

CHAPTER-1

INTRODUCTION & PROJECT FEATURES

1.0 GENERAL

The Pabbar river is in Yamuna basin in Northern region originating from Gangdari Dhar in Great Himalayan ranges in Shimla District of Himachal Pradesh. Sawra Kuddu Hydroelectric Project is a run of the river development on the Pabbar River in Rohru & Jubbal Tehsils, at a distance of 130 kms from Shimla. Location is shown in Figure-1.

Hydel Potential of Yamuna basin in Himachal Pradesh has been identified as 1044.82 MW. Giri (60 MW), Andhra (16.95 MW) and Gumma (3.00 MW) are already in operation. Proposed Sawra Kuddu HEP (110 MW) development utilizes the water of Pabbar river. Shalvi (7 MW) and Renuka Dam (40 MW) are also the proposed Hydroelectric Projects of Yamuna basin which is likely to be taken up for execution in future. The MOU's for the implementation of Tangnu-Romai (44 MW), Paudital Lassa (36 MW), and Sainj (5.50 MW) have already been signed with the various IPPs by the H.P. Government.

HPSEB has created a Special Purpose Vehicle, namely, Pabbar Valley Power Corporation for execution of Hydroelectric Projects in Pabbar Valley. It has been allotted Sawra Kuddu Hydroelectric Project (110 MW) and Chirgaon Majhgaon Hydroelectric Project (46 MW). Dhamwari Sunda Hydroelectric Project (70 MW) has also been allotted to Pabbar Valley Power Corporation (PVPC) subject to decision of the arbitration case for cancellation of Implementation Agreement with IPP.

Chirgaon-Majhgaon Hydroelectric Project being a tailrace development of Dhamwari Sunda Hydroelectric Project (70 MW) can only be constructed once arbitration case for Dhamwari Sunda is decided. Thus, PVPC has taken up construction of Sawra Kuddu Hydroelectric Project.

1.1. PROJECT FEATURES

Sawra Kuddu Hydroelectric Project has been contemplated as a power generation development on Pabbar River in Shimla district. It envisages utilization of water of Pabbar river through average gross head of 213.50 m for generation of 110 MW of power in a underground

powerhouse near village Snail close to the border of Himachal Pradesh with Uttranchal. The project comprises following features:

- A 15.5 m high diversion barrage at a average river bed elevation of 1410.5 m. Eleven gated spillways at crest elevation 1412.5 m have been designed to pass design average of 3,000 cumecs. Energy dissipation arrangement would be in the form of stilling basin.
- Intake structure having four bays of 4mx3 m on left bank of the river.
- A surface desilting tank comprising of four basins 80 m long, 19.5 m wide and 10.5 m deep. Maximum particle size to be removed would be of the order of 0. 2mm.
- A 5m diameter, D-Shaped concrete lined head race tunnel having 11.3 km length and design discharge 65 cumecs.
- A underground, restricted orifice type 14m dia, 73.10m high surge shaft at the end of head race tunnel.

- An underground steel liner pressure shaft 3.5 m diameter and 312 m long having 3 branches of 2 m dia each and 49 m long.
- An underground powerhouse 12m wide and 15 m long housing 3 No. vertical axis Francis turbines driven generating units of 36.67 MW each, to provide installed capacity of 110 MW under a gross head of 213.5m.
- Tail race tunnel 5 m diameter, D- Shaped concrete lined, 440 m long would discharge the water back into Pabbar river on the left bank at the boundary of Himachal Pradesh and Uttranchal.
- The Project would generate 386 million units and 507 million units of energy in 90% and 50% dependable year respectively.

Layout plan of the Project is depicted in Figure-2.

The Sawra Kuddu Hydroelectric Project is located on the Pabbar River between the Longitudes 77°-45'-00" to 77°-49'-33" East and Latitudes 31°-07'-54" to 31°-03'-30" North in Rohru Tehsil of Distt. Shimla of Himachal Pradesh.

