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FEASIBILITY STUDIES READY FOR INVOLVEMENT OF PRIVATE INVESTMENT UNDER 1998 POWER POLICY

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SYNOPSIS

Inventory studies in the northern mountainous areas of Pakistan including NWFP, Northern Areas as well as on barrages and canal-falls in the irrigation systems of low-lying areas of the country have revealed hydro-power potential at more than one hundred individual sites.

So far 13 feasibility studies have been prepared in the public sector and are being offered to the private sector for setting up power plants. A number of projects were initiated by the Government of NWFP and Letters of Support (LoS) were issued under the Government of Pakistan Policy Frame-work of 1994-95. However, no concrete results were achieved. Only three of these projects stands allocated to private investors but their fate is unknown.

The Government of Pakistan has reviewed the whole issue of private Power Policy and finally issued the Revised Policy for New Private Independent Power Projects in July 1998. This policy is much more favourable for hydro-power projects than the previous one. It provides a tariff-structures more adequate for hydro-power and ensures more transparent procedures. The policy stipulates further that the project sites should be offered for IPP's preferably on the basis of feasibility studies prepared in the public sector.

There are five projects available in NWFP for early issuance of Request for Proposals (RFP) to invite investors under international Competitive Bidding (ICB) for implementation as their feasibility studies are readily available.

The locations are :

1. Khan Khwar near Besham, Swat District ..... 72 MW
2. Golen near Kaghozi, Chitral District ..... 100 MW
3. Dara Khwar near Bahrain, Swat District ..... 35 MW
4. Summar Gah upstream of Dassu, Kohistan District ..... 28 MW
5. Batal Khwar near Utror, Swat District ..... 8 MW

An integrated transmission study has been carried out to transport the energy into the National Grid whilst costs are to be borne by the respective projects.

Presently preparations are being undertaken by Government of NWFP in collaboration with the Federal Government Institutions Like PPIB and NEPRA to attract investment for these projects.

As the lead time for hydel plants is relatively longer, it is strongly recommended that work on their implementation be started immediately to ensure their commissioning by 2005-2006. By that time, the surplus thermal power is expected to be fully utilized to meet the demand of the coming years.

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BACKGROUND

Inventory-studies in the mountainous areas of Pakistan including the NWFP, the Northern Areas and Azad Jammu & Kashmir as well as on barrages and canal-falls in the irrigation systems in the plains and low-lying areas of the country have revealed hydropower potential at more than a hundred individual sites. Some of the sites are enlisted in the **Table 1.**

So far 13 feasibility studies have been prepared in the public sector and can be offered to the private sector for setting up power plants at the proposed sites. A number of projects were initiated by the Government of NWFP and Letters of Support (LOS) were issued under the Government of Pakistan Policy Framework of 1994/95. However, no concrete results were achieved. Only three of these projects stand allocated to private investors but nothing can be said about their fate.

REVISED POWER POLICY

The Government of Pakistan announced in July 1998 the Revised Policy for new private Independent Power Producers (IPP's). This policy is much more favourable for hydropower projects than the previous ones. It provides a tariff structure which is as well - oriented to hydropower as it is for coal-fired plants and it ensures more transparent procedures. The policy stipulates that the project sites should be offered for IPP's, preferably on the basis of comprehensive feasibility studies prepared in the public sector.

READY PROJECTS

There are five projects in NWFP whose feasibility studies are readily available. Request for Proposals (RFP) to invite private investors under International Competitive Bidding (ICB) for implementation can be prepared and issued without loss of time.

These five projects are located in Swat, Kohistan and Chitral Districts and are very favourable as far as capital and energy production costs are concerned.

The locations are:

1. Khan Khwar near Besham, Swat District ..... 72 MW
2. Golen near Kaghozi, Chitral District ..... 100 MW
3. Dara Khwar near Bahrain, Swat District ..... 35 MW
4. Summar Gah upstream of Dassu, Kohistan District ..... 28 MW
5. Batal Khwar near Utror, Swat District ..... 8 MW

The site layouts of these projects are in the attached charts A to E. The country map at F shows the locations of 13 sites for which feasibility studies have been completed.

The projects at Sr. Nos. 1 to 3 above are located in those areas where electricity supply for local population is already available and the power will primarily be provided to the National Grid. The projects at Sr. Nos.4 and 5 above are located in those areas where only very weak power supply or none at all is available for local population, who will be the primary beneficiary of

these projects. The surplus power will be transmitted to the grid.

An integrated transmission study has also been carried out to transport the energy from these plants into the National Grid whilst costs of individual lines are to be borne by the concerned projects.

The salient features of the five projects are presented below:

1. Khan Khwar Hydro-power Project

The project is located across the River Khan Khwar in the Swat district. The Khan Khwar is a tributary of the Indus River. The project area is accessible by road and is at a distance of 245 km from Rawalpindi/Islamabad and 270 km from Peshawar.

