CHAPTER 3

POWER DEVELOPMENT PLAN (1ST SCREENING)

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3.1 CONSIDERATION OF POWER DISCHARGE

3.1.1 Collection on Hydrological Data

Hydrological data of nine hydropower potential sites will be collected. Potential sites are classified into two types, sites using natural rivers (Yokunch and Baljuvon) and artificial canals (Nurbakhsh, Surhak-1, Sathad, Shibanai, Pakhtakor, Faizobod and Bohtar). Hydrological data are essential factor for power generation plan such as maximum power discharge, annual power generation, plant capacity factor and so on. Therefore it is important to ensure the reliability of the data by using various documents.

Meanwhile, it is difficult to collect reliable hydrological data in Tajikistan due to lack of observation stations, aging facilities and inadequacy of operation record of intake weirs. As discharge data of artificial canals is particularly unavailable, discharge is estimated by means of site surveys, relevant data and interviews at the 1st screening stage.

(1) Natural River

River observation stations at Khatlon province are as shown in Table 3.1-1. Since hydrological data is not observed at Yokunch and Baljuvon rivers, the discharge data at these sites is estimated by hydrological data of Yaksu river and Kizilsu river

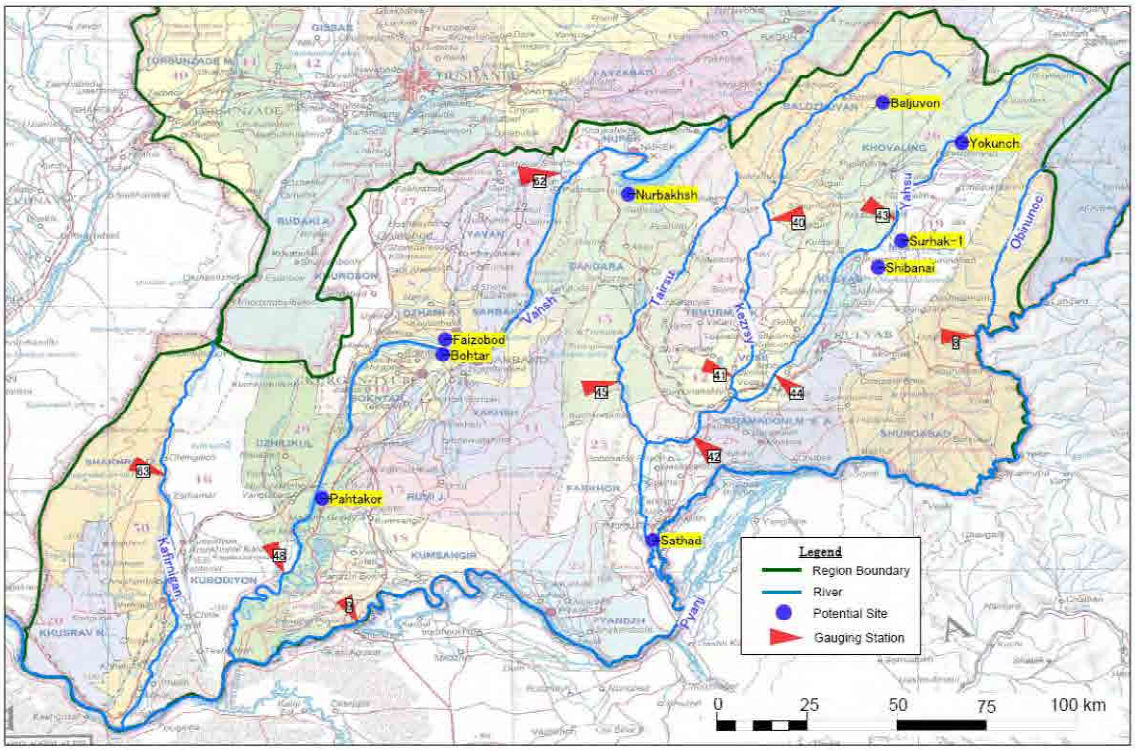


Fig. 3.1-1 River Observation Stations at Khatlon Province

Table 3.1-1 Hydrological Gauging Stations at Khatlon Province

Station No.	Station Name	River	Observation Period (Data Availability)		Period of Data Collection
			Discharge	Water Level	
8	Hirmanjo	Pyanj	1966 - 1990	1966 - 1990 2004 - Present	
9	Nijni Pyanj	Pyanj	1966 - 1990	1966 - 1990 2010 - Present	
40	Bobonshaid	Kizulsu	1955 - 1990	1960 - 1990	2001 to present
41	Kurbonshoid	Kizulsu	1978 - 1990	1978 - 1990	1970 to 1990
42	Samonchi	Kizulsu	1960 - 1990	1960 - 1990	1980 to 1990
43	Karboztonak	Yahsu	1960 – Present	1946 – Present	1980 to 1990
44	Vose	Yahsu	1960 - Present	1942 - Present	1970 to present
45	Shahbur	Tairsu	1961 - 1990	1961 - 1990	
48	Zapat	Vahsh	1983 - 1990	1983 - 1990	1980 o 1990
62	Gofilabad	Dagana	1963 - 1990	1963 - 1990	
63	Taptki	Kafirnigan	1960 - Present	1930 - Present	

collected

(2) Artificial Canals

Artificial canals for irrigation, fishery, water supply and industrial water are maintained by Ministry of Land Reclamation and Water Resources (MLRWR). Discharge of artificial canals is determined by water demand of supply area. Discharge data of artificial canals are shown below.

Item	Data Reliability	Actual Situation of Data
Discharge Observation Record	◎	Discharge observation of artificial canals is not conducted.
Manual and record for gate operation of intake weirs	○	Gates of intake weirs has been operated empirically and not been recorded.
Interviews	△	Persons in charge of water resource and agriculture at each district know the situation of canals.

JICA Study Team requested persons in charge of water resource and agriculture at each district to provide discharge observation records and manual / record for operation of intake weirs. However, these data is hardly obtained because of inadequate implementation of observations.

Therefore, discharge of artificial canals is estimated by interviews with person in charge of water resource and local residents, on-site surveys and related hydrological data. Related Hydrological data to complement the interviews is discharge of upper dam site, canal networks, water demand and cross section of canals. These complementary information for estimation of discharge of artificial canals is as shown in Table 3.1-2.

Table 3.1-2 Hydrological Information on Artificial Canals

Survey Item		Estimation of Canal Discharge
Discharge from Dam Site at Upper Stream	- Discharge Data	Inflow at inlet of canal
Canal Network Map	- Network map - Water privilege for each canal	Balance between inflow and outflow at the target canal network
Water Use	- Irrigation (area (km^2) and crop item) - Fishery cultivation (area (km^2), number of pond and fish item) - Drinking Water (supply area (km^2) and population) - Industry (Number of manufacturer)	Estimation of discharge of target canal
Water Privilege	- Stakeholder - Water demand for each water use	Review of maximum discharge
Canal Design Discharge	- Maximum canal discharge - Flood discharge	Review of maximum discharge
Cross Section of Canal	- Dimension - Type	Estimation of maximum discharge for canal

3.1.2 Determination of Power Discharge

Power discharge at the 1st screening stage is established based on discharge during winter season (minimum discharge) when power shortage occurs. If there is no water during winter, discharge during summer is used.

Power discharge of each site is determined by means of the following ways;

- Interviews with persons in charge of water resource department of local governments (water use (irrigation, drinking water and domestic use), gate operation and annual fluctuation of discharge)
- Interviews with local residents (discharge in winter and flood water level)
- Technical Judgment by site survey of river and canal situation such as width, depth and velocity
- In the case of natural river, more than 10% of minimum discharge is reserved for maintenance flow discharge

Discharge in summer and winter and power discharge according to the above-mentioned ways is summarized in Table 3.2-1.

3.2 POWER GENERATION PLAN

The power output is estimated by using power discharge and head. The power discharge is estimated as described in Section 3.1 and the head is established by the measurement at site. The head means the effective head and the power output is estimated as per the following formula.

$$\textit{Power Output (P) = Maximum Power Discharge(Q)} \times \textit{Head (m)} \times 10 \times 0.8$$

The estimated power output is summarized in Table 3.2-1.

Table 3.2-1 Salient Features of Each Site based on Results of Site Survey

Item			1	2	3	4	5	6	7	8	8' (Option)	9
			Nurbakhsh	Surhak-1	Sathad	Yokunch	Shibanai	Pahtakor	Faizobod	Bohtar	Bohtar	Peshtova-2
Rayon (District)			Dangara	Muminabad	Farhor	Khovaling	Temurmalik	Jilikul	Jomi	Bohtar	Bohtar	Baljuvon
Jamoat (Village)			Okhsu	Marhok	Baridom	Yokunch	Shibanai	Kuibeshe	Faizobod	Ges	Ges	Peshtova
River	Type of Water Source		Water Use Canal	Natural River	Irrigation Canal	Natural River	Irrigation Canal	Irrigation Canal	Irrigation Canal	Irrigation Canal	Irrigation Canal	Natural River
	River/Canal		Dangara Canal	Chashma Canal	Sulho Canal	Yokunch River	Shibanai Canal	Kaiganobod Canal	Shorobod Canal	Canal from Golovnoy Dam (PK25)	Canal from Golovnoy Dam (PK25)	River
	Main River		Vakhsh	Yakhsu	Pyanj	Yakhsu	Kizilsu	Vahksh	Vakhsh	Vakhsh	Vakhsh	Kizilsu
	Discharge (m^3/s)	Winter	10.5	1.0	1.5	2.5	0.6	2.5	3.0	N/A	N/A	N/A
			1.0	0.8	0.0	*4.0	0.5	1.0	1.0	0.0	10.0	N/A
		Summer	60.0	2.5	7.0	4.0	1.5	7.0	16.0	N/A	N/A	N/A
			1.5	0.5	1.0	*3.0	0.06 - 0.08	1.0	6.0 - 10.0	10.0	10.0	N/A
Power Plan	Power output (kW)		5,285	170	120	500	42	150	180	1,201	1,201	320
			400	26	28	432	16	24	24	0	240	220*
	Effective Head (m)		50.3	15.0	8.0	20.0	7.0	6.0	6.0	4.0	4.0	N/A
			50.0	4.0	3.5	20.0	4.0	3.0	3.0	3.0	3.0	N/A
	Power Discharge (m^3/s)		12.6	1.2	1.8	3.0	0.7	3.0	3.6	36.0	36.0	N/A
			1.0	0.8	1.0	2.7	0.5	1.0	1.0	0.0	10.0	N/A
Distance to Demand Area (km)			2.6	0.7	0.1	5.0	0.1	0.1	0.1	0.1	0.1	-
Beneficial Target	Population (people)		2,000	1,400	500	2,500	1,600	20,000	1,000	1,200	1,200	-
	Household		400	200	51	400	178	4,000	100	120	120	-
	Hospital / Clinic (place)		0/1	0/1	1/0	0/1	0/1	1/1	0/1	1/0	1/0	-
	Educational organization (place)		1	1	1	2	1	1	1	1	1	-
Structure Planning	Intake weir		–	–	–	–	–	–	–	–	–	N/A
			Not Necessary	Not Necessary	Not Necessary	New Construction (85m)	New Construction (400m)	New Construction (4.5m)	New Construction (7m)	Not Necessary	Not Necessary	N/A
	Intake			New construction	–	Repair of existing intake	–	–	–	–	–	N/A
			New Construction	Not Necessary	New Construction	New Construction	New Construction	New Construction	New Construction	Included in Powerhouse	Included in Powerhouse	N/A
	Conduit		–	Repair of existing conduit 500m	–	Repair of existing conduit 1200m	–	–	–	–	–	N/A
			Not Necessary	Concrete Canal (550m)	Not Necessary	New Construction (800m)	Not Necessary	Not Necessary	Not Necessary	Included in Powerhouse	Included in Powerhouse	N/A
	Headtank		–	New construction	New construction	New construction	New construction	New construction	New construction	–	–	N/A
			New Construction	New Construction	New Construction	New Construction	New Construction	New Construction	New Construction	Not Necessary	Not Necessary	N/A
	Spillway		–	New construction	–	–	–	–	–	–	–	N/A
			Not Necessary	New Construction	Not Necessary	New Construction	Not Necessary	Not Necessary	Not Necessary	Not Necessary	Not Necessary	N/A
	Penstock		–	New construction	New construction	New construction	New construction	New construction	New construction	–	–	N/A
			New Construction (485m)	New Construction	New Construction	New Construction	New Construction	New Construction	New Construction	Not Necessary	Not Necessary	N/A
	Powerhouse		Existing underground facility owned by Ministry of Land Reclamation and Water Resources can be utilized.	New construction	New construction	New construction	New construction	New construction	New construction Generator, turbine×2 units)	Repair of small hydroelectric powerhouse constructed before	Repair of small hydroelectric powerhouse constructed before	N/A
			New Construction	New Construction	New Construction	New Construction	New Construction	New Construction	New Construction	New Construction	New Construction	N/A
	Outlet		–	–	–	–	–	–	–	–	–	N/A
			New Construction	New Construction	New Construction	New Construction	New Construction	New Construction	New Construction	New Construction	New Construction	N/A
	Other Works		Slope Protection at Penstock	Access Road to Powerhouse		Access Road and Bridge	Slope Protection at Channel		River Bank Protection Work	Demolition of Existing P/H	Demolition of Existing P/H	N/A
			Foundation Improvement Works	Slope Protection		Slope Protection				River Protection Works	River Protection Works	
Access	Distance from District Center (km)	Intake	10.0	8.4	11.8	23.2	6.0	2.3	9.1	28.8	28.8	N/A
		P/H	11.2	-	-	-	-	-	-	-	-	
	Length of Unpaved Road (km)	Intake	0.4	3.6	1.0	21.0	3.0	0.2	1.5	0.1	0.1	N/A
		P/H	0.5	-	-	-	-	-	-	-	-	
Barriers					Close to Afghanistan Border and the Site is in the Military Zone	Landslide Potential Area	Landslide and Flood Potential Area	No water in winter season		No water in winter season		No access from Dec. to May

Yellow Character means the revised plan based on the Study.

Source : Research, Application Form, Plan 2009-2020

3.3 FACILITY PLAN

Based on the results of site survey, faculties required for the power plant are summarized in Table 3.2-1.

3.4 OUTLINES OF POWER DEVELOPMENT PLAN IN EACH SITE

3.4.1 Nurbakhsh Site

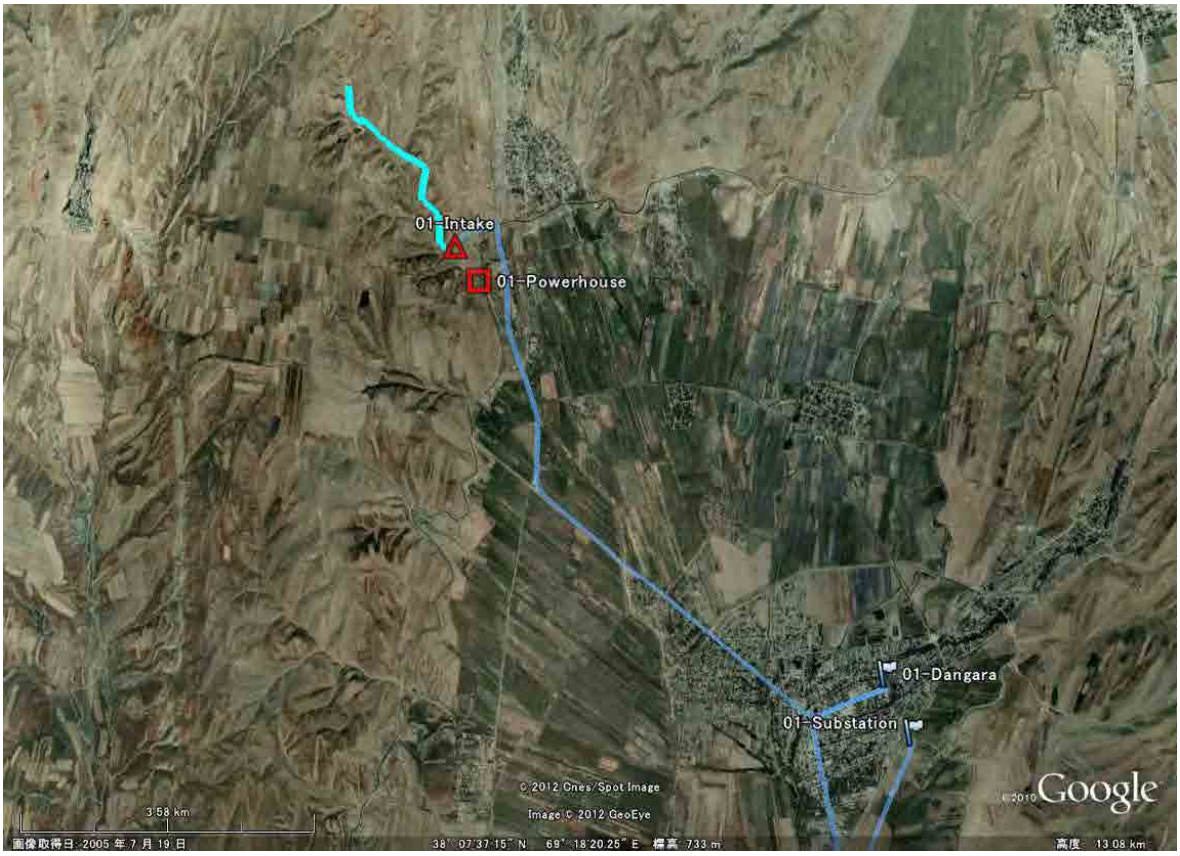


Fig. 3.4-1 General Location at Nurbakhsh Site
(Blue :Reconnaissance route, Light blue: waterway, △:Intake, □:Power station)

