TRIDENT

APPLICATION FOR ISSUANCE OF POWER GENERATION LICENSE

FOR
7.55 MW LCC HYDROPOWER PROJECT
DISTRICT GUJRANWALA
(LOWR CHENAB CANAL RD 0+000)

SUBMITTED BY:
TRIDENT POWER GR (PRIVATE) LIMITED
REGISTERED ADDRESS: SUIT # 8, GROUND FLOOR, EVACUEE TRUST COMPLEX, F-5/1, ISLAMABAD
BUSINESS ADDRESS: HOUSE NO. 359-H, STREET NO. 4, PHASE V, DHA, LAHORE CANTT
TEL: +92 51 2870422-23; CELL: +92 300 5553435

TRIDENT **Trident Power GR (Pvt) Limited**

The Registrar
National Electric Power Regulatory Authorit
Islamabad

APPLICATION FOR A GENERATION LICENSE

Dear Sir,

I, Yousuf Mehboob Khan, Chief Executive Office, being the duly authorized representative of M/s Trident Power GR (Private) Limited by virtue of Board Resolution dated February 28, 2017, hereby apply to the National Electric Power Regulatory Authority for the grant of a Generation License to the Trident Power GR (Private) Limited pursuant to section 3(1) of the Regulation of Generation, Transmission and Distribution of Electric Power Act, 1997.

I certify that the documents-in-support attached with this application are prepared and submitted in conformity with the provisions of the National Electric Power Regulatory Authority Licensing (Application and Modification Procedure) Regulations, 1999, and undertake to abide by the terms and provisions of the above-said regulations. I further undertake and confirm that the information provided in the attached documents-in-support is true and correct to the best of my knowledge and belief.

A Bank Draft # 17046835 dated March 20, 2017 sum of Rupees 146,864, being the non-refundable license application fee calculated in accordance with Schedule II to the National Electric Power Regulatory Authority Licensing (Application and Modification Procedure) Regulations, 1999, is also attached herewith.

TRIDENT POWER GR (PRIVATE) LIMITED
TRIDENT

Date: March 20, 2017

Yousuf Mehboob Khan
Chief Executive Officer

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TRIDENT POWER GR (PRIVATE) LIMITED
TRIDENT

Date: March 20, 2017

Yousuf Mehboob Khan
Chief Executive Officer

Trident Power GR (Pvt) Limited

MINUTES OF BOARD OF DIRECTORS MEETING

The meeting of the Board of Directors of **M/s. Trident Power GR (Private) Limited** was held on Tuesday, February 28, 2017 at 10:30 a.m. at Suite 8, Ground Floor, Evacuee Trust Complex, F-5/1, Islamabad, which was attended by the following directors:

Present

- Mr. Fiaz Ahmad
- Mr. Yousuf Mehboob Khan
- Mr. Zafar Ikram Sheikh
- Syed Hadi Ali Rizvi

Chair

The Directors elected **Mr. Yousuf Mehboob Khan** to be the Chairman of the meeting. Quorum being present proceedings of the meeting was commenced on the instructions of the Chairman. Notice of the meeting was taken as read. The directors passed the following resolutions unanimously:

Resolution No. 1: Resolved that minutes of the last meeting of the Board of Directors be hereby confirmed and adopted.

Resolution No. 2: Resolved that the Company be and is hereby authorized to apply for the Power Generation License and to file a upfront tariff petition for submission to National Electric Power Regulatory Authority (NEPRA) for determination of the reference generation tariff and submitting application for Generation License in respect of the 7.55 MW LCC Hydro power Project and in relation thereto, enter into and execute all required documents, make all filings and pay all applicable fees, in each, of any nature whatsoever.

Resolution No. 3: Further resolved that **Mr. Yousuf Mehboob Khan** (Chairman & Director) be and hereby authorized and empowered to sign, execute and deal with the National Electric Power Regulatory Authority (NEPRA) regarding the generation license, adoption of upfront tariff, tariff approval, power purchase agreement and other related approvals and represent and sign all the related documents in respect of the same on behalf of the Company.

Mr. Yousuf Mehboob Khan, Chief Executive Officer of the Company be hereby also authorized to delegate all or any of the above powers in respect of the foregoing to any other person as deemed appropriate.

There being no other business, the meeting ended with a vote of thanks to the Chair.

Fiaz Ahmad	Yousuf Mehboob Khan	Zafar Ikram Sheikh	Syed Hadi Ali Rizvi
Director	CEO/Director	Director	Director

Date: February 28, 2017
Islamabad

TRIDENT POWER GR (PRIVATE) LIMITED
TRIDENT

Yousuf Mehboob Khan
Chairman

SECURITIES AND EXCHANGE COMMISSION OF PAKISTAN

COMPANY REGISTRATION OFFICE

1st Floor SLIC Building No.7, Blue Area,
Islamabad

Corporate Universal Identification No. **0083313**

I hereby certify that **TRIDENT POWER GR (PRIVATE) LIMITED** is this day incorporated under the Companies Ordinance, 1984 (XLVII of 1984) and that the company is **limited by shares.**

Given under my hand at **Islamabad** this **First** day of **April,** Two Thousand and **Thirteen**.

Fee Rs. **12000/-**

(Shaukat Hussain)
Additional Registrar of Companies

NO JR1 31698
Dated 1-4-13

CERTIFIED TO BE TRUE COPY

The Companies Ordinance, 1984

(Company Limited by Shares)

MEMORANDOM OF ASSOCIATION

Of

TRIDENT POWER GR (PVT.) LIMITED

I. The name of company is **TRIDENT POWER GR (PVT.) LIMITED**

II. The Registered office of the company will be situated in Islamabad Capital Territory.

III. The objects, for which the company is established are:-

1. To carry on all or any of the businesses of generating, purchasing, importing, transforming, converting, distributing, supplying, exporting and dealing in electricity and all other forms of energy and products or services associated therewith and of promoting the conservation and efficient use of electricity and to perform all other acts which are necessary or incidental to the business of electricity generation, transmission, distribution and supply.

2. To locate, establish, construct, equip, operate, use, manage and maintain Hydel, solar thermal power plants, coal fired power plants, power grid station, transforming, switching, conversion, and transmission facilities, grid stations, cables, overhead lines, sub-stations, switching stations, tunnels, cable bridges, link boxes, heat pumps, plant and equipment for combined heat and power schemes, offices, computer centers, shops, dispensing machines for pre-payment cards and other devices, showrooms, depots, factories, workshops, plants, printing facilities, warehouses and other storage facilities.

3. To purchase or otherwise acquire, produce, manufacture, refine, treat, purify, blend, reduce, distil, store, transport, market, distribute, supply, sell and otherwise dispose of and generally trade in any and all kinds of petroleum and petroleum products, oils, gas, hydrocarbons, petrochemicals, asphalt, bituminous substances and the products and by- products which may be derived, produced, repaired, developed, compounded, made or manufactured there from and or acquire and take over the running or likely to be running business of alike nature with or without assets, liabilities, rights, privileges, goodwill, registration, trade mark, import and export registration, or any other facilities.

4. To carry on the business of oil and petroleum, fabricate, contract, erect, lay, and manufacturers of plant, machinery and apparatus for oil and petroleum, gas and chemical installations and to purchase or otherwise acquire, produce, manufacture, refine, treat, purify, blend, reduce, distil, store, transport, market, distribute, supply, sell and otherwise dispose off and generally trade in any and all kinds of petroleum and petroleum products.

5. To carry on the business as petroleum engineers, providing consultancy services, preparation of feasibilities for all sorts of petroleum related industries and to manufacture, buy, sell, import, export and to deal in all sorts of oil field equipments.

6. To carry on in or outside Pakistan the business of manufacturers, importers, exporters, indenters, transporters, dealers in all articles and commodities akin to or connected with any of the business of the Company capable of being conveniently carried on or necessary for the promotion of the objects herein contained, as permissible, under law.

7. To carry on the business of construction, erection and maintenance with all its ancillary services for or in respect of power house, bridges, roads, spillways, reservoirs, seaports, water supply, apartments, multi-story flats, business offices, markets, warehouses, industrial and commercial building.

8. To carry on the business of all kind of goods, commodities and merchandise as agents, selling agents, buying agents, publicity agents, brokers, commission agents, indentures, indenting agents, canvassers, advertisers for any person, firms, companies, corporations, government and/ or government sponsored corporations (Including but without prejudice to the said generality and in particular for importers, exporters, buyers, sellers, manufacturers, merchants, tradesmen, and to carry on the business of importers, exporters of all kind of goods commodities and merchandise from and to all countries of the world, and develop business including the appointment of sale agents or representatives in any part of the world.

9. To carry on the business of general order suppliers including Government, Semi-Government Agencies, Armed Forces, Army, Military or Defense and commission agents, indenters, traders and as general merchants, wholesalers, retailers, dealers, distributors, stockiest agents, sub-agents in any goods or products or within the scope of the object of the Company and subject to any permission required under the law.

10. To apply for, tender, offer and accept purchase or acquire any contracts and concessions for or in relation to the projection execution, carrying out improvements, management. administration or control of works and conveniences and undertake, execute, carry out. dispose of or otherwise turn to account the same.

11. To establish and manage branches, zonal, divisional and sub offices and to appoint representatives of the company or its allied associated concerns anywhere in Pakistan or in foreign countries.

12. To go in for, buy or otherwise acquire and use any patent design, copyright, licenses, concession, convenience, innovation, invention, trade marks, or process, rights, or privileges, plants, tools or machinery and the like in Pakistan or elsewhere, which may for the time being appear to be useful or valuable for adding to the efficiency or productivity of the Company's work or business, as permissible under the law.

13. To carry out joint venture agreements with other companies or countries within the scope of the objects of the Company.

14. To import, export, invent, design, develop, produce, manufacture, assemble, test, install, maintain, renovate, refurbish, recondition, utilize operate, manage, acquire, sell, hire out, supply and otherwise deal in plant, equipment and apparatus for the business of the company.

15. To do the business of importing, exporting, simple & heavy machinery, technology uses for the company's business and any other business.

16. To provide for the benefit of other persons consultancy, advisory, training and management services , including but not limited to IT, Finance and Telecom Sectors; concerning or connected with anything that the company does in the exercise of its power or has power to do, or in which the company has gained or developed expertise in the course of its business, and to provide training and educational courses, documentation and material for employees of the company and for other persons in matters which in the opinion of the company and for other persons in matter are connected with, of concern or are of benefit to, the business and activates of the company or which utilize the company's communications systems or services.

17. To pay all costs, charges, and expenses preliminary or incidental incurred in formation or about the promotion and establishment of the Company and to remunerate any person, firm or company for services rendered or to be rendered in or about the formation or promotion of the Company or the conduct of its business.

18. To grant pensions, allowances, gratuities and bonuses to employees of the Company or any of them or the dependants of all or any of the employees and to subscribe to any labor, industrial, charitable or other institutions, clubs, societies and funds.

19. To create any Reserve fund, sinking fund, Insurance fund or any special or other funds whether for depreciation or for repairing, improving, extending or maintaining

any of the property of the Company or for redemption of debentures/ventures or redeemable preference shares or for other purpose or purposes conducive to the interest of the Company.

20. To apply for and obtain necessary consents, permissions and licences from any government, state, local and other authorities for enabling the Company to carry on any of its objects into effect as and when required by law.

21. To distribute all or any of the property of the company among the members in specie or kind but so that no distribution amounting to a reduction in capital is made without sanction of the court where requisite.

22. To do all or any of the above acts and all such acts as are incidental or may be thought conducive to the attainment of the above objects or any of them, and as agents, contractors, trustees or otherwise and either alone or in conjunction with others with the intention that the objects set forth in each of the several paragraphs of this memorandum shall be in no way limited or restricted by reference to or by inference in terms of any other paragraph of this memorandum.

23. It is undertaken that the Company shall not by advertisement, pamphlets or through other means, offer for sale or take advance money for the further sale of plots, houses, flats etc., to the general public or individuals.

24. Notwithstanding anything stated in any object clause, the Company shall obtain such other approval or license from the competent authority, as may be required under any law for the time being in force, to undertake a particular business.

25. It is declared that notwithstanding anything contained in the foregoing object clauses of this Memorandum of Association nothing contained therein shall be construed as empowering the Company to undertake or to indulge in business of banking company, leasing, investment, managing agency, insurance business, any of the NBFC business, multi-level marketing (MLM), Pyramid and Ponzi Scheme, commodity, future contract or share trading business locally or internationally, directly or indirectly as restricted under the law or any unlawful operation.

IV. The liability of the Member is Limited.

V. The Authorize Share Capital of the Company is Rs. 20,00,000/- (Rupees Two Million only) divided into 20.000 ordinary shares of Rs.100/-(Rupees Hundred only) each with powers to the company from time to time to increase and reduce its capital subject to any permission required under the law

We the several persons, whose names and addresses are subscribed below are desirous of being formed into a Company in pursuance of the Memorandum of Association and we respectively agree to take the number of shares in the capital of the Company set opposite to our respective names:-

Name and surname (present & former) in full (in Block Letters)	NIC No. (in case of foreigner, Passport No)	Father's/ Husband's Name in full	Nationality with any former Nationality	Occupation	Residential Address in full	Number of shares taken by each subscriber	Signatures
FIAZ AHMED	61101-1916032-5	HAKIM JAN	PAKISTANI	BUSINESS	MARGALA ROAD, HOUSE 60, SECTOR F-8/2 ISLAMABAD	25	
YOUSAF MEHBOOB KHAN	61101-1916030-3	MEHBOOB ALI KHAN	PAKISTANI	BUSINESS	HOUSE NO 3, STREET NO 1 SECTOR F-6/3 ISLAMABAD	25	
ZAFAR IKRAM SHEIKH	31101-7738774-7	SHEIKH IKRAM UD DIN	PAKISTANI	BUSINESS	HOUSE NO 01 BLOCK 14 BALDIA ROAD BAHAWALNAGAR	26	
SYED HADI ALI RIZVI	42201-6153104-1	SYED ALI AKBAR RIZVI	PAKISTANI	BUSINESS	IBHRAHAM REHMAT ULLAH ROAD HOUSE NO B-81 MOHALLAH K.D.A SCHEME 1-A KARACHI EAST	24	
			Total number of shares to be taken			100	

Dated: The 11th day of March 2013

National Institutional Facilitation Technologies Pvt. Ltd.

5th Floor, AWT Plaza I.I. Chundrigar Road, Karachi, Pakistan

Company Registration Office Islamabad

CERTIFIED TO BE TRUE COPY

Assistant Registrar

No. JRI 192
Dated 5/7/13

THE COMPANIES ORDINANCE, 1984
(COMPANY LIMITED BY SHARES)

ARTICLES OF ASSOCIATION

OF

TRIDENT POWER GR (PVT.) LIMITED

1. **TRIDENT POWER GR (PVT.) LIMITED** is established as a private Company with limited liability in accordance with and subject to the provisions of the Companies Ordinance, 1984 and accordingly the following provisions shall have effect, namely:

   (a) The numbers of the members for the time being of the Company (exclusive of persons who are for the time being in the employment of the Company), is not to exceed to fifty but when two or more persons hold one or more shares in the company jointly they shall, for the purpose of this paragraph, be treated as a single member;

   (b) Any invitation to the public to subscribe for any shares or debentures or debenture stock of the Company is hereby prohibited.

   (c) The right to transfer shares of the Company shall be restricted in manner hereinafter appearing,

2. The regulations contained in Table "A" in the First Schedule to The Companies Ordinance, 1984 shall apply to the Company, subject to the articles hereinafter provided.

INTERPRETATION

3. In these Articles unless there is something in the subject or context inconsistent therewith:

   (i) "The Company" means the above named Company.

   (ii) "The Ordinance" means the Companies Ordinance, 1984, or any statutory modification or re-enactment thereof for time being in force in Pakistan;

   (iii) "The Directors" means the Directors for the time being of the Company or the Directors assembled at a Board;

   (iv) "Month" means a calendar month;

   (v) "The Office" means the Registered Office for the time being of the Company;

   (vi) "The Seal" in relation to a Company means the common Seal of the Company.

   (vii) "Writing" shall include printing and lithography and any other mode or modes representing or reproducing words in a visible form.

(viii) Words importing the singular number only shall include the plural number and vice versa;

(ix) Words importing the masculine gender only shall include the feminine gender;

(x) Words importing persons shall include corporations.

(xi) Subject as aforesaid any words or expressions defined in the Ordinance; shall except where the subject or context forbids bear the same meaning in these Articles.

CAPITAL

4. The Authorize Share Capital of the Company is Rs. 20,00,000/- (Rupees Two Million only) divided into 20,000 ordinary shares of Rs.100/-(Rupees Hundred only) each with powers to the company from time to time to increase and reduce its capital subject to any permission required under the law.

5. The shares shall be under the control of the Directors who may allot or otherwise dispose off the same to such persons, firms or corporation on such terms and conditions and at such times, as they may deem fit.

6. Transfer of shares shall not be made or registered without the previous sanctions of the Directors if registration of shares is refused, the Directors shall within one month from the date when instrument of transfer was lodged send notice of refusal to the transferee and the transferor.

7. An instrument of share transfer must be accompanied by the certificate of shares sought to be transferred thereby.

GENERAL MEETINGS

8. An annual General meeting, of the Company shall be held within eighteen months from the date of it's incorporation and thereafter once at least in every calendar year within four months following the close of its financial year at such time and place as the Directors may determine, provided however, that no greater interval than fifteen months shall be allowed to elapse between two general meetings.

9. The above mentioned meeting shall be called Annual General Meetings. All other general meetings shall be called extraordinary general meeting.

PROCEEDINGS AT GENERAL MEETING

10. At least Twenty-One days' notice of any General Meeting specifying the place, day and the hour of meeting and, in case of special business, the general nature of such business shall be given to members in manner hereinafter mentioned or in such other manner as may from time to time be prescribed by the Company in General Meeting. The accidental omission to give any such notice to or the non-receipt of any such notice by any member shall not invalidate the proceedings at any General Meeting or any resolution passed thereat.

11. The business of an Annual General Meeting shall be to receive and consider the profit and loss account, the balance sheet and the reports of the directors and auditors, to declare dividends, to elect the directors and to appoint and fix the remuneration of, the auditors.

and to transact any other business which under these presents ought to be transacted at an Annual General Meeting and all business transacted at an Extraordinary General Meeting shall be deemed special.

12. Two members present in person who represent not less than twenty five percent of the total voting power either of their own account or as proxies shall constitute quorum for a General Meeting.

13. No business shall be transacted at any General meeting unless the requisite quorum shall be present at the commencement of business.

14. At every General Meeting the Chairman appointed b y the Directors as the Chairman of the Meeting shall take the Chair, but if there be no such chairman or he be not presents within fifteen minutes after the time appointed for the meeting or is unwilling to act as Chairman, the members present shall choose a Director as Chairman and if none of the Directors be present, or willing to act as Chairman, the members present shall choose from one of their members, to be Chairman of the Meeting.

15. If within half an hour from the time appointed for the holding of a General Meeting the requisite quorum be not present, the meeting, if convened on the requisition of or by members, shall be dissolved and in every other case, it shall stand adjourned to the same day in the next week at the same hour and place, and, if at such adjourned meeting the requisite quorum be not present within half an hour from the time appointed for the meeting, two members present in person shall constitute a quorum and may transact the business for which the meeting was called.

16. The Chairman with the consent of the meeting may adjourn any General Meeting from time to time and from place to place but no business shall be transacted at any adjourned meeting other than the business left unfinished at the meeting from which the adjournment took place and which might have been transacted at that meeting.

17. Every question submitted to any General Meeting shall be decided in the first instance by a show of hands and in the case of equality of votes the Chairman shall, both on a show of hands and at the poll have a casting vote in addition to the vote or votes to which he may be entitled as a member.

VOTES OF MEMBERS

18. Upon a show of hands every member holding ordinary shares present in person or by proxy or attorney or in case of corporation under section 162 of the Ordinance shall have one vote except for election of Directors in which case, the provisions of section 178 of the Ordinance shall apply and upon a poll every member present in person or by proxy or attorney or by representative under section 162 of the Ordinance shall have votes proportionate to the paid up value of the shares carrying voting rights held by such member.

19. (a) Votes may be given, either personally or by proxy or attorney or representative subject to the provisions of the Ordinance

(b) No person shall be appointed a proxy who is not a member of the Company and qualified to vote save that a corporation or an organization being a member of

the Company may appoint as its representative any person whether a member of the Company or not. An attorney of a member need not himself be a member.

20. The instrument appointing a proxy, and every power of attorney or other authority (if any) under which it assigned, or a notarially certified copy of that power of authority shall be deposited a the registered office of the Company, not less than 48 hours before the time for holding the meeting. Otherwise the instrument of proxy shall not be treated as valid.

DIRECTORS

21. The number of directors shall not be less than two nor more than nine.

22. The persons hereinafter named shall be the first directors and they shall hold the office upto the First Annual General Meeting.

(1) **FIAZ AHMED**

(2) **YOUSAF MEHBOOB KHAN**

(3) **ZAFAR IKRAM SHEIKH**

(4) **SYED HADI ALI RIZVI**

23. A Director may, with the approval of the directors, by notice in writing under his hand appoint any person to be an alternate director during his absence of not less than three months from Pakistan, and such appointment shall have effect and such appointee, whilst he holds office as an alternate director, shall be entitled to notice of meeting of directors, and to attend and vote thereat accordingly, but he shall ipso facto vacate office if and when the appointer returns to Pakistan or vacates office as Director, or removers the appointee from office by notice in writing under his hand.

24. The Directors shall subject to clause 21 hereof fix the number of Directors to comprise the Board of Directors at least 35 days before the convening of General Meeting at which election of directors is to take place.

25. The directors shall have power to fill a casual vacant but so that the total number of directors shall not at nay time exceed the maximum number fixed in clause 24 hereof. But any Director appointed in a casual vacancy shall hold office only for the remainder of the term of the director in whose place he is appointed and shall then be eligible for re-election.

26. A Director must be a member of the Company except where the director is a nominee of a corporation or an organization, which is a member of the Company.

27. The remuneration of every director shall be such sum not exceeding Rs 500/- for every meeting of the Board attended by him, as may from time to time be fixed by the Board.

28. If any Director being willing is called upon to perform extra services (which expression shall include work done by a Director as a member of any committee formed by the Directors), or to make any special exertion in going or residing abroad or otherwise for any of the purposes of the Company, the directors may remunerate such director as may b determined by the Directors.

29. The continuing directors may act not withstanding any vacancy in their body, but so that if the number falls below the minimum fixed above, the Directors shall not except in emergencies or for the purposes of filling vacancies act so long as the number remains below the minimum.

ELECTION OF DIRECTORS

30. At the first annual general meeting of the Company, the whole of the directors shall retire from office

31. A director shall hold office for a period of three years, unless he earlier resigns, becomes disqualified from being a Director or otherwise ceases to hold office.

32. A retiring director shall be eligible for re-election

33. The company at the annual general meeting at which a director retires in manner aforesaid may fill up the vacated office by electing a person thereto as provided in the Ordinance.

MANAGING DIRECTOR

34.

(a) The directors shall within fifteen days of the incorporation of the Company appoint any individual to be the Chief Executive, hereinafter called the Managing Director, of the company, to hold office till the holding of the first annual general meeting, unless the earlier resigns or otherwise ceases to hold office.

(b) within fourteen days of election of Directors under the preceding Articles or the office of Chief Executive falling vacant, as the case may be as prescribed by section 199 of the Companies Ordinance, 1984, the directors shall appoint any individual, including an elected director, to be the Managing Director of the Company for a period not exceeding three years on such terms and conditions as the Directors deem fit.

(c) On the expiry of the term of his office, the Managing Director shall be eligible for reappointment.

35. The directors of a company by resolution passed by not less than three fourth of the total number of directors for the time being, or the company by a special resolution may remove the managing director before the expiry of his term of office notwithstanding anything contained in the articles or in any agreement between the company and the managing director.

36. The remuneration of Managing Director shall from time to time be fixed by the Directors and may be by way of fixed salary or by any other mode.

37. The directors may from time to time entrust to and confer upon the Managing Director for the time being such of powers as they may think fit and may confer such powers for such time and to be exercised for such objects and purposes and upon such terms and condition s and with such restrictions as they think expedient and may from time to time revoke, withdraw alter or vary all or any of such powers.

PROCEEDINGS OF DIRECTORS

38. The directors may meet together for the dispatch of business, adjourn and otherwise regulate their meetings and proceedings, as they think fit, and may determine the quorum necessary for the transactions of the business. Until otherwise determined two Directors shall be a quorum.

39. A director may, at any time, convene a meeting of directors. A Director who is at any time not in Pakistan shall not during such time be entitled to notice of any such meeting.

40. Questions arising at any meeting shall be decided by a majority of votes, and in case of an equality of votes, the Chairman shall have a second or casting vote.

41. The directors may elect as chairman of their meetings and determine the period for which he is to hold office; and unless otherwise determined, the chairman shall be elected annually. If no such chairman is elected, or if at any meeting the chairman is not present within ten minutes after the time appointed for holding the same or is unwilling to act as chairman, the directors present shall choose one of their numbers to be chairman of the meeting.

42. A meeting of directors for the time being at which a quorum is present shall be competent to exercise all or any of the authorities, powers and discretions by or under the Articles of the Company for the time being vested in or exercisable by the directors generally.

43. The Directors may delegate any of their powers not required to be exercised in their meeting to committees consisting of such member or members of their body as they think fit and may from time to time revoke such delegation. Any committee so formed shall in the exercise of the powers delegated, conform to any restrictions that may from time to time be imposed upon it by the Directors.

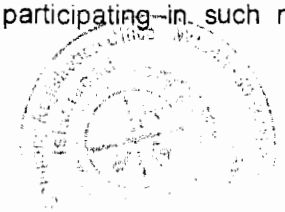
44. The meeting and proceedings of any such committee of two or more members shall be governed by the provisions herein contained for regulating the meetings and proceedings of the directors so far as the same are applicable thereto, and are not superseded by any regulations made by the directors under the last preceding clause.

45. All acts done by any meeting of the Directors or by a committee of directors or by any person acting as a director shall notwithstanding that it shall afterwards be discovered that there was some defect in the appointment of such directors or persons acting as aforesaid or that they or any of them were disqualified be as valid as if every such persons had been duly appointed and was qualified to be a director.

46. A resolution in writing signed by all the directors for the time being present in Pakistan, shall be valid and effectual as if it had been passed at a meeting of the directors duly called and constituted.

MINUTES

47. (a) The directors shall cause a fair and accurate summary of the minutes of all proceedings of general meetings and meetings of its directors and committee of directors, along with the names of those participating in such meetings, to be entered in properly maintained books.



(b) Any such minutes of any general meeting, or of any meeting of the directors or of any committee of the directors if purporting to be signed by the Chairman of such meeting, or by the chairman of the next succeeding meeting shall be receivable as prima facie evidence of the matter stated in such minutes.

POWERS OF DIRECTORS

48. The management of the business of the company shall be vested in the directors, and the directors may exercise all such powers and do all such acts and things as the company is by its articles of association or otherwise authorized to exercise and do and are not hereby or by statute directed or required to be exercised or done by the Company in general meeting, but subject nevertheless to the provisions of the Companies Ordinance, 1984 or to any of these presents and regulations being not inconsistent with the aforesaid provisions, as may from time to time be prescribed by the company in general meeting provided that no regulations made by the company in general meeting shall invalidate any prior act of the directors which would have been valid if such regulation had not been made.

BORROWING POWERS

49. The Directors may from time to time raise or borrow any sums of money for and on behalf the company from the members or other persons, Companies, firms or banks or they may themselves advance money to the company on such terms as may be approved by the directors.

50. The directors may raise and secure payment of such sum or sums of money in such manner and upon such terms and conditions in all respects as they think fit, and in particular by the issue of debentures or bonds or by mortgage or charge of all or any part of the property of the company.

THE SEAL

51. The directors shall provide for the safe custody of the seal and the seal shall never be used except by the authority of the Directors or a committee of directors previously given and in the presence of two directors who shall sign every instrument to which the seal is affixed.

ACCOUNTS

52. The directors shall cause true accounts to be kept in such form as they may decide for sums of money received and expended by the company and the mattes in respect of which such receipt and expenditure take place and of all sales and purchases of goods by the company and of the assets, credits and liabilities of the Company.

53. The books of account shall be kept at the registered office of the company or at such other place or places as the directors think fit.

54. The directors shall, from time to time, determine whether and to what extent and at what times and places, under what conditions or regulations the accounts and books of the company or any of them shall be opened to the inspections of the members (not being a director) and no member not being a director shall have any right of inspecting any account or book or document of the company except as conferred bylaw or authorized by the directors or by a resolution of the company in a general meeting.

AUDIT

55. Once at least in every year the accounts of the Company shall be examined and the fairness of profit and loss account and balance sheet ascertained by one or more auditor or auditors.

56. The first auditor of the company shall be appointed by the directors.

NOTICES

57. (a) A notice may be given by the company upon any member either personally or by sending it by post to him to his registered address or (if he has no registered address in Pakistan) to the address, if any, within Pakistan supplied by him to the company for the giving of notices to him.

(b) Where a notice is sent by post, service of the notice shall be deemed to be effected by properly addressing, prepaying and posting a letter containing the notice unless the contrary is proved, to have been effected at the time at which the letters would be delivered in the ordinary course of post.

58. Each holder of registered share whose registered place of address is not in Pakistan may from time to time notify in writing to the Company an address in Pakistan which shall be deemed his registered place or address within the meaning of the last preceding clause.

WINDING UP

59. If the company shall be wound up, whether voluntarily or otherwise the liquidator may, with the sanction of a special resolution, divide amongst the contributories in specie or kind, any part of the assets of the Company and may with the like sanction, vest any part of the assets of the Company in trustees upon such trusts for the benefit of the contributories, or any of them as the liquidator with the like sanction shall think fit.

INDEMNITY

60. Every director, manager, auditor, secretary, chief accountant and other officer or servant of the company shall be indemnified by the company against, and it shall be the duty of the directors out of the funds of the company to pay all costs, losses and expenses which any such officer or servant may incur or become liable to by reason of any contract entered into or thing done by him as such officer or servant or in any way in the discharge of his duties and the amount for which such indemnity is provided shall immediately attach as a lien on the property of the Company and have priority as between the members over all other claims.

No director, auditor or other officer of the company shall be liable for the acts, receipts, neglect or default of any other director or officer or for joining in any receipt or other act for conformity or for any loss or expenses happening to the company through the insufficiency or deficiency of title to any property acquired by order of the directors for or on behalf of the company or for the insufficiency or deficiency of any security in or upon which any of the money of the company shall be invested or for any loss or damage arising from bankruptcy, insolvency of any person with whom any moneys, securities or effects shall be deposited or for any loss occasioned by any error of judgment or oversight on his part or for any other damage or misfortune whatever which shall happen in the execution of the duties of his office or in relation thereto unless the same happens through his own dishonesty.

AUDIT

55. Once at least in every year the accounts of the Company shall be examined and the fairness of profit and loss account and balance sheet ascertained by one or more auditor or auditors.

56. The first auditor of the company shall be appointed by the directors.

NOTICES

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No director, auditor or other officer of the company shall be liable for the acts, receipts, neglect or default of any other director or officer or for joining in any receipt or other act for conformity or for any loss or expenses happening to the company through the insufficiency or deficiency of title to any property acquired by order of the directors for or on behalf of the company or for the insufficiency or deficiency of any security in or upon which any of the money of the company shall be invested or for any loss or damage arising from bankruptcy, insolvency of any person with whom any moneys, securities or effects shall be deposited or for any loss occasioned by any error of judgment or oversight on his part or for any other damage or misfortune whatever which shall happen in the execution of the duties of his office or in relation thereto unless the same happens through his own dishonesty.

We the several persons, whose names and addresses are subscribed below are desirous of being formed into a Company in pursuance of the Article of Association and we respectively agree to take the number of shares in the capital of the Company set opposite to our respective names:-

Name and surname (present & former) in full (in Block Letters)	NIC No. (in case of foreigner, Passport No)	Father's/ Husband's Name in full	Nationality with any former Nationality	Occupation	Residential Address in full	Number of shares taken by each subscriber	Signatures
FIAZ AHMED	61101-1916032-5	HAKIM JAN	PAKISTANI	BUSINESS	MARGALA ROAD, HOUSE 60, SECTOR F-8/2 ISLAMABAD	25	
YOUSAF MEHBOOB KHAN	61101-1916030-3	MEHBOOB ALI KHAN	PAKISTANI	BUSINESS	HOUSE NO 3, STREET NO 1 SECTOR F-6/3 ISLAMABAD	25	
ZAFAR IKRAM SHEIKH	31101-7738774-7	SHEIKH IKRAM UD DIN	PAKISTANI	BUSINESS	HOUSE NO 01 BLOCK 14 BALDIA ROAD BAHAWALNAGAR	26	
SYED HADI ALI RIZVI	42201-6153104-1	SYED ALI AKBAR RIZVI	PAKISTANI	BUSINESS	IBHRAHAM REHMAT ULLAH ROAD HOUSE NO B-81 MOHALLAH K.D.A SCHEME 1-A KARACHI EAST	24	
			Total number of shares to be taken			100	

Dated: The 11th day of March 2013

National Institutional Facilitation Technologies Pvt. Ltd.

5th Floor, AWT Plaza I.I. Chundrigar Road, Karachi, Pakistan

CERTIFIED TO BE TRUE COPY

No. JRI

Dated

Assistant Registrar
Company Registration Office
Islamabad

PARTICULARS OF DIRECTORS AND OFFICERS, INCLUDING THE CHIEF EXECUTIVE, MANAGING AGENT, SECRETARY, CHIEF ACCOUNTANT, AUDITORS AND LEGAL ADVISERS, OR OF ANY CHANGE THEREIN

THE COMPANIES ORDINANCE, 1984

[SECTION 205] FORM 29

1 Incorporation Number

2 Name of Company: TRIDENT POWER GR (PVT) LIMITED

3 Fee Paid (Rs.): 600 Name and Branch of Bank: ISLAMABAD MCB - Islamabad Stock Exchange [1390]

4 Receipt No: E-2013-146335 15/03/2013

5 Mode of Payment (Indicate): Bank Challan

6. Particulars*:

6.1. New Appointment/Election

Present Name in Full (a)	NIC No. or Passport No. in case of Foreign National (b)	Father / Husband Name (c)	Usual Residential Address (d)	Designation (e)	Nationality** (f)	Business Occupation*** (if any) (g)	Date of Present Appointment or Change (h)	Mode of Appointement / change / any other remarks (i)
FIAZ AHMED	61101-1916032-5	S/O HAKIM JAN	MARGALA ROAD HOUSE NO 60 SECTOR F-8/2 ISLAMABAD ISLAMABAD	Director	Pakistan	BUSINESS	Since Incorporation	
SYED HADI ALI RIZVI	42201-8153104-*	S/O SYED AKBAR ALI RIZVI	IBRAHIM REHMAT ULLAH ROAD HOUSE NO B-81 MOHALLAH K D A SCHEME 1-A KARACHI EAST	Director	Pakistan	BUSINESS	Since Incorporation	
YOUSAF MEHBOOB KHAN	61101-1916030-3	S/O MEHBOOB ALI KHAN	HOUSE NO 3, STREET NO 1 SECTOR F-6/3 ISLAMABAD ISLAMABAD	Director	Pakistan	BUSINESS	Since Incorporation.	
ZAFAR IKRAM SHEIKH	35101-7738724-*	S/O SHEKH IKRAM UD DIN	HOUSE # 01 BLOCK 14 BALDIA ROAD BAHAWALNAGAR BAHAWALNAGAR Punjab Pakistan 62300	Director	Pakistan	BUSINESS	Since Incorporation.	

6.2. Ceasing of Officer/Retirement/Resignation

Present Name in Full (a)	NIC No. or Passport No. in case of Foreign National (b)	Father / Husband Name (c)	Usual Residential Address (d)	Designation (e)	Nationality** (f)	Business Occupation*** (if any) (g)	Date of Present Appointment or Change (h)	Mode of Appointement / change / any other remarks (i)

6.3. Any other change in particulars relating to columns (e) to (g) above

Present Name in Full (a)	NIC No. or Passport No. in case of Foreign National (b)	Father / Husband Name (c)	Usual Residential Address (d)	Designation (e)	Nationality** (f)	Business Occupation*** (if any) (g)	Date of Present Appointment or Change (h)	Mode of Appointement / change / any other remarks (i)

Name of Signatory: YOUSAF MEHBOOB KHAN Designation: Director

Signature of Chief Executive/Secretary

Date (DD/MM/YYYY): 15/03/2013

CERTIFIED TO BE TRUE COPY

Assistant Registrar
Company Registration Office
Islamabad

No. PPDB/ 377 /2016

PUNJAB POWER DEVELOPMENT BOARD

ENERGY DEPARTMENT

Irrigation Secretariat, Old Anarkali, Lahore
(Ph: 042-99213879 Fax: 042-99213885)

Date: 21 / 03 /2016

M/s SPEC Energy DMCC
House # 56, Main Nazimuddin Road
Islamabad

Subject: **LETTER OF INTEREST (LOI) FOR DEVELOPMENT OF 7.55 MW HYDROPOWER PROJECT ON LOWER CHENAB CANAL (LCC) AT RD. 0 + 000, DISTRICT GUJRANWALA**

The Evaluation of Statement of Qualification (SOQ) submitted by M/s SPEC Energy DMCC, for 7.55 MW Raw Site HPP on Lower Chenab Canal (LCC) at RD. 0 + 000, District Gujranwala (the "Project") has been considered by PPDB Board during its 33rd meeting held on 18th November 2015 as per eligibility criteria laid down in the Punjab Power Generation Policy-2006 (Revised-2009) (the "Policy") and Pre-Qualification Documents (PQD) issued to your company.

2. After due diligence, the Board has unanimously decided to issue Letter of Interest (the "LOI"), with four (4) months compressed timeline for completion of the Feasibility Study, to the Consortium comprising of following members:

(i)	**SPEC Energy DMCC**	**Main Sponsor**
(ii)	UNIK Fabrics (Pvt.) Ltd.	Member
(iii)	Trans Tech Pakistan	Member
(iv)	Automotive Spares and Accessories (Pvt.) Ltd.	Member

3. In response to this Office letter No. PPDB/126/2016 dated 27.01.2016, your Company has submitted the Bank Guarantee # LG-08160020 amounting to Rs. 790,485/- (Rupees Seven Hundred & Ninety Thousand Four Hundred and Eighty Five only), issued on February 11, 2016 with the expiry date of January 10, 2017, by Askari Bank Limited, AWT Plaza, The Mall, Rawalpindi, in the name of M/s Trans Tech Pakistan.

4. Now, this LOI is being issued on behalf of Government of the Punjab (the "GoPb"), in terms of the provisions of the Policy. GoPb hereby confirms its interest in your proposal to conduct the feasibility study for the development of the Project subject to the following:

a. You are required to complete the Feasibility Study of the Project, at no risk and cost to, and without any obligation on the part of, the GoPb / PPDB and its agencies, within four (4) months from the date of issuance of this LOI.

b. You will not disturb the irrigation regime.

c. You will be provided with the available data / information regarding feasibility study of the Project. You are required to conduct the Feasibility Study; complete, at

internationally acceptable standards and in accordance with the terms and conditions stipulated in the Policy. The updated Feasibility Study must include an Environmental Impact Assessment Study, detailed design of power house, load flow and stability studies, design of interconnection / transmission lines, details pertaining to infrastructure, project cost, financing and, financing terms, tariff calculations and assumptions of financial calculations including economic / financial analysis. You are advised to liaise with the power purchaser while determining your plant size and site, project layout, transmission line and interconnection arrangements, etc.

d. You will carry out the Feasibility Study according to the specific milestones appended herewith at **Annex-A,** and submit monthly progress reports showing progress against these milestones.

e. You will establish a Special Purpose Vehicle (SPV) company and shall maintain the shares in this company in accordance with Para 39 & 40 of the Policy and will submit copy of Memorandum & Articles of Association as well as the Form 29 duly attested by the Securities & Exchange Commission of Pakistan (SECP). The shareholding in the said SPV must be reflected in accordance with the submitted SOQ.

f. PPDB will appoint a Panel of Experts (POE) to monitor the progress of Feasibility Study, verify attainment of the aforesaid milestones and to ensure implementation of the Project consistent with national and provincial needs.

g. The Main Sponsor will be liable for all obligations and liabilities of and on behalf of other Sponsors. Further processing of the Feasibility Study is subject to acceptance of GoPb in accordance with the Policy.

h. The validity of this LOI is four (4) months from the date of its issuance, where after, it will automatically be lapse with immediate effect. Issuance of this LOI or the lapsing of its validity, or your conducting a Feasibility Study there under, cannot form the basis of any claim for compensation or damages by the Sponsors or the project company or any party claiming through them against the GoPb / PPDB or any of its agencies, employees or consultants on any grounds whatsoever, during or after the expiration of its validity.

i. You are, therefore, required to complete the Feasibility Study for the said Project within the validity of this LOI. In case there is delay in completion of the Feasibility Study within the validity of this LOI, a one-time extension by PPDB Committee may be granted up to a maximum period of thirty (30) days, provided the Panel of Experts is satisfied that the Feasibility Study is being conducted in a satisfactory manner and is likely to be completed shortly. Furthermore, extension in validity of the LOI will only be provided upon submission of a bank guarantee in **double the original amount and valid beyond 180-days of the extended LOI period**.

j. **In case, you fail to meet the relevant milestones and standards, PPDB will terminate this LOI and encash the Bank Guarantee due to non-performance.**

k. This LOI has been issued in duplicate on the date hereof, and it shall come into effect when one copy hereof is received by PPDB after having been duly countersigned by you. Nevertheless, this LOI shall lapse if the countersigned copy is not received at PPDB within five (05) days of its issuance.

Regards,

SANIYA AWAIS
Managing Director

Accepted and agreed for & on behalf of:

Signature: _____

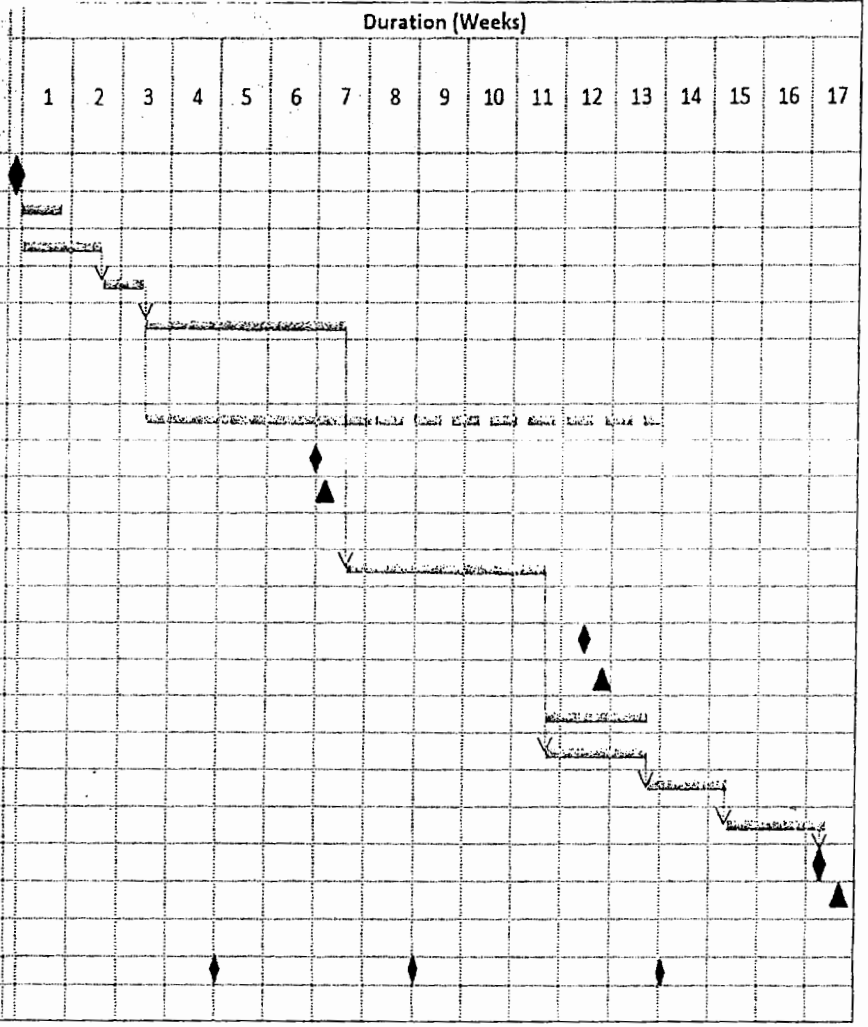
Date: _____

ENCL: *As stated above*

CC:

1. The Chairman, NEPRA, Islamabad
2. The Secretary to Chief Minister Punjab, Lahore
3. The Chairman WAPDA, WAPDA House Lahore
4. The Secretary, Ministry of Water & Power, Islamabad
5. The Chief Executive Officer, Central Power Purchasing Agency (CPPA), Islamabad
6. The Chairman PPDB Board / Additional Chief Secretary, Government of the Punjab, Energy Department, Lahore
7. The Managing Director, Private Power & Infrastructure Board (PPIB), Islamabad
8. The Chairman, Government of the Punjab, Planning & Development Department, Lahore
9. The Secretary, Government of the Punjab, Energy Department, Lahore
10. The Secretary, Government of the Punjab, Irrigation Department, Lahore
11. The Secretary, Government of the Punjab, Environement Protection Department, Lahore
12. The Chief Executive Officer, Gujranwala Electric Power Company (GEPCO), Gujranwala
13. The Chief Engineer (Power), Government of the Punjab, Energy Department, Lahore
14. The Chief Engineer, Irrigation Zone, Faisalabad
15. The Chief Executive Officer, Punjab Power Development Company (PPDCL), Lahore

Sr. No.	Activities	Dates (2016)	Time (Days)
1	Issuance of LOI	21-Mar	
2	Acceptance/Return of LOI	26-Mar	5
3	Procurement of Consultants	31-Mar	10
4	Mobilization of Consultants	5-Apr	5
5	Update Hydrological Data, Geology, Geo-technical, Seismicity,Topographic Survey & Power Potential study	5-May	30
4	Update Interconnection & IEE Study	25-May	50
6	POE Meeting	2-May	1
8	Issuance of Minutes of meeting	3-May	1
9	Selection of Final Layout, Sizing of HPP, Optimization of Selected Layout & Finalization of Feasibility Level Design	4-Jun	30
10	POE Meeting	11-Jun	1
11	Issuance of Minutes of meeting	12-Jun	1
12	Construction Planning & Project Cost Estimate	19-Jun	15
13	Economic & Financial Analysis	19-Jun	15
14	Draft Feasibility Report & Review of POE	29-Jun	10
15	Final Feasibility Report Submission	14-Jul	15
16	Meeting/Approval by POE	14-Jul	1
17	Issuance of Minutes of meeting	19-Jul	1
	Progress Reports		
	Monthly Reports		
	Total Days		120



21.3.16

No. PPDB/ 553 /2016
PUNJAB POWER DEVELOPMENT BOARD
ENERGY DEPARTMENT
Irrigation Secretariat, Old Anarkali, Lahore
(Ph: 042-99213879 Fax: 042-99213885)

Date: 01 / 3 /2016

M/s Trident Power GR (Pvt.) Limited
359-H, Street # 4, Phase-V, DHA
Lahore

Subject: **ISSUANCE OF LETTER OF INTEREST (LOI) FOR DEVELOPMENT OF 7.55 MW HYDROPOWER PROJECT ON LOWER CHENAB CANAL (LCC) AT RD. 0 + 000, DISTRICT GUJRANWALA**

A Letter of Interest (the "LOI") was issued vide this office letter No. PPDB/377/2016 dated 21.03.2016 with four (4) months compressed timeline for completion of the Feasibility Study, to the Consortium comprising of following members,

(i)	**SPEC Energy DMCC**	**Main Sponsor**
(ii)	UNIK Fabrics (Pvt.) Ltd.	Member
(iii)	Trans Tech Pakistan	Member
(iv)	Automotive Spares and Accessories (Pvt.) Ltd.	Member

2. In accordance with the stipulations of Para-4(e) of the said LOI, your Company has recently submitted the Special Purpose Vehicle (SPV) in the name of **M/s Trident Power GR (Private) Limited**, having Memorandum and Articles of Association.

3. In this regard, it is intimated that in future, all the official correspondence will be made in the name of **M/s Trident Power GR (Private) Limited**.

Regards,

Managing Director
Punjab Power Development Board

CC:
1. The Chairman, NEPRA, Islamabad
2. The Chairman WAPDA, WAPDA House Lahore
3. The Secretary, Ministry of Water & Power, Islamabad
4. The Chief Executive Officer, Central Power Purchasing Agency (CPPA), Islamabad
5. The Chairman PPDB Board / Additional Chief Secretary, Government of the Punjab, Energy Department, Lahore
6. The Managing Director, Private Power & Infrastructure Board (PPIB), Islamabad
7. The Secretary, Government of the Punjab, Energy Department, Lahore
8. The Secretary, Government of the Punjab, Irrigation Department, Lahore
9. The Secretary, Government of the Punjab, Environement Protection Department, Lahore
10. The Chief Executive Officer, Gujranwala Electric Power Company (GEPCO), Gujranwala
11. The Chief Engineer (Power), Government of the Punjab, Energy Department, Lahore
12. The Chief Engineer, Irrigation Zone, Faisalabad
13. The Chief Executive Officer, Punjab Power Development Company (PPDCL), Lahore

No. PPDB/ 377 /2017

PUNJAB POWER DEVELOPMENT BOARD

ENERGY DEPARTMENT

Irrigation Secretariat, Old Anarkali, Lahore
(Ph: 042-99213879 Fax: 99213875)

Date: 07 / 03 /2017

M/s Trident Power GR (Pvt.) Limited
359-H, Street # 4, Phase-V, DHA
Lahore

Subject: **APPROVAL OF FEASIBILITY STUDY REPORT OF 7.55 MW HYDROPOWER PROJECT ON LOWER CHENAB CANAL (LCC) AT RD. 0 + 000, DISTRICT GUJRANWALA**

A letter of Interest (LOI) was issued to M/s Trident Power GR (Pvt.) Limited (the "Sponsor") for development of 7.55 MW Hydropower Project on Lower Chenab Canal (LCC) at RD. 0+000, District Gujranwala (the "Project") in accordance with the Punjab Power Generation Policy-2009 (the "Policy") with the compressed timelines of four (4) months for completion of Feasibility Study Report (the "FSR"). The Panel of Experts (POEs), comprising of following members, was appointed by PPDB to monitor, review and approve the FSR of the Project being developed by the Sponsor:

1) The Managing Director, Punjab Power Development Board (PPDB), Lahore
2) The Managing Director, Private Power & Infrastructure Board (PPIB), Islamabad
3) Dr. Engineer Javed Yunas Uppal, Chairman EPDC, Lahore
4) The Chief Executive Officer, Gujranwala Electric Power Company (GEPCO), Gujranwala
5) The Project Director, Punjab Power Management Unit (PPMU), Lahore
6) The Superintending Engineer, LCC (East) Circle, Irrigation Department, Faisalabad

2. After thorough review of the FSR, the POE, vide its meeting held on 23rd August 2016, approved the said FSR subject to approval of Initial Environmental Examination Report (IEE) from Environment Protection Agency (EPA) and approval of Interconnection Study from Gujranwala Electric Power Company (GEPCO). During the meeting, the Sponsor submitted the undertaking to opt for upfront tariff. POE members shall certify the duly filled Performa (Annex-II) regarding net annual plant factor to apply for NEPRA's Upfront Tariff for Small Hydropower Generation Projects, notified by GoP, Ministry of Water & Power on March 28, 2016 (hereinafter refer to as "Upfront Tariff"). The POEs resolved that:

a. *The Feasibility Study Report of 7.55 MW Hydropower Project on Lower Chenab Canal (LCC) at RD. 0+000, District Gujranwala has been approved unanimously by POE subject to submission of approvals of IEE and Interconnection Study from the relevant Authorities.*

b. *In the final version of feasibility study report, the Sponsor shall include the undertaking that they unconditionally accept NEPRA's upfront tariff.*

c. *Prior to implementation of the Project, the sponsor is required to confirm the detailed design of the Project through Model Study at Irrigation Research Institute (IRI), Nandipur. The Sponsor shall also obtain NOC from Irrigation Department.*

3. The Sponsor has submitted the approval of IEE from EPA vide their letter dated 07.02.2017 and approval of Interconnection Study from GEPCO vide their letter dated 16.02.2017. Since the above conditions have been met with, the FSR of the Project stands approved.

4. In view of the above and relevant stipulations of the Policy, the Sponsor is required to approach National Electric Power Regulatory Authority (NEPRA) for grant of Generation License and acceptance of NEPRA's Upfront Tariff. The Upfront Tariff application must be in accordance with the terms & conditions of NEPRA's notified Upfront Tariff for Small Hydropower Generation Projects. A copy of duly signed & stamped complete set of final FSR is being enclosed herewith.

5. PPDB appreciates the Sponsor's efforts towards completion of FSR and hopes that the same pace and spirit would be kept by the Sponsor for timely completion of the Project to meet the energy needs of the country.

Regards,

SANIYA AWAIS
Managing Director

ENCL: *Complete set of stamped & signed Final Feasibility Study Report*

CC:

1. The Chairman PPDB Board / Additional Chief Secretary, Government of the Punjab, Energy Department, Lahore
2. The Managing Director, Private Power & Infrastructure Board (PPIB), Islamabad
3. The Chief Executive Officer, Gujranwala Electric Power Company (GEPCO), Gujranwala
4. The Project Director, Punjab Power Management Unit (PPMU), Lahore
5. Dr. Engr. Javed Yunas Uppal, Chairman EPDC, 1-A, Aibak Block, Garden Town Lahore
6. The Superintending Engineer, LCC (East) Circle, Irrigation Department, Faisalabad

No. PPDB/ 388 /2017
PUNJAB POWER DEVELOPMENT BOARD
ENERGY DEPARTMENT
Irrigation Secretariat, Old Anarkali, Lahore
(Ph: 042-99213879 Fax: 042-99212796)

Date: 08/03/**2017**

Annexure – I

National Electric Power Regulatory Authority,
Islamabad

Hydropower Project (HPP) on Lower Chenab Canal (LCC) at RD. 0+000, District Gujranwala

1. We hereby recommend Trident Power GR (Pvt.) Limited, for grant of uptront tariff, as approved by the National Electric Power Regulatory Authority *vide* its determination dated October 14, 2015, for its Hydropower Project of 7.55 MW installed capacity to be located on Lower Chenab Canal (LCC) at RD. 0+000, District Gujranwala.

2. We further confirm that our Panel of Experts has provided a certificate regarding net annual plant factor of Trident Power GR (Pvt.) Limited for its Hydropower Project of 7.55 MW installed capacity to be located on Lower Chenab Canal (LCC) at RD. 0+000, District Gujranwala on the prescribed format which is enclosed for consideration of the Authority.