The dam is located at km 9 on Besham-Mingora road across Khan Khwar river. The water will be transferred from there through a headrace tunnel, a pressure shaft and a pressure tunnel to the power house to be located on the right bank of the River Indus on the Karakorum Highway, 3 km South of Besham Qila.

The 30 m high concrete dam will create a reservoir of about 1.1 million cubic meter total capacity, out of which 400,000 cubic meter will be used as live storage for four hour daily peak operation during dry season.

The powerhouse is of pit type with a 27.5 m subsurface depth. The building will be 15.5 m above the ground. It will house two vertical shaft Francis type turbine-generating sets of 34.25 MW each and one horizontal shaft impulse turbine of 3.65 MW capacity. Tailrace and outlet structure will discharge the water into the Indus River.

The total annual production of electricity is estimated at 306 GWh, out of which 105 GWh will be produced during peak hours. The firm capacity is 70.7 MW.

Salient Features (Khan Khwar)

1. Optimized Maximum Output ..... 72 MW
2. Designed Maximum Discharge ..... 35m^3/s
3. Gross Head 254m
4. Total Project Cost ..... US$86 millionsor US$1190/kW installed
5. Energy Cost (including transmission) ..... 3.3US cents/kWh
6. EIR 17.4%

2. Golen Gol Hydro-power Project

Golen Gol Hydropower Project is located in the Chitral district on the left bank of the Mastuj River near the confluence of Mastuj and Golen Gol rivers. The weir and lateral intake will be about 1 km upstream of the Babuka village. From the weir and the intake there will be a head race channel (designed as an open channel) which will be the link between sand trap and the headrace tunnel. The tunnel is designed not only as a part of conduit system but also as a storage used for peaking during the winter months. The headrace tunnel will discharge the flow into the combination of vertical and horizontal

pressure shafts which will in turn feed the turbines for the generation of hydropower. The tailrace will deliver the water to Mastuj River.

Salient Features (Golen Gol)

1.	Designed Capacity (Pelton type turbines)	106MW (total three units)
2.	Gross Head	435m
3.	Design Discharge	$30m^3$
4.	Average Annual Output of Energy	436GWh
5.	Estimated Capital Cost	US$ 92.530 millionor $873/kW
6	Cost of Generation (including transmission up to Dir)	3.87US cents/kWh

3. Daral Khwar Hydro-power Project

The project is located on the River Daral Khwar also in the Swat district. The Daral Khwar is a tributary of the Swat River. The project area is accessible by road at a distance of 185 km from Peshawar. The site is near Bahrain at the confluence of Daral Khwar and the Swat River.

The weir will be of about 40 m length and 3 m height. It will divert the water to a lateral intake and from there through a short connection tunnel with gravel spill of 58 m aggregate length to a sand trap and a short headrace canal. It will be located 4.5 km North West of Bahrain at 1718 m.a.s.l. on Daral Khwar river. The water will be transferred from there through a headrace tunnel and an embedded penstock to the powerhouse to be located on the right bank of Swat River on the main Mingora-Kalam road 2 km south of Bahrain.

The total annual production of electricity will be 148 GWh out of which 29 GWh will be the peak energy.

An outdoor 132 kV switch-yard will be located partly on the roof of and partly adjacent to the powerhouse and will be connected to the National Grid.

Salient Features (Daral Khwar)

1.	Optimized Power Station Output	35MW
2.	Designed Discharge	$15m^3/s$
3.	Gross Head	318m
4.	Total Project Cost	US$ 38 millions or US$1080/kW installed
5.	Energy Cost (including transmission)	3.68US cents/kWh
6.	EIRR	14.7%

4. Summar Gah Hydro-power Project

Summar Gah Hydropower Project is located on Summar Gah Gosak which is a left bank tributary of the River Indus about 30 km north west of Dassu. This area falls under the district administration of Dassu which is the Headquarters of Kohistan area. The powerhouse is located below the Karakoram Highway at village Gosak situated on the left bank of Summar Gah.

A weir of 5.0 m height located at Gosak will divert the water via an intake and a sand trap to a canal connected to a tunnel. Then a penstock will lead the water to the power house. The tailrace will take the water to the River Indus.

Salient Features (Summar Gah)

1. Capacity 28.08MW
2. Gross Head 399.5m
3. Discharge ..... 9.00m^3/s
4. Catchment area ..... 147km^2
5. Annual Energy 101.5GWh
6. Total cost of project ..... US$25.65 million
7. Cost per kW ..... US$ 913kW
8. Cost of Energy (including transmission) ..... 5.1US cents/kWh

5. Batal Khwar Hydropower Project

This project is also located in the Upper Swat area across the River Batal Khwar. The Tyrolian weir 6.30 m high located at Utror will divert the water to the power house from where the water will flow into Gabral river.