1.2 HYDROLOGY

1.2.1 LOCATION

The Pabbar river originates in the Gangdari Dhar ranges of the Great Himalayas. The river flows in a southwesterly direction down to Rohru township, some 55 Km from its source where it turns in southeasterly direction. Some 20 kms southeast of Rohru the Pabbar River leaves HP territory and enters Uttranchal, where the Pabbar River joins the Tons River, which is a major tributary of the Yamuna River. At the proposed dam site the catchment area of Pabbar River is about 1034 Sq. Km.

1.2.2 RIVER AND ITS TRIBUTARIES

The Pabbar River is a major tributary of the Tons river which in itself is a prominent tributary of the Yamuna River. The Pabbar river

originates in the Gangdari Dhar ranges of the Great Himalayas at about 5100 m elevation above mean sea level. The bed gradient of the river; over the entire stretches ranges between 15 and 40 m/Km but reaches values up to 200m/Km in the upper most regions. The river valley is located between steep and high mountain ranges in its upper regions and is very narrow. Along the lower stretches, the valley is usually wider, and part of the flood plains form cultivated land. The Pabbar River delivers a substantial amount of sediment load, particularly during snowmelt and flood seasons.

It is joined by various nallah/Khads in its course from its origin to Hatkoti. It is joined by Supin & Sundru Khad from Right bank and Pabbar river from the left bank near Tagnu. Further, it is joined by Khanjara Khad from right bank, Gumalti Khad from left bank, Andhra Khad from right bank, Peja from the left bank, Masrat from right bank, Pakhal from the left bank, Shikdi Khad from the right bank near Rohru, Dogri Khad from the right and last but not the least Biskalti Khad from the right bank near Hatkoti.

The Pabbar Valley is mostly narrow and characterized by steep slopes. At diversion barrage site upstream of Hatkoti, however, the

valley is wider and offers the possibility of creating a reservoir for diurnal water regulation with storage of around 4 hours.

1.2.3 CATCHMENT

The catchment area of Pabbar River at the proposed dam site is about 1034 Km². The elevation of the catchment is between 1400m above mean sea level (M.S.L). and 5000m above M.S.L. About 25% of the area is located below 2,000m above M.S.L, 35% between 2000 m above M.S.L and 3000m above M.S.L. and 40% above 3000m above M.S.L. The permanent snow line in the basin is approximately 4500m above M.S.L. Only 2% area of the catchment is situated above this level.

1.3. METEOROLOGICAL CHARACTERSTICS

1.3.1. RAINFALL

The year can be divided into four seasons determined by the broad climate conditions prevailing in the region. The seasons are the winter season from December to March, the summer or pre-monsoon

from April to June, the monsoon season from July to September and the post monsoon seasons October and November.

In the winter season higher regions of Himalayas receives precipitation as snow while moderate rainfall occurs in the foothills and adjoining plains. The summer season is the transitional period before the onset of the southwest monsoon. The southwest monsoon normally strikes the region towards at he end of the June. Normally the monsoon currents from the Bay of Bengal brings monsoon rain over the region, but sometimes in association with certain weather conditions both branches of monsoon i.e., the Bay of Bengal and Arabian Sea, arrive more or less simultaneously and cause the onset of the monsoon over the region. The post monsoon season normally lasts for less than two months and is comparatively dry.

There are three rain gauging stations in Pabbar catchment area i.e. Rohru (1525m above M.S.L.), Jubbal (2020 m above M.S.L.) and Khadralla (2596m above M.S.L.). All these stations are however situated in the lower part of the catchment and upstream of the proposed Sawra-Kuddu Hydroelectric Project. At Rohru & Jubbal, data is available since

1951 but some years are missing and the series contain frequent gaps, at Khadralla data is available during 1951-1983.