Regards,

SAMAA AWAIS
Managing Director

ENCL: *As stated above*

Annexure – II

Date: March 07, 2017

The Registrar,
National Electric Power Regulatory Authority,
Islamabad

SUBJECT: - Certificate Regarding Annual Plant Factor

A Panel of Experts appointed by **Punjab Power Development Board (PPDB)**, in respect of small hydropower project of **M/s Trident Power GR (Pvt.) Limited**.

2. Based on the proposed installed capacity and long term historical hydrological site data, our findings are as follows:

1	Name of the company	M/s Trident Power GR (Pvt.) Limited
2	Project Location / Address	Lower Chenab Canal (LCC) at RD. 0+000, Left Bank River Chenab, District Gujranwala
3	Design Discharge	250 m^3/sec
4	Gross head [meters]	3.6
5	Net head [meters]	3.5
6	Gross plant installed capacity [MW] - **A**	7.5 MW
7	Auxiliary consumption @ 1% - **B**	0.4415 GWh/annum
8	Net plant installed capacity [MW] - **C = A - B** (to be used for computation of net annual plant factor)	7.425 MW
9	Net deliverable energy per annum [GWh] - **D**	43.71 GWh/annum
10	Net annual plant factor based on net deliverable energy [(D x 1,000) / (C x 24 x 365) x 100]	66.53%

Monthly benchmark hydrology [m^3/s]:

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Average
80.7	88.1	142.1	161.2	186.3	225.6	232.2	217.7	214.9	159.9	159.9	162.5	**169.26**

Monthly benchmark net deliverable energy [GWh]

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
3.87	1.78	3.22	3.55	4.2	5.02	5.26	4.89	4.88	3.56	3.59	3.69	**45.51**

3. We hereby confirm that the net annual plant factor as detailed above may be used for allowing upfront tariff, to the aforesaid company for the project site detailed above.

Mr. Munawar Iqbal
Director (Hydel)
Private Power & Infrastructure Board (PPIB)
Government of Pakistan

Dr. Engineer Javed Yunas Uppal
Chairman
Engineering Project Development Consultants

Representative of Project Director
Punjab Power Management Unit (PPMU)
Energy Department

Representative of Chief Executive Officer
Gujranwala Electric Power Company (GEPCO)

Representative of Superintending Engineer
LCC East Circle, Irrigation Department,
Faisalabad

Superintending Engineer
Lower Chenab Canal East Circl
Faisalabad

NOTE: "Due to nature of data and resultant conclusion as described in the Feasibility Study of the Project, POE jointly and/or individually will not be responsible for reliability of data contents and its conclusion."

GUJRANWALA ELECTRIC POWER COMPANY LIMITED

055-9200519-26
x: 055-9200594
mail:cedevgepco@gmail.com

OFFICE OF CHIEF EXECUTIVE OFFICER, GEPCO LTD.
565-A MODEL TOWN GEPCO HEADQUARTERS G.T.ROAD GUJRANWALA
PROJECT MANAGEMENT UNIT

). 6493-97

Dated : 15/02/2017

Mr. Tariq Mahmood
General Manager
Trident Power GB (Pvt) Limited

Sub: REVISED GRID INTERCONNECTION STUDY FOR 7.55MW LOWER CHENAB (LCC) HYDRO POWER PROJECT, KHANKI, DISTRICT GUJRANWALA, PUNJAB

Ref: Your office letter dated 09-02-2017

It is communicated that the captioned interconnection studies (Load Flow analysis, Short Circuit analysis, Dynamic and Transient Stability analysis) carried out by M/S Power Planners International letter have been re-viewed by PMU Directorate GEPCO. All the existing and proposed substations & Power Plants in the vicinity of 7.55MW Lower Chenab (LCC) Hydro Power Project, Khanki, have been modeled in the study. The dispersal of 7.55MW Power from captioned Power Plant through 3No. 11kV Feeders with Osprey Conductor (9km length) fulfills the requirements i.e.

(i) Voltage : ± 5% of Nominal Voltage

(ii) 3No. 11kV Feeders with Osprey Conductor (9km length) are adequate for dispersal of 7.55MW power under normal & N-1 contingency conditions.

(iii) With 7.55MW Lower Chenab (LCC) Hydro Power Project, the fault levels at existing grid stations will not exceed the rating of already installed circuit breakers.

(iv) The system remains stable under 3-Phase & Single Phase fault conditions.

(Muhammad Riaz)
Chief Engineer (Development)
GEPCO, Gujranwala

C:

(i) The General Manager (Operation) GEPCO for information please.
(ii) Chief Engineer (P&E) GEPCO for information please.
(Marketing & Tariff) GEPCO for information.

NO. DD (EIA) EPA/E-370(IEE)/1412/2016
Dated 26/01/2017

[illegible]
[illegible] Executive Officer,
Orient Power (Pvt.) Limited,
[illegible] 259-H, Street # 1, Phase-5, DHA, Lahore Cantt.

[illegible]

APPROVAL OF EPA PUNJAB FOR THE PROJET "CONSTRUCTION OF 7.55-MW LOWER CHENAB CANAL HYDROPOWER PROJECT, GUJRANWALA"

[illegible] of Project	Construction of 7.55-MW Lower Chenab Canal Hydropower Project.
[illegible]cation of Project	New Khanki Barrage Tensil Wazirabad District Gujranwala.
[illegible] of filing of IEE	09.06.2016

2. EPA Punjab has reviewed the Initial Environmental Examination Report (IEE) and considered Site Inspection Report received from Deputy Director / Ex-District Officer (Environment), Gujranwala vide letter No. 544/DOE/GRW dated 22.08.2016. EPA Punjab has also considered the recommendations of Committee of Experts (Meeting dared 23.11.2016), recommendations of EA Committee (Meeting dated 14.12.2016) and other relevant record.

3. **Environmental Protection Agency, Punjab accords approval for construction / installation of your aforesaid project subject to the following conditions:**

i. The proponent shall ensure compliance of Punjab Environmental Quality Standards (PEQS).

ii. Mitigation Measures suggested in the IEE report and Environmental Management Plan (EMP) shall be strictly adhered to minimize any negative impacts on soil, ground water, air and biological resources of the project area.

iii. Monitoring shall be carried out during the entire period of the project activities. Monitoring reports of the whole operation shall be submitted to EPA, Punjab on quarterly basis.

iv. Camping sites shall be located at suitable distance away from any settlement to avoid disturbance to the local people. Sewage generated from camping sites shall be treated in septic tanks.

v. The proponent shall take measures to control dust and the area around the project site shall be kept clean.

vi. The proponent shall ensure efficient health and first aid treatment facilities for protection of workers.

vii. The proponent shall plant at least 10000 trees of minimum height 6-7 feet in consultation with the Deputy Director / Ex-District Officer (Environment) under intimation to this office.

viii. The proponent shall do proper landscaping after completion of the project.

ix. The construction material shall be piled / stored in such a way that it shall not destroy the flora / environment of the locality.

x. The proponent shall care about noise issues during construction and operation stage of the project.

xi. The objections / complaints of the locals / stakeholders (if any) shall be redressed on priority basis.

xii. The proponent shall provide compensation to the inhabitants in case of loss of agricultural land, crop, property, etc. in accordance with the rates that are agreed upon. All conflicting issues regarding compensation, etc. shall be settled amicably before the start of the project activities.

xiii. The proponent shall submit comprehensive map of the area showing each and every component of the project.

xiv. The proponent shall adopt all mitigation measures on scientific basis to minimize the effects on nearby community from the project activities.

xv. The proponent shall provide details of nearest human settlement and comprehensive layout of road network surrounding the project site.

xvi. The proponent shall provide the ultimate disposal of wastewater.

xvii. The proponent shall obtain NOC / clearance from all other concerned departments before commencement of work.

P.T.O

xviii. The proponent shall appoint Environmental Manager (having relevant qualification and experience) for the project and shall convey his name along with his complete Mailing Address and Phone Numbers.

xix. Arrangements shall be made for safe disposal of solid and hazardous waste. The solid waste shall be retained within the unit boundary / premises and shall be disposed off in an environmental friendly way at a suitable disposal facility.

xx. The proponent shall ensure that strict and efficient health and safety measures are in place for protection of the workers in case of any environmental emergency and these measures are backed by a comprehensive emergency response system.

xxi. At least 90% unskilled and to the extent possible skilled jobs shall be given to locals after providing them proper training.

xxii. The proponent shall ensure all necessary measures for the protection of sensitive / protected areas in the vicinity.

xxiii. The proponent shall prepare a Community Development Plan and implement it for the benefit of communities of the project area.

xxiv. The proponent shall provide a copy of IEE Report and this letter to the contractors for its implementation letter and spirit.

xxv. The proponent shall restore the environment of the area after completion of the project.

xxvi. The proponent shall follow the SOPs regarding dengue larvae eradication and shall ensure removal of stagnant water on daily basis.

xxvii. The proponent shall submit Environmental audit report of actual versus perceived / assessed impacts to EPA Punjab after completion of construction.

xxviii. This approval can be withdrawn at anytime without any prior notice if deem necessary in the public / national interest.

6. The proponent shall be liable for correctness, exhaustiveness and validity of information supplied to this department by the environmental consultant.

7. The proponent shall be liable for compliance of Regulations 13, 14, 18 and 19 of IEE/EIA Regulations, 2000, regarding approval, confirmation of compliance, entry, inspections and monitoring.

8. This approval is accorded only for the construction phase of the project. The proponent shall apply for confirmation of compliance under Regulation 14 of IEE / EIA Regulation, 2000 by submitting Environmental Management Plan for operational phase along with compliance status report of the Environmental Approval of the construction phase of the project.

9. Any change in the approved project shall be communicated to EPA, Punjab and shall be implemented after obtaining the approval.

10. This approval shall be treated as null and void if all or any of the conditions mentioned above, is are not complied with. This approval does not absolve the proponent of the duty to obtain any other approval or consent that may be required under any law in force and is subjudice to legal proceedings in any legal fora / court.

11. This approval shall be valid (for commencement of construction) for a period of three years from the date of issue under Regulation 17 of IEE / EIA Regulations, 2000.

ASSISTANT DIRECTOR (EIA)
for Director General, EPA, Punjab
Ph: # 042-99232282

NO. & DATE EVEN.

A copy is forwarded to the Deputy Director / Ex-District Officer (Environment), Gujranwala w.r.t. his letter No. 544/DOE/GRW dated 22.08.2016. He is requested to ensure compliance of the conditions mentioned in the Environmental Approval and to furnish compliance status report accordingly.

ASSISTANT DIRECTOR (EIA)
for Director General, EPA, Punjab

From:

The Executive Engineer
Khanki Division LCC (E)
Khanki

To:

The Superintending Engineer
Lower Chenab Canal, East Circle
Faisalabad

No _____/40-MII Dated _____/2017

SUBJECT: ***IRRIGATION DEPARTMENT OWNED LAND ON LEASE FOR 7.55 MW HYDRO POWER PROJECT ON LOWER CHENAB CANAL AT RD 0+000 DISTRICT GUJRANWALA.***

Reference: Your office endorsement No.587/528-M dated 24-01-2017.

It is submitted that Deputy Collector, Khanki Division has submitted detailed report on the subject noted above vide letter No.04 dated 27-02-2016 which is self explanatory (copy attached). As per revenue record, Khasra No.29 (680 Kanal, 4 Marla) is the ownership of Irrigation Department and is right of way of Lower Chenab Canal. This Area cannot be handed over permanently, however the same can be leased out in case of dire necessity of the company with the following terms and conditions:-

1. The land can only be leased out on temporary basis and the operating agency will be bound to return the possession of the land as and when required by the Irrigation Department.
2. In case Irrigation Department wants to take over the said land in future for its own use, the Energy Department shall be bound to remove their infrastructure from the said land.
3. In case, any damage to infrastructure of 7.55 MW Hydropower Project due to any mishap of Canal System, Irrigation Department neither will be responsible nor pay any kind of compensation to the Energy Department.
4. Lease of land amount will be assessed by the District Price Assessment Committee Gujranwala and will be paid by the operating agency "Energy Department" to the Irrigation Department in advance.
5. The operating agency will be responsible for the payment of cost of any type of losses so occurred to the canal system, structures or adjacent public / private property during construction or operation.

Following documents are attached herewith:-

i. Photo copy of Deputy Collector, Khanki Division letter No. 04 dated 27-02-2017.
ii. Dasti Khaka (map) of proposed land / site.

The report is submitted as desired for your kind information and further necessary action please.

D.A
As above

Executive Engineer
Khanki Division LCC (E)
Khanki

1.1 INTRODUCTION

God has blessed Pakistan with a tremendous hydel potential of more than 60,000 MW. However, only 15% of the hydroelectric potential has been harnessed so far. The remaining untapped potential, if properly exploited, can effectively meet Pakistan's ever-increasing demand for electricity in a cost-effective way.

High head sites exist in hilly areas and Low head hydropower sites are located at barrages, and small falls in large rivers and artificial canals which can be utilized to develop energy. All these low head hydropower projects have very little or no negative impact on the environment and social life in the area. The most significant feature of all these projects is that they are practically emission-free and help to curb global warming, since they replace thermal power in the power supply systems. In addition country will save lot of foreign exchange by reducing import of costly fuel by utilizing environmental friendly Hydel energy.

During the last two & half decades more thermal power stations have been added to the system than development of hydel power stations, which resulted in increase in power tariff. To achieve target of meeting power demand at an affordable cost of generation, the installation of new hydel power plants is important and necessary. From this point of view, Punjab Power Development Board (PPDB) (a subsidiary of Punjab Energy Department), was established by the Government of Punjab to invite private sponsors for the development of low head hydropower projects in Punjab and fully assist them in all matters of project implementation. The LCC Hydropower Project is being proposed for development.

This chapter includes the summary of necessary studies done for the evaluation of available power and energy potential of the LCC Hydropower Project.

1.2 BACKGROUND

Pursuant to "Punjab Power Generation Policy 2006 (Revised 2009)", the Punjab Power Development Board (PPDB) invited the private firms/consortium for the development of 11 No. Raw sites Hydropower Projects in May, 2015. On the basis of prequalification documents submitted by private firms/consortium, PPDB issued a Letter of Intent (LOI) to M/s Trident Power GR (Pvt.) Ltd on March 22, 2016 for the

development of Hydropower Project on Lower Chenab Canal (LCC) utilizing head available at head regulator of LCC at RD 0+000. M/s Trident Power GR (Pvt.) Ltd engaged the services of M/s Aipel Consultants on April 07, 2016 for review and updating the Feasibility Study and Initial Environmental Examination (IEE) of LCC Hydropower Project. The feasibility study is being furnished in the light of available discharge data for the last twenty five years, available topographic layout information and geotechnical investigations carried out earlier by NESPAK and NKB (New Khanki Barrage) Consultants.

1.3 LOCATION & ACCESS TO THE PROJECT SITE

1.3.1. Access by Road

The proposed LCC Hydropower Project site is located at the left bank of Chenab River about 17 km south-east of Wazirabad which is connected to the port at Karachi through a network of highways including the main G.T.road. The approach to site from Wazirabad is through Wazirabad – Saroki / Alipur Chatha –Khanki road. The location map of proposed LCC Hydropower Project site is shown in **Figure – 1.1**.

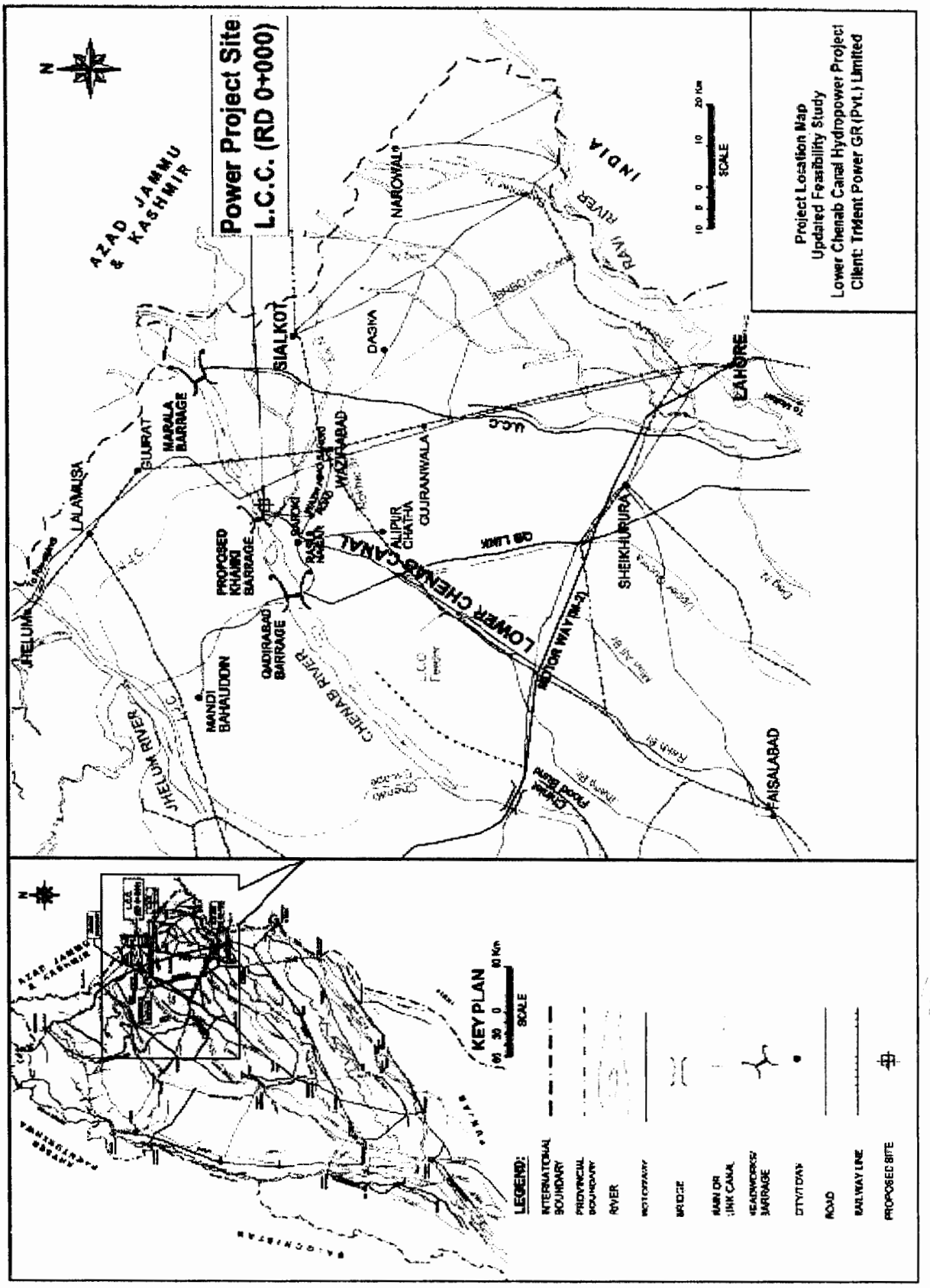
1.3.2. Access by Rail

The nearest railway station is Khanki Kacha on the Sialkot – Faisalabad line. Wazirabad is the nearest railway station on Karachi – Peshawar main railway line.

1.3.3. Access by Air

Sialkot International Airport, about 50 km north-east of the site, is the nearest airport. However the major international airport is the Allama Iqbal International Airport, in Lahore, about 160 km from the site, where many international airlines operate commercially.

Figure – 1.1: Location map of proposed LCC Hydropower Project Site



1.4 PREVIOUS STUDIES

1.4.1. Study by WAPDA-GTZ (1992)

In 1992, WAPDA in association with GTZ, prepared an inventory of potential sites on canals, and barrages for hydropower development in Pakistan. The report assessed the power and energy estimates for various low head hydel power sites which identified the fall at the LCC head regulator as a potential site. In the assessment study, gauge and discharge data for the period 1978-87 were used for estimating the water availability and gross head. The gauge and flow data pertained to the post-Tarbela and pre Water Apportionment Accord (WAA) of 1991. Design discharge of the canal for assessing the hydropower potential, was taken from longitudinal section of the canal prepared by the PID. Full supply discharge of 231 m^3/sec (8,158 ft^3/s) downstream of the canal fall was selected as preliminary design discharge and a net head of 2.63 m (8.63 ft) was used for calculating the maximum power potential of 4.95 MW.

1.4.2. New Khanki Barrage Project (2008)

Hydropower potential at the LCC regulator was also studied by the Punjab Barrage Consultants. A design discharge of 246.4 m^3/sec (8,700 ft^3/sec) was considered for power potential based on flow duration curve developed using 10-day historic discharge data for the period 1994-2003. Net head for power potential was computed using the upstream pond level at EL 224 m (735 ft) and constant tail water level at EL 220.4 m (723 ft). The increase in head was proposed by shifting of the canal fall at Chenawan at RD 40+200 of LCC to the head regulator of the LCC.

The net head for power generation was thereby increased to 4.9 m (16 ft). The proposed arrangement for power house at LCC required feeding of two canals, presently off taking from Chenawan regulator, directly from Khanki barrage through a separate feeder channel. The installed capacity of 10.5 MW was worked out with an average annual energy of 52 GWh. The hydropower scheme was subsequently dropped from the new Khanki barrage project and a new head regulator at Chenawan fall had since been constructed.

1.4.3. Pre-Feasibility/Ranking Study by NESPAK (2010)

In 2010, NESPAK carried out pre-feasibility / ranking study of (10) potential power generation sites on canals and barrages of the Punjab Irrigation system (Task-I). The site at the head of LCC was among the sites studied. The pre-feasibility/ranking study comprised selection of preferred layout, preliminary design of the scheme, environmental and social impacts assessment, costing, construction scheduling and determining the 'economic internal rate of return' (EIRR) and unit generation costs for each site.

This study was based on the hydrological data since the Water Apportionment Accord (WAA) of 1991. The study concluded that the power generation site at the head of LCC has good potential and ranked this site (with new Khanki Barrage) as one of the top five ranked schemes for hydropower development.

1.4.4. Feasibility Study by NESPAK (2011)

During the second stage (Task-2), the feasibility studies of five (5) top ranked schemes (identified in the Task-I) were carried out by NESPAK. Among 5 top ranked power generation sites, the feasibility study of LCC Hydropower Project at RD 0+000 of was completed by NESPAK in 2011. The feasibility study envisaged installed capacity of 7.55 MW with an average annual energy of 43.61 GWh. It was proposed that the powerhouse shall be equipped with two Kaplan units and, shall be constructed in a separate canal to be proposed between the New LCC and existing LCC.

On April 07, 2016, M/s Aipel Consultants was awarded the consultancy agreement for review and updating the Feasibility Study and Initial Environmental Examination (IEE) of LCC Hydropower Project.

1.5 EXISTING SITE CONDITIONS & CONSTRUCTION OF NEW KHANKI BARRAGE

At present, Project Management Office (PMO, Barrages) of the Punjab Irrigation Department, Government of Punjab is executing the construction of New Khanki Barrage (900 feet downstream of the existing headworks), which will cause the dismantling of the existing headworks and LCC. Accordingly the New LCC Regulator has been constructed and it is expected that New LCC shall be commissioned in October, 2016.

1.5.1. Existing LCC Head Regulator

There are two head regulators of the Lower Chenab Canal (LCC). The main head regulator consisting of 12 bays is adjacent to the existing Khanki headworks and was a part of its original construction. The subsidiary head regulator, constructed subsequently, consists of 6 bays located on left side of the main head regulator. **Figure-1.2 & 1.3** shows the upstream and downstream views of the regulators.

Figure – 1.2: Upstream View of Existing LCC Head Regulators

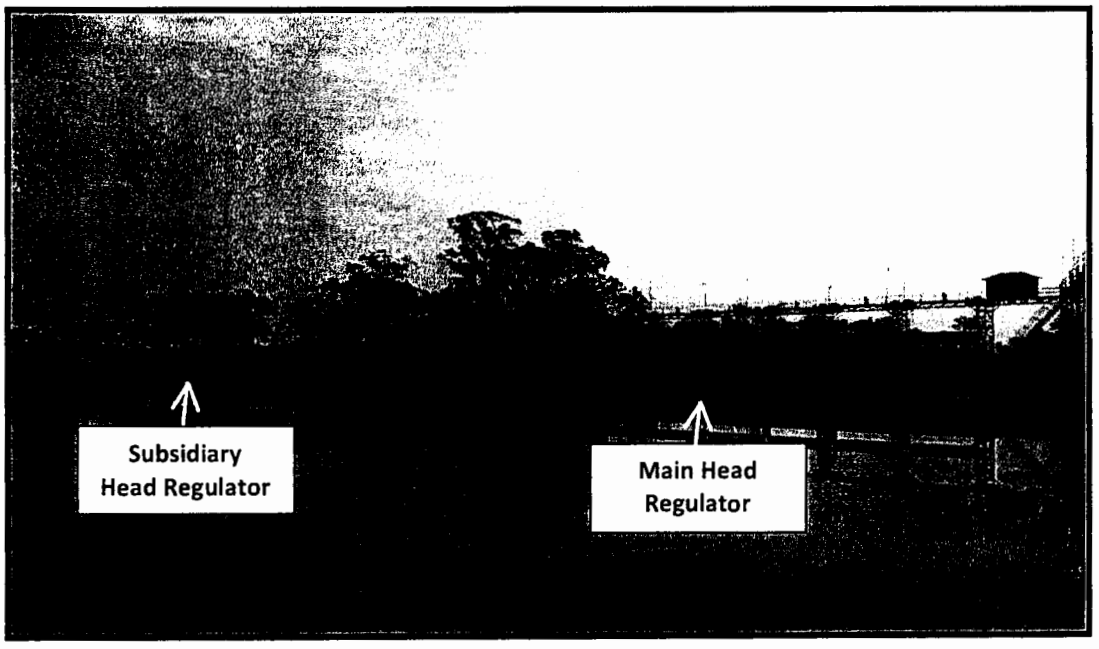
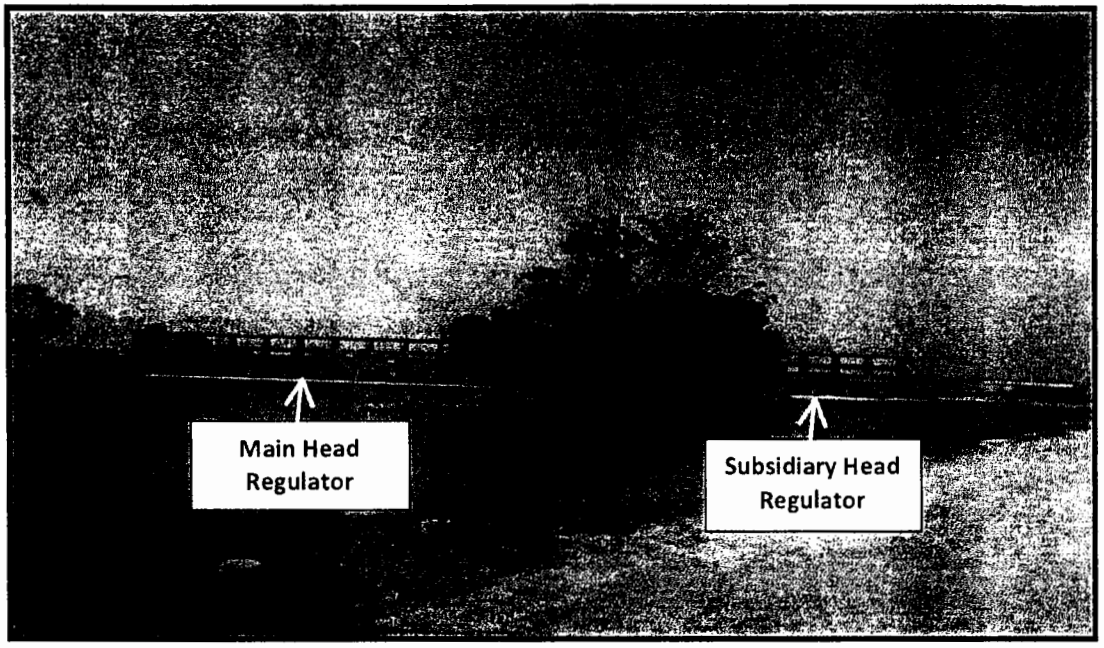


Figure – 1.3: Downstream View of Existing LCC Head Regulators



1.5.2. New LCC Head Regulator

A new LCC Head Regulator at RD 0+000 is under construction by Punjab Irrigation Department and 95% of the its civil and electromechanical works have been completed. This new head regulator comprised of 6 bays having width of 30 ft. each. On the commissioning of Lower Chenab Canal (LCC) which is expected in October 2016, the existing LCC head regulators shall be dismantled. **Figure-1.4 & 1.5** shows the upstream and downstream view of new under construction LCC head regulator.

Figure – 1.4: Upstream View of Under Construction New LCC Head Regulator

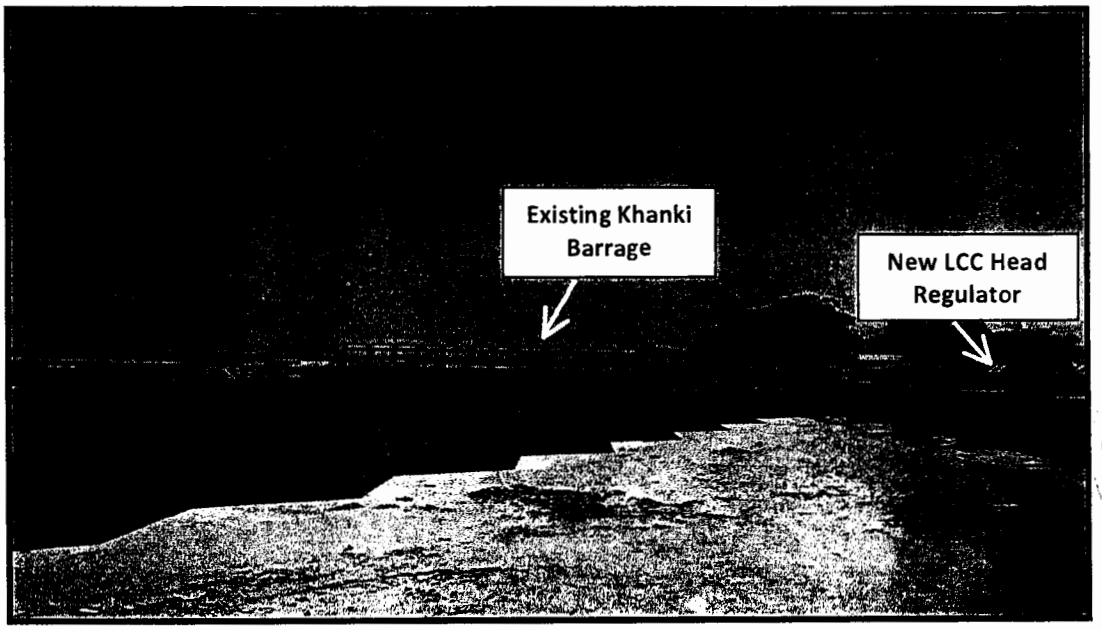
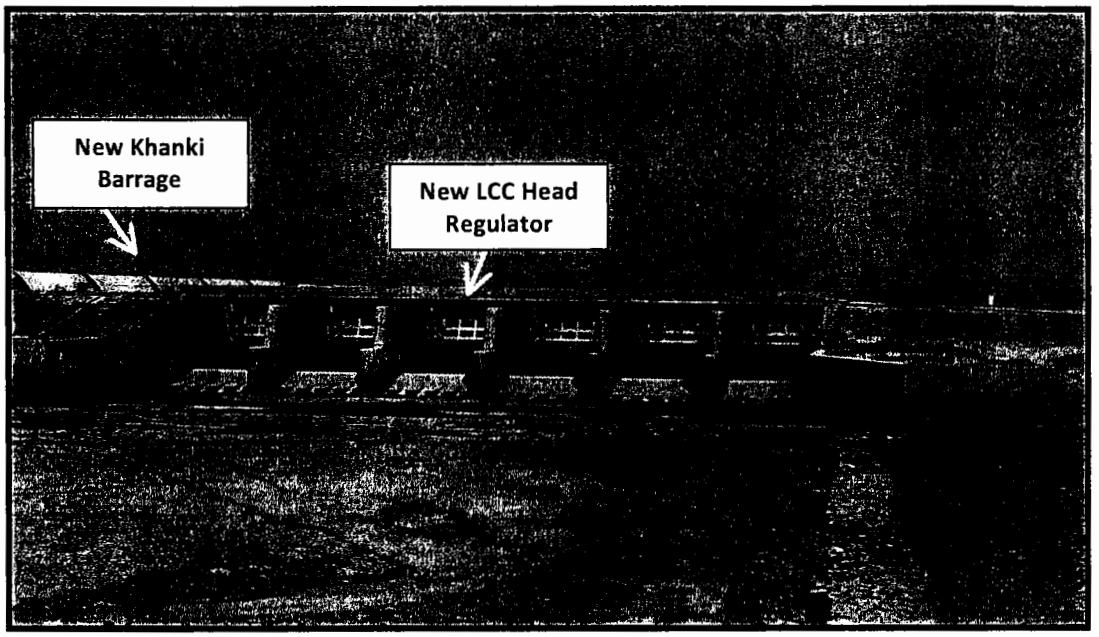


Figure – 1.5: Downstream View of Under Construction New LCC Head Regulator



1.6 NEED FOR AN UPDATED STUDY

The earlier studies were conducted with the idea that the powerhouse at LCC RD 0+000 shall be constructed during the construction of New Khanki Barrage and the alternatives were furnished accordingly. Besides this, only two power generating units were suggested for powerhouse. However, it is believed that two units may not be practicable for the leading European manufacturers for such low heads and high discharges. Secondly, in order to avoid extensive care & handling of water and complex construction methodology, a revised project layout with simpler construction methodology is recommended. Furthermore, previous studies did not consider efficient measures for canal bed load which is required to be given due importance. A need for an updated and bankable feasibility study for the said hydropower scheme was envisaged by PPDB incorporating the latest prevailing prices of civil works and selection of appropriate power generating units.

1.7 CLIMATE

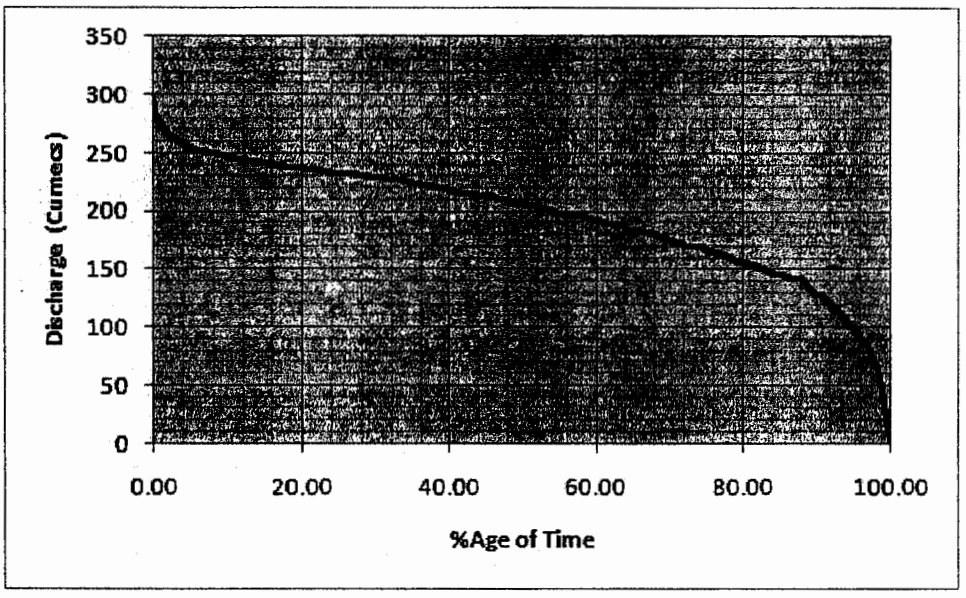
The mean annual rainfall of the area is about 1045 mm (41 inches). The maximum rainfall occurs during the months of July, August and September, which is about 70% of the annual rainfall. Precipitation in the project area is characterized by the monsoon season. Most of the rainfall occurs during the monsoon season (May to

October). Winter rains generally occur during the months of January, February and March.

1.8 HYDROLOGY AND DISCHARGE OPTIMIZATION

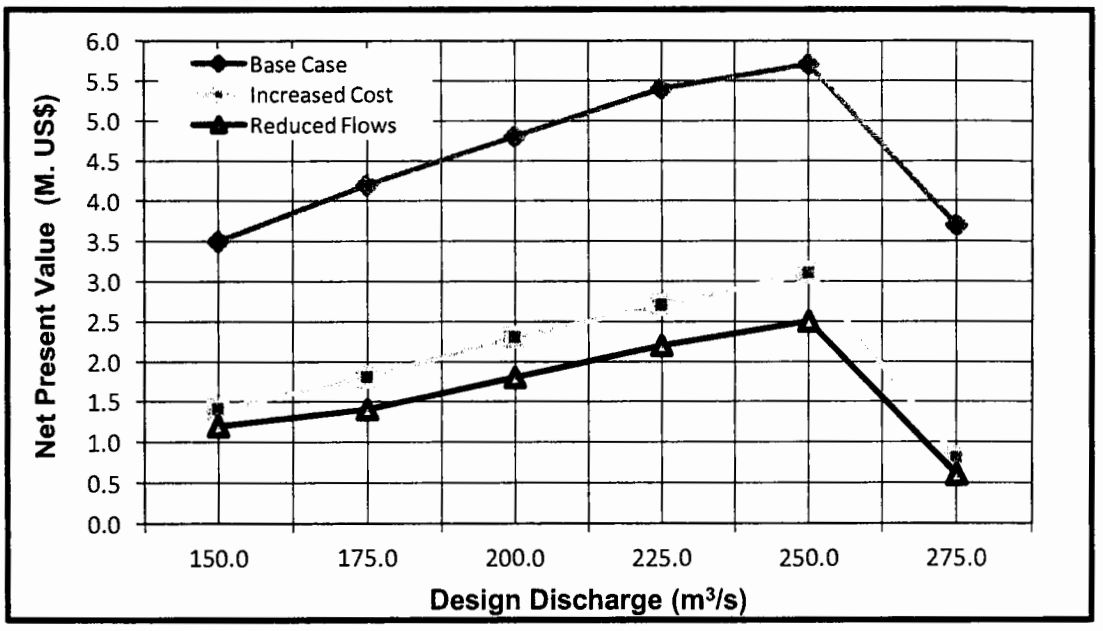
LCC off-takes from the left bank of Khanki Barrage. The canal was commissioned in 1892. At present, construction of New Khanki Barrage and New LCC Regulator is also in progress. Discharge data since 1991 is considered and the flow duration curve is provided in Figure 1.6 below:

Figure 1.6: Flow Duration Curve



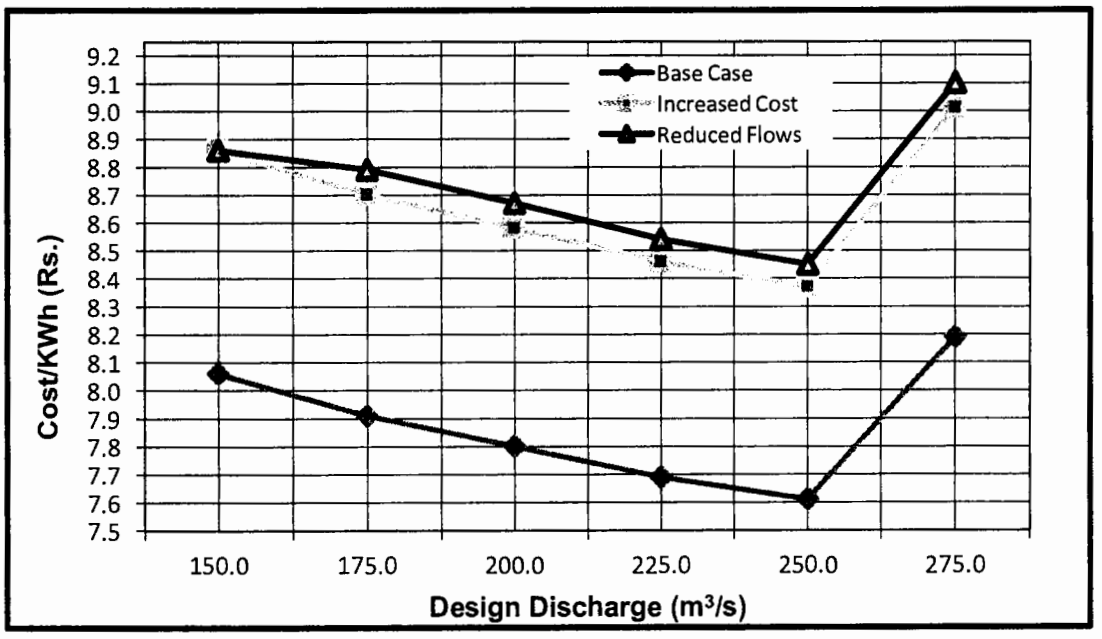
With power and energy values, benefits and costs have been estimated for design discharges ranging from 150 m^3/s to 275 m^3/s. Three scenarios have been analyzed to check the sensitivity of selected capacity. These three scenarios include the selection of discharge after its comparison with Net Present Value (NPV), Cost/KWh and Benefit to Cost Ratios (BCR) respectively.

Figure - 1.6: NPV vs Design Discharge Curve



Similarly, the unit cost vs discharge curves are drawn for above mentioned three scenarios and are presented in **Figure - 1.7**.

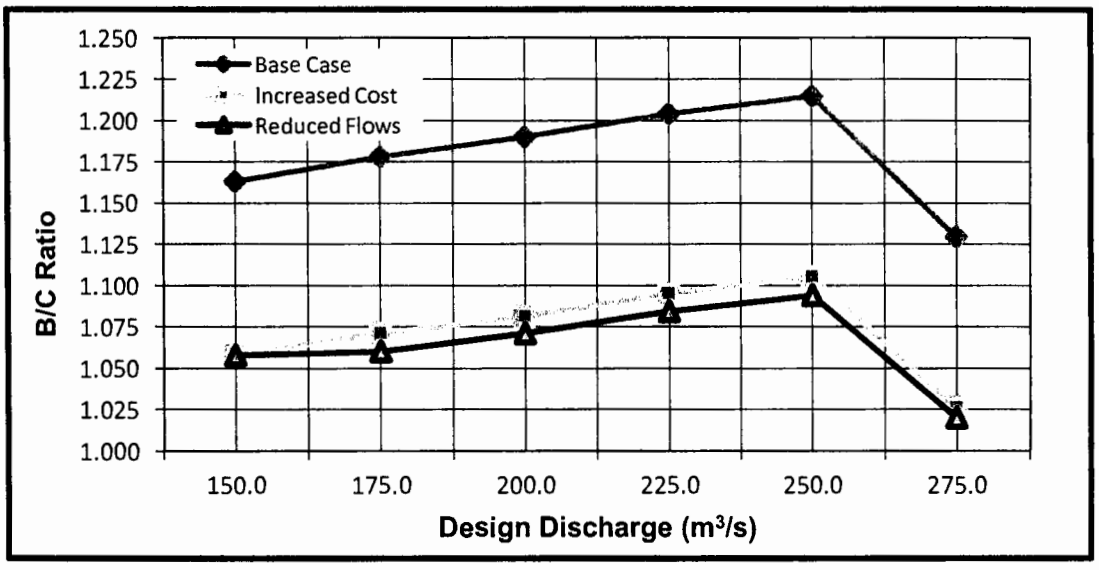
Figure - 1.7: Cost/kWh vs Design Discharge Curve



The graph indicates that unit cost for all the three scenarios decreases to minimum and then it increases again. The analysis for all the three scenarios indicates that unit cost/KWh is minimum for the design discharge of 250 m^3/s. Benefit to cost ratio

has also been checked for various discharges. The B/C ratio vs. discharge curves are drawn for above mentioned three scenarios and is presented in **Figure - 1.8**.

Figure - 1.8: B/C Ratio vs Design Discharge Curve



The graph indicates that B/C ratio increases to maximum for a discharge of 250 m^3/s and then it decreases for higher discharge. All the three scenarios indicate that B/C ratio is maximum at design discharge of 250 m^3/s.

From all the three scenarios, it can be concluded that NPV is in maximum range for a design discharge of 250 m^3/s. From the analysis, it can be inferred that the project would provide maximum net benefits when discharge is 250 m^3/s.

1.9 GEOTECHNICAL AND GEOLOGICAL STUDY

The top surface of the Project area comprises of Clayey Silt/Silty Clay/Lean Clay (Soft to Very Stiff) up to a depth of 7.0 m below NSL. The material is underlain by Sandy Silt/ Silty Sand (Very Soft to Very Stiff, Dense to Very Dense) up to a maximum investigated depth of 20 m depth below NSL.

The Groundwater was encountered at 5.60 m depth in the boreholes drilled up to a maximum depth of 20 m below NSL.

The arrival time of shear waves and longitudinal waves at each successive meter are obtained from seismic records with source at a distance of 1.0 meter. The interpreted

results of Seismic Investigations at BH-2 indicate that shear wave velocity ranges between 103 m/sec to 543 m/sec and compressional wave velocity varies between 228 m/sec to 910 m/sec up to 20 m depth.

1.10 INITIAL ENVIRONMENTAL EXAMINATION

The LCC Hydropower Project seems to be environment friendly. It has minimal environmental impacts. Environmental considerations have formed an integral part of the evaluation of layout and design alternatives with the result that all the potential effects of the project have been mitigated. The proposed project layout plan does not involve any permanent land acquisition or resettlements.

1.11 ALTERNATIVES AND PROJECT COMPONENTS

The following two alternatives options have been considered:

Alternative 1: Construction of power plant within New LCC at RD 1+500

Alternative 2: Construction of power plant in separate canal off-taking upstream of New LCC

It is expected that New LCC Regulator shall be commissioned in October, 2016.

It is proposed that powerhouse should be constructed within the main canal at RD 1+500 and an illustrative layout of this alternative is provided as Drawing No. LCC-HEPP-FS-18. The canal banks shall be raised on both sides from RD 0+000 up to the powerhouse which will allow the utilization of available head at RD 0+000 for power generation at RD 1+500. In this scenario, the canal will follow its original regime and there will be minimum disturbance to the hydrological behavior of the canal. The main canal shall be diverted temporarily during canal closure and coffer dams shall be constructed on upstream and downstream of the proposed powerhouse at the confluence of diversion and main canal. Therefore, construction works of the power plant can be executed independently without disturbing the canal operations. A spillway catering the same discharge capacity as of LCC head regulator is proposed alongside the powerhouse within the main canal in order to safely manage the canal operations during emergency shutdown of the power plant.

The Hydropower Project utilizes a net head of 11.5 ft. available at the Regulator / fall structure at RD 0+000. The New Regulator at RD 0+000 shall be de-activated meaning thereby the gates will always be fully open. The discharge shall be regulated by the downstream spillway gates and power generating units as it will regulate with much better efficiency. The Regulator at RD 0+000 of New LCC shall only be activated in case of flood condition in the reservoir in order to avoid flood levels in the canal.

1.12 SELECTION OF TURBINE

As per the available head of 11.5 ft. at the proposed project site, it is recommended to install Kaplan Type Horizontal Turbines. Major parameters of selected unit are mentioned in Table-1.1.

Table – 1.1: Turbine Characteristics

Design or Rated Net head	3.5 m
Design or Rated Discharge	250 m^3/s
Rated turbine output	1.95 MW
Turbine speed	90.5 rpm
Generator speed	750 rpm
Specific speed	869.9
Runaway speed	254 rpm
Runner diameter	3642 mm
Number of runner blades	3
Runner weight	13042 kg
Inlet height	8.47 m
Hydraulic thrust	10450 kg
Number of units	4
Installed capacity	7.5 MW
Average Net Deliverable Energy / Year	43.71 Gwh

1.13 POWER AND ENERGY ESTIMATION

Power and energy estimation is furnished on the basis of the following:

- Net head is 11.5 ft. (3.5m)
- Design discharge is 8827 cusecs. (250 m3/s)
- Installed capacity of LCC Hydropower Plant is 7500 KW which gives us average annual energy of 43.71 GWh.
- Plant capacity factor is 66.53 %.

1.14 CONSTRUCTION PLANNING & MANAGEMENT

The LCC Hydropower Project is planned to be constructed in a period of36 months. This includes Civil, Electro-mechanical, Transmission and Interconnection works from installation to commissioning. Special consideration should be given to the critical tasks related to the canal closure and schedule delivery of Turbines, Generators & other E&M equipment to site.

1.15 PROJECT COST ESTIMATION

Rates being charged at the Construction of New Khanki Barrage including escalation up to year 2015 have been considered. Cost of electromechanical equipments has been considered from European origin. Total EPC Cost as mentioned in Table 11.1 above is PKR 2,461,709,999 and the same has been considered for financial analysis.

1.16 ECONOMIC ANALYSIS

The Economic indicators namely (i) EIRR at 10%, 12% and 14% discount rates is Rs. 552,793,431.75, Rs. 268,124,912.10 and Rs. 62,621,893 respectively.

1.17 FINANCIAL ANALYSIS

A detailed financial analysis is carried out from the investor's point of view. Total project cost including the interest during construction is PKR 2,461,709,999.

Operation and maintenance cost has been considered during the thirty years including fixed & variable costs, water charges and insurance costs. Tariff structure is encountered as per 2002 Power Policy of Government of Pakistan and the results of analysis provide us a Leveliezed Tariff of 12.15 Rs/kWh which is outstanding under the circumstances. We have also considered a debt service in terms of loan from the banks and return on equity has been calculated accordingly as per NEPRA rules and regulations. However, the Sponsor has decided to opt for the Nepra's approved upfront tariff dated 14th October, 2015. Therefore, all prevailing norms forming upfront tariff has been considered.

IRR of the project is 12.59%. The evaluation criterion is to accept the project if it generates positive NPV and higher IRR than the discount rate proposed by sponsor of the project. Therefore, Sensitivity analysis is conducted to decide the acceptability of the project. The project has capacity to bear unexpected adverse changes in cost and revenue. The project can be developed as per NEPRA's upfront tariff.

1.18 CONCLUSIONS

- The construction of the Power Plant at RD 1+500 within New LCC (Main Canal) provides us maximum power and energy. It involves the simpler construction methodology also.

- The installed capacity of the Power Plant is 7500 KW and mean annual energy is 44.15 GWh. The electricity shall be sold to National Grid.

- The Project is economically feasible and has the capacity to offset adverse change in variable and generate economic benefits. It offers good return for diverting scarce resources.

- This can easily be developed in accordance to NEPRA's upfront tariff.

nepra	**LCC Hydropower Project Details of Generation Facility Schedule - IV**	TRIDENT

A. GENERATION BUSINESS INFORMATION

(i)	Name of Company / Licensee	Trident Power GR (Private) Limited.
(ii)	Registered Office	Suit # 8, Ground Floor, Evacuee Trust Complex, F-5/1, Islamabad
(iii)	Business Address	House # 359 H, Street # 4, Phase V, DHA Lahore

B. TYPE AND LOCATION

(i)	Type of Generation Facility	Hydropower Plant / Run of Canal
(ii)	Location of Generation Facility	Lower Bari Doab Canal at RD 260+000, Okara Cantt in the Province of Punjab, Pakistan
(iii)	Expected life of Facility from COD	30 Years
(iv)	Tentative Commissioning & Operation Date	15th November, 2019 (Tentative)

C. WATER SOURCE

(i)	Stream / Tributary / Canal	Lower Chenab Canal (LCC), District Gujranwala in the Province of Punjab, Pakistan

D. MAIN DESIGN FEATURES

(i)	Plant Design Discharge	250 Cumecs
(ii)	Gross Head	3.6 meter
(iii)	Net Head	3.5 meter
(iv)	Installed Capacity	7.5 MW
(v)	Plant Factor	66.53%

E. PROJECT MAJOR COMPONENTS

TRIDENT POWER (PRIVATE) LIMITED

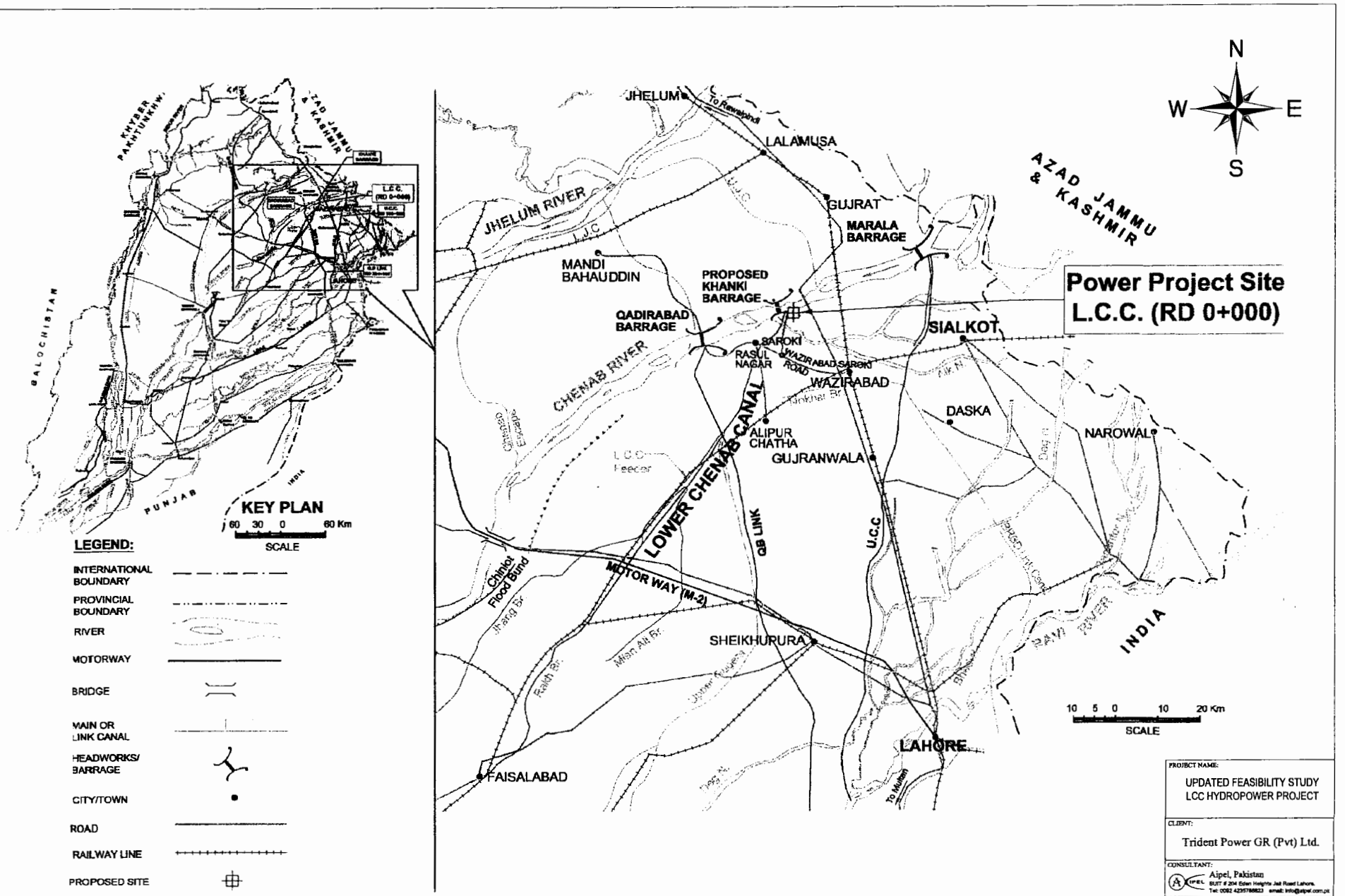
(i)	Powerhouse (Within Main Canal)	Size: 32m X 42m Bottom Pit Elevation: 680.3 ft. (207.4 m) Loading Bay Elevation: 725.3 ft.(221.13 m) Roof Slab Bottom Elevation: 757.3 ft. (230.89 m) Hydraulic gates & Trashrack provided on u/s of powerhouse Stoplogs provided on d/s of powerhouse 20 Tons overhead travelling crane Office building & control room Spillway provided within the main canal within the same axis
(ii)	Electromechanical Equipments	04 Nos Kaplan Horizontal Units With rated output of 1875 KW each. Turbine Runner Dia: 3.46 m with rated & runway speed of 103.4 rpm & 323 rpm respectively. 1.96 MVA Generator Capacity. Transformer Capacity 1.96 MVA. Draft Tube: L = 16.5 m; Exit width = 7.2 m; Height = 5.2 m
(iii)	Accommodation for O&M Staff	Operation & maintenance Staff Colony of 80m X 61m size.

