PUNJAB RURAL MUNICIPAL SERVICES COMPANY

5th Floor, KD Plaza, MM Alam Road, Gulberg-III, Lahore, Pakistan
Telephone: +92-42-99333613

Request for Bids

Punjab Rural Sustainable Water Supply & Sanitation Project (PRSWSSP)

(One-Envelope Bidding Process)

RFB Reference No:	PK-LG& CD-546505-CW-RFB
Project:	PUNJAB RURAL SUSTAINABLE WATER SUPPLY & SANITATION PROJECT
Contract Title:	**Procurement of Civil Works for PRSWSSP, Cluster North, Tehsil Kot Momin (Phase-I) Part-b** Tehsil Kot Momin: Wan Miana and Wan Miana & Rahimpur
Employer:	PUNJAB RURAL MUNICIPAL SERVICES COMPANY (PRMSC)
Country:	PAKISTAN
Loan No.:	IBRD-92670
Issued On:	09.10.2026

PUNJAB RURAL MUNICIPAL SERVICES COMPANY (PRMSC)

A COMPANY SET UP UNDER SECTION 42 OF THE COMPANIES ACT, 2017

SPECIFIC PROCUREMENT NOTICE
REQUEST FOR BIDS

Procurement of Civil Works of Priority Villages Pilot Phase-I (Part-b)

Country:	PAKISTAN
Name of Project:	PUNJAB RURAL SUSTAINABLE WATER SUPPLY & SANITATION PROJECT
Employer:	PUNJAB RURAL MUNICIPAL SERVICES COMPANY (PRMSC)
Loan No.:	IBRD-92670

1. Government of the Islamic Republic of Pakistan (who has extended the financing to Punjab Rural Municipal Services Company) has received a loan from the **World Bank** (IBRD) towards the cost of the Punjab Rural Sustainable Water Supply & Sanitation Project (PRSWSSP) and intends to apply part of the proceeds toward payments under the Procurement of Civil Works of Priority Villages.

2. Punjab Rural Municipal Services Company - PRMSC (the Employer) now invites sealed Bids from eligible Bidders for the following Contract Packages;

Sr. No.	Description / STEP Activity No.	Bid Security (Pak. Rs. In million)
1	Procurement of Civil Works for PRSWSSP, Cluster South-III, Tehsil Khairpur Tamewali & Kahror Pacca (Phase-I) Part-b PK-LG& CD-546503-CW-RFB Tehsil Karor Pacca: Hamble wala Tehsil Khairpur Tamia wali: Tibbi Ghaffar Bakhsh and Jhoke Lal	18.00
2	Procurement of Civil Works for PRSWSSP, Cluster North, Tehsil Kot Momin (Phase-I) Part-b PK-LG& CD-546505-CW-RFB Tehsil Kot Momin: Wan Miana and Wan Miana & Rahimpur	11.00
3	Procurement of Civil Works for PRSWSSP, Cluster South-II, Tehsils Alipur and Shujjabad (Phase-I) Part-b PK-LG& CD-546506-CW-RFB Tehsils Alipur: Nawandera Tehsils Shujjabad: Khoja Dera, Matotli and Sikandarabad Gharbi	21.00
4	Procurement of Civil Works for PRSWSSP, Cluster Centre, Tehsil Pakpattan, Darya Khan, Bhowana (Phase-I) PK-LG& CD-546507-CW-RFB Tehsil Pakpattan: Asadullah Pur and Nizam Adlike Tehsil Darya Khan: Chak No 46/ML and Chak No 47/ML Tehsil Bhowana: Chak 156 and Chak 203	32.00

3. Bidding will be conducted through national competitive procurement using Request for Bids (RFB) as specified in the World Bank's Procurement Regulations for IPF Borrowers dated July 2016 (Revised ("Procurement Regulations"), and is open to all eligible Bidders as defined in the Procurement Regulations &Bidding Document.

4. Interested eligible Bidders may obtain further information from the Office of the Employer and inspect the Bidding Document during office hours [Monday to Friday] at the address given below.

5. The Bidders may download the Bidding Document at no cost from the website: www.prmsc.punjab.gov.pk/tenders. Soft copy of Bidding Document can also be obtained from PRMSC Head Office, Lahore free of cost. Bidders opting to download the Bidding Documents from any of the aforesaid website, shall inform the Punjab Rural Municipal Services Company, in writing at the address given below failing which Company shall not be responsible if they do not receive clarifications and amendments, if any from the Company.

6. A Pre-bid Meeting shall take place on October 19, 2026 15:00 hours at Conference Room, PRMSC, 5th floor KD Plaza MM Alam Road, Lahore. Bidders have the option to attend online pre-bid meeting through zoom link, Meeting ID: 868 8135 8982 Passcode: 465696. https://us06web.zoom.us/j/86881358982?pwd=iHthTO7fub8amlc9BAA9E1MQu4dFJg.1

7. Bids must be delivered to the address below on or before **November 05, 2026 at 1200 hours** for all the above-mentioned packages. Electronic Bidding will not be permitted. Late Bids will be rejected. Bids will be publicly opened in the presence of the Bidders' designated representatives and anyone who chooses to attend at the address below on **November 05, 2026 at 1230 hours**.

8. The Bids must be accompanied by a Bid Security as mentioned above, for each contract package in the shape of unconditional Bank Guarantee or Call Deposit Receipt (CDR) in the name of **"Punjab Rural Municipal Services Company"**.

9. Attention is drawn to the Procurement Regulations for IPF Borrowers requiring the Borrower to disclose information on the successful Bidder's beneficial ownership, as part of the Contract Award Notice, using the Beneficial Ownership Disclosure Form as included in the Bidding Document.

10. The address referred to above is:

Chief Executive Officer
Punjab Rural Municipal Services Company (PRMSC)
5th Floor, KD Plaza, MM Alam Road, Gulberg-III, Lahore, Pakistan
Telephone: +92-42-99333613
Email address: proc.prmsc@punjab.gov.pk

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PART 1 – Bidding Procedures

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Section I - Instructions to Bidders

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Section I - Instructions to Bidders

A. General

1. Scope of Bid

1.1 In connection with the Specific Procurement Notice - Request for Bids (RFB), specified in the Bid Data Sheet (BDS)**,** the Employer, as specified **in the BDS,** issues this bidding document for the provision of Works as specified in Section VII, Works' Requirements. The name, identification and number of lots (contracts) of this RFB are specified **in the BDS.**

1.2 Throughout this bidding document:

(a) the term "in writing" means communicated in written form (e.g. by mail, e-mail, and fax, including if specified **in the BDS**, distributed or received through the electronic-procurement system used by the Employer) with proof of receipt;

(b) if the context so requires, "singular" means "plural" and vice versa;

(c) "Day" means calendar day, unless otherwise specified as "Business Day". A Business Day is any day that is an official working day of the Borrower. It excludes the Borrower's official public holidays; and

(d) "ESHS" means environmental, social (including sexual exploitation and abuse (SEA) and gender based violence (GBV)), health and safety.

2. -Source of Funds

2.1 The Borrower or Recipient (hereinafter called "Borrower") specified **in the BDS** has received or has applied for financing (hereinafter called "funds") from the International Bank for Reconstruction and Development or the International Development Association (hereinafter called "the Bank") in an amount specified **in the BDS**, toward the project named **in the BDS**. The Borrower intends to apply a portion of the funds to eligible payments under the contract(s) for which this bidding document is issued.

2.2 Payment by the Bank will be made only at the request of the Borrower and upon approval by the Bank, and will be subject, in all respects, to the terms and conditions of the Loan (or other financing) Agreement. The Loan (or other financing) Agreement prohibits a withdrawal from the loan account for the purpose of any payment to persons or entities, or for any import of goods, equipment, plant, or

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materials, if such payment or import is prohibited by a decision of the United Nations Security Council taken under Chapter VII of the Charter of the United Nations. No party other than the Borrower shall derive any rights from the Loan (or other financing) Agreement or have any claim to the proceeds of the Loan (or other financing).

3. Fraud and Corruption

3.1 The Bank requires compliance with the Bank's Anti-Corruption Guidelines and its prevailing sanctions policies and procedures as set forth in the WBG's Sanctions Framework, as set forth in Section VI.

3.2 In further pursuance of this policy, bidders shall permit and shall cause their agents (where declared or not), subcontractors, subconsultants, service providers, suppliers, and their personnel, to permit the Bank to inspect all accounts, records and other documents relating to any initial selection process, prequalification process, bid submission, proposal submission, and contract performance (in the case of award), and to have them audited by auditors appointed by the Bank.

4. Eligible Bidders

4.1 A Bidder may be a firm that is a private entity, or a state-owned enterprise or institution, subject to ITB 4.6, or any combination of them in the form of a joint venture (JV), under an existing agreement, or with the intent to enter into such an agreement supported by a letter of intent. In the case of a joint venture, all members shall be jointly and severally liable for the execution of the entire Contract in accordance with the Contract terms. The JV shall nominate a Representative who shall have the authority to conduct all business for and on behalf of any and all the members of the JV during the Bidding process and, in the event the JV is awarded the Contract, during contract execution. Unless specified **in the BDS**, there is no limit on the number of members in a JV.

4.2 A Bidder shall not have a conflict of interest. All Bidders found to have a conflict of interest shall be disqualified. A Bidder may be considered to have a conflict of interest for the purpose of this Bidding process, if the Bidder:

(a) directly or indirectly controls, is controlled by or is under common control with another Bidder; or

(b) receives or has received any direct or indirect subsidy from another Bidder; or

(c) has the same legal representative as another Bidder; or

(d) has a relationship with another Bidder, directly or through common third parties, that puts it in a position to influence

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the Bid of another Bidder, or influence the decisions of the Employer regarding this bidding process; or

(e) or any of its affiliates participated as a consultant in the preparation of the design or technical specifications of the works that are the subject of the Bid; or

(f) or any of its affiliates has been hired (or is proposed to be hired) by the Employer or Borrower as Project Manager for the Contract implementation;

(g) would be providing goods, works, or non-consulting services resulting from or directly related to consulting services for the preparation or implementation of the project specified in the BDS ITB 2.1 that it provided or were provided by any affiliate that directly or indirectly controls, is controlled by, or is under common control with that firm;

(h) has a close business or family relationship with a professional staff of the Borrower (or of the project implementing agency, or of a recipient of a part of the loan) who: (i) are directly or indirectly involved in the preparation of the bidding document or specifications of the contract, and/or the Bid evaluation process of such contract; or (ii) would be involved in the implementation or supervision of such contract unless the conflict stemming from such relationship has been resolved in a manner acceptable to the Bank throughout the procurement process and execution of the contract.

4.3 A firm that is a Bidder (either individually or as a JV member) shall not participate in more than one Bid, except for permitted alternative Bids. This includes participation as a Subcontractor in other Bids. Such participation shall result in the disqualification of all Bids in which the firm is involved. A firm that is not a Bidder or a JV member may participate as a subcontractor in more than one Bid.

4.4 A Bidder may have the nationality of any country, subject to the restrictions pursuant to ITB 4.8. A Bidder shall be deemed to have the nationality of a country if the Bidder is constituted, incorporated or registered in and operates in conformity with the provisions of the laws of that country, as evidenced by its articles of incorporation (or equivalent documents of constitution or association) and its registration documents, as the case may be. This criterion also shall apply to the determination of the nationality of proposed subcontractors or subconsultants for any part of the Contract including related Services.

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4.5 A Bidder that has been sanctioned by the Bank, pursuant to the Bank's Anti-Corruption Guidelines, in accordance with its prevailing sanctions policies and procedures as set forth in the WBG's Sanctions Framework as described in Section VI paragraph 2.2 d., shall be ineligible to be prequalified for, initially selected for, bid for, propose for, or be awarded a Bank-financed contract or benefit from a Bank-financed contract, financially or otherwise, during such period of time as the Bank shall have determined. The list of debarred firms and individuals is available at the electronic address specified in the BDS.

4.6 Bidders that are state-owned enterprises or institutions in the Employer's Country may be eligible to compete and be awarded a Contract(s) only if they can establish, in a manner acceptable to the Bank, that they (i) are legally and financially autonomous (ii) operate under commercial law, and (iii) are not under supervision of the Employer.

4.7 A Bidder shall not be under suspension from Bidding by the Employer as the result of the operation of a Bid–Securing or Proposal-Securing Declaration.

4.8 Firms and individuals may be ineligible if so indicated in Section V and (a) as a matter of law or official regulations, the Borrower's country prohibits commercial relations with that country, provided that the Bank is satisfied that such exclusion does not preclude effective competition for the supply of goods or the contracting of works or services required; or (b) by an act of compliance with a decision of the United Nations Security Council taken under Chapter VII of the Charter of the United Nations, the Borrower's country prohibits any import of goods or contracting of works or services from that country, or any payments to any country, person, or entity in that country. When the Works are implemented across jurisdictional boundaries (and more than one country is a Borrower, and is involved in the procurement), then exclusion of a firm or individual on the basis of ITB 4.8 (a) above by any country may be applied to that procurement across other countries involved, if the Bank and the Borrowers involved in the procurement agree.

4.9 A Bidder shall provide such documentary evidence of eligibility satisfactory to the Employer, as the Employer shall reasonably request.

4.10 A firm that is under a sanction of debarment by the Borrower from being awarded a contract is eligible to participate in this

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procurement, unless the Bank, at the Borrower's request, is satisfied that the debarment;

(a) relates to fraud or corruption, and

(b) followed a judicial or administrative proceeding that afforded the firm adequate due process.

5. Eligible Materials, Equipment and Services

5.1 The materials, equipment and services to be supplied under the Contract and financed by the Bank may have their origin in any country subject to the restrictions specified in Section V, Eligible Countries, and all expenditures under the Contract will not contravene such restrictions. At the Employer's request, Bidders may be required to provide evidence of the origin of materials, equipment and services.

B. Contents of Bidding Document

6. Sections of Bidding Document

6.1 The bidding document consists of Parts 1, 2, and3, which include all the sections specified below, and which should be read in conjunction with any Addenda issued in accordance with ITB 8.

PART 1 Bidding Procedures

- Section I - Instructions to Bidders (ITB)
- Section II - Bid Data Sheet (BDS)
- Section III - Evaluation and Qualification Criteria
- Section IV - Bidding Forms
- Section V - Eligible Countries
- Section VI - Fraud and Corruption

PART 2 Works' Requirements

- Section VII- Works' Requirements

PART 3 Conditions of Contract and Contract Forms

- Section VIII - General Conditions of Contract (GCC)
- Section IX - Particular Conditions of Contract (PCC)
- Section X - Contract Forms

6.2 The Specific Procurement Notice - Request for Bids (RFB) issued by the Employer is not part of this bidding document.

6.3 Unless obtained directly from the Employer, the Employer is not responsible for the completeness of the bidding document,

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responses to requests for clarification, the minutes of the pre-Bid meeting (if any), or Addenda to the bidding document in accordance with ITB 8. In case of any contradiction, documents obtained directly from the Employer shall prevail.

6.4 The Bidder is expected to examine all instructions, forms, terms, and specifications in the bidding document and to furnish with its Bid all information and documentation as is required by the bidding document.

7. Clarification of Bidding Document, Site Visit, Pre-Bid Meeting

7.1 A Bidder requiring any clarification of the bidding document shall contact the Employer in writing at the Employer's address specified **in the BDS** or raise its inquiries during the pre-Bid meeting if provided for in accordance with ITB 7.4. The Employer will respond in writing to any request for clarification, provided that such request is received prior to the deadline for submission of Bids within a period specified **in the BDS**. The Employer shall forward copies of its response to all Bidders who have acquired the bidding document in accordance with ITB 6.3, including a description of the inquiry but without identifying its source. If so specified **in the BDS**, the Employer shall also promptly publish its response at the web page identified in the BDS. Should the clarification result in changes to the essential elements of the bidding document, the Employer shall amend the bidding document following the procedure under ITB 8 and ITB 22.2.

7.2 The Bidder is advised to visit and examine the Site of Works and its surroundings and obtain for itself on its own responsibility all information that may be necessary for preparing the bid and entering into a contract for construction of the Works. The costs of visiting the Site shall be at the Bidder's own expense.

7.3 The Bidder and any of its personnel or agents will be granted permission by the Employer to enter upon its premises and lands for the purpose of such visit, but only upon the express condition that the Bidder, its personnel, and agents will release and indemnify the Employer and its personnel and agents from and against all liability in respect thereof, and will be responsible for death or personal injury, loss of or damage to property, and any other loss, damage, costs, and expenses incurred as a result of the inspection.

7.4 If so specified **in the BDS**, the Bidder's designated representative is invited to attend a pre-Bid meeting and/or a Site of Works visit. The purpose of the meeting will be to clarify issues and to answer questions on any matter that may be raised at that stage.

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7.5 The Bidder is requested, to submit any questions in writing, to reach the Employer not later than one week before the meeting.

7.6 Minutes of the pre-Bid meeting, if applicable, including the text of the questions asked by Bidders, without identifying the source, and the responses given, together with any responses prepared after the meeting, will be transmitted promptly to all Bidders who have acquired the bidding document in accordance with ITB 6.3 Any modification to the bidding document that may become necessary as a result of the pre-Bid meeting shall be made by the Employer exclusively through the issue of an addendum pursuant to ITB 8 and not through the minutes of the pre-Bid meeting. Nonattendance at the pre-Bid meeting will not be a cause for disqualification of a Bidder.

8. Amendment of Bidding Document

8.1 At any time prior to the deadline for submission of bids, the Employer may amend the bidding document by issuing addenda.

8.2 Any addendum issued shall be part of the bidding document and shall be communicated in writing to all who have obtained the bidding document from the Employer in accordance with ITB 6. The Employer shall also promptly publish the addendum on the Employer's web page in accordance with ITB 7.1.

8.3 To give prospective Bidders reasonable time in which to take an addendum into account in preparing their Bids, the Employer may, at its discretion, extend the deadline for the submission of Bids, pursuant to ITB 22.2.

C. Preparation of Bids

9. Cost of Bidding

9.1 The Bidder shall bear all costs associated with the preparation and submission of its Bid, and the Employer shall in no case be responsible or liable for those costs, regardless of the conduct or outcome of the Bidding process.

10. Language of Bid

10.1 The Bid, as well as all correspondence and documents relating to the Bid exchanged by the Bidder and the Employer, shall be written in the language specified **in the BDS**. Supporting documents and printed literature that are part of the Bid may be in another language provided they are accompanied by an accurate translation of the relevant passages in the language specified **in the BDS**, in which case, for purposes of interpretation of the Bid, such translation shall govern.

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11. Documents Comprising the Bid

11.1 The Bid shall comprise the following:

(a) **Letter of Bid** prepared in accordance with ITB 12;

(b) **Bill of Quantities or Activity Schedule**: completed in accordance with ITB 12 and ITB 14, as specified **in the BDS**;

(c) **Bid Security or Bid-Securing Declaration**, in accordance with ITB 19.1;

(d) **Alternative Bid**, if permissible, in accordance with ITB 13;

(e) **Authorization:** written confirmation authorizing the signatory of the Bid to commit the Bidder, in accordance with ITB 20.3;

(f) **Bidder's Eligibility:** documentary evidence in accordance with ITB 17 establishing the Bidder's eligibility to Bid;

(g) **Qualifications**: documentary evidence in accordance with ITB 17 establishing the Bidder's qualifications to perform the contract if its Bid is accepted;

(h) **Conformity**: a technical proposal in accordance with ITB 16;

(i) any other document required **in the BDS**.

11.2 In addition to the requirements under ITB 11.1, Bids submitted by a JV shall include a copy of the Joint Venture Agreement entered into by all members. Alternatively, a letter of intent to execute a Joint Venture Agreement in the event of a successful bid shall be signed by all members and submitted with the Bid, together with a copy of the proposed Agreement.

11.3 The Bidder shall furnish in the Letter of Bid information on commissions and gratuities, if any, paid or to be paid to agents or any other party relating to this Bid.

12. Letter of Bid and Schedules

12.1 The Letter of Bid and Schedules shall be prepared using the relevant forms furnished in Section IV, Bidding Forms. The forms must be completed without any alterations to the text, and no substitutes shall be accepted except as provided under ITB 20.3. All blank spaces shall be filled in with the information requested.

13. Alternative Bids

13.1 Unless otherwise specified **in the BDS**, alternative Bids shall not be considered.

13.2 When alternative times for completion are explicitly invited, a statement to that effect will be included **in the BDS** and the method of evaluating different alternative times for completion will be described in Section III, Evaluation and Qualification Criteria.

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13.3 Except as provided under ITB 13.4 below, Bidders wishing to offer technical alternatives to the requirements of the bidding document must first price the Employer's design as described in the bidding document and shall further provide all information necessary for a complete evaluation of the alternative by the Employer, including drawings, design calculations, technical specifications, breakdown of prices, and proposed construction methodology and other relevant details. Only the technical alternatives, if any, of the Bidder with the Most Advantageous Bid conforming to the basic technical requirements shall be considered by the Employer.

13.4 When specified **in the BDS**, Bidders are permitted to submit alternative technical solutions for specified parts of the Works. Such parts will be identified **in the BDS** and described in Section VII, Works 'Requirements. The method for their evaluation will be stipulated in Section III, Evaluation and Qualification Criteria.

14. Bid Prices and Discounts

14.1 The prices and discounts quoted by the Bidder in the Letter of Bid and in the Activity Schedule or Bill of Quantities shall conform to the requirements specified below.

14.2 The Bidder shall submit a Bid for the whole of the Works described in ITB 1.1 by filling in prices for all items of the Works, as identified in Section IV. Bidding Forms. In case of admeasurement contracts, the Bidder shall fill in rates and prices for all items of the Works described in the Bill of Quantities. Items against which no rate or price is entered by the Bidder will not be paid for by the Employer when executed and shall be deemed covered by the rates for other items and prices in the Bill of Quantities.

14.3 The price to be quoted in the Letter of Bid,in accordance with ITB 12.1, shall be the total price of the Bid, excluding any discounts offered.

14.4 The Bidder shall quote any discounts and indicate the methodology for their application in the Letter of Bidin accordance with ITB 12.1.

14.5 Unless otherwise specified **in the BD S**and the Conditions of Contract, the prices quoted by the Bidder shall be fixed. If the prices quoted by the Bidder are subject to adjustment during the performance of the Contract in accordance with the provisions of the Conditions of Contract, the Bidder shall furnish the indices and weightings for the price adjustment formulae in the Schedule of Adjustment Data in Section IV- Bidding Forms and the Employer may require the Bidder to justify its proposed indices and weightings.

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14.6 If so specified in ITB 1.1, Bids are invited for individual lots (contracts)or for any combination of lots (packages). Bidders wishing to offer discounts for the award of more than one Contract shall specify in their Bid the price reductions applicable to each package, or alternatively, to individual Contracts within the package. Discounts shall be submitted in accordance with ITB 14.4, provided the Bids for all lots (contracts) are opened at the same time.

14.7 All duties, taxes, and other levies payable by the Contractor under the Contract, or for any other cause, as of the date 28 days prior to the deadline for submission of Bids, shall be included in the rates and prices[1] and the total Bid price submitted by the Bidder.

15. Currencies of Bid and Payment

15.1 The currency(ies) of the Bid and the currency(ies) of payments shall be in Pak Rupees.

15.2 However with prior agreement of Bank the bids can be invited in up to three freely convertible currencies.

15.3 Subject to 15.1 bidders may be required by the Employer to justify, to the Employer's satisfaction, their local and foreign currency requirements, and to substantiate that the amounts included in the unit rates and prices and shown in the Schedule of Adjustment Data are reasonable[2],in which case a detailed breakdown of the foreign currency requirements shall be provided by Bidders.

16. Documents Comprising the Technical Proposal

16.1 The Bidder shall furnish a technical proposal including a statement of work methods, equipment, personnel, schedule and any other information as stipulated in Section IV, Bidding Forms, in sufficient detail to demonstrate the adequacy of the Bidders' proposal to meet the work's requirements and the completion time.

17. Documents Establishing the Eligibility and Qualifications of the Bidder

17.1 To establish Bidder's eligibility in accordance with ITB 4, Bidders shall complete the Letter of Bid, included in Section IV, Bidding Forms.

17.2 In accordance with Section III, Evaluation and Qualification Criteria, to establish its qualifications to perform the Contract, the Bidder shall provide the information requested in the corresponding information sheets included in Section IV, Bidding Forms.

17.3 If a margin of preference applies as specified in accordance with ITB 33.1, domestic Bidders, individually or in joint ventures,

[1] In lump sum contracts, delete "rates and prices and the."

[2] For lump sum contracts, delete "unit rates and prices and shown in the Schedule of Adjustment Data are reasonable" and replace with "Lump Sum."

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applying for eligibility for domestic preference shall supply all information required to satisfy the criteria for eligibility specified in accordance with ITB 33.1.

18. Period of Validity of Bids

18.1 Bids shall remain valid for the Bid Validity period specified **in the BDS**. The Bid Validity period starts from the date fixed for the Bid submission deadline (as prescribed by the Employer in accordance with ITB 22.1). A Bid valid for a shorter period shall be rejected by the Employer as nonresponsive.

18.2 In exceptional circumstances, prior to the expiration of the Bid validity period, the Employer may request Bidders to extend the period of validity of their Bids. The request and the responses shall be made in writing. If a Bid Security is requested in accordance with ITB 19, it shall also be extended for twenty-eight (28) days beyond the deadline of the extended validity period. A Bidder may refuse the request without forfeiting its Bid Security. A Bidder granting the request shall not be required or permitted to modify its Bid, except as provided in ITB 18.3.

18.3 If the award is delayed by a period exceeding fifty-six (56) days beyond the expiry of the initial Bid validity period, the Contract price shall be determined as follows:

(a) in the case of **fixed price** contracts, the Contract price shall be the Bid price adjusted by the factor specified **in the BDS;**

(b) in the case of **adjustable** price contracts, no adjustment shall be made; or

(c) in any case, Bid evaluation shall be based on the Bid price without taking into consideration the applicable correction from those indicated above.

19. Bid Security

19.1 The Bidder shall furnish as part of its Bid, either a Bid-Securing Declaration or a Bid Security as specified **in the BDS**, in original form and, in the case of a Bid Security, in the amount and currency specified **in the BDS**.

19.2 A Bid Securing Declaration shall use the form included in Section IV, Bidding Forms.

19.3 If a Bid Security is specified pursuant to ITB 19.1, the Bid Security shall be a demand guarantee in any of the following forms at the Bidder's option:

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(a) an unconditional guarantee issued by a bank or non-bank financial institution (such as an insurance, bonding or surety company);

(b) an irrevocable letter of credit;

(c) a cashier's or certified check; or

(d) another security specified **in the BDS**,

from a reputable source from an eligible country. If an unconditional guarantee is issued by a non-bank financial institution located outside the Employer's Country, the issuing non-bank financial institution shall have a correspondent financial institution located in the Employer's Country to make it enforceable, unless the Employer has agreed in writing, prior to Bid submission, that a correspondent financial institution is not required. In the case of a bank guarantee, the Bid Security shall be submitted either using the Bid Security Form included in Section IV, Bidding Forms, or in another substantially similar format approved by the Employer prior to Bid submission. The Bid Security shall be valid for twenty-eight (28) days beyond the original validity period of the Bid, or beyond any period of extension if requested under ITB 18.2.

19.4 If a Bid Security or Bid Securing Declaration is specified pursuant to ITB 19.1, any Bid not accompanied by a substantially responsive Bid Security or Bid-Securing Declaration shall be rejected by the Employer as non-responsive.

19.5 If a Bid Security is specified pursuant to ITB 19.1, the Bid Security of unsuccessful Bidders shall be returned as promptly as possible upon the successful Bidder's signing the Contract and furnishing the Performance Security and if required in the BDS, the Environmental, Social, Health and Safety (ESHS) Performance Security pursuant to ITB 48.

19.6 The Bid Security of the successful Bidder shall be returned as promptly as possible once the successful Bidder has signed the Contract and furnished the required Performance Security and if required in the BDS, the Environmental, Social, Health and Safety (ESHS) Performance Security.

19.7 The Bid Security may be forfeited or the Bid-Securing Declaration executed:

PROVIDED

(a) if a Bidder withdraws its Bid during the period of Bid validity specified by the Bidder on the Letter of Bid, or any extension thereto provided by the Bidder; or

(b) if the successful Bidder fails to:

(i) sign the Contract in accordance with ITB 47; or

(ii) furnish a Performance Security and if required in the BDS, the Environmental, Social, Health and Safety (ESHS) Performance Security in accordance with ITB 48.

19.8 The Bid Security or the Bid-Securing Declaration of a JV shall be in the name of the JV that submits the Bid. If the JV has not been constituted into a legally enforceable JV, at the time of Bidding, the Bid Security or the Bid-Securing Declaration shall be in the names of all future members as named in the letter of intent mentioned in ITB 4.1 and ITB 11.2.

19.9 If a Bid Security is not required **in the BDS**, pursuant to ITB 19.1, and;

(a) if a Bidder withdraws its Bid during the period of Bid validity specified by the Bidder on the Letter of Bid; or

(b) if the successful Bidder fails to: sign the Contract in accordance with ITB 45, or furnish a Performance Security and if required in the BDS, the Environmental, Social, Health and Safety (ESHS) Performance Security in accordance with ITB 46;

the Borrower may**,** if provided for **in the BDS,** declare the Bidder ineligible to be awarded a contract by the Employer for a period of time stated **in the BDS**.

20. Format and Signing of Bid

20.1 The Bidder shall prepare one original of the documents comprising the Bid as described in ITB 11 and clearly mark it "ORIGINAL". Alternative Bids, if permitted in accordance with ITB 13, shall be clearly marked "ALTERNATIVE". In addition, the Bidder shall submit copies of the Bid in the number specified **in the BDS,** and clearly mark each of them "COPY." In the event of any discrepancy between the original and the copies, the original shall prevail.

20.2 Bidders shall mark as "CONFIDENTIAL" information in their Bids which is confidential to their business. This may include proprietary information, trade secrets, or commercial or financially sensitive information.

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20.3 The original and all copies of the Bid shall be typed or written in indelible ink and shall be signed by a person duly authorized to sign on behalf of the Bidder. This authorization shall consist of a written confirmation as specified **in the BDS** and shall be attached to the Bid. The name and position held by each person signing the authorization must be typed or printed below the signature. All pages of the Bid where entries or amendments have been made shall be signed or initialed by the person signing the Bid.

20.4 In case the Bidder is a JV, the Bid shall be signed by an authorized representative of the JV on behalf of the JV, and so as to be legally binding on all the members as evidenced by a power of attorney signed by their legally authorized representatives.

20.5 Any interlineations, erasures, or overwriting shall be valid only if they are signed or initialed by the person signing the Bid.

D. Submission and Opening of Bids

21. Sealing and Marking of Bids

21.1 The Bidder shall deliver the Bid in a single, sealed envelope (one-envelope Bidding process). Within the single envelope the Bidder shall place the following separate, sealed envelopes:

(a) in an envelope marked "ORIGINAL", all documents comprising the Bid, as described in ITB 11; and

(b) in an envelope marked "COPIES", all required copies of the Bid; and

(c) if alternative Bids are permitted in accordance with ITB 13, and if relevant:

(i) in an envelope marked "ORIGINAL- ALTERNATIVE BID", the alternative Bid; and

(ii) in the enveloped marked "COPIES – ALTERNATIVE BID" all required copies of the alternative Bid.

21.2 The inner and outer envelopes shall:

(a) bear the name and address of the Bidder;

(b) be addressed to the Employer in accordance with ITB 22.1;

(c) bear the specific identification of this Bidding process specified in accordance with BDS 1.1; and

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(d) bear a warning not to open before the time and date for Bid opening.

21.3 If all envelopes are not sealed and marked as required, the Employer will assume no responsibility for the misplacement or premature opening of the Bid.

22. Deadline for Submission of Bids

22.1 Bids must be received by the Employer at the address and no later than the date and time specified **in the BDS**. When so specified **in the BDS**, Bidders shall have the option of submitting their Bids electronically. Bidders submitting Bids electronically shall follow the electronic bid submission procedures specified **in the BDS.**

22.2 The Employer may, at its discretion, extend the deadline for the submission of Bids by amending the bidding document in accordance with ITB 8, in which case all rights and obligations of the Employer and Bidders previously subject to the deadline shall thereafter be subject to the deadline as extended.

23. Late Bids

23.1 The Employer shall not consider any Bid that arrives after the deadline for submission of Bids, in accordance with ITB 22. Any Bid received by the Employer after the deadline for submission of Bids shall be declared late, rejected, and returned unopened to the Bidder.

24. Withdrawal, Substitution, and Modification of Bids

24.1 A Bidder may withdraw, substitute, or modify its Bid after it has been submitted by sending a written notice, duly signed by an authorized representative, and shall include a copy of the authorization in accordance with ITB 20.3, (except that withdrawal notices do not require copies). The corresponding substitution or modification of the Bid must accompany the respective written notice. All notices must be:

(a) prepared and submitted in accordance with ITB 20 and ITB 21 (except that withdrawal notices do not require copies), and in addition, the respective envelopes shall be clearly marked "WITHDRAWAL," "SUBSTITUTION," "MODIFICATION"; and

(b) received by the Employer prior to the deadline prescribed for submission of Bids, in accordance with ITB 22.

24.2 Bids requested to be withdrawn in accordance with ITB 24.1 shall be returned unopened to the Bidders.

24.3 No Bid may be withdrawn, substituted, or modified in the interval between the deadline for submission of Bids and the expiration of the period of Bid validity specified by the Bidder on the Letter of Bid or any extension thereof.

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25. Bid Opening

25.1 Except in the cases specified in ITB 23 and ITB 24.2, the Employer shall publicly open and read out in accordance with this ITB, all Bids received by the deadline, at the date, time and place specified **in the BDS**, in the presence of Bidders' designated representatives and anyone who chooses to attend. All Bidders, or their representatives and any interested party may attend a public opening. Any specific electronic Bid opening procedures required if electronic bidding is permitted in accordance with ITB 22.1, shall be as specified **in the BDS**.

25.2 First, envelopes marked "WITHDRAWAL" shall be opened and read out and the envelope with the corresponding Bid shall not be opened, but returned to the Bidder. No Bid withdrawal shall be permitted unless the corresponding withdrawal notice contains a valid authorization to request the withdrawal and is read out at Bid opening.

25.3 Next, envelopes marked "SUBSTITUTION" shall be opened and read out and exchanged with the corresponding Bid being substituted, and the substituted Bid shall not be opened, but returned to the Bidder. No Bid substitution shall be permitted unless the corresponding substitution notice contains a valid authorization to request the substitution and is read out at Bid opening.

25.4 Next, envelopes marked "MODIFICATION" shall be opened and read out with the corresponding Bid. No Bid modification shall be permitted unless the corresponding modification notice contains a valid authorization to request the modification and is read out at bid opening.

25.5 Next, all remaining envelopes shall be opened one at a time, reading out: the name of the Bidder and whether there is a modification; the total Bid Price, per lot (contract) if applicable, including any discounts and alternative Bids; the presence or absence of a Bid Security, or Bid Securing Declaration, if required; and any other details as the Employer may consider appropriate.

25.6 Only Bids, alternative Bids and discounts that are opened and read out at Bid opening shall be considered further for evaluation. The Letter of Bid underpriced Schedules are to be initialed by representatives of the Employer attending Bid opening in the manner specified **in the BDS**.

25.7 The Employer shall neither discuss the merits of any Bid nor reject any Bid (except for late Bids, in accordance with ITB 23.1).

25.8 The Employer shall prepare a record of the Bid opening that shall include, as a minimum:

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(a) the name of the Bidder and whether there is a withdrawal, substitution, or modification;

(b) the Bid Price, per lot (contract) if applicable, including any discounts;

(c) the presence or absence of a Bid Security or Bid-Securing Declaration, if one was required; and

(d) any alternative Bids.

25.9 The Bidders' representatives who are present shall be requested to sign the record. The omission of a Bidder's signature on the record shall not invalidate the contents and effect of the record. A copy of the record shall be distributed to all Bidders.

E. Evaluation and Comparison of Bids

26. Confidentiality

26.1 Information relating to the evaluation of Bids and recommendation of contract award, shall not be disclosed to Bidders or any other persons not officially concerned with the Bidding process until information on Intention to Award the Contract is transmitted to all Bidders in accordance with ITB 43.

26.2 Any effort by a Bidder to influence the Employer in the evaluation of the Bids or Contract award decisions may result in the rejection of its Bid.

26.3 Notwithstanding ITB 26.2, from the time of Bid opening to the time of Contract award, if a Bidder wishes to contact the Employer on any matter related to the Bidding process, it shall do so in writing.

27. Clarification of Bids

27.1 To assist in the examination, evaluation, and comparison of the Bids, and qualification of the Bidders, the Employer may, at its discretion, ask any Bidder for a clarification of its Bid given a reasonable time for a response. Any clarification submitted by a Bidder that is not in response to a request by the Employer shall not be considered. The Employer's request for clarification and the response shall be in writing. No change, including any voluntary increase or decrease in the prices or substance of the Bid shall be sought, offered, or permitted, except to confirm the correction of arithmetic errors discovered by the Employer in the evaluation of the Bids, in accordance with ITB 31.

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27.2 If a Bidder does not provide clarifications of its Bid by the date and time set in the Employer's request for clarification, its Bid may be rejected.

28. Deviations, Reservations, and Omissions

28.1 During the evaluation of Bids, the following definitions apply:

(a) "Deviation" is a departure from the requirements specified in the bidding document;

(b) "Reservation" is the setting of limiting conditions or withholding from complete acceptance of the requirements specified in the bidding document; and

(c) "Omission" is the failure to submit part or all of the information or documentation required in the bidding document.

29. Determination of Responsiveness

29.1 The Employer's determination of a Bid's responsiveness is to be based on the contents of the Bid itself, as defined in ITB11.

29.2 A substantially responsive Bid is one that meets the requirements of the bidding document without material deviation, reservation, or omission. A material deviation, reservation, or omission is one that:

(a) if accepted, would:

(i) affect in any substantial way the scope, quality, or performance of the Works specified in the Contract; or

(ii) limit in any substantial way, inconsistent with the bidding document, the Employer's rights or the Bidder's obligations under the proposed Contract; or

(b) if rectified, would unfairly affect the competitive position of other Bidders presenting substantially responsive Bids.

29.3 The Employer shall examine the technical aspects of the Bid submitted in accordance with ITB 16, in particular, to confirm that all requirements of Section VII, Works' Requirements have been met without any material deviation, reservation or omission.

29.4 If a Bid is not substantially responsive to the requirements of the bidding document, it shall be rejected by the Employer and may not subsequently be made responsive by correction of the material deviation, reservation, or omission.

30. Nonmaterial Nonconformities

30.1 Provided that a Bid is substantially responsive, the Employer may waive any nonconformities in the Bid.

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30.2 Provided that a Bid is substantially responsive, the Employer may request that the Bidder submit the necessary information or documentation, within a reasonable period of time, to rectify nonmaterial nonconformities in the Bid related to documentation requirements. Requesting information or documentation on such nonconformities shall not be related to any aspect of the price of the Bid. Failure of the Bidder to comply with the request may result in the rejection of its Bid.

30.3 Provided that a Bid is substantially responsive, the Employer shall rectify quantifiable nonmaterial nonconformities related to the Bid Price. To this effect, the Bid Price shall be adjusted, for comparison purposes only, to reflect the price of a missing or nonconforming item or component in the manner specified **in the BDS**.

31. Correction of Arithmetical Errors

31.1 Provided that the Bid is substantially responsive, the Employer shall correct arithmetical errors on the following basis:

(a) only for admeasurement contracts, if there is a discrepancy between the unit price and the total price that is obtained by multiplying the unit price and quantity, the unit price shall prevail and the total price shall be corrected, unless in the opinion of the Employer there is an obvious misplacement of the decimal point in the unit price, in which case the total price as quoted shall govern and the unit price shall be corrected;

(b) if there is an error in a total corresponding to the addition or subtraction of subtotals, the subtotals shall prevail and the total shall be corrected; and

(c) if there is a discrepancy between words and figures, the amount in words shall prevail, unless the amount expressed in words is related to an arithmetic error, in which case the amount in figures shall prevail subject to (a) and (b) above.

31.2 Bidders shall be requested to accept correction of arithmetical errors. Failure to accept the correction in accordance with ITB 31.1, shall result in the rejection of the Bid.

32. Conversion to Single Currency

32.1 For evaluation and comparison purposes, the currency(ies) of the Bid shall be converted into a single currency as specified **in the BDS**.

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33. Margin of Preference

33.1 Unless otherwise specified **in the BDS,** a margin of preference for domestic Bidders[3] shall not apply.

34. Subcontractors

34.1 Unless otherwise stated **in the BDS**, the Employer does not intend to execute any specific elements of the Works by subcontractors selected in advance by the Employer, Financial Parts

34.2 The subcontractor's qualifications shall not be used by the Bidder to qualify for the Works unless their specialized parts of the Works were previously designated by the Employer **in the BDS** as can be met by subcontractors referred to hereafter as 'Specialized Subcontractors', in which case, the qualifications of the Specialized Subcontractors proposed by the Bidder may be added to the qualifications.

34.3 Bidders may propose subcontracting up to the percentage of total value of contracts or the volume of works as specified **in the BDS**. Subcontractors proposed by the Bidder shall be fully qualified for their parts of the Works.

35. Evaluation of Bids

35.1 The Employer shall use the criteria and methodologies listed in this ITB and Section III, Evaluation and Qualification criteria. No other evaluation criteria or methodologies shall be permitted. By applying the criteria and methodologies the Employer shall determine the Most Advantageous Bid. This is the Bid of the Bidder that meets the Qualification Criteria and whose Bid has been determined to be:

(a) substantially responsive to the bidding document; and

(b) the lowest evaluated cost.

35.2 To evaluate a Bid, the Employershall consider the following:

(a) the Bid price, excluding Provisional Sums and the provision, if any, for contingencies in the Summary Bill of Quantities[4]

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[3] An individual firm is considered a domestic Bidder for purposes of the margin of preference if it is registered in the country of the Employer, has more than 50 percent ownership by nationals of the country of the Employer, and if it does not subcontract more than 10 percent of the contract price, excluding provisional sums, to foreign contractors. JVs are considered as domestic Bidders and eligible for domestic preference only if the individual member firms are registered in the country of the Employer or have more than 50 percent ownership by nationals of the country of the Employer, and the JV shall be registered in the country of the Borrower. The JV shall not subcontract more than 10 percent of the contract price, excluding provisional sums, to foreign firms. JVs between foreign and national firms will not be eligible for domestic preference.

[4] In lump sum contracts, delete "Bill of Quantities" and replace with "Activity Schedule."

for admeasurement contracts, but including Daywork[5] items, where priced competitively;

(b) price adjustment for correction of arithmetic errors in accordance with ITB 31.1;

(c) price adjustment due to discounts offered in accordance with ITB 14.4;

(d) converting the amount resulting from applying (a) to (c) above, if relevant, to a single currency in accordance with ITB 32;

(e) price adjustment for nonconformities in accordance with ITB 30.3; and

(f) the additional evaluation factors are specified in Section III, Evaluation and Qualification Criteria.

35.3 The estimated effect of the price adjustment provisions of the Conditions of Contract, applied over the period of execution of the Contract, shall not be taken into account in Bid evaluation.

35.4 If this bidding document allows Bidders to quote separate prices for different lots (contracts), the methodology to determine the lowest evaluated cost of the contract combinations, including any discounts offered in the Letter of Bid, is specified in Section III, Evaluation and Qualification Criteria.

36. Comparison of Bids

36.1 The Employer shall compare the evaluated costs of all substantially responsive Bids established in accordance with ITB 35.2 to determine the Bid that has the lowest evaluated cost.

37. Unbalanced or Front-Loaded Bids

37.1 If the Bid for an admeasurement contract, which results in the lowest evaluated costis, in the Employer's opinion, seriously unbalanced or, front loaded, the Employer may require the Bidder to provide written clarifications. Clarifications may include detailed price analyses to demonstrate the consistency of the Bid priceas with the scope of works, proposed methodology, schedule and any other requirements of the bidding document.

[5] Daywork is work carried out following instructions of the Project Manager and paid for on the basis of time spent by workers, and the use of materials and the Contractor's equipment, at the rates quoted in the Bid. For Daywork to be priced competitively for Bid evaluation purposes, the Employer must list tentative quantities for individual items to be costed against Daywork (e.g., a specific number of tractor driver staff-days, or a specific tonnage of Portland cement), to be multiplied by the Bidders' quoted rates and included in the total Bid price.

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37.2 After the evaluation of the information and detailed price analyses presented by the Bidder, the Employer may as appropriate:

(a) accept the Bid; or

(b) require that the amount of the Performance Security be increased at the expense of the Bidder to a level not exceeding 20% of the Contract Price; or

(c) reject the Bid.

38. Qualification of the Bidder

38.1 The Employer shall determine to its satisfaction whether the eligible Bidder that is selected as having submitted the lowest evaluated cost and substantially responsive Bid meets the qualifying criteria specified in Section III, Evaluation and Qualification Criteria.

38.2 The determination shall be based upon an examination of the documentary evidence of the Bidder's qualifications submitted by the Bidder, pursuant to ITB 17. The determination shall not take into consideration the qualifications of other firms such as the Bidder's subsidiaries, parent entities, affiliates, subcontractors (other than Specialized Subcontractors if permitted in the bidding document), or any other firm(s) different from the Bidder.

38.3 An affirmative determination of qualification shall be a prerequisite for award of the Contract to the Bidder. A negative determination shall result in disqualification of the Bid, in which event the Employer shall proceed to the substantially responsive Bid which offers the next lowest evaluated cost to make a similar determination of that Bidder's qualifications to perform satisfactorily.

39. Most Advantageous Bid

39.1 Having compared the evaluated costs of Bids, the Employer shall determine the Most Advantageous Bid. The Most Advantageous Bid is the Bid of the Bidder that meets the Qualification Criteria and whose Bid has been determined to be:

(a) substantially responsive to the bidding document; and

(b) the lowest evaluated cost.

40. Employer's Right to Accept Any Bid, and to Reject Any or All Bids

40.1 The Employer reserves the right to accept or reject any Bid, and to annul the Bidding process and reject all Bids at any time prior to Contract Award, without thereby incurring any liability to Bidders. In case of annulment, all Bids submitted and specifically, Bid securities, shall be promptly returned to the Bidders.

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41. Notification of Intention to Award

41.1 The Employer shall send to each Bidder the Notification of Intention to Award the Contract to the successful Bidder. The Notification of Intention to Award shall contain, at a minimum, the following information:

(a) the name and address of the Bidder submitting the successful Bid;

(b) the Contract price of the successful Bid;

(c) the names of all Bidders who submitted Bids, and their Bid prices as readout, and as evaluated;

(d) a statement of the reason(s) the Bid (of the unsuccessful Bidder to whom the notification is addressed) was unsuccessful, unless the price information in c) above already reveals the reason;

(e) instructions on how to request a debriefing and/or submit a complaint.

F. Award of Contract

42. Award Criteria

42.1 Subject to ITB 41, the Employer shall award the Contract to the successful Bidder. This is the Bidder whose Bid has been determined to be the Most Advantageous Bid as specified in ITB 40.

43. Notification of Award

43.1 Prior to the expiration of the Bid Validity Period or any extension thereof, and, upon satisfactorily addressing any complaint that has been filed, the Employer shall notify the successful Bidder, in writing, that its Bid has been accepted. The notification of award (hereinafter and in the Conditions of Contract and Contract Forms called the "Letter of Acceptance") shall specify the sum that the Employer will pay the Contractor in consideration of the execution of the contract (hereinafter and in the Conditions of Contract and Contract Forms called "the Contract Price").

43.2 Within ten (10) Business Days after the date of transmission of the Letter of Acceptance, the Employer shall publish the Contract Award Notice which shall contain, at a minimum, the following information:

(a) name and address of the Employer;

(b) name and reference number of the contract being awarded, and the selection method used;

(c) names of all Bidders that submitted Bids, and their Bid prices as read out at Bid opening, and as evaluated;

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(d) names of all Bidders whose Bids were rejected either as nonresponsive or as not meeting qualification criteria, or were not evaluated, with the reasons therefor;

(e) the name of the successful Bidder, the final total contract price, the contract duration and a summary of its scope; and

(f) successful Bidder's Beneficial Ownership Disclosure Form, if specified in BDS ITB 47.1.

43.3 The Contract Award Notice shall be published on the Employer's website with free access if available, or in at least one newspaper of national circulation in the Employer's Country, or in the official gazette. The Employer shall also publish the contract award notice in UNDB online.

43.4 Until a formal contract is prepared and executed, the Letter of Acceptance shall constitute a binding Contract.

44. Debriefing by the Employer

44.1 On receipt of the Employer's Notification of Intention to Award referred to in ITB 43.1, an unsuccessful Bidder has three (3) Business Days to make a written request to the Employer for a debriefing. The Employer shall provide a debriefing to all unsuccessful Bidders whose request is received within this deadline.

44.2 Where a request for debriefing is received within the deadline, the Employer shall provide a debriefing within five (5) Business Days, unless the Employer decides, for justifiable reasons, to provide the debriefing outside this timeframe.

44.3 Where a request for debriefing is received by the Employer later than the three (3)-Business Day deadline, the Employer should provide the debriefing as soon as practicable, and normally no later than fifteen (15) Business Days from the date of publication of Public Notice of Award of contract.

44.4 Debriefings of unsuccessful Bidders may be done in writing or verbally. The Bidder shall bear their own costs of attending such a debriefing meeting.

45. Signing of Contract

45.1 The Employer shall send to the successful Bidder the Letter of Acceptance including the Contract Agreement, and, if specified in the BDS, a request to submit the Beneficial Ownership Disclosure Form providing additional information on its beneficial ownership. The Beneficial Ownership Disclosure Form, if so requested, shall be submitted within eight (8) Business Days of receiving this request.

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45.2 The successful Bidder shall sign, date and return to the Employer, the Contract Agreement within twenty-eight (28) days of its receipt.

46. Performance Security

46.1 Within twenty-eight (28) days of the receipt of the Letter of Acceptance from the Employer, the successful Bidder shall furnish the Performance Security and, if required in the BDS, the Environmental, Social, Health and Safety (ESHS) Performance Security in accordance with the General Conditions of Contract, subject to ITB 38.2 (b), using for that purpose the Performance Security and ESHS Performance Security Forms included in Section X, Contract Forms, or another form acceptable to the Employer. If the Performance Security furnished by the successful Bidder is in the form of a bond, it shall be issued by a bonding or insurance company that has been determined by the successful Bidder to be acceptable to the Employer. A foreign institution providing a bond shall have a correspondent financial institution located in the Employer's Country, unless the Employer has agreed in writing that a correspondent financial institution is not required.

46.2 Failure of the successful Bidder to submit the above-mentioned Performance Security and, if required in the BDS, the Environmental, Social, Health and Safety (ESHS) Performance Security, or to sign the Contract Agreement shall constitute sufficient grounds for the annulment of the award and forfeiture of the Bid Security. In that event the Employer may award the Contract to the Bidder offering the next Most Advantageous Bid.

47. Adjudicator

47.1 The Employer proposes the person named **in the BDS** to be appointed as Adjudicator under the Contract, at the hourly fee specified **in the BDS**, plus reimbursable expenses. If the Bidder disagrees with this proposal, the Bidder should so state in his Bid. If, in the Letter of Acceptance, the Employer does not agree on the appointment of the Adjudicator, the Employer will request the Appointing Authority designated in the Particular Conditions of Contract (PCC) pursuant to Clause 23.1 of the General Conditions of Contract (GCC), to appoint the Adjudicator.

48. Procurement Related Complaint

48.1 The procedures for making a Procurement-related Complaint are as specified in the BDS.

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Section II - Bid Data Sheet (BDS)

The following specific data for the Works to be procured shall complement, supplement, or amend the provisions in the Instructions to Bidders (ITB). Whenever there is a conflict, the provisions herein shall prevail over those in ITB.

ITB Reference	A. General
ITB 1.1	The Employer is: **Punjab Rural Municipal Services Company (PRMSC)** The reference number of the Request for Bids (RFB) is: **PK-LG& CD-546505-CW-RFB** The name of the RFB is: **Procurement of Civil Works for PRSWSSP, Cluster North, Tehsil Kot Momin (Phase-I) Part-b**
ITB 1.2(a)	**Electronic –Procurement System** Not Used
ITB 2.1	The Borrower is: Government of Islamic Republic of Pakistan (who has extended the financing to Punjab Rural Municipal Services Company) Loan Agreement amount: US$ 442.40Million The name of the Project is: **Punjab Rural Sustainable Water Supply and Sanitation Project**
ITB 4.1	Maximum number of members in the Joint Venture (JV) shall be: Three (03)
ITB 4.5	A list of debarred firms and individuals is available on the Bank's external website: http://www.worldbank.org/debarr.
	The following new Sub-Clauses are added at the end of ITB 4: "The Bidder shall also meet the following eligibility requirements: ITB 4.11 If Bidder is not registered at the time of submission of its Bid, s/he shall be required to register its firm with the respective Tax Entity(s) and Pakistan Engineering Council in the appropriate category and specialization code CE-09, CE-10 prior to the signing of Contract.
B. Contents of Bidding Document	

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<table>
<tr><td>ITB 7.1</td><td>For <u>Clarification of Bid purposes</u> only, the Employer's address is:
Attention: Chief Executive Officer, PRMSC
Address: Punjab Rural Municipal Services Company (PRMSC)
5th Floor, KD Plaza, MM Alam Road, Gulberg-III, Lahore, Pakistan
Telephone: +92-42-99333613
Electronic mail address: <u>proc.prmsc@punjab.gov.pk</u></td></tr>
<tr><td>ITB 7.1</td><td>Requests for clarification should be received by the Employer no later than: 07 days</td></tr>
<tr><td>ITB 7.1</td><td>Web page: <u>https://prmsc.punjab.gov.pk</u></td></tr>
<tr><td>ITB 7.4</td><td>A Pre-Bid meeting shall take place, if so required, at the following date, time and place:

Conference Room: Punjab Rural Municipal Services Company (PRMSC)
5th Floor, KD Plaza, MM Alam Road, Gulberg-III, Lahore, Pakistan
Telephone: +92-42-99333613
Electronic mail address: Proc.prmsc@punjab.gov.pk

Maximum two (02) representatives of a bidder, will be allowed. Further, for ease of bidder, the bidder can attend the pre-bid meeting online at the following zoom link;
<table>
<tr><td>Topic:</td><td>Pre-Bid Civil Works Meeting</td></tr>
<tr><td>Date:</td><td>19.10.2026</td></tr>
<tr><td>Time:</td><td>15:00</td></tr>
<tr><td>Zoom Link:</td><td>https://us06web.zoom.us/j/86881358982?pwd=iHthTO7fub8amlc9BAA9E1MQu4dFJg.1</td></tr>
<tr><td>Meeting ID:</td><td>868 8135 8982</td></tr>
<tr><td>Passcode:</td><td>465696</td></tr>
</table>
A site visit conducted by the Employer shall not be organized.</td></tr>
<tr><td colspan="2">C. Preparation of Bids</td></tr>
<tr><td>ITB 10.1</td><td>Language of the Bid: English
All correspondence exchange shall be in English language.
Language for translation of supporting documents and printed literature is English.</td></tr>
<tr><td>ITB 11.1 (b)</td><td>The following schedules shall be submitted with the Bid:</td></tr>
</table>

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	Bill of Quantities as required in accordance with the Bidding Document
ITB 11.1 (i)	The Bidder shall submit the following additional documents in its Bid: • Registration of the firm with concerned authority for doing business • **Code of Conduct (ESHS)** The Bidder shall submit its Code of Conduct that will apply to its employees and subcontractors, to ensure compliance with its Environmental, Social, Health and Safety (ESHS) obligations under the contract that will include the following requirements, e.g. risks associated with: labor influx, spread of communicable diseases, sexual harassment, gender based violence, sexual exploitation and abuse, illicit behavior and crime, and maintaining a safe environment etc. In addition, the Bidder shall detail how this Code of Conduct will be implemented. This will include: how it will be introduced into conditions of employment/engagement, what training will be provided, how it will be monitored and how the Contractor proposes to deal with any breaches. The Contractor shall be required to implement the agreed Code of Conduct. • **Management Strategies and Implementation Plans (MSIP) to Manage the (ESHS) Risks** The Bidder shall submit Management Strategies and Implementation Plans (MSIP) to manage the following key Environmental, Social, Health and Safety (ESHS) risks. ▪ Traffic Management Plan to ensure safety of local communities from construction traffic; ▪ Water Resource Protection Plan to prevent contamination of drinking water; ▪ Boundary Marking and Protection Strategy for mobilization and construction to prevent offsite adverse impacts; ▪ Strategy for obtaining Consents/Permits prior to the start of relevant works such as opening a quarry or borrow pit, if so required; ▪ Gender based violence and sexual exploitation and abuse (GBV/SEA) prevention and response action plan. The Contractor shall be required to submit for approval, and subsequently implement, the Contractor's Environment and Social Management Plans (C-ESMP), in accordance with the Particular Conditions of Contract Sub-Clause 16.2, that includes the agreed Management Strategies and Implementation Plans described here. The Bidder shall also submit the additional documents as per specified requirements of the Bidding Document.
ITB 13.1	Alternative Bids shall not be considered.
ITB 13.2	Alternative times for completion shall not be permitted.

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ITB 13.4	Alternative technical solutions shall not be permitted for the Works.
ITB 14.5	The prices quoted by the Bidder shall be subject to adjustment during the performance of the Contract.
ITB 15.1	The price shall be quoted by the Bidder in: Pak Rupees only. All payments under the Contract shall be made in Pak Rupees only. A Bidder expecting to incur expenditures in other currencies for inputs to the Works supplied from outside the Employer's Country shall bear all costs and risks for arranging such currencies including currency exchange rate parity.
ITB 15.2	Not Applicable
ITB 15.3	Not Applicable
ITB 18.1	The Bid validity period shall be 120 days.
ITB 18.3 (a)	The Bid price shall be adjusted by the following factor(s): Not Applicable
ITB 19.1	A Bid Security shall be required, in the shape of unconditional Bank Guarantee or Call Deposit Receipt (CDR) duly supported by undertaking provided in the Bidding Document. A Bid-Securing Declaration shall not be required. The amount and currency of the Bid Security shall be **PKR 11 Million/- (Pak Rupees Eleven Million Only)**
ITB 19.3	The text of ITB 19.3 is substituted with the following: "The Bid Security shall be in the form of unconditional Bank Guarantee or Call Deposit Receipt (CDR) issued by a Scheduled Bank in Pakistan using the Bid Security Form included in Section IV, Bidding Forms, in favour of the **Punjab Rural Municipal Services Company** valid for a period of 28 days beyond the original validity period of the Bid, or beyond any period of extension if requested under ITB 18.2."
ITB 19.8	In case of Joint Venture, the Bid Security shall be in the name of the Joint Venture or in the name of any JV member.
ITB 19.9	Not Applicable
ITB 20.1	In addition to the original of the Bid, the number of copies is**:** One (01) The Bidders shall also submit the PDF copy of the entire Bid and **Word/Excel** copy of the technical and financial parts of Bid on a USB device, which is mandatory. ***In case of non-compliance, the bid may be declared as non-Responsive.***
ITB 20.3	***In case the bid is not typed or written in indelible ink, the bid may be declared as non-Responsive.***

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	The written confirmation of authorization to sign on behalf of the Bidder shall consist of**:** An Authority Letter in original issued by the Bidder duly signed and stamped.
D. Submission and Opening of Bids	
ITB 22.1	For **Bid submission purposes** only, the Purchaser's address is: Attention: Chief Executive Officer Address: Punjab Rural Municipal Services Company (PRMSC) 5th Floor, KD Plaza, MM Alam Road, Gulberg-III, Lahore, Pakistan The deadline for Bid submission is: **Date: November 05, 2026 Time: 1200 hours** **Bidders shall not have the option of submitting their Bids electronically.**
ITB 25.1	The Bid opening shall take place at: Conference Room Punjab Rural Municipal Services Company (PRMSC) 5th Floor, KD Plaza, MM Alam Road, Gulberg-III, Lahore, Pakistan **Date: November 05, 2026 Time: 1230 hours**
ITB 25.1	Bidders shall not have the option of submitting their Bids electronically.
ITB 25.6	The Letter of Bid and priced Summary of Bill of Quantities shall be initialed by all representatives of the Employer conducting Bid opening.
E. Evaluation and Comparison of Bids	
ITB 30.3	The adjustment shall be based on the average price of the item or component as quoted in other substantially responsive Bids. If the price of the item or component cannot be derived from the price of other substantially responsive Bids, the Employer shall use its best estimate.
ITB 32.1	Not Applicable
ITB 33.1	A margin of domestic preference shall not apply.
ITB 34.1	At this time the Employer does not intend to execute certain specific parts of the Works by subcontractors selected in advance.
ITB 34.2	Not Applicable

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ITB 34.3	Contractor's proposed subcontracting: Maximum percentage of subcontracting permitted is 10% of the Accepted Contract Amount excluding the Provisional Sums.
F. Award of Contract	
ITB 45.1	The successful Bidder shall submit the Beneficial Ownership Disclosure Form.
ITB 46.1 and 46.2	The successful Bidder shall be required to submit the Performance Security only in accordance with the Conditions of Contract.
ITB 47.1	The Adjudicator and its hourly fee shall be mutually agreed at the time of finalization of the Adjudicator in accordance with GCC 23.1.
ITB 48.1	The procedures for making a Procurement-related Complaint are detailed in the "Procurement Regulations for IPF Borrowers (Annex III)." If a Bidder wishes to make a Procurement-related Complaint, the Bidder should submit its complaint following these procedures, in writing (by the quickest means available, that is either by email or fax), to: Attention: **PRMSC GRIEVANCES REDRESSAL MECHANISM COMMITTEE** 5th Floor, KD Plaza, MM Alam Road, Gulberg-III, Lahore, Pakistan (Off): +92(42)99333610 In summary, a Procurement-related Complaint may challenge any of the following: **1.** the terms of the Bidding Documents; and **2.** the Employer's decision to award the Contract.

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Section III - Evaluation and Qualification Criteria

This section contains all the criteria that the Employer shall use to evaluate Bids and qualify Bidders through post-qualification. No other factors, methods or criteria shall be used other than specified in this bidding document. The Bidder shall provide all the information requested in the forms included in Section IV, Bidding Forms.

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1. Margin of Preference

Not Applicable

2. Evaluation

In addition to the criteria listed in ITB 35.2 (a) – (e) the following criteria shall apply:

2.1 Adequacy of Technical Proposal

Evaluation of the Bidder's Technical Proposal will include an assessment of the Bidder's technical capacity to mobilize key equipment and personnel for the contract consistent with its proposal regarding work methods, scheduling, and material sourcing in sufficient detail and fully in accordance with the requirements stipulated in Section VII, Works'Requirements.

Assessment of adequacy of Technical Proposal shall be carried out in accordance with the Bidding Document especially the Requirements as described in Section VII, Scope of Works.

2.2 Multiple Contracts

Not Applicable

2.3 Alternative Completion Times

Not Applicable

2.4 Sustainable procurement

Not Applicable

2.5 Alternative Technical Solutions for Specified Parts of Works

Not Applicable

2.6 Specialized Subcontractors

Not Applicable

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3. Qualification

Eligibility and Qualification Criteria			Compliance Requirements				Documentation
No.	Subject	Requirement	Single Entity	Joint Venture (existing or intended)			Submission Requirements
				All members Combined	Each Member	At least one Member	
1. Eligibility							
1.1	**Nationality**	Nationality in accordance with ITB 4.4	Must meet requirement	N/A	Must meet requirement	N/A	Forms ELI – 1.1 and 1.2, with attachments
1.2	**Conflict of Interest**	No conflicts of interest in accordance with ITB 4.2	Must meet requirement	N/A	Must meet requirement	N/A	Letter of Bid
1.3	**Bank Eligibility**	Not having been declared ineligible by the Bank, as described in ITB 4.5.	Must meet requirement	N/A	Must meet requirement	N/A	Letter of Bid
1.4	**State-owned enterprise or institution of the Borrower country**	Meets conditions of ITB 4.6	Must meet requirement	N/A	Must meet requirement	N/A	Forms ELI – 1.1 and 1.2, with attachments
1.5	**United Nations resolution or Borrower's country law**	Not having been excluded as a result of prohibition in the Borrower's country laws or official regulations against commercial relations with the Bidder's country, or by an act of compliance with UN Security Council resolution, both in accordance with ITB 4.8 and Section V.	Must meet requirement	N/A	Must meet requirement	N/A	Letter of Bid

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Eligibility and Qualification Criteria			Compliance Requirements				Documentation
No.	Subject	Requirement	Single Entity	Joint Venture (existing or intended)			Submission Requirements
				All members Combined	Each Member	At least one Member	
2. Historical Contract Non-Performance							
2.1	**History of Non-Performing Contracts**	Non-performance of a contract[1] did not occur as a result of contractor default since 1st July 2016, based on all information on fully settled disputes or litigation.	Must meet requirement[1] & 2	N/A	Must meet requirement[2]	N/A	Form CON-2
2.2	**Suspension Based on Execution of Bid /Proposal Securing Declaration by the Employer or withdrawal of the Bid within Bid validity period**	Not under suspension based on execution of a Bid/Proposal Securing Declaration pursuant to ITB 4.7 or withdrawal of the Bid pursuant ITB 19.9	Must meet requirement	N/A	Must meet requirement	N/A	Letter of Bid
2.3	**Pending Litigation**	Bidder's financial position and prospective long term profitability sound according to criteria established in 3.1	Must meet requirement	N/A	Must meet requirement	N/A	Form CON – 2

[1] Nonperformance, as decided by the Employer, shall include all contracts where (a) nonperformance was not challenged by the contractor, including through referral to the dispute resolution mechanism under the respective contract, and (b) contracts that were so challenged but fully settled against the contractor. Nonperformance shall not include contracts where Employers decision was overruled by the dispute resolution mechanism. Nonperformance must be based on all information on fully settled disputes or litigation, i.e. dispute or litigation that has been resolved in accordance with the dispute resolution mechanism under the respective contract and where all appeal instances available to the Bidder have been exhausted.

[2] This requirement also applies to contracts executed by the Bidder as JV member.

Eligibility and Qualification Criteria			Compliance Requirements				Documentation
No.	Subject	Requirement	Single Entity	Joint Venture (existing or intended)			Submission Requirements
				All members Combined	Each Member	At least one Member	
		below and assuming that all pending litigation will be resolved against the Bidder					
2.4	**Litigation History**	No consistent history of court/arbitral award decisions against the Bidder[3] since 1st July 2016	Must meet requirement	N/A	Must meet requirement	N/A	Form CON – 2
2.5	**Declaration: Environmental, Social, Health, and Safety (ESHS) past performance**	Declare any civil work contracts that have been suspended or terminated and/or performance security called by an employer for reasons related to the non-compliance of any environmental, or social (including sexual exploitation and abuse (SEA) and gender-based violence (GBV)), or health or safety requirements or safeguard in the **past five years (05).**	Must make the declaration. Where there are Specialized Sub-contractor/s, the Specialized Sub-contractor/s must also make the declaration.	N/A	Each must make the declaration. Where there are Specialized Sub-contractor/s, the Specialized Sub-contractor/s must also make the declaration.	N/A	Form CON-3 ESHS Performance Declaration

[3]The Bidder shall provide accurate information on the Letter of Bid about any litigation or arbitration resulting from contracts completed or ongoing under its execution over the last five years. A consistent history of court/arbitral awards against the Bidder or any member of a joint venture may result in disqualifying the Bidder.

PBWSP

Eligibility and Qualification Criteria			Compliance Requirements				Documentation
No.	Subject	Requirement	Single Entity	Joint Venture (existing or intended)			Submission Requirements
				All members Combined	Each Member	At least one Member	
3. Financial Situation and Performance							
3.1	**Financial Capabilities**	(i) The Bidder shall demonstrate that it has access to, or has available, liquid assets, unencumbered real assets, lines of credit, and other financial means (independent of any contractual advance payment) sufficient to meet the construction cash flow requirements of Eq. **PKR 133 million** for the subject contract(s) net of the Bidder's other commitments	Must meet requirement	Must meet Requirement	N/A	N/A	Form FIN – 3.1, with attachments
		(ii) The Bidders shall also demonstrate, to the satisfaction of the Employer, that it has adequate sources of finance to meet the cash flow requirements on works currently in progress and for future contract commitments.	Must meet requirement	Must meet requirement	N/A	N/A	
		(iii) The audited balance sheets or, if not required by the laws of the Bidder's country, other	Must meet requirement	N/A	Must meet requirement	N/A	

PPWSP

Eligibility and Qualification Criteria			Compliance Requirements				Documentation
No.	Subject	Requirement	Single Entity	Joint Venture (existing or intended)			Submission Requirements
				All members Combined	Each Member	At least one Member	
		financial statements acceptable to the Employer, for the last three (03) years shall be submitted and must demonstrate the current soundness of the Bidder's financial position and indicate its prospective long-term profitability.					
3.2	**Average Annual Construction Turnover**	Minimum average annual construction turnover of Eq. **PKR 309 million**, calculated as total certified payments received for contracts in progress and/or completed within the last three (03) years, divided by three (03) years.	Must meet requirement	Must meet requirement	N/A	Must meet 50% of the requirement	Form FIN – 3.2
4. Experience							
4.1 (a)	**General Construction Experience**	Experience under construction contracts in the role of prime contractor, JV member, subcontractor, or management contractor for at least the last ten (10) years, starting 1st July 2016	Must meet requirement	N/A	Must meet requirement	N/A	Form EXP – 4.1

PSWSP

Eligibility and Qualification Criteria			Compliance Requirements				Documentation
No.	Subject	Requirement	Single Entity	Joint Venture (existing or intended)			Submission Requirements
				All members Combined	Each Member	At least one Member	
4.2	**Specific Construction & Contract Management Experience**	A minimum number of two (02) similar contracts, each with a value of at least Eq. **PKR 309 million** that have been satisfactorily and substantially[4] completed as a prime contractor, joint venture member[5], management contractor or sub-contractor between 1st July 2016 and bid submission deadline. The similarity shall be based on the physical size, complexity, methods/technology and/or other characteristics described in Section VII, Works' Requirements.	Must meet requirement	Must meet requirement[6]	N/A	N/A	Form EXP 4.2

[4] Substantial completion shall be based on **80%** or more works completed under the contract.

[5] For contracts under which the Bidder participated as a joint venture member or sub-contractor, only the Bidder's share, by value, shall be considered to meet this requirement.

[6] In the case of JV, the value of contracts completed by its members shall not be aggregated to determine whether the requirement of the minimum value of a single contract has been met. Instead, each contract performed by each member shall satisfy the minimum value of a single contract as required for single entity. In determining whether the JV meets the requirement of total number of contracts, only the number of contracts completed by all members each of value equal or more than the minimum value required shall be aggregated.

PSWSS

4. Key Personnel

The Bidder must demonstrate that it will have a suitably qualified (and in adequate numbers) minimum Key Personnel, as described in the table below, that are required to perform the Contract.

The Bidder shall provide details of the Key Personnel and such other Key Personnel that the Bidder considers appropriate, together with their academic qualifications and work experience. The Bidder shall complete the relevant Forms in Section IV, Bidding Forms. Failure to provide the required information will result in the bidder being declared non-responsive.

The Contractor shall require the Employer's consent to substitute or replace the Key Personnel (reference the Particular Conditions of Contract 9.1).

No.	PERSONNEL	Relevant Academic Qualifications	Minimum Years of Relevant Work Experience	Nos. Required
1	Project Engineer	B.Sc. Civil Engineering	8	01
2	Site Engineer	B.Sc. Civil Engineering	5	01
3	Sub Engineers	DAE in Civil	5	03
4	Sub Engineers	DAE in Electrical	5	01
5	Quantity Surveyor	DAE in Civil	5	01

PSWSD

Item No.	Position/ specialization	Relevant academic qualifications	Minimum years of relevant work experience
Suitable experts in the following specializations			
1	Health, Safety and Environment (HSE) Expert	Graduate (16 years education) in Environmental Engineer/Sciences	Five (05) years' experience in similar work related to HSE.
2	Social Safeguards Specialist	Graduate (16 years education) in Sociology	Five (05) years' experience in similar work related to social safeguards
3	Gender Specialist	Graduate (16 years education) in Sociology/Gender Sciences	Five (05) years' experience in similar work related to gender action plan implementation

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5. Equipment

The Bidder must demonstrate that it will have access to the key Contractor's equipment listed hereafter:

No.	Equipment	Minimum Number required
1	Excavator	01 No
2	Concrete mixing machine capacity one bag	06 No
3	Concrete mixing machine capacity half bag	06 No
4	Scaffoldings and shattering	20,000 Sft
5	Water Bowsers	06 No
6	Total Station Machine	02 No
7	Level Machine	02 No
8	Concrete Vibrators	04 No

The Bidder shall provide further details of proposed items of equipment using the relevant Form in Section IV. Failure to provide the required information will result in the bidder being declared non-responsive.

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Letter of Bid

INSTRUCTIONS TO BIDDERS: DELETE THIS BOX ONCE YOU HAVE COMPLETED THE DOCUMENT

The Bidder must prepare this Letter of Bid on stationery with its letterhead clearly showing the Bidder's complete name and business address.

Note: All italicized text is to help Bidders in preparing this form.

Date of this Bid submission: [*insert date (as day, month and year) of Bid submission*]
RFB No.: [*insert number of RFB process*]
Alternative No.:[*insert identification No. if this is a Bid for an alternative*]

To: **[*insert complete name of Employer*]**

(a) **No reservations:** We have examined and have no reservations to the bidding document, including Addenda issued in accordance with ITB 8;

(b) **Eligibility**: We meet the eligibility requirements and have no conflict of interest in accordance with ITB 4;

(c) **Bid-Securing Declaration:** We have not been suspended nor declared ineligible by the Employer based on execution of a Bid-Securing Declaration or Proposal-Securing Declaration in the Employer's Country in accordance with ITB 4.7;

(d) **Conformity:** We offer to execute in conformity with the bidding document the following Works: **[***insert a brief description of the Works]*_____

(e) **Bid Price**: The total price of our Bid, excluding any discounts offered in item (f) below is:

Total price is: PKR _____ [*insert the total price of the Bid in words and figures*];

(f) **Discounts:** The discounts offered and the methodology for their application are:

(i) The discounts offered are: [*Specify in detail each discount offered.*]

(ii) The exact method of calculations to determine the net price after application of discounts is shown below: [*Specify in detail the method that shall be used to apply the discounts*];

(g) **Bid Validity Period:** Our Bid shall be valid for a period specified in BDS ITB 18.1 of days from the date fixed for the Bid submission deadline in accordance with the bidding document, and it shall remain binding upon us and may be accepted at any time before the expiration of that period;

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(h) **Performance Security:** If our Bid is accepted, we commit to obtain a performance security in accordance with the Bidding Document;

(i) **One Bid Per Bidder:** We are not submitting any other Bid(s) as an individual Bidder or as a subcontractor, and we are not participating in any other Bid(s) as a Joint Venture member, and meet the requirements of ITB 4.3, other than alternative Bids submitted in accordance with ITB 13;

(j) **Suspension and Debarment**: We, along with any of our subcontractors, suppliers, consultants, manufacturers, or service providers for any part of the contract, are not subject to, and not controlled by any entity or individual that is subject to, a temporary suspension or a debarment imposed by the World Bank Group or a debarment imposed by the World Bank Group in accordance with the Agreement for Mutual Enforcement of Debarment Decisions between the World Bank and other development banks. Further, we are not ineligible under the Employer's Country laws or official regulations or pursuant to a decision of the United Nations Security Council;

(k) **State-owned enterprise or institution:** [*select the appropriate option and delete the other*] [*We are not a state-owned enterprise or institution*] / [*We are a state-owned enterprise or institution but meet the requirements of ITB 4.6*];

(l) **Commissions, gratuities and fees:** We have paid, or will pay the following commissions, gratuities, or fees with respect to the Bidding process or execution of the Contract: [*insert complete name of each Recipient, its full address, the reason for which each commission or gratuity was paid and the amount and currency of each such commission or gratuity*]

Name of Recipient	Address	Reason	Amount

(If none has been paid or is to be paid, indicate "none.")

(m) **Binding Contract**: We understand that this Bid, together with your written acceptance thereof included in your Letter of Acceptance, shall constitute a binding contract between us, until a formal contract is prepared and executed;

(n) **Not Bound to Accept:** We understand that you are not bound to accept the lowest evaluated cost Bid, the Most Advantageous Bid or any other Bid that you may receive; and

(o) **Fraud and Corruption:** We hereby certify that we have taken steps to ensure that no person acting for us or on our behalf engages in any type of Fraud and Corruption; and

(p) **Adjudicator:** We accept the appointment of *[insert name proposed in Bid Data Sheet]* as the Adjudicator.

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[or]

We do not accept the appointment of *[insert name proposed in Bid Data Sheet]* as the Adjudicator, and propose instead that *[insert name]* be appointed as Adjudicator, whose daily fees and biographical data are attached.

Name of the Bidder: *[*insert complete name of person signing the Bid*]

Name of the person duly authorized to sign the Bid on behalf of the Bidder:**[*insert complete name of person duly authorized to sign the Bid*]

Title of the person signing the Bid: [*insert complete title of the person signing the Bid*]

Signature of the person named above: [*insert signature of person whose name and capacity are shown above*]

Date signed [*insert date of signing*] **day of** [*insert month*], [*insert year*]

*: In the case of the Bid submitted by joint venture specify the name of the Joint Venture as Bidder
**: Person signing the Bid shall have the power of attorney given by the Bidder to be attached with the Bid

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Schedules

1. Bill of Quantities

[Available at Part-II]

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2. Schedule of Payment Currencies

NOT APPLICABLE

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3. Schedule of Adjustment Data

Element Number	Element Description	Bidder's Amount [PKR]	Bidder's Proposed Weighting for Coefficients*
i.	Non-adjustable		a: (0.2)
ii.	Cement (OPC)		b: ( )
iii.	Steel (M.S. bars [deformed, 40/60 grade]		c: ( )
iv.	High Speed Diesel		d: ( )
v.	Labour (Un-skilled/skilled)		e: ( )
vi.	HDPE/PVC Pipe		f: ( )
vii	RCC Pipe		g: ( )
viii	Bricks		h: ( )
ix	Crush		i: ( )
		Total	**1.00**

* The Bidder shall enter a value within the range such that the total weighting shall be equal to 1.00.

The base and current rates of each cost element shall be taken from the notification(s) by Finance Department of Government of the Punjab for Price Variation Adjustment for the district prescribed in the list, nearest to the location of the Works.

Note:

1. Cement (OPC) [Bags] shall represent all kinds of Cement.
2. Steel (M.S. bars deformed, 40/60 grade) shall represent all kinds of steel reinforcing bars and structural steel and all kind of MS angle/sheet and sections.
3. High Speed Diesel [Litre] shall represent all kinds of fuels and lubricants.
4. Labour (Un-skilled/skilled) shall represent all kinds of labour.
5. HDPE/PVC pipe shall represent all kind of pressure (PN)/class and size of pipes
6. RCC pipes shall represent all kinds/class and size of pipes
7. Bricks shall represent all kind of bricks, bricks ballast and bricks tiles
8. Crush shall represent all size and grade of crush

CWSSP

Form of Bid Security

Form of Bid Security - Bank Guarantee

[Guarantor letterhead or SWIFT identifier code]

Beneficiary:

[Insert name and address of the Employer*]*

Request for Bids No: *_[Insert reference number for the Request for Bids]*

Date: [*Insert date of issue]*

BID GUARANTEE No.:*[Insert guarantee reference number]*

Guarantor: *_[Insert name and address of place of issue, unless indicated in the letterhead]*

We have been informed that *[insert name of the Bidder, which in the case of a joint venture shall be the name of the joint venture (whether legally constituted or prospective) or the names of all members thereof]* (hereinafter called "the Applicant") has submitted or will submit to the Beneficiary its Bid (hereinafter called "the Bid") for the execution of *[insert description of contract]* under Request for Bids No. [*insert number*] ("the RFB").

Furthermore, we understand that, according to the Beneficiary's conditions, Bids must be supported by a Bid guarantee.

At the request of the Applicant, we, as Guarantor, hereby irrevocably undertake to pay the Beneficiary any sum or sums not exceeding in total an amount of *[insert amount in letters]* (*insert amount in numbers*) upon receipt by us of the Beneficiary's complying supported by the Beneficiary's statement, whether in the demand itself or a separate signed document accompanying or identifying the demand, stating either that the Applicant:

(a) has withdrawn its Bid during the period of Bid validity specified by the Applicant in the Letter of Bid ("the Bid Validity Period"), or any extension thereto provided by the Applicant; or

(b) having been notified of the acceptance of its Bid by the Beneficiary during the period of Bid validity, (i) fails to execute the contract agreement or (ii) fails to furnish the performance security and, if required, the Environmental, Social, Health and Safety (ESHS) Performance Security, in accordance with the Instructions to Bidders ("ITB") of the Beneficiary's bidding document.

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This guarantee will expire: (a) if the Applicant is the successful Bidder, upon our receipt of copies of the contract agreement signed by the Applicant and the performance security and, if required, the Environmental, Social, Health and Safety (ESHS) Performance Security, issued to the Beneficiary in relation to such contract agreement; and (b) if the Applicant is not the successful Bidder, upon the earlier of (i) our receipt of a copy of the Beneficiary's notification to the Applicant of the results of the Bidding process; or (ii) twenty-eight days after the end of the Bid Validity Period.

Consequently, any demand for payment under this guarantee must be received by us at the office indicated above on or before that date.

This guarantee is subject to the Uniform Rules for Demand Guarantees (URDG) 2010 Revision, ICC Publication No. 758.

_____

[signature(s)]

Note: All italicized text is for use in preparing this form and shall be deleted from the final product.

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Form of Call Deposit Receipt (CDR) Undertaking

[Guarantor letterhead or SWIFT identifier code]

Beneficiary:

[Insert name and address of the Employer*]*

Request for Bids No: *_[Insert reference number for the Request for Bids]*

Date: [*Insert date of issue]*

CDR No.:*[Insert guarantee reference number]*

Guarantor: *_[Insert name and address of place of issue, unless indicated in the letterhead]*

We have been informed that *[insert name of the Bidder, which in the case of a joint venture shall be the name of the joint venture (whether legally constituted or prospective) or the names of all members thereof]* (hereinafter called "the Applicant") has submitted or will submit to the Beneficiary its Bid (hereinafter called "the Bid") for the execution of *[insert description of contract]* under Request for Bids No. [*insert number*] ("the RFB").

Furthermore, we understand that, according to the Beneficiary's conditions, Bids must be supported by a CDR.

At the request of the Applicant, we, as Guarantor, hereby irrevocably undertake to pay the Beneficiary any sum or sums not exceeding in total an amount of *[insert amount in letters]* (*insert amount in numbers*) upon receipt by us of the Beneficiary's complying supported by the Beneficiary's statement, whether in the demand itself or a separate signed document accompanying or identifying the demand, stating either that the Applicant:

(a) has withdrawn its Bid during the period of Bid validity specified by the Applicant in the Letter of Bid ("the Bid Validity Period"), or any extension thereto provided by the Applicant; or

(b) having been notified of the acceptance of its Bid by the Beneficiary during the period of Bid validity, (i) fails to execute the contract agreement or (ii) fails to furnish the performance security and, if required, the Environmental, Social, Health and Safety (ESHS) Performance Security, in accordance with the Instructions to Bidders ("ITB") of the Beneficiary's bidding document.

This guarantee will expire: (a) if the Applicant is the successful Bidder, upon our receipt of copies of the contract agreement signed by the Applicant and the performance security and, if required, the Environmental, Social, Health and Safety (ESHS) Performance Security, issued

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to the Beneficiary in relation to such contract agreement; and (b) if the Applicant is not the successful Bidder, upon the earlier of (i) our receipt of a copy of the Beneficiary's notification to the Applicant of the results of the Bidding process; or (ii) twenty-eight days after the end of the Bid Validity Period.

Consequently, any demand for payment under this guarantee must be received by us at the office indicated above on or before that date.

_____

[signature(s)]

Note: All italicized text is for use in preparing this form and shall be deleted from the final product.

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Technical Proposal

Technical Proposal Forms

- **Key Personnel Schedule**
- **Equipment**
- **Site Organization**
- **Method Statement**
- **Mobilization Schedule**
- **Construction Schedule**
- **ESHS Management Strategies and Implementation Plans**
- **Code of Conduct (ESHS)**
- **Others**

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FORM PER -1

Key Personnel Schedule

Bidders should provide the names and details of the suitably qualified Key Personnel to perform the Contract. The data on their experience should be supplied using the Form PER-2 below for each candidate.

Key Personnel

1.	**Title of position:**	
	Name of candidate:	
	Duration of appointment:	[*insert the whole period (start and end dates) for which this position will be engaged*]
	Time commitment: for this position:	[*insert the number of days/week/months/ that has been scheduled for this position*]
	Expected time schedule for this position:	[*insert the expected time schedule for this position (e.g. attach high level Gantt chart*]
2.	**Title of position:** *[Environmental Specialist]*	
	Name of candidate:	
	Duration of appointment:	[*insert the whole period (start and end dates) for which this position will be engaged*]
	Time commitment: for this position:	[*insert the number of days/week/months/ that has been scheduled for this position*]
	Expected time schedule for this position:	[*insert the expected time schedule for this position (e.g. attach high level Gantt chart*]
3.	**Title of position:** *[Health and Safety Specialist]*	
	Name of candidate:	
	Duration of appointment:	[*insert the whole period (start and end dates) for which this position will be engaged*]
	Time commitment: for this position:	[*insert the number of days/week/months/ that has been scheduled for this position*]
	Expected time schedule for this position:	[*insert the expected time schedule for this position (e.g. attach high level Gantt chart*]
4.	**Title of position:** *[Social Specialist]*	
	Name of candidate:	

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	Duration of appointment:	[*insert the whole period (start and end dates) for which this position will be engaged*]
	Time commitment: for this position:	[*insert the number of days/week/months/ that has been scheduled for this position*]
	Expected time schedule for this position:	[*insert the expected time schedule for this position (e.g. attach high level Gantt chart*]
5.	**Title of position:** *[insert title]*	
	Name of candidate	
	Duration of appointment:	[*insert the whole period (start and end dates) for which this position will be engaged*]
	Time commitment: for this position:	[*insert the number of days/week/months/ that has been scheduled for this position*]
	Expected time schedule for this position:	[*insert the expected time schedule for this position (e.g. attach high level Gantt chart*]

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Form PER-2:

Resume and Declaration

Key Personnel

Name of Bidder

Position [*#1*]: [*title of position from Form PER-1*]		
Personnel information	**Name:**	**Date of birth:**
	Address:	**E-mail:**
	Professional qualifications:	
	Academic qualifications:	
	Language proficiency:*[language and levels of speaking, reading and writing skills]*	
details		
	Address of employer:	
	Telephone:	**Contact (manager / personnel officer):**
	Fax:	
	Job title:	**Years with present employer:**

Summarize professional experience in reverse chronological order. Indicate particular technical and managerial experience relevant to the project.

Project	**Role**	**Duration of involvement**	**Relevant experience**
[main project details]	*[role and responsibilities on the project]*	*[time in role]*	*[describe the experience relevant to this position]*

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Declaration

I, the undersigned Key Personnel, certify that to the best of my knowledge and belief, the information contained in this Form PER-2 correctly describes myself, my qualifications and my experience.

I confirm that I am available as certified in the following table and throughout the expected time schedule for this position as provided in the Bid:

Commitment	**Details**
Commitment to duration of contract:	*[insert period (start and end dates) for which this Key Personnel is available to work on this contract]*
Time commitment:	*[insert the number of days/week/months/ that this Key Personnel will be engaged]*

I understand that any misrepresentation or omission in this Form may:

(a) be taken into consideration during Bid evaluation;

(b) my disqualification from participating in the Bid;

(c) my dismissal from the contract.

Name of Key Personnel: [*insert name*]

Signature: _____

Date: (day month year): _____

Countersignature of authorized representative of the Bidder:

Signature: _____

Date: (day month year): _____

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Equipment

The Bidder shall provide adequate information to demonstrate clearly that it has the capability to meet the requirements for the key equipment listed in Section III (Evaluation and Qualification Criteria). A separate Form shall be prepared for each item of equipment listed, or for alternative equipment proposed by the Bidder. The Bidder shall provide all the information requested below, to the extent possible. Fields with asterisk (*) shall be used for evaluation.

Type of Equipment*		
Equipment Information	**Name of manufacturer,**	**Model and power rating**
	Capacity*	**Year of manufacture***
Current Status	**Current location**	
	Details of current commitments	
Source	**Indicate source of the equipment** **☐ Owned ☐ Rented ☐ Leased ☐ Specially manufactured**	

The following information shall be provided only for equipment not owned by the Bidder.

Owner	**Name of owner**	
	Address of owner	
	Telephone	**Contact name and title**
	Fax	**Telex**
Agreements	**Details of rental / lease / manufacture agreements specific to the project**	

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Site Organization

[insert Site Organization information]

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Method Statement

[insert Method Statement]

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Mobilization Schedule

[insert Mobilization Schedule]

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Construction Schedule

[insert Construction Schedule]

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ESHS Management Strategies and Implementation Plans

(ESHS-MSIP)

The Bidder shall submit comprehensive and concise Environmental, Social, Health and Safety Management Strategies and Implementation Plans (ESHS-MSIP) as required by ITB 11.1 (i) of the Bid Data Sheet. These strategies and plans shall describe in detail the actions, materials, equipment, management processes etc. that will be implemented by the Contractor, and its subcontractors.

In developing these strategies and plans, the Bidder shall have regard to the ESHS provisions of the contract including those as may be more fully described in the Works Requirements in Section VII.

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Code of Conduct: Environmental, Social, Health and Safety (ESHS)

The Bidder shall submit the Code of Conduct that will apply to the Contractor's employees and subcontractors as required by ITB 11.1 (i) of the Bid Data Sheet. The Code of Conduct shall ensure compliance with the ESHS provisions of the contract, including those as may be more fully described in the Works Requirements in Section VII.

In addition, the Bidder shall submit an outline of how this Code of Conduct will be implemented. This will include: how it will be introduced into conditions of employment/engagement, what training will be provided, how it will be monitored and how the Contractor proposes to deal with any breaches.

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Others

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Bidder's Qualification

To establish its qualifications to perform the contract in accordance with Section III (Evaluation and Qualification Criteria) the Bidder shall provide the information requested in the corresponding Information Sheets/Forms included hereunder

The information provided in the Forms shall be substantiated with valid documentary evidences otherwise the requirement will not be considered as complied.

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Form ELI -1.1: Bidder Information Form

Date: _____
RFB No. and title: _____
Page_____of _____pages

Bidder's name
In case of Joint Venture (JV), name of each member:
Bidder's actual or intended country of registration: *[indicate country of Constitution]*
Bidder's actual or intended year of incorporation:
Bidder's legal address [in country of registration]:
Bidder's authorized representative information Name: _____ Address: _____ Telephone/Fax numbers: _____ E-mail address: _____
1. Attached are copies of original documents of ☐ Articles of Incorporation (or equivalent documents of constitution or association), and/or documents of registration of the legal entity named above, in accordance with ITB 4.4. ☐ In case of JV, letter of intent to form JV or JV agreement, in accordance with ITB 4.1. ☐ In case of state-owned enterprise or institution, in accordance with ITB 4.6 documents establishing: • Legal and financial autonomy • Operation under commercial law • Establishing that the Bidder is not under the supervision of the Employer 2. Included are the organizational chart, a list of Board of Directors, and the beneficial ownership.*[If required under BDS ITB 45.1, the successful Bidder shall provide additional information on beneficial ownership, using the Beneficial Ownership Disclosure Form.]*

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Form ELI -1.2: Information Form for JV Bidders

(tobe completed for each member of Joint Venture)

Date: _____
RFB No. and title: _____
Page _____ of _____ pages

Bidder's Joint Venture name:
JV member's name:
JV member's country of registration:
JV member's year of constitution:
JV member's legal address in country of constitution:
JV member's authorized representative information Name: _____ Address: _____ Telephone/Fax numbers: _____ E-mail address: _____
1. Attached are copies of original documents of ☐ Articles of Incorporation (or equivalent documents of constitution or association), and/or registration documents of the legal entity named above, in accordance with ITB 4.4. ☐ In case of a state-owned enterprise or institution, documents establishing legal and financial autonomy, operation in accordance with commercial law, and is not under the supervision of the Employer, in accordance with ITB 4.6. 2. Included are the organizational chart, a list of Board of Directors, and the beneficial ownership. *[If required under BDS ITB 45.1, the successful Bidder shall provide additional information on beneficial ownership for each JV member using the Beneficial Ownership Disclosure Form.]*

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Form CON – 2: Historical Contract Non-Performance, Pending Litigation and Litigation History

Bidder's Name: _____
Date: _____
Joint Venture Member's Name_____
RFB No. and title: _____
Page _____of _____pages

Non-Performed Contracts in accordance with Section III, Evaluation and Qualification Criteria			
☐ Contract non-performance did not occur since 1st January *[insert year]*specified in Section III, Evaluation and Qualification Criteria, Sub-Factor 2.1. ☐ Contract(s) not performed since 1st January *[insert year]* specified in Section III, Evaluation and Qualification Criteria, requirement 2.1			
Year	**Non-performed portion of contract**	**Contract Identification**	**Total Contract Amount (Equivalent PKR)**
[insert year]	*[insert amount and percentage]*	Contract Identification: *[indicate complete contract name/ number, and any other identification]* Name of Employer: *[insert full name]* Address of Employer: *[insert street/city/country]* Reason(s) for nonperformance: *[indicate main reason(s)]*	*[insert amount]*
Pending Litigation, in accordance with Section III, Evaluation and Qualification Criteria			
☐ No pending litigation in accordance with Section III, Evaluation and Qualification Criteria, Sub-Factor 2.3. ☐ Pending litigation in accordance with Section III, Evaluation and Qualification Criteria, Sub-Factor 2.3 as indicated below.			

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Year of dispute	Amount in dispute (currency)	Contract Identification	Total Contract Amount (Equivalent PKR)
		Contract Identification: _____ Name of Employer: _____ Address of Employer: _____ Matter in dispute: _____ Party who initiated the dispute: ____ Status of dispute: _____	
		Contract Identification: Name of Employer: Address of Employer: Matter in dispute: Party who initiated the dispute: Status of dispute:	

Litigation History in accordance with Section III, Evaluation and Qualification Criteria

☐ No Litigation History in accordance with Section III, Evaluation and Qualification Criteria, Sub-Factor 2.4.

☐ Litigation Historyin accordance with Section III, Evaluation and Qualification Criteria, Sub-Factor 2.4 as indicated below.

Year of award	Outcome as percentage of Net Worth	Contract Identification	Total Contract Amount (Equivalent PKR)
[insert year]	*[insert percentage]*	Contract Identification: [indicate complete contract name, number, and any other identification] Name of Employer: *[insert full name]* Address of Employer: *[insert street/city/country]* Matter in dispute: *[indicate main issues in dispute]* Party who initiated the dispute: *[indicate "Employer" or "Contractor"]* Reason(s) for Litigation and award decision *[indicate main reason(s)]*	*[insert amount]*

PROVISIONAL

Form CON – 3: Environmental, Social, Health, and Safety Performance Declaration

[The following table shall be filled in for the Bidder/ each member of a Joint Venture]

Bidder's Name: *[insert full name]*
Date: *[insert day, month, year]*
Joint Venture Member's Name: *[insert full name]*
RFB No. and title: *[insert RFB number and title]*
Page *[insert page number]* of *[insert total number]* pages

Environmental, Social, Health, and Safety Performance Declaration in accordance with Section III, Qualification Criteria, and Requirements			
☐ **No suspension or termination of contract**: An employer has not suspended or terminated a contract and/or called the performance security for a contract for reasons related to Environmental, Social, Health, or Safety (ESHS) performance since the date specified in Section III, Qualification Criteria, and Requirements, Sub-Factor 2.5. ☐ **Declaration of suspension or termination of contract**: The following contract(s) has/have been suspended or terminated and/or Performance Security called by an employer(s) for reasons related to Environmental, Social, Health, or Safety (ESHS) performance since the date specified in Section III, Qualification Criteria, and Requirements, Sub-Factor 2.5. Details are described below:			
Year	**Suspended or terminated portion of contract**	**Contract Identification**	**Total Contract Amount (Equivalent PKR)**
[insert year]	*[insert amount and percentage]*	Contract Identification: *[indicate complete contract name/ number, and any other identification]* Name of Employer: *[insert full name]* Address of Employer: *[insert street/city/country]* Reason(s) for suspension or termination: *[indicate main reason(s) e.g. for GBV/ SEA breaches]*	*[insert amount]*
[insert year]	*[insert amount and percentage]*	Contract Identification: *[indicate complete contract name/ number, and any other identification]* Name of Employer: *[insert full name]* Address of Employer: *[insert street/city/country]* Reason(s) for suspension or termination: *[indicate main reason(s)]*	*[insert amount]*

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…	…	*[list all applicable contracts]*	…
Performance Security called by an employer(s) for reasons related to ESHS performance			
Year	**Contract Identification**		**Total Contract Amount (Equivalent PKR)**
[insert year]	Contract Identification: *[indicate complete contract name/ number, and any other identification]* Name of Employer: *[insert full name]* Address of Employer: *[insert street/city/country]* Reason(s) for calling of performance security: *[indicate main reason(s) e.g. for GBV/ SEA breaches]*		*[insert amount]*

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Form FIN – 3.1: Financial Situation and Performance

Bidder's Name: _____
Date: _____
Joint Venture Member's Name_____
RFB No. and title: _____
Page _____of _____pages

1. Financial Data

Type of Financial Information in (PKR)	**Historic information for previous three (03) *years*, (Equivalent PKR, exchange rate)**		
	Year 1	**Year 2**	**Year 3**
Statement of Financial Position (Information from Balance Sheet)			
Total Assets (TA)			
Total Liabilities (TL)			
Total Equity/Net Worth (NW)			
Current Assets (CA)			
Current Liabilities (CL)			
Working Capital (WC)			
Information from Income Statement			
Total Revenue (TR)			
Profits Before Taxes (PBT)			
Cash Flow Information			
Cash Flow from Operating Activities			

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2. Sources of Finance

Specify sources of finance to meet the cash flow requirements on works currently in progress and for future contract commitments.

No.	Source of finance	Amount (Equivalent PKR)
1		
2		
3		

3. Financial documents

The Bidder and its parties shall provide copies of financial statements for three (03) years pursuant Section III, Evaluation and Qualifications Criteria, Sub-factor 3.2. The financial statements shall:

(a) reflect the financial situation of the Bidder or in case of JV member, and not an affiliated entity (such as parent company or group member).

(b) be independently audited or certified in accordance with local legislation.

(c) be complete, including all notes to the financial statements.

(d) correspond to accounting periods already completed and audited.

☐ Attached are copies of financial statements[12] for the three (03) years required above; and complying with the requirements

[12] If the most recent set of financial statements is for a period earlier than 12 months from the date of bid, the reason for this should be justified.

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Current Contract Commitments / Works in Progress

Bidders and each member to a JV should provide information on their current commitments on all contracts that have been awarded, or for which a letter of intent or acceptance has been received, or for contracts approaching completion, but for which an unqualified, full completion certificate has yet to be issued.

Current Contract Commitments					
No.	**Name of Contract**	**Employer's Contact Address, Tel, Fax**	**Value of Outstanding Work [Current PKR Equivalent]**	**Estimated Completion Date**	**Average Monthly Invoicing Over Last Six Months [Eq. PKR/month)]**
1					
2					
3					
4					
5					

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Form FIN - 3.2: Average Annual Construction Turnover

Bidder's Name: _____
Date: _____
Joint Venture Member's Name_____
RFB No. and title: _____
Page _____of _____pages

	Annual turnover data (construction only)		
Year	**Amount** **Currency**	**Exchange rate**	**PKR equivalent**
[indicate year]	*[insert amount and indicate currency]*		
Average Annual Construction Turnover *			

* See Section III, Evaluation and Qualification Criteria, Sub-Factor 3.2.

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Form EXP - 4.1: General Construction Experience

Bidder's Name: _____
Date: _____
Joint Venture Member's Name_____
RFB No. and title: _____
Page _____of _____pages

Starting Year	Ending Year	Contract Identification	Role of Bidder
		Contract name: _____ Brief Description of the Works performed by the Bidder: _____ Amount of contract: _____ Name of Employer: _____ Address: _____	
		Contract name: _____ Brief Description of the Works performed by the Bidder: _____ Amount of contract: _____ Name of Employer: _____ Address: _____	
		Contract name: _____ Brief Description of the Works performed by the Bidder: _____ Amount of contract: _____ Name of Employer: _____ Address: _____	

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Form EXP - 4.2: Specific Construction and Contract Management Experience

Bidder's Name: _____
Date: _____
Joint Venture Member's Name_____
RFB No. and title: _____
Page _____of _____pages

Similar Contract No.	**Information**			
Contract Identification				
Award date				
Completion date				
Role in Contract	Prime Contractor ☐	Member in JV ☐	Management Contractor ☐	Sub-contractor ☐
Total Contract Amount			Eq. PKR*	
If member in a JV or subcontractor, specify participation in total Contract amount			*	
Employer's Name:				
Address: Telephone/fax number E-mail:				

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Form EXP - 4.2 (cont.)
Specific Construction and Contract Management Experience (cont.)

Similar Contract No.	Information
Description of the similarity in accordance with Sub-Factor 4.2of Section III:	
1. Amount	
2. Physical size of required works items	
3. Complexity	
4. Methods/Technology	
5. Construction rate for key activities	
6. Other Characteristics	

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Section V - Eligible Countries

Eligibility for the Provision of Goods, Works and Services in Bank-Financed Procurement

In reference to ITB 4.8, and 5.1, for the information of the Bidders, at the present time firms, goods and services from the following countries are excluded from this Bidding process:

Under ITB 4.8(a) and 5.1: Israel

Under ITB 4.8(b) and 5.1: Israel

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Section VI - Fraud and Corruption

(Section VI shall not be modified)

1. Purpose

1.1 The Bank's Anti-Corruption Guidelines and this annex apply with respect to procurement under Bank Investment Project Financing operations.

2. Requirements

2.1 The Bank requires that Borrowers (including beneficiaries of Bank financing); bidders (applicants/proposers), consultants, contractors and suppliers; any sub-contractors, sub-consultants, service providers or suppliers; any agents (whether declared or not); and any of their personnel, observe the highest standard of ethics during the procurement process, selection and contract execution of Bank-financed contracts, and refrain from Fraud and Corruption.