Salient Features (Batal Khwar)

1. Designed Discharge ..... 5.78m^3/s
2. Head 176m
3. Design Capacity 8100kW
4. Total Cost ..... US$ 30.99million ($3,826/kW)
5. Cost of Energy (including transmission) ..... 6.3US cents/kWh

ECONOMIC EVALUATION OF PROJECTS

The economic analysis of High Head Hydroelectric Power Plants has been carried out by means of:

- Thermal Equivalence Basis;
- and Benefits Quantified on Basis of LRMC

Economic analysis methodology assigns benefits to the hydro on basis or equivalent avoided thermal plant. The development of this equivalent thermal plant has, however, to be done with care. The hydro output can be stated to be:

- A capacity contribution designated by the capacity available for 4 hrs a day throughout the year or for 365 days.
- An energy contribution designated by the energy generated by the hydel power plant.

It needs to be mentioned that most hydro plants have the capacity available to be less than the installed capacity. In case of run of river plant the firm capacity is say about 25% of the installed capacity. Only where investments are made to construct daily storages does this ratio improve to say about 90%. Thus the equivalent thermal avoided is not equal to the installed capacity of the hydro but is in fact equal to the firm capacity available 4 hrs a day for 365 days. This benefit is about:

- 4 c/kWh for energy supplied during the 4 peak hours

- 3 c/kWh for capacity available for 4 hrs/day for 3 hrs days

The energy contributions off peak do not result in any avoided thermal capacity and therefore in fact only results in avoided fuel and O&M cost of the thermal power plant.

This benefit is about 3.0 c/kWh.

The benefits of the hydel are therefore:

- Capacity : about 600 $/kW ($ 64.8/kW/a or $ 5.4/kW/m)
  : 4 c/kWh energy (peak)
- Off-peak energy : 3 c/kWh energy

but the capacity benefit is usually less than the installed capacity. The other and rigorous method of economic analysis is by quantifying the benefits on basis of the voltage level at which the hydro is to be connected. These are defined by the Long Run Marginal Cost (LRMC) of the system at the relevant voltage level. These for the WAPDA system are:

	Capacity $/kW	Peak Energy c/kWh	Off-peak Energy c/kWh
• Generation Level	435.0	3.49	2.98
• 220 kV Level	563.0	3.58	3.08
• 132 kV Level	649.0	3.67	3.17
• 66 kV Level	683.0	3.81	3.26
• 11 kV Level	786.0	4.87	3.99

The LRMC approach captures the system impact of adding new hydro facility and it also captures the impact of the geographic location i.e. distance of proposed hydro from the grid or load system. It also captures the variation in system costs by months. (The LRMC is calculated on a monthly basis).

Economic analysis of above projects is summarized:

	IRR%	NPV[1] M.Rs	IRR%	NPV[1] M.Rs
• Khan Khwar	17.39	1424.0	17.06	1110.0
• Golen Gol	17.11	2192.0	18.70	1200.0
• Daral Khwar	14.68	13.21	11.15	3.21
• Summar Gah	12.17	90.0	14.20	125.0
• Batal Khwar	13.08	70.0	15.40	115.0

