	1219	1555	509	0	1160	290

Source: WAPDA Power Systems Statistics

Table S4 Summary of Project Cost Estimate

Description	F.C. (million US$)	L.C. (million US$)	Total (million US$)
I. Base Cost			
(1) Local Contract			
L-1 : Access Road	0.0	3.3	3.3
L-2 : WAPDA Camp	0.0	5.0	5.0
L-3 : Power supply system	0.0	1.0	1.0
Sub-total (1)	0.0	9.3	9.3
(2) International Contract			
I-1 : Diversion Tunnel	37.5	33.4	70.9
I-2 : Main Civil Works	188.2	163.6	351.8
I-3 : Gate and Penstock	45.7	8.1	53.8
I-4 : Turbines and Auxiliaries	50.2	5.6	55.8
I-5 : Gererators and Auxiliaries	70.0	7.9	77.9
I-6 : Switchgear Equipment	16.8	1.8	18.6
I-7 : Transmission Line & S/S	14.8	5.0	19.8
I-8 : Irrigation Facilities	16.8	23.0	39.8
Sub-total (2)	440.0	248.4	688.4
Sub-total (1)+(2)	440.0	257.7	697.7
(3) Engineering Service	34.0	11.3	45.3
(4) Administration	0.0	17.4	17.4
(5) Land Compensation	0.0	2.5	2.5
(6) Environmental Mitigation	0.0	5.0	5.0
Sub-total (1) to (6)	474.0	293.9	767.9
(7) Tax	0.0	120.1	120.1
Sub-total I (Base cost)	474.0	414.0	888.0
II. Contingency			
Price Contingency	91.5	77.6	169.1
Physical Contingency	46.3	45.5	91.8
Sub-total II (Contingency)	137.8	123.1	260.9
Total Project Cost	611.8	537.1	1,148.9

FIGURES



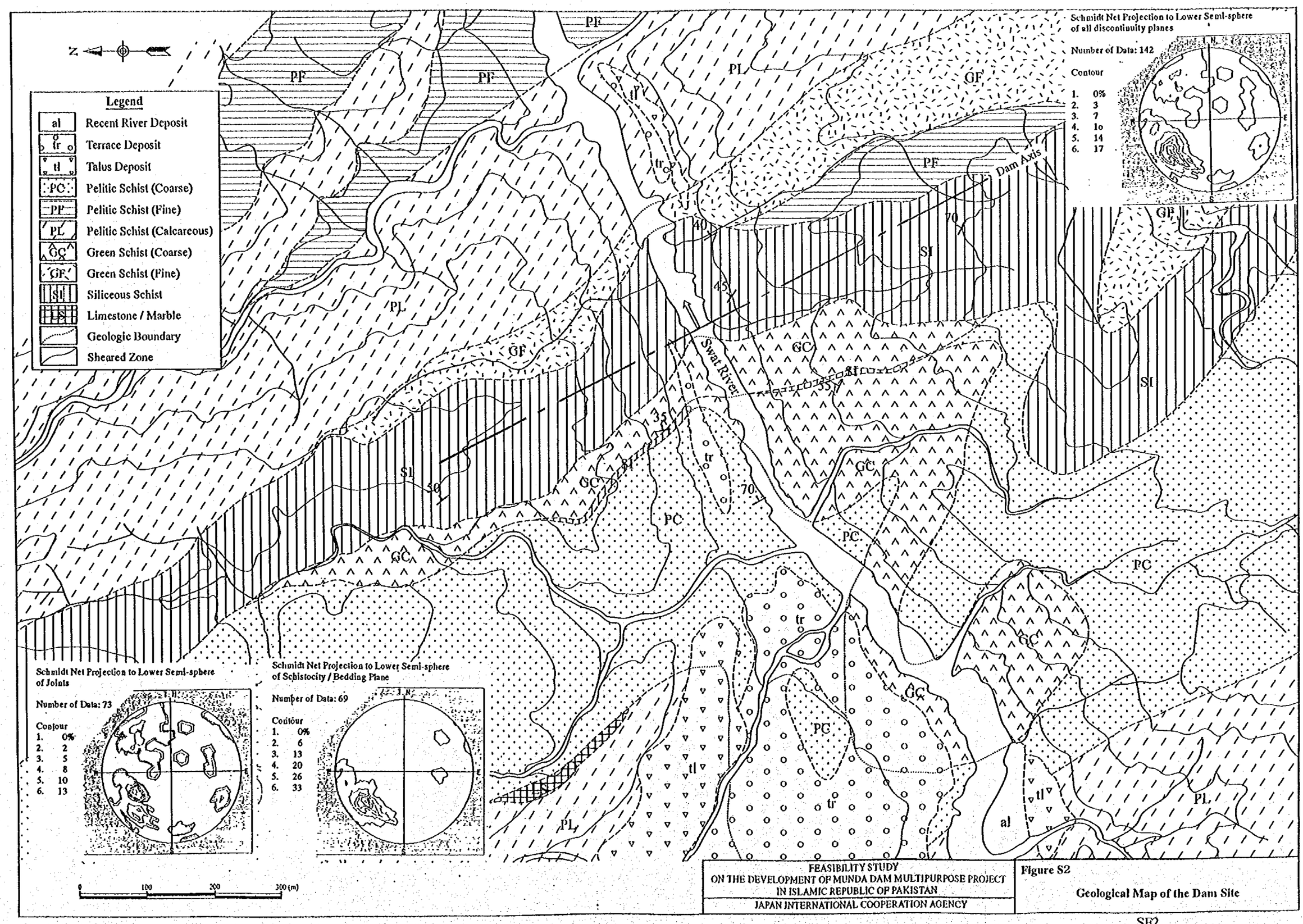
Federally Administered Tribal Areas		
	District and Tribal	Headquarter
a	South Waziristan	Wana
b	North Waziristan	Miranshah
c	Kurram	Parachinar
d	Orakzai	Adam Khel
e	Khyber	Landi Kotal
f	Mohmand	Yakkaghund
g	Bajaur	Khar

	District and Tribal	Headquarter
1	Chitral	Chitral
2	Swat	Kalam
3	Dir	Dir
4	Kohistan	Dasu
5	Mansehra	Mansehra
6	Batgram	Batgram
7	Buner	Saidu
8	Malakand	Malakand
9	Mardan	Mardan
10	Swabi	Swabi
11	Abbottabad	Abbottabad
12	Haripur	Haripur
13	Charsadda	Charsadda
14	Nowshera	Nowshera
15	Peshawar	Peshawar
16	Kohat	Kohat
17	Karak	Karak
18	Bannu	Bannu
19	Lakki Marwat	Lakki Marwat
20	Dera Ismail Khan	Dera Ismail Khan
21	Tank	Tank

Note: The boundaries of some new districts and the locations of some headquarters are approximate.