2.2 To this end, the Bank:

a. Defines, for the purposes of this provision, the terms set forth below as follows:

i. "corrupt practice" is the offering, giving, receiving, or soliciting, directly or indirectly, of anything of value to influence improperly the actions of another party;

ii. "fraudulent practice" is any act or omission, including misrepresentation, that knowingly or recklessly misleads, or attempts to mislead, a party to obtain financial or other benefit or to avoid an obligation;

iii. "collusive practice" is an arrangement between two or more parties designed to achieve an improper purpose, including to influence improperly the actions of another party;

iv. "coercive practice" is impairing or harming, or threatening to impair or harm, directly or indirectly, any party or the property of the party to influence improperly the actions of a party;

v. "obstructive practice" is:

(a) deliberately destroying, falsifying, altering, or concealing of evidence material to the investigation or making false statements to investigators in order to materially impede a Bank investigation into allegations of a corrupt, fraudulent, coercive, or collusive practice; and/or threatening, harassing, or intimidating any party to prevent it from disclosing its knowledge of matters relevant to the investigation or from pursuing the investigation; or

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(b) acts intended to materially impede the exercise of the Bank's inspection and audit rights provided for under paragraph 2.2 e. below.

b. Rejects a proposal for award if the Bank determines that the firm or individual recommended for award, any of its personnel, or its agents, or its sub-consultants, sub-contractors, service providers, suppliers and/ or their employees, has, directly or indirectly, engaged in corrupt, fraudulent, collusive, coercive, or obstructive practices in competing for the contract in question;

c. In addition to the legal remedies set out in the relevant Legal Agreement, may take other appropriate actions, including declaring mis-procurement, if the Bank determines at any time that representatives of the Borrower or of a recipient of any part of the proceeds of the loan engaged in corrupt, fraudulent, collusive, coercive, or obstructive practices during the procurement process, selection and/or execution of the contract in question, without the Borrower having taken timely and appropriate action satisfactory to the Bank to address such practices when they occur, including by failing to inform the Bank in a timely manner at the time they knew of the practices;

d. Pursuant to the Bank's Anti- Corruption Guidelines and in accordance with the Bank's prevailing sanctions policies and procedures, may sanction a firm or individual, either indefinitely or for a stated period of time, including by publicly declaring such firm or individual ineligible (i) to be awarded or otherwise benefit from a Bank-financed contract, financially or in any other manner;[1] (ii) to be a nominated[2] sub-contractor, consultant, manufacturer or supplier, or service provider of an otherwise eligible firm being awarded a Bank-financed contract; and (iii) to receive the proceeds of any loan made by the Bank or otherwise to participate further in the preparation or implementation of any Bank-financed project;

e. Requires that a clause be included in bidding/request for proposals documents and in contracts financed by a Bank loan, requiring (i) bidders (applicants/proposers), consultants, contractors, and suppliers, and their sub-contractors, sub-consultants, service providers, suppliers, agents personnel, permit the Bank to inspect[3] all accounts, records and other documents relating to the procurement process, selection

[1] For the avoidance of doubt, a sanctioned party's ineligibility to be awarded a contract shall include, without limitation, (i) applying for pre-qualification, expressing interest in a consultancy, and bidding, either directly or as a nominated sub-contractor, nominated consultant, nominated manufacturer or supplier, or nominated service provider, in respect of such contract, and (ii) entering into an addendum or amendment introducing a material modification to any existing contract.

[2] A nominated sub-contractor, nominated consultant, nominated manufacturer or supplier, or nominated service provider (different names are used depending on the particular bidding document) is one which has been: (i) included by the bidder in its pre-qualification application or bid because it brings specific and critical experience and know-how that allow the bidder to meet the qualification requirements for the particular bid; or (ii) appointed by the Borrower.

[3] Inspections in this context usually are investigative (i.e., forensic) in nature. They involve fact-finding activities undertaken by the Bank or persons appointed by the Bank to address specific matters related to investigations/audits, such as evaluating the veracity of an allegation of possible Fraud and Corruption, through the appropriate mechanisms. Such activity includes but is not limited to: accessing and examining a firm's or individual's financial records and information, and making copies thereof as relevant; accessing and examining any other documents, data and information (whether in hard copy or electronic format) deemed relevant for the investigation/audit, and making copies thereof as relevant; interviewing staff and other relevant individuals; performing physical inspections and site visits; and obtaining third party verification of information.

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and/or contract execution, and to have them audited by auditors appointed by the Bank.

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PART 2 – Works' Requirements

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Section VII-Works' Requirements

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PREAMBLES

1. The Bill of Quantities shall be read in conjunction with the Conditions of Contract, Technical Provisions and Drawings.
2. In case of any variation or item not available in the priced bill of quantities, the same will be analyzed as per prevalent market rate adopting standard procedure for the purpose.
3. The rates entered against the various Items in the following Bill of Quantities are those referred to in the Contract as the Contract Rates and shall cover the execution, completion and maintenance in every respect as shown on and described in the Contract, with or without such modifications, either by way of additions or deductions or such alterations as may be ordered in writing during the progress of the works and include but not by way of limitation all matters and things particularly referred to in the Contract.
4. The quantities in the Bill of Quantities are estimated amounts and the Employer does not expressly nor by implication agree that the actual amount of work to be performed will correspond therewith. No payments will be made on account of anticipated profits for work covered by the Contract which is not performed.
5. The rates shall be quoted in figures as well as in words and shall cover all costs of every kind whatsoever, including but not limited to all office charges, supervision, transport, materials, and labour, the provision, maintenance, use and efficient repair of all plant equipment, and appliances of every kind the construction and maintenance of all Temporary Works of every description and the performance of all services that may be required for the proper execution completion and maintenance of the Works in full and complete accordance with the provisions of the Contract and the undertaking and discharge of all obligations and responsibilities therein defined.
6. The Contractor shall be deemed to have fully considered all the conditions obligations and requirements of Contract before entering the respective rates against the various Items in the following Bill of Quantities.
7. Where a discrepancy exists between the unit rate and extended total amount the unit rate shall be taken as correct and the total amount adjusted accordingly. Similarly, where a discrepancy exists between the rates quoted in the figures and the words the rates quoted in words shall be taken as correct and the total amount adjusted accordingly.
8. A rate or price shall be entered against each item in the priced Bill of Quantities, whether quantities are stated or not. The cost of items against which the Contractor will have failed to enter a rate or price shall be deemed to be covered by other rates and prices entered in the Bill of Quantities.
9. The whole cost of complying with the provisions of the Contract shall be included in the items provided in the priced Bill of Quantities, and where no items are provided, the cost shall be deemed to be distributed among the rates and prices entered for the related items of the Works.
10. All measurements shall be taken net except when otherwise specified and shall be applicable to finished work only as completed notwithstanding any trade custom to the contrary.

11. Except as may otherwise be provided under the terms of the Contract of the unit rates, prices, and lump sum amount entered in the Bill of Quantities, will be the rates at which the Contractor with be paid and shall be deemed to have included all costs of whatsoever nature for performing the works including but not limited to income tax, super tax, profits, rentals of equipment, etc. and the costs of accepting the general risks, liabilities and obligations set forth or implied in the Contract.
12. The unit rate in the bill of quantities for any item of work shall apply to completed work in all respects conforming to the Contract covering the total cost of material, labour, plant, shuttering and equipment required for the execution of that item of work, as well as covering the share of any from the other general expenses to be incurred by the Contractor during the execution of the Works. These general expenses shall include, but are not restricted to, the following, unless otherwise stated in the Contract.

    i. Preparation and submission of bids including the Site inspection;
    ii. Employment, mobilization and accommodation of the Contractor's staff including official holidays, annual leaves, sick leaves, compensation, bonuses insurance etc.;
    iii. Mobilization and demobilization of construction plant and equipment, transportation within the Site, operation, maintenance, repair, depreciation and all related costs;
    iv. Costs related to the Contractor's Site Camps, office for the Engineer including the provisions of all utility facilities;
    v. Costs shall also include providing, testing and commissioning of the complete installation;
    vi. Costs of laboratory testing, survey work and all assistance to the Engineer as required by the Contract;
    vii. Cost of bank / insurance guarantees / bonds;
    viii. Costs of all temporary works;
    ix. Costs of all work items for which there is no direct payment, and which are considered in the Contract as subsidiary to other items in the bill of quantities; Overheads and profit;
    x. All other expenses the Contractor may encounter in the proper execution of the Contract.

ENGINEERING DESIGN AND CONSTRUCTION SUPERVISION
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TEHSIL KOT MOMIN, DISTRICT SARGODHA VILLAGES (WAN MIANA, WAN MIANA COLONY & RAHIMPUR) PHASE-1
ENGINEER'S ESTIMATE
ABSTRACT OF COST

Sr. No	Description	Cost
1	WATER SUPPLY SYSTEM	
2	SEWERAGE SYSTEM	
3	ROAD RESTORATION	
4	EMP COST (PS)	3,041,150
5	EMPLOYER/ENGINEER'S FACILITIES	
TOTAL		
ADD 5% (PRA charges)		
GRAND TOTAL		
Rs. in Million		

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WATER SUPPLY
SUMMARY OF COST

Bill No.	Description	Cost
1.1)	INSTALLATION OF EJECTOR PUMP	
1.2)	PUBLIC STAND POST INCLUDING FILTRATION	
1.3)	ELECTRIFICATION	
1.4)	INSTALLATION OF TUBEWELL	
1.5)	TUBEWELL PUMP ROOM	
1.6)	OVERHEAD WATER TANK	
1.7)	DISTRIBUTION SYSTEM	
1.8)	ELECTRIFICATION	
1.9)	BOUNDARY WALL	
2.0)	LOWERING OF SUB SOIL WATER TABLE	
2.1)	GEOTECHNICAL INVESTIGATION	
	TOTAL (WATER SUPPLY)	

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BILL OF QUANTITY

Bill No. 1: INSTALLATION OF EJECTOR PUMP

Sr. No.	Ref	Description	Unit	Quantity	Unit Rate (Rs)	Amount (Rs)
1	23/1	Boring for tubewell in all types of soil except shingle and rock, from ground level to specific depth, including sinking and withdrawing of casing pipe, complete:-				
		1) Upto 0 to 100' depth d) 6" (150 mm) i/d	Per R.Ft of Bore	100		
		2) Upto 101' to 200' depth b) 6" (150 mm) i/d	Per R.Ft of Bore	100		
		3) Upto 201' to 300' b) 6" (150 mm) i/d	Per R.Ft of Bore	100		
		4) Upto 301' to 400' b) 6" (150 mm) i/d	Per R.Ft of Bore	100		
		5) Upto 401' to 500' b) 6" (150 mm) i/d	Per R.Ft of Bore	100		
2	23/13	Providing and installing P.V.C. blind pipe, B.S.S. in tubewell bore hole, including sockets and solvents and jointing with strainer, (PS-3051=BS-3505), etc. complete. **b) Class-D (12 bar)** v) 4" i/d (100 mm)	Per R.Ft	440		
3	23/8	Providing and installing, P.V.C. strainer B.S.S. in tubewell bore hole, including sockets and solvents, etc. complete:- **b) Class-D** v) 4" i/d (100 mm)	Per R.Ft	50		
4	23/11	Providing and installing P.V.C. Bail/End plug, in tubewell bore hole:- **b) B.S.S. Class 'D'** v) 4" i/d (100mm)	Per R.Ft	10		
5	23/17	Shrouding with graded pea gravel 3/8" to 1/8" (10 to 3 mm), around tubewell in bore hole.	cft	43.09		
6	23/31	Providing & mixing Bentonite clay / powder have swelling factor of 1200% for lining / seal and plug earthen boreholes / ponds in the specified ratio conforming to IS:6186 for stabilization of soil as specified by the designer etc complete in all respect.	Per Pounds	51.59		
7	23/32	P/F Ejector Pump of specified Suction and Delivery heads, coupled with Single Phase Seimen Electric Motor of required rating for water supply i/c the cost of connection charges, necessary wire, PVC pipes etc complete in all respect as approved and directed by the Engineer Incharge. ii) G-IV (2-1/2" x 2") with 2.5 HP Electric Motor, 38-Mtr Suction and 38 M delivery head	Job	1		

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TEHSIL KOT MOMIN, DISTRICT SARGODHA VILLAGES (WAN MIANA, WAN MIANA COLONY & RAHIMPUR)

BILL OF QUANTITY

Bill No. 1: INSTALLATION OF EJECTOR PUMP

Sr. No.	Ref	Description	Unit	Quantity	Unit Rate (Rs)	Amount (Rs)
8	6/6	Providing and laying reinforced cement concrete (including prestressed concrete), using Ordinary Portland Cement / Sulphate resisting cement / Slag cement as may be required; coarse sand and screened graded and washed aggregate, in required shape and design, including forms, moulds, shuttering, lifting, compacting, curing, rendering and finishing exposed surface, complete (but excluding the cost of steel reinforcement, its fabrication and placing in				
		(c) Reinforced cement concrete in Pile cap, slab of rafts / strip foundation, base slab of column and retaining walls; etc and footing beams, other structural members other than those mentioned in 6(a-d) above not requiring form work (i.e. horizontal shuttering) complete in all respects:-				
		(2) Type B (nominal mix 1: 1½: 3)	Per Cft	32.00		
9	6/12	Fabrication of mild steel reinforcement for cement concrete including cutting, bending, laying in position, making joints and fastenings, including cost of binding wire and labour charges for binding of steel reinforcement (also includes removal of rust)				
		(b) Deformed bars (ii)(Grade-60)	100 kg	1.02		
10	N/S	Taking samples at every 5 ft. or from each stratum as per direction of the Engineer including submission construction charts etc. and results of analysis.	Each	80		
11	N/S	Geophysical logging of bore (self potential resistivity Both short normal and Gama) complete in all respect.	Job	1		
12	N/S	Physical & Chemical and Bacteriological Testing of Water	Per Sample	1		
13	L/S	Electricity Connection including all appurtenances.	Job	1		
TOTAL						

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TEHSIL KOT MOMIN, DISTRICT SARGODHA VILLAGES (WAN MIANA, WAN MIANA COLONY & RAHIMPUR)

BILL OF QUANTITY

Bill No. 2: PUBLIC STAND POST INCLUDING FILTRATION

Sr. No.	Ref	Description	Unit	Quantity	Unit Rate (Rs)	Amount (Rs)
1	3/21	Excavation in foundation of building, bridges and other structures, including dagbelling, dressing, refilling in layers around structure with excavated earth, watering and ramming lead 'upto one chain (30 m) and lift upto 5 ft. (1.5 m). **1) Depth upto 5ft (1.5m)** 1) By Manual ii) Ordinary soil	1000 Cft	0.50		
2	26/43	Spraying termite proofing by using liquid FMC/ Biflex/ Terminex Exin/ Ms Hextar or equivalent @ specified suspension concenterate (SC), Mixing Ability- HEXTAR with Ratio (1:250) =540 Sft or equivalent approved liquid applying with shower and certificate will be provided by the contractor for 10- years complete in all respect. as approved by the Engineer Incharge	Per Sft	621.60		
3	6/5	Cement concrete plain including placing, compacting, finishing and curing complete (including screening and washing of stone aggregate). (h) Nominal mix Ratio 1: 3: 6	100 Cft	1.10		
4	7/4	Pacca brick work in foundation and plinth i) Cement, sand mortar Ratio 1 : 4	100 Cft	6.30		
5	6/37	Providing and laying damp proof course of cement concrete 1:2:4 (cement, sand, shingle), including bitumen coating. (b) with 2 coats of bitumen: i) 1½" thick (40 mm)	100 Sft	0.85		
6	6/39	Providing and laying vertical damp proof course with cement sand plaster and bitumen coating:- (b) with 2 coats of bitumen:- ii) Ratio 1:3 b) ¾" thick (20 mm)	100 Sft	0.85		
7	7/5	Pacca brick work in ground floor:- i) cement, sand mortar Ratio 1:4	100 Cft	5.95		

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TEHSIL KOT MOMIN, DISTRICT SARGODHA VILLAGES (WAN MIANA, WAN MIANA COLONY & RAHIMPUR)

BILL OF QUANTITY

Bill No. 2: PUBLIC STAND POST INCLUDING FILTRATION

Sr. No.	Ref	Description	Unit	Quantity	Unit Rate (Rs)	Amount (Rs)
8	6/6	Providing and laying reinforced cement concrete (including prestressed concrete), using Ordinary Portland Cement / Sulphate resisting cement / Slag cement as may be required; coarse sand and screened graded and washed aggregate, in required shape and design, including forms, moulds, shuttering, lifting, compacting, curing, rendering and finishing exposed surface, complete (but excluding the cost of steel reinforcement, its fabrication and placing in position, etc.):-				
		(a) Reinforced cement concrete in roof slab, beams, columns lintels, girders and other structural members laid in situ or precast laid in position, or prestressed members cast in situ, complete in all respects:-				
		(2) Type B (nominal mix 1: 1½: 3)	Cft	271.00		
		(c) Reinforced cement concrete in Pile cap, slab of rafts / strip foundation, base slab of column and retaining walls; etc and footing beams, other structural members other than those mentioned in 6(a-d) above not requiring form work (i.e. horizontal shuttering) complete in all respects:-				
		(2) Type B (nominal mix 1: 1½: 3)	Cft	78.90		
9	6/12	Fabrication of mild steel reinforcement for cement concrete, including cutting, bending, laying in position, making joints and fastenings, including cost of binding wire and labour charges for binding of steel reinforcement (also includes removal of rust from bars):-				
		(b) Deformed bars (ii)(Grade-60)	100 kg	10.45		
10	1/1	Carriage of 100 Cft. (2.83 cu.m) of all materials like stone aggregate, spawl , kankar lime (unslaked), surkhi , etc. or 150 Cft. (4.25 cu.m) of timber, by truck or by any other means owned by the contractor (crushed stone aggregate and bajri used in concrete items)				
		Lead From Sargodah quarry	100 Cft	4.40		
11	11/9	Cement plaster 1:4 upto 20' (6.00 m) height:-				
		b) ½" (13 mm) thick	100 Sft	18.40		

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TEHSIL KOT MOMIN, DISTRICT SARGODHA VILLAGES (WAN MIANA, WAN MIANA COLONY & RAHIMPUR)

BILL OF QUANTITY

Bill No. 2: PUBLIC STAND POST INCLUDING FILTRATION

Sr. No.	Ref	Description	Unit	Quantity	Unit Rate (Rs)	Amount (Rs)
12	11/10	Cement plaster 3/8" (10 mm) thick under soffit of R.C.C. roof slabs only, upto 20' height.				
		c) 1:4	100 Sft	4.35		
13	11/18	Cement pointing struck joints, on walls, upto 20' (6.00 m) hiehgt:-				
		b) ratio 1:3	100 Sft	18.40		
14	3/15	Filling, watering and ramming earth under floors:-				
		(i) with surplus earth from foundation, etc.	1000 Cft	0.35		
		(ii) with new earth excavated from out side, lead upto one chain (30m)	1000 Cft	0.25		
15	3/16	Extra for every 50 ft. (15 m) additional lead or part thereo				
		i) for earth work soft, ordinary, hard and very hard (up to 1000 ft)	1000 Cft	5.00		
16	10/4	Dry rammed brick or stone ballast, 1½" to 2"(40 mm to 50 mm) gauge.	100 Cft	1.05		
17	10/22	Providing & Laying mosaic flooring consisiting of one part of cement and marble powder in the ratio of 3:1 and two parts of marble chips,laid over 1"(25 mm) thick flooring of 1:2:4 cement concrete including rubbing and polishing complete with finishing :- 1½"(40 mm) thick mosaic flooring, consisting of ½ "(13mm) mosaic topping				
		(b) using white cement	100 Sft	1.60		
18	10/37	Mosaic dado or skirting with one part of cement and marble powder in the ratio of 3:1 and two parts of marble chips, laid over ½"(13 mm) thick cement plaster 1:3, including rubbing and polishing, complete with finishing:				
		(b) using white cement :				
		ii) ½"(13 mm) thick	100 Sft	0.30		
19	10/42	Providing and fixing marble strip of any shade for dividing the mosaic flooring into panels				
		a) Size 1½" x3/8" (40 x 10 mm)	Rft	15.00		
20	9/5	Single layer of tiles 9"x4½"x1½" (225x113x40 mm) laid over 4"(100 mm) earth and 1" (25 mm) mud plaster without Bhoosa, grouted with cement sand 1:3 on top of RCC roof slab, provided with 34 lbs.per %Sft. or 1.72 Kg/Sq.m bitumen coating sand blinded.	100 Sft	3.00		

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BILL OF QUANTITY
Bill No. 2: PUBLIC STAND POST INCLUDING FILTRATION

Sr. No.	Ref	Description	Unit	Quantity	Unit Rate (Rs)	Amount (Rs)
21	26/38	Supplying and laying polythene sheet over D.P.C under floors and on roofs, etc. (i) 300 gauge (0.003" thick)	Sft	300.00		
22	9/15	Khuras on roof 2'x2'x6" (600 x 600 x 150 mm)	Each	1.00		
23	9/16	Bottom Khuras of brick masonry in cement mortar 1:6, 4'x2'x4½" (1200x600x113 mm) over 3" (75 mm) cement concrete 1:4:8.	Each	1.00		
24	10/10	Brick on edge flooring, laid in 1:6 cement mortar, over a bed of ¾" (20 mm) thick cement mortar 1:6.	100 Sft	2.20		
25	12/60 (b)	P/F 3/4" dia heavy duty sliding bolt of specified material i/c the cost of hardware omplete in all respect as approved and directed by the Engineer Incharge. b) brass sliding bolt, 10" (250 mm) long	Each	1.00		
26	11/23	Priming coat of chalk under distemper.	100 Sft	8.25		
27	11/24	Distempering (a) new surface ii) two coats	100 Sft	8.25		
28	10/45	Providing and laying superb quality Porcelain glazed tiles flooring of Master /Stile brand or approved equivalent manufacturer of specified size in approved design, Color and Shade with adhesive/ bond over 3/4" thick (1:3) cement plaster i/c the cost of sealer for finishing the joints i/c cutting grinding complete in all respect as approved and directed by the Engineer Incharge. a) Full body Glazed Tile (i) 400 mmX400 mm	Per Sft	89.10		
29	25/62	P/F Iron door comprising of specified leaves made of 1-1/4" x1-1/4" x3/16" MS angle iron for leaf frame, diagonal and horizontal braces duly welded with MS. sheet 18-SWG i/c the cost of sliding bolt, tower bolt and painting 3-coats but excluding the cost of Chowkat complete in all respect as approved and directed by the Engineer incharge. (ii) Double Leaf	Per Sft	24.50		

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BILL OF QUANTITY

Bill No. 2: PUBLIC STAND POST INCLUDING FILTRATION

Sr. No.	Ref	Description	Unit	Quantity	Unit Rate (Rs)	Amount (Rs)
30	12/17	Providing and fixing 2" wide MS/ GI Chowkat singel/double rebate made of 16 SWG MS sheet pressed/ welded/ supported with M.S. flat 1- 1/4"x1/8" i/c 6"long M.S. Flat 1"x1/8"hold fasts (6-Nos) welded/ screwed, punching of lock hole covered with MS Box,coating with antirust paint including filling with cement sand mortar (1:8) and embedding hold fast in cement concrete (1:2:4) ,complete in all respect as approved and directed by Engineer Incharge. (ii) 10.50 " wide	Per Sft	24.50		
31	25/42	Providing and fixing steel windows using M.S. sheet (16 SWG) moulded tubular pipe 1½"x1½" (40x40mm) for frame and 1¼"x1¼" (30x30mm) for leaves including M.S. square bars ¼"x¼" (6x6 mm) welded around each panel of frame, 5 mm thick glass panes fixed with double M.S. square tubular pipe 3/8"x3/8" (10x10mm) (22 SWG) beading with U' shaped rubber lining, brass fitting, holdfast, including painting three coats complete in all respects. a) For openable panels fixed with wire gauze 24 SWG, 12x12 mesh and glass panes ¼" (6 mm) thick.	Per Sft	36.00		
32	19/47 (v)	Providing and fixing uPVC rain water down pipe 110mm dia with shoe, bend, clamp etc.	Rft	13		
33	N/S	Design, Supply, Install, Testing and Commissioning of water filtration plant, capable of removing Turbidity and Bacteria & Viruses, having capacity of 2000 litres/ hour, and fully automated (Auto filtration, flush and backwash process) complete in all respects as per drawings, specifications and directions of the Engineer. The major components include; Feed/ Backwash Pump (Stainless Steel, NEMA Insulation Class F and Pump Efficiency ≥ 50%) Silica Sand Media (Suspended Solids Removal upto 100 micron) Activated Carbon Media (Coconut shells, NSF Certified Manufacturer) FRP Vessels (OP 150 psi, NSF Certified) Screen Filter (Washable, 70-100 Micron, Stainless Steel)	No.	1		

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BILL OF QUANTITY

Bill No. 2: PUBLIC STAND POST INCLUDING FILTRATION

Sr. No.	Ref	Description	Unit	Quantity	Unit Rate (Rs)	Amount (Rs)
		UV Sterilizeer of well-reputed brand in SS Vessel Raw and Product Water Tanks (500 Gallons, Food Garde Material) Pressure Gauges, Rotameters, Flow Meters, Level Switches/ Sensors, Multiport valves Stainless Steel 304 Frame Skid Panel Control panel skid for complete automation and manual operation Pipe work including feed water pipe line connection and delivery pipeline and necessary gate and flow regulating valves. Providing and fixing steel water taps including header. uPVC pipe and all necassary arrangements to drain off the spent/ waste water as per direction of Engineer.				
	B	**SOAKAGE PIT**				
34	3/21	Excavation in foundation of building, bridges and other structures, including dagbelling, dressing, refilling in layers around structure with excavated earth, watering and ramming lead 'upto one chain (30 m) and lift upto 5 ft. (1.5 m). **1) By Manual** ii) Ordinary soil	0.36	1000 Cft.		
35	10/30	Supplying and filling sand under floor; or plugging in wells.	0.10	100Cft		
36	6/5	Cement concrete plain including placing, compacting, finishing and curing complete (including screening and washing of stone aggregate): **(h) Ratio 1: 3: 6**	0.16	100 Cft.		
37	7/7	Pacca brick work other than building upto 10ft. (3 m) height. 1:3	0.81	100Cft		

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BILL OF QUANTITY

Bill No. 2: PUBLIC STAND POST INCLUDING FILTRATION

Sr. No.	Ref	Description	Unit	Quantity	Unit Rate (Rs)	Amount (Rs)
38	6/6	Providing and laying reinforced cement concrete (including prestressed concrete), using Ordinary Portland Cement / Sulphate resisting cement / Slag cement as may be required; coarse sand and screened graded and washed aggregate, in required shape and design, including forms, moulds, shuttering, lifting, compacting, curing, rendering and finishing exposed surface, complete (but excluding the cost of steel reinforcement, its fabrication and placing in position, etc.):- (a) Reinforced cement concrete in roof slab, beams, columns lintels, girders and other structural members laid in situ or precast laid in position, or prestressed members cast in situ, complete in all respects:- (1) Type A (nominal mix 1:1:2)	14.67	Cft.		
39	6/12	Fabrication of mild steel reinforcement for cement concrete, including cutting, bending, laying in position, making joints and steel chairs, etc. complete in all respect. and fastenings, including cost of binding wire and labour charges for binding of steel reinforcement (also Includes removal of rust from bars):- ('c) Deformed bars (Grade-60)	0.47	100 Kg		
40	1/1	Carriage of 100 Cft. (2.83 cu.m) of all materials like stone aggregate, spawl , kankar lime (unslaked), surkhi , etc. or 150 Cft. (4.25 cu.m) of timber, by truck or by any other means owned by the contractor. Lead from approved nearby quarry	0.25	1000Cft		
41	23/17	Shrouding with graded pea gravel 3/8" to 1/8" (10 to 3 mm), around tubewell in bore hole.	40.00	Per Cft		
42	3/5	Earthowrk in ordinary soil for embankments lead upto 100 ft. (30 m), including ploughing, mixing and compaction by mechanical means at optimum moisture content and dressing to designed section, complete in all respects:- i) 95% to 100% maximum modified AASHTO dry density.	1.30	1000 Cft.		
Total Amount						

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TEHSIL KOT MOMIN, DISTRICT SARGODHA VILLAGES (WAN MIANA, WAN MIANA COLONY & RAHIMPUR)

BILL OF QUANTITY

Bill No. 3: ELECTRIFICATION

Sr. No.	Description	M.R.S (Item/Chap)	Qty.	Unit	Rate (Rs.) In Figure	Amount (Rs.)
1.0	**WIRING AND ACCESSORIES**					
1.1	Wiring of light or fan point from switch board/dimmer to the point with 3x1.5 mm^2 (P+N+E) PVC insulated single core stranded cables in 25 mm PVC conduit/pipe concealed in walls, columns and slabs including accessories, PVC box, 10 Amp. gang switch 1 or 2 way as required, one for each light or fan and installed as in specifications complete in all respects.	8(c-ii)/24, 3(iii)/24, 16(i)/24, 34(ii)/24	12	Each		
1.2	Circuit wiring from DB/ MCBs to gang switches board and from switch board to another switch board with 3x2.5 mm^2 (P+N+E) PVC insulated single core stranded cables in 25mm PVC pipe/conduit concealed in walls, columns and slabs as required complete in all respects.	8(c-iii)/24, 3(iii)/24	4	Each		
1.3	The same as item No. 1.1 but from one light point to another light point.	8(c-ii)/24, 3(iii)/24	20	Each		
1.4	10/13 Amp 3 pin universal flush mounting switch socket outlet wired from DB/MCBs to first outlet with 3x4 mm^2 (P+N+E) single core cable stranded (away from switch board) in 25mm PVC pipe/conduit concealed in walls, columns and slabs as required complete in all respects.	8(c-iv)/24, 17(ii)/24, 39(i)/24, 3(iii)/24	3	Each		
1.5	The same as item No.1.4 but wiring from one socket outlet to another socket outlet with 3x2.5 mm^2 (P+N+E) single core stranded cable in 25mm PVC pipe/conduit concealed in walls, columns and slabs as required complete in all respects.	8(c-iii)/24, 3(iii)/24, 16(ii), 38(i)	3	Each		
1.6	15/20 Amp 3 pin mounting switch socket outlet wired from DB MCBs to independent socket outlet with 3x6 mm^2 (P+N+E) single core stranded cable (away from switchboard) in 25mm PVC pipe/conduit concealed in walls, columns and slabs as required complete in all respects.	8(c-v)/24, 3(iii)/24, 38(ii)/24, 16(ii)/24	3	Each		
2.0	**DISTRIBUTION BOARDS**					
	D.Bs with TP incoming adjustable moulded case circuit breaker and SP miniature outgoing circuit breakers, Panel box SWG 16 powder coated RAL colour 7032, IP class 44 and with all accessories. alongwith all installation and operational accessories as per specification or as shown on the drawings.					

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BILL OF QUANTITY

Bill No. 3: ELECTRIFICATION

Sr. No.	Description	M.R.S (Item/Chap)	Qty.	Unit	Rate (Rs.) In Figure	Amount (Rs.)
2.1	**DB- Room**					
	01 No. Incoming 25 Amps (Adj.) MCCB TP 25kA Icu=100%Ics 05 Nos. outgoing 10A, MCB, SP, RC=10 kA, Icu=100%Ics 04 Nos. outgoing 20A, MCB, SP, RC=10 kA, Icu=100%Ics 03 Nos. outgoing 10A, MCB, SP, RC=10 kA, Icu=100%Ics (Spare) P/F wall mounted DB (Distribution Board) 6" deep, 20~60A, made with 16SWG Sheet (Recessded/Surf ace mounted Type), Powder coated Paint, i/c the cost of Lock, Indication lights,Thimble, Copper Comb, Wiring, Netural & Earth Bar, Door Earthing, Digital Voltmeter,Digital Ammeter,Volt Selector Swi tch, Ammeter selector switch, Current Transformers and Controles Complete in all respect as approved and directed by the Engineer Incharge (Breakers will be Paid Separately).	85(b-iii)/24, 85(a-iii)/24, 94(i)/24, 94(ii)/24, 94(iv)/24, 94(iii)/24, 94(v)/24, 94(vi)/24, 94(xv)/24	1	Each		
3.0	**Conduits / Pipes**					
3.2	PVC pipe/conduit Class-D 100 mm dia with accessories suitable for laying multi-core cables in trenches/directly burried on road crossings including excavation.	27(e)/23, 6/3	100	Rft.		
4.0	**FANS & ACCESSORIES**					
4.1	Providing and fixing Copper Winded Exhaust Fan with louver and shutter made of Pak/Younas/G.F.C. i/c the cost of necessary cable and hardware for connection from ceiling rose complete as approved and directed by Engineer Incharge.					
	b) Steel body					
i)	18" dia	102(b-ii)/24	3	Each		
4.2	Providing and fixing Copper winded wall bracket fan made of Pak/Younas/G.F.C or NEECA approved equivalent i/c the cost of necessary cable and hardware for connection as approved and directed by Engineer					
i)	18" Sweep dia	103(i)/24	4	Each		
5.0	**Power Cables**					
5.1	Supply and erection of copper conductor cables for service connection, in prelaid pipe/G.I. wire/trenches, etc. (rate for cable only)					
	PVC insulated, PVC sheathed 2 core, 600/1000 volt non armoured cable					
(a)	10 mm (7/0.052") For 10HP Motor	11(c-vi)/24	200	Rft.		

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BILL OF QUANTITY

Bill No. 3: ELECTRIFICATION

Sr. No.	Description	M.R.S (Item/Chap)	Qty.	Unit	Rate (Rs.) In Figure	Amount (Rs.)
5.2	Supply and erection of single core PVC insulated copper conductor cables, in prelaid PVC pipe/M.S. conduit/G.I pipe/wooden strip batten/wooden casing an capping/G.I. wire/trenches (rate for cables only)					
	450/750 volts, PVC insulated:					
(a)	10 mm sq (7/0.052")	8(c-vi)/24	300	Rft.		
6.0	**EARTHING**					
6.1	Providing,making & testing/commissionin of Rod type Earth point comprising of 5/8"dia.(16mmdia)10ft long copper coated M.S.rod driven in ground duly fixed with clamp with Tinned earth test link copper plate (300x50x10mm),i/c the cost of brass nuts,spacers,bolts washers lugs etc but excluding the cost of copper strand & manhole. as approved and directed by Engineer Incharge **(Rod Type Earthing)**.	111 /24	2	Each		
	TOTAL					

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BILL OF QUANTITY

Bill No. 3: ELECTRIFICATION

Item No.	Description	Qty.	Unit	Unit Rate (Rs.)	Total Amount (Rs.)
	Design, Supply, transportation at site, storage, installation, testing and commissioning of the following items of work (unless specifically stated otherwise) including all material, labour, tools and accessories etc. required for proper completion of each item as per specification and drawings and/or as directed by the Engineer.				
1.0	**LIGHT FITTINGS AND FANS**				
	Following LED Luminaries of suitable wattage make suitable for the project requirements. Contractor to submit lighting design calculation to determine the adequacy of the wattage and should adjust the number of LEDs/wattage as per project lighting requirements. The fitting shall be approved by the Engineer.				
1.1	Light Fixture Type LED Batten Ceiling/surface mounted, 18W complete in all respect with allied accessories make Philips, GE,Pierlite or approved equivalent. The fitting shall be approved by the Engineer.	8	Each		
1.2	Wall bracket Light Fixture Type LED 12 Watt energy saving lamp with holder and complete in all respect with allied accessories. The fitting shall be approved by the Engineer.	2	Each		
1.3	20W LED Water tight light fixture IP 65 complete in all respect with all allied accessories. The fitting shall be approved by the Engineer.	6	Each		
	TOTAL NON MRS				
	TOTAL MRS + NON MRS				

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BILL OF QUANTITY

Bill No. 4: TUBEWELL INSTALLATION

Sr. No.	Ref	Description	Unit	Quantity	Unit Rate (Rs)	Amount (Rs)
1	3/2	Earthwork excavation in ashes, sand and soft soil or silt clearance, undressed lead upto 50 ft (15 metre). (water storage pit 40'x30'x5')	1000 Cft	12.00		
2	23/2	Direct Rotary/Reverse Rotary drilling of bore for tubewell in all types of soil except single, gravel and rock. a) from ground level to 250 ft. below ground level i) 15" to 18" (375 to 450 mm) i/d	P/Rft	500		
		b) exceeding 250 ft. (75 m) depth below ground level:- i) 15" to 18" (375 to 450 mm) i/d	Rft	500		
3	23/10	Providing and installing Fiberglass Reinforced Polypropelene (FRP) Blank pipe of specified wall thickness in Tubewell bore hole including the cost of male / female coupling with Nylone strip, studs complete in all respect as approved and directed by the Engineer Incharge. v) 8"dia (5mm thickness)	P/Rft	840		
4	23/9	Providing and installing Fiberglass Reinforced Polypropelene (FRP) strainer of specifid wall thickness having slot size of 0.9mm to1.10mm in Tubewell borehole i/c the cost of male/female coupling with Nylone Strip,studs complete in all respect as approved and directed by the Engineer Incharge. v) 8" inch dia (5 mm thickness)	P/Rft	140		
5	23/10	Providing and installing Fiberglass Reinforced Polypropelene (FRP) bail plug of specified wall thickness in Tubewell bore hole including the cost of male / female coupling with Nylone strip, studs complete in all respect as approved and directed by the Engineer Incharge. v) 8"dia (5mm thickness)	P/Rft	20		
6	23/17	Shrouding with graded pea gravel 3/8" to 1/8" (10 to 3 mm), around tubewell in bore hole.	Cft	1403.9		
7	23/31	Providing & mixing Bentonite clay/powder have swelling factor of 1200% for lining/seal and plug earthen boreholes/ponds in the specified ratio conforming to IS:6186 for stabilization of soil as specified by the designer etc complete in all respect.	Per Pounds	1341.22		

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BILL OF QUANTITY

Bill No. 4: TUBEWELL INSTALLATION

Sr. No.	Ref	Description	Unit	Quantity	Unit Rate (Rs)	Amount (Rs)
8	23/13	Providing and installing P.V.C blind pipe B.S.S. Class 'B' 3" i/d in tubewell borehole for gravel feeding including sockets, solvents and jointing etc.				
		a) 3" i/d (75mm)	Per Rft	60		
9	23/37	Providing and fixing, air valve 2½ (65mm) dia of B.S.S. quality and weight (complete with jointing material).				
		b) double	Each	2		
10	N/S	Development of tube well and Perfoermance long pumping testas per specifications.	Per Hour	40		
11	N/S	Taking samples at every 5 ft , or from each stratum as per direction of the Engineer including submission construction charts etc. and results of analysis.	Each	200		
12	N/S	Geophysical logging of bore (self potential resistivity Both short normal and Gama) complete in all respect.	Job	2		
13	N/S	Providing & fixing M.S Centralizers.	Each	25		
14	N/S	Chemical and physical analysis of water sample from approved laboratory.	Job	2		
15	N/S	Providing and fixing of MS cap 8" dia 1/4	Job	2		
16	N/S	Supply, Installation, testing and commissioning of submersible borehole pump set flow: **0.25 cusec** Pump Set: Flow: 0.25 Cusec Head: 200 ft Setting Depth: 100 ft Minimum Pump Efficiency: 76.25% Minimum Motor Effieciency: 75% Material: Complete Pump Set in SS304 (EN 1.4301) Maximum Operating Temperature: 40C or higher Maximum Liquid Temperature: 40C or higher Minimum Efficiency Index: 0.70 or more CE approved. Approved for drinking water ACS,DM174 or equivalent 3×400V, 50 Hz, 2 Pole, Submersible IP68 motor, Insulation class F/H				

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Bill No. 4: TUBEWELL INSTALLATION

Sr. No.	Ref	Description	Unit	Quantity	Unit Rate (Rs)	Amount (Rs)
		Motor Control Unit (MCU): MCU (Motor Control Unit) with VFD consisting of MCCB, Over/Under voltage relay, Phase reversal relay,volt meter, ampere meter, indicating lights for all above relays, on/off push buttons. DOL Motor Control Unit with Dry running relay, Magnetic Contactor, Circuit Breaker, EOCR, EVR, Volt Selector Switch, Ampere Selector Switch, Current Transformer etc. All contained in lockable cabinet complete in all respect. Accessories: Cable Termination Kit, MS Flanged Riser Pipes 100 ft 3'' Schedule 40, Sluice Valve, Non-return Valve, MS Nipple, MS Bend, Bore cover plate, Installation clamp, Gaskets, Nut Bolts, Drop Cable 3×10 mm2120 ft length with cable connector & clamps, Electrode and Electrode wire 90 ft and other necessary fittings. NOTE: Pumps origin Europe/USA Pumps will be tested at the premises of the manufacturers. Manufacturer should be ISO 9001 Certified.	Each P/Set	2		
17	N/S	Providing, fixing, commissioning & testing of Hypo Chlorinator (make Europe/USA or equivalent) consisting of multifunction dosing pump with a microcontroller (RX controller) make Europe/USA or equivalent complying to EU directives 2006/95/EC and 2004/108/EC, having capacity of 8-10 Liter/hour and maximum pressure of 10 bar, having standard power supply of 230V A.C ± 10%, 50 Hz single phase, Insulation protection rating of IP65, complete with all accessories like injection valve, suction hose, discharge hose, valves, RX probe, level switch, dosing tank to be installed, complete in all respect.	Job	2		
Total Amount						

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BILL OF QUANTITY

Bill No. 5: TUBEWELL PUMP ROOM

Sr. No.	Ref	Description	Unit	Quantity	Unit Rate (Rs)	Amount (Rs)
		2nd BI-ANNUAL-2025 (01.07.2025 to 31.12.2025)				
1	3/21	Excavation in foundation of building, bridges and other structures, including dagbelling, dressing, refilling in layers around structure with excavated earth, watering and ramming lead 'upto one chain (30 m) and lift upto 5 ft. (1.5 m).				
		1) By Manual				
		ii) in ordinary soil.	1000 Cft.	2.78		
2	6/3	Cement concrete brick or stone ballast 1½ " to 2" (40 mm to 50 mm) gauge, in foundation and plinth:-				
		b) (Ratio 1:4:8)	100 cft	1.78		
3	7/4	Pacca brick work in foundation and plinth in:				
		i) Cement, sand mortar Ratio 1:3	100 cft	6.00		
4	6/39	Providing and laying vertical damp proof course with cement sand plaster and bitumen coating:-				
		(b) with 2 coats of bitumen:-				
		ii) Ratio 1:3				
		b) ¾ " thick (20mm)	100 Sft	1.50		
5	7/5	Pacca brick work in ground floor (super structure)				
		i). Cement, sand mortar Ratio 1:4	100 Cft	6.22		
6	7/6	Add extra labour on item No. 5 for brickwork in:-				
		i) first floor	100Cft.	1.16		
7	3/15	Filling, watering and ramming earth under floors:-				
		i) with surplus earth from foundation, etc.	1000 Cft.	1.68		
		ii) with new earth excavated from outside, lead upto one chain (30 m).	1000 Cft.	0.62		
8	3/16	Extra for every 50 ft. (15 m) additional lead or part thereof :-				
		i) for earhtwork soft, ordinary, hard and verv hard.	1000 Cft.	11.16		
9	6/2	Dry rammed brick or stone ballast, 1½" to 2"(40 mm to 50 mm) gauge.	100 Cft	0.92		
10	6/5	Cement concrete plain including placing, compacting, finishing and curing complete (including screening and washing of stone aggregate):				
		(i) Nominal Ratio 1: 4: 8	100 Cft	0.46		

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BILL OF QUANTITY

Bill No. 5: TUBEWELL PUMP ROOM

Sr. No.	Ref	Description	Unit	Quantity	Unit Rate (Rs)	Amount (Rs)
11	10/16	Providing and laying topping of cement concrete 1:2:4, including surface finishing and dividing in panels for floor:- (c) 1½"(40 mm) thick	100 Sft	1.84		
12	6/6	Providing and laying reinforced cement concrete (including prestressed concrete), using Ordinary Portland Cement / Sulphate resisting cement / Slag cement as may be required; coarse sand and screened graded and washed aggregate, in required shape and design, including forms, moulds, shuttering, lifting, compacting, curing, rendering and finishing exposed surface, complete (but excluding the cost of steel reinforcement, its fabrication and placing in position, etc.):- (a) Reinforced cement concrete in roof slab, beams, columns lintels, girders and other structural members laid in situ or precast laid in position, or prestressed members cast in situ, complete in all respects:- (2) Type B (nominal mix 1: 1½: 3)	Per Cft	272.96		
		(c) Reinforced cement concrete in Pile cap, slab of rafts / strip foundation, base slab of column and retaining walls; etc and footing beams, other structural members other than those mentioned in 6(a-d) above not requiring form work (i.e. horizontal shuttering) complete in all respects:- (2) Type B (nominal mix 1: 1½: 3)	Per Cft	395.82		
13	6/12	Fabrication of mild steel reinforcement for cement concrete, including cutting, bending, laying in position, making oints and fastenings, including cost of binding wire and labour charges for binding of steel reinforcement (also includes removal of rust from bars):- (b) Deformed bars (ii)(Grade-60)	100 Kg	21.24		
14	11/9.	Cement plaster 1:4 upto 20' (6.00 m) height:- c) ¾" (20 mm) thick	100 Sft	8.98		

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BILL OF QUANTITY

Bill No. 5: TUBEWELL PUMP ROOM

Sr. No.	Ref	Description	Unit	Quantity	Unit Rate (Rs)	Amount (Rs)
15	11/18.	Cement pointing struck joint, on walls upto 20' height. a) ratio 1:2	100 Sft	9.86		
16	11/10.	Cement plaster 3/8" (10 mm) thick under soffit of R.C.C. roof slabs only, upto 20' height. c) 1:4	100 Sft	1.80		
17	9/5.	Single layer of tiles 9"x4½"x1½" (225x113x40 mm) laid over 4"(100 mm) earth and 1" (25 mm) mud plaster without Bhoosa, grouted with cement sand 1:3 on top of RCC roof slab, provided with 34 lbs.per %Sft. or 1.72 Kg/Sq.m bitumen coating sand blinded.	100 Sft	4.00		
18	9/14	Khassi parnalas in cement, sand mortar 1:2, 12" (300 mm) outside width finished smooth with a floating coat of neat cement.	Rft	25.00		
19	9/15	Khuras on roof 2'x2'x6" (600 x 600 x 150 mm)	Each	2.00		
20	9/16	Bottom Khuras of brick masonry in cement mortar 1:6, 4' x 2' x 4.5" over 3" cement concrete 1:4:8	Each	2.00		
21	11/23	Distempering:- a) new surface:- ii) two coats	100 Sft	8.60		
22	25/62	P/F Iron door comprising of specified leaves made of 1-1/4" x1-1/4" x3/16" MS angle iron for leaf frame, diagonal and horizontal braces duly welded with MS. sheet 18-SWG i/c the cost of sliding bolt, tower bolt and painting 3-coats but excluding the cost of Chowkat complete in all respect as approved and directed by the Engineer incharge. (ii) Double Leaf	Per Sft	56.00		

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BILL OF QUANTITY

Bill No. 5: TUBEWELL PUMP ROOM

Sr. No.	Ref	Description	Unit	Quantity	Unit Rate (Rs)	Amount (Rs)
23	12/17	Providing and fixing 2" wide MS/ GI Chowkat singel/double rebate made of 16 SWG MS sheet pressed/ welded/ supported with M.S. flat 1- 1/4"x1/8" i/c 6"long M.S. Flat 1"x1/8"hold fasts (6-Nos) welded/ screwed, punching of lock hole covered with MS Box,coating with antirust paint including filling with cement sand mortar (1:8) and embedding hold fast in cement concrete (1:2:4) ,complete in all respect as approved and directed by Engineer Incharge. (ii) 10.50 " wide	Per Sft	56.00		
24	25/42	Providing and fixing steel windows using M.S. sheet (16 SWG) moulded tubular pipe 1½"x1½" (40x40mm) for frame and 1¼"x1¼" (30x30mm) for leaves including M.S. square bars ¼"x¼" (6x6 mm) welded around each panel of frame, 5 mm thick glass panes fixed with double M.S. square tubular pipe 3/8"x3/8" (10x10mm) (22 SWG) beading with U' shaped rubber lining, brass fitting, holdfast, including painting three coats complete in all respects. a) For openable panels fixed with wire gauze 24 SWG, 12x12 mesh and glass panes ¼" (6 mm) thick.	Per Sft	36.00		
25	25/10+11	Fabrication of heavy steel work, with angle, tees, flat iron round iron and sheet iron for making trusses, girders, tanks, etc., including cutting, drilling, revitting, handling, assembling and fixing, including erection in position. (Top Cover & Girder)	100 Kg	6.84		
26	23/52	Providing and fixing Chain Pulley Block of 5 ton capacity with 5 meter length of chain, as per required specifications complete in all respect and as approved by the Engineer Incharge.	Each	2.00		
27	1/1	Carriage of 100 Cft. (2.83 cu.m) of all materials like stone aggregate, spawl, kankar lime (unslaked), surkhi, etc. or 150 Cft. (4.25 cu.m) of timber, by truck or by any other means owned by the contractor. (crushed stone aggregate and bajri used in concrete items) (Lead 270 Km)	100 Cft.	6.06		
Total Amount						

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BILL OF QUANTITY

Bill No. 6: OVER HEAD WATER TANK (10,000 gallons)

Sr. No.	Ref	Description	Unit	Quantity	Unit Rate (Rs)	Amount (Rs)
		2nd BI-ANNUAL-2025 (01.07.2025 to 31.12.2025)				
1	3/21	Excavation in foundation of building, bridges and other structures, including dagbelling, dressing, refilling in layers around structure with excavated earth, watering and ramming lead 'upto one chain (30 m) and lift upto 5 ft. (1.5 m).				
		2) a) By Excavator				
		ii) Ordinary soil	1000Cft	3.35		
		b) Lift from 5ft (1.5m) to 15 ft (4.5 m):-				
		ii) Ordinary soil	1000Cft	3.35		
2	6/5	Cement concrete plain including placing, compacting, finishing and curing complete (including screening and washing of stone aggregate):				
		(i) Ratio 1: 4: 8	100Cft	1.70		
3	6/6	Providing and laying reinforced cement concrete (including prestressed concrete), using Ordinary Portland Cement / Sulphate resisting cement / Slag cement as may be required; coarse sand and screened graded and washed aggregate, in required shape and design, including forms, moulds, shuttering, lifting, compacting, curing, rendering and finishing exposed surface, complete (but excluding the cost of steel reinforcement, its fabrication and placing in position, etc.):-				
		(a) Reinforced cement concrete in roof slab, beams, columns lintels, girders and other structural members laid in situ or precast laid in position, or prestressed members cast in situ, complete in all respects:-				
		(1) Type A (nominal mix 1:1:2)	P.Cft	1,276.40		
		(2) Type B (nominal mix 1: 1½: 3)	P.Cft	1,765.05		
		(c) Reinforced cement concrete in Pile cap, slab of rafts / strip foundation, base slab of column and retaining walls; etc and footing beams, other structural members other than those mentioned in 6(a-d) above not requiring form work (i.e. horizontal shuttering) complete in all respects:-				
		(2) Type B (nominal mix 1: 1½: 3)	P.Cft	1,115.15		

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BILL OF QUANTITY

Bill No. 6: OVER HEAD WATER TANK (10,000 gallons)

Sr. No.	Ref	Description	Unit	Quantity	Unit Rate (Rs)	Amount (Rs)
4	6/12	Fabrication of mild steel reinforcement for cement concrete, including cutting, bending, laying in position, making joints and fastenings, including cost of binding wire and labour charges for binding of steel reinforcement (also includes removal of rust from bars):-				
		('c) Deformed bars (Grade-60)	100kg	212.00		
5	6/16	Extra labour for laying concrete plain or reinforced:				
		a) above 20' (6 m) upto 40'(12 m) height	100Cft	5.00		
		b) Above 40' upto 50' height	100Cft	3.05		
		c) Above 50' upto 60' height	100Cft	11.10		
6	25/36	Providing and fixing stair railing of 2½" (63 mm) i/d G.I. pipe, welded with 5/8"x5/8" (16x16 mm) square M.S. bars 2'-9" (838 mm) high, fixed in each step, complete in all respects, including painting, polishing three coats.	Rft	50.67		
7	10/22	Providing & Laying mosaic flooring consisiting of one part of cement and marble powder in the ratio of 3:1 and two parts of marble chips,laid over 1"(25 mm) thick flooring of 1:2:4 cement concrete including rubbing and polishing complete with finishing :- a) 1-3/8"(35 mm) thick mosaic flooring, consisting of 3/8"(10mm) mosaic topping (ii) using white cement	100 Sft	3.20		
8	10/35	Mosaic dado or skirting with one part of cement and marble powder in the ratio of 3:1 and two parts of marble chips, laid over ½"(13 mm) thick cement plaster 1:3, including rubbing and polishing, complete with finishing: (a) using grey cement: i) 3/8"(10 mm) thick	100 Sft	5.70		
9	13/9	Bitumen coating to plastered or cement concrete surface:- i) 20 lbs. per 100 Sft. (9.07 Kg per Sq.m)	100 Sft	8.95		

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Bill No. 6: OVER HEAD WATER TANK (10,000 gallons)

Sr. No.	Ref	Description	Unit	Quantity	Unit Rate (Rs)	Amount (Rs)
10	13/33	Providing and applying weather shield paint of approved quality on external surface of building including preparation of surface, application of primer complete in all respect:				
		a) new surface:				
		i) 1st coat	100 Sft	47.75		
		ii) 2nd coat	100 Sft	47.75		
11	10/43	Providing and laying Tuff Pavers, having 7000 PSI, crushing strength of approved manufacturer, over 2" to 3" sand cushion i/c grouting with sand in joints i/c finishing to require slope . complete in all respect (50% Grey / 50% Coloured)				
		b) 60-mm thick	Per Sft	4,469.85		
12	18/3	a) Providing and laying sub-base course of stone product of approved quality and grade, including placing, mixing, spreading and compaction of sub-base material to required depth, camber, grade to achieve 100% maximum modified AASHO dry density, including carriage of all material to site of work except gravel and aggregate.				
		ii) Crushed stone aggregate.	100Cft	22.35		
13	6/32	Providing and embedding 10" (250mm) wide PVC water stopper in expansion joints of RCC structures (Retaining walls, water tanks, Slabs) complete in all respect. ii) 10" wide 10 mm thick	Rft	74.35		
14	1/1.	Carriage of 100 Cft. (2.83 cu.m) of all materials like stone aggregate, spawl, kankar lime (unslaked), surkhi, etc. or 150 Cft. (4.25 cu.m) of timber, by truck or by any other means owned by the contractor. (crushed stone aggregate and bajri used in concrete items) (Lead from approved querry)	100 Cft	65.20		
16	3/17	Transportation of earth all types when the total distance, including the lead covered in the item of work, is more than 1000 ft. (300 m)				
		a) upto ¼ mile (400 m).				

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Sr. No.	Ref	Description	Unit	Quantity	Unit Rate (Rs)	Amount (Rs)
		b) for every 330 ft. (100 m) additional lead or part thereof, beyond ¼ mile (400 m) upto one mile. (1.6 Km.) (Lead 1/2 km)	1000 Cft	1.30		
		Plinth Protection				
17	3/21	Excavation in foundation of building, bridges and other structures, including dagbelling, dressing, refilling in layers around structure with excavated earth, watering and ramming lead 'upto one chain (30 m) and lift upto 5 ft. (1.5 m).				
		1) By Manual				
		ii) in ordinary soil.	1000 Cft.	0.40		
18	6/2	Dry rammed brick or stone ballast, 1½" to 2"(40 mm to 50 mm) gauge.	100Cft	2.85		
19	6/5	Cement concrete plain including placing, compacting, finishing and curing complete (including screening and washing of stone aggregate):				
		(i) Ratio 1: 4: 8	100Cft	2.85		
20	7/4	Pacca brick work in foundation and plinth in:- i) Cement, sand mortar:-				
		Ratio 1:5	100Cft	5.70		
21	10/16	Providing and laying topping of cement concrete 1:2:4, including surface finishing and dividing in panels:-				
		(a) 1"(25 mm) thick	100Cft	8.90		
28	23/34	Supplying, fixing and testing ductile iron pipe with flange including the cost of specials, (teepu pipe / alpine steel or approved equivalent manufacturer, complying Class K-12, ISO - 2531 & BS - 4772, & jointing material with all fittings and accessories complete in all respect as approved by the Engineer Incharge				
		ii) 4" dia (100 mm)	P.Rft	169.00		
30	N/S	6 " dia C.I air vent on roof of overhead water tank.	Each	1.00		
31	N/S	MS ladder including painting as per drawings.	Rft	21.00		

ENGINEERING DESIGN AND CONSTRUCTION SUPERVISION
CLUSTER NORTH
PUNJAB RURAL SUSTAINABLE WATER SUPPLY AND SANITATION PROJECT
TEHSIL KOT MOMIN, DISTRICT SARGODHA VILLAGES (WAN MIANA, WAN MIANA COLONY & RAHIMPUR)

BILL OF QUANTITY

Bill No. 6: OVER HEAD WATER TANK (10,000 gallons)

Sr. No.	Ref	Description	Unit	Quantity	Unit Rate (Rs)	Amount (Rs)
32	N/S	M.S rungs (weight not less than 7.5 kg each) of approved shape, size and section treated with DTS epoxy coating where ever specified, including carriage, embedded in concrete according to correct lines and levels.	Each	9.00		
33	N/S	Air tight MS cover over tank as per drawings.	Each	2.00		
34	N/S	Providing, installing, testing and commissioning Hydrostatic Level Submersible Transmitter/ Indicator for direct mounting in Over Head Reservoirs make of USA/Europe or equivalent, alongwith Level Display unit, Shielded wire of 3m complete in all respect as per instructions of the Engineer Incharge and including the following features. i) Range = 0m to 20m H2O ii) Accuracy= 0.1 % iii) Cable length= 10m iv) Output = 4-20 mA v) Housing material= Stainless Steel 316L vi) Measuring cell = Ceramics vii) Sealing material between sensor and housing= FPM.	Each	1.00		
Total Amount						

ENGINEERING DESIGN AND CONSTRUCTION SUPERVISION
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TEHSIL KOT MOMIN, DISTRICT SARGODHA VILLAGES (WAN MIANA, WAN MIANA COLONY & RAHIMPUR)

BILL OF QUANTITY

Bill No. 7: DISTRIBUTION NETWORK

Sr. No.	Ref.	Description	Unit	Quantity	Rate (Rs)	Amount (Rs)
1	3/46	Excavation of trenches in all kinds of soil, except cutting rock, for watersupply pipelines/electric cables upto 5 ft. (1.5 m) depth from ground level, including backfilling, trimming, dressing sides, leveling the beds of trenches to correct grade and cutting pits for joints, etc. complete in all respects.	1000Cft	328.00		
2	23/42	Providing, laying, cutting, jointing, testing and disinfecting High Density Polyethylene Pipe (HDPE-100) working presure pipe, Beta/ Dadex/ Popular/ IIL or equivalent including the cost of specials, in trenches, as approved & directed by the engineer incharge, complete in all respects.				
		a) PN-6 (SDR-26)				
		1. 90 mm dia	Rft.	27,400.00		
		2. 110 mm dia	Rft.	11,800.00		
		3. 160 mm dia	Rft.	600.00		
3	6/5	Cement concrete plain including placing,compacting, finishing and curing complete (including screening and washing of stone aggregate).				
		(f) Nominal Ratio 1: 2: 4	100Cft	18.00		
4	10/3	Supplying and filling sand under floor; or plugging in wells. (under Road)	100Cft	608.00		
		Valve Chambers				
5	3/46	Excavation of trenches in all kinds of soil, except cutting rock, for watersupply pipelines/electric cables upto 5 ft. (1.5 m) depth from ground level, including backfilling, trimming, dressing sides, leveling the beds of trenches to correct grade and cutting pits for joints, etc. complete in all respects.	1000 Cft	25.05		
6	6/5	Cement concrete plain including placing, compacting, finishing and curing complete (including screenin and washing of stone aggregate):				
		(h) Ratio 1: 3: 6	100 Cft	8.79		
		(f) Ratio 1: 2: 4	100 Cft	18.84		
7	7 /7	Pacca brick work other than building upto 10ft. (3 m) height.				
		i) cement, sand mortar:-				
		Ratio 1:3	100 Cft	65.94		
8	21/11	Providing and fixing 1¼"x1¼"x3/16" (31x31x5 mm) angle iron step, in manhole chambers, including carriage and setting the same in work to correct lines and levels.	Each	219.00		

ENGINEERING DESIGN AND CONSTRUCTION SUPERVISION
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TEHSIL KOT MOMIN, DISTRICT SARGODHA VILLAGES (WAN MIANA, WAN MIANA COLONY & RAHIMPUR)

BILL OF QUANTITY

Bill No. 7: DISTRIBUTION NETWORK

Sr. No.	Ref.	Description	Unit	Quantity	Rate (Rs)	Amount (Rs)
9	11 /8	Cement plaster 1:3 upto 20' (6.00 m) height:-				
		b) ½" (13 mm) thick	100 Sft	43.80		
10	6/6	Providing and laying reinforced cement concrete (including prestressed concrete), using Ordinary Portland Cement / Sulphate resisting cement / Slag cement as may be required; coarse sand and screened graded and washed aggregate, in required shape and design, including forms, moulds, shuttering, lifting, compacting, curing, rendering and finishing exposed surface, complete (but excluding the cost of steel reinforcement, its fabrication and placing in position, etc.):-				
		(a) Reinforced cement concrete in roof slab, beams, columns lintels, girders and other structural members laid in situ or precast laid in position, or prestressed members cast in situ, complete in all respects:-				
		(3) Type C (nominal mix 1: 2: 4)	Per Cft	2,563.49		
		(c) Reinforced cement concrete in Pile cap, slab of rafts / strip foundation, base slab of column and retaining walls; etc and footing beams, other structural members other than those mentioned in 6(a-d) above not requiring form work (i.e. horizontal shuttering) complete in all respects:-				
		(3) Type C (nominal mix 1: 2: 4)	Per Cft	1,680.00		
11	6/12	Fabrication of mild steel reinforcement for cement concrete including cutting, bending, laying in position, making joints and fastenings, including cost of binding wire and labour charges for binding of steel reinforcement (also includes removal of rust)				
		(b) Deformed bars (ii)(Grade-60)	100 kg	192.66		
12	10/10	Brick on edge flooring, laid in 1:6 cement mortar, over a bed of ¾" (20 mm) thick cement mortar 1:6.	100 Sft.	11.68		
13	23/35	Providing and fixing sluice valve of B.S.S. quality and weight, Class `B', for cast iron pipe line, and Asbestos cement pipe line (including cost of jointing material):-				
		a) 3" i/d (75 mm)	No.	48.00		
		b) 4" i/d (100 mm)	No.	13.00		
		d) 6" i/d (150 mm)	No.	2.00		

ENGINEERING DESIGN AND CONSTRUCTION SUPERVISION
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TEHSIL KOT MOMIN, DISTRICT SARGODHA VILLAGES (WAN MIANA, WAN MIANA COLONY & RAHIMPUR)

BILL OF QUANTITY

Bill No. 7: DISTRIBUTION NETWORK

Sr. No.	Ref.	Description	Unit	Quantity	Rate (Rs)	Amount (Rs)
14	23/37	Providing and fixing, air valve 2½" (65mm) dia of B.S.S. quality and weight (complete with jointing material).				
		b) double	Each	15.00		
15	1/1	Carriage of 100 Cft. (2.83 cu.m) of all materials like stone aggregate, spawl, kankar lime (unslaked), surkhi, etc. or 150 Cft. (4.25 cu.m) of timber, by truck or by any other means owned by the contractor. (crushed stone aggregate and bajri used in concrete items) (Lead from sargodha querry)	100 Cft.	78.50		
16	N/S	Providing, transportation, fixing and Jointing of MS flanges to joint the valves (sluice vlave, air vlave and fire hydrant) with HDPE pipe line complete in all respect and as per approval of The Engineer.				
		1. 90 mm dia	Each	92.00		
		2. 110 mm dia	Each	26.00		
		3. 160 mm dia	Each	4.00		
17	N/S	Providing & fixing of RPC manhole cover manufactured with 100% recycled plastic composite material, 650 mm (26"dia) with clear opening size 600 mm (24" dia) and rpc manhole frame having dia meter 790 mm (31.1") with average breaking load capacity of 10 ton and weight including frame of 50 kg (minimum).	Per set	73.00		
18	N/S	Providing & installation of GI water supply connection pipe including 15mm (1/2”) inner dia HDPE pipe from distribution line to plinth level, 1/2” inner dia GI pipe 4ft/height from plinth level of the building, GI saddle clamp, brass with foam & nuts, ferrule double action complete in all respect. It includes (1/2’’) saddle clamp 110 mm x 1/2’’, brass ferrule 1/2’’, HDPE pipe connector for ferrule valve joint, 15 mm x (1/2’’) nipple, 15 mm female elbow, 15 mm x 1/2’’ GI pipe (4ft & 1 ft.). It also includes carriage, loading and unloading complete in all respect as per drawings, specifications and directed by the Engineer. **(including water meter manual operation- dry type digit and pointer type (LXSG-15E-65E) dry operational with magnetic field and moving rotary fan with multi jet)**				
		Connection from 90 mm dia pipe	No.	1,500.00		

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TEHSIL KOT MOMIN, DISTRICT SARGODHA VILLAGES (WAN MIANA, WAN MIANA COLONY & RAHIMPUR)

BILL OF QUANTITY

Bill No. 7: DISTRIBUTION NETWORK

Sr. No.	Ref.	Description	Unit	Quantity	Rate (Rs)	Amount (Rs)
19	N/S	Mannual boring for laying of 90mm dia HDPE Pipe under roads/nulla etc complete in all respects to satisfaction of Engineer In-charge.	Rft	200.00		
Total Amount						

ENGINEERING DESIGN AND CONSTRUCTION SUPERVISION
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TEHSIL KOT MOMIN, DISTRICT SARGODHA VILLAGES (WAN MIANA, WAN MIANA COLONY & RAHIMPUR)

Bill No. 1.9: ELECTRIFICATION

Sr. No.	Description	M.R.S (Item/Chap)	Unit	Qty.	Rate (Rs.) In Figure	Amount (Rs.)
1.0	**WIRING AND ACCESSORIES**					
1.1	Wiring of light or fan point from switch board/dimmer to the point with 3x1.5 mm^2 (P+N+E) PVC insulated single core stranded cables in 25 mm PVC conduit/pipe concealed in walls, columns and slabs including accessories, PVC box, 10 Amp. gang switch 1 or 2 way as required, one for each light or fan and installed as in specifications complete in all respects.	8(c-ii)/24, 3(iii)/24, 16(i)/24, 34(ii)/24	Each	10		
1.2	Circuit wiring from DB/ MCBs to gang switches board and from switch board to another switch board with 3x2.5 mm^2 (P+N+E) PVC insulated single core stranded cables in 25mm PVC pipe/conduit concealed in walls, columns and slabs as required complete in all respects.	8(c-iii)/24, 3(iii)/24	Each	8		
1.3	The same as item No. 1.1 but from one light point to another light point.	8(c-ii)/24, 3(iii)/24	Each	20		
1.4	10/13 Amp 3 pin universal flush mounting switch socket outlet wired from DB/MCBs to first outlet with 3x4 mm^2 (P+N+E) single core cable stranded (away from switch board) in 25mm PVC pipe/conduit concealed in walls, columns and slabs as required complete in all respects.	8(c-iv)/24, 17(ii)/24, 39(i)/24, 3(iii)/24	Each	2		
1.5	The same as item No.1.4 but wiring from one socket outlet to another socket outlet with 3x2.5 mm^2 (P+N+E) single core stranded cable in 25mm PVC pipe/conduit concealed in walls, columns and slabs as required complete in all respects.	8(c-iii)/24, 3(iii)/24, 16(ii), 38(i)	Each	2		
1.6	15/20 Amp 3 pin mounting switch socket outlet wired from DB MCBs to independent socket outlet with 3x6 mm^2 (P+N+E) single core stranded cable (away from switchboard) in 25mm PVC pipe/conduit concealed in walls, columns and slabs as required complete in all respects.	8(c-v)/24, 3(iii)/24, 38(ii)/24, 16(ii)/24	Each	2		
3.0	**DISTRIBUTION BOARDS**					
	D.Bs with TP incoming adjustable moulded case circuit breaker and SP miniature outgoing circuit breakers, Panel box SWG 16 powder coated RAL colour 7032, IP class 44 and with all accessories. alongwith all installation and operational accessories as per specification or as shown on the drawings.					
3.1	**DB- PUMP ROOM**					
-	01 No. Incoming 25 Amps (Adj.) MCCB TP 25kA Icu=100%Ics					
-	03 Nos. outgoing 10A, MCB, SP, RC=10 kA, Icu=100%Ics					
-	01 No. outgoing 20A, MCB, SP, RC=10 kA, Icu=100%Ics					
-	02 Nos. outgoing 10A, MCB, SP, RC=10 kA, Icu=100%Ics (Spare)					
-	03 Nos. outgoing 10A, MCB, SP, RC=10 kA, Icu=100%Ics (Space)					
-	P/F wall mounted DB (Distribution Board) 6" deep, 20~60A, made with 16SWG Sheet (Recessded/Surf ace mounted Type), Powder coated Paint, i/c the cost of Lock, Indication lights,Thimble, Copper Comb, Wiring, Netural & Earth Bar, Door Earthing, Digital Voltmeter,Digital Ammeter,Volt Selector Swi tch, Ammeter selector switch, Current Transformers and Controles Complete in all respect as approved and directed by the Engineer Incharge (Breakers will be Paid Separately).	85(b-iii)/24, '85(a-iii)/24, 94(i)/24, 94(ii)/24, 94(iv)/24, 94(iii)/24, 94(v)/24, 94(vi)/24, 94(xv)/24	Each	2		

Bill No. 1.9: ELECTRIFICATION

Sr. No.	Description	M.R.S (Item/Chap)	Unit	Qty.	Rate (Rs.) In Figure	Amount (Rs.)
4.0	**MAIN PANEL BOARD**					
4.1	LV Switchgear Panel/Main Panel Board of 14 SWG, IP class 54/44 & RAL 7032 including I/C and O/G following electrical items, foundation/base frame with all installation and operational accessories as per site requirements, as per tender specifications and drawings and as directed by the Engineer.					
	INCOMING					
-	01 No. 63 Amps (Adj.) MCCB TP 25kA Icu=100%Ics					
-	01 No. VSS (07 position)					
-	01 No. 0-600 Volts AC DIGITAL Voltmeter					
-	03 Nos. 80/5 Amps Current Transformers					
-	01 No. ASS (R-Y-B-OFF)					
-	01 No. 0-100 Amps AC DIGITAL Ammeter					
-	03 Nos. RYB, LED indication lights					
	OUTGOING					
-	02 Nos. 25 Amps (Adj.) MCCB TP 18kA Icu=100%Ics (For Running Motor & Pump room DB)					
-	01 No. 20 Amps MCB DP 10kA Icu=100%Ics (For S Motor)					
-	01 No. 32 Amps (Adj.) MCCB TP 18kA Icu=100%Ics *(For PFI)*					
-	01 No. 25 Amps (Adj.) MCCB TP 18kA Icu=100%Ics *(Spare)*					
-	01 No. 20 Amps MCB DP 10kA Icu=100%Ics *(Spare)*	88(a-i)/24, 87(a-vi)/24, 87(a-i)/24, 94(i)/24, 94(ii)/24, 94(iv)/24, 94(iii)/24, 94(v)/24, 94(vi)/24, 94(xv)/24				
-	01 No. 25 Amps (Adj.) MCCB TP 18kA Icu=100%Ics *(Space)*					
-	14 SWG steel sheet Panel RAL 7032, IP= 54/44 and all other accessories,					
-	Electrolytic copper bus bar with electrical grade PVC mountings 3 for each, nuts, bolts and washers, control MCB etc. (120Amps. R+Y+B N, 50 Hz, 415 V, AC)					
-	All other accessories required for completion of the qulaity works including Cable gland and lugs etc		Each	2		
-	Contractor shall submit the genuine certificate from the manufacturer/authorized agent clear by indicating the project name make/model/rating of MCCB, MCB, magnetic contactors, terminal blocks and voltmeters/ ammeter alongwith warranties.					
5.0	**Conduits / Pipes**					
5.1	PVC pipe/conduit Class-B 100 mm dia with accessories suitable for laying multi-core cables in walls/barriers/structure.	25(b)/23	Rft.	300		
5.2	PVC pipe/conduit Class-B 100 mm dia with accessories suitable for laying multi-core cables from pole to pole in trenches/directly burried including excavation.	25(b)/23, 6/3	Rft.	300		
5.3	PVC pipe/conduit Class-D 100 mm dia with accessories suitable for laying multi-core cables in trenches/directly burried on road crossings including excavation.	27(e)/23, 6/3	Rft.	200		
6.0	**FANS & ACCESSORIES**					
6.1	Providing and fixing Copper Winded Exhaust Fan with louver and shutter made of Pak/Younas/G.F.C. i/c the cost of necessary cable and hardware for connection from ceiling rose complete as approved and directed by Engineer Incharge.					
	a) Plastic body					
i)	12" dia	102(a-ii)/24	Each	2		
	b) Steel body					
i)	18" dia	102(b-ii)/24	Each	2		

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TEHSIL KOT MOMIN, DISTRICT SARGODHA VILLAGES (WAN MIANA, WAN MIANA COLONY & RAHIMPUR)

Bill No. 1.9: ELECTRIFICATION

Sr. No.	Description	M.R.S (Item/Chap)	Unit	Qty.	Rate (Rs.) In Figure	Amount (Rs.)
6.2	Providing and fixing Copper winded wall bracket fan made of Pak/Younas/G.F.C or NEECA approved equivalent i/c the cost of necessary cable and hardware for connection as approved and directed by Engineer					
i)	18" Sweep dia	103(i)/24	Each	2.00		
8.0	**Power Cables**					
8.1	Supply and erection of copper conductor cables for service connection, in prelaid pipe/G.I. wire/trenches, etc. (rate for cable only)					
	PVC insulated, PVC sheathed 2 core, 600/1000 volt non armoured cable					
(a)	4 mm (7/0.036") For 0.25 HP Motor	11(a-iv)/24	Rft.	200		
	PVC insulated, PVC sheathed 4 core, 600/1000 volt non armoured cable					
(a)	10 mm (7/0.052") For 10HP Motor	11(c-vi)/24	Rft.	300		
(b)	16 mm (7/0.064") From Transforme to MPB	11(c-vii)/24	Rft.	400		
8.2	Supply and erection of single core PVC insulated copper conductor cables, in prelaid PVC pipe/M.S. conduit/G.I pipe/wooden strip batten/wooden casing an capping/G.I. wire/trenches (rate for cables only)					
	450/750 volts, PVC insulated:					
(a)	4 mm sq (7/0.036")	8(c-iv)/24	Rft.	200		
(b)	10 mm sq (7/0.052")	8(c-vi)/24	Rft.	300		
(c)	16 mm sq (7/0.064")	8(c-vii)/24	Rft.	600		
9.0	**CABLE TRAYS**					
9.1	Providing and fixing 4" deep cable tray with straight flange fabricated with perforated G.I. Sheet of specified guage, size and depth duly wall supported/ ceiling hung on painted brackets of MS angle iron of 1"x1"x1/8" and MS patti of 1-1/2"x3/16" size @5 ft. C/C, hangers i/c the cost of hardwares as approved and directed by the Engineer Incharge.					
	(a) 16 SWG					
	(i) 4"X4"	98 (a-i)/24	Rft.	150		
9.2	Providing and fixing screwless cable tray cover fabricated with 18 SWG G.I. Sheet of required size i/c the cost of hardware as approved and directed by the Engineer Incharge					
	(i) 4" Wide	100 (i)/24	Rft.	150		
10.0	**EARTHING**					
10	Providing,making & testing/commissionin of **Rod type Earth** point comprising of 5/8"dia.(16mmdia)10ft long copper coated M.S.rod driven in ground duly fixed with clamp with Tinned earth test link copper plate (300x50x10mm),i/c the cost of brass nuts,spacers,bolts washers lugs etc but excluding the cost of copper strand & manhole. as approved and directed by Engineer Incharge **(Rod Type Earthing)**.	111 /24	Each	12		
	TOTAL MRS ITEMS					

ENGINEERING DESIGN AND CONSTRUCTION SUPERVISION
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TEHSIL KOT MOMIN, DISTRICT SARGODHA VILLAGES (WAN MIANA, WAN MIANA COLONY & RAHIMPUR)

Bill No. 1.9: ELECTRIFICATION

Item No.	Description	Qty.	Unit	Unit Rate (Rs.)	Total Amount (Rs.)
	Design, Supply, transportation at site, storage, installation, testing and commissioning of the following items of work (unless specifically stated otherwise) including all material, labour, tools and accessories etc. required for proper completion of each item as per specification and drawings and/or as directed by the Engineer.				
1.0	**LIGHT FITTINGS AND FANS**				
	Following LED Luminaries of suitable wattage make suitable for the project requirements. Contractor to submit lighting design calculation to determine the adequacy of the wattage and should adjust the number of LEDs/wattage as per project lighting requirements. The fitting shall be approved by the Engineer.				
1.1	Light Fixture Type LED Batten Ceiling/surface mounted, 18W complete in all respect with allied accessories. The fitting shall be approved by the Engineer.	4	Each		
1.2	Wall bracket Light Fixture Type LED 12 Watt energy saving lamp with holder and complete in all respect with allied accessories. The fitting shall be approved by the Engineer.	2	Each		
1.3	20W LED Water tight light fixture IP 65 complete in all respect with all allied accessories. The fitting shall be approved by the Engineer.	4	Each		
2.0	**POWER FACTOR IMPROVEMENT PANEL (PFI)**				
2.1	14 SWG steel sheet clad IP 44/54 colour RAL 7035 powder coated power factor improvement panel (PFI) including Cu busbar, heavy duty incoming and outgoing circuit breaker to capacitor, magnetic contactors, continuous digital p.f controller, on & off pushbuttons etc. complete with all components/ accessories as per specifications and drawings.				
-	**PFI - 10 kVAR**				
-	**MATERIAL** 6 steps with continuous digital power factor and capacitor controller with all accessories etc.	2	Each		
-	01 No.Hand/OFF/Auto selector switch 02 Nos. 5 kVAR capacitor 02 Nos. 32 A Magnetic contactor (AC-3) 02 Nos. 25A MCCB, TP (Adj.) RC= 18 kA Circuit breaker, Icu=100%Ics 01 No. 80/5 Amps Current Transformers 03 Nos. Indication light - (for magnetic contactor and phase) 03 Nos. Push Buttons (ON/OFF) 03 Nos. Auxiliary contractor (NO/NC) 01 No. Panel light with limit switch 02 No. Exhaust fan 6" & Louver 8" sweep with thermosttae relay and all accessories etc. 14 SWG steel sheet Panel RAL 7032, IP= 54/44 and all other accessories, All other accessories required for completion of the qulaity works including Cable gland and lugs etc Electrolytic copper bus bar with electrical grade PVC mountings 3 for each, nuts, bolts and washers, control MCB etc. (120Amps. R+Y+B N, 50 Hz, 415 V, AC) Contractor shall submit the genuine certificate from the manufacturer/authorized agent clear by indicating the project name make/model/rating of MCCB, MCB, magnetic contactors, terminal blocks and voltmeters/ ammeter alongwith warranties.				
TOTAL NON MRS ITEMS					
TOTA MRS + NON MRS ITEMS					

ENGINEERING DESIGN AND CONSTRUCTION SUPERVISION
CLUSTER NORTH
PUNJAB RURAL SUSTAINABLE WATER SUPPLY AND SANITATION PROJECT

TEHSIL KOT MOMIN, DISTRICT SARGODHA VILLAGES (WAN MIANA, WAN MIANA COLONY & RAHIMPUR)
BILL OF QUANTITY

Bill No. 1.9: BOUNDARY WALL

Sr. No.	Ref.	Description	Unit	Quantity	Rate (Rs)	Amount (Rs)
1	3/21	Excavation in foundation of building, bridges and other structures, including dagbelling, dressing, refilling in layers around structure with excavated earth, watering and ramming leadupto one chain (30 m)lift upto 5 ft (1.5m).				
		2) a) By Excavator				
		ii) in ordinary soil.	1000Cft	5.86		
2	6/5	Cement concrete plain including placing, compacting, finishing and curing complete (including screening and washing of stone aggregate):				
		(h) Ratio 1:3:6	100Cft	2.37		
3	6/6	Providing and laying reinforced cement concrete (including prestressed concrete), using Ordinary Portland Cement / Sulphate resisting cement / Slag cement as may be required; coarse sand and screened graded and washed aggregate, in required shape and design, including forms, moulds, shuttering, lifting, compacting, curing, rendering and finishing exposed surface, complete (but excluding the cost of steel reinforcement, its fabrication and placing in position, etc.):-				
		(a) Reinforced cement concrete in roof slab, beams, columns lintels, girders and other structural members laid in situ or precast laid in position, or prestressed members cast in situ, complete in all respects:-				
		(2) Type B (nominal mix 1: 1½: 3)	Cft	412.24		
		(c) Reinforced cement concrete in Pile cap, slab of rafts / strip foundation, base slab of column and retaining walls; etc and footing beams, other structural members other than those mentioned in 6(a-d) above not requiring form work (i.e. horizontal shuttering) complete in all respects:-				
		(2) Type B (nominal mix 1: 1½: 3)	Cft	641.25		
4	6/12	Fabrication of mild steel reinforcement for cement concrete, including cutting, bending, laying in position, making joints and fastenings, including cost of binding wire and labour charges for binding of steel reinforcement (also includes removal of rust from bars):-				
		b) Deformed bars (ii)(Grade 60)	100 Kg	33.46		

ENGINEERING DESIGN AND CONSTRUCTION SUPERVISION
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PUNJAB RURAL SUSTAINABLE WATER SUPPLY AND SANITATION PROJECT

TEHSIL KOT MOMIN, DISTRICT SARGODHA VILLAGES (WAN MIANA, WAN MIANA COLONY & RAHIMPUR)
BILL OF QUANTITY

Bill No. 1.9: BOUNDARY WALL

Sr. No.	Ref.	Description	Unit	Quantity	Rate (Rs)	Amount (Rs)
5	1/1	Carriage of 100 Cft. (2.83 cu.m) of all materials like stone aggregate, spawl , kankar lime (unslaked), surkhi , etc. or 150 Cft. (4.25 cu.m) of timber, by truck or by any other means owned by the contractor.				
		Lead From approved quarry	100Cft	8.88		
6	7/4	Pacca brick work in foundation and plinth in:-				
		i) Cement, sand mortar:-				
		Ratio 1:3	100Cft.	42.96		
7	6/37	Providing and laying damp proof course of cement concrete 1:2: 4(using cement, sand and shingle), including bi tumen coating :-				
		(b) with 2 coats of bitumen:				
		ii) 2" thick (50 mm)	100Sft	6.75		
8	7/7	Pacca brick work other than building upto 10ft. (3 m) height.				
		Ratio 1:3	1000Cft	29.05		
9	11/8	Cement plaster 1:3 upto 20' (6.00 m) height:-				
		b) ½" (13 mm) thick	100 Sft.	48.76		
10	11/18	Cement pointing struck joints, on walls, upto 20' (6.00 m) hiehgt:-				
		a) Ratio 1:2	100 Sft.	48.76		
11	25/31	Making and fixing steel grated door with 1/16" thick (1.5mm) sheeting, including angle iron frame 2"x2"x3/8" (50x50x10 mm) and ¾" (20 mm) square bars 4" (100 mm) centre to centre, with locking arrangement.	P.Sft	144.00		
12	13/5 (d)	Painting new surface:-				
		d) Preparing surface and painting guard bars, gates of iron bars, gratings, railing (including standards, braces, etc.) and in similar open work:-				
		i) priming coat.	100 Sft.	1.44		
		ii) each subsequent coat of paint.(2 Coats)	100 Sft.	2.88		
13	13/33	Providing and applying weather shield paint of approved quality on external surface of building including preparation of surface, application of primer complete in all respect.				
		a) new surface:				
		i) 1st coat	100 Sft.	32.16		
		ii) 2nd coat	100 Sft.	32.16		
Total (A) (Rs.)						

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BILL OF QUANTITY

Bill No. 2: LOWERING OF SUB SOIL WATER TABLE

Sr. No.	Ref.	Description	Unit	Quantity	Rate (Rs)	Amount (Rs)
1		Lowering of sub-soil water level and maintain subsoil water level 3 to 5 feet below foundation level of structures as per approved dewatering plan through pumping out water from tube wells including supply and install suitable numbers of dewatering pumps sets (tube wells boreholes, pipe, stainers, pumps, motors, column pipes.delivery pipes, clamps etc.) capable to pump out water including labor, generator, diesel, oil etc. and disposal of pumped out water at safe place min mum 100 feet away from the working site till the completion of job, complete with all respect and as per instruction of Engineer in Charge.	Job	2		
					Total Amount (Rs.)	-

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BILL OF QUANTITY

BILL NO. 10: GEOTECHNICAL INVESTIGATIONS

Sr. No.	Description	Unit	Quantity	Unit Rate (Rs)	Amount (Rs)
A.	**FIELD INVESTIGATIONS**				
A1	Mobilization and demobilization of at least Three (01) set of hand auger / percussion boring equipments alongwith allied accessories at sites (i.e. at least one set of equipment for each Tehsil) including setting-up and shifting of equipment from one investigation point to another. The equipment shall be adequate in quantity to meet the time schedule. Minimum diameter of borehole should be 100 mm for Hand Auger and 200 mm for Percussion boring.	Job	1.00		
A2	Execution of fifteen (15) boreholes up to maximum depth of 15 m below NSL in overburden soils by using hand auger / percussion boring method including backfilling of boreholes to their original position using cement-sand-bentonite mix.	L.M.	250.00		
A3	Performance of Standard Penetration Tests (SPTs) in boreholes generally at 1 m depth interval or as necessary along with collection of SPT samples, including their labelling, packing, storage & transportation to an approved testing laboratory.	No	250.00		
A4	Collection of relatively undistrubed soil samples from boreholes through Shelby sampler, including their waxing, labelling, packing, storage & transportation to an approved testing laboratory.	No	15.00		
A5	Performance of field permeability test in boreholes at selected depths using constant / variable head condition.	No	5.00		
A6	Collection of bulk composite soil samples (at least 50 kg - 100 kg of A-6 / A-7 material) from borrow areas located adjacent to the project sites (i.e. at least three samples for each Tehsil).	No	5.00		
A7	Collection of water samples (if encountered) from boreholes including their labelling, packing, storage & transportation to an approved testing laboratory.	No	5.00		
	Sub-Total A				-

Note: Establishment of coordinates and ground elevations of all the boreholes using total station is included in the scope of work. The coordinates should be provided with reference to a permanent bench mark established at site.
Hand auger will be used for execution of borehole in sandy / clayey soil. However, percussion method of boring will be required if gravelly strata encountered.
Contractor will be responsible for arrangement of Personnel Protective Equipments (PPEs) such as safety helmets and jackets for NESPAK site supervisory / visiting staff. Moreover, pick & drop (i.e. residence / hotel to site and site to hotel / residence) of
All soil / water samples collected from boreholes must be labelled, stored and transported as per ASTM. The area and clearance ratio of thin walled tubes should be in strict compliance with relevant ASTM standard.

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BILL OF QUANTITY

BILL NO. 10: GEOTECHNICAL INVESTIGATIONS

Sr. No.	Description	Unit	Quantity	Unit Rate (Rs)	Amount (Rs)
B.	**LABORATORY TESTING**				
B1	Sieve Analysis	No.	25.00		
B2	Hydrometer Analysis	No.	10.00		
B3	Liquid and Plastic Limits	No.	15.00		
B4	Bulk & Dry Density	No.	15.00		
B5	Consolidation with Swell Pressure Measurement	No.	5.00		
B6	Unconfined Compression	No.	15.00		
B7	Sulphate Content of Soil	No.	5.00		
B8	Chloride Content of Soil	No.	5.00		
B9	Organic Matter Content of Soil	No.	5.00		
B10	Complete chemical analysis of water samples i/c TDS, Cl, SO4 & pH	No.	5.00		
Sub-Total B					**-**
Total (A+B)					**-**

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SEWERAGE LINES, PUMPING STATION AND ALLIED WORKS
SUMMARY OF COST

Bill No.	Description	Cost
2.0)	**KOT MOMIN**	
2.1	COMMUNAL SEPTIC TANK	
2.2	BRICK DRAIN	
2.3	SEWERLINE	
2.4	INFLUENT WASTE WATER PUMPING STATION	
2.5	ANAEROBIC BAFFLED REACTOR (0.2 CUSEC)	
2.6	ELECTRIFICATION	
2.7	STAFF QUARTER	
2.8	BOUNDARY WALL	
2.9	LOWERING OF SUB SOIL WATER TABLE	
TOTAL (SEWERAGE LINES, PUMPING STATION AND ALLIED WORKS)		

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BILL OF QUANTITY

BILL NO. 2.1 SEPTIC TANK AND SOAKAGE PIT

SR. NO.	Ref	DESCRIPTION	QUANTITY	UNIT	UNIT RATE (Rs)	AMOUNT (Rs)
		SEPTIC TANK (CIVIL WORKS)				
1	3/21	Excavation in foundation of building, bridges and other structures, including dagbelling, dressing, refilling in layers around structure with excavated earth, watering and ramming lead 'upto one chain (30 m) and lift upto 5 ft. (1.5 m).				
		1) By Manual				
		ii) Ordinary soil	12.39	1000 Cft.		
2	10/3	Supplying and filling sand under floor; or plugging in wells.	0.22	100Cft		
3	6/5	Cement concrete plain including placing, compacting, finishing and curing complete (including screening and washing of stone aggregate):				
		(h) Ratio 1: 3: 6	2.12	100 Cft.		
4	6/6	Providing and laying reinforced cement concrete (including prestressed concrete), using Ordinary Portland Cement / Sulphate resisting cement / Slag cement as may be required; coarse sand and screened graded and washed aggregate, in required shape and design, including forms, moulds, shuttering, lifting, compacting, curing, rendering and finishing exposed surface, complete (but excluding the cost of steel reinforcement, its fabrication and placing in position, etc.):-				
		(a) Reinforced cement concrete in roof slab, beams, columns lintels, girders and other structural members laid in situ or precast laid in position, or prestressed members cast in situ, complete in all respects:-				
		(1) Type A (nominal mix 1:1:2)	1,364.45	Cft.		

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BILL OF QUANTITY

BILL NO. 2.1 SEPTIC TANK AND SOAKAGE PIT

SR. NO.	Ref	DESCRIPTION	QUANTITY	UNIT	UNIT RATE (Rs)	AMOUNT (Rs)
		(c) Reinforced cement concrete in Pile cap, slab of rafts / strip foundation, base slab of column and retaining walls; etc and footing beams, other structural members other than those mentioned in 6(a-d) above not requiring form work (i.e. horizontal shuttering) complete in all respects:-				
		1) Type A (nominal mix 1: 1: 2)	493.85	Cft.		
5	6/12	Fabrication of mild steel reinforcement for cement concrete, including cutting, bending, laying in position, making joints and fastenings, including cost of binding wire and labour charges for binding of steel reinforcement (also includes removal of rust from bars):-				
		('c) Deformed bars (Grade-60)	67.45	100 Kg		
6	19/47	Providing, fixing, testing and commissioning of µ-PVC (Unplasticized Polyvinyl Chloride Nikasi/SWV pipe, Dadex/Popular/Beta or approved equivalent manufacturer, plain/Bell Ended/Z-Joints conforming to BS4514/BS5255-EN1329 including the cost of specials and Solvents complete in all respects, as per drawings & specifications and/ or as approved and directed by the Engineer Incharge.				
		(iii) 50mm	8.00	P.Rft		
		(v) 160 mm	42.00	P.Rft		
7	6/32	Providing and embedding 10" (250mm) wide PVC water stopper in expansion joints of RCC structures (Retaining walls, water tanks, Slabs) complete in all respect .				
		ii) 10 mm thick	116.67	Rft		

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BILL OF QUANTITY

BILL NO. 2.1 SEPTIC TANK AND SOAKAGE PIT

SR. NO.	Ref	DESCRIPTION	QUANTITY	UNIT	UNIT RATE (Rs)	AMOUNT (Rs)
		FORCEMAIN				
8	3/46	Excavation of trenches in all kinds of soil, except cutting rock, for watersupply pipelines/electric cables upto 5 ft. (1.5 m) depth from ground level, including backfilling, trimming, dressing sides, leveling the beds of trenches to correct grade and cutting pits for joints, etc. complete in all respects.				
		i) ordinary	1000Cft	2.63		
9	10/3	Providing and laying sand under and around the sewer pipe, including leveling, manual compaction, complete in all respect. (for bedding of forcemain)	100Cft	2.50		
10	6/5	Cement concrete plain including placing, compacting, finishing and curing complete (including screening and washing of stone aggregate): (Thrust Blocks pervisional Qty)				
		(f) Nominal mix Ratio 1: 2: 4	100Cft	0.50		
11	23/30	Providing, laying, cutting, jointing, testing and disinfecting High Density Polyethylene Pipe (HDPE-100) working presure pipe conforming to standard ISO4427, PS3580, Beta/ Dadex/ Popular/ IIL or approved equivalent manufacturer, including the cost of specials, in trenches,as approved & directed by the engineer incharge, complete in all respects. **PN-6**				
		110mm	Rft	300.00		
12	1/1	Carriage of 100 Cft. (2.83 cu.m) of all materials like stone aggregate, spawl , kankar lime (unslaked), surkhi , etc. or 150 Cft. (4.25 cu.m) of timber, by truck or by any other means owned by the contractor. Lead from approved nearby quarry	100Cft	16.71		

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BILL OF QUANTITY

BILL NO. 2.1 SEPTIC TANK AND SOAKAGE PIT

SR. NO.	Ref	DESCRIPTION	QUANTITY	UNIT	UNIT RATE (Rs)	AMOUNT (Rs)
		Valve Chambers				
13	3/46	Excavation of trenches in all kinds of soil, except cutting rock, for watersupply pipelines/electric cables upto 5 ft. (1.5 m) depth from ground level, including backfilling, trimming, dressing sides, leveling the beds of trenches to correct grade and cutting pits for joints, etc. complete in all respects.	1000 Cft	0.34		
14	6/5	Cement concrete plain including placing, compacting, finishing and curing complete (including screenin and washing of stone aggregate):				
		(h) Ratio 1: 3: 6	100 Cft	0.12		
		(f) Ratio 1: 2: 4	100 Cft	0.01		
15	7 /7	Pacca brick work other than building upto 10ft. (3 m) height.				
		i) cement, sand mortar:-				
		Ratio 1:3	100 Cft	0.90		
16	21/11	Providing and fixing 1¼"x1¼"x3/16" (31x31x5 mm) angle iron step, in manhole chambers, including carriage and setting the same in work to correct lines and levels.	Each	3.00		
17	11 /8	Cement plaster 1:3 upto 20' (6.00 m) height:-				
		b) ½" (13 mm) thick	100 Sft	0.60		

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BILL OF QUANTITY

BILL NO. 2.1 SEPTIC TANK AND SOAKAGE PIT

SR. NO.	Ref	DESCRIPTION	QUANTITY	UNIT	UNIT RATE (Rs)	AMOUNT (Rs)
18	6/6	Providing and laying reinforced cement concrete (including prestressed concrete), using Ordinary Portland Cement / Sulphate resisting cement / Slag cement as may be required; coarse sand and screened graded and washed aggregate, in required shape and design, including forms, moulds, shuttering, lifting, compacting, curing, rendering and finishing exposed surface, complete (but excluding the cost of steel reinforcement, its fabrication and placing in position, etc.):-				
		(a) Reinforced cement concrete in roof slab, beams, columns lintels, girders and other structural members laid in situ or precast laid in position, or prestressed members cast in situ, complete in all respects:-				
		(3) Type C (nominal mix 1: 2: 4)	Per Cft	35.11		
		(c) Reinforced cement concrete in Pile cap, slab of rafts / strip foundation, base slab of column and retaining walls; etc and footing beams, other structural members other than those mentioned in 6(a-d) above not requiring form work (i.e. horizontal shuttering) complete in all respects:-				
		(3) Type C (nominal mix 1: 2: 4)	Per Cft	48.00		
19	6/12	Fabrication of mild steel reinforcement for cement concrete including cutting, bending, laying in position, making joints and fastenings, including cost of binding wire and labour charges for binding of steel reinforcement (also includes removal of rust)				
		(b) Deformed bars (ii)(Grade-60)	100 kg	2.64		
20	10/10	Brick on edge flooring, laid in 1:6 cement mortar, over a bed of ¾" (20 mm) thick cement mortar 1:6.	100 Sft.	0.16		

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BILL OF QUANTITY

BILL NO. 2.1 SEPTIC TANK AND SOAKAGE PIT

SR. NO.	Ref	DESCRIPTION	QUANTITY	UNIT	UNIT RATE (Rs)	AMOUNT (Rs)
21	23/35	Providing and fixing sluice valve of B.S.S. quality and weight, Class `B', for cast iron pipe line, and Asbestos cement pipe line (including cost of jointing material):-				
		b) 4" i/d (100 mm)	No.	1.00		
22	1/1	Carriage of 100 Cft. (2.83 cu.m) of all materials like stone aggregate, spawl, kankar lime (unslaked), surkhi, etc. or 150 Cft. (4.25 cu.m) of timber, by truck or by any other means owned by the contractor. (crushed stone aggregate and bajri used in concrete items) (Lead from sargodha querry)	100 Cft.	0.41		
23	N/S	Providing, transportation, fixing and Jointing of MS flanges to joint the valves (sluice vlave, air vlave and fire hydrant) with HDPE pipe line complete in all respect and as per approval of The Engineer.				
		2. 110 mm dia	Each	2.00		
24	NS	Providing and Fixing RPC Manhole Cover Manufactured with 100% Recycled Plastic Composite Material, 650 mm (26"dia) with clear opening size 600 mm (24" dia) and RPC manhole frame having dia meter 790 mm (31.1") with average breaking load capacity of 10 Ton and weight including frame of 50 kg (Minimum).	Per Set	3		

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BILL OF QUANTITY

BILL NO. 2.1 SEPTIC TANK AND SOAKAGE PIT

SR. NO.	Ref	DESCRIPTION	QUANTITY	UNIT	UNIT RATE (Rs)	AMOUNT (Rs)
25	Quotation	Designing, manufacturing, testing at manufacturer's workshop, supplying at site, installation, testing, commissioning, guarantee and maintenance for one year during defect Liability Period of each item of following equipment: Close coupled, non-clogging submersible Pump for sewage/wastewater application, following discharge and rated head with suitable AC induction, totally enclosed, 3-Ph, 400 V, 50 Hz, insulation class F, Ingress protection IP 68 motors to be installed in wet well, alongwith electrical cable upto 10 m and control cable upto 10m, motor control unit, pressure gauge at discharge side, 01 Nos. sluice valve, 01 No non-return valve including final inspection at test bed as per Specifications. All equipment shall be from internationally reputed approved manufacturers and have USA/Europe origin. **a) Pump** Type: Submersible Application: Municipal sewage/wastewater Capacity = 25 m3/hr Head = 30 ft Min. Free Particle Size = 50 mm Min. Pump Efficiency = 70% Maximum speed = 1500-3000 rpm Casing: Cast iron ASTM A 48 Class 35, EN GJL 250 or better Impeller: Cast iron ASTM A 48 Class 35, EN GJL 250 or better Shaft: Stainless Steel AISI 431 or better Shaft Sleeve: Stainless Steel AISI 304 or better				

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BILL OF QUANTITY

BILL NO. 2.1 SEPTIC TANK AND SOAKAGE PIT

SR. NO.	Ref	DESCRIPTION	QUANTITY	UNIT	UNIT RATE (Rs)	AMOUNT (Rs)
		Mechanical Seal: Two mechanical seals Primary Seal : Silicon Carbide-Silicon Carbide Secondary Seal: Silicon Carbide-Carbon. Ingress Protection = IP 68 **b) Motor** Rated power suitable for Pump described in "a)" Insulation Class = F Ingress Protection = IP 68 Min. Efficiency = as per IE-2 **c) Motor Control Unit (MCU)** 2) Motor Control Unit (MCU) MCU (Motor Control Unit) consisting of MCCB, Over/Under voltage relay, Phase reversal relay, volt meter, ampere meter, EVR, Volt Selector Switch, Ampere Selector Switch, Current Transformer, indicating lights for all above relays, on/off push buttons. VFD Motor Control Unit with Dry running relay, Circuit Breaker, DC SPD, AC SPD, DC Change Over Switch, Auto Start Stop with Any input, Self-diagnostic and Self Protection, Dry Run Protection, Digital Controls with Complete Protective Functions, Ground Fault Monitoring, AC Short Circuit Protection, Under / Over Voltage and Over/ Current Protection, Reverse current Blocking, -10 to 40 Degree Celsius, Remote Monitoring and MPPT, water Level Detection, Pressure Level Detection, A/M Selector Switch, etc. All contained in lockable cabinet complete in all respect. d) 2 No's Sluice valve (rising type) and 1 No. Non return valve of B.S.S. 5163 quality and weight with each pumping set.	No.	2		
26		2" Felxible pipe 100 meter long		LS		

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BILL OF QUANTITY

BILL NO. 2.1 SEPTIC TANK AND SOAKAGE PIT

SR. NO.	Ref	DESCRIPTION	QUANTITY	UNIT	UNIT RATE (Rs)	AMOUNT (Rs)
27	N/S	Providing, installing, testing and commissioning Hydrostatic Level Submersible Transmitter/ Indicator for direct mounting in Over Head Reservoirs make of USA/Europe or equivalent, alongwith Level Display unit, Shielded wire of 3m complete in all respect as per instructions of the Engineer Incharge and including the following features. i) Range = 0m to 20m H2O ii) Accuracy= 0.1 % iii) Cable length= 10m iv) Output = 4-20 mA v) Housing material= Stainless Steel 316L vi) Measuring cell = Ceramics vii) Sealing material between sensor and housing= FPM	No.	1.00		
A-Total Amount						

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BILL OF QUANTITY

BILL NO. 2.2 BRICK DRAIN

Sr. No	Ref	DESCRIPTION	QTY.	UNIT	RATE (Rs.)	AMOUNT (Rs.)
1	4/13	Dismantling brick work in lime or cement mortar.	238.53	100Cft.		
2	4/19	c) Dismantling cement concrete 1:2:4 plain.	52.08	100Cft.		
3	4/20	Dismantling cement concrete reinforced, separating reinforcement from concrete, cleaning and straightening the same.	34.72	100Cft.		
4	3/7	Earthwork excavation in open cutting for storm water channels, drains, sullage drains in open areas, roads, streets, lanes, including under pinning of walls and shoring to protect existing works, shuttering and timbering the trenches, dressed to designed level and dimensions, trimming, removal of surface water from trenches, back filling and surplus excavated material disposed of and dressed within 50 ft. (15 m) lead:-				
		1) Upto 5' (1.5 meter) depth	118.74	1000 Cft		
		2) From 5.01 ft. (1.5 m) to 10.0 ft. (3.0 m) depth	11.87	1000 Cft		
5	10/3	Supplying and filling sand under floor; or plugging in wells. (Provisional for road cuts to be decided by the competent authority)	23.65	100 Cft.		
6	3/24	Compaction of earthwork (soft, ordinary or hard soil) :-				
		a) Mixing, moistening earth to optimum moisture content in layers for compaction, etc. complete.	87.57	1000 Cft.		
		c) Ramming earthwork (all types of soil).	87.57	1000 Cft.		

