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DEVELOPMENT OF LOW HEAD HYDROPOWER PROJECTS ON CANALS IN PUNJAB PAKISTAN

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By:

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Abstract

Punjab with population of 93 Million is the largest province of Pakistan. It contributes 65 % of GDP and consumes 62% - 68% of the total national power. Currently, the province faces more than 2600 MW of shortfall and 6-18 hours of power load shedding during peak demand. Most of the industry is running on 40 to 50% capacity resulting in large scale lay-offs and unemployment with serious law & order and social implications. Government of the Punjab has recognized the energy crises. Punjab Power Policy 2009 provides a framework for the development of power plants in the province using all types of technologies including Hydel, Solar, Wind and Bio-mass, etc. Punjab has a total hydel potential of 600-1000 MW on canals and barrages. This paper highlights the details of low head hydropower projects on canals in Punjab being under implementation.

1.0 Introduction

Pakistan is still a net importer of energy and it spends about 30% of total imports, to import oil to meet its energy needs. The gap between the demand and supply in the past was met through installation of thermal power projects based on costly imported fuel. This situation disturbed the Hydel- thermal mix ratio from 65:35 to 35:65 which had resulted into unbearable increase in electricity tariff besides increasing dependency on imported fuels for energy need of the country. To explore and utilize renewable energy resources in Punjab and mitigate dependence on imported fuels is the need of time.

Federal Government established Alternative Energy Development Board (AEDB) in year 2003 to exploit the renewable energy resources of the country with the target to produce 2030MW through renewable means. This aspect is also envisaged in Vision 2025(WAPDA) regarding Energy Expansion Plan of the country. Punjab is fortunately endowed with great Hydro Power Potential on canal falls. There are 316 identified sites on canal falls with a total potential of 480 MW, out of which 48 sites have potential of more than 2 MW.

Energy demand in the country is increasing at rate of 8 to 10 % per annum. The gap between demand and supply has always been increasing. Punjab is fortunately endowed with Hydel Power on canal falls/barrages which is predominately low head with high volume of discharge. In the past, the hydel potential on canal falls/barrages could not be exploited due to non availability of cost effective technology for low heads. With the recent technological development, it is now possible to exploit the potential on canal and barrages.

Under Power Generation Policy, 2002 announced by Government of Pakistan, Punjab Government has introduced its Power Generation Policy (Revised), 2009 and has also established Punjab Power Development Board (PPDB) for its implementation. Punjab Power Development Board provides One Window Facility to the Private Investors for development of project based on any technology like Hydel, Thermal, Wind, Solar and Biomass. Private Investors are invited to invest in the Power Project to meet the energy shortage in the Province. Any private investor may follow the detailed procedure outlined in the Policy.

1.1 Opportunities in Punjab

Pakistan has been facing substantial shortages in the power sector and the province of Punjab is no exception. Punjab with 68% of the consumption of generated power and gas is worst

affected and has to endure both power and gas load shedding with adverse social and economic consequences.

Following the 18th amendment in the Constitution of Pakistan, the provinces are now vested with full authority to develop power projects of any capacity through public or private sector and establish required regulatory framework. In view of lingering energy crisis and opportunity provided by the new enabling framework, the Government of the Punjab decided to play a pro-active role in the energy sector. An independent Energy Department has accordingly been established to vigorously pursue power generation and oil & gas projects in the province.

Punjab with population of 93 million is the largest province of Pakistan and contributes 65 % of the GDP. It has a large industrial base with more than 48,000 units. There is a growing un-met demand of energy which offers an opportunity for investments in power generation projects based on various indigenous sources.

1.1.1 Hydel

- Punjab has a total low-head hydel potential of 600-1000 MW on canals and barrages. First lot of five (5) hydel power projects on canals is ready for implementation. (Fig.-1 & Table-1b).
- Out of three potential larger sites shared with AJK, 600 MW project can be undertaken at Mahl in collaboration with the Govt. of AJK.
- 5 small hydel projects (55MW), whose feasibility studies have been completed, are ready to be implemented under joint venture mode. These projects are to be established at the following sites: Khanki Barrage; Qadirabad Barrage; Lower Chenab Canal; Upper Chenab Canal; and Qadirababd Balloki Link Canal. (Fig.-1 & Table-1b).

1.1.2 Coal

- Punjab has sizeable coal reserves, estimated at 235 million tons, of varying quality in Salt Range.
- A coal purchase agreement has been signed for a minimum of 2400 tons/day of coal supply from Baluchistan (Chamalang) for a 300 MW plant in District Muzaffargarh in JV mode.
- Energy Department is seeking private sector investment in proposed 300 MW power plant at District Rahimyar Khan based on imported coal.
- 16 Industrial Estates under Punjab Small Industries Corporation have been targeted for establishment of dedicated power plants (10-50 MW) using mix of coal, biomass and solid waste. These will be dedicated projects with energy buy back guarantee.

1.1.3 Biomass, Biogas and Waste to Energy

- Huge potential of biomass based power generation exists on unutilized crop residue of around 34 million tons per annum consisting of rice husk, rice straw, maize stalk and cotton stick, etc.
- 35 million livestock in Punjab offers substantial opportunity for biogas power projects.
- 12,300 tons/day of solid waste is produced in urban centres of Punjab which is a readily available source for generation of power.

- 32 MW Thermal Power Plant on Municipal solid waste near Faisalabad City with completed feasibility study and identified land is ready for interested investors in JV/PPP mode.

1.1.4 Solar and Wind

- Huge potential for generation of power through solar energy especially in Southern Punjab.
- 5000 Acres of land in Cholistan has been reserved by the GoPunjab for the establishment of solar power plants
- 50 MW CSP Solar project in District Muzaffargarh is planned in public sector/JV mode.
- Wind corridor in Kalarkahar area, around 10-20 KM wide and 250 Km long, promises considerable potential for wind power projects.