Mean monthly and mean Annual precipitation (mm) at the three stations within the catchment based on daily data is as follows in the Table-1.1:

Table-1.1

| MONTH | ROHRU | JUBBAL | KHADRALA |
|---------------|--------------|---------------|-----------------|
| JAN | 88 | 91 | 139 |
| FEB | 93 | 74 | 146 |
| MARCH | 89 | 88 | 104 |
| APRIL | 54 | 59 | 54 |
| MAY | 51 | 68 | 77 |
| JUNE | 72 | 82 | 111 |
| JULY | 185 | 214 | 311 |
| AUGUST | 170 | 185 | 297 |
| SEPTEMBER | 115 | 112 | 157 |
| OCTOBER | 36 | 43 | 63 |
| NOVEMBER | 15 | 13 | 24 |
| DECEMBER | 34 | 39 | 189 |
| ANNUAL | 1003 | 1068 | 1673 |

1.3.2 TEMPERATURE

The daily maximum temperature in the region varies 30°-40° C in Summer and 10-20 degree centigrade in winter. The daily minimum temperature is about 10-20° C in summer and a few degrees below freezing point in winter. The available data on temperatures in the Pabbar river basin are limited to observations made at the Andhra Hydel Project during the period Oct. 1983 to April 1986. These observations indicate max temperature of 35-40°C in summer and 15 to 20°C in winter. The minimum temperature is 10-15°C in summer and –2 to - 6°C in winter.

1.4 HYDROLOGICAL CHARACTERISTICS

The catchment Area of Pabbar river above the proposed Dam site of Sawra –Kuddu HEP near Hatkoti village is 1034 Km² and is elongated leaf shaped as shown in Plate No.1.

The discharges of Pabbar river like other rivers in Himachal Pradesh is least during winter months i.e. from Nov. to Feb. and starts

increasing from March due to melting of snow. The bulk contribution is from June to August. Discharge measuring stations at Tagnu, Dhamwari, Mandly and Sawra bridge have been set up by HPSEB and good data bank is available for these sites. The maximum and minimum ten daily discharges at the diversion site are 292.64 cumecs and 8.38 cumecs respectively.

1.5. WATER AVAILABILITY

Based on available/computed data of Pabber river at diversion site from 1978-79 to 1999-2000, a flow duration curve has been drawn using Weibull's distribution method. The flow duration curves for overall period been shown in Plate No. II. The curve reveals that 13.00 cumecs of discharge is available for 90% of the period, 30.00 cumecs for 50% of the overall period and design discharge of 65.00 cumecs is available for 18% of the total duration of 28 years.

A flow duration curve for the lean period flows (Nov. to Feb.) reveals that a discharge of 6.40 cumecs is available for 90% of the total duration during the lean periods.

1.6 DESIGN FLOOD

In the Dhamwari Sunda Hydroelectric Project report of the 50 year flood at Sawra was estimated to be 2,000m³/s from the calculations made at Dhamwari. Since the catchment area at Dhamwari is just 230 Sq.Kms. and the figures were just an estimate as the same was not calculated from the values at Sawra.

The difference in catchment areas at Dhamwari & Sawra is about five times and the precipitation mostly in Dhamwari is in the form of snow and at Sawra in the form of rain. The flash flood in the catchment during the year 1997 suggested to adopt 3000 m³/s design flood.

1.7 POWER STUDIES

1.7.1 DESIGN HEAD

Average net operating head for power-generation has been worked out as 198 m between Full Reservoir Level (FRL) 1423.50 m and Normal Tail Water Level (NTWL) 1210 m, Minimum Draw Down Level (MDDL) 1418 m and Normal Tail Water Level 1210 m. Losses in water

conductor system corresponding to design discharge of 65 cumecs from intake to generating units, have been worked out as 17.67 m. Net head, therefore, has been calculated as 194 m as follows in Table-1.2.

Table-1.2

| | |
|--------------------|--------------------------------|
| FRL | 1423.50 m |
| MDDL | 1418.00 m |
| NTWL | 1210.00 m |
| Losses | 17.67 m |
| Maximum Gross Head | $1423.50 - 1210.00 = 213.50$ m |
| Minimum Gross Head | $1418 - 1210 = 208$ m |
| Design Net Head | $211.67 - 17.67 = 194$ m |

Sawra- Kuddu Hydroelectric Project is a run-of-the river development on the Pabbar river for generation of hydro power. It has been contemplated as a peaking station. Installed capacity of the project has been kept as 110 MW comprising 3 units of 36.67 MW each with overall efficiency of generation as 0.89.