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BILL OF QUANTITY

BILL NO. 2.2 BRICK DRAIN

Sr. No	Ref	DESCRIPTION	QTY.	UNIT	RATE (Rs.)	AMOUNT (Rs.)
7	6/5(h)	Cement concrete plain including placing, compacting, finishing and curing complete (including screening and washing of stone aggregate): (h) Ratio 1: 3: 6 (Lean Concrete)	124.91	100 Cft.		
8	6/5(f)	Cement concrete plain including placing, compacting, finishing and curing complete (including screening and washing of stone aggregate): (f) Ratio 1: 2: 4	23.28	100 Cft.		
9	6/6	Providing and laying reinforced cement concrete (including prestressed concrete), using Ordinary Portland Cement / Sulphate resisting cement / Slag cement as may be required; coarse sand and screened graded and washed aggregate, in required shape and design, including forms, moulds, shuttering, lifting, compacting, curing, rendering and finishing exposed surface, complete (but excluding the cost of steel reinforcement, its fabrication and placing in position, etc.):- (a) Reinforced cement concrete in roof slab, beams, columns lintels, girders and other structural members laid in situ or precast laid in position, or prestressed members cast in situ, complete in all respects:- (2) Type B (nominal mix 1:1.5:3)	3650.74	Per Cft		

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BILL OF QUANTITY

BILL NO. 2.2 BRICK DRAIN

Sr. No	Ref	DESCRIPTION	QTY.	UNIT	RATE (Rs.)	AMOUNT (Rs.)
10	6/12 (b)	Fabrication of mild steel reinforcement for cement concrete, including cutting, bending, laying in position, making joints and fastenings, including cost of binding wire and labour charges for binding of steel reinforcement (also includes removal of rust from bars):-				
		(ii) (Grade-60)	91.08	100 Kg		
11	7/7 (i)	Pacca brick work other than building upto 10ft. (3 m) height. 1:3	477.06	100Cft.		
12	11/8	Cement plaster 1:3 upto 20' (6.00 m) height:- b) ½" (13 mm) thick	1272.17	100 Sft.		
13	3/17	Transportation of earth all types when the total distance, including the lead covered in the i tem of work, is more than 1000 ft. (300 m) **Total Lead 2 KM** (Transportation will be paid as per actual lead chart to be approved by the Engineer)	36.43	1000 Cft		
14	1/1	Carriage of 100 Cft. (2.83 cu.m) of all materials like stone aggregate, spawl , kankar lime (unslaked), surkhi , etc. or 150 Cft. (4.25 cu.m) of timber, by truck or by any other means owned by the contractor (crushed stone aggregate and bajri used in concrete items) Lead From nearest quarry (Sargodha Quarry) (193km)	165.12	100 Cft.		
15	13/9 (i)	Bitumen coating to plastered or cement concrete surface:- i) 20 lbs. per 100 Sft. (9.07 Kg per Sq.m)	691.44	100 Sft		

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BILL OF QUANTITY

BILL NO. 2.2 BRICK DRAIN

Sr. No	Ref	DESCRIPTION	QTY.	UNIT	RATE (Rs.)	AMOUNT (Rs.)
16	19/47	Providing, fixing, testing and commissioning of µ-PVC (Unplasticized Polyvinyl Chloride) Nikasi/ SWV pipe, Dadex / Popular / Beta or approved equivalent manufacturer, plain / Bell Ended / Z - Joints conforming to BS 4514 / BS 5255 - EN 1329 including the cost of specials and Solvents complete in all respects, as per drawings & specifications and / or as approved and directed by the Engineer Incharge.				
		(iii) 50mm	2795.31	Per Rft		
		(v) 110 mm	4176.00	Per Rft		
17	25/10	Fabrication of heavy steel work, with angle, tees, flat iron round iron and sheet iron for making trusses, girders, tanks, etc., including cutting, drilling, revitting, handling,assembling and fixing, but excluding erection in position. (screen)	0.58	100 Kg		
18	N/S	Providing & fixing of RPC slab manufactured with 100% recycled plastic composite material.				
		1.5 ft x 3 ft.	368.75	Nos		
		2 ft x 3 ft.	1015.75	Nos		
Total Amount						

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BILL OF QUANTITY

BILL NO 2.6 INFLUENT WASTEWATER PUMPING STATION

SR. NO.	Ref	DESCRIPTION	QUANTITY	UNIT	UNIT RATE (Rs)	AMOUNT (Rs)
		CIVIL WORKS				
1	3/49	Jungle clearance and removing within 100 ft. (30 m). (Provisional Qty to be executed after approval of the Engineer)				
		a) Ordinary	7.20	100 Sft.		
		b) Heavy	4.80	100 Sft.		
2	3/50	Uprooting Sarkanda growth and disposal within 100 ft. (30 m) (Provisional Qty to be executed after approval of the Engineer)	6.00	100 Sft.		
3	26/36	Bailing out water:- (Provisional Qty to be executed after approval of the Engineer)				
		b) by pump	7.20	1000 Cft		
4	3/21(a)	Excavation in foundation of building, bridges and other structures, including dagbelling, dressing, refilling in layers around structure with excavated earth, watering and ramming lead 'upto one chain (30 m) and lift upto 5 ft. (1.5 m)				
		1) Depth upto 5ft (1.5m)				
		b) By Excavator				
		ii) in ordinary soil.	6.00	1000 Cft.		
		2) a) Depth from 5.1 ft (1.5m) to 15 ft (4.5 m):- By Excavator				
		ii) Ordinary soil	8.00	1000 Cft.		
		b) Depth above 15.1 ft (4.5 m):-				
		ii) Ordinary soil	2.00	1000 Cft.		
5	26/43	Spraying termite proofing by using liquid FMC / Biflex / Terminex Exin / Ms Hextaror equivalent @ specified suspension concenterate (SC), Mixing Ability-HEXTAR with Ratio (1:250) =540 Sft or equivalent approved liquid applying with shower and certificate will be provided by the contractor for 10 years complete in all respect as approved by the Engineer Incharge.	1,108.00	Sft		
6	6/5	Cement concrete plain including placing, compacting, finishing and curing complete (including screening and washing of stone aggregate):				
		(f) Nominal mix Ratio 1:2:4	4.00	100Cft		
7	13/9	Bitumen coating to plastered or cement concrete surface:-				
		i) 20 lbs. per 100 Sft. (9.07 Kg per Sq.m)	38.00	100 Sft.		

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BILL OF QUANTITY

BILL NO 2.6 INFLUENT WASTEWATER PUMPING STATION

SR. NO.	Ref	DESCRIPTION	QUANTITY	UNIT	UNIT RATE (Rs)	AMOUNT (Rs)
8	6/6	Providing and laying reinforced cement concrete (including prestressed concrete), using Ordinary Portland Cement / Sulphate resisting cement / Slag cement as may be required; coarse sand and screened graded and washed aggregate, in requi red shape and design, including forms, moulds, shuttering, lifting, compacting, curing, rendering and f inishing exposed surface, complete (but excluding the cost of steel reinforcement, its fabrication and placing in position, etc.):-				
		(a) Reinforced cement concrete in roof slab, beams, columns lintels, girders and other structural members laid in situ or precast laid in position, or prestressed members cast in situ, complete in all respects:-				
		(1) Type A (nominal mix 1:1:2)	3,416.00	Per Cft		
		(c) Reinforced cement concrete in Pile cap, slab of rafts / strip foundation, base slab of column and retaining walls; etc and footing beams, other structural members other than those mentioned in 6(a-d) above not requiring form work (i.e. horizontal shuttering) complete in all respects:-				
		(1) Type A (nominal mix 1: 1: 2)	1,647.00	Per Cft		
9	6/12	Fabrication of mild steel reinforcement for cement concrete, including cutting, bending, laying in position making joints and fastenings including cost of binding wire and labour charges for binding of steel reinforcement (also includes removal of rust from bars)				
		C) Deformed bars (Grade 60)	229.73	100 Kg		

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BILL OF QUANTITY

BILL NO 2.6 INFLUENT WASTEWATER PUMPING STATION

SR. NO.	Ref	DESCRIPTION	QUANTITY	UNIT	UNIT RATE (Rs)	AMOUNT (Rs)
15	25/10,11	Providing and fabrication of heavy steel work with angle, tees, flat iron, round iron and sheet iron for making trusses, girders, tanks, etc., including, cutting, drilling, rivitting, handling, assembling and fixing, including erection and fitting in position iron trusses, staging of water tanks, etc. as per drawings. (Perovisional Qty)	16.70	100 Kg		
16	25/36	Providing and fixing terrace railing of 2" (50mm) i/d conduit pipe 16 SWG, welded with 5/8"x5/8" (16x16mm) suitable arrangement, complete in all respects, as per design and drawing.	234.00	Per Rft.		
18	1/1	Carriage of 100 Cft. (2.83 cu.m) of all materials like stone aggregate, spawl , kankar lime (unslaked), surkhi , etc. or 150 Cft. (4.25 cu.m) of timber, by truck or by any other means owned by the contractor. Lead From approved nearby quarry	42.51	100Cft.		
19	23/18	Providing, laying, cutting, jointing, testing and disinfecting cast iron pipe line (BS-2035) in trenches, with flanged and flanged joints, complete in all respects: -				
		iv) 6" (150 mm) i/d	65.00	Rft		
		v) 8" (200 mm) i/d	20.00	Rft		
21	23/21	Providing and fixing cast iron special of B.S.S. Class `B' (such as bend, tee cross collar , reducer, tail piece, flanged spigot, cap, flanged socket, taper, angle branch, plug etc.) for cast iron pipe line , complete:-				
		b) C.I flanged specials, with flanged and flanged joints:-				
		i) 3" to 6" (75 to 150 mm) i/d DN 150 Bend 6 No 200x200x150 Reducing Tee 6 No DN 150 Puddle Flange DN 800 Pipe Barrel	1,140.00	Per Kg		
22	23/35	Providing and fixing sluice valve of B.S.S. quality and weight, Class `B', for cast iron pipe line, and Asbestos cement pipe line (including cost of jointing material):-				
		d) 6" i/d (150 mm)	4.00	Each		

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BILL OF QUANTITY

BILL NO 2.6 INFLUENT WASTEWATER PUMPING STATION

SR. NO.	Ref	DESCRIPTION	QUANTITY	UNIT	UNIT RATE (Rs)	AMOUNT (Rs)
23	23/44	Providing and fixing heavy duty Check valve of specified diameter and material for pressure rating PN-16 made of Crane (USA), Hatersly (UK), Scon (Pakistan) or approved equivalent manufacturer i/c the cost of all accessories flanges,nut/bolt and gaskit where required complete in all respect as approved and directed by the Engineer Incharge.				
		(b) Flange Ended Ductile Iron Valve				
		(xi) 6" dia	4.00	Each		
22	3/17	Transportation of earth all types when the total distance, including the lead covered in the item of work, is more than 300m				
		a) upto ¼ mile (400 m).	12.00	1000 Cft.		
		b) for every 330 ft. (100 m) additional lead or part thereof, beyond ¼ mile (400 m) upto one mile. (1.6 Km.) (Lead 1 Km)	12.00	1000 Cft.		
23	13/45	Preparing surface and painting with Matt/Glossy high chemical resistant/hard wearing Polyurethane paint (Epoxy Paint) by sprayer/Brush i/c the cost of Primer coat , all material and labour complete in all respects as approved and directed by the Engineer Incharge.				
		(i)Priming Coat	2,671.00	Per Sft		
		(ii) Each and subsequent Coat	5,342.00	Per Sft		
		<u>FORCEMAIN</u>				
25	3/46	Excavation of trenches in all kinds of soil, except cutting rock, for watersupply pipelines/electric cables upto 5 ft. (1.5 m) depth from ground level, including backfilling, trimming, dressing sides, leveling the beds of trenches to correct grade and cutting pits for joints, etc. complete in all respects.				
		i) ordinary	10.32	1000 Cft.		
26	10/3	Providing and laying sand under and around the sewer pipe, including leveling, manual compaction, complete in all respect. (for bedding of forcemain)	9.16	100Cft.		

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SR. NO.	Ref	DESCRIPTION	QUANTITY	UNIT	UNIT RATE (Rs)	AMOUNT (Rs)
27	6/5	Cement concrete plain including placing, compacting, finishing and curing complete (including screening and washing of stone aggregate): (Thrust Blocks pervisional Qty)				
		(f) Nominal mix Ratio 1: 2: 4	1.00	100Cft		
28	23/30	Providing, laying, cutting, jointing, testing and disinfecting High Density Polyethylene Pipe (HDPE-100) working presure pipe conforming to standard ISO4427, PS3580, Beta/ Dadex/ Popular/ IIL or approved equivalent manufacturer, including the cost of specials, in trenches,as approved & directed by the engineer incharge, complete in all respects.				
		PN-8				
		ii) 160 mm	1,000.00	Rft		
29	23/35	Providing and fixing sluice valve of B.S.S. quality and weight, Class `B', for cast iron pipe line, and Asbestos cement pipe line (including cost of jointing material):-				
		b) 4" i/d (100 mm)	4.00	Each		
30	1/1	Carriage of 100 Cft. (2.83 cu.m) of all materials like stone aggregate, spawl , kankar lime (unslaked), surkhi , etc. or 150 Cft. (4.25 cu.m) of timber, by truck or by any other means owned by the contractor. Lead from approved nearby quarry	0.88	100Cft.		
31	3/13(a) & 24(c)	Rehandling of earthwork, lead upto a single throw of kassi, phaorah or shovel, including ramming earth in all types of soil.	9.18	1000 Cft.		
				TOTAL MRS ITEMS (A)		

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BILL NO 2.6 INFLUENT WASTEWATER PUMPING STATION

SR. NO.	Ref	DESCRIPTION	QUANTITY	UNIT	UNIT RATE (Rs)	AMOUNT (Rs)
	B	**CIVIL AND MECHANICAL WORKS NON-MRS**				
1	Quotation	Designing, manufacturing, testing at manufacturer's workshop, supplying at site, installation, testing, commissioning, guarantee and maintenance for one year during defect Liability Period of each item of following equipment: Close coupled, non-clogging submersible Pump for sewage/wastewater application, following discharge and rated head with suitable AC induction, totally enclosed, 3-Ph, 400 V, 50 Hz, insulation class F, Ingress protection IP 68 motors to be installed in wet well, alongwith electrical cable upto 10 m and control cable upto 10m, motor control unit, pressure gauge at discharge side, 01 Nos. sluice valve, 01 No non-return valve including final inspection at test bed as per Specifications. All equipment shall be from internationally reputed approved manufacturers and have USA/Europe origin. **a) Pump** Capacity =40 m³/h (0.40 cusecs) Head = 30 ft Min. Free Particle Size = 50 mm Min. Pump Efficiency = 70% Maximum speed = 1500-3000 rpm Casing: Cast iron ASTM A 48 Class 35, EN GJL 250 or better Impeller: Cast iron ASTM A 48 Class 35, EN GJL 250 or better Shaft: Stainless Steel AISI 431 or better Shaft Sleeve: Stainless Steel AISI 304 or better Mechanical Seal: Two mechanical seals Primary Seal : Silicon Carbide-Silicon Secondary Seal: Silicon Carbide-Carbon. Ingress Protection = IP 68 **b) Motor** Rated power suitable for Pump described in "a)" Insulation Class = F Ingress Protection = IP 68 Min. Efficiency = as per IE-2	2	No		

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BILL OF QUANTITY

BILL NO 2.6 INFLUENT WASTEWATER PUMPING STATION

SR. NO.	Ref	DESCRIPTION	QUANTITY	UNIT	UNIT RATE (Rs)	AMOUNT (Rs)
		c) Motor Control Unit (MCU) 2) Motor Control Unit (MCU) MCU (Motor Control Unit) consisting of MCCB, Over/Under voltage relay, Phase reversal relay, volt meter, ampere meter, EVR, Volt Selector Switch, Ampere Selector Switch, Current Transformer, indicating lights for all above relays, on/off push buttons. VFD Motor Control Unit with Dry running relay, Circuit Breaker, DC SPD, AC SPD, DC Change Over Switch, Auto Start Stop with Any input, Self-diagnostic and Self Protection, Dry Run Protection, Digital Controls with Complete Protective Functions, Ground Fault Monitoring, AC Short Circuit Protection, Under / Over Voltage and Over/ Current Protection, Reverse current Blocking, -10 to 40 Degree Celsius, Remote Monitoring and MPPT, water Level Detection, Pressure Level Detection, A/M Selector Switch, etc. All contained in lockable cabinet complete in all respect.				
2	Quotation	Designing, manufacturing, testing at manufacturer's workshop, supplying at site, installation, testing, commissioning, guarantee and maintenance for one year during defect Liability Period of each item of following equipment: Close coupled, non-clogging submersible Pump for sewage/wastewater application, following discharge and rated head with suitable AC induction, totally enclosed, 3-Ph, 400 V, 50 Hz, insulation class F, Ingress protection IP 68 motors to be installed in wet well, alongwith electrical cable upto 10 m and control cable upto 10m, motor control unit, pressure gauge at discharge side, 01 Nos. sluice valve, 01 No non-return valve including final inspection at test bed as per Specifications. All equipment shall be from internationally reputed approved manufacturers and have USA/Europe origin.				

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BILL OF QUANTITY

BILL NO 2.6 INFLUENT WASTEWATER PUMPING STATION

SR. NO.	Ref	DESCRIPTION	QUANTITY	UNIT	UNIT RATE (Rs)	AMOUNT (Rs)
		a) Pump Type: Submersible Application: Municipal sewage/wastewater Capacity = 35 m3/hr Head = 30 ft Min. Free Particle Size = 50 mm Min. Pump Efficiency = 70% Maximum speed = 1500-3000 rpm Casing: Cast iron ASTM A 48 Class 35, EN GJL 250 or better Impeller: Cast iron ASTM A 48 Class 35, EN GJL 250 or better Shaft: Stainless Steel AISI 431 or better Shaft Sleeve: Stainless Steel AISI 304 or better Mechanical Seal: Two mechanical seals Primary Seal : Silicon Carbide-Silicon Carbide Secondary Seal: Silicon Carbide-Carbon. Ingress Protection = IP 68 **b) Motor** Rated power suitable for Pump described in "a)" Insulation Class = H Ingress Protection = IP 68 Min. Efficiency = as per IE-2 **c) Motor Control Unit (MCU)** 2) Motor Control Unit (MCU) MCU (Motor Control Unit) consisting of MCCB, Over/Under voltage relay, Phase reversal relay, volt meter, ampere meter, EVR, Volt Selector Switch, Ampere Selector Switch, Current Transformer, indicating lights for all above relays, on/off push buttons. VFD Motor Control Unit with Dry running relay, Circuit Breaker, DC SPD, AC SPD, DC Change Over Switch, Auto Start Stop with Any input, Self-diagnostic and Self Protection, Dry Run Protection, Digital Controls with Complete Protective Functions, Ground Fault Monitoring, AC Short Circuit Protection, Under / Over Voltage and Over/ Current Protection, Reverse current Blocking, -10 to 40 Degree Celsius, Remote Monitoring and MPPT, water Level Detection, Pressure Level Detection, A/M Selector Switch, etc. All contained in lockable cabinet complete in all respect.	2	No		

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BILL OF QUANTITY

BILL NO 2.6 INFLUENT WASTEWATER PUMPING STATION

SR. NO.	Ref	DESCRIPTION	QUANTITY	UNIT	UNIT RATE (Rs)	AMOUNT (Rs)
3	RA-05	Providing Fixing Melleable Iron Steps conforming to ASTM 48 specification for grey iron or equal including the manhole as per drawing including carriager and setting the same to correct line and levels to the satisfaction of Engineer Incharge.	58	No.		
4	RA-01	Providing and fixing motorized operated penstock gate (including gear and automatic switch) as per B.S.S 7775 of below mentioned size with CI shutter and frame/channel with interior brass channel on bottom and two sides through which gate travels i/c non-magnetic SS spindle with square thread CI head stock and wheel etc complete in all respect as per drawing and directed by the engineer incharge				
		Penstock Gate Size with clear opening (310mm x 310mm)	2	No.		
		FORCEMAIN				
5	RA-02	Providing, transportation, fixing and Jointing of MS flanges to joint the valves with HDPE pipe line complete in all respect and as per approval of The Engineer.				
		MS Flange (160mm) 6" Dia	4	Each		
					Sub Total (B)	
					Total Amount (A+B)	
					Grand Total	

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COST ESTIMATE

BILL NO. 2.7 ANAEROBIC BAFFLED REACTOR

SR. NO.	Ref	DESCRIPTION	QUANTITY	UNIT	UNIT RATE (Rs)	AMOUNT (Rs)
		CIVIL WORKS				
1	3/49	Jungle clearance and removing within 100 ft. (30 m). (Provisional Qty to be executed after approval of the Engineer)				
		a) light	435.60	100 Sft.		
		b) thick	435.60	100 Sft.		
2	3/50	Uprooting Sarkanda growth and disposal within 100 ft. (30 m) (Provisional Qty to be executed after approval of the Engineer)	435.60	100 Sft.		
3	26/36	Bailing out water:- (Provisional Qty to be executed after approval of the Engineer)				
		b) by pump	217.80	1000 Cft		
4	3/25	Compaction of earthwork with power road roller (compaction equipment to be decided as per site condition after approval of the Engineer), including ploughing, mixing, moistening earth to optimum moisture content in layers, etc. complete: (Surplus earth for sewer line and disposal will be used)				
		i) 95% to 100% maximum modified AASHO dry density.	108.00	1000 Cft		
5	3/21	Excavation in foundation of building, bridges and other structures, including dagbelling, dressing, refilling around structure with excavated earth, watering and ramming lead upto one chain (30 m) and lift upto 5 ft. (1.5 m)				
		b) By Excavator				
		ii) Ordinary soil	24.90	1000 Cft.		
6	3/27	Extra for slush or Daldal including. (Provisional Qty to be executed after approval of the Engineer)dewatering.	2.00	1000 Cft		
7	21/17	Desilting/Desludging of disposal work collecting tank, including removal of sludge within 3 chains (90 metre).	108.90	100Cft.		
8	10/3	Supplying and filling sand under floor; or plugging in wells.	2.92	100Cft		

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COST ESTIMATE

BILL NO. 2.7 ANAEROBIC BAFFLED REACTOR

SR. NO.	Ref	DESCRIPTION	QUANTITY	UNIT	UNIT RATE (Rs)	AMOUNT (Rs)
9	6/5	Cement concrete plain including placing, compacting, finishing and curing complete (including screening and washing of stone aggregate): **(h) Ratio 1: 3: 6**	16.48	100 Cft.		
10	6/6	Providing and laying reinforced cement concrete (including prestressed concrete), using Ordinary Portland Cement / Sulphate resisting cement / Slag cement as may be required; coarse sand and screened graded and washed aggregate, in required shape and design, including forms, moulds, shuttering, lifting, compacting, curing, rendering and finishing exposed surface, complete (but excluding the cost of steel reinforcement, its fabrication and placing in position, etc.):- (a) Reinforced cement concrete in roof slab, beams, columns lintels, girders and other structural members laid in situ or precast laid in position, or prestressed members cast in situ, complete in all respects:- (1) Type A (nominal mix 1:1:2)	7,528.47	Cft.		
		(c) Reinforced cement concrete in Pile cap, slab of rafts / strip foundation, base slab of column and retaining walls; etc and footing beams, other structural members other than those mentioned in 6(a-d) above not requiring form work (i.e. horizontal shuttering) complete in all 1) Type A (nominal mix 1: 1: 2)	4,036.78	Cft.		
11	6/12	Fabrication of mild steel reinforcement for cement concrete, including cutting, bending, laying in position, making joints and steel chairs, etc. complete in all respect. and fastenings, including cost of binding wire and labour charges for binding of steel reinforcement (also Includes removal of rust from bars):- ('c) Deformed bars (Grade-60)	419.79	100 Kg		
12	7/7(i)	Pacca brick work other than building upto 10ft. (3 m) height. i) cement, sand mortar:- Ratio 1:3	26.34	100Cft.		

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COST ESTIMATE

BILL NO. 2.7 ANAEROBIC BAFFLED REACTOR

SR. NO.	Ref	DESCRIPTION	QUANTITY	UNIT	UNIT RATE (Rs)	AMOUNT (Rs)
13	23/30	Providing, laying, cutting, jointing, testing and disinfecting High Density Polyethylene Pipe (HDPE-100) working presure pipe, Beta/ Dadex/ Popular/ IIL or equivalent including the cost of specials, in trenches, as approved & directed by the engineer incharge, complete in all respects. **b) PN-8 (SDR-21)** ii) 160 mm	840.00	P.Rft		
14	23/42	Providing and fixing heavy duty Gate valve of specified diameter and material for pressure rating PN-16 mde of Crane (USA), Hatersly (UK) or Scon (Pakistan) i/c the cost of all accessories flanges,nut/bolt and gaskit where required complete in all respect as approved and directed by the Engineer Incharge. (b) Flange Ended Ductile Iron Valve (xi) 6" dia	4.00	Each		
15	23/18	Providing, laying, cutting, jointing, testing and disinfecting cast iron pipe line (BS-2035) in trenches (and vent), with flanged and flanged joints, complete in all respects:- d) 6" (150 mm) i/d	144.00	P.Rft		
16	23/21	Providing and fixing cast iron specials of B.S.S. Class 'B' (such as bend, tee, cross collar, reducer, tail piece, flanged socket, flanged spigot, cap, taper, angle branch, plug, etc) for Asbestos cement pipe line, with comet joint and rubber ring, complete. i) 3" to 6" (75 to 150 mm) i/d	1,242.00	Per Kg		
17	11/8a	Cement plaster 1:3 upto 20' (6.00 m) height:- 3/8" (10 mm) thick	70.23	100Sft		
18	6/32	Providing and embedding 10" (250mm) wide PVC water stopper in expansion joints of RCC structures (Retaining walls, water tanks, Slabs) complete in all respect. i) 6 mm thick	366.00	Rft		

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COST ESTIMATE

BILL NO. 2.7 ANAEROBIC BAFFLED REACTOR

SR. NO.	Ref	DESCRIPTION	QUANTITY	UNIT	UNIT RATE (Rs)	AMOUNT (Rs)
19	1/1	Carriage of 100 Cft. (2.83 cu.m) of all materials like stone aggregate, spawl , kankar lime (unslaked), surkhi , etc. or 150 Cft. (4.25 cu.m) of timber, by truck or by any other means owned by the contractor. Lead from approved nearby quarry	124.28	1000Cft		
20	13/45	Preparing surface and painting with Matt/Glossy high chemical resistant/hard wearing Polyurethane paint (Epoxy Paint) by sprayer/Brush i/c the cost of Primer coat , all material and labour complete in all respects as approved and directed by the Engineer Incharge.				
		(i)Priming Coat	14,806.00	Per Sft		
		(ii) Each and subsequent Coat	29,612.00	Per Sft		
21	10/43	Providing and laying Tuff Pavers, having 7000PSI, crushing strength of approved manufacturer, over 2" to 3" sand cushion i/c grouting with sand in joints i/c finishing to require slope. Complete in all respect. 50% Grey / 50% Coloured)				
		b) 60-mm thick	4,000.00	Per Sft		
22	18/3a	Providing and laying sub-base course of stone product approved quality and grade, including placing, mixing, spreading and compaction of sub-base material to required depth, camber, grade to achieve 100% maximum modified AASHO dry density, including carriage of all material to site of work except gravel and aggregate.	20.00	100Cft.		
23	13/33	Providing and applying weather shield paint of approved quality on external surface of building including preparation of surface, application of primer complete in all respect: a) new surface:				
		i) 1st coat	30.96	100 Sft.		
		ii) 2nd coat	30.96	100 Sft.		
24	3/15	Filling, watering and ramming earth under floors:-				
		i) with surplus earth from foundation, etc.	17.43	1000 Cft.		
		ii) with new earth excavated from outside,	110.57	1000 Cft.		

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TEHSIL KOT MOMIN, DISTRICT SARGODHA VILLAGES (WAN MIANA, WAN MIANA COLONY & RAHIMPUR)
COST ESTIMATE

BILL NO. 2.7 ANAEROBIC BAFFLED REACTOR

SR. NO.	Ref	DESCRIPTION	QUANTITY	UNIT	UNIT RATE (Rs)	AMOUNT (Rs)
25	3/16	Extra for every 50 ft. (15 m) additional lead or part thereof i) for earhtwork soft, ordinary, hard and very hard.(Lead 1000ft)	110.57	1000 Cft.		
26	3/17	Transportation of earth all types when the total distance, including the lead covered in the item of work, is more than 1000 ft. (300 m) (Transportation will be paid as per actual lead chart to be approved by the Engineer) a) upto ¼ mile (400 m).	110.57	1000 Cft.		
		A-Total Amount				
B		**NON MRS**				
1	N/S	Providing & fixing of RPC manhole cover manufactured with 100% recycled plastic composite material, 650 mm (26"dia) with clear opening size 600 mm (24" dia) and rpc manhole frame having dia meter 790 mm (31.1") with average breaking load capacity of 10 ton and weight including frame of 50 kg (minimum).	24.00	Each		
2	N/S	Providing and fixing motorized operated penstock gate (including gear and automatic switch) as per B.S.S 7775 of below mentioned size with CI shutter and frame/channel with interior brass channel on bottom and two sides through which gate travels i/c non-magnetic SS spindle with square thread CI head stock and wheel etc complete in all respect as per drawing and directed by the engineer incharge Penstock Gate Size with clear opening (310mm x 310mm)	4.00	Each		
3	N/S	Mannual boring for laying of HDPE Pipe under roads complete in all respects to satisfaction of Engineer In-charge. (Provisional Qty) i) 160 mm	40.00	Rft		
					B-Total Amount	
					Grand Total (A+B)	

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BILL OF QUANTITY

BILL NO 2.3 SEWER LINES

SR. NO.	Ref	DESCRIPTION	QUANTITY	UNIT	UNIT RATE (Rs)	AMOUNT (Rs)
A		**2nd BI-ANNUAL-2025 (01.07.2025 to 31.12.2025)**				
		SEWER LINE				
1	3/43	Earth work excavation in open cutting for water supply lines, sewers and manholes including backfilling, shuttering of wooden vertical planks, struts and beams, dressing to correct section and dimension according to templates and levels and removing surface water i/c back filling in all types of soil except shingle, gravel and rock, complete in all respect. If wooden planks, beams and struts are not used at site, the Composite Rates may be reduced by **1) By Manual** i) RS. 5,489.75 1000 Cft ii) RS. 6,418.75 1000 Cft i) 0 ft. to 7.0 ft. (0 to 2.10 m) depth	248.87	1000 Cft.		
2	21/3	Providing and laying R.C.C pipe sewers,moulded with R.C.C 1:1.5:3 conforming to ASTM specifications C-76-79 (Latest version), class II,Wall B including carriage of pipes from factory to site of work, lowering in trenches to correct alignment and grade, jointing with rubber ring, cutting pipes where necessary, testing, etc. complete. **a) Class-II** (i) 310 mm (12") i/d	9,214.00	Rft.		
		b) Class-III (i) 310 mm (12") i/d	3,948.00	Rft.		
3	3/25	Compaction of earthwork with power road roller (compaction equipment to be decided as per site condition after approval of the Engineer), including ploughing, mixing, moistening earth to optimum moisture content in layers, etc. complete: ii) 90% maximum modified AASHO dry density (backfilling)	23.96	1000 Cft.		

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BILL OF QUANTITY

BILL NO 2.3 SEWER LINES

SR. NO.	Ref	DESCRIPTION	QUANTITY	UNIT	UNIT RATE (Rs)	AMOUNT (Rs)
4	21/22	Providing and laying sand under and around the sewer pipe, including leveling, manual compaction, complete in all respect. (Provisional Qty for filling under major road as per approval of the Engineer.)	31.39	100Cft.		
5	21/21	Providing and laying crushed stone aggregate of 1/4" to 1-1/2" guage under and around the sewer pipe, including leveling, manual compaction, complete in all respects.	282.55	100Cft		
6	3/17	Transportation of earth all types when the total distance, including the lead covered in the item of work, is more than 1000 ft. (300 m) (Transportation will be paid as per actual lead chart to be approved by the Engineer)				
		a) upto ¼ mile (400 m).	79.83	1000 Cft.		
		MANHOLES and House Connection Chamber				
7	3/43	Earth work excavation in open cutting for water supply lines, sewers and manholes including backfilling, shuttering of wooden vertical planks, struts and beams, dressing to correct section and dimension according to templates and levels and removing surface water i/c back filling in all types of soil except shingle, gravel and rock, complete in all respect. If wooden planks, beams and struts are not 1) By Manual i) RS. 5,489.75 1000 Cft ii) RS. 6,418.75 1000 Cft				
		i) 0 ft. to 7.0 ft. depth	89.15	1000 Cft.		
8	21/21	Providing and laying crushed stone aggregate of 1/4" to 1" guage under and around the sewer pipe,including leveling, manual compaction, complete in all respects.	93.66	100Cft.		
9	6/5	Cement concrete plain including placing, compacting, finishing and curing complete (including screening and washing of stone aggregate):				
		nominal mix Ratio 1:3:6	59.38	100Cft		
		nominal mix Ratio 1:2:4	31.23	100Cft		

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BILL OF QUANTITY

BILL NO 2.3 SEWER LINES

SR. NO.	Ref	DESCRIPTION	QUANTITY	UNIT	UNIT RATE (Rs)	AMOUNT (Rs)
10	6/6	Providing and laying reinforced cement concrete (including prestressed concrete), using coarse sand and screened graded and washed aggregate, in required shape and design, ncluding forms, moulds, shuttering, lifting, compacting, curing, rendering and finishing exposed surface, complete (but excluding the cost of steel reinforcement, its fabrication and placing in posi tion, etc.)				
		(a) (i) Reinforced cement concrete in roof slab, beams, columns lintels, girders and other structural members laid in situ or precast laid in position, or prestressed members cast in situ, complete in all respects:-				
	0.84	(2) Type B (nominal mix 1: 1½: 3)	661.50	Per Cft		
11	6/12 (c)	Fabrication of mild steel reinforcement for cement concrete, including cutting, bending, laying in position, making joints and fastenings, including cost of binding wire and labour charges for binding of steel reinforcement (also includes removal of rust from bars):-				
		('c) Deformed bars (Grade-60)	18.00	100Kg		
12	1/1	Carriage of 100 Cft. (2.83 cu.m) of all materials like stone aggregate, spawl , kankar lime (unslaked), surkhi , etc. or 150 Cft. (4.25 cu.m) of timber, by truck or by any other means owned by the contractor (crushed stone aggregate and bajri used in concrete items) Lead From Approved Query)	336.00	100 Cft.		
13	7/7	Pacca brick work other than building upto 10ft. (3 m) height.				
		i) cement, sand mortar:-				
		Ratio 1:3	168.13	100Cft.		
14	7/10	Extra for pacca brick work in steining of wells or any other circular masonry..	141.40	100Cft.		
15	11/16	Cement pointing flush upto 20' (6.00m) height:-				
		a) ratio 1:2	158.76	100 Sft.		
16	11/8	Cement plaster 1:3 upto 20' (6.0 m) ht:				

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BILL OF QUANTITY

BILL NO 2.3 SEWER LINES

SR. NO.	Ref	DESCRIPTION	QUANTITY	UNIT	UNIT RATE (Rs)	AMOUNT (Rs)
		b) 1/2"(13mm) thick	279.86	100 Sft.		
17	21/6	Constructing standard gully grating chamber, 3'x2½' (900x750 mm), with chinaware trap as per PHED Drawing STD/PD No. 3 of 1977, complete in all respects.	29.00	Each		
18	19/47	Providing, fixing, testing and commissioning of µ-PVC (Unplasticized Polyvinyl Chloride Nikasi/SWV pipe, Dadex/Popular/Beta or approved equivalent manufacturer, plain/Bell Ended/Z-Joints conforming to BS4514/BS5255-EN1329 including the cost of specials and Solvents complete in all respects, as per drawings & specifications and/ or as approved and directed by the Engineer Incharge.				
		(v) 4"(110 mm)	2,882.00	Rft.		
19	21/11	Providing and fixing 1¼"x1¼"x3/16" (31x31x5 mm) angle iron step, in manhole chambers, including carriage and setting the same in work to correct lines and levels.	958.00	Each		
20	13/9	Bitumen coating to plastered or cement concrete surf ace: -				
		i) 20 lbs. per 100 Sf t. (9.07 Kg per Sq.m)	279.86	100 Sft.		
21	21/7	Extra for making and finishing benching floor work in manholes chambers with 1/8(3mm) thick cement	26.64	100 Sft.		
22	25/10+11	Fabrication of heavy steel work, with angle, tees, flat iron round iron and sheet iron for making trusses, girders, tanks, etc., including cutting, drilling, revitting, handling, assembling and fixing, but including erection in position. (For Grating)	4.44	100 Kg		
23	3/17	Transportation of earth all types when the total distance, including the lead covered in the item of work, is more than 1000 ft. (300 m) (Transportation will be paid as per actual lead chart to be approved by the Engineer)				
		a) upto ¼ mile (400 m).	21.60	1000 Cft.		
				Sub Total (A)		

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BILL OF QUANTITY

BILL NO 2.3 SEWER LINES

SR. NO.	Ref	DESCRIPTION	QUANTITY	UNIT	UNIT RATE (Rs)	AMOUNT (Rs)
B		**NON MRS ITEMS**				
1	NS	Providing and Fixing RPC Manhole Cover Manufactured with 100% Recycled Plastic Composite Material, 650 mm (26"dia) with clear opening size 600 mm (24" dia) and RPC manhole frame having dia meter 790 mm (31.1") with average breaking load capacity of 10 Ton and weight including frame of 50 kg (Minimum).	212.00	Per Set		
					Sub Total (B)	
					Grand Total	

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BILL NO. 2.6.9: ELECTRIFICATION OF DISPOSAL STATION (WAN MIANA)

Sr. No.	Description	M.R.S (Item/Chap)	Qty.	Unit	Rate (Rs.) In Figure	Amount (Rs.)
1.0	**WIRING AND ACCESSORIES**					
1.1	Wiring of light or fan point from switch board/dimmer to the point with 3x1.5 mm^2 (P+N+E) PVC insulated single core stranded cables in 25 mm PVC conduit/pipe concealed in walls, columns and slabs including accessories, PVC box, 10 Amp. gang switch 1 or 2 way as required, one for each light or fan and installed as in specifications complete in all respects.	8(c-ii)/24, 3(iii)/24, 16(i)/24, 34(ii)/24	24	Each		
1.2	Circuit wiring from DB/ MCBs to gang switches board and from switch board to another switch board with 3x2.5 mm^2 (P+N+E) PVC insulated single core stranded cables in 25mm PVC pipe/conduit concealed in walls, columns and slabs as required complete in all respects.	8(c-iii)/24, 3(iii)/24	8	Each		
1.3	The same as item No. 1.1 but from one light point to another light point.	8(c-ii)/24, 3(iii)/24	40	Each		
1.4	10/13 Amp 3 pin universal flush mounting switch socket outlet wired from DB/MCBs to first outlet with 3x4 mm^2 (P+N+E) single core cable stranded (away from switch board) in 25mm PVC pipe/conduit concealed in walls, columns and slabs as required complete in all respects.	8(c-iv)/24, 17(ii)/24, 39(i)/24, 3(iii)/24	6	Each		
1.5	The same as item No.1.4 but wiring from one socket outlet to another socket outlet with 3x2.5 mm^2 (P+N+E) single core stranded cable in 25mm PVC pipe/conduit concealed in walls, columns and slabs as required complete in all respects.	8(c-iii)/24, 3(iii)/24, 16(ii), 38(i)	6	Each		
1.6	15/20 Amp 3 pin mounting switch socket outlet wired from DB MCBs to independent socket outlet with 3x6 mm^2 (P+N+E) single core stranded cable (away from switchboard) in 25mm PVC pipe/conduit concealed in walls, columns and slabs as required complete in all respects.	8(c-v)/24, 3(iii)/24, 38(ii)/24, 16(ii)/24	6	Each		
2.0	**Road / Street Lighting Poles and Foundations**					
2.1	10m high single arm octagonal shape electric street light pole, made of hot dipped 4.5 mm thick (7 SWG) galvanized steel, tappered from 225 mm at bottom to 100 mm at top, with 1500 mmx60 mmx4mm thick dia. arm for luminaire installation, duly G.I.welded with 470x470x20 mm base plate with the help of 4 no triangular stiffeners 100x350x20 mm of GI sheet, with built in junction box with shutter & one (01) no. 2A SP MCB 10kA breaker, i/c the cost of nuts & J-rag bolts, duly fixed in prelaid concrete foundation, foundation will be paid additionally as approved and directed by the Engineer Incharge.	69(a-ii)/24, 85(a-i)/24	12	Each		
2.2	Road/Street Lighting Pole Foundations including 04 nos. of dia 25mm J-Bolts, PVC long Bends Class (3000 Psi- cylinder strength) concrete, 60 grade reinforced steel, Excavation, Blinding Concrete, Common Backfilling & Bitchmen Coating etc. as shown on drawing. Complete in all respect.	11 (c)/6, 8 (ii)/6, 12/9, 3/10	12	Each		

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TEHSIL KOT MOMIN, DISTRICT SARGODHA VILLAGES (WAN MIANA, WAN MIANA COLONY & RAHIMPUR)

BILL NO. 2.6.9: ELECTRIFICATION OF DISPOSAL STATION (WAN MIANA)

Sr. No.	Description	M.R.S (Item/Chap)	Qty.	Unit	Rate (Rs.) In Figure	Amount (Rs.)
3.0	**DISTRIBUTION BOARDS**					
	D.Bs with TP incoming adjustable moulded case circuit breaker and SP miniature outgoing circuit breakers, Panel box SWG 16 powder coated RAL colour 7032, IP class 44 and with all accessories. alongwith all installation and operational accessories as per specification or as shown on the drawings.					
3.1	**DB- Staff Building**					
	01 No. Incoming 25 Amps (Adj.) MCCB TP 25kA Icu=100%Ics 05 Nos. outgoing 10A, MCB, SP, RC=10 kA, Icu=100%Ics 04 Nos. outgoing 20A, MCB, SP, RC=10 kA, Icu=100%Ics 03 Nos. outgoing 10A, MCB, SP, RC=10 kA, Icu=100%Ics (Spare) P/F wall mounted DB (Distribution Board) 6" deep, 20~60A, made with 16SWG Sheet (Recessded/Surf ace mounted Type), Powder coated Paint, i/c the cost of Lock, Indication lights,Thimble, Copper Comb, Wiring, Netural & Earth Bar, Door Earthing, Digital Voltmeter,Digital Ammeter,Volt Selector Swi tch, Ammeter selector switch, Current Transformers and Controles Complete in all respect as approved and directed by the Engineer Incharge (Breakers will be Paid Separately).	85(b-iii)/24, 85(a-iii)/24, 94(i)/24, 94(ii)/24, 94(iv)/24, 94(iii)/24, 94(v)/24, 94(vi)/24, 94(xv)/24	2	Each		
4.0	**MAIN PANEL BOARD**					
4.1	LV Switchgear Panel/Main Panel Board of 14 SWG, IP class 54/44 & RAL 7032 including I/C and O/G following electrical items, foundation/base frame with all installation and operational accessories as per site requirements, as per tender specifications and drawings and as directed by the Engineer.		2	Each		
	MATERIAL					
	INCOMING					
	- 01 No. 63 Amps (Adj.) MCCB TP 25kA Icu=100%Ics - 01 No. VSS (07 position) - 01 No. 0-600 Volts AC DIGITAL Voltmeter - 03 Nos. 80/5 Amps Current Transformers - 01 No. ASS (R-Y-B-OFF) - 01 No. 0-100 Amps AC DIGITAL Ammeter - 03 Nos. RYB and indication lights	86(a-iii)/24 87(a-i)/24, 87(a-vi)/24, 87(a-i)/24, 94(i)/24, 94(ii)/24, 94(iv)/24, 94(iii)/24, 94(v)/24, 94(vi)/24, 94(xv)/24				
	OUTGOING					
	- 01 No. 20 Amps (Adj.) MCB DP 10kA Icu=100%Ics (For S PUMP) - 02 Nos. 20 Amps (Adj.) MCB DP 10kA Icu=100%Ics (For HP RUNNING MOTORS) - 01 Nos. 20 Amps (Adj.) MCB DP 10kA Icu=100%Ics (For HP STAND BY MOTORS) - 01 No. 25 Amps (Adj.) MCCB TP 18kA Icu=100%Ics (For DB- Staff Building) - 01 Nos. 25 Amps (Adj.) MCCB TP 18kA Icu=100%Ics (For External lighting) - 01 No. 25 Amps (Adj.) MCCB TP 18kA Icu=100%Ics *(For PFI)*		2	Each		

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Sr. No.	Description	M.R.S (Item/Chap)	Qty.	Unit	Rate (Rs.) In Figure	Amount (Rs.)
-	02 Nos. 25 Amps (Adj.) MCCB TP 18kA Icu=100%Ics *(Spare)*					
-	1 Nos. 32 Amp. Magnetic Contactor AC-3					
-	14 SWG steel sheet Panel RAL 7032, IP= 54/44 and all other accessories,					
-	Electrolytic copper bus bar with electrical grade PVC mountings 3 for each, nuts, bolts and washers, control MCB etc. (130Amps. R+Y+B N, 50 Hz, 415 V, AC)					
-	All other accessories required for completion of the qulaity works including Cable gland and lugs etc					
-	Contractor shall submit the genuine certificate from the manufacturer/authorized agent clear by indicating the project name make/model/rating of MCCB, MCB, magnetic contactors, terminal blocks and voltmeters/ ammeter alongwith warranties.					
5.0	**Conduits / Pipes**					
5.1	PVC pipe/conduit Class-B 100 mm dia with accessories suitable for laying multi-core cables in walls/barriers/structure.	25(b)/23	200	Rft.		
5.2	PVC pipe/conduit Class-B 100 mm dia with accessories suitable for laying multi-core cables from pole to pole in trenches/directly burried including excavation.	25(b)/23, 6/3	2,000	Rft.		
5.3	PVC pipe/conduit Class-D 100 mm dia with accessories suitable for laying multi-core cables in trenches/directly burried on road crossings including excavation.	27(e)/23, 6/3	600	Rft.		
6.0	**FANS & ACCESSORIES**					
6.1	Providing and fixing Copper Winded Exhaust Fan with louver and shutter made of Pak/Younas/G.F.C. i/c the cost of necessary cable and hardware for connection from ceiling rose complete as approved and directed by Engineer Incharge.					
	a) Plastic body					
i)	12" dia	102(a-ii)/24	2	Each		
	b) Steel body					
i)	18" dia	102(b-ii)/24	2	Each		
6.3	Providing and fixing Copper winded ceiling fan made of Pak/Younas/G.F.C or NEECA approved equivalent i/c the cost of necessary cable and hardware for connection as approved and directed by Engineer Incharge.					
i)	56" dia	104(iii)/24	4	Each		

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Sr. No.	Description	M.R.S (Item/Chap)	Qty.	Unit	Rate (Rs.) In Figure	Amount (Rs.)
7.0	**LED Road Light Fixtures**					
7.1	Road Lighting LED Cobra-head Luminaries of 90 Watt with 10800 Lumens conforming to IP 66 & IK 08 or above Philips/Osram/Thorn or equivalent with corrosion resistant die casted Aluminium housing, silicon gasket in special groove, UV stable & scratch resistant synthetic materials, thermally hardened glass complete with LED Chip (Philips Lumiled/Cree/Nichia/Osram make or equivalent), programmable LED driver (Harvard/ TCI/ Lumotech/ Philips/VOSSLOHSchwabe/ Lightech make or equivalent), minimum 10kV surge protection rating i/c the cost of all accessories/ components required for proper operation, fully flexible for future upgradation and easy replacements for maintenance purposes, bucket elevator charges as approved and directed by the Engineer Incharge.	70(c-v)/24	12	Each		
8.0	**Power Cables**					
8.1	Supply and erection of copper conductor cables for service connection, in prelaid pipe/G.I. wire/trenches, etc. (rate for cable only)					
	PVC insulated, PVC sheathed 2 core, 600/1000 volt non armoured cable					
(a)	4 mm (7/0.036") For 2HP Motor	11(a-iv)/24	300	Rft.		
	PVC insulated, PVC sheathed 4 core, 600/1000 volt non armoured cable					
(b)	10 mm (7/0.052") For 10HP Motor	11(c-vi)/24	2,000	Rft.		
(c)	16 mm (7/0.064") From MPB to Incoming Supply	11(c-vii)/24	400	Rft.		
8.2	Supply and erection of single core PVC insulated copper conductor cables, in prelaid PVC pipe/M.S. conduit/G.I pipe/wooden strip batten/wooden casing an capping/G.I. wire/trenches (rate for cables only)					
	450/750 volts, PVC insulated:					
(a)	4 mm sq (7/0.036")	8(c-iv)/24	300	Rft.		
(b)	10 mm sq (7/0.052")	8(c-vi)/24	2,000	Rft.		
(c)	16 mm sq (7/0.064")	8(c-vii)/24	600	Rft.		
8.3	3 Nos. 1 core 2.5 mm^2 Cu/PVC 450/750 Voltage grade cable (stranded conductor) (Imported copper shall be used. Verified documentary evidence for source of copper & PVC shall be furnished prior to manufacturing) from junction box to the fitting through the hollow of pole.					
-	For 10m Pole	8(c-iii)/24	12	Each		

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Sr. No.	Description	M.R.S (Item/Chap)	Qty.	Unit	Rate (Rs.) In Figure	Amount (Rs.)
9.0	**CABLE TRAYS**					
9.1	Providing and fixing 4" deep cable tray with straight flange fabricated with perforated G.I. Sheet of specified guage, size and depth duly wall supported/ ceiling hung on painted brackets of MS angle iron of 1"x1"x1/8" and MS patti of 1-1/2"x3/16" size @5 ft. C/C, hangers i/c the cost of hardwares as approved and directed by the Engineer Incharge.					
	(a) 16 SWG					
	(i) 4"X4"	98 (a-i)/24	150	Rft.		
	(ii) 9"X4"	98 (a-ii)/24	500	Rft.		
9.2	Providing and fixing screwless cable tray cover fabricated with 18 SWG G.I. Sheet of required size i/c the cost of hardware as approved and directed by the Engineer Incharge					
	(i) 4" Wide	100 (i)/24	150	Rft.		
	(ii) 8" Wide	100 (iv)/24	500	Rft.		
10.0	**EARTHING**					
10.1	Providing,making & testing/commissionin of Rod type Earth point comprising of 5/8"dia.(16mmdia)10ft long copper coated M.S.rod driven in ground duly fixed with clamp with Tinned earth test link copper plate (300x50x10mm),i/c the cost of brass nuts,spacers,bolts washers lugs etc but excluding the cost of copper strand & manhole. as approved and directed by Engineer Incharge **(Rod Type Earthing)**.	111 /24	4	Each		
TOTAL MRS						

ENGINEERING DESIGN AND CONSTRUCTION SUPERVISION
CLUSTER NORTH
PUNJAB RURAL SUSTAINABLE WATER SUPPLY AND SANITATION PROJECT
SEWARAGE SYSTEM/ DISPOSAL STATION OF OF WAN MIANA (TEHSIL KOT MOMIN DISTRICT SARGODHA)

ENGINEER'S COST ESTIMATE FOR ELECTRICAL WORKS (N-MRS ITEMS)

Item No.	Description	Qty.	Unit	Unit Rate (Rs.)	Total Amount (Rs.)
	Design, Supply, transportation at site, storage, installation, testing and commissioning of the following items of work (unless specifically stated otherwise) including all material, labour, tools and accessories etc. required for proper completion of each item as per specification and drawings and/or as directed by the Engineer.				
1.0	**LIGHT FITTINGS AND FANS**				
	Following LED Luminaries of suitable wattage make suitable for the project requirements. Contractor to submit lighting design calculation to determine the adequacy of the wattage and should adjust the number of LEDs/wattage as per project lighting requirements. The fitting shall be approved by the Engineer.				
1.1	Light Fixture Type LED Batten Ceiling/surface mounted, 18W complete in all respect with allied accessories make Philips, GE,Pierlite or approved equivalent. The fitting shall be approved by the Engineer.	10	Each		
1.2	Light Fixture Type LED Batten above mirror, 10W complete in all respect with allied accessories make Philips, GE,Pierlite or approved equivalent. The fitting shall be approved by the Engineer.	2	Each		
1.3	Wall bracket Light Fixture Type LED 12 Watt energy saving lamp with holder and complete in all respect with allied accessories. The fitting shall be approved by the Engineer.	6	Each		
1.4	20W LED Water tight light fixture IP 65 complete in all respect with all allied accessories. The fitting shall be approved by the Engineer.	10	Each		
1.5	Light Fixture LED Downlight Ceiling/surface mounted, 12W complete in all respect with allied accessories. The fitting shall be approved by the Engineer.	4	Each		
2.0	**POWER FACTOR IMPROVEMENT PANEL (PFI)**				
2.1	14 SWG steel sheet clad IP 44/54 colour RAL 7035 powder coated power factor improvement panel (PFI) including Cu busbar, heavy duty incoming and outgoing circuit breaker to capacitor, magnetic contactors, continuous digital p.f controller, on & off pushbuttons etc. complete with all components/ accessories as per specifications and drawings.				
2.1	**PFI - 10 kVAR**				
-	**MATERIAL**	2	Each		
-	6 steps with continuous digital power factor and capacitor controller with all accessories etc.				
	01 No.Hand/OFF/Auto selector switch				
	02 Nos. 5 kVAR capacitor				
	02 Nos. 32 A Magnetic contactor (AC-3)				
	02 Nos. 25A MCCB, TP (Adj.) RC= 18 kA Circuit breaker, Icu=100%Ics				
	01 No. 80/5 Amps Current Transformers				
	03 Nos. Indication light - (for magnetic contactor and phase)				
	03 Nos. Push Buttons (ON/OFF)				
	03 Nos. Auxiliary contractor (NO/NC)				
	01 No. Panel light with limit switch				

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SEWARAGE SYSTEM/ DISPOSAL STATION OF OF WAN MIANA (TEHSIL KOT MOMIN DISTRICT SARGODHA)

ENGINEER'S COST ESTIMATE FOR ELECTRICAL WORKS (N-MRS ITEMS)

Item No.	Description	Qty.	Unit	Unit Rate (Rs.)	Total Amount (Rs.)
	02 No. Exhaust fan 6" & Louver 8" sweep with thermosttae relay and all accessories etc. 14 SWG steel sheet Panel RAL 7032, IP= 54/44 and all other accessories, All other accessories required for completion of the qulaity works including Cable gland and lugs etc Electrolytic copper bus bar with electrical grade PVC mountings 3 for each, nuts, bolts and washers, control MCB etc. (120Amps. R+Y+B N, 50 Hz, 415 V, AC) Contractor shall submit the genuine certificate from the manufacturer/authorized agent clear by indicating the project name make/model/rating of MCCB, MCB, magnetic contactors, terminal blocks and voltmeters/ ammeter alongwith warranties.				
TOTAL NON MRS					
TOTAL MRS + NON MRS					

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TEHSIL KOT MOMIN, DISTRICT SARGODHA VILLAGES (Kot Fateh Khan, Burj Ghulam Rasool, Bagri, Sughrewala, Fattuwala, Thathi Kalan, Thathi Khurd, Kot Ghazi Kalan, Kot Ghazi Khurd, Chani Dal, Thatha Bhairan, Dullewala, Mumrana, Kot Kala, Chak Suleman, Sewar)

BILL OF QUANTITY

BILL NO. 2.4 SEPTIC TANK AND SOAKAGE PIT

SR. NO.	Ref	DESCRIPTION	QUANTITY	UNIT	UNIT RATE (Rs)	AMOUNT (Rs)
		2nd BI-ANNUAL-2025 (01.07.2025 to 31.12.2025)				
		SEPTIC TANK (CIVIL WORKS)				
1	3/21	Excavation in foundation of building, bridges and other structures, including dagbelling, dressing, refilling in layers around structure with excavated earth, watering and ramming lead 'upto one chain (30 m) and lift upto 5 ft. (1.5 m).				
		1) By Manual				
		ii) Ordinary soil	17.60	1000 Cft.		
2	10/3	Supplying and filling sand under floor; or plugging in wells.	3.20	100Cft		
3	6/5	Cement concrete plain including placing, compacting, finishing and curing complete (including screening and washing of stone aggregate):				
		(h) Ratio 1: 3: 6	4.84	100 Cft.		
4	6/6	Providing and laying reinforced cement concrete (including prestressed concrete), using Ordinary Portland Cement / Sulphate resisting cement / Slag cement as may be required; coarse sand and screened graded and washed aggregate, in required shape and design, including forms, moulds, shuttering, lifting, compacting, curing, rendering and finishing exposed surface, complete (but excluding the cost of steel reinforcement, its fabrication and placing in position, etc.):-				
		(a) Reinforced cement concrete in roof slab, beams, columns lintels, girders and other structural members laid in situ or precast laid in position, or prestressed members cast in situ, complete in all respects:-				
		(1) Type A (nominal mix 1:1:2)	410.80	Cft.		

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TEHSIL KOT MOMIN, DISTRICT SARGODHA VILLAGES (Kot Fateh Khan, Burj Ghulam Rasool, Bagri, Sughrewala, Fattuwala, Thathi Kalan, Thathi Khurd, Kot Ghazi Kalan, Kot Ghazi Khurd, Chani Dal, Thatha Bhairan, Dullewala, Mumrana, Kot Kala, Chak Suleman, Sewar)

BILL OF QUANTITY

BILL NO. 2.4 SEPTIC TANK AND SOAKAGE PIT

SR. NO.	Ref	DESCRIPTION	QUANTITY	UNIT	UNIT RATE (Rs)	AMOUNT (Rs)
		(c) Reinforced cement concrete in Pile cap, slab of rafts / strip foundation, base slab of column and retaining walls; etc and footing beams, other structural members other than those mentioned in 6(a-d) above not requiring form work (i.e. horizontal shuttering) complete in all respects:-				
		1) Type A (nominal mix 1: 1: 2)	952.00	Cft.		
5	6/12	Fabrication of mild steel reinforcement for cement concrete, including cutting, bending, laying in position, making joints and fastenings, including cost of binding wire and labour charges for binding of steel reinforcement (also includes removal of rust from bars):-				
		('c) Deformed bars (Grade-60)	49.47	100 Kg		
6	7/7	Pacca brick work other than building upto 10ft. (3 m) height. 1:3	28.05	100Cft		
7	11/8	Cement plaster 1:3 upto 20' (6.00 m) height:- b) ½" (13 mm) thick	60.80	100 Sft.		
8	19/47	Providing, fixing, testing and commissioning of µ-PVC (Unplasticized Polyvinyl Chloride Nikasi/SWV pipe, Dadex/Popular/Beta or approved equivalent manufacturer, plain/Bell Ended/Z-Joints conforming to BS4514/BS5255-EN1329 including the cost of specials and Solvents complete in all respects, as per drawings & specifications and/ or as approved and directed by the Engineer Incharge.				
		(iii) 50mm	320.00	P.Rft		
		(v) 110 mm	1,680.00	P.Rft		
9	23/17	Shrouding with graded pea gravel 3/8" to 1/8" (10 to 3 mm), around tubewell in bore hole.	250.00	Per Cft		

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BILL OF QUANTITY

BILL NO. 2.4 SEPTIC TANK AND SOAKAGE PIT

SR. NO.	Ref	DESCRIPTION	QUANTITY	UNIT	UNIT RATE (Rs)	AMOUNT (Rs)
10	1/1	Carriage of 100 Cft. (2.83 cu.m) of all materials like stone aggregate, spawl , kankar lime (unslaked), surkhi , etc. or 150 Cft. (4.25 cu.m) of timber, by truck or by any other means owned by the contractor. Lead from approved nearby quarry	11.80	1000Cft		
		A-Total Amount				
	B	**SOAKAGE PIT**				
1	3/21	Excavation in foundation of building, bridges and other structures, including dagbelling, dressing, refilling in layers around structure with excavated earth, watering and ramming lead 'upto one chain (30 m) and lift upto 5 ft. (1.5 m). **1) By Manual** ii) Ordinary soil	14.52	1000 Cft.		
2	10/30	Supplying and filling sand under floor; or plugging in wells.	4.00	100Cft		
3	6/5	Cement concrete plain including placing, compacting, finishing and curing complete (including screening and washing of stone aggregate): **(h) Ratio 1: 3: 6**	6.40	100 Cft.		
4	7/7	Pacca brick work other than building upto 10ft. (3 m) height. 1:3	32.40	100Cft		

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BILL OF QUANTITY

BILL NO. 2.4 SEPTIC TANK AND SOAKAGE PIT

SR. NO.	Ref	DESCRIPTION	QUANTITY	UNIT	UNIT RATE (Rs)	AMOUNT (Rs)
5	6/6	Providing and laying reinforced cement concrete (including prestressed concrete), using Ordinary Portland Cement / Sulphate resisting cement / Slag cement as may be required; coarse sand and screened graded and washed aggregate, in required shape and design, including forms, moulds, shuttering, lifting, compacting, curing, rendering and finishing exposed surface, complete (but excluding the cost of steel reinforcement, its fabrication and placing in position, etc.):-				
		(a) Reinforced cement concrete in roof slab, beams, columns lintels, girders and other structural members laid in situ or precast laid in position, or prestressed members cast in situ, complete in all respects:-				
		(1) Type A (nominal mix 1:1:2)	586.80	Cft.		
6	6/12	Fabrication of mild steel reinforcement for cement concrete, including cutting, bending, laying in position, making joints and steel chairs, etc. complete in all respect. and fastenings, including cost of binding wire and labour charges for binding of steel reinforcement (also Includes removal of rust from bars):-				
		('c) Deformed bars (Grade-60)	18.64	100 Kg		
7	1/1	Carriage of 100 Cft. (2.83 cu.m) of all materials like stone aggregate, spawl , kankar lime (unslaked), surkhi , etc. or 150 Cft. (4.25 cu.m) of timber, by truck or by any other means owned by the contractor. Lead from approved nearby quarry				
			10.00	1000Cft		

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BILL OF QUANTITY

BILL NO. 2.4 SEPTIC TANK AND SOAKAGE PIT

SR. NO.	Ref	DESCRIPTION	QUANTITY	UNIT	UNIT RATE (Rs)	AMOUNT (Rs)
8	23/17	Shrouding with graded pea gravel 3/8" to 1/8" (10 to 3 mm), around tubewell in bore hole.	1,600.00	Per Cft		
B-Total Amount						
Grand Total						

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TEHSIL KOT MOMIN, DISTRICT SARGODHA VILLAGES (WAN MIANA, WAN MIANA COLONY & RAHIMPUR)
BILL OF QUANTITY

BILL NO. 2.9 STAFF QUARTER

Sr. No.	Ref	Description	Unit	Quantity	Rate (Rs)	Amount (Rs)
1	3/21	Excavation in foundation of building, bridges and other structures, including dagbelling, dressing, refilling in layers around structure with excavated earth, watering and ramming lead upto one chain (30 m) depth upto 5 ft (1.5m).				
		2) a) By Excavator				
		ii) Ordinary soil	1000 Cft.	2.13		
		iii) Hard soil or Soft murum	1000 Cft.	2.13		
2	3/8	Excavation in shingle or gravel formation and rock, not requiring blasting, undressed lead upto 100 ft (30 m).				
		i) Dry	1000 Cft.	4.26		
3	3/18	Dressing and levelling of earhtwork to designed section, etc. complete:-				
		c) Gravel work or soft rock not requiring blasting.	1000 Cft.	4.26		
4	26/43	Spraying termite proofing by using liquid FMC/ Biflex/ Terminex Exin/Ms Hextar or equivalent @ specified suspension concenterate (SC), Mixing Ability-HEXTAR with Ratio (1:250) = 540 Sft or equivalent approved liquid applying with shower and certificate will be provided by the contractor for 10- years complete in all respect as approved by the Engineer Incharge.	Sft	4,049.02		
5	6/5	Cement concrete plain including placing, compacting, finishing and curing complete (including screening and washing of stone aggregate).				
		(f) Nominal mix Ratio 1: 2: 4	100 Cft.	2.30		
		(h) Nominal mix Ratio 1: 3: 6	100 Cft.	6.56		
6	6/13	Precast cement concrete solid or face blocks (1:2:4), including cost of templates.	Cft.	1,634.80		
7	6/37	Providing and laying damp proof course of cement concrete 1:2:4 (cement, sand, shingle), including bitumen coating.				
		(b) with 2 coats of bitumen:				
		i) 1½" thick (40 mm)	100 Sft.	3.18		

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BILL OF QUANTITY

BILL NO. 2.9 STAFF QUARTER

Sr. No.	Ref	Description	Unit	Quantity	Rate (Rs)	Amount (Rs)
8	6/39	Providing and laying vertical damp proof course with cement sand plaster and bitumen coating:- (a) with one coat of bitumen and one coat of polythene sheet 500 gauge: ii) Ratio 1:3 b) ¾" thick (20 mm)	100 Sft.	2.80		
9	6/14	Precast cement concrete hollow blocks (1: 2: 4) , including cost of templates and constructing walls thereof.	Cft.	1,553.58		
10	6/6	Providing and laying reinforced cement concrete (including prestressed concrete), using Ordinary Portland Cement / Sulphate resisting cement / Slag cement as may be required; coarse sand and screened graded and washed aggregate, in required shape and design, including forms, moulds, shuttering, lifting, compacting, curing, rendering and finishing exposed surface, complete (but excluding the cost of steel reinforcement, its fabrication and placing in position, etc.):- (a) Reinforced cement concrete in roof slab, beams, columns lintels, girders and other structural members laid in situ or precast laid in position, or prestressed members cast in situ, complete in all respects:- (2) Type B (nominal mix 1: 1½: 3)	Per Cft	813.96		
		(c) Reinforced cement concrete in Pile cap, slab of rafts / strip foundation, base slab of column and retaining walls; etc and footing beams, other structural members other than those mentioned in 6(a-d) above not requiring form work (i.e. horizontal shuttering) complete in all respects:- (2) Type B (nominal mix 1: 1½: 3)	Per Cft	608.76		

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BILL OF QUANTITY

BILL NO. 2.9 STAFF QUARTER

Sr. No.	Ref	Description	Unit	Quantity	Rate (Rs)	Amount (Rs)
11	6/12	Fabrication of mild steel reinforcement for cement concrete, including cutting, bending, laying in position, making joints and fastenings, including cost of binding wire and labour charges for binding of steel reinforcement (also includes removal of rust from bars):-				
		(b) Deformed bars (ii)(Grade-60)	100 kg	29.56		
12	1/1	Carriage of 100 Cft. (2.83 cu.m) of all materials like stone aggregate, spawl , kankar lime (unslaked), surkhi , etc. or 150 Cft. (4.25 cu.m) of timber, by truck or by any other means owned by the contractor. Lead From Sargodha quarry	100Cft.	22.00		
13	11/9	Cement plaster 1:4 upto 20' (6.00 m) height:-				
		a) 3/8" (10 mm) thick	100 Sft.	55.24		
14	11/12	Cement plaster 3/8" (10 mm) thick under soffit of R.C.C. roof slabs only, upto 20' height.				
		c) 1:4	100 Sft.	24.00		
15	3/15	Filling, watering and ramming earth under floors:-				
		(i) with surplus earth from foundation, etc	1000 Cft.	1.88		
		(ii) with new earth excavated from out side, lead upto one chain (30m)	1000 Cft.	2.62		
16	3/16	Extra for every 50 ft. (15 m) additional lead or part thereof				
		i) for earth work soft, ordinary, hard and very heard (up to 1000 ft)	1000 Cft.	52.40		
17	10/3	Supplying and filling sand under floor; or plugging in wells. (Provisional as Slect Fill)	100 Cft.	26.72		
18	6/2	Dry rammed brick or stone ballast, 1½" to 2"(40 mm to 50 mm) gauge.	100 Cft.	3.74		

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BILL OF QUANTITY

BILL NO. 2.9 STAFF QUARTER

Sr. No.	Ref	Description	Unit	Quantity	Rate (Rs)	Amount (Rs)
19	10/45	Providing and laying superb quality Porcelain glazed tiles flooring of MASTER brand of specified size in approved design,Color and Shade with adhesive/bondover 3/4" thick (1:3) cement plaster i/c the cost of sealer for finishing the joints i/c cutting grinding complete in all respect as approved and directed by the Engineer Incharge. a) Full body Glazed tiles (i) 400 mm x 400 mm	Sft	847.70		
20	10/33	Tile skirting laid in 1:2 cement mortar, over ¾"(20 mm) thick cement mortar, 1:2 including cement washing and filling joints complete:- (b) mosaic tiles	100 Sft.	1.78		
21	10/37	Providing and laying 3/8" thick Prepolished Marble skirting/ risers having uniform texture (spotless) of size 24" x 6" of approved quality and shade with adhesive bond over 3/4" thick (1:2) cement sand mortor complete in all respect i/c the cost of matching sealer to finish the joints as approved and directed by the Engineer Incharge. **i) China Verona**	Sft	286.72		
22	9/5	Single layer of tiles 9"x4½"x1½" (225x113x40 mm) laid over 4"(100 mm) earth and 1" (25 mm) mud plaster without Bhoosa, grouted with cement sand 1:3 on top of RCC roof slab, provided with 34 lbs.per %Sft. or 1.72 Kg/Sq.m bitumen coating sand blinded.	100 Sft.	14.54		
23	26/38	Supplying and laying polythene sheet over D.P.C under floors and on roofs, etc. (i) 300 gauge (0.003" thick)	Per Sft.	1,454.00		

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BILL OF QUANTITY

BILL NO. 2.9 STAFF QUARTER

Sr. No.	Ref	Description	Unit	Quantity	Rate (Rs)	Amount (Rs)
24	12/16	Providing and fixing M.S. sheet hollow pressed frame of doors, windows, C. windows, etc. (chowkat only) of 20 SWG welded with M.S. flat 6"x 1¼" x 1/8" (150 mmx30mmx3mm) M.S. holdfast 9"x1"x1/8" (225mmx25mmx3mm) welded/screwed 4" (100 mm) long iron hinges, including filling chowkat with cement sand mortar 1:8 and embedding holdfast in cement concrete 1:2:4, complete in all respects:				
		a) single rebate	Per Sft.	133.00		
		b) double rebate	Per Sft.	42.00		
25	12/12	P/F 1-1/2" thick solid flush door comprising of 2.5 mm thick Commercial ply compressed over 2.5 mm thick commercial ply over 1" thick packing wood in style and rails under proper pressure i/c the cost of nails, tower bolt , handles, glue, sawing charges, Painting charges, sand papering and 3/8" thick matching wooden lipping as approved and directed by the Engineer Incharge.	Per Sft.	175.00		
26	12/60	P/F 3/4" dia heavy duty sliding bolt of specified material i/c the cost of hardware omplete in all respect as approved and directed by the Engineer Incharge.				
		b) brass				
		i) 10" (250 mm) long	Each	8.00		
27	13/5	Painting new surface:-				
		c) Preparing surface and painting of doors and windows any type (including edges):-				
		i) priming coat.				
		ii) each subsequent coat of paint. (2 coats)	100 Sft.	3.50		

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BILL OF QUANTITY

BILL NO. 2.9 STAFF QUARTER

Sr. No.	Ref	Description	Unit	Quantity	Rate (Rs)	Amount (Rs)
28	25/52	Providing and fitting all types of glazed aluminium windows of anodised bronze colour partly fixed and partly sliding using delux sections of approved manufacturer having frame size of 100 x 20 mm (4"x¾") and leaf frame sections of 50 x 20 mm (2"x¾"), all of 1.6mm thickness including 5 mm thick imported tinted glass with rubber gasket using pproved standard latches, hardware etc., as approved by the Engineer in-charge.	Per Sft.	252.00		
29	25/58	Providing and fixing M.S. flat ½"x1/8" (13mm x 3mm) grill including ¾" x 1/8" (20 mmx3 mm) M.S. flat f rame, in windows of approved design, including painting three coats, complete in all respects.	Per Sft.	252.00		
30	11/23	Priming coat of chalk under distemper.	100 Sft.	41.66		
31	11/24	Distempering (a) new surface ii) two coats	100 Sft.	41.66		
32	11/18	Cement pointing struck joints, on walls, upto 20' (6.00 m) hiehgt:- (external wall) a) ratio 1:2	100 Sft.	41.98		
		PLUMBING WORKS				
33	19/7	Providing and fitting glazed earthen ware wash hand basin /vanity 56x40 cm (22"x16") including bracket set, waste pipe and waste coupling, etc. ii) coloured, with pedestal	Each	2.00		
34	19/8	Providing and fixing stainless steel sink with drain board, size 120x60 cm (48"x24") including bracket set, waste pipe and waste coupling.	Each	2.00		
35	19/29	Providing and fixing chromium plated shower rose:- ii) 2x15 cm (¾"x6")	Each	2.00		
36	19/30	Providing and fixing, chromium plated mixing valve, for wash hand basin, sink or shower.	Each	6.00		

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BILL OF QUANTITY

BILL NO. 2.9 STAFF QUARTER

Sr. No.	Ref	Description	Unit	Quantity	Rate (Rs)	Amount (Rs)
37	23/19	Providing, laying, cutting, jointing, testing and disinfecting G.I. pipe line in trenches, with socket joints, using G.I pipes of B.S.S. 1387-1967complete in all respects with specials and valves:- ii) Medium Quality (Provisional)				
		b) ¾" i/d (20 mm) 2.65mm thick	Per Rft.	55.20		
		c) 1" i/d (25 mm) 3.25mm thick	Per Rft.	40.00		
38	19/4	Providing and fitting glazed earthen ware water closet, squatter type, combined with foot rest. ii) coloured	Each	2.00		
39	19/13	Providing and fitting plastic made low down flushing cistern 1363 liters (3 gallons) capacity, including bracket set, copper connection etc., complete.				
		ii) coloured	Each	2.00		
40	19/20	Providing and fixing looking glass 55x40 cm size and 5mm thick, first quality	Each	2.00		
41	19/23	Providing and fixing Bathroom Accessories (7-piece set) Master brand - One Cosmetic Shelf, One Towel rod with bracket, One soap dish, One double hook, One towel ring, brush holder, toilet paper holder & looking glass i/c the cost of hardwares etc complete in all respect as approved and directed by the Engineer incharge.				
		i) Plastic Soap Dish	Each	2.00		
		ii) Plastic toilet paper holder	Each	2.00		
		iii) Plastic towel rail	Each	2.00		
		iv) Plastic shelf 60x13 cm (24:x5") with bracket and railing	Each	2.00		
42	19/27	Providing and fixing chromium plated bib cock i) 2 cm (¾")	Each	8.00		
43	19/34	Providing and fixing floor trap of cast iron, including concrete chamber all round, and C.I grating: ii) 10x7.5 cm (4"x3")	Each	4.00		

ENGINEERING DESIGN AND CONSTRUCTION SUPERVISION
CLUSTER NORTH
PUNJAB RURAL SUSTAINABLE WATER SUPPLY AND SANITATION PROJECT
TEHSIL KOT MOMIN, DISTRICT SARGODHA VILLAGES (WAN MIANA, WAN MIANA COLONY & RAHIMPUR)
BILL OF QUANTITY

BILL NO. 2.9 STAFF QUARTER

Sr. No.	Ref	Description	Unit	Quantity	Rate (Rs)	Amount (Rs)
44	19/36	Providing and fitting gully trap, including cement concrete, cost of PVC grating 15x15cm and masonry chamber 30x30cm.	Each	4.00		
45	23/33	Providing, laying, testing and commissioning of POLY PROPYLENE RANDOM COPOLYMER (PPRC) water supply pipe (Dadex/ Popular/ Beta or approved equivalent manufacturer, with specified pressure rating PN (PRESSURE NOMINAL) and conforming to DIN 8077-8078 code i/c cost of solvent, specials, making jharries complete in all respect as approved and directed by Engineer Incharge. (Internal/ External Diameters mentioned). **b) PN-20 pipe**				
		(ii) 25 mm	Rft	138.00		
		(iii) 32 mm	Rft	40.00		
46	19/47	Providing, fixing, testing and commissioning of µ-PVC (Unplasticized Polyvinyl Chloride) Nikasi/ SWV pipe, Dadex/ Popular/ Beta or approved equivalent manufacturer, plain/ Bell Ended/ Z-Joints conforming to BS 4514/ BS5255 - EN 1329 including the cost of specials and Solvents complete in all respects, as per drawings & specifications and/ or as approved and directed by the Engineer Incharge.				
		(iv) (82mm)	Rft	294.00		
		(v) (110 mm)	Rft	30.00		
		(vi) (160 mm)	Rft	80.00		
47	19/49	Providing, fixing, testing and commissioning of µ-PVC (Unplasticized polyvinyl Chloride) Nikasi/ waste pipe Fittings make of Dadex/ Popular/ Beta or approved equivalent manufacturer, conforming to code EN-1329 including the cost of Solvents complete in all respect as approved and directed by the Engineer Incharge. **a) P-Trap**				
		(i) 4" dia	Each	8.00		

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BILL OF QUANTITY

BILL NO. 2.9 STAFF QUARTER

Sr. No.	Ref	Description	Unit	Quantity	Rate (Rs)	Amount (Rs)
48	19/51	Providing and hoisting vertical/ horizontal type storage tank of required capacity made of rotationally molded from (HDPE), double ply polyethelene of approved manufacturer i/c cost of making connection for inlet/ outlet pipe, float valve i/c all cost of specials & labour complete in all respect as approved and directed by the Engineer Incharge.	Per gallon	400.00		
49	12/25	Providing and fixing almirah shutter comprising of 3/4" thick both side Laminated/ Glossy MDF (Karachi) sheet with 1" x 3/4" deodar wood golla all around the leaf fixed on (3"x1" Kail wood frame i/c the cost of 1/2" full brass hinges, C.P. handles, catchers, screws, and rawal plugs, polishing/ painting 3 coat to gola & frame i/c the cost of locking arrangement complete in all	Sft	120.00		
50	19/51	Providing and hoisting vertical/ horizontal type storage tank of required capacity made of rotationally molded from (HDPE), double ply polyethelene of approved manufacturer i/c cost of making connection for inlet/outlet pipe, float valve i/c all cost of specials & labour complete in all respect as approved and directed by the Engineer Incharge.	Per Gallon	400.00		
Total MRS Items						
		NON MRS TTEMS				
51	N/S	Providing and installing domestic pump and motor including boring, pipe, strainer, fittings etc. Compete in all respect.	Each	2.00		
Total Non - MRS Items						
Total Amount						

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BILL OF QUANTITY

Bill No. 2.8: BOUNDARY WALL

Sr. No.	Ref.	Description	Unit	Quantity	Rate (Rs)	Amount (Rs)
1	3/21	Excavation in foundation of building, bridges and other structures, including dagbelling, dressing, refilling in layers around structure with excavated earth, watering and ramming leadupto one chain (30 m)lift upto 5 ft (1.5m).				
		b) By Excavator				
		ii) in ordinary soil.	1000Cft	10.73		
2	6/5	Cement concrete plain including placing, compacting, finishing and curing complete (including screening and washing of stone aggregate):				
		(h) Ratio 1:3:6	100Cft	4.39		
3	6/6	Providing and laying reinforced cement concrete (including prestressed concrete), using Ordinary Portland Cement / Sulphate resisting cement / Slag cement as may be required; coarse sand and screened graded and washed aggregate, in required shape and design, including forms, moulds, shuttering, lifting, compacting, curing, rendering and finishing exposed surface, complete (but excluding the cost of steel reinforcement, its fabrication and placing in position, etc.):-				
		(a) Reinforced cement concrete in roof slab, beams, columns lintels, girders and other structural members laid in situ or precast laid in position, or prestressed members cast in situ, complete in all respects:-				
		(2) Type B (nominal mix 1: 1½: 3)	Cft	752.02		
		(c) Reinforced cement concrete in Pile cap, slab of rafts / strip foundation, base slab of column and retaining walls; etc and footing beams, other structural members other than those mentioned in 6(a-d) above not requiring form work (i.e. horizontal shuttering) complete in all respects:-				
		(2) Type B (nominal mix 1: 1½: 3)	Cft	1161.00		
4	6/12	Fabrication of mild steel reinforcement for cement concrete, including cutting, bending, laying in position, making joints and fastenings, including cost of binding wire and labour charges for binding of steel reinforcement (also includes removal of rust from bars):-				
		C) Deformed bars (Grade 60)	100 Kg	60.76		

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TEHSIL KOT MOMIN, DISTRICT SARGODHA VILLAGES (WAN MIANA, WAN MIANA COLONY & RAHIMPUR)
BILL OF QUANTITY

Bill No. 2.8: BOUNDARY WALL

Sr. No.	Ref.	Description	Unit	Quantity	Rate (Rs)	Amount (Rs)
5	1/1	Carriage of 100 Cft. (2.83 cu.m) of all materials like stone aggregate, spawl , kankar lime (unslaked), surkhi , etc. or 150 Cft. (4.25 cu.m) of timber, by truck or by any other means owned by the contractor.				
		Lead From approved quarry	100Cft	16.11		
6	7/4	Pacca brick work in foundation and plinth in:- i) Cement, sand mortar:-				
		Ratio 1:3	100Cft.	78.81		
7	6/37	Providing and laying damp proof course of cement concrete 1:2: 4(using cement, sand and shingle), including bi tumen coating :- (b) with 2 coats of bitumen:				
		ii) 2" thick (50 mm)	100Sft	12.37		
8	7/7	Pacca brick work other than building upto 10ft. (3 m) height.				
		Ratio 1:3	1000Cft	53.16		
9	11/8	Cement plaster 1:3 upto 20' (6.00 m) height:-				
		b) ½" (13 mm) thick	100 Sft.	138.46		
10	11/18	Cement pointing struck joints, on walls, upto 20' (6.00 m) hiehgt:-				
		a) Ratio 1:2	100 Sft.	138.46		
11	25/31	Making and fixing steel grated door with 1/16" thick (1.5mm) sheeting, including angle iron frame 2"x2"x3/8" (50x50x10 mm) and ¾" (20 mm) square bars 4" (100 mm) centre to centre, with locking arrangement.	P.Sft	216.00		
12	13/5 (d)	Painting new surface:- d) Preparing surface and painting guard bars, gates of iron bars, gratings, railing (including standards, braces, etc.) and in similar open work:- i) priming coat.	100 Sft.	2.16		
		ii) each subsequent coat of paint.(2 Coats)	100 Sft.	4.32		
Total (A) (Rs.)						

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BILL OF QUANTITY

Bill No. 2.5.8 LOWERING OF SUB SOIL WATER TABLE

Sr. No.	Ref.	Description	Unit	Quantity	Rate (Rs)	Amount (Rs)
1		Lowering of sub-soil water level and maintain subsoil water level 3 to 5 feet below foundation level of structures as per approved dewatering plan through pumping out water from tube wells including supply and install suitable numbers of dewatering pumps sets (tube wells boreholes, pipe, stainers, pumps, motors, column pipes.delivery pipes, clamps etc.) capable to pump out water including labor, generator, diesel, oil etc. and disposal of pumped out water at safe place min mum 100 feet away from the working site till the completion of job, complete with all respect and as per instruction of Engineer in Charge.	Job	2		
					Total Amount (Rs.)	

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TEHSIL KOT MOMIN, DISTRICT SARGODHA VILLAGES (WAN MIANA, WAN MIANA COLONY & RAHIMPUR)

ROAD RESTORATION
SUMMARY OF COST

Bill No.	Description	Cost
3.0)	**KOT MOMIN**	
3.1	ROAD RESTORATION	
	TOTAL (SEWERAGE LINES, PUMPING STATION AND ALLIED WORKS)	

ENGINEERING DESIGN AND CONSTRUCTION SUPERVISION
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TEHSIL KOT MOMIN, DISTRICT SARGODHA VILLAGES (WAN MIANA, WAN MIANA COLONY & RAHIMPUR)

BILL OF QUANTITY

BILL NO. 3.1.1 Road Restoration

SR. NO.	Ref	DESCRIPTION	QUANTITY	UNIT	UNIT RATE (Rs)	AMOUNT (Rs)
		CIVIL WORKS				
1	4/45	Dismantling and removing road metalling.	215.20	100Cft.		
2	4/46	Dismantling and removing road pavement, etc., including screening and stacking of byproducts upto one chain lead (30 metre).	717.35	100Cft.		
3	4/29	Dismantling brick or flagged flooring without concrete foundation.	3,387.18	100Sft.		
4	6/5	Cement concrete plain including placing, compacting, finishing and curing complete (including screening and washing of stone aggregate): (f) Ratio 1: 2: 4	82.30	100Cft		
5	18/20	Providing and laying dry brick pavement/soling in streets or roads, etc. sand grouted, laid in proper camber, including preparation, watering, compaction of bed to proper camber, and sand cushion.	596.43	100Cft		
6	21/8	Restoration of brick pavement on edge, over laid service line, with 2" (50 mm) sand cushion under soling.	3,387.18	100Sft.		
7	10/43	Providing and laying Tuff Pavers, having 7000 PSI, crushing strength of approved manufacturer, over 2" to 3" sand cushion i/c grouting with sand in joints i/c finishing to require slope . complete in all respect. (50% Grey / 50% Coloured) b) 60-mm thick	31,104.00	Per Sft		
8	18/3	a) Providing and laying sub-base course of stone product of approved quality and grade, including placing, mixing, spreading and compaction of sub-base material to required depth, camber, grade to achieve 100% maximum modified AASHO dry density, including carriage of all material to site of work except gravel and aggregate.				
		ii) Crushed stone aggregate	1,810.92	100Cft.		

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BILL OF QUANTITY

BILL NO. 3.1.1 Road Restoration

SR. NO.	Ref	DESCRIPTION	QUANTITY	UNIT	UNIT RATE (Rs)	AMOUNT (Rs)
9	21/10	Restoration of metalled road, on laid service line, including compaction:-				
		a) Carpetted road, with 2" (50 mm) carpet and 10" (250 mm) depth of stone metal for sub-base and base.	344.33	100Sft.		
		c) Black Topped Road with two coats of surfacing & 10" (250 mm) depth of stone metal, for sub base & base.	516.49	100Sft.		
10	3/1	Earthwork excavation undressed lead upto a single throw of Kassi, phaorah or shovel:-				
		ii) In ordinary soil.	288.66	1000 Cft.		
11	14/1	Dressing and levelling of earhtwork to designed section, etc. complete:-				
		b) Ordinary or hard soil.	5,691.13	100Sft.		
12	3/17	Transportation of earth all types when the total distance, including the lead covered in the i tem of work, is more than 1000 ft. (300 m) **Total Lead 1 KM** (Transportation will be paid as per actual lead chart to be approved by the Engineer)	288.66	1000Cft		
13	1/1	Carriage of 100 Cft. (2.83 cu.m) of all materials like stone aggregate, spawl , kankar lime (unslaked), surkhi , etc. or 150 Cft. (4.25 cu.m) of timber, by truck or by any other means owned by the contractor (crushed stone aggregate and bajri used in concrete items)				
		Lead From nearest quarry (Sargodha Quarry) (193km)	72.42	100 Cft.		
					Total Amount	

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TEHSIL KOT MOMIN, DISTRICT SARGODHA VILLAGES (WAN MIANA, WAN MIANA COLONY & RAHIMPUR)

COST ESTIMATE

Bill 4: ESMP (ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN)

Sr. No.	Ref	Description	Unit	Quantity	Rate (PKR)	Amount (PKR)
	A	**Personal Protective Equipments**				
1	NS	**Safety Jackets** EN ISO 201171: 360 degree visibility Fluorescent yellow/orange:retro reflective strips: breathable mesh fabric: secure Velcro or zipper closure. provided in approriatc sizes are required by Staff.	Each	60	654	39,240
2	NS	**Safely Hehnels** EN-397: High-density polyethylene (HDPE) or ABS plastic: adjustable screw harness: Adjustable headbands, chin straps. and non-allergic sweatbands. color-coded (white for engineers. yellow for workers)	Each	60	5,668	340,080
3	NS	**Safety Gloves** EN 388: Nitrilc-coated or leather palm; abrasion and cut-resistant; breathable back; conforms to EN388 safety ratings	Each	100	650	65,000
4	NS	**Dust Mnsk (Dust proofmask)** ISO 16975: Disposable N95 or FFP2 class mask: elastic bonds: nose clip for sealing: replace after use	Each	200	500	100,000
5	NS	**Safety Shoes & Toes** EN ISO 20345. requiring a toe cap to withstand a minimum 200-joule impact and 15 kilonewtons (kN) of compression Steel toe cap; anti-slip, oil-resistant sole; leather upper; ankle support for shoes only	Each	70	8,175	572,250
6	NS	**Safety Harness Belt** ISO 10333: High-tenacity polyester webbing, minimum width 45mm; adjustable shoulder and thigh straps with metal buckles; dorsal D-ring for fall arrest. side D-rings for position.fog; ond chest strap with quick-connect buckle; Renowned Brand	Each	6	4,905	29,430
7	NS	**Protective Goggles** ISO 16321: Anti-fog, scratch-resistant: side shielding for wrap-around protection: adjustable strap	Each	20	545	10,900
8	NS	**Ear Plugs** ISO 4869-1: Soft polyurethane foam: noise reduction rating (NRR) of 30 dB or more	Each	40	175	7,000

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COST ESTIMATE

Bill 4: ESMP (ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN)

Sr. No.	Ref	Description	Unit	Quantity	Rate (PKR)	Amount (PKR)
	B	**Health Safety Environment Materials / Testing**				
9	NS	**First Aid Kit** ISO 7010-E003: Painkiller, eyewash solution. antibiotic ointment. thermometer, plasters, sterile gauze, dressings. sterile eye dressings, triangular bandages. crepe rolled bandages, safety pins, disposable sterile gloves and tweezers), pain killers, burn creams, pyodine solution (big bottle), other medication as required by tehsil team is adequate size and quantity	Each	2	27,250	54,500
10	NS	**Warning/ Safety Signs** 1SO 7010: Weatherproof PVC or Plastic or aluminum signs: reflective print: standardized colors and pictograms (danger, caution, mandatorv)	Each	50	500	25,000
11	NS	**Green Mesh** Green safety netting for site periphery: 50% shading: UV-stabilized HDPE material.	Sft	400	40	16,000
12	NS	**DCP Fire Extinguisher (Dry Chemical Powder)** ISO 7165: 6.kg; ABC type; The extinguishing agent is mono ammonium phosphate and ammonium sulphate powder and the discharge time of the agent is 13 second	No.	2	11,990	23,980
13	NS	**CO2 Fire Extinguisher** ISO 7165: 5 kg: frost-free horn: suitable for electrical and liquid fires: discharge time of the agent in 13 second	No.	2	14,170	28,340
14	NS	**Fire Alarm** ICS 13.030.10: Proper segregation. PPE for handlers, timely removal, record keeping per solid waste rules	No.	4	10,900	43,600
15	NS	**Trapuline** Water proof trapuline sheet made from polyethylene or canva	Sft	60	600	36,000

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COST ESTIMATE

Bill 4: ESMP (ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN)

Sr. No.	Ref	Description	Unit	Quantity	Rate (PKR)	Amount (PKR)
16	NS	**Safety Cones** UV-resistant PVC or rubber material: at least 28 to 36 inches in height: high-visibility orange color with reflective collars (minimum 4-inch reflective band) for day and night visibility	Each	24	3,270	78,480
17	NS	**Tree Plantation** 5-6 feet height: Native species plantation: soil preparation and watering included	No.	200	545	109,000
18	NS	**Barricading/ Fencing (Reflective tape, poles, safety mesh/netting)** ISO 13857: include poles, reflecting tapes, plastic mesh netting; minimum 3 feet height; durable and visible	Rft	600	20	12,000
19	NS	**Trainings** HSE Training, Rescue Training. Labour Code of Conduct, Environmental Code of Conduct, Defensive Driver Trainings, Labour Laws and Labour Rights, GAP Training, C-ESMP Training. and anyother as required by E&S wing	Quaterly	8	27,250	218,000
20	NS	**Water Sprinkling** Water sprinkling through tank mounted on tractor	Per Trip	60	1,500	90,000
21	NS	**Medical Screening for Workers** CBC, Anti HCV, HBsAG, HIV, RPR, LFTs, RFTs etc.	Persons	60	1,635	98,100
	C	**Environmental Testing and Monitoring**				
22	NS	**Ambient Air Quality** As per the parameters and methodology defined by EPA (Quarterly in every village**)**	Each	6	27,250	163,500
23	NS	**Groundwater Quality Test** As per the parameters and methodology defined by EPA (Quarterly in every village**)**	Each	6	21,800	130,800
24	NS	**Surface Water Quality Test** As per the parameters and methodology defined by EPA (Quarterly in every village**)**	Each	6	21,800	130,800
25	NS	**Waste Water Quality Test** As per the parameters and methodology defined by EPA (Quarterly in every village**)**	Each	6	21,800	130,800

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COST ESTIMATE

Bill 4: ESMP (ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN)

Sr. No.	Ref	Description	Unit	Quantity	Rate (PKR)	Amount (PKR)
26	NS	**Noise Level Monitoring** As per the parameters and methodology defined by EPA (Quarterly in every village)	Each	6		
	D	**Site Specific / Contractors Environmental and Social Management Plan**				
27	NS	**CESMP Formulation** By an individual or firm as approved by PRMSC Environment Wing	Per Village	2		
	E	**HSE Staff**				
28	NS	**HSE Supervisor** Bachelor's degree in Environmental Sciences / Engineering. NEBOSH or IOSH certification will be preffered, with over one year of experience in Occupational Health and Safety. one HSE person for 10-15 village, hiring of HSE staff will be approved by E&S prior to contract signing	Per Month Village	24		
	E	**Waste Management and House Keeping**				
29	NS	**Handling and disposal of Hazardous Material** **I**CS 13.030.30: Safe storage, labeling, and transportation. spill kits and secondary containment as per MSDS	3 times per village for duration of contract	6		
30	NS	**Handling and disposal of Solid Waste Material** ICS 13.030.10: Proper segregation, PPE for handlers, timely removal, recordkeeping per solid waste rules	3 times per village for duration of contract	6		
Total Amount						

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TEHSIL KOT MOMIN, DISTRICT SARGODHA VILLAGES (Kot Fateh Khan, Burj Ghulam Rasool, Bagri, Sughrewala, Fattuwala, Thathi Kalan, Thathi Khurd, Kot Ghazi Kalan, Kot Ghazi Khurd, Chani Dal, Bhutto Colony, Chani Nakka, Thatha Bhairan, Dullewala, Mumrana, Kot Kala, Chak Suleman, Wada Khoo, Bhairan Wala, Sewar)

BILL OF QUANTITY

5. Employer Facilities

Sr. No.	Ref. MRS	Description	Unit	Quantity	Unit Rate (Rs)	Amount (Rs)
1		Providing and maintaining site offices (portable air condition (1,5 ton AC) cabin containers lined with win board size 20'x8'x8.5' with toilet & kitchen, all-time availability of water and electricity) for the entire duration of the project to the Employer and the Engineer. It includes office tables, chairs, water dispenser, electric heater, steel almirah for document storage, etc complete with all respect. After completion of the project these containers and all accessories will be the property of PRMSC	Nos	1.0		
2		Providing 02 Nos office boy in accordance with the special provisions of the bidding document and up to the satisfaction of the Employer/Engineer.	Per month	20.0		
3		Providing and maintaining the Cost of Utility Services (Electricity, Water, Gas, etc.) for the 01 No. office.	Per month	20.0		
					Total Amount	

PART 3 – Conditions of Contract and Contract Forms

PRSWSSP

Section VIII - General Conditions of Contract

PRSWSSP

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PRSWSP

General Conditions of Contract

A. General

1. Definitions

1.1 Boldface type is used to identify defined terms.

(a) The Accepted Contract Amount means the amount accepted in the Letter of Acceptance for the execution and completion of the Works and the remedying of any defects.

(b) The Activity Schedule is a schedule of the activities comprising the construction, installation, testing, and commissioning of the Works in a lump sum contract. It includes a lump sum price for each activity, which is used for valuations and for assessing the effects of Variations and Compensation Events.

(c) The Adjudicator is the person appointed jointly by the Employer and the Contractor to resolve disputes in the first instance, as provided for in GCC 23.

(d) Bank means the financing institution **named in the PCC**.

(e) Bill of Quantities means the priced and completed Bill of Quantities forming part of the Bid.

(f) Compensation Events are those defined in GCC Clause 42 hereunder.

(g) The Completion Date is the date of completion of the Works as certified by the Project Manager, in accordance with GCC Sub-Clause 53.1.

(h) The Contract is the Contract between the Employer and the Contractor to execute, complete, and maintain the Works. It consists of the documents listed in GCC Sub-Clause 2.3 below.

(i) The Contractor is the party whose Bid to carry out the Works has been accepted by the Employer.

(j) The Contractor's Bid is the completed bidding document submitted by the Contractor to the Employer.

(k) The Contract Price is the Accepted Contract Amount stated in the Letter of Acceptance and thereafter as adjusted in accordance with the Contract.

PRSWSP

(l) Days are calendar days; months are calendar months.

(m) Dayworks are varied work inputs subject to payment on a time basis for the Contractor's employees and Equipment, in addition to payments for associated Materials and Plant.

(n) A Defect is any part of the Works not completed in accordance with the Contract.

(o) The Defects Liability Certificate is the certificate issued by Project Manager upon correction of defects by the Contractor.

(p) The Defects Liability Period is the period **named in the PCC** pursuant to Sub-Clause 34.1 and calculated from the Completion Date.

(q) Drawings means the drawings of the Works, as included in the Contract, and any additional and modified drawings issued by (or on behalf of) the Employer in accordance with the Contract, include calculations and other information provided or approved by the Project Manager for the execution of the Contract.

(r) The Employer is the party who employs the Contractor to carry out the Works, **as specified in the PCC**.

(s) Equipment is the Contractor's machinery and vehicles brought temporarily to the Site to construct the Works.

(t) "In writing" or "written" means hand-written, type-written, printed or electronically made, and resulting in a permanent record;

(u) The Initial Contract Price is the Contract Price listed in the Employer's Letter of Acceptance.

(v) The Intended Completion Date is the date on which it is intended that the Contractor shall complete the Works. The Intended Completion Date is **specified in the PCC**. The Intended Completion Date may be revised only by the Project Manager by issuing an extension of time or an acceleration order.

(w) Materials are all supplies, including consumables, used by the Contractor for incorporation in the Works.

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(x) Plant is any integral part of the Works that shall have a mechanical, electrical, chemical, or biological function.

(y) The Project Manager is the person **named in the PCC** (or any other competent person appointed by the Employer and notified to the Contractor, to act in replacement of the Project Manager) who is responsible for supervising the execution of the Works and administering the Contract.

(z) PCC means Particular Conditions of Contract.

(aa) The Site is the area **defined as such in the PCC**.

(bb) Site Investigation Reports are those that were included in the bidding document and are factual and interpretative reports about the surface and subsurface conditions at the Site.

(cc) Specification means the Specification of the Works included in the Contract and any modification or addition made or approved by the Project Manager.

(dd) The Start Date is **given in the PCC**. It is the latest date when the Contractor shall commence execution of the Works. It does not necessarily coincide with any of the Site Possession Dates.

(ee) A Subcontractor is a person or corporate body who has a Contract with the Contractor to carry out a part of the work in the Contract, which includes work on the Site.

(ff) Temporary Works are works designed, constructed, installed, and removed by the Contractor that are needed for construction or installation of the Works.

(gg) A Variation is an instruction given by the Project Manager which varies the Works.

(hh) The Works are what the Contract requires the Contractor to construct, install, and turn over to the Employer, **as defined in the PCC**.

2. Interpretation 2.1 In interpreting these GCC, words indicating one gender include all genders. Words indicating the singular also include the plural and words indicating the plural also include the singular. Headings have no significance. Words have their normal meaning under the language of the Contract unless specifically defined.

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The Project Manager shall provide instructions clarifying queries about these GCC.

2.2 If sectional completion is **specified in the PCC**, references in the GCC to the Works, the Completion Date, and the Intended Completion Date apply to any Section of the Works (other than references to the Completion Date and Intended Completion Date for the whole of the Works).

2.3 The documents forming the Contract shall be interpreted in the following order of priority:

(a) Agreement,

(b) Letter of Acceptance,

(c) Contractor's Bid,

(d) Particular Conditions of Contract,

(e) General Conditions of Contract, including Appendices,

(f) Specifications,

(g) Drawings,

(h) Bill of Quantities,[1] and

(i) any other document **listed in the PCC** as forming part of the Contract.

3. Language and Law

3.1 The language of the Contract and the law governing the Contract are **stated in the PCC**.

3.2 Throughout the execution of the Contract, the Contractor shall comply with the import of goods and services prohibitions in the Employer's Country when

(a) as a matter of law or official regulations, the Borrower's country prohibits commercial relations with that country; or

(b) by an act of compliance with a decision of the United Nations Security Council taken under Chapter VII of the Charter of the United Nations, the Borrower's Country prohibits any import of goods from that country or any payments to any country, person, or entity in that country.

[1] In lump sum contracts, delete "Bill of Quantities" and replace with "Activity Schedule."

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4. Project Manager's Decisions

4.1 Except where otherwise specifically stated, the Project Manager shall decide contractual matters between the Employer and the Contractor in the role representing the Employer.

5. Delegation

5.1 Otherwise **specified in the PCC,** the Project Manager may delegate any of his duties and responsibilities to other people, except to the Adjudicator, after notifying the Contractor, and may revoke any delegation after notifying the Contractor.

6. Communications

6.1 Communications between parties that are referred to in the Conditions shall be effective only when in writing. A notice shall be effective only when it is delivered.

7. Subcontracting

7.1 The Contractor may subcontract with the approval of the Project Manager, but may not assign the Contract without the approval of the Employer in writing. Subcontracting shall not alter the Contractor's obligations.

8. Other Contractors

8.1 The Contractor shall cooperate and share the Site with other contractors, public authorities, utilities, and the Employer between the dates given in the Schedule of Other Contractors, as **referred to in the PCC.** The Contractor shall also provide facilities and services for them as described in the Schedule. The Employer may modify the Schedule of Other Contractors, and shall notify the Contractor of any such modification.

9. Personnel and Equipment

9.1 The Contractor shall employ the key personnel and use the equipment identified in its Bid, to carry out the Works or other personnel and equipment approved by the Project Manager. The Project Manager shall approve any proposed replacement of key personnel and equipment only if their relevant qualifications or characteristics are substantially equal to or better than those proposed in the Bid.

9.2 If the Project Manager asks the Contractor to remove a person who is a member of the Contractor's staff or work force, stating the reasons, the Contractor shall ensure that the person leaves the Site within seven days and has no further connection with the work in the Contract.

9.3 If the Employer, Project Manager or Contractor determines, that any employee of the Contractor be determined to have engaged in Fraud and Corruption during the execution of the Works, then that employee shall be removed in accordance with Clause 9.2 above.

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10. Employer's and Contractor's Risks

10.1 The Employer carries the risks which this Contract states are Employer's risks, and the Contractor carries the risks which this Contract states are Contractor's risks.

11. Employer's Risks

11.1 From the Start Date until the Defects Liability Certificate has been issued, the following are Employer's risks:

(a) The risk of personal injury, death, or loss of or damage to property (excluding the Works, Plant, Materials, and Equipment), which are due to

(i) use or occupation of the Site by the Works or for the purpose of the Works, which is the unavoidable result of the Works or

(ii) negligence, breach of statutory duty, or interference with any legal right by the Employer or by any person employed by or contracted to him except the Contractor.

(b) The risk of damage to the Works, Plant, Materials, and Equipment to the extent that it is due to a fault of the Employer or in the Employer's design, or due to war or radioactive contamination directly affecting the country where the Works are to be executed.

11.2 From the Completion Date until the Defects Liability Certificate has been issued, the risk of loss of or damage to the Works, Plant, and Materials is an Employer's risk except loss or damage due to

(a) a Defect which existed on the Completion Date,

(b) an event occurring before the Completion Date, which was not itself an Employer's risk, or

(c) the activities of the Contractor on the Site after the Completion Date.

12. Contractor's Risks

12.1 From the Starting Date until the Defects Liability Certificate has been issued, the risks of personal injury, death, and loss of or damage to property (including, without limitation, the Works, Plant, Materials, and Equipment) which are not Employer's risks are Contractor's risks.

13. Insurance

13.1 The Contractor shall provide, in the joint names of the Employer and the Contractor, insurance cover from the Start Date to the end of the Defects Liability Period, in the amounts and

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deductibles **stated in the PCC** for the following events which are due to the Contractor's risks:

(a) loss of or damage to the Works, Plant, and Materials;

(b) loss of or damage to Equipment;

(c) loss of or damage to property (except the Works, Plant, Materials, and Equipment) in connection with the Contract; and

(d) personal injury or death.

13.2 Policies and certificates for insurance shall be delivered by the Contractor to the Project Manager for the Project Manager's approval before the Start Date. All such insurance shall provide for compensation to be payable in the types and proportions of currencies required to rectify the loss or damage incurred.

13.3 If the Contractor does not provide any of the policies and certificates required, the Employer may effect the insurance which the Contractor should have provided and recover the premiums the Employer has paid from payments otherwise due to the Contractor or, if no payment is due, the payment of the premiums shall be a debt due.

13.4 Alterations to the terms of an insurance shall not be made without the approval of the Project Manager.

13.5 Both parties shall comply with any conditions of the insurance policies.

14. Site Data

14.1 The Contractor shall be deemed to have examined any Site Data **referred to in the PCC**, supplemented by any information available to the Contractor.

15. Contractor to Construct the Works

15.1 The Contractor shall construct and install the Works in accordance with the Specifications and Drawings.

16. The Works to Be Completed by the Intended Completion Date

16.1 The Contractor may commence execution of the Works on the Start Date and shall carry out the Works in accordance with the Program submitted by the Contractor, as updated with the approval of the Project Manager, and complete them by the Intended Completion Date.

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17. Approval by the Project Manager

17.1 The Contractor shall submit Specifications and Drawings showing the proposed Temporary Works to the Project Manager, for his approval.

17.2 The Contractor shall be responsible for design of Temporary Works.

17.3 The Project Manager's approval shall not alter the Contractor's responsibility for design of the Temporary Works.

17.4 The Contractor shall obtain approval of third parties to the design of the Temporary Works, where required.

17.5 All Drawings prepared by the Contractor for the execution of the temporary or permanent Works, are subject to prior approval by the Project Manager before this use.