1. Analysis based upon different base year of cost.

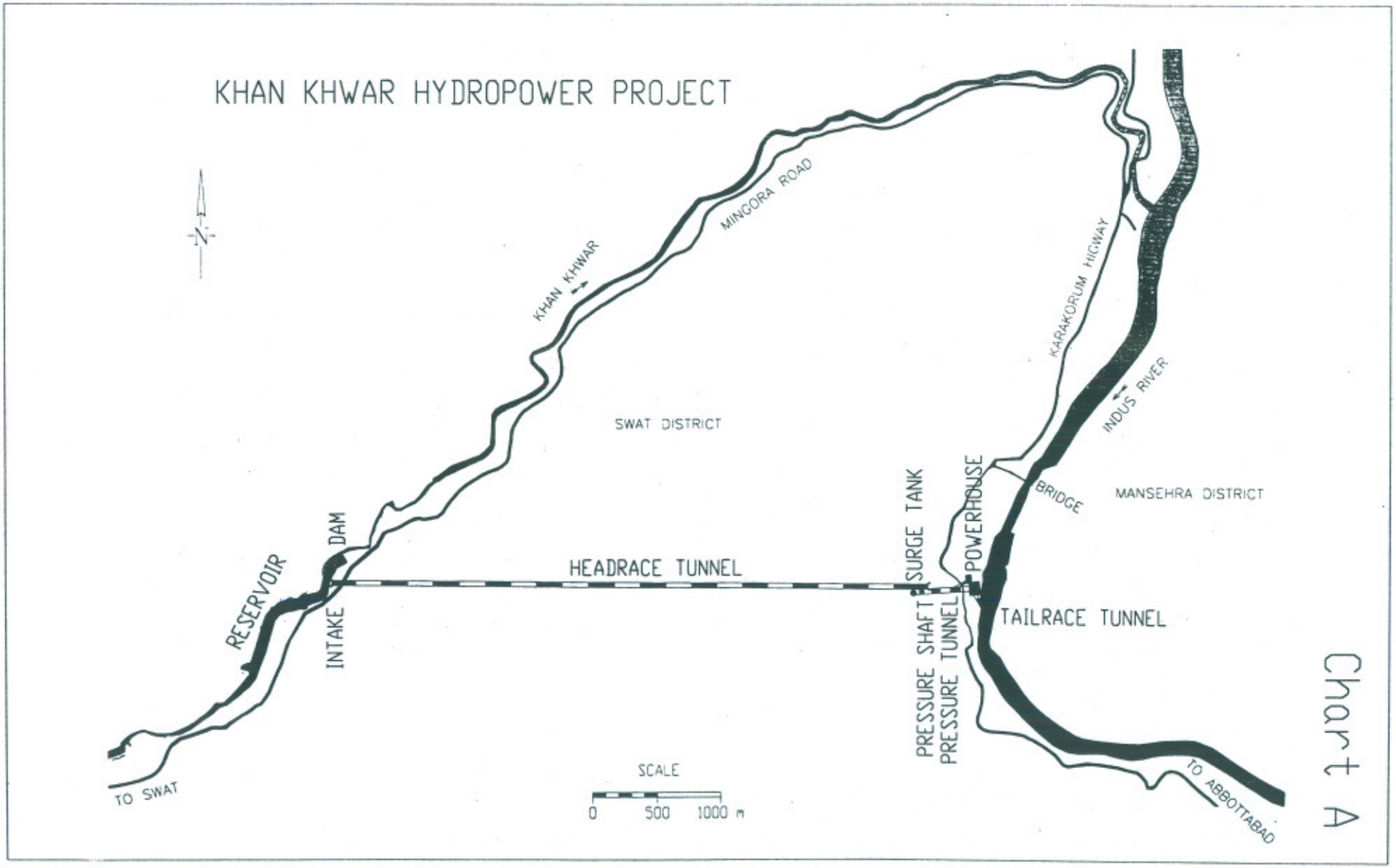
CONCLUSIONS

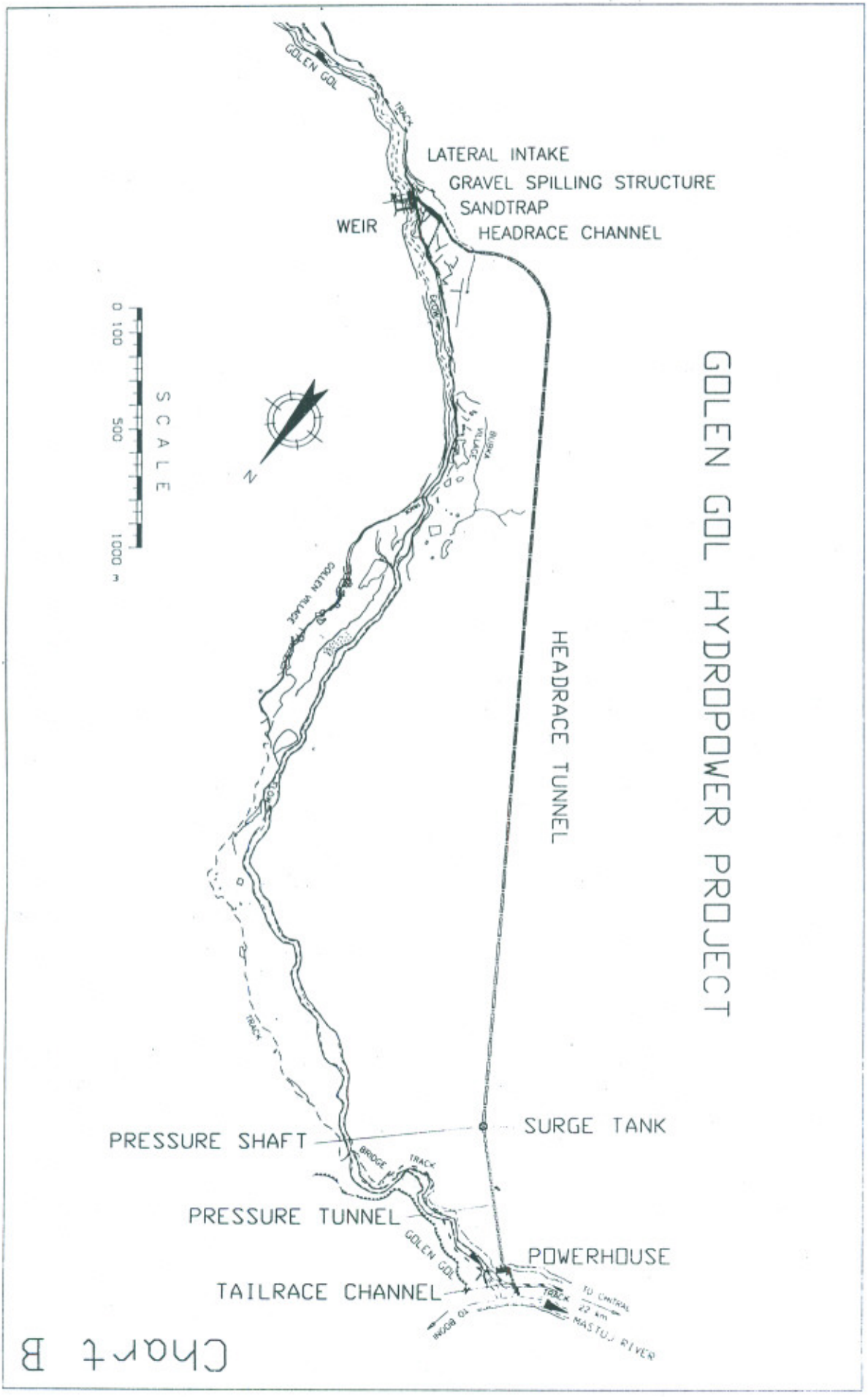
The above indicates that the proposed hydroelectric additions will results in savings when compared to equivalent thermal additions. The total system costs will therefore be less than what these would be if the demand was met by thermal generating facilities. This would also translate into a lower tariff at consumer level.