1.1.5 Policy and Institutional Framework:

Government of Punjab has developed and an enabling power policy to facilitate investment in this vital sector. Punjab Power Policy 2009 provides a framework for the development of power plants in both public and private sector as well for joint venture projects. The policy is intended to promote all types of technologies including hydel, coal, solar, wind and bio-mass. Hydel projects in the private sector would be implemented on Build-Own-Operate-Transfer (BOOT) basis while other projects in the private sector can be established on either BOOT basis or on Build-Own-Operate (BOO) basis.

2.0 Historical hydel stations on canal falls

The development of small hydel power units in Pakistan was initiated in early 1950s. The Pakistan Water and Power Development Authority (WAPDA) took over the responsibilities of Power Sector in April 1959. The existing power generation, transmission and distribution facilities in different parts of the country were transferred to it. Low-head hydropower facilities convert the potential energy possessed by a body of water because of its height above a reference point (head) into electricity that is sent to energy consumers via electric transmission systems. A low-head hydro project generally describes an installation with a fall of water less than 5 meters. The salient features of the low hydel power stations installed in the past are described in Table-2. Brief of these hydel stations is as under:

2.1 Renala Khurd low head power station

This is a small, low-head, run-of-river, about one megawatt capacity power station on the flows of Lower Bari Doab canal. Having five units, each of 22,000 watts rated production capacity, this plant was set up to meet the electricity needs of the Mitchells Fruit Farms and Food Processing unit etc.

2.2 Rasul hydel power station

The second small hydro-power plant of 9.6 MW (3X3.2 MW) capacity was put, into operation in Malakand (NWFP) in July 1938. This was upgraded to 20 MW with the addition of two units of 5 MW each in October 1952 for coping with the increasing power load in the marketing area. Meanwhile, in July and thereafter in December 1952, small hydel power stations were commissioned on canals at Rasul (Punjab) and Dargai (NWFP) having 22 MW (2X11 MW) and 20 MW (4X5 Mw) generating capacity respectively. In February 1958, 4 MW Kurram Garhi hydel power stations, located in NWFP, had started producing electricity. This small power station has four units of equal capacity.

2.3 Chichoki Malian hydel power station

In May-June 1959, another small hydroelectric power station, Chichoki Malian, located near Sheikhupura, had been commissioned. This 13 MW power generating centre with four units, each of 4.4 MW capacity became the third small hydel power plant located on a canal in the Punjab province after Renala (1925) and Rasul (1952).

2.4 Shadiwal hydel power station

After that in June 1961, a 14 MW (2x6.75 MW) Shadiwal small hydel power plant near Gujrat was commissioned.

2.5 Nandipur hydel power station

Another 14 MW (3x4.6 MW) Nandipur small hydroelectric power plant near Gujranwala had started producing electricity in March 1963.

3.0 New Hydel Power Stations ON CANALS in Punjab

The first lot of new hydel power stations on canals in Punjab (Fig-1) is a great breakthrough in the energy sector. The main objective of these new projects is to generate electricity and lay down track for hydel project implementation in the near future in Punjab. Asian Development Bank offered a multi-tranche loan of US$ 500 Million to the Govt. of Pakistan for development of renewable energy resources in Pakistan under Renewable Energy Development Sector Investment Programme (REDSIP). The first tranche of US$ 65 Million, including 20% equity, was approved by ADB for Punjab.

The tasks for pre-construction stage i.e., appointment of consultants, review of feasibility studies, preparation of tender level designs / tender documents, International Competitive Bidding (ICB) for EPC/Turnkey contracts, technical and financial evaluation of bids have been completed under the ADB procedures.

The mode of implementation of the REDSIP is EPC /Turnkey, which in the terms of ADB is “Procurement of Plant, Design, Supply and Install” on Turnkey basis. In EPC mode, the Contractor takes full responsibility of detailed designs (Engineering), Procurement and Construction / Commissioning of Plant and carries the associated risks against a fixed price and time schedule. The ICB on EPC Turnkey basis for implementation of Hydropower Projects is the first example in Punjab.

Most of the HPPs under REDSIP are based on combination of Canal Falls at a distance of 7-10 km apart; to have minimum water head to avail very low head technology.

Construction of Hydropower Project is a specialized job which involves several experts of various engineering disciplines and Technologies. The Hydro Turbines, Generators, Governors and associated atomized controls etc. will have to be imported for such projects because no local manufactures are available. Similarly, the Erection, Testing and Commissioning of the plant will also be done by Foreign Experts and representative of the foreign manufacturers. This multi disciplinary activity will definitely transfer the skill and technology to the Country and will encourage the local industry to come forward to develop the Hydro Power Equipments for small hydro power projects.

Government of Punjab is the sponsoring authority for REDSIP project. However, the project execution is the responsibility of Energy Department through Punjab Power Management Unit (PPMU) and Punjab Hydropower Consultants (PHC). These new 5 hydel projects will accelerate the economic activity in the project areas and resultantly will improve the Socio-Economic conditions. Following paragraphs explain the details of hydel power projects on canals in Punjab.

3.1 Marala Hydropower Project (MHPP)

The Marala Hydropower Project with an estimated plant capacity of 7.64 MW will be constructed as a run of the river hydropower project in the power canal in bypass arrangement opposite R.D 2+850 of Upper Chenab Canal (UCC). The site is located approx. 25 Km from the district town of Sialkot in Punjab province. The layout plan of MHPP is shown in Fig.-2.