FEASIBILITY STUDY
ON THE DEVELOPMENT OF MUNDA DAM MULTIPURPOSE PROJECT
IN ISLAMIC REPUBLIC OF PAKISTAN
JAPAN INTERNATIONAL COOPERATION AGENCY

Figure S1
NWFP Administrative Districts and FATA Tribal Areas



FEASIBILITY STUDY
ON THE DEVELOPMENT OF MUNDA DAM MULTIPURPOSE PROJECT
IN ISLAMIC REPUBLIC OF PAKISTAN
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Figure S2

Geological Map of the Dam Site

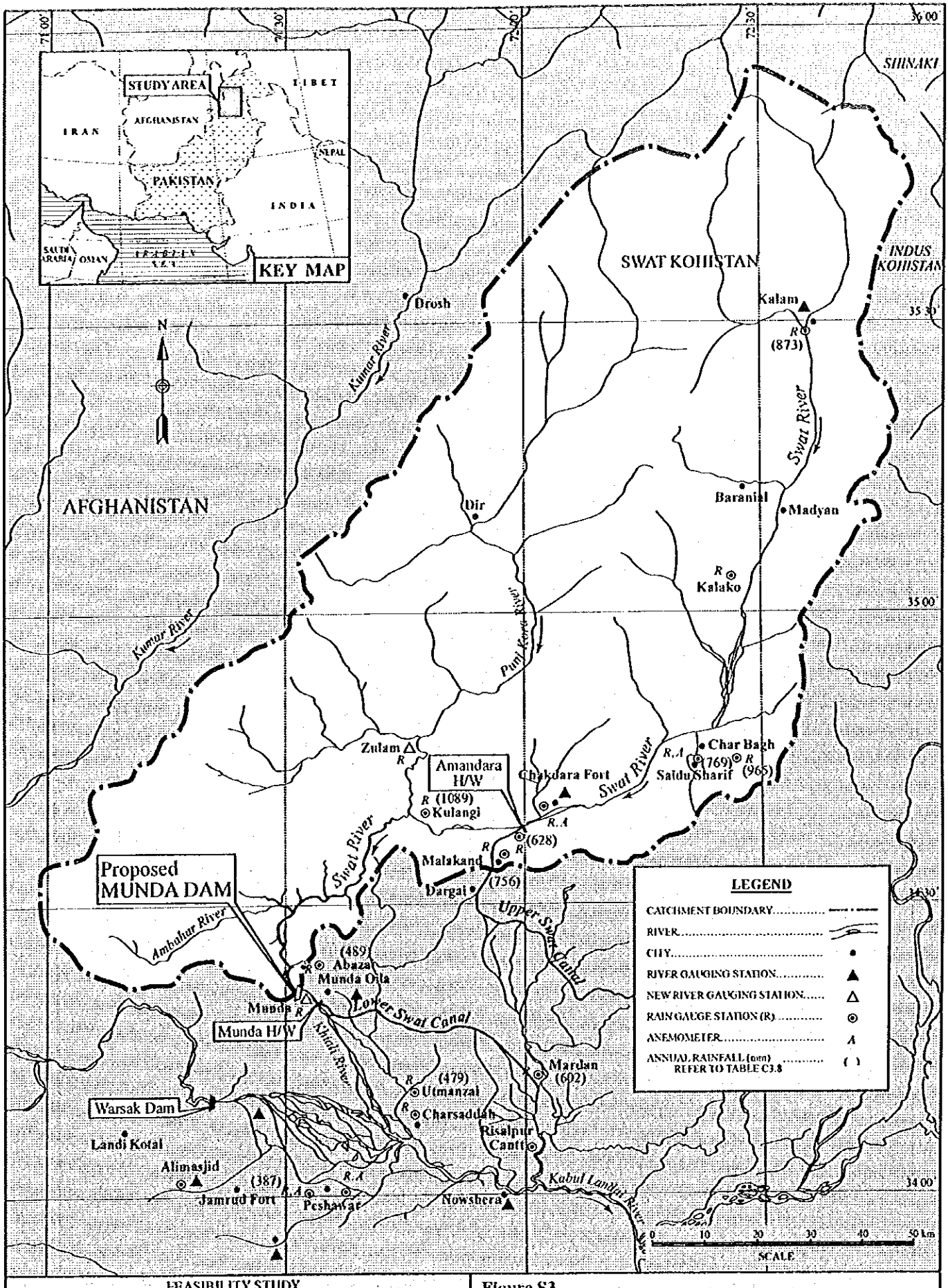