In view of relatively long lead time of these projects it is strongly felt that their construction should be taken in hand as soon as possible to ensure their commissioning by the year 2005/2006. By that time the surplus power of thermal plants (IPP's) in the country is expected to have been fully utilized by the additional power demand in the coming years.

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4. Feasibility study of 1997 prepared by SHYDO - GTZ for Daral Khwar.


KHAN KHWAR HYDROPOWER PROJECT
N
MINGORA ROAD
KHAN KHWAR
KARAKORUM HIGHWAY
INDUS RIVER
SWAT DISTRICT
MANSEHRA DISTRICT
BRIDGE
SURGE TANK
POWERHOUSE
RESERVOIR
DAM
HEADRACE TUNNEL
INTAKE
PRESSURE SHAFT
PRESSURE TUNNEL
TAILRACE TUNNEL
TO SWAT
TO ABBOTTABAD
SCALE
0 500 1000 m
Chart A


GOLEN GOL HYDROPOWER PROJECT
LATERAL INTAKE
GRAVEL SPILLING STRUCTURE
SANDTRAP
HEADRACE CHANNEL
WEIR
HEADRACE TUNNEL
SURGE TANK
PRESSURE SHAFT
PRESSURE TUNNEL
POWERHOUSE
TAILRACE CHANNEL
SCALE
0 100 500 1000 m
N
GOLEN GOL
TRACK
BRIDGE
TO CHITRAL 22 km
MASTUJ RIVER
Chart B