The main components are permanent diversion; head race channel, power house, tail race channel, and spillway. The Scope of Civil works activities start from the fall structure of U.C.C Head Regulator Bridge at RD 000+000 to RD 5+000 of the Upper Chenab Canal system. The hydropower project mainly consists of shifting of fall from R.D 000+000 to R.D 2+850 so to utilize the head for energy output. A power canal (in a bypass arrangement) situated at right side of UCC with power house approximately midway (opposite Rd 2+850 of UCC) will be constructed. It includes intake section, power house and tail race section etc. Spillway shall be constructed at an appropriate location in U.C.C, downstream of the point at which Power Canal takes off. The embankments of U.C.C downstream of existing fall shall be raised up to its junction with Power Canal and upstream of Spillway.

U.C.C operates throughout the year with a closure period of one (1) month i.e January. On left side of U.C.C, M.R.Link Canal is running parallel to U.C.C, which remains close from 15th of October to 15th of April. It is intended to use M.R.Link Canal during its six (6) months closure period to divert the flow of U.C.C and then return it to U.C.C downstream of the entry of Power Canal in U.C.C. Following this diversion, the Contractor shall dewater the upstream part of U.C.C and after necessary dewatering shall commence construction of spillway. It is anticipated that within this period of six (6) months the Contractor may not be able to complete the Spillway structure at all respects. But he has to construct it up to such level and ensure its safety so that immediately after 15th of April, work on Spillway could be abandoned and U.C.C can operate during period from 15th of April to 15th of October. In order to complete Spillway structure, the Contractor will then repeat the steps taken in first closure of M.R.Link Canal and ensure that the structure is fully complete before upcoming 15th of October.

The electrical and mechanical equipment involves four (4) sets of double regulated horizontal shaft Kaplan turbines, each 2.0 MW, with a rated head of 2.16 m, rated flow of 105 m^3/s complete with all auxiliary equipment including regulating gear, turbine casing, guide vanes, thrust and guide bearings, etc. It also consists of four (4) sets of digital electro hydraulic governors with P.I.D. control complete with all accessories including governor oil pumps, pressure tanks and air compressors. Four (4) sets of draft tubes with 4 hydraulically operated roller gates and four (4) sets of power intake trash racks and two sets of stop logs are important parts of the project.

The MHPP has been awarded to Chinese contractors M/s SINOTEC-SHPE (JV). The contract value is Rs. 3049 million. The bidder has mobilized its survey, geotechnical teams under the provisions of the Contract. The Construction will be taken up after detailed design stage and model study. The implementation time is estimated 1085 **days** including mobilization, detail design, Construction / Procurement of plant and equipment transportation, site installation, testing and Commissioning etc.

For the purpose of dispersal of power, the Marala Hydropower station shall be interconnected through single circuit 11 kV overhead transmission lines with WAPDA/PEPCO power system at Head Marala 66 kV substation at a distance of approximately 2 km away. The Cost of Transmission Line is included in the lump sump price Bid. Annual energy varies from year to year depending on the inflows keeping in view other water requirements. However, average annual energy generated through the construction of Marala powerhouse has been estimated

as 50.30 GWh. The project will save an amount of Rs.200 million annually that would otherwise be required for import of oil needed for equivalent thermal plant.

3.2 Pakpattan Hydropower Project (PHPP)

Pakpattan Hydropower Project is planned to be implemented on Pakpattan Canal in Pakpattan District of Punjab Province. The Project site ((Latitude $30^0$22'20" and Longitude 73^0 30' 14") is located approximately 8 KM from the district town of Pakpattan. Pakpattan is connected to National Highway (Lahore-Multan) at Okara through Deepalpur and at Sahiwal. Access to the project area is gained from Pakpattan through metalled road up to RD 112+350 and kacha road to powerhouse Location at RD 114+000 along the right bank of canal. The Pakpattan Hydropower Project with an estimated plant capacity of 2.82 MW will be constructed as a run of the river hydropower project in the power canal in bypass arrangement opposite R.D 114+000 of Pakpattan Canal. The layout plan of PHPP is shown in Fig.-3.

The Pakpattan Canal off takes from the right side of Sulimanki Barrage. The discharges of Pakpattan Canal are controlled by its head regulator. The designed discharge of Pakpattan Canal is 187 m³/sec. A number of fall structures exist along the canal where hydropower projects could be developed. The falls at RD 112+350 and RD 124+950 have been selected for hydropower development.

The main components are permanent diversion; head race channel, power house, tail race channel, and spillway. The Scope of Civil work activities start from the fall structure at RD 112+350 to the fall at RD 124+950 of the Pakpattan Canal system. The hydropower project mainly consists of combination of two falls to utilize the head for energy output. A power canal (in a bypass arrangement) situated at right side of Pakpattan Canal shall be constructed between the two fall structures and the power house will be constructed approximately midway (opposite Rd 114+000 of Pakpattan Canal) in the power canal. It includes intake section, gated spillway, power house and tail race section etc. The bed level and the embankment of the power canal upstream of power house shall be constructed to the existing level upstream of the fall structure at RD 112+350. The power canal downstream of the power house shall be designed and constructed to the bed level downstream of the fall structure at RD 124+950.

The hydro-mechanical equipment comprises two (2) sets of double regulated horizontal shaft Kaplan turbines, each 1.48 MW, with a rated head of 4.2 m, rated flow of 40 m^3/s complete with all auxiliary equipment including regulating gear, turbine casing, guide vanes, thrust and guide bearings, etc for Pakpattan Hydel power project. The delivery of the Turbines, Generators, Governors and Control System shall be from foreign countries. However, partly local supply is foreseen for the mechanical and electrical equipment of the power house/switchyard. Two (2) sets of digital electro hydraulic governors with P.I.D. control complete with all accessories including governor oil pumps, pressure tanks and air compressors, two (2) sets of draft tubes with 2 hydraulically operated roller gates and two (2) sets of power intake trash racks and stop logs are important parts of the scheme.