18. Safety and Protection of the Environment

18.1 The Contractor shall be responsible for the safety of all activities on the Site.

18.2 The Contractor shall take all reasonable steps to protect the environment (both on and off the Site) and to limit damage and nuisance to people and property resulting from pollution, noise and other results of his operations.

19. Discoveries

19.1 Anything of historical or other interest or of significant value unexpectedly discovered on the Site shall be the property of the Employer. The Contractor shall notify the Project Manager of such discoveries and carry out the Project Manager's instructions for dealing with them.

20. Possession of the Site

20.1 The Employer shall give possession of all parts of the Site to the Contractor. If possession of a part is not given by the date **stated in the PCC,** the Employer shall be deemed to have delayed the start of the relevant activities, and this shall be a Compensation Event.

21. Access to the Site

21.1 The Contractor shall allow the Project Manager and any person authorized by the Project Manager access to the Site and to any place where work in connection with the Contract is being carried out or is intended to be carried out.

22. Instructions, Inspections and Audits

22.1 The Contractor shall carry out all instructions of the Project Manager which comply with the applicable laws where the Site is located.

22.2 The Contractor shall keep, and shall make all reasonable efforts to cause its Subcontractors and subconsultants to keep, accurate and systematic accounts and records in respect of the Works in

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such form and details as will clearly identify relevant time changes and costs.

22.3 Pursuant to paragraph 2.2 e. of Appendix B to the General Conditions, the Contractor shall permit and shall cause its subcontractors and subconsultants to permit, the Bank and/or persons appointed by the Bank to inspect the Site and/or the accounts and records relating to the procurement process, selection and/or contract execution, and to have such accounts and records audited by auditors appointed by the Bank if requested by the Bank. The Contractor's and its Subcontractors' and subconsultants' attention is drawn to Sub-Clause 25.1 (Fraud and Corruption) which provides, inter alia, that acts intended to materially impede the exercise of the Bank's inspection and audit rights constitute a prohibited practice subject to contract termination (as well as to a determination of ineligibility pursuant to the Bank's prevailing sanctions procedures).]

23. Appointment of the Adjudicator

23.1 The Adjudicator shall be appointed jointly by the Employer and the Contractor, at the time of the Employer's issuance of the Letter of Acceptance. If, in the Letter of Acceptance, the Employer does not agree on the appointment of the Adjudicator, the Employer will request the Appointing Authority **designated in the PCC**, to appoint the Adjudicator within 14 days of receipt of such request.

23.2 Should the Adjudicator resign or die, or should the Employer and the Contractor agree that the Adjudicator is not functioning in accordance with the provisions of the Contract, a new Adjudicator shall be jointly appointed by the Employer and the Contractor. In case of disagreement between the Employer and the Contractor, within 30 days, the Adjudicator shall be designated by the Appointing Authority **designated in the PCC** at the request of either party, within 14 days of receipt of such request.

24. Procedure for Disputes

24.1 If the Contractor believes that a decision taken by the Project Manager was either outside the authority given to the Project Manager by the Contract or that the decision was wrongly taken, the decision shall be referred to the Adjudicator within 14 days of the notification of the Project Manager's decision.

24.2 The Adjudicator shall give a decision in writing within 28 days of receipt of a notification of a dispute.

24.3 The Adjudicator shall be paid by the hour at the **rate specified in the PCC,** together with reimbursable expenses of the types

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specified in the PCC, and the cost shall be divided equally between the Employer and the Contractor, whatever decision is reached by the Adjudicator. Either party may refer a decision of the Adjudicator to an Arbitrator within 28 days of the Adjudicator's written decision. If neither party refers the dispute to arbitration within the above 28 days, the Adjudicator's decision shall be final and binding.

24.4 The arbitration shall be conducted in accordance with the arbitration procedures published by the institution named and, in the place, **specified in the PCC.**

25. Fraud and Corruption

25.1 The Bank requires compliance with the Bank's Anti-Corruption Guidelines and its prevailing sanctions policies and procedures as set forth in the WBG's Sanctions Framework, as set forth in Appendix A to the GCC.

25.2 The Employer requires the Contractor to disclose any commissions or fees that may have been paid or are to be paid to agents or any other party with respect to the bidding process or execution of the Contract. The information disclosed must include at least the name and address of the agent or other party, the amount and currency, and the purpose of the commission, gratuity or fee.

B. Time Control

26. Program

26.1 Within the time **stated in the PCC**, after the date of the Letter of Acceptance, the Contractor shall submit to the Project Manager for approval a Program showing the general methods, arrangements, order, and timing for all the activities in the Works. In the case of a lump sum contract, the activities in the Program shall be consistent with those in the Activity Schedule.

26.2 An update of the Program shall be a program showing the actual progress achieved on each activity and the effect of the progress achieved on the timing of the remaining work, including any changes to the sequence of the activities.

26.3 The Contractor shall submit to the Project Manager for approval an updated Program at intervals no longer than the period **stated in the PCC.** If the Contractor does not submit an updated Program within this period, the Project Manager may withhold the amount **stated in the PCC** from the next payment certificate and continue to withhold this amount until the next payment after the date on which the overdue Program has been submitted. In the case of a lump sum contract, the Contractor shall provide an

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updated Activity Schedule within 14 days of being instructed to by the Project Manager.

26.4 The Project Manager's approval of the Program shall not alter the Contractor's obligations. The Contractor may revise the Program and submit it to the Project Manager again at any time. A revised Program shall show the effect of Variations and Compensation Events.

27. Extension of the Intended Completion Date

27.1 The Project Manager shall extend the Intended Completion Date if a Compensation Event occurs or a Variation is issued which makes it impossible for Completion to be achieved by the Intended Completion Date without the Contractor taking steps to accelerate the remaining work, which would cause the Contractor to incur additional cost.

27.2 The Project Manager shall decide whether and by how much to extend the Intended Completion Date within 21 days of the Contractor asking the Project Manager for a decision upon the effect of a Compensation Event or Variation and submitting full supporting information. If the Contractor has failed to give early warning of a delay or has failed to cooperate in dealing with a delay, the delay by this failure shall not be considered in assessing the new Intended Completion Date.

28. Acceleration

28.1 When the Employer wants the Contractor to finish before the Intended Completion Date, the Project Manager shall obtain priced proposals for achieving the necessary acceleration from the Contractor. If the Employer accepts these proposals, the Intended Completion Date shall be adjusted accordingly and confirmed by both the Employer and the Contractor.

28.2 If the Contractor's priced proposals for an acceleration are accepted by the Employer, they are incorporated in the Contract Price and treated as a Variation.

29. Delays Ordered by the Project Manager

29.1 The Project Manager may instruct the Contractor to delay the start or progress of any activity within the Works.

30. Management Meetings

30.1 Either the Project Manager or the Contractor may require the other to attend a management meeting. The business of a management meeting shall be to review the plans for remaining work and to deal with matters raised in accordance with the early warning procedure.

30.2 The Project Manager shall record the business of management meetings and provide copies of the record to those attending the

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meeting and to the Employer. The responsibility of the parties for actions to be taken shall be decided by the Project Manager either at the management meeting or after the management meeting and stated in writing to all who attended the meeting.

31. Early Warning

31.1 The Contractor shall warn the Project Manager at the earliest opportunity of specific likely future events or circumstances that may adversely affect the quality of the work, increase the Contract Price, or delay the execution of the Works. The Project Manager may require the Contractor to provide an estimate of the expected effect of the future event or circumstance on the Contract Price and Completion Date. The estimate shall be provided by the Contractor as soon as reasonably possible.

31.2 The Contractor shall cooperate with the Project Manager in making and considering proposals for how the effect of such an event or circumstance can be avoided or reduced by anyone involved in the work and in carrying out any resulting instruction of the Project Manager.

C. Quality Control

32. Identifying Defects

32.1 The Project Manager shall check the Contractor's work and notify the Contractor of any Defects that are found. Such checking shall not affect the Contractor's responsibilities. The Project Manager may instruct the Contractor to search for a Defect and to uncover and test any work that the Project Manager considers may have a Defect.

33. Tests

33.1 If the Project Manager instructs the Contractor to carry out a test not specified in the Specification to check whether any work has a Defect and the test shows that it does, the Contractor shall pay for the test and any samples. If there is no Defect, the test shall be a Compensation Event.

34. Correction of Defects

34.1 The Project Manager shall give notice to the Contractor of any Defects before the end of the Defects Liability Period, which begins at Completion, and is **defined in the PCC.** The Defects Liability Period shall be extended for as long as Defects remain to be corrected.

34.2 Every time notice of a Defect is given, the Contractor shall correct the notified Defect within the length of time specified by the Project Manager's notice.

35. Uncorrected Defects

35.1 If the Contractor has not corrected a Defect within the time specified in the Project Manager's notice, the Project Manager

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shall assess the cost of having the Defect corrected, and the Contractor shall pay this amount.

D. Cost Control

36. Contract Price[2]

36.1 The Bill of Quantities shall contain priced items for the Works to be performed by the Contractor. The Bill of Quantities is used to calculate the Contract Price. The Contractor will be paid for the quantity of the work accomplished at the rate in the Bill of Quantities for each item.

37. Changes in the Contract Price[3]

37.1 If the final quantity of the work done differs from the quantity in the Bill of Quantities for the particular item by more than 25 percent, provided the change exceeds 1 percent of the Initial Contract Price, the Project Manager shall adjust the rate to allow for the change. The Project Manager shall not adjust rates from changes in quantities if thereby the Initial Contract Price is exceeded by more than 15 percent, except with the prior approval of the Employer.

37.2 If requested by the Project Manager, the Contractor shall provide the Project Manager with a detailed cost breakdown of any rate in the Bill of Quantities.

38. Variations

38.1 All Variations shall be included in updated Programs[4] produced by the Contractor.

38.2 The Contractor shall provide the Project Manager with a quotation for carrying out the Variation when requested to do so by the Project Manager. The Project Manager shall assess the quotation, which shall be given within seven (7) days of the request or within any longer period stated by the Project Manager and before the Variation is ordered.

38.3 If the Contractor's quotation is unreasonable, the Project Manager may order the Variation and make a change to the Contract Price, which shall be based on the Project Manager's

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2 In lump sum contracts, replace GCC Sub-Clauses 36.1 as follows:
36.1 The Contractor shall provide updated Activity Schedules within 14 days of being instructed to by the Project Manager. The Activity Schedule shall contain the priced activities for the Works to be performed by the Contractor. The Activity Schedule is used to monitor and control the performance of activities on which basis the Contractor will be paid. If payment for materials on site shall be made separately, the Contractor shall show delivery of Materials to the Site separately on the Activity Schedule.

3 In lump sum contracts, replace entire GCC Clause 37 with new GCC Sub-Clause 37.1, as follows:
37.1 The Activity Schedule shall be amended by the Contractor to accommodate changes of Program or method of working made at the Contractor's own discretion. Prices in the Activity Schedule shall not be altered when the Contractor makes such changes to the Activity Schedule.

4 In lump sum contracts, add "and Activity Schedules" after "Programs."

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own forecast of the effects of the Variation on the Contractor's costs.

38.4 If the Project Manager decides that the urgency of varying the work would prevent a quotation being given and considered without delaying the work, no quotation shall be given and the Variation shall be treated as a Compensation Event.

38.5 The Contractor shall not be entitled to additional payment for costs that could have been avoided by giving early warning.

38.6 If the work in the Variation corresponds to an item description in the Bill of Quantities and if, in the opinion of the Project Manager, the quantity of work above the limit stated in Sub-Clause 39.1 or the timing of its execution do not cause the cost per unit of quantity to change, the rate in the Bill of Quantities shall be used to calculate the value of the Variation. If the cost per unit of quantity changes, or if the nature or timing of the work in the Variation does not correspond with items in the Bill of Quantities, the quotation by the Contractor shall be in the form of new rates for the relevant items of work.[5]

38.7 Value Engineering: The Contractor may prepare, at its own cost, a value engineering proposal at any time during the performance of the contract. The value engineering proposal shall, at a minimum, include the following;

(a) the proposed change(s), and a description of the difference to the existing contract requirements;

(b) a full cost/benefit analysis of the proposed change(s) including a description and estimate of costs (including life cycle costs) the Employer may incur in implementing the value engineering proposal; and

(c) a description of any effect(s) of the change on performance/functionality.

The Employer may accept the value engineering proposal if the proposal demonstrates benefits that:

(a) accelerate the contract completion period; or

(b) reduce the Contract Price or the life cycle costs to the Employer; or

[5] In lump sum contracts, delete this paragraph.

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(c) improve the quality, efficiency, safety or sustainability of the Facilities; or

(d) yield any other benefits to the Employer,

without compromising the functionality of the Works.

If the value engineering proposal is approved by the Employer and results in:

(a) a reduction of the Contract Price; the amount to be paid to the Contractor shall be the **percentage specified in the PCC** of the reduction in the Contract Price; or

(b) an increase in the Contract Price; but results in a reduction in life cycle costs due to any benefit described in (a) to (d) above, the amount to be paid to the Contractor shall be the full increase in the Contract Price.

39. Cash Flow Forecasts

39.1 When the Program,[6] is updated, the Contractor shall provide the Project Manager with an updated cash flow forecast. The cash flow forecast shall include different currencies, as defined in the Contract, converted as necessary using the Contract exchange rates.

40. Payment Certificates

40.1 The Contractor shall submit to the Project Manager monthly statements of the estimated value of the work executed less the cumulative amount certified previously.

40.2 The Project Manager shall check the Contractor's monthly statement and certify the amount to be paid to the Contractor.

40.3 The value of work executed shall be determined by the Project Manager.

40.4 The value of work executed shall comprise the value of the quantities of work in the Bill of Quantities that have been completed.[7]

40.5 The value of work executed shall include the valuation of Variations and Compensation Events.

[6] In lump sum contracts, add "or Activity Schedule" after "Program."

[7] In lump sum contracts, replace this paragraph with the following: "The value of work executed shall comprise the value of completed activities in the Activity Schedule."

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40.6 The Project Manager may exclude any item certified in a previous certificate or reduce the proportion of any item previously certified in any certificate in the light of later information.

41. Payments

41.1 Payments shall be adjusted for deductions for advance payments and retention. The Employer shall pay the Contractor the amounts certified by the Project Manager within 28 days of the date of each certificate. If the Employer makes a late payment, the Contractor shall be paid interest on the late payment in the next payment. Interest shall be calculated from the date by which the payment should have been made up to the date when the late payment is made at the prevailing rate of interest for commercial borrowing for each of the currencies in which payments are made.

41.2 If an amount certified is increased in a later certificate or as a result of an award by the Adjudicator or an Arbitrator, the Contractor shall be paid interest upon the delayed payment as set out in this clause. Interest shall be calculated from the date upon which the increased amount would have been certified in the absence of dispute.

41.3 Unless otherwise stated, all payments and deductions shall be paid or charged in the proportions of currencies comprising the Contract Price.

41.4 Items of the Works for which no rate or price has been entered in shall not be paid for by the Employer and shall be deemed covered by other rates and prices in the Contract.

42. Compensation Events

42.1 The following shall be Compensation Events:

(a) The Employer does not give access to a part of the Site by the Site Possession Date pursuant to GCC Sub-Clause 20.1.

(b) The Employer modifies the Schedule of Other Contractors in a way that affects the work of the Contractor under the Contract.

(c) The Project Manager orders a delay or does not issue Drawings, Specifications, or instructions required for execution of the Works on time.

(d) The Project Manager instructs the Contractor to uncover or to carry out additional tests upon work, which is then found to have no Defects.

(e) The Project Manager unreasonably does not approve a subcontract to be let.

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(f) Ground conditions are substantially more adverse than could reasonably have been assumed before issuance of the Letter of Acceptance from the information issued to bidders (including the Site Investigation Reports), from information available publicly and from a visual inspection of the Site.

(g) The Project Manager gives an instruction for dealing with an unforeseen condition, caused by the Employer, or additional work required for safety or other reasons.

(h) Other contractors, public authorities, utilities, or the Employer does not work within the dates and other constraints stated in the Contract, and they cause delay or extra cost to the Contractor.

(i) The advance payment is delayed.

(j) The effects on the Contractor of any of the Employer's Risks.

(k) The Project Manager unreasonably delays issuing a Certificate of Completion.

42.2 If a Compensation Event would cause additional cost or would prevent the work being completed before the Intended Completion Date, the Contract Price shall be increased and/or the Intended Completion Date shall be extended. The Project Manager shall decide whether and by how much the Contract Price shall be increased and whether and by how much the Intended Completion Date shall be extended.

42.3 As soon as information demonstrating the effect of each Compensation Event upon the Contractor's forecast cost has been provided by the Contractor, it shall be assessed by the Project Manager, and the Contract Price shall be adjusted accordingly. If the Contractor's forecast is deemed unreasonable, the Project Manager shall adjust the Contract Price based on the Project Manager's own forecast. The Project Manager shall assume that the Contractor shall react competently and promptly to the event.

42.4 The Contractor shall not be entitled to compensation to the extent that the Employer's interests are adversely affected by the Contractor's not having given early warning or not having cooperated with the Project Manager.

43. Tax

43.1 The Project Manager shall adjust the Contract Price if taxes, duties, and other levies are changed between the date 28 days before the submission of bids for the Contract and the date of the

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last Completion certificate. The adjustment shall be the change in the amount of tax payable by the Contractor, provided such changes are not already reflected in the Contract Price or are a result of GCC Clause 44.

44. Currencies

44.1 Where payments are made in currencies other than the currency of the Employer's Country **specified in the PCC,** the exchange rates used for calculating the amounts to be paid shall be the exchange rates stated in the Contractor's Bid.

45. Price Adjustment

45.1 Prices shall be adjusted for fluctuations in the cost of inputs only if **provided for in the PCC.** If so provided, the amounts certified in each payment certificate, before deducting for Advance Payment, shall be adjusted by applying the respective price adjustment factor to the payment amounts due in each currency. A separate formula of the type specified below applies to each Contract currency:

$$\mathbf{P_c = A_c + B_c\, Imc/Ioc}$$

where:

P_c is the adjustment factor for the portion of the Contract Price payable in a specific currency "c."

A_c and B_c are coefficients[8] **specified in the PCC,** representing the nonadjustable and adjustable portions, respectively, of the Contract Price payable in that specific currency "c;" and

Imc is the index prevailing at the end of the month being invoiced and Ioc is the index prevailing 28 days before Bid opening for inputs payable; both in the specific currency "c."

45.2 If the value of the index is changed after it has been used in a calculation, the calculation shall be corrected and an adjustment made in the next payment certificate. The index value shall be deemed to take account of all changes in cost due to fluctuations in costs.

46. Retention

46.1 The Employer shall retain from each payment due to the Contractor the proportion **stated in the PCC** until Completion of the whole of the Works.

[8] The sum of the two coefficients A_c and B_c should be 1 (one) in the formula for each currency. Normally, both coefficients shall be the same in the formulae for all currencies, since coefficient A, for the nonadjustable portion of the payments, is a very approximate figure (usually 0.15) to take account of fixed cost elements or other nonadjustable components. The sum of the adjustments for each currency are added to the Contract Price.

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46.2 Upon the issue of a Certificate of Completion of the Works by the Project Manager, in accordance with GCC 53.1, half the total amount retained shall be repaid to the Contractor and half when the Defects Liability Period has passed and the Project Manager has certified that all Defects notified by the Project Manager to the Contractor before the end of this period have been corrected. The Contractor may substitute retention money with an "on demand" Bank guarantee.

47. Liquidated Damages

47.1 The Contractor shall pay liquidated damages to the Employer at the rate per day **stated in the PCC** for each day that the Completion Date is later than the Intended Completion Date. The total amount of liquidated damages shall not exceed the amount **defined in the PCC.** The Employer may deduct liquidated damages from payments due to the Contractor. Payment of liquidated damages shall not affect the Contractor's liabilities.

47.2 If the Intended Completion Date is extended after liquidated damages have been paid, the Project Manager shall correct any overpayment of liquidated damages by the Contractor by adjusting the next payment certificate. The Contractor shall be paid interest on the overpayment, calculated from the date of payment to the date of repayment, at the rates specified in GCC Sub-Clause 41.1.

48. Bonus

48.1 The Contractor shall be paid a Bonus calculated at the rate per calendar day **stated in the PCC** for each day (less any days for which the Contractor is paid for acceleration) that the Completion is earlier than the Intended Completion Date. The Project Manager shall certify that the Works are complete, although they may not be due to be complete.

49. Advance Payment

49.1 The Employer shall make advance payment to the Contractor of the amounts **stated in the PCC** by the date **stated in the PCC,** against provision by the Contractor of an Unconditional Bank Guarantee in a form and by a bank acceptable to the Employer in amounts and currencies equal to the advance payment. The Guarantee shall remain effective until the advance payment has been repaid, but the amount of the Guarantee shall be progressively reduced by the amounts repaid by the Contractor. Interest shall not be charged on the advance payment.

49.2 The Contractor is to use the advance payment only to pay for Equipment, Plant, Materials, and mobilization expenses required specifically for execution of the Contract. The Contractor shall demonstrate that advance payment has been used in this way by

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supplying copies of invoices or other documents to the Project Manager.

49.3 The advance payment shall be repaid by deducting proportionate amounts from payments otherwise due to the Contractor, following the schedule of completed percentages of the Works on a payment basis. No account shall be taken of the advance payment or its repayment in assessing valuations of work done, Variations, price adjustments, Compensation Events, Bonuses, or Liquidated Damages.

50. Securities

50.1 The Performance Security shall be provided to the Employer no later than the date specified in the Letter of Acceptance and shall be issued in an amount **specified in the PCC,** by a bank or surety acceptable to the Employer, and denominated in the types and proportions of the currencies in which the Contract Price is payable. The Performance Security shall be valid until a date 28 days from the date of issue of the Certificate of Completion in the case of a Bank Guarantee, and until one year from the date of issue of the Completion Certificate in the case of a Performance Bond.

51. Dayworks

51.1 If applicable, the Dayworks rates in the Contractor's Bid shall be used only when the Project Manager has given written instructions in advance for additional work to be paid for in that way.

51.2 All work to be paid for as Dayworks shall be recorded by the Contractor on forms approved by the Project Manager. Each completed form shall be verified and signed by the Project Manager within two days of the work being done.

51.3 The Contractor shall be paid for Dayworks subject to obtaining signed Dayworks forms.

52. Cost of Repairs

52.1 Loss or damage to the Works or Materials to be incorporated in the Works between the Start Date and the end of the Defects Correction periods shall be remedied by the Contractor at the Contractor's cost if the loss or damage arises from the Contractor's acts or omissions.

E. Finishing the Contract

53. Completion

53.1 The Contractor shall request the Project Manager to issue a Certificate of Completion of the Works, and the Project Manager shall do so upon deciding that the whole of the Works is completed.

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54. Taking Over

54.1 The Employer shall take over the Site and the Works within seven days of the Project Manager's issuing a certificate of Completion.

55. Final Account

55.1 The Contractor shall supply the Project Manager with a detailed account of the total amount that the Contractor considers payable under the Contract before the end of the Defects Liability Period. The Project Manager shall issue a Defects Liability Certificate and certify any final payment that is due to the Contractor within 56 days of receiving the Contractor's account if it is correct and complete. If it is not, the Project Manager shall issue within 56 days a schedule that states the scope of the corrections or additions that are necessary. If the Final Account is still unsatisfactory after it has been resubmitted, the Project Manager shall decide on the amount payable to the Contractor and issue a payment certificate.

56. Operating and Maintenance Manuals

56.1 If "as built" Drawings and/or operating and maintenance manuals are required, the Contractor shall supply them by the dates **stated in the PCC.**

56.2 If the Contractor does not supply the Drawings and/or manuals by the dates **stated in the PCC** pursuant to GCC Sub-Clause 56.1**,** or they do not receive the Project Manager's approval, the Project Manager shall withhold the amount **stated in the PCC** from payments due to the Contractor.

57. Termination

57.1 The Employer or the Contractor may terminate the Contract if the other party causes a fundamental breach of the Contract.

57.2 Fundamental breaches of Contract shall include, but shall not be limited to, the following:

(a) the Contractor stops work for 28 days when no stoppage of work is shown on the current Program and the stoppage has not been authorized by the Project Manager;

(b) the Project Manager instructs the Contractor to delay the progress of the Works, and the instruction is not withdrawn within 28 days;

(c) the Employer or the Contractor is made bankrupt or goes into liquidation other than for a reconstruction or amalgamation;

(d) a payment certified by the Project Manager is not paid by the Employer to the Contractor within 84 days of the date of the Project Manager's certificate;

(e) the Project Manager gives Notice that failure to correct a particular Defect is a fundamental breach of Contract and the

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Contractor fails to correct it within a reasonable period of time determined by the Project Manager;

(f) the Contractor does not maintain a Security, which is required;

(g) the Contractor has delayed the completion of the Works by the number of days for which the maximum amount of liquidated damages can be paid, as **defined in the PCC**; or

(h) if the Contractor, in the judgment of the Employer has engaged in Fraud and Corruption, as defined in paragrpah 2.2 a of the Appendix A to the GCC, in competing for or in executing the Contract, then the Employer may, after giving fourteen (14) days written notice to the Contractor, terminate the Contract and expel him from the Site.

57.3 Notwithstanding the above, the Employer may terminate the Contract for convenience.

57.4 If the Contract is terminated, the Contractor shall stop work immediately, make the Site safe and secure, and leave the Site as soon as reasonably possible.

57.5 When either party to the Contract gives notice of a breach of Contract to the Project Manager for a cause other than those listed under GCC Sub-Clause 56.2 above, the Project Manager shall decide whether the breach is fundamental or not.

58. Payment upon Termination

58.1 If the Contract is terminated because of a fundamental breach of Contract by the Contractor, the Project Manager shall issue a certificate for the value of the work done and Materials ordered less advance payments received up to the date of the issue of the certificate and less the percentage to apply to the value of the work not completed, as **specified in the PCC.** Additional Liquidated Damages shall not apply. If the total amount due to the Employer exceeds any payment due to the Contractor, the difference shall be a debt payable to the Employer.

58.2 If the Contract is terminated for the Employer's convenience or because of a fundamental breach of Contract by the Employer, the Project Manager shall issue a certificate for the value of the work done, Materials ordered, the reasonable cost of removal of Equipment, repatriation of the Contractor's personnel employed solely on the Works, and the Contractor's costs of protecting and securing the Works, and less advance payments received up to the date of the certificate.

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59. Property

59.1 All Materials on the Site, Plant, Equipment, Temporary Works, and Works shall be deemed to be the property of the Employer if the Contract is terminated because of the Contractor's default.

60. Release from Performance

60.1 If the Contract is frustrated by the outbreak of war or by any other event entirely outside the control of either the Employer or the Contractor, the Project Manager shall certify that the Contract has been frustrated. The Contractor shall make the Site safe and stop work as quickly as possible after receiving this certificate and shall be paid for all work carried out before receiving it and for any work carried out afterwards to which a commitment was made.

61. Suspension of Bank Loan or Credit

61.1 In the event that the Bank suspends the Loan or Credit to the Employer, from which part of the payments to the Contractor are being made:

(a) The Employer is obligated to notify the Contractor of such suspension within 7 days of having received the Bank's suspension notice.

(b) If the Contractor has not received sums due to it within the 28 days for payment provided for in Sub-Clause 40.1, the Contractor may immediately issue a 14-day termination notice.

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APPENDIX A
TO GENERAL CONDITIONS

Fraud and Corruption

(Text in this Appendix shall not be modified)

1. Purpose

1.1 The Bank's Anti-Corruption Guidelines and this annex apply with respect to procurement under Bank Investment Project Financing operations.

2. Requirements

2.1 The Bank requires that Borrowers (including beneficiaries of Bank financing); bidders (applicants/proposers), consultants, contractors and suppliers; any sub-contractors, sub-consultants, service providers or suppliers; any agents (whether declared or not); and any of their personnel, observe the highest standard of ethics during the procurement process, selection and contract execution of Bank-financed contracts, and refrain from Fraud and Corruption.

2.2 To this end, the Bank:

a. Defines, for the purposes of this provision, the terms set forth below as follows:

i. "corrupt practice" is the offering, giving, receiving, or soliciting, directly or indirectly, of anything of value to influence improperly the actions of another party;

ii. "fraudulent practice" is any act or omission, including misrepresentation, that knowingly or recklessly misleads, or attempts to mislead, a party to obtain financial or other benefit or to avoid an obligation;

iii. "collusive practice" is an arrangement between two or more parties designed to achieve an improper purpose, including to influence improperly the actions of another party;

iv. "coercive practice" is impairing or harming, or threatening to impair or harm, directly or indirectly, any party or the property of the party to influence improperly the actions of a party;

v. "obstructive practice" is:

(a) deliberately destroying, falsifying, altering, or concealing of evidence material to the investigation or making false statements to investigators in order to materially impede a Bank investigation into allegations of a corrupt, fraudulent, coercive, or collusive practice; and/or threatening, harassing, or intimidating any party to prevent it from disclosing its knowledge of matters relevant to the investigation or from pursuing the investigation; or

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(b) acts intended to materially impede the exercise of the Bank's inspection and audit rights provided for under paragraph 2.2 e. below.

b. Rejects a proposal for award if the Bank determines that the firm or individual recommended for award, any of its personnel, or its agents, or its sub-consultants, sub-contractors, service providers, suppliers and/ or their employees, has, directly or indirectly, engaged in corrupt, fraudulent, collusive, coercive, or obstructive practices in competing for the contract in question;

c. In addition to the legal remedies set out in the relevant Legal Agreement, may take other appropriate actions, including declaring mis-procurement, if the Bank determines at any time that representatives of the Borrower or of a recipient of any part of the proceeds of the loan engaged in corrupt, fraudulent, collusive, coercive, or obstructive practices during the procurement process, selection and/or execution of the contract in question, without the Borrower having taken timely and appropriate action satisfactory to the Bank to address such practices when they occur, including by failing to inform the Bank in a timely manner at the time they knew of the practices;

d. Pursuant to the Bank's Anti- Corruption Guidelines and in accordance with the Bank's prevailing sanctions policies and procedures, may sanction a firm or individual, either indefinitely or for a stated period of time, including by publicly declaring such firm or individual ineligible (i) to be awarded or otherwise benefit from a Bank-financed contract, financially or in any other manner;1 (ii) to be a nominated2 sub-contractor, consultant, manufacturer or supplier, or service provider of an otherwise eligible firm being awarded a Bank-financed contract; and (iii) to receive the proceeds of any loan made by the Bank or otherwise to participate further in the preparation or implementation of any Bank-financed project;

e. Requires that a clause be included in bidding/request for proposals documents and in contracts financed by a Bank loan, requiring (i) bidders(applicants/proposers), consultants, contractors, and suppliers, and their sub-contractors, sub-consultants, service providers, suppliers, agents personnel, permit the Bank to inspect[3] all accounts, records and other documents relating to the procurement process, selection and/or contract execution, and to have them audited by auditors appointed by the Bank.

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1 For the avoidance of doubt, a sanctioned party's ineligibility to be awarded a contract shall include, without limitation, (i) applying for pre-qualification, expressing interest in a consultancy, and bidding, either directly or as a nominated sub-contractor, nominated consultant, nominated manufacturer or supplier, or nominated service provider, in respect of such contract, and (ii) entering into an addendum or amendment introducing a material modification to any existing contract.

2 A nominated sub-contractor, nominated consultant, nominated manufacturer or supplier, or nominated service provider (different names are used depending on the particular bidding document) is one which has been: (i) included by the bidder in its pre-qualification application or bid because it brings specific and critical experience and know-how that allow the bidder to meet the qualification requirements for the particular bid; or (ii) appointed by the Borrower.

3 Inspections in this context usually are investigative (i.e., forensic) in nature. They involve fact-finding activities undertaken by the Bank or persons appointed by the Bank to address specific matters related to investigations/audits, such as evaluating the veracity of an allegation of possible Fraud and Corruption, through the appropriate mechanisms. Such activity includes but is not limited to: accessing and examining a firm's or individual's financial records and information, and making copies thereof as relevant; accessing and examining any other documents, data and information (whether in hard copy or electronic format) deemed relevant for the investigation/audit, and making copies thereof as relevant; interviewing staff and other relevant individuals; performing physical inspections and site visits; and obtaining third party verification of information.

APPENDIX B

Environmental, Social, Health and Safety (ESHS) Metrics for Progress Reports

[Note to Employer: the following metrics may be amended to reflect the Employer's environmental, social, health and safety policies and/or the ESHS requirements of the project. The metrics that are required should be determined by the ESHS risks of the Works and not necessarily by the scale of the Works]

Metrics for regular reporting:

a. *environmental incidents or non-compliances with contract requirements, including contamination, pollution or damage to ground or water supplies;*

b. *health and safety incidents, accidents, injuries and all fatalities that require treatment;*

c. *interactions with regulators: identify agency, dates, subjects, outcomes (report the negative if none);*

d. *status of all permits and agreements:*

   i. work permits: number required, number received, actions taken for those not received;

   ii. status of permits and consents:

   iii. *list areas/facilities with permits required (quarries, asphalt & batch plants), dates of application, dates issued (actions to follow up if not issued), dates submitted to resident engineer (or equivalent), status of area (waiting for permits, working, abandoned without reclamation, decommissioning plan being implemented, etc.);*

   - *list areas with landowner agreements required (borrow and spoil areas, camp sites), dates of agreements, dates submitted to resident engineer (or equivalent);*
   - *identify major activities undertaken in each area in the reporting period and highlights of environmental and social protection (land clearing, boundary marking, topsoil salvage, traffic management, decommissioning planning, decommissioning implementation);*
   - *for quarries: status of relocation and compensation (completed, or details of activities and current status in the reporting period).*

e. *health and safety supervision:*

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i. safety officer: number days worked, number of full inspections & partial inspections, reports to construction/project management;

ii. number of workers, work hours, metric of PPE use (percentage of workers with full personal protection equipment (PPE), partial, etc.), worker violations observed (by type of violation, PPE or otherwise), warnings given, repeat warnings given, follow-up actions taken (if any);

f. worker accommodations:

i. number of expats housed in accommodations, number of locals;

ii. date of last inspection, and highlights of inspection including status of accommodations' compliance with national and local law and good practice, including sanitation, space, etc.;

iii. actions taken to recommend/require improved conditions, or to improve conditions.

g. HIV/AIDS: provider of health services, information and/or training, location of clinic, number of non-safety disease or illness treatments and diagnoses (no names to be provided);

h. gender (for expats and locals separately): number of female workers, percentage of workforce, gender issues raised and dealt with (cross-reference grievances or other sections as needed);

i. training:

i. number of new workers, number receiving induction training, dates of induction training;

ii. number and dates of toolbox talks, number of workers receiving Occupational Health and Safety (OHS), environmental and social training;

iii. number and dates of HIV/AIDS sensitization and/or training, no. workers receiving training (this reporting period and in the past); same questions for gender sensitization, flag person training.

iv. number and date of GBV /SEA sensitization and/or training, number of workers receiving training on code of conduct (in the reporting period and in the past), etc.

j. environmental and social supervision:

i. environmentalist: days worked, areas inspected and numbers of inspections of each (road section, work camp, accommodations, quarries, borrow areas, spoil areas, swamps, forest crossings, etc.), highlights of activities/findings (including violations of environmental and/or social best practices, actions taken), reports to environmental and/or social specialist/construction/site management;

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ii. sociologist: days worked, number of partial and full site inspections (by area: road section, work camp, accommodations, quarries, borrow areas, spoil areas, clinic, HIV/AIDS center, community centers, etc.), highlights of activities (including violations of environmental and/or social requirements observed, actions taken), reports to environmental and/or social specialist/construction/site management; and

iii. community liaison person(s): days worked (hours community center open), number of people met, highlights of activities (issues raised, etc.), reports to environmental and/or social specialist /construction/site management.

k. *Grievances*: list new grievances (e.g. allegations of GBV / SEA) received in the reporting period and unresolved past grievances by date received, complainant, how received, to whom referred to for action, resolution and date (if completed), data resolution reported to complainant, any required follow-up(Cross-reference other sections as needed):

i. Worker grievances;

ii. Community grievances

l. Traffic and vehicles/equipment:

i. traffic accidents involving project vehicles & equipment: provide date, location, damage, cause, follow-up;

ii. accidents involving non-project vehicles or property (also reported under immediate metrics): provide date, location, damage, cause, follow-up;

iii. overall condition of vehicles/equipment (subjective judgment by environmentalist); non-routine repairs and maintenance needed to improve safety and/or environmental performance (to control smoke, etc.).

m. Environmental mitigations and issues (what has been done):

i. dust: number of working bowsers, number of waterings/day, number of complaints, warnings given by environmentalist, actions taken to resolve; highlights of quarry dust control (covers, sprays, operational status); % of rock/spoil lorries with covers, actions taken for uncovered vehicles;

ii. erosion control: controls implemented by location, status of water crossings, environmentalist inspections and results, actions taken to resolve issues, emergency repairs needed to control erosion/sedimentation;

iii. quarries, borrow areas, spoil areas, asphalt plants, batch plants: identify major activities undertaken in the reporting period at each, and highlights of environmental and social protection: land clearing, boundary marking, topsoil salvage, traffic management, decommissioning planning, decommissioning implementation;

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iv. blasting: number of blasts (and locations), status of implementation of blasting plan (including notices, evacuations, etc.), incidents of off-site damage or complaints (cross-reference other sections as needed);

v. spill cleanups, if any: material spilled, location, amount, actions taken, material disposal (report all spills that result in water or soil contamination;

vi. waste management: types and quantities generated and managed, including amount taken offsite (and by whom) or reused/recycled/disposed on-site;

vii. details of tree plantings and other mitigations required undertaken in the reporting period;

viii. details of water and swamp protection mitigations required undertaken in the reporting period.

n. compliance:

i. compliance status for conditions of all relevant consents/permits, for the Work, including quarries, etc.): statement of compliance or listing of issues and actions taken (or to be taken) to reach compliance;

ii. compliance status of C-ESMP/ESIP requirements: statement of compliance or listing of issues and actions taken (or to be taken) to reach compliance

iii. compliance status of GBV/SEA prevention and response action plan: statement of compliance or listing of issues and actions taken (or to be taken) to reach compliance

iv. compliance status of Health and Safety Management Plan re: statement of compliance or listing of issues and actions taken (or to be taken) to reach compliance

v. other unresolved issues from previous reporting periods related to environmental and social: continued violations, continued failure of equipment, continued lack of vehicle covers, spills not dealt with, continued compensation or blasting issues, etc. Cross-referene other sections as needed.

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Section IX -Particular Conditions of Contract

A. General	
GCC 1.1 (d)	The financing institution is: World Bank/IBRD
GCC 1.1 (r)	The Employer is: **Punjab Rural Municipal Services Company (PRMSC)** Address: Punjab Rural Municipal Services Company (PRMSC) 5th Floor, KD Plaza, MM Alam Road, Gulberg-III, Lahore, Pakistan Telephone: +92-42-99333613 Electronic mail address: proc.prmsc@punjab.gov.pk Chief Executive Officer / Project Director
GCC 1.1 (v)	The Intended Completion Date for the whole of the Works shall be 14 months.
GCC 1.1 (y)	The Project Manager is Chief Resident Engineer (CRE) or any other official nominated by the Engineering Design and Construction Supervision (EDCS) Consultant (the Consultant hired by the Employer) and approved by the Employer
GCC 1.1 (aa)	The Site is located at _____ and is defined in drawings No. *[insert numbers]*
GCC 1.1 (dd)	The Start Date shall be_____*[date to be inserted at the time of signing of the Contract, maximum 14 days beyond date of signing of the Contract]*.
GCC 1.1 (hh)	The Works are described in Section VII –"Works' Requirements"
GCC 1.1 (ii)	The following is added as GCC 1.1. (ii) "ESHS" means environmental, social (including sexual exploitation and abuse (SEA) and gender-based violence (GBV)), health and safety.
GCC 2.2	Sectional Completions are: Not Applicable
GCC 2.3(i)	The following documents also form part of the Contract: (i) the ESHS Management Strategies and Implementation Plans; and

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	(ii) Code of Conduct (ESHS).
GCC 3.1	The language of the Contract is English. The law that applies to the Contract is the law of Islamic Republic of Pakistan.
GCC 4.1	With reference to Sub-Clause 4.1, the following provisions shall also apply; The Project Manager shall obtain the specific approval of the Employer before carrying out his duties in accordance with the following Clauses/Sub-Clauses: a) Any action regarding sub-letting of any part of the Works under Sub-Clause 7.1 "Subcontracting". b) Approving Key Personnel under Sub-Clause 9.1 "Personnel and Equipment". c) Any action under Clause 27 regarding "Extension of the Intended Completion Date" and "additional cost". d) Issuing a Variation Order under Clause 38 "Variations". e) Release of Retention Money to the Contractor under Sub-Clause 46.2 "Retention". f) Issuance of "Certificate of Completion" under Clause 53 "Completion". g) Issuing "Defect Liability Certificate" and "final payment certificate" under Clause 55 "Final Account". h) The amount to be withheld for late submission of an updated Program
GCC 5.1	The Project manager may delegate any of his duties and responsibilities.
GCC 8.1	Schedule of other contractors: Not Applicable
GCC 9.1	The names of other Key Personnel and equipment shall be mutually agreed prior to signing of the Contract Agreement.
GCC 9.2	**Code of Conduct (ESHS)** The following is inserted at the end of GCC 9.2: "The reasons to remove a person include behavior which breaches the Code of Conduct (ESHS) (e.g. spreading communicable diseases, sexual harassment, gender based violence (GBV), sexual exploitation or abuse, illicit activity or crime)."
GCC 13.1	The minimum insurance amounts and deductibles shall be: (a) for loss or damage to the Works, Plant and Materials: to the full replacement value plus additional amount of fifteen percent (15%) of such

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	replacement value to cover any additional costs incidental to rectification of loss or damage, including professional fees and the cost of demolition and removal of debris. The permitted deductible shall not exceed 10% of loss amount on each & every loss. (b) For loss or damage to Equipment: to the full replacement value including delivery to the Site. (c) for loss or damage to property (except the Works, Plant, Materials, and Equipment) in connection with Contract: to the full value of loss or damage. (d) for personnel injury or death: (at least PKR 0.5 million for bodily injury (any one person) and at least 1 million for fatal case (any one person) (i) of the Contractor's employees: as per statutory requirements of the Islamic Republic of Pakistan. (ii) of other people: as per statutory requirements of the Islamic Republic of Pakistan. The permitted deductible(s) are 'Nil' for para (b), (c) and (d).
GCC 14.1	Site Data are: as per Section VII - Works' Requirements.
GCC 16.1 (add new 16.2)	**ESHS Management Strategies and Implementation Plans** The following is inserted as a new Sub-Clause 16.2: " **16.2** The Contractor shall not carry out any Works, including mobilization and/or pre-construction activities (e.g. limited clearance for haul roads, site accesses and work site establishment, geotechnical investigations or investigations to select ancillary features such as quarries and borrow pits), unless the Project Manager is satisfied that appropriate measures are in place to address environmental, social, health and safety risks and impacts. At a minimum, the Contractor shall apply the Management Strategies and Implementation Plans and Code of Conduct, submitted as part of the Bid and agreed as part of the Contract. The Contractor shall submit, on a continuing basis, for the Project Manager's prior approval, such supplementary Management Strategies and Implementation Plans as are necessary to manage the ESHS risks and impacts of ongoing works. These Management Strategies and Implementation Plans collectively comprise the Contractor's Environmental and Social Management Plan (C-ESMP). The C-ESMP shall be approved prior to the commencement of construction activities (e.g. excavation, earth works, bridge and structure works, stream and road diversions, quarrying or extraction of materials, concrete batching and asphalt manufacture). The approved C-ESMP shall be reviewed, periodically (but not less than every six (6) months), and updated in a timely manner, as required, by the Contractor to

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	ensure that it contains measures appropriate to the Works activities to be undertaken. The updated C-ESMP shall be subject to prior approval by the Project Manager."
GCC 20.1	The text of Sub-Clause 20.1 is replaced as under: "The Employer shall give the Contractor possession of those parts of the Site within such times as may be required to enable the Contractor to proceed in accordance with the Program."
GCC 23.1 & GCC 23.2	Appointing Authority for the Adjudicator: Chairman Pakistan Engineering Council
GCC 24.3	Hourly rate and types of reimbursable expenses to be paid to the Adjudicator shall be mutually agreed at the time of finalization of the Adjudicator in accordance with GCC 23.1.
GCC 24.4	Any dispute arising out of or in connection with this Contract, including any question regarding its existence, validity, or termination shall be referred to and finally resolved by arbitration under the Rules and Provisions of the Pakistan Arbitration Act 1940 amended from time to time. The place of arbitration shall be: Lahore
B. Time Control	
GCC 26.1	The Contractor shall submit for approval a Program for the Works within fourteen (14) days from the date of the Letter of Acceptance to the Project Manager showing the general methods, arrangements, order, and timing for all the activities in the Works in the form of using project management tools like MS project, Primavera or equal etc.
GCC 26.2	**ESHS Reporting** Inserted at the end of GCC 26.2: "In addition to the progress report, the Contractor shall also provide a report on the Environmental, Social, Health and Safety (ESHS) metrics set out in Appendix B. In addition to Appendix B reports, the Contractor shall also provide immediate notification to the Project Manager of incidents in the following categories. Full details of such incidents shall be provided to the Project Manager within the timeframe agreed with the Project Manager. (a) confirmed or likely violation of any law or international agreement; (b) any fatality or serious (lost time) injury; (c) significant adverse effects or damage to private property (e.g. vehicle accident, damage from fly rock, working beyond the boundary)

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	(d) major pollution of drinking water aquifer or damage or destruction of rare or endangered habitat (including protected areas) or species; or (e) any allegation of gender-based violence (GBV), sexual exploitation or abuse, sexual harassment or sexual misbehavior, rape, sexual assault, child abuse or defilement, or other violations involving children.
GCC 26.3	The period between Program updates is fourteen (14) days. The amount to be withheld for late submission of an updated Program is PKR 500,000.
C. Quality Control	
GCC 34.1	The Defects Liability Period is: three hundred and sixty-five (365) days after issuance of Certificate of Completion.
D. Cost Control	
GCC 38.2	At the end of 38.2 add after the first sentence: "The Contractor shall also provide information of any ESHS risks and impacts of the Variation."
GCC 38.7	Not Applicable
GCC 40 (Add new GCC 40.7)	The following is inserted as a new Sub-Clause 40.7: "**40.7** If the Contractor was, or is, failing to perform any ESHS obligations "or work under the Contract, the value of this work or obligation, as determined by the Project Manager, may be withheld until the work or obligation has been performed, and/or the cost of rectification or replacement, as determined by the Project Manager, may be withheld until rectification or replacement has been completed. Failure to perform includes, but is not limited to the following: (i) failure to comply with any ESHS obligations or work described in the Works' Requirements which may include: working outside site boundaries, excessive dust, failure to keep public roads in a safe usable condition, damage to offsite vegetation, pollution of water courses from oils or sedimentation, contamination of land e.g. from oils, human waste, damage to archeology or cultural heritage features, air pollution as a result of unauthorized and/or inefficient combustion; (ii) failure to regularly review C-ESMP and/or update it in a timely manner to address emerging ESHS issues, or anticipated risks or impacts;

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	(iii) failure to implement the C-ESMP e.g. failure to provide required training or sensitization; (iv) failing to have appropriate consents/permits prior to undertaking Works or related activities; (v) failure to submit ESHS report/s (as described in Appendix C), or failure to submit such reports in a timely manner; (vi) failure to implement remediation as instructed by the Engineer within the specified timeframe (e.g. remediation addressing non-compliance/s).
GCC 41.1	The 3rd and 4th sentences comprising text "If the Employer makes a late payment, …….the currencies in which payments are made." are deleted.
GCC 44.1	The currency of the Employer's Country is: Pak. Rupees (PKR)
GCC 45.1	The text of Sub-Clause GCC 45.1 is replaced as under: Prices of Civil Works shall be adjusted for fluctuations in the cost of labour and material inputs only. The amounts certified in each payment certificate, before deducting for Advance Payment, shall be adjusted by applying the following price adjustment factor to the due payment amounts. To the extent that full compensation for any rise or fall in Costs is not covered by the provisions of this or other Clauses, the Accepted Contract Amount shall be deemed to have included amounts to cover the contingency of other rises and falls in costs. $P_n = a + b\frac{L_n}{L_0} + c\frac{E_n}{E_0} + d\frac{M_n}{M_0} + \ldots\ldots\ldots\ldots\ldots\ldots$ where: "P_n " is the adjustment factor for the portion of the Contract Price for Civil Works carried out in period "n", this period being a month; "a" is a fixed coefficient, stated in the Schedule of Adjustment Data, representing the non-adjustable portion in contractual payments; "b", "c", "d", ... are coefficients representing the estimated proportion of each cost element related to the execution of the Civil Works as stated in the Schedule of Adjustment Data; "L_n ", "E_n ", "M_n ", ... are the current rates for period "n", each of which is applicable to the relevant tabulated cost element; and "L_o ", "E_o ", "M_o ", ... are the base rates, each of which is applicable to the relevant tabulated cost elements for the month falling on the date thirty (30) days prior to the deadline for submission of Bids. The following conditions shall apply to the price adjustment(s):

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	a. No price increase will be allowed beyond the Intended Completion Date unless extended by the Project Manager under the terms of the Contract. No price increase will be allowed for periods of delay for which the Contractor is responsible. The Employer will, however, be entitled to any price decrease occurring during such periods of delay. b. No price adjustment shall be payable on the portion of the Contract price paid to the Contractor as an advance payment. c. No price adjustment shall be payable for any fluctuation in the rates of elements other than those given in Schedule of Adjustment Data.
GCC 46.1	The proportion of payments retained is: 10% of Interim Payment Certificate and ceiling amount shall be 5% of the Accepted Contract Amount.
GCC 47.1	The liquidated damages for the whole of the Works are 0.10% of the final Contract Price per day. The maximum amount of liquidated damages for the whole of the Works is 10% of the Accepted Contract Price.
GCC 48.1	Not Applicable
GCC 49.1	The Advance Payment shall be 10% of the Accepted Contract Amount and shall be paid to the Contractor within 28 days after: a) receipt of an acceptable Performance Security by the Employer in accordance with Sub-Clause COC50.1; b) signing of Contract Agreement by the Parties; c) receipt of an acceptable bank guarantee by the Employer for the same amount and currency of the advance payment from a Scheduled Bank in Pakistan, in the prescribed form; and d) receipt of Contractor's invoice for advance payment by the Employer.
GCC 49.1 (added)	The following shall stand inserted/added in the clause: a) **"Secure Advance Payment"**: The Contractor shall be entitled to receive from the Employer Secure Advance in the case of non-perishable materials required, namely; (i) **Steel, HDPE Pipe, RCC Pipe**, @ **50%** of the total material required with an amount not exceeding seventy five percent (**75%**) of the monetary value of the materials, as per BOQ, and (ii) in case of **pumping unit** @ **75%** of cost as per BOQ, that shall be for bonafide use of Work, when those are delivered at respective site upon assessment, verification and certification by the Engineer/Project Manager. Following shall be the conditions precedent:

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	b) For the provision of Secure Advance, the Contractor can bring **maximum 50%** of the total required material mentioned in Bill of Quantities (BOQs) to the site, c) The non-perishable materials delivered to the site must "appear to be in accordance with the Specifications for the Permanent Works defined in the Contract", d) Upon inspection, verification, necessary testing where required, certification and satisfactory acceptance by the Engineer/Project Manager, the non-perishable materials shall become the Employer's property, e) The requirement of plant and materials shall be for near use in the Work, nonperishable, nonfragile, and noncombustible, f) The non-perishable materials shall be hypothecated to the Employer by the Contractor and the Contractor shall submit corresponding invoice for advance payment to the Employer through Engineer/Project Manager, g) The Materials shipped and en-route to the Site shall be insured by the Contractor. The Contractor shall be exclusively responsible for safe delivery of the Material at site covering all the related risks. In case of any damage to the Materials till the delivery at site and before their usage in Permanent Works, the Contractor shall manage the replacement of material at its own cost & expenses without any liability towards the Employer, h) The Contractor shall ensure and guarantee Materials, delivered at site are properly stored on Site, protected against loss, theft, damage or deterioration to the satisfaction of the Engineer/Project Manager, at the risk and cost of the Contractor, until their use in Permanent Works is accepted by the Employer, i) In case the Contractor does not replace or compensate the damaged shipment of Material (including items/quantities) that are damaged during their storage at site before their use in Permanent Works, the Employer shall confiscate/recover the corresponding value of the Material from the next Interim Payment (IPC), appropriately determined by the Employer, without any notice to the Contractor, j) The Contractor shall notify the Employer/Engineer of the Materials shipped and en-route to the Site and mail the following documents to the Employer/Engineer: i. one original plus four copies of the Contractor's invoice showing Materials' description, quantity, unit price, and total amount,

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	ii. delivery note, railway receipt, or truck receipt, iii. detailed description of Materials, packing details, weight, dimension and volume of consignment be provided, k) The Contractor's records of the requirements, orders, receipts and use of materials must be kept in a form approved by the Engineer, and such records shall be available for inspection by the Engineer/Project Manager, l) The Contractor shall submit with his monthly statement the estimated value of the materials delivered on Site together with such documents as may be required by the Engineer/Project Manager for the purpose of valuation of materials and providing evidence of ownership and adjustment/payment therefor, m)The Engineer/Project Manager shall assess the value of delivered Materials and accord a certificate for its use at site, n) **The escalation/price adjustment shall not be applied to payments for materials brought onto Site for which a secure advance has been paid.** Only the value of the executed works shall be included in the formula governing Price Adjustment under Clause 45 viz. Price Adjustment which shall be applied to the value of the executed works for the relevant month (which will include the cost of the incorporated plant and materials but not the stockpiled plant and materials); o) The Material so brought on site, shall neither be allowed to be shifted from the site nor disposed of, and the Employer and/or its Engineer/Project Manager shall keep an eye on the delivered Material ensuring that dual advance is not given on same Material. p) The Secure Advance paid to the Contractor under the above provisions shall be adjusted from the monthly payments on actual consumption basis of respective material, duly certified by the Engineer/Project Manager. q) Secure **Advance shall only be grated, at risk and cost of the Contractor, against an indemnity bond** acceptable to the employer, specifying that materials have been delivered at the site and have properly been stored and protected against any loss or damage or deterioration up to the satisfaction of the Engineer.
GCC 49.3	The text of sub-clause 49.3 is replaced as under: "Advance payment shall be recovered in equal installation over the remaining contract period after three months from the date of receipt of mobilization advance."

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GCC 50.1	An Environmental, Social, Safety and Health (ESHS) Performance Security shall not be provided to the Employer.
GCC 50.1	The Performance Security shall be in the form of an unconditional and irrevocable Bank Guarantee issued by a Scheduled Bank in Pakistan in the amount of five percent (05%) of the Accepted Contract Amount and in the same currency of the Accepted Contract Amount. However, additional performance security is required, in case of abnormally low bids. In case of Joint Venture, the Performance Security shall be in the name of the Joint Venture.
E. Finishing the Contract	
GCC 56.1	The Contractor shall furnish to the Project Manager "As-Built drawings and Operation & Maintenance manuals" at the completion of whole of the Works under the Contract as per GCC Sub-Clause 53.1.
GCC 56.2	The amount to be withheld for failing to produce "As-Built drawings and Operation & Maintenance manuals" by the time required in GCC 56.1 is PKR 2.00 million.
GCC 57.2 (g)	The maximum number of days is: one hundred (100)
GCC 58.1	The percentage to apply to the value of the work not completed, representing the Employer's additional cost for completing the Works, is 35%.

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Section X - Contract Forms

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Notification of Intention to Award

[*This Notification of Intention to Award shall be sent to each Bidder that submitted a Bid.*]

[*Send this Notification to the Bidder's Authorized Representative named in the Bidder Information Form*]

For the attention of Bidder's Authorized Representative

Name: *[insert Authorized Representative's name]*

Address: *[insert Authorized Representative's Address]*

Telephone/Fax numbers: *[insert Authorized Representative's telephone/fax numbers]*

Email Address: *[insert Authorized Representative's email address]*

[IMPORTANT: insert the date that this Notification is transmitted to Bidders. The Notification must be sent to all Bidders simultaneously. This means on the same date and as close to the same time as possible.]

DATE OF TRANSMISSION: This Notification is sent by: [*email/fax*] on [*date*] (local time)

Notification of Intention to Award

Employer: *[insert the name of the Employer]*
Project:*[insert name of project]*
Contract title: *[insert the name of the contract]*
Country: *[insert country where RFB is issued]*
Loan No. /Credit No. / Grant No.: *[insert reference number for loan/credit/grant]*
RFB No: *[insert RFB reference number from Procurement Plan]*

This Notification of Intention to Award (Notification) notifies you of our decision to award the above contract after which, you may:

a) request a debriefing in relation to the evaluation of your Bid, and/or

b) submit a Procurement-related Complaint in relation to the decision to award the contract.

1. The successful Bidder

Name:	[*insert name of successful Bidder*]
Address:	[*insert address of the successful Bidder*]
Contract price:	[*insert contract price of the successful Bid*]

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2. Other Bidders ***[INSTRUCTIONS: insert names of all Bidders that submitted a Bid. If the Bid's price was evaluated include the evaluated price as well as the Bid price as read out.]***

Name of Bidder	Bid price	Evaluated Bid price (if applicable)
[*insert name*]	[*insert Bid price*]	[*insert evaluated price*]
[*insert name*]	[*insert Bid price*]	[*insert evaluated price*]
[*insert name*]	[*insert Bid price*]	[*insert evaluated price*]
[*insert name*]	[*insert Bid price*]	[*insert evaluated price*]
[*insert name*]	[*insert Bid price*]	[*insert evaluated price*]

3. Reason/s why your Bid was unsuccessful

[INSTRUCTIONS: State the reason/s why <u>this</u> Bidder's Bid was unsuccessful. Do NOT include: (a) a point-by-point comparison with another Bidder's Bid or (b) information that is marked confidential by the Bidder in its Bid.]

4. How to request a debriefing

DEADLINE: The deadline to request a debriefing expires at midnight on [*insert date*] (local time).

You may request a debriefing in relation to the results of the evaluation of your Bid. If you decide to request a debriefing your written request must be made within three (3) Business Days of receipt of this Notification of Intention to Award.

Provide the contract name, reference number, name of the Bidder, contact details; and address the request for debriefing as follows:

Attention: [*insert full name of person, if applicable*]

Title/position: [*insert title/position*]

Agency: [*insert name of Employer*]

Email address: [*insert email address*]

Fax number: [*insert fax number*] ***delete if not used***

If your request for a debriefing is received within the 3 Business Days deadline, we will provide the debriefing within five (5) Business Days of receipt of your request.

The debriefing may be in writing, by phone, video conference call or in person. We shall promptly advise you in writing how the debriefing will take place and confirm the date and time.

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If the deadline to request a debriefing has expired, you may still request a debriefing. In this case, we will provide the debriefing as soon as practicable, and normally no later than fifteen (15) Business Days from the date of publication of the Contract Award Notice.

5. How to make a complaint

Period: Procurement-related Complaint challenging the decision to award shall be submitted by midnight, [*insert date*] (local time).

Provide the contract name, reference number, name of the Bidder, contact details; and address the Procurement-related Complaint as follows:

Attention: [*insert full name of person, if applicable*]

Title/position: [*insert title/position*]

Agency: [*insert name of Employer*]

Email address: [*insert email address*]

Fax number: [*insert fax number*] ***delete if not used***

At this point in the procurement process, you may submit a Procurement-related Complaint challenging the decision to award the contract. You do not need to have requested, or received, a debriefing before making this complaint. Your complaint must be submitted within the seven business days after issuance of NoIA.

Further information:

For more information see the Procurement Regulations for IPF Borrowers (Procurement Regulations)[https://policies.worldbank.org/sites/ppf3/PPFDocuments/Forms/DispPage.aspx?docid=4005] (Annex III). You should read these provisions before preparing and submitting your complaint. In addition, the World Bank's Guidance "How to make a Procurement-related Complaint" [http://www.worldbank.org/en/projects-operations/products-and-services/brief/procurement-new-framework#framework] provides a useful explanation of the process, as well as a sample letter of complaint.

In summary, there are four essential requirements:

1. You must be an 'interested party'. In this case, that means a Bidder who submitted a Bid in this bidding process, and is the recipient of a Notification of Intention to Award.
2. The complaint can only challenge the decision to award the contract.
3. You must submit the complaint within the period stated above.
4. You must include, in your complaint, all of the information required by the Procurement Regulations (as described in Annex III).

If you have any questions regarding this Notification, please do not hesitate to contact us.

On behalf of the Employer:

PBWSP

Signature: _____

Name: _____

Title/position: _____

Telephone: _____

Email: _____

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Beneficial Ownership Disclosure Form

INSTRUCTIONS TO BIDDERS: DELETE THIS BOX ONCE YOU HAVE COMPLETED THE FORM

This Beneficial Ownership Disclosure Form ("Form") is to be completed by the successful Bidder[1]. In case of joint venture, the Bidder must submit a separate Form for each member. The beneficial ownership information to be submitted in this Form shall be current as of the date of its submission.

For the purposes of this Form, a Beneficial Owner of a Bidder is any natural person who ultimately owns or controls the Bidder by meeting one or more of the following conditions:

- *directly or indirectly holding 25% or more of the shares*
- *directly or indirectly holding 25% or more of the voting rights*
- *directly or indirectly having the right to appoint a majority of the board of directors or equivalent governing body of the Bidder*

RFB No.: [*insert number of RFB process*]
Request for Bid No.: [*insert identification*]

To: **[*insert complete name of Employer*]**

In response to your request in the Letter of Acceptance *dated [insert date of letter of Acceptance]* to furnish additional information on beneficial ownership: *[select one option as applicable and delete the options that are not applicable]*

(i) we hereby provide the following beneficial ownership information.

Details of beneficial ownership

Identity of Beneficial Owner	Directly or indirectly holding 25% or more of the shares (Yes / No)	Directly or indirectly holding 25 % or more of the Voting Rights (Yes / No)	Directly or indirectly having the right to appoint a majority of the board of the directors or an equivalent governing body of the Bidder (Yes / No)
[include full name (last, middle, first),			

nationality, country of residence]			

OR

(ii) *We declare that there is no Beneficial Owner meeting one or more of the following conditions:*

- directly or indirectly holding 25% or more of the shares
- directly or indirectly holding 25% or more of the voting rights
- directly or indirectly having the right to appoint a majority of the board of directors or equivalent governing body of the Bidder

OR

(iii) We declare that we are unable to identify any Beneficial Owner meeting one or more of the following conditions. [If this option is selected, the Bidder shall provide explanation on why it is unable to identify any Beneficial Owner]

- directly or indirectly holding 25% or more of the shares
- directly or indirectly holding 25% or more of the voting rights
- directly or indirectly having the right to appoint a majority of the board of directors or equivalent governing body of the Bidder]"

Name of the Bidder:*[*insert complete name of the Bidder*]_____

Name of the person duly authorized to sign the Bid on behalf of the Bidder:**[*insert complete name of person duly authorized to sign the Bid*]_____

Title of the person signing the Bid: [*insert complete title of the person signing the Bid*]_____

Signature of the person named above: [*insert signature of person whose name and capacity are shown above*]_____

Date signed [*insert date of signing*] **day of** [*insert month*], [*insert year*]____

* In the case of the Bid submitted by a Joint Venture specify the name of the Joint Venture as Bidder. In the event that the Bidder is a joint venture, each reference to "Bidder" in the Beneficial Ownership Disclosure Form (including this Introduction thereto) shall be read to refer to the joint venture member.

** Person signing the Bid shall have the power of attorney given by the Bidder. The power of attorney shall be attached with the Bid Schedules.

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Letter of Acceptance

[on letterhead paper of the Employer***]***

. . . . . ***[date]***. . . . . .

To: . . . . . ***.[name and address of the Contractor]*** . . . . . .

Subject: . . . . . ***.[Notification of Award Contract No]***. . . . . .

This is to notify you that your Bid dated . . . ***.[insert date]*** . . . . for execution of the . . . . . ***. . . .[insert name of the contract and identification number, as given in the PCC]***. . . . . for the Accepted Contract Amount of . . . . . ***.[insertamount in numbers and words and name of currency]***, as corrected and modified in accordance with the Instructions to Bidders is hereby accepted by our Agency.

You are requested to furnish (i) the Performance Security and an Environmental, Social, Health and Safety Performance Security ***[Delete ESHS Performance Security if it is not required under the contract]***within 28 days in accordance with the Conditions of Contract, using for that purpose the of the Performance Security Form and the ESHS Performance Security Form, ***[Delete reference to the ESHS Performance Security Form if it is not required under the contract]***and (ii)the additional information on beneficial ownership in accordance with BDSITB 47.1, within eight (8) Business days using the Beneficial Ownership Disclosure Form, included in Section X -Contract Forms, of the bidding document.
[Choose one of the following statements:]

We accept that _____***[insert the name of Adjudicator proposed by the Bidder]*** be appointed as the Adjudicator.

[or]

We do not accept that _____***[insert the name of the Adjudicator proposed by the Bidder]*** be appointed as the Adjudicator, and by sending a copy of this Letter of Acceptance to _____***[insert name of the Appointing Authority]***, the Appointing Authority, we are hereby requesting such Authority to appoint the Adjudicator in accordance with ITB48.1 and GCC23.1.

Authorized Signature: .....

Name and Title of Signatory: .....

Name of Agency: .....

Attachment: Contract Agreement

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Contract Agreement

THIS AGREEMENT made the . . . . . .day of . . . . . ., ..., between . . . . . ***[name of the*** Employer***]***. . . . . (hereinafter "the Employer"), of the one part, and . . . . . ***[name of the Contractor]***. . . . .(hereinafter "the Contractor"), of the other part:

WHEREAS the Employer desires that the Works known as . . . . .***[name of the Contract]***. . . . .should be executed by the Contractor, and has accepted a Bid by the Contractor for the execution and completion of these Works and the remedying of any defects therein,

The Employer and the Contractor agree as follows:

1. In this Agreement words and expressions shall have the same meanings as are respectively assigned to them in the Contract documents referred to.

2. The following documents shall be deemed to form and be read and construed as part of this Agreement. This Agreement shall prevail over all other Contract documents.

(a) the Letter of Acceptance

(b) the Letter of Bid

(c) the addenda Nos _____(if any)

(d) the Particular Conditions

(e) the General Conditions of Contract, including appendix;

(f) the Specification

(g) the Drawings

(h) Bill of Quantities;[4]and

(i) any other document **listed in the PCC** as forming part of the Contract;

3. In consideration of the payments to be made by the Employer to the Contractor as specified in this Agreement, the Contractor hereby covenants with the Employer to execute the Works and to remedy defects therein in conformity in all respects with the provisions of the Contract.

4. The Employer hereby covenants to pay the Contractor in consideration of the execution and completion of the Works and the remedying of defects therein, the Contract Price or such other sum as may become payable under the provisions of the Contract at the times and in the manner prescribed by the Contract.

[4] In lump sum contracts, delete "Bill of Quantities" and replace with "Activity Schedule."

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IN WITNESS whereof the parties hereto have caused this Agreement to be executed in accordance with the laws of . . . . . ***[name of the borrowing country]***. . . . .on the day, month and year specified above.

Signed by: .....
for and on behalf of the Employer

in the presence of: .....
Witness, Name, Signature, Address, Date

Signed by: .....
for and on behalf the Contractor

in the presence of: .....
Witness, Name, Signature, Address, Date

PRSWSP

Performance Security- Bank Guarantee

[Guarantor letterhead or SWIFT identifier code]

Beneficiary: *[insert name and Address of* Employer*]*

Date: _ *[Insert date of issue]*

PERFORMANCE GUARANTEE No.: *[Insert guarantee reference number]*

Guarantor: *[Insert name and address of place of issue, unless indicated in the letterhead]*

We have been informed that _ *[insert name of Contractor, which in the case of a joint venture shall be the name of the joint venture]* (hereinafter called "the Applicant") has entered into Contract No. *[insert reference number of the contract]* dated *[insert date]* with the Beneficiary, for the execution of _ *[insert name of contract and brief description of* Works*]* (hereinafter called "the Contract").

Furthermore, we understand that, according to the conditions of the Contract, a performance guarantee is required.

At the request of the Applicant, we as Guarantor, hereby irrevocably undertake to pay the Beneficiary any sum or sums not exceeding in total an amount of *[insert amount in figures]* (_____) *[insert amount in words]*,[1] such sum being payable in the types and proportions of currencies in which the Contract Price is payable, upon receipt by us of the Beneficiary's complying demand supported by the Beneficiary's statement, whether in the demand itself or in a separate signed document accompanying or identifying the demand, stating that the Applicant is in breach of its obligation(s) under the Contract, without the Beneficiary needing to prove or to show grounds for your demand or the sum specified therein.

This guarantee shall expire, no later than the …. Day of ……, 2… [2], and any demand for payment under it must be received by us at this office indicated above on or before that date.

This guarantee is subject to the Uniform Rules for Demand Guarantees (URDG) 2010 Revision, ICC Publication No. 758, except that the supporting statement under Article 15(a)

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[1] *The Guarantor shall insert an amount representing the percentage of the Accepted Contract Amount specified in the Letter of Acceptance, less provisional sums, if any, and denominated either in the currency(ies) of the Contract or a freely convertible currency acceptable to the Beneficiary.*

[2] *Insert the date twenty-eight days after the expected completion date as described in GC Clause 53.1. The Employer should note that in the event of an extension of this date for completion of the Contract, the Employer would need to request an extension of this guarantee from the Guarantor. Such request must be in writing and must be made prior to the expiration date established in the guarantee. In preparing this guarantee, the Employer might consider adding the following text to the form, at the end of the penultimate paragraph: "The Guarantor agrees to a one-time extension of this guarantee for a period not to exceed [six months] [one year], in response to the Beneficiary's written request for such extension, such request to be presented to the Guarantor before the expiry of the guarantee."*

is hereby excluded.

_____

[signature(s)]

Note: All italicized text (including footnotes) is for use in preparing this form and shall be deleted from the final product.

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Advance Payment Security

Bank Guarantee

[Guarantor letterhead or SWIFT identifier code]

Beneficiary: *[Insert name and Address of* Employer*]*

Date: *[Insert date of issue]*

ADVANCE PAYMENT GUARANTEE No.: *[Insert guarantee reference number]*

Guarantor: *[Insert name and address of place of issue, unless indicated in the letterhead]*

We have been informed that *[insert name of Contractor, which in the case of a joint venture shall be the name of the joint venture]* (hereinafter called "the Applicant") has entered into Contract No. *[insert reference number of the contract]* dated *[insert date]* with the Beneficiary, for the execution of *[insert name of contract and brief description of* Works*]* (hereinafter called "the Contract").

Furthermore, we understand that, according to the conditions of the Contract, an advance payment in the sum *[insert amount in figures]* () *[insert amount in words]* is to be made against an advance payment guarantee.

At the request of the Applicant, we as Guarantor, hereby irrevocably undertake to pay the Beneficiary any sum or sums not exceeding in total an amount of *[insert amount in figures]* () *[insert amount in words]*[1] upon receipt by us of the Beneficiary's complying demand supported by the Beneficiary's statement, whether in the demand itself or in a separate signed document accompanying or identifying the demand, stating either that the Applicant:

(a) has used the advance payment for purposes other than the costs of mobilization in respect of the Works; or

(b) has failed to repay the advance payment in accordance with the Contract conditions, specifying the amount which the Applicant has failed to repay.

A demand under this guarantee may be presented as from the presentation to the Guarantor of a certificate from the Beneficiary's bank stating that the advance payment referred to above

[1] *The Guarantor shall insert an amount representing the amount of the advance payment and denominated either in the currency(ies) of the advance payment as specified in the Contract, or in a freely convertible currency acceptable to the Employer.*

PBWSP

has been credited to the Applicant on its account number *[insert number]* at *[insert name and address of Applicant's bank]*.

The maximum amount of this guarantee shall be progressively reduced by the amount of the advance payment repaid by the Applicant as specified in copies of interim statements or payment certificates which shall be presented to us. This guarantee shall expire, at the latest, upon our receipt of a copy of the interim payment certificate indicating that ninety (90) percent of the Accepted Contract Amount, less provisional sums, has been certified for payment, or on the *[insert day]* day of *[insert month]*, 2 *[insert year]*,[2] whichever is earlier. Consequently, any demand for payment under this guarantee must be received by us at this office on or before that date.

This guarantee is subject to the Uniform Rules for Demand Guarantees (URDG) 2010 Revision, ICC Publication No. 758, except that the supporting statement under Article 15(a) is hereby excluded.

_____

[signature(s)]

Note: All italicized text (including footnotes) is for use in preparing this form and shall be deleted from the final product.

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[2] *Insert the expected expiration date of the Time for Completion. The Employer should note that in the event of an extension of the time for completion of the Contract, the Employer would need to request an extension of this guarantee from the Guarantor. Such request must be in writing and must be made prior to the expiration date established in the guarantee. In preparing this guarantee, the Employer might consider adding the following text to the form, at the end of the penultimate paragraph: "The Guarantor agrees to a one-time extension of this guarantee for a period not to exceed [six months][one year], in response to the Beneficiary's written request for such extension, such request to be presented to the Guarantor before the expiry of the guarantee."*

LEGEND:

Ø3" PROPOSED WATER LINE

Ø4" PROPOSED WATER LINE

Ø6" PROPOSED WATER LINE

SETTLEMENT BOUNDARY

WASHOUT VALVE

AIR RELIEF VALVE

DEAD END

GATE VALVE

PROPOSED TUBEWELL

PROPOSED STANDPOST INCLUDING FILTRATION

PROPOSED OVERHEAD WATER TANK

ABBREVIATION

HDPE	HIGH DENSITY POLYETHYLENE
MS PIPE	MILD STEEL PIPE
OHWT	OVERHEAD WATER TANK
D	DIAMETER
mm	MILLIMETER
ft	FEET
in	INCH
PGL	PROPOSED GROUND LEVEL
GL	GROUND LEVEL
DPC	DAMP PROOF COURSE
PCC	PLAIN CEMENT CONCRETE

NOTES

1. ALL PIPE DIAMETERS ARE IN INCHES AND LENGTHS ARE IN FEET UNLESS OTHERWISE SPECIFIED.
2. ALL DRAWINGS SHALL BE READ IN CONJUNCTION WITH ALL OTHER RELEVANT DRAWINGS.
3. ALL PIPES ARE HDPE PN-6(PE-100, SDR-26) PIPES UNLESS AND OTHERWISE SPECIFIED. DIA AND PIPE MATERIAL OF TRANSMISSION LINES ARE MENTIONED ON THEIR RESPECTIVE DRAWINGS.
4. ALL PIPES HAVE BEEN INDICATED BY OUTER DIAMETER.
5. ALL WATER SUPPLY PIPES ARE BURIED PIPES.
6. THE CONTRACTOR SHALL ARRANGE FOR ALL REQUIRED PERMITS BEFORE THE EXECUTION OF THE WORKS.
7. PROPOSED WATER SUPPLY NETWORK WILL BE MADE FUNCTIONAL ONLY AFTER COMPLETE TESTING (INDIVIDUAL LINES AND LOOPS).
8. REMOVAL OF LEAKAGES (IF ANY) AND DISINFECTION OF THE LINES SHALL BE STRICTLY ACCORDING TO PROVISIONS OF THE SPECIFICATIONS AND DIRECTIONS OF THE ENGINEER.
9. MINIMUM EARTH COVER OVER CROWN OF PIPE SHALL NOT BE LESS THAN 3 FT.
10. THRUST BLOCK WILL BE PROVIDED AT EACH BEND AND JUNCTION.
11. UNTIL COMPLETE LAYING OF THE PROPOSED NETWORK, EXISTING NETWORK SHALL CONTINUE TO OPERATE INDEPENDENTLY. UPON LAYING AND TESTING OF THE NEW NETWORK, THE PROPOSED SYSTEM WILL BECOME OPERATIONAL INDEPENDENT OF THE EXISTING NETWORK TO AVOID TRAVELING OF CONTAMINATION TO NEW NETWORK.
12. THE LOCATION OF AIR VALVES AND SLUICE VALVES IS TENTATIVE. HOWEVER, THE EXACT LOCATION SHALL BE FINALIZED DURING EXECUTION IN CONSULTATION WITH THE ENGINEER.
13. AIR RELIEF VALVE SHOULD BE INSTALLED AFTER 2,000 METER INTERVALS, AT SUMMITS OR AS PER SITE CONDITIONS TO FACILITATE ESCAPE OF TRAPPED AIR.
14. THE CONTRACTOR SHALL VERIFY THE ALIGNMENT OF PIPES IN ACCORDANCE WITH DRAWING AND AS PER DIRECTIONS OF THE ENGINEER.
15. SERVICE CONNECTIONS SHALL BE MADE FREE OF LEAKAGES AT CONNECTIONS POINTS WITH THE NETWORKS LINES AND SEALED PROPERLY.
16. LEAKAGE TEST DURATION FOR OHWT TANK SHOULD BE AT LEAST 72 HOURS.
17. CONTRACTOR SHALL BE FULLY LIABLE TO CONSTRUCT THE ENTIRE WATER SUPPLY SYSTEM IN ACCORDANCE WITH THE OVERALL OBJECTIVES TO PROVIDE CONTAMINATION FREE WATER TO THE CONSUMERS. ANY COMPLAINT LODGED DURING THE DEFECT LIABILITY PERIOD SHALL BE ADDRESSED AND RECTIFIED BY THE CONTRACTOR TO COMPLETE SATISFACTION OF THE ENGINEER AND O&M AGENCY.
18. THE CONTRACTOR SHALL PROVIDE TRAINING TO THE O&M AGENCY FOR REPAIR AND MAINTENANCE OF THE PROPOSED WATER SUPPLY SYSTEM.
19. CONTRACTOR SHALL GIVE CONSTRUCTION METHOD STATEMENT BEFORE START OF WORK, IT SHALL INCLUDE ALL OPERATIONS SUCH AS MANAGEMENT OF TRAFFIC, DIVERSION OF NULLAH AND ANY OTHER RELATED WORK DURING THE OPERATION .
20. CONTRACTOR SHALL PREPARE AND SUBMIT SHOP DRAWINGS TO THE ENGINEER FOR APPROVAL PRIOR TO CONSTRUCTION.
21. THE CONTRACTOR SHALL PREPARE AS-BUILT DRAWINGS OF THE COMPLETE WATER SUPPLY SYSTEM ON AUTOCAD AND GIS SOFTWARES (MENTIONING INSTALLATION TIME, DIAMETER, MATERIAL, LENGTH, DEPTH ETC.) AND EDITABLE COPIES SHALL BE HANDED OVER TO THE ENGINEER, TO HIS ENTIRE SATISFACTION.
22. ALL MATERIALS, WORKMAN SHIP AND TESTING SHALL BE IN ACCORDANCE WITH ENGINEERING STANDARDS, MATERIALS, SPECIFICATION, DRAWINGS AND AS APPROVED BY THE ENGINEER.
23. INCASE OF CHANGE OF LOCATION AND CAPACITY OF TUBEWELLS & OHWT DUE TO ANY REASONS, HYDRAULIC MODEL SHALL BE RECONFIRMED /REVISED WHICH MAY REQUIRE CHANGE IN DESIGN /DRAWINGS ACCORDINGLY.
24. STRICT COMPLIANCE TO HEALTH SAFETY AND ENVIRONMENTAL MANAGEMENT PLANS SHALL BE OBSERVED BY THE CONTRACTOR.
25. ANY MODIFICATION IN PLAN WHICH MAY BE REQUIRED AS PER SITE CONDITIONS, SHALL BE REFERRED TO DESIGNER FOR APPROVAL AND ISSUANCE OF REVISED CONSTRUCTION DRAWINGS.
26. CAPACITY OF TUBEWELL ALONG WITH PUMP HEAD OF EACH VILLAGE/SETTLEMENT IS GIVEN IN THE TABLE BELOW:

SR. NO	VILLAGE / SETTLEMENT NAME	CAPACITY OF TUBEWELL (CUSEC)	PUMP HEAD (ft)	NO. OF TUBEWELLS	PUMP SETTING DEPTH (ft)
01	RAHIMPUR	0.25	170	01	115
02	WAN MIANA	0.25	200	01	100

CLIENT
PUNJAB RURAL MUNICIPAL SERVICES COMPANY (PRMSC)

CONSULTANT
NATIONAL ENGINEERING SERVICES PAKISTAN (PVT.) LTD.
HEAD OFFICE:- NESPAK HOUSE, I-C, BLOCK-N, MODEL TOWN EXTENSION, LAHORE, PAKISTAN.

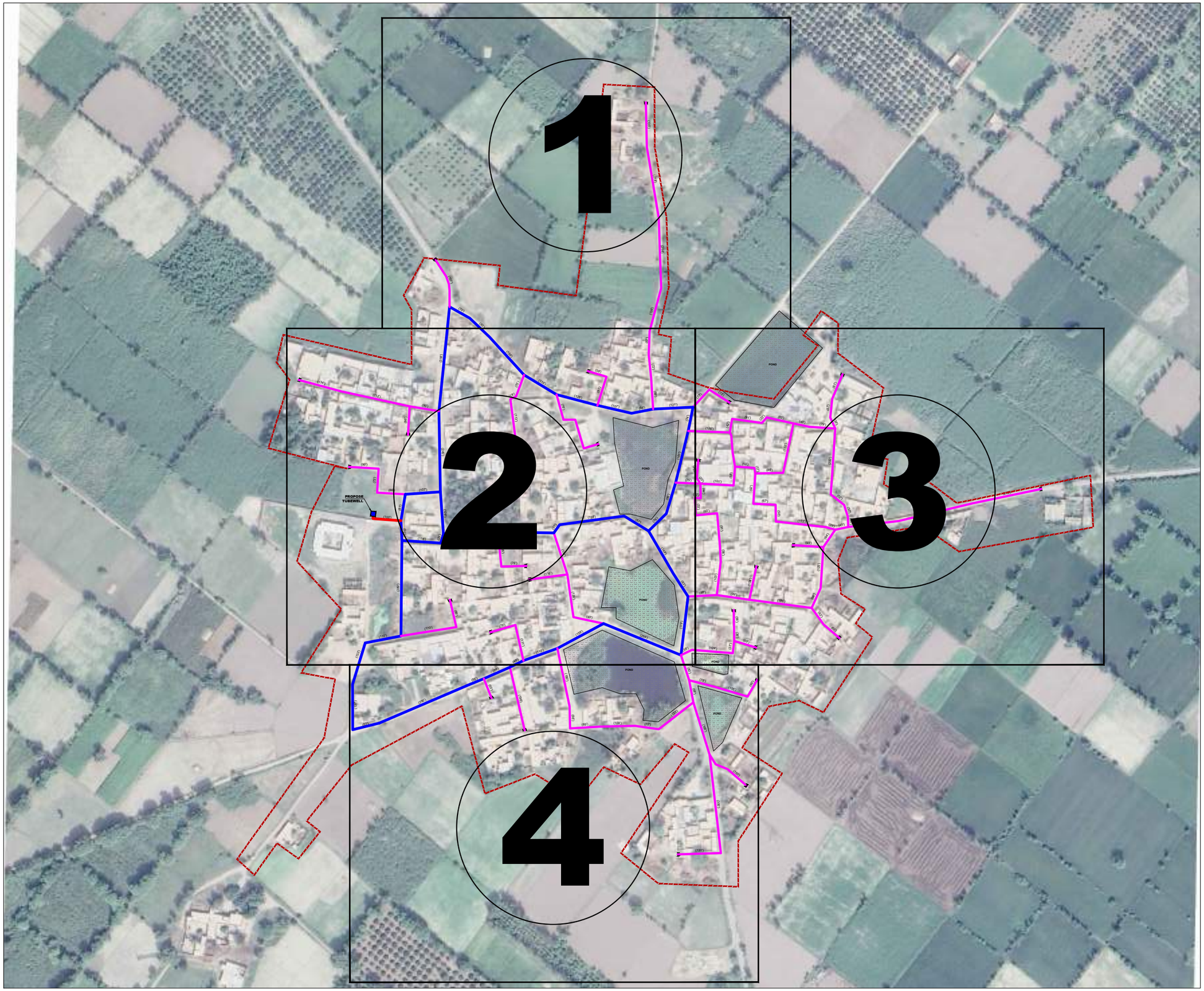
REV.	DATE	DESCRIPTION	APPROVED
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SUBMITTED	
RECOMMENDED	
CHD./VER.	
APPROVED	

PROJECT
ENGINEERING DESIGN & CONSTRUCTION SUPERVISION CLUSTER (NORTH)
PUNJAB RURAL SUSTAINABLE WATER SUPPLY & SANITATION PROJECT

WATER SUPPLY SYSTEM
LEGENDS & GENERAL NOTES

DATE: AUGUST, 2025
DRAWING No.: **4979/11/DD/1J100**
SCALE: N.T.S
REV.: 0



RAHIMPUR
(TEHSIL: KOT MOMIN)

100 50 0 100 feet
GRAPHIC SCALE

(SHEET 1 OF 4)

CLIENT
PUNJAB RURAL MUNICIPAL SERVICES COMPANY (PRMSC)

CONSULTANT
NATIONAL ENGINEERING SERVICES PAKISTAN (PVT.) LTD.
HEAD OFFICE:- NESPAK HOUSE, I-C, BLOCK-N, MODEL TOWN EXTENSION, LAHORE, PAKISTAN.

REV.	DATE	DESCRIPTION	APPROVED
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RECOMMENDED	
CHD./VER.	
APPROVED	

PROJECT
ENGINEERING DESIGN & CONSTRUCTION SUPERVISION CLUSTER (NORTH)
PUNJAB RURAL SUSTAINABLE WATER SUPPLY & SANITATION PROJECT

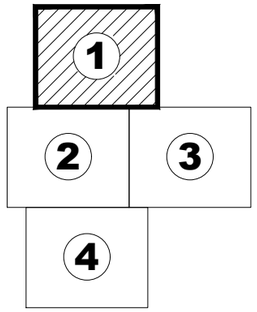
RAHIMPUR
INDEX OF SHEETS OF PROPOSED WATER SUPPLY SYSTEM

DATE: OCTOBER, 2025
DRAWING No.: **4979/11/DD/1J115**
SCALE: 1" = 100'
REV.: 0



N

RAHIMPUR
(TEHSIL: KOT MOMIN)



SHEET INDEX

LEGEND:

- BOUNDARY OF PRINCIPLE SETTLEMENT
- Ø90mm PROPOSED WATER LINE (PN-6)
- Ø110mm PROPOSED WATER LINE (PN-6)
- PIPE LENGTH (100')
- DEAD END
- PROPOSED TUBEWELL
- POND

100 50 0 100 feet
GRAPHIC SCALE

(SHEET 1 OF 4)

CLIENT
PUNJAB RURAL MUNICIPAL SERVICES COMPANY (PRMSC)

CONSULTANT
NATIONAL ENGINEERING SERVICES PAKISTAN (PVT.) LTD.
HEAD OFFICE:- NESPAK HOUSE, I-C, BLOCK-N, MODEL TOWN EXTENSION, LAHORE, PAKISTAN.

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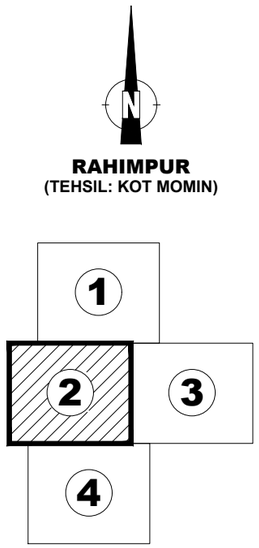
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SUBMITTED	
RECOMMENDED	
CHD./VER.	
APPROVED	

PROJECT
ENGINEERING DESIGN & CONSTRUCTION SUPERVISION CLUSTER (NORTH)
PUNJAB RURAL SUSTAINABLE WATER SUPPLY & SANITATION PROJECT

RAHIMPUR
LAYOUT PLAN OF
PROPOSED WATER SUPPLY SYSTEM

DATE: OCTOBER, 2025
DRAWING No.: **4979/11/DD/1J115**
SCALE: 1" = 100'
REV.: 0





LEGEND:

BOUNDARY OF PRINCIPLE SETTLEMENT	
Ø90mm PROPOSED WATER LINE (PN-6)	
Ø110mm PROPOSED WATER LINE (PN-6)	
PIPE LENGTH	(100')
DEAD END	
PROPOSED TUBEWELL	
POND	

100 50 0 100 feet

GRAPHIC SCALE

(SHEET 2 OF 4)

CLIENT

PUNJAB RURAL MUNICIPAL SERVICES COMPANY (PRMSC)

CONSULTANT

NATIONAL ENGINEERING SERVICES PAKISTAN (PVT.) LTD.

HEAD OFFICE:- NESPAK HOUSE, I-C, BLOCK-N, MODEL TOWN EXTENSION, LAHORE, PAKISTAN.

REV.	DATE	DESCRIPTION	APPROVED
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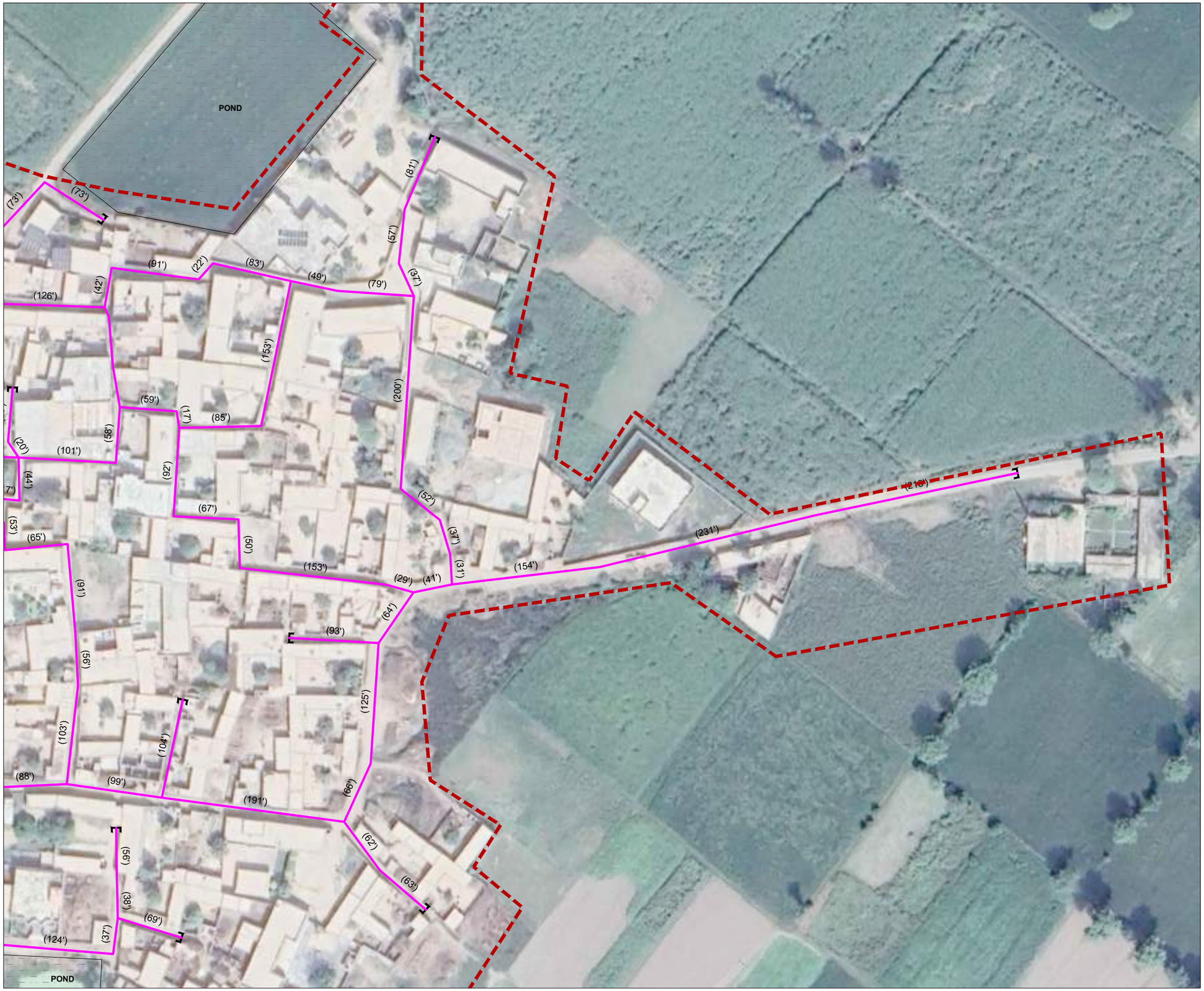
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SUBMITTED	
RECOMMENDED	
CHD./VER.	
APPROVED	

PROJECT

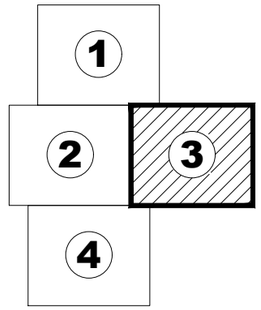
ENGINEERING DESIGN & CONSTRUCTION SUPERVISION CLUSTER (NORTH)
PUNJAB RURAL SUSTAINABLE WATER SUPPLY & SANITATION PROJECT

RAHIMPUR
LAYOUT PLAN OF
PROPOSED WATER SUPPLY SYSTEM

DATE	DRAWING No.	SCALE	REV.
OCTOBER, 2025	**4979/11/DD/1J115**	1" = 100'	0



RAHIMPUR
(TEHSIL: KOT MOMIN)



SHEET INDEX

LEGEND:

BOUNDARY OF PRINCIPLE SETTLEMENT	
Ø90mm PROPOSED WATER LINE (PN-6)	
Ø110mm PROPOSED WATER LINE (PN-6)	
PIPE LENGTH	(100')
DEAD END	
PROPOSED TUBEWELL	
POND	

100 50 0 100 feet
GRAPHIC SCALE

(SHEET 3 OF 4)

CLIENT
PUNJAB RURAL MUNICIPAL SERVICES COMPANY (PRMSC)

CONSULTANT
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HEAD OFFICE:- NESPAK HOUSE, I-C, BLOCK-N, MODEL TOWN EXTENSION, LAHORE, PAKISTAN.

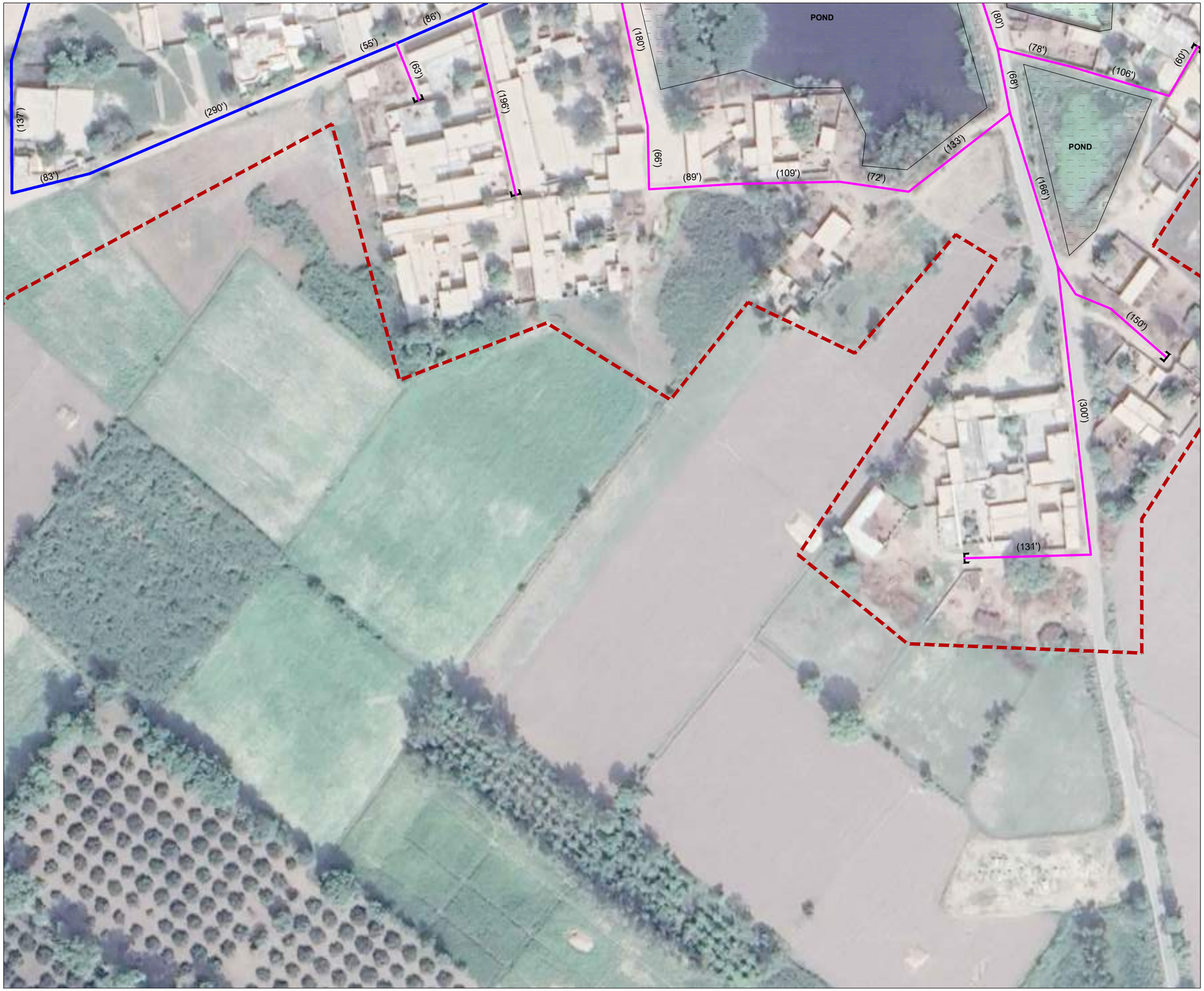
REV.	DATE	DESCRIPTION	APPROVED
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RECOMMENDED	
CHD./VER.	
APPROVED	

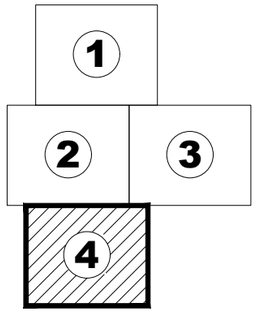
PROJECT
ENGINEERING DESIGN & CONSTRUCTION SUPERVISION CLUSTER (NORTH)
PUNJAB RURAL SUSTAINABLE WATER SUPPLY & SANITATION PROJECT

RAHIMPUR
LAYOUT PLAN OF
PROPOSED WATER SUPPLY SYSTEM

DATE: OCTOBER, 2025
DRAWING No.: **4979/11/DD/1J115**
SCALE: 1" = 100'
REV.: 0



RAHIMPUR
(TEHSIL: KOT MOMIN)



SHEET INDEX

LEGEND:

BOUNDARY OF PRINCIPLE SETTLEMENT	
Ø90mm PROPOSED WATER LINE (PN-6)	
Ø110mm PROPOSED WATER LINE (PN-6)	
PIPE LENGTH	(100')
DEAD END	
PROPOSED TUBEWELL	
POND	

100 50 0 100 feet

GRAPHIC SCALE

(SHEET 4 OF 4)

CLIENT

PUNJAB RURAL MUNICIPAL SERVICES COMPANY (PRMSC)

CONSULTANT

NATIONAL ENGINEERING SERVICES PAKISTAN (PVT.) LTD.

HEAD OFFICE:- NESPAK HOUSE, I-C, BLOCK-N, MODEL TOWN EXTENSION, LAHORE, PAKISTAN.

REV.	DATE	DESCRIPTION	APPROVED
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RECOMMENDED	
CHD./VER.	
APPROVED	

PROJECT

ENGINEERING DESIGN & CONSTRUCTION SUPERVISION CLUSTER (NORTH)
PUNJAB RURAL SUSTAINABLE WATER SUPPLY & SANITATION PROJECT

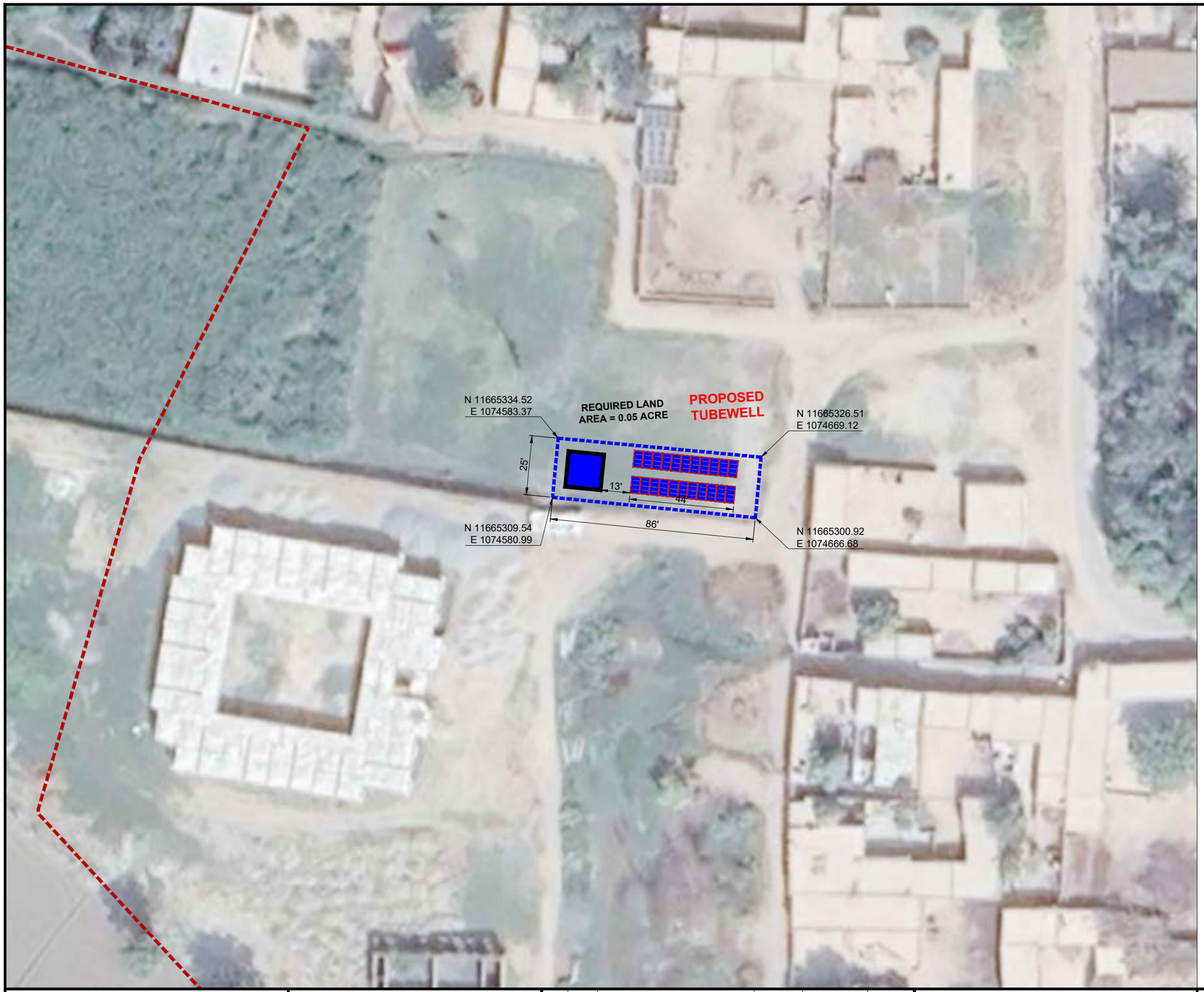
RAHIMPUR
LAYOUT PLAN OF
PROPOSED WATER SUPPLY SYSTEM

SCALE: 1" = 100'

DATE: OCTOBER, 2025

DRAWING No.: **4979/11/DD/1J115**

REV.: 0



MOUZA RAHIMPUR
(TEHSIL: KOT MOMIN)

LEGEND:

BOUNDARY OF PRINCIPLE SETTLEMENT

BOUNDARY OF REQUIRED LAND FOR OHWT

PROPOSED TUBEWELL

40 20 0 40 feet

GRAPHIC SCALE

CLIENT

PUNJAB RURAL MUNICIPAL SERVICES COMPANY (PRMSC)

CONSULTANT

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REV.	DATE	DESCRIPTION	APPROVED	APPROVED	
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02				RECOMMENDED	
01				CHD./VER.	