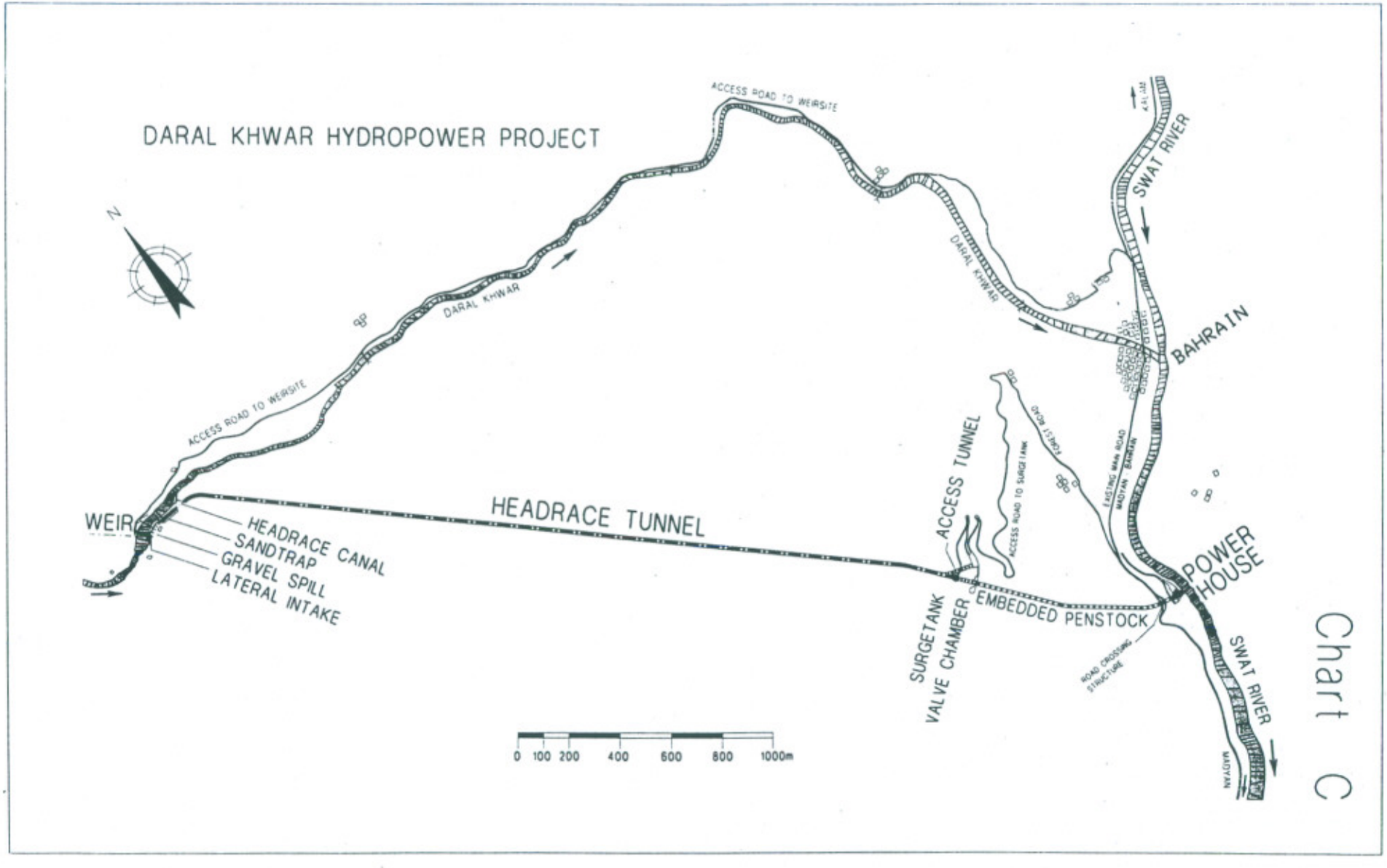
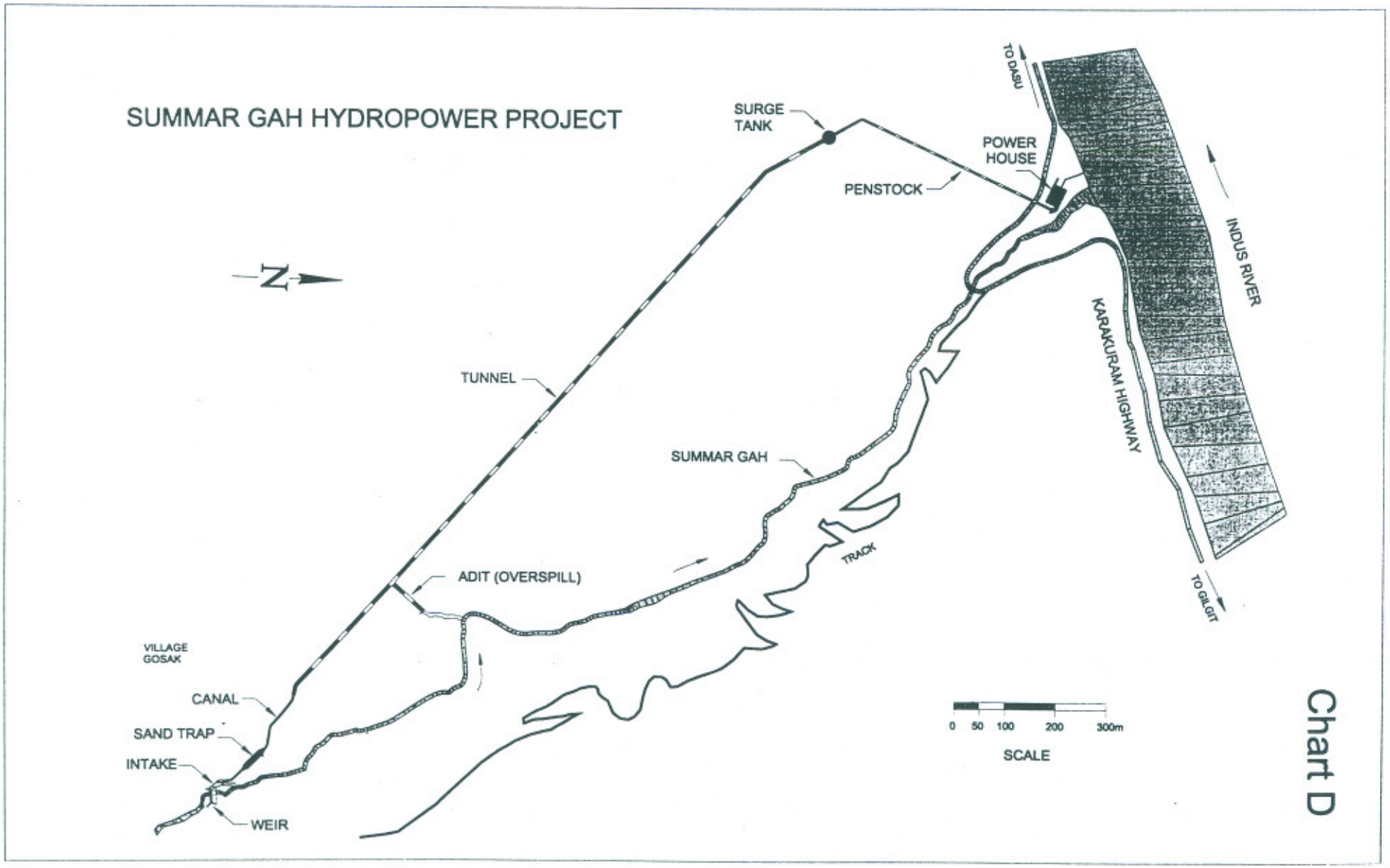