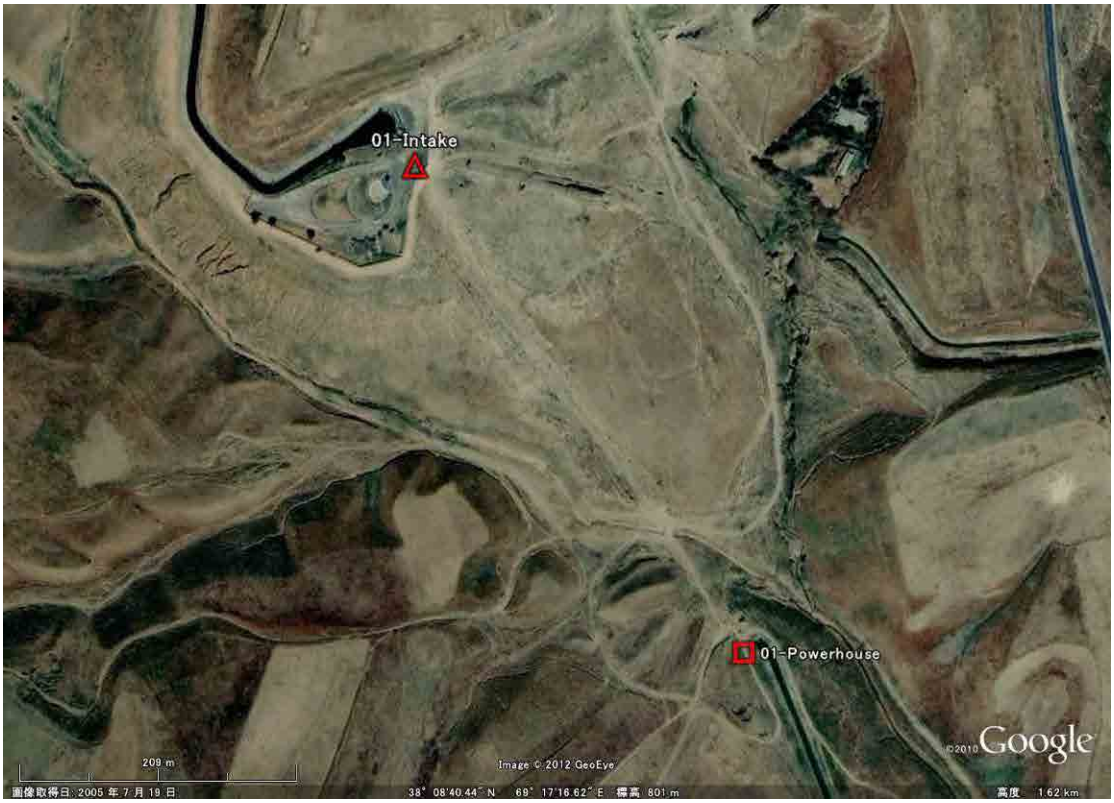


Fig. 3.4-2 Power Station Area of Nurbakhsh *(△:Intake, □: Power station)*

	
Distribution Pond of Main Canal	Penstock Route
Nurbakhsh Site	

(1) Canal Network

Nurbakhsh site is planned as a power plant utilizing the head between Dangara irrigation canal from Nurek and the tributary canal.

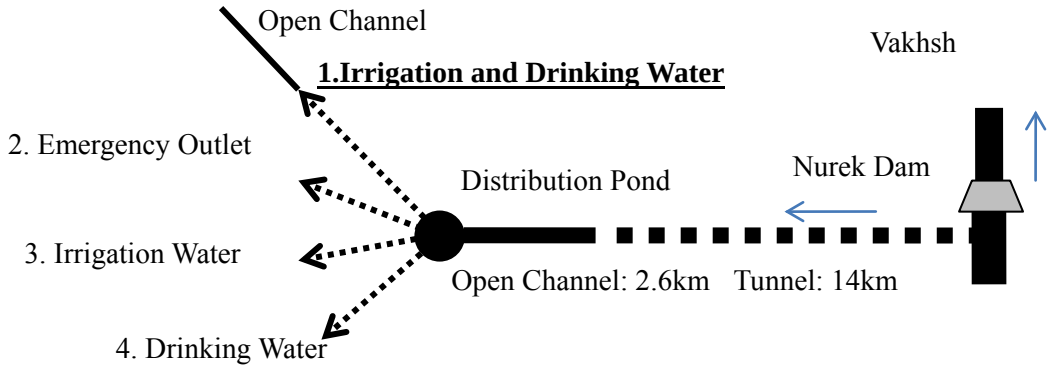


Fig. 3.4-3 Canal System at Nurbakhsh

The length of Dangara irrigation canal is 14km of tunnel from the intake weir at Nurek reservoir and 2.6km of open channel. Maximum intake discharge is 50.0m^3/s. Actual intake records are 5.0-9.0m^3/s during summer season (April - September) and 2.0m^3/s during winter season (October - March) in recent years. Dangara irrigation canal diverges into four tributary canals at Nurbakhsh intake weir. Maximum and recent actual intake discharge records of each canal are as shown below.

Canal	No. of Gate	Maximum Discharge (m^3/s)	Summer (Apr.-Sept.)	Winter (Oct.-Mar.)	Water Use
1	2	20 m^3/s (10 m^3/s ×2)	1.5 m^3/s	1.0 m^3/s	Drinking Water, Irrigation
2	1	30 m^3/s	0.2 m^3/s	0m^3/s	Spillway
3	2	30 m^3/s (15 m^3/s ×2)	1.0 ~ 7.5 m^3/s	0 m^3/s	Drinking Water, Irrigation
4	2	1 m^3/s (0.5 m^3/s ×2)	0.6 m^3/s	0.4m^3/s	Drinking Water

The head between Dangara irrigation canal and canal 1 is used for this Study. Since canal 1 is mainly used for domestic water for Dangara district, water discharge is available there during winter season. Canal 1 flows into the Tairsu river finally. Canal 1 doesn't overflow because flood discharge is regulated at Nurek dam and canal 2.

According to interview, it would be possible to negotiate with MLRWR to take the water of more than 1.0m^3/s during winter season (October to March)

(2) Power Generation Plan

Outlet of canal 1 is 500m away from distribution pond of Dangara irrigation canal. Canal 1 and distribution pond are connected by two buried pipes. Difference of 60.0m (Effective head of 50.0m) between the intake and powerhouse will be the head for power generation plan.

Regarding power discharge, water discharge during summer season (1.5m^3/s) is used to maximize annual power generation. However, power shortage in winter is serious problem in Tajikistan and stable power supply during winter is also emphasized in this Study. As a conclusion, power discharge for power generation plan is determined as 1.0m^3/s in winter.

(3) Power Facility Plan

The power plant, with available head between intake and outlet, is to be developed. A powerhouse located on the right bank of the open channel, a head tank and a penstock are to be constructed. The penstock is planned to be placed underground and in parallel with the existing steel pipes. Meanwhile, exposure of the existing pipes and collapses of the surrounding ground were identified in the 2nd site survey, therefore examination of impacts to the existing pipes due to the construction works of the penstock is required. In addition, slopes along the penstock route are eroded, therefore the slope protection works may be required. To avoid the replacement of an existing bridge over a water channel near the outlet, it is required that the penstock should be installed under the water channel.

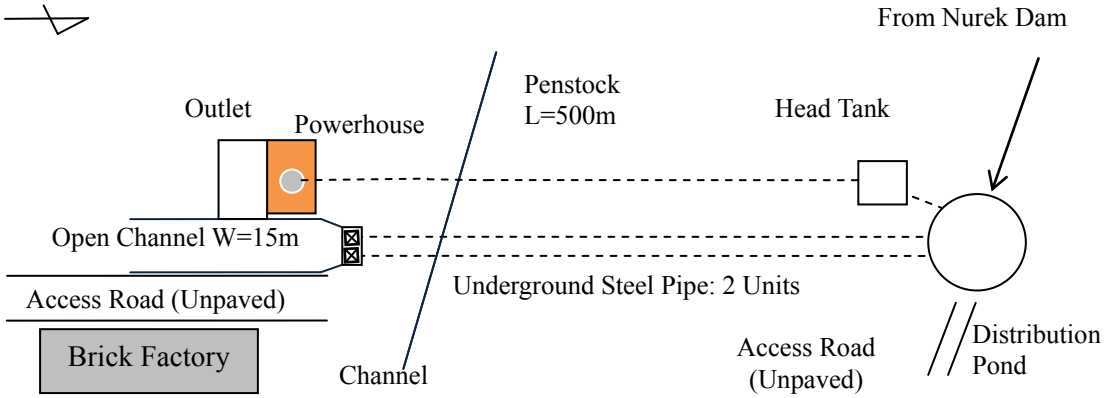


Fig. 3.4-4 Power Facility Plan at Nurbakhsh Site

(4) Concerns about Facility and Construction Planning

The accessibility to the site is very good. The construction works of the penstock in the vicinity of the existing pipes are required, therefore special cares in planning of facility layout and construction methods should be paid not to give adverse impacts to the existing pipes. In addition, the collapses of the surrounding ground of the existing pipes show the ground is eroded. It is anticipated that, in the penstock works, the consolidation works of the ground, such as re-compaction works, improvement of foundation, etc., are necessary.

3.4.2 Surhak-1 Site

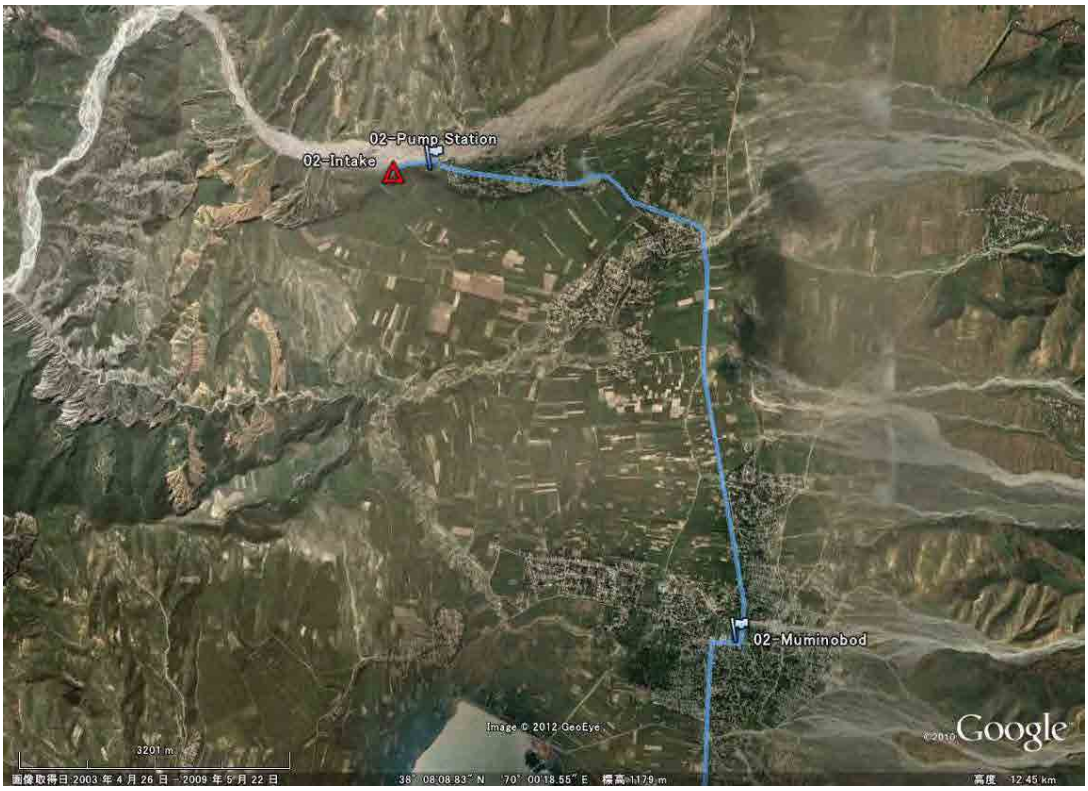


Fig. 3.4-5 General Location at Surhak-1 Site *(Blue :Reconnaissance route, ⊿:Intake)*

Fig. 3.4-6 Site Area of Surhak-1 *(Blue :Reconnaissance Route, ⊿:Intake)*

	
Chashma Canal	Meeting with Muminobod Government
Surhak-1 Site	

(1) Canal Network

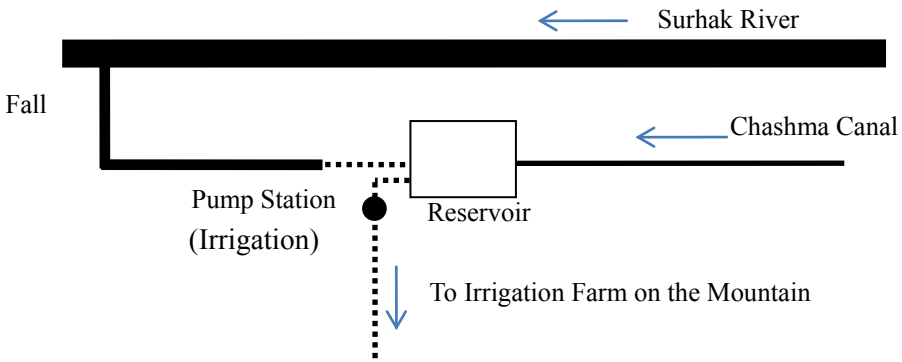


Fig. 3.4-7 Canal System at Surhak-1

Surhak-1 site is planned as a hydropower plant utilizing the drop at confluence of Chashma canal and Surhak river and also utilizing topographical drop in the distance of 200m from the intake point to the confluence point.

Chashma canal has water source at Marhot village and Alako village approximately 4km upper from the intake point. There is a pump station for irrigation constructed by the aid of UNDP at approximately 500m upper from intake point.

According to the interview, Chashma canal has discharge of 0.5m3/s during summer season (April to October) and 0.8m3/s during winter season (November to March). Because the pump station as mentioned above takes 50% of discharge from the canal for irrigation of cotton during May to September, water discharge in winter is larger than in summer. This station is operated at the interval of water intake for 3 days and pause for 10 days from May to September. Therefore actual discharge of Chashma canal during summer season is assumed to vary from 0.4 to 0.8m^3/s.

Local residents answered at the interview that Surhak river and Chashma canal have never overflowed in past 50 years in flood season.

(2) Power Generation Plan

Drop of 15.0m at the confluence of Chashma canal and Surhak river and the topography in the distance of 200m from the intake point to confluence point are proposed for the head of power generation in previous study. However, little topographic drop between the intake and confluence is observed by simple measurement and observation of topography at the site. Consequently the head of power generation is determined as 4.0m at the confluence point of Chashma canal and Surhak river.

Power discharge is planned as 0.8 m^3/s for winter season.

(3) Power Facility Plan

The canal from the downstream of the pump station to the head tank site is required to be improved. The head tank is constructed at the downstream end of the canal and the powerhouse is constructed at about 10m downstream of the head tank.

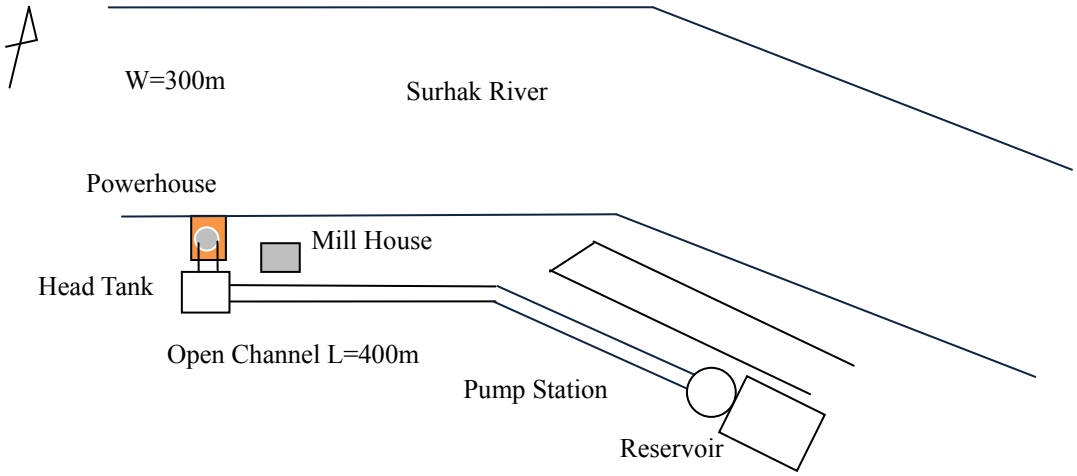


Fig. 3.4-8 Power Facility Plan at Surhak-1 Site

(4) Concerns about Facility and Construction Planning

The access around the site is unpaved road of 4m wide and the approach of about 200m long to the powerhouse needs to be planned in the river course. From the viewpoint of accessibility of the heavy equipment, the road improvement works and temporary road construction works in the river course are necessary.

In addition, the water for the mill house should be secured.