F. Expected Civil and E&M Contractors

(i)	Expected Turbine Manufacturers	Andritz Hydro, Austria Mavel, Czech Republic Global Hydro, Austria Vaptech, Balgharia

TRIDENT POWER (PVT.) LIMITED TRIDENT

		HPP, France
(ii)	Expected EPC Contractors	Nishian Engineers, Pakistan Sinotech, China Descon, Pakistan Sambu, Pakistan/Korea



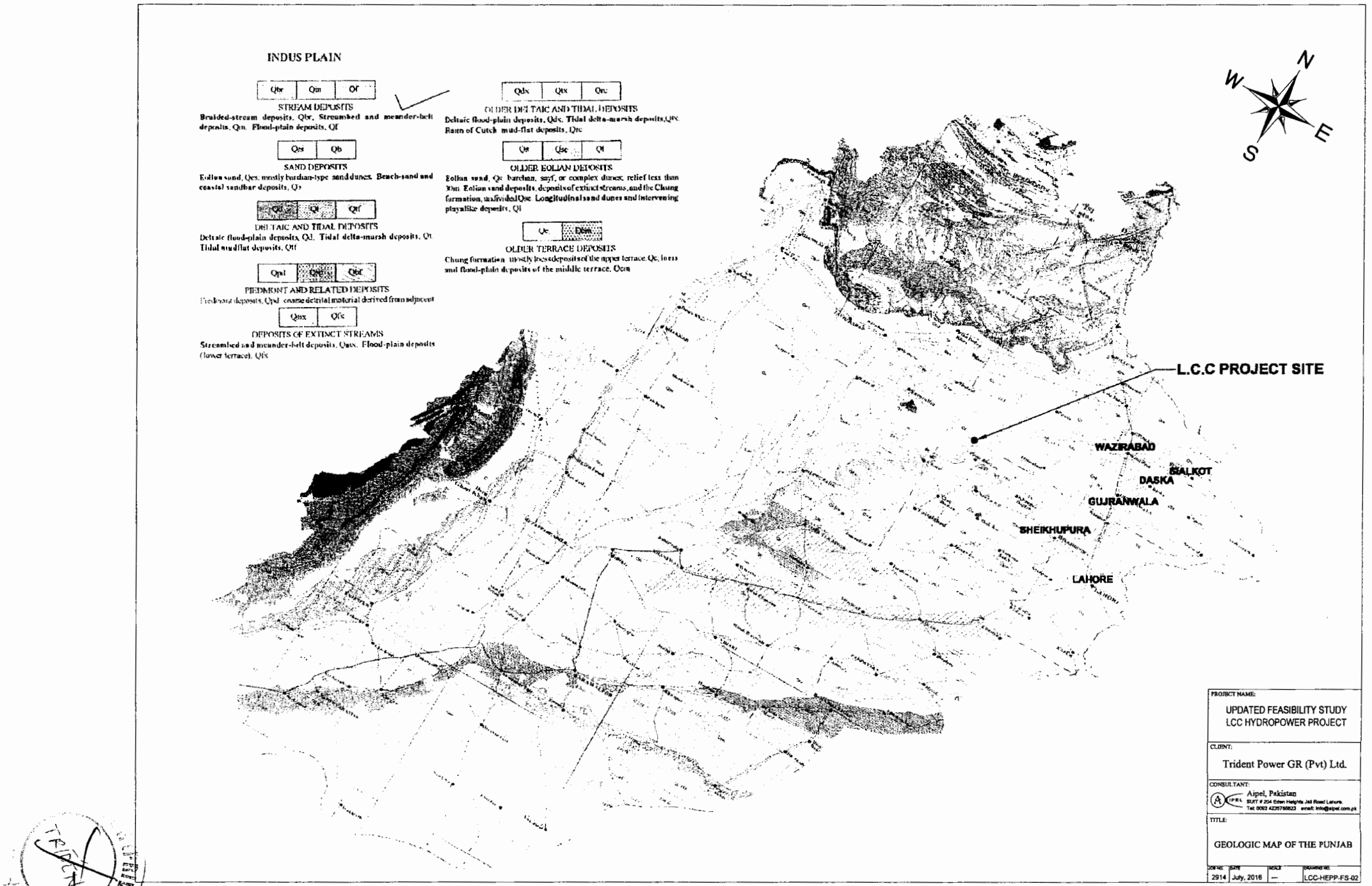
PROJECT NAME:
UPDATED FEASIBILITY STUDY
LCC HYDROPOWER PROJECT

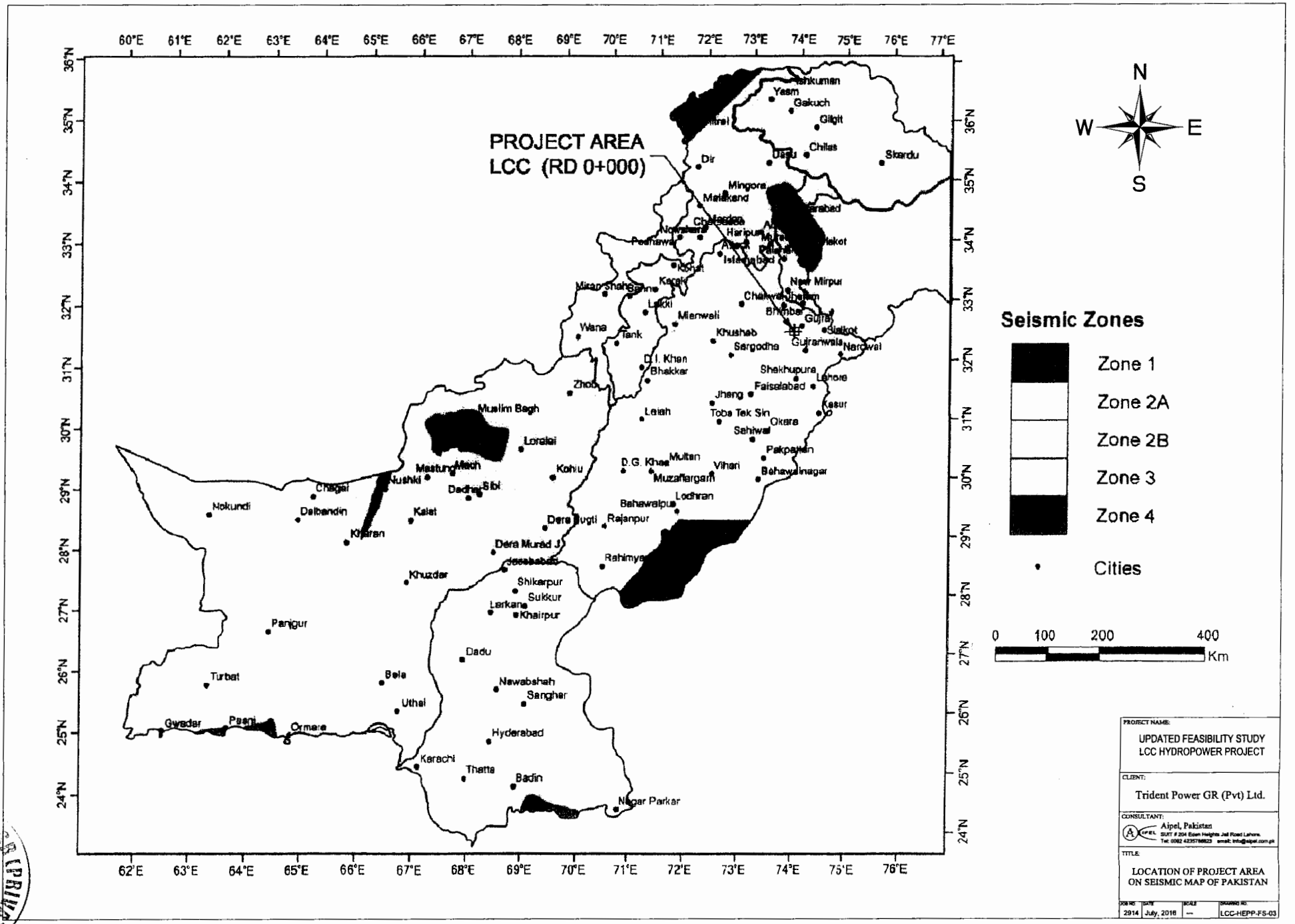
CLIENT:
Trident Power GR (Pvt) Ltd.

CONSULTANT:
Aipel, Pakistan
SUIT # 204 Eden Heights Jail Road Lahore.
Tel: 0092 4235788823 email: info@aipel.com.pk

TITLE:
PROJECT LOCATION MAP

JOB NO.	DATE	SCALE	DRAWING NO.
2914	July, 2016	—	LCC-HEPP-FS-01


INDUS PLAIN
Qbr
Qm
Of
STREAM DEPOSITS
Braided-stream deposits, Qbr; Streambed and meander-belt deposits, Qm; Flood-plain deposits, Of
Qes
Qb
SAND DEPOSITS
Eolian sand, Qes, mostly barchan-type sand dunes; Beach-sand and coastal sandbar deposits, Qs
Qd
Qf
Qtf
DELTAIC AND TIDAL DEPOSITS
Deltaic flood-plain deposits, Qd; Tidal delta-marsh deposits, Qt; Tidal mudflat deposits, Qtf
Qpd
Qpf
Qtaf
PIEDMONT AND RELATED DEPOSITS
Piedmont deposits, Qpd; coarse detrital material derived from adjacent
Qmx
Qfx
DEPOSITS OF EXTINCT STREAMS
Streambed and meander-belt deposits, Qmx; Flood-plain deposits (lower terrace), Qfx
Qdx
Qtx
Qrc
OLDER DELTAIC AND TIDAL DEPOSITS
Deltaic flood-plain deposits, Qdx; Tidal delta-marsh deposits, Qtx; Rann of Cutch mud-flat deposits, Qrc
Qe
Qsc
Ql
OLDER EOLIAN DEPOSITS
Eolian sand, Qe: barchan, seyf, or complex dunes; relief less than 30m; Eolian sand deposits, deposits of extinct streams, and the Chaung formation, undivided Qsc: Longitudinal sand dunes and intervening playalike deposits, Ql
Qc
Qcm
OLDER TERRACE DEPOSITS
Chaung formation, mostly loess deposits of the upper terrace, Qc; loess and flood-plain deposits of the middle terrace, Qcm
N
W
E
S
L.C.C PROJECT SITE
WAZIRABAD
SIALKOT
DASKA
GUJRANWALA
SHEIKHUPURA
LAHORE
PROJECT NAME:
UPDATED FEASIBILITY STUDY
LCC HYDROPOWER PROJECT
CLIENT:
Trident Power GR (Pvt) Ltd.
CONSULTANT:
Aipel, Pakistan
TITLE:
GEOLOGIC MAP OF THE PUNJAB
JOB NO.
2914
DATE
July, 2016
SCALE
—
DRAWING NO.
LCC-HEPP-FS-02


PROJECT AREA
LCC (RD 0+000)
N
W
E
S
Seismic Zones
Zone 1
Zone 2A
Zone 2B
Zone 3
Zone 4
Cities
0 100 200 400
Km
PROJECT NAME:
UPDATED FEASIBILITY STUDY
LCC HYDROPOWER PROJECT
CLIENT:
Trident Power GR (Pvt) Ltd.
CONSULTANT:
Aipel, Pakistan
TITLE:
LOCATION OF PROJECT AREA
ON SEISMIC MAP OF PAKISTAN
2914
July, 2016
LCC-HEPP-FS-03

01. GENERAL

The Project area lies within main canal at RD 1+500 of Lower Chenab Canal (LCC).

The overall duration of the LCC Hydropower Project is planned to be 36 months (1077 days) including 14 months (420 days) for pre-construction activities and 22 months (660 days) for construction of the project.

Sequence of project development is as follows:

- Registration with Punjab Power Development Board
- Submission of Statement of Qualification to PPDB
- Acquisition of Letter of Intent (LOI)
- Hiring of Consultant for Preparation of Detailed Feasibility Study
- Approval of Feasibility Study from Panel of Experts (POEs) of PPDB
- Approval of Initial Environmental Examination from EPA, Punjab
- Approval of Interconnection Study from MEPCO
- Acquisition of Power Generation License from NEPRA
- Tender Stage Design and Preparation of Bidding Documents for Civil & Electromechanical Works
- Selection of EPC Contractor & Construction Works of the Plant
- Financial Close
- Signing of Energy Purchase Agreement
- Project Completion & Commercial Operations of the Plant
- Plant Operations & Maintenance

02. MILESTONES ACHIEVED

Following major pre-construction stage activities have been successfully accomplished.

- Feasibility Study approved from PPDB
- IEE approved from EPA Punjab
- Interconnection Study approved from MEPCO

At the moment, following activities are in progress:

- Acquisition of Power Generation License from NEPRA

- ❖ Parallel efforts for Financial Close
- ❖ Preparation of EPC Bidding Documents & Tender Stage Engineering

03. CONSTRUCTION PLANNING

The LCC Hydropower Project is planned to be constructed in a period of 22 months (660 days). This includes Civil, Electromechanical and interconnection works from installation to commissioning. The pre-construction activities shall precede the construction work for the LCC Hydropower Project. These include:

- Approval of Tariff and Power Generation Certificate by NEPRA.
- Issuance of NOC by the Punjab, EPA.
- Appointment of Project Management Consultant.
- Acquisition of Land.
- Detailed Engineering Design.
- Preparation of Tender Documents.
- Tendering and Award of Contract.

The dedicated time of 22 months is to be staggered, shared and distributed in such a way that the project works are executed, completed and commissioned within the period of 22 months. This task is to be achieved through the construction management.

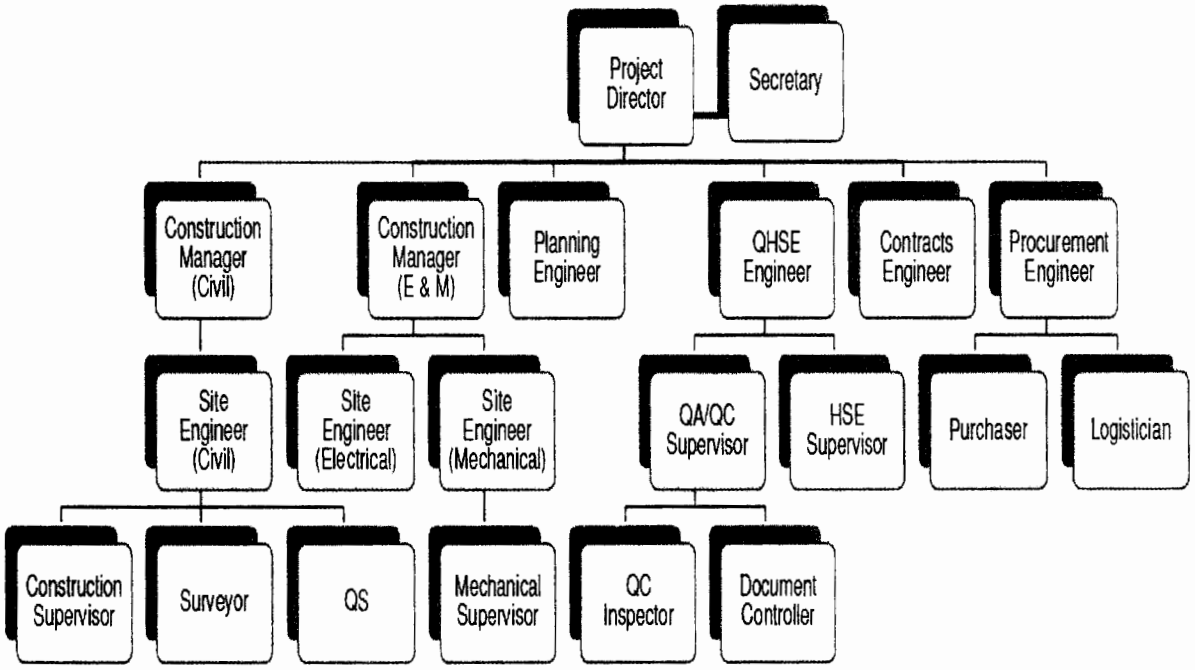
Experience shows that valuable time is lost due to poor construction planning. In some cases, the construction plant idles due to lack of essential spares. In other cases, the material delivery is not well timed to allow uninterrupted execution of site works. Important considerations for timely completion of the project are:

i. Assess requirements of construction material, skill and number of construction workers and types of tools and plants.
ii. Arrange logistic supports for an efficient supply chain.
iii. Minimize idling of plant and resources through critical paths.
iv. Maximize work output by keeping the plant and resources at optimum level of performance and operation.
v. Anticipate problems and analyse them for their likely time impacts.
vi. Suggest contingent plans and means to ward off problematic situation.

3.1. PROJECT ORGANIZATION

The construction of the LCC Hydropower Project could be conveniently managed with an efficient, professional and dedicated team. The project organization proposed for successful execution of the Project is given in Figure-1.

Figure-1 Project Organization



The overall responsibility of management of the entire project shall rest on the Project Director, who shall be assisted by Construction Manager (Civil), Construction Manager (E&M), Planning Engineer, Contracts Engineer, Procurement Engineer, & QHSE Engineer. Down the line of organizational hierarchy are the Site Engineer (Civil), Site Engineer (Mechanical) & Site Engineer (Electrical). The Site Engineers shall be responsible for the execution of works in accordance with the specifications and the schedule of progress.

3.4. SEQUENCE AND SCHEDULE OF CONSTRUCTION ACTIVITIES

The Construction activities at the Project site shall begin with the mobilization of the Contractor at the Project site followed by the preparatory works including Clearance of site area, Construction of Contractor's camp & offices, Stores areas, mobilization of Batching Plant and Construction of access road.

The construction work of civil works of the major components of the project can be commenced simultaneously.

3.4.1 POWERHOUSE

Implementation schedule of the powerhouse would depend upon the most critical activity of the pit excavation. The depth of the pit is about 34ft. The water table is at a depth of about 18ft. Hence, out of 34ft. excavation, about 16ft. will be under water. Excavation in the powerhouse has to proceed from El. 577.80ft. (NSL) to El. 543.65ft. It will be excavated in two stages. In the first stage, excavation will be carried out up to ground water El. 559.80ft. in dry.

At this stage, dewatering shall be done by installing pumps at the periphery of the excavation to depress the water table. The dewatering will continue until water level shall be lowered to El. 543.65ft., so that excavation could be started for second stage.

The dewatering will be continued to maintain the water table at El. 543.65ft. so as to facilitate the second stage excavation in dry up to the powerhouse foundation elevation 543.65ft. The elevation of 543.65ft shall be kept dry until the foundation structure of powerhouse elevates above the original ground water elevation of 559.80ft. The pumped ground water will be tested and if found clean, shall be fed to LBDC.

Soon after the completion of excavation, sheet pilling will be done followed by the concrete works of foundations of powerhouse.

When the depressed water table will be at the El. 543.65ft. which is lower than the foundation levels of the upstream & downstream transition and intake forebay. It is therefore, imperative that during the second stage, construction of these structures should also be taken up simultaneously along with the super structure of the

powerhouse.

The construction of civil works of the powerhouse is estimated to be completed in 14 months.

3.4.2 UPSTREAM & DOWNSTREAM TRANSITION

Construction of upstream & downstream transition shall be taken up alongside the construction of powerhouse. The excavation and compaction will consume 1.5 months followed by concreting of foundation slab and walls in 3 months.

3.4.6 INSTALLATION OF E&M EQUIPMENT

The E&M equipment would be delivered at the site latest before the end of 13th month of the schedule. The turbo-generator units and transformer will be installed from month 16 to 20. Transmission line will also be installed by the end of month 20.

3.4.7 CONNECTION OF HEADRACE & TAILRACE WITH LBDC

The portion between the main canal and headrace channel as well as the portion between canal and tailrace channel will be removed at the last stage of project construction before testing and commissioning of the units

3.4.8 TESTING AND COMMISSIONING

Trial run shall be carried out and completed during month 21. Defects, if any, would be removed by the start of 22th month. Commercial operation shall commence from the month 22.

3.4.9 MISCELLANEOUS WORKS

The Miscellaneous works include rectification of punch list items, if any, dumping of the excavated earth fill and landscaping works.

The excavated material will be spread on LBDC banks and tracks throughout along the Project area to strengthen them, filling of low lying areas and stabilization of slopes along the headrace & tailrace channel and landscaping of the Project area.

01. PROJECT BACKGROUND

Pursuant to "Punjab Power Generation Policy 2006 (Revised 2009)", the Punjab Power Development Board (PPDB) invited the private firms/consortium for the development of 11 No. Raw sites Hydropower Projects in May, 2015. On the basis of prequalification documents submitted by private firms/consortium, PPDB issued a Letter of Intent (LOI) to M/s Trident Power GR (Pvt.) Ltd on March 22, 2016 for the development of Hydropower Project on Lower Chenab Canal (LCC) utilizing head available at head regulator of LCC at RD 0+000. M/s Trident Power GR (Pvt.) Ltd engaged the services of M/s Aipel Consultants on April 07, 2016 for review and updating the Feasibility Study and Initial Environmental Examination (IEE) of LCC Hydropower Project. The feasibility study is being furnished in the light of available discharge data for the last twenty five years, available topographic layout information and geotechnical investigations carried out earlier by NESPAK and NKB (New Khanki Barrage) Consultants.

02. INTRODUCTION

Maintenance activities at predetermined time intervals shall be conducted in order to ensure the following:

- Quality and reliable operation of equipment in the service environment through planned, periodic inspection and checking of components and systems together with replacement or rectification of parts wherever required.
- Maximum availability of equipment and a minimum of unplanned shut downs by using planned / periodic shutdowns to inspect all equipment (serviceable and non-serviceable).
- Eradication of operational problems by a timely analysis of the cause of faults / problems and replacement of short term solutions by long lasting and permanent ones.

03. PREVENTIVE MAINTENANCE OF HYDRO TURBINE

In order to achieve above objectives of maintenance, time has to be allotted every year for each machine. Normally the periodicity and the procedure for maintenance is recommended by the manufacturer of the equipment. However, maintenance is required according to the following guidelines:

3.1 ROUTINE MAINTENANCE

Normally there will be daily, weekly, monthly and quarterly checks as per the maintenance schedules. These checks are necessary for controlling any change in the installed clearances, commissioning characteristics etc. connected with the performance of equipment. Rectification and adjustment wherever required should be carried out in order to arrest any deterioration of the equipment.

3.2 DAILY MAINTENANCE CHECKS

Foundation Parts and Expansion Joints

Check for any leakage in draft tube manholes, spiral casing manhole, expansion joint.

Vacuum Breaking Valve

Check the working of both vacuum breaking valve and see that there is no abnormality in the springs, seats etc.

Water Seal and Air Seal

Check the position of water leakage around the water seal and check that there is no excessive splashing and water level do not rise in top cover.

Turbine Guide Bearing

- Check the oil level (stand still machine/running machine).
- Note the temperature of bearing and check that the temperature of oil and guide bearing pads are within limits.
- Note the maximum and minimum temperature of the previous day.
- Check for any oil leakage from the bearing housing and check that oil is flowing above the bearing pads.

Guide Apparatus

- Check any leakage from GV servomotor and its piping.

Oil Leakage Unit

- Check any leakage from pipe line joints.
- Check its satisfactory running on `Auto'. Top Cover Drain System:
- Main supply of `ON' for DPM.
- Vibration noise in the pump motor.
- Any leakage from the water piping.
- Working and water pressure of the ejector.

Centralized Grease Lubrication System

- Check for any leakage from grease pipes, unions and nipples.
- Check grease container and fill grease, if required.

Oil Header

- Check from Perspex sheet manhole any splashing of oil from top and bottom bush.
- Check any oil leakage from the joints.
- Note the pressure difference of opening and closing side of runner. Oil Pressure System:
- Check if there is any abnormal sound in the running of the motor and pump unit of OPU.
- Check the oil level in pressure accumulator.
- Check any oil leakage from oil piping and its valve.
- Check for overheating of motor.
- Note the timing of OPU pumps running.

Mechanical Cabinet of Governor

- ❖ Pressure in transducer.
- ❖ Check any oil leakage from joints of piping.

3.3 WEEKLY MAINTENANCE CHECKS

- ❖ Greasing of guide vanes and servomotor with centralized grease lubrication system and manually.
  - Oil in the gear box shall be checked.
  - Check for any leakage
  - Working of end pressure relay and solenoid valves, if defective, should be reported.
- ❖ Cleaning of OPU filters
- ❖ Cleaning of throttle filters in the governor mechanical cabinet.
- ❖ Cleaning of governor compressor air filters and checking of oil levels.
- ❖ Checking physically oil of OPU of the running machine after sample taking through the sampling cock and do the crackle test for detecting presence of water. Take remedial measures. 6. Check oil level of all the bearings. Check wobbling of shaft at coupling flange and at oil header servo-tube.

3.4 MONTHLY MAINTENANCE CHECKS

All the checks covered as part of the weekly maintenance are also carried out as part of the monthly check. In addition to these checks, more attention is paid and short shutdowns, if required, for rectification are taken.

3.4.1. ANNUAL PREVENTIVE MAINTENANCE OF HYDRO TURBINES

After successful running of plant for about one year, a few weeks are required to inspect rotating parts, control equipment and measuring instruments and to analyze the cause of changes in the performance characteristics, if any. Modify, repair or replace (wherever required) worn out parts in order to prevent unplanned outages of plant at later date. After every five years it is necessary to inspect the machine more critically for

abnormalities like fatigue defects or excessive wear and tear of some parts or any change in original parameters/clearances etc. This exercise becomes very essential in cases where performance level has been observed to have gone down in 5 years operation. The checks for annual maintenance specified for Ravi Hydropower Plant are enlisted below:

3.4.1.1 Foundation Parts:

i. Check condition of water path system. The damage due to capitation and wear to be rectified.
ii. Check painting of spiral casing.

3.4.1.2 Runner:

i. Check the condition of the surfaces of the runner hub and the blades. The damage due to cavitations & wear to be rectified by welding and grinding.
ii. Check the runner blade seals by pressurizing the system. Change seals if necessary. No oil leakage is to be allowed.
iii. Check the runner sealing for hermetic tightness, leakages of water in the runner hub is not to be permitted.

3.4.1.3 Guide Apparatus:

i. Check the presence of rubber sealing cords and the tightness of the rubber sealing between the adjacent guide vanes in fully dosed position of guide apparatus.
ii. Change oil in the regulating ring.
iii. Replace damaged shear pins.
iv. Check cup sealing of guide vane journals and replace, if necessary.
v. Check the bushes of guide vanes and change the worn out bushes of guide vanes journals.
vi. Inspect the servomotor and change the seals, if these are worn out.

3.4.1.4 Guide Bearing:

i. Check the condition of rubbing surfaces of guide bearing. Clean the surface and polish it with the help of chalk powder.
ii. Adjust the clearances by moving the segments with the help of adjusting bolts.
iii. Thorough cleaning of housing if necessary.

3.4.1.5 Shaft Gland Seal and Air Seal:

i. Check the condition of rubbing surface of sealing rings. In case found damaged change the same.
ii. Check pipe lines and piping joints for any leakage if any, attend the same.

3.4.1.6 Emergency Slide Valve:

i. Check the functioning of emergency slide valve and the condition of inner surfaces.
ii. Swift return of the valve in its original position after emergency operation should also be checked.

3.4.1.7 Centralized Grease Lubrication System:

i. Check satisfactory working of CGLS system.
ii. Attend wherever fault is located.

3.4.1.8 Oil Header:

i. Measure clearances of upper and lower bushes, if found increased get the bushes replaced.
ii. Clean the oil bath.
iii. Check the rubber cord fixed below the guide to check any oil dipping on the exciter winding.

3.4.1.9 Oil Leakage Unit:

i. Check satisfactory working on Auto as well as manual.
ii. Clean the tank.
iii. Check the pipeline joints and valves for leakage, attend wherever necessary.

3.4.1.10 Oil Cooling Unit:

i. Check all the oil and water pipe lines for leakage and attend if necessary.

ii. Check satisfactory working of all cooling unit.

3.4.1.11 Governor Mechanical Cabinet:

i. Check filter and throttle if found damaged replace the same.

ii. Attend leakage of oil through pipe line joints and valves.

iii. Check auto rod setting, if found disturbed; set the same.

3.4.2. Turbine Auxiliaries

3.4.2.1. DPM

- ❖ Inspect top cover drain system, overhaul the ejector and drainage pumps.
- ❖ Check pipe lines and valves. Replace gaskets and other parts, if necessary.

3.4.2.2. Oil Cooling Unit

- ❖ Overhaul cooling pumps
- ❖ Attend all the valves and pipe lines for leakage.

3.4.2.3. Centralized Grease Lubrication System

- ❖ Overhaul greasing pumps ii) Check whole greasing lines. Replace worn out valves and gaskets etc.
- ❖ Check all the nylon pipes connected with the guide vane bushes. Replace damaged pipes.
- ❖ Check that all the guide vanes are receiving grease properly.

3.4.2.4. Oil Leakage Unit

- ❖ Check the oil leakage unit overhauls the pumps.
- ❖ Clean tank and check that float is properly working.
- ❖ Checking all the pipe lines and valves for leakages.

04. REQUIREMENT OF EFFECTIVE MAINTENANCE

In addition to planning maintenance and implementing a suitable schedule (on the basis of seasonal water availability perhaps), the following items also require attention otherwise it may be difficult to keep to the schedules in practice:

- Man Power Planning and arrangement is essential as without experienced and skilled staff any maintenance programme may fall.

- Planning and arrangement of spares and consumable in advance so that time is not lost in re-commissioning the plant after the shut down.

- The maintenance engineers should have in his possession all the erection and commissioning log sheets documents to establish a record of installed clearances, parameters, alignment results, test characteristics of all the power plant equipment. These may be required at the time of diagnosis of the operational problems as well as defined maintenance purpose.

- Log sheets of the previous maintenance exercise carried out on the machines. These may be required to compare with the clearances / settings / characteristics achieved during present maintenance.

- History registers of all plant should be kept with records of all the abnormalities observed on the machine and details of action taken. This data can be used to as a guideline for future maintenance work at the power station.
- Some of the major problems encountered in the hydro turbines are damage in runners due to erosion, cracking and cavitations due pressure pulsation in draft tube, instability of operation at partial gate opening. Other serious issues include failure of turbine guide bearings, leakages of water through turbine guide bearings, leakage of water through guide vane seals and turbine gland seals.

10.1 GENERAL

This chapter briefly describes the construction planning and management of the project. Based on the project scope, construction material quantities, sequence of activities and their dependence on the hydrological conditions, the LCC Hydropower Project is planned to be constructed in 36 months.

The activity schedule is presented in **Figure – 10.1**, showing the duration and sequence of activities spanning the entire period of 36 months. The schedule indicates major construction stage activities and is based on the assumption that the project shall be awarded to a qualified constructor on EPC basis having similar experience in the construction of hydraulic structures and powerhouses and with the experience in the design, manufacture or procurement of hydropower generating equipment.

10.2 CONSTRUCTION PLANNING

The LCC Hydropower Project is planned to be constructed in a period of 36 months. This includes Civil, Electro-mechanical, Transmission and Interconnection works from installation to commissioning. The pre-construction activities shall precede the construction activities of the LCC Hydropower Project.

These include:

- Submission of Updated Feasibility Study and Approval by PPDB.
- Approval of Tariff and Power Generation Certificate by NEPRA.
- Issuance of NOC by the Punjab, EPA.
- Appointment of Project Implementation Consultant.
- Acquisition of Land.
- Tender Design, Documents and Tendering.
- Award of EPC Contract.

Major activities to be undertaken and estimated time to be dedicated for each of these are elaborated in **Table – 10.1** as under:

Table – 10.1: Time Line of Major Activities

Sr. #	Activity	Days
1.	Investigations and Detailed Design by EPC Contractor	180
2.	Mobilization/Installation of Temporary Facilities	45
3.	Construction of Residential Colony	90
4.	Excavation of Temporary Diversion Channel	60
5.	Construction of Upstream and Downstream Coffer Dams	30
6.	Excavation of Powerhouse and Spillway Foundations	150
7.	Construction of Powerhouse and Spillway Substructure	270
8.	Construction of Powerhouse and Spillway Superstructure	210
9.	Manufacturing of Turbines, Generators, other E&M Equipment and Spillway Gates	600
10.	Delivery at site	120
11.	Installation of Turbines, Generators & other E&M Equipment	240
12.	Transmission & Interconnection at Wazirabad Grid Station	120
13.	Testing and Commissioning	30

The dedicated time of 36 months for the above listed activities is to be staggered, shared and distributed in such a way that the project works are executed, completed and commissioned within the period of 36 months. This task is to be achieved through the construction management. Experience shows that valuable time is lost due to poor construction planning. In some cases, the construction plant idles due to lack of essential spares. In other cases, the material delivery is not well timed to allow uninterrupted execution of site works. Important considerations for timely completion of the project are:

- Assess requirements of construction material, skill and number of construction workers and types of tools and plants.
- Arrange logistic supports for an efficient supply chain.
- Minimize idling of plant and resources through critical paths.
- Maximize work output by keeping the plant and resources at optimum level of performance and operation.
- Anticipate problems and analyse them for their likely time impacts.
- Suggest contingent plans and means to ward off problematic situation.

10.2.1 Suggested Methodology

It is assumed that one EPC Contractor would execute the entire Civil, E&M and Structural Steel works. Single source EPC Contract has many advantages over split scope contracts. The EPC Contractor may, however, engage sub-contractors for specialized jobs that include supply of materials, powerhouse electrification, Transmission Line/Interconnection etc.

The site works shall be executed in accordance with the construction management plan. The construction activities include care and handling of water, bulk excavation and disposal, concrete mixing and placing and structural steel works. For preparation of quality concrete, batching plant shall be used. The construction schedule shall be coordinated with the local irrigation authorities to avoid disruption to the canal flows for irrigation purposes.

Working conditions at the project site are expected to be excellent. Care and handling of water in the excavated area may be a construction hazard for which extra resources would be needed.

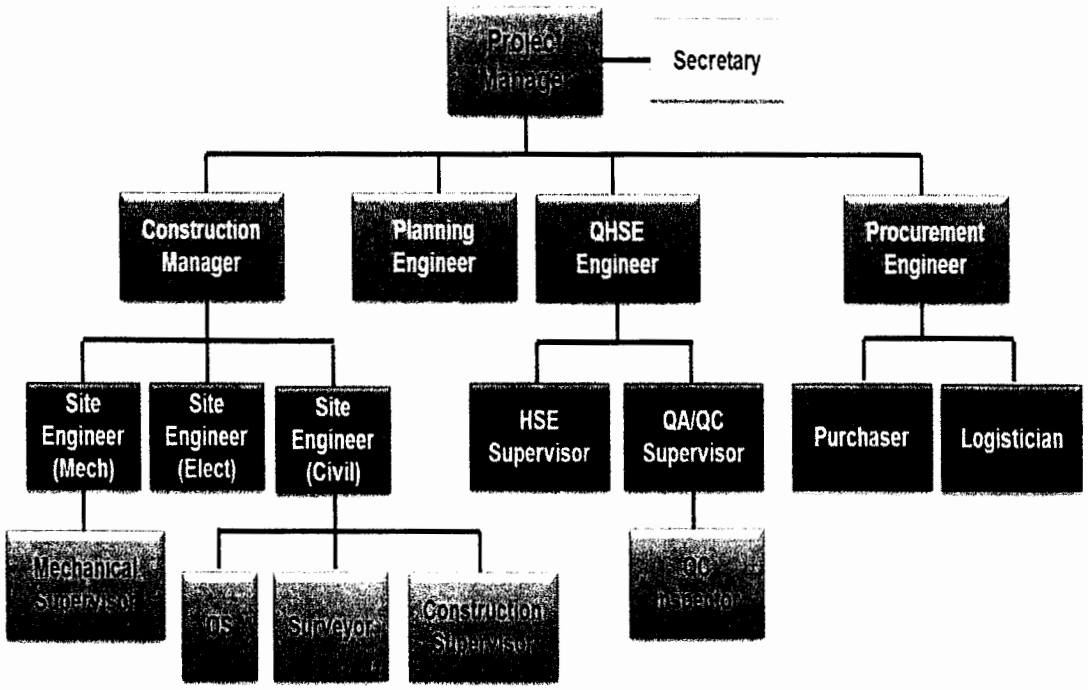
10.2.2 Construction Means

For all works, conventional construction methods shall be applied. Surface excavations require conventional earth moving equipment only. The construction work shall start with the excavation of temporary diversion channel on the left side of the canal. The majority of the work force shall be local, with site laborers and semi-skilled labor available from the project area and skilled labor also coming from the region as well as from other parts of the Country. Foreign experts shall be hired for special tasks, especially that associated with installation and testing of major equipment (if necessary).

10.3 PROJECT ORGANIZATION

The construction of the project could be conveniently managed with an efficient, professional and dedicated managerial team. The project organization proposed for successful execution of the project is given in **Figure - 10.1**.

Figure - 10.1 Project Organization



The above staff shall have the roles and responsibilities as under:

- The overall responsibility of the management of the entire project organization shall rest with an experienced professional, who has extensive exposure on successfully handling the project related issues. He shall act in the capacity of Project Manager. He shall be assisted by Construction Manager, Planning Engineer, QHSE Engineer and Procurement Engineer.

- The Construction Manager shall deal with the day to day construction issue and ensure compliance with the design and specification codes. He would maintain close liaison with the Irrigation Department and monitor the quality and site productivity. The Construction manager shall have extensive experience on construction related problems with a capacity to make a sound judgement for quick decision making.

- The Procurement Engineer is a direct assistant to Project Manager, who shall assist him in preparation of an inventory of material for smooth execution of works at site. He shall also be responsible for preparation of

supply/delivery orders of all kind of materials, spares, tools etc. at site.

- The QHSE Engineer is also a direct assistant to the Project Manager, who shall assist him in resolving day to day problems regarding safety, quality and environmental hazards at site.

- The Planning Engineer is also a direct assistant to the Project Manager for scheduling the site activities and preparation of monthly progress reports.

- Down the line of organizational hierarchy are the site engineers each for Civil and E&M works. The site engineers shall be responsible for execution of works in accordance with the specifications and schedule of progress. The site engineers shall be assisted by construction supervisors.

10.4 SCHEDULE OF ACTIVITIES

10.4.1 Investigations & Detail Design

The detailed engineering design, drawings and related investigations shall be the responsibility of EPC Contractor. About 06 months have been envisaged for additional investigations, working out the plant size and final layout for review and approval by the sponsor and PPDB. Side by side the contractor shall move for procurement of Turbines, Generators & other E&M equipment.

10.4.2 Mobilization

Temporary roads shall be required to the disposal area, as well as temporary and permanent camps. Aggregate processing and concrete batching facilities shall be erected and operated by the contractor. The Contractor shall also construct camps, offices and other utilities with sufficient work area.

At project completion, the roads to all permanent facilities and relocated public road shall be upgraded and finished with proper drainage, paving and shoulders. The estimated time for mobilization is 1.5 month.

10.4.3 Temporary Diversion Channel

Construction of temporary diversion channel shall be initiated as soon as possible. Once the temporary diversion channel is excavated, the upstream and downstream cofferdams shall be constructed during canal closure period. This shall allow construction activities of the powerhouse and spillway to commence. The excavation of temporary diversion channel is estimated to be completed in 02 months.

10.4.4 Powerhouse and Spillway

Upon enclosing the powerhouse and spillway site, a time dense activity program must be carried out to excavate, install dewatering system and treat the foundation. On completion of excavation and foundation treatment, the steel reinforced base concrete shall be poured and subsequent concrete works shall be completed leaving spaces for second stage concreting which shall be placed during installation of embedded part for turbine/draft tubes/gates/stoplogs.

The superstructure shall be accordingly completed in accordance with the planned sequence. The draft tube liner and turbine embedded part shall be available for installation during the second stage concreting. The powerhouse and spillway substructure and superstructure does not require unusual construction techniques or methods for reinforced concrete construction.

The powerhouse roof shall be constructed along with the installation of powerhouse crane, which can be used for turbines, generators and installation of other E&M equipment. Backfilling around powerhouse and spillway shall be done upon completion of up and downstream retaining walls. All these activities related to powerhouse and spillway construction shall require 21 months.

In equivalent with installation of the turbine and generator, the other electromechanical equipment and controls shall be installed. The other architectural work, parking and security shall be completed parallel to testing and commissioning of the plants.

Upon completion of spillway along with gates, canal flows shall be diverted toward the powerhouse/spillway. Flows through the turbines shall be stopped by placing stoplogs upstream and downstream.

10.4.5 Procurement and Installation of Major Equipment

The scheduling and procurement of major equipment shall be the responsibility of the EPC contractor. Procurement of major equipment requires careful planning so that installation can be finished prior to desire commissioning date.

a. Turbine, Generator & Other E&M Equipment

The critical items are the procurement of turbines and generators which needs to be planned carefully to avoid delay in the project. The process of procuring hydropower turbines, generators and other E&M equipment shall take about 20 months, whereas, about 08 months shall be required for installation of these equipment.

b. Switchyard Equipment

In parallel of procurement of E&M equipment for powerhouse, transmission line and interconnection equipment shall be procured. The transmission facility and interconnection shall require 04 months. However, the transmission line shall be constructed by Power Purchaser.

The switchyard equipment is not a critical task. The equipment can be easily procured from the local market. Installation shall require no more than 2 months.

c. Spillway Gates

Installation of gates is also not a critical path of supply for construction completion. Once the spillway civil works are completed, the embedded parts installed, the gates shall be installed. Testing of gates shall be conducted parallel to turbine testing. The fabrication of the gates needs to be started parallel with civil construction.

10.4.6 Testing and Commissioning

Testing and commissioning includes testing of all equipment and facilities, operational test of electromechanical equipment under load conditions (both dry and wet condition) and safety tests. The activities require 01 month after erection of the E&M equipment.

10.4.7 Miscellaneous Works

The miscellaneous works include rectification of punch list items (if any), dumping of the excavated earthfill and landscaping works. The excavated material can be spread on the canal banks and tracks throughout along the Project area to strengthen them, filling of low lying areas and landscaping of the Project area.

10.5 CONCLUSION

- Based on the project scope, construction quantities, sequence of activities and their dependence on expected canal closure, the total construction period of 36 months is estimated.

- It should be noted that construction of temporary diversion canal must be finished well before January to use the closing time for diverting the main canal and to start powerhouse and spillway construction.

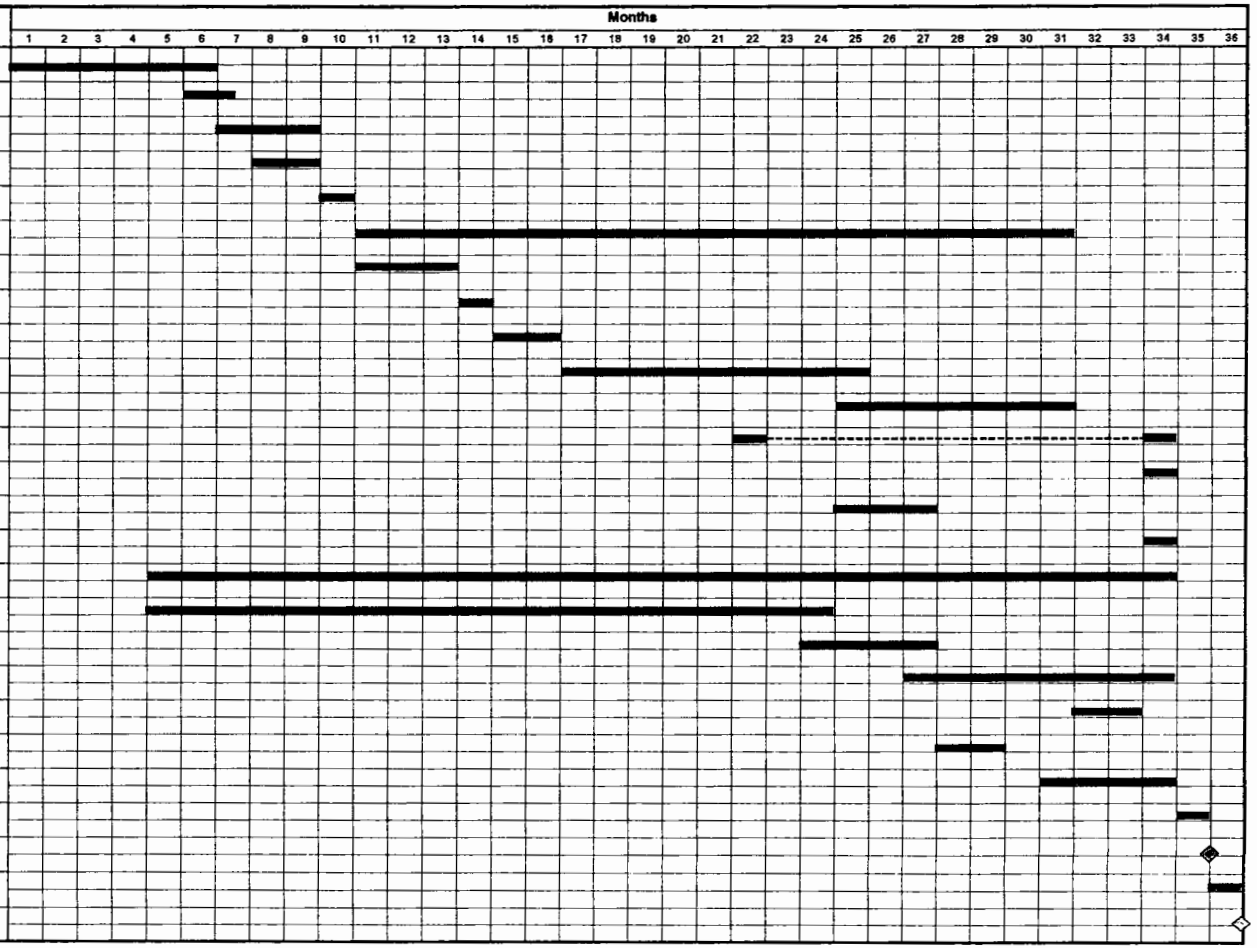
- Special consideration should be given to the critical tasks related to the canal closure and schedule delivery of Turbines, Generators & other E&M equipment to site.

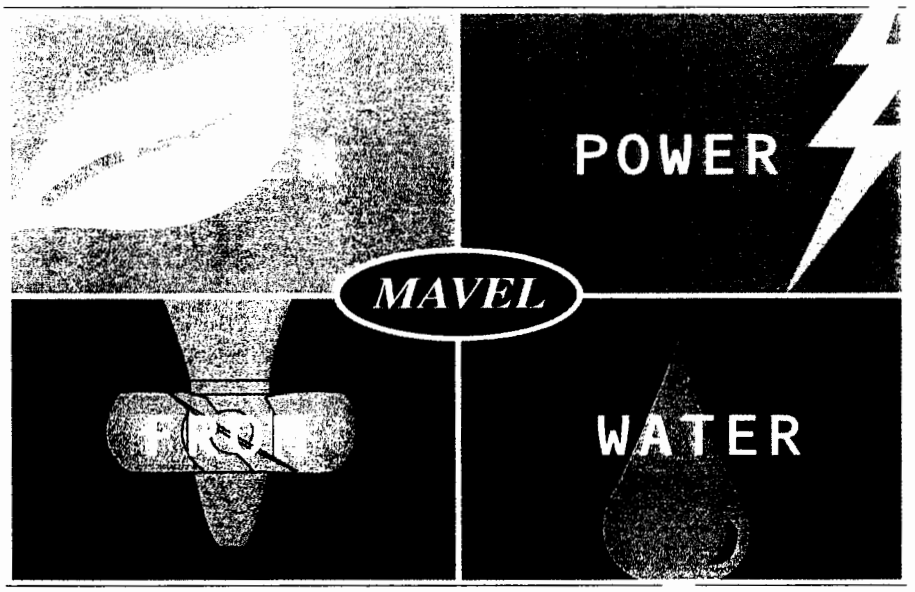
Figure - 10.1

LCC HYDRO POWER PROJECT

ACTIVITY SCHEDULE

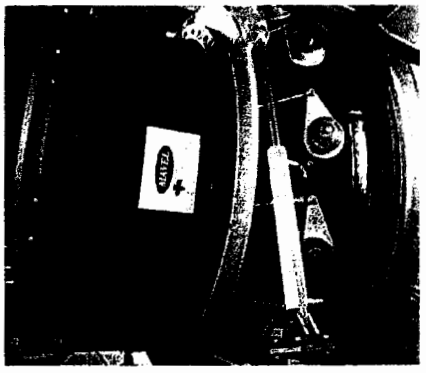
ACTIVITY	Period (Months)
INVESTIGATIONS ANO DETAIL DESIGN BY EPC CONTRACTOR	6
MOBILIZATION / INSTALLATION OF TEMPORARY FACILITIES	1.5
CONSTRUCTION OF RESIDENTIAL COLONY	3
EXCAVATION OF TEMPORARY DIVERSION CHANNEL	2
CONSTRUCTION OF U/S AND D/S COFFER DAM	1
POWERHOUSE & SPILLWAY (CIVIL WORKS)	
Excavation 1st Stage	3
Installation of Dewatering System	1
Excavation 2nd Stage	2
Construction of Powerhouse and Spillway Substructure	9
Construction of Powerhouse and Spillway Superstructure	7
HEADRACE (Banks Raising & Slope Protection)	2
TAILRACE (Excavation & Slope Protection)	1
CONSTRUCTION OF SWITCHYARD	3
REMOVAL OF U/S AND D/S COFFER DAM	1
E&M WORKS	
Manufacturing of Turbines, Generators, Other E&M Equipment and Spillway Gates	20
Delivery at Site	4
Installation of Turbines, Generators and Other E&M Equipment	8
Installation of Spillway Gates	2
Installation of Switchyard Equipment	2
Transmission and Interconnection at Wazirabad Grid Station	4
TESTING AND COMMISSIONING	1
COMMERCIAL OPERATION	
REMOVAL OF DEFECTS AND MISC WORKS	1
PROJECT COMPLETION	





TECHNICAL OFFER (Part A)
&
BUDGETARY PRICE (Part B)
Hydro Power Plant (HPP) LCC , Pakistan

4 x Kaplan Pit Turbine KP3000K3



Offer No.: 0-27814

ELABORATED BY:

Bert Brands,
Pavel Skala, Sales Dept.

Benešov, July 15, 2016

CONTENT

A TECHNICAL PROPOSAL

1. CUSTOMER DATA

Mr. Yousuf Mehboob Khan
Director
Trident Power JB (private) Limited
Suite 8,Ground Floor Evacuee
Trust complex, F-5/1,Islamabad

Tel +92 333-5123749

Email usufkhan@gmail.com

2. INTRODUCTION

Dear Mr. Khan,

Thanks for your inquiry dtd. May 2016 for the design, manufacturing, supply and installation supervision of the Electro Mechanical part of the Run of River Hydroelectricity Project "LCC" in Pakistan .

We are pleased to submit you hereby our offer and price for a solution with horizontal Kaplan PIT turbines.

The concept of these HPP is quite similar to the HPP Lovosice in Czech republic, which you visited with Mr. Usman Anwar in May 25th 2016.

We hope that this offer will meet your requirements and we are looking forward to receive your reaction.

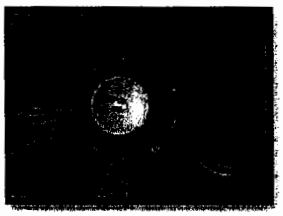
After rewarding the supply contract, we already guarantee you now that our highly motivated team will do its utmost to realize this project in the best possible way together with our subcontractors.

3. MAVEL COMPANY SUMMARY

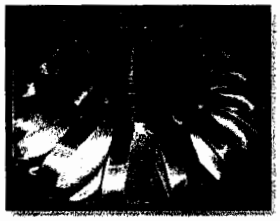
M a v e l, a.s. is one of the premier global suppliers of hydroelectric turbines for projects with over 450 Kaplan, Francis and Pelton turbines installed over the past 25 years at more than 300 sites and over 400 MW total power around the world. The ISO 9001:2008, ISO 3834-2:2005 and ISO 14001:2004 certified Czech-American owned company designs and manufactures the full turbine scope at its 2 Czech production facilities.

Turbine Range

M a v e l, a.s. has over 100 proprietary turbine design configurations for Kaplan, Francis and Pelton turbines ranging in size from 30 kW to 30 MW per unit. This allows M a v e l, a.s. to provide customers with the best turbine option for low, medium and high head installations. Mavel's turbines are suitable for projects with heads ranging from 1.2 meters to 1000 meters and discharge ranges per turbine from 0.1 cubic meters per second (m^3/s) to 100 m^3/s.


Kaplan Runner


Francis Runner


Pelton Runner

The majority of the turbines Mavel has installed have been Kaplans. With orders for over 245 Kaplan turbines, installations include the 18.87 MW Grodnenskaya project in Belarus, the 700 kW Boatlock No.1 project in Massachusetts and over twenty-two projects (42 turbines) in Poland. This experience has made Mavel one of the leading global experts in low-head hydroelectric power.