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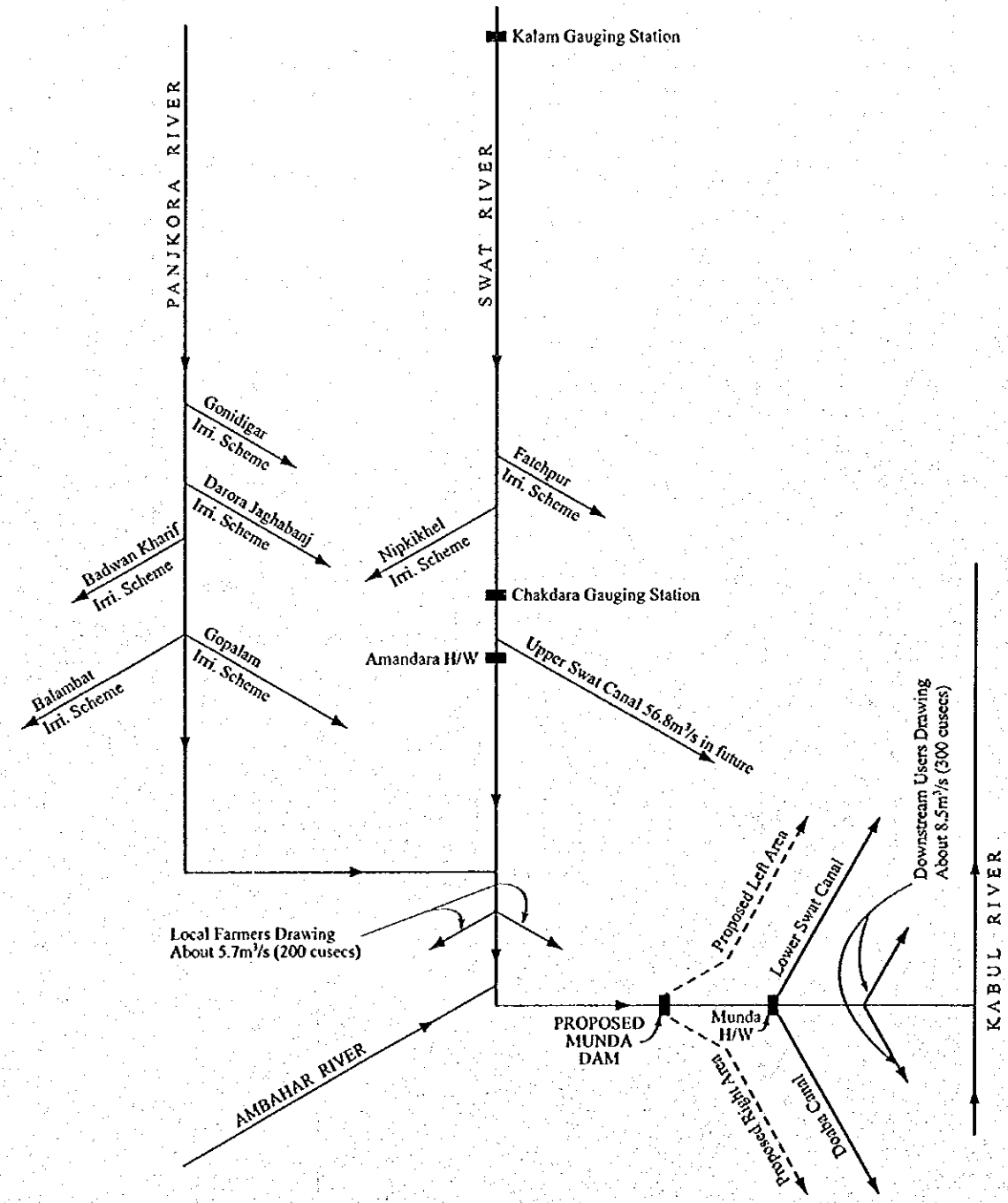
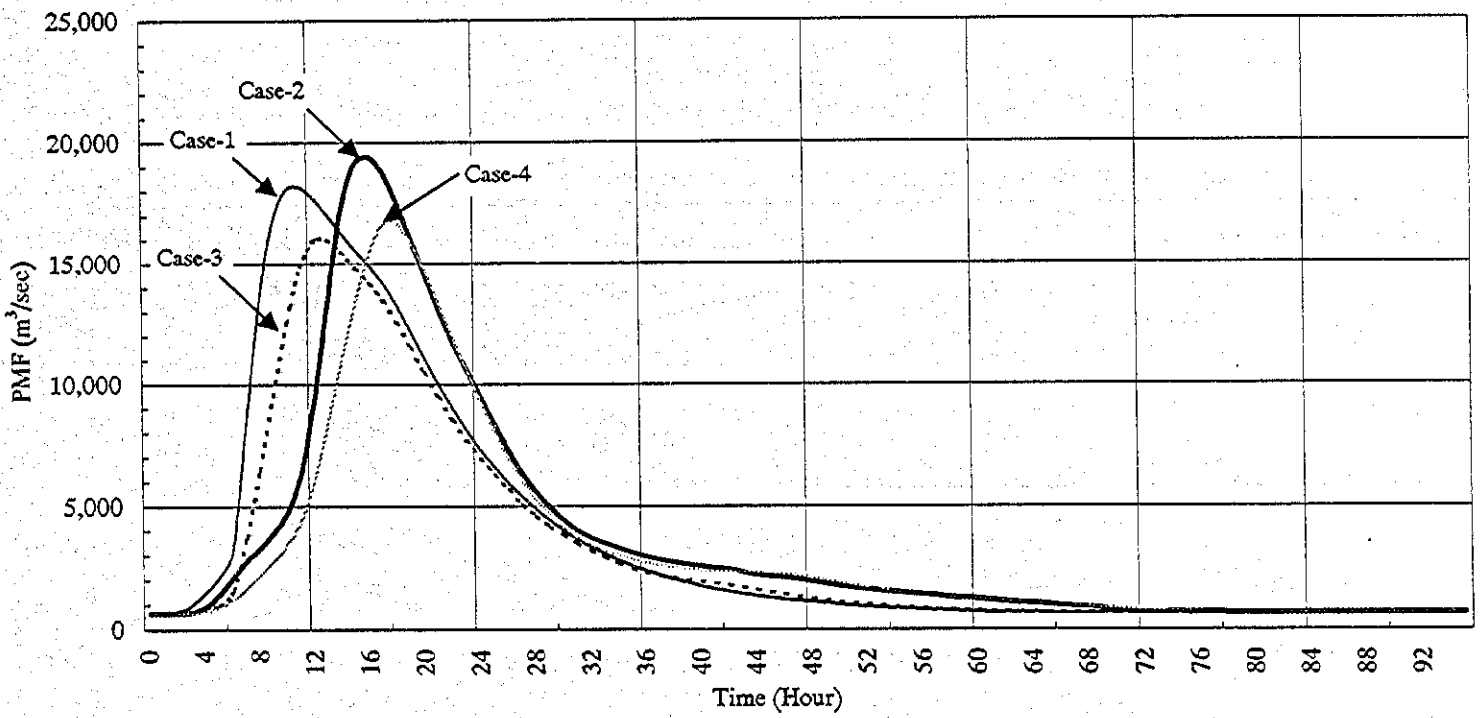
Figure S3

Existing Hydrometeorological Stations along Swat River



Notes : 1) Intake discharges for the about irrigation schemes and canals are presented in Tables C4.1, C4.4 and C4.6 in Appendix C.
2) Future intake discharge for both of LSC and Doaba canal is 37.4m³/s on annual averaage.