3.4.3 Sathad Site

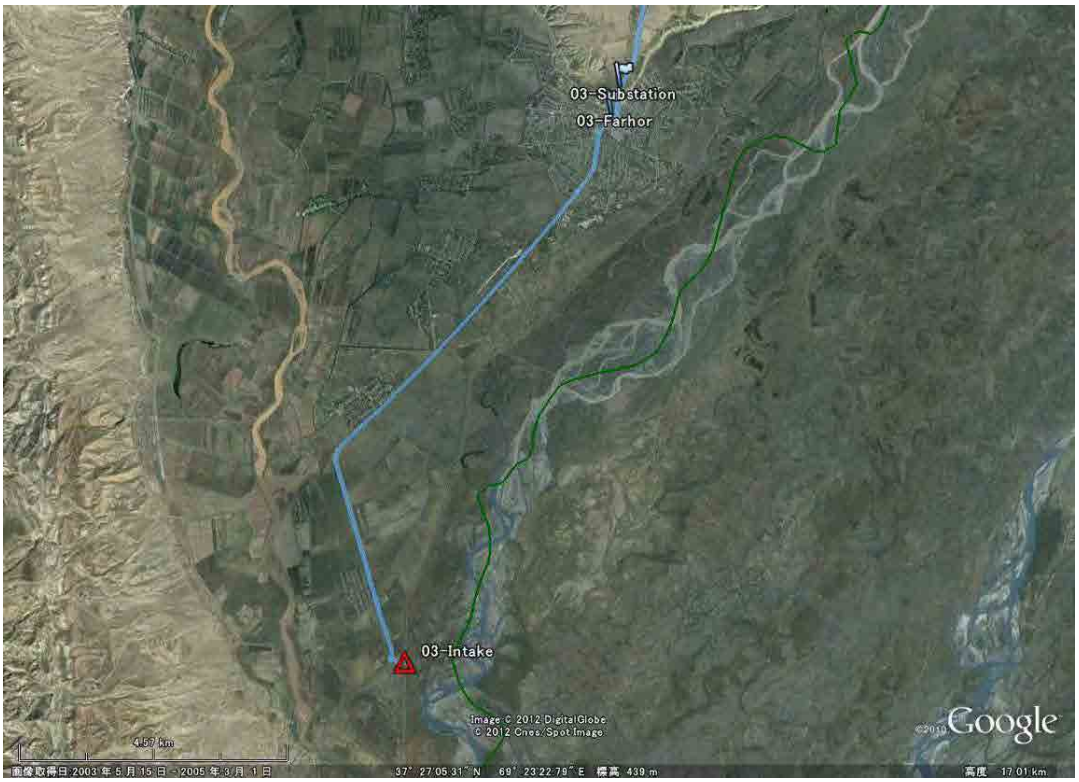


Fig. 3.4-9 General Location at Sathad Site *(Blue :Reconnaissance route, ⊿:Intake)*

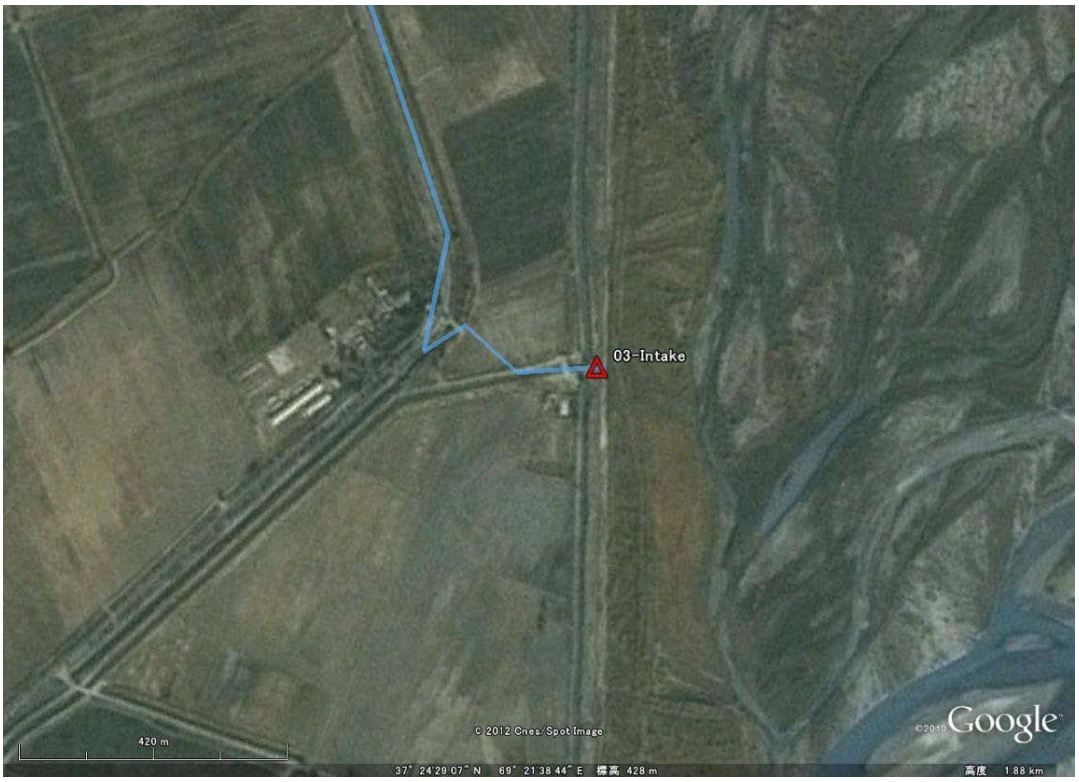


Fig. 3.4-10 Site Area of Sathad *(Blue :Reconnaissance route, ⊿:Intake)*

	
Fall Structure at Sathad	Borderline with Afghanistan
Sathad Site	

(1) Canal Network

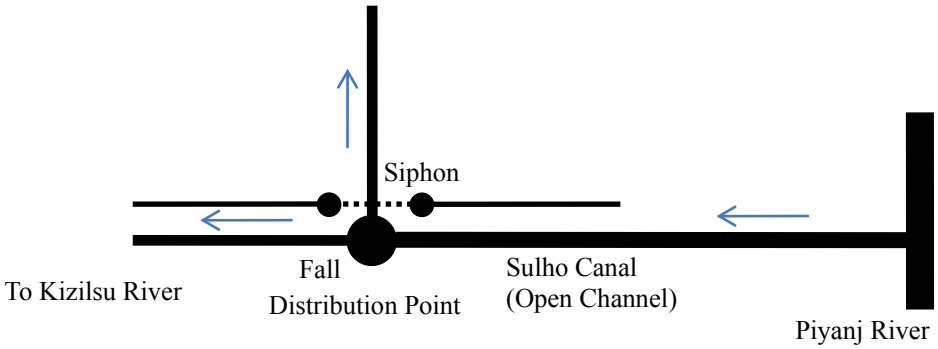


Fig. 3.4-11 Waterway System at Sathad

Sathad site is planned as a hydropower plant using the drop structure at the tributary canal of Sulho canal which is branched from Pyanj river by Golgon intake weir.

According to the interview with the person in charge of water resource at Farhor district, Sulho canal is being used for irrigation. The maximum intake discharge of canal is 22.0m^3/s. Sulho canal has 22.0m^3/s of discharge during summer farming season (April - September) and 4.0m^3/s in other season. Sulho canal diverges into the main canal and tributary canal which is for the tailrace to Kizilsu river at Sathad site. The tributary canal has 4m^3/s during summer farming season (April - September) and 2.0m^3/s in other season.

However, discharge of Sulho canal at upper stream of diversion is estimated at 2.0m^3/s at Sathad by the site survey of discharge and canal situation. As the canal width is narrow and height allowance of both banks is low, Sulho canal hardly flows maximum 22.0m^3/s which is obtained from the interview. Discharge at the tributary canal is estimated at 1.0m^3/s. Local residents answered at the interview that the tributary canal currently has the same or slightly more discharge as summer season and no water in winter season. And they also answered that the canal has never overflowed in flood season at Sathad.

(2) Power Generation Plan

8.0m at the drop structure is proposed for the head of power generation in previous study. However, the height of drop is estimated at 3.3m to 3.5m by simple measurement at the site. Consequently the head of power generation is determined as 3.5m.

Although specific information on maximum discharge is not obtained, discharge in summer season (April to September) is estimated at approximately 1.0m^3/s by the interviews with local residents and on-site river situation. On the other hand, because of local residents answers that there is no flow during winter, power discharge is determined as 1.0m^3/s.

(3) Power Facility Plan

It is difficult to arrange power facilities on the right bank, because there are residences, the branched canal and a channel for agriculture equipped with a siphon. Although the power plant should be arranged on the left bank, it is impossible to construct the power plant in the area which has a width of 14m up to the boundary of the Afghanistan and where any activities are prohibited as a military zone.

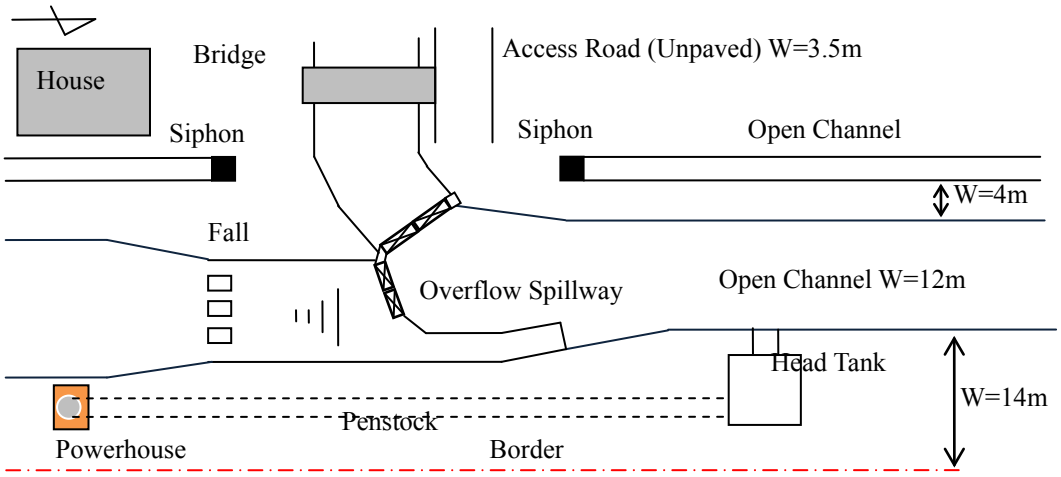


Fig. 3.4-12 Power Facility Plan at Sathad Site

(4) Concerns about Facility and Construction Planning

The access to the site is unpaved road of 4m wide, therefore the road improvement works are required for passage of the heavy equipment.

A temporary bridge to go over the canal from the right bank to the left bank is necessary.

The development of the power plant is very difficult because of its location in the neighboring border area of Afghanistan.

3.4.4 Yokunch Site

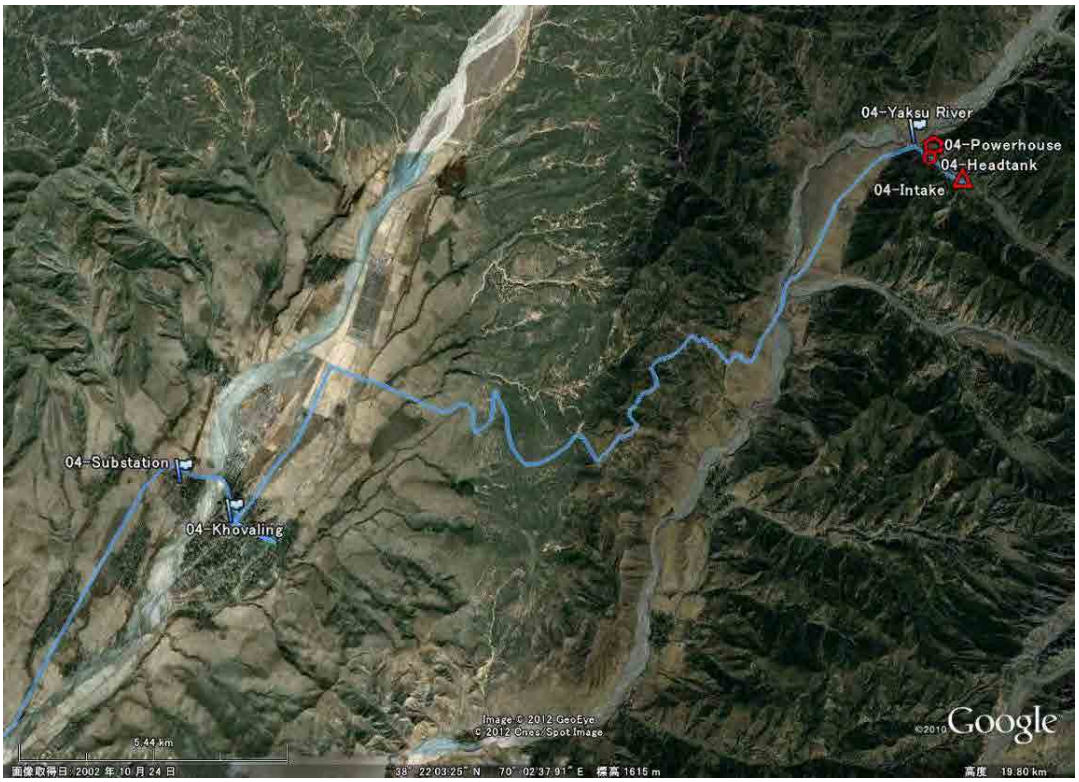


Fig. 3.4-13 General Location at Yokunch Site
(Blue :Reconnaissance Route, △:Intake, □:Power Station)

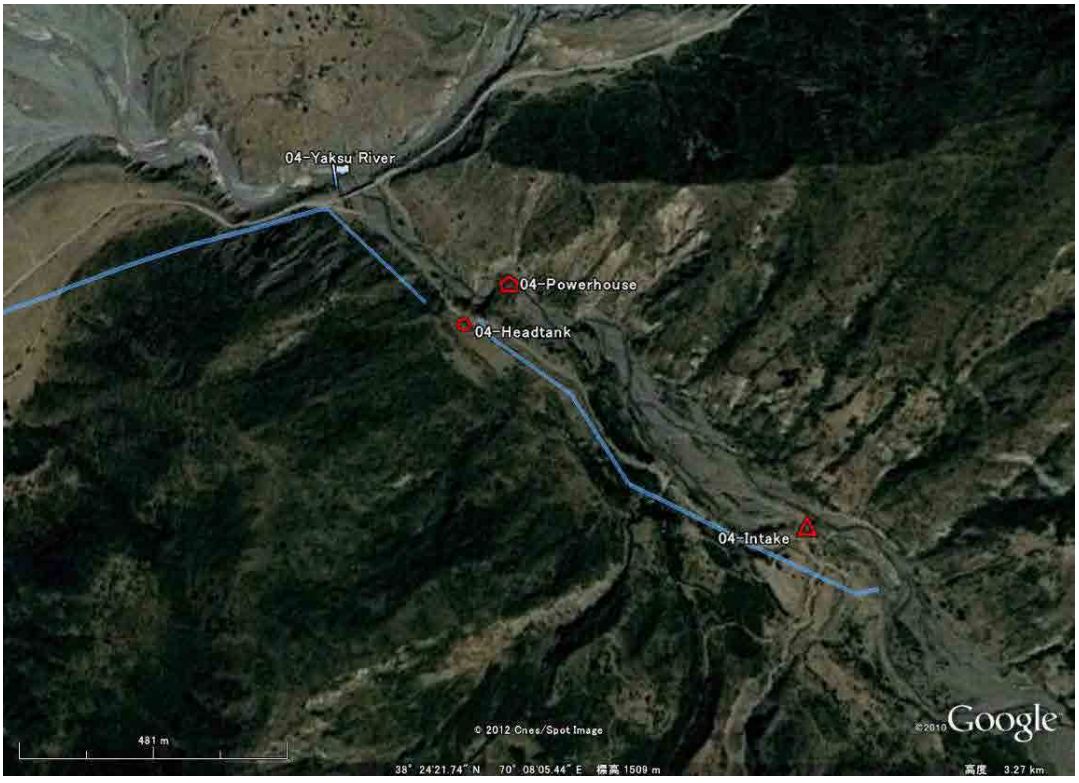


Fig. 3.4-14 Site Area of Yokunch *(Blue :Reconnaissance Route, △:Intake, □:Power Station)*

	
Yokunch River	Proposed Weir Location
Yokunch Site	

(1) Canal Network

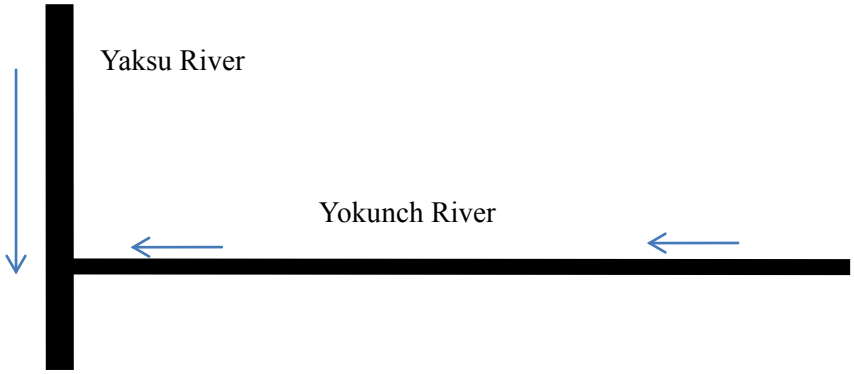


Fig. 3.4-15 Canal System at Yokunch Site

Yokunch site is planned as a hydropower plant using topographical drop of Yokunch river.