PROJECT

ENGINEERING DESIGN & CONSTRUCTION SUPERVISION CLUSTER (NORTH)
PUNJAB RURAL SUSTAINABLE WATER SUPPLY & SANITATION PROJECT

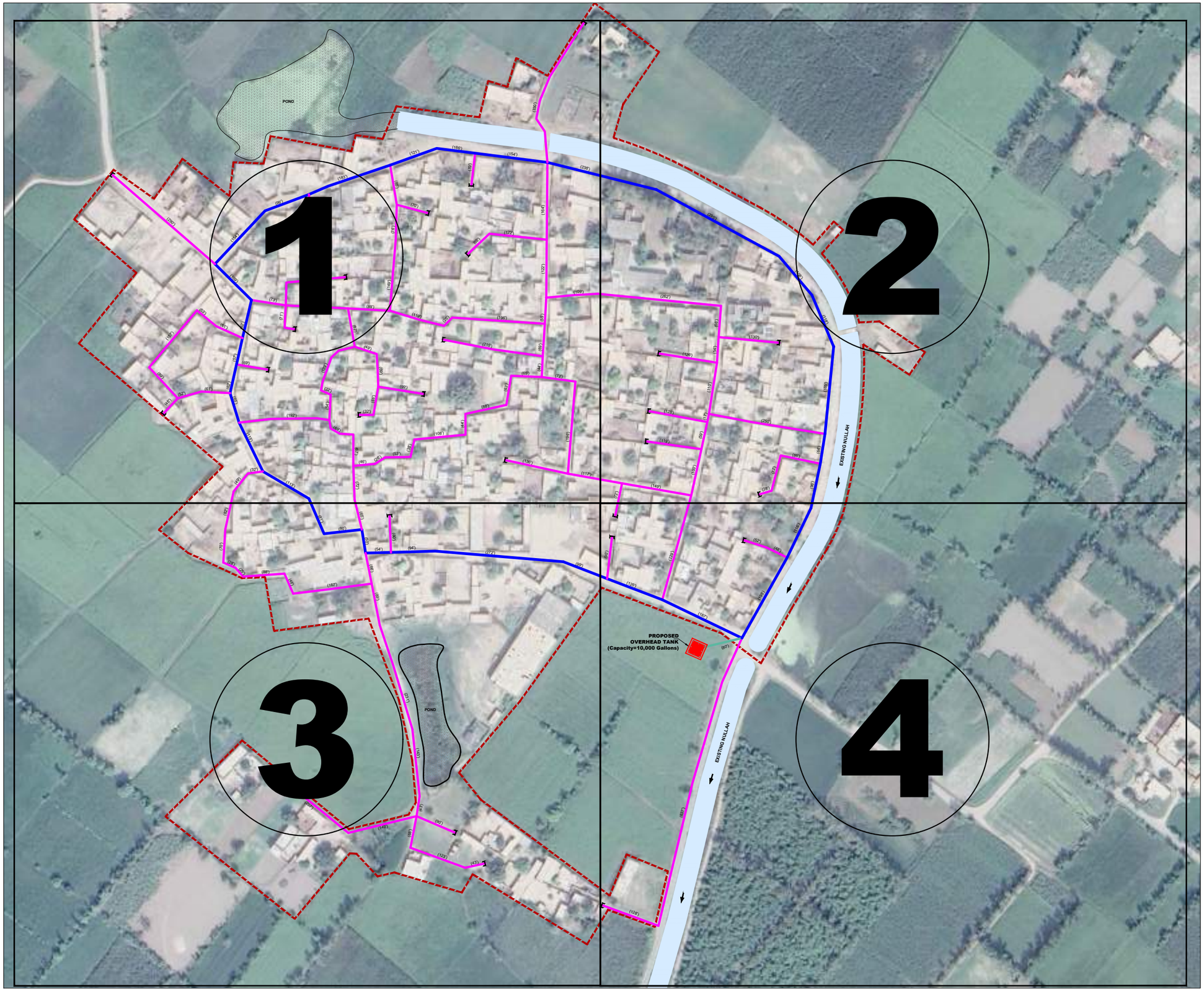
MOUZA RAHIMPUR
LOCATION PLAN OF PROPOSED TUBEWELL

SCALE: 1" = 40'

DATE: OCTOBER, 2025

DRAWING No.: **4979/11/DD/1J116**

REV.: 0



N

WAN MIANA
(TEHSIL: KOT MOMIN)

LEGEND:

BOUNDARY OF PRINCIPLE SETTLEMENT	
Ø90mm HDPE PROPOSED WATER LINE (PN-6)	
Ø110mm HDPE PROPOSED WATER LINE (PN-6)	
Ø6" M.S PROPOSED WATER LINE	
PIPE LENGTH	(100')
DEAD END	
PROPOSED OVERHEAD TANK	
EXISTING NULLAH	
POND	

200 100 0 200 feet
GRAPHIC SCALE

CLIENT
PUNJAB RURAL MUNICIPAL SERVICES COMPANY (PRMSC)

CONSULTANT
NATIONAL ENGINEERING SERVICES PAKISTAN (PVT.) LTD.
HEAD OFFICE:- NESPAK HOUSE, I-C, BLOCK-N, MODEL TOWN EXTENSION, LAHORE, PAKISTAN.

REV.	DATE	DESCRIPTION	APPROVED
04			
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PROJECT
ENGINEERING DESIGN & CONSTRUCTION SUPERVISION CLUSTER (NORTH)
PUNJAB RURAL SUSTAINABLE WATER SUPPLY & SANITATION PROJECT

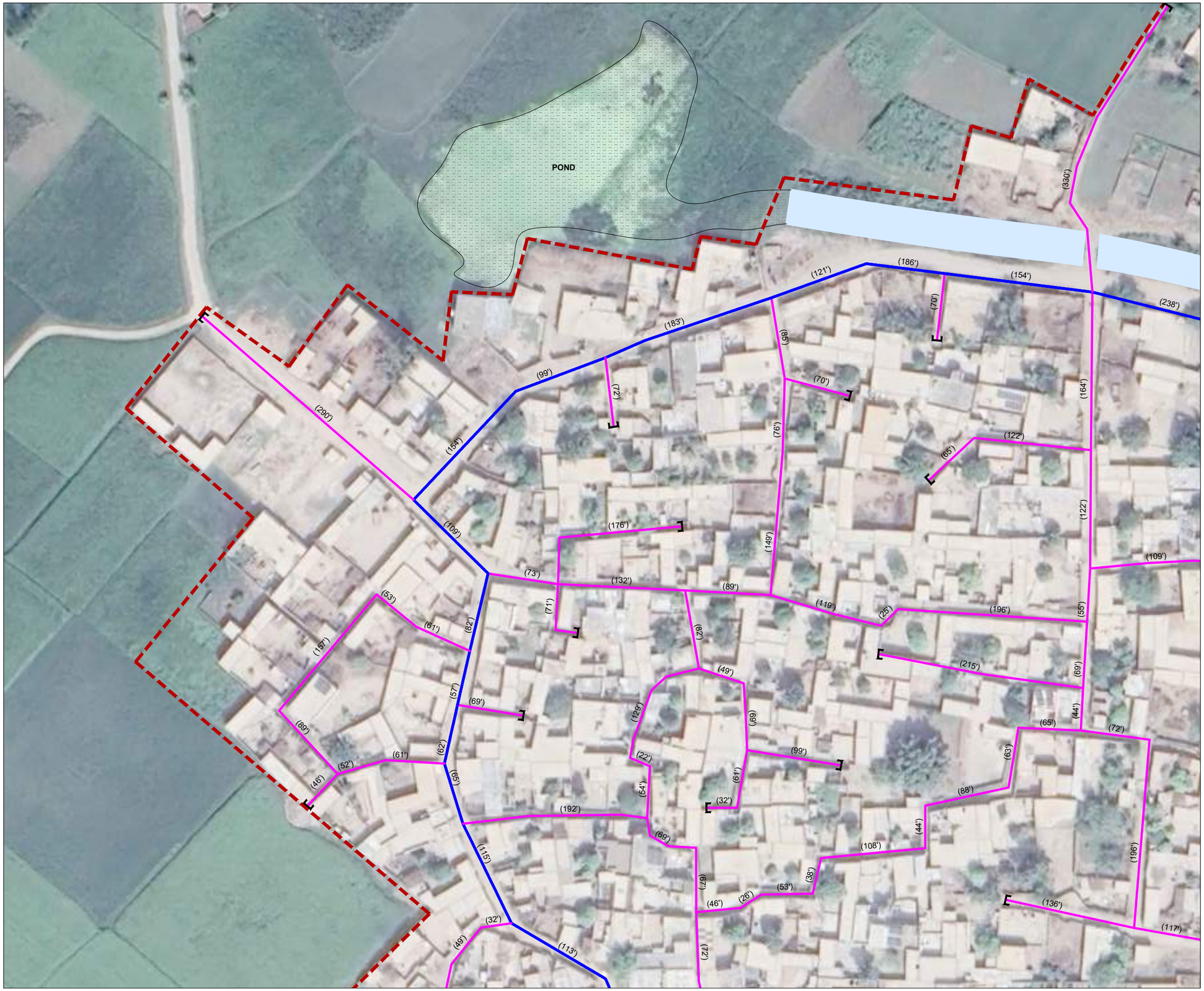
WAN MIANA
PROPOSED WATER SUPPLY SYSTEM
(SHEET INDEX)

SCALE: 1" = 200'

DATE: OCTOBER, 2025

DRAWING No.: **4979/11/DD/1J123**

REV.: 0



WAN MIANA
(TEHSIL: KOT MOMIN)

1	2
3	4

SHEET INDEX

LEGEND:

- BOUNDARY OF PRINCIPLE SETTLEMENT
- Ø90mm HDPE PROPOSED WATER LINE (PN-6)
- Ø110mm HDPE PROPOSED WATER LINE (PN-6)
- Ø6" M.S PROPOSED WATER LINE
- PIPE LENGTH (100')
- DEAD END
- PROPOSED OVERHEAD TANK
- EXISTING NULLAH
- POND

100 50 0 100 feet
GRAPHIC SCALE

(SHEET 1 OF 4)

CLIENT
PUNJAB RURAL MUNICIPAL SERVICES COMPANY (PRMSC)

CONSULTANT
NATIONAL ENGINEERING SERVICES PAKISTAN (PVT.) LTD.
HEAD OFFICE:- NESPAK HOUSE, I-C, BLOCK-N, MODEL TOWN EXTENSION, LAHORE, PAKISTAN.

REV.	DATE	DESCRIPTION	APPROVED
04			
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APPROVED	

PROJECT
ENGINEERING DESIGN & CONSTRUCTION SUPERVISION CLUSTER (NORTH)
PUNJAB RURAL SUSTAINABLE WATER SUPPLY & SANITATION PROJECT

WAN MIANA
LAYOUT PLAN OF PROPOSED WATER SUPPLY SYSTEM

DATE	DRAWING No.	SCALE	REV.
OCTOBER, 2025	4979/11/DD/1J123	1" = 100'	0



WAN MIANA
(TEHSIL: KOT MOMIN)

1	2
3	4

SHEET INDEX

LEGEND:

- BOUNDARY OF PRINCIPLE SETTLEMENT
- Ø90mm HDPE PROPOSED WATER LINE (PN-6)
- Ø110mm HDPE PROPOSED WATER LINE (PN-6)
- Ø6" M.S PROPOSED WATER LINE
- PIPE LENGTH (100')
- DEAD END
- PROPOSED OVERHEAD TANK
- EXISTING NULLAH
- POND

100 50 0 100 feet
GRAPHIC SCALE

(SHEET 2 OF 4)

CLIENT
PUNJAB RURAL MUNICIPAL SERVICES COMPANY (PRMSC)

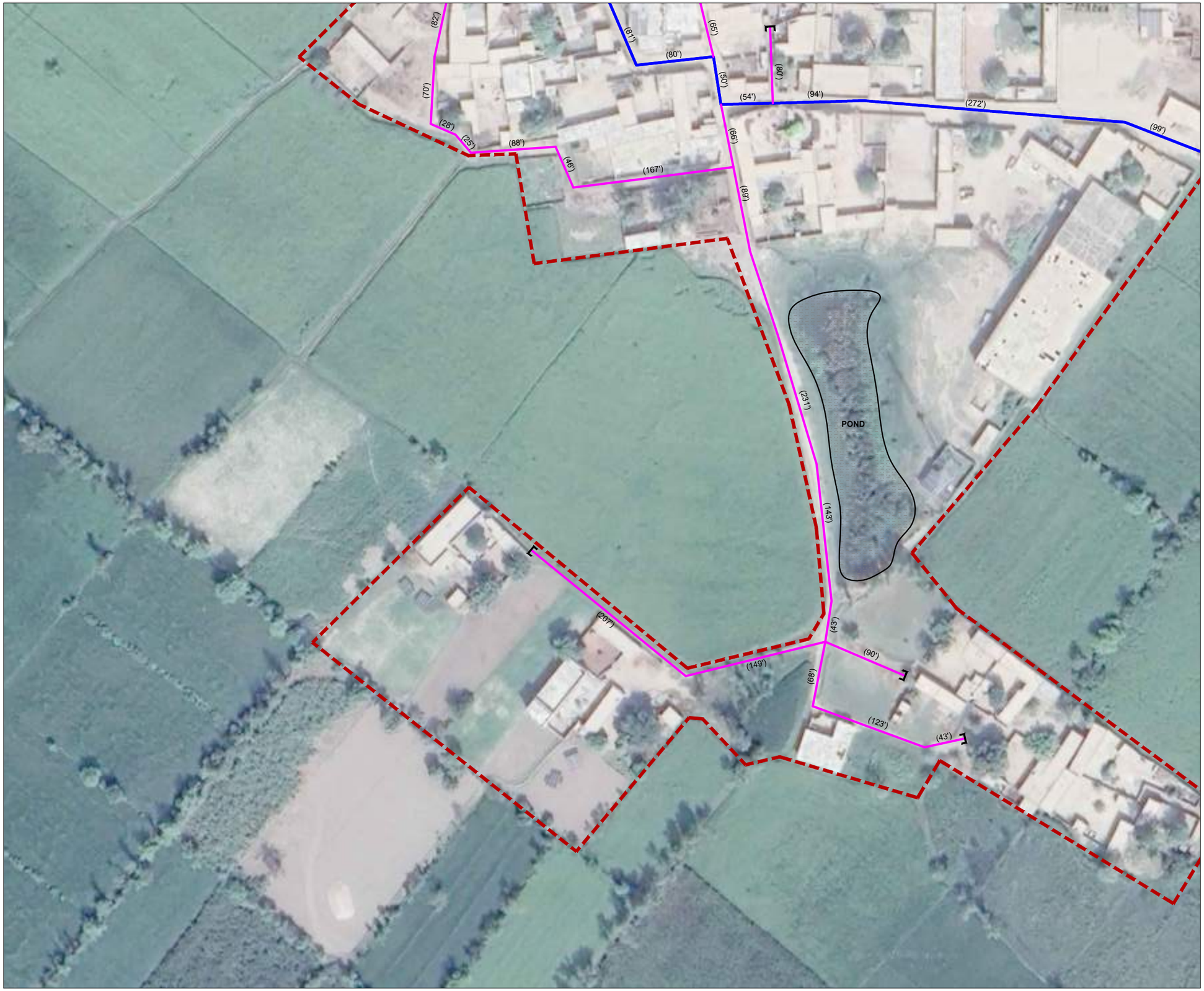
CONSULTANT
NATIONAL ENGINEERING SERVICES PAKISTAN (PVT.) LTD.
HEAD OFFICE:- NESPAK HOUSE, I-C, BLOCK-N, MODEL TOWN EXTENSION, LAHORE, PAKISTAN.

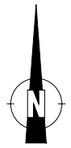
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PROJECT
ENGINEERING DESIGN & CONSTRUCTION SUPERVISION CLUSTER (NORTH)
PUNJAB RURAL SUSTAINABLE WATER SUPPLY & SANITATION PROJECT

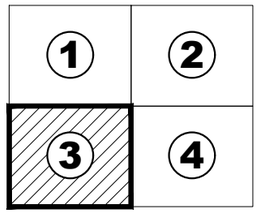
WAN MIANA
LAYOUT PLAN OF PROPOSED WATER SUPPLY SYSTEM

SCALE: 1" = 100'
DATE: OCTOBER, 2025
DRAWING No.: **4979/11/DD/1J123**
REV.: 0





WAN MIANA
(TEHSIL: KOT MOMIN)



SHEET INDEX

LEGEND:

- BOUNDARY OF PRINCIPLE SETTLEMENT
- Ø90mm HDPE PROPOSED WATER LINE (PN-6)
- Ø110mm HDPE PROPOSED WATER LINE (PN-6)
- Ø6" M.S PROPOSED WATER LINE
- PIPE LENGTH (100')
- DEAD END
- PROPOSED OVERHEAD TANK
- EXISTING NULLAH
- POND

100 50 0 100 feet

GRAPHIC SCALE

(SHEET 3 OF 4)

CLIENT

PUNJAB RURAL MUNICIPAL SERVICES COMPANY (PRMSC)

CONSULTANT

NATIONAL ENGINEERING SERVICES PAKISTAN (PVT.) LTD.

HEAD OFFICE:- NESPAK HOUSE, I-C, BLOCK-N, MODEL TOWN EXTENSION, LAHORE, PAKISTAN.

REV.	DATE	DESCRIPTION	APPROVED
04			
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02			
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SUBMITTED	
RECOMMENDED	
CHD./VER.	
APPROVED	

PROJECT

ENGINEERING DESIGN & CONSTRUCTION SUPERVISION CLUSTER (NORTH)
PUNJAB RURAL SUSTAINABLE WATER SUPPLY & SANITATION PROJECT

WAN MIANA
LAYOUT PLAN OF PROPOSED WATER SUPPLY SYSTEM

DATE	DRAWING No.	SCALE	REV.
OCTOBER, 2025	4979/11/DD/1J123	1" = 100'	0



WAN MIANA
(TEHSIL: KOT MOMIN)

1	2
3	4

SHEET INDEX

LEGEND:

- BOUNDARY OF PRINCIPLE SETTLEMENT
- Ø90mm HDPE PROPOSED WATER LINE (PN-6)
- Ø110mm HDPE PROPOSED WATER LINE (PN-6)
- Ø6" M.S PROPOSED WATER LINE
- PIPE LENGTH (100')
- DEAD END
- PROPOSED OVERHEAD TANK
- EXISTING NULLAH
- POND

100 50 0 100 feet
GRAPHIC SCALE

(SHEET 4 OF 4)

CLIENT
PUNJAB RURAL MUNICIPAL SERVICES COMPANY (PRMSC)

CONSULTANT
NATIONAL ENGINEERING SERVICES PAKISTAN (PVT.) LTD.
HEAD OFFICE:- NESPAK HOUSE, I-C, BLOCK-N, MODEL TOWN EXTENSION, LAHORE, PAKISTAN.

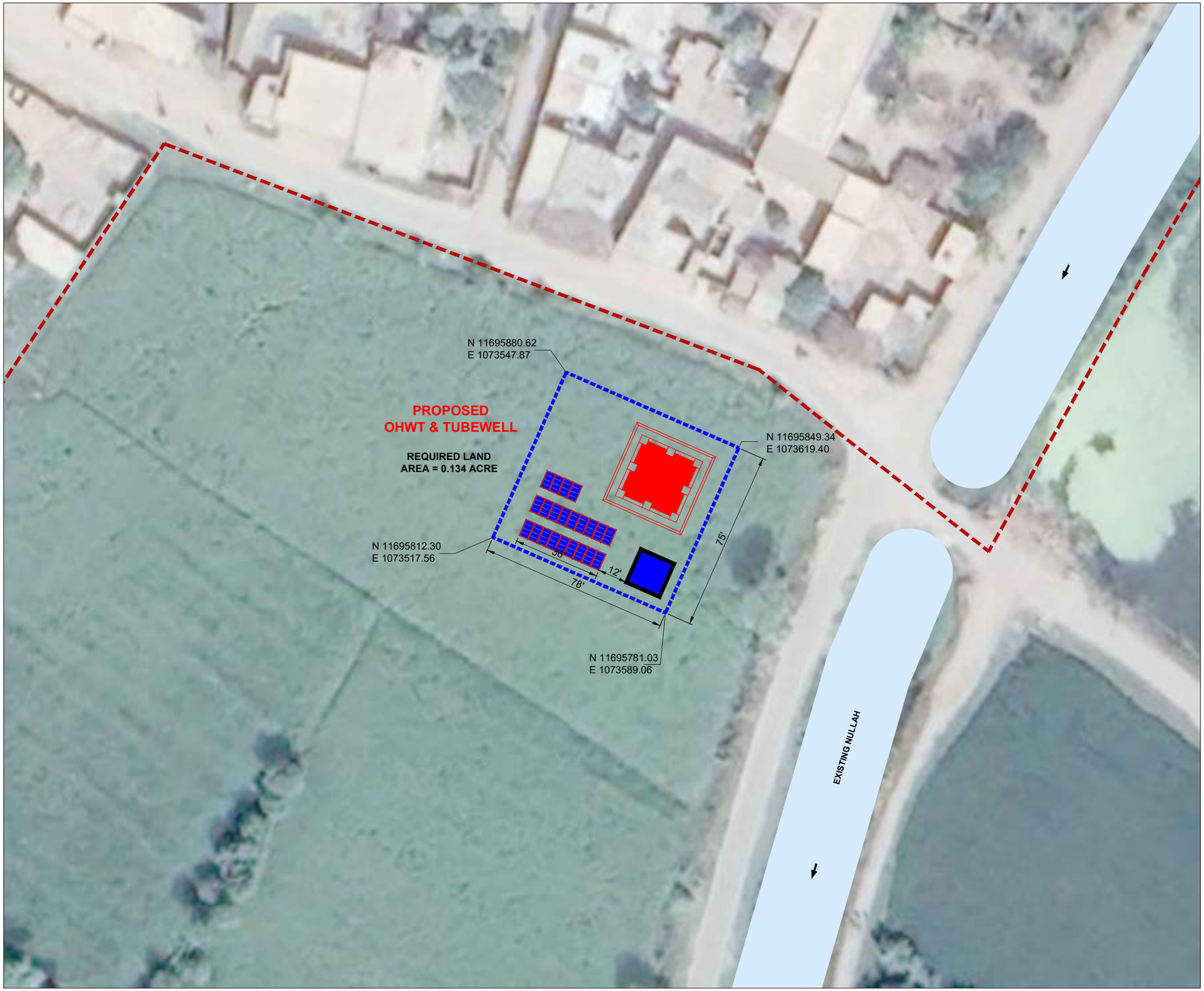
REV.	DATE	DESCRIPTION	APPROVED
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03			
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DRAWN	WALEED
SUBMITTED	
RECOMMENDED	
CHD./VER.	
APPROVED	

PROJECT
ENGINEERING DESIGN & CONSTRUCTION SUPERVISION CLUSTER (NORTH)
PUNJAB RURAL SUSTAINABLE WATER SUPPLY & SANITATION PROJECT

WAN MIANA
LAYOUT PLAN OF
PROPOSED WATER SUPPLY SYSTEM

SCALE: 1" = 100'
DATE: OCTOBER, 2025
DRAWING No.: **4979/11/DD/1J123**
REV.: 0



WAN MIANA
(TEHSIL: KOT MOMIN)

LEGEND:

- BOUNDARY OF PRINCIPLE SETTLEMENT
- BOUNDARY OF REQUIRED LAND FOR OHWT
- PROPOSED OVER HEAD WATER TANK (OHWT)
- PROPOSED TUBEWELL
- EXISTING NULLAH

100 50 0 100 feet
GRAPHIC SCALE

CLIENT
PUNJAB RURAL MUNICIPAL SERVICES COMPANY (PRMSC)

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HEAD OFFICE:- NESPAK HOUSE, I-C, BLOCK-N, MODEL TOWN EXTENSION, LAHORE, PAKISTAN.

REV.	DATE	DESCRIPTION	APPROVED	APPROVED
04				DRAWN: WALEED
03				SUBMITTED:
02				RECOMMENDED:
01				CHD./VER.:

PROJECT
ENGINEERING DESIGN & CONSTRUCTION SUPERVISION CLUSTER (NORTH)
PUNJAB RURAL SUSTAINABLE WATER SUPPLY & SANITATION PROJECT

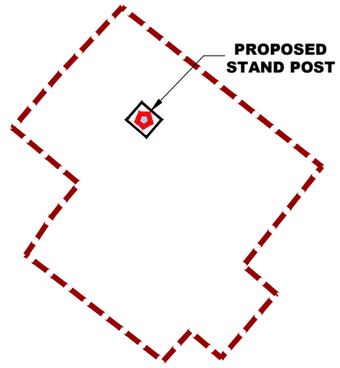
WAN MIANA
LOCATION PLAN OF
PROPOSED OHWT & TUBEWELL

SCALE: 1" = 40'
DATE: OCTOBER, 2025
DRAWING No.: **4979/11/DD/1J124**
REV.: 0



N

WAN MIANA COLONY
(TEHSIL: KOT MOMIN)



KEY PLAN

LEGEND:

BOUNDARY OF PRINCIPLE SETTLEMENT

PROPOSED STAND POST (2000 LTR/HR)

120 60 0 60 feet

GRAPHIC SCALE

CLIENT

PUNJAB RURAL MUNICIPAL SERVICES COMPANY (PRMSC)

CONSULTANT

NATIONAL ENGINEERING SERVICES PAKISTAN (PVT.) LTD.

HEAD OFFICE:- NESPAK HOUSE, I-C, BLOCK-N, MODEL TOWN EXTENSION, LAHORE, PAKISTAN.

REV.	DATE	DESCRIPTION	APPROVED
04			
03			
02			
01			

DRAWN	WALEED
SUBMITTED	
RECOMMENDED	
CHD./VER.	
APPROVED	

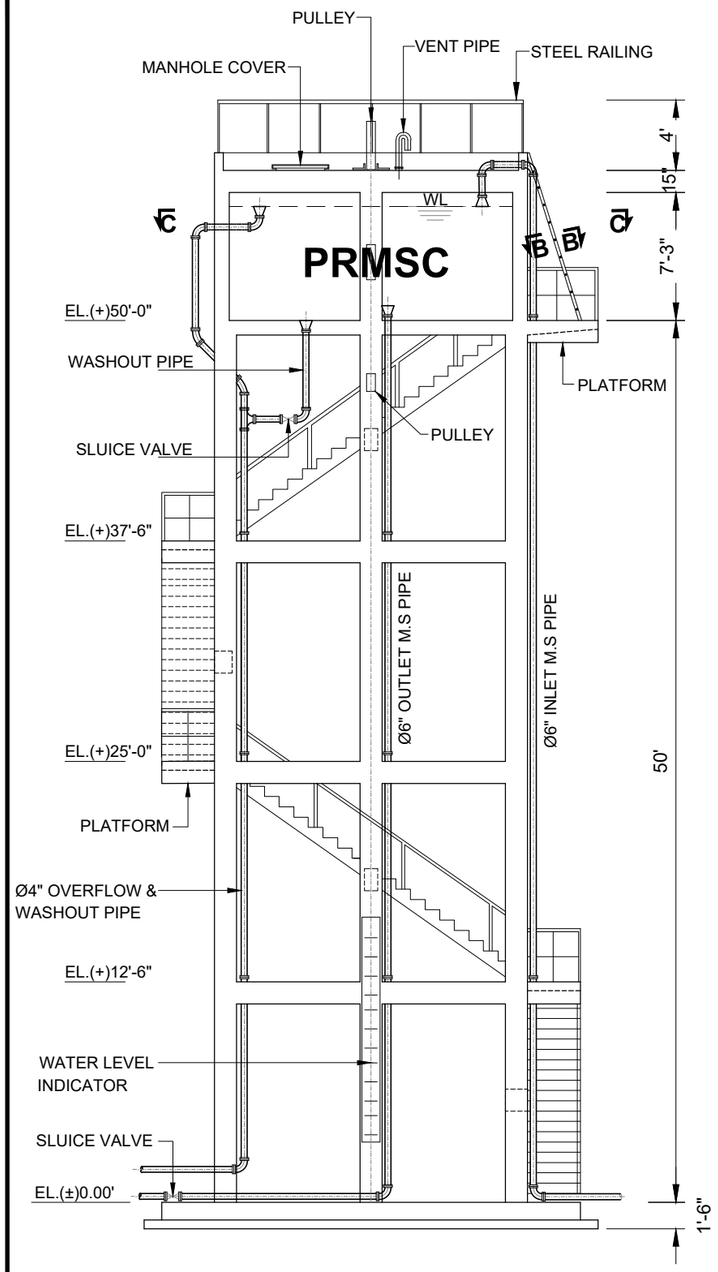
PROJECT

ENGINEERING DESIGN & CONSTRUCTION SUPERVISION CLUSTER (NORTH)
PUNJAB RURAL SUSTAINABLE WATER SUPPLY & SANITATION PROJECT

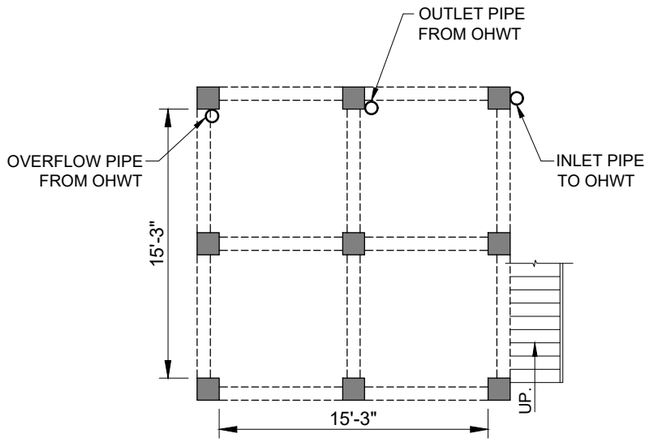
WAN MIANA COLONY
LOCATION PLAN OF
PROPOSED STAND POST (2000 LTR/HR)

DATE	DRAWING No.	REV.
OCTOBER, 2025	**4979/11/DD/1J125**	0

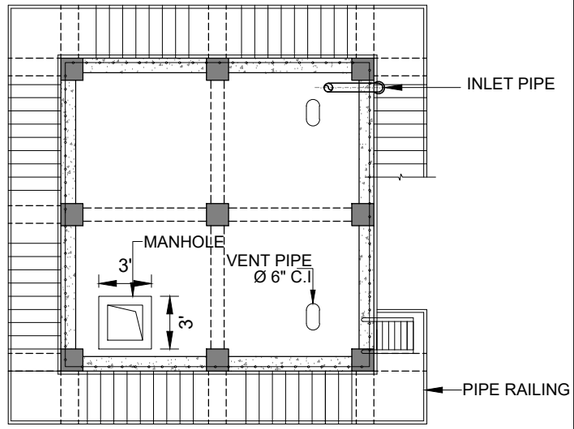
SCALE: 1" = 60'



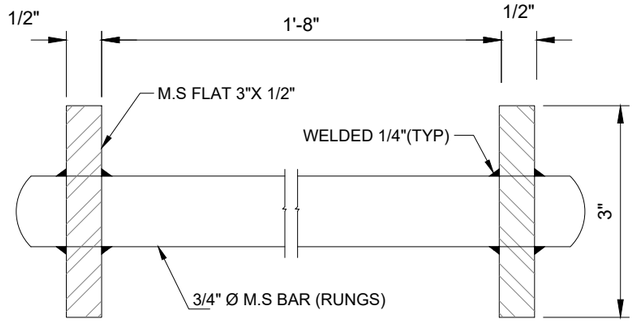
ELEVATION



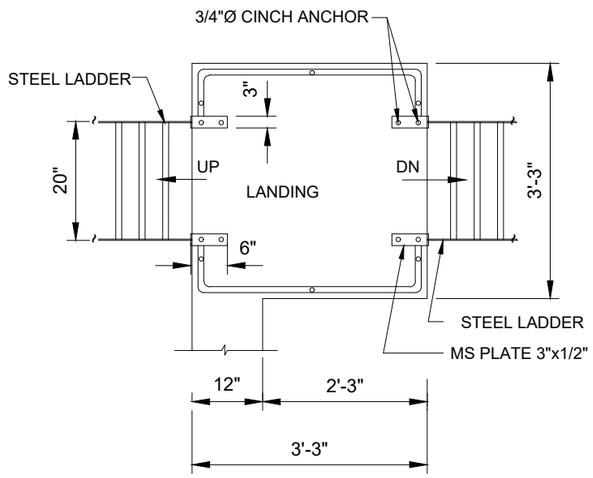
GROUND FLOOR PLAN



TOP ROOF PLAN

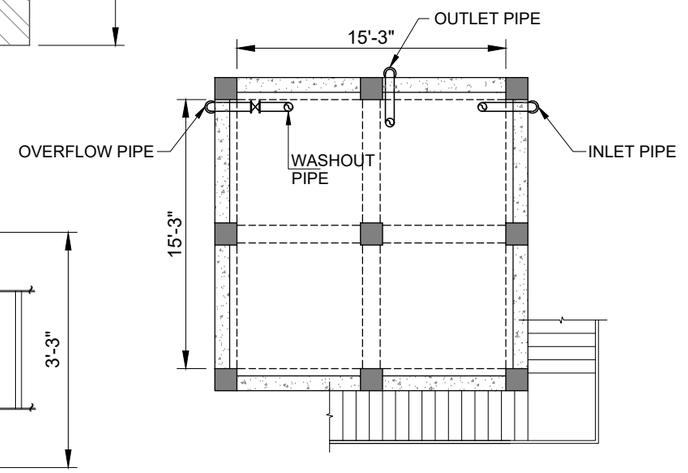


SECTION B-B



LANDING

SCALE 1/2"= 1'- 0"



SECTION C-C

NOTE

1. ALL DIMENSIONS ARE IN FEET UNLESS OTHERWISE SPECIFIED.

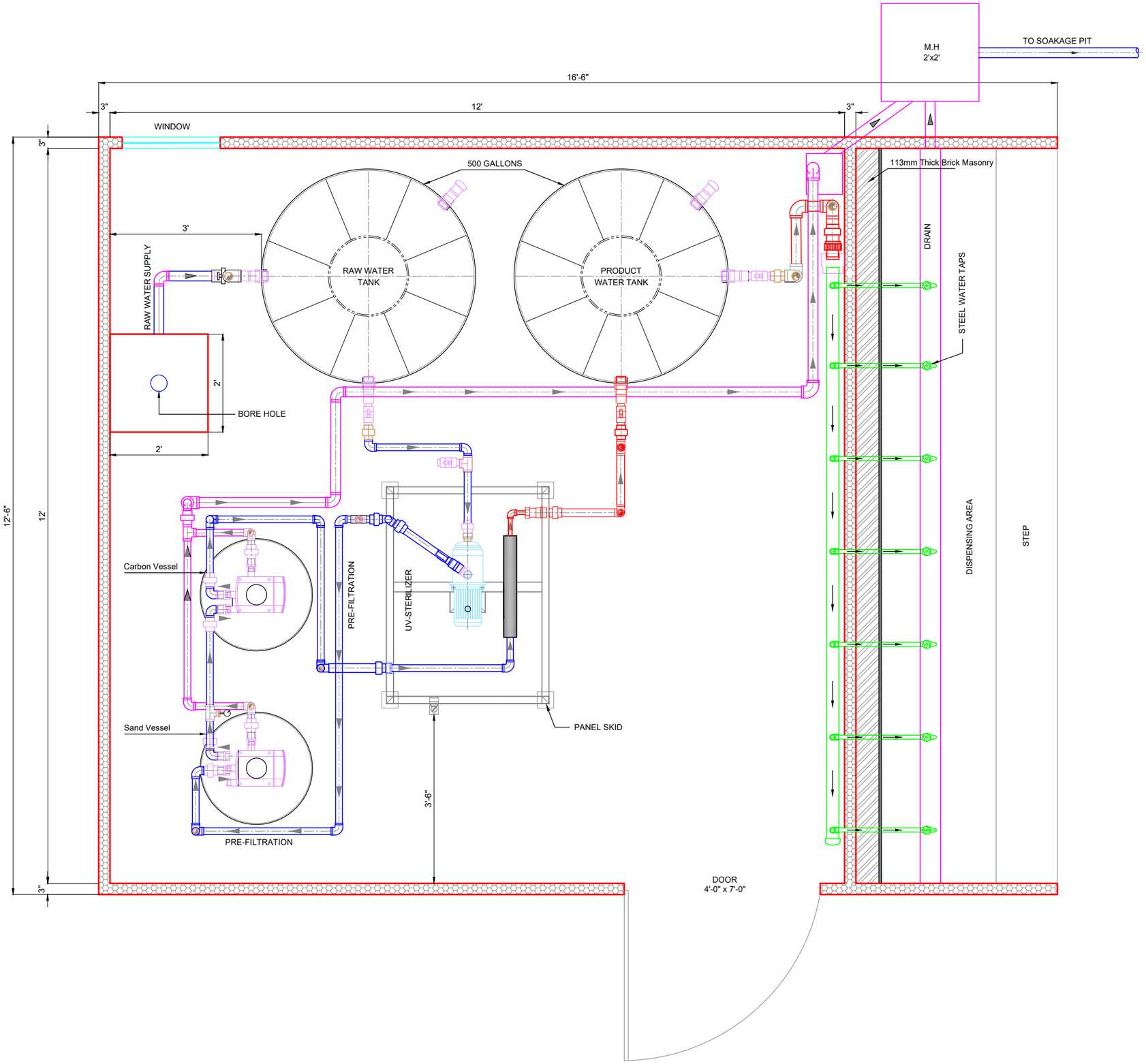
CLIENT	PUNJAB RURAL MUNICIPAL SERVICES COMPANY (PRMSC)	CONSULTANT	NATIONAL ENGINEERING SERVICES PAKISTAN (PVT.) LTD. HEAD OFFICE:- NESPAK HOUSE, I-C, BLOCK-N, MODEL TOWN EXTENSION, LAHORE, PAKISTAN.

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02				RECOMMENDED	
01				CHD./VER.	
				APPROVED	

PROJECT: ENGINEERING DESIGN & CONSTRUCTION SUPERVISION CLUSTER (NORTH) PUNJAB RURAL SUSTAINABLE WATER SUPPLY & SANITATION PROJECT

WAN MIANA
OVERHEAD WATER TANK
(CAPACITY = 10,000 GALLONS)

DATE	DRAWING No.	SCALE	REV.
OCTOBER, 2025	**4979/11/DD/1J126**	1"=9'-0"	0



CLIENT

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CONSULTANT

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CHD./VER.	
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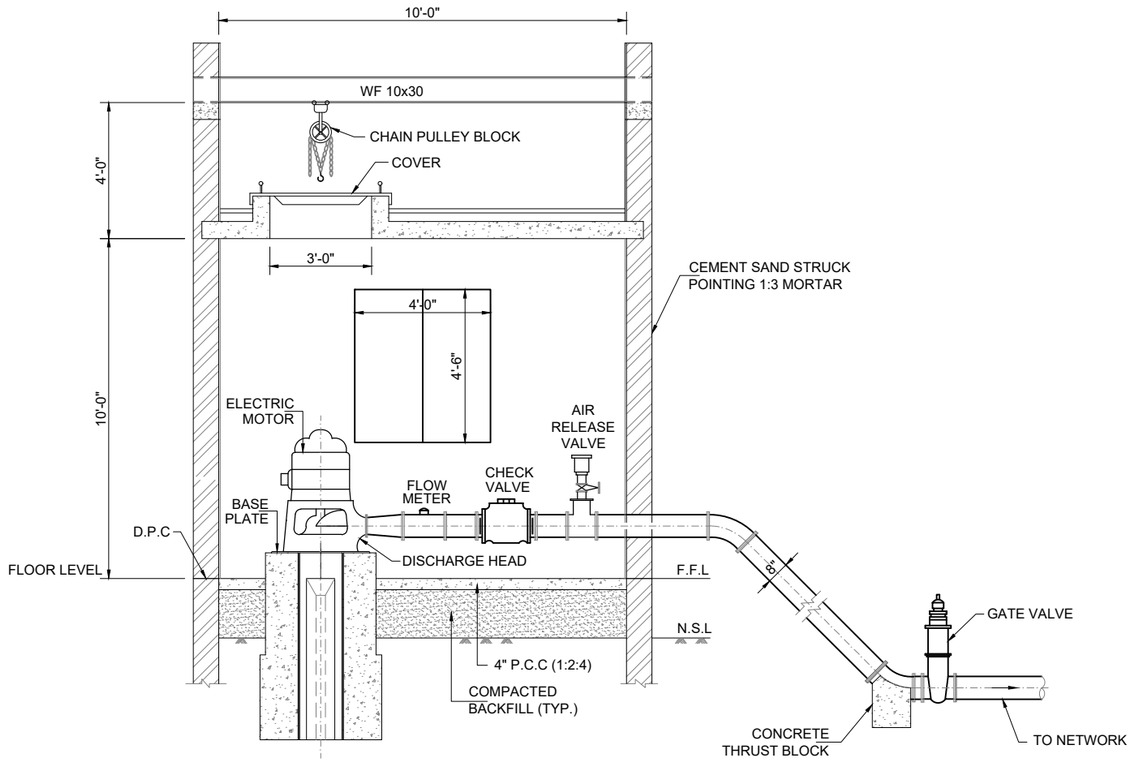
PROJECT

ENGINEERING DESIGN & CONSTRUCTION SUPERVISION CLUSTER (NORTH)
PUNJAB RURAL SUSTAINABLE WATER SUPPLY & SANITATION PROJECT

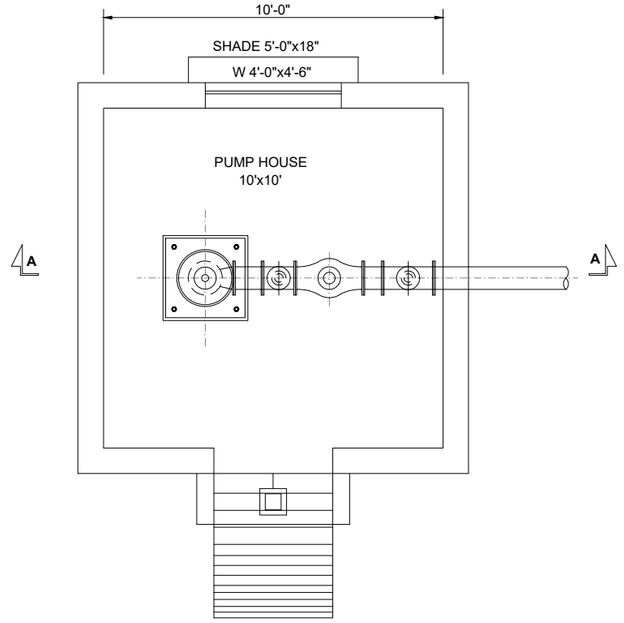
TYPICAL LAYOUT PLAN OF STAND POST INCLUDING FILTRATION

DATE	DRAWING No.	REV.
OCTOBER, 2025	4979/11/DD/1J127	0

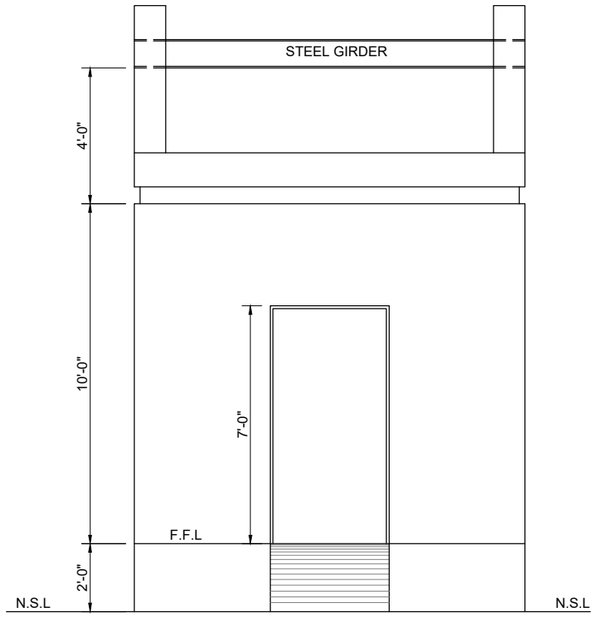
SCALE 1:24



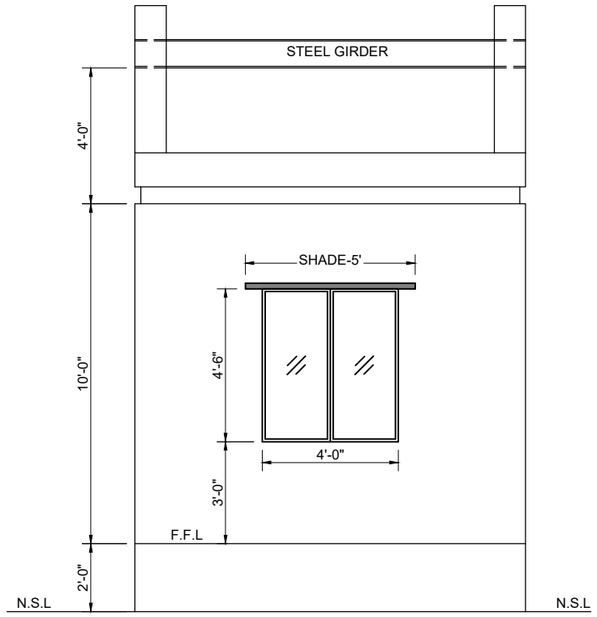
SECTION A-A



PLAN



FRONT ELEVATION



BACK ELEVATION

NOTE

1. ALL DIMENSIONS ARE IN FEET UNLESS OTHERWISE SPECIFIED.
2. SUBJECT TO MODIFICATION IN ACCORDANCE WITH ACTUAL FIELD CONDITION ENCOUNTERED DURING DRILLING OF BORE HOLES

CLIENT

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PROJECT

ENGINEERING DESIGN & CONSTRUCTION SUPERVISION CLUSTER (NORTH)
PUNJAB RURAL SUSTAINABLE WATER SUPPLY & SANITATION PROJECT

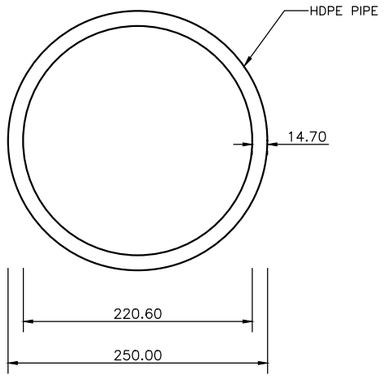
WATER SUPPLY SYSTEM TUBE WELL AND PUMP HOUSE DETAIL

SCALE: N.T.S

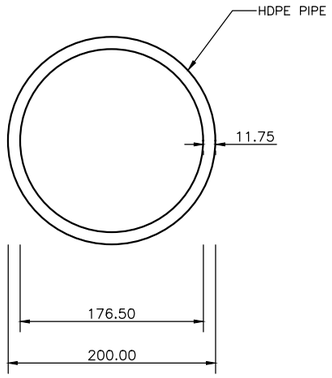
DATE: OCTOBER, 2025

DRAWING No.: **4979/11/DD/1J128**

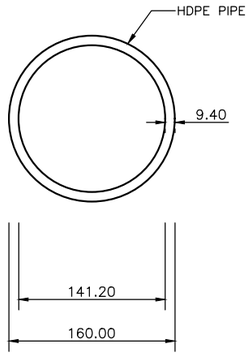
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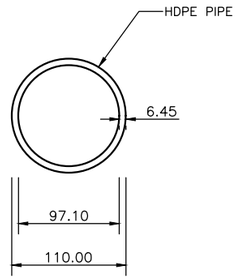
10" (250mm) DIA HDPE (PN-10)
PIPE DETAIL



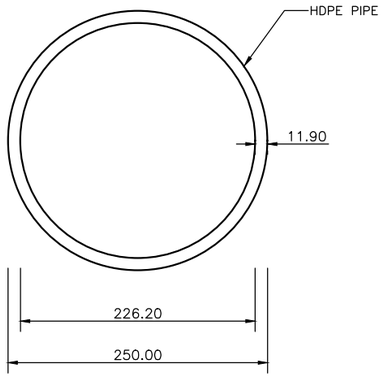
8" (200mm) DIA HDPE (PN-10)
PIPE DETAIL



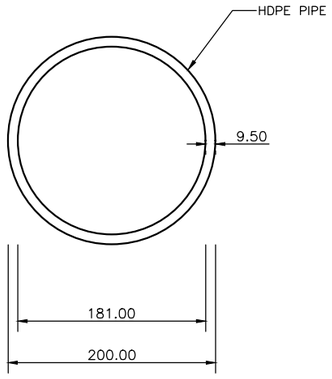
6" (160mm) DIA HDPE (PN-10)
PIPE DETAIL



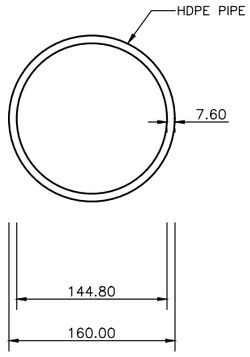
4" (110mm) DIA HDPE (PN-10)
PIPE DETAIL



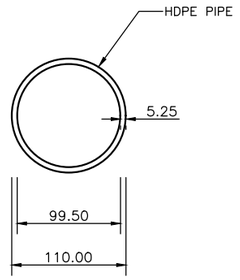
10" (250mm) DIA HDPE (PN-8)
PIPE DETAIL



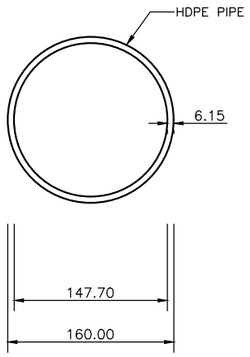
8" (200mm) DIA HDPE (PN-8)
PIPE DETAIL



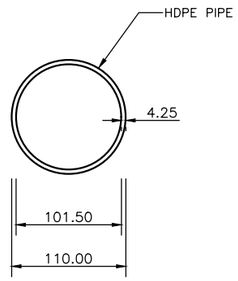
6" (160mm) DIA HDPE (PN-8)
PIPE DETAIL



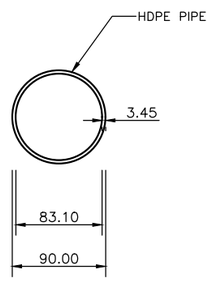
4" (110mm) DIA HDPE (PN-8)
PIPE DETAIL



6" (160mm) DIA HDPE (PN-6)
PIPE DETAIL



4" (110mm) DIA HDPE (PN-6)
PIPE DETAIL



3" (90mm) DIA HDPE (PN-6)
PIPE DETAIL

Outer Dia		Internal Dia (PN-6)		Internal Dia (PN-8)		Internal Dia (PN-10)	
mm	inches	mm	inches	mm	inches	mm	inches
90	3	83.10	3.27	81.40	3.21	79.40	3.13
110	4	101.50	4.00	99.50	3.92	97.10	3.82
160	6	147.70	5.81	144.80	5.70	141.20	5.56
200	8	184.60	7.27	181.00	7.12	176.50	6.95
250	10	230.80	9.09	226.20	8.91	220.60	8.68

NOTES

1. ALL DIMENSIONS ARE IN METERS AND PIPE DIAMETERS ARE IN MILLIMETERS UNLESS OTHER SPECIFIED.
2. THIS DRAWING SHALL BE READ IN CONJUNCTION WITH ALL OTHER RELEVANT DRAWINGS.

CLIENT

PUNJAB RURAL MUNICIPAL SERVICES COMPANY (PRMSC)

CONSULTANT

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HEAD OFFICE:- NESPAK HOUSE, I-C, BLOCK-N, MODEL TOWN EXTENSION, LAHORE, PAKISTAN.

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04			
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PROJECT

ENGINEERING DESIGN & CONSTRUCTION SUPERVISION CLUSTER (NORTH)
PUNJAB RURAL SUSTAINABLE WATER SUPPLY & SANITATION PROJECT

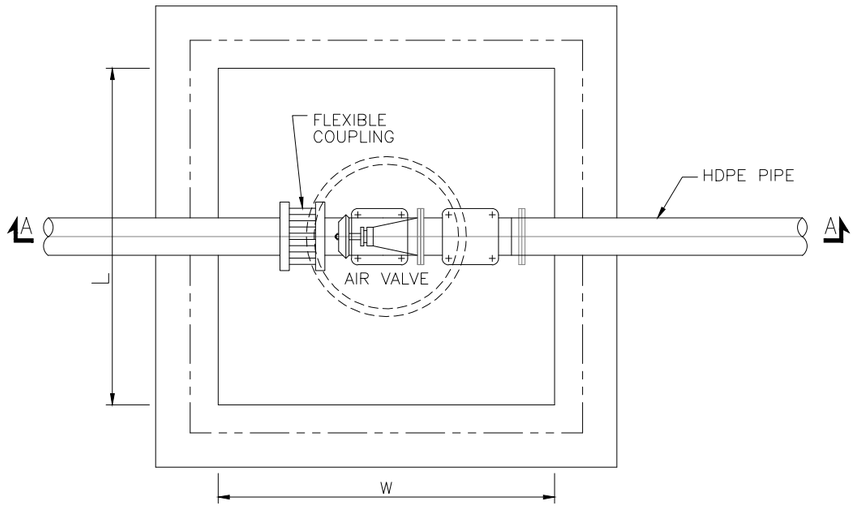
TYPICAL HDPE PIPE CROSS SECTION DETAILS

SCALE: NTS

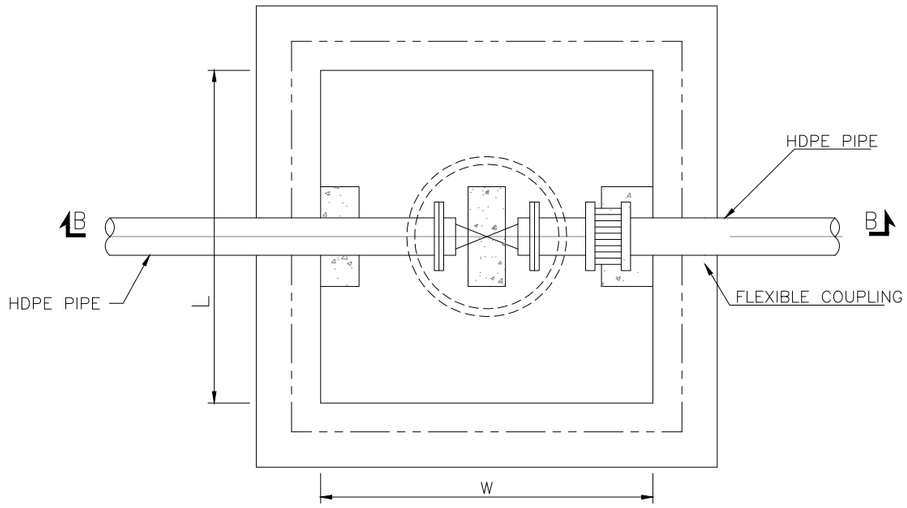
DATE: OCTOBER, 2025

DRAWING No.: **4979/11/DD/1J129**

REV.: 0

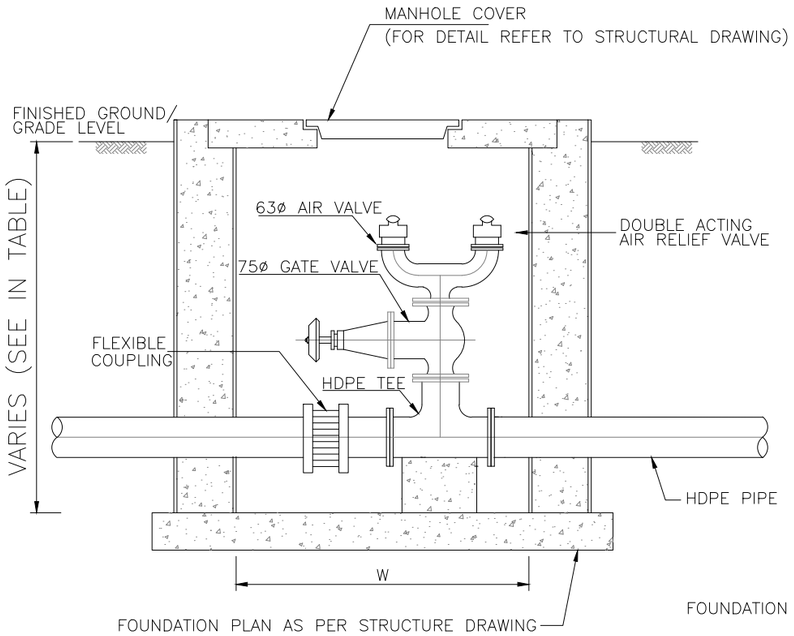


PLAN OF AIR VALVE CHAMBER

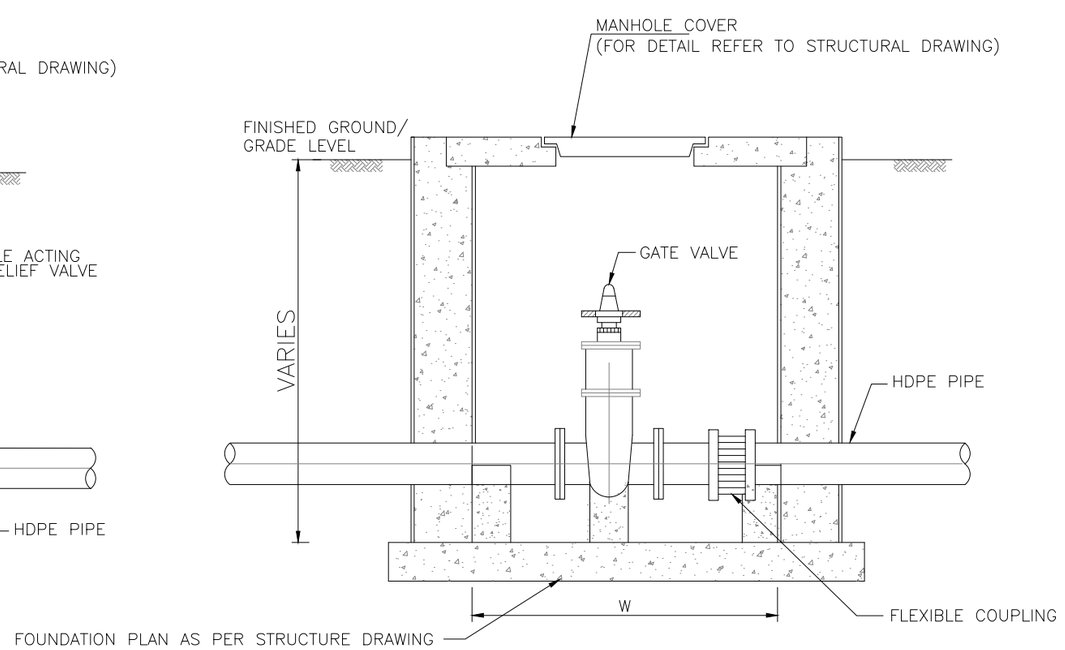


PLAN OF SLUICE VALVE CHAMBER

TABLE FOR CHAMBER			
PIPE DIA. (mm)	LENGTH (L) (in)	WIDTH (W) (in)	HEIGHT (H) (in)
90	48	48	48
110	48	48	48
160	48	48	51
200	54	54	51



SECTION A–A



SECTION B–B

NOTES

1. ALL DIMENSIONS ARE IN FEET UNLESS OTHERWISE SPECIFIED
2. READ THIS DRAWING IN CONJUNCTION WITH ALL RELEVANT DRAWINGS
3. BURIED FLANGES, BOLTS, NUTS ETC. TO BE CLEANED AND PRIMED WITH PETROLATUM PASTE AND WRAPPED WITH DOUBLE THICKNESS PETROLATUM IMPREGNATED IN DRY SYNTHETIC CARRIER TAPE BEFORE BACKFILLING.
4. THRUST BLOCK BEARING AREA TO BE EQUAL TO OR GREATER THAN THAT SHOWN IN THE TABLES. THE AREA IN A SOUND AND DRY CONDITION.
5. THRUST BLOCKS TO BE CAST AGAINST UNDISTURBED GROUND.

CLIENT
PUNJAB RURAL MUNICIPAL SERVICES COMPANY (PRMSC)

CONSULTANT
NATIONAL ENGINEERING SERVICES PAKISTAN (PVT.) LTD.
HEAD OFFICE:- NESPAK HOUSE, I-C, BLOCK-N, MODEL TOWN EXTENSION, LAHORE, PAKISTAN.

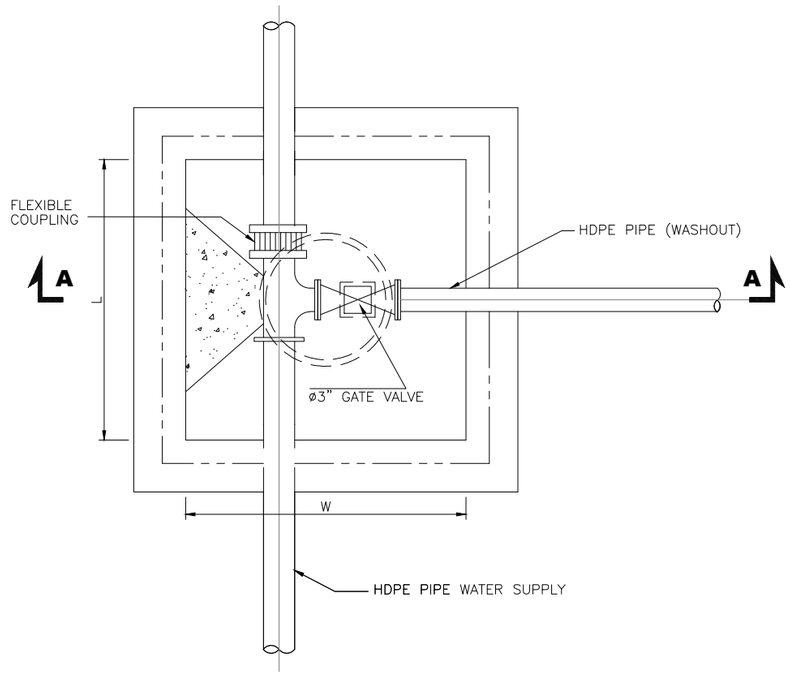
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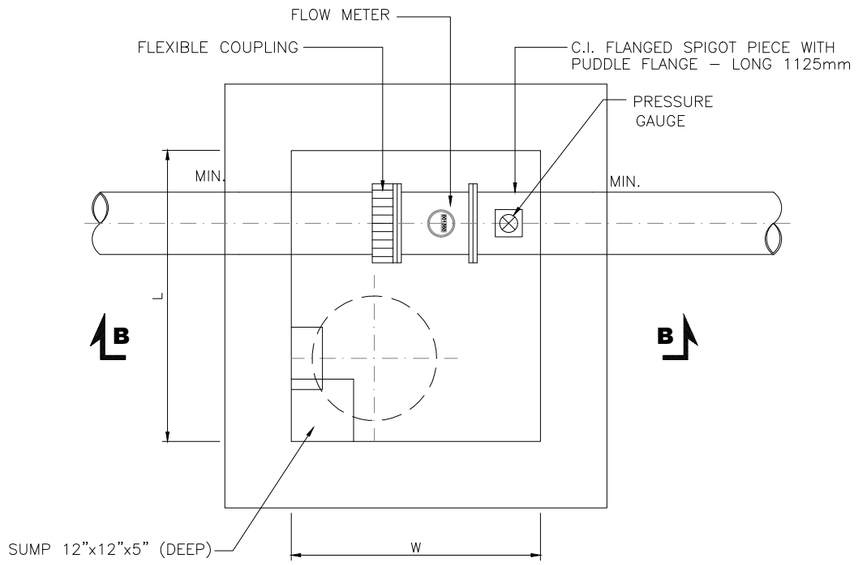
PROJECT
ENGINEERING DESIGN & CONSTRUCTION SUPERVISION CLUSTER (NORTH)
PUNJAB RURAL SUSTAINABLE WATER SUPPLY & SANITATION PROJECT

AIR VALVE CHAMBER, SLUICE VALVE CHAMBER DETAILS

DATE: OCTOBER, 2025
DRAWING No.: **4979/11/DD/1J130**
SCALE: NTS
REV.: 0

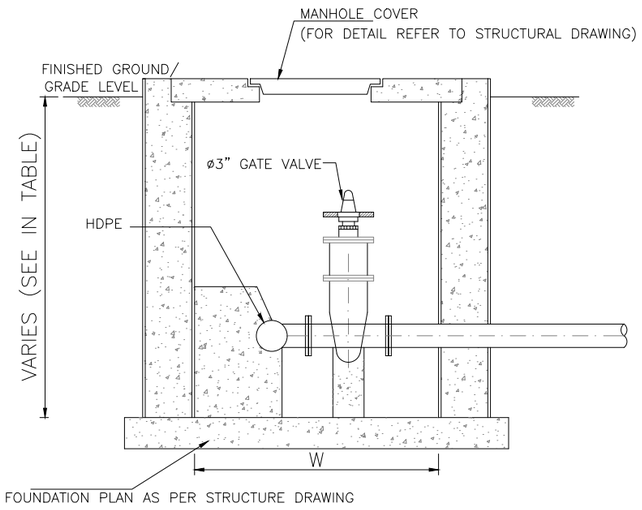


PLAN
WASHOUT VALVE CHAMBER DETAIL

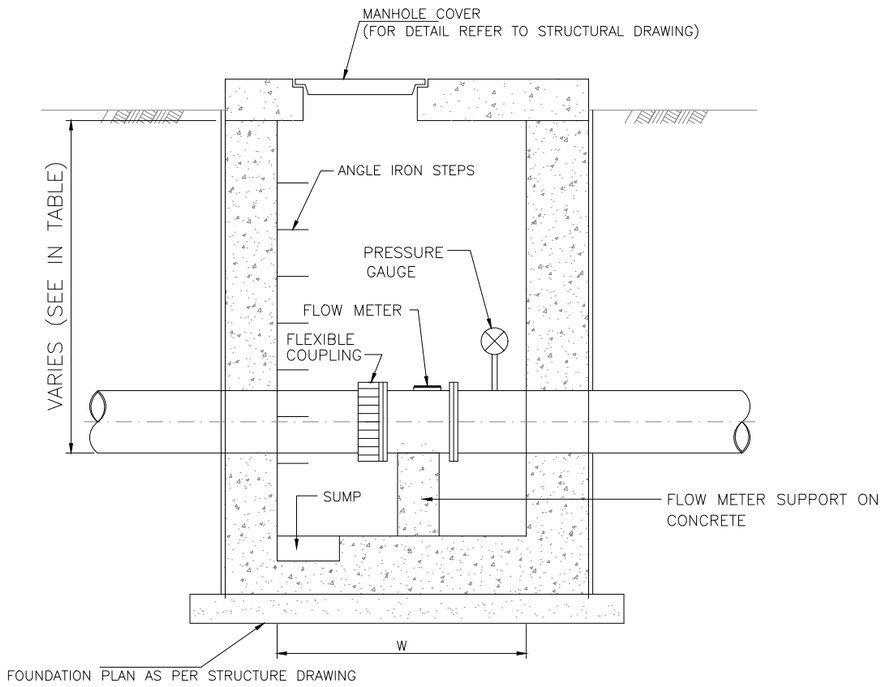


PLAN
FLOW METER CHAMBER

TABLE FOR CHAMBER			
PIPE DIA. (mm)	LENGTH (L) (in)	WIDTH (W) (in)	HEIGHT (H) (in)
90	48	48	48
110	48	48	48
160	48	48	51
200	54	54	51



SECTION A–A



SECTION B–B

NOTES

1. ALL DIMENSIONS ARE IN FEET UNLESS OTHERWISE SPECIFIED
2. READ THIS DRAWING IN CONJUNCTION WITH ALL RELEVANT DRAWINGS
3. BURIED FLANGES, BOLTS, NUTS ETC. TO BE CLEANED AND PRIMED WITH PETROLATUM PASTE AND WRAPPED WITH DOUBLE THICKNESS PETROLATUM IMPREGNATED IN DRY SYNTHETIC CARRIER TAPE BEFORE BACKFILLING.
4. THRUST BLOCK BEARING AREA TO BE EQUAL TO OR GREATER THAN THAT SHOWN IN THE TABLES. THE AREA IN A SOUND AND DRY CONDITION.
5. THRUST BLOCKS TO BE CAST AGAINST UNDISTURBED GROUND.

CLIENT
PUNJAB RURAL MUNICIPAL SERVICES COMPANY (PRMSC)

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PUNJAB RURAL SUSTAINABLE WATER SUPPLY & SANITATION PROJECT

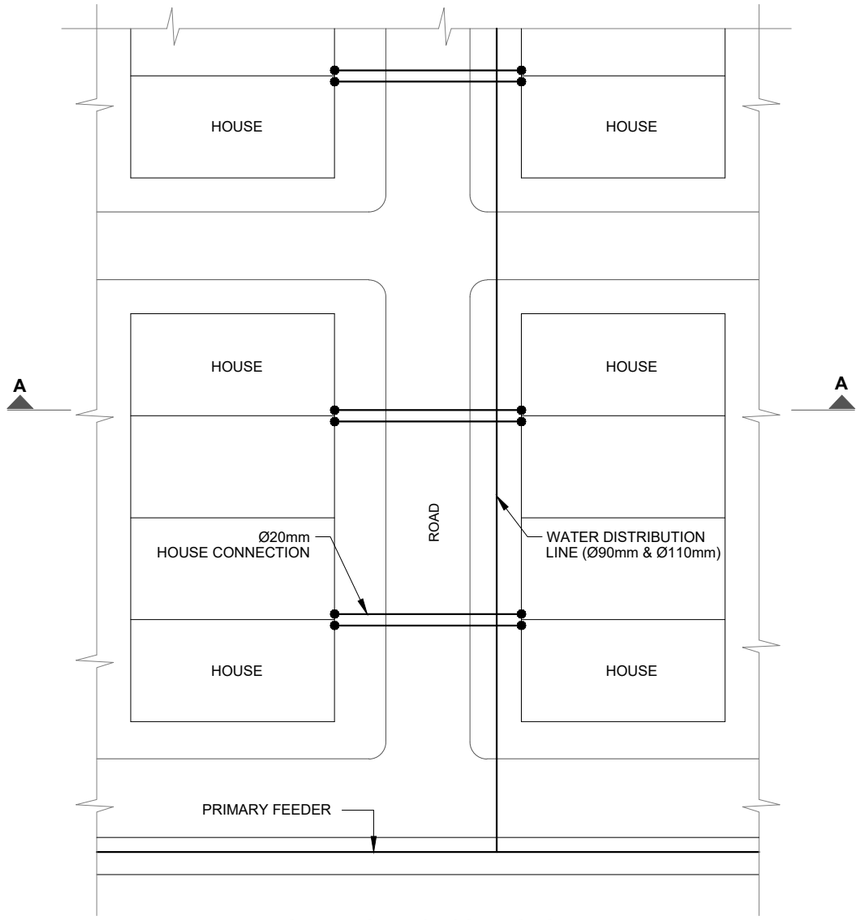
WASHOUT VALVE ,FLOW METER CHAMBER DETAILS

SCALE: NTS

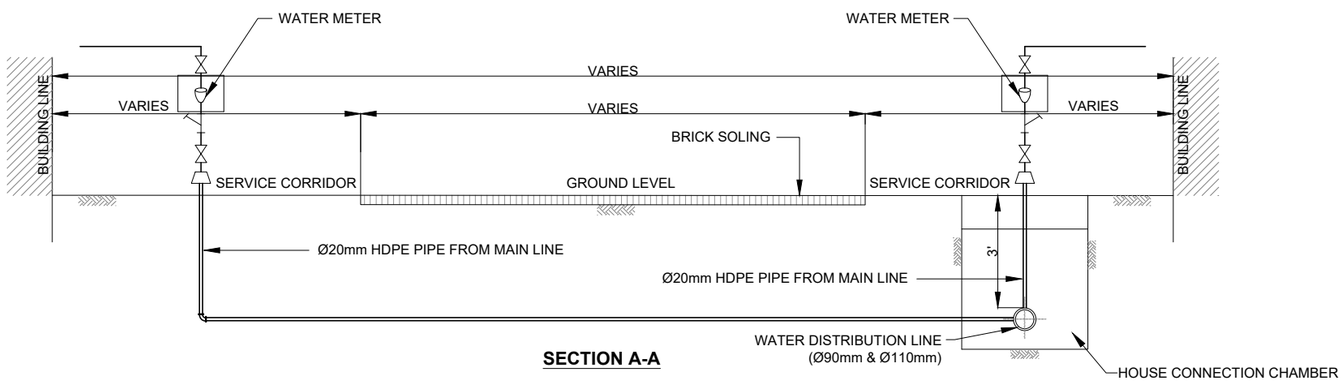
DATE: OCTOBER, 2025

DRAWING No.: **4979/11/DD/1J130**

REV.: 0



WATER SUPPLY SERVICE CONNECTION DETAIL
FROM PRIMARY WATER DISTRIBUTION LINE



SECTION A-A

CLIENT

PUNJAB RURAL MUNICIPAL SERVICES COMPANY (PRMSC)

CONSULTANT

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HEAD OFFICE:- NESPAK HOUSE, I-C, BLOCK-N, MODEL TOWN EXTENSION, LAHORE, PAKISTAN.

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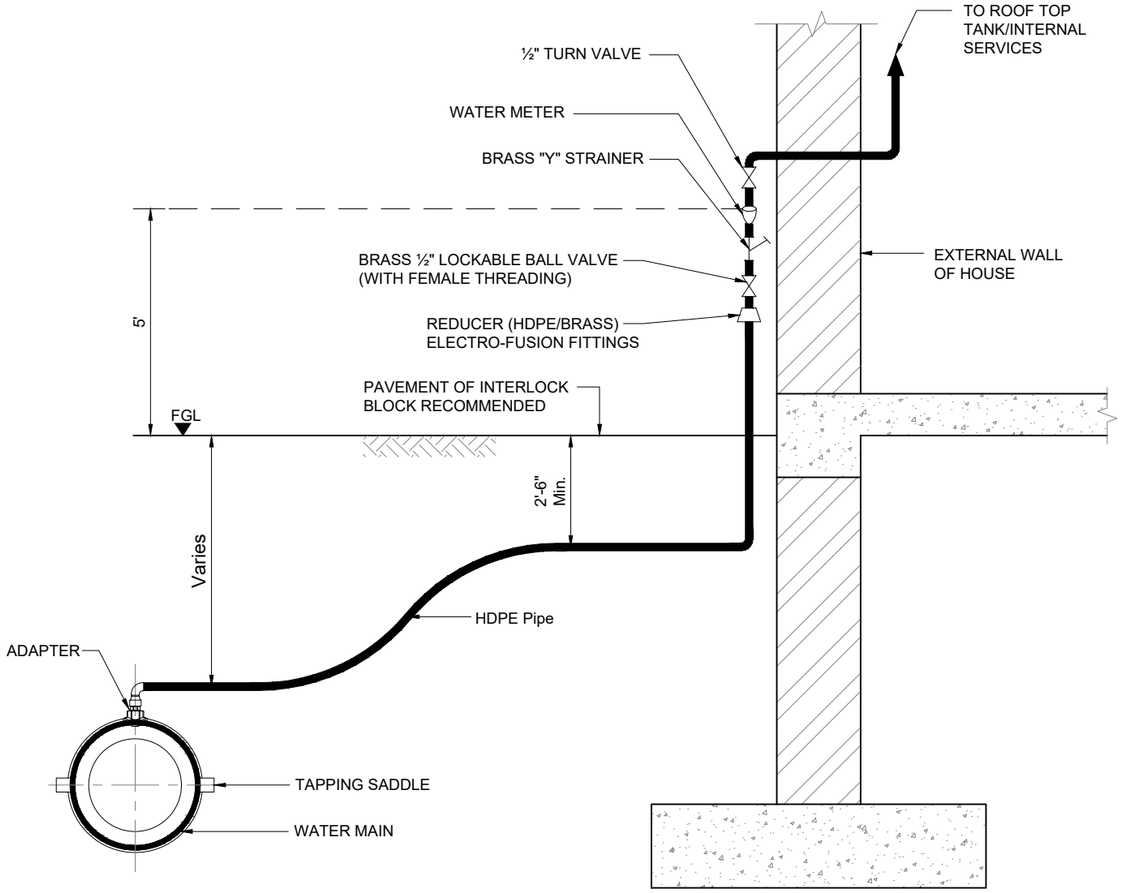
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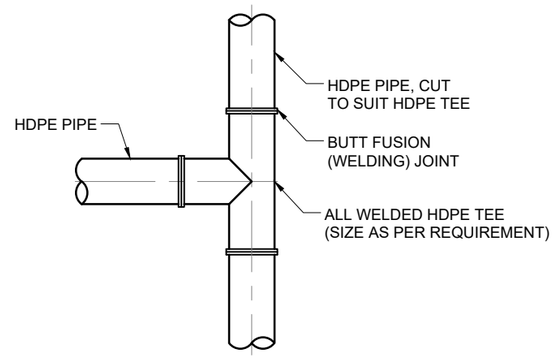
TYPICAL HOUSE CONNECTION SCHEMATIC

DATE	DRAWING No.	REV.
OCTOBER, 2025	**4979/11/DD/1J131**	0

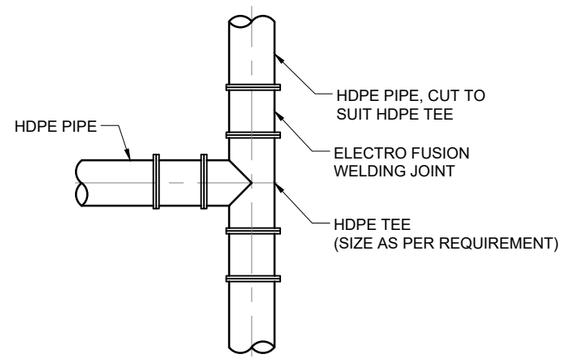
SCALE



TYPICAL HOUSE CONNECTION DETAIL



(BUTT FUSION JOINT)
CONNECTION OF HDPE PIPE TO HDPE PIPE



(ELECTRO FUSION JOINT)
CONNECTION OF HDPE PIPE TO HDPE PIPE

NOTES:

1. ALL DIMENSIONS ARE IN FEET.
2. MECHANICAL TAPPING SADDLE+FERRULE SHALL BE USED FOR HDPE WATER MAINS.
3. ELECTRO-FUSION MONO BLOCK TAPPING SADDLE SHALL BE USED FOR HDPE WATER MAIN.
4. HDPE PIPE SHALL BE PE100, PN6 (HDPE PIPE FITTINGS AND ACCESSORIES).
5. THE METER SHALL BE INSTALLED ABOVE FGL.
6. THE UPSTREAM & DOWNSTREAM DISTANCE OF METER SHALL BE AS PER MANUFACTURER'S RECOMMENDATION.

CLIENT
PUNJAB RURAL MUNICIPAL SERVICES COMPANY (PRMSC)

CONSULTANT
NATIONAL ENGINEERING SERVICES PAKISTAN (PVT.) LTD.
HEAD OFFICE:- NESPAK HOUSE, I-C, BLOCK-N, MODEL TOWN EXTENSION, LAHORE, PAKISTAN.

REV.	DATE	DESCRIPTION	APPROVED
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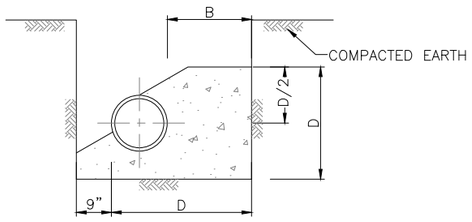
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SUBMITTED	
RECOMMENDED	
CHD./VER.	
APPROVED	

PROJECT
ENGINEERING DESIGN & CONSTRUCTION SUPERVISION CLUSTER (NORTH)
PUNJAB RURAL SUSTAINABLE WATER SUPPLY & SANITATION PROJECT

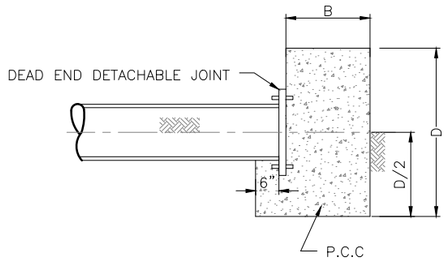
TYPICAL HOUSE CONNECTION DETAILS

DATE	DRAWING No.	REV.
OCTOBER, 2025	**4979/11/DD/1J132**	0

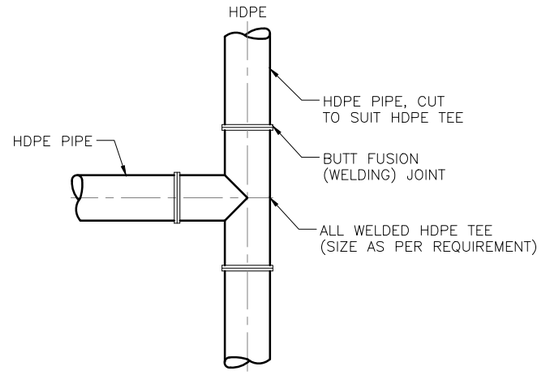
SCALE: NTS



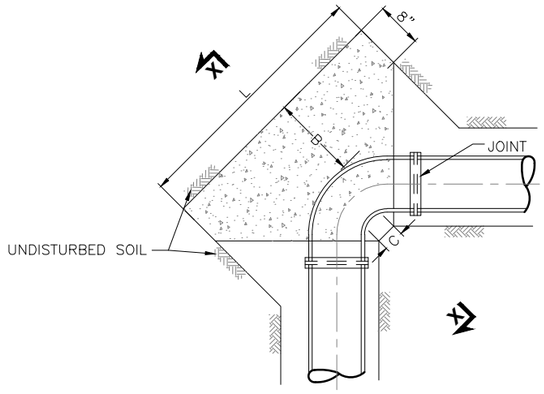
SECTION X-X



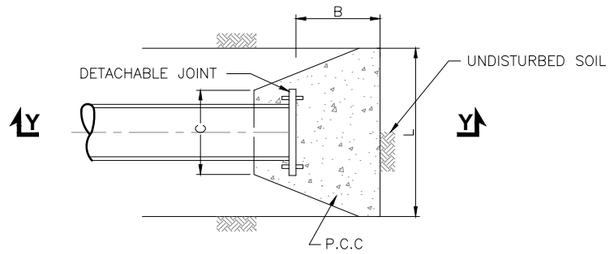
SECTION Y-Y



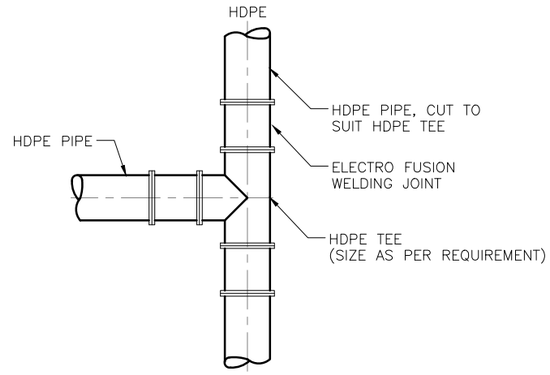
(BUTT FUSION JOINT)
CONNECTION OF HDPE PIPE TO HDPE PIPE



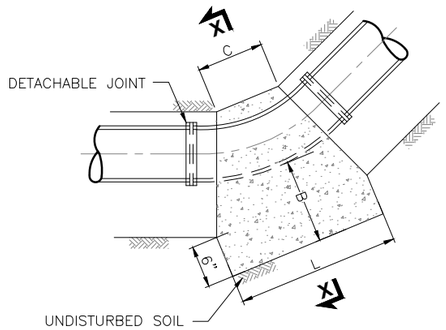
PLAN
90° BEND



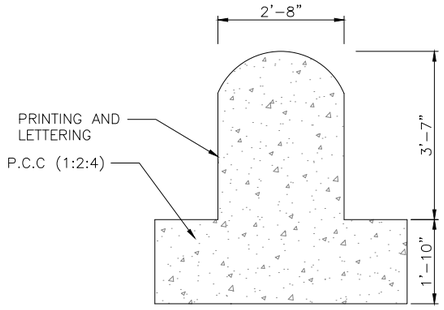
PLAN
DEAD END BLOCK



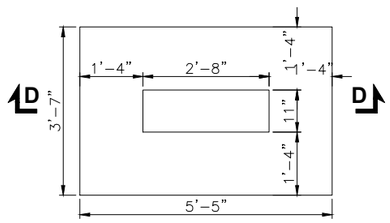
(ELECTRO FUSION JOINT)
CONNECTION OF HDPE PIPE TO HDPE PIPE



PLAN
45° BEND



SECTION D-D



PLAN
INDICATION POST

NOTES

1. SAFE TRENCH CONDITIONS ARE NECESSARY TO COMPLETE THE WORK.
2. THRUST BLOCK BEARING AREA TO BE EQUAL TO OR GREATER THAN THAT SHOWN IN THE TABLES. THE AREA IN A SOUND AND DRY CONDITION.
3. THRUST BLOCKS TO BE CAST AGAINST UNDISTURBED GROUND.
4. ALL DIMENSIONS ARE IN FEET UNLESS OTHERWISE SPECIFIED.

CLIENT
PUNJAB RURAL MUNICIPAL SERVICES COMPANY (PRMSC)

CONSULTANT
NATIONAL ENGINEERING SERVICES PAKISTAN (PVT.) LTD.
HEAD OFFICE:- NESPAK HOUSE, I-C, BLOCK-N, MODEL TOWN EXTENSION, LAHORE, PAKISTAN.

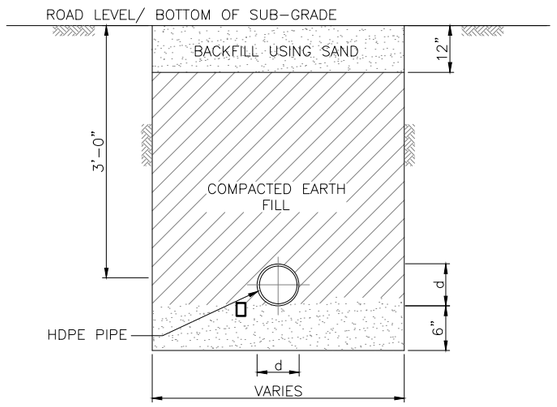
REV.	DATE	DESCRIPTION	APPROVED
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SUBMITTED	
RECOMMENDED	
CHD./VER.	
APPROVED	

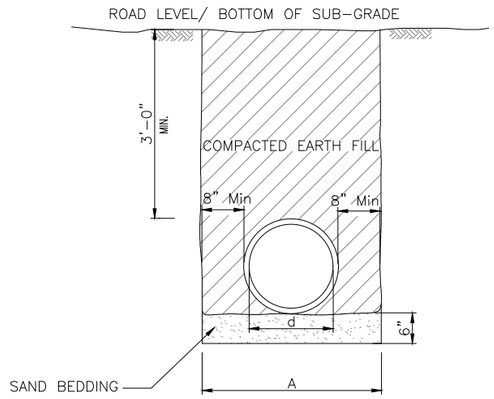
PROJECT
ENGINEERING DESIGN & CONSTRUCTION SUPERVISION CLUSTER (NORTH)
PUNJAB RURAL SUSTAINABLE WATER SUPPLY & SANITATION PROJECT

MISCELLANEOUS DETAILS OF WATER SUPPLY SYSTEM (THRUST BLOCKS & TRENCH)

DATE	DRAWING No.	SCALE	REV.
OCTOBER, 2025	4979/11/DD/1J133	NTS	0



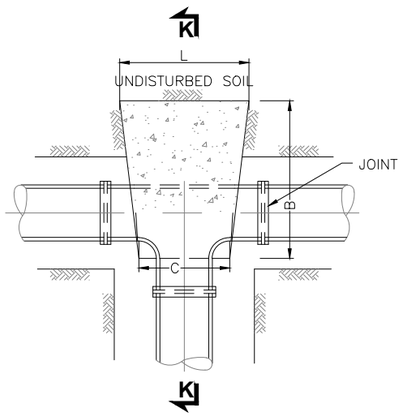
DETAIL FOR PIPE CROSSING UNDER ROAD



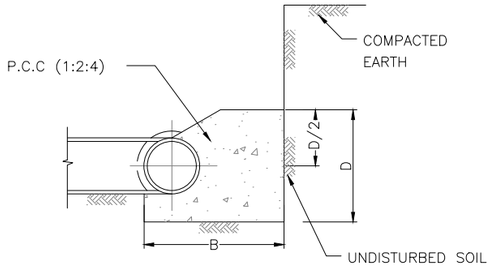
TRENCH DETAIL

ANCHOR BLOCK DIMENSIONS FOR PIPE FITTINGS																
DIA IN inch	AT TEES AND DEAD ENDS				AT 90° BENDS				AT 45° BENDS				AT 22 1/2° BENDS			
	C	B	D	L	C	B	D	L	C	B	D	L	C	B	D	L
3" (90mm)	5"	18"	18"	18"	5"	18"	24"	24"	5"	18"	18"	18"	6"	18"	18"	18"
4" (110mm)	6"	18"	18"	18"	5"	18"	18"	24"	5"	18"	18"	18"	6"	18"	18"	18"
6" (160mm)	8"	21"	21"	24"	5"	21"	24"	30"	5"	21"	21"	27"	6"	21"	24"	27"

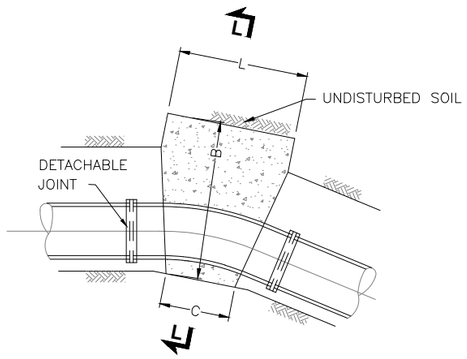
TRENCH WIDTH SCHEDULE	
NOMINAL OUTER DIA OF PIPE IN mm (d)	TRENCH WIDITH (A)
3" (90mm)	2'-4"
4" (110mm)	2'-4"
6" (160mm)	2'-6"
8" (200mm)	2'-8"



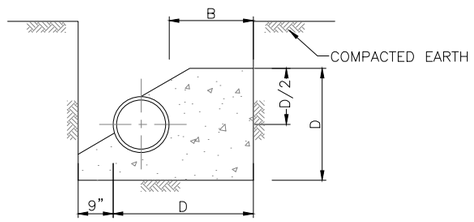
PLAN TEE



SECTION K-K



PLAN 22 1/2° BEND



SECTION L-L

NOTES

1. SAFE TRENCH CONDITIONS ARE NECESSARY TO COMPLETE THE WORK.
2. THRUST BLOCK BEARING AREA TO BE EQUAL TO OR GREATER THAN THAT SHOWN IN THE TABLES. THE AREA IN A SOUND AND DRY CONDITION.
3. THRUST BLOCKS TO BE CAST AGAINST UNDISTURBED GROUND.
4. ALL DIMENSIONS ARE IN FEET UNLESS OTHERWISE SPECIFIED.
5. ROAD CUTTING SHALL BE CARRIED OUT USING MECHANICAL ROAD CUTTER.
6. EXCAVATION DEPTH AND WIDTH MAY VARY AS PER AVAILABLE RIGHT OF WAY OF ROAD. IT WILL BE DECIDED BY THE ENGINEER.

CLIENT
PUNJAB RURAL MUNICIPAL SERVICES COMPANY (PRMSC)

CONSULTANT
NATIONAL ENGINEERING SERVICES PAKISTAN (PVT.) LTD.
HEAD OFFICE:- NESPAK HOUSE, I-C, BLOCK-N, MODEL TOWN EXTENSION, LAHORE, PAKISTAN.

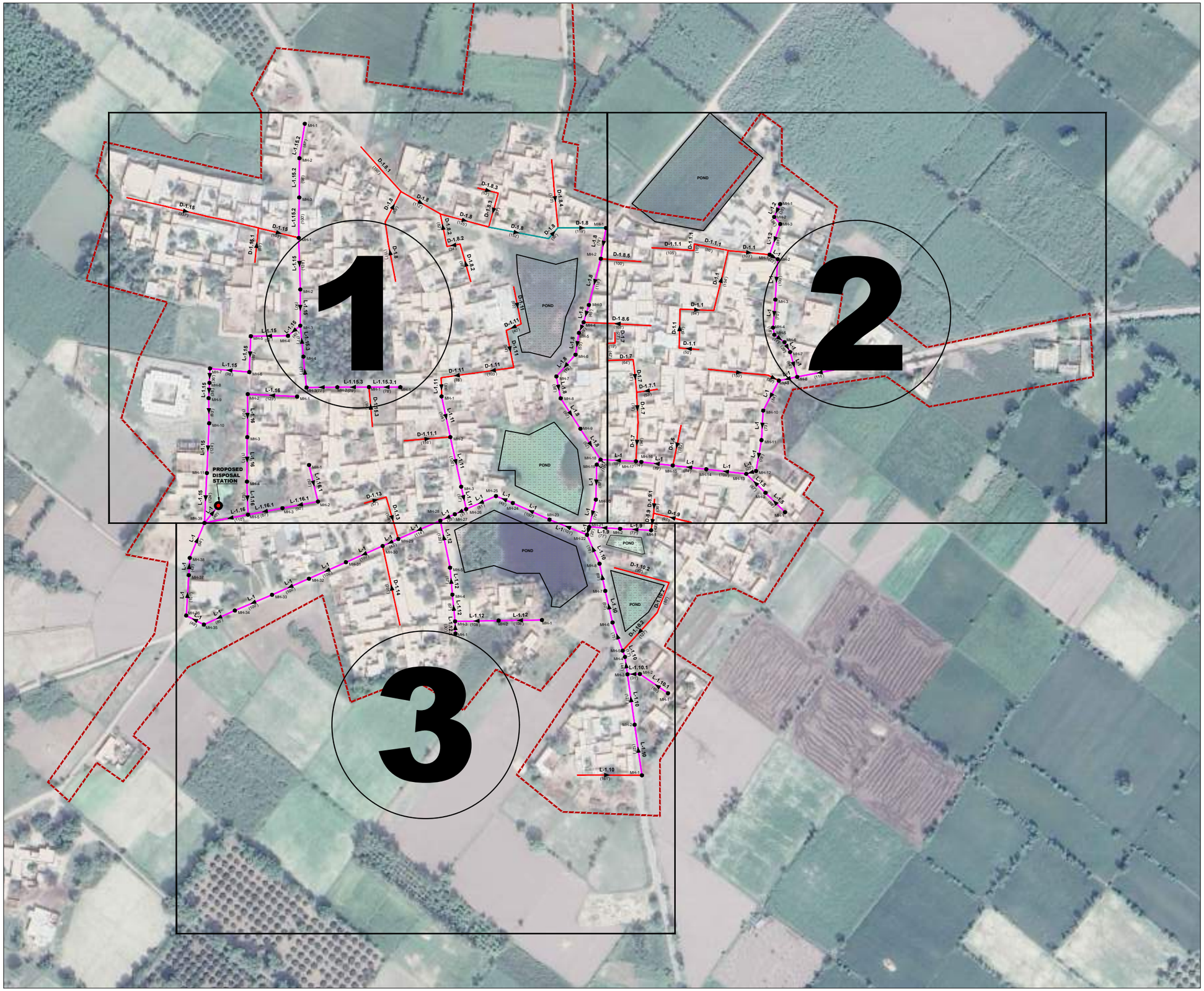
REV.	DATE	DESCRIPTION	APPROVED
04			
03			
02			
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DRAWN	WALEED
SUBMITTED	
RECOMMENDED	
CHD./VER.	
APPROVED	

PROJECT
ENGINEERING DESIGN & CONSTRUCTION SUPERVISION CLUSTER (NORTH)
PUNJAB RURAL SUSTAINABLE WATER SUPPLY & SANITATION PROJECT

MISCELLANEOUS DETAILS OF WATER SUPPLY SYSTEM (THRUST BLOCK & TRENCH)

SCALE: NTS
DATE: OCTOBER, 2025
DRAWING No.: **4979/11/DD/1J134**
REV.: 0



N

MOUZA RAHIMPUR
(TEHSIL: KOT MOMIN)

240 120 0 240 feet
GRAPHIC SCALE

CLIENT
PUNJAB RURAL MUNICIPAL SERVICES COMPANY (PRMSC)

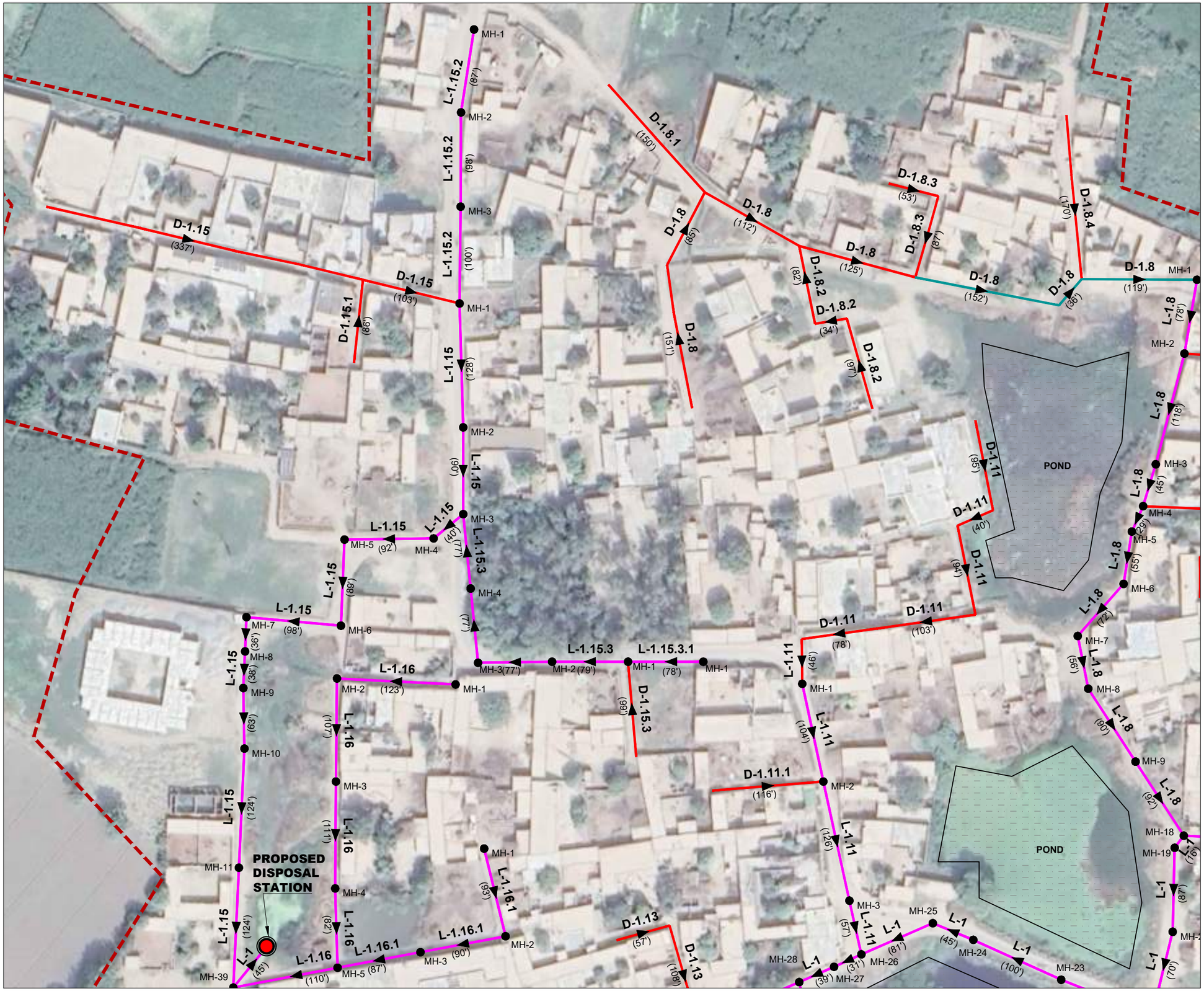
CONSULTANT
NATIONAL ENGINEERING SERVICES PAKISTAN (PVT.) LTD.
HEAD OFFICE:- NESPAK HOUSE, I-C, BLOCK-N, MODEL TOWN EXTENSION, LAHORE, PAKISTAN.

REV.	DATE	DESCRIPTION	APPROVED		
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03				SUBMITTED	
02				RECOMMENDED	
01				CHD./VER.	

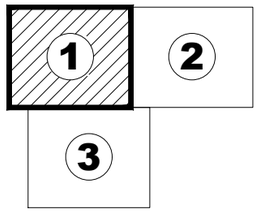
PROJECT
ENGINEERING DESIGN & CONSTRUCTION SUPERVISION CLUSTER (NORTH)
PUNJAB RURAL SUSTAINABLE WATER SUPPLY & SANITATION PROJECT

MOUZA RAHIMPUR
PROPOSED SEWERAGE SYSTEM
(SHEET INDEX)

DATE: DECEMBER, 2025
DRAWING No.: **4979/11/DD/2J114**
SCALE: 1" = 240'
REV.: 0



RAHIMPUR
(TEHSIL: KOT MOMIN)



SHEET INDEX

LEGEND:

BOUNDARY OF PRINCIPLE SETTLEMENT
PROPOSED DRAIN (12"x12")
PROPOSED DRAIN (15"x12")
Ø12" PROPOSED SEWER
DRAIN NAME **D-1**
DRAIN LENGTH (100')
PROPOSED DISPOSAL STATION
POND

100 50 0 100 feet
GRAPHIC SCALE

(SHEET 1 OF 3)

CLIENT
PUNJAB RURAL MUNICIPAL SERVICES COMPANY (PRMSC)

CONSULTANT
NATIONAL ENGINEERING SERVICES PAKISTAN (PVT.) LTD.
HEAD OFFICE:- NESPAK HOUSE, I-C, BLOCK-N, MODEL TOWN EXTENSION, LAHORE, PAKISTAN.