4. SITE DATA

The following site data are provided:

Rated Net Head	3,56 m
Rated Design Discharge	250 m^3/s

5. PROPOSED TECHNOLOGY AND PARAMETERS

I. Scope of Supply

Based on these data M a v e l proposes the use of four (4) Horizontal Kaplan PIT turbines, type **M a v e l KP3000K3 .**

Each turbine package includes the following equipment:

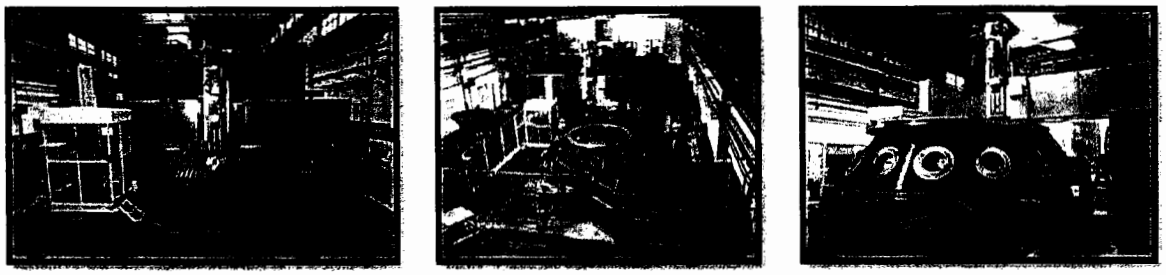
Equipment	Included Yes / No
• **Kaplan Pit Turbine MAVEL KP3000K3 with a runner diameter of 3000 mm and 3 blades, incl. accessories and auxiliary equipment.**	Yes
• Automatic Regulation of Runner Blades and Guide Vanes	Yes
• Transmitters of Guide Vane Position	Yes
• Gearbox	Yes
• Cooling and Lubrication unit	Yes
• Turbine Sensors	Yes
• Hydraulic Pressure Unit (HPU	Yes
• Horizontal Synchronous Generator	Yes
• Technological Design	Yes
• Technical Documentation + Manuals	Yes
• Assembly Advisory Services and Commissioning	Yes
• Training for Employers Staff	Yes
• Set of Basic Spare Parts	Yes
• Transport	Yes

The **Electrical part** of the equipment, includes the following:

Electrical Equipment	Included Yes / No
• **See for the Appendix 2**	Yes
• Technological Design	Yes
• Technical Documentation + Manuals	Yes
• Assembly Advisory Services and Commissioning	Yes
• Training for Employers Staff	Yes
• Set of Basic Spare Parts	Yes
• Transport	Yes

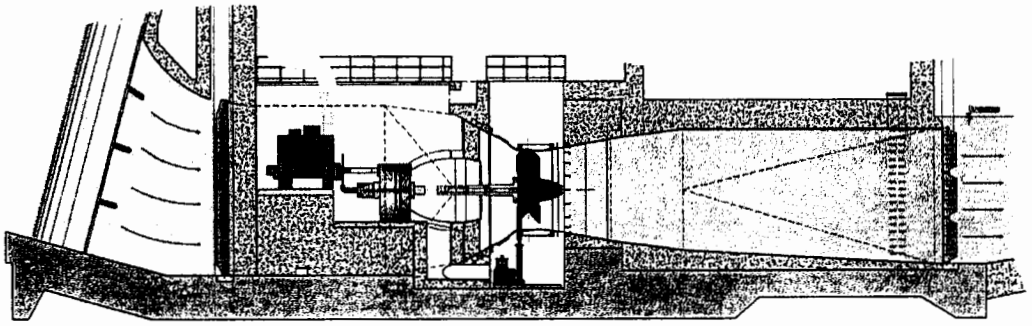
II. Turbine Description

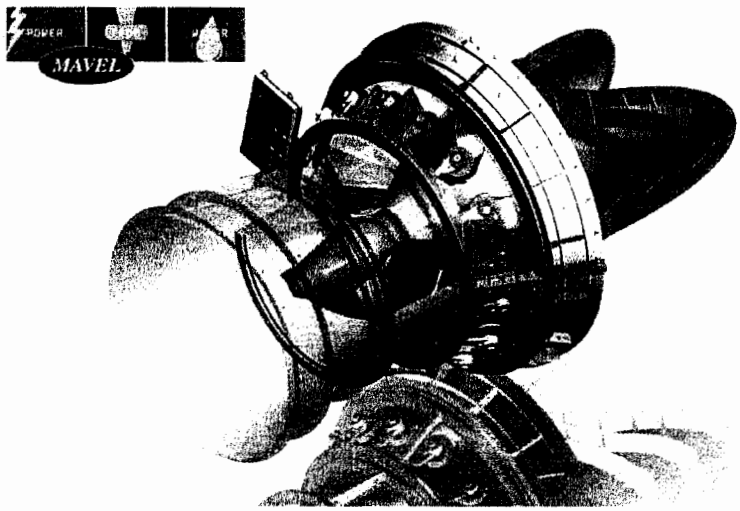
The primary equipment of the power plant will be a straight-flow Kaplan Pit turbine with three (3) runner blades.
The Kaplan turbine is supplied with a spur gearbox and synchronous generator which are located in the turbine "Pit" from concrete .
The spur gearbox connects the turbine with the generator. A lubrication and cooling unit with a sensing device is part of the gearbox.



A 6-axis milling machine in Mavel's factory

III. Approximative Turbine/Powerhouse Design (see Appendix 1 for preliminary drawings)

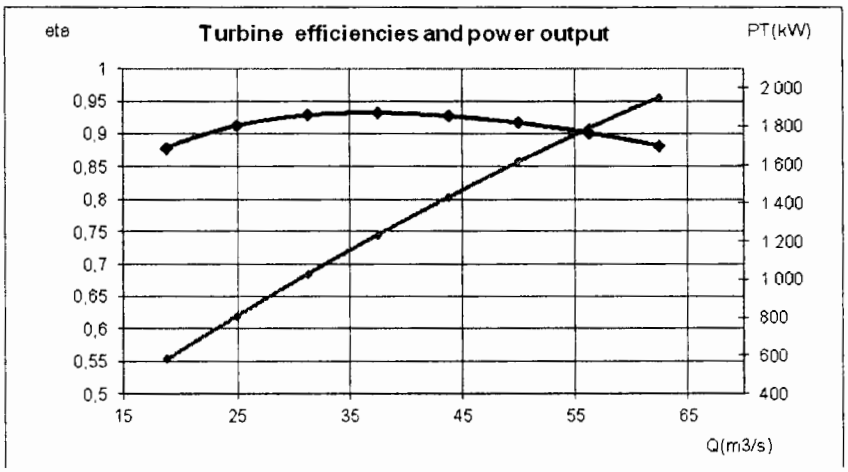




IV. Turbine Parameters

Type	MAVEL KP3000K3
Number of Units	4
Nominal Net Head	3,56m
Design Discharge per unit	62,5 m^3/s
Turbine Output per unit	**1944 kW**
Turbine Speed	130,4 rpm

V. Preliminary Turbine Efficiencies and Outputs at various Outputs:



Notes: **The power-output shall measured in accordance with IEC-standard Publ. 62006, Class A**

VI. Hydraulic Pressure Unit

The hydraulic pressure unit fulfils the following functions:

- regulation of guide vane positions
- regulation of turbine speed
- regulation of maximum output power
- regulation of minimum output power
- processing of auxiliary signals
- failure automatics

VII. Generator Parameters

Number of Units	4
Type	Synchronous
Arrangement	Horizontal
Total rated Unit output	**2106 kVA**
Power factor	0,9
Voltage	11 kV
Frequency	50 Hz
Voltage Regulator	Made by Basler
Generator Speed	600 rpm

Notes:

- **the efficiencies and Outputs of the Generators have to be confirmed by the Generator manufacturer in the next stage of offering.**
- **Mavel recommend to change the generator voltage to 6.6KV for such unit unit output and also increase the power factor to min. 0,9 to reduce the compensation unit of the power plant**

VIII. Limits of Supply

- Drainage and dewatering pipes embedded into concrete. (Design by Mavel, but execution of work by the Civil constructor)
- Any civil works
- Powerhouse installations. Mavel provides Assembly Advisory Services to local workforce.
- Erection and installation of the Equipment. Mavel provides Assembly Advisory Services to local workforce.
- Trolleys, gangways, ladders, covers etc.
- Cranes and Craneworks.
- Tests and inspections over Mavel's standard scope of supply
- Connection to the grid
- Procurement of any documents, permits, licenses etc.
- Local safe accommodation, security services at the project site, place of accommodation and during local transport.
- Local transport of Mavel's employees (commuting to the project) to and from the airport
- Any taxes, fees, duties, V.A.T. and customs

2. CONDITIONS AND OTHER TERMS

I. Payment Conditions

To be negotiated during contract negotiations.

Proposal:

1. 10% Advanced payment
2. 90% L/C
3. 15% upon approval of Basic Design
4. 15% upon approval of Final Design
5. 30% against shipping docs. of embedded steel parts
6. 10% upon Factory Acceptance Test (FAT) or similar
7. 10% against shipping docs. of the balance of the equipment
8. 5% after Installation
9. 5% upon issuance of Taking Over Certificate (TOC)

II. Warranty

The Warranty period for the Equipment is 24 months from the date of commissioning or 30 months from the date of their delivery CIF Mombasa, whichever comes earlier. The Supplier's Warranty to the Equipment is furnished only under conditions that the Equipment was installed, tested and commissioned under Technical Assistance of the Supplier. The Warranty subjects to the conditions specified by the Supplier in the Contract.

III. Packing

Our proposal includes cost of packaging. The imported equipment will be packed with seaworthy packing. Any claim of the Purchaser concerning damage of the supply of the Goods has to be notified to the Supplier immediately after arrival of the Equipment to CIF nearest seaport.

IV. Exchange Rate

Mavel reserves the right to change the total price should the official exchange rate, provided by the Czech National Bank (CNB), between the USD and the Czech Crown change more than 2% from the date of this proposal to the signing of a contract.

V. Dispatch from Factory

Turbines, including auxiliary equipment will be ready to dispatch as follows:

- Embedded Steel Parts : 7 – 9 months
- Turbine Equipment (balance): 16 - 18 months
- Generators : 16 – 18 months
- Balance of electrical equipment: 16 – 18 months

After delivery of the Equipment to the site, the Customer takes all necessary measures to assure a proper safe unloading, storing and protecting of the Equipment against theft, humidity, flooding, fire, and any other risk, etc. An all risk insurance policy is to be procured by the Customer for the Total Price from the moment of delivery of the Equipment to the site.

The delivery from Mavel's assembly hall to the harbour in Karachi takes approximately 6 -- 8 weeks

Note: The dispatch counts from the date of signing the contract, receipt of the first advance payment and opening L/C, whichever comes later.

VI. Technical Assistance during Assembly and Commissioning.

The price for Technical Assistance during assembly, commissioning and testing is included in the total price.

Technical assistance means providing technical consultancy and physical participation of the Offering Party's expert(s) during the assembly and commissioning works of the Equipment and training of the operating staff as defined in this document.

VII. Limitation of Liability.

Supplier's aggregate liability to the Customer for all claims of any kind under or in connection with the Contract, or Supplier's performance or non-performance of the work or other work required, covered by or furnished pursuant to the Contract, whether based in Contract, tort (including negligence and strict liability), warranty or otherwise shall not exceed 10% of the Total Contract Price. Burden of proof of gross negligence shall be incumbent on Customer.

Supplier and its sub-suppliers shall not be liable for any indirect, special, consequential, or incidental damages of any nature or kind including, without limitation, lost profits or revenues, loss of production and/or financial losses, interruption of operation, cost of capital, costs of replacement products or service, loss or damage to data or third party property, arising out of, related to, or concerning the performance of Supplier pursuant to the Contract documents, including but not limited to liability for negligence, even if Supplier has been advised of the possibility of such damages.

VIII. Other Terms.

For the support of our Technical Assistance during Installation and Commissioning, Internet connection, standard accommodation nearby the Project site and local commuting as well as transport from-to international airport shall be provided by the Purchaser free of charge.
If the Equipment is not possible to deliver to or receive at the site destination or if installation and commissioning cannot be completed latest xx months after contract signing, for reasons not attributable solely to Supplier's control and responsibility, the equipment is considered as accepted by the Customer and the final payments shall become due within 14 days from the written request of Supplier.

The technical proposal is prepared by Mavel solely based upon the input data provided by the Customer. The Customer is solely responsible for such a data in whole and in part.

IX. Proposal Validity

This offer is valid for 90 days from the date of this proposal.

We hope that our proposal of technology will meet your expectations and we look forward to working with you.

Yours sincerely,

Bert Brands and Pavel Skala
Sales dept.
M a v e l, a.s.

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256 01 Benešov
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www.mavel.cz

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Mob. +420 607 478 671
E-mail: brands@mavel.cz

Mob. +420 724 163 742
E-mail: skala@mavel.cz

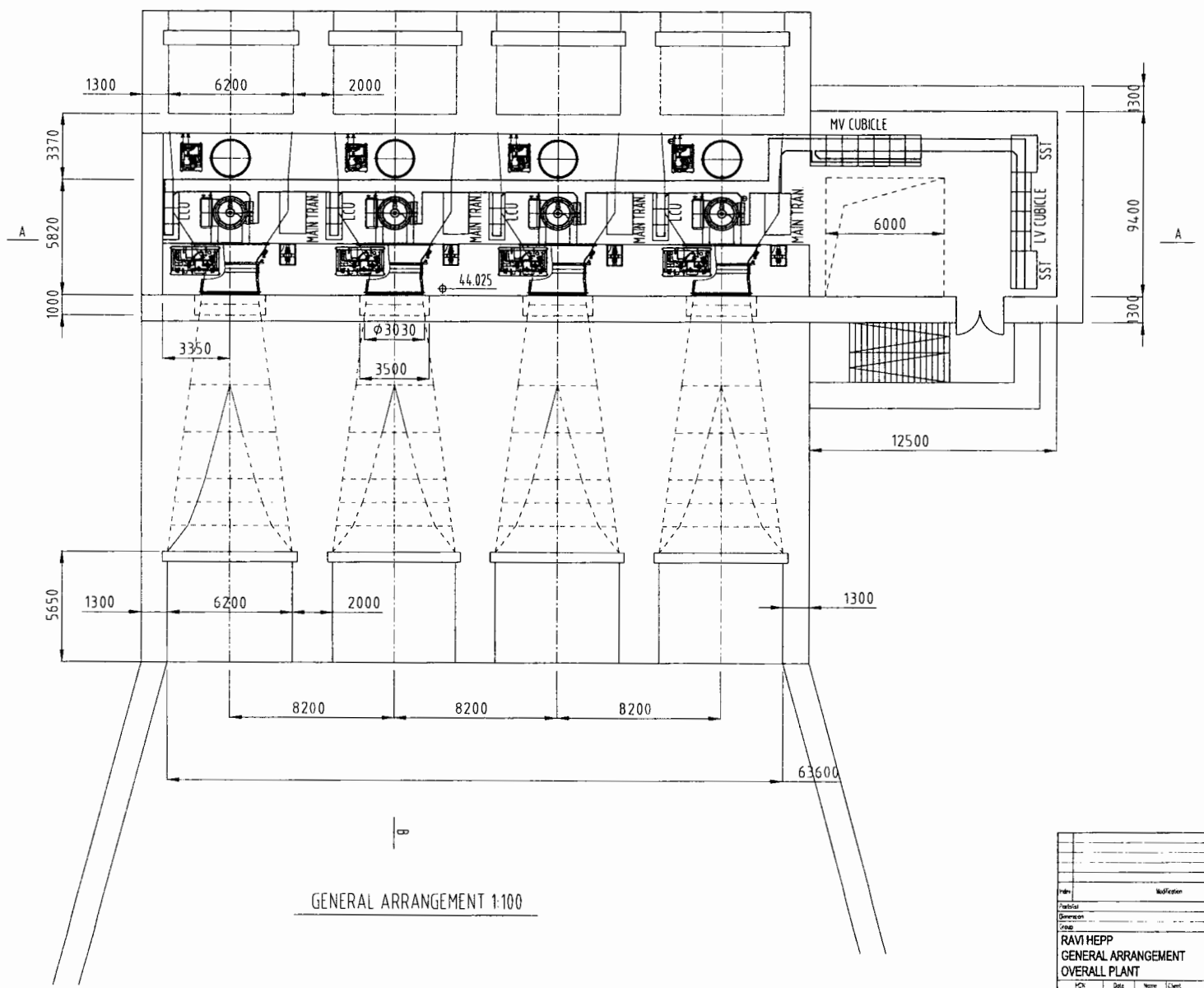
3. LIST OF APPENDICES

Appendix 1:

1.1 Cross section 3-3
1.2 Ground plan 2-2
1.3 Longitudinal section
1.4 Heaviest and largest parts

Appendix 2: **2.1. Technical description of the electrical system**
2.2 Conceptual SLD – LCC
2.3 Conceptual Control system_SCADA – LCC

Appendix 3: **Company ISO Certificates**



GENERAL ARRANGEMENT 1:100

Index	Modification	Date	Prepared by	Checked 1	Checked 2	Approved

Partslist — Art. N°
Generation — Class N°
Group — Type
Sheet

RAVI HEPP
GENERAL ARRANGEMENT
OVERALL PLANT

Weight — Material

HCK	Date	Name	Client
Drawn	2013.11.28	ZNN	Plant: RAVI HEPP
Checked 1	2013.11.28	JAK	Project N°
Checked 2			Contract N°
Appr.		HCK-EPS	File

Rights in protection and use ISO 16016 reserved

Scale: 1:100

Replace

Material N°

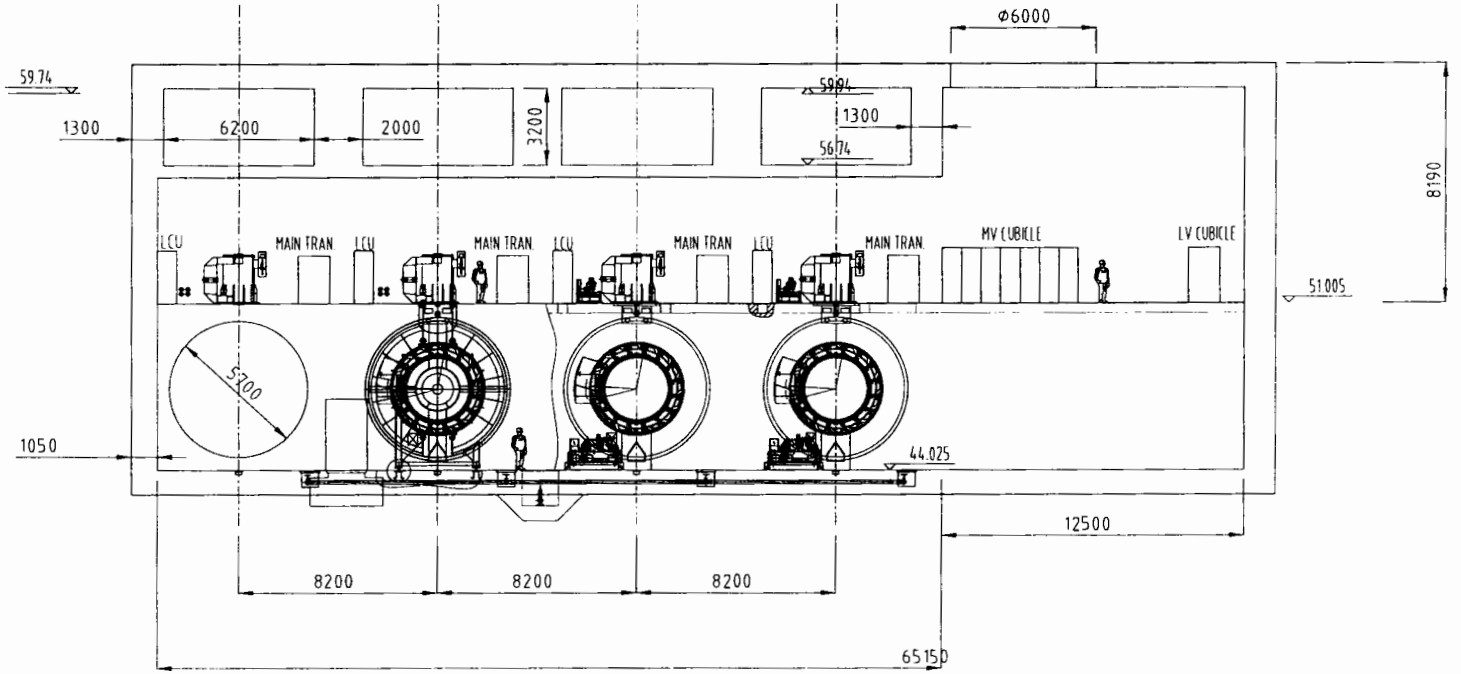
Drawing N°: RVI-200-02-001

Index — Sht. 1 — Id. 3

ANDRITZ Hydro

CAD A1STD1

A1

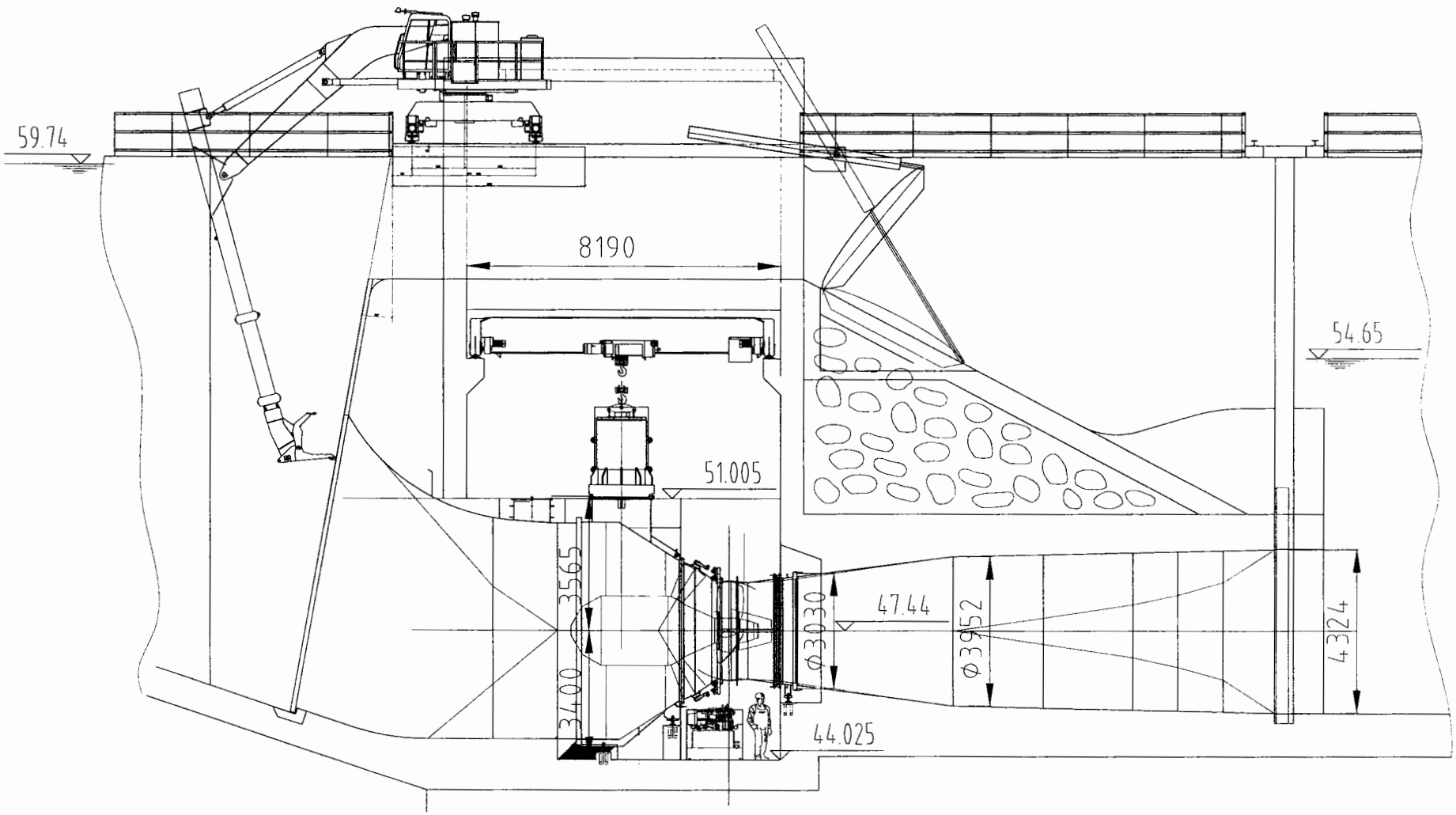


SECTION A-A 1:100

RAVI HEPP
GENERAL ARRANGEMENT
SECTION A-A

ANDRITZ Hydro

RVI-200-02-001



SECTION B-B 1:100

A3ST02				Drawn	2013.11.28	ZNN	Client	ANDRITZ Hydro	RAVI HEPP GENERAL ARRANGEMENT SECTION B-B
CAD				Check	2013.11.28	JXK	Plant RAVI HEPP		
				Appr.			Project-No.		Drw. Nr. RVI-100-01-001 Index Sht 3/3 of A3
M	Modification	Date	Des.	Scale			Code		

ANDRITZ Hydro

Trident Power GR (Private) Limited
359H, Street 4, DHA, Phase V, Lahore Pakistan

Subject: Expression of Interest for Design, Manufacturing, Supply, Installation, Testing & Commissioning of Powerhouse Equipments for 7.5 MW LCC Hydropower Project

Dear Sir,

Andritz Hydro is one of the major supplier of powerhouse equipments operating worldwide. We are very much interested to execute the electromechanical works of 7.5 MW LCC Hydropower Project located on Lower Chenab Canal (LCC) at RD 0+1500, District Gujranwala, Pakistan. We are fully capable and prepared to undertake this project.

It is to express our keen interest that we will fully cooperate with Trident Power GR (Private) Limited for the execution of the said project. We will execute the manufacturing and engineering works upon award of the contract. A brief company profile of our company and reference list of equipments is also enclosed with this letter and you may contact us anytime if you require any information.

Best Regards,
For & On Behalf of Andritz

Name:
Designation:

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Beijing Branch Office
18F/B.1-7 Hanwei Plaza
No.7 Guanghua Road
Chaoyang District
Beijing, P.R.China
Tel.:+86 (10) 6561 3388
Fax: +86 (10) 6561 4192
P.C.:100004
www.andritz.com/hydro

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北京分公司
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中国北京
电话: +86 (10) 6561 3388
传真: +86 (10) 6561 4192
邮政编码：100004
www.andritz.com/hydro

Habib Rafiq (Pvt.) Limited
PROJECT MANAGEMENT DIVISION (PMD)
13-Block-H, Gulberg-II, Lahore-Pakistan.
Tel : (+92-42) 35711411, 35711716
Fax : (+92-42) 35762274, 35757247, 35710890
E-mail: hrl@habibrafiq.com - URL: www.habibrafiq.com

Trident Power GR (Private) Limited
359H, Street 4, DHA, Phase V, Lahore Pakistan

Subject: Expression of Interest for EPC Contract of 7.5 MW LCC Hydropower Project

Dear Sir,

Habib Rafiq Private Limited is an Engineering & Construction Company having experience in infrastructure development sector significantly barrages, canals and highways. We are actively working in hydropower sector and, are very much interested to execute the construction works of 7.5 MW LCC Hydropower Project located on Lower Chenab Canal (LCC) at RD 1+500, District Gujranwala. We are fully capable and prepared to undertake this project.

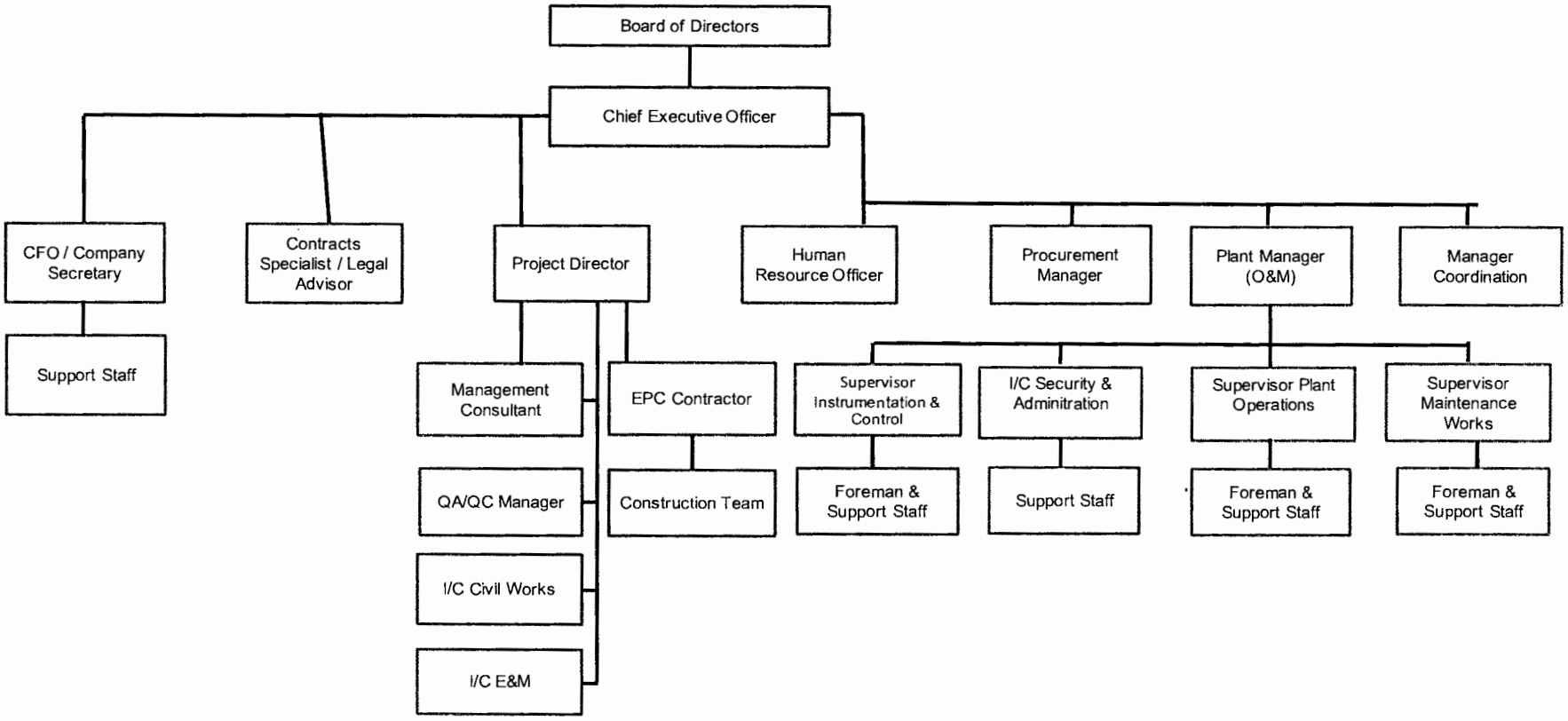
It is to express our keen interest that we will fully cooperate with Trident Power GR (Private) Limited for the execution of the said project. We will participate in the EPC Bidding and execute the construction and detailed engineering works upon award of the contract. A brief company profile of our company is also enclosed with this letter and you may contact us anytime if you require any information.

Best Regards,
Fore & On Behalf of
Habib Rafiq (Pvt.) Limited

Name: **Engr. M. Zahid Nadeem**
Designation: General Manager/ IMR

TRIDENT

ORGANIZATION CHART
TRIDENT POWER GR (PRIVATE) LIMITED.
7.55 MW LCC HYDROPOWER PROJECT



Proposed Personnel

1.	**Proposed Position:** Hydrologist
	Name: Nazakat Hussain
	Qualification/Experience: B.E Civil, NED Karachi; MSE Hydropower, UET Lahore; Masters in Environmental Management Sciences, Holland 16 MW Naltar IV Hydropower Project; 34 MW Harpo Hydropower Project; 40 MW Marala Hydropower Project; 72 MW Khan Khwar Hydropower Project; 130 MW Duber Khawar Hydropower Project; 121 MW Allai Khwar Hydropower Project and a number of small and medium hydropower plants in GB, KP, Punjab and AJK
2.	**Title of Position:** Hydropower Engineer
	Name: Zaheer Butt
	Qualification/Experience: M. Phil (Water Resources Engineering) UET Lahore, Pakistan (1995-98). Post Graduate Diploma in Surface Water Hydrology UNESCO-IHE, Institute for Water Education, Delft, The Netherlands (93-94).B. Sc Civil Engineering UET, Lahore, Pakistan (1979-83) Chief Engineer (Retired 2014) Additional Director WAPDA (Hydro Planning Organization) and managed successfully the design, construction management and contracts management of Jinnah Hydropwer Project published a number of research papers on hydropower technologies worldwide.
3.	**Title of Position:** Project Lead Coordinator
	Name: Usman Anwar
	Qualification/ Experience: B.E Civil NUST Pakistan Project Engineer 20,000 MW Fujairah II independent Water & Power Plant, UAE; Team Leader 4.6 MW Ravi Hydropower Project, LBDC (detailed feasibility study); Team Leader 1.7 MW Kot Sarwar Hydropower Project, Jhang Branch Canal; 5 MW Chashma II Hydropower Project, Chashma near Mianwali (Tender Design Manager) 4 MW Thak Chilas Hydropower Project, Chillas (Tender Design Manager); Detailed Project Scheduling and Cost Estimation for 650 MW Lower Palas HPP, Palas Valley, GB for Daewoo E&C; Tender Design Manager 26 MW Shigarthang HEPP; 4.8 MW Sahiwal Hydropower Project, (Feasibility Review) Contributions on few small hydropower projects in Punjab.

4.	**Title of Position:** Advisor
	Name: Dr. Tabassum Zahoor
	Qualification/ Experience: Doctor of Philosophy (Ph.D.), Civil Engineering Colorado State University, Fort Collins, USA; Master of Engineering (M.Engg.), Water Resources Engineering from Asian Institute of Technology (AIT), Bangkok, Thailand. Bachelor of Engineering (B.E.), Civil Engineering N.E.D. University of Engineering and Technology, Karachi. Design Team Leader - Construction of Jinnah Barrage Rehabilitation Project. Chief Hyraulics Neelam Jehlum HEPP Hydraulics Expert 184 MW Chashma Hydropower Project. Team Leader Design and Construction of 1.8 MW Foundation Hydel Power Project. Hydraulics Expert Ranolia HEPP Design Team Leader Naltar Hydropower Project
5.	**Title of Position:** Lead Structural Engineer
	Name: Muhammad Hamza Saeed
	Qualification/ Experience: MSc Structural Engineering MS Structural CGPA: 3.80 (4.0 Scale) GOLD MEDALIST; BE Civil NUST Multipurpose Machalgho Hydropower project Paktia Afghanistan Multipurpose Pashdan Hydropower Project Harat Afghanistan Satpara Hydropower Project, Skardu Pakistan Detail design of Chapra dam KPK Pakistan Detail design of Kiyala dam KPK Pakistan Bada Dam Spilway Ghol Banda Dam Spilway Aquaducts For Palai Dam Project Design Review of Patrind Hydropower project Muzafarabad
6.	**Title of Position:** Highway Engineer (for access roads)
	Name: M. Yaseen Yousafzai
	Qualification/ Experience: BE Civil NUST Project Manager Muzzaffar Abad Chakothi Road Muzaffarabd Kokala Bridge A number of highway projects in KPK & AJK on behalf of FWO

7.	**Title of Position: Planning /Scheduling Engineer**
	Name: Omer Islam
	Qualification/ Experience: Civil Engineering from NUST with experience of construction management in infrastructure development projects within Pakistan significantly Mangla Dam Raising Project, Satpara Dam Project and Construction of New Khanki Barrage.
8.	**Title of Position: Sr. Mechanical Engineer (Turbine Expert)**
	Name: Hafiz Nazim
	Qualification/ Experience: BE Mechanical, UET, Lahore Turbine Lead Expert Neelam Jehlum Hydropower Project, AJK Ravi Hydropower Project, LBDC, Punjab Kot Sarwar Hydropower Project, JBC, Punjab
9.	**Title of Position:** Mechanical Engineer (Hydromechanical Equipments)
	Name: Abdul Rehman
	Qualification/ Experience: B.Sc. Mechanical, UET, Lahore Project Design Engineer Construction of New Khanki Barrage Design of Hydraulic Gates of Cross Regulators of LBDC
10.	**Title of Position:** Electrical Engineer
	Name: Yaseen Bhatti
	Qualification/ Experience: B.Sc. (Electrical) Engg Power: Year (Annual, 1971). 42 years of experience in construction, operation, maintenance and rehabilitation / up-gradation of Hydel Turbines, preparation of specification of turbines and generator for capacity enhancement of all electro-mechanical equipment and its related auxiliaries. Experience of planning, design, construction, commissioning and operational/maintenance experience of 11KV lines, dewatering system all along the Power Channel of Ghazi-Barotha.

11.	**Title of Position:** Geological Engineer
	Name: Abdul Rehman
	Qualification/ Experience: Highly qualified and experienced Geological Engineers having Gold Medal from PAEC, Tamgha-i-Baga from PAEC with services and expertise on a number of dam and river projects countrywide.
12.	**Title of Position:** Survey Engineer
	Name: Munawar Hussain
	Qualification/ Experience: Graduation course in Surveying technology from Survey of Pakistan Training Institute, Risalpur during 1965-1967. Highly professional & extensive experience in surveying, leveling, bathymetric surveying, planning of projects in Pakistan and abroad on rivers, hilly areas and canals etc.
13.	**Title of Position:** Chief Economist (For Economic Analysis)
	Name: Mian Muhammad Hafeez-Ur-Rehman
	M.Sc. Agricultural Economics, University of Agriculture, Faisalabad (1974); B.Sc. Agriculture - University of Agriculture, Faisalabad (1969) Second Division. Chief Economist Retired from WAPDA from Dasu Hydropower Project.
14.	**Title of Position:** Economist (For Financial Analysis)
	Name: Irfan Ahmad
	Qualification/Experience: Chartered Accountant Prepared financial and economic analysis of a number of thermal, IWPP and hydropower plants
15.	**Title of Position:** Quantity Surveyor/Draftsman
	Name: Imran Saeed
	Qualification/Experience: DAE Civil Managed the quantification and estimation Ravi Hydropower Project, Kot Sarwar Hydropower Project and number of roads, industrial and building projects etc.

16.	**Title of Position:** Lead Auto Cad Operator
	Name: Muhammad Ali
	Qualification/Experience: DAE Civil Responsible for drafting drawings on cad and contributed on Dasu HEPP as lead Cad Operator, Naltar IV HPP, Ravi HPP and Keyal Khwar HPP
17.	**Title of Position:** Accountant/ Administration
	Name: Muhammad Sajid
18.	**Title of Position:** Mechanical Engineer (for design of cooling water system of powerhouse)
	Name: Israr Ahmad Niazi
	Qualification/Experience: B.E Mechanical, NED, Karachi Sr. Design Manager for design of cooling water system for Dasu HPP; Pumps Station for New Khanki Barrage etc.

11.1 GENERAL

The project cost estimate involves preliminary works, complete civil and electromechanical works, installation, testing and commissioning charges of mechanical items, cost of procuring services of engineering & project management consultant and acquisition of land.

We have quantified all the items and considered the prevailing rates being charged by the Contractor for the Construction of New Khanki Barrage. Furthermore, Material Rate System of Government of Punjab (MRS-2015) has also been considered for the comparison of civil works. Meanwhile, cost of few similar hydroelectric power projects have also been considered for comparison purposes.

The project construction schedule is considered 26 which include detailed engineering, civil works, manufacturing, supply and commissioning of electromechanical works etc. Since a detailed topographic surveying and geotechnical investigations was not carried out at this stage, therefore, we have considered contingencies in quantifying the jobs for excavation and structural works.

11.2 MAIN BILL OF QUANTITIES (BOQ'S)

The BOQs of civil works as presented in Table 11.1 have been worked out from the proposed project layout plan and quantities furnished after preliminary design of the components of the power plant. All the items are quantified on the basis of early engineering carried out at this stage and are expected to be changed during execution phase. Similarly, the prices of electromechanical works are furnished on the basis of preliminary design.

Table 11.1: Project Cost Estimate

Sr. #	Description of Work	Unit	Quantity	Amount (Rs.)
1	Excavation & Dressing	Cft	12,092,340.00	141,119,478
2	Canal Lining	Cft	1,375,888.00	63,572,886
3	Dewatering	LS	1.00	18,098,000
4	Road Works	Cft	111,350.00	12,293,040
5	Power House & Spillway	LS	1.00	323,912,123
6	Concrete	Cft	341,682.50	131,870,250
7	Reinforcement	Ton	1,005.00	135,495,000
8	Miscellaneous including land acquisition, preliminary costs, Project Management Consultant Fee etc.,	LS	1.00	217,000,000
10	Hydro Mechanical for Spillway Gates	LS	1.00	110,000,000
11	Electromechanical	LS	1.00	1,308,349,223
	Total			**2,461,709,999**

11.3 BASIS OF PRICES

- Rates being charged at the Construction of New Khanki Barrage including escalation up to year 2015 have been considered.
- Cost of electromechanical equipments has been considered from European origin.
- The enlisted bill of quantities is kept slightly higher and all quantities furnished as per the site requirements and proposed project layout plan.
- Financial charges have been included.
- Cost of conducting detailed engineering, tender preparation and verification and project management consultancy have been included in our prices.

Table-11.2: Cost Estimate of Civil Works

Sr. #	Description of Work	Unit	Quantity	Amount (Rs.)
1	Excavation & Dressing	Cft	12,092,340.00	141,119,478
2	Canal Lining	Cft	1,375,888.00	63,572,886
3	Dewatering	LS	1.00	18,098,000
4	Road Works	Cft	111,350.00	12,293,040
5	Power House & Spillway	LS	1.00	323,912,123
6	Concrete	Cft	341,682.50	131,870,250
7	Reinforcement	Ton	1,005.00	135,495,000
8	Miscellaneous	LS	1.00	217,000,000
10	Hydro Mechanical	LS	1.00	110,000,000
Total				**1,153,360,776**

Table-11.3: Earthworks

Sr. #	Description of Work	Unit	Quantity	Unit Rate (Rs.)	Amount (Rs.)
1	Excavation in Temporary Diversion Canal	Cft	6,875,000	10.00	68,750,000
2	Excavation in Access Road	Cft	89,080	8.00	712,640
3	Excavation in Power House (30m lead)	Cft	252,000	18.00	4,536,000
4	Excavation in Power House (150m lead)	Cft	108,000	17.00	1,836,000
5	Headrace Canal Filling	Cft	4,500,000	14.00	63,000,000
6	Excavation for Spillway	Cft	56,250	18.00	1,012,500
7	Dressing of subgrade on bed	Sft	155,400	5.00	777,000
8	Dressing of subgrade on slope	Sft	56,610	8.75	495,338
Sub Total- 1			**12,092,340**		**141,119,478**

Table-11.4: Canal Lining

Sr. #	Description of Work	Unit	Quantity	Unit Rate (Rs.)	Amount (Rs.)
1	Stone Pitching u/s of Powerhouse	Cft	375,000	55.00	20,625,000
2	Stone Pitching on Embankments	Cft	72,000	244.27	17,587,086
3	Stone Pitching d/s powerhouse	Cft	300,000	55.00	16,500,000
4	Temporary Canal Prisom Works	Cft	625,000	12.00	7,500,000
5	Brick Masonry	Cft	3,888	350.00	1,360,800
Sub Total- 2			**1,375,888**		**63,572,886**

Table 11.5: Dewatering

Sr. #	Description of Work	Unit	Quantity	Amount (Rs.)
1	Dewatering	LS	1	18,778,750
	Sub Total-3			**18,778,750**

Table 11.6: Road Works

Sr. #	Description of Work	Unit	Quantity	Amount (Rs.)
1	Sub Base Course	cft.	44,540	1,692,520
2	Base Course	cft.	44,540	2,583,320
3	Asphaltic Wearing Course	cft.	22,270	8,017,200
	Sub Total-4			**12,293,040**

Table 11.7: Power House & Spillway

Sr. #	Description of Work	Unit	Quantity	Amount (Rs.)
1	Powerhouse (Building accessories, flooring, etc)	LS	1	323,912,123
	Sub Total-5			**323,912,123**

Table 11.8: Concrete

Sr. #	Description of Work	Unit	Quantity	Amount (Rs.)
1	Lean Concrete	Cft	7,500	370.00
2	Structural Concrete - Power House	Cft	173,256	520.00
3	Structual Concrete - Spillway	Cft	58,438	490.00
4	Concrete - Other	Cft	11,200	450.00
5	Plaster layer on bed	Sft	75,946	55.00
6	Plaster layer on slope	Sft	15,343	75.00
	Sub Total- 6		**341,683**	

Table 11.9: Steel Reinforcement

Sr. #	Description of Work	Unit	Quantity	Amount (Rs.)
1	Steel Reinforcement – Powerhouse & Spillway	Ton	987	133,245,000
2	Steel Reinforcement – Other	Ton	18	2,250,000
	Sub Total-7			**135,495,000**

Table 11.10: Miscellaneous

Sr. #	Description of Work	Unit	Quantity	Amount (Rs.)
1	Bridge	LS	1	2,000,000.00
2	PMC, Land Acquisition Etc	LS	1	150,000,000.00
3	O&M Staff Colony	LS	1	50,000,000.00
Sub Total-8				**202,000,000**

Table 11.10: Electromechanical Works

Sr.No	Description	Unit	Qty	Rate Per Unit (PKR)	Total Cost (PKR)
1	**MECHANICAL EQUIPMENT**				
1.1	Pit type kaplan Double regulated horizontal shaft turbines, 1900 KW, complete with flow meters, pressure gauges, draft tubes, steel liners, foundation steel frames, anchores etc.	Set	4	172,710,000.00	690,840,000
1.2	cooling water system including pumps, piping, valves strainers etc.	Set	4	4,750,000.00	19,000,000
1.3	Drainage and Dewatering pump, complete with electric motor of about 3 HP, suction and delivery pipes	No.	4	1,000,000.00	4,000,000
1.4	Digital Governors complete with PID characteristics,based on PLC instrumentation and indications, power and control cables, hydraulic power packs,Auto frequency and speed control, Automatic local control,Manual and auto mode,Speed adjustable (0-10%),Black start operation,Hydraulic oil (charged plus spare)	Set	4	2,396,578.00	9,586,312

1.5	Powerhouse (20 Tonne) pendant operated bridge crane complete with runway conductors, power cable, chain pulley blocks, slings, rails, embedded anchors, sole pales etc.	No	1	3,000,000.00	3,000,000
1.6	Parallel shaft speed increaser(gears) with speed ratio of 85.7/750	No	4	1,530,976.00	6,123,904
1.7	Water Level Measuring Devices	Nos	4	550,000.00	2,200,000
1.8	Control and instrumentation	Lot	4	2,750,990.00	11,003,960
1.9	Fire extinguisher (dry powder type) of capacity 8 kg	No.	8	87,200.00	697,600
1.1	Painting of all Hydraulic and Mechanical structures	Lump sum			
1.11	Spare parts for turbines, digital governors, mechnaical auxilliaries, generators, synchronizer, control panels etc. for five (5) years operation (provide a seprate detail and breakdown prices of spares)	Lot	1	13,860,000.00	13,860,000
1.12	Items necessary for the operation of the Turbine-generating units and maintenance tools (give details)	Set	1	8,000,000	8,000,000
2	**HYDRAULIC STEEL STRUCTURE**				
2.1	At power intake structure 8.96m wide and 9.7 m high stoplog (4 sections) including embeded parts, rails etc	No	1	9,800,000	9,800,000
2.2	Removable trashrack along with rail for power intake 9.0m width and 12.0m height complete with 1st and 2nd stage embedded parts	No	2	1,900,000	3,800,000
2.3	Trashrack Cleaner (Inclined, Hoist boom, max. rotation 330°, Rake "payload" 2 tonnes, Grab net capacity 4 tonnes along with trolley, Payload minimum 3 tonnes	No	1	12,000,000	12,000,000

2.4	Mobile Crane 2 tonne for handling Stoplog , at inlet and outlet and Trashrack (**optional**)	No	1	8,000,000	8,000,000
2.5	Draft Tube outlet stoplogs (width 8.96 m x Height 6.4m complete with embeded parts	No	4	5,500,000	22,000,000
2.6	Two monorail hoists 3 ton capacity for handling of intake stoplogs, trashrack, outlet stoplog.	No	2	1,200,000	2,400,000
Total Mechanical (A)					**826,311,776**
3	**ELECTRICAL EQUIPMENT**				
3.1	**GENERATORS**				
3.1.2	Generators rated 1.97 MVA,P.f.0.85, along with generator control panel, static excitation and AVR panel, Field switch cubicle	No	4	77,000,000.00	308,000,000
3.1.3	Generator Circuit Breaker Cubicle	No	4	8,500,000	34,000,000
3.1.4	Generator Earthing Cubicle	No	3	2,190,000	6,570,000
3.1.5	Measuring/signalling devices	Lot	1	500,000	500,000
3.2	**TRANSFORMERS**				-
3.2.1	Step up transformer	No	4	6,000,000	24,000,000
3.2.2	Auxiliary transformer 100 kVA,11kV/0.4 kV for station services	No	3	4,000,000	12,000,000
3.2.3	Distribution transformer of size 100 kVA ,11kv/400 volts	No	8	2,300,000	18,400,000
3.2.4	Distribution transformer of size 200 kVA ,11kv/400 volts	No	6	1,500,000	9,000,000
3.2.5	Distribution transformer of size 2.95 MVA,11kV/575V for steel furnace	No.	4	1,100,000	4,400,000
3.3	**SWITCHGEARS**				-
3.3.1	11/33kV Switchgear Panels complete	No	8	2,300,000	18,400,000

3.3.2	Low Voltage Distribution panels with MCCBs	No	6	2,000,000	12,000,000
3..4.1	Battery and Battery Charger complete	Sets	2	1,600,000	3,200,000
3.4.2	D.C/A.C converters/Inverters, including UPS	Lot	1	1,870,000	1,870,000
3.4.3	220 V D.C distribution Panel	No.	1	3,000,000	3,000,000
3.4.4	48 V D.C distribution Panel	No.	1	2,000,000	2,000,000
3.4.5	CONTROL, Protection and Instrumentation System for Generators and their auxiliaries, Transformers, MV and LV system, including operator station	Lot	1	2,570,000	2,570,000
3.4.6	EARTHING SYSTEM complete including connections to individual equipments/systems			2,400,000	2,400,000
3.4.7	FIRE Detection and fire alarm SYSTEM	Lot	1	6,000,000	6,000,000
3.4.8	Cable trays and MV Power Cables with termination and all other accessories	Lot	1	7,600,000	7,600,000
3.4.9	Cable trays and Low voltage cables with termination and all other accessories	Lot	1	1,200,000	1,200,000
3.4.10	Cable trays and Control Cables with termination and all other accessories	Lot	1	2,100,000	2,100,000
3.4.11	Internal and External lighting power house and fence area.	Lot	1	2,500,000	2,500,000
3.4.12	TELECOMMUNICATION SYSTEM, consisting of PABX, telephone cabling, telephone sets etc.	Lot	1	800,000	800,000
Total Electrical (B)					**482,510,000**
Total - E& M (A+B)					**1,308,349,224**

Total EPC Cost as mentioned in Table 11.1 above is PKR 2,461,709,999 and the same has been considered for financial analysis.

13.1 GENERAL

The objective of this analysis is to walk around the feasibility of 7.5 MW hydropower plant proposed at Lower Chenab Canal at RD 0+000, District Gujranwala, province of Punjab, Pakistan whereby the Sponsor is interested to develop this project on IPP mode as per Punjab Power Generation Policy 2006 (Revised 2009). The financial viability of the hydropower plant is examined using the integrated appraisal structure (integrated approach uses IRR & NPV appraisal techniques) which analyzes the project and its desirability in different perspective. The project magnetism will be examined from the investor's point of view and bankers' judgment while evaluating the cost of power and energy generated.

Following is analyzed in this chapter:

1. Viability of the project in accordance to NEPRA's upfront tariff.
2. What sources of financing will be used to cover the project's costs? What are the features of this kind of financing?
2. Is there any sufficient working capital in the project?
3. What is the contribution of the project to the investors?
4. What are the risks of the project and how can we mitigate it in order to guarantee the viability and sustainability of the project?
5. Is the project financially viable in terms of enough net cash flows?

Integrated approach uses IRR, NPV appraisal techniques.

13.2 PROJECT COST

Project involves following costs:

a. Construction Cost
b. Operation cost

13.2.1 CONSTRUCTION COST

At Rupee to Dollar parity rate of Rs. 101.10 (sourced from National Bank of Pakistan dated 10th February, 2015) the project cost is estimated to be PKR 2,461,710,000.00.

Debt equity ratio is proposed to be 75:25. Seventy five percent of the project cost before interest shall be financed by bank borrowing, the debt shall be retired in first 10 years of its operation. Project cost is estimated to be as under:

Table 13.1: Project Cost Estimate

Sr. #	Description of Work	Unit	Quantity	Amount (Rs.)
1	Excavation & Dressing	Cft	12,092,340.00	141,119,478
2	Canal Lining	Cft	1,375,888.00	63,572,886
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8	Miscellaneous	LS	1.00	217,000,000
10	Hydro Mechanical	LS	1.00	110,000,000
11	Electromechanical	LS	1.00	1,308,349,223
	Total			**2,461,709,999**

Out of total cost of Rs. 984.68 million, Rs. 984.68 million & Rs. 492.34 million shall be incurred in the first, second and third year respectively.

13.2.2 OPERATION COST

Operation cost includes the following:

i. Water usage charges.
ii. Insurance.
iii. Variable operation and maintenance.

13.2.2.1 WATER USAGE CHARGES

As per clause 8.2.3 of Punjab Power Generation Policy 2006 (revised in 2009) the water use charges shall be fixed at the rate of PKR 0.15/kwh. The same has been considered while determining the tariff.

13.2.2.2 INSURANCE COST

Insurance cost on EPC is 1% of the project cost.

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13.2.2.3 VARIABLE OPERATION AND MAINTENANCE

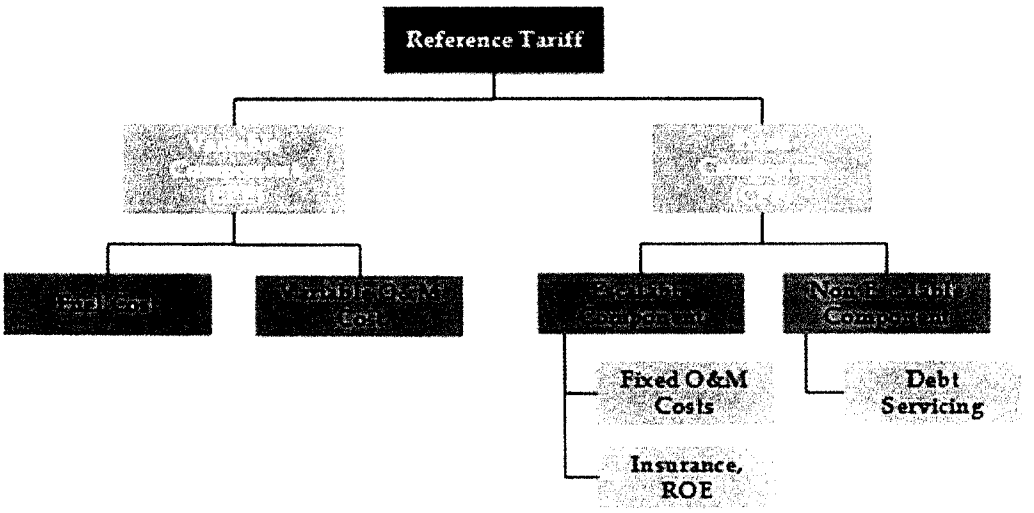
It includes salaries of staff, boarding, lodging and plant maintenance cost. It has been considered while furnishing the final tariff and cash flow of the project.