Yokunch river is the tributary of Yaksu river located at western part of Khatlon. Riverbed gradient between intake and powerhouse is steep and flow velocity is fast. According to the interview, Yokunch river has discharge of 3.0m^3/s during August – September and of 4.0m^3/s in other season. Water use of Yokunch river is only small amount of intake for domestic use by a household near the intake weir and it does not affect the power generation plan.

There is the trace of flood in wide area at riverside of left bank and it is necessary to consider the countermeasure against flood.

(2) Power Generation Plan

Topographical drop of 20.0m is proposed for the head of power generation in previous study. Drop of 20m is assumed to be obtained by on-site measurement of elevation by altimeter and Global Positioning System (GPS) and observation of topography of 800m between the intake point and head tank point at the downstream of left bank. Consequently the head of power generation is determined as 20.0m.

Discharge of 3.0 - 4.0 m^3/s is observed at the site survey in April of 2012. 10% of 3.0m^3/s is reserved for river maintenance flow and power discharge for the 1st screening is determined as 2.7 m^3/s.

(3) Power Facility Plan

An intake is installed in the Yokunch River and the water way (pipe) is installed on the left bank of the Yokunch River. A head tank is planned to be installed on the flat area which is about 800m downstream from the intake. A powerhouse is situated at the area of about 5m higher from river bed taking into account of flood.

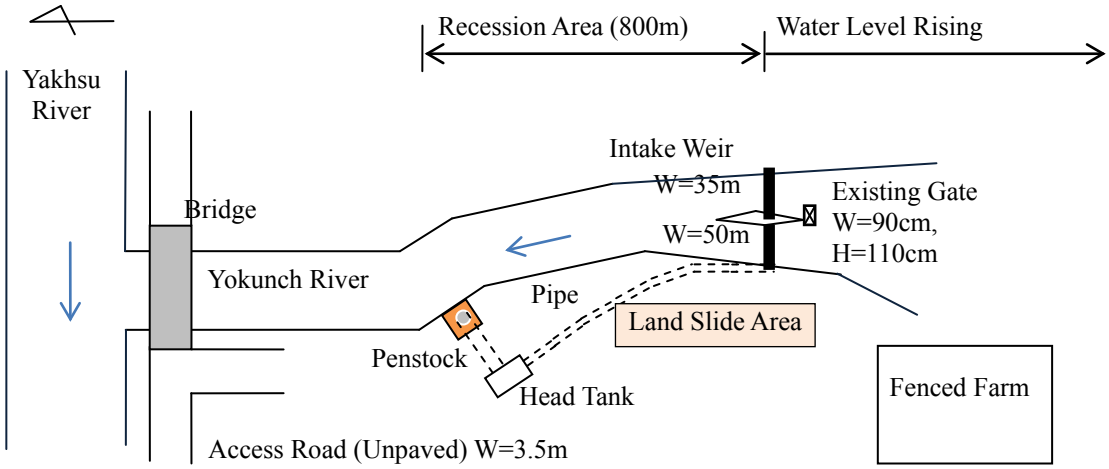


Fig. 3.4-16 Power Facility Plan at Yokunch Site

(4) Concerns about Facility and Construction Planning

The left bank of the upstream from the intake in the Yokunch River is a highly eroded area. The river course near the fenced farm has become quite wide due to river bank erosion during flooding. Therefore, it is evaluated that the water level rise by installation of the weir may develop the river bank erosion. The area along the water way is in bad geological conditions and a landslide prone area, therefore it is expected that the installation and maintenance of the water way would be hard.

The access road to the site, which is unpaved, of 21km long and 3 to 4m wide and shows bad conditions, is passing through the mountain area, and it becomes inaccessible in the season of heavy rain and snow. In addition, the bridge of 4m wide on the Yakhsu River, which is about 5km far from the powerhouse site, cannot allow the pass of heavy equipment.

Moreover, there is no access road to the intake and it is difficult to construct the access road, thus heavy equipment should pass in the river course when river discharge is less.

Excavation and concreting works of the intake facilities will be carried out by man-power.

3.4.5 Shibanai Site

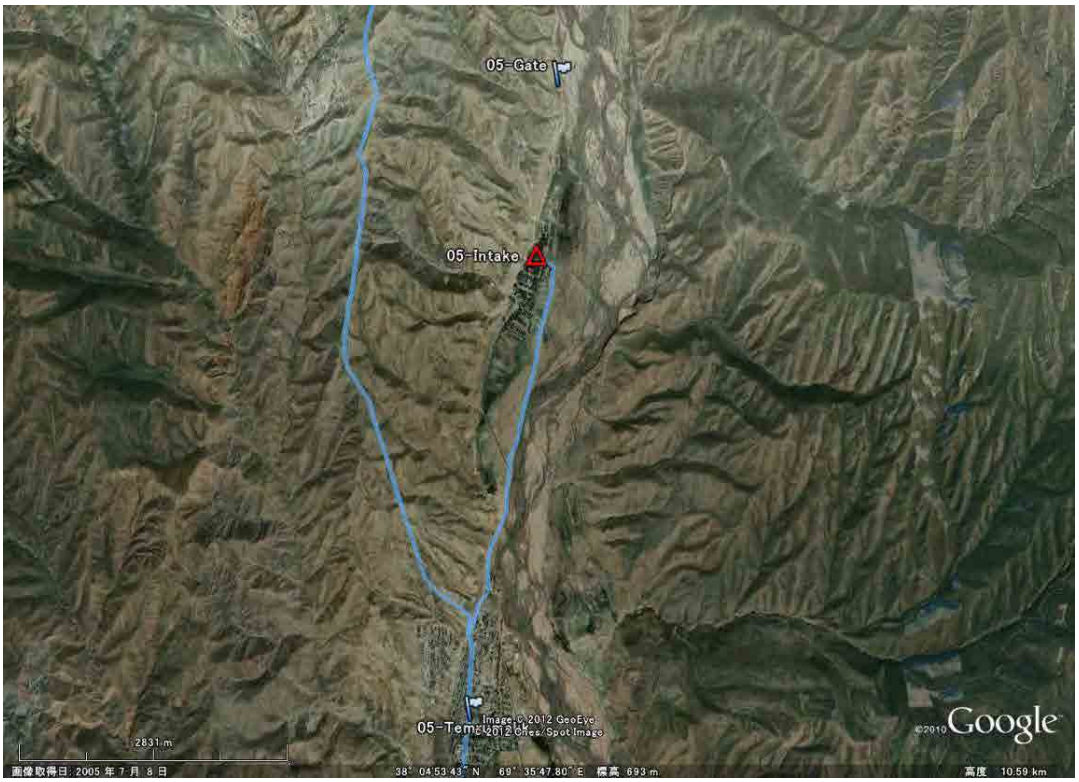


Fig. 3.4-17 General Location Map at Shibanai Site *(Blue :Reconnaissance Route △ :Intake)*

Fig. 3.4-18 Site Area of Shibanai *(△:Intake)*

	
Shibanai Canal	Intake at Kizilsu River
Shibanai Site	

(1) Canal Network

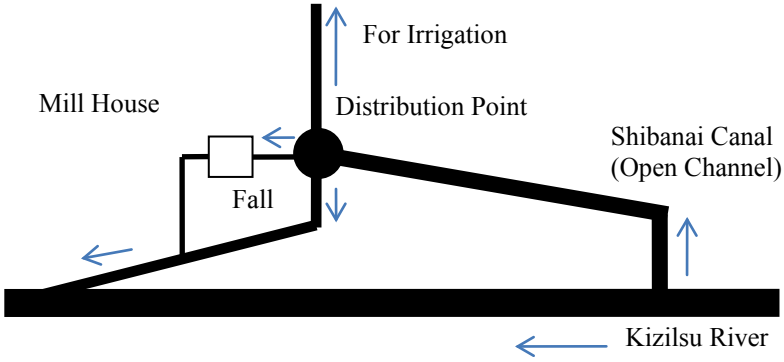


Fig. 3.4-19 Waterway System at Shibanai

Shibanai site is planned as a power station using the drop structure of Shibanai canal to which water is taken from Kizilsu river.

Shibanai canal is taken from Kizilsu river and used for irrigation. According to the interview, it has discharge of 0.5 m^3/s throughout the year. There are no gate and weir at the intake point of Kizilsu river. Water flows into Shibanai canal naturally. Discharge into the canal is controlled by only dammed with sandbag when flooding. Local residents answered at the interview that Shibanai canal has water flow in winter season as well.

Shibanai canal diverges into the main canal for irrigation of downstream and the tributary canal for tailrace to Kizilsu river. Drop structure of the tributary canal is utilized in this Study. The tributary canal has little discharge during farming summer season (April to September) because of irrigation by way of the main canal. Discharge of the tributary canal is estimated at 0.06 m^3/s to 0.08 m^3/s by on-site observation. On the other hand, as there is no demand for irrigation in winter season, the main canal is cut off at Shibanai site and flows into the tributary canal. Therefore discharge of tributary canal is estimated at 0.5m^3/s during winter season.

Local residents answered that Shibanai canal doesn't overflow because discharge is regulated at the upper intake at Kizilsu river. However since it is natural intake without weir and gate, discharge regulation by sandbag has a risk of collapse and overflow at the intake. According to the interview, surrounding area is damaged by the flood at the end of March in 2012. It is necessary to consider the countermeasure against flood at the intake.

(2) Power Generation Plan

7.0m at the drop structure of Shibanai canal and the tributary canal to Kizilsu river is proposed for the head of power generation in previous study. Length of drop structure is estimated at approximately 4.0m by simple measurement at the site, therefore the head of power generation is determined as 4.0m.

Power discharge is determined as 0.5m^3/s of winter's water intake.

(3) Power Facility Plan

A fall of 4.0m high in Shibanai irrigation canal is utilized for the small hydropower development. No permanent intake facility such as a weir is equipped and it is difficult to install it on the Kizilsu river having the width of more than 400m. A head tank is installed in the existing Shibanai canal and the fall is utilized without any modifications. Required facilities and works would be an intake weir/ mouth, a water way, a head tank, a penstock, a powerhouse, transmission/ distribution lines and slope protection works.

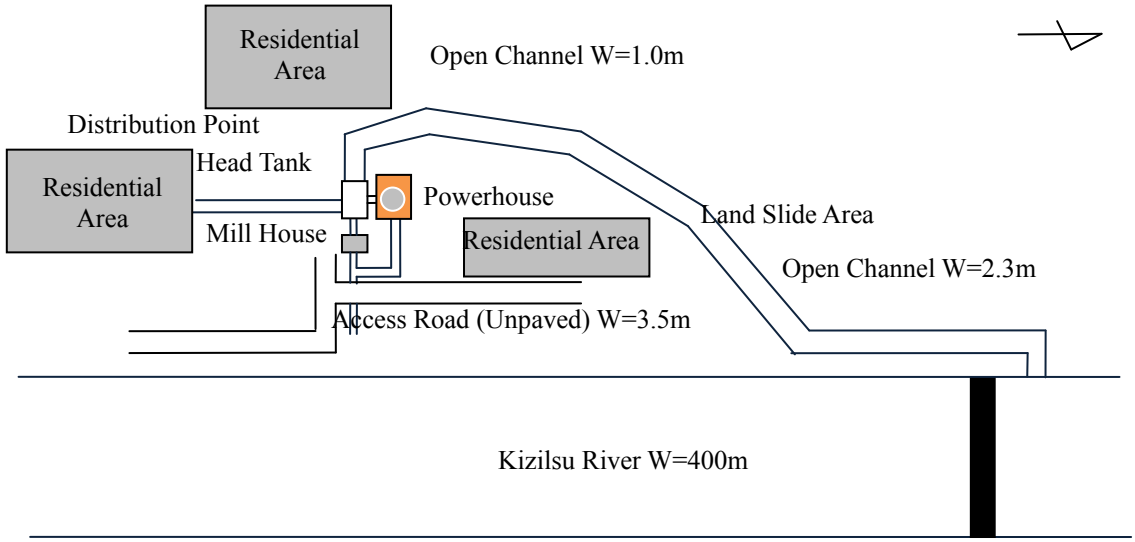


Fig. 3.4-20 Power Facility Plan at Shibanai Site

(4) Concerns about Facility and Construction Planning

Total length of the access road from Sovet to the site is 6km and the access road of about 3km long from the powerhouse site out of total length of 6km is unpaved and of 3 to 4m wide, therefore the road improvement works for such unpaved distance are required for the access of heavy equipment. Around the powerhouse, there are residence and farming area, therefore the installation works with heavy equipment are impossible. The river course of the Kizilsu River is used for the access to the intake area.

Since the site is in a flood prone area, the design of the intake and the water way should take such situation into account.

The mountain on the right bank of the intake water way has a high potential of landslide and collapse.

3.4.6 Pakhtakor Site

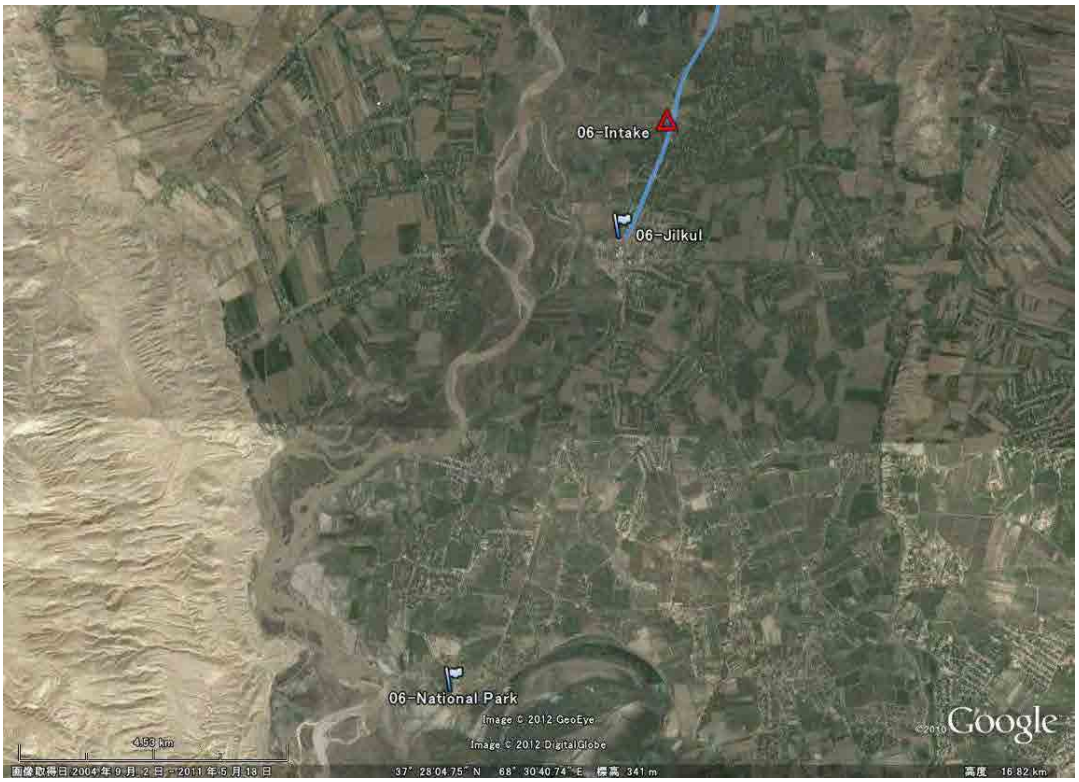


Fig. 3.4-21 General Location at Pakhtakor Site *(Blue :Reconnaissance Route ⊿ :Intake)*

Fig. 3.4-22 Site Are of Pakhtakor (⊿:Intake)

	
Kaiganobod Canal	Drop Structure at Pakhtakor
Pakhtakor Site	

(1) Canal Network

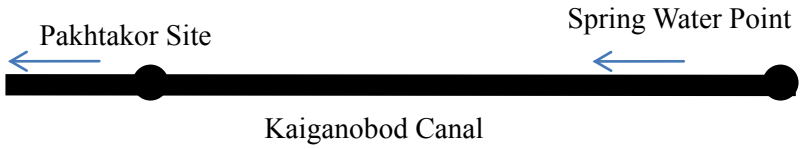


Fig. 3.4-23 Canal System at Pakhtakor

Pakhtakor is planned as a power plant using the drop structure of the canal sourced from underground water at Kaiganobod. According to the interview with the person in charge of water resource at Jilkul district, this canal is used for irrigation and there is no other intake between the water source point and Pakhtakor site. Discharge is 10.0m^3/s in summer farming season (May - October) and 3.0 – 4.0m^3/s in other season. Interviewee answered that amount of runoff at Kaiganobod is recorded but it was impossible to disclose.

By site survey of discharge and canal situation at Pakhtakor site, river width is approximately 4m, water depth is 30 – 50 cm, flow velocity is less than 1.0m^3/s at upper point of drop structure and discharge is estimated at approximately 1.0m^3/s. Local residents answered that discharge at the canal during summer season is equal to current situation when interviewed or slightly more, and discharge during winter is less. And the canal has never overflowed in the past at Pakhtakor site.

(2) Power Generation Plan

6.0m at the drop structure is proposed for the head of power generation in previous study. However the length of drop is estimated at 2.5m to 3.0m by simple measurement at the site. The head of power generation is decided as 3.0m in this Study.

Power discharge is decided as 1.0m^3/s considering the interviews with local residents and on-site survey.

(3) Power Facility Plan

A powerhouse is installed at the right bank of the fall. Required facilities are a head tank, a

penstock, a powerhouse and transmission/ distribution lines.

The existing gates on the fall are required to be replaced. The upstream and downstream banks in the irrigation canal are eroded and the bank protection works are required.