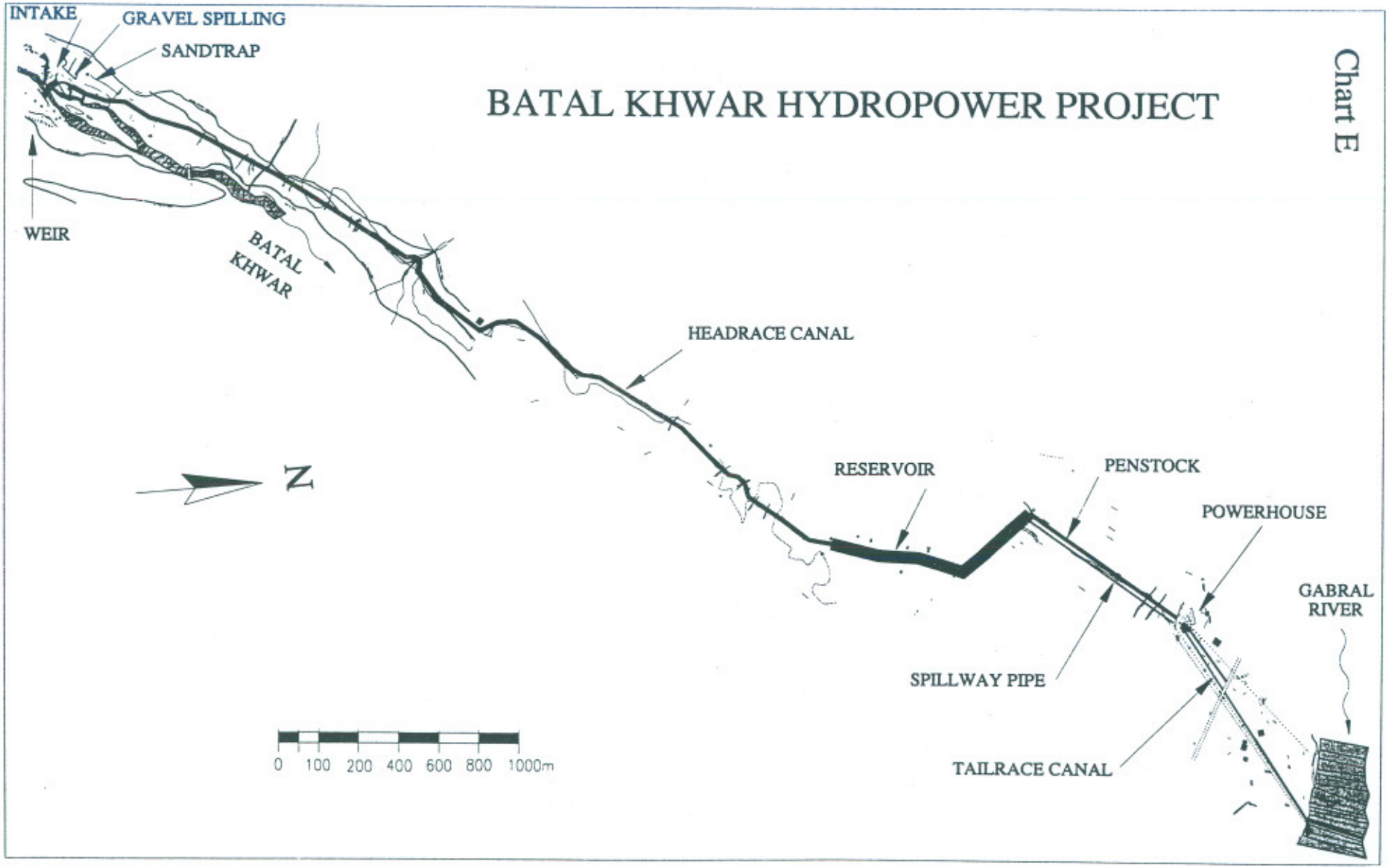