13.3 REVENUE

The project shall sell the units produced to power purchaser through 11 KV transmission line, however, using the step-up transformer it shall be linked with Waziarabad 132 Kv grod station.

13.3.1 TARIFF STRUCTURE

Tariff under the 2002 Power Policy of Government of Pakistan has two basic components – Energy Purchase Price (Variable Component) and Capacity Purchase Price (Fixed Component).



13.3.2 TWO-PART TARIFF STRUCTURE

13.3.2.1 CAPACITY PURCHASE PRICE

The CPP is the payment made for components that are independent of the amount of electricity generated; in essence, this component of the tariff is paid for "being there" and is irrespective of dispatch. The CPP is paid monthly by WAPDA as long as the plant availability is in line with the established Dependable Capacity (required and checked by WAPDA). The CPP has two fundamental components: the Escalable portion and the inescapable portion.

13.3.2.2 ESCALABLE COMPONENT

This component is the driver of IPP profitability and includes expenses that are indexed to inflation and PKR/USD parity. The escalable component is adjusted for inflation (linked to US CPI) and for changes in the exchange rate. Included under this component are operation and maintenance costs, insurance costs and the ROE component.

13.3.2.3 NON ESCALABLE COMPONENT

This component covers debt servicing charges, including interest payments, principal repayment and any other lender fees. The debt servicing component is not indexed.

13.3.2.4 ENERGY PURCHASE PRICE

The EPP is the component of the tariff which is based on the actual dispatch of the plant, with fuel costs being the main component (for thermal plants), and includes variable O&M costs which are indexed to inflation (linked to US CPI) and adjusted for PKR/USD exchange rate movements. Any increases in the fuel costs are directly translated into a higher tariff.

As reflected by the structure of the EPP, fuel cost is essentially a pass-through item and the entire impact of the increase/decrease is passed on. In hydro power there is no impact of oil prices.

13.4 PROPOSED TARIFF

Proposed tariff is based on the following data:

Production Estimate LCC Hydro Power Project	
Plant Capacity (MW)	7.5
Plant factor	66.53%
Production (Annual) KWH	45.51
Production (Over life) KWH	1365.3
Conversion Rate	101.10

Table 13.2: Proposed Tariff

Description	**Years**		**Years**	
	1-10	**11-30**	**1-10**	**11-30**
	Rs. /KWh	**Rs. /KWh**	**Us Cents /KWh**	**Us Cents /KWh**
Fixed Cost				
Water usage charges	0.15	0.15	0.15	0.15
Insurance	0.70	0.28	0.69	0.28
Debt Service	8.35	-	8.26	-
Return on equity	2.37	2.37	2.35	2.35
Total Fixed Cost	**11.57**	**2.80**	**11.45**	**2.77**
Variable Cost				
Operation & Maintenance	0.58	0.58	0.58	0.58
Total	**12.15**	**3.38**	**12.03**	**3.35**

Over the first 10 years of plant operation the proposed tariff is Rs. 12.15 /KWh and over the remaining life it is Rs. 3.38/KWh. In first ten years tariff is higher due to debt servicing of the loan as per industry practice.

13.5 DEBT SERVICE

Debt servicing includes repayment of principal and interest. It is assumed that loan shall be obtained from local bank. Applicable interest is one year KIPBOR + 350 basis points at current rates it comes to 10%.

Table 13.3: Loan Schedule					
Year	Opening Balance	Installment	Interest	Principal	Closing Balance
1	2,282,743,683	371,506,022	228,274,368	143,231,654	2,139,512,029
2	2,139,512,029	371,506,022	213,951,203	157,554,819	1,981,957,210
3	1,981,957,210	371,506,022	198,195,721	173,310,301	1,808,646,909
4	1,808,646,909	371,506,022	180,864,691	190,641,331	1,618,005,578
5	1,618,005,578	371,506,022	161,800,558	209,705,464	1,408,300,113
6	1,408,300,113	371,506,022	140,830,011	230,676,011	1,177,624,103
7	1,177,624,103	371,506,022	117,762,410	253,743,612	923,880,491
8	923,880,491	371,506,022	92,388,049	279,117,973	644,762,518
9	644,762,518	371,506,022	64,476,252	307,029,770	337,732,747
10	337,732,747	371,506,022	33,773,275	337,732,747	0
		3,715,060,221	**1,432,316,538**	**2,282,743,683**	

13.6 RETURN ON EQUITY

It is the return to the owner of the project over its life. In current law and order situation the proposed return of equity of 17% is based on the following factors:

Looting of pedestrian	0.50%
Hostility of locals	0.50%
Business venture risk	0.50%
Bureaucratic hurdles	0.50%
Total Risk	2.00%
Add allowed by NEPRA	15.00%
Total return on equity	17.00%

Equity repatriation and dividend is proposed to be as under:

Table 13.4: Return on Equity

Year	Initial Investment	Total Repayment	Dividend	Equity Repatriation	Closing Balance
1	615,427,500	105,573,232	104,622,675	950,557	614,476,943
2	614,476,943	105,573,232	104,461,080	1,112,151	613,364,792
3	613,364,792	105,573,232	104,272,015	1,301,217	612,063,575
4	612,063,575	105,573,232	104,050,808	1,522,424	610,541,152
5	610,541,152	105,573,232	103,791,996	1,781,236	608,759,916
6	608,759,916	105,573,232	103,489,186	2,084,046	606,675,870
7	606,675,870	105,573,232	103,134,898	2,438,334	604,237,536
8	604,237,536	105,573,232	102,720,381	2,852,850	601,384,686
9	601,384,686	105,573,232	102,235,397	3,337,835	598,046,851
10	598,046,851	105,573,232	101,667,965	3,905,267	594,141,584
11	594,141,584	105,573,232	101,004,069	4,569,162	589,572,422
12	589,572,422	105,573,232	100,227,312	5,345,920	584,226,502
13	584,226,502	105,573,232	99,318,505	6,254,726	577,971,776
14	577,971,776	105,573,232	98,255,202	7,318,030	570,653,746
15	570,653,746	105,573,232	97,011,137	8,562,095	562,091,651
16	562,091,651	105,573,232	95,555,581	10,017,651	552,074,001
17	552,074,001	105,573,232	93,852,580	11,720,651	540,353,349
18	540,353,349	105,573,232	91,860,069	13,713,162	526,640,187
19	526,640,187	105,573,232	89,528,832	16,044,400	510,595,787
20	510,595,787	105,573,232	86,801,284	18,771,948	491,823,840
21	491,823,840	105,573,232	83,610,053	21,963,179	469,860,661

22	469,860,661	105,573,232	79,876,312	25,696,919	444,163,741
23	444,163,741	105,573,232	75,507,836	30,065,396	414,098,346
24	414,098,346	105,573,232	70,396,719	35,176,513	378,921,833
25	378,921,833	105,573,232	64,416,712	41,156,520	337,765,313
26	337,765,313	105,573,232	57,420,103	48,153,128	289,612,185
27	289,612,185	105,573,232	49,234,071	56,339,160	233,273,025
28	233,273,025	105,573,232	39,656,414	65,916,817	167,356,208
29	167,356,208	105,573,232	28,450,555	77,122,676	90,233,531
30	90,233,531	105,573,232	15,339,700	90,233,531	(0.00)
		3,167,196,947	2,551,769,447	615,427,500	

13.7 WACC

Real Weighted average cost of capital at proposed capital structure is worked out to be 10.74%.

13.8 PROJECT APPRAISAL

Inflows and outflows of the project have placed under this table to work out IRR and NPV.

TRIDENT POWER GB (PRIVATE) LIMITED

Table 13.5: Financial Model

YEAR	PROJECT COST	VARIABLE O&M		Water Discharge	Insurance Cost	TOTAL COST	CAPACITY KWh	CPP CHARGES	EPP CHARGES	TOTAL REVENUES	NET REVENUES
		Local	Foreign								
1	(984,684,000)	-	-	-	-	(984,684,000)	-	-	-	-	(984,684,000)
2	(984,684,000)	-	-	-	-	(984,684,000)	-	-	-	-	(984,684,000)
3	(492,342,000)	-	-	-	-	(492,342,000)	-	-	-	-	(492,342,000)
4	-	(12,982,849)	(12,982,849)	(6,675,777)	(28,015,655)	(60,657,130)	44,505,180	11.42	0.73	540,692,518	480,035,388
5	-	(12,982,849)	(12,982,849)	(6,675,777)	(36,516,957)	(69,158,432)	44,505,180	11.42	0.73	540,692,518	471,534,086
6	-	(12,982,849)	(12,982,849)	(6,675,777)	(35,212,780)	(67,854,255)	44,505,180	11.42	0.73	540,692,518	472,838,263
7	-	(12,982,849)	(12,982,849)	(6,675,777)	(33,908,603)	(66,550,078)	44,505,180	11.42	0.73	540,692,518	474,142,440
8	-	(12,982,849)	(12,982,849)	(6,675,777)	(32,604,426)	(65,245,901)	44,505,180	11.42	0.73	540,692,518	475,446,617
9	-	(12,982,849)	(12,982,849)	(6,675,777)	(31,300,249)	(63,941,724)	44,505,180	11.42	0.73	540,692,518	476,750,794
10	-	(12,982,849)	(12,982,849)	(6,675,777)	(29,996,072)	(62,637,547)	44,505,180	11.42	0.73	540,692,518	478,054,971
11	-	(12,982,849)	(12,982,849)	(6,675,777)	(28,691,895)	(61,333,370)	44,505,180	11.42	0.73	540,692,518	479,359,148
12	-	(12,982,849)	(12,982,849)	(6,675,777)	(27,387,718)	(60,029,192)	44,505,180	11.42	0.73	540,692,518	480,663,325
13	-	(12,982,849)	(12,982,849)	(6,675,777)	(26,083,541)	(58,725,015)	44,505,180	11.42	0.73	540,692,518	481,967,502
14	-	(12,982,849)	(12,982,849)	(6,675,777)	(24,779,364)	(57,420,838)	44,505,180	2.65	0.73	150,604,388	93,183,550
15	-	(12,982,849)	(12,982,849)	(6,675,777)	(23,475,187)	(56,116,661)	44,505,180	2.65	0.73	150,604,388	94,487,727
16	-	(12,982,849)	(12,982,849)	(6,675,777)	(22,171,010)	(54,812,484)	44,505,180	2.65	0.73	150,604,388	95,791,904
17	-	(12,982,849)	(12,982,849)	(6,675,777)	(20,866,833)	(53,508,307)	44,505,180	2.65	0.73	150,604,388	97,096,081
18	-	(12,982,849)	(12,982,849)	(6,675,777)	(19,562,655)	(52,204,130)	44,505,180	2.65	0.73	150,604,388	98,400,258
19	-	(12,982,849)	(12,982,849)	(6,675,777)	(18,258,478)	(50,899,953)	44,505,180	2.65	0.73	150,604,388	99,704,435
20	-	(12,982,849)	(12,982,849)	(6,675,777)	(16,954,301)	(49,595,776)	44,505,180	2.65	0.73	150,604,388	101,008,612
21	-	(12,982,849)	(12,982,849)	(6,675,777)	(15,650,124)	(48,291,599)	44,505,180	2.65	0.73	150,604,388	102,312,789
22	-	(12,982,849)	(12,982,849)	(6,675,777)	(14,345,947)	(46,987,422)	44,505,180	2.65	0.73	150,604,388	103,616,966
23	-	(12,982,849)	(12,982,849)	(6,675,777)	(13,041,770)	(45,683,245)	44,505,180	2.65	0.73	150,604,388	104,921,143
24	-	(12,982,849)	(12,982,849)	(6,675,777)	(11,737,593)	(44,379,068)	44,505,180	2.65	0.73	150,604,388	106,225,320
25	-	(12,982,849)	(12,982,849)	(6,675,777)	(10,433,416)	(43,074,891)	44,505,180	2.65	0.73	150,604,388	107,529,497
26	-	(12,982,849)	(12,982,849)	(6,675,777)	(9,129,239)	(41,770,714)	44,505,180	2.65	0.73	150,604,388	108,833,674
27	-	(12,982,849)	(12,982,849)	(6,675,777)	(7,825,062)	(40,466,537)	44,505,180	2.65	0.73	150,604,388	110,137,851
28	-	(12,982,849)	(12,982,849)	(6,675,777)	(6,520,885)	(39,162,360)	44,505,180	2.65	0.73	150,604,388	111,442,028
29	-	(12,982,849)	(12,982,849)	(6,675,777)	(5,216,708)	(37,858,183)	44,505,180	2.65	0.73	150,604,388	112,746,205
30	-	(12,982,849)	(12,982,849)	(6,675,777)	(3,912,531)	(36,554,006)	44,505,180	2.65	0.73	150,604,388	114,050,382
31	-	(12,982,849)	(12,982,849)	(6,675,777)	(2,608,354)	(35,249,829)	44,505,180	2.65	0.73	150,604,388	115,354,559
32	-	(12,982,849)	(12,982,849)	(6,675,777)	(1,304,177)	(33,945,652)	44,505,180	2.65	0.73	150,604,388	116,658,736
33	-	(12,982,849)	(12,982,849)	(6,675,777)	-	(32,641,475)	44,505,180	2.65	0.73	150,604,388	117,962,913
TOTAL	(2,461,710,000)	(389,485,467)	(389,485,467)	(200,273,310)	(557,511,530)	(3,998,465,774)	1,335,155,400	-	-	8,419,012,942	4,420,547,168

INTERNAL RATE OF RETURN	**12.59%**
NPV @ 10.74%	**252,223,664**

13.11 CONCLUSION

The Project is financially feasible. Proposed tariff is reasonable. Debt service coverage ratio (ADSCR) is also acceptable. The project can be developed as per NEPRA's upfront tariff.

Table 13.6: Annual Debt Coverage

Year	Tariff	Annual net cash flows	Loan Repayment	ADSR
	Rs./KWh	Rs.	Rs.	Ratio
1	12.15	480,035,388	371,506,022	1.29
2	12.15	471,534,086	371,506,022	1.27
4	12.15	472,838,263	371,506,022	1.27
5	12.15	474,142,440	371,506,022	1.28
6	12.15	475,446,617	371,506,022	1.28
7	12.15	476,750,794	371,506,022	1.28
8	12.15	478,054,971	371,506,022	1.29
9	12.15	479,359,148	371,506,022	1.29
10	12.15	480,663,325	371,506,022	1.29

PUNJAB POWER DEVELOPMENT BOARD

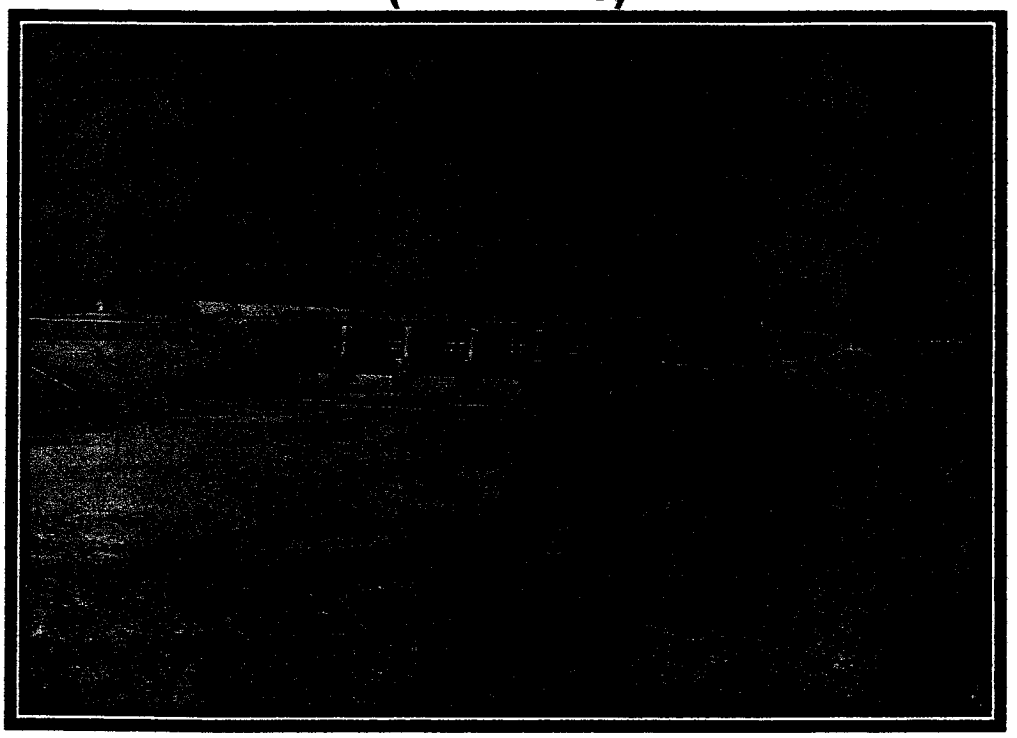
ENERGY DEPARTMENT

(VOLUME – 3)

UPDATED FEASIBILITY STUDY

LCC HYDROPOWER PROJECT

(RD 0+000)



May, 2016

TRIDENT

TRIDENT POWER GR (PVT.) LTD.
359H, STREET NO. 4, PHASE-V
DHA , LAHORE CANTT
TEL: 0092 4235 788 619

AIPEL

AIPEL
204-EDEN HEIGHTS, JAIL ROAD,
GULBERG, LAHORE
TEL: 0092 4235 786 823

NO. DD (EIA)/EPA/F-370(IEE)/1412/2016/102.
Dated: 26 /01 / 2017

To

Mr. Yousaf Mehboob Khan,
Chief Executive Officer,
Trident Power GR (Pvt.) Limited.,
House # 359-H, Street # 4, Phase-5, DHA, Lahore Cantt.,
Lahore.

Subject: **DECISION OF EPA PUNJAB FOR THE PROJET "CONSTRUCTION OF 7.55-MW LOWER CHENAB CANAL HYDROPOWER PROJECT, GUJRANWALA"**

1.	Description of Project:	Construction of 7.55-MW Lower Chenab Canal Hydropower Project.
2.	Location of Project:	New Khanki Barrage Tehsil Wazirabad District Gujranwala.
3.	Date of filing of IEE:	09.06.2016

4. EPA Punjab has reviewed the Initial Environmental Examination Report (IEE) and considered Site Inspection Report received from Deputy Director / Ex-District Officer (Environment), Gujranwala vide letter No. 544/DOE/GRW dated 22.08.2016. EPA Punjab has also considered the recommendations of **Committee of Experts** (Meeting dated 23.11.2016), recommendations of **EA Committee** (Meeting dated 14.12.2016) and other relevant record.

5. **Environmental Protection Agency, Punjab accords approval for construction / installation of your aforesaid project subject to the following conditions:**

i. The proponent shall ensure compliance of Punjab Environmental Quality Standards (PEQS).
ii. Mitigation Measures suggested in the IEE report and Environmental Management Plan (EMP) shall be strictly adhered to minimize any negative impacts on soil, ground water, air and biological resources of the project area.
iii. Monitoring shall be carried out during the entire period of the project activities. Monitoring reports of the whole operation shall be submitted to EPA, Punjab on quarterly basis.
iv. Camping sites shall be located at suitable distance away from any settlement to avoid disturbance to the local people. Sewage generated from camping sites shall be treated in septic tanks.
v. The proponent shall take measures to control dust and the area around the project site shall be kept clean.
vi. The proponent shall ensure efficient health and first aid treatment facilities for protection of workers.
vii. The proponent shall plant at least 10000 trees of minimum height 6-7 feet in consultation with the Deputy Director / Ex-District Officer (Environment) under intimation to this office.
viii. The proponent shall do proper landscaping after completion of the project.
ix. The construction material shall be piled / stored in such a way that it shall not destroy the flora / environment of the locality.
x. The proponent shall care about noise issues during construction and operation stage of the project.
xi. The objections / complaints of the locals / stakeholders (if any) shall be redressed on priority basis.
xii. The proponent shall provide compensation to the inhabitants in case of loss of agricultural land, crop, property, etc. in accordance with the rates that are agreed upon. All conflicting issues regarding compensation, etc. shall be settled amicably before the start of the project activities.
xiii. The proponent shall submit comprehensive map of the area showing each and every component of the project.
xiv. The proponent shall adopt all mitigation measures on scientific basis to minimize the effects on nearby community from the project activities.
xv. The proponent shall provide details of nearest human settlement and comprehensive layout of road network surrounding the project site.
xvi. The proponent shall provide the ultimate disposal of wastewater.
xvii. The proponent shall obtain NOC / clearance from all other concerned departments before commencement of work.

P.T.O

xviii. The proponent shall appoint Environmental Manager (having relevant qualification and experience) for the project and shall convey his name along with his complete Mailing Address and Phone Numbers.

xix. Arrangements shall be made for safe disposal of solid and hazardous waste. The solid waste shall be retained within the unit boundary / premises and shall be disposed off in an environmental friendly way at a suitable disposal facility.

xx. The proponent shall ensure that strict and efficient health and safety measures are in place for protection of the workers in case of any environmental emergency and these measures are backed by a comprehensive emergency response system.

xxi. At least 90% unskilled and to the extent possible skilled jobs shall be given to locals after providing them proper training.

xxii. The proponent shall ensure all necessary measures for the protection of sensitive / protected areas in the vicinity.

xxiii. The proponent shall prepare a Community Development Plan and implement it for the benefit of communities of the project area.

xxiv. The proponent shall provide a copy of IEE Report and this letter to the contractors for its implementation letter and spirit.

xxv. The proponent shall restore the environment of the area after completion of the project.

xxvi. The proponent shall follow the SOPs regarding dengue larvae eradication and shall ensure removal of stagnant water on daily basis.

xxvii. The proponent shall submit Environmental audit report of actual versus perceived / assessed impacts to EPA Punjab after completion of construction.

xxviii. This approval can be withdrawn at anytime without any prior notice if deem necessary in the public / national interest.

6. The proponent shall be liable for correctness, exhaustiveness and validity of information supplied to this department by the environmental consultant.

7. The proponent shall be liable for compliance of Regulations 13, 14, 18 and 19 of IEE/EIA Regulations, 2000, regarding approval, confirmation of compliance, entry, inspections and monitoring.

8. This approval is accorded only for the construction phase of the project. The proponent shall apply for confirmation of compliance under Regulation 14 of IEE / EIA Regulation, 2000 by submitting Environmental Management Plan for operational phase along with compliance status report of the Environmental Approval of the construction phase of the project.

9. Any change in the approved project shall be communicated to EPA, Punjab and shall be commenced after obtaining the approval.

10. This approval shall be treated as null and void if all or any of the conditions mentioned above, is/are not complied with. This approval does not absolve the proponent of the duty to obtain any other approval or consent that may be required under any law in force and is subjudice to legal proceedings in any legal fora / court.

11. This approval shall be valid (for commencement of construction) for a period of three years from the date of issue under Regulation 17 of IEE / EIA Regulations, 2000.

ASSISTANT DIRECTOR (EIA)
for Director General, EPA, Punjab
Ph: # 042-99232282

NO. & DATE EVEN.

A copy is forwarded to the Deputy Director Ex-District Officer (Environment), Gujranwala w.r.t. his letter No. 544/DOE/GRW dated 22.08.2016. He is requested to ensure compliance of the conditions mentioned in the Environmental Approval and to furnish compliance status report accordingly.

ASSISTANT DIRECTOR (EIA)
for Director General, EPA, Punjab

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List of Acronyms

Abbreviations

AP	Affected Persons
BHU	Basic Health Unit
CCPP	Combined Cycle Power Plant
CO	Carbon Mono Oxide
ED	Energy Department
EPA	Environmental Protection Agency
EIRR	Economic Internal Rate of Return
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
ESMP	Environmental and Social Management Plan
ESHS	Environmental Social Health and Safety
EPC	Engineering Procurement and Construction
ER	Environmental Report
GT	Grand Trunk
GWH	Giga Watt Hour
GENCO	Generation Company
GW	Ground Water
IEE	Initial Environmental Examination
IPP	Independent Power Producer
KV	Kilo Volt
KAPCO	Kot Addu Power Company
KESC	Karachi Electric Supply Corporation
LCC	Lower Chenab Canal
LPG	Liquefied Petroleum Gas
LOI	Letter of Intent
LAA	Land Acquisition Act
MAF	Million Acre Feet
MW	Mega Watt
NSL	Natural Surface Level
NEQS	National Environmental Quality Standards
NO_x	Nitrogen Oxides
NOC	No Objection Certificate
NESPAK	National Engineering Services Pakistan
NGO	Non-Government Organization
NPO	No Project Option
O&M	Operation and Maintenance
PEPA	Pakistan Environmental Protection Agency
PPDB	Punjab Power Development Board
PEPCO	Pakistan Electric Power Company
PAEC	Pakistan Atomic Energy Commission
PSHA	Probabilistic Seismic hazard Assessment

PAP	Project Affected Persons
PPE	Personal Protective Equipment
ROW	Right of Way
SO_x	Sulphur Oxides
SW	Surface Water
TPL	Trident Power GR (Pvt.) Ltd.
WAPDA	Water and Power Development Authority
WAA	Water Apportionment Accord
WHO	World Health Organization

Weights and Measures

km	Kilometer
ft	Feet/Foot
m^3	Cubic meter
ft^3	Cubic feet
sec	Seconds
m	Meter
mm	Millimeter
°C	Degree centigrade
dB	decibels
Cusecs	Cubic feet per seconds

EXECUTIVE SUMMARY

ES-1 Introduction

Punjab Irrigation network comprises 14 barrages/headworks including Khanki weir. Total length of canals is 23,200 miles which provide irrigation supplies to about 22.0 million acres (8.9 million hectares). Besides irrigating vast lands of the province, Punjab irrigation network has a large power potential on its different canals and barrages.

Lower Chenab Canal (LCC) off-takes from Khanki Headworks on Chenab River and is one of the oldest structures on the river. Khanki weir serves LCC irrigation system designed and constructed in the year 1887 as an inundation canal and converted into a perennial canal in 1892. Keeping in view the ever increasing electricity requirements of the country, and to utilize the head available at the head regulator of LCC, a Hydropower Project of low head hydel was conceived.

Pursuant to "Punjab Power Generation Policy 2006 (Revised 2009)", the Punjab Power Development Board (PPDB) invited the private firms/consortium for the development of 11 No. Raw sites Hydropower Projects in May, 2015. On the basis of prequalification documents submitted by private firms/consortium, PPDB issued a Letter of Intent (LOI) to M/s Trident Power GR (Pvt.) Ltd on March 22, 2016 for the development of Hydropower Project on Lower Chenab Canal (LCC) utilizing head available at head regulator of LCC at RD 0+000. M/s Trident Power GR (Pvt.) Ltd engaged the services of M/s Aipel Consultants on April 07, 2016 for review and updating the Feasibility Study and Initial Environmental Examination (IEE) of LCC Hydropower Project.

ES-2 Project Overview

In 1992, WAPDA in association with GTZ prepared an inventory of potential sites on canals and barrages for hydropower development in Pakistan. The report identified the fall at the LCC head regulator as a potential hydropower site. In 2008, the hydropower potential at the LCC head regulator was also studied by the Punjab Barrages Consultants.

In 2010, NESPAK carried out pre-feasibility / ranking study of (10) potential power generation sites on canals and barrages of the Punjab Irrigation system (Task-I) and ranked this LCC Head Regulator (with the implementation of new Khanki Barrage Project) as one of the top five ranked schemes for hydropower development. Later on, the Feasibility Study of 7.55 MW LCC Hydropower Project was carried out by M/s National Engineering Services Pakistan (Pvt.) Ltd (NESPAK) in 2011 (Task-II).

The proposed LCC Hydropower Project site is located at the left bank of Chenab River about 17 Km downstream from main GT Road, Wazirabad bypass in district Gujranwala of Punjab Province. Wazirabad is connected to other parts of the country by metaled roads, railway and power transmission line. The approach to the proposed hydropower project site from Wazirabad is through Wazirabad – Saroki / Alipur Chatha – Khanki road.

The nearest railway station to the site is Khanki Kacha on the Sialkot – Faisalabad line. Wazirabad is the nearest railway station on Karachi – Peshawar main railway line.

Sialkot International Airport, about 50 km north east of the site, is the nearest airport. However the major international airport is the Allama Iqbal International Airport in Lahore, about 160 km from the site, where many international airlines operate commercially.

The proposed project involves the development of hydropower plant utilizing head available at head regulator of LCC at RD 0+000. Currently, the Construction of New Khanki Barrage (900 ft. downstream of existing Khanki headworks) and New LCC Head Regulator are in progress which shall cause dismantling of the existing LCC Head Regulator. In this scenario, hydropower plant shall be developed considering the new LCC Head Regulator.

The Powerhouse of the LCC Hydropower Project is proposed to be constructed within the canal at RD 1+500 of LCC. The Project includes constructing all the necessary components associated with the construction of Powerhouse i.e. Spillway, Temporary Diversion Channel, Switchyard, Transmission Line and allied works. The main salient features of the project are tabulated in **Table – 1.**

Table – 1: Salient Features of the Project

Sr #	Features	Facts
1	Installed Capacity of the Project	7.5 MW
2	Annual Energy	44.51 GWh
3	Design Discharge	250 m^3/s
4	Construction Period	36 Months
5	Length of Proposed Transmission Line	20 Km

ES-3 Policy, Legal and Administrative Framework

The apex environmental law in the Punjab is The Punjab Environmental Protection (Amendment) Act, 2012, which has been derived through enactment or adaptation of the Pakistan Environmental Protection Act, 1997. The Act is applicable to a broad range of issues and extends to air, water, soil, marine and noise pollution, as well as the handling of hazardous waste. The requirement of conducting Environmental Assessment (Initial Environmental Examination or Environmental Impact Assessment) emanates from this Act.

The proposed LCC Hydropower Project, because of its relatively small size (7.5 MW), falls in Schedule-I of Category 'B' "Energy" having a capacity less than 50 MW in accordance with the PEPA Regulations, 2000. According to these guidelines, a category 'B' project is likely to have minimal or no adverse environmental impact which can be easily mitigated.

ES-4 Baseline Conditions

There are two major settlements of the study area, viz. Khanki Headworks colony at left bank of the river and Khanki Village. The education facilities are good at Khanki village because of the presence of number of schools. Health facilities are almost the same as present in the general rural conditions of the district. Electricity is available but natural gas is not available. There is no bank facility but postal service is connected with Wazirabad city.

The use of Liquefied Petroleum Gas (LPG) cylinders is common in the area which is an alternate source of heating, lighting, cooking and rickshaw transport. Other

infrastructure such as telephonic communication, private postal services are available near the site.

Water supply system is also present because the old Khanki village receives certain civic facilities when Khanki Barrage was constructed here more than a century ago. Ground water is used for drinking purposes. The area is agriculturally rich which includes cereal crops, vegetables, fodder/forage and fruit trees. No forest is present in the area. Livestock and poultry are present abundantly so people are dependent on their agriculture and the livestock.

ES-5 Environmental Impacts and Mitigation Measures

Fortunately, no adverse impacts of the proposed project are expected on long term basis, though a few short term adverse impacts can be forecasted which could be mitigated through good engineering practices during construction phase of the project.

The proposed project shall not cause any dislocation/resettlement of any person as the new residential colony for barrage employees has already been constructed under new Khanki Barrage project. The barrage employees shall be shifted to this new residential colony before handing over the proposed project site and the project shall find a clear land for the construction of temporary diversion channel. Land area of about 20 Acres shall be temporarily acquired for the construction of temporary diversion channel, which is a government land.

The proposed project shall yield a positive impact on the study area in terms of raising the social status of the local people by generation of employment during construction and operational phase.

ES-6 Public Consultation

Public consultation was held with the stakeholders of the project area as an important process adopted to prepare this report and to seek informed apprehensions of the communities before identifying and analyzing the likely impacts of the project on the well-being of the inhabitants. The discussion did not reveal any apprehension about the impacts of the project.

ES-7 Environmental Management Plan

An EMP has been developed and updated to provide implementation mechanism for the mitigation measures identified while updating IEE. The EMP provides the organizational structure for the environmental management system during the project execution, a mitigation plan, an environmental monitoring and training needs assessment plan, in addition to communication and documentation requirements, in the context of environmental management.

ES-7 Conclusion

On the basis of the overall impact assessment, it is concluded that the proposed LCC Hydropower Project is unlikely to cause any significant, lasting impact on the social, physical and biological environment of the area, provided that the proposed activities are carried out in accordance with recommendations of this report, and the mitigation measures included in this updated IEE are completely and effectively implemented. The proposed LCC Hydropower Project is environmental friendly and is recommended for implementation.

1.0 INTRODUCTION

Today Pakistan is facing multifarious problems and challenges. These challenges are not a product of sudden incident; rather it is a cumulative outcome of lack of planning and misplaced priorities of the state. Among these challenges, energy crises is the acute one as it is energy that derives the engine of economy and overall functions of modern economic order.

The power sector in Pakistan has been facing shortages of electricity generating capacity due to low pace of development of new power plants to meet the growing demand for electricity. This has been aggravated by the rising price of oil, shortage of natural gas and lesser focus on hydropower development. The effect of the large gap between demand and supply of electric power has led to massive load shedding in Pakistan. Due to the widening of this gap, all walks of life from industry to domestic are being adversely affected.

The primary cause for this worse energy crisis among others is the expensive energy mix which is predominantly fossil fuel based resulting heavy dependency on expensive oil imports and depleting natural gas reserves. For the long term energy security of the country and to ensure sustainable development of the country, hydropower development is considered as the most feasible option.

As the country requires immediate relief, the focus should be broadened from mega hydropower projects to include the development of smaller hydropower projects (i.e. with installed capacity less than 50 MW) that have much shorter gestation periods. Compared to large hydro projects, small hydro projects are typically run-of-river or run-of-canal with no storage and thus have much lower environment and displacement impacts. These projects also attract more attention from private investors, lenders and multilateral agencies.

The Provincial Governments have been authorized under the Constitution of Pakistan to undertake activities in the power sector. As such, the Government of the Punjab set up the Punjab Power Development Board (PPDB) in 1995 for implementation of power generation projects through one window operation. In 2000, WAPDA assessed Hydropower generation potential of more than 600 MW at 317 locations in Punjab. To exploit this potential, the Government of the Punjab framed

the "Punjab Power Generation Policy 2006 (Revised 2009)" for implementation through PPDB.

Pursuant to "Punjab Power Generation Policy 2006 (Revised 2009)", the Punjab Power Development Board (PPDB) invited the private firms/consortium for the development of 11 No. Raw sites Hydropower Projects in May, 2015. On the basis of prequalification documents submitted by private firms/consortium, PPDB issued a Letter of Intent (LOI) to M/s Trident Power GR (Pvt.) Ltd on March 22, 2016 for the development of Hydropower Project on Lower Chenab Canal (LCC) utilizing head available at head regulator of LCC at RD 0+000.

M/s Trident Power GR (Pvt.) Ltd engaged the services of M/s Aipel Consultants on April 07, 2016 for review and updating the Feasibility Study and Initial Environmental Examination (IEE) of LCC Hydropower Project. In accordance with the scope of work of Updated Feasibility Study, the hydrological characteristics of LCC at RD 0+000 have been reviewed and the project layout has been revised with the objective to construct the powerhouse of the proposed hydropower project within the canal. Considering the updated discharge data upto year 2015, the design discharge is selected as 250 m^3/s.

1.1 Updated IEE Study

1.1.1 Need for the Updated IEE Study

In 2011, M/s NESPAK carried out the Initial Environmental Examination (IEE) for LCC Hydropower Project and accordingly submitted a comprehensive IEE report alongwith the Feasibility Report of LCC Hydropower Project (as Volume-4) to the Proponent Energy Department (ED).

Now, as a result of Updated Feasibility Study of the LCC hydropower Project, updating of Initial Environmental Examination (IEE) is also required to include social and environmental aspects of project as per revised layout and to update and augment the findings of 2011 IEE study report prepared by NESPAK. This updated IEE requires clearance from the Punjab-EPA. M/s Trident Power GR (Pvt.) Ltd shall submit this IEE report to Punjab-EPA for Environmental Approval and issuance of No Objection Certificate (NOC) for the Project.

1.1.2 Study Scope

This updated IEE Study identifies and analyzes the physical, ecological and socio-economic significant impacts, both positive and adverse, which are likely to occur due to the construction and operation of hydropower plant together with the proposed mitigation measures for significant adverse impacts.

1.1.3 Study Methodology

The key steps that were followed while conducting the updated IEE are briefly described below:

Screening - During this phase, information on the project was compiled and reviewed. In addition, information on relevant legislation, regulations, guidelines and standards was reviewed and compiled. The Feasibility Report and IEE of the project submitted by NESPAK in 2011 were also reviewed in detail. The details of topography, geology and hydrology were collected from the other Chapters prepared for Updated Feasibility Study of the Project.

A detailed review of the latest project layout plan was carried out in order to understand the proposed project and the extent of the development activities required. The review of the layout plan helped to visualize the nature and extent of the impacts related to the implementation and operation of the proposed project.

Environmental Survey and Public Consultation – During this phase, a number of visits were made during March to May, 2016 in order to record and update an environmental baseline of the project area. Information were mainly collected regarding impact on resettlement issues, land acquisition, agriculture (crops, animals, forest), ecology (wildlife including aquatic species like fish, and terrestrial like birds, forest trees & shrubs, etc.), infrastructure (transport network, township) and other socioeconomic aspects (cost, education, health, history, etc).

During this phase, public consultation was also carried out with different stakeholders including government departments, concerned agencies and local population to solicit their concerns, suggestions, recommendations and expectations.

Environmental Screening and Mitigation Measures - During the environmental screening, the environmental, socioeconomic, and project information collected in previous steps was used to determine the potential impacts of the proposed project. Subsequent to this, the potential impacts were characterized in order to determine their significance. Mitigation measures were identified where required to minimize the significant environmental impacts.

Report Compilation - Report compilation was the last step of the study. The report includes a brief description of the proposed project, a review of environmental legislation relevant to the project, a description of baseline environmental and socioeconomic conditions in the project area, and potential project impacts and mitigation measures.

1.2 Organization of the Report

Section-2 describes the project and its components. **Section-3** describes the legislative and institutional setup in the country, relevant to the environment and environmental assessment. Baseline conditions are presented in **Section-4**, whereas environmental impact assessment and associated mitigation measures are discussed in **Section-5**. **Section-6** covers the public consultation. **Section-7** introduces the environmental management/monitoring requirements during the project execution. Finally, **Section-8** provides the conclusion of the study.

2.0 PROJECT DESCRIPTION

The proposed LCC Hydropower Project involves the development of hydropower plant utilizing head available at head regulator of LCC at RD 0+000. Currently, the Construction of New Khanki Barrage (900 ft. downstream of existing Khanki headworks) and New LCC Head Regulator are in progress which shall cause dismantling of the existing LCC Head Regulator. In this scenario, hydropower plant shall be developed considering the newly developed regulator.

The proposed LCC Hydropower Project, because of its relatively small size (7.5 MW), falls in Schedule-I of Category 'B' "Energy" having a capacity less than 50 MW in accordance with the PEPA Regulations, 2000. According to these guidelines, a category 'B' project is likely to have minimal or no adverse environmental impact which can be easily mitigated.

2.1 Need for the Project

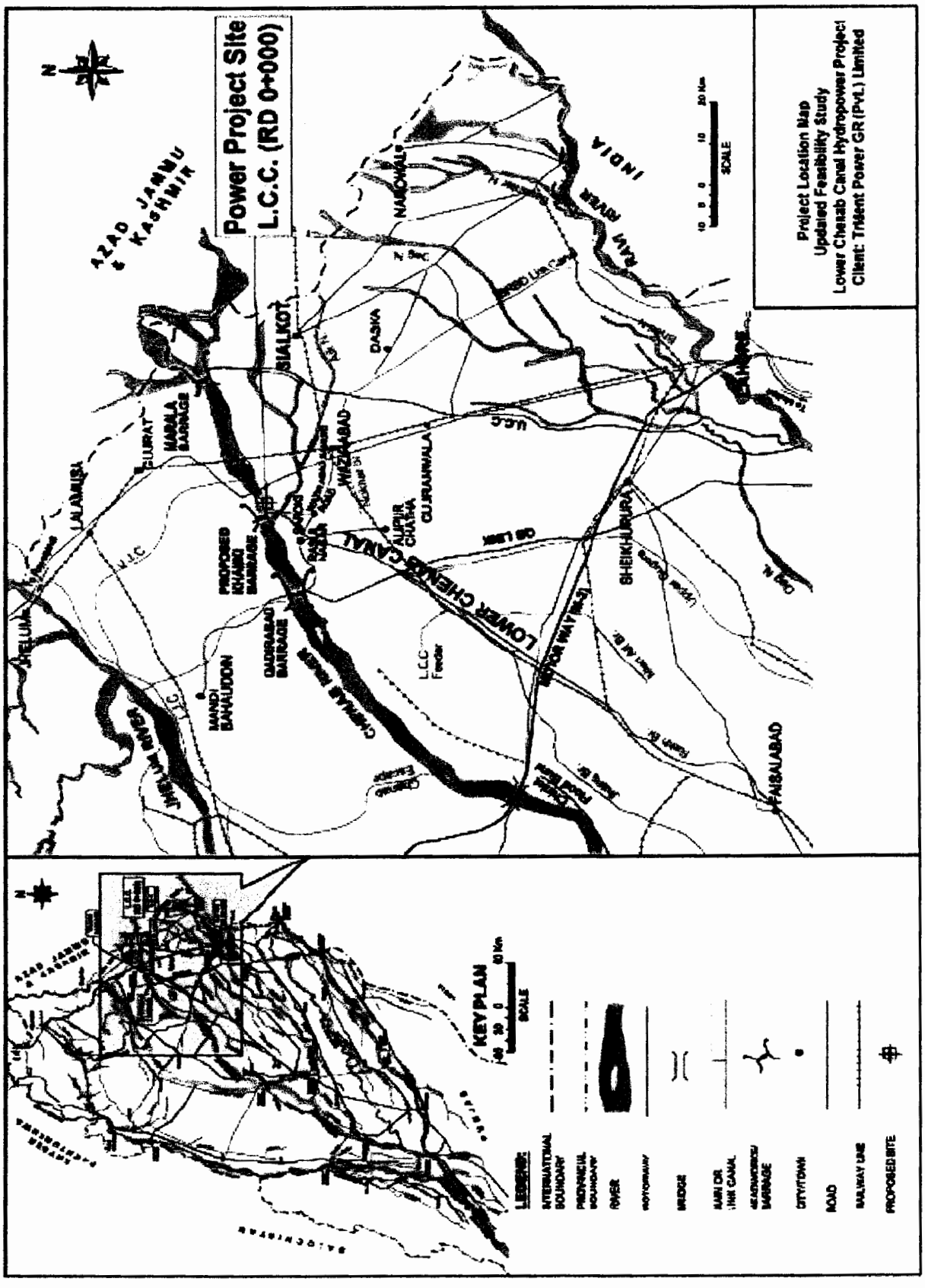
The need for the project arises from the fast growing demand for electrical energy in Pakistan together with the increasing attraction of far too cheaper hydropower as compared to very costly thermal generation using fossil fuels.

2.2 Project Location

The potential site for installation of LCC Hydropower Plant is located at the left bank of Chenab River at the Head Regulator of the LCC at RD 0+000 at Khanki Barrage, about 17 Km downstream from main GT Road, Wazirabad bypass in district Gujranwala of Punjab Province. The location map of proposed LCC Hydropower Project site is shown in **Figure - 1**.

The proposed project involves the development of hydropower plant utilizing head available at Head Regulator of LCC at RD 0+000. Currently, the Construction of New Khanki Barrage (900 ft. downstream of existing Khanki headworks) and New LCC Head Regulator are in progress which shall cause dismantling of the existing LCC Head Regulator. In this scenario, hydropower plant shall be developed considering the new LCC Head Regulator.

Figure - 1: Location map of proposed LCC Hydropower Project Site



2.2.1 Existing LCC Head Regulator

There are two head regulators of the Lower Chenab Canal (LCC). The main head regulator consisting of 12 bays is adjacent to the existing Khanki headworks and was a part of its original construction. The subsidiary head regulator, constructed subsequently, consists of 6 bays located on left side of the main head regulator. **Figure - 2 & 3** shows the upstream and downstream views of the regulators.

Figure - 2: Upstream View of Existing LCC Head Regulators

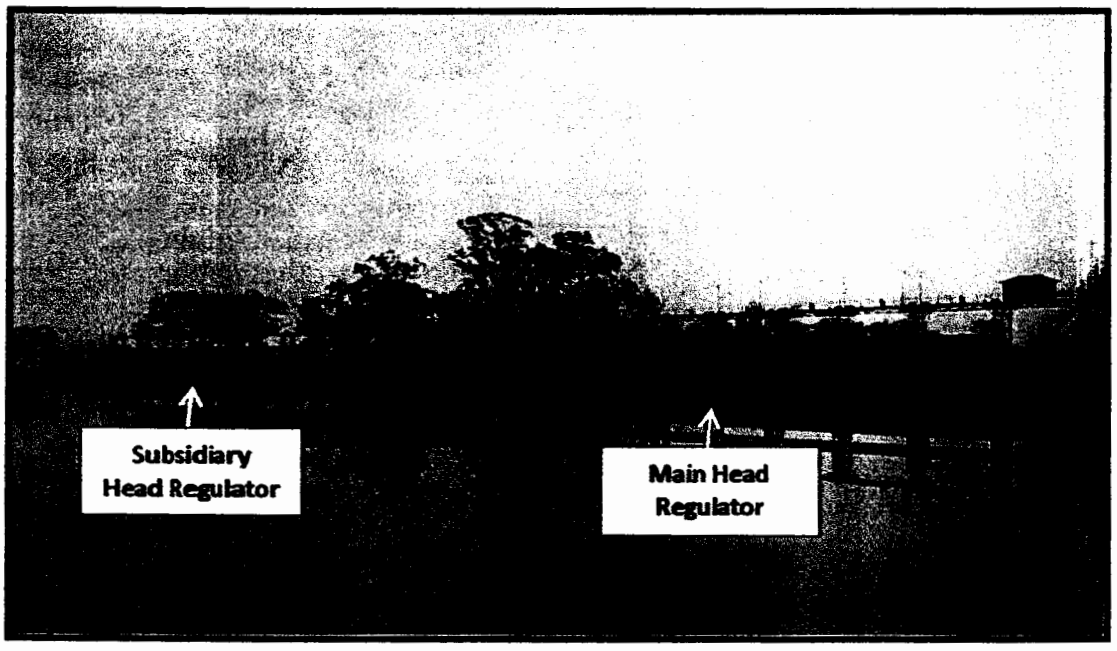
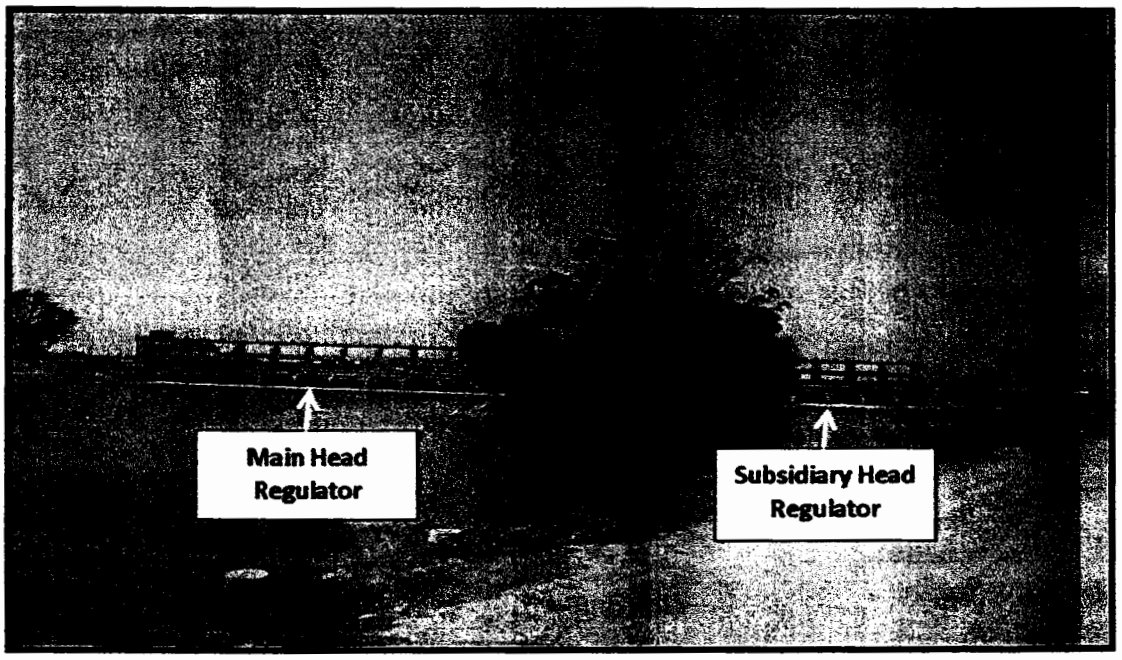


Figure - 3: Downstream View of Existing LCC Head Regulators



2.2.2 New LCC Head Regulator

A new LCC Head Regulator at RD 0+000 is under construction by Punjab Irrigation Department and 95% of the its civil and electromechanical works have been completed. This new head regulator comprised of 6 bays having width of 30 ft. each. On the commissioning of Lower Chenab Canal (LCC) which is expected in October 2016, the existing LCC head regulators shall be dismantled. **Figure - 4 & 5** shows the upstream and downstream view of new under construction LCC head regulator.

Figure - 4: Upstream View of Under Construction New LCC Head Regulator

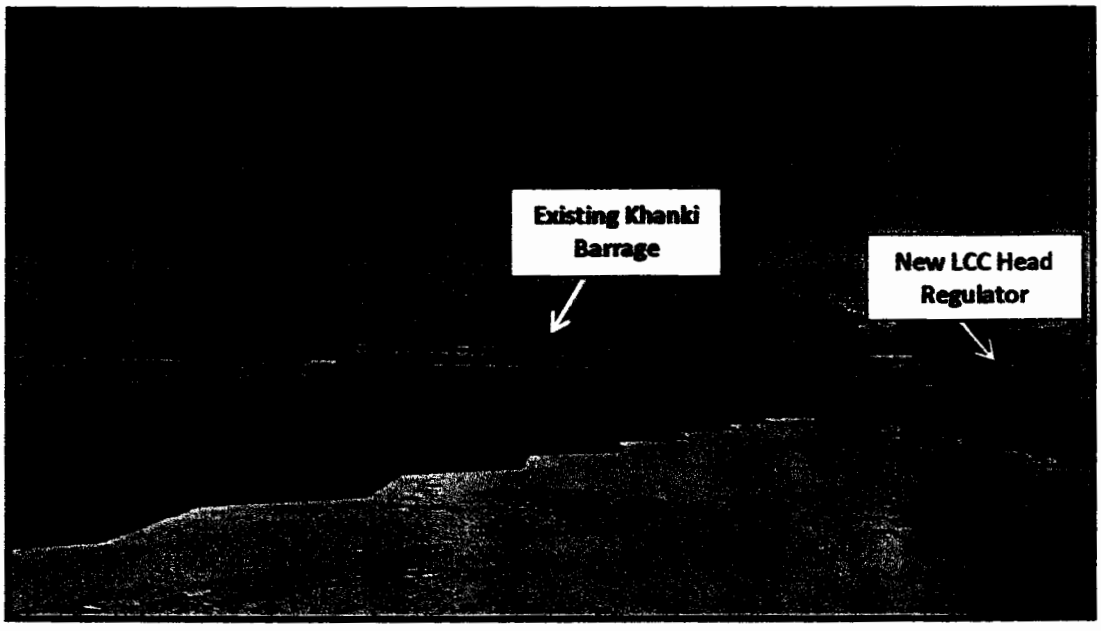
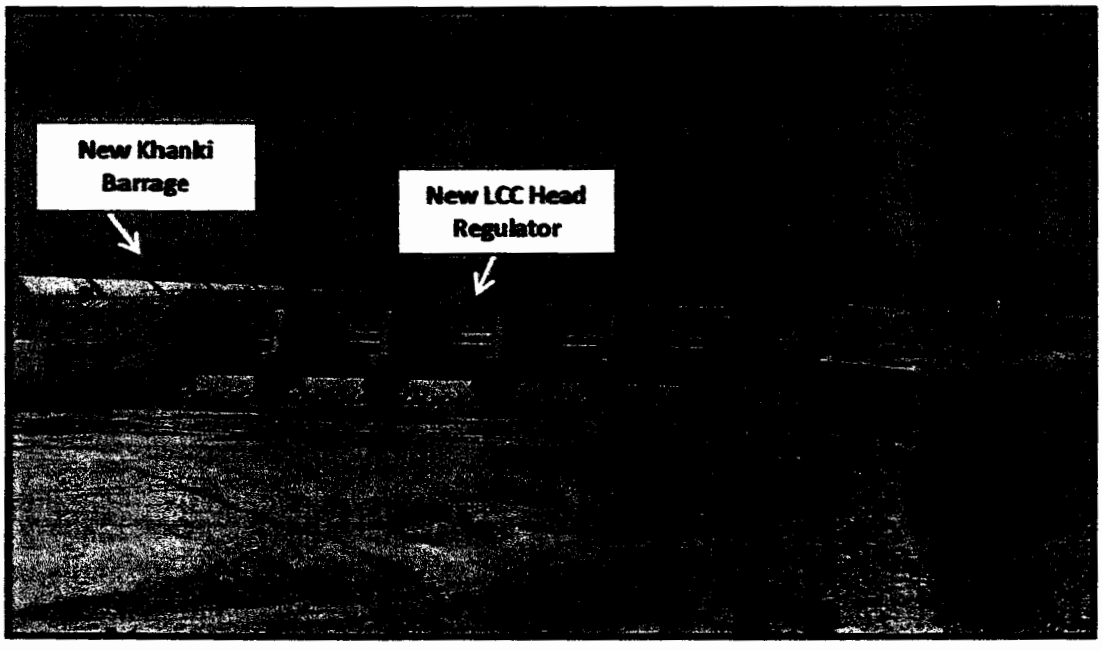


Figure - 5: Downstream View of Under Construction New LCC Head Regulator



2.3 Accessibility to the Project Area

2.3.1 Access by Road

The site is located about 17 km south-east of Wazirabad which is connected to tne port at Karachi through a network of highways including the main G.T. road. The approach to site from Wazirabad is through Wazirabad – Saroki / Alipur Chatha – Khanki road.