REV.	DATE	DESCRIPTION	APPROVED		
04				DRAWN	WALEED
03				SUBMITTED	
02				RECOMMENDED	
01				CHD./VER.	
				APPROVED	

PROJECT
ENGINEERING DESIGN & CONSTRUCTION SUPERVISION CLUSTER (NORTH)
PUNJAB RURAL SUSTAINABLE WATER SUPPLY & SANITATION PROJECT

RAHIMPUR
LAYOUT PLAN OF
PROPOSED SEWERAGE SYSTEM

SCALE 1" = 100'
DATE DECEMBER, 2025
DRAWING No. **4979/11/DD/2J114**
REV. 0



RAHIMPUR
(TEHSIL: KOT MOMIN)

1 | 2
3

SHEET INDEX

LEGEND:

BOUNDARY OF PRINCIPLE SETTLEMENT
PROPOSED DRAIN (12"x12")
PROPOSED DRAIN (15"x12")
Ø12" PROPOSED SEWER
DRAIN NAME — D-1
DRAIN LENGTH — (100')
PROPOSED DISPOSAL STATION
POND

100 50 0 100 feet
GRAPHIC SCALE

(SHEET 2 OF 3)

CLIENT
PUNJAB RURAL MUNICIPAL SERVICES COMPANY (PRMSC)

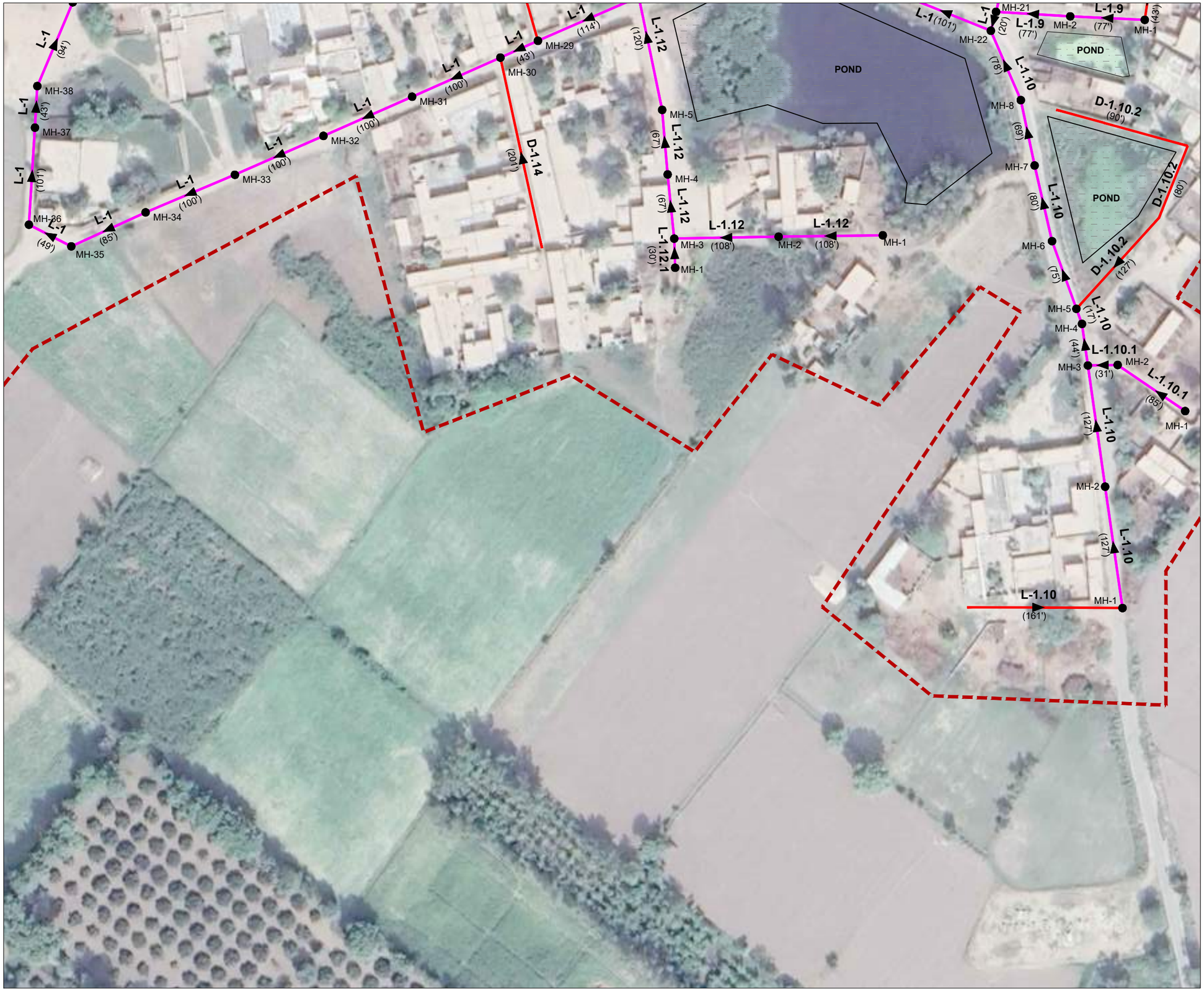
CONSULTANT
NATIONAL ENGINEERING SERVICES PAKISTAN (PVT.) LTD.
HEAD OFFICE:- NESPAK HOUSE, I-C, BLOCK-N, MODEL TOWN EXTENSION, LAHORE, PAKISTAN.

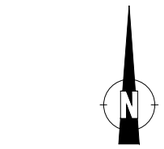
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03				SUBMITTED:
02				RECOMMENDED:
01				CHD./VER.:
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PROJECT
ENGINEERING DESIGN & CONSTRUCTION SUPERVISION CLUSTER (NORTH)
PUNJAB RURAL SUSTAINABLE WATER SUPPLY & SANITATION PROJECT

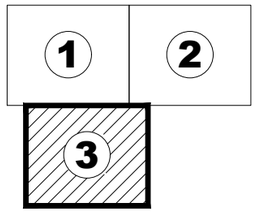
RAHIMPUR
LAYOUT PLAN OF
PROPOSED SEWERAGE SYSTEM

SCALE: 1" = 100'
DATE: DECEMBER, 2025
DRAWING No.: **4979/11/DD/2J114**
REV.: 0





RAHIMPUR
(TEHSIL: KOT MOMIN)



SHEET INDEX

LEGEND:

BOUNDARY OF PRINCIPLE SETTLEMENT

PROPOSED DRAIN (12"x12")

PROPOSED DRAIN (15"x12")

Ø12" PROPOSED SEWER

DRAIN NAME **D-1**

DRAIN LENGTH (100')

PROPOSED DISPOSAL STATION

POND

100 50 0 100 feet

GRAPHIC SCALE

(SHEET 3 OF 3)

CLIENT

PUNJAB RURAL MUNICIPAL SERVICES COMPANY (PRMSC)

CONSULTANT

NATIONAL ENGINEERING SERVICES PAKISTAN (PVT.) LTD.

HEAD OFFICE:- NESPAK HOUSE, I-C, BLOCK-N, MODEL TOWN EXTENSION, LAHORE, PAKISTAN.

REV.	DATE	DESCRIPTION	APPROVED
04			
03			
02			
01			

DRAWN	WALEED
SUBMITTED	
RECOMMENDED	
CHD./VER.	
APPROVED	

PROJECT

ENGINEERING DESIGN & CONSTRUCTION SUPERVISION CLUSTER (NORTH)
PUNJAB RURAL SUSTAINABLE WATER SUPPLY & SANITATION PROJECT

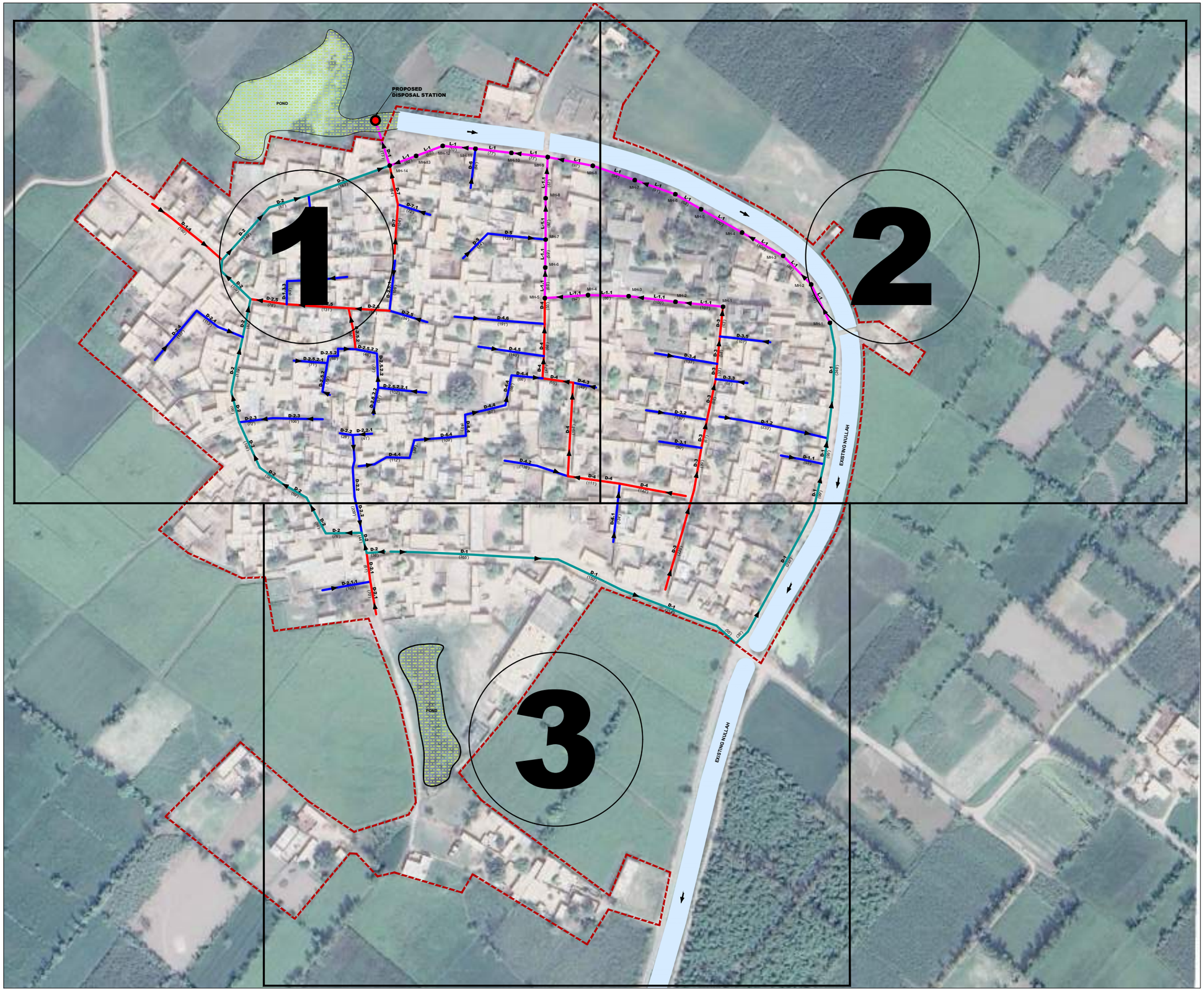
RAHIMPUR
LAYOUT PLAN OF
PROPOSED SEWERAGE SYSTEM

SCALE 1" = 100'

DATE DECEMBER, 2025

DRAWING No. **4979/11/DD/2J114**

REV. 0

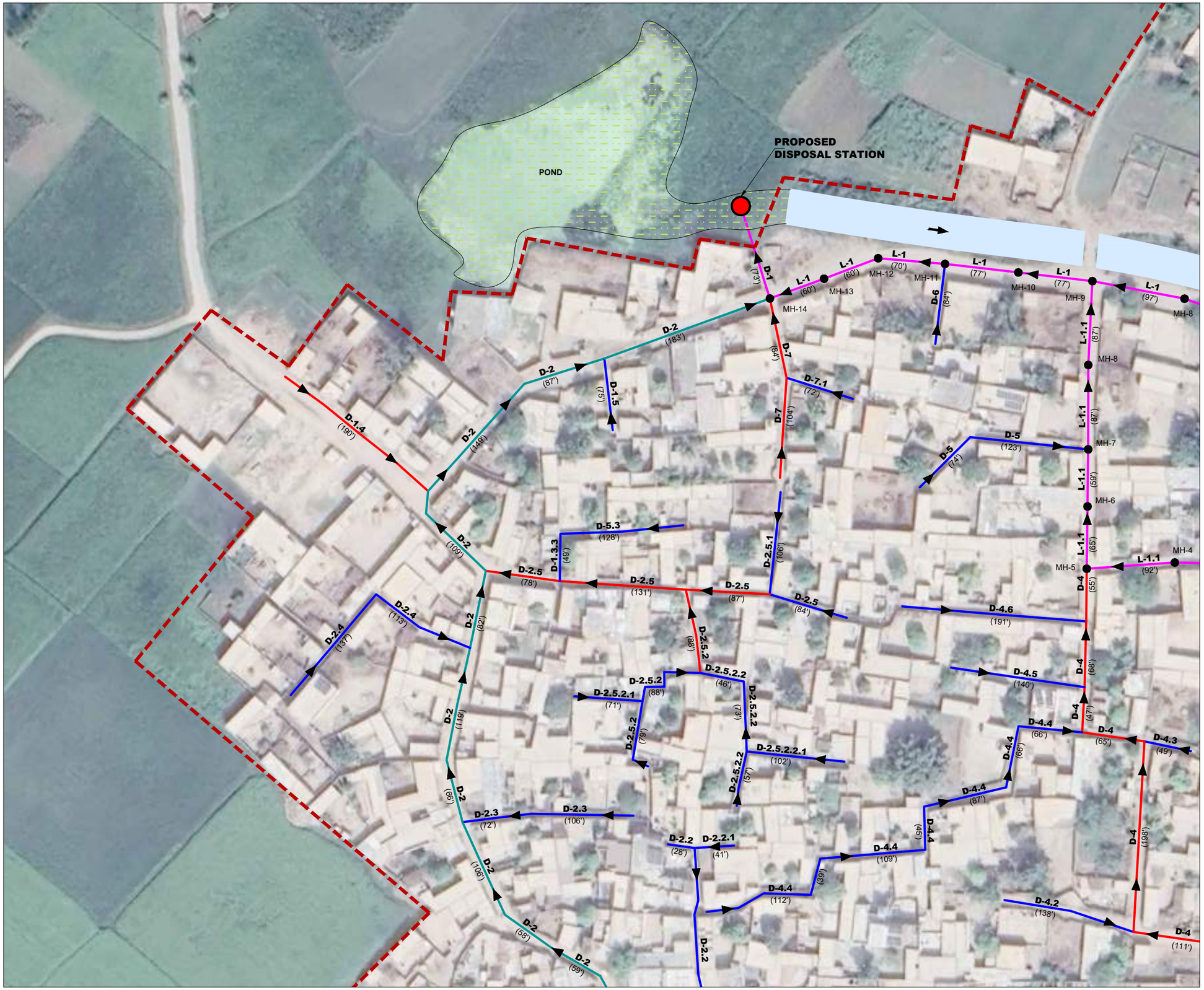


WAN MIANA
(TEHSIL: KOT MOMIN)

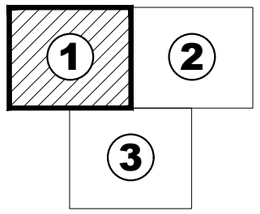
200 100 0 200 feet
GRAPHIC SCALE

CLIENT	CONSULTANT			PROJECT	WAN MIANA PROPOSED SEWERAGE SYSTEM (SHEET INDEX)
PUNJAB RURAL MUNICIPAL SERVICES COMPANY (PRMSC)	NATIONAL ENGINEERING SERVICES PAKISTAN (PVT.) LTD. HEAD OFFICE:- NESPAK HOUSE, I-C, BLOCK-N, MODEL TOWN EXTENSION, LAHORE, PAKISTAN.	04 / 03 / 02 / 01	DRAWN / SUBMITTED / RECOMMENDED / CHD./VER.	ENGINEERING DESIGN & CONSTRUCTION SUPERVISION CLUSTER (NORTH) PUNJAB RURAL SUSTAINABLE WATER SUPPLY & SANITATION PROJECT	SCALE: 1" = 200' DATE: DECEMBER, 2025 DRAWING No.: 4979/11/DD/2J120 REV.: 0

REV.	DATE	DESCRIPTION	APPROVED	APPROVED



WAN MIANA
(TEHSIL: KOT MOMIN)



SHEET INDEX

LEGEND:

BOUNDARY OF PRINCIPLE SETTLEMENT	
PROPOSED DRAIN (10"x12")	
PROPOSED DRAIN (12"x12")	
PROPOSED DRAIN (15"x12")	
DRAIN NAME	D-1
LENGTH	(100')
Ø12" PROPOSED SEWER	
LINE NUMBER	L-1
MANHOLE NUMBER	MH-10
PROPOSED MANHOLE	
PROPOSED DISPOSAL STATION	
EXISTING NULLAH	
POND	

100 50 0 100 feet
GRAPHIC SCALE

(SHEET 1 OF 3)

CLIENT
PUNJAB RURAL MUNICIPAL SERVICES COMPANY (PRMSC)

CONSULTANT
NATIONAL ENGINEERING SERVICES PAKISTAN (PVT.) LTD.
HEAD OFFICE:- NESPAK HOUSE, I-C, BLOCK-N, MODEL TOWN EXTENSION, LAHORE, PAKISTAN.

REV.	DATE	DESCRIPTION	APPROVED
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DRAWN	WALEED
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RECOMMENDED	
CHD./VER.	
APPROVED	

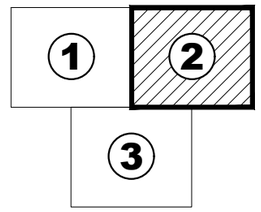
PROJECT
ENGINEERING DESIGN & CONSTRUCTION SUPERVISION CLUSTER (NORTH)
PUNJAB RURAL SUSTAINABLE WATER SUPPLY & SANITATION PROJECT

WAN MIANA
LAYOUT PLAN OF PROPOSED SEWERAG SYSTEM

DATE	DRAWING No.	SCALE	REV.
DECEMBER, 2025	4979/11/DD/2J120	1" = 100'	0



WAN MIANA
(TEHSIL: KOT MOMIN)



SHEET INDEX

LEGEND:

BOUNDARY OF PRINCIPLE SETTLEMENT	
PROPOSED DRAIN (10"x12")	
PROPOSED DRAIN (12"x12")	
PROPOSED DRAIN (15"x12")	
DRAIN NAME	D-1
LENGTH	(100')
Ø12" PROPOSED SEWER	
LINE NUMBER	L-1
MANHOLE NUMBER	MH-10
PROPOSED MANHOLE	
PROPOSED DISPOSAL STATION	
EXISTING NULLAH	
POND	

100 50 0 100 feet
GRAPHIC SCALE

(SHEET 2 OF 3)

CLIENT
PUNJAB RURAL MUNICIPAL SERVICES COMPANY (PRMSC)

CONSULTANT
NATIONAL ENGINEERING SERVICES PAKISTAN (PVT.) LTD.
HEAD OFFICE:- NESPAK HOUSE, I-C, BLOCK-N, MODEL TOWN EXTENSION, LAHORE, PAKISTAN.

REV.	DATE	DESCRIPTION	APPROVED
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DRAWN	WALEED
SUBMITTED	
RECOMMENDED	
CHD./VER.	
APPROVED	

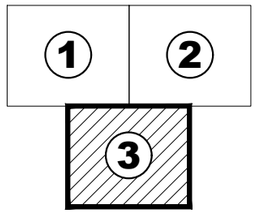
PROJECT
ENGINEERING DESIGN & CONSTRUCTION SUPERVISION CLUSTER (NORTH)
PUNJAB RURAL SUSTAINABLE WATER SUPPLY & SANITATION PROJECT

WAN MIANA
LAYOUT PLAN OF PROPOSED SEWERAG SYSTEM

SCALE: 1" = 100'
DATE: DECEMBER, 2025
DRAWING No.: **4979/11/DD/2J120**
REV.: 0



WAN MIANA
(TEHSIL: KOT MOMIN)



SHEET INDEX

LEGEND:

BOUNDARY OF PRINCIPLE SETTLEMENT	
PROPOSED DRAIN (10"x12")	
PROPOSED DRAIN (12"x12")	
PROPOSED DRAIN (15"x12")	
DRAIN NAME	**D-1**
LENGTH	(100')
Ø12" PROPOSED SEWER	
LINE NUMBER	**L-1**
MANHOLE NUMBER	MH-10
PROPOSED MANHOLE	
PROPOSED DISPOSAL STATION	
EXISTING NULLAH	
POND	

100 50 0 100 feet
GRAPHIC SCALE

(SHEET 3 OF 3)

CLIENT
PUNJAB RURAL MUNICIPAL SERVICES COMPANY (PRMSC)

CONSULTANT
NATIONAL ENGINEERING SERVICES PAKISTAN (PVT.) LTD.
HEAD OFFICE:- NESPAK HOUSE, I-C, BLOCK-N, MODEL TOWN EXTENSION, LAHORE, PAKISTAN.

REV.	DATE	DESCRIPTION	APPROVED
04			
03			
02			
01			

DRAWN	WALEED
SUBMITTED	
RECOMMENDED	
CHD./VER.	
APPROVED	

PROJECT
ENGINEERING DESIGN & CONSTRUCTION SUPERVISION CLUSTER (NORTH)
PUNJAB RURAL SUSTAINABLE WATER SUPPLY & SANITATION PROJECT

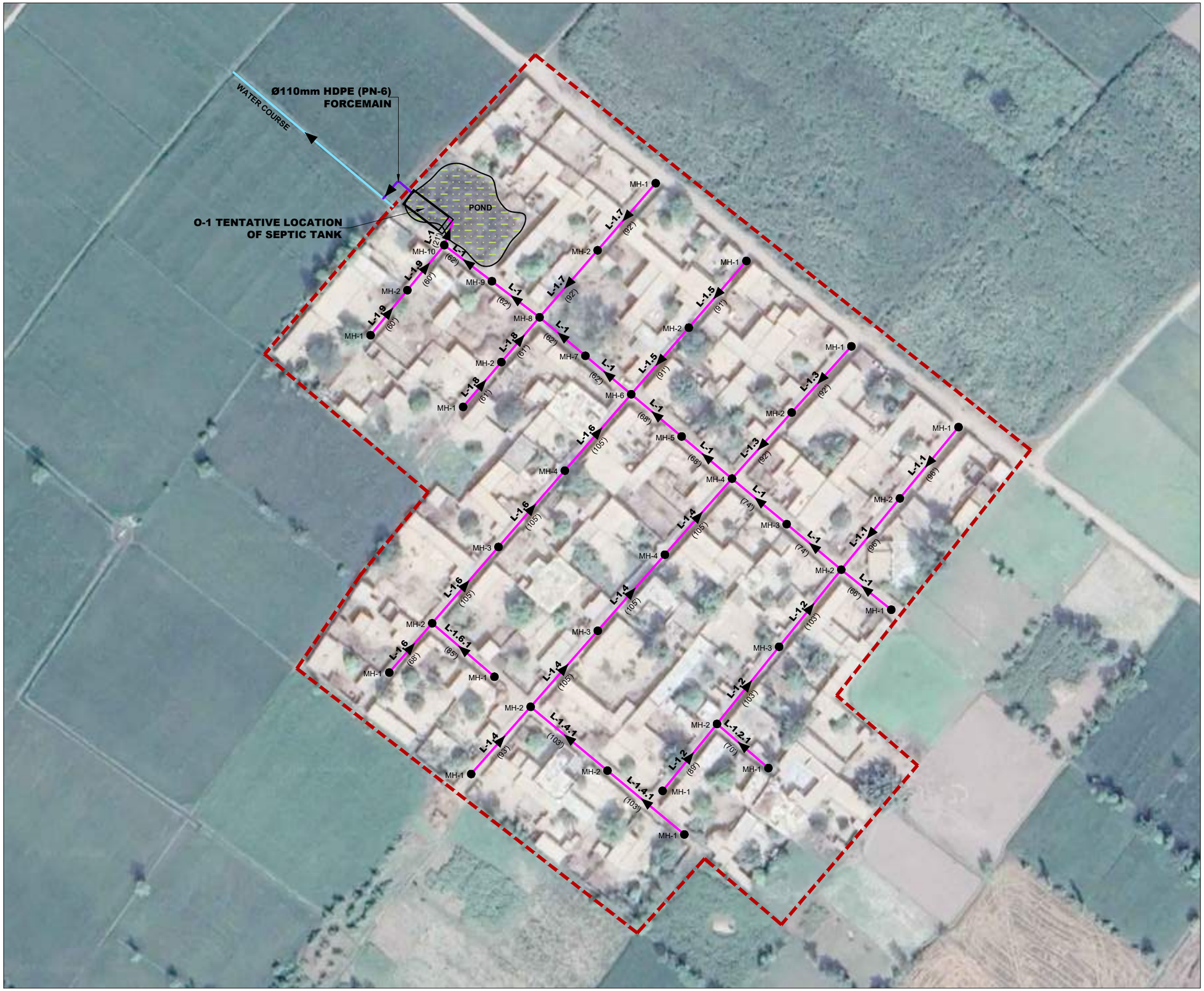
WAN MIANA
LAYOUT PLAN OF
PROPOSED SEWERAG SYSTEM

SCALE: 1" = 100'

DATE: DECEMBER, 2025

DRAWING No.: **4979/11/DD/2J120**

REV.: 0



WAN MIANA COLONY
(TEHSIL: KOT MOMIN)

LEGEND:

BOUNDARY OF PRINCIPLE SETTLEMENT	
Ø12" PROPOSED SEWER	
Ø160mm HDPE PROPOSED FORCEMAIN	
LINE NUMBER	L-1
MANHOLE NUMBER	MH-10
PROPOSED MANHOLE	
PIPE LENGTH	(100')
PROPOSED SEPTC TANK	
WATER COURSE	
POND	

100 50 0 100 feet
GRAPHIC SCALE

CLIENT
PUNJAB RURAL MUNICIPAL SERVICES COMPANY (PRMSC)

CONSULTANT
NATIONAL ENGINEERING SERVICES PAKISTAN (PVT.) LTD.
HEAD OFFICE:- NESPAK HOUSE, I-C, BLOCK-N, MODEL TOWN EXTENSION, LAHORE, PAKISTAN.

REV.	DATE	DESCRIPTION	APPROVED	APPROVED	
04				DRAWN	WALEED
03				SUBMITTED	
02				RECOMMENDED	
01				CHD./VER.	

PROJECT
ENGINEERING DESIGN & CONSTRUCTION SUPERVISION CLUSTER (NORTH)
PUNJAB RURAL SUSTAINABLE WATER SUPPLY & SANITATION PROJECT

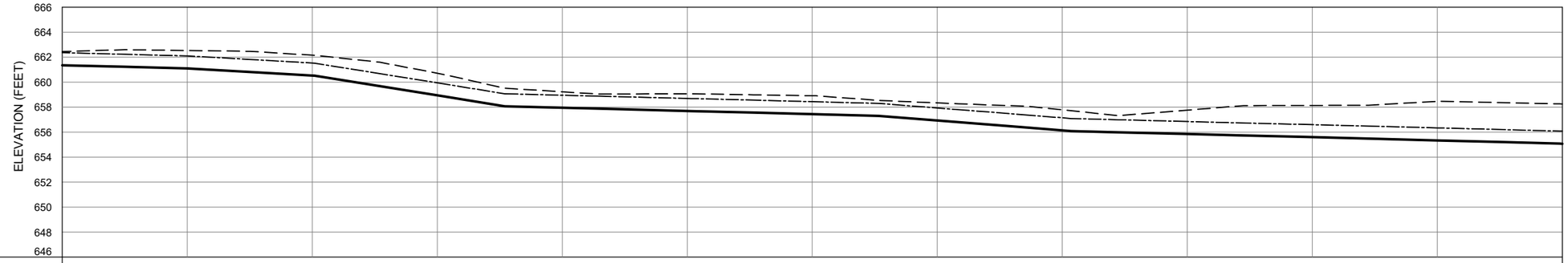
WAN MIANA COLONY
LAYOUT PLAN OF PROPOSED SEWERAGE SYSTEM

SCALE: 1" = 100'

DATE: DECEMBER, 2025

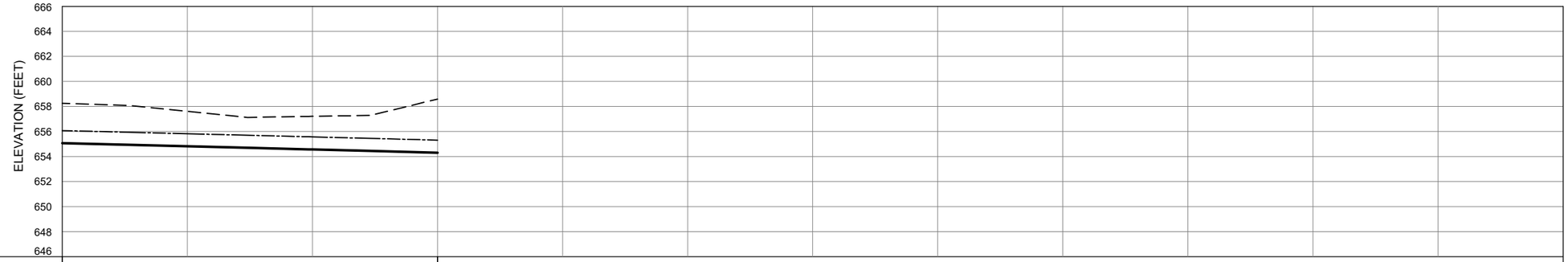
DRAWING No.: **4979/11/DD/2J121**

REV.: 0



DRAIN SIZES (INCHES)	(15" x 12")																						
SLOPE	0.002565			0.005772			0.0016033			0.002565					0.007856			0.002565					
ROAD LEVEL (FEET)	662.45	662.6	662.54	662.47	662.15	661.6	660.64	659.52	659.05	659.07	658.99	658.91	658.54	658.27	658.07	657.72	657.32	657.72	658.12	658.14	658.15	658.47	658.37	658.26
WATER LEVEL (FEET)	662.36	662.23	662.10	661.82	661.52	660.68	659.88	659.07	658.88	658.69	658.56	658.43	658.30	657.80	657.37	657.09	656.99	656.86	656.73	656.61	656.48	656.34	656.21	656.08
BED LEVEL (FEET)	661.36	661.23	661.10	660.82	660.52	659.68	658.88	658.07	657.88	657.69	657.56	657.43	657.30	656.80	656.37	656.09	655.99	655.86	655.73	655.61	655.48	655.34	655.21	655.08
CHAINAGE (FEET)	0+000	0+050	0+100	0+150	0+202	0+254	0+304	0+354	0+429	0+503	0+553	0+603	0+653	0+717	0+772	0+807	0+845	0+895	0+945	0+995	1+045	1+100	1+149	1+198

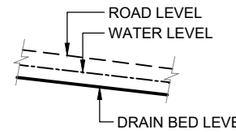
PROFILE (D-1)



DRAIN SIZES (INCHES)	(15" x 12")						
SLOPE	0.002565						
ROAD LEVEL (FEET)	658.25	658.08	657.6	657.13	657.21	657.29	658.59
WATER LEVEL (FEET)	656.08	655.94	655.82	655.70	655.58	655.45	655.31
BED LEVEL (FEET)	655.08	654.94	654.82	654.70	654.58	654.45	654.31
CHAINAGE (FEET)	1+200	1+254	1+301	1+348	1+397	1+446	1+500

PROFILE (D-1)

LEGEND:-



NOTES:-

1. ALL LEVELS ARE IN FEET.
2. ALL SIZES ARE IN INCHES UNLESS OTHERWISE SPECIFIED.
3. MATERIAL FOR RECTANGULAR DRAINS SHALL BE BRICK MASONARY.
4. FOR BEDDING AND STUCTURAL DETAIL PLEASE REFER RELEVANT STRUCTURAL DRAWINGS.
5. DRAIN SHALL BE COVERED WITH R.C.C SLAB.



VER. SCALE 1"=10'-0"



HOR. SCALE 1"=100'-0"

(SHEET 1 OF 3)

CLIENT

PUNJAB RURAL MUNICIPAL SERVICES COMPANY (PRMSC)

CONSULTANT

NATIONAL ENGINEERING SERVICES PAKISTAN (PVT.) LTD.

HEAD OFFICE:- NESPAK HOUSE, I-C, BLOCK-N, MODEL TOWN EXTENSION, LAHORE, PAKISTAN.

REV.	DATE	DESCRIPTION	APPROVED
04			
03			
02			
01			

DRAWN	WALEED
SUBMITTED	
RECOMMENDED	
CHD./VER.	
APPROVED	

PROJECT

ENGINEERING DESIGN & CONSTRUCTION SUPERVISION CLUSTER (NORTH)
PUNJAB RURAL SUSTAINABLE WATER SUPPLY & SANITATION PROJECT

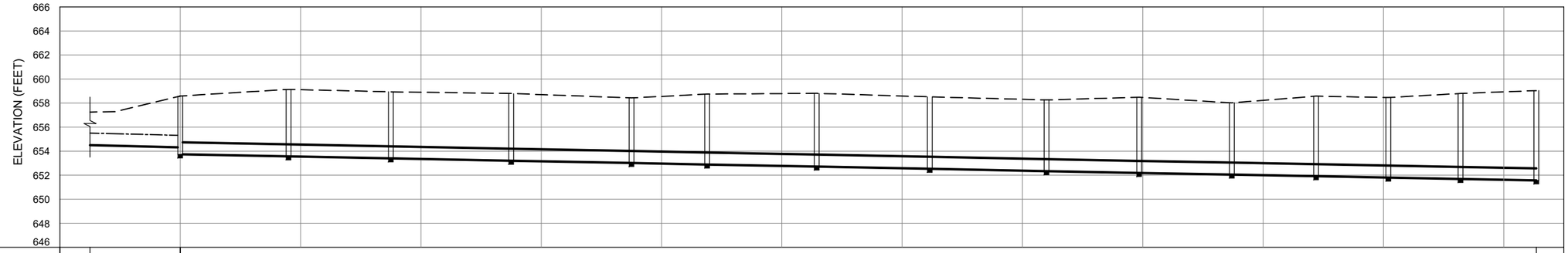
WAN MIANA
DRAIN PROFILE (D-1)

SCALE: 1" = 100'

DATE: DECEMBER, 2025

DRAWING No.: **4979/11/DD/2J141**

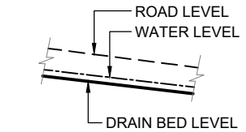
REV.: 0

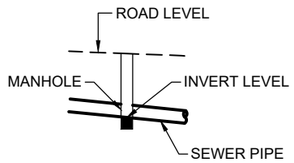


DATUM																
DRAIN SIZES & PIPE DIAMETER (INCHES)	(15" x 12")	Ø12"														
SLOPE	0.002565	0.001933														
ROAD LEVEL (FEET)	658.59	659.14	658.94	658.8	658.43	658.75	658.81	658.52	658.26	658.49	658.02	658.58	658.46	658.8	659.04	
DRAIN WATER LEVEL (FEET)	655.31															
PIPE LEVEL (FEET)	654.31 653.73	653.56	653.4	653.2	653.01	652.89	652.71	652.53	652.34	652.19	652.05	651.91	651.8	651.68	651.56	
CHAINAGE (FEET)	1+500	1+590	1+675	1+775	1+875	1+938	2+029	2+123	2+220	2+297	2+374	2+444	2+504	2+564	2+627	
MANHOLE NO.	MH-1	MH-2	MH-3	MH-4	MH-5	MH-6	MH-7	MH-8	MH-9	MH-10	MH-11	MH-12	MH-13	MH-14	DISPOSAL STATION	

PROFILE (L-1)

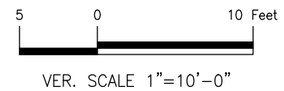
LEGEND:-





NOTES:-

1. ALL LEVELS ARE IN FEET UNLESS OTHERWISE SPECIFIED.
2. ALL PIPE DIAMETERS ARE IN INCHES UNLESS OTHERWISE SPECIFIED.
3. READ THIS DRAWING IN CONJUNCTION WITH ALL RELEVANT DRAWINGS.
4. FOR LAYOUT PLAN, REFER TO RELEVANT DRAWINGS.
5. FOR REINFORCEMENT DETAIL AND CLASS OF PIPES REFER TO RELEVANT DRAWING.
6. THE PIPE SHALL BE MANUFACTURED AS PER SPECIFICATIONS.
7. THE CONTRACTOR SHALL ARRANGE FOR ALL REQUIRED PERMITS BEFORE THE EXECUTION OF THE WORKS.
8. THE CONTRACTOR SHALL SET OUT THE ALIGNMENT FOR SEWER LINE AND OTHER RELATED STRUCTURES AS PER SITE CONDITIONS AND OBTAIN APPROVAL OF THE ENGINEER PRIOR TO COMMENCING EXCAVATION.
9. NUMBERS & LOCATIONS OF MANHOLES SHOWN ON DRAWINGS SHALL BE FINALIZED AT SITE AS PER EXISTING SITE CONDITIONS.
10. BEFORE EXECUTION OF WORK, CONTRACTOR SHALL CHECK/VERIFY THE RL/IL OF ALL BRANCH SEWER/LATERALS TO ENSURE THAT THEY WILL BE TRAPPED IN THE PROPOSED TRUNK SEWER WITH MINIMUM SLOPE REQUIREMENT AS PER EXISTING SITE CONDITIONS.
11. AS BUILT DRAWINGS SHALL BE PREPARED/SUBMITTED BY THE CONTRACTOR AFTER COMPLETION OF THE WORK.



(SHEET 2 OF 3)

CLIENT

PUNJAB RURAL MUNICIPAL SERVICES COMPANY (PRMSC)

CONSULTANT

NATIONAL ENGINEERING SERVICES PAKISTAN (PVT.) LTD.

HEAD OFFICE:- NESPAK HOUSE, I-C, BLOCK-N, MODEL TOWN EXTENSION, LAHORE, PAKISTAN.

REV.	DATE	DESCRIPTION	APPROVED
04			
03			
02			
01			

DRAWN	WALEED
SUBMITTED	
RECOMMENDED	
CHD./VER.	
APPROVED	

PROJECT

ENGINEERING DESIGN & CONSTRUCTION SUPERVISION CLUSTER (NORTH)
PUNJAB RURAL SUSTAINABLE WATER SUPPLY & SANITATION PROJECT

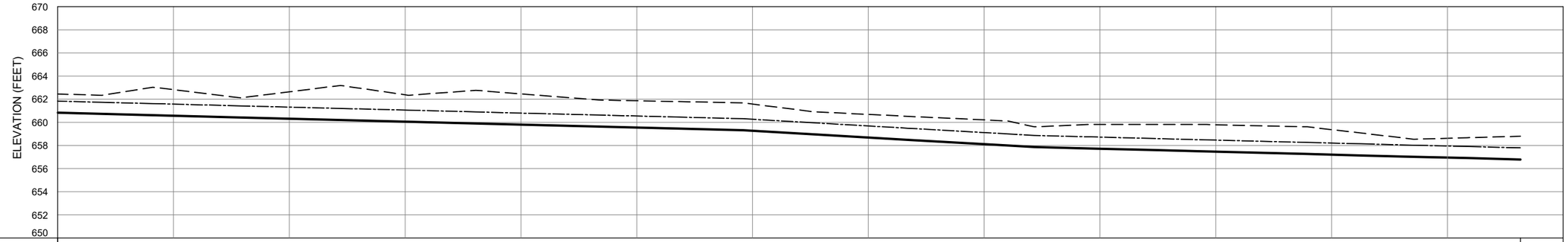
WAN MIANA
SEWER PROFILE (L-1)

SCALE: 1" = 100'

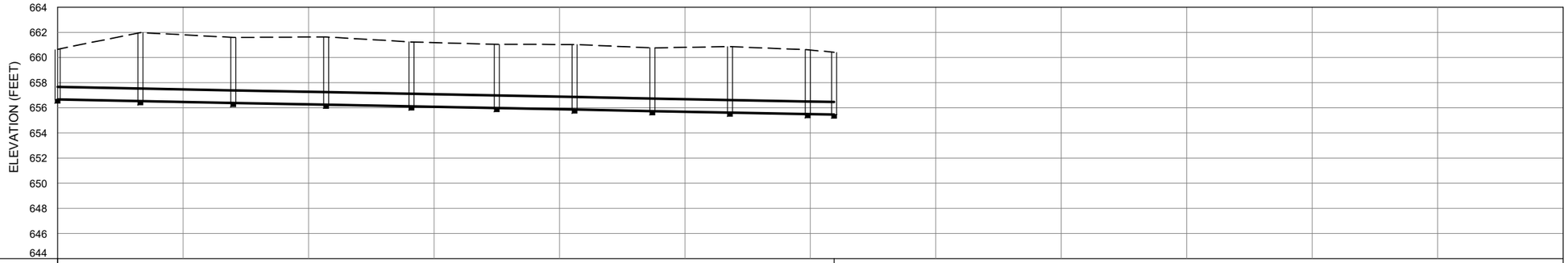
DATE: DECEMBER, 2025

DRAWING No.: **4979/11/DD/2J141**

REV.: 0


ELEVATION (FEET)
670
668
666
664
662
660
658
656
654
652
650
DATUM

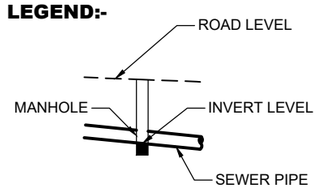
| | | |



DATUM											
DIAMETER (INCHES)	Ø12"										
SLOPE	0.001933										
ROAD LEVEL (FEET)	660.66	661.99	661.6	661.64	661.24	661.05	661.04	660.77	660.87	660.62	660.42
INVERT LEVEL (FEET)	656.66	656.53	656.39	656.25	656.11	655.98	655.86	655.74	655.62	655.50	655.46
CHAINAGE (FEET)	0+000	0+066	0+140	0+214	0+282	0+350	0+412	0+474	0+536	0+598	0+619
MANHOLE NO.	MH-1	MH-2	MH-3	MH-4	MH-5	MH-6	MH-7	MH-8	MH-9	MH-10	SEPTIC TANK

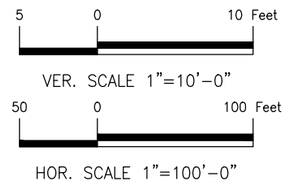
PROFILE (L-1)

LEGEND:-



NOTES:-

1. ALL LEVELS ARE IN FEET UNLESS OTHERWISE SPECIFIED.
2. ALL PIPE DIAMETERS ARE IN INCHES UNLESS OTHERWISE SPECIFIED.
3. READ THIS DRAWING IN CONJUNCTION WITH ALL RELEVANT DRAWINGS.
4. FOR LAYOUT PLAN, REFER TO RELEVANT DRAWINGS.
5. FOR REINFORCEMENT DETAIL AND CLASS OF PIPES REFER TO RELEVANT DRAWING.
6. THE PIPE SHALL BE MANUFACTURED AS PER SPECIFICATIONS.
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11. AS BUILT DRAWINGS SHALL BE PREPARED/SUBMITTED BY THE CONTRACTOR AFTER COMPLETION OF THE WORK.



(SHEET 1 OF 1)

CLIENT

PUNJAB RURAL MUNICIPAL SERVICES COMPANY (PRMSC)

CONSULTANT

NATIONAL ENGINEERING SERVICES PAKISTAN (PVT.) LTD.

HEAD OFFICE:- NESPAK HOUSE, I-C, BLOCK-N, MODEL TOWN EXTENSION, LAHORE, PAKISTAN.

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04			
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DRAWN	WALEED
SUBMITTED	
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CHD./VER.	
APPROVED	

PROJECT

ENGINEERING DESIGN & CONSTRUCTION SUPERVISION CLUSTER (NORTH)
PUNJAB RURAL SUSTAINABLE WATER SUPPLY & SANITATION PROJECT

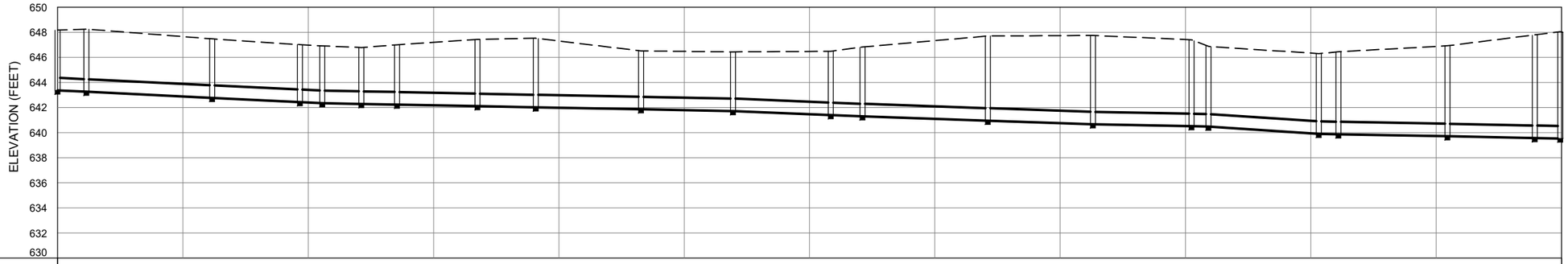
WAH MIANA COLONY SEWER PROFILE (L-1)

SCALE: 1" = 100'

DATE: DECEMBER, 2025

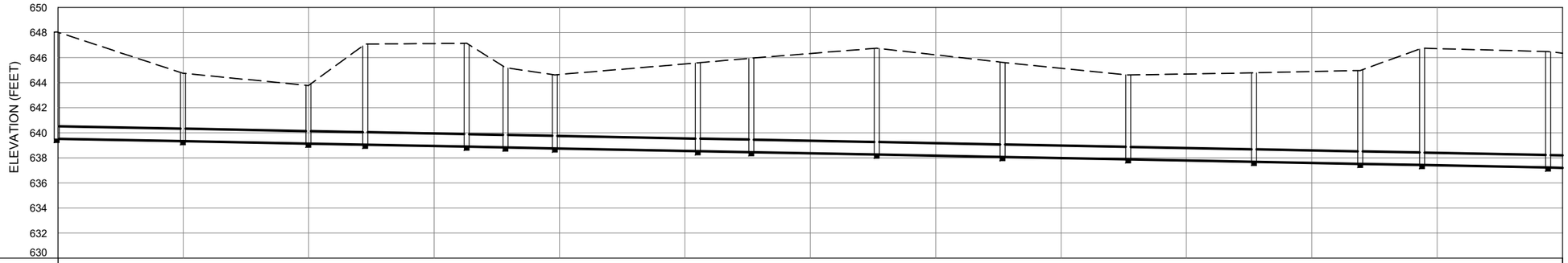
DRAWING No.: **4979/11/DD/2J142**

REV.: 0



DATUM																						
DIAMETER (INCHES)	Ø12"																					
SLOPE	0.004799					0.001933								0.004101		0.003442			0.001933		0.00659	0.001933		
ROAD LEVEL (FEET)	648.18	648.26	647.48	647.02	646.92	646.79	647.01	647.44	647.53	646.52	646.44	646.49	646.83	647.71	647.75	647.41	646.88	646.3	646.45	646.93	647.8	648.06
INVERT LEVEL (FEET)	643.37	643.26	642.77	642.44	642.35	642.29	642.24	642.11	642.02	641.86	641.72	641.4	641.3	640.95	640.66	640.51	640.48	639.9	639.87	639.71	639.57	639.53
CHAINAGE (FEET)	0.0	23.0	123.4	193.4	211.2	242.4	270.8	335.0	381.6	465.6	539.0	617.0	642.3	742.3	826.1	904.8	918.4	1006.4	1022.1	1109.1	1178.8	1199.1
MANHOLE NO.	MH-1	MH-2	MH-3	MH-4	MH-5	MH-6	MH-7	MH-8	MH-9	MH-10	MH-11	MH-12	MH-13	MH-14	MH-15	MH-16	MH-17	MH-18	MH-19	MH-20	MH-21	MH-22

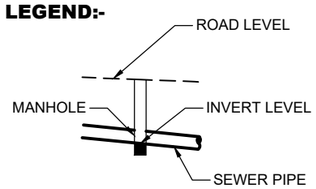
PROFILE (L-1)



DATUM																						
DIAMETER (INCHES)	Ø12"																					
SLOPE	0.001933																					
ROAD LEVEL (FEET)	648.06	644.76	643.78	647.09	647.15	645.2	644.63	645.59	645.96	646.76	645.63	644.62	644.79	644.98	646.76	646.49						
INVERT LEVEL (FEET)	639.53	639.34	639.14	639.06	638.9	638.84	638.76	638.54	638.46	638.27	638.07	637.88	637.69	637.52	637.43	637.23						
CHAINAGE (FEET)	1199.1	1299.8	1399.8	1445.2	1525.9	1557.0	1596.4	1710.4	1753.0	1853.0	1953.4	2053.6	2153.9	2238.6	2287.9	2388.5						
MANHOLE NO.	MH-22	MH-23	MH-24	MH-25	MH-26	MH-27	MH-28	MH-29	MH-30	MH-31	MH-32	MH-33	MH-34	MH-35	MH-36	MH-37						

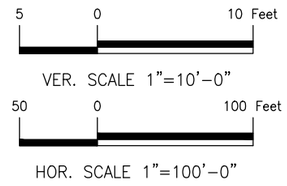
PROFILE (L-1)

LEGEND:-



NOTES:-

1. ALL LEVELS ARE IN FEET UNLESS OTHERWISE SPECIFIED.
2. ALL PIPE DIAMETERS ARE IN INCHES UNLESS OTHERWISE SPECIFIED.
3. READ THIS DRAWING IN CONJUNCTION WITH ALL RELEVANT DRAWINGS.
4. FOR LAYOUT PLAN, REFER TO RELEVANT DRAWINGS.
5. FOR REINFORCEMENT DETAIL AND CLASS OF PIPES REFER TO RELEVANT DRAWING.
6. THE PIPE SHALL BE MANUFACTURED AS PER SPECIFICATIONS.
7. THE CONTRACTOR SHALL ARRANGE FOR ALL REQUIRED PERMITS BEFORE THE EXECUTION OF THE WORKS.
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11. AS BUILT DRAWINGS SHALL BE PREPARED/SUBMITTED BY THE CONTRACTOR AFTER COMPLETION OF THE WORK.



(SHEET 1 OF 2)

CLIENT

PUNJAB RURAL MUNICIPAL SERVICES COMPANY (PRMSC)

CONSULTANT

NATIONAL ENGINEERING SERVICES PAKISTAN (PVT.) LTD.

HEAD OFFICE:- NESPAK HOUSE, I-C, BLOCK-N, MODEL TOWN EXTENSION, LAHORE, PAKISTAN.

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04			
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02			
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DRAWN	WALEED
SUBMITTED	
RECOMMENDED	
CHD./VER.	
APPROVED	

PROJECT

ENGINEERING DESIGN & CONSTRUCTION SUPERVISION CLUSTER (NORTH)
PUNJAB RURAL SUSTAINABLE WATER SUPPLY & SANITATION PROJECT

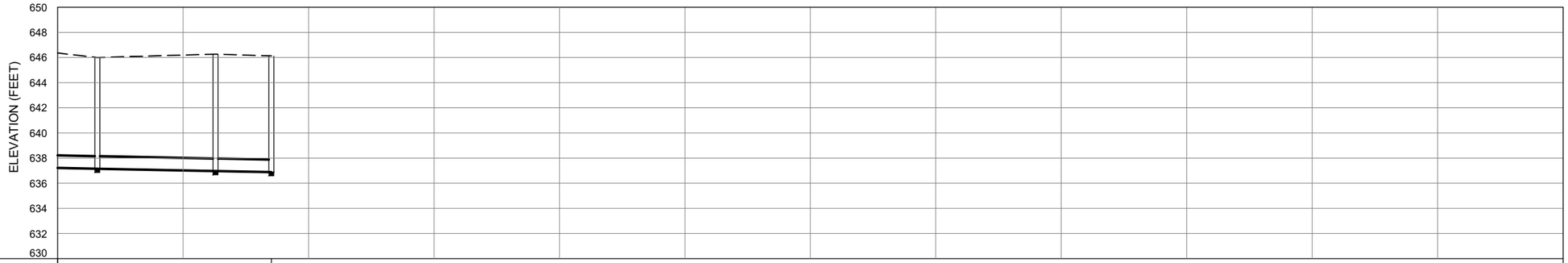
RAHIMPUR SEWER PROFILE (L-1)

SCALE: 1" = 100'

DATE: DECEMBER, 2025

DRAWING No.: **4979/11/DD/2J135**

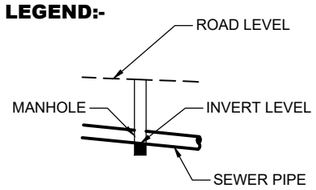
REV.: 0



DIAMETER (INCHES)	Ø12"		
SLOPE	0.001933		
ROAD LEVEL (FEET)	646.01	646.27	646.13
INVERT LEVEL (FEET)	637.15	636.97	636.88
CHAINAGE (FEET)	2431.6	2525.8	2570.3
MANHOLE NO.	MH-38	MH-39	O-6

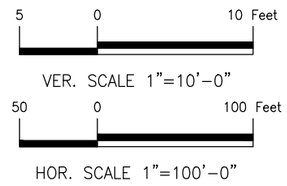
PROFILE (L-1)

LEGEND:-



NOTES:-

1. ALL LEVELS ARE IN FEET UNLESS OTHERWISE SPECIFIED.
2. ALL PIPE DIAMETERS ARE IN INCHES UNLESS OTHERWISE SPECIFIED.
3. READ THIS DRAWING IN CONJUNCTION WITH ALL RELEVANT DRAWINGS.
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6. THE PIPE SHALL BE MANUFACTURED AS PER SPECIFICATIONS.
7. THE CONTRACTOR SHALL ARRANGE FOR ALL REQUIRED PERMITS BEFORE THE EXECUTION OF THE WORKS.
8. THE CONTRACTOR SHALL SET OUT THE ALIGNMENT FOR SEWER LINE AND OTHER RELATED STRUCTURES AS PER SITE CONDITIONS AND OBTAIN APPROVAL OF THE ENGINEER PRIOR TO COMMENCING EXCAVATION.
9. NUMBERS & LOCATIONS OF MANHOLES SHOWN ON DRAWINGS SHALL BE FINALIZED AT SITE AS PER EXISTING SITE CONDITIONS.
10. BEFORE EXECUTION OF WORK, CONTRACTOR SHALL CHECK/VERIFY THE RL/IL OF ALL BRANCH SEWER/LATERALS TO ENSURE THAT THEY WILL BE TRAPPED IN THE PROPOSED TRUNK SEWER WITH MINIMUM SLOPE REQUIREMENT AS PER EXISTING SITE CONDITIONS.
11. AS BUILT DRAWINGS SHALL BE PREPARED/SUBMITTED BY THE CONTRACTOR AFTER COMPLETION OF THE WORK.



(SHEET 2 OF 2)

CLIENT

PUNJAB RURAL MUNICIPAL SERVICES COMPANY (PRMSC)

CONSULTANT

NATIONAL ENGINEERING SERVICES PAKISTAN (PVT.) LTD.

HEAD OFFICE:- NESPAK HOUSE, I-C, BLOCK-N, MODEL TOWN EXTENSION, LAHORE, PAKISTAN.

REV.	DATE	DESCRIPTION	APPROVED
04			
03			
02			
01			

DRAWN	WALEED
SUBMITTED	
RECOMMENDED	
CHD./VER.	
APPROVED	

PROJECT

ENGINEERING DESIGN & CONSTRUCTION SUPERVISION CLUSTER (NORTH)
PUNJAB RURAL SUSTAINABLE WATER SUPPLY & SANITATION PROJECT

RAHIMPUR
SEWER PROFILE (L-1)

SCALE: 1" = 100'

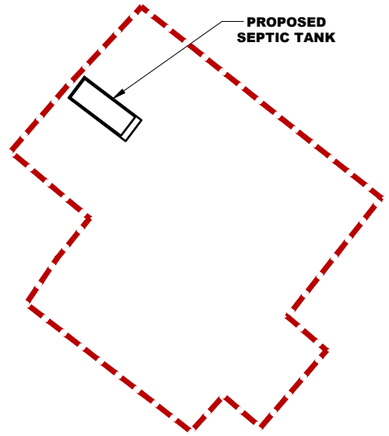
DATE: DECEMBER, 2025

DRAWING No.: **4979/11/DD/2J135**

REV.: 0



WAN MIANA COLONY
(TEHSIL: KOT MOMIN)



KEY PLAN

LEGEND:

BOUNDARY OF PRINCIPLE SETTLEMENT

PROPOSED SEPTC TANK

CLIENT

PUNJAB RURAL MUNICIPAL SERVICES COMPANY (PRMSC)

CONSULTANT

NATIONAL ENGINEERING SERVICES PAKISTAN (PVT.) LTD.

HEAD OFFICE:- NESPAK HOUSE, I-C, BLOCK-N, MODEL TOWN EXTENSION, LAHORE, PAKISTAN.

REV.	DATE	DESCRIPTION	APPROVED
04			
03			
02			
01			

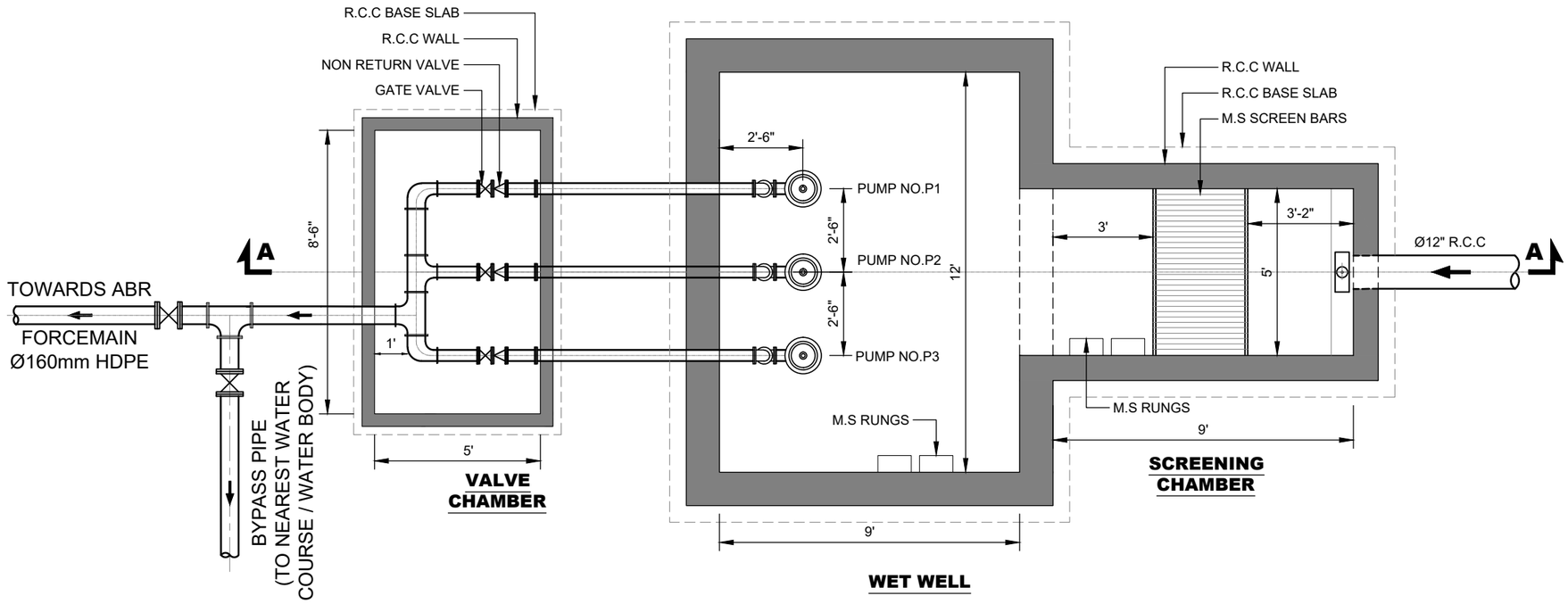
DRAWN	WALEED
SUBMITTED	
RECOMMENDED	
CHD./VER.	
APPROVED	

PROJECT

ENGINEERING DESIGN & CONSTRUCTION SUPERVISION CLUSTER (NORTH)
PUNJAB RURAL SUSTAINABLE WATER SUPPLY & SANITATION PROJECT

WAN MIANA COLONY
LOCATION PLAN OF SEPTIC TANK

DATE	DRAWING No.	SCALE	REV.
DECEMBER, 2025	**4979/11/DD/2J162**	1" = 50'	0



SCHEDULE OF PUMPS

PUMP	DISCHARGE (CUSEC)	HEAD (FEET)	STATUS
PUMP 1	0.30	30'-0"	WORKING
PUMP 2	0.30		WORKING
PUMP 3	0.30		STAND BY

NOTES

1. ALL DIMENSIONS ARE IN FEET AND PIPE DIAMETERS ARE IN INCHES UNLESS OTHER SPECIFIED.
2. THIS DRAWING SHALL BE READ IN CONJUNCTION WITH ALL OTHER RELEVANT DRAWINGS.

CLIENT
PUNJAB RURAL MUNICIPAL SERVICES COMPANY (PRMSC)

CONSULTANT
NATIONAL ENGINEERING SERVICES PAKISTAN (PVT.) LTD.
HEAD OFFICE:- NESPAK HOUSE, I-C, BLOCK-N, MODEL TOWN EXTENSION, LAHORE, PAKISTAN.

REV.	DATE	DESCRIPTION	APPROVED
04			
03			
02			
01			

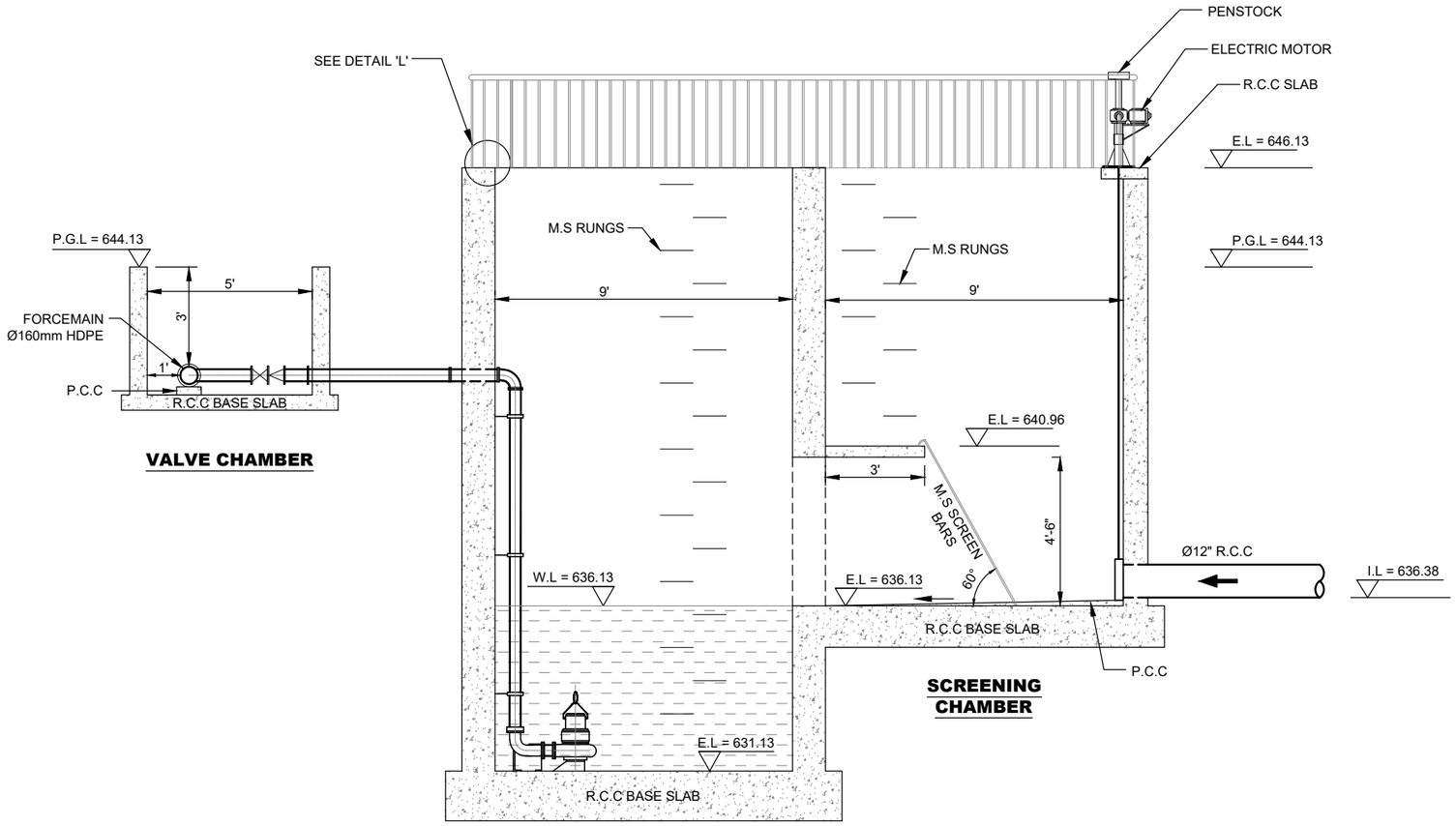
DRAWN	WALEED
SUBMITTED	
RECOMMENDED	
CHD./VER.	
APPROVED	

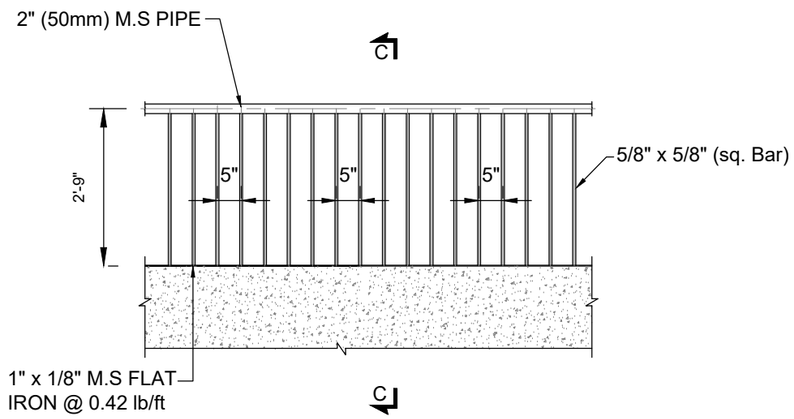
PROJECT
ENGINEERING DESIGN & CONSTRUCTION SUPERVISION CLUSTER (NORTH)
PUNJAB RURAL SUSTAINABLE WATER SUPPLY & SANITATION PROJECT

PUMPING STATION AT RAHIMPUR FUNCTIONAL DRAWING (PLAN)

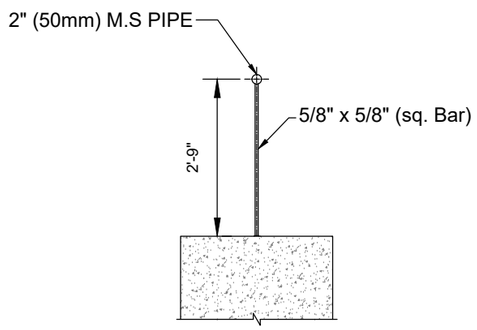
SCALE

DATE: DECEMBER, 2025
DRAWING No.: **4533/11/DD/2J163**
REV.: 0





DETAIL 'L'



SECTION C-C

NOTES

1. ALL DIMENSIONS ARE IN FEET AND PIPE DIAMETERS ARE IN INCHES UNLESS OTHER SPECIFIED.
2. THIS DRAWING SHALL BE READ IN CONJUNCTION WITH ALL OTHER RELEVANT DRAWINGS.

CLIENT

PUNJAB RURAL MUNICIPAL SERVICES COMPANY (PRMSC)

CONSULTANT

NATIONAL ENGINEERING SERVICES PAKISTAN (PVT.) LTD.

HEAD OFFICE:- NESPAK HOUSE, I-C, BLOCK-N, MODEL TOWN EXTENSION, LAHORE, PAKISTAN.

REV.	DATE	DESCRIPTION	APPROVED
04			
03			
02			
01			

DRAWN	WALEED
SUBMITTED	
RECOMMENDED	
CHD./VER.	
APPROVED	

PROJECT

ENGINEERING DESIGN & CONSTRUCTION SUPERVISION CLUSTER (NORTH)
PUNJAB RURAL SUSTAINABLE WATER SUPPLY & SANITATION PROJECT

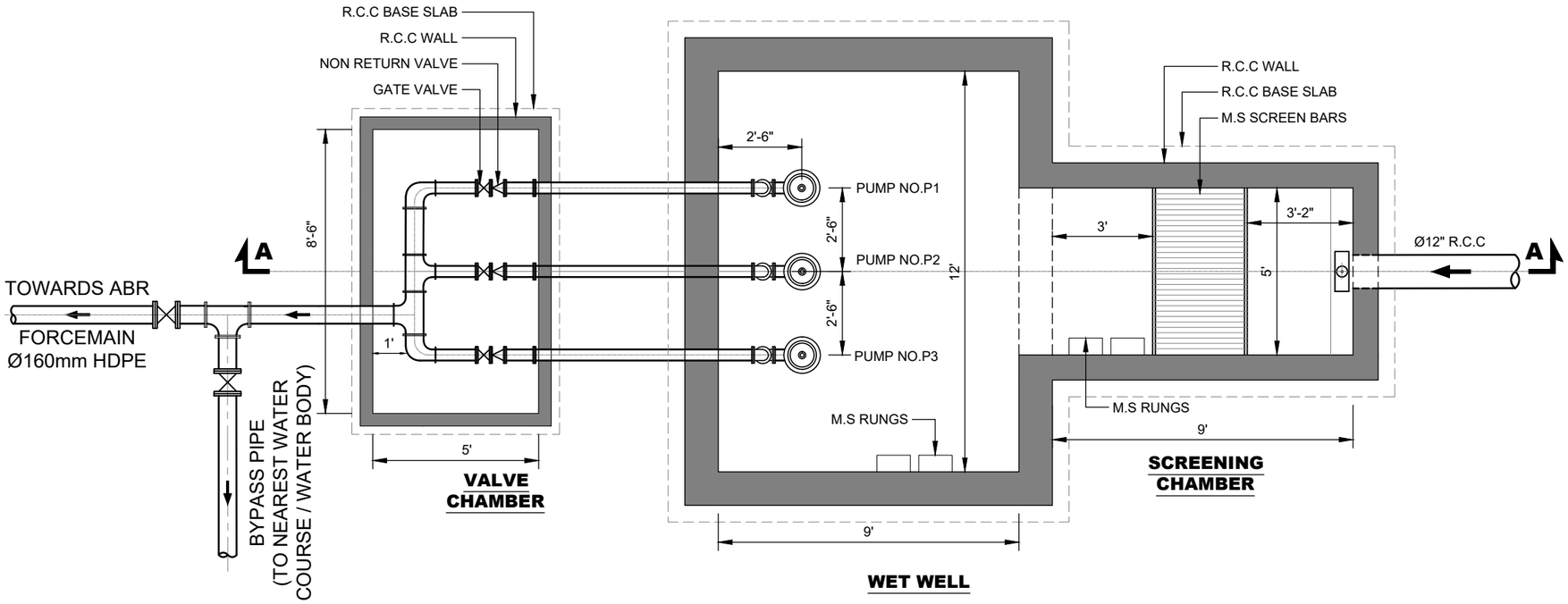
PUMPING STATION AT RAHIMPUR
FUNCTIONAL DRAWING (SECTION)

SCALE

DATE: DECEMBER, 2025

DRAWING No.: **4533/11/DD/2J164**

REV.: 0



SCHEDULE OF PUMPS

PUMP	DISCHARGE (CUSEC)	HEAD (FEET)	STATUS
PUMP 1	0.40	30	WORKING
PUMP 2	0.30		WORKING
PUMP 3	0.25		STAND BY

NOTES

1. ALL DIMENSIONS ARE IN FEET AND PIPE DIAMETERS ARE IN INCHES UNLESS OTHER SPECIFIED.
2. THIS DRAWING SHALL BE READ IN CONJUNCTION WITH ALL OTHER RELEVANT DRAWINGS.

CLIENT
PUNJAB RURAL MUNICIPAL SERVICES COMPANY (PRMSC)

CONSULTANT
NATIONAL ENGINEERING SERVICES PAKISTAN (PVT.) LTD.
HEAD OFFICE:- NESPAK HOUSE, I-C, BLOCK-N, MODEL TOWN EXTENSION, LAHORE, PAKISTAN.

REV.	DATE	DESCRIPTION	APPROVED
04			
03			
02			
01			

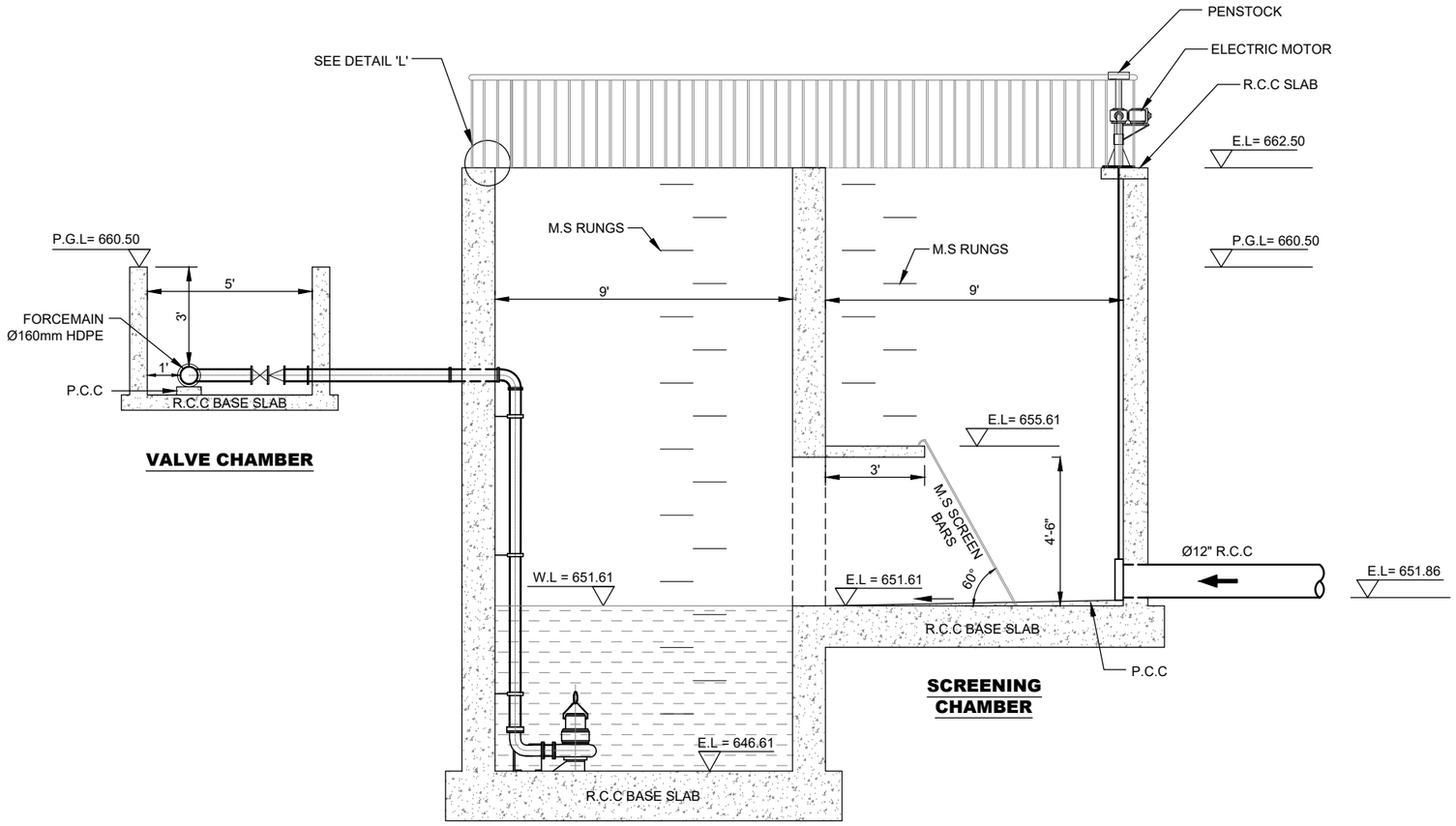
DRAWN	WALEED
SUBMITTED	
RECOMMENDED	
CHD./VER.	
APPROVED	

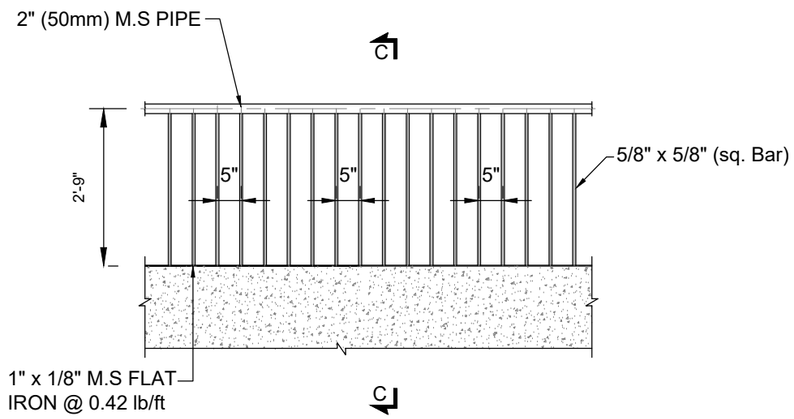
PROJECT
ENGINEERING DESIGN & CONSTRUCTION SUPERVISION CLUSTER (NORTH)
PUNJAB RURAL SUSTAINABLE WATER SUPPLY & SANITATION PROJECT

PUMPING STATION AT RAHIMPUR
FUNCTIONAL DRAWING (PLAN)

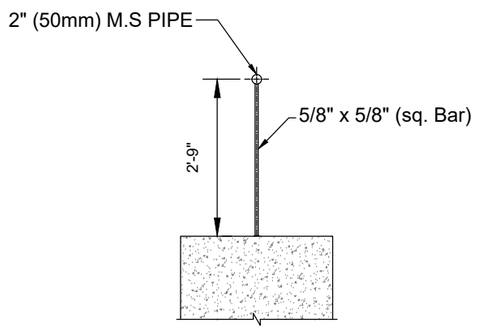
SCALE

DATE: DECEMBER, 2025
DRAWING No.: **4533/11/DD/2J165**
REV.: 0





DETAIL 'L'



SECTION C-C

NOTES

1. ALL DIMENSIONS ARE IN FEET AND PIPE DIAMETERS ARE IN INCHES UNLESS OTHER SPECIFIED.
2. THIS DRAWING SHALL BE READ IN CONJUNCTION WITH ALL OTHER RELEVANT DRAWINGS.

CLIENT

PUNJAB RURAL MUNICIPAL SERVICES COMPANY (PRMSC)

CONSULTANT

NATIONAL ENGINEERING SERVICES PAKISTAN (PVT.) LTD.

HEAD OFFICE:- NESPAK HOUSE, I-C, BLOCK-N, MODEL TOWN EXTENSION, LAHORE, PAKISTAN.

REV.	DATE	DESCRIPTION	APPROVED
04			
03			
02			
01			

DRAWN	WALEED
SUBMITTED	
RECOMMENDED	
CHD./VER.	
APPROVED	

PROJECT

ENGINEERING DESIGN & CONSTRUCTION SUPERVISION CLUSTER (NORTH)
PUNJAB RURAL SUSTAINABLE WATER SUPPLY & SANITATION PROJECT

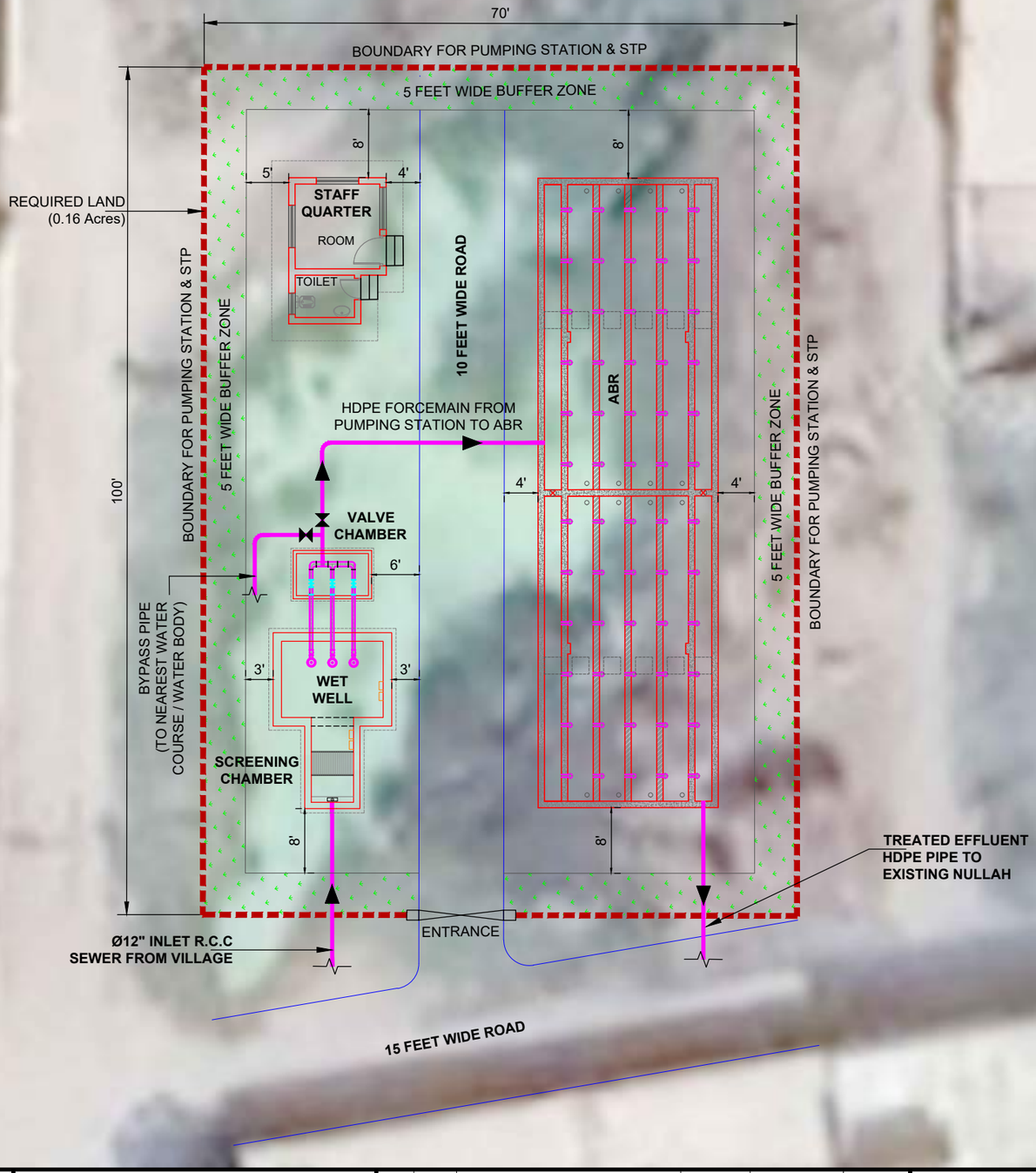
PUMPING STATION AT RAHIMPUR
FUNCTIONAL DRAWING (SECTION)

SCALE

DATE: DECEMBER, 2025

DRAWING No.: **4533/11/DD/2J166**

REV.: 0



MOUZA RAHIMPUR
(TEHSIL: KOT MOMIN)

16 8 0 16 feet
GRAPHIC SCALE

CLIENT
PUNJAB RURAL MUNICIPAL SERVICES COMPANY (PRMSC)

CONSULTANT
NATIONAL ENGINEERING SERVICES PAKISTAN (PVT.) LTD.
HEAD OFFICE:- NESPAK HOUSE, I-C, BLOCK-N, MODEL TOWN EXTENSION, LAHORE, PAKISTAN.

REV.	DATE	DESCRIPTION	APPROVED
04			
03			
02			
01			

DRAWN	WALEED
SUBMITTED	
RECOMMENDED	
CHD./VER.	
APPROVED	

PROJECT
ENGINEERING DESIGN & CONSTRUCTION SUPERVISION CLUSTER (NORTH)
PUNJAB RURAL SUSTAINABLE WATER SUPPLY & SANITATION PROJECT

MOUZA RAHIMPUR LAYOUT PLAN OF PROPOSED SEWERAGE TREATMENT PLANT

SCALE: 1" = 16'
DATE: DECEMBER, 2025
DRAWING No.: 4979/11/DD/167
REV.: 0



N

WAN MIANA
(TEHSIL: KOT MOMIN)

16 8 0 16 feet
GRAPHIC SCALE

CLIENT
PUNJAB RURAL MUNICIPAL SERVICES COMPANY (PRMSC)

CONSULTANT
NATIONAL ENGINEERING SERVICES PAKISTAN (PVT.) LTD.
HEAD OFFICE:- NESPAK HOUSE, I-C, BLOCK-N, MODEL TOWN EXTENSION, LAHORE, PAKISTAN.

REV.	DATE	DESCRIPTION	APPROVED
04			
03			
02			
01			

DRAWN	WALEED
SUBMITTED	
RECOMMENDED	
CHD./VER.	
APPROVED	

PROJECT
ENGINEERING DESIGN & CONSTRUCTION SUPERVISION CLUSTER (NORTH)
PUNJAB RURAL SUSTAINABLE WATER SUPPLY & SANITATION PROJECT

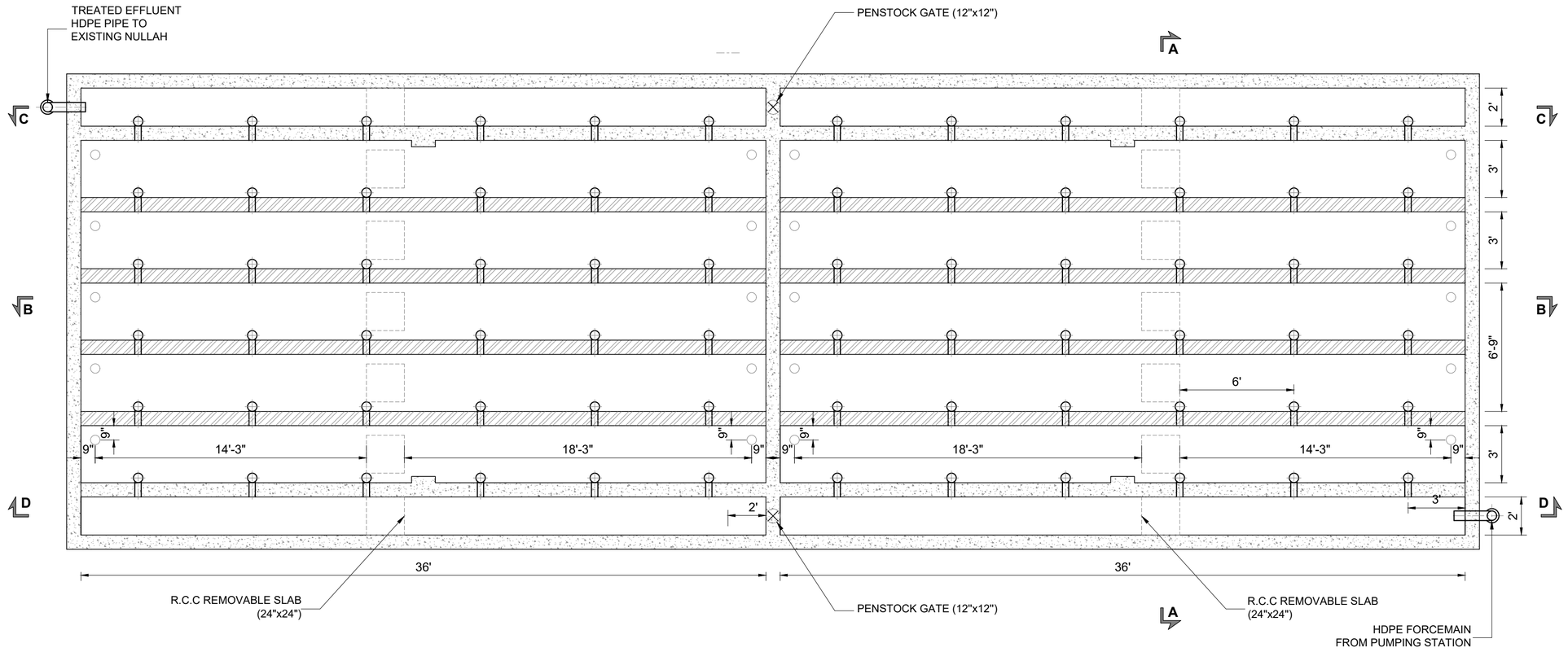
LAYOUT PLAN OF PROPOSED SEWERAGE TREATMENT PLANT (0.20 Cusec) AT WAN MIANA

SCALE: 1" = 16'

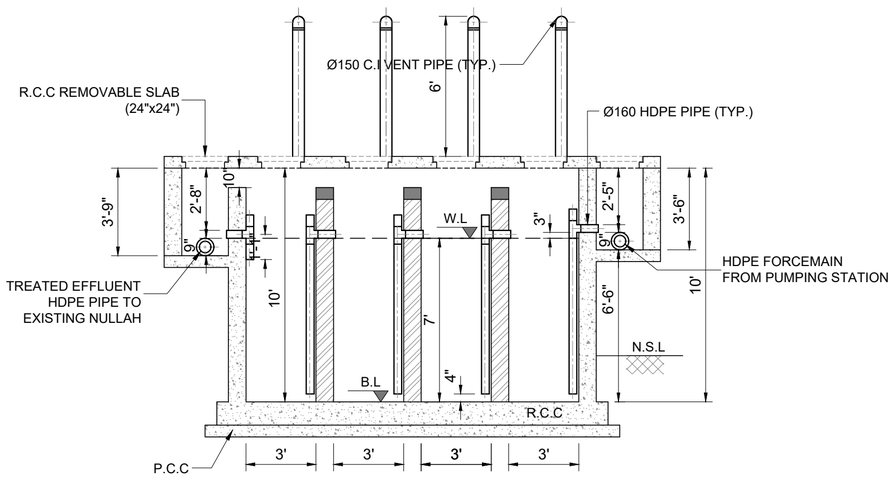
DATE: DECEMBER, 2025

DRAWING No.: **4979/11/DD/2J168**

REV.: 0



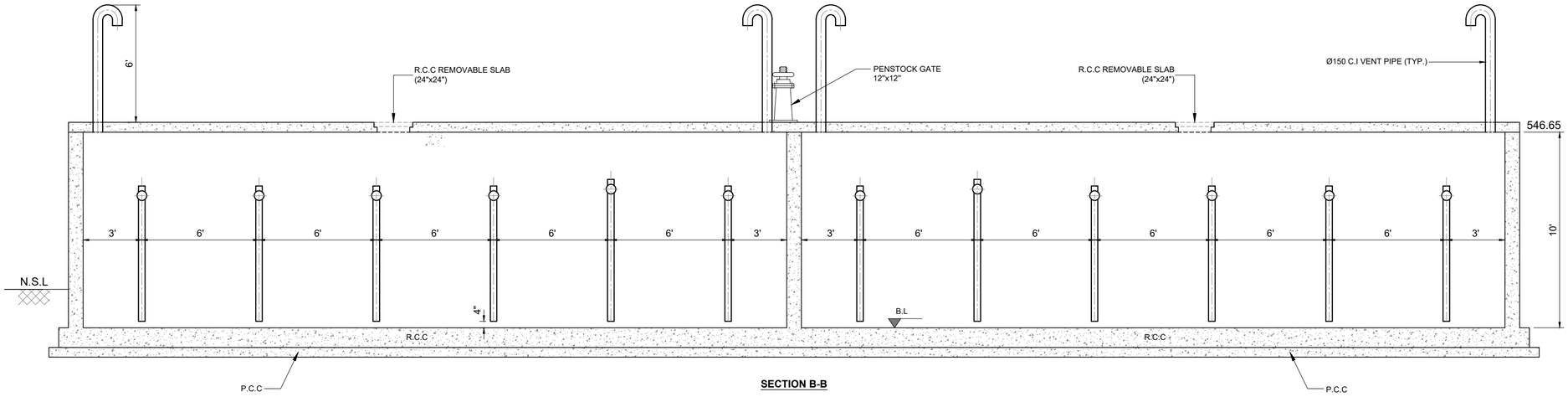
PLAN OF
ANAEROBIC BAFFLED REACTOR (ABR)



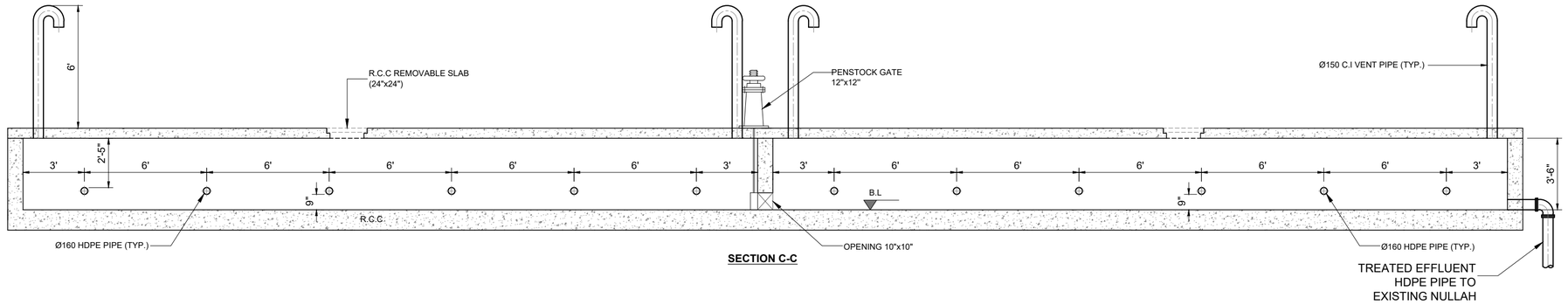
SECTION A-A

(SHEET 1 OF 2)

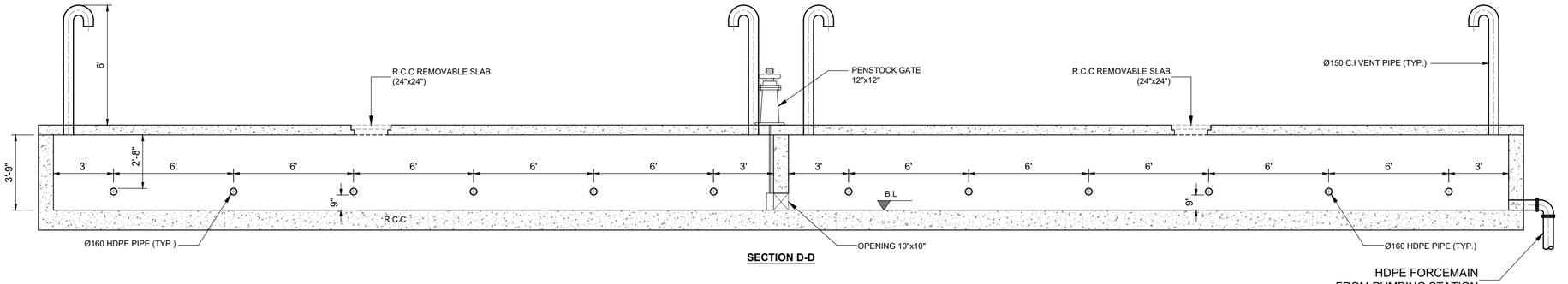
CLIENT: PUNJAB RURAL MUNICIPAL SERVICES COMPANY (PRMSC)	CONSULTANT: NATIONAL ENGINEERING SERVICES PAKISTAN (PVT.) LTD. HEAD OFFICE:- NESPAK HOUSE, I-C, BLOCK-N, MODEL TOWN EXTENSION, LAHORE, PAKISTAN.	04		DRAWN	NASEEM
		03		SUBMITTED	
		02		RECOMMENDED	
		01		CHD./VER.	
		REV. / DATE / DESCRIPTION	APPROVED	APPROVED	
PROJECT: ENGINEERING DESIGN & CONSTRUCTION SUPERVISION CLUSTER (NORTH) PUNJAB RURAL SUSTAINABLE WATER SUPPLY & SANITATION PROJECT	**ANAEROBIC BAFFLED REACTOR (ABR) PLAN AND SECTIONS (0.20 CUSECS) RAHIMPUR**			SCALE: 1" = 80'	
	DATE: DECEMBER, 2025	DRAWING No.: **4979/11/DD/2J169**		REV.: 0	



SECTION B-B



SECTION C-C



SECTION D-D

CLIENT

PUNJAB RURAL MUNICIPAL SERVICES COMPANY (PRMSC)

CONSULTANT

NATIONAL ENGINEERING SERVICES PAKISTAN (PVT.) LTD.

HEAD OFFICE:- NESPAK HOUSE, I-C, BLOCK-N, MODEL TOWN EXTENSION, LAHORE, PAKISTAN.

REV.	DATE	DESCRIPTION	APPROVED
04			
03			
02			
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DRAWN	NASEEM
SUBMITTED	
RECOMMENDED	
CHD./VER.	
APPROVED	

PROJECT

ENGINEERING DESIGN & CONSTRUCTION SUPERVISION CLUSTER (NORTH)
PUNJAB RURAL SUSTAINABLE WATER SUPPLY & SANITATION PROJECT

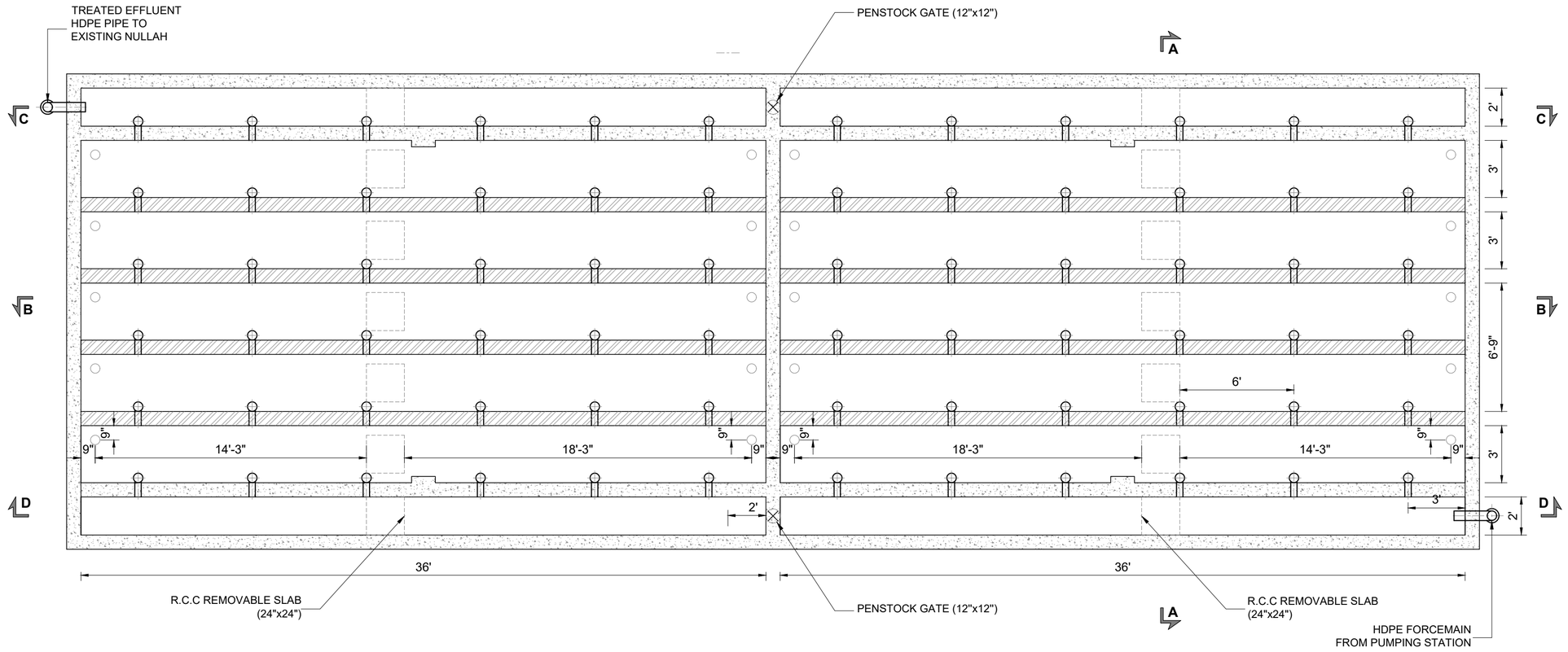
ANAEROBIC BAFFLED REACTOR (ABR) SECTIONS (0.20 CUSECS) RAHIMPUR

SCALE: 1" = 80'

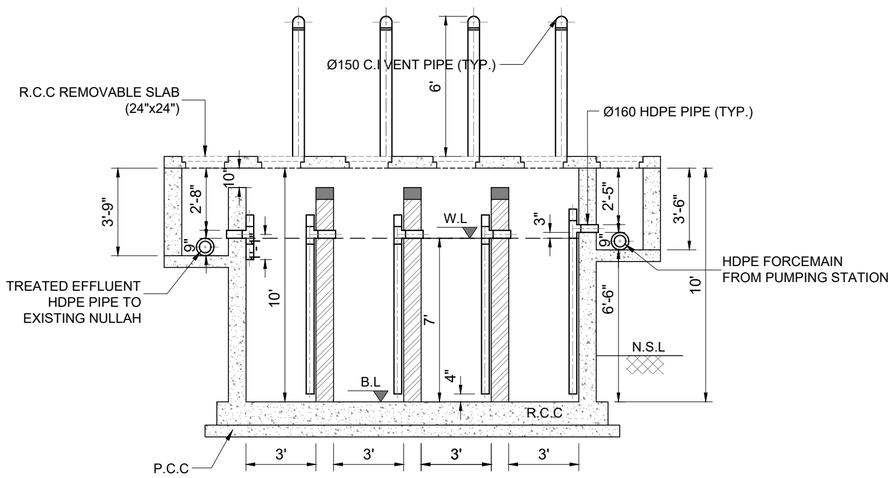
DATE: DECEMBER, 2025

DRAWING No.: **4979/11/DD/2J169**

REV.: 0



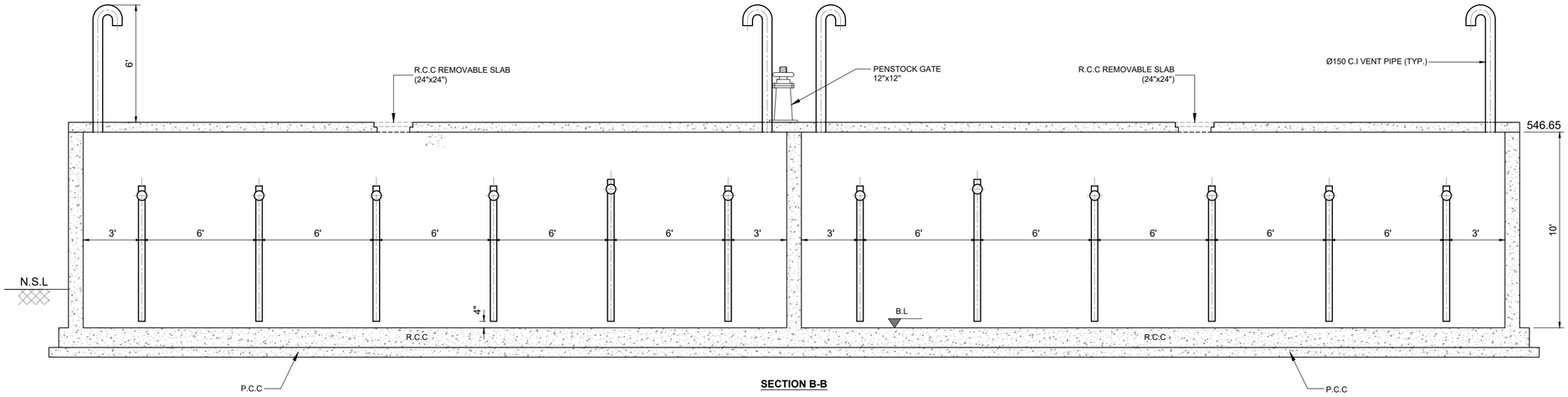
PLAN OF
ANAEROBIC BAFFLED REACTOR (ABR)



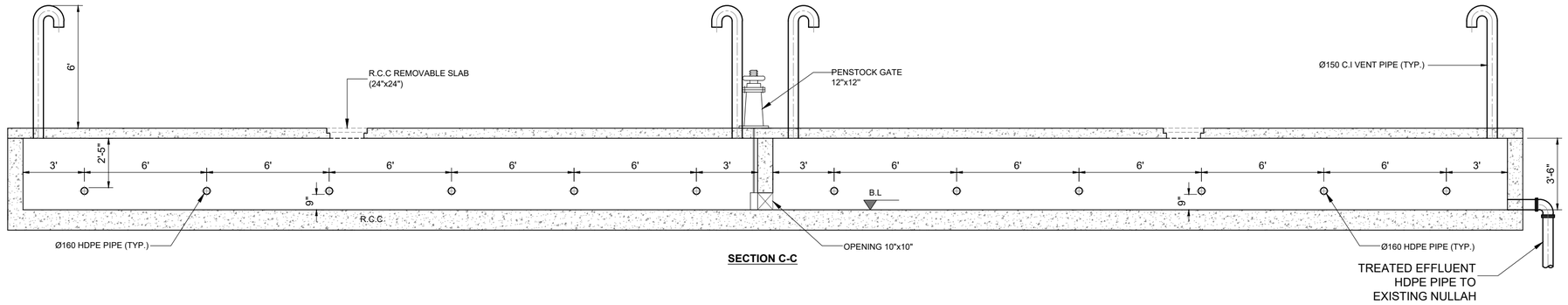
SECTION A-A

(SHEET 1 OF 2)

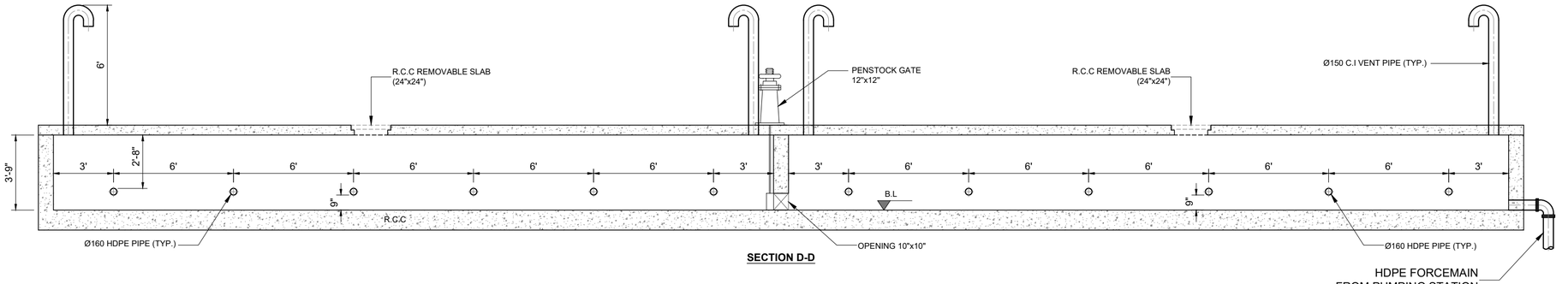
CLIENT: PUNJAB RURAL MUNICIPAL SERVICES COMPANY (PRMSC)	CONSULTANT: NATIONAL ENGINEERING SERVICES PAKISTAN (PVT.) LTD. HEAD OFFICE:- NESPAK HOUSE, I-C, BLOCK-N, MODEL TOWN EXTENSION, LAHORE, PAKISTAN.	04		DRAWN	NASEEM
		03		SUBMITTED	
		02		RECOMMENDED	
		01		CHD./VER.	
		REV. / DATE / DESCRIPTION	APPROVED	APPROVED	
PROJECT: ENGINEERING DESIGN & CONSTRUCTION SUPERVISION CLUSTER (NORTH) PUNJAB RURAL SUSTAINABLE WATER SUPPLY & SANITATION PROJECT	**ANAEROBIC BAFFLED REACTOR (ABR) PLAN AND SECTIONS (0.20 CUSECS) WAN MIANA**			SCALE: 1" = 80'	
	DATE: DECEMBER, 2025	DRAWING No.: **4979/11/DD/2J170**		REV.: 0	



SECTION B-B



SECTION C-C



SECTION D-D

(SHEET 2 OF 2)

CLIENT

PUNJAB RURAL MUNICIPAL SERVICES COMPANY (PRMSC)

CONSULTANT

NATIONAL ENGINEERING SERVICES PAKISTAN (PVT.) LTD.