1.7.2 INSTALLED CAPACITY STUDIES

The design discharge of 65 cumecs which is available 18% of the time affords most economical results. Studies of Power Generation with different installed capacity have been carried out. It was found that no appreciable energy gain from 110 MW to 115 MW was found and accordingly the installed capacity has been fixed at 110MW. The annual Generation in 90% & 50% dependable years works out to be 385.78 GWH & 506.61 GWH.

1.7.3 UNIT SIZE

Minimum Power Generation on average ten daily flow basis in 90% & 50% dependable years will be of the order of 22.8 MW & 16.8 MW respectively. The unit size of 36.67 MW, keeping in view if generation is required through out the day in lean flow then also generation at any given time will not fall below 51% of the rated capacity. Considering the Pattern of flows and minimum generation, three units of 36.67 MW each have been proposed.

1.8 TRANSMISSION OF POWER

It is proposed to evacuate the power generated *inter alia* at Sawra Kuddu project by laying a 100 Kms long, 220 KV line with ZEBA conductor up to 220/132 sub station Giri. The transmission line would carry the power generated by other projects also in the valley.

1.9 CONSTRUCTION SCHEDULE

Project has been planned to be completed in five and half years period including one year for infrastructure activities and preparation of tenders etc. With this schedule the Project is likely to be completed by September, 2010. First unit of the Project would be commissioned by March, 2010. Second and third units are proposed to be commissioned by August & September, 2010.

1.10 GEOLOGY AND SOILS

Detailed geological appraisal of various Project components has been carried out. Fresh and hard, light grey bedded quartzite with gneissose quartzite belonging to Jatog formation are exposed on the

right bank of the proposed diversion structure. Geological investigations in the form of seismic refraction measurements have been carried out at Dam site. It has revealed overburden/well compacted strata to the tune of 50m at the dam site. In view of thick overburden in the riverbed it has been decided to construct a barrage at the diversion structure.

Headrace tunnel will pass through greenish grey quartzite, chlorite schist with bands of quartzite and gneiss, carbonaceous phyllites and quartzite gneiss. This will generally be good tunneling media. Quartzite and schist will fair to good quality tunneling media and phyllites will vary between poor to good quality tunneling conditions.

Rock mass in the underground powerhouse cavity based on sub-surface geological exploration has been found as good to moderately jointed. Rock mass likely to be encountered will be quartzite phyllite. Quartzite is assessed to contain 80 to 100% quartz. It is highly permeable in nature due to bitterness and hence grouting would be carried out.

It is expected that 40% of tunnel rock mass encountered would be good to very good, around 37% would be fair, 13% poor and 2% very poor.

1.11 SEISMOLOGY

The Project area falls in the Zone V of the Seismic Zoning Map of India. The Magnitude frequency relationship of seismic events of the area within 31-32° N and 77-79° E corresponding to Yamuna and Satluj basins show that the maximum acceleration in the area having magnitude of 6 has occurred once. Magnitude versus frequency curve of this area is enclosed as Plate-III. Detailed spectrum acceleration studies for the Project are being got conducted by IIT, Roorkee. Diversion Barrage and underground structures would be designed as per the peak acceleration response spectrum obtained from these studies.

1.12 IMPACT ON SURFACE WATER, GROUND WATER & IRRIGATION

The diversion structure of Sawra Kuddu Hydroelectric Project is a small barrage with 13.5m height, hence small storage of water vis-a-vis submergence of area will be involved. Most of the ;reservoir would be confined within the river banks. Through Head Race Tunnel (HRT) and pressure shaft water fed to powerhouse would escape back into Pabbar

River through a tailrace tunnel. In view of these aspects, no impact on ground water or surface water is anticipated. The HRT runs parallel to Pabbar river and very little area in between HRT and Pabbar river is involved. The ground water position of this area will not be changed due to existing steep slope of surface. There is no major irrigation scheme in the area. In view of the above, this project will not have any adverse impact on irrigation, ground and surface water position of the area.