2.3.2 Access by Rail

The nearest railway station is Khanki Kacha on the Sialkot – Faisalabad line. Wazirabad is the nearest railway station on Karachi – Peshawar main railway line.

2.3.3 Access by Air

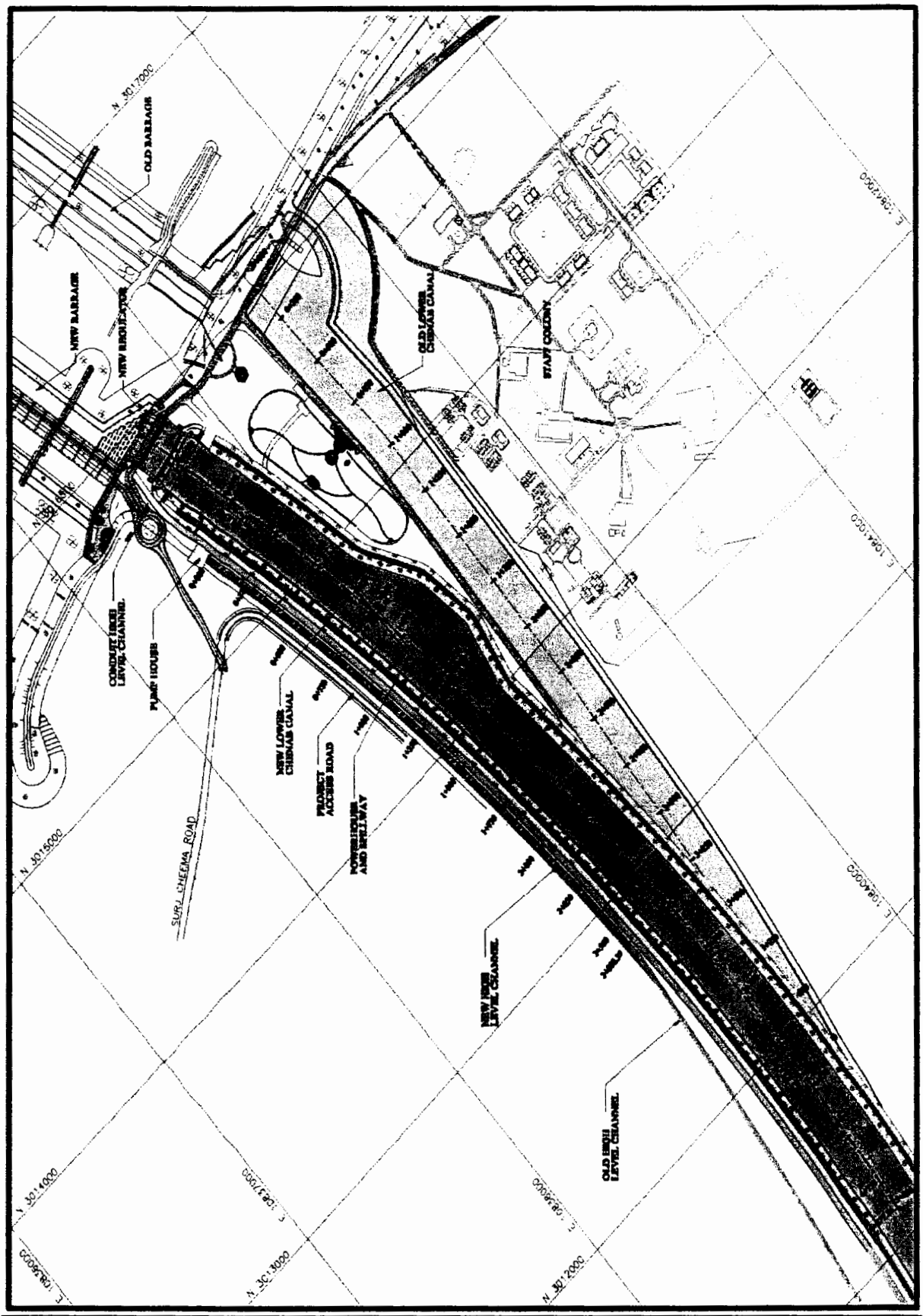
Sialkot International Airport, about 50 km north-east of the site, is the nearest airport. However the major international airport is the Allama Iqbal International Airport, in Lahore, about 160 km from the site, where many international airlines operate commercially.

2.4 Project Components

The latest project layout as per updated feasibility study is presented in **Figure – 6** and the main components of the proposed LCC Hydropower Project are as follows:

- Construction of the Powerhouse containing (04) four Horizontal Kaplan Turbines with a combined capacity of 7.5 MW,
- Construction of Spillway on the left side of Powerhouse which is proposed to pass the same design discharge as of LCC i.e. 425 m^3/s,
- Construction of a Switchyard on the right side of the Powerhouse and 33 kV Transmission Line to link the project with 132/11 kV Wazirabad Grid Station,
- Construction of 600 m (approx.) long Access Road from LCC Head Regulator at RD 0+000 to Powerhouse.

Figure - 6: Layout of Proposed LCC Hydropower Project



2.5 Construction Aspects

2.5.1 Project Ownership and Contractor's Arrangements

The project Proponent, i.e. M/s Trident Power GR (Pvt.) Ltd ED shall make the arrangements for the execution of the proposed project after having approval of updated feasibility study from the Punjab Irrigation Department. The Proponent shall start the process of tendering the project for competitive bidding to select the potential EPC contractor based on the pre-formulated selection criteria. The EPC Contractor shall be responsible for Engineering Procurement and Construction of the proposed project.

2.5.2 Work Force

It is expected that the skilled staff shall be engaged in the construction and installation work during the construction stage of the proposed project. The breakdown of the staff strength during the average and peak construction stages is expected as 100 and 200, respectively.

2.5.3 Construction Material's Procurement, Storage and Transportation

The EPC Contractor engaged for construction shall make his own arrangements for procurement/supply of construction materials, their transportation and storage under strict supervision. The requirement of aggregate for construction of various project structures shall be estimated. The concrete work for the powerhouse is of small quantity therefore single concrete batching plants shall be used. This proposed hydropower site shall be investigated further before taking up construction of the project. Excavated material shall also be used as construction material where filling is required. Additional material shall be collected from the quarries, which are approved by local government, client and the construction consultants.

Water Requirements

Water requirement during construction is to meet the domestic demand and requirement of project construction activities like concrete preparation and wet drilling during excavation for powerhouse. It shall be the EPC Contractor's responsibility to confirm the suitability and availability of the water to the site.

Power Requirements

Electric power shall be needed for operation of construction equipment, quarries, lighting of work areas, colonies, labor camps, de-watering and water supply. During construction, the EPC contractor is expected to have self-generation to meet his electrical needs (diesel generators on site in a distributed fashion). During operation, the power plant shall take power from the standby diesel generator only during routine startup operation.

Transportation

- Material from quarry sites shall be transported to batching plant by trucks.
- Power plant equipment and construction equipment shall also be transported to site.

2.6 Project Implementation Schedule

As the project is at feasibility stage, project implementation date shall be decided after the tendering of the proposed power station. However, it is estimated that the proposed LCC Hydropower Project shall be completed in 36 months from the beginning of construction to commissioning of the project.

2.7 Previous Studies

2.7.1 Study by WAPDA-GTZ (1992)

In 1992, WAPDA in association with GTZ, prepared an inventory of potential sites on canals, and barrages for hydropower development in Pakistan. The report assessed the power and energy estimates for various low head hydel power sites which identified the fall at the LCC head regulator as a potential site. In the assessment study, gauge and discharge data for the period 1978-87 were used for estimating the water availability and gross head. The gauge and flow data pertained to the post-Tarbela and pre Water Apportionment Accord (WAA) of 1991. Design discharge of the canal for assessing the hydropower potential, was taken from longitudinal section of the canal prepared by the PID. Full supply discharge of 231 m^3/sec (8,158 ft^3/s)

downstream of the canal fall was selected as preliminary design discharge and a net head of 2.63 m (8.63 ft) was used for calculating the maximum power potential of 4.95 MW.

2.7.2 New Khanki Barrage Project (2008)

Hydropower potential at the LCC regulator was also studied by the Punjab Barrage Consultants. A design discharge of 246.4 m^3/sec (8,700 ft^3/sec) was considered for power potential based on flow duration curve developed using 10-day historic discharge data for the period 1994-2003. Net head for power potential was computed using the upstream pond level at EL 224 m (735 ft) and constant tail water level at EL 220.4 m (723 ft). The increase in head was proposed by shifting of the canal fall at Chenawan at RD 40+200 of LCC to the head regulator of the LCC.

The net head for power generation was thereby increased to 4.9 m (16 ft). The proposed arrangement for power house at LCC required feeding of two canals, presently off taking from Chenawan regulator, directly from Khanki barrage through a separate feeder channel. The installed capacity of 10.5 MW was worked out with an average annual energy of 52 GWh. The hydropower scheme was subsequently dropped from the new Khanki barrage project and a new head regulator at Chenawan fall had since been constructed.

2.7.3 Pre-Feasibility / Ranking Study by NESPAK (2010)

In 2010, NESPAK carried out pre-feasibility / ranking study of (10) potential power generation sites on canals and barrages of the Punjab Irrigation system (Task-I). The site at the head of LCC was among the sites studied. The pre-feasibility/ranking study comprised selection of preferred layout, preliminary design of the scheme, environmental and social impacts assessment, costing, construction scheduling and determining the 'economic internal rate of return' (EIRR) and unit generation costs for each site.

This study was based on the hydrological data since the Water Apportionment Accord (WAA) of 1991. The study concluded that the power generation site at the head of LCC has good potential and ranked this site (with new Khanki Barrage) as one of the top five ranked schemes for hydropower development.

2.7.4 Feasibility Study by NESPAK (2011)

During the second stage (Task-2), the feasibility studies of five (5) top ranked schemes (identified in the Task-I) were carried out by NESPAK. Among 5 top ranked power generation sites, the feasibility study of LCC Hydropower Project at RD 0+000 of was completed by NESPAK in 2011. The feasibility study envisaged installed capacity of 7.55 MW with an average annual energy of 43.61 GWh.

On April 07, 2016, M/s Aipel Consultants was awarded the consultancy agreement for review and updating the Feasibility Study and Initial Environmental Examination (IEE) of LCC Hydropower Project. This IEE report strongly ensures and advocates the environmental soundness of the project in accordance with the requirements of the NEQS Pakistan and the rules/regulations made under the Punjab Environmental Protection (Amendment) Act, 2012.

2.8 Analysis of Alternatives

Different alternatives considered for the project include No Project Option (NPO), other power generation options, project layout alternatives, interconnection alternatives and route alternatives of Transmission Line as described below:

2.8.1 No Project Option

The current power production in Pakistan is about 24,906 MW and the demand supply gap is around 4000 to 5000 MW for the year 2014/15 resulting in load shedding of almost 6 to 8 hours a day in urban centers of Pakistan and even more in the rural areas. This gap is increasing annually and causing a great economic loss to the country apart from the human suffering due to regular power outages. Government of Pakistan is endeavoring hard to reduce the shortage of power. It is utilizing all available energy generating resources. It has started many thermal, coals, nuclear and renewable power generation projects to fill the demand gap. Government is working itself along with its power development companies to reduce the power shortage.

No project Option (NPO), if exercised, shall deprive Pakistan of about 7.5 MW power, which can be generated from the cheapest sources. In the light of the above situation, NPO is not acceptable for this project.

2.8.2 Other Power Generation Options

Two major potential power generation options available in Pakistan are hydel and thermal (based on natural gas, coal and oil fuels). In Pakistan, it has two integrated public sector power utilities, the Pakistan Electric Power Company (PEPCO) which was formally a part of Pakistan Water & Power Development Authority (WAPDA) and the Karachi Electric Supply Corporation (KESC). PEPCO supplies power to all of Pakistan, except the metropolitan city of Karachi, which is supplied by KESC. The systems of PEPCO and KESC are interconnected through a 220KV double circuit transmission line. Out of total installed generation capacity of about 24,906 MW in Pakistan, 6,902 MW belong to hydro, 7,663 MW as thermal GENCOS of PEPCO and KESC, 787 MW to the Pakistan Atomic Energy Commission (PAEC) and 9,085 MW to Independent Power Producers Thermal (IPPs). 256 MW is being produced through Wind.

The largest IPP is Kot Addu CCPP with 1600 MW installed capacity, owned, operated and maintained by KAPCO whereas HUBCO's Hub power station of installed capacity of 1292 MW is the second largest IPP of the country.

Hydel power generation option is the best and is considered for bridging the demand and supply gap because hydel power projects are renewable power generation source and environment friendly. The feasibility studies for several hydel power generation projects in Pakistan are in progress apart from small hydel projects. Feasibility and Detailed Design of Kalabagh Dam have already been completed long ago but its construction could not be initiated due to various reasons. Similarly the construction of projects like Basha Diamer Dam may take more than ten years. In this scenario, small hydel power station is a good option.

2.8.3 Project Layout Alternatives

The main consideration during planning has been that the hydropower scheme should not disturb the proposed and approved layout and design of the new Khanki barrage and the new LCC head regulator. Therefore, only those layout options have been considered which have the flexibility to accommodate the planned project. The following criterion has been adopted while conceiving the alternative layouts:

- The identified layouts are within the selected reach and do not interfere with the irrigation system. Both irrigation system and power generation system could be operated simultaneously without any disturbance.
- Environmental and social impacts.
- Climatic and hydrological conditions.
- The alternative with short water way and maximum head is preferred.
- The project plan is furnished considering the topographic and geological features of the project area and should involve the easier construction methodology.
- The selected alternative should involve the minimum resettlement issues.
- The existing/planned scheme(s) of the irrigation system should not be affected by the identified layout.
- Minimum or preferably no land acquisition. The government-owned land has been preferred over the private owned land.
- Minimum construction period with optimum utilization of the annual canal closure period
- Minimum head loss for maximizing the power potential

The following two options have been considered:

Option 1: Construction of power plant within New LCC at RD 1+500;

Option 2: Construction of power plant in separate canal off-taking U/s of New LCC.

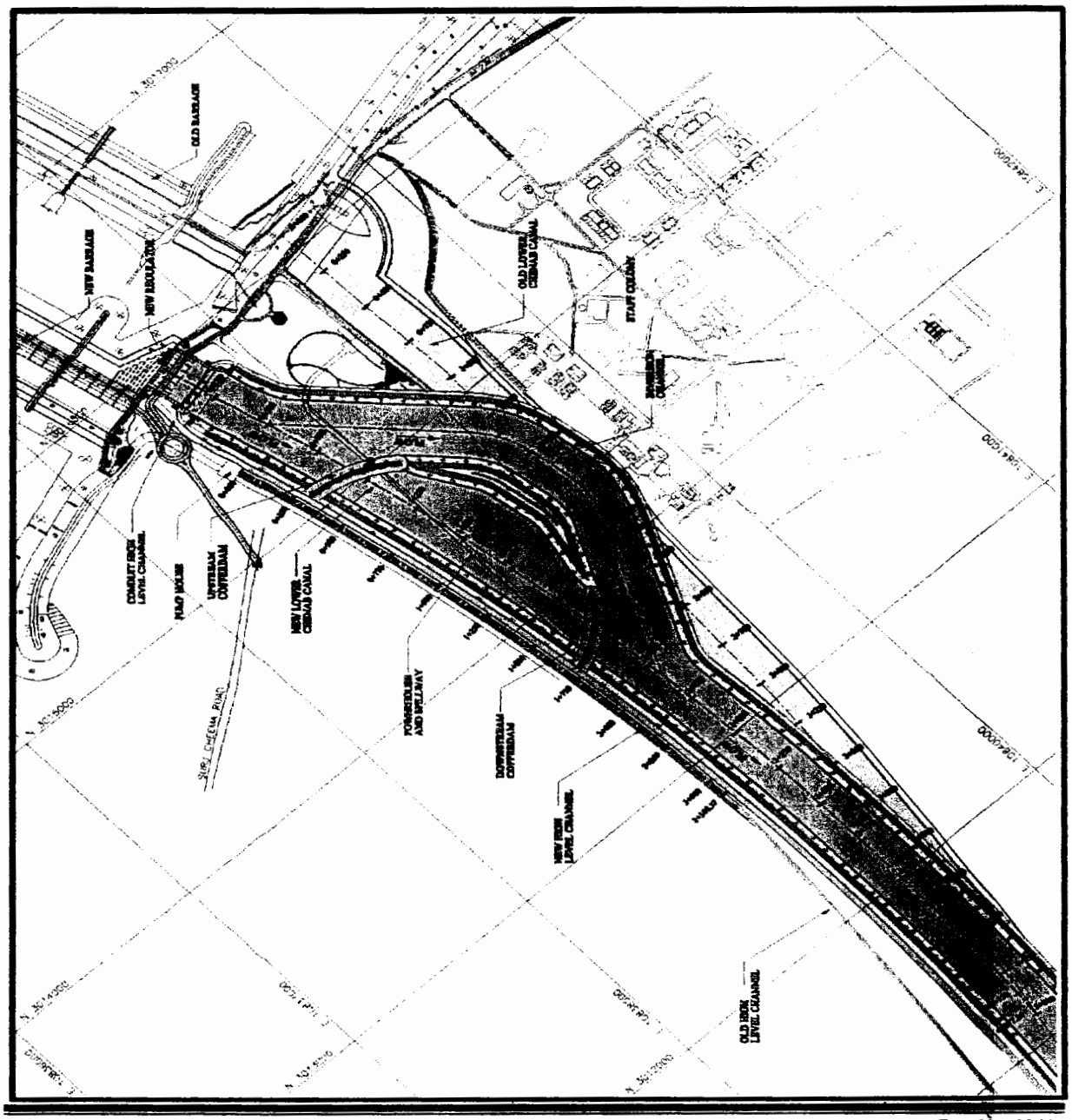
These are discussed below:

Option 1: Construction of power plant within New LCC at RD 1+500.

The New LCC Head Regulator is expected to be commissioned in October, 2016. It is proposed that powerhouse shall be constructed within the main canal at RD 1+500. The canal banks shall be raised on both sides from RD 0+000 up to the powerhouse which shall allow the utilization of available head at RD 0+000 for power generation at RD 1+500. In this scenario, the canal shall follow its original regime

and there shall be minimum disturbance to the hydrological behavior of the canal. The main canal shall be diverted temporarily during canal closure and coffer dams shall be constructed on upstream and downstream of the proposed powerhouse at the confluence of temporary diversion channel and main canal. Therefore, construction works of the power plant can be executed independently without disturbing the canal operations. An auxiliary spillway catering the same discharge capacity as of LCC head regulator is proposed alongside the powerhouse within the main canal in order to safely manage the canal operations during emergency shutdown of the power plant. The layout plan of Option is presented in **Figure – 7**.

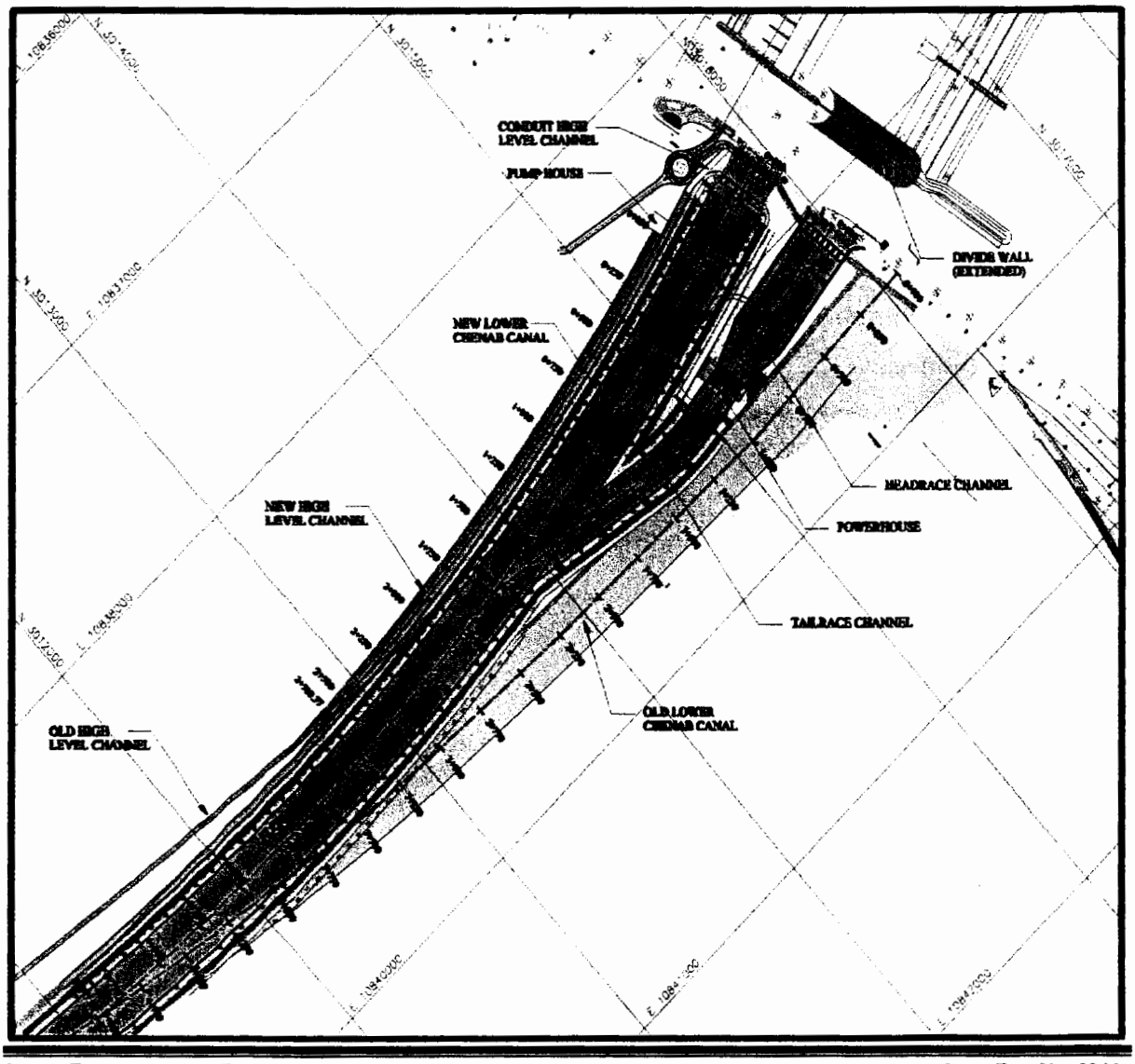
Figure - 7: Layout Plan of Option – 1



Option 2: Construction of power plant in separate canal off-taking U/s of New LCC.

The power house is located close to the proposed new head regulator of LCC i.e. between the existing LCC and the proposed new head reach of the LCC. An un-gated/skimming platform weir is to be provided for diverting the flow into the power house. The power house is placed at about 140 m (460 feet) downstream of the head regulator for relatively smooth flow with minimum turbulence in the power house. The tailrace of the power house is transitioned into the new LCC head reach after removal of the plug at its downstream end. Furthermore, the extension of divide wall of the left under sluice of the New Khanki Barrage is proposed. The layout plan of Option is presented in **Figure – 8**.

Figure - 8: Layout Plan of Option – 2



The recommended project alternative option is **Option no. 1**.

2.8.4 Interconnection Alternatives

In order to choose best interconnection alternative, a criteria has been developed based on the following considerations:

- Distance between the power station and the point of grid connection.
- Generation capacity of the power station.
- Transmission line capacity.
- Voltage regulation concerns:
- Cost of interconnection.
- Environmental issue.

The following options have been worked out in the light of the above recommendations.

Option 1: Direct connection to nearby 11 kV system;

Option 2: Interconnection at 11 kV side of the nearest 132 kV grid station;

Option 3: Interconnection utilizing 33 kV voltage level;

Option 4: Interconnection utilizing 33 kV voltage stepped up to 132 kV at grid station;

Option 5: Interconnection at the nearest 132 kV grid station;

Option 6: Interconnection with nearby 132 kV transmission line.

Recommended interconnection option for the power station is **Option no. 3**.

2.8.5 Route Alternatives of Transmission Line

There are two power schemes planned at Khanki headworks, one on the left bank of the river at LCC (the LCC powerhouse) and second on the right bank of the river (the Khanki powerhouse).

Following options related to the transmission line were considered and evaluated:

Option 1: Connection with the Shadiwal grid station at right bank of the river.

Option 2: Along the existing route. i.e, Khanki Headworks Colony to Wazirabad grid;

Option 3: Partial diversions from the existing route as mentioned under option 1.

These are discussed below:

Option 1: Connection with the Shadiwal Grid

There is another partially laid down but totally abandoned transmission line at right bank of the river which leads to Shadiwal powerhouse some 18 km from the proposed powerhouse. The Shadiwal powerhouse is connected with Gujrat grid station with a total distance more than 25 km. Though first half route from Khanki Headwork is comparatively clear from main human interventions but next half crosses major settlements like Trikha, Shadiwal, etc. This option was also considered but was rejected on technical grounds.

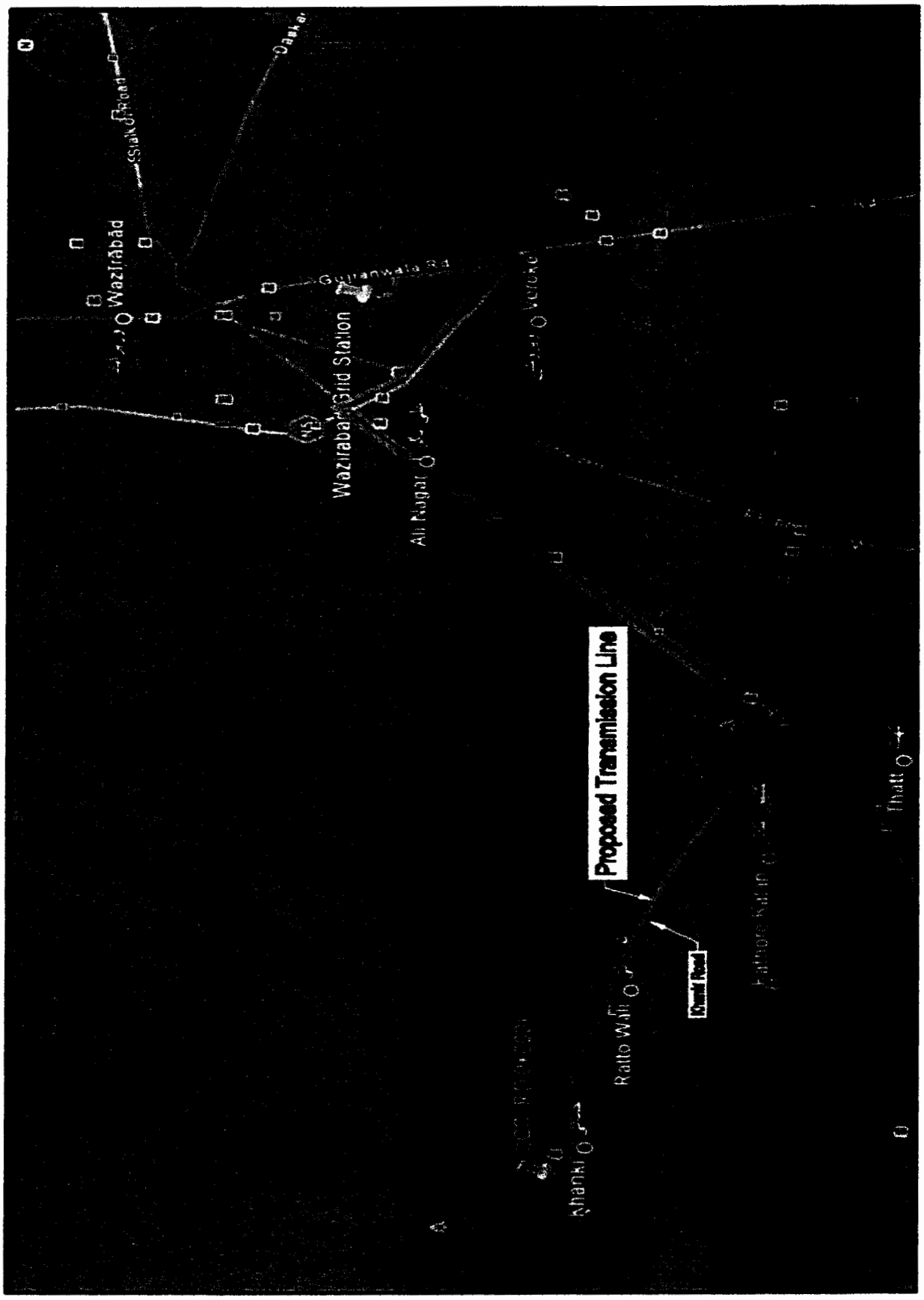
Option 2: Along the Existing Route to Wazirabad Substation

Existing route of the transmission line (18 km) has nothing adverse until it touches the settlement of Ahmad Nagar where the cables are almost touching the buildings of the community. It is evident that the settlement came into existence after the construction of transmission line but a new line along the same route, may cause health hazard to the human settlement in a length of about a km. This option, thus, rejected on the basis of threat to human life as well as a foreseeable high cost of compensation.

Option 3: Diversions from the Existing Route

Diversion of the existing transmission line from Police Choki Khathoor at Khanki road and then along the railway track up to Wazirabad bypass from where the route is along GT road which takes it to the existing line Wazirabad Grid Station. This diversion is shown in **Figure - 9**. Though the proposed diversions shall cause to increase distance by 1.5 km but it shall not disturb the present settlements and is recommended.

Figure - 9: Proposed Route for Connection to the Grid



3.0 LEGAL AND ADMINISTRATIVE FRAMEWORK POLICY

3.1 General

The Project is expected to comply with all national legislations to obtain all regulatory clearances required. Government of Pakistan has framed regulations and legislation for keeping the environmental and social impacts of the project at minimal under the Pakistan Environmental Protection Act 1997 (Pak-EPA). It is mandatory to carry out detailed Environmental Impact Assessment (EIA) of the development projects depending upon the nature and magnitude of the impacts. Pak-EPA regulatory guidelines exempt a Hydropower project, from being put to EIA when;

- The hydropower electric generation is less than 50MW.
- The capacity of transmission line less than 11KV and no grid station.
- The Project site is not classified as environmentally sensitive area.

This Project falls under the category of the projects requiring an IEE because of minimal environmental impacts.

3.2 Regulatory Requirements in Pakistan

Under section 12 (with subsequent amendment) of 1997 Act, a Project falling under any category specified in Schedule I (S.R.O 339(1)/2000), requires proponent to file an IEE with concerned federal agency (Pak-EPA). Projects falling under any category specified in schedule II require the proponent to file an EIA with the federal agency. Within ten working days of the IEE or EIA having been deposited the federal agency will confirm that the document submitted is complete for the purpose of review. Subsequently, the federal agency shall make every effort to complete IEE review within 45 days and an EIA within 90 days of filing.

Pak-EPA regulation (SRO 339(1)/2000) states that an IEE is required for federal or provincial hydropower projects with a total generation of less than 50 MW and/or transmission line less than 11 kV and/or the project site is not lies in environmentally sensitive area. An EIA, on the other hand is required for all other federal or provincial

hydropower projects and also for the projects are likely to cause adverse environmental effects.

Recognizing that the Pak-EPA has delegated powers to provincial EPAs to enforce the provision of 1997 Act, an IEE or EIA must be submitted to the provincial agencies in whose jurisdiction the project falls which in this case is the Punjab Environmental Protection Agency (Punjab-EPA). At the time of application, the Project proponent is also required to pay a specified fee to the concerned EPA.

3.2.1 Punjab Environmental Protection (Amendment) Act, 2012

Section 12 of the Punjab Environmental Protection (Amendment) Act 2012 makes it mandatory for the proponent of a project to file with the Environmental Protection Agency either an Initial Environmental Examination (IEE) or Environmental Impact Assessment (EIA), as the case may be, in respect of the project.

As per definition given in the Punjab Environmental Protection (Amendment) Act 2012, Environmental Impact Assessment (EIA) means an environmental study comprising collection of data, prediction of qualitative and quantitative impacts, comparison of alternatives, evaluation of preventive and compensatory measures, formulation of environmental management & training plans & monitoring arrangements, and framing of recommendations and such other components as may be prescribed. The provision of Section 12 has been incorporated "as it is" in the new Punjab Environmental Protection (Amendment) Act, 2012.

3.3 Other Environment Related Acts

This section outlines statutes apart from the Pakistan Environmental Protection Act, 1997, which are relevant to the project.

3.3.1 The Forest Act, 1927 and the Forest (Amendment) Act 2010

The Act, *inter alia*, deals with the matters related with protection and conservation of natural vegetation/habitats. In that matter it empowers the concerned agency to declare protected and reserved forest areas and maintaining these. In spite of the fact that it recognizes the right of people for access to the natural resources for their household use, it prohibits unlawful cutting of trees and other vegetation. Therefore,

for cutting trees for the construction purposes or otherwise, prior permission is required from the forest department of the concerned province.

3.3.2 Provincial Wildlife Act, 1974

In addition to empowering provincial wildlife department to establish game reserves, parks, and wildlife sanctuaries, these acts regulate the hunting and disturbance of wildlife. The project site does not come within the game reserve area therefore this act shall not apply on the site. However, Hunting, trapping and shooting within the project area by construction site workers shall be prohibited and considered as a disciplinary offence.

3.3.3 The Land Acquisition Act, 1894

The law deals with the matters related with acquisition of private land and other immovable properties existing on the land required for the project. The public purpose, inter alia, includes the construction of development projects including related roads, quarry areas, colonies, etc. For that matter it may also be applicable at private level provided the public utility of the project is established. As the land is a provincial subject, the proponent has to acquire the land for the project through the provincial government.

3.3.4 Antiquities Act, 1975

The Antiquities Act of 1975 ensures the protection of Pakistan's cultural resources. The Act defines "antiquities" as ancient products of human activity, historical sites, or sites of anthropological or cultural interest, national monuments, etc.

The Act is designed to protect these antiquities from destruction, theft, negligence, unlawful excavation, trade, and export. The law prohibits new construction in the proximity of a protected antiquity and empowers the Government of Pakistan to prohibit excavation in any area that may contain articles of archaeological significance. Under the Act, the project proponents are obligated to ensure that no activity is undertaken in the proximity of a protected antiquity, report to the Department of Archaeology, Government of Pakistan, any archaeological discovery made during the course of the project.

3.3.5 National Environmental Quality Standards (NEQS) 2000

The NEQS 2000 specify the following standards:

- Maximum allowable concentration of the Pollutants, (32 parameters) in emission and liquid industrial effluents discharge to inland water.
- Maximum allowable concentration of pollutants, (16 parameters) in gaseous emission
- Maximum allowable concentration of pollutants (two parameters) in gaseous emission from vehicle exhaust and noise emission from vehicles.
- Maximum allowable noise level from vehicles

These standards apply to the gaseous emission and liquid effluents discharged by batching plants, campsite and construction machinery. The standards for vehicles will apply during the construction as well as operation phase of the project. The Standard prescribes maximum allowable noise levels for road vehicles and construction machinery is 85 dB. Precise standards for air quality are not available under NEQS, 2000.

3.3.6 Guidelines for Environmental Assessment

The Pak-EPA has published a set of environmental guidelines for conducting environmental assessments and the environmental management of different types of development projects. The guidelines that are relevant to the proposed project are listed below, followed by comments on their relevance to the proposed project:

Guidelines for the preparation and review of Environmental Report:

The guidelines on the preparation and review of environmental reports target the project proponents, and specify;

- The nature of the information to be included in environmental reports
- The minimum qualifications of the EIA team appointed.

- The need to incorporate suitable mitigation measures at every stage of project implementation.
- The need to specify monitoring procedures.
- The terms of reference for the reports are to be prepared by the project proponents themselves. The report must contain baseline data on the project area, detailed assessment thereof, and mitigation measures.

Guidelines for Public Consultation:

These guidelines deal with possible approaches to public consultation and techniques for designing an effective program of consultation that reaches out to all major stakeholders and ensures that their concerns are incorporated in any impact assessment study.

3.4 Interaction with other Agencies

The proponent is responsible for ensuring that the project complies with the laws and regulations controlling the environmental concerns of construction and operation, and that all preconstruction requisites, such as permits and clearances are met. This section describes the nature of the relationship between the proponent and line departments.

Punjab-EPA

The proponent is responsible for preparing the complete environmental documentation required by the Punjab-EPA and remain committed for getting clearance from it. Moreover, it is also desirable that once clearance from Punjab-EPA is obtained, the proponent should remain committed to the approved project design. No deviation is permitted in design and scope of rehabilitation during project implementation without the prior and explicit permission of the EPA.

Revenue Departments of Punjab

Under the national law, matters relating to land use and ownership are provincial subjects, and for the purposes of this project, the respective Revenue Departments of Punjab are empowered to carry out the acquisition of private land or built-up

property for public purposes. In order to depute land acquisition collectors (LACs) and other revenue staff who shall be responsible for handling matters related to acquisition of land and the disbursement of compensation, the proponent must lodge applications with the Punjab government.

The proponent shall provide logistical support and assist in preparing the documents necessary for notification. It shall also need to liaise with the departments of agriculture, horticulture, and forestry in order to evaluate affected vegetation resources, such as trees and crops, etc., for compensation purposes. Where public buildings/infrastructure is involved, the proponent shall approach the relevant departments for valuation of the affected building or infrastructure before removing the facilities. Likewise, the proponent shall liaise with other relevant departments/ agencies for relocation of public facilities such as electricity and telephone poles, public water supply schemes, public buildings, etc.

Punjab Forestry and Wildlife Departments

The project is expected to involve clearing of vegetation and trees within the proposed project area. The project contractor shall be responsible for acquiring a 'No Objection Certificate' (NOC) from the respective Forest Departments and Local Administration depending upon the type of forest, viz., demarcated, un-demarcated or individual forests under threat. The application for an NOC shall need to be endorsed by the proponent. Where construction is to be carried out in close proximity of protected forests and wildlife areas, the proponent is required to coordinate with the departments to ensure that impacts on vegetation and wildlife are minimized.

4.0 BASELINE CONDITIONS

4.1 Overview of Baseline

The description of existing baseline conditions includes physical environment such as topography, geology/seismicity, soil erosion/contamination, meteorology, water resources; biological environment like flora, fauna, crops, horticulture and forestry and socio-economic environment including demography, source of income, civic amenities and utilities etc.

Several field surveys and consultation were conducted by NESPAK in the process of preparing IEE during feasibility study. During updating IEE, the field work for determination of environmental baseline and in particular socio-economic setting of the project area due to revised layout, under-construction new khanki barrage and new LCC head regulator was undertaken during March to May, 2016.

4.2 Existing Baseline Conditions

The proposed LCC Hydropower Project site is located at the left bank of Chenab River about 17 Km downstream from main GT Road, Wazirabad bypass in district Gujranwala of Punjab Province. The approach to the proposed hydropower project site from Wazirabad is through Wazirabad – Saroki / Alipur Chatha – Khanki road.

The project area is flat and current land use pattern in the surrounding area is residential, commercial and agricultural. The land in this area is very fertile and a number of crops are invariably grown.

The groundwater is the main source of drinking water, which is mechanically pumped out through hand and motor pumps. Other major source of groundwater is tube well which is being used for drinking and agricultural purpose. There is no sewerage system in the adjacent villages. The common wastewater discharges are the use of soakage pits and open fields. Open drain system exists in Khanki Village which is being used to evacuate water from streets for discharge in open areas.

There is no disposal facility available for solid waste and no arrangements of solid waste collection were seen in the adjacent villages. People of these settlements

throw their wastes into the streets or in open areas. A part of this waste is being reused as manure to the agricultural fields comprising animal manure and organic portions.

4.3 Physical Resources of the Project Area

4.3.1 Topography and Geology

Topography

The topography of the area is flat and current land use pattern in surrounding area is residential, commercial and agricultural. Almost entire area is a flood plain with mild to gentle slopes towards south west and partly cultivated. The land in this area is very fertile and a number of crops are invariably grown.

Geology

The project site is located in Punjab, which is a plain of alluvial material as well as rocks at deeper depth. Probabilistic Seismic Hazard Assessment (PSHA) recently carried out for revision of seismic provisions of the Building Code of Pakistan, shows that the site area falls in Zone 2A. It is therefore, recommended that the project structures should be designed to cater for the requirements of Zone 2A of Building Code of Pakistan (2007).

4.3.2 Soils

The top surface comprises Clayey Silts and Clay/Lean Clay (Soft to Very Stiff) up to a depth of 7.0 m below NSL. The material is underlain by Sandy Silt/ Silty Sand (Very Soft to Very Stiff, Dense to Very Dense) up to a maximum investigated depth of 20 m below NSL. Groundwater is encountered at 5.60 m depth in the boreholes drilled up to a maximum depth of 20 m below NSL.

4.3.3 Meteorology

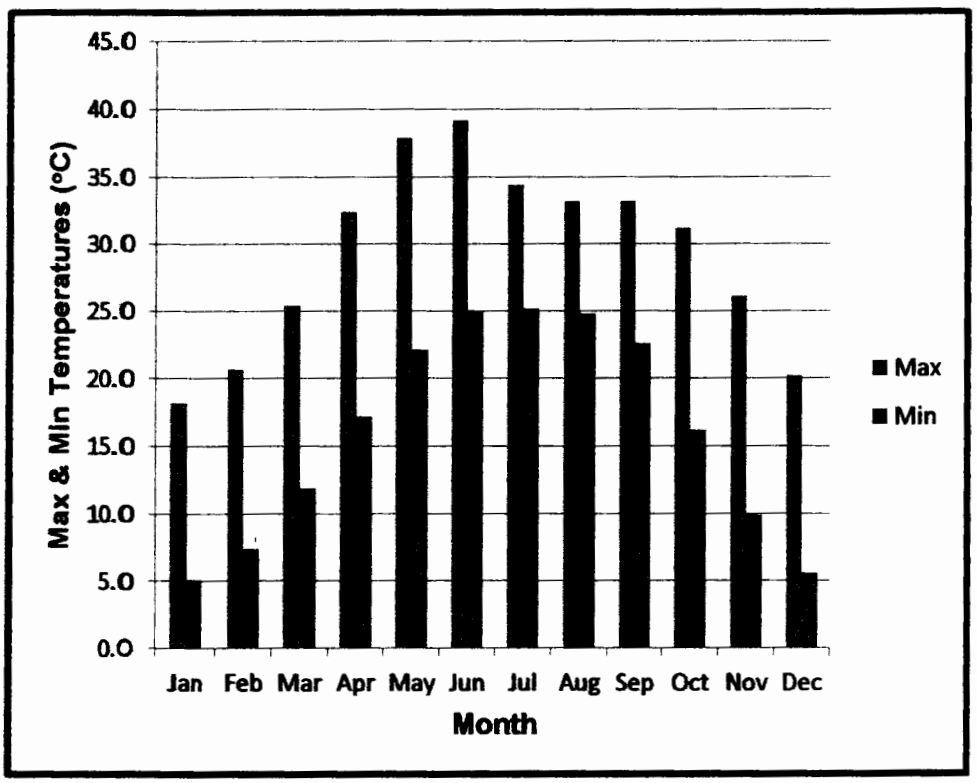
The country has four distinct climate seasons. April, May and June are extremely hot and dry months. July, August and September are hot and humid with intensive heat and scattered rainfall. The cool and dry period starts at the beginning of October and

continues through November. December, January and February are the coldest months of the year. Due to the diversity of the climate, a large variety of crops is grown to support the agricultural economy. The same is experienced at the project site and shall not affect the construction schedule of the project. However, Moonsoon season in July and August affects the area whereas March and April being the spring season are very pleasant months.

Meteorological data (Temperature, Rainfall, Humidity and Wind Speed) for Sialkot meteorological station being the closest to the Project site has been analyzed for the period of last ten years (2006-2015).

June and July are the hottest months in summer season. December and January are the coldest months in winter season. The mean daily temperature ranges from (June being the hottest month) 30°C to 32°C in the summer season (May to July) and 11°C to 13°C in winter season (January and December). Mean monthly temperature in June rises to a highest value of 32.1°C and falls to the lowest value of 11.6°C in January. **Figure - 10** shows the mean monthly maximum and mean monthly minimum temperatures.

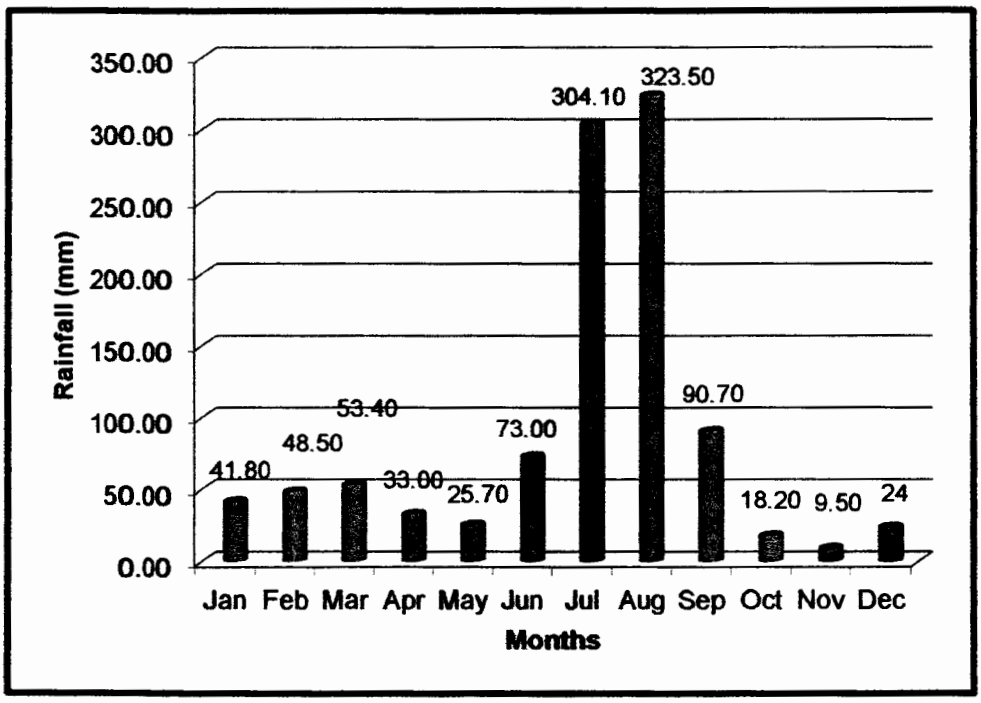
Figure - 10: Mean Monthly Maximum and Minimum Temperatures



In Pakistan the mean annual rainfall ranges from 4 to 30 inches in the lower Indus region to the northern foot hills. Only a small proportion of this annual rainfall (i.e. from 1 to 17 inches) makes any direct or useful contribution to irrigation water supplies. The rest is either converted to Direct Runoff or becomes a part of the ground water. While a small proportion is lost by evaporation. According to estimation, the present direct contribution to the crops is 9 MAF/Annual.

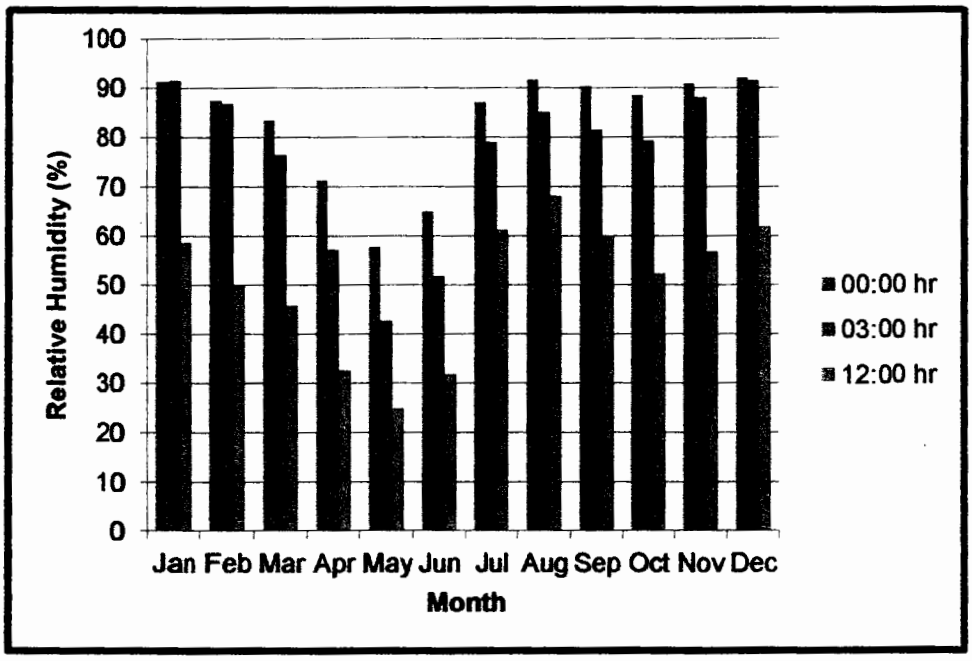
Daily rainfall data for Sialkot was collected and processed for monthly and annual rainfall basis. The mean annual rainfall of the area is about 1045 mm (41 inches). The maximum rainfall occurs during the months of July, August and September, which is about 70% of the annual rainfall. Precipitation in the project area is characterized by the monsoon season. Most of the rainfall occurs during the monsoon season (May to October). Winter rains generally occur during the months of January, February and March. **Figure - 11** shows Average Annual Rainfall.

Figure - 11: Average Annual Rainfall



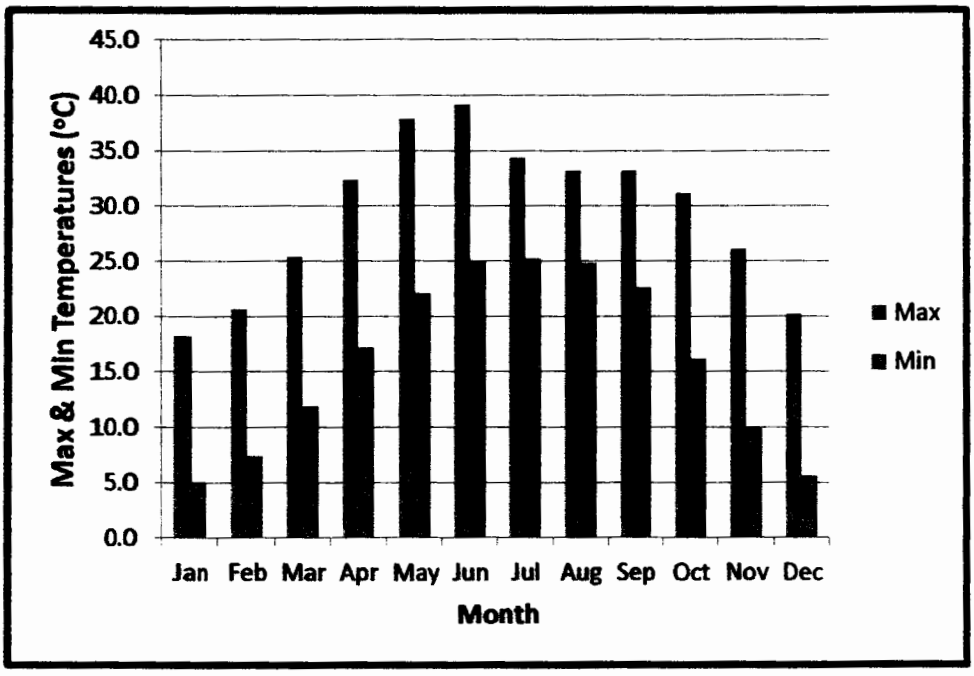
The relative humidity data at 00:00, 03:00 and 12:00 hours are available. At 00:00 hour the relative humidity varies from lowest value of 58% in May to highest value of 92% in December. At 12:00 hour, the lowest value is 24.9 % in May to highest value of 68 % in August. **Figure - 12** shows Relative Humidity.

Figure - 12: Relative Humidity



The wind data was recorded on daily basis for particular timings 00:00 hours, 03:00 hours and 12:00 hours. The monthly mean wind speed data reveals that at 00:00 hours, the wind speeds are generally lower while higher wind speed are recorded at 03:00 and 12:00 hours. During summers wind speeds are generally higher than the wind speeds in winters. **Figure - 13** shows Mean Monthly Maximum and Minimum Wind Speed.

Figure - 13: Mean Monthly Maximum and Minimum Wind Speed



4.4 Ecological Resources

Mainly a country's wilderness areas and scenic landscapes with their associated flora and fauna form natural capital of a country. Both collectively and within each level, the range or variety of the resources is referred to as the "Biological Diversity". The contribution of the "Natural capital" is recognized at three distinct levels including genera, species, and community habitat and ecosystem.

The greater the number of genera, species and habitats and ecosystems present within these units, the greater is the Biodiversity. It is in this background that the biological environment of the area is discussed hereunder:

4.4.1 Natural Flora

The natural flora of the area comprises rich crops but occasional trees. Shrubs, forages, herbs (medicinal plants), weeds and grasses are, of course, part and parcel of the agricultural features towards further richness. The cultivated agriculture is loaded with grain crops (wheat, rice etc.), vegetables (turnip, guord, ladyfinger rice etc.), fruit trees and fodders. The information about the most significant natural vegetation and agricultural flora is given below:

Forests

There is no forest area or large forest trees in the area. The dominant floral species found along the canal system include, *Albizia lebbeck (Sirin), sunbal, Tamarix aphylla (Frash), Prosopis juliflora (Mesquite), Eucalyptus spp. (Safada), tahli (Shesham) and dherek etc.*

Shrubs, Herbs, Grasses, Weeds

Herbs are also the shrubs but all shrubs are not herbs because herb is a shrub category with medicinal value. The dominant shrub species are *Prosopis glandulosa (Mesquite), Calotropis procera (Akk) and Capparis aphylla (Karir).* Livestock in this area is proportionally rich but forage species are limited, thus overgrazing of palatable species of grass and herbs is seen which has severely declined the palatable floral species and increased the ratio of unpalatable like Akk. Among

weeds, *pohli, piazi, kandiari and lehly (Convolvulus arvensis)* are common especially in the wheat crop.

Medicinal Plants

With regard to medicinal plants, no authentic data is available. Anyhow, local people have conveyed some information about the presence of *Chaenopodium album (Bathu), makhan booti, kandli booty, Calotropis (Akk), bakhra, phothkena, antshent, thema, pohli, podina, aksin, etc.*

4.4.2 Natural Fauna

Natural fauna of the Study Area shows universal symmetry and comprises almost all lasses of mammals, reptiles and amphibians, insects, butterflies & vectors, fresh water fish, birds and fowls present in South Asia. Livestock and poultry are part of the managed or domesticated agriculture and are also present in the Study Area as a part and parcel of human settlements. The information about the most significant wild animals, domesticated and human friendly animal species is given below:

Mammals

The dominant terrestrial fauna reported in the Study Area includes mammals species such as Canius aureus (Asiatic jackal), wild boar, Felis chaus (jungle cat), Herpestes edwards (common mongoose), Hystrise indica (porcupine), Petaurista petaurista (common squirrel), Mus booduga (Indian field mouse), Mus musculus (common house mouse), and Rattus rattus (common rat). Other than them, dog, common cat, rabbit, hare, porcupine are also in abundance.