HEAD OFFICE:- NESPAK HOUSE, I-C, BLOCK-N, MODEL TOWN EXTENSION, LAHORE, PAKISTAN.

REV.	DATE	DESCRIPTION	APPROVED
04			
03			
02			
01			

DRAWN	NASEEM
SUBMITTED	
RECOMMENDED	
CHD./VER.	
APPROVED	

PROJECT

ENGINEERING DESIGN & CONSTRUCTION SUPERVISION CLUSTER (NORTH)
PUNJAB RURAL SUSTAINABLE WATER SUPPLY & SANITATION PROJECT

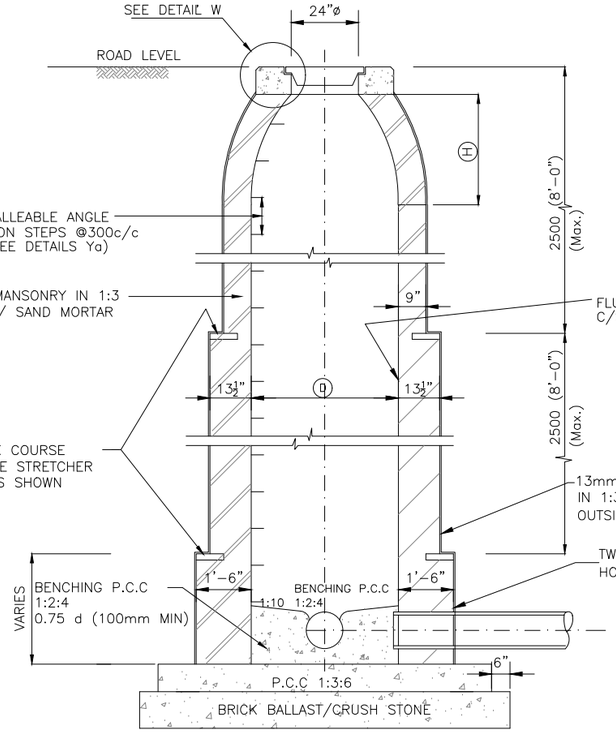
ANAEROBIC BAFFLED REACTOR (ABR) SECTIONS (0.20 CUSECS) WAN MIANA

SCALE: 1" = 80'

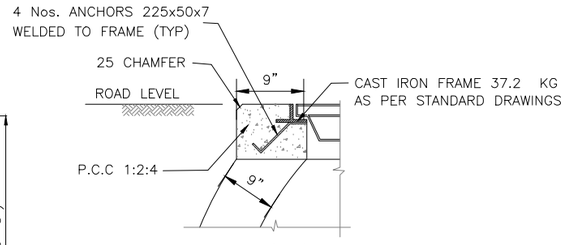
DATE: DECEMBER, 2025

DRAWING No.: **4979/11/DD/2J170**

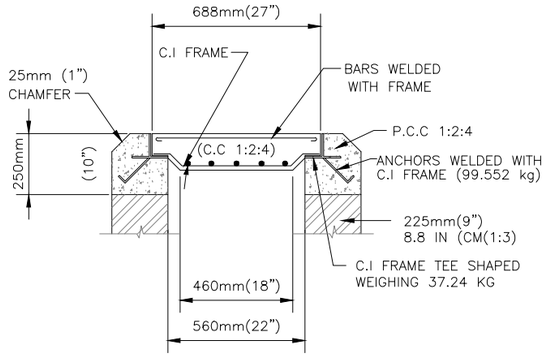
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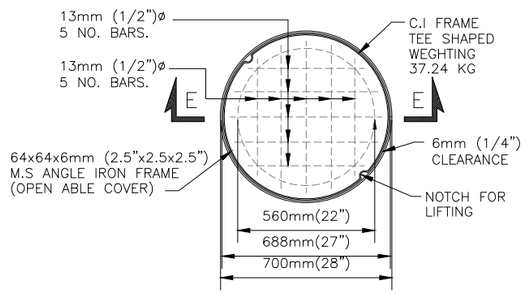
SECTION A–A



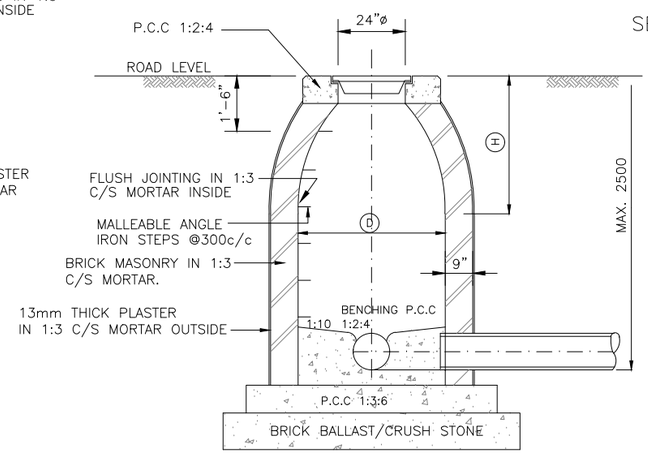
DETAIL–'W'
SCALE = 1:25



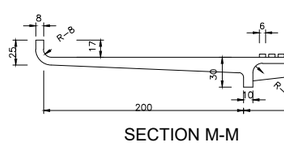
SECTION AT E–E



PLAN OF MANHOLE COVER
560mm (22") DIA
N.T.S.

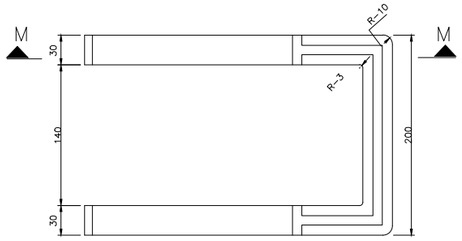


SECTION B–B

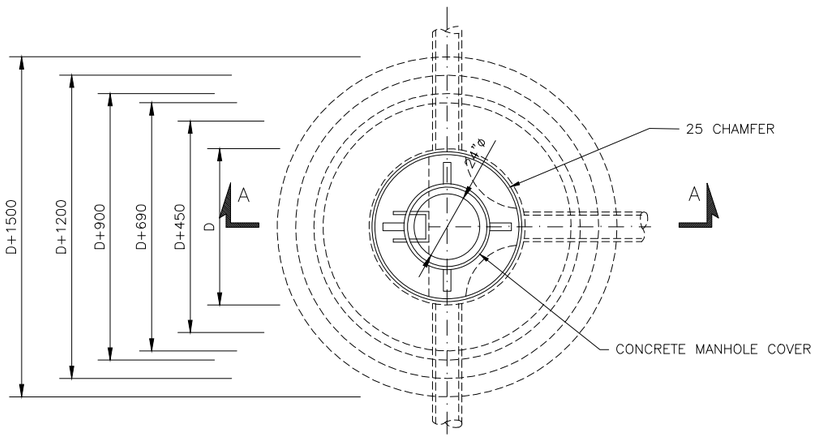


SECTION M-M

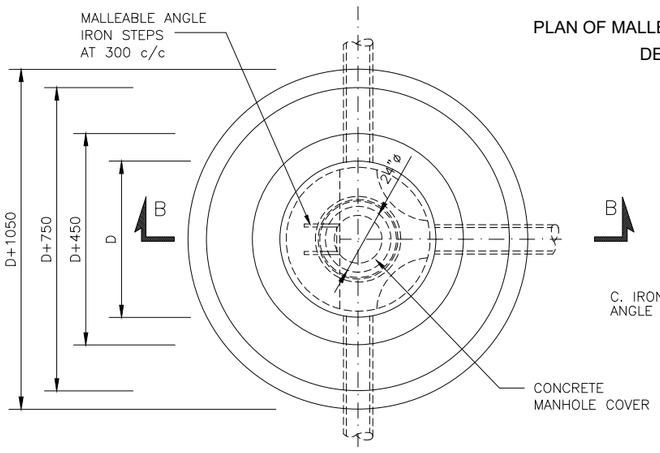
TABLE – 3			
SEHEDULE OF MANHOLE			
SR. NO.	PIPE DIA. (INCHES)	(D) (INCHES)	(H) (INCHES)
1	12"	4'–4"	3'–9"



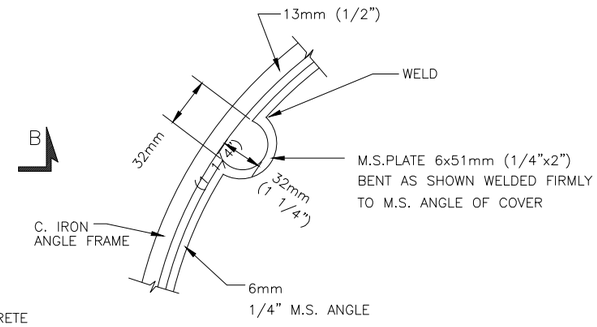
PLAN OF MALLEABLE ANGLE IRON STEP
DETAIL 'Ya'



SEWER MANHOLE PLAN
FOR DEPTH ≥ 2500 (8'–0")



SEWER MANHOLE PLAN
FOR DEPTH ≤ 2500 (8'–0")



DETAIL OF NOTCH
N.T.S.

NOTES

1. ALL DIMENSIONS ARE IN FEET AND PIPE DIAMETERS ARE IN INCHES UNLESS OTHER SPECIFIED.
2. THIS DRAWING SHALL BE READ IN CONJUNCTION WITH ALL OTHER RELEVANT DRAWINGS.
3. FOR EXECUTION REFER TO RELEVANT STRUCTURAL DRAWINGS.

CLIENT
PUNJAB RURAL MUNICIPAL SERVICES COMPANY (PRMSC)

CONSULTANT
NATIONAL ENGINEERING SERVICES PAKISTAN (PVT.) LTD.
HEAD OFFICE:- NESPAK HOUSE, I-C, BLOCK-N, MODEL TOWN EXTENSION, LAHORE, PAKISTAN.

REV.	DATE	DESCRIPTION	APPROVED	APPROVED	
04				DRAWN	NASEEM
03				SUBMITTED	
02				RECOMMENDED	
01				CHD./VER.	

PROJECT
ENGINEERING DESIGN & CONSTRUCTION SUPERVISION CLUSTER (NORTH)
PUNJAB RURAL SUSTAINABLE WATER SUPPLY & SANITATION PROJECT

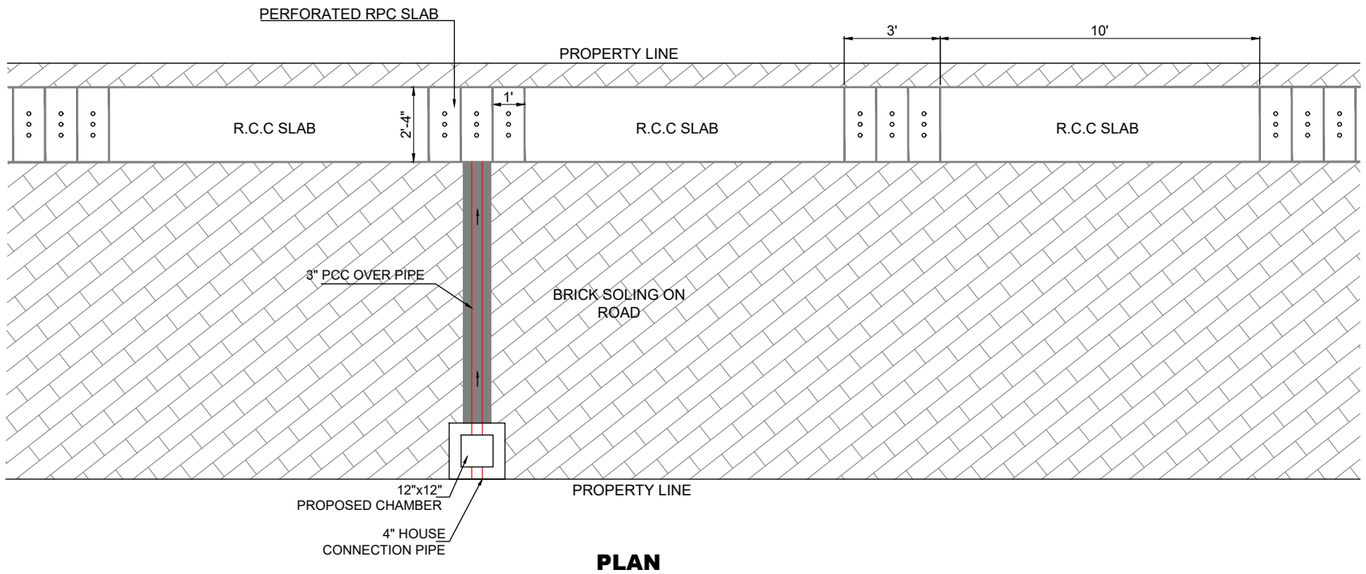
TYPICAL MANHOLE DETAILS

SCALE: N.T.S

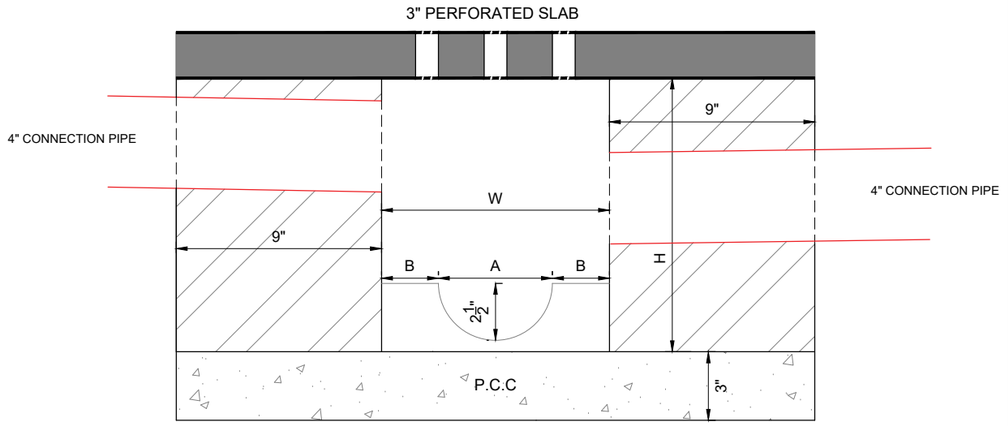
DATE: DECEMBER, 2025

DRAWING No.: 4979/11/DD/2J137

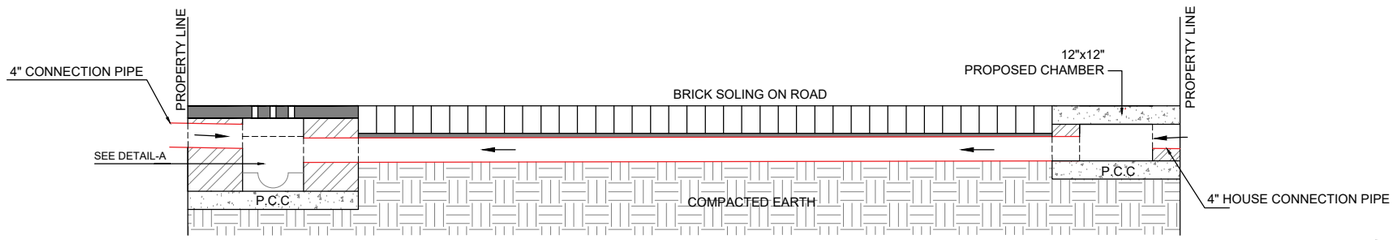
REV.: 0



PLAN



DETAIL-A



SECTION

[illegible]

NOTES

1. ALL DIMENSIONS ARE IN FEET AND PIPE DIAMETERS ARE IN INCHES UNLESS OTHER SPECIFIED.
2. THIS DRAWING SHALL BE READ IN CONJUNCTION WITH ALL OTHER RELEVANT DRAWINGS.
3. FOR EXECUTION REFER TO RELEVANT STRUCTURAL DRAWINGS.

CLIENT

PUNJAB RURAL MUNICIPAL SERVICES COMPANY (PRMSC)

CONSULTANT

NATIONAL ENGINEERING SERVICES PAKISTAN (PVT.) LTD.

HEAD OFFICE:- NESPAK HOUSE, I-C, BLOCK-N, MODEL TOWN EXTENSION, LAHORE, PAKISTAN.

REV.	DATE	DESCRIPTION	APPROVED
04			
03			
02			
01			

DRAWN	NASEEM
SUBMITTED	
RECOMMENDED	
CHD./VER.	
APPROVED	

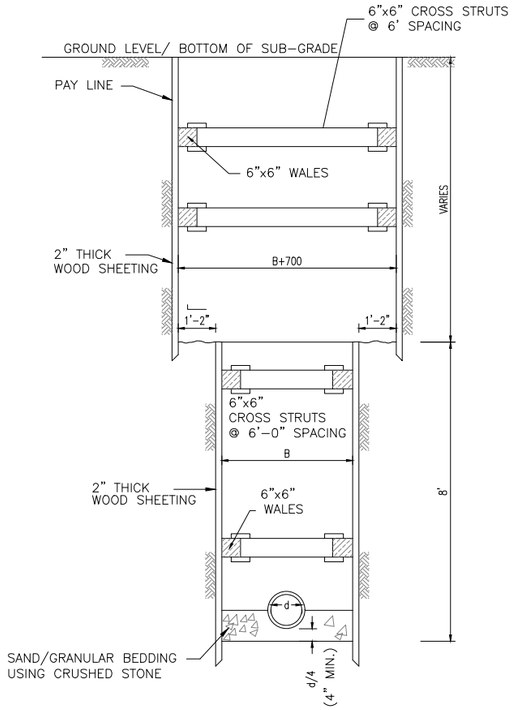
PROJECT

ENGINEERING DESIGN & CONSTRUCTION SUPERVISION CLUSTER (NORTH)
PUNJAB RURAL SUSTAINABLE WATER SUPPLY & SANITATION PROJECT

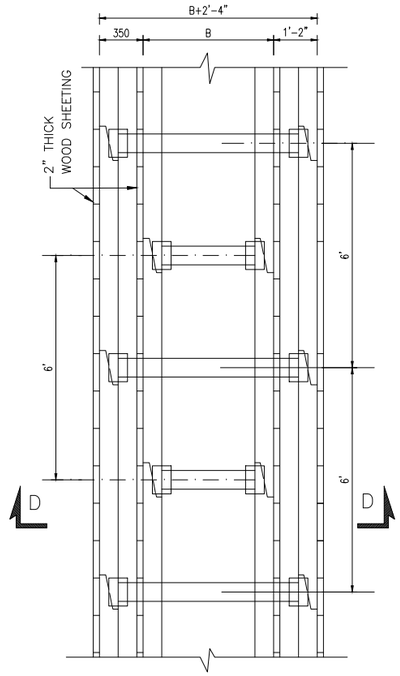
TYPICAL CROSS SECTION OF PROPOSED DRAIN

DATE	DRAWING No.	REV.
DECEMBER, 2025	**4979/11/DD/2J178**	0

SCALE



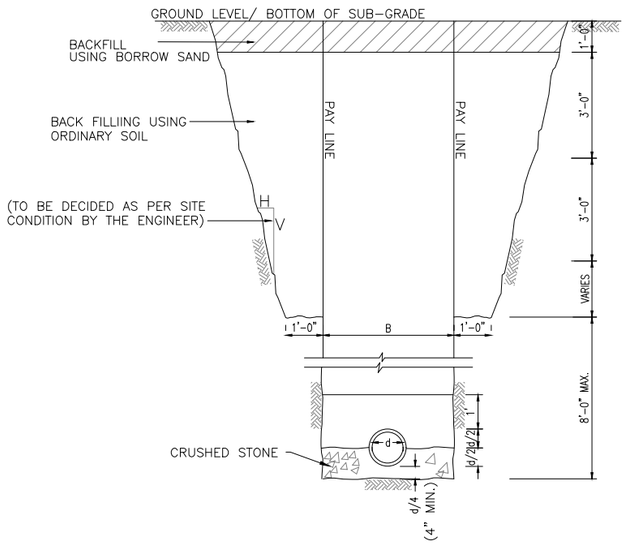
SECTION D-D



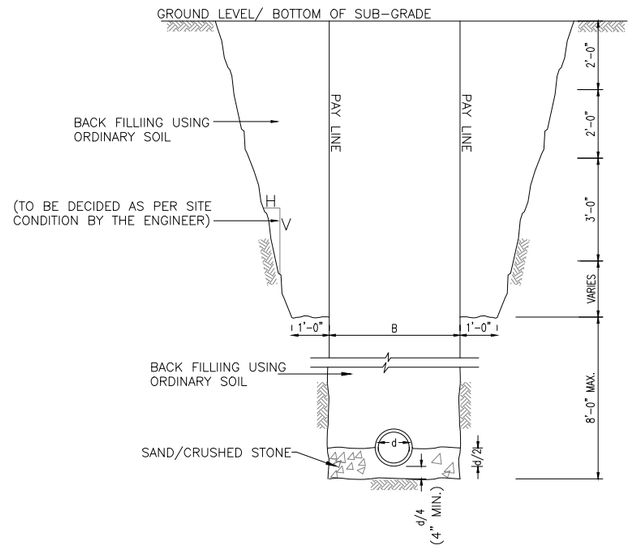
PLAN
TRENCH WITH TIMBERING AND BRACING

TABLE – 2			
SEHEDULE OF TRENCH			
SR. NO.	PIPE INSIDE DIA. (Inches)	TRENCH Ⓑ WITH TIMBERING	WIDTH Ⓑ WITHOUT TIMBERING
1	12"	42"	32"

CLASS OF RCC SEWER		
DIAMETER OF RCC PIPE (in)	COVER DEPTH (ft)	CLASS OF PIPE
12	0–3.6	CLASS II,SAND BEDDING
	3.7–5.6	CLASS II
	5.7–7.7	CLASS III
	ABOVE	CLASS IV



SECTION OF TRENCH WITHOUT
TIMBERING AND BRACING
(FOR SEWERS TO BE LAID UNDER ROAD CROSSING)



SECTION OF TRENCH WITHOUT
TIMBERING AND BRACING

NOTE

1. ALL DIMENSIONS ARE IN INCHES UNLESS OTHERWISE NOTED.
2. READ THIS DRAWINGS IN CONJUNCTION WITH ALL RELEVANT DRAWINGS.
3. THE BEDDING MATERIAL SHOULD BE WELL GRADED GRANULAR FILL WITH FINE NOT MORE THAN 15% HOWEVER, THE MAXIMUM PARTICLE SIZE SHOULD BE AS UNDER.

PIPE DIAMETER (INCH)	MAXIMUM PARTICLE SIZE (INCH)
4≤	1/2
6 – 8	3/4
10 – 16	1
≥ 16	1–1/2

4. THE THICKNESS OFF BEDDING MATERIAL SHOULD BE AT LEAST OUTSIZE DIAMETERS OF THE PIPE /12. HOWEVER, IN NO CASE IT SHOULD BE LESS THAN 6 INCH.
5. BEDDING MATERIAL SHOULD BE COMPACTED IN LAYERS OF THICKNESS APPROPRIATE TO TYPE AND SIZE OF COMPACTED EQUIPMENT TO AT LEAST 90% OF MODIFIED AASHTO MAXIMUM DRY DENSITY.
6. THE BASE OF THE EXCAVATION SHOULD BE PROOF ROLLED PRIOR PLACEMENT OF BEDDING MATERIAL IF SOFT/LOOSE POCKET IS ENCOUNTERED. IT SHOULD BE REMOVED AND REPLACED WITH THE BEDDING MATERIAL.
7. THE JOINT OF ALL THE SEWER PIPES ARE REQUIRED TO BE SOIL TIGHT AND SHOULD NOT PERMIT THE TRANSPORT OF SOIL AT ANY TIME DURING IT SERVICE LIFE.

CLIENT
PUNJAB RURAL MUNICIPAL SERVICES COMPANY (PRMSC)

CONSULTANT
NATIONAL ENGINEERING SERVICES PAKISTAN (PVT.) LTD.
HEAD OFFICE:- NESPAK HOUSE, I-C, BLOCK-N, MODEL TOWN EXTENSION, LAHORE, PAKISTAN.

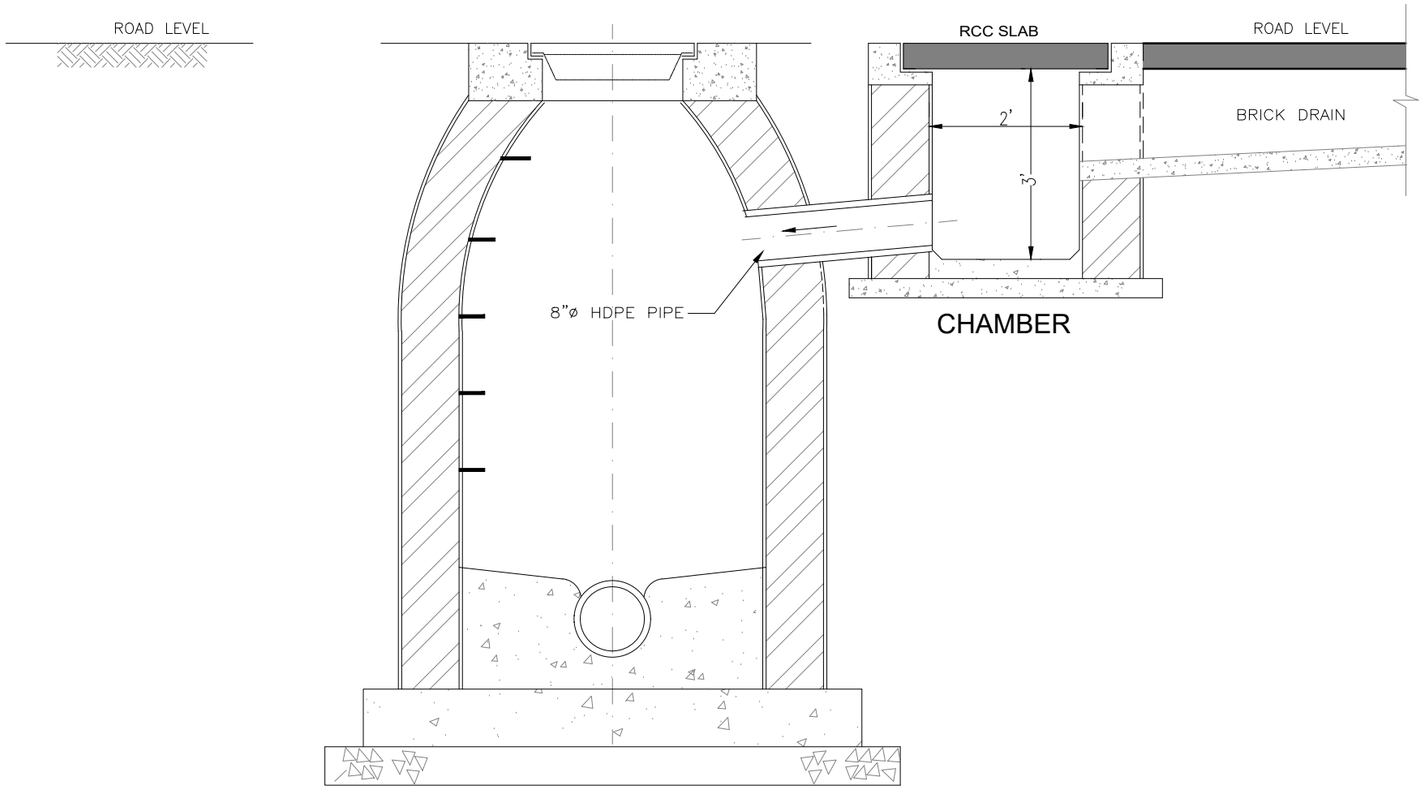
REV.	DATE	DESCRIPTION	APPROVED
04			
03			
02			
01			

DRAWN	NASEEM
SUBMITTED	
RECOMMENDED	
CHD./VER.	
APPROVED	

PROJECT
ENGINEERING DESIGN & CONSTRUCTION SUPERVISION CLUSTER (NORTH)
PUNJAB RURAL SUSTAINABLE WATER SUPPLY & SANITATION PROJECT

TRENCH DETAIL & CLASS DETAIL OF SEWER PIPES

DATE: DECEMBER, 2025
DRAWING No.: **4979/11/DD/2J179**
SCALE: **N.T.S**
REV.: 0



CONNECTION OF PROPOSED GULLY
GRATING CHAMBER WITH MANHOLE

NOTES

1. ALL DIMENSIONS ARE IN FEET AND PIPE DIAMETERS ARE IN INCHES UNLESS OTHER SPECIFIED.
2. THIS DRAWING IS FOR CONNECTION OF PROPOSED DRAIN WITH PROPOSED SEWER THROUGH GRATING CHAMBER. FOR CONSTRUCTION OF GRATING CHAMBER REFER TO RELEVANT STRUCTURAL DRAWING.
3. THIS DRAWING SHALL BE READ IN CONJUNCTION WITH ALL OTHER RELEVANT DRAWINGS.

CLIENT
PUNJAB RURAL MUNICIPAL SERVICES COMPANY (PRMSC)

CONSULTANT
NATIONAL ENGINEERING SERVICES PAKISTAN (PVT.) LTD.
HEAD OFFICE:- NESPAK HOUSE, I-C, BLOCK-N, MODEL TOWN EXTENSION, LAHORE, PAKISTAN.

REV.	DATE	DESCRIPTION	APPROVED
04			
03			
02			
01			

DRAWN	NASEEM
SUBMITTED	
RECOMMENDED	
CHD./VER.	
APPROVED	

PROJECT
ENGINEERING DESIGN & CONSTRUCTION SUPERVISION CLUSTER (NORTH)
PUNJAB RURAL SUSTAINABLE WATER SUPPLY & SANITATION PROJECT

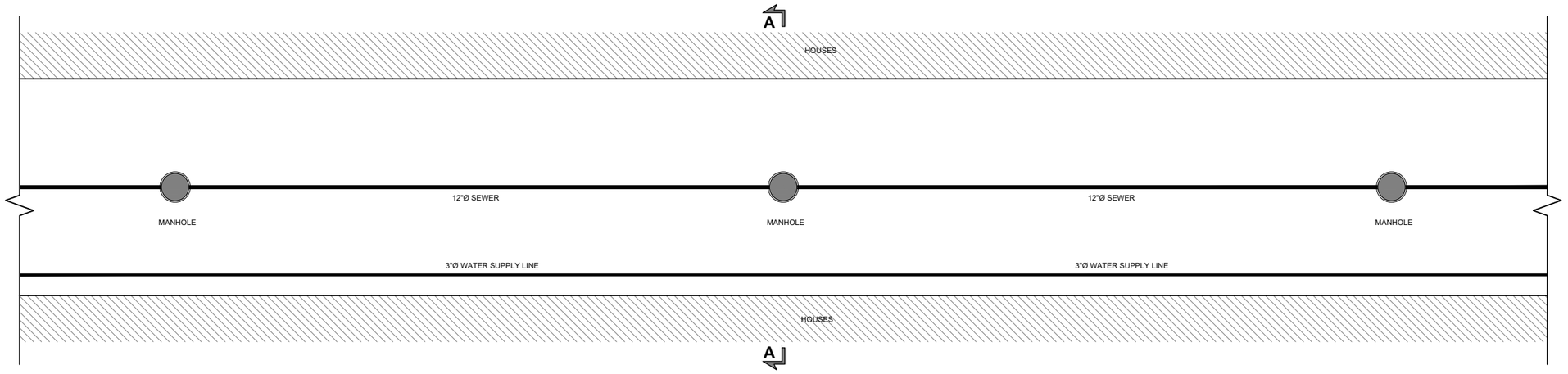
TYPICAL GRATING CHAMBER DETAIL FOR CONNECTION OF PROPOSED DRAIN WITH PROPOSED SEWER

SCALE

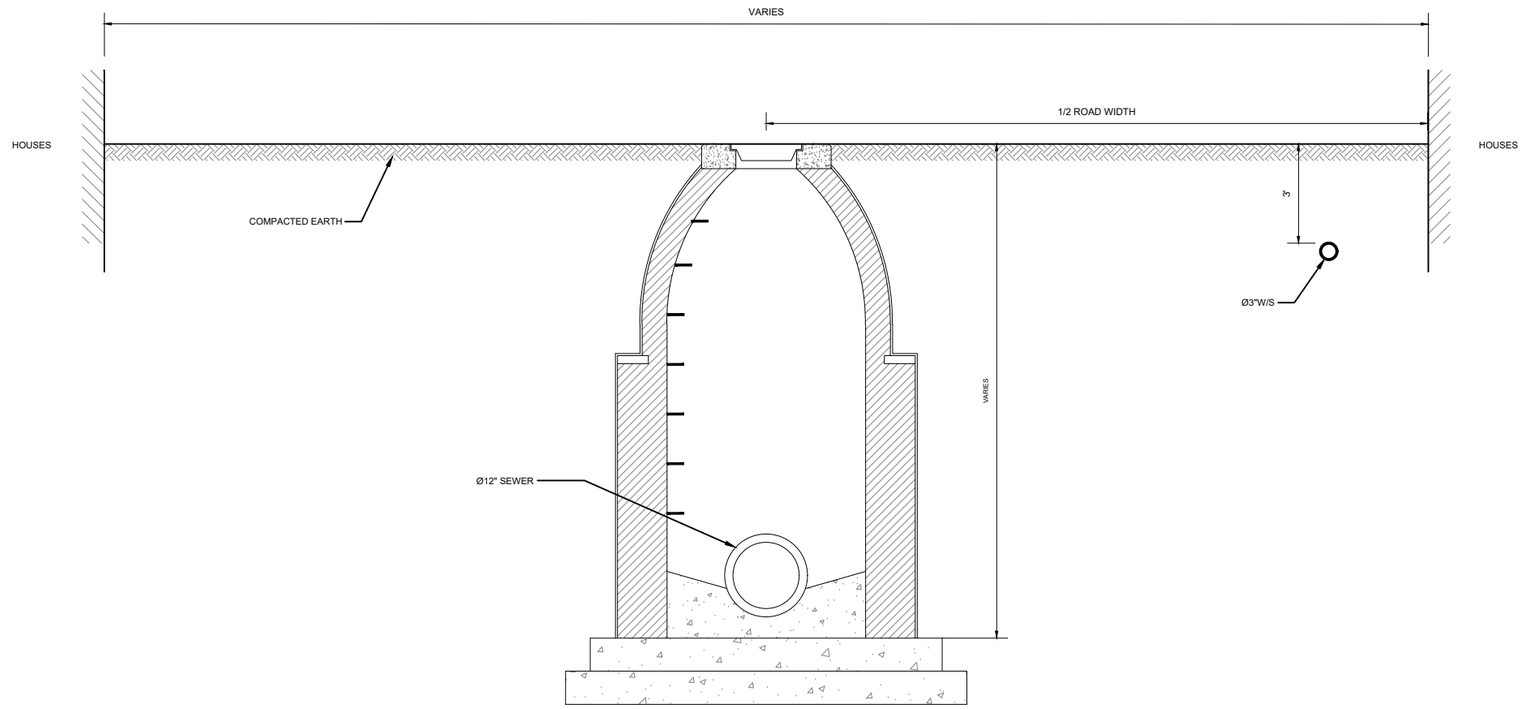
DATE: DECEMBER, 2025

DRAWING No.: **4979/11/DD/2J180**

REV.: 0



TYPICAL LAYOUT PLAN OF PROPOSED UTILITIES



SECTION A-A

NOTES:

1. ALL DIMENSIONS ARE IN FEET UNLESS OTHERWISE SPECIFIED.
2. ALL DIAMETERS ARE IN INCHES UNLESS OTHERWISE SPECIFIED.
3. FOR LEGENDS AND GENERAL NOTES REFER TO RELEVANT DRAWING.
4. FOR LAYOUT PLAN, REFER TO RELEVANT DRAWING.
5. READ THIS DRAWING IN CONJUNCTION WITH ALL RELEVANT DRAWINGS.
6. WIDTH OF WALKWAY/CARRIAGEWAY VARY AT DIFFERENT SECTIONS OF THE ROAD.
7. TENTATIVE DEPTHS OF UTILITIES ARE SHOWN IN TYPICAL CROSS SECTION ACTUAL DEPTHS MAY VARY ON SITE.
8. THE CONTRACTOR SHALL SET OUT THE ALIGNMENT FOR SEWER LINE AND OTHER RELATED STRUCTURES AS PER SITE CONDITIONS AND OBTAIN APPROVAL OF THE ENGINEER PRIOR TO COMMENCING EXCAVATION.
9. FOR EXECUTION REFER TO RELEVANT STRUCTURAL DRAWINGS.

CLIENT

PUNJAB RURAL MUNICIPAL SERVICES COMPANY (PRMSC)

CONSULTANT

NATIONAL ENGINEERING SERVICES PAKISTAN (PVT.) LTD.

HEAD OFFICE:- NESPAK HOUSE, I-C, BLOCK-N, MODEL TOWN EXTENSION, LAHORE, PAKISTAN.

REV.	DATE	DESCRIPTION	APPROVED
04			
03			
02			
01			

DRAWN	NASEEM
SUBMITTED	
RECOMMENDED	
CHD./VER.	
APPROVED	

PROJECT

ENGINEERING DESIGN & CONSTRUCTION SUPERVISION CLUSTER (NORTH)
PUNJAB RURAL SUSTAINABLE WATER SUPPLY & SANITATION PROJECT

CROSS SECTION OF PROPOSED UTILITIES

DATE	DRAWING No.	REV.
SEPTEMBER, 2025	**4979/11/DD/2J181**	0

SCALE

TABLE - 1

STANDARD RCC PIPES FOR SEWERAGE SCHEMES CONFORMING TO ASTM SPECIFICATION CLASS-II, WALL-B, STEEL RE-INFORCEMENT.

Dead load to produce a 0.01-inch crack = 1000
Dead load to produce the ultimate load = 1500
Concrete Strength =4000 Psi

S/NO	Internal Dia of Pipe (Inch)	Wall Thick-ness(Inch)	Concrete Cover (Inch)	Lap length for welded splice (Inches)	Area of Steel as Per ASCE C76-20 (Sq- Inch)		Dia of bar for Inner ring	Area of ring for inner Cage (sq-inch)	Dia of bar for outer ring	Area of ring for Outer Cage (sq-inch)	Nos of Circular Rings required as Per Column No.4 & 5		Nos of Circular Rings (Reinforcement) To be Provided		Spacing of bars (Inch)		Area of Steel provided as per ASTM C76-20 spacing requirments for inner cage	Area of Steel provided as per ASTM C76-20 spacing requirements for outer cage	length of Rings for Bell no*[(outerdia+cover)* 3.142 + lap (FT)	length of Rings for shell no*[(dia+cover)*3.142 + lap]		Total length of Inner Rings	Weight of outer Rings (lbs)	Weight of Rings Per 8 ft inner pipe in		STRAIGHT BARS						Total Weight of Steel col: 20 + 21+27	
																											Dia (IN)	Area of bars (sq-inch)	No: of Bars		Total Length of Inner+Outer cage)	Wt of straight bars for inner cage only (Lbs)			
					Inner Cage	Outer Cage					Inner Cage	Outer Cage	Inner Cage	Outer Cage	Inner Cage	Outer Cage				Inner Cage	Outer Cage			(Kg)	(Lbs)			Inner Cage	Outer Cage		(Kg)	(Lbs)	(Kg)	(Lbs)
1	2	3	3	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23			24	25	26	27	28	29		30	
1	12	2	0.75	2	0.07	-	3/16	0.0276			30	-	25		4.0		0.086		10.018	91.127		101.145		4.513	9.507	3/16"	0.0276	4	0	32	1.4	3.0	5.7	12.51
2	18	2.25	0.75	2	0.07	-	3/16	0.0276			30	-	25		4.0		0.086		12.112	112.198		124.310		5.301	11.694	3/16"	0.0276	4	0	32	1.4	3.0	6.7	14.69
2	18	2.5	0.75	2	0.07	-	3/16	0.0276			30	-	25		4.0		0.086		14.206	133.269		147.475		6.289	13.882	3/16"	0.0276	4	0	32	1.4	3.0	7.7	16.87
4	21	2.75	0.98	2	0.07	-	3/16	0.0276			30	-	25		4.0		0.086		16.078	151.781		167.859		7.159	15.777	3/16"	0.0276	4	0	32	1.4	3.0	8.5	18.78
5	24	3	1.03	2	0.07	-	3/16	0.0276			30	-	25		4.0		0.086		18.060	171.798		189.878		8.098	17.847	3/16"	0.0276	4	0	32	1.4	3.0	9.5	20.86
6	27	3.25	1.14	2	0.12	-	1/4	0.0491			30	-	25		4.0		0.153		0.000	208.495		208.495		15.807	34.839	3/16"	0.0491	5	0	40	3.0	6.7	18.8	41.52
7	30	3.5	1.20	2	0.14	-	1/4	0.0491			29	-	25		4.0		0.153		0.000	230.253		230.253		17.457	38.475	3/16"	0.0491	5	0	40	3.0	6.7	20.8	46.15
8	33	3.75	1.31	2	0.15	-	1/4	0.0491			24	-	25		4.0		0.153		0.000	252.011		252.011		19.106	42.110	3/16"	0.0491	6	0	48	3.6	8.0	22.7	50.13
9	36	4	1.00	2	0.12	0.07	1/4	0.0491	3/16	0.0276	20	20	25	25	4.0	4.0	0.153	0.086	0.000	252.929	279.004	252.929	26.224	19.188	42.247	1/4"	0.0491	6	6	101	7.6	16.8	33.7	85.26
10	42	4.5	1.00	2	0.16	0.09	1/4	0.0491	3/16	0.0276	34	28	26	27	3.8	3.7	0.160	0.093	0.000	303.775	350.796	303.775	32.972	23.031	50.760	1/4"	0.0491	7	7	117	8.9	19.6	48.9	103.32
11	48	5	1.00	2	0.18	0.11	1/4	0.0491	1/4	0.0491	29	18	31	20	3.2	5.1	0.160	0.123	0.000	410.679	296.493	410.679	49.543	31.151	68.657	1/4"	0.0491	8	8	134	10.2	22.4	63.8	140.58
12	54	5.5	1.00	2	0.21	0.13	3/8	0.1105	1/4	0.0491	15	20	18	21	5.6	4.8	0.249	0.129	0.000	266.844	349.795	266.844	58.450	45.520	100.325	1/4"	0.0491	9	9	151	11.4	25.2	83.5	183.95
13	60	6	1.00	2	0.24	0.15	3/8	0.1105	1/4	0.0491	17	24	18	26	5.3	3.8	0.282	0.160	0.000	311.508	492.718	311.508	80.327	53.139	117.118	1/4"	0.0491	10	10	168	12.7	28.0	102.3	225.42
14	66	6.5	1.00	2	0.31	0.19	3/8	0.1105	3/8	0.1105	22	14	25	17	4.0	6.0	0.345	0.235	0.000	449.142	545.464	449.142	129.884	76.617	168.864	1/4"	0.0491	11	11	176	13.3	29.4	148.9	328.14
15	72	7	1.00	2	0.35	0.21	1/2	0.1964	3/8	0.1105	14	15	17	17	6.0	6.0	0.417	0.235	0.000	532.115	376.812	532.115	141.595	100.718	221.982	3/8"	0.1104	12	12	192	32.7	72.1	197.7	435.72

TABLE - 2

STANDARD RCC PIPES FOR SEWERAGE SCHEMES CONFORMING TO ASTM SPECIFICATION CLASS-III, WALL-B, STEEL RE-INFORCEMENT.

Dead load to produce a 0.01-inch crack = 1350
Dead load to produce ultimate load = 2000
Concrete Strength = 4000 Psi

S/NO	Internal Dia of Pipe (Inch)	Wall Thick-ness(Inch)	Concrete Cover (Inch)	Lap length for welded splice (Inches)	Area of Steel as Per ASCE C76-20 (Sq- Inch)		Dia of bar for inner ring	Area of ring for inner Cage (sq-inch)	Dia of bar for outer ring	Area of ring for Outer Cage (sq-inch)	Nos of Circular Rings required as Per Column No.4 & 5		Nos of Circular Rings (Reinforcement) To be Provided		Spacing of bars (Inch)		Area of Steel provided as per ASTM C76-20 spacing requirments for inner cage	Area of Steel provided as per ASTM C76-20 spacing requirements for outer cage	length of Rings for Bell no*[(outerdia+cover)* 3.142 + lap (FT)	length of Rings for shell no*[(dia+cover)*3.142 + lap]		Total length of Inner Rings	Weight of outer Rings (lbs)	Weight of Rings Per 8 ft inner pipe in		STRAIGHT BARS						Total Weight of Steel col: 20 + 21+27	
																											Dia (IN)	Area of bars (sq-inch)	No: of Bars		Total Length of Inner+Outer cage)	Wt of stright bars for inner cage only (Lbs)			
					Inner Cage	Outer Cage					Inner Cage	Outer Cage	Inner Cage	Outer Cage	Inner Cage	Outer Cage				Inner Cage	Outer Cage			(Kg)	(Lbs)			Inner Cage	Outer Cage		(Kg)	(Lbs)	(Kg)	(Lbs)
1	2	3	3	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23			24	25	26	27	28	29		30	
1	12	2	0.8	2	0.07	-	3/16	0.0276			30	-	25		4.0		0.086		10.018	91.127		101.145		4.513	9.507	3/16"	0.028	4	0	32	1.4	3.0	5.7	12.5
2	15	2.25	0.8	2	0.07	-	3/16	0.0276			30	-	25		4.0		0.086		12.112	112.198		124.310		5.301	11.684	3/16"	0.028	4	0	32	1.4	3.0	6.7	14.7
2	18	2.5	0.8	2	0.07	-	3/16	0.0276			30	-	25		4.0		0.086		14.206	133.269		147.475		6.289	13.862	3/16"	0.028	4	0	32	1.4	3.0	7.7	16.9
4	21	2.75	1.0	2	0.07	-	3/16	0.0276			30	-	25		4.0		0.086		16.079	151.781		167.859		7.159	15.777	3/16"	0.028	4	0	32	1.4	3.0	8.5	18.8
5	24	3	1.1	2	0.07	-	3/16	0.0276			30	-	25		4.0		0.086		18.080	171.798		189.878		8.098	17.847	3/16"	0.028	4	0	32	1.4	3.0	9.5	20.9
6	27	3.25	1.1	2	0.18	-	1/4	0.0491			27	-	28		3.6		0.172		0.000	233.515		233.515		17.704	39.020	1/4"	0.049	5	0	40	3.0	6.7	20.7	45.7
7	30	3.5	1.2	2	0.18	-	1/4	0.0491			30	-	31		3.2		0.190		0.000	285.514		285.514		21.646	47.709	1/4"	0.049	5	0	40	3.0	6.7	24.7	54.4
8	33	3.75	1.3	2	0.2	-	1/4	0.0491			34	-	35		2.8		0.215		0.000	352.818		352.818		26.749	58.955	1/4"	0.049	6	0	48	3.6	8.0	30.4	67.0
9	36	4	1.0	2	0.17	0.10	1/4	0.0491	3/16	0.0276	29	29	31	31	3.2	3.2	0.190	0.107	0.000	313.508	345.965	313.508	32.518	23.769	52.386	1/4"	0.049	6	6	101	7.6	16.8	46.1	101.7
10	42	4.5	1.0	2	0.21	0.12	1/4	0.0491	1/4	0.0491	35	20	35	22	2.7	4.8	0.221	0.135	0.000	420.612	285.833	420.612	47.762	31.889	70.283	1/4"	0.049	7	7	117	8.9	19.6	62.4	137.6
11	48	5	1.0	2	0.24	0.14	3/8	0.1105	1/4	0.0491	18	23	20	25	5.1	4.0	0.276	0.153	0.000	265.053	370.617	265.053	61.929	45.219	99.663	1/4"	0.049	8	8	134	10.2	22.4	83.5	184.0
12	54	5.5	1.0	2	0.29	0.17	3/8	0.1105	1/4	0.0491	22	25	23	30	4.4	3.3	0.318	0.184	0.000	340.967	499.708	340.967	83.500	58.184	128.183	1/4"	0.049	9	9	151	11.4	25.2	107.5	236.9
13	60	6	1.0	2	0.34	0.20	1/2	0.1964	3/8	0.1105	15	14	17	17	6.0	6.0	0.417	0.235	0.000	278.718	314.316	278.718	116.173	84.525	186.292	1/4"	0.049	10	10	168	12.7	28.0	150.6	332.4
14	66	6.5	1.0	2	0.41	0.24	1/2	0.1964	3/8	0.1105	16	17	19	19	5.3	5.3	0.467	0.282	0.000	341.348	390.107	341.348	145.168	103.518	228.154	1/4"	0.049	11	11	176	13.3	29.4	182.7	402.7
15	72	7	1.0	2	0.49	0.29	1/2	0.1964	3/8	0.1105	21	21	22	23	4.8	4.4	0.540	0.318	0.000	429.796	509.534	429.796	191.569	130.341	287.371	3/8"	0.110	12	12	192	32.7	72.1	250.0	551.0

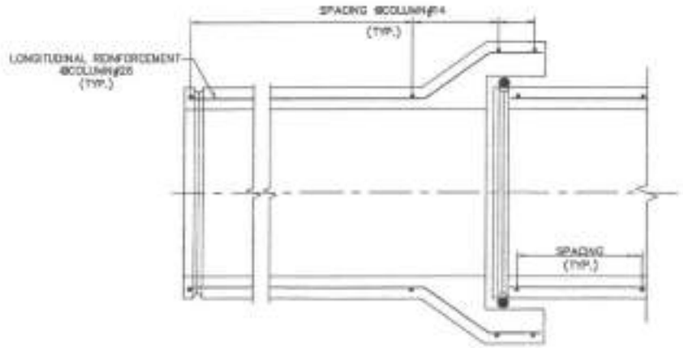
CLIENT	CONSULTANT					PROJECT	SCALE
PUNJAB RURAL MUNICIPAL SERVICES COMPANY (PRMSC)	NATIONAL ENGINEERING SERVICES PAKISTAN (PVT.) LTD.	04			DRAWN	NASEEM	ENGINEERING DESIGN & CONSTRUCTION SUPERVISION CLUSTER (NORTH) PUNJAB RURAL SUSTAINABLE WATER SUPPLY & SANITATION PROJECT	REINFORCEMENT DETAIL OF SEWER PIPES	N.T.S
	HEAD OFFICE:- NESPAK HOUSE, I-C, BLOCK-N, MODEL TOWN EXTENSION, LAHORE, PAKISTAN.	03			SUBMITTED				
		02			RECOMMENDED			DATE: DECEMBER, 2025	DRAWING No.: 4979/11/DD/2J182
		01			CHD./VER.				REV.: 0
		REV.	DATE	DESCRIPTION	APPROVED	APPROVED			

TABLE - 3

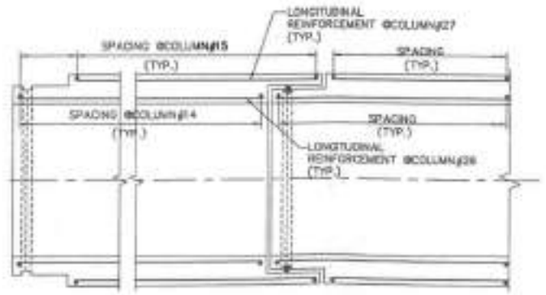
STANDARD RCC PIPES FOR SEWERAGE SCHEMES CONFORMING TO ASTM SPECIFICATION CLASS-IV, WALL-B, STEEL RE-INFORCEMENT.

Dead load to produce a 0.01-inch crack = 2000
Dead load to produce the ultimate load = 3000
Concrete Strength =4000Psi

S/NO	Internal Dia of Pipe (Inch)	Wall Thickness(inch)	Concrete Cover (inch)	Lap length for welded splice (Inche)	Area of Steel as Per ASCE C76-20 (Sq- Inch)		Dia of bar for inner ring	Area of ring for inner Cage (sq-inch)	Dia of bar for outer ring	Area of ring for Outer Cage (sq-inch)	Nos of Circular Rings required as Per Column No.4 & 5		Nos of Circular Rings (Reinforcement) To be Provided		Spacing of bars (inch)		Area of Steel provided as per ASTM C76-20 spacing requirements for inner cage	Area of Steel provided as per ASTM C76-20 spacing requirements for outer cage	length of Rings for Bell no*((dia+cover)*3.142 + lap) (FT)	length of Rings for shell no*((dia+cover)*3.142 + lap)		Total length of inner Rings	Weight of outer Rings (lbs)	Weight of Rings Per 4 ft inner pipe in		STRAIGHT BARS						Total Weight of Steel col: 30 + 21+27	
																											Dia (IN)	Area of bars (sq-inch)	No: of Bars		Total Length of Inner+Outer cage)	Wt of stright bars for inner cage only (Lbs)			
					Inner Cage	Outer Cage					Inner Cage	Outer Cage	Inner Cage	Outer Cage	Inner Cage	Outer Cage				Inner Cage	Outer Cage			(Kg)	(Lbs)			Inner Cage	Outer Cage		(Kg)	(Lbs)	(Kg)	(Lbs)
1	2	3	3	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23			24	25	26	27	28	29		30	
1	12	2	0.75	2	0.07	-	3/16	0.0276			20	-	25		4.0		0.086		10.018	91.127		101.146		4.313	9.507	3/16"	0.028	4	0	32	1.4	3.0	5.7	12.5
2	15	2.25	0.75	2	0.10	-	3/16	0.0276			29	-	31		3.2		0.107		12.112	141.467		153.579		6.550	14.435	3/16"	0.028	4	0	32	1.4	3.0	7.9	17.4
2	18	2.5	0.75	2	0.14	-	1/4	0.0491			23	-	25		4.0		0.153		14.206	133.269		147.475		11.181	24.643	3/16"	0.028	4	0	32	1.4	3.0	12.5	27.6
4	21	2.75	0.98	2	0.20	-	1/4	0.0491			33	-	35		2.8		0.218		16.078	217.773		233.850		17.730	39.078	3/16"	0.028	4	0	32	1.4	3.0	19.1	42.1
5	24	3	1.05	2	0.27	-	3/8	0.1105			20	-	25		4.0		0.345		18.080	171.798		189.878		32.390	71.388	3/16"	0.028	4	0	32	1.4	3.0	33.8	74.4
6	27	3.25	1.14	2	0.31	-	3/8	0.1105			22	-	25		4.0		0.345		0.000	208.495		208.495		35.566	78.388	1/4"	0.049	5	0	40	3.0	5.7	38.6	85.1
7	30	3.5	1.23	2	0.35	-	3/8	0.1105			25	-	25		4.0		0.345		0.000	230.253		230.253		39.278	86.568	1/4"	0.049	5	0	40	3.0	5.7	42.3	93.2
8	33	3.75	1.00	2	0.27	0.16	3/8	0.1105	1/4	0.0491	20	26	25	27	4.0	3.7	0.345	0.166	0.000	233.198	276.589	233.198		39.780	87.675	1/4"	0.049	5	6	96	7.3	16.0	47.1	103.7
9	36	4	1.00	2	0.30	0.18	3/8	0.1105	1/4	0.0491	22	29	25	31	4.0	3.2	0.345	0.190	0.000	252.829	345.965	252.829	57.810	43.129	95.056	1/4"	0.049	6	6	101	7.6	16.8	77.0	169.7
10	42	4.5	1.00	2	0.35	0.21	3/8	0.1105	3/8	0.1105	25	15	27	25	3.7	4.0	0.373	0.345	0.000	315.459	324.810	315.459	122.119	53.813	118.603	1/4"	0.049	7	7	117	8.9	19.6	118.1	260.3
11	48	5	1.00	2	0.42	0.24	1/2	0.1964	3/8	0.1105	17	17	20	20	5.0	5.1	0.496	0.278	0.000	267.734	296.493	267.734	111.473	81.194	178.951	1/4"	0.049	8	8	134	10.2	22.4	141.9	312.8
12	54	5.5	1.00	2	0.50	0.30	1/2	0.1964	3/8	0.1105	20	22	22	23	4.8	4.4	0.540	0.318	0.000	326.143	383.109	326.143	144.037	98.907	217.991	1/4"	0.049	9	9	151	11.4	25.2	175.7	387.2
Concrete Strength =5000Psi																																			
13	60	6	1.00	2	0.59	0.35	1/2	0.1964	3/8	0.1105	24	25	26	27	3.8	3.7	0.638	0.373	0.000	426.274	499.208	426.274	187.687	129.273	284.918	1/4"	0.049	10	10	168	12.7	28.0	227.1	500.6
14	66	6.5	1.00	2	0.69	0.41	1/2	0.1964	3/8	0.1105	28	30	30	31	3.3	3.2	0.737	0.428	0.000	538.970	629.964	538.970	236.847	163.449	360.242	1/4"	0.049	11	11	176	13.3	29.4	284.2	626.5
15	72	7	1.00	2	0.79	0.47	1/2	0.1964	3/8	0.1105	32	34	34	36	2.9	2.7	0.835	0.497	0.000	664.230	797.532	664.230	299.848	201.436	443.965	1/4"	0.049	12	12	192	14.5	32.1	352.0	776.0



BELL AND SPIGOT JOINT REINFORCEMENT DETAILS FOR DIA ≤ 24"
(STANDARD LENGTH OF SEWER PIPE=8'-0")



TONGUE & GROOVE JOINT REINFORCEMENT DETAILS FOR DIA > 24"
(STANDARD LENGTH OF SEWER PIPE=8'-0")

NOTES

1. BELL & SPIGOT JOINTS CAN BE USED FROM 310MM(12") DIA TO 810MM(24") DIA SIZE WITH RUBBER GASKETS.
2. TONGUE AND GROOVE JOINTS CAN BE USED FROM 690MM(27") DIA AND ABOVE.
3. THE JOINT DETAILS/SHAPES OF PIPES ARE DRAWN ON THE BASIS OF DATA/INFORMATION PROVIDED FROM EPHED. HOWEVER, ANY ALTERNATE ARRANGEMENT WHICH SATISFIES ALL THE RELEVANT TESTS AS PER STANDARD CODES AND PRACTICES CAN BE ADOPTED AFTER APPROVAL FROM THE ENGINEER.
4. WHERE ONE LINE OF CIRCULAR REINFORCEMENT IS USED, IT SHALL BE PLACED FROM 33 TO 50 PERCENT OF THE WALL THICKNESS FROM INNER SURFACE OF THE PIPE EXCEPT THAT FOR WALL THICKNESS LESS THAN 60MM (2½"). THE NOMINAL PROTECTIVE COVER OF THE CONCRETE OVER THE CIRCUMFERENTIAL REINFORCEMENT IN THE BARREL OF THE PIPE SHALL BE 20MM (3/4").
5. IN THE CASE OF DOUBLE CAGE REINFORCEMENT, THE CONCRETE COVER SHALL BE 25MM(1") FROM INNER AND OUTER SURFACE OF THE PIPE.
6. THE CENTER TO CENTER SPACING OF CIRCUMFERENTIAL REINFORCEMENT IN A CAGE SHALL NOT EXCEED 4 IN. FOR PIPE UP TO 4 IN. WALL THICKNESS, NOR EXCEED THE WALL THICKNESS FOR LARGER PIPE, AND SHALL IN NO CASE EXCEED 6 IN..
7. THE SPLICES ARE TO BE WELDED AND PULL TESTS OF REPRESENTATIVE SPECIMEN SHALL DEVELOP AT LEAST 50% OF THE MINIMUM SPECIFIED STRENGTH OF THE STEEL AND THERE SHALL BE A MINIMUM LAP OF 50MM(2").
8. MINIMUM NO. OF STRAIGHT BARS SHALL BE FOUR AND ABOVE THE NUMBER OF STRAIGHT BARS ARE FIXED IN SUCH A MANNER THAT THE CIRCUMFERENTIAL SPACING BETWEEN STRAIGHT BARS DOES NOT EXCEED 460MM(18") FOR SINGLE CAGE REINFORCEMENT AND 915MM(36") FOR DOUBLE CAGE REINFORCEMENT, THE STRAIGHT BARS IN STAGGERED BETWEEN INNER CAGE AND OUTER CAGE THEREBY LEAVING THE HORIZONTAL DISTANCE OF NOT MORE THAN 460MM(18").
9. THESE DRAWING ARE PROJECT SPECIFIC AND CANNOT BE USED ON OTHER PROJECTS.
10. SPACERS SHALL BE USED TO LINK UP THE INNER AND OUTER CAGE WITH ONE ANOTHER. THE CIRCUMFERENTIAL SPACING BETWEEN THE SPACERS SHALL BE KEPT 610MM(24") SO AS TO FROM A SINGLE SET.
11. THE PIPES ARE TO BE MANUFACTURED ACCORDING TO THE A.S.T.M C-20.

CLIENT
PUNJAB RURAL MUNICIPAL SERVICES COMPANY (PRMSC)

CONSULTANT
NATIONAL ENGINEERING SERVICES PAKISTAN (PVT.) LTD.
HEAD OFFICE:- NESPAK HOUSE, I-C, BLOCK-N, MODEL TOWN EXTENSION, LAHORE, PAKISTAN.

REV.	DATE	DESCRIPTION	APPROVED		
04				DRAWN	NASEEM
03				SUBMITTED	
02				RECOMMENDED	
01				CHD./VER.	
				APPROVED	

PROJECT
ENGINEERING DESIGN & CONSTRUCTION SUPERVISION CLUSTER (NORTH)
PUNJAB RURAL SUSTAINABLE WATER SUPPLY & SANITATION PROJECT

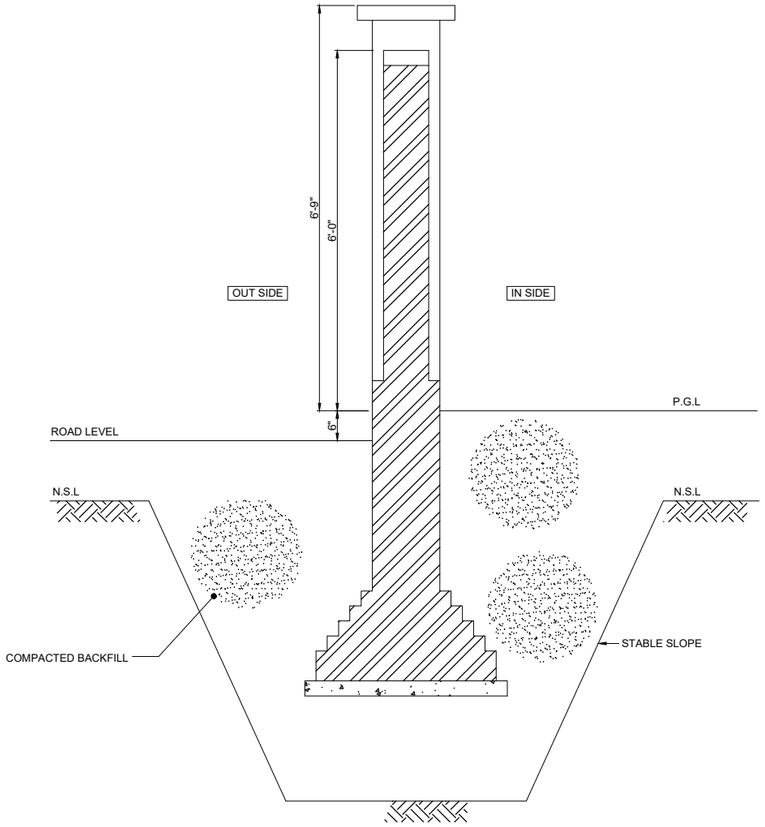
REINFORCEMENT DETAIL OF SEWER PIPES

SCALE: N.T.S

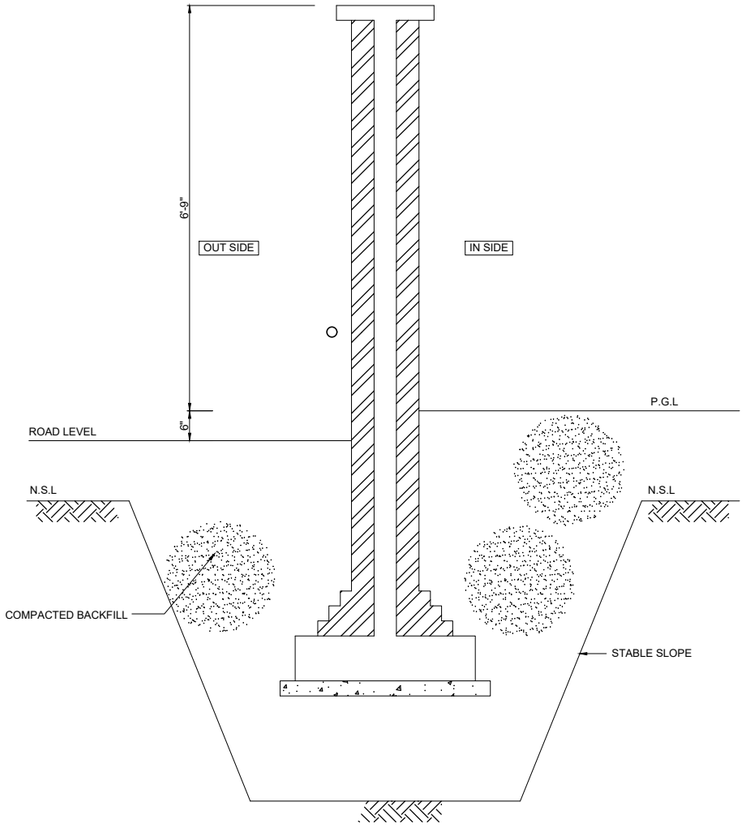
DATE: DECEMBER, 2025

DRAWING No.: 4979/11/DD/2J182

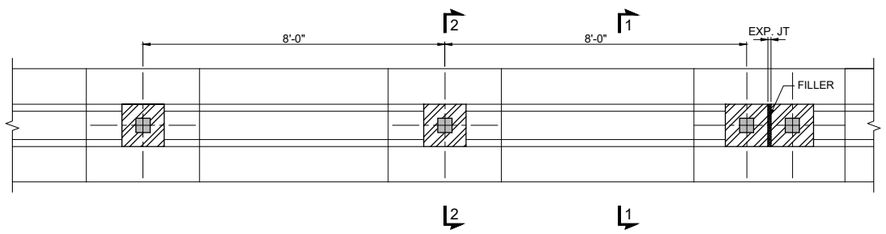
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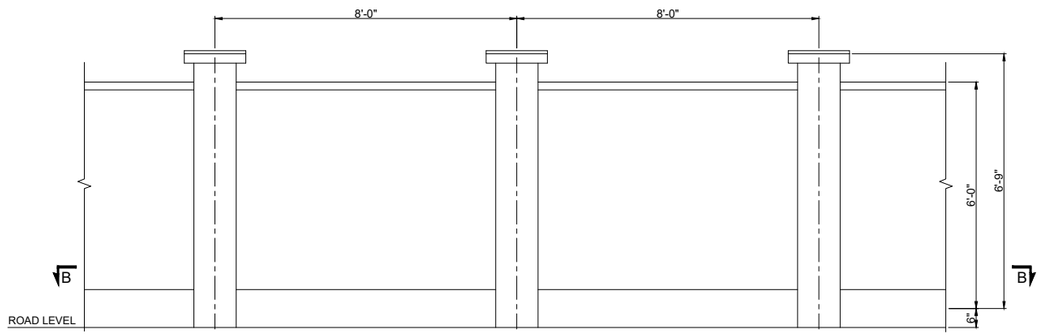
SECTION 1-1



SECTION 2-2



SECTION B-B



TYPE WALL ELEVATION

NOTES:
1. ALL DIMENSIONS ARE IN FEET AND INCHES UNLESS OTHERWISE NOTED.
2. FOR CONSTRUCTION PLEASE REFER TO RELEVANT STRUCTURAL DRAWINGS.

CLIENT
PUNJAB RURAL MUNICIPAL SERVICES COMPANY (PRMSC)

CONSULTANT
NATIONAL ENGINEERING SERVICES PAKISTAN (PVT.) LTD.
HEAD OFFICE:- NESPAK HOUSE, I-C, BLOCK-N, MODEL TOWN EXTENSION, LAHORE, PAKISTAN.

REV.	DATE	DESCRIPTION	APPROVED
04			
03			
02			
01			

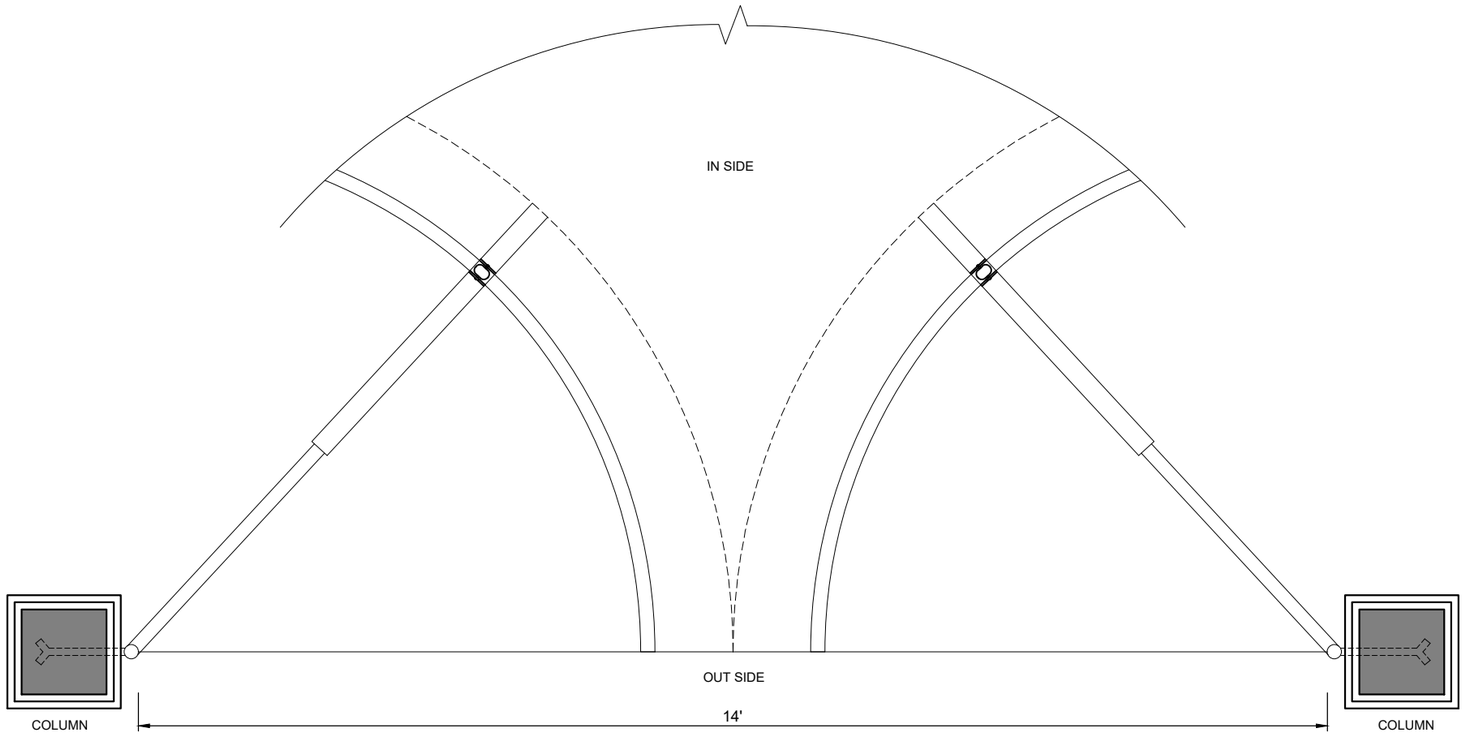
DRAWN	WALEED
SUBMITTED	
RECOMMENDED	
CHD./VER.	
APPROVED	

PROJECT
ENGINEERING DESIGN & CONSTRUCTION SUPERVISION CLUSTER (NORTH)
PUNJAB RURAL SUSTAINABLE WATER SUPPLY & SANITATION PROJECT

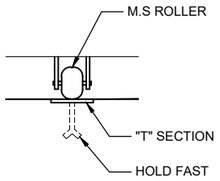
BOUNDARY WALL FOUNDATION & SECTIONS

SCALE

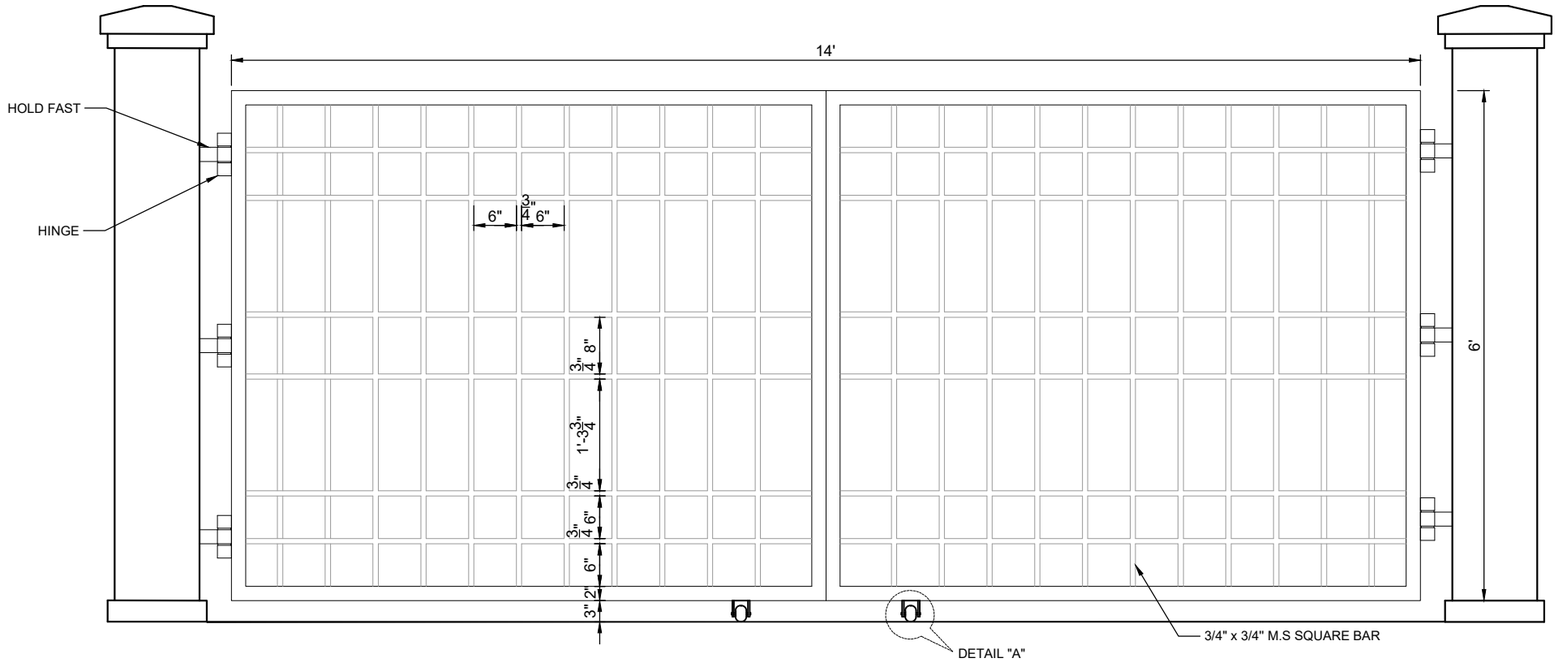
DATE: DECEMBER, 2025
DRAWING No.: **4979/11/DD/2J183**
REV.: 0



PLAN



DETAIL "A"



FRONT ELEVATION

CLIENT: PUNJAB RURAL MUNICIPAL SERVICES COMPANY (PRMSC)	CONSULTANT: NATIONAL ENGINEERING SERVICES PAKISTAN (PVT.) LTD. HEAD OFFICE:- NESPAK HOUSE, I-C, BLOCK-N, MODEL TOWN EXTENSION, LAHORE, PAKISTAN.	04			DRAWN: WALEED
		03			SUBMITTED:
		02			RECOMMENDED:
		01			CHD./VER.:
		REV.	DATE	DESCRIPTION / APPROVED	APPROVED:

PROJECT: ENGINEERING DESIGN & CONSTRUCTION SUPERVISION CLUSTER (NORTH) PUNJAB RURAL SUSTAINABLE WATER SUPPLY & SANITATION PROJECT

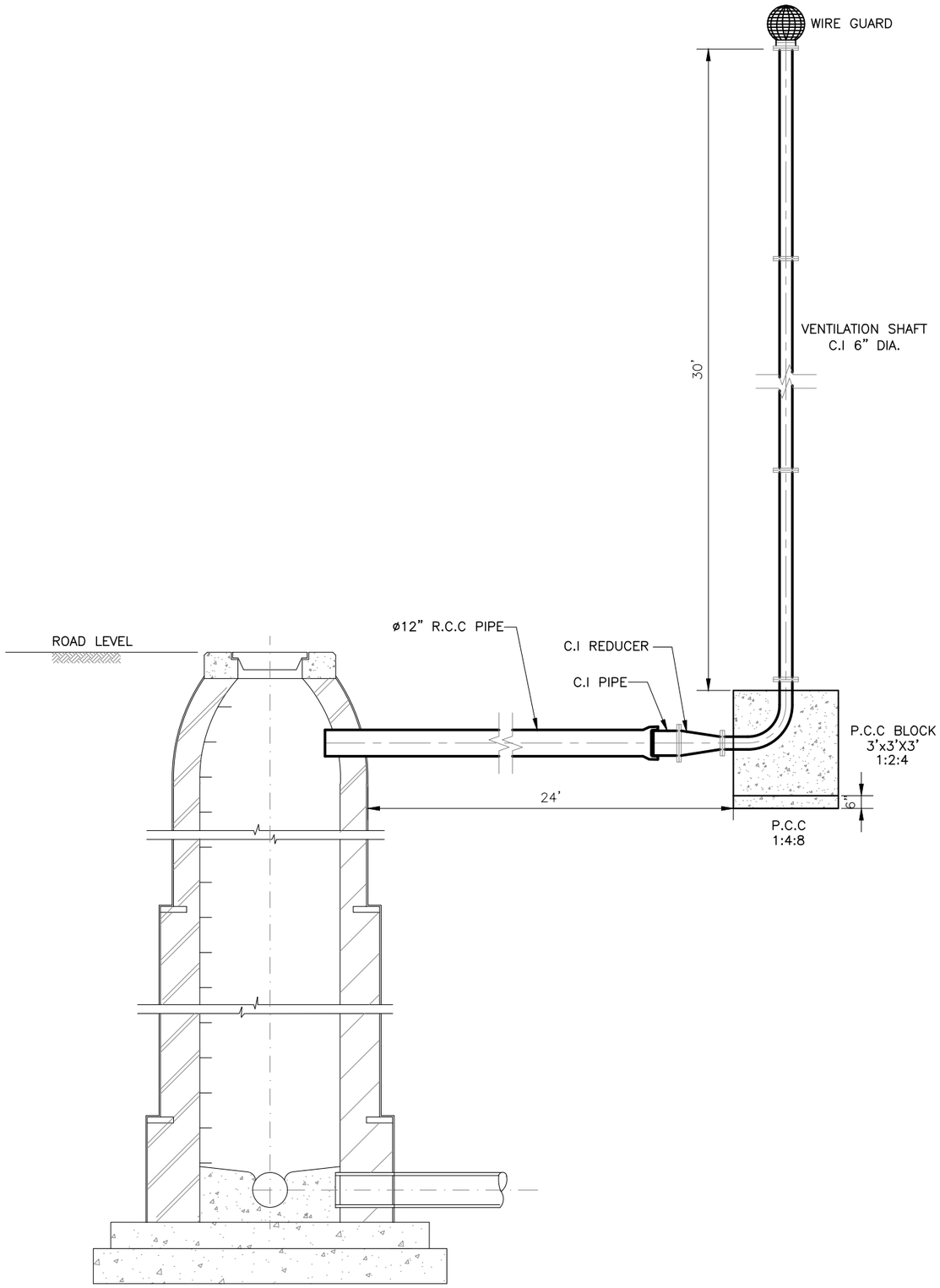
LAYOUT PLAN & FRONT ELEVATION OF GATE

DATE: DECEMBER, 2025

DRAWING No.: **4979/11/DD/2J184**

SCALE:

REV.: 0



NOTES

1. ALL DIMENSIONS ARE IN FEET AND PIPE DIAMETERS ARE IN INCHES UNLESS OTHER SPECIFIED.
2. THIS DRAWING IS FOR VENTILATION SHAFT ARRANGEMENT ONLY. FOR CONSTRUCTION OF MANHOLE REFER TO RELEVANT DRAWINGS.
3. THIS DRAWING SHALL BE READ IN CONJUNCTION WITH ALL OTHER RELEVANT DRAWINGS.

CLIENT

PUNJAB RURAL MUNICIPAL SERVICES COMPANY (PRMSC)

CONSULTANT

NATIONAL ENGINEERING SERVICES PAKISTAN (PVT.) LTD.

HEAD OFFICE:- NESPAK HOUSE, I-C, BLOCK-N, MODEL TOWN EXTENSION, LAHORE, PAKISTAN.

REV.	DATE	DESCRIPTION	APPROVED
04			
03			
02			
01			

DRAWN	NASEEM
SUBMITTED	
RECOMMENDED	
CHD./VER.	
APPROVED	

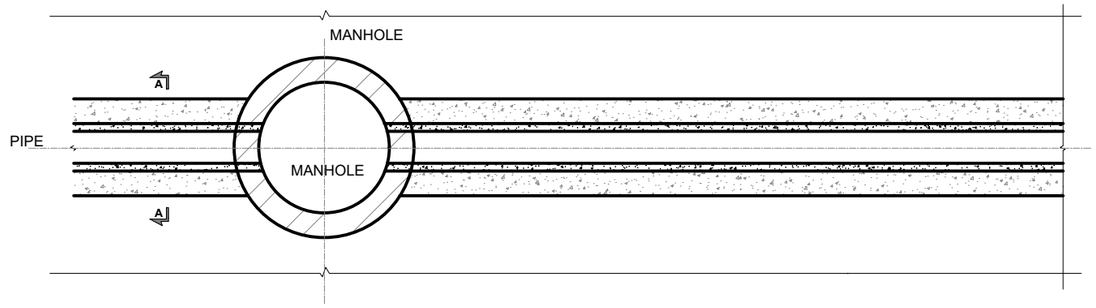
PROJECT

ENGINEERING DESIGN & CONSTRUCTION SUPERVISION CLUSTER (NORTH)
PUNJAB RURAL SUSTAINABLE WATER SUPPLY & SANITATION PROJECT

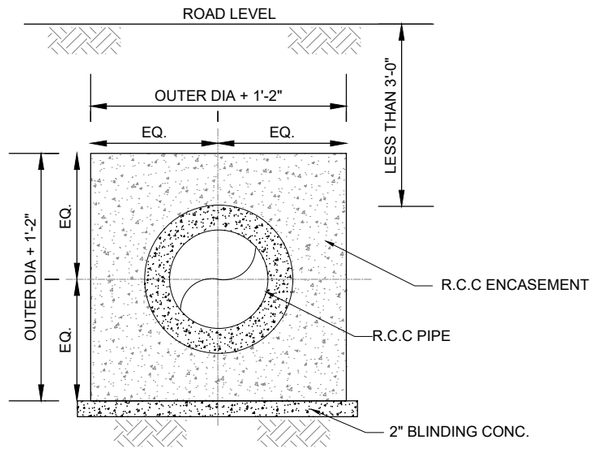
TYPICAL VENTILATION SHAFT DETAIL

DATE	DRAWING No.	REV.
DECEMBER, 2025	**4979/11/DD/2J185**	0

SCALE: **N.T.S**



TYPICAL LAYOUT PLAN



SECTION A-A

(CONCRETE OUTLINE)

NOTES

1. ALL DIMENSIONS ARE IN FEET AND PIPE DIAMETERS ARE IN INCHES UNLESS OTHER SPECIFIED.
2. THIS DRAWING SHALL BE READ IN CONJUNCTION WITH ALL OTHER RELEVANT DRAWINGS.
3. FOR EXECUTION REFER TO RELEVANT STRUCTURAL DRAWINGS.

CLIENT

PUNJAB RURAL MUNICIPAL SERVICES COMPANY (PRMSC)

CONSULTANT

NATIONAL ENGINEERING SERVICES PAKISTAN (PVT.) LTD.

HEAD OFFICE:- NESPAK HOUSE, I-C, BLOCK-N, MODEL TOWN EXTENSION, LAHORE, PAKISTAN.

REV.	DATE	DESCRIPTION	APPROVED
04			
03			
02			
01			

DRAWN	NASEEM
SUBMITTED	
RECOMMENDED	
CHD./VER.	
APPROVED	

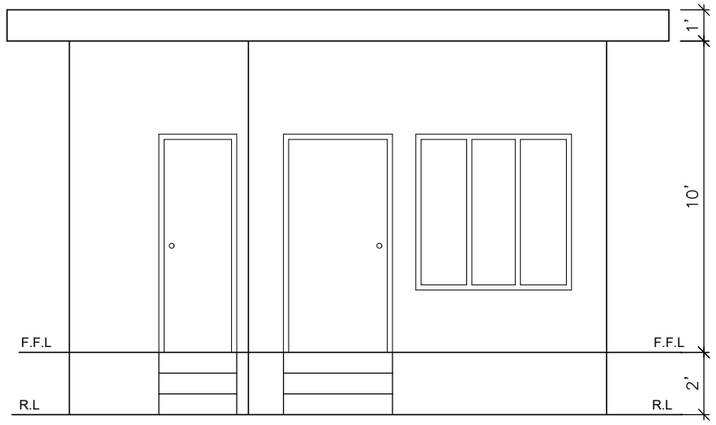
PROJECT

ENGINEERING DESIGN & CONSTRUCTION SUPERVISION CLUSTER (NORTH)
PUNJAB RURAL SUSTAINABLE WATER SUPPLY & SANITATION PROJECT

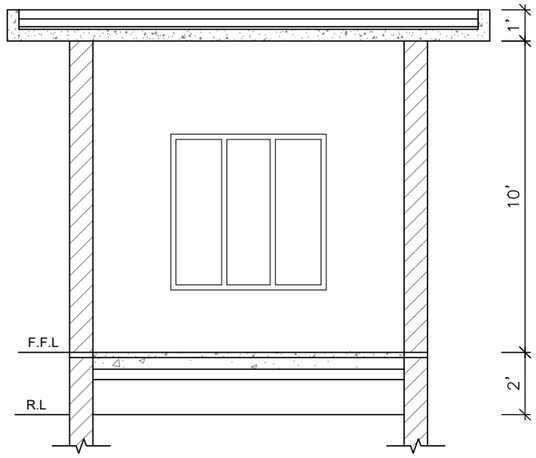
RCC ENCASEMENT

DATE	DRAWING No.	REV.
DECEMBER, 2025	4979/11/DD/2J186	0

SCALE



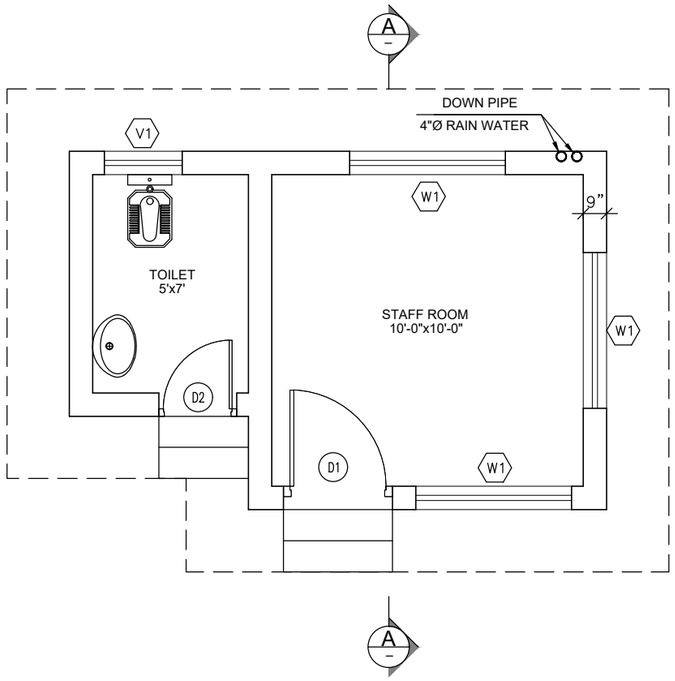
ELEVATION



SECTION A-A

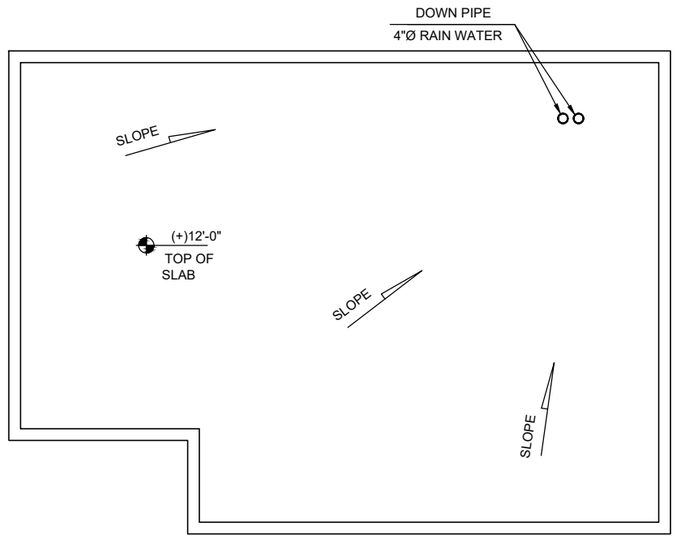
SCHEDULE OF DOORS, WINDOWS AND VENTILATOR

TYPE	OPENING SIZE	SILL LEVEL	DESCRIPTION
D1	3'–6" x 7'–0"	–	PRESSED STEEL FRAME WITH DEODAR WOOD SINGLE LEAF DOOR
D2	2'–6" x 7'–0"	–	PRESSED STEEL FRAME WITH DEODAR WOOD SINGLE LEAF DOOR
W1	6'–0" x 4'–6"	2'–6"	M.S. BOX SECTION FRAME GLAZED OPENABLE WINDOW WITH FIXED WIREGAUZE INSIDE & GRILE
V1	3'–0 x 2'–0"	5'–0"	M.S. BOX SECTION FRAME GLAZED OPENABLE WINDOW WITH FIXED WIREGAUZE INSIDE & GRILE



GROUND FLOOR PLAN

(STAFF ROOM & TOILET)
COVERED AREA = 170 SFT



ROOF PLAN

(STAFF ROOM & TOILET)

NOTES:

1. ALL DIMENSIONS ARE IN FEET UNLESS OTHERWISE SPECIFIED.
2. THIS DRAWING TO BE READ IN CONJUNCTION WITH ALL OTHER RELEVANT DRAWINGS.
3. FOR EXECUTION REFER TO RELEVANT STRUCTURAL DRAWINGS.

CLIENT

PUNJAB RURAL MUNICIPAL SERVICES COMPANY (PRMSC)

CONSULTANT

NATIONAL ENGINEERING SERVICES PAKISTAN (PVT.) LTD.

HEAD OFFICE:- NESPAK HOUSE, I-C, BLOCK-N, MODEL TOWN EXTENSION, LAHORE, PAKISTAN.

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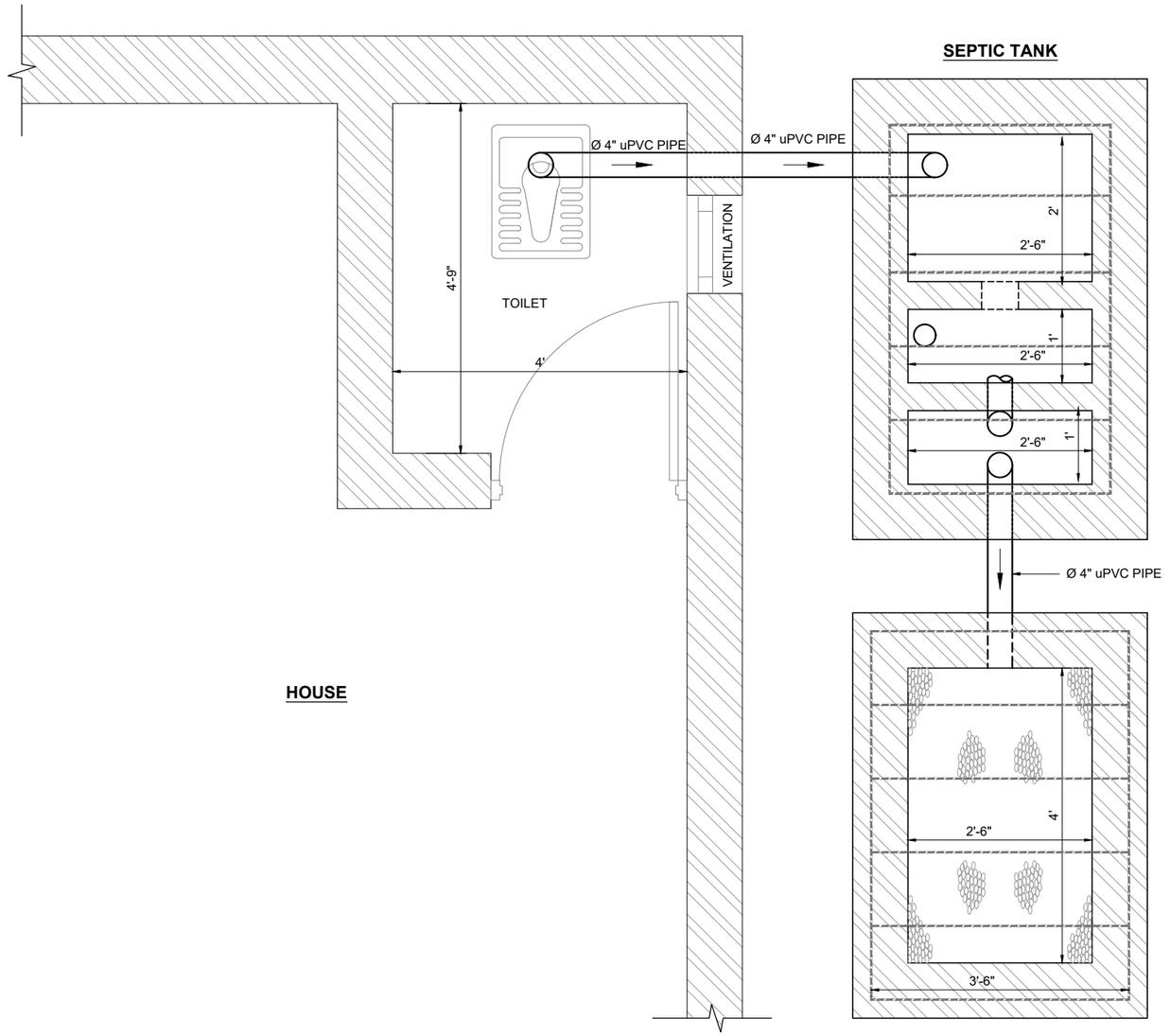
PROJECT

ENGINEERING DESIGN & CONSTRUCTION SUPERVISION CLUSTER (NORTH)
PUNJAB RURAL SUSTAINABLE WATER SUPPLY & SANITATION PROJECT

STAFF QUATRTER

DATE	DRAWING No.	REV.
DECEMBER, 2025	**4979/11/DD/2J187**	0

SCALE 1" = 75'



TYPICAL CONNECTION OF TOILET WITH SEPTIC TANK & SOAKAGE PIT

NOTES

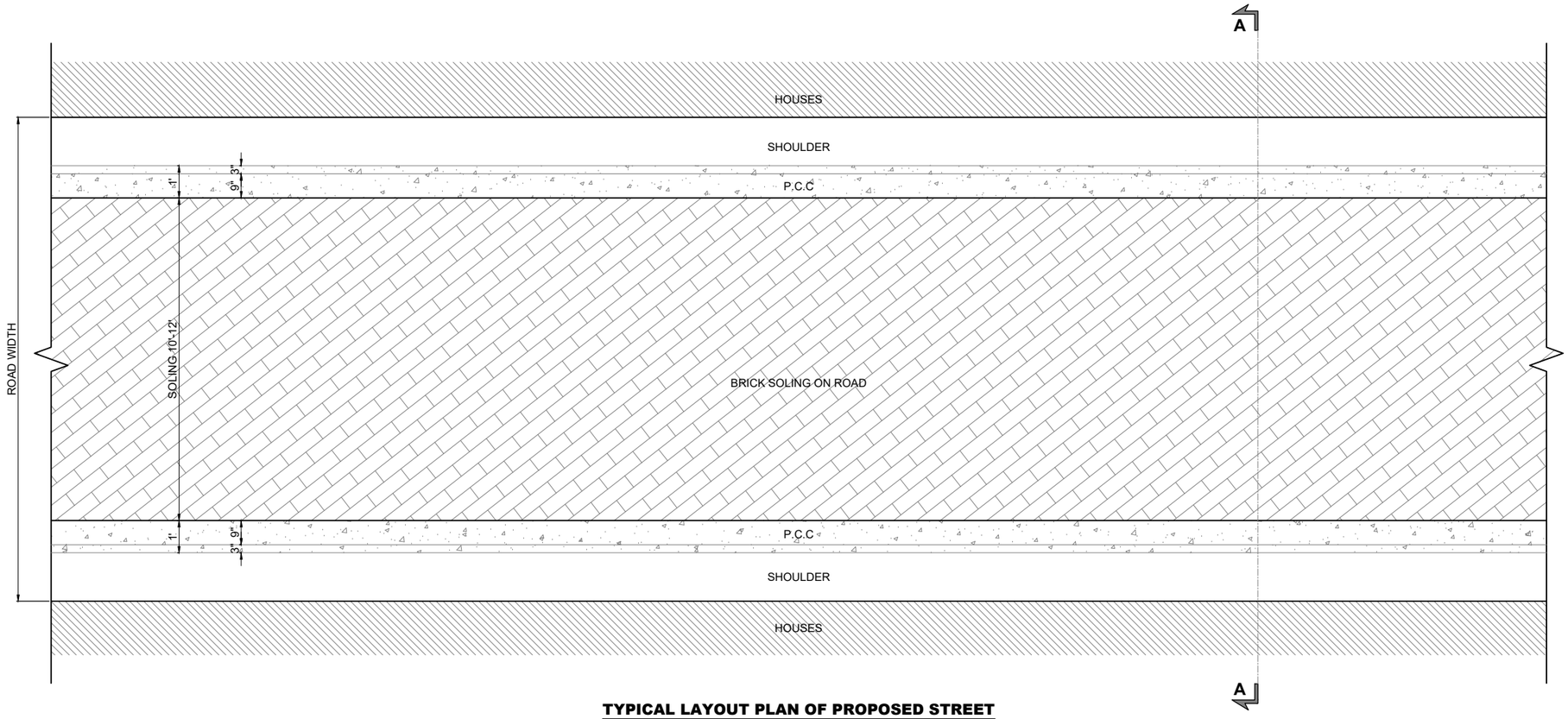
1. ALL DIMENSIONS ARE IN FEET AND PIPE DIAMETERS ARE IN INCHES UNLESS OTHER SPECIFIED.
2. THIS DRAWING SHALL BE READ IN CONJUNCTION WITH ALL OTHER RELEVANT DRAWINGS.

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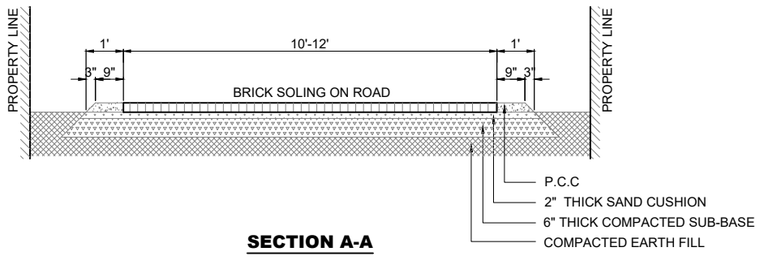
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TYPICAL CONNECTION OF TOILET WITH SEPTIC TANK & SOAKAGE PIT

DATE	DRAWING No.	REV.	SCALE
DECEMBER, 2025	**4979/11/DD/2J188**	0	1:24



TYPICAL LAYOUT PLAN OF PROPOSED STREET



SECTION A-A

NOTES

1. ALL DIMENSIONS ARE IN FEET UNLESS OTHER SPECIFIED.
2. THIS DRAWING SHALL BE READ IN CONJUNCTION WITH ALL OTHER RELEVANT DRAWINGS.