The PHPP has been awarded to Chinese Contractors M/s SINOTEC-SHPE-SKAF (JV). The teams of survey and geotechnical have been mobilized. The Contract Value is Rs. 1047 million. The implementation time is estimated 885 days which includes Mobilization, Detailed Design, model study, Construction / Procurement of Plant and Equipment, Transportation, Site Installation, Testing and Commissioning etc.

For the purpose of dispersal of power, the Pakpattan Hydropower station shall be interconnected through single circuit 11 kV overhead transmission line with WAPDA/PEPCO power system at 132 kV Bunga Hayat grid station at a distance of approximately 7 km away. The cost of Transmission Line is included in the lump sump Price Bid. The average annual

energy generated through the construction of Pakpattan powerhouse has been estimated as 21.89 GWh. The project will save an amount of Rs.109 million annually that would otherwise be required for import of oil needed for equivalent thermal plant.

3.3 Deg-outfall Hydropower Project (DHPP)

Deg-Outfall Hydropower Project is planned to be implemented on Upper Chenab Canal Main Line Lower in Sheikhupura District of Punjab Province. The Project site is accessible by main road from Lahore to Sheikhupura. The project site (Latitude 31037'53" and Longitude 740 06' 09") is located at R.D. 283+100 of Upper Chenab Canal (Main Line Lower) about 6 km from the Lahore-Faisalabad road and is about 19 from Sheikhupura City, the district headquarters. The layout plan of DHPP is shown in Fig.-4.

The Deg Out Fall Hydropower Project with an estimated plant capacity of 4.04 MW will be constructed as a run of the river hydropower project in by-pass arrangement opposite R.D 282+225 of Upper Chenab Canal (UCC). Upper Chenab Canal (Main Line Lower) is controlled from Bombanwala head regulator. The designed discharge of the head regulator is 315 m^3/sec. A number of fall structures exist along this canal where hydropower projects can be developed. The falls at RD 266+000 and RD 283+400 have been selected for hydropower development. The power canal is situated at right side of the existing U.C.C.

The main components are permanent diversion; head race channel, power house, tail race channel, and spillway. The Scope of Civil works activities start from the fall structure at RD 266+000 to RD 283+819 of the Upper Chenab Canal system. The Deg Outfall hydropower project mainly consists of combination of two falls (RD 266+000 and RD 283+100) to utilize the head for energy output. A power canal (in a bypass arrangement) situated at right side of UCC between R.D 280+400 and R.D 283+819 and the power house will be constructed approximately midway (opposite Rd 282+225 of UCC). It includes intake section, gated spillway, power house and tail race section etc. The bed level and the embankment of the power canal upstream of power house shall be constructed to the existing level of UCC upstream of the fall structure at RD 266+000. The power canal downstream of the power house shall be designed and constructed to the bed level of UCC at RD 283+819 in accordance with the bed level downstream of fall structure at R.D 283+100.

The hydro-mechanical equipment comprises two (2) sets of double regulated horizontal shaft Kaplan turbines, each 2.12 MW, with a rated head of 4.0 m, rated flow of 60 m^3/s complete with all auxiliary equipment including regulating gear, turbine casing, guide vanes, thrust and guide bearings, for Deg-Outfall Hydel power project. The foreign delivery of the Turbines, Generators, Governors and Control System has been considered. However, partly local supply is foreseen for the mechanical and electrical equipment of the power house/switchyard.

The transmission line will be connected by Power House complex with nearest 132 KV at ICI Ataabad substation. The transmission line is a double circuit 11 KV overhead line with 6 km length. The DHPP is ready for award. The implementation time is estimated 885 days which includes mobilization, detailed design, model study, construction / procurement of plant and equipment, transportation, site installation, testing and commissioning, etc. The average annual energy generated through the construction of Deg-Outfall powerhouse has been estimated as 27.65 GWh. The project will save an amount of Rs. 138 million annually that would otherwise be required for import of oil needed for equivalent thermal plant.

3.4 Chianwali Hydropower Project (CHPP)

Chianwali Hydropower Project is planned to be implemented on Upper Chenab Canal (Main Line Lower) at RD 131+250, located 8 km from Gujranwala District of Punjab Province with Latitude 32001'15" and Longitude 740 12' 05"). The Project Site is accessible main road from

Lahore –Gujranwala G.T Road at the town of Kamonki by Qila Deedar Singh Road, crossing the D.R Bridge at R.D 139+165 of U.C.C and then along the inspection track of U.C.C upto the Powerhouse location.

Upper Chenab Canal (Main Line Lower) is controlled from Bombanwala head regulator. The designed discharge of the head regulator is 315 m³/sec. The falls at RD 128+000 and RD 164+400 have been selected for hydropower development. The powerhouse is located at RD 131+250 approximately 600 m downstream of existing fall structure at RD 128+000 towards the left bank of the canal to make maximum use of the existing road for construction purposes. The powerhouse and spillway are placed adjacently along the same axis. An access road is realigned to pass over the powerhouse draft tube and spillway to connect the existing right bank road. There are two falls (drop structures) at RD 128+000 and RD 164+000 which will be combined at RD 131+250 to have the required head to run the power plant. A feeder channel will be constructed in the right of way (ROW) of the main UCC canal to feed the distributaries in Sheikhupura, Akbar and Harpoki at RD 163+000. The layout plan of CHPP is shown in Fig.-5.