DARAL KHWAR HYDROPOWER PROJECT
ACCESS ROAD TO WEIRSITE
DARAL KHWAR
SWAT RIVER
BAHRAIN
ACCESS ROAD TO WEIRSITE
WEIR
HEADRACE CANAL
SANDTRAP
GRAVEL SPILL
LATERAL INTAKE
HEADRACE TUNNEL
ACCESS TUNNEL
ACCESS ROAD TO SURGE TANK
SURGE TANK
VALVE CHAMBER
EMBEDDED PENSTOCK
POWER HOUSE
ROAD CROSSING STRUCTURE
SWAT RIVER
MADYAN
0 100 200 400 600 800 1000m

Chart C


SUMMAR GAH HYDROPOWER PROJECT
SURGE TANK
POWER HOUSE
PENSTOCK
TO DASU
INDUS RIVER
KARAKURAM HIGHWAY
TO GILGIT
N
TUNNEL
SUMMAR GAH
TRACK
ADIT (OVERSPILL)
VILLAGE GOSAK
CANAL
SAND TRAP
INTAKE
WEIR
0 50 100 200 300m
SCALE
Chart D

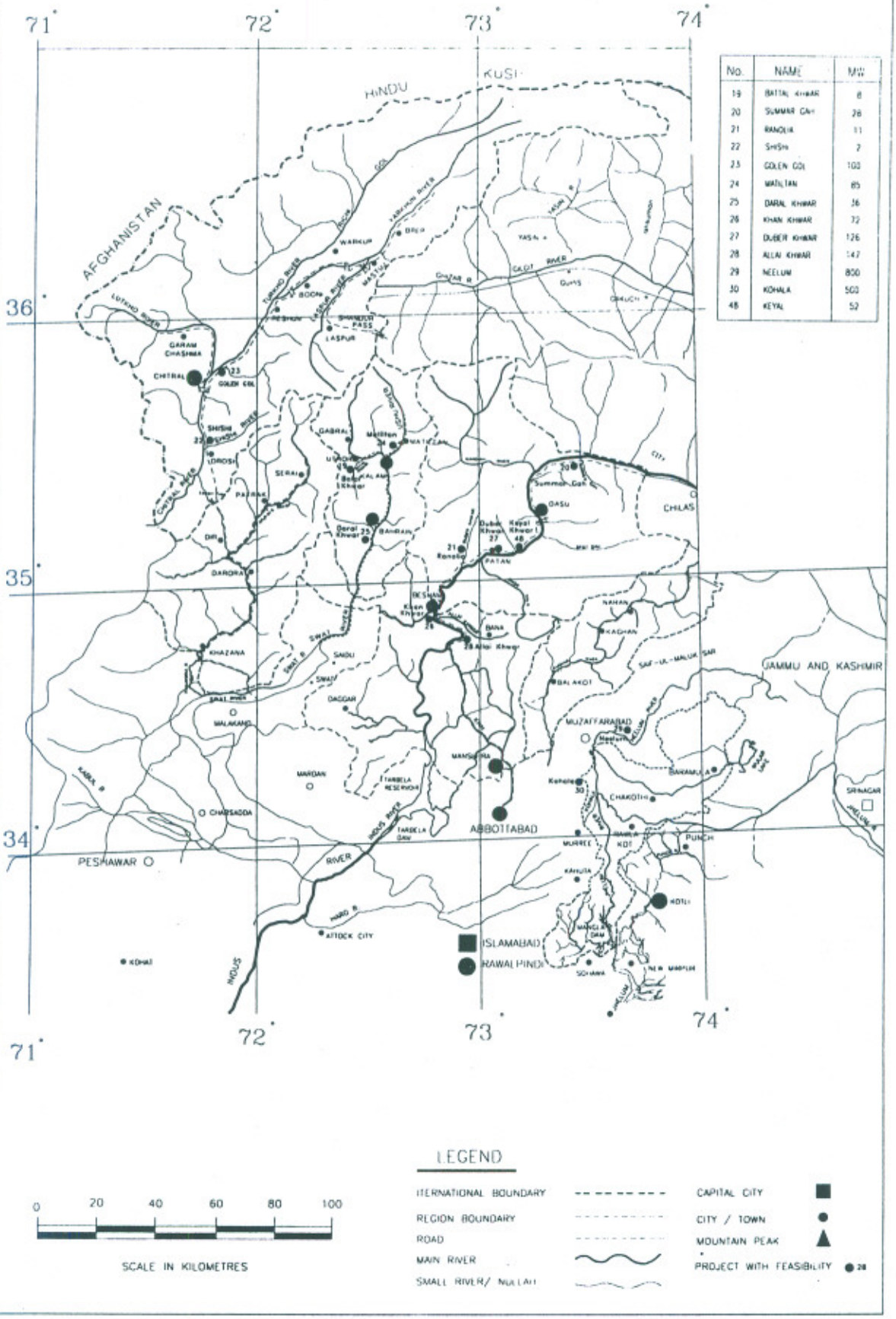


BATAL KHWAR HYDROPOWER PROJECT

Chart E

Chart F

PROJECTS WITH FEASIBILITY STUDY



No.	NAME	MW
19	BATTAL KHWAR	6
20	SUMMAR GAH	28
21	RANOLIA	11
22	SHISHI	7
23	GOLEN GOL	103
24	MATILTAN	85
25	DARAL KHWAR	36
26	KHAN KHWAR	72
27	DUBER KHWAR	126
28	ALLAI KHWAR	147
29	NEELUM	850
30	KOHALA	500
48	KEYAL	52

LEGEND

INTERNATIONAL BOUNDARY
REGION BOUNDARY
ROAD
MAIN RIVER
SMALL RIVER/ NULLAH
CAPITAL CITY
CITY / TOWN
MOUNTAIN PEAK
PROJECT WITH FEASIBILITY ● 28

0 20 40 60 80 100

SCALE IN KILOMETRES