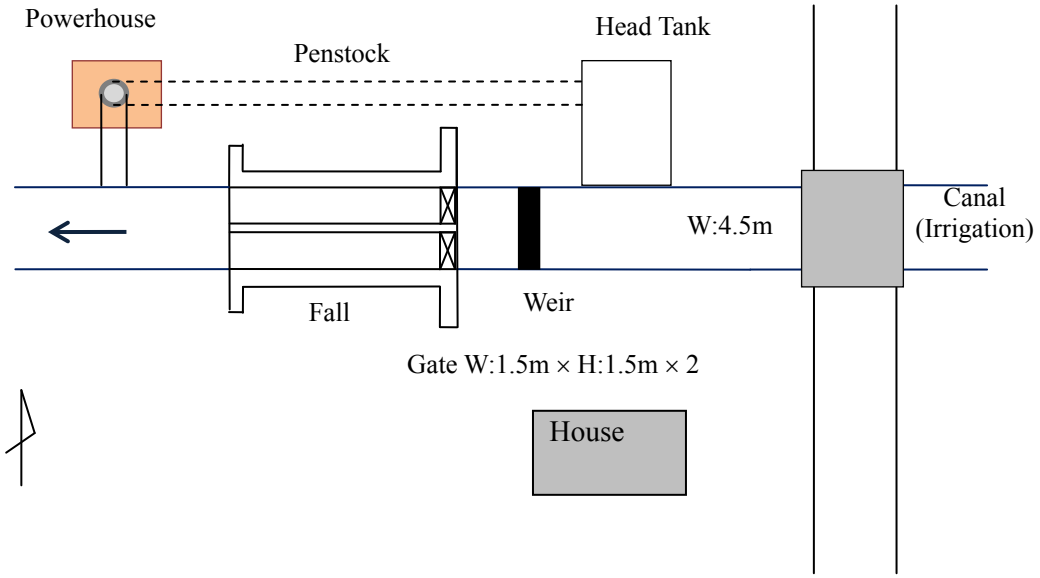


Fig. 3.4-24 Power Facility Plan at Pakhtakor Site

(4) Concerns about Facility and Construction Planning

River diversion works are necessary, since the water is flowing throughout the year.

3.4.7 Faizobod Site

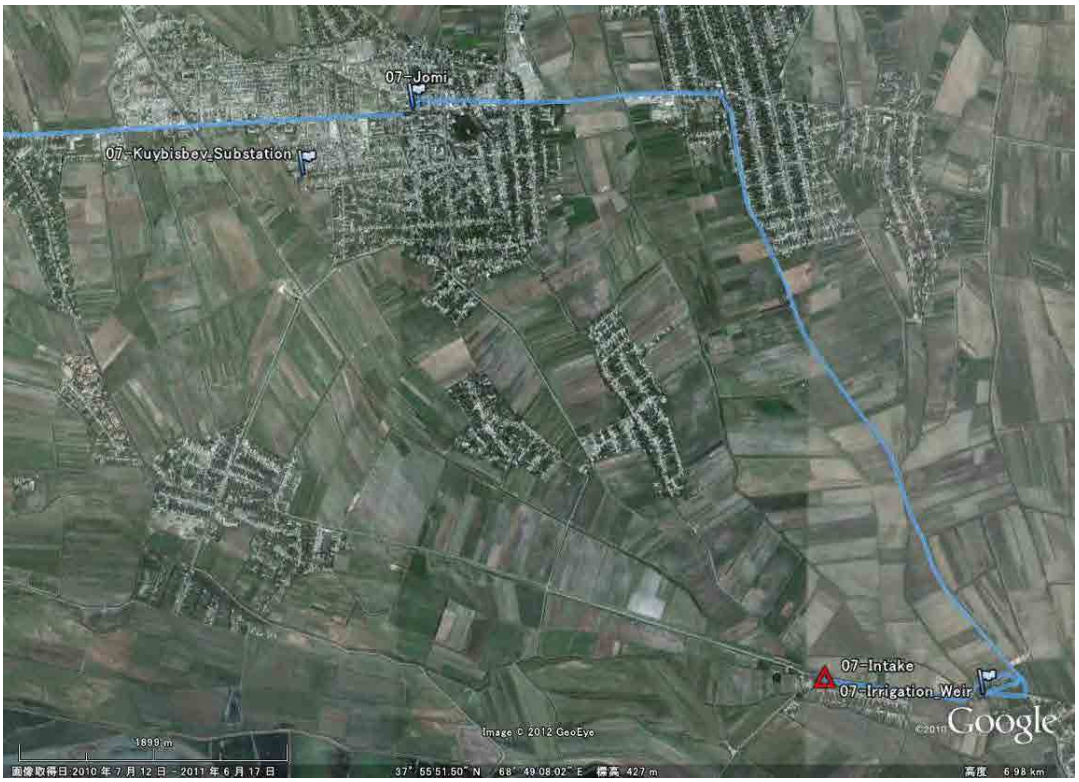


Fig. 3.4-25 General Location at Faizobod Site *(Blue :Reconnaissance Route, ⊿ :Intake)*

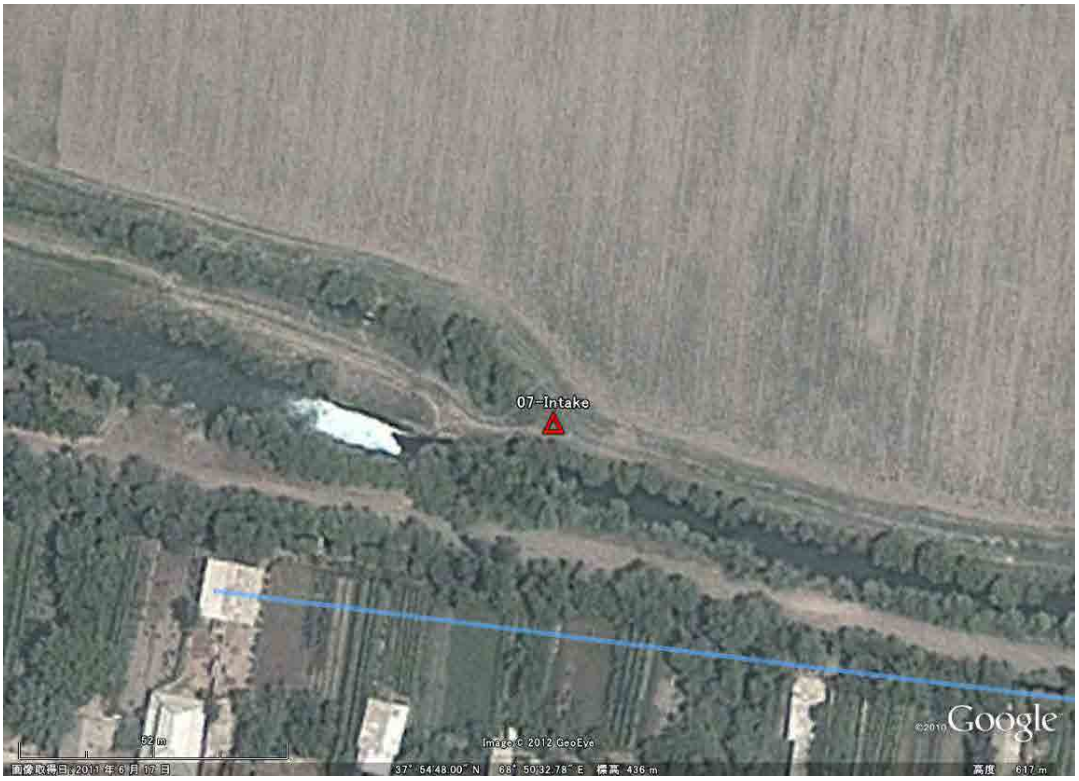


Fig. 3.4-26 Site Area of Faizobod *(Blue :Reconnaissance route, ⊿:Intake)*

	
Drop Structure at Faizobod	Distribution Pond of Shorobod Canal
Faizobod Site	

(1) Canal Network

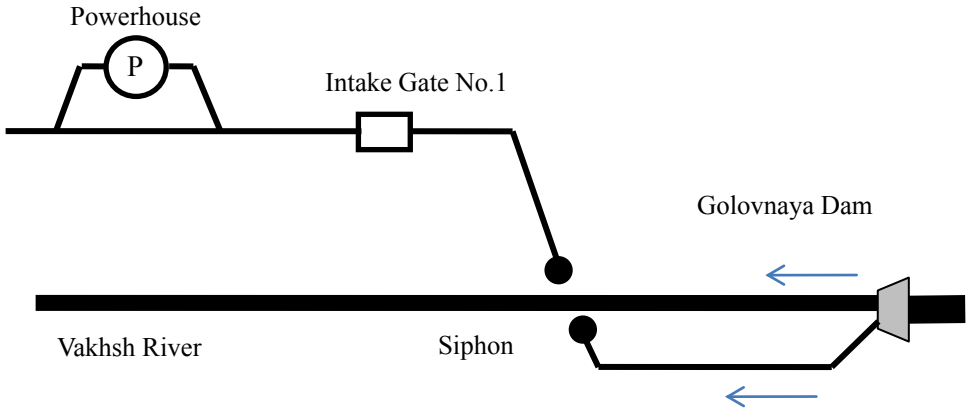


Fig. 3.4-27 Canal System at Faizobod

Faizobod site is planned as a power plant using the drop structure at the tributary canal of Shorobod canal. Shorobod canal managed by MLRWR is taken from the tailrace of Golovnaya power plant and used for irrigation, domestic water and fishery at Jomi district. Maximum intake discharge is 40.0m^3/s during summer cotton farming season (April - September) and 8.0m^3/s during winter season (October - March).

Actual intake record and the breakdown of water use during winter season of 2011 - 2012 is as shown below.

Period	Intake	Water Use
2011 November	6 m^3/s	Fishery: 3 m^3/s, Others: 3 m^3/s
December	5 m^3/s	Fishery: 3 m^3/s, Others: 2 m^3/s
2012 January	4 m^3/s	Fishery: 3 m^3/s, Others: 1 m^3/s
February	4 m^3/s	Fishery: 3 m^3/s, Others: 1 m^3/s
March	5 m^3/s	Fishery: 3 m^3/s, Others: 2 m^3/s

Note : Prepared by the interview with the person in charge of water resource at Jomi district

Discharge of 3.0m^3/s is reserved for fishery cultivation at Jomi district throughout the year. Amount of the intake decreases during non farming season of cotton (November - March) and water for fishery and other domestic use is mainly consumed.

Shorobod canal diverges into seven tributary canals by the intake weir maintained by MLRWR. Faizobod site is located at one of the tributary canals and 1,100m west from the intake weir. Maximum intake discharge of the canal is 10.0m^3/s. The canal has discharge of 1.0m^3/s during non farming season September – March, 6.0 - 8.0m^3/s during April – July and 10.0m^3/s during August. The canal doesn't overflow because discharge in flood is controlled at upper intake weir of Golovnaya power plant.

According to the interview, it would be possible to negotiate with MLRWR to take the water of more than 1.0m^3/s during winter season (September - March).

(2) Power Generation Plan

6.0m at the drop structure is proposed for the head of power generation in previous study. However the length of drop structure is estimated by approximately 3.0m by simple measurement at the site. Therefore the head of power generation is determined as 3.0m in this Study.

Power discharge is determined as 1.0m^3/s of winter's water intake.

(3) Power Facility Plan

The power plant is planned to use the existing fall on the existing irrigation canal. A powerhouse is installed on the left bank of the canal, and required facilities would be an intake weir, a head tank, a penstock, the powerhouse and transmission/ distribution lines. The banks of the canal need to be raised because of back water of the intake weir, and due to this, a road along the canal is also required to be refurbished. Moreover, there is a small canal on the left bank of the canal, which is required to be replaced.

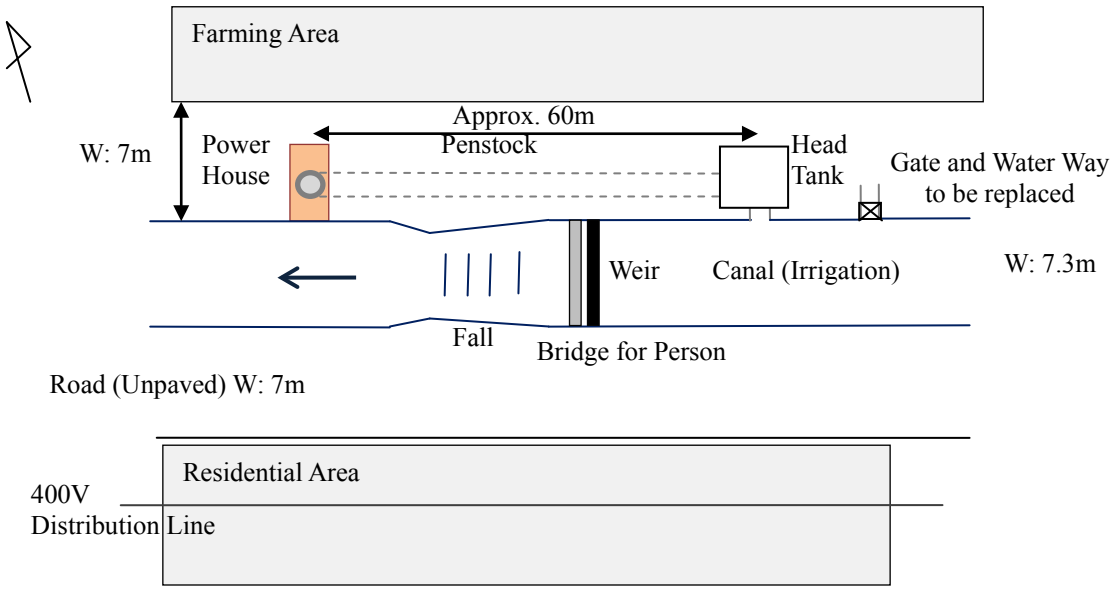


Fig. 3.4-28 Power Facility Plan at Faizobod Site

(4) Concerns about Facility and Construction Planning

The accessibility to the site is good, however a temporary bridge is necessary to access to the right bank of the canal.

The water is flowing throughout the year, therefore diversion works is required.

In case that the plant facilities are arranged at the area between the canal and the farming area, the construction works would be hard because the area is narrow.

3.4.8 Bohtar Site

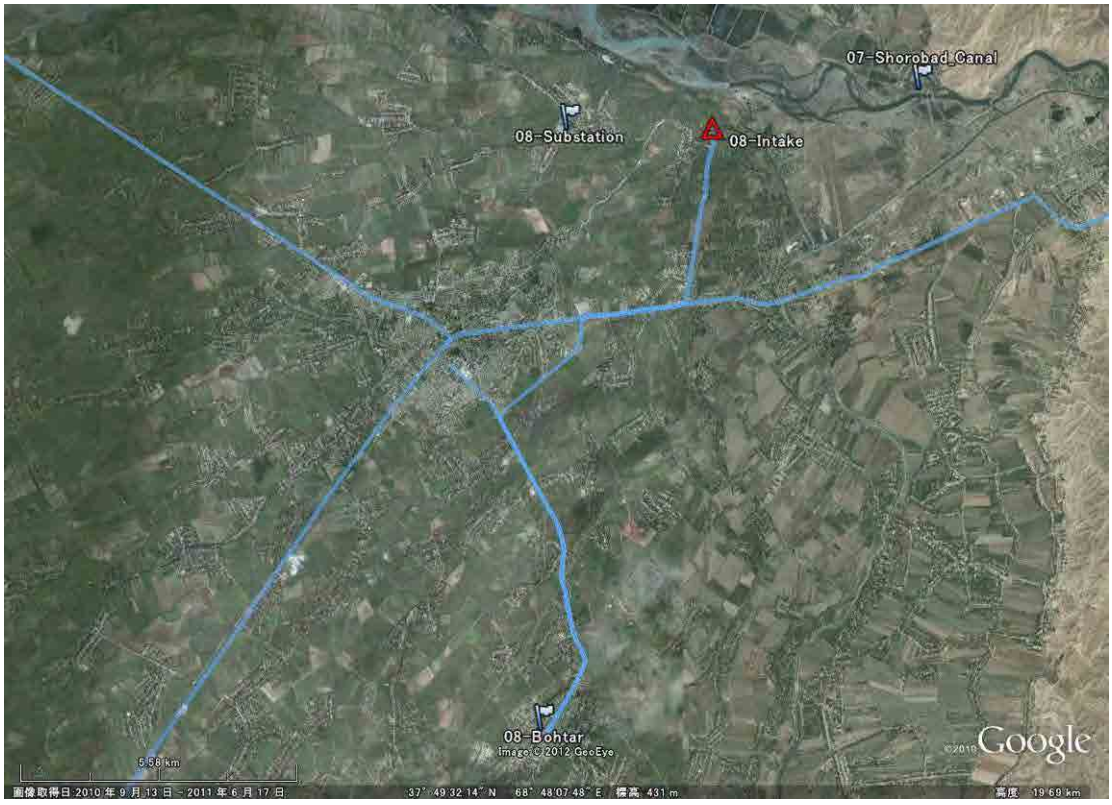


Fig. 3.4-29 General Location at Bohtar Site *(Blue :Reconnaissance Route ⊿:Intake)*