The main components are permanent diversion; head race channel, power house, tail race channel, and spillway. The civil works involved are: Construction of power canal works in by-pass arrangement between R.D 129+256 to R.D 133+035 on right side of U.C.C. Raising of Existing U.C.C embankments from upstream of Powerhouse Location up to R.D 128+000 according to remodeled cross sections. Similarly excavation of U.C.C bed from downstream of Powerhouse Location up to R.D 164+400 according to remodeled cross sections. Construction of new District Road Bridges adjacent to the existing Fall cum Village Road Bridges at R.D 128+000 and R.D 164+400 of UCC and dismantling the existing Fall cum Bridge at the same R.Ds'. Construct new Bridges adjacent to the existing Bridges with piles foundations at R.D 139+165 and R.D 148+669 of UCC and dismantle the VR Bridges with shallow foundations at same locations. Gated Spillway structure with service bridge. Powerhouse buildings and ancillary structures including Machine Hall, Control Building, Intake and outlet bays with cut-offs, and retaining walls etc. Paving of 2.5 Km (approx.) long and 4.5m wide access road with double surface treatment.

The power facilities involved are two (2) sets of double regulated horizontal shaft Kaplan turbines, each 2.8 MW, with a rated head of 4.2 m, rated flow of 75 m^3/s complete with all auxiliary equipment including regulating gear, turbine casing, guide vanes, thrust and guide bearings, etc., two (2) sets of digital electro hydraulic governors with P.I.D. control complete with all accessories including governor oil pumps, pressure tanks and air compressors, two (2) sets of draft tubes with 2 hydraulically operated roller gates, two (2) sets of power intake trash racks and stop logs.

The CHPP is at advance stage and to be awarded in near future. The implementation time is estimated 1080 days which includes mobilization, detailed design, model study, construction / procurement of plant and equipment, transportation, site installation, testing and commissioning, etc. The average annual energy generated through the construction of Chianwali powerhouse has been estimated as 30.20 GWh. The project will save an amount of Rs.151 million annually that would otherwise be required for import of oil needed for equivalent thermal plant.

3.5 Okara Hydropower Project (OHPP)

Okara Hydropower Project is planned to be implemented on Lower Bari Doab Canal (LBDC) at RD 199+000, located in Okara District of Punjab Province. The Project site is accessible by main road from Lahore to Multan Road near Okara. The site (Latitude 300 49' 54" and Longitude 730 29' 13") is located approximately 10 Km from the district town of Okara. The Okara Hydropower Project will be constructed in bypass arrangement opposite R.D 199+000 of

Lower Bari Doab Canal (L.B.D.C).The Lower Bari Doab Canal off takes from Left side of Balloki Barrage. The discharges of Lower Bari Doab Canal are controlled by its head regulator. The designed discharge of head regulator is 278 m³/sec. There exists a number of falls structure along the canal where hydropower project could be developed. The falls at RD 196+954 and RD 227+565 have been selected for hydropower development. The layout plan of OHPP is shown in Fig.-6.

The Okara Hydropower Project with an estimated plant capacity of 4.16 MW will be constructed as a run of the river hydropower project in the power canal in bypass arrangement opposite R.D 199+000 of Lower Bari Doab Canal (L.B.D.C). The Scope of Civil works activities start from the fall structure at RD 196+954 to the fall at RD 227+454 of the Lower Bari Doab Canal system. The hydropower project mainly consists of combination of two falls to utilize the head for energy output. A power canal (in a bypass arrangement) situated at right side of L.B.D.C shall be constructed between the two fall structures and the power house will be constructed approximately midway (opposite Rd 199+000 of L.B.D.C) in the power canal. It includes intake section, gated spillway, power house and tail race section etc. The bed level and the embankment of the power canal upstream of power house shall be constructed to the existing level upstream of the fall structure at RD 196+954. The power canal downstream of the power house shall be designed and constructed to the bed level downstream of the fall structure at RD 227+454

The hydro-mechanical equipment comprises two (2) sets of double regulated horizontal shaft Kaplan turbines, each 2.18 MW, with a rated head of 3.5 m, rated flow of 70 m^3/s complete with all auxiliary equipment including regulating gear, turbine casing, guide vanes, thrust and guide bearings, etc for Okara Hydel power project. The foreign delivery of the Turbines, Generators, Governors and Control System has been foreseen. However, partly local supply is possible for the mechanical and electrical equipment of the power house/switchyard.

For the purpose of dispersal of power, the Okara Hydropower station shall be interconnected through double circuit 11 kV overhead transmission lines with WAPDA/PEPCO power system at 132 kV Okara grid station at a distance of approximately 7 km away.

The OHPP is at advance stage and to be awarded in the near future. The implementation time is estimated 885 days which includes mobilization, detailed design, model study, construction / procurement of plant and equipment, transportation, site installation, testing and commissioning, etc.

The average annual energy generated through the construction of Okara powerhouse has been estimated as 26.60 GWh. The project will save an amount of Rs.133 million annually that would otherwise be required for import of oil needed for equivalent thermal plant.