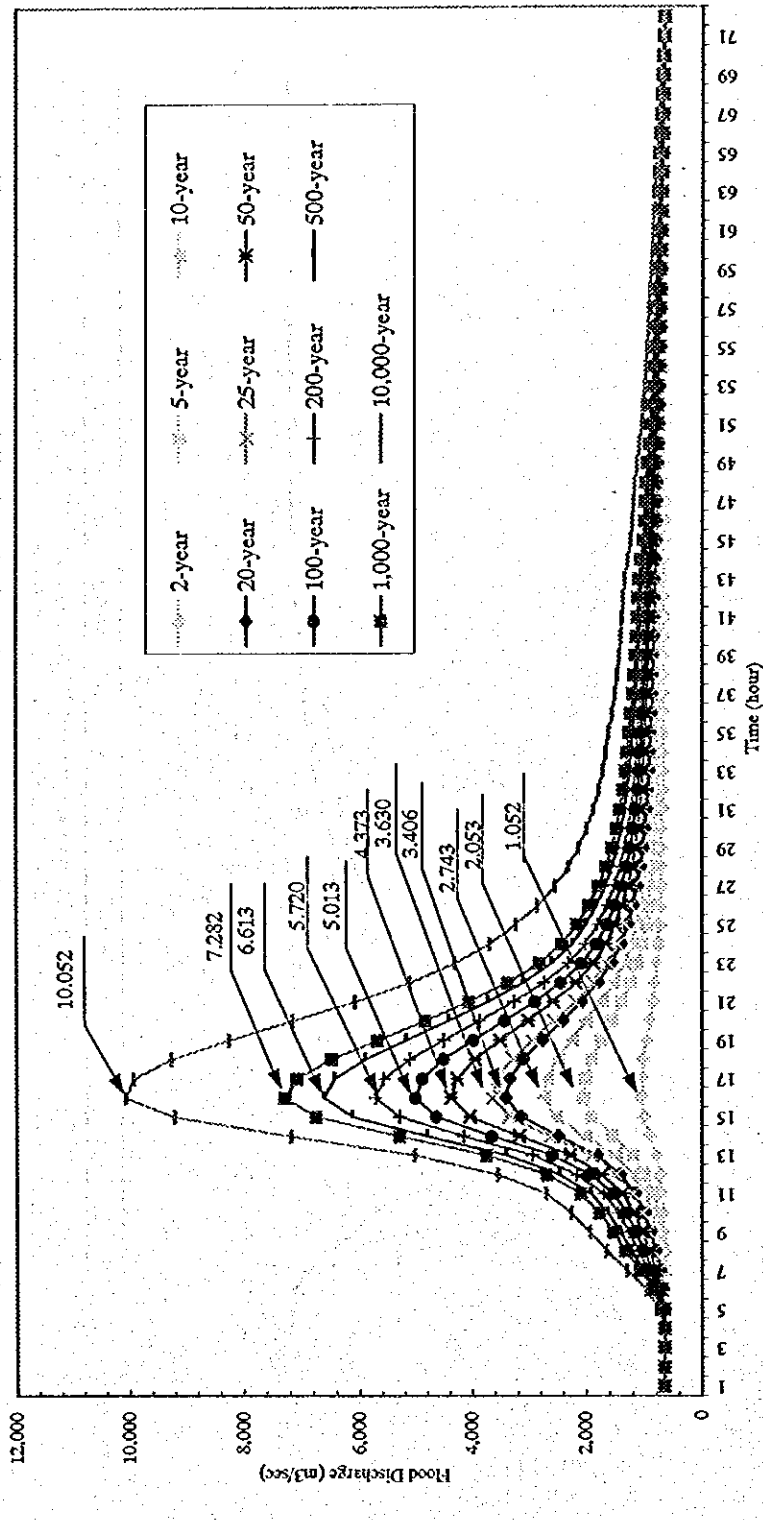
FEASIBILITY STUDY ON THE DEVELOPMENT OF MUNDA DAM MULTIPURPOSE PROJECT IN ISLAMIC REPUBLIC OF PAKISTAN JAPAN INTERNATIONAL COOPERATION AGENCY	**Figure S4** **Irrigation Schemes of Swat River Basin**



Qp	Tp	Case	Unit Hydrograpgh Condition	PMP
18,169	11	1	Average Unit Hydrograph 1991 and 1995	24-PMP
19,393	16	2	Average Unit Hydrograph 1985, 1986 and 1988	24-PMP
15,988	13	3	Average Unit Hydrograph 1991 and 1995	72-PMP
16,706	18	4	Average Unit Hydrograph 1985, 1986 and 1988	72-PMP

Qp Peak Flow, m^3/sec
Tp Time to Peak, hours

Figure S5
Estimated Composite PMF at Munda Dam Site



FEASIBILITY STUDY ON THE DEVELOPMENT OF MUNDA DAM MULTIPURPOSE PROJECT IN ISLAMIC REPUBLIC OF PAKISTAN JAPAN INTERNATIONAL COOPERATION AGENCY	**Figure S6** **Flood Frequency for Different Return Periods at Munda Dam Site**

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Figure S7
Energy Sector Organization of the Government