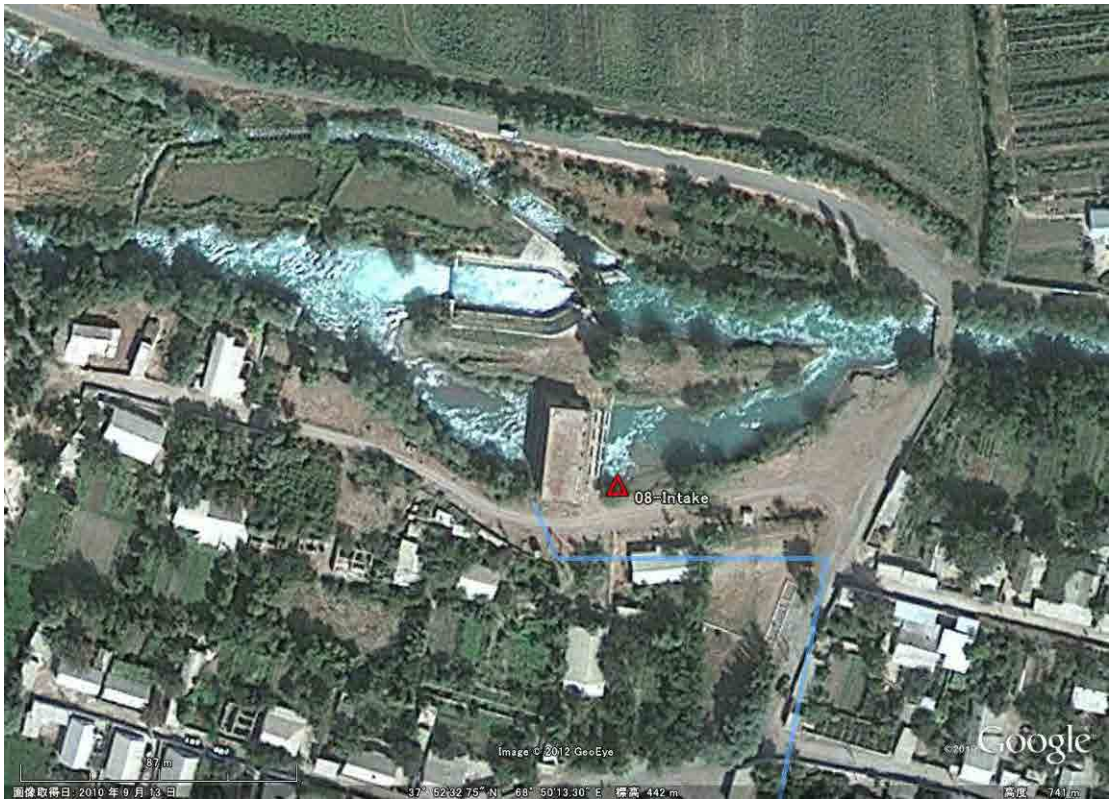


Fig. 3.4-30 Site Area of Bohtar *(Blue :Reconnaissance Route, ⊿ :Intake)*

	
Outlet of Powerhouse	Building of Powerhouse
Bohtar Site	

(1) Canal Network

Bohtar site is located at the canal named PK25 and planned as a power plant using the site of old power plant constructed in Soviet era.

Canal of PK46 taken from tailrace of Golovnaya power plant diverges at Intake Gate No.1 into the canal used for irrigation of south part of Khatlon and power plants of Prepadaya (29.95MW) and Central (15.1MW) and the canal of PK25 used for irrigation at Bohtar, Rumij and Jilkul district.

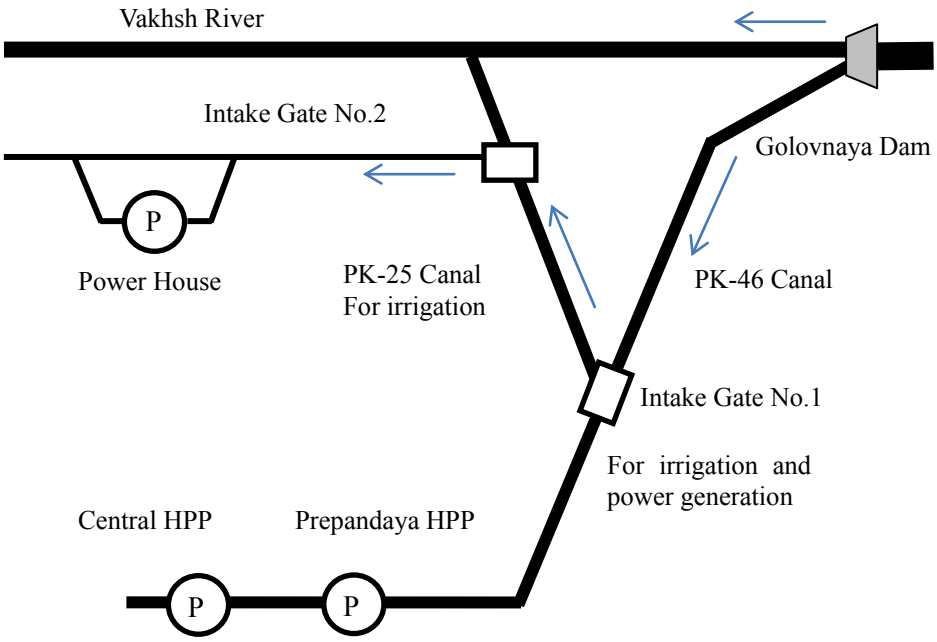


Fig. 3.4-31 Canal System at Bohtar Site

PK25 takes the water during summer season (March - November), and there is no water at PK25 during winter season (December - February). When the old power plant was in operation, PK25 had discharge of more than 40.0m^3/s, however present maximum intake discharge is 40.0m^3/s. Recent actual intake record shows 10.0m^3/s for irrigation demand.

The canal doesn't overflow because discharge is regulated in flood at upper intake weir of Golovnaya power plant.

According to the interview, it would be possible to negotiate with MLRWR to take the water during winter and increase the discharge during summer.

(2) Power Generation Plan

4.0m at the old powerhouse is proposed for the head of power generation in previous study. The length of drop at the old powerhouse is estimated at 3.0m by simple measurement at the site. The head of power generation is determined as 3.0m accordingly.

The person in charge of the water resource of Bohtar district answered that there is 10.0m^3/s during summer season (March to November) and no water flow during winter season (December to February). As there are two operational power plants at the downstream of the canal diverged from PK46, problem on water distribution may occur to ensure water flow during winter season.

Meanwhile, deputy chairman of Khatlon expressed his opinion that it would be possible to ensure water flow during winter season. Therefore additional plan which is possible to operate in winter season is considered as an option in this Study.

According to the interview, there was much discharge when the old power station was in operation and it would be possible to negotiate with MLRWR to take the water up to maximum 40.0m^3/s.

However because maximum intake discharge of canals at downstream of the old power station is designed at less than 40.0m^3/s, renovation of canals is required to increase the water discharge. In addition, house of local residents is constructed at the waterside and it is necessary to assess the impact of water level fluctuation to local residents.

Consequently, although there remains further consideration of power discharge, 10.0m^3/s is adapted for the power discharge in this Study.

(3) Power Facility Plan

The renovation of the existing power plant is required for the development of the new power plant. The existing power plant has severe damage, therefore all of the plant facilities are demolished and the plant is newly constructed. Gates and structures on the existing spillway are required to be renewed. And the downstream and upstream canal is also to be improved.

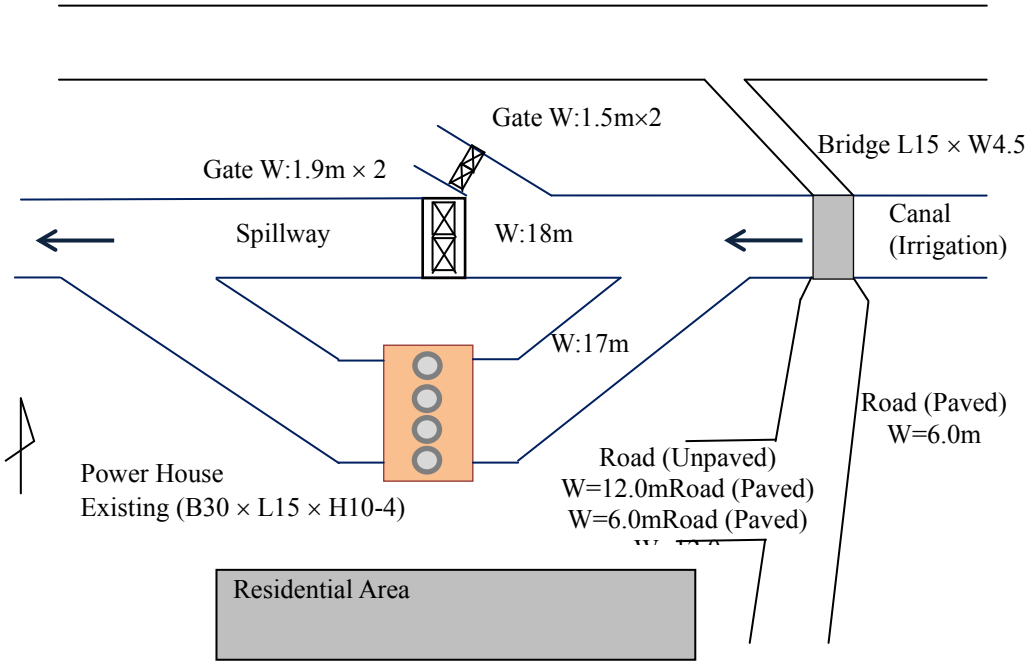


Fig. 3.4-32 Power Facility Plan at Bohtar Site

(4) Concerns about Facility and Construction Planning

The construction works is relatively easy because river discharge can be readily diverted.

The construction works of the spillway and revetment (bank protection) would be easily implemented in the non-farming season when the water is not flowing in the canal.

3.4.9 Baljuvon Site

Fig. 3.4-33 Vicinity Map of Baljuvon District Office

	
Baljuvon Ditrict Government Office	Shurabdarya River
Baljuvon	

There is no access road to the site in the season of heavy snow or higher water level due to the melting snow. Such being the case, the site visit during 2nd site survey in April, 2012 could not be made. Hence, the results of meeting with the personnel of Baljuvon District Office and interview survey are summarized below.

There are five (5) small hydropower development plans studied by Barki Tojik in 2009. In addition, there is one small hydropower plant which was constructed by aid of UNDP but has not

operated. These plants are listed below.

Mulokoni	60kW
Peshtova-1	55kW
Peshtova-2	220kW
Horma	300kW, under construction by aid of IsDB, the plant of 180kW out of total output of 300kW was completed and is operating.
Pusht Bog	200kW, the plant is to be developed by Barki Tojik. The plant is situated in the vicinity of a scenic water fall.
UNDP Project	30kW, the project resulted in failure.

These sites are located in the northern part of Baljuvon, the passage in the river course by four wheel driving car is necessary to visit the sites. Therefore, there is none of accessible way by a car from December to May due to heavy snow or high water level. The residents in the north area come to the center of Baljuvon District on foot or donkey.

People who live in Mulokoni village cannot access to electricity.

Shahidon village located at about 15km downstream of Peshtova-1 and 2 sites is electrified and equipped with a substation.

As mentioned above, it is difficult to visit the sites from December to May.

In addition, the UNDP project has not been in operation, because of inadequate design and technical problems.

Although viability of development of power plant has not evaluated because the site survey could not be carried out, in this Study, Pechtova-2 project which was requested by the district and is with the capacity of more than 100kW is selected as an object site.

3.5 ENVIRONMENTAL AND SOCIAL CONSIDERATIONS

Document survey, site survey, and interview for residents were conducted on the natural and social environment of candidate sites based on the following criteria. The risk of each candidate sites is shown in Table 3.5-1.

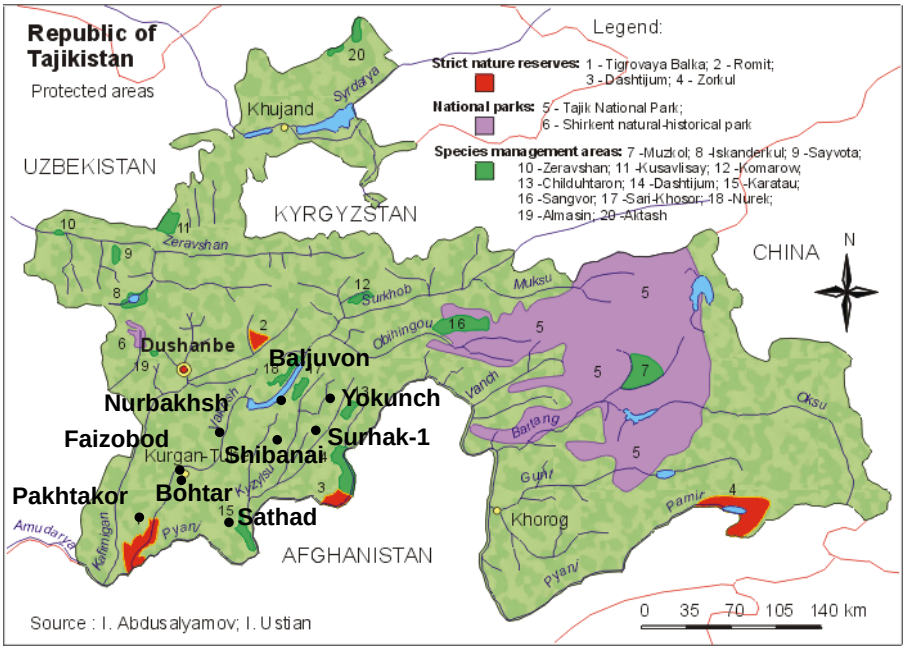
- National parks, Protected areas
- Habitats of threatened species
- Natural disaster (volcano, landslide, strong earthquake zone, etc.)
- Resettlement, land acquisition, etc.
- Ethnic minorities and indigenous peoples
- Accessibility (flood)
- Electrification
- Needs of residents

Table 3.5-1 Risk of Candidate Sites

Project		Rayon (District)	Jamoat (Village)	National park, Protected area	Threatened species (source: red list of Tajikistan)	Threatened species (souece:hearing at the site)	Volcano / landslide / earthquake zone	Ressetlement	Ethnic minorities, Indigenous people	Accessibility (Flood)	Electrification
1	Nurbakhsh	Dangara	Okhsu	-	-	-	-	-	-	-	○
2	Surhak-1	Muminabad	Marhok	Childuhtaron species management area (10km from the site)	Markhor	Brown bear	Landslide	-	-	-	○
3	Sathad	Farhor	Baridom	Karatau species management area (5km from the site)	Goitred gazelle	-	-	-	-	-	○
4	Yokunch	Khovaling	Yokunch	Childuhtaron species management area (5km from the site)	Markhor	Brown bear, Bukhara red deer	Landslide	-	-	Difficulty in access during heavy snow and rain season	○ (Village has been electrified since April, 2012.)
5	Shibanai	Temurmalik	Shibanai	-	-	-	-	-	-	-	○
6	Pahtakor	Jilikul	Kuibeshe	Tigrovaya Balka strict nature reserve (1km from the site)	Bukhara red deer	-	-	-	-	-	○
7	Faizobod	Jomi	Faizobod	-	-	-	-	-	-	-	○
8	Bohtar	Bohtar	Ges	-	-	-	-	-	-	-	○
9	Baljuvon	Baljuvon	Peshtova	-	Brown bear	-	N/A	N/A	N/A	No access by mobile between December to May	○

3.5.1 National Parks, Protected Areas

Locations of national parks and protected areas are shown in Fig.3.5-1. There are 3 strict nature reserves and 5 species management areas in Khatlon district.

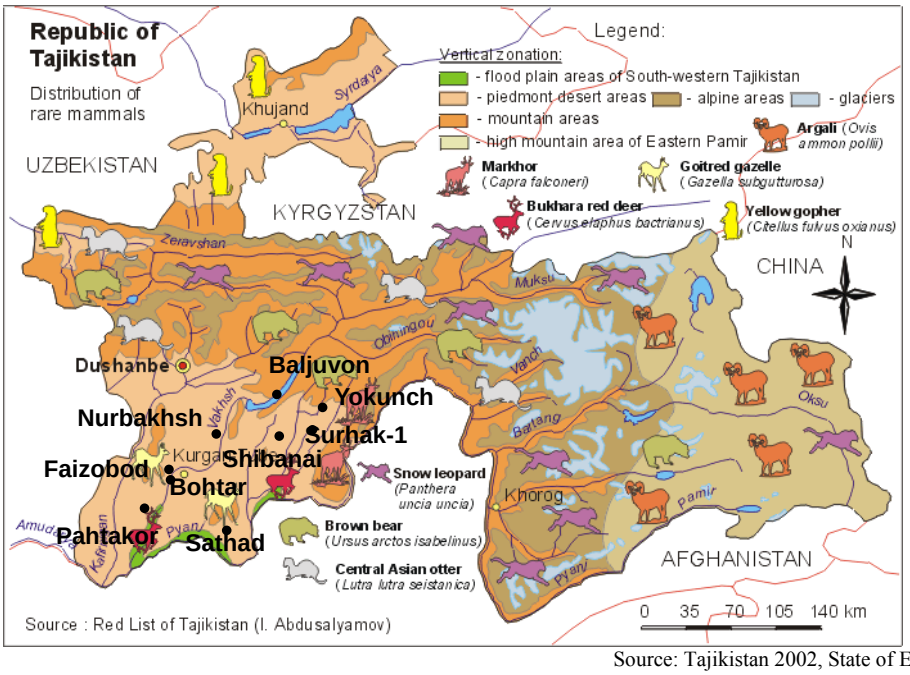


Source: Tajikistan 2002, State of Environment Report

Fig. 3.5-1 Location of National Parks and Protected Areas

3.5.2 Habitats of Threatened Species

Distribution of rare mammals is shown in Fig.3.5-2.