4. ACKNOWLEDGEMNT

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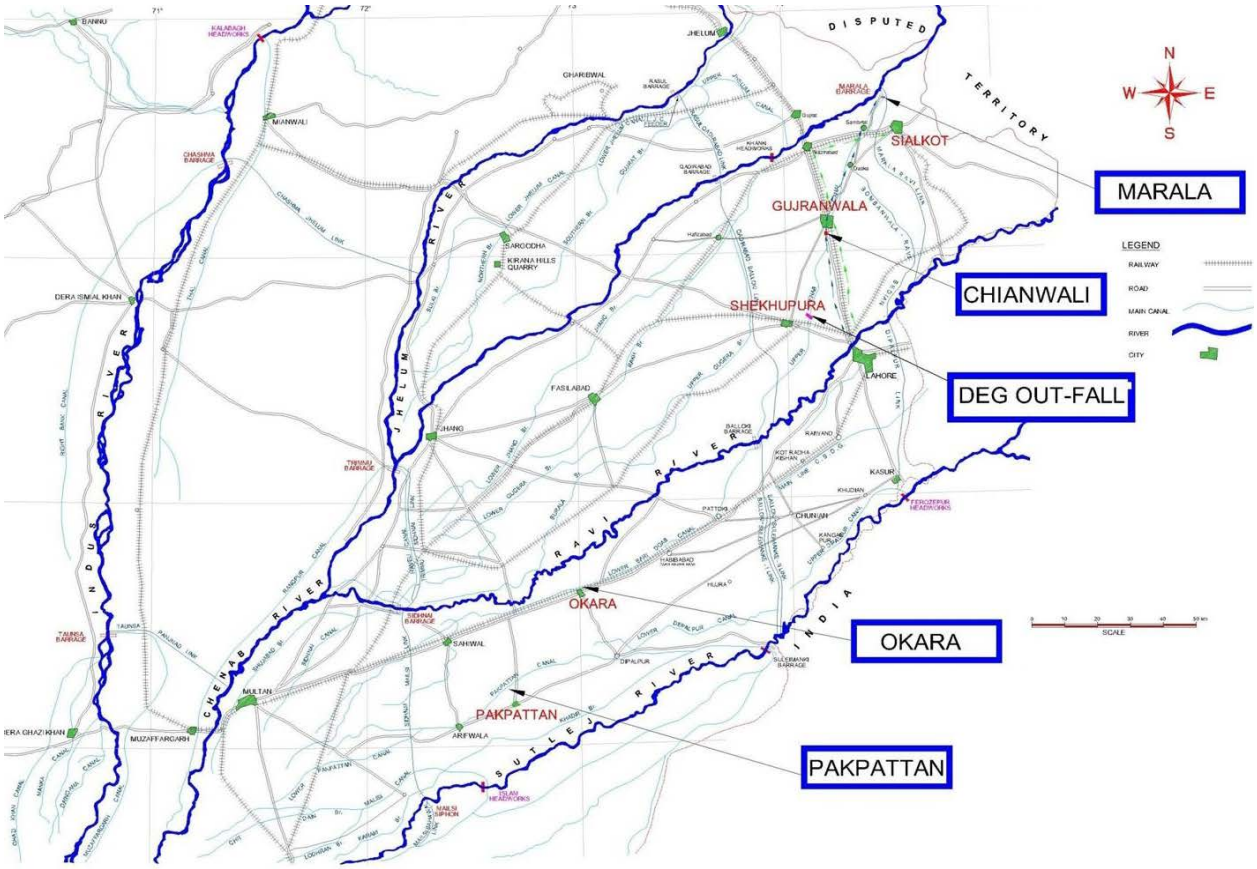


Figure 1: Map showing locations of first lot of five low head hydel power stations

Table -1a: Salient features of first lot of hydel power stations on canals in Punjab

Sr. #	Project Name	PH Design Flow	Rated Flow per unit	Design Net Head	No. of Units	Turbine output per unit	Plant Installed Capacity	Av. Annual Generation
		(m^3/s)	(m^3/s)	(m)	(no.)	(MW)	(MW)	GWh
1	Marala	420	105	2.16	4	1.91	7.64	50.30
2	Chianwali	150	75	4.20	2	2.82	5.38	30.20
3	Deg Outfall	120	60	4.00	2	2.12	4.04	27.65
4	Pakpattan	80	40	4.20	2	1.48	2.82	21.89
5	Okara	140	70	3.50	2	2.18	4.16	26.60

Table -1b: Salient features of next lot of hydel power stations on canals/barrages in Punjab

Sr. No.	Hydropower site	Installed Capacity	Average Annual Energy	Plant Factor	Base Cost		Cost per MW	
		(MW)	(GWh)	(%)	(M.Rs.)	MUS.$	M.Rs.	M.US$
1	Lower Chenab Canal (RD 0+000)	7.55	43.61	65.94	2625	30.52	347.68	4.04
2	New Khanki Barrage	14.09	38.34	31.06	4316	50.19	306.32	3.56
3	Qaiderabad Barrage	23.00	54.53	27.06	6331	73.62	275.26	3.20
4	Upper Chenab Canal (RD 133+296)	3.58	17.19	54.76	1311	15.24	366.20	4.26
5	Qaiderabad Balloki Link Canal (304+985)	7.68	52.59	78.17	2921	33.97	380.34	4.42

Table -2: Salient features of historical hydel power stations on canals in Punjab

Sr. No.	Power Station	Location		Installed Generation Capacity MW	Units Generated GWh	Overall Cost of Generation Ps/KWh	Utilization Factor %	Plant Factor (%)	Avg. cost of Generation. Ps/Kwh 1975-95	Data of Commission	No. of units
		Canal	Province								
1	Rasul	Upper Jhelum Canal offecting from Mangla Dam	Punjab	22	32.8	36.91	16.97	32.98	9.43	May 1951	2x11
2	Shadiwal	Upper Jhelum Canal offecting from Mangla Dam	Punjab	13.5	42.67	22.12	35.98	42.92	10.53	June 1961	2x6.75
3	Chichoki Malian	Upper Chenab Canal offecting from Marala Barrage	Punjab	13.2	22.88	40.71	19.73	37.16	10.00	1959	3x4.4
4	Nandipur	Upper Chenab Canal offecting from Marala Barrage	Punjab	13.8	33.66	35.95	27.77	45.10	13.40	March 1963	3x4.6
6	Renala	Lower Bari Doab Canal offecting from Balloki Barrage	Punjab	1.1	3.61	99.39	37.37	60.92	34.40	1925	5x0.22