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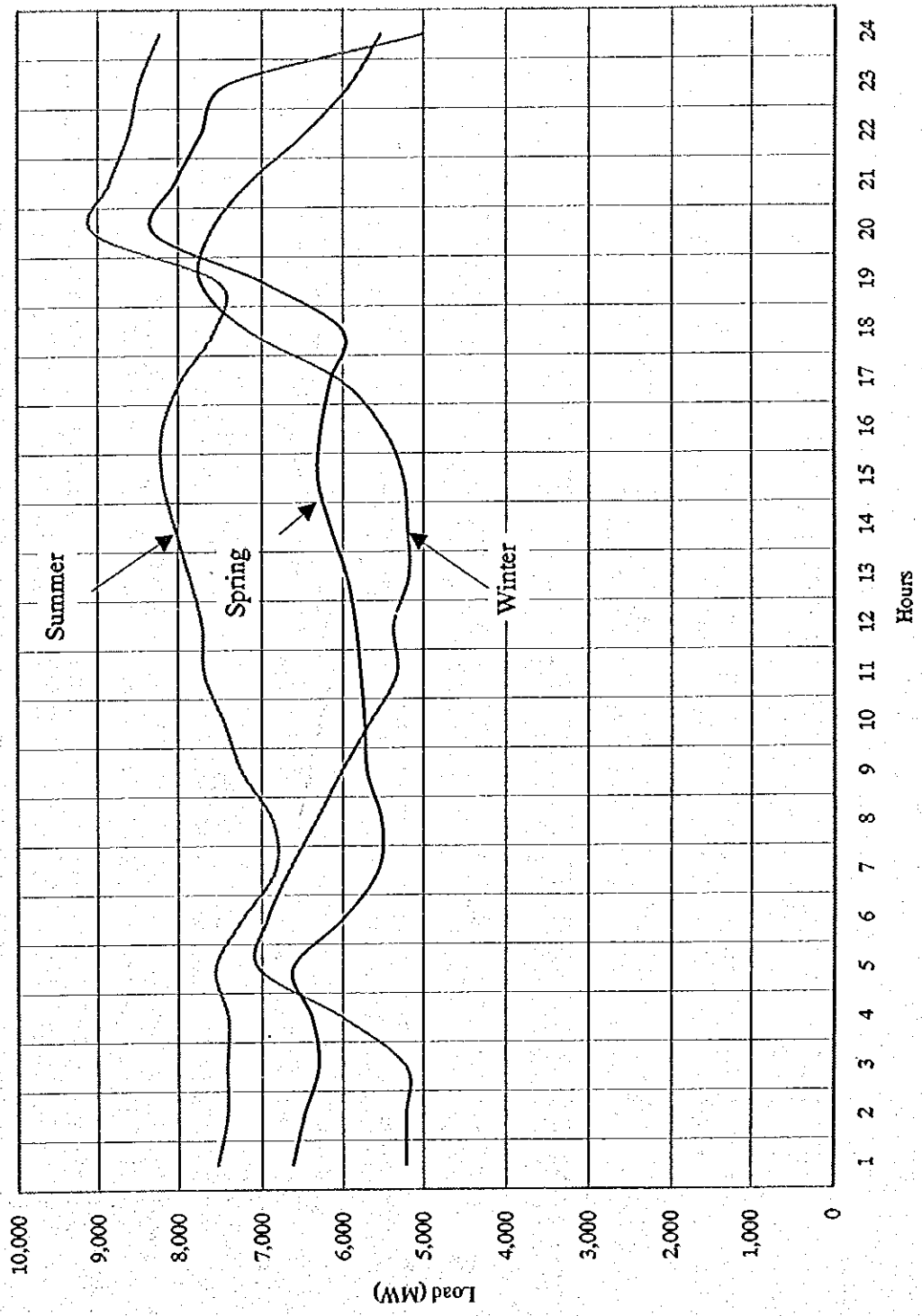
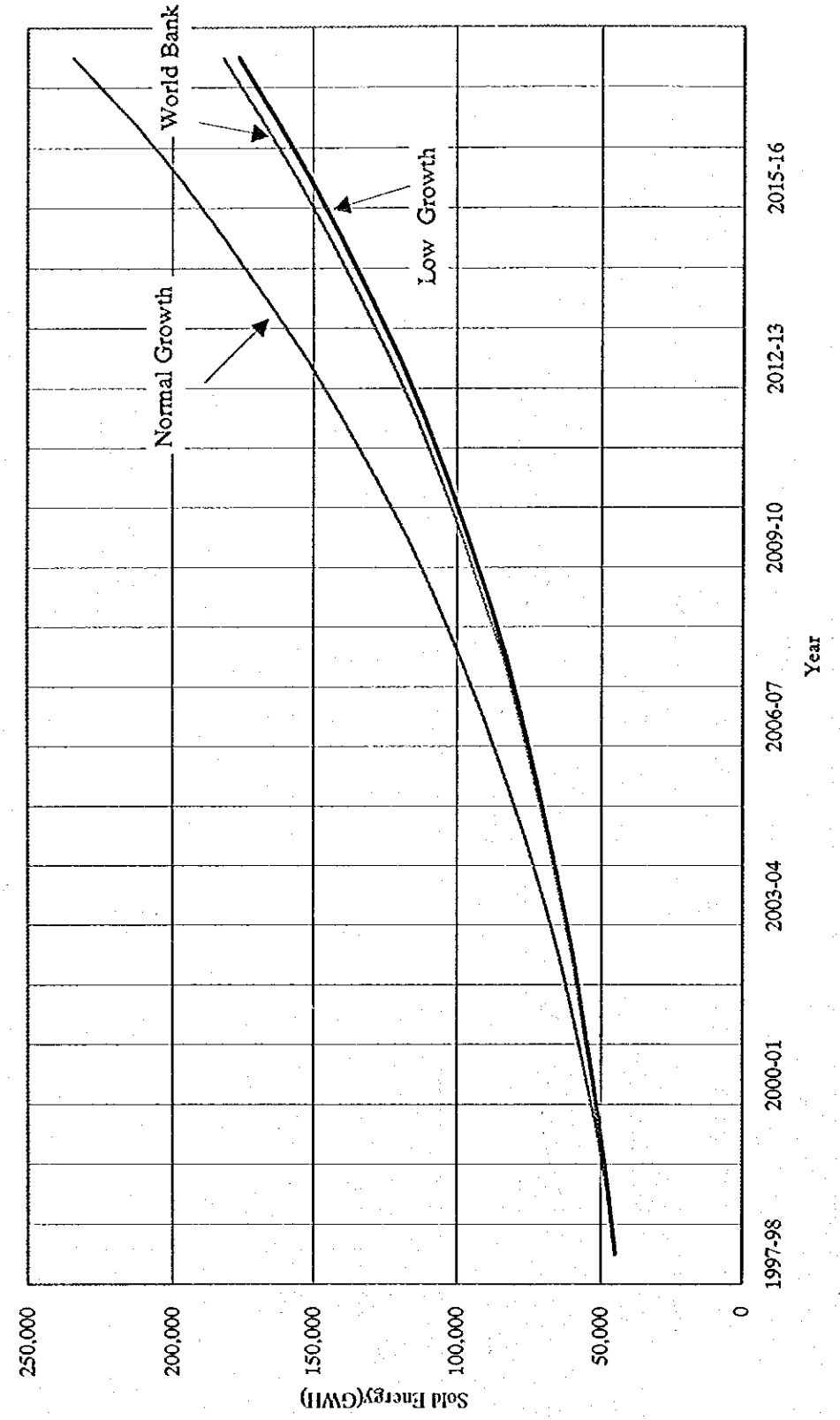
Figure S8