Source: Tajikistan 2002, State of Environment Report

Fig. 3.5-2 Distribution of rare mammals

In Khatlon district, Bukhara red deer (*Cervus elaphus bactrianus*) inhabits in wetland, Goitred gazelle (*Gazella subgutturosa*) and Brown bear (*Ursus arctos isabelinus*) inhabit in the mountainous area.

These rare mammals may inhabit in the surrounding areas of Surhak-1, Sathad, Yokunch, Pahtakor close to the strict reserve areas and the species management areas. However Sathad and Pahtakor, where are adjacent to farmland and residential area, are able to be considered that they are different from habitat of these species.

3.5.3 Natural Disaster

There are no volcano and earthquake zones near the candidate sites, but the marks of old land slide was identified in Shrhak-1 and Yokunch whose candidate sites are along the river. The flood occurred at 1km east from Shibanai point in Kizilsu River between 30th March, 2012 and 4th April, 2012.

3.5.4 Resettlement and Land Acquisition

It was confirmed that resettlement and compensation of farm land would not occur at all candidate sites (except Baljuvon). The old power plant facility and the land in Bohtar are privately-owned by Mr. Fayzulliev Nusratullo, therefore it needs to acquire them. Other lands except Bohtar belong to the MLRWR.

3.5.5 Ethnic Minorities

Ethnic Minorities were not confirmed at all candidate sites (except Baljuvon).

3.5.6 Needs of Residents

The resulted of the interview for residents of each candidate sites (except Baljuvon) on small hydro power development and demands for electricity are shown in Table 3.5-2.

Residents in all sites have strong demand for small hydro power development because of only 2 or 4 hour-power supply in winter. In Yokunch village, power supply has just started from April, 2012. The interviewee of Yokunch has not electricity in his house, and there are no electricity in primary school and clinic as well.

Table 3.5-2 (1) Result of Interview

Project		1. Nurbakhsh	2. Surhak-1	3. Sathad	4. Yokunch
Implementation conditions of hearing					
Date		17/04/2012	18/04/2012	17/04/2012	19/04/2012
Place	(District/Village)	Dangara/Mirali	Muninabad/Marhok	Farhor/Baridom	Khovaling/Yokunch
Answerer	Name	Mizari Safaro	Abdukarim Zaridov	Shodawat Bajabadi	Soenazar Mizoev
	Sex	Male	Male	Male	Male
	Age	64	52	27	57
	Occupation	Retire (Engineer of Bariki Tojik)	Public official (Agriculture department of Muninabad District)	Security of the bank	Farmer
Demand for hydroelectric power					
(1)	What do you think about the electric power supply by a hydropower plant?	necessary	necessary	necessary	necessary
(2)	Do you have a desire for stable electric power supply by a hydropower plant?	Yes	Yes	Yes	Yes
(3)	If you get stable electric power, what do you want to use for?	lighting, TV, refrigerator, cooking	PC, TV, lighting, refrigerator	TV, lighting	TV, lighting, refrigerator
(4)	There is a possibility that traffic and noise by trucks increase during construction of the hydropower plant. It is acceptable?	OK	OK	OK	OK
(5)	There is a possibility that the use of irrigation water by hydropower plant will change. Is it acceptable?	OK	OK: Irrigation is not used for agriculture.	OK	OK
(6)	Do you support for construction of the hydropower plant?	Yes	Yes	Yes	Yes
Demand survey					
(1)	How many people are there in your family?	10 (8 children)	9(7 children)	14	11 (9 children)
(2)	Do you have electric at home?	Yes	Yes	Yes	No
(3)	Do you have a generator at home?	No	No	No	Yes
	If yes, what is fuel for generation?	-	-	-	gasoline
(4)	What kind of electric equipment or tool do you have?	TV, radio, iron, washing machine, heater, cooking stove	TV, light, refrigerator, DVD, PC, heater, cooking stove	TV, radio, light, refrigerator	TV. Light, DVD
(5)	What do you use for heating?	heater, firewood-stove	heater, firewood-stove	firewood-stove	firewood-stove
(6)	How long do you need heating?	October-March	October-April	October-March	October-April
(7)	How long do you need heating in one day?	24h	24h	2-3times/day	24h
(8)	What do you use for lighting at home?	light, torch, candle	light, candle, torch	light, candle	candle, torch
(9)	How long do you burn wooden fuels at a time?	-	-	-	-
(10)	Others				There are no electricity and generator in the school and the clinic.

※Interview was conducted in Mirali village, where is close to Nurbakhsh, because there were no residents around Nurbakhsh site.

Table 3.5-2 (2) Result of Interview

Project		5. Shibanai	6. Pahtakor	7. Faizobod	8. Bohtar
Implementation conditions of hearing					
Date		20/04/2012	16/04/2012	15/04/2012	16/04/2012
Place	(District/Village)	Temurmalik/Shibanai	Jilikul/Kuibeshe	Jomi/Faizobod	Bohtar/Ges
Answerer	Name	Odinai Ackram	Mausur Poudov	Rostam Arajav	Rahamat Rov
	Sex	Male	Male	Male	Male
	Age	28	12	42	22
	Occupation	Farmer	student	Farmer	without occupation
Demand for hydroelectric power					
(1)	What do you think about the electric power supply by a hydropower plant?	necessary		necessary	necessary
(2)	Do you have a desire for stable electric power supply by a hydropower plant?	Yes		I want to let you construct HPP early.	Yes
(3)	If you get stable electric power, what do you want to use for?	lighting, TV		heating, lighting, TV, cooking	heating, lighting, TV, cooking
(4)	There is a possibility that traffic and noise by trucks increase during construction of the hydropower plant. It is acceptable?	OK		OK	OK
(5)	There is a possibility that the use of irrigation water by hydropower plant will change. Is it acceptable?	OK		OK	OK
(6)	Do you support for construction of the hydropower plant?	Yes		Yes	Yes
Demand survey					
(1)	How many people are there in your family?	4 (2 children)	7 (5 children)	7 (5 children)	11 (9 children)
(2)	Do you have electric at home?	Yes		Yes	Yes
(3)	Do you have a generator at home?	No		No	No
	If yes, what is fuel for generation?	-		-	-
(4)	What kind of electric equipment or tool do you have?	TV, light, refrigerator, cooking, heater	TV, light, CD player	TV, light	TV, light
(5)	What do you use for heating?	heater, firewood-stove		firewood-stove	firewood-stove
(6)	How long do you need heating?	November-March		September-March	September-March
(7)	How long do you need heating in one day?	2times/day		3-4h	night-morning
(8)	What do you use for lighting at home?	light, candle		torch, candle	torch, candle
(9)	How long do you burn wooden fuels at a time?	-		-	-
(10)	Others			There are no generators in the school and the clinic. Students bring firewood to the school in	There are no generators in the school and the clinic.

※Interview in Pahtakor is not enough, because there were no residents around the site.

3.5.7 Environmental Impact Prediction

Following impacts brought by small hydro power development at each candidate sites are predicted based on the situation of natural and social environment (Table 3.5-3).

As for the natural environment, noise, vibration, and traffic accident due to the transportation of the materials and the construction works may affect on birds and mammals in Shrhak-1 and Yokunch, whose candidate sites are located in the mountainous zone. There is a possibility that vegetation of the right side of a bank slope of the canal would be lost by the prevention work of landslide in Shrhak-1. In case that concrete revetment would be applied in order to prevent water leakage, it may impair wetland environment where has established around the point of current water leakage of the canal.

The small hydro power project is planning in a natural river in Yokunch. It is supposed that the damming of a river may affect on aquatic organisms such as migratory fish living in a river channel, and the inhabiting of fauna and flora in the river would be affected because of a 800m-long water reduction area between weir and outlet. Moreover, developing a construction road may damage a part of vegetation. There is little impact in other sites because they are surrounded by farmland and residential area.

As for the social environment, the positive impact on socio-economic is expected in every sites.
It is necessary to pay attention to noise and vibration during the transportation of the materials and construction because the candidate sites and the roads to be used for the material transportation are close to the residential area. It is necessary to avoid interfering the operation of a brick factory on the left side bank of the candidate site in Nurbakhsh when the transportation of the material during the construction, and to maintain water supply to a mill house with a waterwheel.

Table 3.5-3 Environmental Impact Prediction

Item		1	2	3	4	5	6	7	8	9
		Nurbakhsh	Surhak-1	Sathad	Yokunch	Shibanai	Pahtakor	Faizobod	Bohtar	Baljuvon
Rayon (District)		Dangara	Muminabad	Farhor	Khovaling	Temurmalik	Jilikul	Jomi	Bohtar	Baljuvon
Jamoat (Village)		Okhsu	Marhok	Baridom	Yokunch	Shibanai	Kuibeshe	Faizobod	Ges	Peshtova
natural environment	During construction	○	△	○	×	○	○	○	○	-
	remarks		・Noise and vibration of transport and construction. ・Impact on vegetation such as wet land and natural grassland.		・Noise and vibration of transport and construction. ・Impact on the vegetation for construction of access road.					-
	During operation	○	○	○	×	○	○	○	○	-
	remarks				・Impact on aquatic organisms because of dam up and reduction of water.					
social environment	During construction	△	○	×	○	×	○	×	×	-
	remarks	Brick factory near the site.		Residence is adjacent to the site.		Residence is adjacent to the site.		Residence is adjacent to the site.	Residence is adjacent to the site.	-
	During operation	◎	◎	◎	◎	◎	◎	◎	◎	-
Total Evaluation		◎	◎	○	△	○	◎	○	○	-

◎ : positive impact
○ : neutral impact
△ : a little negative impact
× : negative impact

3.6 CRITERIA TO SELECT PROMISING SITES

MEI has plan of thirty nine (39) candidate sites for small hydropower development in Khatlon Province, however MEI has no documents to exemplify the selection results nor the criteria to prioritize them. Whereas Barki Tojik studied these small hydropower potential sites and has selection criteria that 1) large amount of water is secured throughout the year, 2) electricity of objective areas is not provided yet or in shortage, and 3) accessibility to site is good.

JICA Study Team recommends the following criteria as high priority selections:

Effect of Benefit	having greater effects of benefit by electricity supply
Development Plan	not less than 100kW in power output and 5m in head
Power Facility Plan	having no potential hazards in landslide, volcano, earthquake, etc, at site for construction of power plant
Water Flow Condition	having stable discharge throughout the year
Accessibility	easy access to site, and located within 10km from demand areas
Environmental and Social Considerations	location without protected areas or natural parks where development activities are prohibited, and no resettlement

3.7 RESULT OF PRELIMINARY EVALUATION

First of all, in terms of the effect of benefit, all of the villages around sites are facing the shortage of electricity in winter season when electricity is provided only in a few hours, therefore the villagers are expecting the small hydropower development.

In light of development plan, namely expected power output (P), the three (3) sites of the Nurbakhsh site (P: 400kW), Yokunch site (P: 500kW), and Bohtar site (P: 240kW, in case of Qmax is 10.0m^3/sec on the basis of summer water flow), are able to have capacities of more than 100kW.

The other five (5) sites are expected to have the capacities of less than 50kW only.

Baljuvon site could not be visited in the 2nd site survey due to high water level of the Kizilsu River. The access road is the river course on the right side and an approach to the access road is close by a bridge on the Kizilsu River, and the bridge is located about 1km from the district center of Baljuvon District. The access road cannot be used from December to May due to inundation. From the viewpoint of accessibility, it is regarded that the priority is low.

Since a mountain road of 21km long, which is the only access to Yokunch site from the district center is unpaved and in bad conditions, the improvement works of the road are required. In addition, the area from the intake weir to the powerhouse is in a landslide potential area, this situation implies that the project development has the higher risk. Accordingly, it is regarded that the priority of Yokunch site among three (3) sites having expectancy of more than 100kW is lower.

Since some amount of water used in Nurbakhsh power plant is utilized for drinking water, it is expected that water discharge of at least 1.0m^3/sec can be secured for power generation through the year. In the future, the possibility of additional intake water should be examined. Accordingly, it is regarded that the development risks of Nurbakhsh site are low.

The development risks in Bohtar site are low, except for securing power discharge. Since there has been no water in the canal in winter season so far, further studies to identify how much water can be ensured for power generation in winter are required.

Based on the above mentioned criteria, the superior Nurbakhsh and Bohtar sites among all of the nine (9) candidate sites for development are compared in Table 3.7-1. The preliminary results were explained to vise chairman of Khatlon Province at Khatlon provincial government office on 24th of April, 2012, followed by MEI and Barki Tojik at Dushanbe in April, 2012. The evaluation results prepared by the JICA Study Team were appreciated.

Table 3.7-1 Evaluation Results of Nurbakhsh and and Bohtar Sites

Criteria \ Site		Nurbakhsh	Bohtar
Effect of Benefit	Having greater effects of benefit by electricity supply (Number of Beneficial household and public facilities such as hospital, etc.))	Beneficial household: 400 Clinic: 1 School: 1	Beneficial household: 120 Clinic: 1 School: 1
Development Plan	Not less than 100kW in power output	400kW	240kW
	Not less than 5m in head	50.0m	3.0m
	Location within 10km from main demand area	2.6km	0.1km
Power Facility Plan	Having no potential hazards in landslide, volcano, earthquake, etc	Possible landslide potential in the penstock route	None
Water Flow Condition	Having stable discharge throughout the year	Summer Season: 1.5 m^3/s Winter Season: 1.0 m^3/s Since the water is for irrigation and drinking water, the water can be secured in winter season.	Summer Season: 10.0 m^3/s Winter Season: 0.0 m^{ab}/s Since the water is for irrigation only, there are no water in the canal in winter season
	Utilizing water for power generation (Not to require coordination with water utilization for irrigation)	Water amount of 1.0m^3/sec for power generation is secured, on the other hand coordination with related organizations is required to ensure additional water amount.	Coordination with related organizations is required to ensure water amount in winter.
Accessibility	Easy access to site and to be able to transport heavy equipment	Good accessibility	Good accessibility
Environmental and Social Consideration	Location without protected area or natural park in which development activities are prohibited	Not applicable	Not applicable
	Not to involve resettlement	Not applicable	Not applicable
	No requirement for land acquisition or no difficulty in land acquisition	Not applicable	Land acquisition is necessary because the development site is privately owned
	No existing facilities or no difficulty in demolition of existing facilities	Two (2) existing pipes have been installed in the area between intake and outlet. These pipes are to be utilized after launching operation of the power plant, the ground reinforcement works, etc. are required.	The existing power plant was constructed in the former soviet union years, the demolishment works are expected to be easy.

CHAPTER 4

OUTLINE OF PROMISING SITE

CHAPTER 4 OUTLINE OF PROMISING SITE

4.1 NURBAKHSH SITE (NO.1)

(1) Power Generation Plan

The planned power generation of Nurbakhsh site utilizes the water for irrigation and domestic use which is conveyed from Nurek dam and the head between the distribution weir and the canal.
The objective canal is supplying the irrigation and domestic use and its actual annual water utilization pattern is shown below.

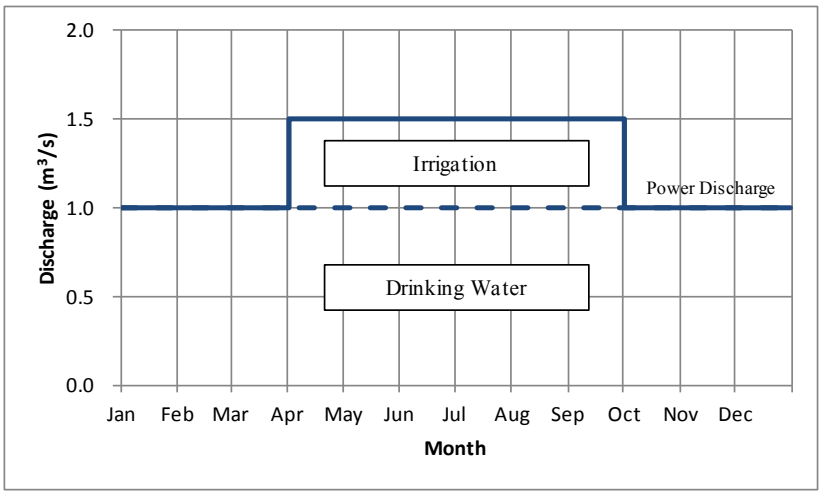


Fig. 4.1-1 Annual Water Utilization Pattern at Nurbakhsh Site

Maximum power discharge is planned as 1.0 m^3/s for winter season when power shortage occurs. The effective head is set at 50.0m based on the result of simple measurement at site.

Power Output	:	400 kW
Maximum Power Discharge	:	1.0 m^3/s
Effective Head	:	50.0 m
Beneficial Targets	:	Household: 400, Clinic: 1, School: 1

(2) Power Facility Plan

The required facilities for the power plant are shown below.

Intake	:	Connect between the existing distribution pond and the head tank
Head Tank	:	Install in the vicinity of the existing distribution pond
Penstock	:	Install in the ground along with the existing buried pipes
Powerhouse	:	Install in the vicinity of the existing outlet
Outlet	:	Connection between the powerhouse and the existing canal

Substation and Transmission/ Distribution Facilities

As for the other works, the consolidation works of the ground and the slope protection works on the penstock route are expected.