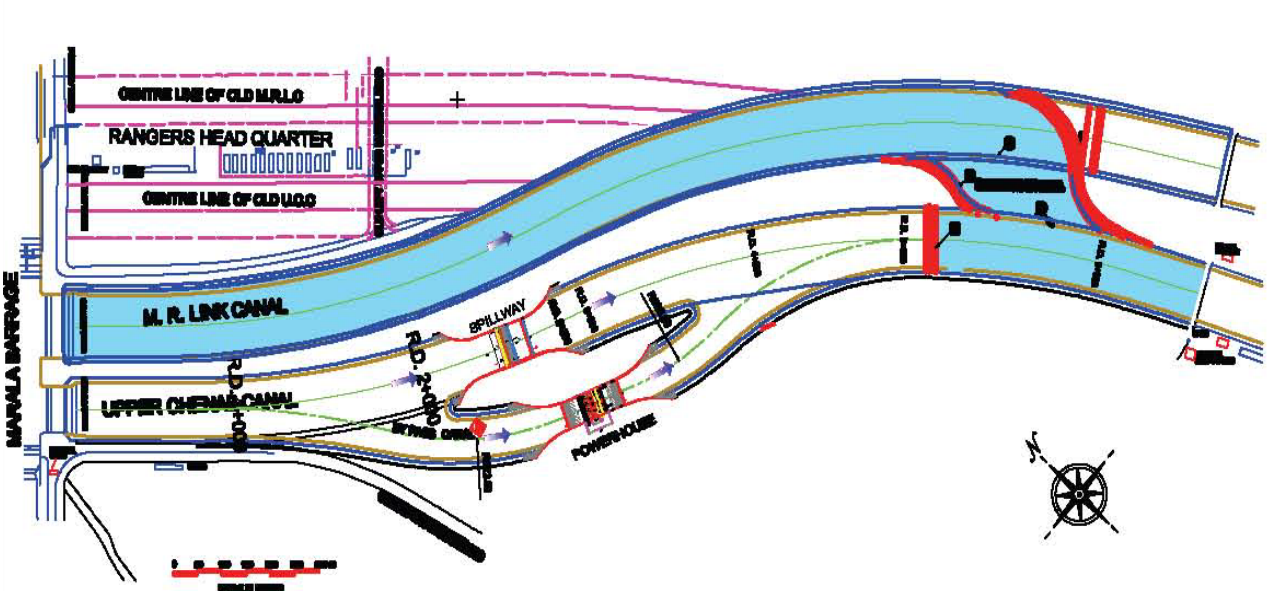


Figure-2: Lay out Plan of Marala Hydro Power Station (MHPP)

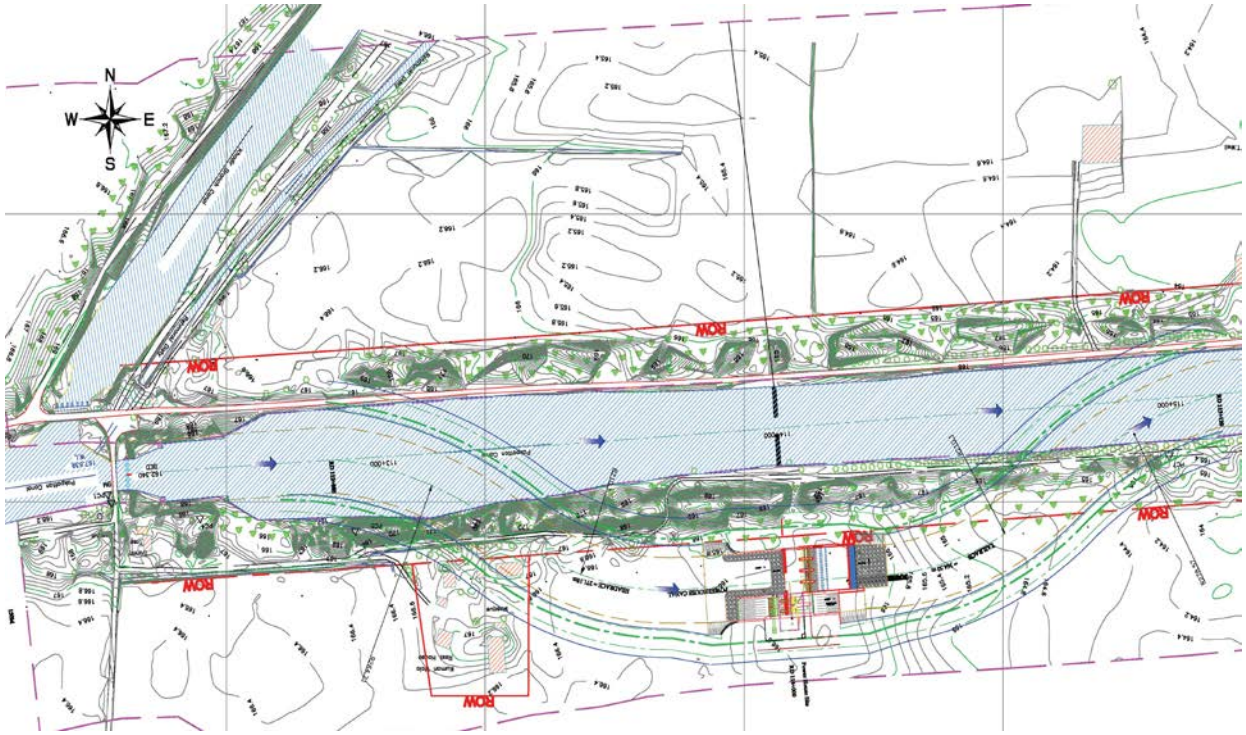


Figure-3: Lay out Plan of Pakpattan Hydro Power Station (PHPP)



Figure-4: Lay out Plan of Deg-out fall Hydro Power Station (DHPP)