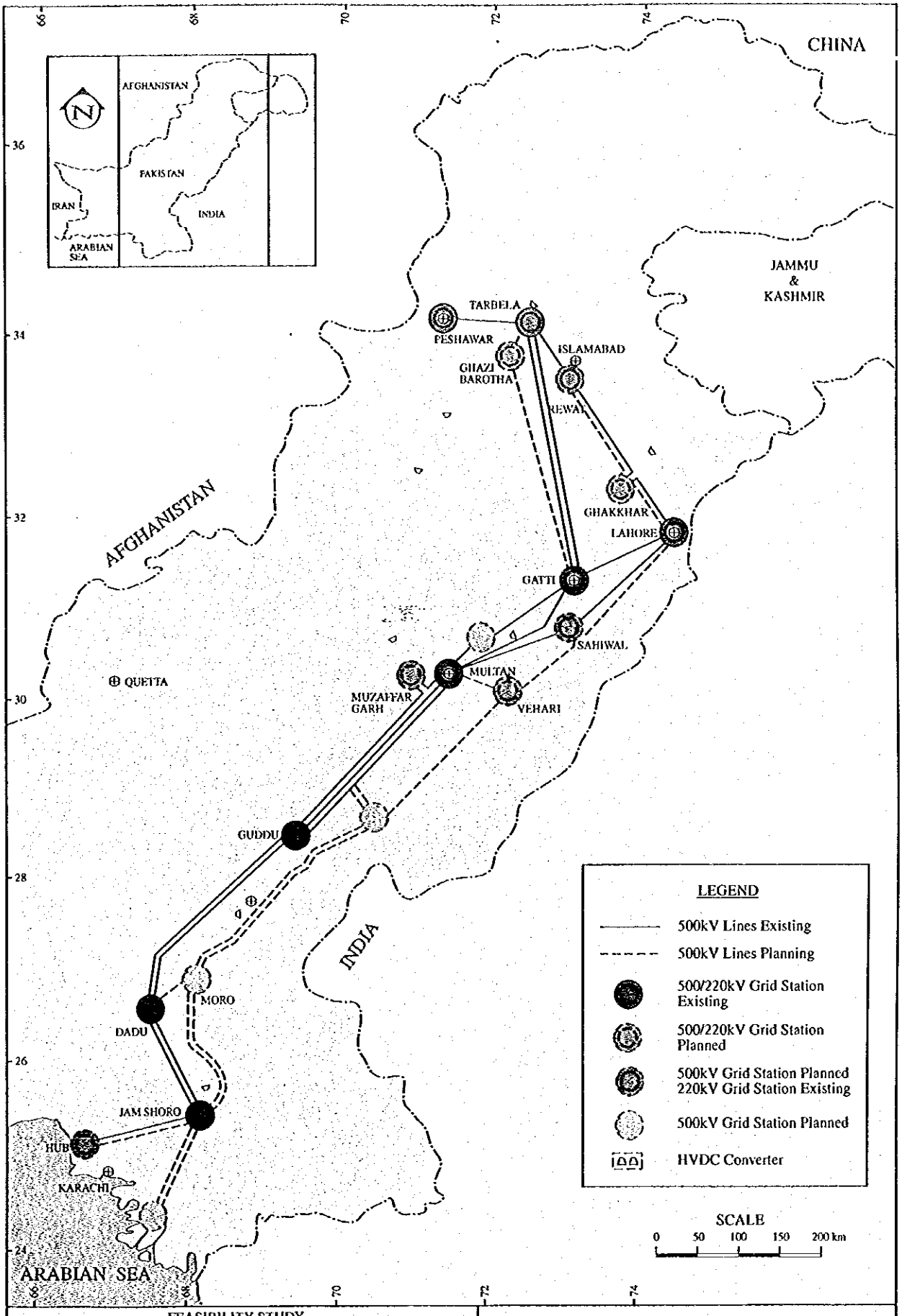
Conceived New Power Sector Organization



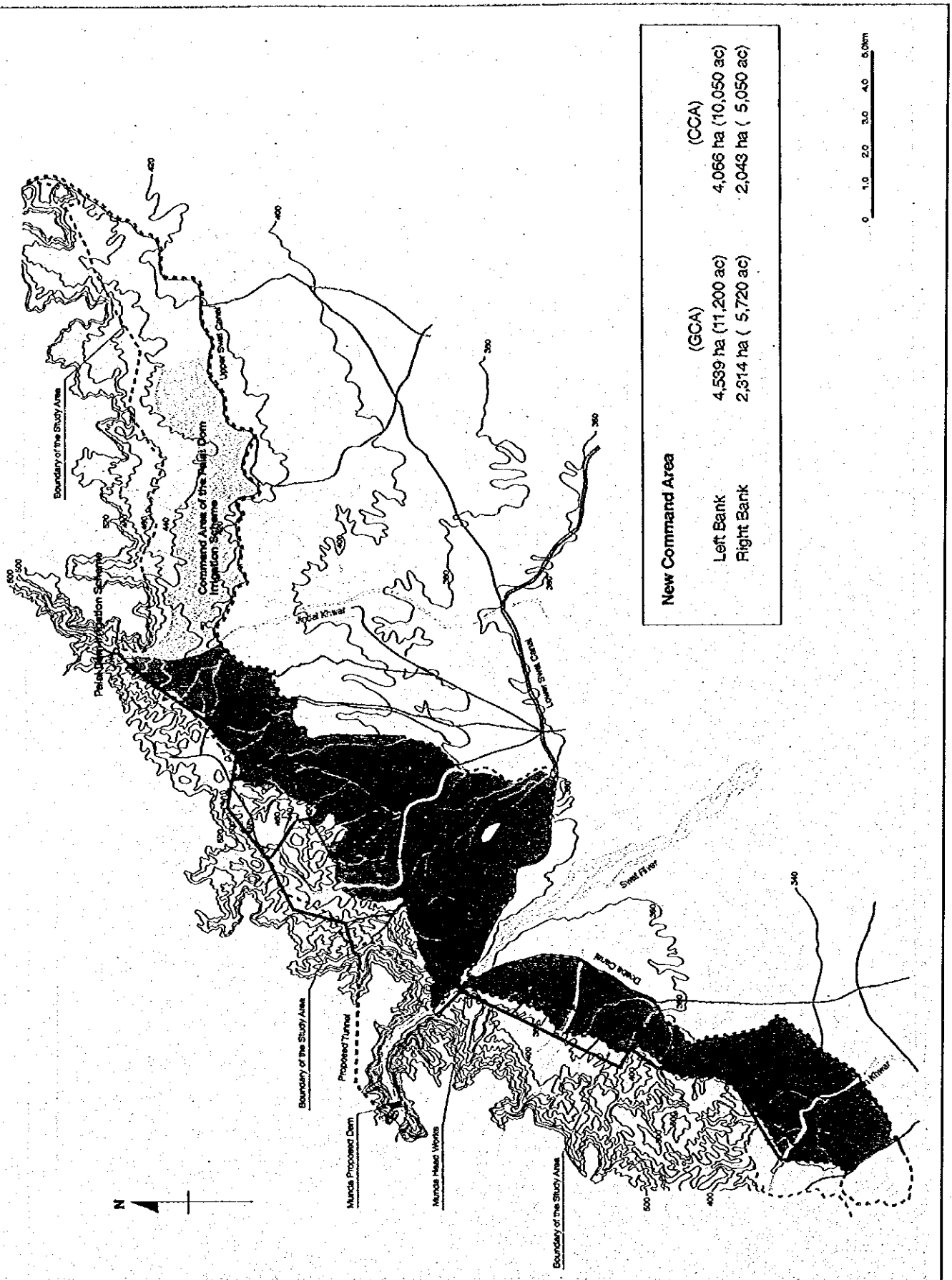
FEASIBILITY STUDY ON THE DEVELOPMENT OF MUNDA DAM MULTIPURPOSE PROJECT IN ISLAMIC REPUBLIC OF PAKISTAN JAPAN INTERNATIONAL COOPERATION AGENCY	**Figure S9** **Daily Load Curves of 3 Seasons**