Reptiles and Amphibians

Herpeto-fauna of the Study Area is represented by several families of reptiles. Common reptiles & amphibians are Kalotas versicolor (garden lizard), Hemidactylus brookii (house gecko), Euphlyctis cyanophlictis (skittering frog), Bufo stomaticus (marbled toad), and Python spp (snake). Scorpions are also common. Among amphibians, frogs, toads and turtles are found in the area. As concerns snakes, they are of many types like karandia, dub kharabba and kalanag, but generally speaking

all types of snakes traditionally a part of water environs are also seen in the Study Area from time to time.

Insects, Butterflies and Vectors

Commonly found insects in the study area are different species of caterpillars, bugs, beetles and other insects. Pests of various crops, vegetables, and fruits are also present but their damage is not significant as per statements of local people. Termite, however, does a lot of damage especially to the wheat crop, if season becomes drier due to less rains. Most of the insects pass into adult life as butterflies, which are common in the early summers.

Among vectors, house flies, mosquitoes, bed bugs, lice and snails are commonly found which spread diseases like cholera, typhoid, gastroenteritis and malaria fever. Natural bee hives also exist at big trees and the bees collect flower nectar of wild flowers from surroundings but their production is limited because wild flowers are not abundantly available.

Of course, there might be a presence of other commonly or un commonly known insects but giving a full account of all species is neither possible nor a requirement of the present limited study.

Birds and Fowl (Avifauna) Communities

The common avifauna of the study area is similar to the avifauna of the central Punjab because attractions for them, more or less, are the same. Exception is given to those bird species which like to stay near flowing waters. Among other birds, nightingale is dominant whose nests can be seen on almost every third tree. Please refer to the Photologs.

This Study Area comprises mainly Streptopelia senegalensis (little brown dove), Passer domesticus (house sparrow), Lanius excubitor (shrike), Pycnonotus leucogenys (bulbul), and Corvus abyssinicus (house crow). Parrot, sharak/myna, vultures and kites, though few in number, but are seen sometimes. There are ring necked parrots and common parrots around the settlements which are reported to damage fruit crops in the surrounding area. Quails, partridge and some water fowls

are also seen time to time. Anyhow Study Area is rich in avifauna especially the free flying birds.

Threats to Avifauna include direct intervention by humans through hunting, trapping, shooting, use of pesticide on crops/fruit trees, and expansion of agriculture and residential areas resulting in loss of bird's habitats.

Aquatic Ecology

LCC has many fish species which mainly travel from contributing Chenab River. Fingerlings belonging to various fish species are rohu (Labeo rohita), mori (Cirrhinus marigala), gulfam (Cyprinus carpio), thaila (Orechromus mossambica), mallhi (Schizothorax plagicstomus), singhara, sehole, desi khagga, etc. Fish is not commercially exploited here in the form of stock or pond fishery because of two main reasons, viz. commercial value of land is high and secondly running water carries carnivore fishes whose contact may destroy farm fish.

4.4.3 Protected Areas

- **National Parks:** To protect and conserve areas of exceptional geological, biological and cultural importance for educational, recreational and scientific uses.
- **Wildlife Sanctuaries:** To protect the species or groups of species of flora and fauna for breeding, and to protect them from extinction.
- **Game Reserves:** To protect flora and fauna for sustainable use.

National Parks

A National Park is an area owned by the government and set aside for protection and preservation of its outstanding scenery, flora and fauna in a natural state. It is accessible to the public for recreation, education and research activities, subject to such restrictions, as the Government may impose.

The construction of access roads, tourist facilities and other buildings in the National Park must not impair the park objectives. Forestry activities must also be controlled in the same way.

No National Park is located within the limits of Study Area.

Wildlife Parks

Wildlife Park is an area owned by the Government and set aside for the rehabilitation of endangered wildlife species under semi natural conditions as well as for the education and recreation of the public. The following acts are prohibited in a wildlife park:

- Hunting, killing or capturing of any wild species or firing any gun or any other fire arms.
- Polluting the water.
- Damaging or destruction of vegetation.

No Wildlife Park is located within the limits of Study Area.

Wildlife Sanctuaries

A Wildlife Sanctuary is an area owned by the Government (set aside by notification in the official gazette) as an undisturbed breeding ground for the protection of wildlife. Public access to the sanctuary is prohibited.

Exploitation of forest resources in a wildlife sanctuary is not permitted except for reducing the fire-hazards, epidemics, insect attacks or other natural calamities. However, no wildlife sanctuary is located within the limits of Study Area.

Private Game Reserves

Private game reserves are areas dedicated by landowners for the purpose of exclusively hunting wild animals within the reserve. Person other than the owner of the reserve are not permitted within the private game reserves without the owner's permission. The owner of a private game reserve is empowered to exercise, within the limits of his private game reserve, the same powers as a wildlife officer.

No private game reserve is found within the limits of Study Area.

4.5 Socio-Economic Environment

4.5.1 Socio-Economic Values

Existing socio-economic profile of any Study Area (especially Project Area) has prime importance in any engineering project because all direct and indirect impacts either positive or adverse have to be faced by the human inhabitants of surrounding settlements. Keeping in view the importance of socio-economic baseline, a survey was conducted to establish the database information of the proposed site.

There are two major settlements of the study area, viz. Khanki Headworks colony at left bank of the river and Khanki Village. Based on the socio-economic survey of the Study Area, average household size is 8.6. About 60% people are agriculturists and remaining 40% are government servants or labourers (40%). The literacy rate is 76%. The education attainment of females is significant because equal opportunity is available to them as those of males. There are equal number of primary, middle and high schools present with an equal gender ratio, i.e. one school of each category for males and females separately.

A new Basic Health Unit (BHU) is functioning since 2015 constructed as a part of new Khanki Barrage project. In case of emergency, the patients had to rush to Wazirabad hospital. Health facilities available in the area presented almost the same picture as that of any rural condition of the Punjab. Seasonal fever and malaria are the common diseases mentioned by the people. Rare cases of Hepatitis, Diabetes and Heart Disease are also reported.

Education facilities are good at Khanki village because of the presence of number of schools. Health facilities are almost the same as present in the general rural conditions of the district and are controlled by Wazirabad Tehsil Administration. Electricity is available in the area but natural gas is not available; so people use wood as a fuel source for cooking and heating. There is no bank facility but postal service is connected with Wazirabad city.

Water supply system is present because the old Khanki village received certain civic facilities when KB was constructed here more than a century ago. For drinking purpose, ground water is used. The use of Liquefied Petroleum Gas

(LPG) cylinders is common in the area which is an alternate source of heating, lighting, cooking and rickshaw transport. Other infrastructure is available for telephonic communication through private sector and some private postal services have approach to the site.

The monthly income group of Rs. 3,400 or Less, has the percentage of 46%, followed by a group 54% having an income of Rs.3,401-20,000. 50% of the people are working in far flung cities due to the scarcity of job opportunities. Willingness to accept unskilled job is quite high.

Wheat and rice were the main crops along with animal fodder. In irrigated and cultivated fields, rice and oat are commonly raised in winter along with wheat, while sorghum (jawar), millets (bajra) and sesame (til) are grown in summer along with maize. Maize and millets are grown mainly for livestock fodder and forage purposes. Wheat straw, maize stalks and grasses are dried and stored for winter stall feeding of livestock. Vegetables are grown at suitable and favorable sites for domestic use only. No commercial growing is undertaken. Vegetables commonly grown are turnip, cauliflower, cabbage, spinach, carrot, tomato, potato, arvi, gourd, tori, bhindi, melons, water melons, etc.

Onions, garlic and coriander (podina) are raised as spices and condiments. There are no commercial fruit orchards due to the small land holdings but some individuals have successfully raised fruit trees for domestic use only. These include oranges, mango, grafted ber, guava kinoo, mulberry, jamman, pomegranate and groundnut.

Almost all the households who have their link with the agriculture are keeping the cattle. Livestock diversity consists of many breeds of goat, sheep, cow and buffalo. Donkey, camel and mule are also being kept for transport purpose. Livestock production is not a major source of income, but some people keep mix breed cows, like the progeny of local cows by the cross of exotic breeds because they yield high volumes of milk.

Veterinary facilities are available but at far flung government and private clinics. Major livestock diseases are curable but present here like indigestion, respiratory diseases, ecto & endo-parasitic diseases as well as infectious and communicable

ailments. Some communicable diseases from livestock to human (zoonotic) are also reported here, viz. reproductive and skin diseases.

Regarding poultry, there are a few commercial poultry farms. Almost every household keeps poultry birds of indigenous (desi) and aseel breeds. Poultry in the area suffered from many diseases like coryza, fowl typhoid and coxiodiosis (a blood parasitic disease). Vaccination against Ranikhet (Newcastle disease) and treatment for other diseases are locally available.

Commercial activities are not significant due to probably two pressing factors. First good business alternatives are available comparing with poultry business and second water surroundings have given rise to a number of disease producing viruses and bacteria against which birds show less resistance, for instance, coryza and bronchitis.

The women are taking active part in household activities (like food cooking, washing of clothes, carrying of fodder for livestock and potable water for human consumption, etc.), child caring and meeting with social obligations. They also actively participate in farm activities like hoeing, harvesting, grain storage and making dung cakes for fuel purpose. They, however, are not paid for their services. They are less considered by the male members to take important decisions.

Generally, local disputes are settled through Panchayat system which is an informal but well organized conflict resolving mechanism existed in the village. If the party/ parties are not satisfied with the decision of the Punchyat, they can approach to lodge complaints to police station or court of law. Generally, the people prefer to settle their disputes through the Panchayat to avoid from long enmity, wastage of time and money.

Religious places including mosques, shrines and graveyards are regarded as sacred heritage and socially sensitive areas to deal with and receive devoted attention from the public. There is one major graveyard and a shrine of Dada Akku present in Wazirabad but none of them shall be directly affected due to the project implementation.

4.5.2 Existing Socio-Economic Conditions, Cultural and Aesthetic Values

- Old fashioned culture liked by the elders but the young generation was seen fond of modern culture;
- The influence of religion was strong and the population liked the Islamic ways;
- Food was very simple, comprised of wheat, rice, meat, vegetables desi ghee, milk and lussi;
- "Shalwar Qamiz" was seen the most commonly worn dress both among men and women, however, women were also observed veil and dopatta;
- Marriages are performed in full mix of Indian and Pakistani traditions. Dowry to the girl for equipping her new house was common, similar to other parts of Punjab; and
- The joint family system was predominant. However, new life style and cultural impacts from the outside world had directly influenced the family system, gradually shifting it to the nuclear family system.

4.6 Environmental Quality Status of the Project Area

In order to assess the environmental quality status of the project area, on site environmental monitoring was carried and monitored data is described below:

Noise

According to the monitored data, noise levels range between 48 dB(A) to 66 dB(A) as against permissible limits, i.e. below 70 dB (A). As there are no ambient noise level standards available in NEQS, therefore, WHO guideline is used as a reference standard as specified for industrial, commercial and traffic areas. Hence, noise is not a problem in the area in the baseline scenario. Noise readings were taken by the WHO standard noise meter.

Ambient Gases

The ambient air of the study area may be classified as lesser polluted because of low vehicular movement. No other major point and non-point sources can be

identified at the site except house chimneys emitting smoke due to the combustion of wood for cooking purpose and non-point sources like limited agricultural runoff. So air quality may be rated as good. The monitored data for the ambient gases was observed in the proposed project area in the baseline survey. From the monitored data, it is evident that concentration of the SO_2, CO and NO_x in the ambient air in the project area ranges below the detection limits of the instrument. The presence of these gases is considerably below the limiting values as set by the World Health Organization (WHO).

Table - 2: WHO Ambient Air Quality Guidelines

Description	Averaging Period	Guideline value in mg/m^3
Sulfur dioxide (SO_2)	24 hour	125 (interim target-1) 50 (interim target-2) 20 (guideline)
	10 minute	500 (guideline)
Nitrogen dioxide (NO_2)	1 year	40 (guideline)
	1 hour	200 (guideline)
Particulate Matter PM10	24 hour	150 (interim target-1) 100 (interim target-2) 75 (interim target-3) 50 (guideline)
Ozone	8 hour daily maximum	160 (interim target-1) 100 (guideline)

Water Quality

To determine the existing water quality of these sources, three (03) water samples were collected from the following locations:

- GW-1 sampling: Ground water sample from hand pump at Khanki village.
- GW-2 sampling: Ground water sample from hand pump at Old Irrigation Colony.
- SW sampling: Surface water sample collected from the location of proposed power plant.

The ground and surface water samples were tested against 22 selected parameters as per requirements of WHO and according to the guidelines of NEQS. The results are explained below:

a) Ground Water

The main source of drinking water in the study area is groundwater, which is mechanically pumped out through hand and motor pumps. The laboratory test results of ground water are listed in **Table - 3**.

Table - 3: Results of Chemical Analysis of Ground Water

Sr. No.	Parameter	Units	WHO Limits	Lab Test Results		
				GW1	GW2	Status
1.	Ph	—	6.5-8.5	7.8	7.9	Normal
2.	Temperature	^0C	—	16	16	Normal
3.	Color	TCU	15	10	14	Normal
4.	Total Dissolved Solids (TDS)	mg/l	1000	250	220	Normal
5.	Total Suspended Solids (TSS)	mg/l	—	1	3	Normal
6.	Taste and Odor	—	Fit / Unfit	Fit	Fit	Normal
7.	Total Hardness as $CaCo_3$	mg/l	500	75	88	Normal
8.	Total Coliform	Number/100ml	0/100 ml	ND	ND	Normal
9.	E-Coli	Number/100ml	0/100 ml	ND	ND	Normal
10.	Nitrate as NO_3	mg/l	50	1.2	0.2	Normal
11.	Ammonia	mg/l	1.5	0	0	Normal
12.	Arsenic	mg/l	0.01	0	0	Normal
13.	Turbidity	NTU	5	2	4	Normal
14.	Calcium Hardness as $CaCo_3$	mg/l	—	40	50	Normal
15.	Magnesium Hardness as $CaCo_3$	mg/l	—	35	38	Normal
16.	Chlorides as Cl^-	mg/l	250	30	60	Normal
17.	Fluoride as F^-	mg/l	1.5	0	0	Normal
18.	Sulphate as SO_4^{2-}	mg/l	400	70	40	Normal
19.	Iron as Fe^{3+}	mg/l	0.3	0.18	0.18	Normal
20.	Sodium	mg/l	200	13	16	Normal
21.	Iodine	mg/l	—	ND	ND	Normal
22.	Zinc as Zn^{2+}	mg/l	3.0	0.21	0.48	Normal

ND - Not Detected

The one-time groundwater results have indicated that all the parameters are within the recommended limits of WHO drinking water quality guidelines.

b) Surface Water

Chenab River is the major source of surface water in the Study Area. The laboratory test results of surface water are listed in **Table - 4**.

Table - 4: Results of Chemical Analysis of Surface Water

Sr. No.	Parameter	Units	NEQS Limits	Lab Test Result	
				SW	Status
1.	Ph	—	6-9	6.80	Normal
2.	Temperature	^0C	=<3^0C	17	Higher
3.	Color	TCU	–	290	Normal
4.	Total Dissolved Solids (TDS)	mg/l	3500	150	Normal
5.	Total Suspended Solids (TSS)	mg/l	200	110	Normal
6.	Taste and Odor	—	Fit / Unfit	Fit	Normal
7.	Total Hardness as $CaCo_3$	mg/l	–	70	Normal
8.	Total Coliform	Number/100ml	0/100ml	50	Normal
9.	E-Coli	Number/100ml	0/100ml	Positive	Normal
10.	Nitrate as NO_3	mg/l	–	9.4	Normal
11.	Ammonia	mg/l	40	0.13	Normal
12.	Arsenic	mg/l	1.0	0	Normal
13.	Turbidity	NTU	–	107	Normal
14.	Calcium Hardness as $CaCo_3$	mg/l	–	37	Normal
15.	Magnesium Hardness as $CaCo_3$	mg/l	–	33	Normal
16.	Chlorides as Cl^-	mg/l	1000	60	Normal
17.	Fluoride as F^-	mg/l	10	0	Normal
18.	Sulphate as SO_4^{2-}	mg/l	600	120	Normal
19.	Iron as Fe^{3+}	mg/l	8.0	0.56	Normal
20.	Sodium	mg/l	–	16	Normal
21.	Iodine	mg/l	–	ND	Normal
22.	Zinc as Zn^{2+}	mg/l	5	0.23	Normal

ND - Not Detected

The one-time test results of surface water show that chemical contents are within the safe limits as per NEQS limiting values. Temperature and the microbial content of the surface water are higher than the normal limits. Surface water profile suggests that this source of water might be fit for irrigation use but may not be used as drinking water source downstream of the canal. As concerns high temperature, it has nothing to deal with the quality of water but presence of total coliform bacteria shows the mixing of toilet waste in the river source.

c) Solid Waste

Solid waste includes human waste, kitchen waste, garbage, etc. In the area, no conventional solid waste collection and transportation system is in practice. There is presently no disposal facility available for solid waste and no arrangements of solid waste collection were seen in the adjacent villages. People of these settlements throw their wastes into the streets or in open areas. A part of this waste is being reused as manure to the agricultural fields comprising animal manure and organic portions (called compost).

d) Wastewater Discharge

There is no sewerage system available in the study area. The common wastewater discharges are the use of soakage pits and open fields. Open drain system exists in Khanki Village which is being used to evacuate water from streets for discharge in open areas.

5.0 ENIVIRONMENTAL IMPACTS AND MITIGATION MEASURES

A summary of the impacts and mitigation measures regarding the project during construction and regular operation of the project is given hereunder. For a comprehensive treatment reference be made to the Environmental Management Plan preceding this write-up.

5.1 Construction related Impacts and Mitigation Measures

5.1.1 Noise

During the construction phase, the noise shall generally be generated from vehicular movement, sand and aggregate processing, concrete mixing & excavation machinery etc. and residents of the nearby settlements (i.e. Khanki village) may get affected especially at night time. Noise levels in the construction area from machinery and vehicles should be as specified in the guidelines by the environmental protection agencies.

Mitigation Measures

Mitigation measures for noise impacts on construction workers shall include standard occupational health and safety practices such as ear protection and enforcement of exposure duration restrictions.

5.1.2 Air Quality

A number of machinery and equipment shall be in operation for the construction of the project, which includes concrete mixers, excavators, dumping trucks, road rollers, haul trucks, transport vehicles, cranes and other construction machinery.

Most of these use diesel engines that generate noise and exhaust emissions. The possibility of exhaust emissions increases when the old vehicles/plants are deployed during the execution. Generally, the above activity shall be generating particulate matter (PM_{10}), smoke, dust, CO and NO in the ambient air, which deteriorates the air quality and resulting in adverse impacts on the human health, fauna and flora.

Fugitive dust due to the construction activities (excavation, compaction, concrete mixing plant, dumping etc.) shall affect the local air quality due to increase of the concentration of particulate matter. The dust may be emitted due to general site work, road improvements and truck traffic.

Mitigation Measures

Following mitigation measures may reduce the severity of temporary adverse impacts:

- *Tuning of vehicles should be made mandatory to reduce the emissions of NO_x, SO_x, CO and PM_{10};*
- *Emissions from the concrete mixing plant should be controlled with appropriate control equipment (such as fabric filters or cyclone separators);*
- *Equipment and vehicles powered with diesel should be well maintained to minimize the particulate emissions;*
- *Haul-trucks carrying, earth, sand, aggregate and other materials should be kept covered during the transportation of materials and storage at site with tarpaulin, to avoid the dust emissions;*
- *For the construction machinery generating noise level above the prescribed of NEQS and WHO limits, Contractor shall make arrangements to bring the noise level within the permissible limits (including proper tuning of vehicles and mufflers/silencers); and*
- *Movements of the trucks and other construction machinery causing high noise levels must be restricted at night time to avoid disturbance to the nearby locality. Truck drivers should be instructed not to play loud music at night and stop the use of horns even at day time.*

5.1.3 Soil Erosion/Contamination

Soil contamination may occur due to the discarded construction materials that include chemicals, oil spills, wires, plastics, pieces of pipes, tins, drums, wood and cardboard packing and other discarded materials. All these wastes create soil contamination around the project site.

One of the most important soil contaminating sources is the generation of solid waste during the construction activities and this generation rate shall increase considerably. It is estimated that on an average 100 laborers shall be employed at construction camp, which shall generate about 50 kg of solid waste for camp site @ 0.5 kg per capita per day. The major components of the workers camp waste are garbage, putrescible waste, rubbish and small portion of ashes and residues. Immediate attention is required for such type of wastes as these are degradable and cause obnoxious odour.

Mitigation Measures

Good engineering practices shall help in controlling the soil contamination both at the construction site and in the peripheries.

Soil contamination due to oil leakages, chemicals and other toxic materials shall be minimized by providing appropriate storage places. Oil and other lubrication materials should be stored in leak proof tanks especially built for oil storage. These tanks should be built away from the main road and residential areas. Access to these tanks should only be allowed to concerned personnel. Safety equipment like fire extinguishers should be placed near these places along with displaying the signs for danger and fire.

Similarly, soil contamination can be curtailed by reducing the oil spills in the camp and at project construction areas by well maintaining the construction vehicles as well as other contaminants in the storage tanks/places. Generation of solid waste shall be an important soil contaminating source and may yield temporary adverse impact but its mitigation shall be possible through good engineering and appropriate storage places. Solid Waste shall be properly managed. Recyclables shall be sold and other wastes shall be disposed-off properly.

5.1.4 Construction Spoil

The major source of construction spoil is likely to be generated from the excavation of the diversion channel and the powerhouse. The hydropower project shall produce construction waste especially from the excavation works. If construction waste is left at places of excavation, it shall remain there in loose form causing dust pollution and hindrance in the natural drainage of the area.

Mitigation Measures

Excavated material should be properly disposed-off ensuring that it shall not block the natural rainwater drainage paths. Open drains for drainage of wastewater should be constructed, if considered necessary during construction. The leftover material like cement mix concrete should be collected and disposed-off into the designated sites.

5.1.5 Water Quality

The water requirements for the project can be divided into two main uses, i.e. water required for construction camp's utilization and for construction purposes. It is estimated that around 100 workers shall be accommodated in the construction camp during average construction activities, who shall utilize around 4000 litters/day of water for washing, cooking and bathing purposes. This water shall be extracted from groundwater and shall have no conflict with the local water users and agriculture of the area.

Due to the construction activities i.e. excavation and dumping of soil, spillage of chemicals, oil, lubricants, detergents, etc, and the surface water quality might get deteriorated. In addition to that, around 3,200 litres/day (3.2 m^3/day) sewage shall be generated at the construction camps. If the generated sewage is not properly treated or disposed-off, this may contaminate the surface (Chenab River) and might affect the groundwater resources apart from soil contamination.

Mitigation Measures

It is recommended that wastewater effluent from contractor's camp should be passed through gravel/sand beds to remove oil/grease contaminants before discharging it into the soakage pit. Construction of the three chamber sumps outside all the contractor's facilities before discharging into the temporary sewerage system could also be considered.

5.1.6 Impacts on Flora

Impact on the vegetation determined depicts that there shall be no significant adverse impact on the trees as the area is not densely populated by trees. No

endangered, threatened or vulnerable species in the project area exists. No any tree exists in the project area required to be fallen. The vegetation cover of project area has been cleared before the construction of the new Khanki Barrage project. The construction of power scheme shall neither have any impact on floral life nor any mitigation measure shall be required.

Mitigation Measures

The impact on flora is not expected to be of higher magnitude and can further be minimized by the proper construction planning. The power station and its various components such as offices, stores, parking areas etc. should be so designed and located, so as to occupy minimum possible area, leaving large area as open spaces, for accommodating maximum numbers of grassy plots, ornamental trees, shrubs and flowery plants. The trees in the open spaces should be saved as far as possible. This shall reduce the negative impact on the flora and also give an aesthetic look to the area and create better environments for the workers to perform their assigned duties.

5.1.7 Impacts on Fauna

Impact on the fauna shall be of minor and of temporary nature, although, a few rarely sighted species of avifauna are reported in the surroundings, but the project is not expected to have any significant adverse impact on them. The proposed project shall rather yield positive impact on the fauna of the project area because the fauna and especially the avifauna shall be attracted to the area again due to recommended extensive plantation. Other than birds, there shall not be any significant, rather insignificant adverse impact on other classes of wild animals including fish. Wild animals, viz. mammals reptiles, amphibians or insects; they shall migrate to the adjacent safer places.

Mitigation Measures

Mitigation measures during vegetation clearance should include site walkovers by a qualified ecologist to identify the presence of any vulnerable species before clearance activities are undertaken. Mitigation measures shall need to be enforced through an Environmental Management Plan (EMP) and contractually bind both

Contractor and their labourers from undertaking illegal poaching and any other hunting and fishing activities.

5.1.8 Resettlement and Land Acquisition

Powerhouse & Spillway

As per revised layout of the proposed LCC Hydropower Project under Updated Feasibility Study, the proposed project involves the construction of a powerhouse and spillway within the canal and a temporary diversion channel at the left bank of new LCC. The entire activity of construction shall be carried out in 36 months and land shall be temporarily acquired for this period for the construction of temporary diversion channel.

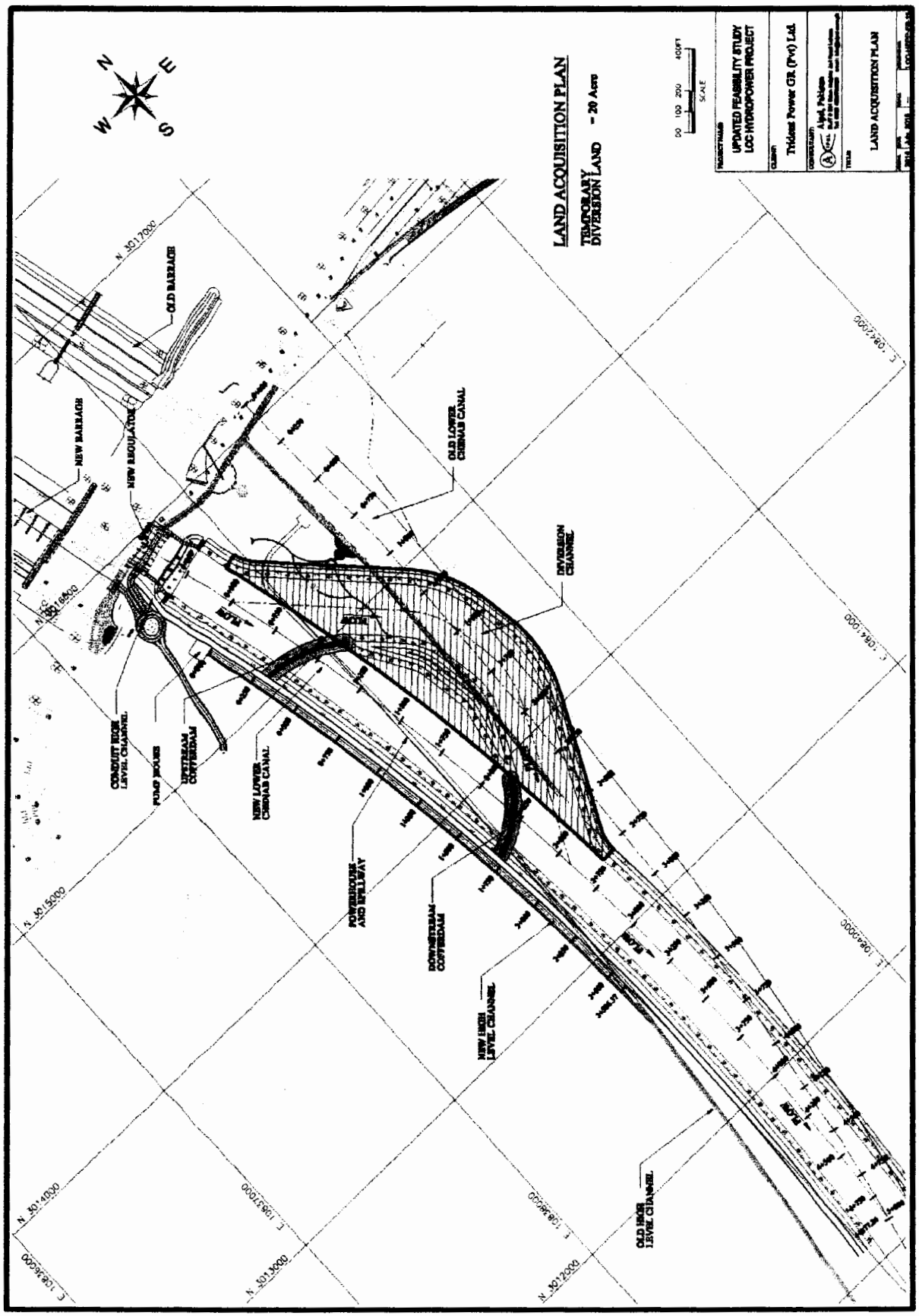
According to the revised layout plan, land area of about 20 Acres shall be acquired for the construction of temporary diversion channel. **Figure - 14** shows the land acquisition requirement for temporary diversion channel. As per LAA, 1894 it is envisaged that only private land shall be compensated according to the market land price. The compensation shall be paid by the Proponent to the private owner (s) of the land.

Since the land for temporary diversion channel is state-owned and was acquired for the construction of new LCC, therefore, no any significant impact shall be caused by the construction of temporary diversion channel.

The proposed project shall not cause any dislocation/resettlement of any person as the new residential colony for barrage employees has already been constructed under new Khanki Barrage project. The barrage employees shall be shifted to this new residential colony before handing over the proposed project site and the project shall find a clear land for the construction of temporary diversion channel.

Under such scenario, it is envisaged that there shall not be any dislocation of the persons, no damage to crops, no removal of trees and thus no adverse impact shall be caused by the construction of powerhouse and temporary diversion channel.

Figure - 14: Land Acquisition Requirement for Temporary Diversion Channel



Transmission Line

The proposed Transmission Line shall involve the construction of 20 km long 33 kV single circuit transmission line. The entire activity of connecting LCC powerhouse with the Wazirabad grid shall be carried out without the bounds of the existing Transmission Line, along the government land so that no additional land could be acquired. *Under such scenario, it is envisaged that there shall not be any dislocation of the persons, no damage to crops, no removal of trees and thus no adverse impact shall be caused by this power component.*

It is envisaged that some poles shall be required to erect along the 20 km Transmission Line route passing it through six small and big villages along the road connecting powerhouse with the Wazirabad grid station.

Being within the ROW, the Transmission Line shall not disturb any built up infrastructure, etc of the private farmers. Construction of Transmission Line and stringing works mainly affect agricultural crops and trees within 10 m wide safety corridor. This factor may become important as and when ROW of the road becomes narrower than safety corridor. But in majority cases the transmission line traverses throughout the open lands.

The sections of the transmission line in between the poles may yield temporary damage or loss during the stringing of power cables. This last activity is usually carried out rapidly, one stretch at a time. Hence, no adverse impact is envisaged. As stated earlier that new 33 kV proposed 20 km transmission line may require the construction of some poles, so no private or public land shall be acquired permanently, as none of the new poles shall be constructed in an established urban or a developing housing area, and sufficient clearance shall be provided around the poles for convenient mobility of agricultural machinery to allow the farmers to continue cultivating their lands without restriction.

5.1.9 Employment Generation

The implementation stage of LCC Hydropower Project spreads over 36 months. At implementation stage, information such as the exact number of construction workers shall enable an assessment of employment to be generated by the scheme. Most of the labour shall be employed from the project area.

The beneficial impact in terms of employment and the indirect positive effects it has on household income is considered to be of minor magnitude. The well-being and working conditions of the labour force is an important issue for this project. Mitigation measures are aimed at increasing the benefits of employment generation during construction.

It is recognized that some poor labour management practices, for instance frequent and long overtime use and lack of legally required minimum wages, combined with a lack of adequate occupational health and safety focus has led to accidents and in some cases strikes in the State. Providing satisfactory and safe work conditions shall promote the labour force's ability to achieve tasks without undue delays and discontentment which can have financial ramifications.

Part of the Contractor's responsibilities shall be to implement adequate health and safety provisions for labourers. In order to address labour management and working condition issues, the contract should include clauses for the following issues:

- Adoption of a human resource policy that sets out the Contractor's approach to managing employees which is compliant with the national labor law. Implementation of a recruitment policy which reflects equal opportunity, fair treatment, and compliance with the national labor law. Information that adequately describes working conditions and grievance procedures shall be provided to workers at the time of hire along with their contracts. Efforts need to be made to use local labor, for instance by consulting with local administration as well as NGOs regarding people who have received building training related to the earthquake rehabilitation activities. Efforts also need to be made to identify appropriate positions that can be considered for female applicants.
- Treatment of employees and working conditions shall be compliant with the Labor Law, for instance in regards to overtime payment (double the hourly wage) and working hours (under the Factories Act, 1934 no adult employee, defined as a worker who has completed his or her 18th year of age, can be required or permitted to work in any establishment in excess of nine hours a day and 48 hours a week.
- No use of child or forced labor. It is recommended that the Contractor does not contract anyone under the age of 18 to work on the project.

- Payment of all salaries shall be on a timely basis as per conditions of employment. Specify maximum number of late payment days before the Contractor should be required to pay compensation on wages.
- Provision of employment certificates and a training register to workers contracted over six months on completion of contracts.
- Establishment of a grievance mechanism for workers to raise reasonable workplace concerns.
- It should contain the commitments in relation to human resource management, working conditions, use of resource by itself, its employees as well as subcontractors' employees and use of a local work force to the largest extent possible.
- A labour camp shall be established for the construction labor force.

The labour camp or construction camps shall provide essential services, including electricity, potable water, adequate cooking and bathing facilities to ensure safe and hygienic conditions. The labor camps shall be addressed in the following plans which the Contractor shall produce in the construction phase:

- Environmental and Social Management Plan (ESMP).
- The Health and Safety Plan.

The camps shall be administered and supervised to ensure health, safety and environmental management taking into account cultural and social sensitivities among the workforce. Where eating is communal, hygienic conditions for preparing and serving of food should be established and monitored. Where transport is provided, a transport coordinator should be assigned to arrange proper transportation of employees. Responsibility and procedures for transportation of sick employees to medical facilities should be established.

5.1.10 Deterioration of Community Health, Safety and Security

There is a potential for social impacts resulting from activities as well as the presence of job seekers and construction workers on the site. As a result of construction an influx and congestion of people may contribute to deterioration of

community health, safety and security due to people's interactions and behaviours. For instance, incidents of accidents, social conflicts, property theft and spread of communicable diseases can occur. Impact magnitude is likely to be minor. However, the social receptors are considered medium sensitive community members who may potentially lack literacy skills to read signs, be young or old, may lack resources and power to prevent crime and / or bullying. There are mitigation measures available and these issues should be addressed early in the construction schedule.

The Contractor shall be required to employ a full time qualified (certified if possible) safety officer for the construction phase duration. The Contractor shall need to carry out a risk assessment and then develop a site and project specific Health and Safety Management Plan aimed at preventing accidents, injuries and work-related diseases for both construction and operation and addressing occupational health and safety as well as community health, safety and security. It shall be based on the Environmental Management Plan (EMP) provided in this document which identifies activities and monitoring indicators associated with good occupational health and safety.

The main measures include:

- Carrying out health screening of labor force and health awareness activities.
- Identifying potential hazards to workers, particularly those that are life threatening.
- Providing preventive and protective measures for hazardous conditions or substances; training and equipping workers with information and Personal Protective Equipment (PPE) with the aim of preventing accidents, injuries or diseases and of minimizing hazards.
- Documenting and reporting occupational accidents, diseases and incidents.
- Developing emergency prevention, preparedness and response arrangements.

Each employee should undergo health screening to help prevent the transfer of diseases. In particular, iodine deficiency, diabetes and tuberculosis for locally

recruited employees and malaria and sexually transmitted diseases for those who are not local should be considered. Bi-annual health awareness sessions should be organized whereby local health officials or NGOs aim at instilling good behaviour, healthy attitudes and knowledge regarding hygiene, disease prevention and general well-being.

Materials, including hazardous substances, for both construction and operation shall be managed safely, for instance their transport and storage shall be arranged to prevent community and personnel exposure.

Care should be exercised for the safe transport of raw materials and the transport and disposal of waste. The Contractor should not be allowed to use products that fall under Hazard Classes 1a or 1b of the World Health Organization's Recommended Classification of Pesticides. Safety processes shall be put in place to promote a safe environment and structural elements of the project shall be designed, constructed and operated to meet good international industry practice. Project vehicles and equipment shall be maintained and project related traffic shall be requested, at a minimum, to travel no more than the speed limit.

Workers shall be provided with personal protective equipment (PPE) and training and there shall be enforcement to ensure usage. Guidelines for maintaining hygienic conditions and appropriate shelter or shading at eating, resting, drinking, smoking and washing facilities on project site shall be established.

The Contractor and the Operator for the LCC Hydropower Project shall endeavour to avoid or minimize risks to and impacts on the health and safety of the local community during the project life cycle from both routine and non-routine circumstances as well as ensure that personnel and property is safeguarded in a manner that avoids or minimizes risk to the community's safety and security. Both the Contractor and the Operator shall be expected to carry out a risk assessment that evaluates health and safety issues for the local community.

5.1.11 Cultural Heritage and Archaeology

Although some changes in the social and cultural behaviour are expected due to interaction of local population with the project staff from outside, development of the

project site is not likely to cause any adverse social impact at all. No place of religious or cultural veneration was sited during field visits to the project area.

During site survey, it was observed that dead ancestors and family elders are held in high reverence and esteem and any disturbance to family graveyards could be emotionally disturbing and discomforting. The project layout including the main structures and ancillary structures should avoid graveyards at all costs, if any.

5.2 Operation related Impacts and Mitigation Measures

5.2.1 Emission of Greenhouse Gases

In comparison to the other power production sources, such as the fossil fuels or nuclear, the hydropower produces relatively small or negligible amount of greenhouse gases which could contribute towards global warming. No greenhouse gases shall be emitted.

Mitigation Measures

Since greenhouse gases shall not be emitted from the powerhouse so no mitigation is required.

5.2.2 Noise

Power station shall be the major source of noise during operation. The noise shall mainly be generated in the power station only through the operation of the electrical and mechanical equipment. Further, the increased access as a consequence of the road improvements may generate some additional traffic which could also impact on the existing noise levels in the project area. Therefore, appropriate noise reduction measures shall be taken to reduce the generation of any noise levels.

Mitigation Measures

Acoustics measure shall be taken care in powerhouse construction for noise reduction, therefore, the noise levels shall not exceed the limiting value as desired by the National and International Standards. Mitigation measures for noise impacts on

workers shall include standard occupational health and safety practices such as ear protection.

5.2.3 Air Quality

During operation, air pollution is expected to be very limited, and the main sources shall be from vehicle emissions / dust from maintenance traffic on unpaved roads and increased traffic due to movement of workforce.

Mitigation Measures

A few mitigation measures such as proper vehicle tuning and road maintenance etc. are available to limit influx of traffic movements resulting from improved road infrastructure.

5.2.4 Soil Contamination

It is estimated that the project operation shall result in generation of about 12 tons/year of solid waste from the proposed power scheme. This waste may contaminate the soils and disturb the aesthetics of the area if remains un-attended. It is further added that oil spills from the vehicles shall also cause to damage the soils and impervious surfaces of the floor.

Mitigation Measures

Keeping in view the above mentioned impact of the project, provisions should be made for proper solid waste management plan, which will involve the following major functional elements:

- *Storage at source*
- *Segregate at source*
- *Collection of waste Storage*
- *Transportation*
- *Disposal of waste (sanitary landfill or any other suitable alternative available)*

Hazardous waste likely to be generated and shall be handled separately as per approved practices to avoid hazard to humans and wildlife. Floors with impervious surface should be designated to avoid the contamination of soils. However, in any case soil contaminated due to the spillage of oil should be removed and replaced with native soil.

The project Proponent should make final disposal arrangements in consultation with the concerned government department and should take written approvals for the final disposal of the waste at the designated disposal site in the nearby area. A separate solid waste management system for the waste from office, common zones and for power station will be required. During the collection of solid waste, recyclable and reusable waste will be separated for resource recovery and reuse of the generated material.

5.2.5 Aquatic Ecology

Some adverse impact on the downstream fishery is expected during project operation stage due to high velocity of water striking the turbines which shall kill the fish, if trapped.

Mitigation Measures

It is very hard to protect fish fauna from killing due to turbine action because protective nets at the mouth of water intakes cannot help fish to slip back to the river. It is, suggested that stock/pond fishery may be established along the downstream of the power station at appropriate distances to breed additional fish.

Two fish ladders are already provided in the new Khanki barrage. It is expected that in the presence of fish ladders, the proposed project shall not cause much adverse impact on the fish fauna and other aquatic life.

5.2.6 Provision of Associated Facilities

The proposed project shall contribute positively to the livelihood of people in the project area. Local community members, considered to be medium sensitive socioeconomic receptors because of their probable dependence on natural

resources and lack of economic capital, shall benefit from the facilities. Moreover, education and health facilities shall be enhanced due to project and these facilities shall also be available for the local communities.

5.2.7 Electricity Generation

The greatest benefit provided by the proposed LCC Hydropower Project shall be the provision of electricity to population, expanding economic activities and increasing demand for energy. The LCC Hydropower Project is proposed to generate 7.5 MW installed capacity. Electricity is recognised as a necessary productive input contributing to a stable economy.

5.2.8 Employment Generation

During operation, a small number of people shall be benefited from employment opportunities. Employees are considered to be a socio-economic receptor of medium sensitivity because they shall have long term contracts that provide fair remuneration on a regular basis. Maintaining a positive employee / employer relationship shall enable the proposed LCC Hydropower Project to put some Corporate Social Responsibility values into action and support a credible reputation. To enhance labour management for the operational phase of the Project, the following procedures are recommended:

- Establish a committee composed of representatives of the employer and workers for discussing work related issues or establish a grievance mechanism.
- Do not employ anyone under the age of 18.
- Provide employment certificates and training register to workers on completion of contracts.

Employees working conditions and terms of employment shall need to be documented in contracts and a system or location to provide on-going, general information related to labour issues shall need to be established.

6.0 PUBLIC CONSULTATION

6.1 Objectives

Public consultation is an integral part of the environmental and social assessment aimed at providing a two-way communication channel between the project stakeholders; project affected persons (PAPs) and communities, and the project proponent. In line with this aim, the objectives of public consultations were to:

- Develop, enhance and maintain communication links between the project proponents and PAPs and communities in the project area;
- Provide key updated project information to the PAPs, communities and other stakeholders, and to solicit their views on the project and its potential or perceived impacts; and
- Ensure that views and concerns of the PAPs and other stakeholders are incorporated into the project design and mitigation actions implemented with the objectives of reducing or offsetting any negative impacts and enhancing benefits of the project to the PAPs and communities.

6.2 Participation Framework

Public consultation is a continued process, and it should be maintained throughout the project cycle. Consultations carried out to update IEE are essentially an initial step in this continuous consultation process, which shall continue during the subsequent project phases as well.

6.3 Methodology for Consultations

The methodology adopted for public consultation included meetings and discussions with community institutions and other grassroots level stakeholders. Following were the key aspects of and sources of information, the consultant used during consultations:

- Desk review of literature, existing information, project documents and report;

- Meetings/consultations with project proponent, key informants i.e. PAPs and community members.
- Interview with the key informants.
- Site visits.

6.4 Public Consultation

Public consultation is a systematic process, which provides an opportunity for planners, citizens, managers and selected representatives to share their experiences, knowledge, concerns and perceptions about any proposed development activity. During present survey, a comprehensive discussion was ensured with the community. The objectives of the public consultation for the proposed project were to:

- Share information with the stakeholders on the proposed project works and their expected impact on the socio-economic environment of the Study Area.
- Understand the stakeholders concerns regarding various aspects of the project, including the existing conditions of the Study Area, up-gradation requirements, and the likely impacts of the construction related activities and operation of the project.

6.5 Stakeholder's View and Concerns

Major view and concerns of the project and study area are given below:

- Government Employees were satisfied over the construction of new khanki headworks colony.
- Most of the people had shown likeness for the proposed project.
- Veterinary facilities are poor.
- Poor drainage system and no sanitation.
- Unpaved streets.
- Demand for local hiring of labour during construction.

6.6 Recommendations

Based on the Public Consultations of the project, the following recommendations are made:

- The management of the Project can capitalize positive perceptions of the residents of the project study area towards the project by offering them maximum employment opportunities at the construction stage and the early stage of operational phase of the plant.
- Insufficient and inadequate socio-economic structure of the people of the project study area also provides ample opportunities to the project management to attract sympathies of the local people in favour of the project.
- The power plant management should offer technical training opportunities to the local youth, if possible.
- Environmental aspects of the project should be well taken care through the implementation of the Environmental Management Plan as recommended in this report.

7.0 ENIVIRONMENTAL MANAGEMENT PLAN (EMP)

7.1 Purpose and Objectives of EMP

An Environmental Management Plan (EMP) provides a delivery mechanism to address the adverse environmental impact of a project during its execution, to enhance project benefits, and to introduce standards of good practice to be adopted for all project works.

The primary objectives of the EMP are to:

- Facilitate the implementation of the mitigation measures identified in the Section-5 of this IEE.
- Define the responsibilities of the project proponents, contractors, and environmental monitors/inspectors, and provide a means of effectively communicating environmental issues among them.
- Define a monitoring mechanism and identify monitoring parameters in order to:
  - Ensure the complete implementation of all mitigation measures.
  - Ensure the effectiveness of the mitigation measures.
- Provide a mechanism for taking timely action in the face of unanticipated environmental situations.
- Identify training requirements at various levels.

7.2 Components of the EMP

The EMP consists of the following components:

- Organizational structure; roles and responsibilities.
- Mitigation plan.
- Environmental monitoring plan.
- Communication and documentation.
- Environmental training.

7.3 Organizational Structure, Roles and Responsibilities

This section provides an organizational structure for environmental management during the construction and operation phase of the proposed project and defines the roles and responsibilities of the various role players for the duration of the project.

7.3.1 Management Approach

Construction Phase

TPL: The overall responsibility for compliance with the environmental management plan rests with the project proponent (TPL). TPL should create a position for Environmental Social Health and Safety (ESHS) Manager to address the environmental concerns of the project to the standards of the Punjab-EPA. TPL should also provide proper health and safety trainings to the project staff involved in O&M.

EPC Contractor: The EPC Contractor shall be responsible for the engineering, procurement and construction activities of the project. The EPC Contractor shall be responsible for the complete implementation of the EMP and the mitigation measures detailed in the EMP. The project EPC contract between TPL and EPC contractor shall be subject to written assurance that they shall comply with Punjab-EPA laws and environmental obligations during construction of the project. Penalties for not observing the obligations should be the part of the EPC contact agreement between KPL and EPC Contractor. The EPC contactor shall ensure internal compliance through a post of Environmental Social Health and Safety (ESHS) Officer to monitor the environmental obligations of the project at the EPC contactor/subcontractor level, and assure environmental compliance of the project as per Punjab-EPA laws. The environmental officer shall ensure that environmental obligations have been complied at all stages of the project and keep a close watch on the environmental compliances during construction stage of the project. This environmental officer shall prepare periodical progress report to comply with the requirements of the law.

Other essential features of the institutional arrangement proposed for the project are:

- The EMP as well as environmental management requirements shall be included in the contract agreement of TPL with EPC Contractor.
- EPC Contractor shall need to have an ESHS Officer to supervise and monitor the concerned compliances of its staff and that of its sub-contractors with environmental management requirements.
- The ESHS Officer shall prepare periodical progress reports of environmental compliance of construction work. He shall also mention occurrence and level of non-compliances at site by the contractor/sub-contractors during various times of reporting period.
- The TPL shall also facilitate the regulatory agencies i.e. Punjab-EPA to visit the project site as and when required.
- ESHS compliance meetings shall be held regularly involving the TPL ESHS Manager, EPC Contractor ESHS Officer and its subcontractors, where compliances and non-compliances shall be reviewed and appropriate measures shall be suggested and agreed among these stakeholders.

Operation Phase

During the operation phase of the powerhouse, environmental management becomes a routine function, as an integral part of the powerhouse operation. The operation and maintenance setup for the operation of the power plant after commissioning should include one staff (with expertise in social, environmental, health and safety) to supervise and monitor the operation and maintenance staff for optimal performance in the social and environmental aspects of the project as per laws of the land.

The O&M staff shall be properly trained to comply with the environmental obligations of the project at its operational stage. Compliance of the staff with social and environmental obligations should be part of the staff contract with TPL and/or O&M entity responsible for the O&M of the project. Concerned personnel policies shall be updated where required to comply with the law of the country. Appropriate social and environmental compliance trainings shall be provided and operational health and safety manuals should be developed by TPL well before commissioning of the

project. The O&M staff should strictly adhere to comply with the developed manuals and procedures at all stages of operation and maintenance of the project.

7.3.2 Organizational Structure and Responsibilities

Construction Phase

The primary responsibilities for the environmental performance of the project lay with the project proponents.

- TPL's Project Manager shall be responsible for the company's compliance with the updated IEE and EMP throughout the project. The ESHS Manager shall report to the TPL's Project Manager about environmental compliances of the project and assist EPC Contractor through hiring of technical expertise to comply with the social and environmental obligations of the project at its construction stage. The ESHS Manager shall also ensure that the EPC Contractor is complying with the environmental obligations of Punjab-EPA. The ESHS Manager shall also monitor, and report the environmental and social performance of the EPC Contractor and its sub-contractors.
- The EPC Contractor's Project Manager shall assume the main responsibility for all environmental matters pertaining to EPC scope of work. The EPC's ESHS Officer shall ensure compliance of social, environmental, health and safety obligations on on-going basis on the project site. ESHS Officer shall report on a daily basis to the EPC's Project Manager.
- TPL shall also coordinate with relevant government departments through its ESHS Manager.
- The EPC Contractor's ESHS Officer shall inspect, monitor and give on-site instructions to the workforce of contractor/sub-contractors on the project site for social and environmental compliance of the project.
- TPL's ESHS Manager shall be responsible for the overall environmental soundness of all construction activities.

- TPL and EPC Contractor shall ensure proper training of the project workforce on social and environmental obligations. Training and refresher trainings shall be provided to the workforce through experts.
- If any monitoring teams from relevant government departments visit the project site, TPL's ESHS Manager shall be responsible for coordinating their visits.

Operation Phase

It is expected that upon commencement of the operation and maintenance phase, TPL's ESHS Manager shall continue to monitor environment, social and operational health and safety aspects to enable continuity and consistency to ensure the aforesaid obligations as per manuals developed for Operation and Maintenance of the Project. Details shall be worked out when the organizational structure of the powerhouse O&M shall be finalized.

7.3.3 Mitigation Plan

The mitigation plan is a key component of the EMP. It lists all the environmental issues of the project and their associated mitigation measures. It should be emphasized that the mitigation measures shall have to be translated into environmental requirements for the design and construction, with legal binding.

7.3.4 Monitoring Plan

The objective of environmental monitoring during the various phases of the proposed project shall be as follows:

- **Compliance Monitoring:** Compliance with the requirements of the EMP shall be checked by monitoring the activities of the contractor on a regular basis. This shall be supplemented by random visits of the ESHS Manager to the project when the work shall be in progress.
- **Effects Monitoring:** The actual impact of the project activities on physical, biological, and socioeconomic receptors of the project area shall be monitored so that any effects either not anticipated in this report

or exceeding the levels anticipated in this report can be identified and appropriate mitigation measures can be adopted in time.

To achieve these objectives the following monitoring program shall be implemented:

Compliance Monitoring

The compliance monitoring of the project activities is principally a tool to ensure that the environmental control measures are strictly adhered to during the project activity. The objectives of the compliance monitoring shall be to:

- Systematically observe the activities undertaken by EPC Contractor and its sub-contractors or any other person associated with the project.
- Verify that the activities are undertaken in compliance with this IEE report and EMP.
- Document and communicate the observations to the concerned person(s) of EPC Contractor and TPL, so that any corrective measures, if required, can be taken in a timely fashion.
- Maintain a record of all incidents of environmental significance and related actions and corrective measures.
- Prepare periodic reports of the environmental performance of project.

Compliance monitoring shall be the responsibility of TPL, the EPC Contractor and its sub-contractors. It shall be carried out by the following:

- KHL's Environmental Social Health and Safety (ESHS) Manager
- Contractor's Environmental Social Health and Safety (ESHS) Officer.

Effects Monitoring

This IEE predicts the impacts of the proposed project on the basis of information available on the environment and the natural processes that link various environmental parameters. Based on this prediction, mitigation measures are introduced such that the predicted residual effects do not exceed acceptable levels.

However, there is always an element of uncertainty in such predictions due to an insufficient grasp of the processes, limitations in prediction techniques, or inadequate data on the environment. This is true for the physical, biological, as well as socioeconomic environment. Consequently, it is possible that even if the mitigation measures are implemented fully, the negative impacts of the project shall exceed acceptable limits.

In order to address the above concerns, effects monitoring shall be undertaken during the project activities, with the overall objective of proper management of environmental risks and uncertainties. Broadly, effects monitoring has four objectives:

i. To verify that the impacts of the proposed project are within acceptable limits, thus establishing credibility (public assurance).

ii. To immediately warn the project proponents (and the regulatory agencies, if required) of unanticipated adverse impact or sudden changes in impact trends so that corrective actions can be undertaken, which may include modified or additional mitigation measures.

iii. To provide information to plan and control the timing, location, and level of certain project activities so that the effects are minimized.

iv. To facilitate research and development by documenting the effects of the proposed project that can be used to validate impact-prediction techniques and provide a basis for more accurate predictions of future impact

The monitoring plan is provided in **Table - 7**.

7.3.5 Communication and Documentation

An effective mechanism for storing and communicating environmental information during the project is an essential requirement of an EMP. The key features of such a mechanism are:

- Recording and maintenance of all information generated during the monitoring in a predetermined format.

- Communicating the information to a central location.
- Storing raw information in a central database.
- Processing the information to produce periodic reports.

A description of the various components of the communication and documentation system is given below:

Data Recording and Maintenance

All forms to be used for recording information during the environmental monitoring shall follow a standard format, which shall correspond to the database into which all the information gathered shall be placed. All common fields shall have identical formats in the database and on the forms. Check boxes shall be used as much as possible for ease in filling out the forms and to facilitate data entry.

All forms shall be numbered and a tracking system shall be developed for each. Whenever a form is released for use in the field, its number shall be recorded. The field staff shall be required to account for each form after completion. In this manner, it shall be ensured that all forms are returned to the office. It shall be ensured that check boxes and report formats to be developed keeping in view the requirements of regulators in order to avoid multiple reporting.