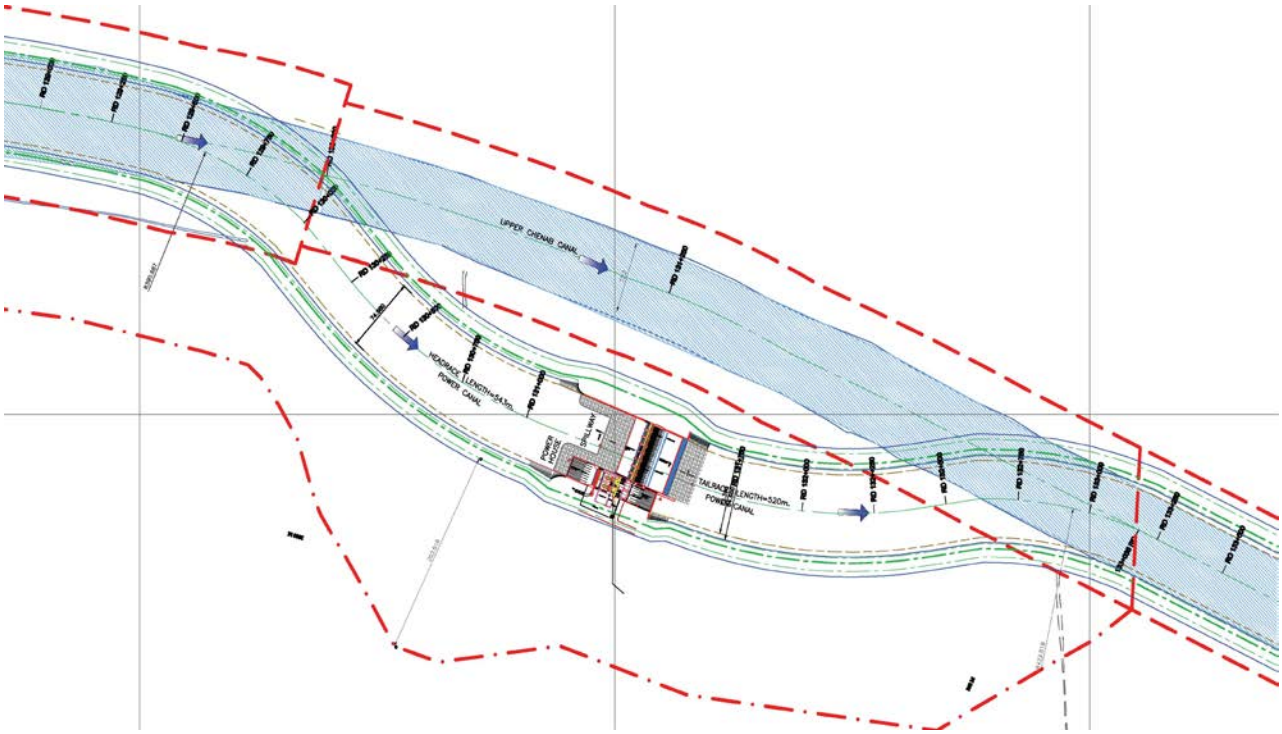


Figure-5: Lay out Plan of Chianwali Hydro Power Station (CHPP)

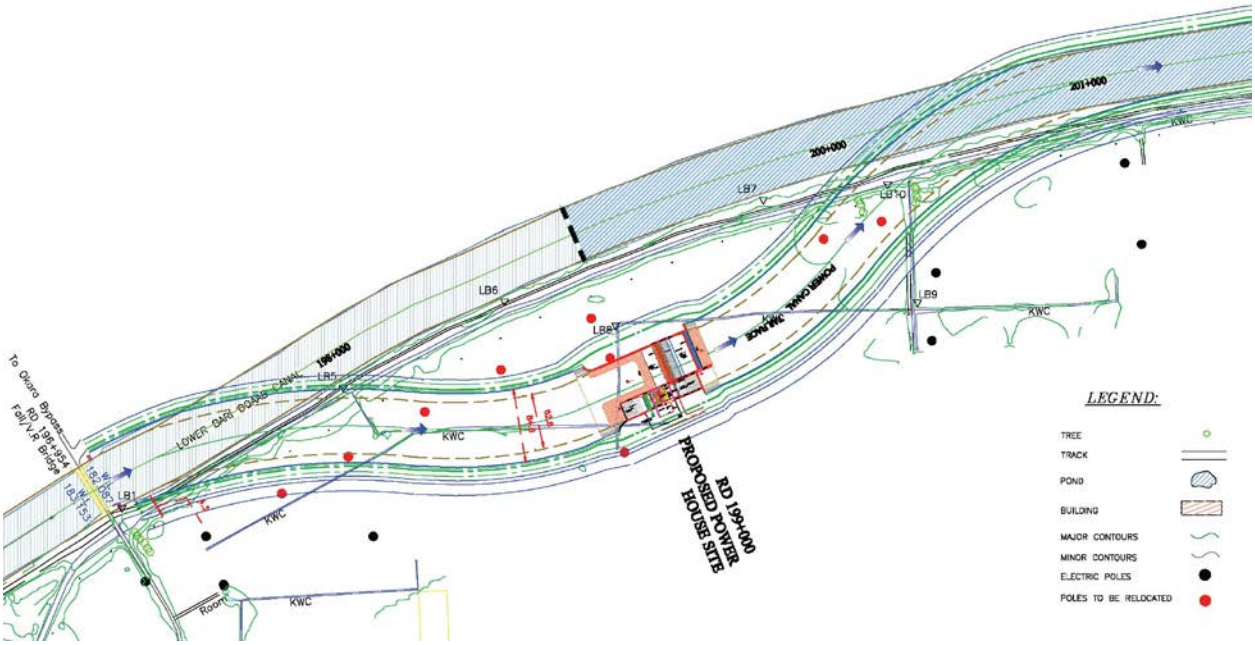


Figure-6: Lay out Plan of Okara Hydro Power Station (OHPP)