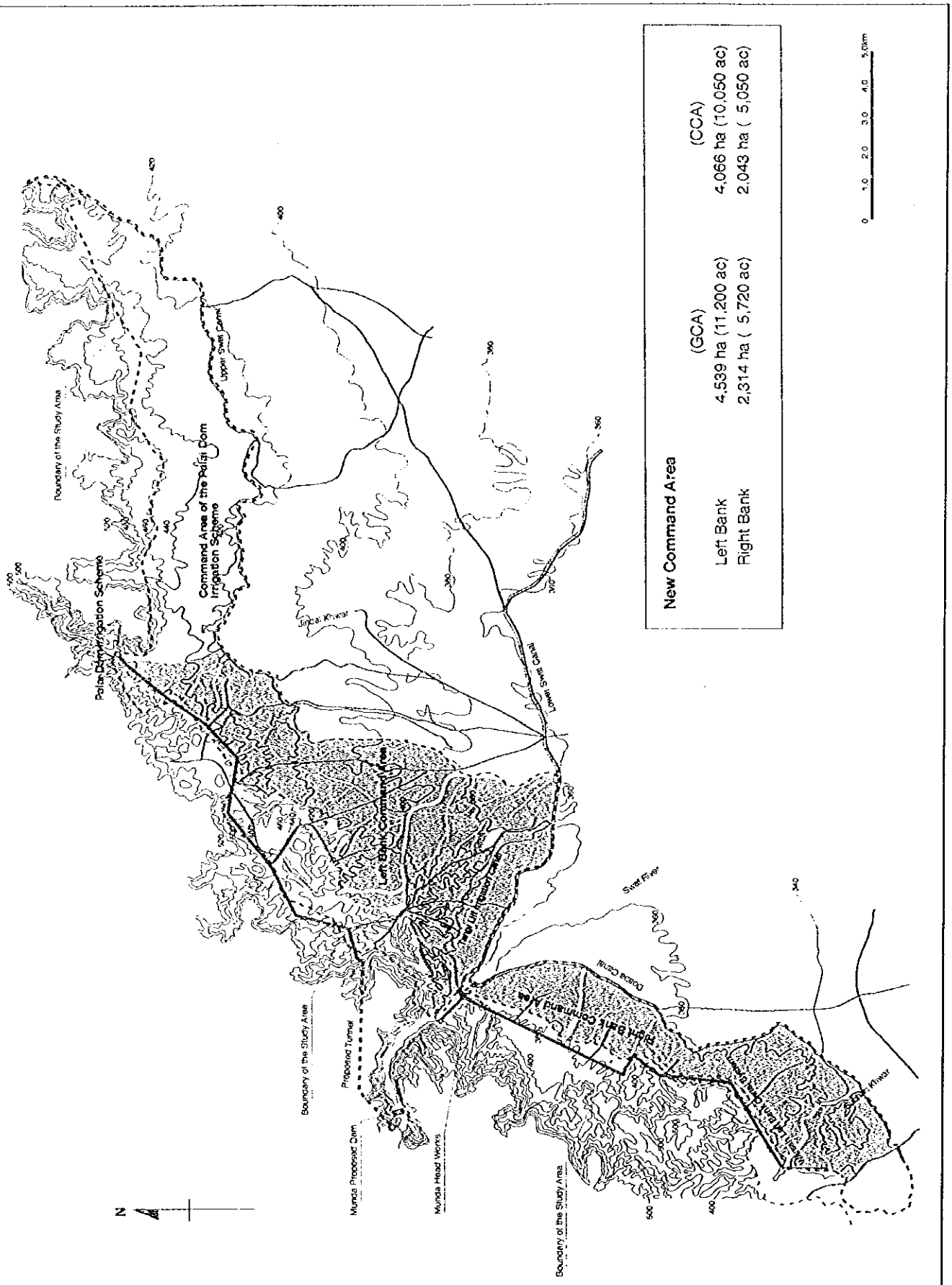
FEASIBILITY STUDY ON THE DEVELOPMENT OF MUNDA DAM MULTIPURPOSE PROJECT IN ISLAMIC REPUBLIC OF PAKISTAN JAPAN INTERNATIONAL COOPERATION AGENCY	**Figure S10** **Comparison of Load Forecast**



FEASIBILITY STUDY ON THE DEVELOPMENT OF MUNDA DAM MULTIPURPOSE PROJECT IN ISLAMIC REPUBLIC OF PAKISTAN JAPAN INTERNATIONAL COOPERATION AGENCY	**Figure S11** **500kV Transmission Line Grid**



FEASIBILITY STUDY ON THE DEVELOPMENT OF MUNDA DAM MULTIPURPOSE PROJECT IN ISLAMIC REPUBLIC OF PAKISTAN JAPAN INTERNATIONAL COOPERATION AGENCY	**Figure S12** **New Command Area of the Munda Multi-Purpose Dam Project**



FEASIBILITY STUDY ON THE DEVELOPMENT OF MUNDA DAM MULTIPURPOSE PROJECT IN ISLAMIC REPUBLIC OF PAKISTAN JAPAN INTERNATIONAL COOPERATION AGENCY	**Figure S12** **New Command Area of the Munda Multi-Purpose Dam Project**

Case No.	Flood Control Volume [x10^6 m^3]	Total Annual Average Damage [x10^6 Rs.]	Flood Control Benefit [x10^6 Rs.]	Flood Control Benefit [x10^6 US.$]
1	0	48.223		
2	1	45.743	2.481	0.050
3	10	33.518	14.705	0.294
4	20	23.557	24.666	0.493
5	50	8.743	39.480	0.790
6	75	4.338	43.885	0.878
7	100	2.246	45.977	0.920
8	150	0.634	47.589	0.952
9	200	0.214	48.009	0.960
10	250	0.084	48.139	0.963
11	300	0.046	48.177	0.964