Meetings

The following environmental meetings shall take place during the project:

- Kick-off meetings.
- Fortnightly meetings.

The purpose of the kick-off meetings shall be to discuss the EMP, and ensure full commitment from concerned parties for its implementation. A periodic meeting shall be held at site during the construction phase. The purpose of the meetings shall be to discuss the conduct of the operation, non-compliances noted by the TPL's ESHS Manager, and EPC's ESHS Officer. The remedial measures shall also be discussed

and agreed during these meetings. The meeting shall be recorded in the form of an Environmental Report (ER) prepared by the EPC's ESHS Officer.

Reports

The EPC's ESHS shall produce periodic reports based on the information collected. These shall include reports for:

- Kick-off meetings,
- Fortnightly meetings,
- Non-compliances,
- Effects monitoring.

At the end of the construction phase, a final report shall also be prepared.

Complaint Register

A complaint register shall be maintained at the project site to document all complaints, grievances and suggestions received from local communities, affected parties, visitors, monitors and other stakeholders. The register shall also contain mitigations measures for the complaints registered by the affected parties.

All complaints received in the complaint register shall be sent to the TPL's ESHS Manager and Project Manager for their information and further action. Availability and maintenance of this register at the project site should be ensured by the TPL. TPL should also ensure that all stakeholders are informed about the "Project Complaint Register" and describe the process of registering complaints.

7.3.6 Environmental Training

Environmental training shall help to ensure that the requirements of EMP are clearly understood and followed by TPL and Contractor's staff and all project personnel throughout the project period. The primary responsibility for providing training to all project personnel shall be that of the TPL's ESHS Manager. The environmental and social responsibility training to the TPL staff should be prerequisite of this project.

This training should be through hiring the technical experts having knowledge of Punjab-EPA laws and obligations.

Training shall cover all staff levels, ranging from the management and supervisory to the skilled and unskilled categories. The scope of the training shall cover the requirements of the EMP, with special emphasis on sensitizing the project staff to the environmental and social aspects of the project and its surrounding areas. For operation and maintenance of the project, environmental, social and operational health and safety manuals shall be developed. The O&M staff shall be trained well before commissioning of the project. New staff hired for O&M shall be trained before taking over the O&M responsibility in the project.

Table - 5: Monitoring Plan for Construction & Operation Phase

Environmental Segment/Element	Reference location/ monitoring point	Monitoring mechanism/parameters	Monitoring frequency
1. Construction Phase			
Dust Emissions	Near project site, access roads and settlements	Visual checks	Daily routine Monitoring
Wastewater	Workers' camp	Effluent discharges from workers' camp to be tested for total coliforms, Ammonia, (BOD), (COD) and other nutrients as per NEQS	One sample Quarterly
Solid Waste	Workers' camps and construction site	Waste generation, storage, collection and disposal	Fortnightly
Drinking Water	Water being used for drinking purposes by workers and nearby community	Discrete grab sampling and laboratory testing of groundwater according to WHO standards	Two samples of drinking water from the construction camp and other from nearby village on quarterly basis
Noise Levels	Project site and nearby settlements	Noise level according to WHO standards	Once prior to the start of construction and then on quarterly basis throughout the construction period
Fumes and gases	Ambient air, silencers of heavy machinery, trucks and other vehicles at project site and adjacent settlements	Pollution parameters including the SO2, NO2, CO, VOC and Particulate Matter according to WHO standards	Monthly monitoring
Health and Safety	Labour camps and construction sites	Medical check-ups and routine safety check-ups of the communicable diseases and accidents	Quarterly
Wildlife and Avifauna	At and around project site or in the whole Study Area	Illegal hunting of fauna/avifauna by contractor staff	Daily

2. Operation Phase			
Potable Water Quality	One sample from workers drinking source and one from pressure/hand pump at Khanki village and Ahmad Nagar	Groundwater sampling as specified by WHO standards	Bi-annually
Wastewater	Just downstream of power station in the River and colony outlet	Effluents discharges as per NEQS	Bi-annually
Noise	Within Project site around it	Noise level according to WHO standards	Bi-annually
Solid Waste	Place reserved for solid waste collection bins/ containers/open field.	Visual observation	Annually

8.0 CONCLUSION

On the basis of the overall impact assessment, it is concluded that the proposed LCC Hydropower Project is unlikely to cause any significant, lasting impact on the social, physical and biological environment of the area, provided that the proposed activities are carried out in accordance with recommendations of this report, and the mitigation measures included in this updated IEE are completely and effectively implemented. The proposed LCC Hydropower Project is environmental friendly and is recommended for implementation.

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Trident Power Gr Private Limited

7.55 MW LCC Hydropower Project

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Trident Power Gr Private Limited

7.55 MW LCC Hydropower Project

01. INTRODUCTION TO APPLICANT

(TRIDENT POWER GR (PRIVATE) LIMITED)

Trident Power GR (Pvt.) Ltd. is a project specific SPV firm solely registered under the Companies Ordinance 1984 for the development of 7.55 MW LCC Hydropower Project. It is a consortium of the following three companies:

i. Trans Tech Pakistan
ii. Spec Energy
iii. Pak Carpet Industries (PCI)

The above mentioned consortium is already developing another power plant of capacity 220 MW namely Ravi HEPP. This consortium has its active presence in Pakistan, Middle East, Central Asia, China & America and contributing in various domains including construction, manufacturing, and real estate and trading where a brief and specific information about the consortium partners is provided below in other sections of this prospectus.

02. PROJECT BACK GROUND

Punjab Power Development Board (PPDB) invited Expression of Interest (EOI) through advertisement dated May 17, 2015 for the development of 7.55 MW hydropower project situated on Lower Chenab Canal, District Gujranwala in Punjab Province of Pakistan. After evaluation, PPDB issued a letter of Intent (LOI) to Trident Power GR (Private) Limited (The Sponsor) for the development of this project.

A detailed feasibility study was carried out and approved by the panel of experts (POEs) of PPDB. Following major milestones of the project has been achieved up till now:

- Feasibility study has been approved by the POEs of PPDB
- IEE approved by EPA Punjab
- Interconnection study approved by MEPCO

- Letter of Consent acquired from Punjab Irrigation Department about land availability

It is planned that this project shall be developed in accordance to upfront tariff approved by NEPRA for the development of small hydropower plants. The electricity shall be sold to national grid through MEPCO's nearest proposed grid station at Ahmed Nagar which is at 09 Km away from the powerhouse site. The plant will generate a net annual energy of 43.71 GWh with plant factor of 66.53%.

3.0. SPONSORS' PROFILE

Trident Power GR (Pvt.) Ltd. is a consortium of following three companies as mentioned above:

i. Trans Tech Pakistan
ii. Spec Energy
iii. Pak Carpet Industries (PCI)

3.1. TRANS TECH PAKISTAN

Trans Tech is actively involved in the following sectors:

- Civil Construction & Engineering
- Automobile
- Oil & Gas
- Alternative Energy
- Food & Beverages

The following are the major projects undertaken by Trans Tech.

- MES Building Construction
- Surface Drainage system
- Lahore Islamabad Motorway (M-2)
- Indus Highway
- Sind Barrage Complex

- Meran Shah Bridges
- Lahore Bypass
- Rewiring Islamabad Sectors
- Optical Fibre Installation
- National Highway Rehabilitation
- Seven Story Plaza
- Houses in Islamabad
- Shopping Plaza
- Primary School
- Ravian Housing DHA

Trans Tech is owned and operated by two seasoned and professional partners and are the key sponsors and owners of the group. Bried description is provided below:

3.1.1. MR. FIAZ AHMAD

Mr. Fiaz Ahmad is the Chairman and Managing Partner of Trans Tech Group. He joined the group since its inception in 1994 and have continued to develop from a small Engineering office to what is now a Pakistan based group. He has been responsible for producing new ventures and transforming the Group into the diversified business it is today. Mr. Ahmad is a renowned acclaimed business leader with deep and comprehensive expertise in introducing new projects in emerging markets. He is credited with launching various projects of civil construction, Automobile, Food & Beverages, oil & gas and Alternate Energy. Mr. Fiaz Ahmad has been managing the above businesses for the past 22 years. Mr. Fiaz is currently a director in Trident Power (Pvt) Private) Limited.

3.1.2. MR. YOUSUF MEHBOOB KHAN

Mr. Yousuf Mehboob Khan is the Co-Chairman, Partner and Director of a number of Trans Tech Group companies. He joined the group in 1994 and is responsible for the continued growth and success of the Group. He is focused on leading the Group to achieve improved growth in revenue and profitability greater innovation and

inventiveness resulting in the good number of Joint ventures with the foreign companies in Pakistan as well as abroad. He is responsible for the strategic planning and business development operations of the Group. He also assists the Chairman in the Group's operations, project management and planning. His areas of expertise include global and regional business issues, priorities of capital and financial flows as well as current management best practices. Mr. Yousuf is currently a CEO & Director of Trident Power (Private) Limited.

3.1.3. AFFILIATIONS OF TRANS TECH GROUP

Trans Tech Pakistan has its Affiliations and Joint Ventures with the following foreign firms and Organizations:

- CHINA PETROLEUM ENGINEERING CONSTRUCTION CORPORATION (CPECC)
- CHINA ROAD & BRIDGE CORPORATION – CHINA (CRBC)
- CHINA THREE GORGES INTERNATIONAL CORPORATION (CTGI)
- CHINA INTERNATIONAL WATER & ELECTRIC CORPORATION – CHINA (CWE)
- CHINA NATIONAL MACHINERY & EQUIPMENT IMPORT & EXPORT CORPORATION – CHINA (CMEC)
- CHINA IPPR INTERNATIONAL ENGINEERING CORP. (IPPR)
- CHINA HEAVY MACHINERY CORPORATION (CHMC)
- SINOHYDRO CORPORATION LTD
- CHINA HARBIN POWER ENGINEERING CO. LTD (HPE)
- CHINA RAILWAY FIRST GROUP CO. LTD (CRFGC)
- CHINA RAILWAY TUNNEL CONSTRUCTION (GROUP) LTD – CHINA (CTG)

3.2. SPEC GROUP

Spec Group / Spec Energy is solely owned and operated by Mr. Zafar Ikram Sheikh who is also currently one of the directors in Trident Power GR (Private) Limited. It is an

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International firm with employees exceeding 6000 and with the projects in various countries. It is involved in the following sectors:

- Oil & Gas
- Power & Energy
- Petrochemical Industry
- Process Industry
- Real Estate

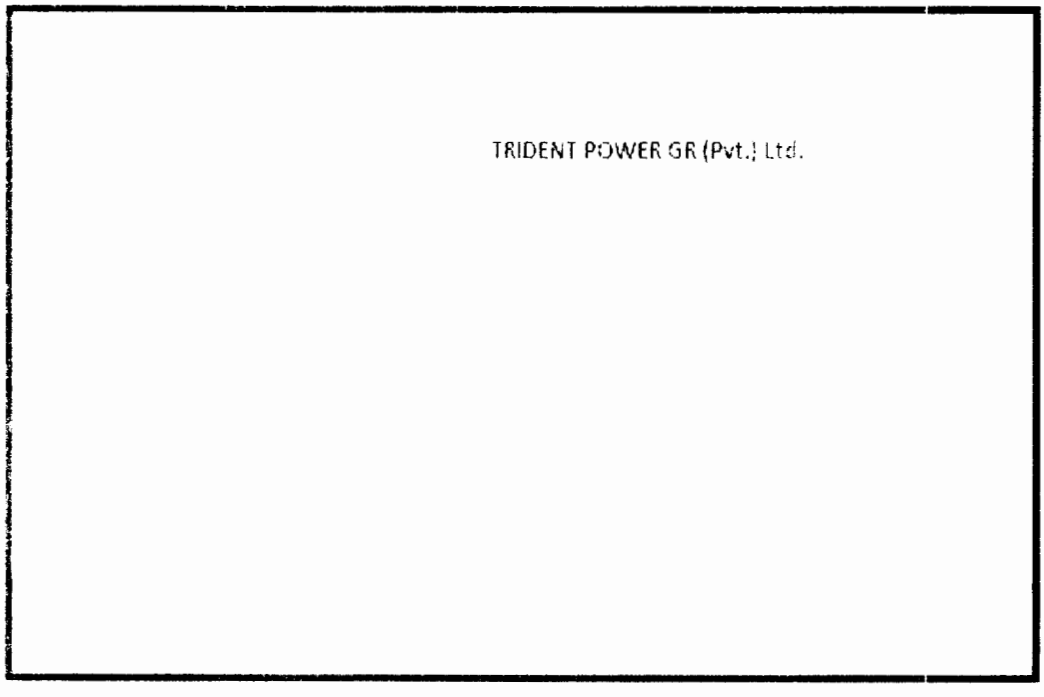
It has its presence and manufacturing workshops in the following countries:

- America (Headquarter)
- UAE (Hamriya Free Zone, Sharjah & Dubai)
- Pakistan
- China
- Iraq
- Russia

Spec energy provides the following services for oil & gas, power, petrochemical sector and process industry:

- Manufacturing
  - Boilers
  - Pre-engineered skid packages
  - Heat Exchangers
  - Pressure Vessels
  - Steam Transformers
  - Piping
- Engineering, procurement & construction (EPC)
- Project Management Consulting
- Construction
- Plant Shutdowns
- Engineering

COMPANY SHAREHOLDING



3.3. PAK CARPET INDUSTRY (GROUP)

Pak Carpet Industry (PCI) Group is headed by Syed Hadi Ali Rizvi. Mr. Rizvi is currently Chairman & CEO of PCI group which includes Pak Carpet Industries Ltd., Unik Fabrics Ltd. and Automotive Spares & Accessories Ltd., with an expected turnover of Rs. 2.25 billion for year 2015-16. Mr. Rizvi is currently a director in Trident Power GR (Private) Limited.

Pak Carpet Industry (PCI) PCI is a renowned name in the carpeting industry since 1948 with an extremely impressive portfolio of products and prides itself on the remarkable achievements since its inception. PCI Flooring (Pak Carpet Industries) is a leading distributor and retailer of flooring, headquartered in Karachi and managing up-country operations through Rawalpindi and Lahore branch offices, we offer institutions, offices, architects and interior designers an almost infinite and unmatchable range of color combinations, textures and patterns, suitable for every kind of commercial and residential flooring applications.

Automotive Spares and Accessories (ASA) is a sister company Pak Carpet Industries Group. ASA entered the automotive industry by becoming supplier of automotive floor carpet to Pak Suzuki Motor Company in 1985. From its humble beginnings as a trading company, ASA today is amongst the largest vendors of automotive interior and related products in Pakistan. The foundations of ASA were laid by keeping in mind its vision of meeting or exceeding customers' expectation in terms of suppliability, quality & cost.

Beside above introduced concept of Carpet tiles, currently representing some of the world leading flooring brands in Pakistan. Recently diversified into packaging industry and are supplying lubricant bottles to one of the market leaders with ambitious plan of expanding this line of business in coming years.

3.6. SPONSORS' FINANCIALS

Trans Tech Pakistan – As per Audited Accounts (Figures in PKR)

	2011	2012	2013	2014	2015
Current Assets	38,998,697	40,741,870	53,505,856	32,717,067	34,306,114
Cash & Cash equivalents	11,858,831	6,714,830	18,798,275	5,718,699	5,051,442
Other Current Assets	31,140,866	34,027,040	34,707,581	26,998,368	29,254,672
Fixed Assets	70,246,840	68,112,718	65,847,155	63,717,917	61,306,024
Total Assets	109,245,537	108,854,588	119,353,011	96,434,984	95,612,138
Current Liabilities	1,166,630	545,556	525,919	499,220	499,220
Long Term Liabilities	-	-	-	-	-
Total Liabilities	1,166,630	545,556	525,919	499,220	499,220
Net Worth	108,078,907	108,309,032	118,827,092	95,935,764	95,112,918
Shareholders' Equity	108,078,907	108,309,032	118,827,092	95,935,764	95,112,918
Capital	57,000,000	57,000,000	57,000,000	57,000,000	57,000,000
Retained Earnings	51,078,907	51,309,032	61,827,092	38,935,764	38,112,918
Other Reserves	-	-	-	-	-
Operating Results					
Revenues	534,596,073	507,866,269	518,023,594	49,458,354	102,378,793
Gross Profit	72,825,003	68,852,669	70,519,916	(920,951)	11,297,728
Income before Interest & Tax	68,748,427	68,822,641	66,469,667	(4,124,933)	7,996,122
Financial Charges	255,144	120,540	295,114	104,225	76,240
Taxation	32,075,764	30,471,976	31,081,416	2,967,501	6,142,728
Net Profit after Tax	36,417,519	34,230,125	35,093,137	(7,196,659)	1,777,154

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SPEC Energy DMCC – As per Audited Accounts (Figures in PKR)

	2010	2011	2012	2013	2014
Current Assets	7,510,873	444,983,484	2,059,395,122	2,849,912,023	2,864,582,846
Cash & Cash Equivalents	7,444,873	222,365,959	417,576,667	198,928,409	288,977,594
Other Current Assets	66,000	222,617,525	1,641,818,455	2,650,983,614	2,575,605,252
Fixed Assets	204,999,907	465,463,944	517,602,703	1,037,412,658	1,800,149,155
Other Assets	119,750	-	-	-	-
Total Assets	212,630,537	910,447,428	2,576,997,826	3,887,324,681	4,664,732,028
Current Liabilities	160,382,957	411,354,398	649,177,901	746,252,258	1,065,510,521
Long Term Liabilities	-	1,234,226	22,470,518	39,894,914	43,841,688
Total Liabilities	160,382,957	412,588,625	671,648,419	786,147,146	1,109,352,235
Net Worth	52,247,580	497,858,803	1,905,349,406	3,101,177,508	3,555,379,793
Shareholders' Equity	52,247,580	497,858,803	1,905,349,406	3,101,177,508	3,555,379,793
Capital	52,800,000	52,800,000	52,800,000	52,800,000	52,800,000
Retained Earnings	(22,535,577)	340,336,234	1,801,746,012	3,020,349,420	3,489,278,390
Other Reserves	21,782,957	104,722,570	50,803,394	28,028,114	13,301,429
Operating Results					
Revenues	2,823,093	944,736,302	3,488,098,020	3,560,719,272	2,846,920,296
Gross Profit	(2,127,998)	444,247,663	1,594,734,874	730,341,612	770,351,683
Income before Interest & Tax	(22,276,980)	364,421,561	1,472,829,494	547,322,714	572,680,944
Financial Charges	59,347	2,277,950	11,410,555	17,501,299	24,492,151
Taxation	-	-	-	-	-
Net Profit after Tax	(22,335,577)	362,143,610	1,461,418,939	529,821,415	548,188,793

Pak Carpet Industries (Private) Limited – As per Audited Accounts (Figures in PKR)

	2011	2012	2013	2014	2015
Current Assets	125,220,617	129,372,924	137,143,663	138,786,802	**191,151,375**
Cash & Cash Equivalents	14,996,080	20,108,454	27,747,376	6,596,475	12,237,321
Other Current Assets	110,224,537	109,264,470	109,396,287	132,190,327	178,914,054
Fixed Assets	3,108,409	2,783,888	85,115,663	83,624,223	**80,350,154**
Other Assets	549,042	548,236	-	-	-
Total Assets	128,878,067	132,705,043	222,259,326	222,411,030	**271,501,529**
Current Liabilities	51,323,119	53,866,368	54,087,268	59,306,106	106,212,260
Long Term Liabilities		-	12,666,125	12,392,823	**11,337,530**
Other Liabilities	2,809,812	2,377,230	-	-	-
Total Liabilities	54,132,931	56,243,598	66,753,393	71,698,929	**117,549,790**
Net Worth	74,745,136	76,461,450	155,505,933	150,712,100	**153,951,739**
Shareholders' Equity	74,745,136	76,461,450	155,505,933	150,712,100	**153,951,739**
Capital	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000
Retained Earnings	69,745,136	71,461,450	78,935,842	76,514,541	81,634,274
Other Reserves		-	71,570,091	69,197,559	67,317,465
Operating Results					
Revenues/Sales	150,162,754	208,986,960	229,228,628	179,971,697	230,348,818
Gross Profit	28,428,547	31,773,137	40,018,734	35,100,709	**66,199,590**
Income before Interest & Tax	8,154,605	7,287,797	12,463,257	(1,013,374)	20,641,406
Financial Charges	72,768	71,483	69,991	203,709	408,978
Taxation	4,107,416	5,500,000	6,255,262	3,839,741	16,992,789
Net Profit after Tax	3,973,984	1,716,314	6,138,004	(5,056,824)	**3,239,639**

04. PROJECT SALIENT FEATURES

4.1. LOCATION & ACCESS TO THE PROJECT SITE

The proposed LCC hydropower project is located at RD 1+1500 of Lowrer Chenab Canal (LCC), District Gujranwala, Pakistan. The plant site is about 17 km south-east of Wazirabad which is connected to the port at Karachi through a network of highways including the main G.T road. The approach to site from Wazirabad is through Wazirabad – Saroki / Alipur Chatha –Khanki road

4.3 POWER & ENERGY

Design Discharge	250	m^3/s
Gross Head	3.6	m
Net Head	3.5	m
Plant Installed Capacity (Gross)	7.5	MW
Net Plant Capacity in MW	7.425	MW
Auxiliary Consumption@1%	0.4415	GWh/annum
Net Deliverable Energy	43.71	GWh/annum
Plant Factor based on Deliverable Energy	**66.53**	**%**

4.4 PROJECT LAYOUT

The site for construction of LCC Hydropower Project is located at RD 1+500. The project has been planned within the main canal. It is proposed that the main canal shall be temporarily diverted on left side during construction period and the powerhouse along with a Spillway shall be constructed at RD 1+500. The discharge shall be regulated by the downstream spillway gates and power generating units as it will regulate with much better efficiency.

The powerhouse structure consists of an intake and main service building to accommodate loading bay and control room. The intake of water from the head race to the turbo-generator units has four bays. The powerhouse will be constructed in RCC.

4.5 CONSTRUCTION PLANNING & MANAGEMENT

The LCC Hydropower Project is planned to be constructed in a period of 36 months. This includes Civil, Electro-mechanical, Transmission and interconnection works from initiation to commissioning. Special consideration should be given to the critical tasks related to the canal closure and schedule delivery of Turbines, Generators & other E&M equipment to site.

4.5. FINANCIAL MANAGEMENT

Total Project Development Cost = USD 25 Million

Proposed Debt: Equity = 75: 25

Equity shall be arranged by the directors of Trident Power GR (Pvt.) Ltd. from their own resources. Financial against debt is being provided by Pak Oman Bank.

05. SOCIAL AND ENVIRONMENTAL IMPACT

The LCC Hydropower Project seems to be environment friendly. It has minimal environmental impacts. Environmental considerations have formed an integral part of the evaluation of layout and design alternatives with the result that all the potential effects of the project have been mitigated. The proposed project layout plan does not involve any permanent land acquisition or resettlements.

There is a potential for social impacts resulting from activities as well as the presence of job seekers and construction workers on the site. As a result of construction an influx and congestion of people may contribute to deterioration of community health, safety and security due to people's interactions and behaviours. For instance, incidents of accidents, social conflicts, property theft and spread of communicable diseases can occur. Impact magnitude is likely to be minor. However, the social receptors are considered medium sensitive community members who may potentially lack literacy skills to read signs, be young or old, may lack resources and power to prevent crime and / or bullying. There are mitigation measures available and these issues should be addressed early in the construction schedule. The Contractor shall be required to employ a full time qualified (certified if possible) safety officer for the construction phase duration. The Contractor shall need to carry out a risk assessment and then develop a site and project specific Health and Safety Management Plan aimed at preventing accidents, injuries and work-related diseases for both construction and operation and addressing occupational health and safety as well as community health, safety and security. It shall be based on the Environmental Management Plan (EMP) provided in this document which identifies activities and monitoring indicators associated with good occupational health and safety.

The main measures include

- Carrying out health screening of labor force and health awareness activities.
- Identifying potential hazards to workers, particularly those that are life threatening.
- Providing preventive and protective measures for hazardous conditions or substances; training and equipping workers with information and Personal Protective Equipment (PPE) with the aim of preventing accidents, injuries or diseases and of minimizing hazards.
- Documenting and reporting occupational accidents, diseases and incidents.
- Developing emergency prevention, preparedness and response arrangements.

Each employee should undergo health screening to help prevent the transfer of diseases. In particular, iodine deficiency, diabetes and tuberculosis for locally recruited employees and malaria and sexually transmitted diseases for those who are not local should be considered. Bi-annual health awareness sessions should be organized whereby local health officials or NGOs aim at instilling good behaviour, healthy attitudes and knowledge regarding hygiene, disease prevention and general well-being. Materials, including hazardous substances, for both construction and operation shall be managed safely, for instance their transport and storage shall be arranged to prevent contamination and personnel exposure.

Care should be exercised for the safe transport of raw materials and the transport and disposal of waste. The Contractor should not be allowed to use products that fall under Hazard Classes 1a or 1b of the World Health Organization's Recommended Classification of Pesticides. Safety processes shall be put in place to promote a safe environment and structural elements of the project shall be designed, constructed and operated to meet good international industry practice. Project vehicles and equipment

shall be maintained and project related traffic shall be requested, at a minimum, to travel no more than the speed limit.

Workers shall be provided with personal protective equipment (PPE) and training and there shall be enforcement to ensure usage. Guidelines for maintaining hygienic conditions and appropriate shelter or shading at eating, resting, drinking, smoking and cooking facilities on project site shall be established.

The Contractor and the Operator for the LCC Hydropower Project shall endeavour to avoid or minimize risks to and impacts on the health and safety of the local community during the project life cycle from both routine and non-routine circumstances as well as ensure that personnel and property is safeguarded in a manner that avoids or minimizes risk to the community's safety and security. Both the Contractor and the Operator shall be expected to carry out a risk assessment that evaluates health and safety issues for the local community.

5.1 CULTURAL HERITAGE AND ARCHAEOLOGY

Although some changes in the social and cultural behaviour are expected due to interaction of local population with the project staff from outside, development of the project site is not likely to cause any adverse social impact at all. No place of religious or cultural veneration was sited during field visits to the project area. During site survey, it was observed that dead ancestors and family elders are held in high reverence and esteem and any disturbance to family graveyards could be emotionally disturbing and discomforting. The project layout including the main structures and ancillary structures should avoid graveyards at all costs, if any.

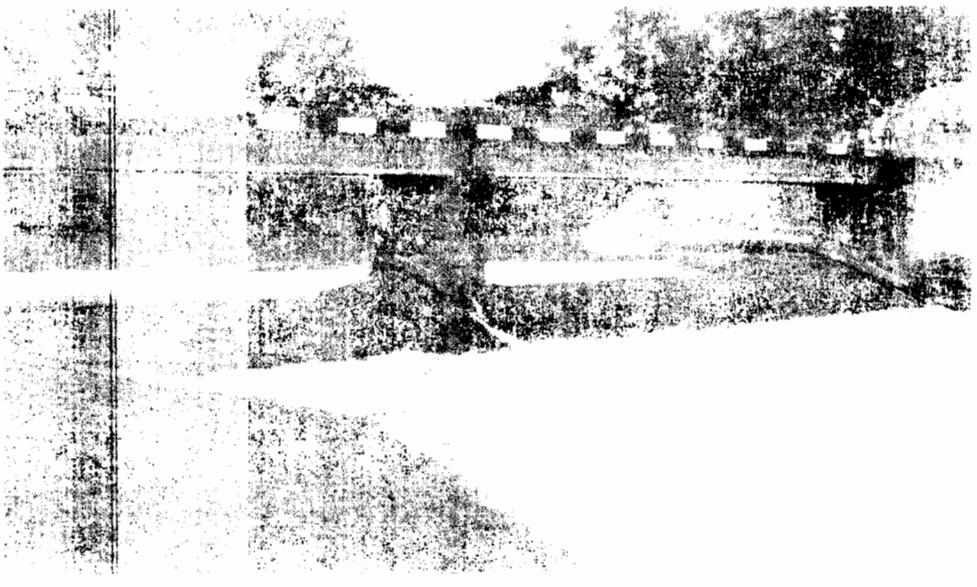
Report No. PPI-203.3-Final/17

INTERCONNECTION STUDY

For

7.5 MW Hydro Power Project on

Lower Chenab Canal (LCC), District Gujranwala



Final Report
(February 2017)

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Executive Summary

- The study objectives, approach and methodology have been described and the plant's data received from the client is validated.
- The GEPCO system data as available with PPI for other studies have been used.
- The interconnection study of Lower Chenab Canal (LCC) HPP to evacuate its maximum power of 7.5 MW is envisaged and studied in detail.
- The nearest substations of GEPCO available for interconnection to LCC HPP is Ahmed Nagar and Gatshia 132 kV.
- In view of the above mentioned 132 kV and 11 kV network available in the vicinity of the site of the LCC HPP, the proposed interconnection scheme is to connect LCC HPP to the 132 kV grid of Ahmed Nagar by connecting three circuits of length 9 km at LCC HPP. The conductor used will be Osprey.
- Detailed load flow studies have been carried out for the peak load conditions of September 2019 for all the proposed schemes under normal and N-1 contingency conditions to meet the reliability criteria.
- Steady state analysis by load flow reveals that proposed schemes are adequate to evacuate the maximum power of 7.5 MW of the plant under normal and contingency conditions as shown in Appendix - C. Power Loss in the three 11kV Osprey conductors is assessed to be **2.26%**.
- The short circuit analysis has been carried out to calculate maximum fault levels at LCC at 11 kV bus and other substations in its vicinity. We find that the fault currents for the proposed scheme are much less than the rated short circuit capacities of switchgear installed at these substations. It was found that there are no violations of exceeding the rating of the equipment due to contribution of fault current from LCC HPP.
- The dynamic stability analysis of proposed schemes of interconnection has been carried out. The stability check for the worst case of three phase fault right on the 11 kV bus bar of LCC HPP substation followed by the final trip of LCC to Ahmed Nagar 11 has been carried out for fault clearing of 9 cycles (180 ms). The system is found strong enough to stay stable and recovered with fast damping.

- The proposed schemes of interconnection have no technical constraints or problems under steady state load flow, short circuit currents and dynamic/transient conditions; and are therefore recommended to be adopted.

Report Contents

8. Conclusions

Appendices

Appendix –A: Generation and Transmission Plan, Load Forecast

Appendix –B: Sketches

Appendix –C: Plotted Results of Load Flow for Chapter – 5

Appendix –D: Results of Short Circuit Calculations for Chapter – 6

Appendix –E: Plotted Results of Stability Analysis for Chapter – 7

Appendix –F: Dynamic Data for LCC HPP

1. Introduction

1.1 Background

The proposed project is a Hydropower Plant LCC HPP connected to the 132/11 kV grid of Ahmed Nagar by connecting three circuits of length 9 km at LCC HPP. The conductor used will be Osprey. The location of LCC-HPP is shown in Appendix-B. The net output planned to be generated from the site is about 7.5 MW of electrical power. The project is expected to start commercial operation by the year 2019. The electricity generated from this project would be supplied to the grid system of GEPCO through the 132 kV Ahmed Nagar available in the vicinity of this project.

1.2 Objectives

The overall objective of the Study is to evolve an interconnection scheme between LCC HPP and GEPCO network, for stable and reliable evacuation of 7.5 MW of electrical power generated from this plant, fulfilling N-1 reliability criteria. The specific objectives are:

1. To develop schemes of interconnections of which right of way (ROW) and space at the terminal substations would be available.
2. To determine the performance of interconnection scheme during steady state conditions of system, normal and N-1 contingency, through load-flow analysis.
3. To check if the contribution of fault current from this new plant increases the fault levels at the adjoining substations to be within the rating of equipment of these substations, and also determine the short circuit ratings of the proposed equipment of the substation at LCC HPP.
4. To check if the interconnection withstands dynamic stability criteria of post fault recovery with good damping after 3-phase faults on the system.

1.3 Planning Criteria

The planning criteria required to be fulfilled by the proposed interconnection is as follows:

Steady State:

Voltage	- 5 %, Normal Operating Condition
	- 10 %, Contingency Conditions
Frequency	50 Hz, Continuous, ± 1% variation steady state
	49.2 - 50.5 Hz, Short Time
Power Factor	0.85 Lagging; 0.9 Leading

Dynamic Transient:

The system should revert back to normal condition after dying out of transients without losing synchronism with good damping.

- For 132 kV and above, the total normal fault clearing time from the instant of initiation of fault current to the complete interruption of current, including the relay time and breaker interruption time to isolate the faulted element, is equal to 100 ms (5 cycles).

- For 11 kV the total normal fault clearing time from the instant of initiation of fault current to the complete interruption of current, including the relay time and breaker interruption time to isolate the faulted element, is equal to 180 ms (9 cycles).

2. Assumptions of Data

The detailed electrical parameters of the generators at Lower Chenab Canal as provides are as follow

2.1 LCC HPP data

Generator data:

Number of Generating Units	=4
Lump sum maximum generating capacity	=7.5 MW
Power factor	= 0.85 lagging, 0.9 leading
Generating Voltage	= 11 kV
Inertia Constant H (turbine + generator)	= 1.5 (MWs/MVA)

2.2 Network data

The surrounding networks available for interconnection to LCC Hydro Power Plant are as shown in Sketches 1 and 2 in Appendix-B.

3. Study Approach and Methodology

3.1 Understanding of the Problem

Lower Chenab Canal HPP 7.5 MW is going to be a hydropower project connected to the 132 kV grid of Ahmed Nagar by three osprey conductors of length 9 km at LCC HPP embedded in the distribution network of GEPCO.

The nearest grid available is Ahmed Nagar 132 kV. This source of local power generation to be embedded in local distribution network with grid of Ahmed Nagar shall provide great relief to the source substations in the vicinity and also help in terms of improving line losses and voltage profile.

The nearest substations of GEPCO available for interconnection to LCC HPP is Ahmed Nagar and Fatehpur 132 kV. The adequacy of this system would be investigated in this study for absorbing and transmitting this power fulfilling the reliability criteria.

3.2 Approach to the problem

The consultant has applied the following approaches to the problem:

- A base case network model has been prepared for the year 2019, which is the commissioning year of LCC HPP, comprising all 500kV, 220kV and 132 kV system, envisaging the load forecast, the generation additions and transmission expansions for that year particularly in GEPCO.
- Month of September 2019 has been selected for the study because it is high water season and we can judge the maximum impact of the plant on the network in these conditions
- Interconnection schemes without any physical constraints, like right of way or availability of space in the terminal substations, have been identified.
- Performed technical system studies for peak load conditions to confirm technical feasibility of the interconnection schemes. The schemes have been subjected to standard analysis like load flow and short circuit, and transient stability study to check the strength of the machines and the proposed interconnection scheme under disturbed conditions.

- Determine the relevant equipment for the proposed technically feasible schemes.
- Recommend the technically most feasible scheme of interconnection from the options considered.

4. Development of Schemes of Interconnection

4.1 The Existing and Ongoing Network

It was found that the nearest existing GEPCO interconnection facilities at the time of commissioning of LCC Hydro Power Project would be:

- Ahmed Nagar 132 kV Sub-station
- Fatehpur 132 kV Substation

The existing 132 kV network available around these 132 kV grid station is shown in Sketch-2 in Appendix-B.

4.2 The Scheme of Interconnection of LCC HPP

In view of the above mentioned 132 kV network available in the vicinity of the site of the LCC HPP, the proposed interconnection scheme is to connect LCC HPP to the 132 kV grid of Ahmed Nagar by connecting three circuits of length 9 km at LCC HPP. The conductor used will be Osprey.

5. Detailed Load Flow Studies

5.1 Base Case 2019, Without LCC HPP

A base case has been developed for the peak load of September 2019, which is in the high water season and will allow us to judge the maximum impact of LCC on the GEPCO network during high water conditions, using the network data supplied authorized by NTDC GEPCO

The results of load flow for this base case are plotted in Exhibit 0.0 of Appendix-C. The system plotted in this Exhibit comprises of 132 kV network feeding Ahmed Nagar and Gakkhar and its surrounding substations.

The load flow results for the normal case show that the power flows on all the circuits are within their normal rating. We find that there are no capacity constraints in terms of power flow or voltage ratings in the surrounding network available in the vicinity of LCC HPP for its connectivity under normal conditions.

The following N-1 contingency tests were run:

Exhibit-0.1	Ahmed Nagar to Fatehpur 132 kV Single Circuit Out
Exhibit-0.2	Gakkhar to Ahmed Nagar 132 kV Single Circuit Out
Exhibit-0.3	Gakkhar to Jaora 132 kV Single Circuit Out
Exhibit-0.4	Gakkhar to QD.Singh 132 kV Single Circuit Out
Exhibit-0.5	New Gujrat to Gakkhar 132 kV Single Circuit Out
Exhibit-0.6	Nokhar to Fatehpur 132 kV Single Circuit Out
Exhibit-0.7	Nokhar to QD.Singh 132 kV Single Circuit Out

The load flow results also show that there are no capacity constraints in the area surrounding and the voltage rating of the bus bars remain within their limits.

5.2 Load Flow with LCC HPP for September 2019

This proposed scheme of interconnection of LCC HPP scheme is to connect LCC HPP to the 132 11 kV grid of Ahmed Nagar by connecting three circuits of length 9 km at LCC HPP. The conductor used will be Osprey. This interconnection scheme has been modeled in the load flow studies. The month September has been selected

because it is a high water season and we want to see the impact of the project when loadings on the lines would be maximum.

The results of load flow with LCC HPP interconnected as per proposed scheme are shown in Exhibit 1.0 in Appendix-C. The power flows on the circuits are seen well within the rated capacities and the voltages on the bus bars are also within the permissible operating range of + 5 % off the nominal.

We find no capacity constraints on adjoining circuits under normal conditions i.e. without any outages of circuits. N-1 contingency analysis has been carried and the plotted results are attached in Appendix – C as follows:

Exhibit-1.1	LCC-I.V to Ahmed Nagar Ti 11 kV Single Circuit Out
Exhibit-1.2	Ahmed Nagar to Fatehpur 132 kV Single Circuit Out
Exhibit-1.3	Gakkhar to Ahmed Nagar 132 kV Single Circuit Out
Exhibit-1.4	Gakkhar to Jaora 132 kV Single Circuit Out
Exhibit-1.5	New Guirat to Gakkhar 132 kV Single Circuit Out
Exhibit-1.6	Gakkhar to QD.Singh 132 kV Single Circuit Out
Exhibit-1.7	Nokhar to Fatehpur 132 kV Single Circuit Out
Exhibit-1.8	Nokhar to QD.Singh 132 kV Single Circuit Out

N-1 contingency criteria has been fulfilled in all the above contingency cases. Also the bus bar voltages are well within the rated limits in above contingency events. Hence there are no additional constraints introduced in this scheme due to the interconnection of LCC HPP.

5.3 Conclusion of Load Flow Analysis

From the analysis discussed above, we conclude that both the proposed interconnection schemes of LCC HPP with GEPCO are adequate to evacuate the power of LCC HPP under normal as well as contingency conditions as shown in Appendix – C. Power Loss in the three 11kV Osprey conductors comes out to be **2.26%.**

6. Short Circuit Analysis

6.1 Methodology and Assumptions

The methodology of IEC 909 has been applied in all short circuit analyses in this report for which provision is available in the PSS/E software used for these studies. The maximum fault currents have been calculated with the following assumptions under IEC 909:

- Set tap ratios to unity
- Set line charging to zero
- Set shunts to zero in positive sequence
- Desired voltage magnitude at bus bars set equal to 1.10 P.U. i.e. 10 % higher than nominal, which is the maximum permissible voltage under contingency condition

For evaluation of maximum short circuit levels we have assumed contribution in the fault currents from all the installed generation capacity of hydel, thermal and nuclear plants in the system in the year 2019 i.e. all the generating units have been assumed on-bar in fault calculation's simulations.

The assumptions about the generator and the transformers data are the same as mentioned in Ch.2 of this report.

6.2 Fault Current Calculations

6.2.1 September 2019 without LCC HPP

In order to assess the short circuit strength of the network of 132 kV without LCC HPP for the grid of GEPCO in the vicinity of the site of the plant, fault currents have been calculated for balanced three-phase and unbalanced single-phase short circuit conditions. These levels will not only give us the idea of the fault levels of Ahmed Nagar 132kV grid station and other grid stations in the vicinity without LCC HPP but also would help us know as to how much the contribution of fault current later on from LCC HPP may add to the existing levels.

The short circuit levels have been represented graphically on the bus bars of 132 kV which are shown in the Exhibit 3.0 attached in Appendix-D.

The fault currents in the Exhibit are given in polar coordinates i.e. the magnitude and the angle of the current. The total fault current is shown below the bus bar.

The tabular output of the short circuit calculations is also attached in Appendix-D for bus bars of our interest i.e. the substations connecting in the 132 kV circuits lying close to LCC HPP. The total maximum fault currents for 3-phase and 1-phase short circuit at these substations are summarized in Table 6.1.

Table 6.1

Maximum Short Circuit Levels without LCC HPP

Substation	3-Phase fault current, kA	1-Phase fault current, kA
Ahmed Nagar 132 kV	10.01	15.01
Wazirabad 132kV	14.52	13.93
Qilla Didar Singh 132kV	15.18	13.65
Nokhar 132kV	32.48	32.22
Fatehpur 132kV	8.07	7.59
Gakkhar 132kV	36.31	39.15
Jaora 132kV	14.67	21.999
New Gujrat 132kV	27.27	27.30

6.2.2 September 2019 with LCC HPP

Fault currents have been calculated for the electrical interconnection of proposed scheme. Fault types applied are three phase and single-phase at the 11 kV bus bar of LCC HPP itself and other bus bars of the 132 kV substations in the electrical vicinity of LCC HPP. The graphic results are shown in Exhibit 3.1.

The tabulated results of short circuit analysis showing all the fault current contributions with short circuit impedances on 11 kV & 132 kV bus bars of the network in the electrical vicinity of LCC HPP are placed in Appendix-D. Brief summary of fault current at significant bus bars of our interest are tabulated in Table 6.2.

Table 6.2

Maximum Short Circuit Levels With LCC HPP

Substation	3-Phase fault current, kA	1-Phase fault current, kA
LCC 11kV	8.44	9.41
Ahmed Nagar 132 kV	10.16	15.22
Wazirabad 132kV	14.53	13.94
Qilla Didar Singh 132kV	15.19	13.66
Nokhar 132kV	32.55	32.26
Fatehpur 132kV	8.12	8.16
Gakkhar 132kV	36.43	39.24
Jaora 132kV	14.68	22.01
New Gujrat 132kV	27.29	27.35

Comparison of Tables 6.1 and 6.2 show slight increase in short circuit levels for three-phase and single – phase faults due to connection of LCC HPP. We find that even after some increase, these fault levels are much below the rated short circuit values of the equipment installed in these substations. The short circuit level at LCC HPP 11 kV bus bar is 8.44 kA and 9.41 kA for 3-phase and 1-phase faults respectively. Therefore industry standard switchgear of the short circuit rating of 25 kA would be fine to be installed at the 11 kV substation of LCC HPP. It would provide large margin for any future increase in short circuit levels due to future generation additions and network reinforcements in this area.

6.3 Conclusion of Short Circuit Analysis

The short circuit analysis results show that for the proposed schemes of interconnection of LCC HPP, we don't find any problem of violations of short circuit ratings of the already installed equipment on the 132 kV equipment of substations in the vicinity of LCC HPP due to fault current contributions from this power house under three-phase faults as well as single phase faults.

The short circuit level at LCC HPP 11 kV bus bar is 8.44 kA and 9.41 kA for 3-phase and 1-phase faults respectively. Therefore industry standard switchgear of the short circuit rating of 25 kA would be fine to be installed at the 11 kV substation of LCC HPP taking care of any future generation additions in its electrical vicinity.

7. Dynamic Stability Analysis

7.1 Assumptions & Methodology

7.1.1 Dynamic Models

The assumptions about the generator and its parameters are the same as mentioned in Ch.2 of this report.

We have employed the generic dynamic models available in the PSS E model library for dynamic modeling of the generator, exciter and the governor as follows:

Generator	GENSAL
Excitation System	EXST1
Speed Governing System	HYGOV

7.1.2 System Conditions

We have used the system conditions of September 2019, which represents the high water season. Most of the hydel generators would be running nearly at their full output.

We have carried out the Dynamic Stability analysis for LCC HPP with the proposed interconnection scheme is to connect LCC HPP to the 132 kV grid of Ahmed Nagar by connecting three circuits of length 9 km at LCC HPP. The conductor used will be Osprey. All the power plants of NTDC from Tarbela to Hub have been dynamically represented in the simulation model.

7.1.3 Presentation of Results

The plotted results of the simulations runs are placed in Appendix-E. Each simulation is run for its first one second for the steady state conditions of the system prior to fault or disturbance. This is to establish the pre fault disturbance conditions of the network under study were smooth and steady. Post fault recovery has been monitored for nineteen seconds.

7.1.4 Worst Fault Cases

Three phase faults are considered as the worst disturbances in the system. Normally we apply 3 phase fault on the bus bar of the power plant, followed by tripping of a circuit emanating from that bus, and trip one of the generators of the plant and or trip one of the inter-bus transformers if there are two voltage levels in the switching

station of the plant. Also we apply 3-phase fault at bus bars at far end of the interconnection of the plant and trip circuit or transformer as the case may be. The fault clearing time of 132 kV breakers has been assumed 9 cycles as stuck-breaker case (severe fault conditions).

7.2 Dynamic Stability Simulations' Results (Year 2019-20)

LCC HPP has been modeled by connecting three circuits from LCC HPP to the 132/11 kV grid of Ahmed Nagar of length 9 km at LCC HPP. The conductor used will be Osprey. All the simulations have been run using H = 1.5 MWs/MVA as per original assumption mentioned in Ch.2.

7.2.1 1-Phase Fault at 11 kV LCC HPP : Trip of 11 kV circuit between LCC and Ahmed Nagar T1 (Stuck Breaker Case)

We applied one-phase fault on LCC HPP 11 kV bus bar, cleared fault in 9 cycles (180 ms) followed by trip of 11 kV circuit between LCC and Ahmed Nagar T1 11kV. We monitored different quantities for one second pre-fault and nineteen seconds after clearance of fault (post-fault) conditions and plotted the results attached in Appendix F and discussed as follows:

Fig. 1.1 Bus Voltages

The bus voltages of 11 kV bus bar of LCC, 132 kV bus bars of Ahmed Nagar, Fazalpur, Gakkhar, Nokhar and Aroop are plotted. The results show recovery of the voltages after clearing of fault.

Fig. 1.2 Frequency

We see the system frequency recovers back to normal quickly after fault clearance.

Fig. 1.3 MW MVAR Output of Generators of LCC HPP

The pre-fault output of generator at LCC HPP was 7.5 MW and it gets back to the same output quickly after fast damping of the oscillations in its output. However MVAR output acquires equilibrium at a new value.

Fig. 1.4 Speed and mechanical power of Generators at LCC HPP

The speed deviation of the generator, after clearing fault, damps down quickly returning to normal speed as of before fault. The transients in mechanical power also damp quickly and settle to a new equilibrium.

Fig. 1.5 MW MVAR Flow on LCC-LV to Ahmed Nagar T1 11kV circuit

Followed by clearing of fault, the trip of the 11 kV circuit from LCC-LV to T1 11 kV circuit caused the entire output of 7.5 MW to flow through the intact two circuits of 11 kV between LCC-LV and Ahmed Nagar T1 and T2 11 kV. We plotted the flows of MW and MVAR on one of this intact circuit and see that the power flows on this circuit attains to steady state level with power swings damping down fast.

Fig. 1.6 Rotor Angles

The rotor angles of the generators of LCC HPP 11kV, New Bong Escape 132kV, Mangla 220kV, Allai 220kV and Guddu-New 500 kV are plotted relative to machine at Ghazi Brotha 500kV. The results show that the rotor angle of LCC HPP gets back after the first swing and damps down quickly. Similarly the rotor angles of other machines swing little after the fault and damp fast after clearing of fault. The system is strongly stable and very strong in damping the post fault oscillations.

7.2.2 Three-Phase Fault at 132 kV Ahmed Nagar : Trip of 132 kV circuit between Ahmed Nagar and Gakkhar

We applied three-phase fault on Ahmed Nagar 132 kV bus bar, cleared fault in 5 cycles (100 ms) followed by trip of 132 kV circuit between Ahmed Nagar and Gakkhar 132kV. We monitored different quantities for one second pre-fault and nineteen seconds after clearance of fault (post-fault) conditions and plotted the results attached in Appendix – I and discussed as follows:

Fig. 2.1 Bus Voltages

The bus voltages of 11 kV bus bar of LCC, 132 kV bus bars of Ahmed Nagar, Hazelpur, Gakkhar, Nokhar and Aroop are plotted. The results show recovery of the voltages after clearing of fault.

Fig. 2.2 Frequency

We see the system frequency recovers back to normal quickly after fault clearance.

Fig. 2.3 MW MVAR Output of Generators of LCC HPP

The pre-fault output of generator at LCC HPP was 7.5 MW and it gets back to the same output quickly after fast damping of the oscillations in its output. However MVAR output acquires equilibrium at a new value.

Fig. 2.4 Speed and mechanical power of Generators at LCC HPP

The speed deviation of the generator, after clearing fault, damps down quickly returning to normal speed as of before fault. The transients in mechanical power also damp quickly and settle to a new equilibrium.

Fig. 2.5 MW MVAR Flow on Ahmed Nagar to Fazalpur 132kV circuit

Followed by clearing of fault, the trip of the 132 kV circuit from Ahmed Nagar to Gatekhar 132 kV circuit caused the entire output of 7.5 MW to flow through the intact circuit of 132 kV between Ahmed Nagar to Fazalpur 132 kV. We plotted the flows of MW and MVAR on this intact circuit and see that the power flows on this circuit attains to steady state level with power swings damping down fast.

Fig. 2.6 Rotor Angles

The rotor angles of the generators of LCC HPP 11kV, New Bong Escape 132kV, Mangla 220kV, Allai 220kV and Guddu-New 500 kV are plotted relative to machine at Ghazi Brotha 500kV. The results show that the rotor angle of LCC HPP gets back after the first swing and damps down quickly. Similarly the rotor angles of other machines swing little after the fault and damp fast after clearing of fault. The system is strongly stable and very strong in damping the post fault oscillations.

7.2.3 Three-Phase Fault at 132 kV Wazirabad : Trip of 132 kV circuit between Wazirabad and New Gujrat (Stuck Breaker Case)

We applied three-phase fault on LCC 132 kV bus bar, cleared fault in 9 cycles (180 ms) followed by trip of 132 kV circuit between Wazirabad and New Gujrat 132kV. We monitored different quantities for one second pre-fault and nineteen seconds after clearance of fault, post-fault conditions and plotted the results attached in Appendix F and discussed as follows:

Fig. 3.1 Bus Voltages

The bus voltages of 11 kV bus bar of LCC, 132 kV bus bars of Ahmed Nagar, Fazalpur, Gakkhar, Nokhar and Aroop are plotted. The results show recovery of the voltages after clearing of fault.

Fig. 3.2 Frequencies

We see the system frequency recovers back to normal quickly after fault clearance.

Fig. 3.3 MW MVAR Output of Generators of LCC HPP

The pre-fault output of generator at LCC HPP was 7.5 MW and it gets back to the same output quickly after fast damping of the oscillations in its output. However MVAR output acquires equilibrium at a new value.

Fig. 3.4 Speed and mechanical power of Generators at LCC HPP

The speed deviation of the generator, after clearing fault, damps down quickly returning to normal speed as of before fault. The transients in mechanical power also damp quickly and settle to new equilibrium.

Fig. 3.5 MW MVAR flow on Ahmed Nagar to Fazalpur 132kV circuit

Followed by clearing of fault, the trip of the 132 kV circuit from Ahmed Nagar to Oukkhar 132 kV circuit caused the entire output of 7.5 MW to flow through the intact circuit of 132 kV between Ahmed Nagar to Fazalpur 132 kV. We plotted the flows of MW and MVAR on this intact circuit and see that the power flows on this circuit attains to steady state level with power swings damping down fast.

Fig. 3.6 Rotor Angles

The rotor angles of the generators of LCC HPP 11kV, New Bong Escape 132kV, Mangla 220kV, Mint 22kV and Goddu-New 500 kV are plotted relative to machine at Ghazi Brotha 500kV. The results show that the rotor angle of LCC HPP gets back after the first swing and damps down quickly. Similarly the rotor angles of other machines swing little after fault and damp fast after clearing of fault. The system is strongly stable and very strong in damping the post fault oscillations.

7.3 Conclusion of Dynamic Stability Analysis

The results of dynamic stability show that the system is very strong and stable for the proposed schemes for the severest possible faults of 11 kV and 132 kV systems near LCC HPP. Therefore there is no problem of dynamic stability for interconnection of LCC HPP; it fulfills all the criteria of dynamic stability.

8. Conclusions

- The interconnection study of Lower Chenab Canal (LCC) HPP to evacuate its maximum power of 7.5 MW is envisaged and studied in detail.
- The nearest substations of GEPCO available for interconnection to LCC HPP is Ahmed Nagar and Gakkhar 132 kV
- In view of the above mentioned 132 kV and 11 kV network available in the vicinity of the site of the LCC HPP, the proposed interconnection scheme is to connect LCC HPP to the 132 11 kV grid of Ahmed Nagar by connecting three circuits of length 9 km at LCC HPP. The conductor used will be Osprey.
- Detailed load flow studies have been carried out for the peak load conditions of and September 2019 for the all the proposed schemes under normal and N-1 contingency conditions to meet the reliability criteria.
- Steady state analysis by load flow reveals that proposed schemes are adequate to evacuate the maximum power of 7.5 MW of the plant under normal and contingency conditions shown in Appendix - C. Power Loss in the three 11kV Osprey conductors comes out to be **2.26%.**
- The short circuit analysis has been carried out to calculate maximum fault levels at LCC at 11 kV and other substations in its vicinity. We find that the fault currents for the proposed scheme are much less than the rated short circuit capacities of switchgear installed at these substations. It was found that there are no violations of exceeding the rating of the equipment due to contribution of fault current from LCC HPP.
- The short circuit level at LCC 11 kV bus bar is 8.44 kA and 9.41 kA for 3-phase and 1-phase faults respectively. Therefore industry standard switchgear of the short circuit rating of 25 kA would be fine to be installed at the 11 kV substation of LCC to accommodate future expansions of generation and transmission in this area.
- The dynamic stability analysis of proposed schemes of interconnection has been carried out. The stability check for the worst case of three phase fault right on the 11 kV bus bar of LCC HPP substation followed by the final trip of LCC to Ahmed Nagar 11 has been performed for fault clearing of 9 cycles (180 ms). The system is found strong enough to stay stable and recovered with fast damping.

- The proposed schemes of interconnection have no technical constraints or problems under steady state load flow, short circuit currents and dynamic/transient conditions; and are therefore recommended to be adopted.