Fig. 4.1-2 Layout Plan of Plant Facilities

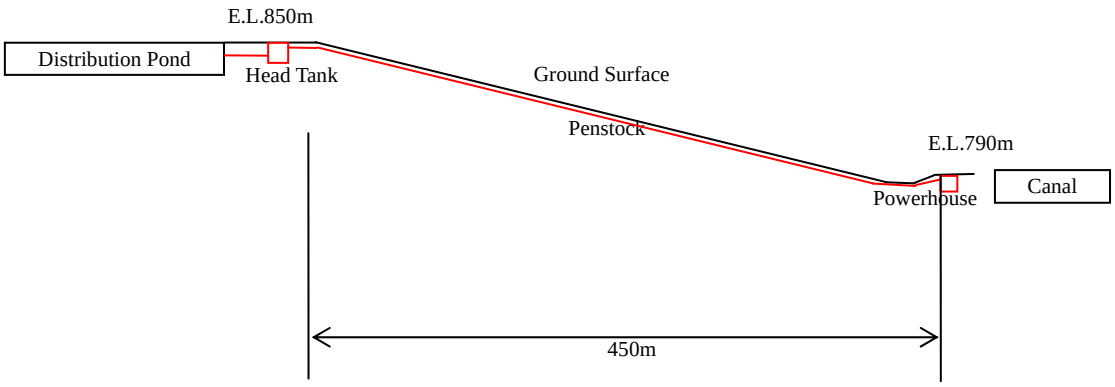


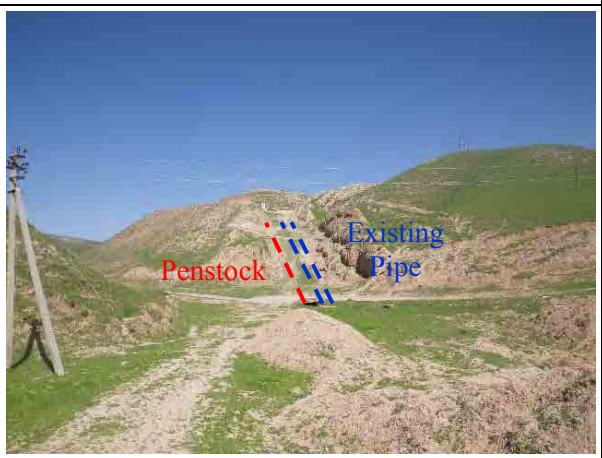
Fig. 4.1-3 Section of Plant Facilities

Distribution Pond

Head Tank Site

Penstock Route and Powerhouse Site

Exposed Existing Pipe



Penstock Route

Discharge Canal

(On April 17, 2012)

4.2 BOHTAR SITE (NO.8)

(1) Power Generation Plan

The planned power generation of Bohtar site utilizes the water for irrigation and domestic use which is conveyed and distributed from Golovnaya dam and the head between upstream and downstream of powerhouse. There is the existing power plant, constructed in the Soviet years, however it has not been operated now.

The water from Golovnaya dam flows down through PK46 canal and then is distributed into PK25 canal at Intake Gate No.1. The water flowing through PK25 canal is distributed into the canal, on which Bohtar power plant is located, at Intake Gate No.2.

Fig. 4.2-1 Canal Network

The objective canal supplies water for irrigation and its actual annual water utilization pattern is shown in Fig.4.2-2.

Maximum power discharge is decided as 10.0m^3/s of summer's water intake. Meanwhile, based on the results of the interview survey, the same and more of the power discharge even in the winter season can be possible. The effective head is set at 3.0m based on the simple measurement result at site.

Power Output	:	240 kW
Maximum Power Discharge	:	10.0 m^3/s
Effective Head	:	3.0 m
Beneficial Targets	:	Household: 120, Clinic: 1, School: 1

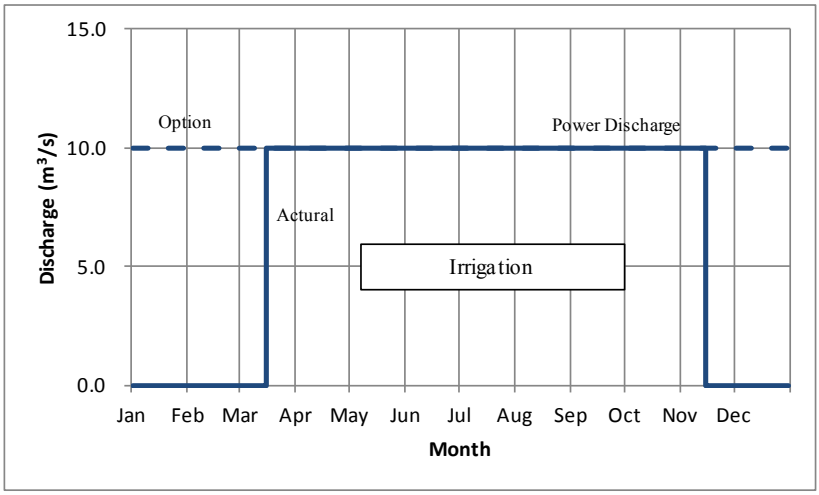


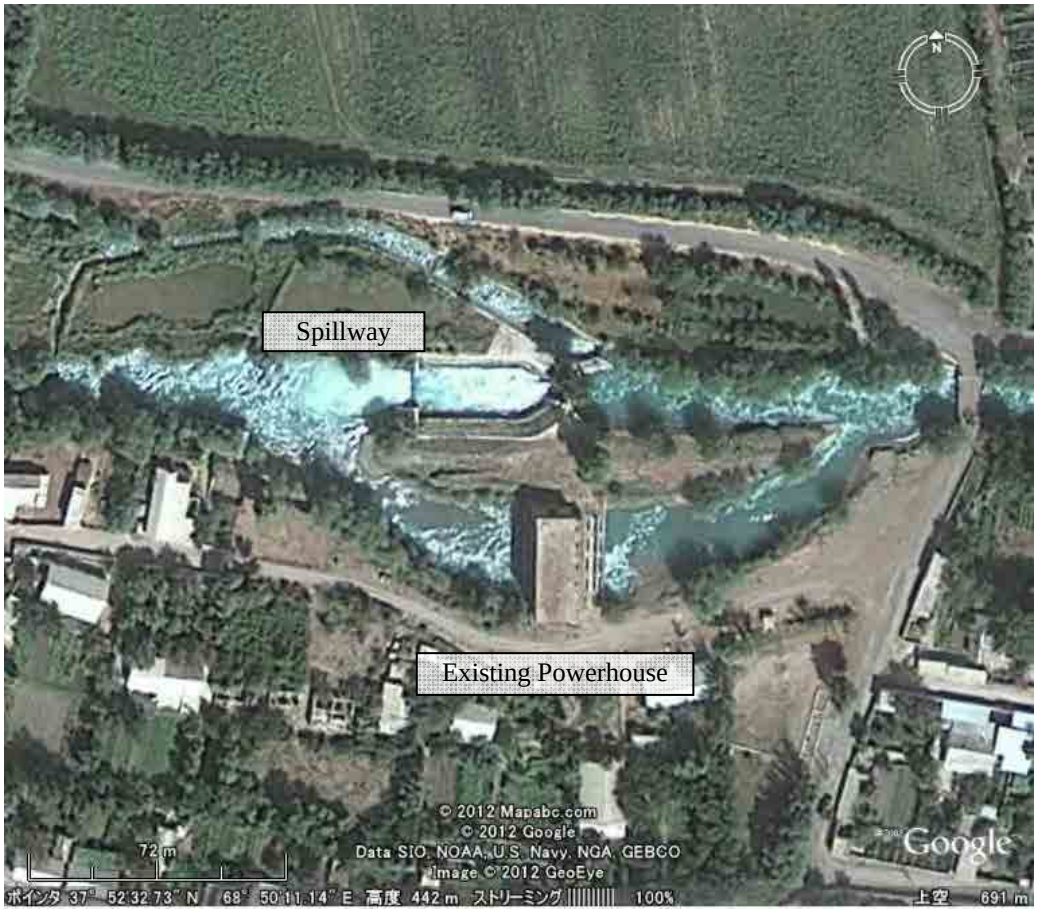
Fig. 4.2-2 Annual Water Utilization Pattern at Bohtar Site

(2) Power Facility Plan

The required facilities for power generation are shown below.

Intake : Install an intake gate integrated with the powerhouse building
Powerhouse : Demolish the existing power plant then re-construct a new power plant
Outlet : Install an outlet gate integrated with the powerhouse building
Substation and Transmission/ Distribution Facilities

As for the other works, demolition of the existing plant, river bank protection works and modification of the spillway are expected.



	
Power House (Outside)	Power House (Inside)

(On March 6, 2012)

	
Spillway	Canal
	
Intake No.1	Intake No.2

(On March 6, 2012)

CHAPTER 5

CONCLUSION

CHAPTER 5 CONCLUSION

In this Study, the third survey was planned to be implemented for a month in December 2012 to confirm potential site conditions in winter season and finalize the evaluation of them.

However, the scope of works of this Study was determined to be modified in the interim report meeting. As described in Chapter 4, Nurbakhsh and Bohtar are abstracted as the promising sites for further development. The Nurbakhsh site was selected as the most preferable sites for the JICA cooperation project formation in the future. The further study for the project formation of JICA granted scheme will be taken over to “PREPARATORY SURVEY FOR THE PROJECT OF MICRO-HYDROELECTRIC POWER GENERATION IN KHATLON PROVINCE IN THE REPUBLIC OF TAJIKISTAN”.

APPENDIX

APPENDIX 1

MEMBER LIST

Appendix 1 : Member List

Ministry of Energy and Industry (MEI)

Mr. Pulod Muhiddinov	First Deputy Minister
Mr. Tilloev Vaysiddin	Head of Renewable Energy Resources Department
Mr. Kholnazarov Nurmahmad	Head of Electro Energy Department
Mr. Kaym	Electro Energy Department
Mr. Khairiddinzoda Akmal	Head of International Relations Department

Barki Tojik (BT)

Mr. Boboev Jura Boboevich	Deputy of Energy and Renewable Energy Sources

Ministry of Land Reclamation and Water Resources (MLRWR)

Mr. Husniddin Sharofiddinov	Head Specialist of Department of Pump Station
Mr. Islomov Huzthed	Chief Specialist of Department of Water Resources

Ministry of Agriculture and Environment Protection (MAEP)

Mr. Homidov Anvar	Head of Hydrology Department

Hydro-Meteorological Agency

Mr. Parvino Saidzhomolovo	Head of Weather Forecast Department
Mr. Hamidov Vohidjon	Head of Hydrological Department

Khatlon Province

Mr. Bahodurov Abdujabbor	Deputy Chairman
Mr. Hurmatov F	Department of Land Improvement
Mr. Safarov Usuf	Agency of Statistics
Mr. Egomberdier Valeri	Electric Engineer
Mr. Bobojonov Sadyloh	Environmental Engineer
Mr. Kataer Abdujabor	Head of Department of Water Resource Management
Mr. Davlator Faridun	Department of Water Resource Management

Dangara District

Mr. Saidalier	Deputy Chairman

Muminobod District

Mr. Zaripov	Chairman

Farhor District

Mr. Karimov Rahmatulo	Deputy Chairman

Khovaling District

Mr. Variev	Deputy Chairman

Temurmalik District

Mr. Talbokov	Construction Manager

Jilkul District

Mr. Ismoihov Abdyalin	Deputy Chairman

Jomi District

Mr. Sulaimonov	Deputy Chairman

Bohtar District

Mr. Ismoihov	Chairman

Baljuvon District

Mr. Aminov	Construction Manager

United Nation Development Program (UNDP)

Ms. Mastona Khaliova	Energy Specialist

Asian Development Bank (ADB)

Ms. Asel Chyngysheva	Portfolio Management Specialist

JICA Tajikistan Office

Mr. Jiro Iida	Chief Representative
Mr. Akihira Sano	Representative
Mr. Hiroki Katayama	Representative

APPENDIX 2

LIST OF COLLECTED DATA

Appendix 2 : List of Collected Data

(Data Collection Survey on the Installment of Small Hydropower Stations for the Communities of Khatlon Oblast in the Republic of Tajikistan)

Electric Power Sector

No	Title of the Documents (URL)	Form (Books, Video, Map and Picture)	Original/ Copy	Publisher	Year
1	STRATEGY for development of small scale hydropower of the Republic of Tajikistan	Electronic Data	Copy	UNDP	2007
2	List of hydropower stations in the Republic of Tajikistan	Electronic Data	Copy	Barki Tojik	2007
3	PSIA Energy Tajikistan-FINAL May 20	Electronic Data	Copy	UNDP	2011
4	Energy Efficiency Master Plan for Tajikistan	Electronic Data	Copy	UNDP	2011
5	RENEWABLE ENERGY AS A DRIVER FOR POVERTY REDUCTION IN TAJIKISTAN	Electronic Data	Copy	UNDP	2011
6	НОРМАТИВНЫЕ ПРАВОВЫЕ АКТЫ И НАЦИОНАЛЬНЫЕ СТАНДАРТЫ ПО ВОЗОБНОВЛЯЕМЫМ ИСТОЧНИКАМ ЭНЕРГИИ, ДЕЙСТВУЮЩИЕ В РЕСПУБЛИКЕ ТАДЖИКИСТАН	Book	Original	MEI	2011
7	ADB's Approach to Renewable Energy in Tajikistan	Electronic Data	Copy	ADB	2009
8	Regional Power Transmission Modernization Project in the Central Asian Republics	Electronic Data	Copy	ADB	2002
9	REVIEW of CDC Energia's Organization, Responsibilities & Current Needs	Electronic Data	Copy	USAID	2011
10	POWER ENERGY OF TAJIKISTAN	Pamphlet	Original	Barki Tojik	—
11	MEI Organization Chart	A4	Copy	MEI	2012

Appendix 2 : List of Collected Data

(Data Collection Survey on the Installment of Small Hydropower Stations for the Communities of Khatlon Oblast in the Republic of Tajikistan)

Electric Power Sector

No	Title of the Documents (URL)	Form (Books, Video, Map and Picture)	Original/ Copy	Publisher	Year
12	Barki Tojik Organization Chart	A4	Copy	Barki Tojik	2012
13	Power Generation of Barki Tojik	A4	Copy	Barki Tojik	2012
14	Electric and thermal energy amounts of charge	A4	Copy	Barki Tojik	2012
15	Long term program of construction of small electric power stations for the period 2009 - 2020	A4	Copy	MEI	2012
16	Foreign Investment in Energy Sector 2012	A4	Copy	MEI	2012

Hydrology and Metrology

No	Title of the Documents (URL)	Form (Books, Video, Map and Picture)	Original/ Copy	Publisher	Year
17	Location Map of the Discharge Gauging Stations	A4	Copy	MLRWR	2012
18	Location Map of the Meteology Gauging Stations	A4	Copy	MLRWR	2012
19	Water Code2001	Electronic Data	Copy	MLRWR	2001
20	Data on Kurgan Tyube Climate in 2011	A4	Original	Khatlon Province	2012
21	Discharge Data of Station No. 40, 41 and 43	A4	Original	MLRWR	2012

Appendix 2 : List of Collected Data

(Data Collection Survey on the Installment of Small Hydropower Stations for the Communities of Khatlon Oblast in the Republic of Tajikistan)

Environment

No	Title of the Documents (URL)	Form (Books, Video, Map and Picture)	Original/ Copy	Publisher	Year
22	National Environmental Action Plan	Electronic Data	Copy	UNDP	2006
23	NATIONAL REPORT THE IMPLEMENTATION OF THE AARHUS CONVENTION IN TAJIKISTAN FOR 2008 - 2010	Electronic Data	Copy	NAEP	2011
24	Review of legislation on environmental impact assessment of the Republic of Tajikistan with regard to introduction and implementation of the Espoo Convention	Electronic Data	Copy	UNECE	2010
25	Red Data Book in Tajikistan	Book	Original	GOT	-
26	State of Environment Report	A4	Copy	GOT	2002
27	National Strategy and Action Plan Conservation and Sustainable Use Biodiversity	A4	Electronic Data	NAEP	2003

Others

No	Title of the Documents (URL)	Form (Books, Video, Map and Picture)	Original/ Copy	Publisher	Year
26	1/750,000 Topological Map of Khatlon	Map	Original	MLRWR	—
27	Land Law	A4	Copy	MLRWR	—
28	TAJ-National-Development-Strategy	Electronic Data	Copy	GOT	2007
29	Millennium Development Goals Tajikistan Progress Report	Electronic Data	Copy	WB	2010

APPENDIX 3

PHOTOGRAPHS

Nurbakhsh

Distribution Pond

Head Tank

Penstock Route

Powerhouse

Substation

Dangara Administration Office

Surhak-1

Intake

Powerhouse

UNDP Pump Station

Surhak River

Substation

Muminobod Administration Office

Sathad

Sulho Canal 1

Sulho Canal 2

Drop Structure

Borderline

Substation

Farhor Administration Office

Yokunch

Yaksu River

Yokunch River

Intake

Penstock Route

Powerhouse

Khovaling Administration Office

Shibanai

Kizilsu River

Shibanai Canal 1

Shibanai Canal 2

Drop Structure

Mill House

Temurmalik Administration Office

Pakhtakor

Kaiganobod Canal

Gate

Drop Structure

Powerhouse

Tigrovaya Balka Area

Jilkul Administration Office

Faizobod

Shorobod Canal

Distribution Pond

Drop Structure

Vakhsh River

Substation

Jomi Administration Office

Bohtar

PK25

Powerhouse Building

Drop Structure

Downstream Canal

Ges Village

Bohtar Administration Office

Baljuvon

	
Kizilsu River	Baljuvon Administration Office


JICA