US $1.0 (1999 price) = Rs.50.00

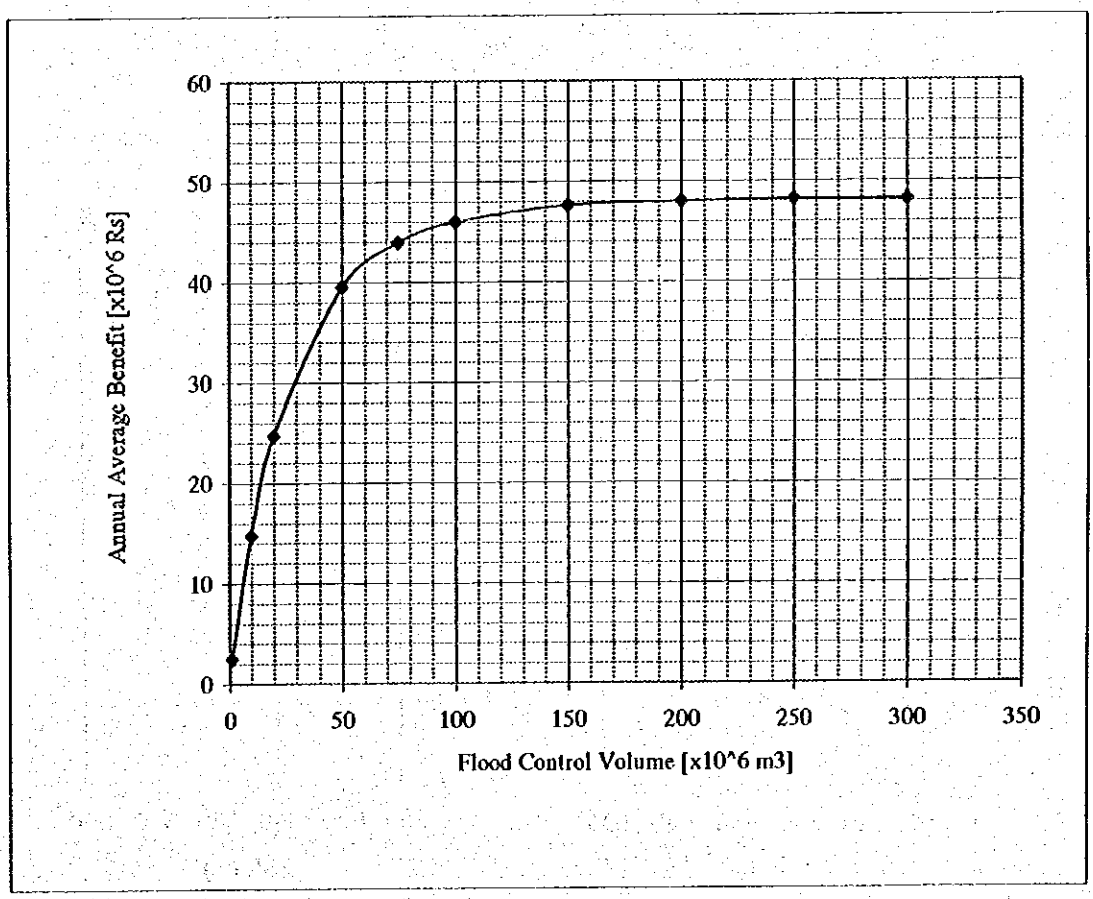


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Figure S13
Flood Control Volume and Benefit

Case No.	Flood Control Volume [x10^6 m^3]	Total Annual Average Damage [x10^6 Rs.]	Flood Control Benefit [x10^6 Rs.]	Flood Control Benefit [x10^6 US.$]
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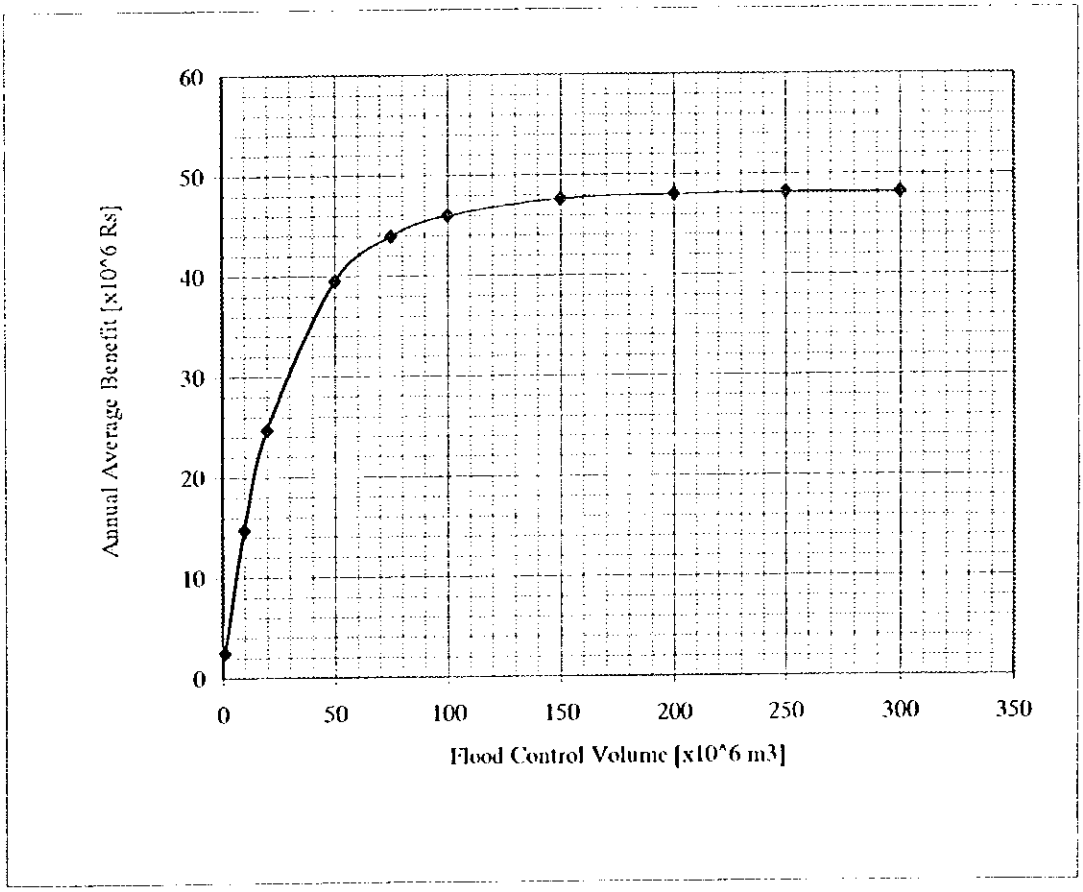

FEASIBILITY STUDY ON THE DEVELOPMENT OF MUNDA DAM MULTIPURPOSE PROJECT IN ISLAMIC REPUBLIC OF PAKISTAN	Figure S13 Flood Control Volume and Benefit
JAPAN INTERNATIONAL COOPERATION AGENCY	