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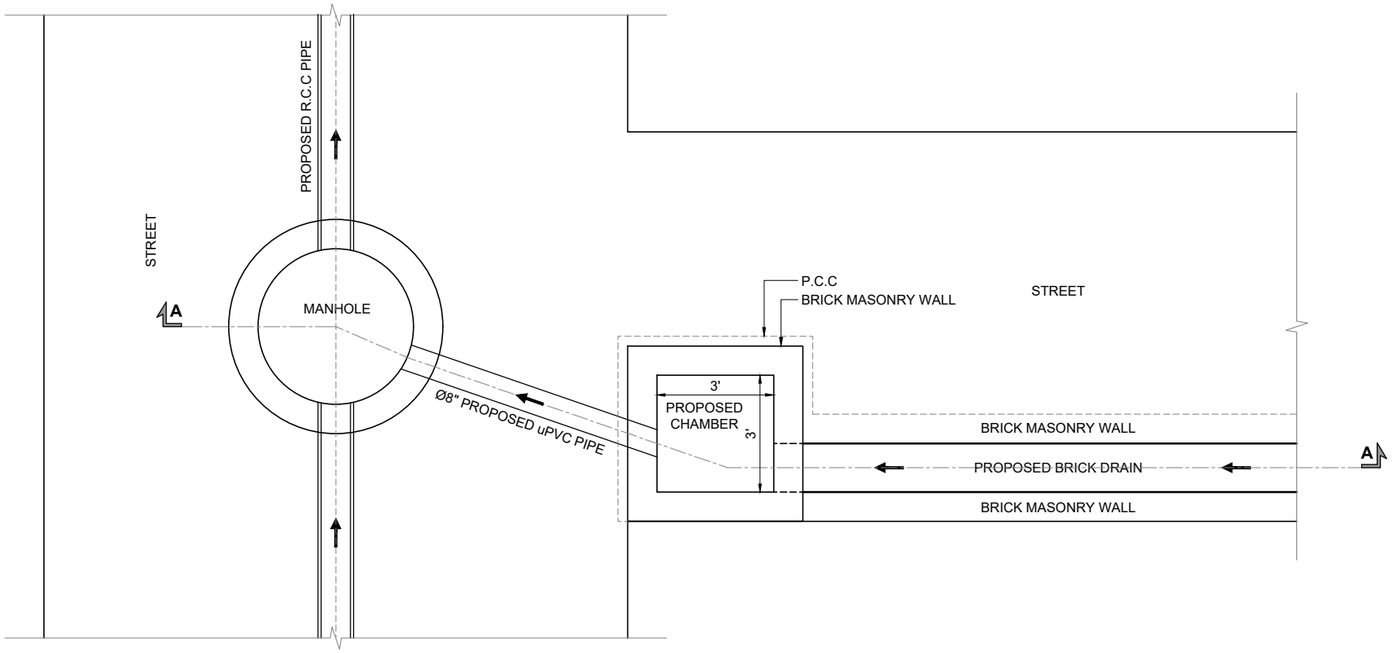
PROJECT

ENGINEERING DESIGN & CONSTRUCTION SUPERVISION CLUSTER (NORTH)
PUNJAB RURAL SUSTAINABLE WATER SUPPLY & SANITATION PROJECT

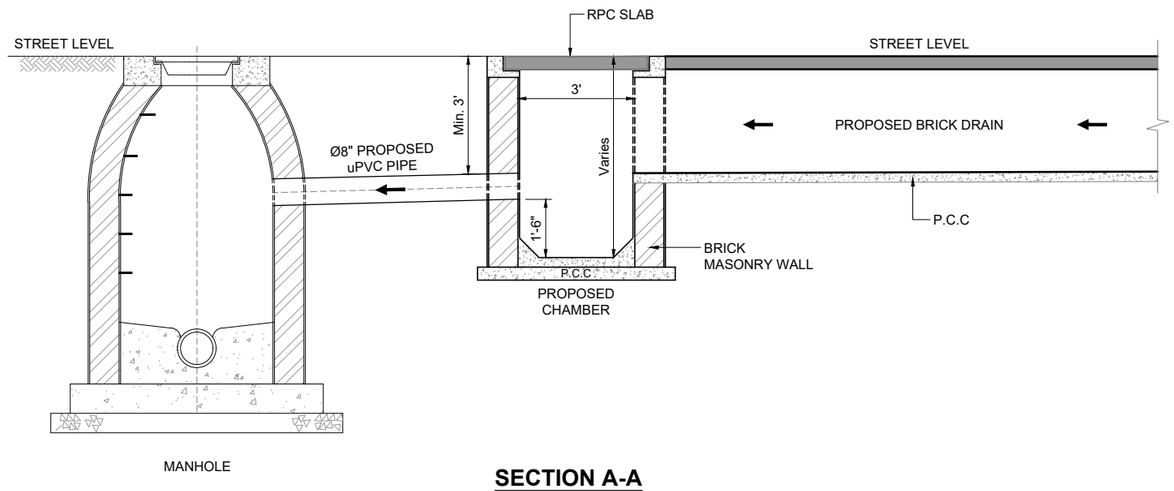
PLAN & SECTIONAL DETAIL OF PROPOSED WIDER STREET FOR NOORPUR THAL

DATE	DRAWING No.	REV.
DECEMBER, 2025	**4979/11/DD/2J189**	0

SCALE 1:50



PLAN



SECTION A-A

NOTES

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CLIENT

PUNJAB RURAL MUNICIPAL SERVICES COMPANY (PRMSC)

CONSULTANT

NATIONAL ENGINEERING SERVICES PAKISTAN (PVT.) LTD.

HEAD OFFICE:- NESPAK HOUSE, I-C, BLOCK-N, MODEL TOWN EXTENSION, LAHORE, PAKISTAN.

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PUNJAB RURAL SUSTAINABLE WATER SUPPLY & SANITATION PROJECT

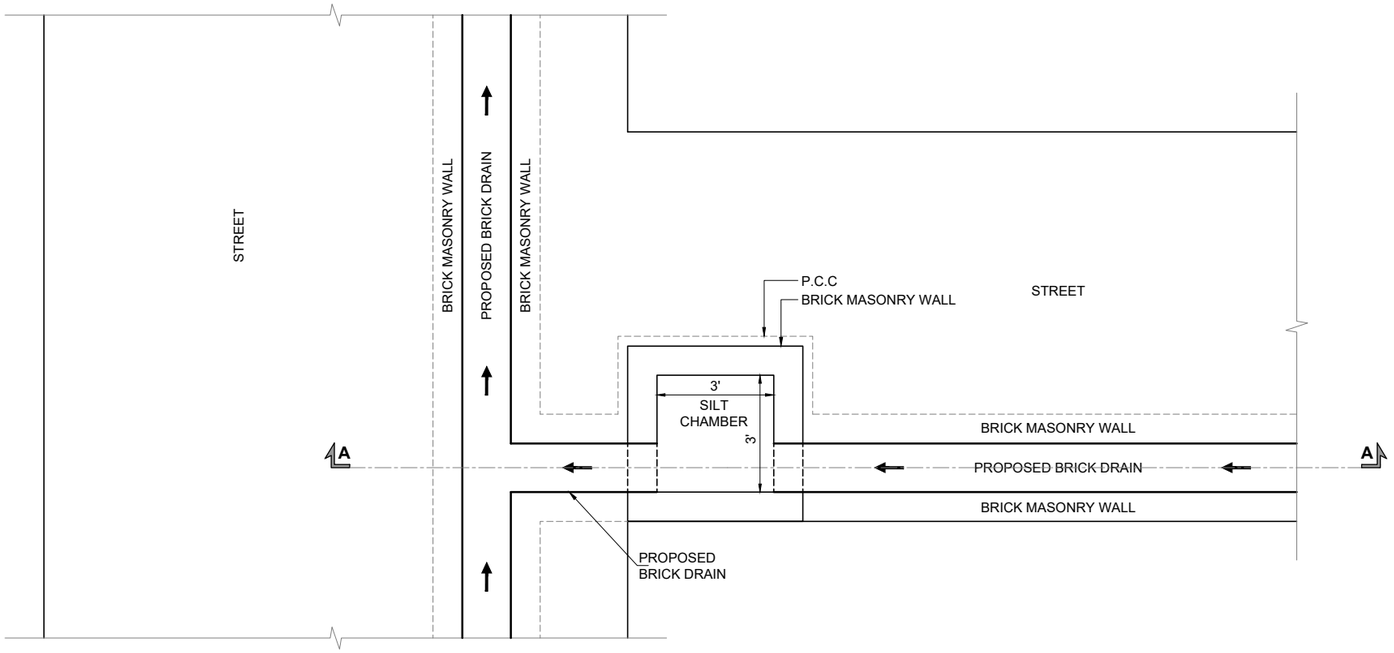
CONNECTION OF DRAIN WITH MANHOLE

SCALE 1:48

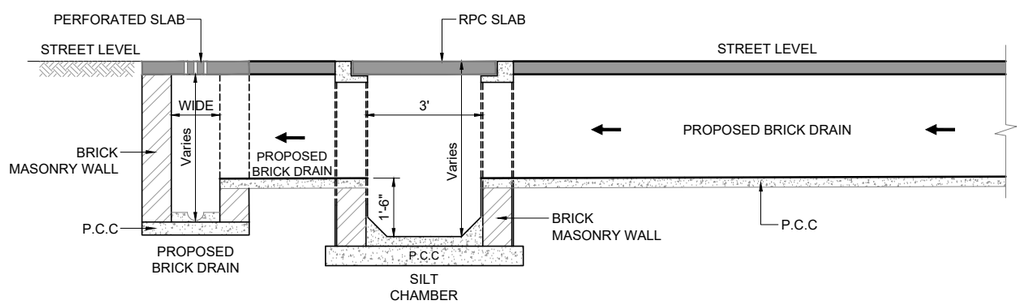
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PLAN



SECTION A-A

NOTES

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		REV. / DATE / DESCRIPTION	APPROVED	APPROVED	

PROJECT: ENGINEERING DESIGN & CONSTRUCTION SUPERVISION CLUSTER (NORTH) PUNJAB RURAL SUSTAINABLE WATER SUPPLY & SANITATION PROJECT

CONNECTION OF DRAIN WITH DRAIN

SCALE: 1:48

DATE: DECEMBER, 2025

DRAWING No.: **4979/11/DD/2J191**

REV.: 0

PRMSC

Punjab Rural Municipal Services Company

"Tender Package for Civil Infrastructure Works

TECHNICAL SPECIFICATIONS

APRIL-2023

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PART-A, GENERAL

SECTION-1 GENERAL

1.1 SITE INFORMATION

The Contractor shall visit the site prior to making his bid and shall ascertain the nature of strata, the earth, its quality/quantity, locations, and suitability to meet the specified requirements, existing situation of working area and he shall base his bid estimates solely on his own studies and tests.

Any information about the properties of the soil that may be shown on the Drawings or obtained by the Contractor as a result of discussion with the Engineer or others shall be prejudice and shall not be considered as a valid basis for the Contractor's bid prices and subsequent execution and completion of works. The bore logs shown on the Drawings, if any, are tentative one and do not mean that the same strata will be involved during boring. The Contractor may carry our boring as per the actual strata at no additional cost to the Works.

1.2 LAYOUT

The layout of works for the purposes of execution of roads, water supply, sewerage, drainage and facilities under the scope of work shall be carried out by the Contractor subject to confirmation / check by the Engineer which must be accurately as per the Drawings and instructions of the Engineer. Before commencement of construction work, the layout shall be checked and certified by the Engineer's Representative or Engineer. The measurement for payment shall not be taken for this item of the work, price shall be deemed to be included in other items of Works.

1.3 SURVEY EQUIPMENT

The Contractor with the approval of the Engineer shall provide survey equipment for the Engineer's Representative and his staff which shall be of the number, type and quality (or equivalent) as listed in **Table** 1.1.

Table 1.1, List of Survey Equipment

Sr. No.	Equipment	Quantity
1	Total Station complete with Standard Accessories model SOKKIA SET 2010 or Equivalent	1-No.
2	Single Tilting Range Pole Prism Complete Set Model SOKKIA KPS 11 PT or Equivalent	1-Set
3	Single Tilting Prism W / Coaxial Target Complete Model SOKKIA KPS 12 or Equivalent	1-Set
4	Automatic Levels, with Standard Aluminium Tripod	2-Nos.

Sr. No.	Equipment	Quantity
	Model B20	
5	Steel Measuring Tapes 50m and 20m long	2-Each
6	Steel Measuring Tapes 3m long	6-Nos.
7	Levelling Staff (4m)	2-Nos.
8	Ranging Rods	as required
9	All Miscellaneous Tools, Equipment and Materials required in Surveying	as required

The cost of said survey equipment shall be deemed included in other items of works; as such no separate payment shall be made. All surveying equipment shall be new and maintained in perfect working condition throughout the contract period and replaced by the Contractor in case of damage or loss under the terms and condition of the agreement.

1.4 PLANT, EQUIPMENT AND TOOLS

The Contractor shall provide at his cost modern plant, equipment and tools, adequate and befitting to the nature, magnitude and size of this Contract, in strict compliance with the requirements of the Contract.

1.5 STORAGE & HANDLING FACILITIES

The Employer will provide the necessary space if available with him, for constructional activities including batching plant, laboratory, workshop, storage of plant, equipment and materials and for Contractor's temporary office/camp, during the currency of the Contract. If the space is ' not available with the Employer then the contractor shall arrange these facilities without additional cost to the Employer.

1.6 TEST LABORATORY TESTING AND TESTING REPORT

Testing, except as otherwise specified herein, shall be performed by testing agency approved by the Engineer and at no extra cost to the Employer. The Contractor shall bear the Cost of such Testing. The Engineer may require all or part testing to be carried out under his supervision only.

The quality control testing shall be performed by the Contractor's competent personnel in accordance with a site testing and quality control program to be established by the Contractor and approved by the Engineer. The Contractor shall keep a complete record of all quality tests performed on site.

All quality control and tests shall be carried out in accordance with

applicable standards and codes.

1.7 PROTECTION OF THE WORKS

The Contractor shall whenever necessary cover up and protect the works from weather and damage by his own or other workmen performing subsequent operation at no extra cost to the Employer including all necessary dust sheets, barriers and guard rails and clear away the same on completion.

1.8 RESTORATION AND CLEANING

Upon completion of the works the Contractor shall restore all items covered by the Contract to the satisfaction of the Engineer.

The Contractor shall do regular cleaning and clean away all rubbish and excess materials that may accumulate from time to time on completion and before handing over. Upon completion of the Works, he shall obliterate all signs of temporary construction facilities such as work areas, structures, foundations of temporary structures, stock piles of excess or waste materials, as directed by the Engineer. Trash shall be removed daily to the satisfaction of the Engineer.

1.9 COORDINATION WITH OTHER WORKS

The Contractor shall coordinate with other Contractors executing other works in the project area or in the vicinity. The Contractor shall plan and schedule these activities in close liaison with other Contractors. The cost of this coordination will be deemed to be included in other items of works as such no separate payment is admissible for the coordination.

1.10 DEFINITIONS

Capitalized terms used in these specifications shall have the meanings specified in Volume-I, Condition of Contract, unless the context expressly or by necessary implication otherwise requires.

1.11 ABBREVIATIONS

Whenever, in these specifications, the following abbreviations are used, the intent and meaning shall be interpreted as follows:

°C	Degree Centigrade
°F	Degree Fahrenheit
AASHTO	American Association of State Highway and Transportation Officials
ASTM	American Society for Testing and Materials
ACI	American Concrete Institute

ASIC	American Institute of Steel Construction
ASCE	American Society of Civil Engineers
AWWA	American Water Works Association
BS	British Standards
BSI	British Standard Institute
CBR	California Bearing Ratio
cm	Centimetre
DIN	Deutsches Institut für Normung
EN	European Norm
HDPE	High Density Polyethylene Pipe
HP	Horse Power
ISO	International Standards Organization
JMF	Job Mix Formula
kg	Kilogram
km	Kilometre
lb	Pound
m	Metre
mm	Millimetre
PN	Pressure Nominal
WBM	Water Bound Macadam

PART-B, WATER DISTRIBUTION NETWORK

SECTION-2 EARTH WORK FOR WATER LINES

2.1 SCOPE OF WORK

EARTH WORK FOR WATER LINES

The work covered by this section of the specifications consists of furnishing all plant, labour, equipment, appliances, and materials and performing all operations in connection with excavation, trenching and back filling (with compaction) for water lines and appurtenances in strict accordance with this section of the specifications and the applicable Drawings, and subject to the terms and conditions of the Contract.

2.2 CLEARING AND GRUBBING

The sites of all excavations shall be cleared of all shrubs, plants, bushes, large roots, rubbish and other surface materials. All such materials shall be removed and disposed of in a manner satisfactory to the Engineer. All trees and shrubbery that are designated by the Engineer to remain shall be adequately protected and preserved in an approved manner.

2.3 EXCAVATION

2.3.1 General

All excavation of whatever substance encountered shall be performed to the depths indicated or as otherwise specified. During excavation, material suitable for backfilling shall be stockpiled in an orderly manner at a sufficient distance from the banks of the excavation to avoid overloading and to prevent sides from caving. All excavated material unsuitable or not require such a manner that street passage is not blocked by excavated material. Grading shall be done as may be necessary to prevent surface water from flowing into trenches or other excavations, and any water accumulated therein shall be removed by pumping or by other approved methods. Unless otherwise indicated or approved by the Engineer, excavation shall be open cut.

2.3.2 Trench Excavation

Unless otherwise directed or permitted by the Engineer not more than 500 feet of any trench in advance of the end of the pipeline already laid shall be opened at any time, unless otherwise directed permitted by the Engineer not more than 1000 feet of any one trench shall be worked on at a time. The banks of the pipe trench shall be as nearly vertical as practicable. Bell holes and depressions for joints shall be dug after the trench bottom has been prepared. The pipe, except for joints, shall rest on the prepared bottom for its length. Bell holes and depressions shall be only of such length, depth, and width as required for properly making the particular type of joints. Stones shall be removed to avoid point bearing. Whenever wet or otherwise unstable

material that is incapable of properly supporting the pipe as determined by the Engineer is encountered in the bottom of the trench, such material shall be removed to the depth required and the trench backfilled to the proper grade with coarse sand, or other suitable approved granular material. Such replacement of unsuitable material will be paid for at the contract unit price for that item of work. Trenches shall be of a depth to provide a maximum cover, over the top of the pipe, of 30 in. from the existing ground surface or finished grade whichever is closer except that trenches for pipe laid in lanes and alleys of narrow travelled way (average width of 8 feet or less between structures) shall be of a depth to provide a minimum cover, over the top of the pipe, of 18 in from the existing ground surface or finished grade whichever is closer.

2.3.3 Excavation for Appurtenances

Excavation for appurtenances shall be sufficient to leave at least 12-inch but not more than 24 in., between the outer surface and the embankment or timber that may be used to hold and protect the banks. Any over depth excavation below such appurtenances that has not been directed by the Engineer, will be considered unauthorized and shall be refilled with compacted sand, gravel or concrete, as directed by the Engineer and at no additional cost to the Employer.

2.3.4 Maintenance of Excavation

All excavation shall be properly maintained while they are open and exposed. Sufficient suitable barricades, warning lights, flood lights, signs, and similar items shall be provided by the Contractor. The Contractor shall be responsible for any damage due to his negligence.

2.3.5 Removal of Water

The Contractor shall build all drains and do ditching, pumping, well pointing, bailing, and all other work necessary to keep the excavation clear of ground water, sewage and storm water during the progress of the work and until the finished work is safe from injury. All water pumped or drained from the work shall be disposed of in a manner satisfactory to the Engineer and necessary precautions against flooding shall be taken.

2.3.6 Sheeting and Bracing

If ordinary open cut excavation is not possible or advisable, sheeting and bracing shall be furnished to the work and to provide working conditions which are safe. The Contractor shall furnish and place all sheeting, shoring, wall braces, timbers and similar items, necessary for the safety of the work, the general public and adjacent property. Sheeting shoring and bracing shall be removed as the work progresses and in such a manner as to prevent damage to finished work and adjacent structures and property. As soon as withdrawn, all voids left by the sheeting and bracing shall be carefully filled

with sand and compacted. The Contractor shall be fully responsible for the safety of work in progress, for the finished work, the workmen, and the public and adjacent property.

2.3.7 Protection of Facilities

Existing subsurface facilities likely to be encountered during the execution of work require special precaution for the protection, such as sewers, drain pipes, water main, conduits and electric cables and the foundations of adjacent structures. The Contractor shall be responsible for the damage of any such facility and shall repair the same at his expense whether or not this facility has been shown on the Drawings.

2.3.8 Surplus Materials

All surplus materials shall be disposed of at locations approved by the Engineer. The disposal of surplus material shall not interfere with other works and shall not damage or spoil other material. When it is necessary to haul earth or rock material over street or pavement, the Contractor shall prevent such material from falling on the street or pavement.

2.3.9 Cutting Pavement

In cutting or breaking street surfacing, the Contractor shall not use equipment which will damage the adjacent pavement. Existing paved surfaces shall be cut back beyond the edges of the trenches to form neat square cuts. The road ballast, brick pavement, and other materials shall be placed on one side and shall be preserved for re-instatement when the trench is filled. Wherever necessary or required for the convenience of the public or individual residents, at street crossings and at private driveways, the Contractor shall provide suitable temporary bridges over unfilled excavations. All such bridges shall be maintained in service until backfilling has been completed. The Contractor shall keep the road crossings manned 24 hours per day. During night time, enough red lights shall be provided to warn traffic. If detour is necessary, the Contractor shall make proper detour for the traffic and shall install signs 1 metre by 1.2 metre in size indicating the detour.

2.4 BACKFILLING

a. The trenches shall not be completely backfilled until all required pressure tests are performed and until the water lines as installed conform to the requirements of specifications. Where in the opinion of the Engineer, damage is likely to result from withdrawing sheeting, shoring; the same shall be left in place and cut off at a level 12-inch below ground surface. Sheeting left in place at the direction of the Engineer will be paid for at the contract unit price/approved rate for that item of work. Trenches shall be backfilled to the ground surface

with selected excavated material or other material that is suitable for proper compaction. Trenches improperly backfilled shall be reopened to the depth required for proper compaction, then refilled and compacted to the specified density. The surface shall be restored to its original or better condition. Pavement and base course disturbed by trenching operations shall be replaced.

b. Lower Portion of Trench: Backfill material shall be deposited in 6-inch maximum thickness layers and compacted with suitable hand tampers to ninety percent of maximum density until there is a cover of not less than 12-inch over the water lines. The backfill material in this portion of trench shall consist of sandy clay or other approved materials free from stones and humps.

c. Remainder of Trench: The remainder of the trench shall be backfilled with material that is free from stones larger than 6-inch in any dimension. Backfill material shall be compacted to ninety percent of maximum density.

2.5 BORROW

Where suitable material for backfill is not available in sufficient quantity from required excavations, suitable material shall be obtained from approved sources at the contractor's responsibility. The necessary clearing and grubbing or borrow areas, disposal and burning of debris there from, the developing of sources including any access roads for hauling and the necessary right-of-way, and the satisfactory drainage of the borrow shall be considered as incidental items to borrow excavation.

2.6 GRADING

After the completion of all backfilling operations, the contractor shall grade the work areas to the lines, grades and elevation shown on the Drawings. Finished grading shall not be done until the installation of all water lines has been completed and tested. The top surface after completion shall be "in level "to the adjacent existing surface. Prior to final acceptance, all damage due to settlement shall be repaired by and at the expense of the Contractor.

2.7 TESTING DENSITY OF SOIL IN PLACE

The Engineer will make tests using the calibrated sand cone method/core cutter method to determine the density of soil in place. If soil in place fails to meet the specified degree of compaction the areas represented by the failing tests shall be removed, replaced and compacted to the specified density in the manner directed by the Engineer and at no additional cost to the Employer.

2.8 MEASUREMENT AND PAYMENT

2.8.1 Measurement

The measurement shall be made for the actual quantity of the work done in cubic foot or cubic metre (whichever is included in Bill of Quantities). The maximum width of the trenches along with height allowed for payment for various pipe sizes are included in the Drawings.

2.8.2 Payment

The unit rate included in the Bill of Quantities for excavation of trenches for water supply lines shall be considered as full compensation for the work specified in this section and shall include all excavation, backfilling, compacting, constructing and removing all temporary arrangements, pumping and dewatering, disposal of surplus materials, removal of soft soil from bottom of trenches, removing the surface material and all incidentals to complete this work in all respects.

SECTION-3 HDPE PIPES & FITTINGS

3.1 SCOPE OF WORK

This work shall consist of providing, laying, testing and disinfection of High-Density Polyethylene (HDPE) pipes conforming to ISO 4427, DIN 8074/8075 & PS 3580 with PN-8, 10 & 12.5 (PE 100) and in trenches to correct alignment and grade, as indicated in the drawing and specifications including all other accessories and equipment.

3.2 DEFINITIONS

The following terms shall have the meanings hereby assigned to them except where the Contract clearly renders these meanings inapplicable.

"Pipe" means pipe or pipes, bends, fittings and other specials and includes joints, jointing parts and materials.

"Valves" means gate valves, butterfly valves, air valves and the like and includes jointing materials, operating gear and associated fittings.

"Installation" means removing from storage, loading, hauling, handling, placing, fixing, jointing in position and testing whether in trench or elsewhere in the Works.

"Pipeline" means those parts of the works comprising pipe, fittings, valves, valve chambers, other chambers, anchors, thrust blocks and all other appurtenances required for proper functioning, operation and maintenance of the pipeline.

3.3 APPLICABLE STANDARDS AND CODES

The following codes and standards, to the extent specified herein, form a part of this specification. The latest edition of these codes and standards shall govern the work.

ISO 4427	Polyethylene (PE) pipes for water supply - specifications
IS0161-1	Thermoplastic pipes for conveyance of fluids - nominal outside diameter and nominal pressure- part 1: Metric series
ISO 1167-1 to 4	Thermoplastic pipes, fittings and assemblies for the conveyance of fluids
IS0 3126	Plastic pipe - Measurement of dimensions
ISO 4065	Thermoplastic pipes - Universal wall thickness table
ISO 6964	Polyolefin pipes and fittings - Determination of carbon black content by calcination and pyrolysis - Test method and basic specification.
ISO 9080	Thermoplastic pipes for the transport of fluids - Method

	of extrapolation of hydrostatic stress rupture data to determine the long-term hydrostatic strength of thermoplastic pipe materials.
ISO 11922-1	Thermoplastic pipes for the conveyance of fluids - Dimensions and tolerances Part: 1: Metric series.
IS012162	Thermoplastic materials for pipes and fittings for pressure applications - Classification and designation - overall service (design) coefficient.
ISO 13761	Plastic pipes and fittings - pressure reduction factors for polyethylene pipeline systems for use at temperatures above 200 C.
ISO 7005- 3	Metallic flanges - Part 3, Copper alloy and composite flanges
BS EN 12201	Plastic piping systems for water supply ·polyethylene
ISO 974	Determination of the brittleness temperature by impact
ISO 2505	Thermoplastics pipes ·Longitudinal reversion
ISO 6259	Determination of tensile properties
ISO 1133	Determination of the melt mass-flow rate (MFR) and the melt volume-flow
ISO 877	Methods of exposure to direct weathering

3.4 TECHNICAL REQUIREMENTS

3.4.1 Material

The Contractor shall identify the manufacturer of the resin, the resin type and classification. In addition, the Contractor shall provide evidence that the resin proposed is suitable for use at the design temperature and under the design pressures.

Any change in the material, the material specification, or the manufacturer's location shall be subject to prior approval of the Engineer.

Pipes and fittings shall be homogenous throughout and free from visible cracks, holes, foreign inclusions, blisters, dents or other damaging defects.

Material shall be uniform in opacity, density, interior smoothness, and other physical properties.

It shall have adequate resistance to weathering and other ageing from storage for a minimum of two years after manufacture.

The material of the polyethylene pipes and fittings which is in contact with or likely to come in contact with drinking water shall not constitute a toxic hazard, shall not support microbial growth and shall not give rise to unpleasant taste or odour, cloudiness or discoloration of the water.

The concentration of substances, chemical and biological agents leached from materials in contact with drinking water, and measurement of the relevant organoleptic / physical parameters, shall not exceed the maximum values recommended by the World Health Organisation in its "Guidelines for Drinking Water Quality" or the EEC Council Directive on the "Quality of Water Intended for Human Consumption", whichever is more stringent in each case.

For the manufacturing of pipes & fittings new materials to be used only (Rework material is not acceptable.)

Pipe manufacturer shall confirm that all fittings to be provided for the pipe systems shall meet the same quality requirements as for the pipes to ensure the same performance for design life cycle.

The pipes and fittings shall be manufactured from polyethylene containing only those antioxidants, UV stabilizers and pigments necessary for the manufacturing process to fulfil the requirements of the specification.

All pipes and fittings shall be suitable for butt fusion or electro fusion techniques.

Contractor shall provide HDPE manufacturers guideline for the applicability of the material used. If required HDPE manufacturers shall provide assistance and training.

3.4.2 Physical Properties

Pipes and fittings shall be made of HDPE and shall comply with the requirements of ISO 4427 PE 100. The material shall be produced by a member of the PE 100 + Association.

The material used for the manufacturer of pipes and fittings shall be in accordance with Table-1 and Table-2 of clause 4.4 of ISO 4427-1. The minimum required strength (MRS) of the material compound shall be 10 MPa at 20°C. The design stress shall be 8 MPa.

Lifecycle durability of 80 years is to be confirmed.

Pressure reducing coefficients, as included in Annexure-A of ISO 4427-1, are also applicable. The thermal stability of polyethylene material shall meet the requirements of ISO 4427.

3.4.3 Pipe Dimensions

The pipe dimensions for water systems shall be based on standard dimensions according to ISO 4427 and measured in accordance with ISO 3126.

Straight pipe shall be supplied in standard lengths measured at 239°C ± 29°C, unless otherwise specified; coil lengths shall not exceed 100 m (328 ft).

Coiled pipes shall be coiled such that localized deformation is voided and diameter of the coil shall not be less than 18 dn.

3.4.4 Pipe Appearance

When viewed without magnification the internal and external surfaces of pipes shall be smooth, clean and free from scoring, cavities and other surface defects. The pipe ends shall be cut cleanly and square to the axis of the pipe.

All polyethylene pipes to be used for the transmission and distribution of potable water shall be black and have blue stripes.

The carbon black content in the compound shall be 2.25% ± 0.25% by mass when measured in accordance with ISO 6964. The dispersion of carbon black when determined in accordance with ISO 11420 shall be equal to or less than grade 3.

3.4.5 Fittings

The fittings shall be injection moulded and formed from material that is compatible to that of the pipe and shall be as resistant to the external and internal environments as the other demands of the pipe system.

At locations where HDPE pipe to metal connections is specified, Nylon-11 based polyamide coating system complying with the requirement of AWWA C224 or epoxy coated backing rings shall be used, or special restrained transition fittings subject to approval by the Engineer. The flanges shall be drilled to ISO 7005-2, as per the design requirements.

3.4.6 Fittings Appearance

When viewed without magnification the internal and external surfaces of pipes shall be smooth, clean and free from scoring, cavities and other surface defects. The fitting shall be blue or black.

3.4.7 Fittings Dimensions

The dimensions shall be measured in accordance with EN/ISO 3126.

3.4.8 Wall Thickness of Fittings

The wall thickness of the body of the fitting at any point shall be equal to or greater than the minimum wall thickness of the corresponding pipe.

3.4.9 Pipe Installation

a. Trench excavation shall be carried out in accordance with Section Excavation of the specifications.

b. Install pipe, fittings, and accessories in accordance with manufacturer's instructions:

- Provide qualification details of the manufacturer's technical expert to be assigned to the Contract. The technical expert shall have expertise, experience and skills necessary for advising and monitoring all aspects of transport, storage, handling, installation and testing of pipes as appropriate.

- The technical expert shall provide comprehensive technical assistance to the Contractor throughout Contract and regularly monitor the Contractor's activities and report on shortcomings.

c. The pipeline shall be within 1-inch of the specified line and the invert level shall be within 6mm of the specified value and shall be such that there is no back fall at any point on a gravity pipeline.

d. Install bedding, surround and backfill in accordance with the pipe manufacturer's requirements.

e. Install appurtenant facilities on the pipeline such as manholes, valve chambers as specified of the specification.

f. Lay pipes from downstream to upstream unless agreed otherwise with the Engineer.

g. HDPE pipelines can accommodate gradual changes of direction in the vertical and horizontal plane. However, the pipe should not normally be bent to a radius less than 25 times the outside diameter of the pipe.

h. When cut pipe is required, ensure that the cutting is done by a machine, leaving a smooth cut at right angles to the axis of the pipe.

i. Ensure that all pipes and fittings are sound and clean before laying. When pipe lying is not in progress, ensure that the pipe ends are at all times fitted with watertight plugs or caps. The plugs or caps shall only be removed for the purposes of making a connection of the pipe end or testing the pipeline. The plugs or cap shall be replaced immediately on completion of the test.

3.4.10 Backfilling

The selected fill material as shown on the Drawings shall be hand-compacted in layers not exceeding 150mm to complete the pipeline surround. Compaction shall be carried out equally on either side of the pipeline to prevent displacement. The backfill shall be hand-compacted up to 300 mm above the crown of the pipe. Any temporary support shall be gradually withdrawn during placing of the bedding and backfill materials to ensure that materials are placed against the trench side. The remaining portion of the trench shall be compacted in layers not exceeding 200 mm using approved mechanical rammers.

Where filter fabric is used to enclose granular pipe surrounds, the fabric will be placed on the prepared trench formation and carefully supported during pipe laying operations. When the pipe has been laid complete with granular surround to the correct level the filter fabric will be closed by forming a lap equal to trench width. Care shall be taken that the membrane is not punctured or damaged in any way during these operations and backfilling

the trench.

Where concrete bedding or surround is specified, concreting shall be carried out as specified in SECTION-20 PLAIN & REINFORCED CONCRETE. The backfill other than first 150 mm of cover shall not be placed before the compressive strength of the concrete has reached 15 MPa. The remaining portion of the trench shall be backfilled as specified.

3.4.11 Cutting Pipes

The Contractor shall be responsible for taking the measurements required to determine the lengths of cut portions of pipes for insertion as closing lengths in pipelines. The pipe and methods of jointing shall be such that the locations of fittings and lengths of pipe can be adjusted in the field to suit field conditions and variations in stationing. No extra payment will be made for such adjustments or for any welding, couplings, fittings, or special lengths required to meet this requirement.

The cutting of ductile iron and HDPE pressure pipes for inserting specials, fittings or closure pieces shall be performed by the Contractor. Cutting shall be carried out in a neat and workman like manner with an approved cutting machine without damage to the pipe and so as to leave a smooth end at right angles to the axis of the pipe. The cut ends of pipes shall be chamfered. The Contractor shall take every precaution to ensure that both the measurements and the cutting of pipes are to the accuracy required and should any errors occur the Contractor shall remedy same at his own expense and as the Engineer directs.

3.4.12 Butt Fusion Jointing

Butt fusion jointing shall only be used to join pipes of the same PE material with compatible MFR and with the same nominal wall thickness and outside diameter. The following procedures shall serve as a general guide only. The Contractor shall obtain detailed jointing instructions from the manufacturer who shall have a technical representative available at the Engineer's request during the jointing process.

- The butt fusion machine should be sited within a shelter and the ends of the pipe being joined should be covered or plugged to prevent through drafts.
- Each component that is to be fused should be held in position in the purpose-built clamping. The lengths of pipe hanging outside the jig should be supported by means of roller cradles.
- The pipe ends should be faced so that the finished surfaces are perfectly smooth free of visible ridges, valleys or other surface imperfections.
- The outside diameters of the pipe ends should match closely without the offset exceeding 10%.

- The pipe ends should be heated to the pipe manufacturer's recommended temperature and interfacial pressure. The Contractor should use a pyrometer or other surface temperature measuring device to confirm and record the actual surface temperature for each weld. Temperature indicating crayons should not come into contact with the surface to be welded.
- After the pipe ends have been properly melted, the heater tool should be removed within the specified time. The molten pipe ends should be brought together and allowed to cool without disturbance to form the permanent weld. The proper bead size and geometry specified for the pipe being welded should be formed.

3.4.13 Saddles/Sidewall Jointing

Saddle /sidewall fusion jointing shall be accomplished by using a mechanical saddle fusion machine that has been designed for this purpose to ensure proper alignment, temperature and force control. The following procedures shall serve as a general guide only. The Contractor shall obtain detailed jointing instructions from the manufacturer who shall have a technical representative available at the Engineer's request during the jointing process.

- Any dirt or coating that might interfere with the proper operation of the saddle fusion machine should be removed from the pipe and the surfaces of the pipe and saddle roughened to expose fresh material and any reside brushed away.
- Test fit the saddle fusion machine to ensure that alignment and contact are as they should be.
- Commence the fusion process and periodically verify the surface temperature using a pyrometer or other surface temperature measuring device. If temperature indicating crayons are used, they should not be used on a surface which comes into contact with the surfaces to be welded.
- After the heating period, remove the heater plate and check for the correct melt pattern on both the fitting and the pipe. Join the fitting to the pipe with the prescribed fusion force.
- Cool the joint without disturbance until the melt has formed a permanent weld. The joint should. not be subjected to any external stresses until the fusion joint has cooled.

3.4.14 Electro Fusion Jointing

Electro fusion jointing involves heating the electro fusion joint internally, either by a wire coil at the interface of the joint or by a conductive polymer. Heat is created by an electric current passed to the conductive material in the fitting.

- Ensure that the fitting is dimensionally appropriate for welding to the

Pipe. Clean the pipe surface in the joint area. Cut the end of the pipe square. Mark on the pipe surface the proper position of the fitting to be installed. Scrape the surface of pipe area to be joined, removing all surface degradation and contamination. Avoid contamination of the scraped pipe surfaces.

- Place the pipe and fitting in the clamping fixture to prevent movement of the pipe or fitting.
- Connect the electro fusion control box to the fitting and to the power source. Apply electric current to the fitting as specified in the manufacturer's instructions. Turn off the current when the proper time has elapsed to heat the joint properly.
- Allow the joint to cool for the recommended time and remove the clamping fixtures. Do not remove prematurely from the clamps as any strain on a joint that has not fully cooled can be detrimental to joint performance.

3.4.15 Mechanical Joints and Fittings

Many types of mechanical connection styles and methods exist. The Contractor shall submit suitable mechanical joints. All such joints shall be recommended and acceptance tested by the manufacturer of the pipe. Where marked on the Drawings end-load resistant fittings of an approved type shall be used.

When tightening polyethylene flanges care shall be taken to produce an equal torque load to the limits given by the manufacturer. A torque wrench shall be used. Since polyethylene creeps under load, it is essential that the bolts are re-tightened several times prior to commissioning to minimize the risk of leakage.

All joint materials and gaskets shall be suitable for use in the prevailing climate, soil, ground water, and potable water and irrigation water conditions.

3.5 TOOLS

The Contractor shall supply all necessary tools for cutting, chamfering, jointing, and testing and for any other requirement for satisfactorily installing the HDPE pipelines.

3.6 CONTROL OF WATER

The Contractor shall furnish, install and operate all necessary machinery, appliances, and equipment to keep the excavation sufficiently free from water during construction of the work to permit proper laying and jointing.

3.7 INSPECTION AND TESTING

3.7.1 Certification and Documentation

Contractor shall supply the Engineer with copies of certificate and test documents. Such documentation shall be subject to the Engineers' approval prior to shipping.

3.7.2 Test Results and Frequencies

The Manufacturer shall establish and maintain a current record of test results according to the requirements of the applicable standards and this specification. The Manufacturer shall perform all the tests required by ISO 4427 to demonstrate the characteristics and quality of the resin material and the dimensional tolerances of the pipe. The Manufacturer shall document all the tests, with frequencies and results as indicated in ISO 4427. The records shall be kept for 10 years as a minimum.

3.7.3 Inspection and Audit Requirements

Pipe shall comply fully with ISO 4427, the requirements of the PE 100 + Association and all the additional requirements of this specification.

To verify compliance with this specification, the Engineer shall reserve the right to appoint an independent third-party inspector to witness the applicable qualification tests, review production records, and inspect general handling and shipping procedures. The third-party inspector shall have full access to the testing and production facilities and will be a fully authorized representative of the Engineer.

3.7.4 Acceptance Criteria

The order shall meet the following criteria:

a. A copy of the raw material Manufacturer's "Certificate of Quality Control Testing" covering each batch of raw material used for pipes purchased under this specification, shall be available for inspection by the Engineer on request.

b. Pipe wall thickness shall be controlled by continuous scanning using ultra-sound or other qualified devices. These devices shall be regularly calibrated for accuracy by certificated agency.

c. Successful test performance and acceptable results for the testing program outlined in this specification.

d. Acceptable results, when tested by the Engineer from samples collected from storage of pipes at the site of works, for tests included in ISO 4427 and summarised in Table 3.1.

Table 3.1, Testing Requirements of HDPE Pipe

Sr. No.	Parameter to be Tested	Test Method
1	Mean Outside Diameter (Min. & Max.)	ISO 3126
2	Out-of-Roundness (Ovality)	ISO 3126
3	Wall Thickness (Min. & Max.)	ISO 3126
4	Minimum Required Strength	ISO 12162
5	Density	ISO 1183
6	Hydrostatic Strength at 20oC	ISO 1167
7	Elongation at Break	ISO 6259
8	Tensile Strength at Yield	ISO 6259
9	Longitudinal Reversion	ISO 2505
10	Carbon Black Content	ISO 6964
11	Melt Mass Flow Rate	ISO 1133

3.7.5 Defects

When the rejected item is a length or coil of pipe, the lengths or coils manufactured immediately before and after the defective lengths or coils shall be carefully examined. If further defects are found, this is sufficient cause for rejecting the entire batch. This will not apply to local damage that did not occur during manufacture, such as gouges or cuts during handling or transit.

3.7.6 Quality Assurance/Quality Control

A copy of the Manufacturer's QA/QC plan shall be submitted to the Engineer with its quotation for review and concurrence prior to award. If Manufacturer's facility is ISO certified, QA audit requirements shall be waived in favour of ISO 9000 registrar audits, unless the Engineer's trend analysis program indicates areas of concern.

3.8 PIPELINE TESTING

3.8.1 General

The Contractor shall submit for the Engineer's approval details of his proposed methods and programme for testing (including details of test equipment) and shall arrange for all tests to be witnessed by the Engineer. Unless otherwise directed by the Engineer, the Contractor shall ensure that no section of pipeline remains untested with pipe trenches and joints left exposed for more than 7 days after laying each pipeline section. The method of achieving this shall be entirely the Contractor's responsibility and no time extension or additional payments whatsoever shall be entertained on account of Contractor's failure to achieve this condition.

The Contractor shall provide all things necessary for carrying out testing and cleaning including potable water, pumps, gauges, pipes, connections, stop-ends and all other temporary works.

Pipelines shall be properly completed and supported before being put under test except as hereinafter detailed.

The Contractor shall provide for transmitting the unsupported end thrusts to solid ground at the ends or into the sides of the trenches.

Before testing any pipeline, the Contractor shall ensure that the anchorage of bends is complete and thrusts from all branch outlets are properly stayed.

No testing will be permitted until seven days after thrust blocks and other holding down works have been completed.

Open ends shall be stopped with plugs, caps, or blank flanges properly jointed and restrained from movement.

No claims whatsoever will be entertained on account of leaking valves, or any other difficulties in closing of lengths of pipe work for testing, which shall be entirely at the Contractor's expense.

All water required for testing and cleaning the pipelines shall be potable water drawn off at locations approved by the Employer and shall be provided by the Contractor at his cost.

In addition to any tests of individual joints or other interim tests which may be specified elsewhere, the Contractor shall submit all parts of the pipelines to a final acceptance test. Notwithstanding the foregoing the Contractor may at any stage of construction, carry out such other tests as he considers desirable to check materials and workmanship on the pipeline but this shall not relieve the Contractor of his obligations to achieve successful tests under the Contract.

The Engineer shall have power to require the Contractor to vary any test procedure or pressure as he (the Engineer) thinks fit at no extra cost to the Employer.

The Contractor should note that neither the satisfactory testing of pipeline, section of a pipeline or any other pipe work, nor the acceptance of such testing by the Engineer or his representative shall in any way relieve the Contractor of any of his responsibilities and obligations under the Contract.

The Contractor shall notify the Engineer at least 24 hours before hand of his intention to test a section of pipeline having satisfied him in the first instance that the section of pipeline to be tested in the presence of the Engineer is satisfactory in all aspects.

Test gauges used for testing pressure pipelines shall be of conventional circular type of approved manufacturer, not less than 8-inch diameter, calibrated in bars or psi. Before any gauge is used, the Contractor shall arrange for it to be calibrated independently and a dated certificate of its accuracy shall be provided to the Engineer.

One additional gauge as above shall be handed over to the Engineer for purposes of verification during testing.

Calibration of pressure gauges shall be carried out by the Contractor at regular intervals as required by the Engineer.

The Contractor shall remain responsible for the care of the works during testing of the pipe work.

3.8.2 Interim Pipeline Testing

The interim test shall be carried out after the pipeline section to be tested has been laid, jointed and backfilled to a depth of at least 12-inch above the crown of the pipe but leaving the joints exposed. The sections to be tested shall be approved by the Engineer. The joints between each tested section shall then be left exposed until the pipeline has passed the Final Test on Completion

For purposes of interim testing, the pipeline shall be divided into sections and each section shall be separately tested to the Engineer's satisfaction for deflection and pressure when each section is completed and before the joints are covered in the case of buried pipes.

The Contractor shall submit to the Engineer detailed procedures for performing hydrostatic pressure tests of installed piping, fittings, valves, meters and appurtenances for approval. Procedures for performing hydrostatic pressure tests for each section of pipeline shall indicate the location and capacity of the test pump, test pressure at the pump as well as that at the highest and lowest points procedures for venting the air from the pipeline and disposing the water after satisfactory testing.

Each pipeline or section thereof shall be filled with water and all air removed as far as possible. If permanent air vents are not located at all high points, the Contractor shall install suitable cocks at such points so that the air can be expelled as the line is filled with water. After all the air has been expelled all cocks shall be closed and the test pressure applied. The line shall be filled slowly to prevent possible water hammer. The test pump and gauge shall be connected to the pipeline at a location other than the highest point in the line to facilitate the release of air from the highest point.

The pressure in the pipeline shall then be raised steadily up to and maintained at rated pressure of the pipe (10-bars for PN10 HDPE pipe) for a period of not less than 12 hours to allow for absorption and achieve conditions as stable as possible for testing. The standing period will commence from the time at which the rated pressure (10-bars for PN10 HDPE pipe) was reached successfully, after which all exposed joints shall be carefully inspected for evidence of leakage.

If neither appreciable movement of the pipeline nor any leakage has been observed during the visual inspection the section shall be subjected to the proper pressure test.

Pumping shall then be resumed and the pressure slowly raised to the specified test pressure i.e., 15-bars for PN10 HDPE pipe (1.5-times rated pressure of pipe). The test pressure shall be continuously maintained by the use of the pump for a period of at least 3 hours and the amount of makeup water required to maintain the pressure shall be accurately measured (to the nearest 1/8 litre) regularly every 30 minutes throughout the test.

The pipeline shall be deemed to have passed the test if:

a. No water is visible coming out of the pipe or joints at any point

b. Leakage is equal to or less than the number of imperial gallons per hour as determined by the following formula:

$$Q = \frac{n \, x \, d \, x \sqrt{p}}{1850}$$

where,

Q = Leakage in imperial gallons per hour

n = Number of joints in test section

d = Nominal diameter of pipe in inches

P = Average test pressure during the test in psi

During all testing, the trench generally and the joint pockets in particular shall be kept clear of water and should the trench become unstable due to work or leaking on testing or re-testing it shall be excavated to solid ground and made up with lean mix concrete or such other material as the Engineer may direct, all at the Contractor's expense. Should a test fail, the Contractor shall at his own expense replace defective pipes or fittings or make good leaking joints or otherwise rectify defective work. Cleaning, inspection and testing shall then be repeated until the work is to the Engineer's satisfaction and at no extra cost to the Employer.

The length of the section of pipeline to be tested shall not normally exceed 1,500 feet or as directed by the Engineer.

A simple stop end consists of a section of steel pipe about 1.5-3.0 feet long onto which a closing plate has been welded, containing the necessary opening for accommodating ingoing water and out-coming air. The stop end may also include an opening through which the test water may be pumped from the line, if necessary. The stop end may be jointed to the pipe to be tested by means of a standard coupling or other method approved by the Engineer. Thrust blocks or temporary anchorages shall be provided to

hold the stop end in place against the test pressure. The Contractor may also use propriety restrained joints in lieu of thrust blocks.

3.8.3 Final Acceptance Testing

The final acceptance test shall be carried out after all lengths have been joined together on completion of construction and interim tests have been carried out satisfactorily on the entire length of the pipeline.

Final pipeline acceptance procedures shall be as prescribed above for interim pipeline testing. The Contractor shall repair the pipeline if it fails to pass this test. The test shall be repeated and repairs affected until the pipe line passes the test.

3.8.4 Valves

Valves and all pipeline appurtenances shall be hydraulically tested together with the pipeline in which they are installed. Valves shall be tested for operation under working pressure and shall be adjusted so that they operate smoothly, seat properly and are installed to tolerances recommended by the manufacturer.

Before pressure testing is started the Contractor shall re-check pipes and valves for cleanliness and shall re-check the operation of all valves. The "open" ends of the pipeline (or sections thereof) shall normally be stopped off by blank flanges or cap ends additionally secured where necessary by temporary struts and wedges all anchor and thrust blocks shall have been completed and all pipe straps and other devices intended to prevent the movement of pipes shall have been securely fastened.

3.9 PIPELINE DISINFECTION

3.9.1 General

Pipelines shall be disinfected after they have been thoroughly cleaned and at the time the pipeline final acceptance testing is satisfactorily completed.

3.9.2 Disinfection of Pipelines

All potable water pipe, fittings, valves, meters and appurtenances shall be disinfected by the Contractor as specified herein.

All water and chlorine required for disinfection of pipelines shall be provided by the Contractor at his own expense. Bacteriological testing will be performed at a laboratory approved by the Employer the cost of which shall be borne by the Contractor.

The attention of the Contractor is directed to the requirements of these Specifications whereby he is responsible for preventing the entry of foreign material of any kind into the pipe work. The Contractor shall take extreme care to keep the interior of the pipe work free of dirt and other foreign material. If in the opinion of the Engineer, direct or other foreign material

enters the pipe work, which will not be removed by flushing, then the Contractor shall clean and swab the interior of the pipe work with a five percent hypochlorite disinfecting solution to the satisfaction of the Engineer.

After testing and immediately before commissioning, all pipelines shall be washed out and disinfected as follows:

- All mains shall be flushed out with clean water until there is no evidence of foreign matter or colour in the waste flushing water.
- A stock disinfecting solution shall be prepared by mixing for not less than 5 minutes, in a clean container, Sodium Hypochlorite solution (15 percent available chlorine) and distilled water in the proportion of 0.8 litres to 1000 litres of water by volume. After mixing, the solution shall stand for a further 5 minutes after which the clear supernatant liquid shall be decanted into another clean container. Stock solutions shall be made up fresh daily.
- The main to be disinfected shall be filled with potable water at the same time as the stock solution is added through a convenient air valve in such quantities (to be determined by the Contractor and approved by the Engineer) as will result in a final solution containing 50-70 mg/l free chlorine. Care shall be taken to ensure that the stock solution is added at a constant rate, commencing when water is fed into the main and ending as soon as the main is full.
- Every main charged with disinfection solution shall stand for 24 hours. A sample shall then be taken at a washout valve by the Contractor in the presence of the Engineer, from whom the sampling bottle shall be obtained. If the sample does not show at least 2 mg/l free chlorine, disinfection shall be repeated. If the sample is satisfactory the main shall be emptied, flushed out and filled with potable water and allowed to stand for 1 hour.
- Two further samples shall then be taken as before, one for a further determination of free chlorine and the other, in a sterilized bottle, for bacteriological analysis. If the free chlorine determination shows more than 4 mg/l free chlorine the main shall be flushed out again. If the bacteriological analysis is unsatisfactory, disinfection and sampling shall be repeated until satisfactory results are obtained before the main is commissioned.
- The Contractor shall provide all equipment, materials and testing apparatus, etc., as may be necessary for the effective disinfection of all pipelines.

3.9.3 Cleaning of Pipe work

All pipe work shall be cleaned by the Contractor after all pressure tests and disinfection operations have been performed and accepted by the

Engineer. However, it is the responsibility of the Contractor to prevent all dirt and foreign mater from entering the pipe work and for cleaning each length of pipe and all fittings, valves, meters and appurtenances, of sand, dirt and foreign matter during the installation. Cleaning of chlorinated lines shall conform to the recommendations of the Chlorine Institute.

All potable water required for testing, flushing and disinfection of pipelines shall be provided by the Contractor at his own expense.

3.9.4 Disposal of Water Used for Testing, Disinfection and Cleaning

The Contractor shall provide suitable means for disposal of water used for testing, disinfection and flushing such that no damage results to facilities, structures or property. These means shall be subject to the approval of the Engineer and local authorities. Details shall be submitted to the Engineer upon request. The Contractor shall be responsible for any damage caused by his filling, testing, disinfection, flushing and wastewater disposal operations.

3.10 PACKING, MARKING AND VENDOR DOCUMENTATION

3.10.1 Pipe Identification and Packing

The marking information and sequence shall comply with ISO 4427. All pipes and fittings, including test samples shall be clearly and permanently marked using indent printing in a colour that contrasts with the pipe.

All pipes shall be indelibly marked at maximum intervals of 1m indicating at least the following information:

- The manufacturer's name and/or trademark;
- The dimensions (nominal outside diameter x nominal wall thickness);
- Material and designation;
- The nominal pressure (PN) in bar;
- The pipe series (S or SDR) (optional);
- The production period (date or code); and
- The number of this International Standard.

The word "water" shall also be included if the pipe is intended for potable water. The maximum quantity of pipe to have the same coil/length number is one silo (coiled pipe) or one bundle (straight lengths). The maximum combined length of pipe in the silo or bundle with the same coil/length number shall not exceed the maximum allowable coil length as specified,

When pipe material is boxed, me coil number shall be clearly marked on the outside edge of the box or silo. Invoices and packing lists shall include the date of manufacture and coil/length numbers for all material in the shipment.

The fittings shall be packaged in bulk or individually protected were necessary in order to prevent deterioration and contamination. The package

shall have at least one label with manufacturer name, type and dimension of the fittings and number of units.

3.10.2 Packaging and Transportation

The Contractor/Manufacturer shall provide packing and transportation procedures for approval by the Engineer and shall comply with the following requirements.

a. Delivery

Delivery of the plastic pipes and fittings to site, shall be no later than six months after the stamped manufacture date.

b. Weathering

A certificate from the pipe/fitting manufacturers shall be provided, confirming that the products may be stored in the open for minimum of 2 years without any adverse effect.

c. Tie-downs

Tie-downs shall be at least 100 mm (4.0 inch) wide and be clean and free from sand, gravel and other such materials. For straight length pipe (up to 12 m (39 ft), a minimum of 6 tie-downs are required.

d. Pallets

The pallets shall be suitable for transporting the material from the place of manufacture to the designated receiving location without causing any damage to the pipe. The pallets shall not contain any broken planks or extremities that may damage the coiled pipe or straight lengths. They shall be durable enough to prevent loose pallet nails from gouging the bottom coil/straight length.

e. Overhang

Pipe shall not overhang at either end of the trailer.

f. Stacking

The Contractor/Manufacturer shall not ship small coils stacked inside silos of larger coils. Frames manufactured for the containment of straight lengths of polyethylene pipe during transport and storage shall not contain nails or other fastening devices that may damage the pipe.

g. Trucking

Where pipes are transported by vehicles, the vehicles should have a flat bed and be free from sharp edges or projections. During transport, polyethylene pipes shall be protected from diesel fumes and be continuously supported to prevent movement between the material and its support.

h. Silos

Silo packs of coiled pipes shall be squarely stacked and well supported on pallets. Coils shall not overhang the pallets and, shall not be stacked higher than 2.3 m (8.0 ft)

3.11 STORAGE OF PIPES AND APPURTENANCES

All pipes and materials shall be stored in accordance with the manufacturer's recommendations and the following:

- Jointing materials and operational gear shall be stored under cover. Pipes may be stored in the open, but shall be placed on adequate timber bearers to prevent damage to sheathing or sockets. Pipes not delivered on manufacturers' pallets may be stacked one above the other up to three pipes high provided suitable protective packing is placed between them. If any pipes or fittings show signs of corrosions or deterioration during storage either they shall immediately be treated at no extra charge by the Contractor to arrest and prevent the corrosion or removed from site as the Engineer directs.
- The Contractor shall properly stack the pipes in his storage area and the stacks shall be laid out in a regular pattern and the limits of each stack marked so that the movement of cranes and vehicles is restricted to access tracks between stacks and the control of delivery and removal of pipes is facilitated.
- The number of tiers of HDPE pressure pipe stacks shall be as per the Manufacturer's instructions and approval of the Engineer. Each pipe, including those in the bottom course, shall bear evenly upon not less than three timbers with an aggregate width not less than 300mm. The pipes shall be stacked parallel to each other.
- The timbers supporting each course of pipes in a stack shall be of uniform thickness and stiff enough for the pipes to be rolled across the stack and shall be supplied by the Contractor at his own expense.
- The outermost pipes in each course shall be secured against rolling by sandbags or by wedges.
- Where the pipes are to be delivered and stacked by the Contractor on sites along the pipeline route, the areas where the pipes are to

be stacked shall, if required, be graded flat by the Contractor at his own expense to provide a firm and even surface and shall be kept free from loose stones, rubble or waste liable to damage the pipes.

- Jointing materials, valves, fittings and specials, meters, gauges and polyethylene sheeting shall be stored in covered storage areas until required for installation.
- Pipe shall be removed from storage and directly distributed to their point of installation only in such quantities as can be installed in one week.

3.12 MEASUREMENT AND PAYMENT

3.12.1 Measurement

Measurement for HDPE pipes for water supply shall be made for the actual quantity of the work done in linear metre or linear feet (whichever is included in Bill of Quantities) on the axis of the piping including all fittings, bends, crosses, tees etc. No deduction will be made for the laying lengths of valves, fire hydrants, specials, etc. installed in the lines

3.12.2 Payment

The unit rate quoted in the Bill of Quantities for supplying and laying HDPE pipe for water supply shall be the full compensation for all cost of completing the item of work as per provision of this section and shall include cost of pipe, its carriage to the site, laying, cutting, joining, testing and disinfecting, etc. and all incidentals to complete the item except valves assembly and backing blocks, which shall be paid separately.

SECTION-4 PIPELINE APPURTENANCES

4.1 SCOPE OF WORK

The work included in this section consists of providing, laying, jointing, cleaning, disinfection, testing and commissioning of pipelines appurtenances for water supply. The Contractor shall provide all labour, materials and equipment necessary including removing from storage, transporting to sites, excavation, backfilling and compaction, laying, jointing and testing, disposal of excess excavated materials and removal of surplus pipes, fittings, valves and jointing materials. The responsibility for the safety and soundness of all material shall rest with the Contractor.

The Contractor is advised to carry out any tests at his cost needed to satisfy himself regarding the soundness of the valves, appurtenances and jointing materials including the pipeline installation before acceptance for testing by the Engineer.

4.2 GATE VALVE

Gate valves shall be of cast iron body conforming to BS 5150 with bolted bonnet, solid wedge, inside screw, non-rising stem, flange connection and fitted with cast iron hand wheel.

Specific clauses of BS 5150 are amplified as follows:

Sr. No.	Parameter	Details
1	Clause 3: Types of Valves	Solid wedge with non-rising stem
2	Clause 4: Nominal Sizes	All valves shall be of flanged end with sizes as specified on the Drawings
3	Clause 5: Nominal Pressure	PN 16 unless otherwise specified on the Drawings
4	Clause 9: Body Tapping	As specified to BS 21 (1S0 /R7) fitted with bronze or gunmetal plug
5	Clause14: Operation	Gate valves shall be provided with cast iron hand wheels or square heads for tee key operation as required. The direction of operation shall be clockwise to close the valve. Hand wheels shall require a force not greater than 20 kg on the outer rim to operate with a balanced pressure across the valve. Tee keys shall require a force not greater than 12 kg applied at the opposite ends of a standard key from the closed position.
6	Clause 19: Test Certificates	The Contractor shall provide a test certificate confirming that the valves have been tested in accordance with BS 5150

Sr. No.	Parameter	Details
		and stating the actual pressure and medium used in the test. In addition, the Contractor shall ensure that the Engineer has access to the manufacturer's works at all reasonable times for the purposes of inspecting the assembled valves and witnessing testing.

The material of construction of gate valves shall be as under:

Sr. No.	Part	Material
1	Body	Grey cast iron
2	Bonnet	Grey cast iron
3	Wedge	Grey cast iron
4	Gland	Grey cast iron
5	Stem	Stainless steel 304
6	Seat Ring, Wedge Ring	Stainless steel 304
7	Back Seat Bush	Stainless steel 304
8	Nuts & Bolts	Stainless steel 304
9	Painting	Wet blue epoxy paint, corrosion resistant

4.3 CHECK VALVE

Check valve shall comply with the requirements of BSS 5153. The valve shall be of swing type with quick acting single door and pressure rating of PN 16 unless otherwise specified on the Drawings. The valve design shall ensure closure in the shortest possible lime following deceleration of the water column, ideally reaching its seat without slamming at the instant forward motion of the column cases.

The material of construction of check valves shall be as under:

Sr. No.	Part	Material
1	Body	Grey cast iron
2	Bonnet (Top Plate)	Grey cast iron
3	Disc	Grey cast iron
4	Seat Rings	Stainless steel 304
5	Hinge Pin	Stainless steel 304
6	Disc Hanger	Grey cast iron
7	Gasket	Flexible graphite
8	Nuts & Bolts	Stainless steel 304
9	Painting	Wet blue epoxy paint, corrosion resistant

Swing Check Closure is affected by gravity (Weight of disc) and reverse flow. The pivot point of the swing check is outside the periphery of the disc and the greater the head, the greater the possibility that the fluid will flow back through the valve before the disc can be shut off. To effect complete shut off, the disc of a swing check valve must travel through a 700 to 900 arc to the valve seat. Without resistance to slow the disc's downward thrust and

reverse flow, the shut off can result in slamming and damaging water hammer.

4.4 AIR-RELEASE VALVE

Automatic air relief valve shall be designed to meet the following conditions:

a. Discharge air during charging of the pipeline.

b. Admit air during emptying of the pipeline or when the pipe in pressure falls below atmospheric pressure during a surge event.

c. Discharge air accumulated at local peaks along operating conditions the pipeline under normal

Conditions 'a' and 'b' shall be met by the employment of a large orifice capable of handling large volumes of air at a high flow rate and condition 'c' by a small orifice capable of discharging small quantities of air as it accumulates. Valves with air intakes or exhaust facilities shall have approved screening arrangements to prevent the ingress of air borne sand.

The valve shall conform to AWWA C512 pressure rating of PN 16 unless otherwise specified on the Drawings. Valve Body ends shall be flanged with raised faces and drilled to EN 1092-1.

The material of construction of air release valves shall be as under:

Sr. No.	Part	Material
1	Body	Grey cast iron
2	Bonnet (Top Plate)	Grey cast iron
3	Float Ball	Stainless steel 304
4	Gasket	EPDM - Asbestos Free
5	Nuts & Bolts	Stainless steel 304
6	Painting	Wet blue epoxy paint, corrosion resistant

Each valve shall be provided with isolating valves as detailed in the Drawings.

4.5 VALVE CHAMBERS

Chambers for gate valves, air valves, washouts, etc. shall be constructed in accordance with the details shown on the Drawings, or as directed by the Engineer.

Brick masonry, Portland cement concrete, and other materials shall meet the specified requirements of the relevant sections of these specifications.

4.6 VALVE BOX

Valve boxes shall be provided for all valves which are installed below ground level in conformance with the details shown in the Drawings. Valve boxes shall be of the heavy-duty type capable of withstanding a ten-ton load when located within carriageways. Ordinary valve boxes shall be used in other locations. All valve boxes shall be of the lockable type. They shall be installed

on concrete bases as shown in the Drawings.

4.7 THRUST BLOCKS

The Contractor shall construct all thrust blocks as shown on the Drawings. Thrust blocks shall be constructed to the dimensions shown on the Drawings. The thrust blocks are designed for soil parameters as shown on the Drawings. Where considerably better ground conditions, such as rock, are encountered, the dimensions of the particular thrust blocks may be reduced. Supporting calculations for any reduced size thrust blocks must be submitted to the Engineer at least 48 hours before construction of that particular thrust block commences.

Unless otherwise specified or directed, thrust blocks shall be provided on pipelines laid to gradients steeper than 1:20; up to 1:15 every third pipe shall be anchored, up to 1:10 every second pipe and at 1:5 every pipe should be anchored.

Concrete shall extend to undisturbed ground on thrust faces or thrust blocks and on both faces of anchor blocks.

Each thrust block shall be designed to have a sufficient bearing area and shall be placed to safely transmit to the surrounding point. Thrust devices shall be cast-in-place concrete. Thrust blocks shall be constructed of Class-C concrete as included in SECTION-20.5.2 and shall be placed between fitting and trench wall or trench bottom, as the case may be. The bearing faces of the block shall be placed against freshly cut and undisturbed trench wall or bottom of sound material. If the thrust exceeds the bearing value of the surrounding soil, the soil shall be pre-compacted before placing concrete. All concrete shall be kept behind the sockets and flanges of fittings. Formwork shall be constructed wherever necessary to confine the concrete to the prescribed dimensions for the block. All form lumber shall be removed before testing.

The blocks shall, unless otherwise shown or directed by the Engineer, be so placed that the pipe and fittings joints will be accessible for repair. Before internal pressure is applied to a pipeline, all concrete thrust blocks shall have been constructed and cured for a minimum of 7 days.

4.8 APPROVAL OF MATERIALS AND EQUIPMENT

As soon as practicable but within thirty-days after the receipt of notice to proceed and before any material or equipment is purchased, the Contractor shall submit for approval by the Engineer a complete schedule of materials and equipment to be incorporated in the work, together with the names and addresses of the manufacturers and their catalogue, item numbers and trade names. The schedule shall include catalogue cuts, diagrams, drawings, and such other descriptive data and as may be required by the Engineer. Samples of materials shall be provided as required. No consideration will be given to partial lists submitted from time to time. Approval of materials and

equipment under this provision shall not be construed as authorization of any deviations from the specifications unless the attention of the Engineer has been directed to the specific deviations. Laboratory results and certifications, specified or otherwise required, shall be submitted prior to delivery of the material or equipment to the site.

4.9 TESTS AND ACCEPTANCE

All valves, fittings and accessories delivered to the job site shall be accompanied by test reports certifying that the valves, couplings and/or fittings and accessories conform to the relevant specifications.

The Contractor shall take the necessary measures to allow the Engineer to be present during the tests at the factory, if the Engineer finds it necessary to do so. Failure to present the aforementioned certificate, or to inform of the date and time of the factory tests, shall constitute grounds for rejection of the valves, fittings or couplings that do not comply with these conditions.

Acceptance of such material shall only be possible if the rejected batch of valves, fittings and joints is tested under the Engineer's supervision, at the Contractor's expense, and only those passing the tests shall be accepted.

In addition, the right shall be reserved for the Engineer to subject any consignment of valves, fittings and couplings to any or all of the tests, over and above the tests conducted by the manufacturer. The Contractor shall furnish all labour, material and equipment necessary to assist in performing the tests and inspecting the valves, fittings and couplings.

4.10 MEASUREMENT AND PAYMENT

4.10.1 Measurement

Measurement for fire hydrants, valves air release valves, washout valves etc. shall be made in number and shall include the chamber and all other materials to complete the work as per Drawings including connection with pipeline. Backing blocks for bends, tees etc. shall be measured in cubic foot or cubic metre (whichever is included in Bill of Quantities).

4.10.2 Payment

The unit rates quoted in the Bill of Quantities for the supply and installation of fire hydrants, air release valves, sluice/gate valves, washout valves including chambers and other specials and shall be full compensation for supply, installation, testing, commissioning, disinfecting and all incidentals to complete the items of the work as per Drawings. The thrust blocks provided will be measured separately for payment.

SECTION-5 PIPE BEDDING

5.1 SCOPE OF WORK

Wherever specifically called for by means of notes on the contract Drawings or by written order of the Engineer, the Contractor shall furnish and place sand bedding under water lines, drain pipes and other structures as a separate item of payment.

5.2 PURITY AND STACKING

Sand bedding shall be from a source and of specifications approved by the Engineer.

The sand stone shall be free from clay, salt, alkali, organic matter, shale, loam, soft flaky particles and other deleterious substances. It shall be stacked at the place designated by the Engineer and kept free from the admixture of deleterious materials mentioned herein. The sand shall not contain clay/silt more than 5%. Laboratory testing prior to its use under bedding will be arranged.

5.3 PLACING OF BEDDING MATERIAL

The material for bedding shall be placed to the specified thickness and compacted by rammers of approved weight. The compaction level shall not be less than 95% of modified dry density as determined by AASHTO T-180.

5.4 MEASUREMENT AND PAYMENT

5.4.1 Measurement

The measurement shall be made by volume for the actual quantity of the work done and the unit of measurement shall be cubic foot or cubic metre (whichever is included in Bill of Quantities).

5.4.2 Payment

Payment for this item of work shall be made for the actual quantity of work done as specified in this section, at the unit rate quoted in the Bill of Quantities.

SECTION-6 WATER SUPPLY SERVICE CONNECTIONS

6.1 SCOPE OF WORK

Work under this section consists of furnishing all material, plant, machinery, labour and performing all functions and operations in connection with the execution of service connections for water supply, in strict accordance with the Drawings and applicable specifications and as directed by the Engineer.

6.2 MATERIAL REQUIREMENTS

SECTION-7 THE EARTH WORK SHALL BE PERFORMED AS PER REQUIREMENTS OF SECTION-2 EARTH WORK FOR WATER LINES

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Service connection pipe shall be of HDPE of diameter as shown on the Drawings. Whereas, Clamp Saddle shall of Polypropylene with built-in rubber washer. Fittings and specials shall be as recommended by the manufacturer of the pipe and as approved by the Engineer. The plugging of the end will be part of the item.

7.1 CONSTRUCTION REQUIREMENTS

Service connection shall be executed as per Drawings or as indicated by the Engineer.

Connection arrangement shall be as per requirements/recommendations of the manufacturer of the pipe and as directed by the Engineer. Service pipe shall be connected with the pipe running either in front of the individual plot or from other side of the road. Service end of the pipe shall be duly plugged.

7.2 MEASUREMENT AND PAYMENT

7.2.1 Measurement

Measurement for service connection shall be number of service connections installed, tested and commissioned including all fittings, saddle arrangement, etc. but excluding cost of pipe as per specifications and accepted by the Engineer for payment.

Measurement for HDPE pipe of specified diameter is in linear metre or linear feet (whichever is included in Bill of Quantities) on the axis of the pipe.

7.2.2 Payment

Measurement as carried above shall be paid for at the unit rate quoted in the Bill of Quantities and shall be full compensation for furnishing all materials, tools, plants, labour and incidentals to complete the work.

PART-C, TUBE WELL

SECTION-8 GENERAL

8.1 DESCRIPTION

The tube well of indicated capacity is to be drilled by direct rotary or reverse rotary method. Total depth of borehole shall vary depending upon the material encountered. An accurate drilling log of the tube well is to be made, and samples of the materials encountered through which the tube well is drilled are to be preserved and handed over to the Engineer.

Upon completion of drilling, blind and slotted tube well casing sections, of specified material, diameter and length are to be placed in the tube well, mild steel pump housing casing of required diameter and length is then to be connected to the tube well casing by means of a tapered reducer and installed in the tube well.

After installation of the pump housing and tube well casing, the tube well is to be shrouded (packed and grouted) with selected gravel of specified quality, sizes and gradation and specified cement grout after which it is to be developed and tested until it will efficiently produce clear water at a pumping rate of 50% higher than the designed capacity. After the tube well has been satisfactorily developed and tested, pump house of the specified design is to be constructed. The tube well is to be equipped with a vertical turbine pump connected to a vertical hollow shaft, electric motor. All motor control and necessary electrical equipment are to be installed, placed in operating condition and tested to demonstrate that the entire installation meets the requirements of the contract documents. A chlorinator and other equipment are to be installed with the tube well as specified.

The connection of electrical equipment to the power main shall be by others, testing of the installed equipment is however, part of this contract. Construction of facilities to convey water from the discharge pipe flange point to water main is part of this Contract.

8.2 CONTRACT DRAWINGS

The Drawings covering tube well and appurtenant works show the scope of work to be performed by the Contract. The tender drawings shall not be used as a basis for placing preliminary orders for materials. The drawings issued for construction will be drawings from which shop erection, concrete placing, formwork or other construction details shall be prepared by the Contractor. The works shall be executed in conformity with the Drawings issued.

8.3 SIZE OF TUBEWELL

The tube well may vary in depth, therefore, minimum and maximum depth for the tube well shall not be guaranteed. The pump head, pump setting and length of housing of tube well shown on the Drawings are indicative only. The

horsepower, rating of the pump motor and the motor controls are specified under applicable sections of specifications.

8.4 BILL OF QUANTITIES

The bill of quantities set forth is the approximate quantities of the works. The amount of bid for each item of bill of quantities shall be full payment for completion and maintenance of the works specified herein and elsewhere in the document and Drawings.

8.5 STANDARDS

Except as otherwise provided by this specification or the Drawings and in case no specification and standards are indicated in the document, all materials, equipment fabrication and testing thereof shall conform to the latest applicable standards and specifications in accordance with the specification epilogue.

If the Contractor, at any time and for any reason wishes to deviate from the above standards, or desires to use material or equipment not covered by the said standards, he shall state the exact nature of the change, the reasons for making the change and shall submit the complete specifications of the materials and equipment for approval of the Engineer, whose decision shall be conclusive and binding on the Contract.

8.6 CONSTRUCTION EQUIPMENT AND MATERIAL

Unless otherwise specifically stated in the document, the Contractor shall furnish all necessary construction equipment and material for the construction and installation of the tube well and appurtenances. The construction equipment shall include but not be limited to drilling equipment of the Rotary or percussion type, together with all supporting and additional equipment and accessories necessary for taking samples for installing the tube well casing and pumping-housing casings, for placing gravel shrouding and cement grouting, for developing and testing the tube well, for determining the straightness and verticality for pump housing casing; for constructing the cement concrete pump pedestal and floor slab for installing the pump motor, motor controls and necessary electrical equipment, chlorinator, valves and discharge pipes, for constructing the pump house and for the performance of development tests.

All construction equipment shall be in good, serviceable condition and shall be capable of doing the work.

The Contractor shall also furnish all testing instruments, equipment and materials required by the Contractor for his use in ascertaining that construction materials, permanently installed equipment and the finished work conforms to the requirements of specifications and for carrying out all

tests required by the specifications to be performed by the Contractor.

Materials to be furnished by the Contractor shall include all materials necessary for the operation and maintenance of the Contractor's equipment and all the materials for installation in the tube well including casing, gravel shrouding, Portland cement, brick, reinforcement, aggregates, electrical conductance, wiring and fittings and all other equipment and materials necessary to perform the work in complete and satisfactory manner.

8.7 CLEAN UP

Upon completion of construction, equipment installation and operation, test of tube well, the Contractor shall tear down and remove all temporary structures provided and occupied by him, shall remove all plant and refuse, all waste materials; shall remove from the site of the work, or satisfactorily cover with earth.

SECTION-9 DRLLING OF BOREHOLE

9.1 SCOPE OF WORK

The work covered under the specifications is furnishing all plant, labour, equipment, appliances, and materials, and in performing all operations in connection with the drilling of borehole(s) in strict accordance with this section of specifications in reasonably close conformity with the lines and dimensions shown on the Drawings or established by the Engineer.

9.2 DRILLING OPERATION

Drilling of tube well shall include, but not be limited to moving in, setting up, preparing the site, drilling the borehole, collecting data and removing temporary casing, dismantling, moving out and cleaning up. Measurement for tube well drilling will be made of the actual depth of each borehole drilled, measuring from the original ground surface. No measurement will be made over-drilling required because of the sloughing, caving ground or for the Contractor's use in setting casing; for tube well abandoned due to jammed tools, caving ground, or negligence on the part of the Contractor; or for tube well not constructed in accordance with all the requirements of these specifications.

9.3 DRILLING

The Contractor shall drill each borehole of the diameter indicated on the Drawings and at the locations shown on the Drawings. The Contractor shall prepare the site for the construction of the tube well and shall provide for the disposal of water, cuttings, and refuse from his operation away from the site and to the satisfaction of the Engineer.

The borehole shall be drilled by the reverse circulation rotary method. Each borehole shall be drilled to the depth specified by the Engineer. It is anticipated that the depth of tube well (s) will vary; however, no minimum depth of any individual tube well or average depth for all tube wells is guaranteed. The borehole shall be drilled sufficiently straight and plumb so that the pump and the tube well casing may be installed concentric with the hole and within the tolerance specified for the plumbness of the casing. Waste materials from the drilling operation shall be disposed of in a manner approved by the Engineer.

The Contractor shall be responsible for protecting the tube well from contamination by foreign materials until the completed tube well and appurtenant facilities are accepted by the Engineer. The Contractor shall bear any expense that may result from damage to any tube well, tools or equipment that may be caused by caving, washing or other disturbance within the tube well.

If unstable material is encountered in drilling, the Contractor shall stabilize the material in a manner approved by the Engineer. The use of drilling fluid additives or other suitable materials may be employed for stabilizing the borehole when such use is specifically approved by the Engineer. If necessary, temporary casing shall be furnished and installed by the Contractor to hold walls of the hole during drilling operations and until the gravel shrouding has been placed. All temporary casing shall be removed by the Contractor in stages as gravel shrouding is placed. The temporary casing may be new or used and will remain the property of the Contractor.

If, in the opinion of the Engineer, it is necessary to discontinue work on any borehole because it is out of line more than the amount specified or on account of jammed tools, caving ground or because of negligence on the part of the Contractor, he will not be entitled to payment for any work done or materials furnished for borehole abandoned as a result of his operations or negligence.

9.4 DATA AND RECORDS

The Contractor shall keep an accurate drilling logs of borehole drilled including description of all materials encountered and their location in the borehole. The fact that the Engineer or his representative may be present and keep a separate record, shall not release the Contractor from this responsibility. In the case of defective or incomplete records, the Contractor shall complete the records at his own expense. All records and data shall be kept by the Contractor on forms approved by the Engineer. The Contractor shall deliver to the Engineer, the original of all records and all such records shall become the property of the Owner.

Representative ditch samples or cuttings of the materials penetrated shall be taken of each lithology encountered and from each ten feet of the depth for non-water bearing depth and each four feet for water bearing depth of the borehole. Special care shall be exercised to determine the thickness and location of each change in material encountered and to obtain satisfactory samples. Immediately upon taking samples, the samples shall be placed in cloth bag, partitioned wooded box, or other approved container, properly marked for identification, and plainly labelled with the depth of the top and bottom of the section of the borehole represented. The containers shall be furnished by the Contractor, the method of obtaining, processing and storing the samples shall be subject to approval by the Engineer. The Contractor shall deliver all samples to the Engineer at the site of the tube well or to the filed headquarters of the Engineer as directed.

9.5 MEASUREMENT AND PAYMENT

9.5.1 Measurement

The quantity of drilling to be paid for shall be measured by linear metre or linear foot, whichever is included in Bill of Quantities, and drilled as mentioned above.

9.5.2 Payment

The accepted quantity measured as provided above shall be paid for at the contract unit price per linear metre or linear foot of drilling (whichever is included in Bill of Quantities) of specified diameter of borehole for the pay items included in the Bill of Quantities, which price and payment shall constitute full compensation for furnishing all materials, various drilling operations, labour, equipment, tools and incidentals necessary to complete the item.

Backfilling of the borehole, if a particular borehole is not developed, shall be done as per instructions of the Engineer, payment for which shall be made separately.

SECTION-10 TUBEWELL CONSTRUCTION

10.1 SCOPE OF WORK

The work shall consist of furnishing all plant, labour, equipment, appliances, and materials and performing all operations in connection with tube well construction except drilling, in accordance with these specifications and in close conformity with the dimensions shown in the Drawings or as established by the Engineer.

10.2 CASINGS

Casing shall consist of all work required in connection with furnishing and installing casing pipe, comprising of steel conductor pipe and steel pump housing pipe and fibre glass / brass or any other specified material, tube well casing (both plain and slotted), required for the tube well and shall include, but not be limited, providing storing, fabricating and installing including concentric reducers and equalizers.

10.2.1 Fibre Glass Strainer & Blind Pipe

Glass Fibre shall conform to the following specifications:

- ASTM-2996 for Filament-Wound Fibreglass
- ASTM 2997 for Centrifugally Cast Fibreglass

The fibre glass strainer will be from the approved source. The Contractor to this effect will submit for approval of the Engineer, a sample with complete specifications. Prior approval of the material is obligatory and without this approval, the procurement and installation of material will not be accepted for measurement and payment.

10.2.2 Fabrication

The depth of conductor pipe and pump house casing will be established by the Engineer for the tube well depending upon local sanitary conditions of shallow ground waters. Lengths of specified diameter of steel casing shall be provided to extend the pump housing casing from the elevation of the top of the pump housing casing to the depth established by the Engineer.

Adjoining sections of conductor pipe and pump housing casing shall be assembled by field welding. Butt welding straps shall be provided. All field welding shall be performed by the electric arc method, using heavily coated welding rods suitable for all position welding. After being deposited welds shall be cleaned of slag and shall show uniform sections, smoothness of weld metal, feather edges without overlap, and freedom from porosity and clinkers. The pump housing casing shall be connected to tube well casing with a concentric tapered reducer.

The length and sizes of tube well casing to be installed will be specified for the tube well by the Engineer, and will be sufficient to extend from the bottom of the pump housing casing to the bottom of the tube well. The bottom of the tube well casing shall be fitted with a bail plug. The tube well casing shall consist of slotted sections for installation in the water yielding formation and plain pipe sections in the lowest one metre of the tube well and opposite non-water yielding formations as directed by the Engineer.

10.2.3 Installation

The Contractor shall install the entire pump housing and tube well casing assembly straight, plumb, and concentric in the drilled hole to permit the installation of the pump in such a manner that it will operate satisfactorily and without damage. The methods employed by the Contractor in the installation of the casing and in obtaining or correcting the verticality and straightness of the pump housing casing shall be subject to the approval of the Engineer.

Centralizer shall be attached to the pump housing casing so that it will be centred in the drilled hole throughout its entire length and held in such position while gravel shrouding is being placed. Centralizers will be placed at 25-feet intervals throughout the length of the tube well or as directed by the Engineer.

The Contractor shall install the pump housing casing, so that the deviation of its axis from the vertical shall not exceed 35 mm at the bottom of the pump housing casing. Measurements for determination of verticality and straightness of the pump housing casing shall be made by the Contractor in the presence of the Engineer, upon completion of gravel shrouding. Plumbs, pipes and dummies used in these tests shall be approved by the Engineer.

Measurements for determining the deviation of the pump housing casing from the vertical shall be made by the use of a circular plumb having a minimum outside diameter of 15 mm less than the inside diameter of the pump housing casing. The plumb shall hang vertically and shall be suspended in the centre of the casing. When the plumb is lowered to the bottom of the pump housing casing, the line from which the plumb is suspended shall not deviate from the centre of the pump housing casing at the top by more than that corresponding to a deviation of the plumb of 35 mm at the bottom of the pump housing casing. All deviations shall refer to a vertical line passing through the centre of the pump housing casing at the top.

Straightness shall be determined by lowering a section of pipe 40 feet long or a dummy of the same length to the bottom of the pump housing casing. The minimum outer diameter of the pipe or dummy shall be 15 mm less than inside diameter of the pump housing casing. If a dummy is used, it shall consist of a rigid spindle with three cylindrical rings, each ring having a height of at least 300 mm. The rings shall be true cylinders and shall be located at each end

and in the centre of the dummy. The central shaft of the dummy shall be rigid so that it will maintain the alignment of the axis of the cylindrical rings. The pump housing casing shall be sufficiently straight so that the pipe or dummy can be passed freely throughout the entire length of the pump housing casing.

The tube well failing to meet the specified requirements for straightness, verticality and concentricity shall be abandoned, and the Contractor shall construct a new well at his own expense at an alternative site designated by the Engineer.

10.3 GROUTING

The annular space outside of the conductor pipe shall be sealed with cement grout. The grout shall consist of one part of cement and one part of sand by volume and not more than 5 gallons of water per cubic foot of cement. Grout materials shall be ordinary Portland cement conforming to BS 12, clean sand and clean portable water. The annular space shall be flushed with water prior to grouting to ensure that the space is open and to remove foreign material. The grout shall be applied from the bottom up and in one continuous operation. The grout shall be placed through a minimum 1-inch diameter grout pipe extending to the bottom of the annular space initially and shall remain submerged in the grout during the entire time the grout is being placed to ensure complete filling of the annular space. The grout shall be pumped into the pipe or applied continuously by gravity.

The pipe may be left in place or it shall be gradually removed. In the event of interruption in the grouting operations, the bottom of the pipe shall be raised until all air and water have been displaced from the grout pipe. The grout shall be allowed to set a minimum of 7 days after placement prior to resuming work on the well.

10.4 GRAVEL SHROUDING

Gravel shrouding shall consist of all work required in connection with furnishing and installing gravel shrouding in the annular space between the conductor pipe and the pump housing pipe, the walls of the borehole and the outside of the casing assembly and in any uncased length of borehole including but not limited to, developing the gravel source, excavating, stockpiling, grading, washing, storing, shipping, and installing gravel shrouding in the tube well.

10.4.1 Material

All gravel used for shrouding shall be clean, hard, well-rounded, washed, carbonate free and water-worn, without thin, flat particles and with the gradation as included in Table 10.1.

Table 10.1, Gradation Requirements for Shrouding Material

Sr. No.	Sieve	Percentage Passing
1	3/8 inch	100
2	No.4	60-80
3	No.7	20-40
4	No.14	0.50

10.4.2 Installation

The specified spaces shall be gravel shrouded by the Contractor from the bottom to the top of the tube well in such a manner that there will be no voids other than the annular space between the gravel particles. The method of placing the gravel, and the equipment used, shall be subject to approval by the Engineer. Water shall be circulated in the tube well, as the gravel is being laced, by lowering the drill pipe inside the casing and operating the circulation pump. The gravel shall be placed to the top of the tube well and shall be finally settled by bailing after all gravel has been placed. The top of the gravel shrouding shall be maintained at the ground level at all times during development, testing and pumping. Gravel and gravel placement not meeting these requirements will be subject to rejection by the Engineer, and all gravel so rejected shall be replaced by the Contractor at his own expense. Temporary casing, if used, shall be carefully withdrawn in 1-3 meters stages during placement of gravel shrouding and gravel shall be introduced so that each stage of the hole above the bottom of the casing is completely filled before the casing is withdrawn to the next stage. The process of withdrawing the temporary casing is at least 3 meters above the top of tube well casing. Above this point, the temporary casing may be removed or left in place, at the option of the Contractor; however, no payment will be made to the Contractor for temporary casing left in place.

10.5 DEVELOPMENT AND TESTING

Development and testing shall consist of all work required in connection with the development of the tube-well to produce the design capacity of water. It is carried out by breaking the layer of bentonite or sealing clay or compounds in the borehole, and taking out mud, chemical used and fine particles of sand from the shrouding and the aquifer near to shrouding throughout the depth of the tube-well strainer. The development of the well shall be so effective that after its completion the turbidity of water and sand content shall be reduced to minimum permissible limit as recommended by WHO standards. After completion of development of tube-well, the water shall be tested to determine the chemical and bacteriological quality of water, draw down at designed discharge and the specific capacity of tube-well. Any tube-well not developed properly and not meeting above standards shall be rejected and re-drilled. The recovery of tube-well during

the test shall also be observed.

10.5.1 Method

The tube-well shall be developed with vertical turbine pumping unit preferably closely coupled with a diesel engine through universal cross shaft which facilitates in pump speed adjustment to draw required discharge from the tube-well. Electric prime mover may also be used but with such arrangement which give variable speeds to the pumping units. The pumping unit shall allow the measurement of water level at any time during operation of the pump; and should be able to reverse its direction of rotation.

10.5.2 Equipment Required

The Contractor shall furnish all the equipment required for the development and testing of the tube-well as indicated below:

a. Vertical turbine pump with variable speed and reversal in direction of rotation. Capable of discharge twice the rated capacity for the design discharge of the tube-we/l.

b. Prime Mover (Electric or diesel) closely coupled with V.T.P. and capable to give a variable/ adjustable speed to the pumping unit.

c. Discharge Measuring Device, Electronic flow metre, sluice valve for regulation of discharge.

d. Electronic measuring device to measure water level in tube-well during operation of pumping unit.

e. Imhoff Cone (Sand Cone)

10.5.3 Back Wash

Back washing is done by reversing the direction of the pumping unit for a small time depending upon the condition of the water pumped. The water is pushed back into the aquifer thus stirring the locked sand particles and loosening them for pumping out. Back washing of tube-well shall be done during development at suitable intervals, to pump all fines from the tube-well shrouding. It shall be single backwash if the well is not pumping greater quantity of sand and shall be doubled if it is sandy. The development and backwashing shall be continued till the sand contents are reduced to permissible limit, which shall be checked continuously by Imhoff Cone graduated in PPM (parts per million).

10.5.4 Duration

Static water level or sub soil water level shall be measured before start of development.

a. Development (1st Stage)

Initial development shall be done step wise as included in Table 10.2.

Table 10.2, Duration of Development for Tube Well

Sr. No.	Discharge	Period of Development
1	0.75 times the designed discharge of tube well	1 hour
2	1.00 times the designed discharge of tube well	1 hour
3	1.25 times the designed discharge of tube well	1 hour
4	1.50 times the designed discharge of tube well	3 hours
5	2.00 times the designed discharge of tube well	3 hours
	Total	9 hours

Backwash shall be done every 5-minutes depending upon the sand contents pumped.

b. Recovery (1st Stage)

Pump shall be stopped after 1st stage of development and well shall be allowed to recover its water table. Reading/measurement of water table shall be taken as provided in the under-mentioned intervals.

Table 10.3, Frequency of Measurement during Recovery Period for Tube Well

Sr. No.	Period (from pump closure)	Measurement Frequency
1	1st 5 minutes	Every minute
2	Up to15 minutes	Every 2-minutes
3	Up to 30 minutes	Every 5-minutes
4	Up to 1 hour	Every 10-minutes
5	Up to 3 hours	Every 20-minutes
	Total	3-hours

c. Testing for Development (2nd Stage)

The well shall be pumped in steps as included in Table 10.2.

Sand contents shall be measured every 5-minutes during each pumping, however during 1st five minutes sand content shall be taken every minute. The water level shall be measured in the same way as explained in Recovery period, for each pumping stage and draw down (the difference between the static water level and that during pumping) shall be worked out for each measurement

d. Recovery (2nd Stage)

The well shall again be allowed to recover and the measurements of water table shall be carried out in the same way as in the first stage of recovery; Table 10.3.

The difference shall be noted between 1st stage and 2nd stage of recovery.

e. Testing for Re-Development (3rd Stage)

The tube-well shall be re-developed for another 9 hours in steps as included in Table 10.2.

Sand contents shall be measured every 5-minutes during each pumping, however during 1st five minutes sand content shall be taken every minute. The water level shall be measured in the same way as explained in Recovery period, for each pumping stage and draw down (the difference between the static water level and that during pumping) shall be worked out for each measurement.

f. Recovery (3rd Stage)

Well shall again be allowed to recover for 3 hours and measurements of water table shall be done as in 1st and 2nd stage; Table 10.3. There shall be no difference at the recovery of water table between 2nd stage and 3rd stage. If it is observed that there is an appreciable difference of recovery, well shall he redeveloped for 6 hours with back wash and recovery should again be allowed for 3 hours to match it with 3rd stage recovery. The process shall be repeated till the preceding recovery is matched.

g. Stop Pumping

The pump shall be stopped for next 4 hours before start of final pumping test for approval of the well.

h. Final Pump Test

The tube-well shall be pumped finally for 4 hours at the rated discharge and final draw down shall be noted to find out the specific capacity of the tube-well.

Hence the summary of development and testing of tube-well is included in Table 10.4.

Table 10.4, Summary of Tube Well Development Procedure

Sr. No.	Development Step	Time Period

1	Development	
	Development, 1st Stage	9 hours
	Recovery, 1st Stage	3 hours
2	Testing	
	Development, 2nd Stage	9 hours
	Recovery, 2nd Stage	3 hours
	Development, 3rd Stage	9 hours
	Recovery, 3rd Stage	3 hours
	Step Pumping	4 hours
	Final Pump Test	4 hours
	Total	44 hours

The duration of development and testing given above is minimum, and may be increased to total duration of 72 hours as per the direction of Engineer.

10.5.5 Performa for Records

Proper Performa shall be developed for development, recovery and testing of the tube-well giving discharge pumped, water level in tube-well, sand contents and timings of the measurements and shall be filled in accurately and precisely. If it seems that there is a mistake in measurement, the process shall be repeated. Proper records shall be kept for each tube-well for subsequent and future references

10.5.6 Operation of Pump & Motor

Power needs to be continuously available to pump during the tests. If power is interrupted, it shall be necessary to terminate the test, allow the well to recover up to initial water level and run a new test. Required pumping rate is to be maintained during the development of the tube-well has been satisfactorily completed and approved by the Engineer. The contractor shall disinfect the tube-well by chlorine solution throughout the entire depth of the well to obtain a minimum chlorine content of 50 parts per million. The procedure and equipment used to introduce and disperse the chlorine in the tube-well shall be approved by the Engineer

10.5.7 Disinfection

After development and testing of the tube well has been satisfactorily completed, and when approved by the Engineer, the Contractor shall disinfect the tube well by dispersing chlorine solution throughout the entire depth of the well to obtain a minimum chlorine content of 50 mg/l. The procedure and equipment used to introduce and disperse the chlorine in the tube well shall be subject to approval of the Engineer.

10.6 SEALING

Upon completion of disinfections of the tube-well, the contractor shall seal the tube-well by welding the 6mm (1/4") steel plate cap to the pump housing casing around its circumference. Compliance with these requirements will

not relieve contractor of his responsibility for safeguarding any complete part of the tube-well until the certificate of acceptance is issued for the entire tube-well installation

10.7 MEASUREMENT AND PAYMENT

10.7.1 Measurement

The quantity of MS housing pipe, blind pipe and screen of specified material and diameter shall be measured in linear metre or linear foot (whichever is included in Bill of Quantities) of actually installed at site on the basis of tentative quantities included in the Drawings.

The bail plugs, well caps and concentric reducers of specified diameter shall be measured in numbers, actually installed as per Drawings.

Grouting of space between inside of well drilled and outside of housing pipe shall be measured in linear metre or linear foot (whichever is included in Bill of Quantities) of actual executed quantity as per site.

The quantity of gravel shrouding shall be measured in cubic foot or cubic metre (whichever is included in Bill of Quantities) of actual executed quantity as per site.

The measurement for development and testing of tube well shall be measured in hours of testing and development to the satisfaction of the Engineer.

10.7.2 Payment

The accepted quantity MS housing pipe, blind pipe and screen of specified material and diameter, as above, shall be paid for at the contract unit rate which price and payment shall constitute full compensation for furnishing all materials, labour, equipment, tools and incidentals to complete these items including cost of centralizers (not payable separately).

The bail plug, well cap, concentric reducer of specified diameter/size, gravel shrouding and cement sand grouting, etc shall be paid at the contract unit rate and this price shall constitute full compensation for furnishing all materials, labour, equipment, etc. to complete this item to the satisfaction of the Engineer.

The payment for development and testing of tube well will be made at the contract unit rate which price and payment will be full compensation for all materials, labour, equipment, development, testing, disinfection, etc. as per the specifications and to the satisfaction of the Engineer.

SECTION-11 WATER TESTING

11.1 SCOPE OF WORK

The work covered under these specifications shall consist of collection, transportation, storage, and laboratory examination of water samples for the tube well that has been developed and tested. The water shall be tested for complete chemical and bacteriological examination in accordance with WHO (World Health Organisation) Guidelines 1985 or latest edition with the procedures established in the latest version of "standard Methods for Examination of Water and Wastewater" published by American Public Health Association. The examination of water samples shall be carried out in a laboratory approved by the Engineer.

11.2 COLLECTION OF WATER SAMPLES

The water samples shall be collected in separate sterilized containers for bacteriological (i.e., Total Coliform, and Faecal Coliform) and Physio-chemical examination. The samples shall be collected from a tap fitted on the discharge pipe of the pump. The tube well shall be operated at its design capacity for a minimum period of 15 minutes, before collecting the first sample.

11.2.1 Collection for Bacteriological examination

The volume of each sample intended for bacteriological examination shall not be less than 100 ml. Sterilized glass bottle provided with ground-glass stoppers shall be used for collecting samples. The sample bottle shall not be kept unopened until the moment, it is required for filling. During sampling, the stopper and neck of the bottle shall be handled to protect from hand contamination. The bottle shall be filled without rinsing and the stopper shall be replaced immediately after the bottle is filled.

11.2.2 Collection for Physio-Chemical Examination

The volume of each sample shall be at least 2 litres. The samples shall be collected in a chemically clean bottle, made of practically colourless glass and fitted with a ground-glass stopper. The bottle shall be rinsed at least three times with the water that is to be sampled before bottle is filled. While sampling, the bottle shall be held near its base.

11.3 TRANSPORTATION AND STORAGE OF SAMPLES

With the water samples intended for bacteriological examination, the laboratory procedures shall be started as soon as possible, preferably within one hour of collection. However, the time elapsing between collection and examination of samples shall in no case exceed 24 hours. During the elapsing between collection and examination, the temperature of samples shall be maintained as close as the time of sampling.

Water samples intended for physio-chemical examination, the samples shall be kept cool during transport and storage. The time elapsing between collection and examination shall in no case exceed 48 hours.

11.4 LABORATORY EXAMINATION

Following methods shall be used for determination of turbidity, colour, total dissolved solids, chlorides, total coliform and faecal coliform, in the water samples:

11.4.1 Turbidity

The turbidity shall be determined by Nephelometric method as described in the "Standard Methods". The turbidity of samples shall be measured and reported in Nephelometric Turbidity Unit (NTU).

11.4.2 Colour

The true colour of sample shall be determined by comparing it with Nesseler colour comparison tubes. The colour shall be determined and reported in colour units based on Platinum-Cobalt scale.

11.4.3 Total Dissolved Solids

The total dissolved solids shall be determined by Filtration-Evaporation method and expressed in mg/l.

11.4.4 Chlorides

Chlorides shall be determined by employing Mohr method, which uses silver nitrate as titrant and Potassium Chromate as the indicator. Chlorides shall be expressed and reported in units of mg/l.

11.4.5 Total Coliform and Faecal Coliform

Total coliform and faecal coliform concentrations shall be determined by employing Standard Methods. Dilution-Tube Technique shall be used. The results shall be reported in units of MPN/100 ml.

11.5 RECORD & DATA

A record shall be made of each sample by the Contractor and each bottle shall be identified including the information sufficient to identify the sample at some later date i.e. name of sample collector; date, hour, and location of sampling and water temperature. All records and data shall be kept by the Contractor on forms approved by the Engineer.

11.6 MEASUREMENT AND PAYMENT

11.6.1 Measurement

The measurement shall be made for each sample, tested in accordance the provisions of this section of the document and accepted by the Engineer.

11.6.2 Payment

Payment shall be made for each set of samples tested and measured as above, at the unit rate appearing in the Bill of Quantities. This price and payment will be full compensation for all steps required to complete the work.

SECTION-12 CONSTRUCTION OF PUMP HOUSE

12.1 SCOPE OF WORK

The work shall consist of construction of pump house complete as per Drawings and in accordance with these specifications and in close conformity with the lines, grades and dimensions shown on the Drawings or as established by the Engineer.

12.2 MATERIALS AND CONSTRUCTION REQUIREMENTS

Materials and construction requirements shall conform to the respective items included in the document.

12.3 MEASUREMENT AND PAYMENT

12.3.1 Measurement

Lump sum or item rate, whichever is included in Bill of Quantities, will be the basis for measurement for the item of various works involved for the completion of this item.

12.3.2 Payment

When the bill of quantities calls for a lump sum price, construction of pump house will be paid for at the contract unit rate which price and payment will be full compensation for all miscellaneous operations for all civil, electrification, lights, fans, complete as shown on the Drawings or established by the Engineer.

SECTION-13 ELECTRICAL & MISC. WORKS

13.1 SCOPE OF WORK

The work shall consist of furnishing all plant, labour, equipment, appliances, and materials and of performing all operations in connection with the electrical work and other works in strict accordance with this section of the specifications and the applicable Drawings, and subject to the terms and conditions of the contract.

13.2 ELECTRICAL WORKS

13.2.1 Regulation

All electrical installation work shall conform to the Electricity Act, 1910 and the Electricity Rules 1937, as adopted and modified by the Government of Pakistan from time to time and WAPDA Specifications; and the requirements specified herein. Except where otherwise shown or specified all electrical equipment shall be suitable for operation 230 volts, 50 cycles, alternating current power supply. All electrical materials shall be new. Defective equipment or equipment damaged during installing or testing shall be replaced or repaired by the Contractor at his own expense.

13.2.2 Coordination

The Drawings indicate the extent and the general location and arrangement of equipment, conduit and wiring. The Contractor shall study building plans and details so that the outlets and equipment will be properly located and readily accessible. Lighting fixture equipment and outlets shall be located to avoid interference with mechanical or structural features; otherwise, lighting fixtures shall be symmetrically located according to building arrangement. If any conflict occurs necessitating departure from the Drawings, details of departure and reasons therefore shall be submitted as soon as practicable for written approval of the Engineer.

13.2.3 Standard Products

Material and equipment used for this work shall be standard products from manufacturers regularly engaged in producing such equipment and shall be the manufacturer's latest standard design complying with specification requirements.

13.2.4 Material and Equipment Schedules

As soon as practicable and before starting installation of any material or equipment, the Contractor shall submit 6 copies of a complete list of materials and equipment proposed for installation to the Engineer for his approval. The list shall include manufacturer's names and materials or equipment identification such as styles, types, or catalogue numbers, to permit ready and complete identification.

13.2.5 Workmanship

All materials and equipment shall be installed in accordance with recommendations of the manufacturer subject to approval by the Engineer and in such a manner as to conform to the contract documents.

13.2.6 Grounding

All electrical equipment, including motors, meters, lighting and distribution panels, switchgear and similar items shall be grounded. All exposed non-current carrying metallic parts of electrical equipment, raceway systems and neutral conductor of the wiring system shall be grounded. Earth plates for the grounding system shall consist of copper plates of the minimum size of 609.6mm square and 3.175mm thick. The top earth plate shall be 2.44m below the ground level with critical watering arrangement or at the natural water level whichever is easy to install. A minimum 152.4mm layer of charcoal and rock salt shall be provided underneath each earth plate and a minimum 457.2mm layer of charcoal and rock salt shall be provided above each earth plate. The ground connection from the earth plate shall be securely bolted by a copper nut and bolt and additionally soldered to the plate. The ground connection including earth plate shall be kept clear of the structure foundation. The earth plate shall be located not nearer than 1.83m from the outer face of the building wall. Ground connections indicated as 3.18x25.4mm copper tape may be made with number 4/0 AWG or SWG cable. Ground connections indicated as 3.18mm by 12.7mm copper tape may be made with number 2/0 AWG or SWG cable. All ground connections shall run vertically and horizontally exposed on the surface of the wall and shall run concealed in the floor. Connections and splices shall be of the brazed, welded, bolted, or pressure connector type, except that pressure connectors or bolted connections shall be used for connections to removable equipment. Ground connection from the building to the earth plate shall be run at a depth not less two feet below ground level.

13.2.7 Conduit

Unless otherwise indicated, electrical wiring shall be run in galvanized steel (G.I.) conduit or PVC Pipe according to the specification PVC pipe shall not be used as conduit for buried or embedded run. Minimum size of raceways for branch circuit wiring shall be 19.1mm. Conduit pipes shall be exposed on walls and ceilings but shall run concealed in floors. Conduit shall be continuous when passing through wall or floor. Conduits installed on the surface of walls shall be supported and secured at intervals of not more than 0.91m and shall be installed parallel or perpendicular to walls, structural members or inter sections of vertical planes and ceilings. Field made bends and offsets shall in general be avoided, but if so required these shall be made with an approved method or by conduit bending machine. Changes in direction of runs shall be made with symmetrical bends or cast-iron fittings. Crushed or deformed raceways shall not be installed. Trapped raceways in damp and wet locations shall be avoided where possible. Care shall be

taken to prevent the lodgement of plaster, dirt or trash in raceways boxes, fittings, and equipment during the course of construction. Clogged raceways shall be entirely free of obstructions or shall be replaced. Raceways crossing expansion joints in concrete slabs shall be provided with suitable expansion fittings or other suitable means to compensate for expansion contraction. Raceways installed underground or under slabs shall be coated with an approved type of protective coating.

a. Galvanized Iron (GI) Conduits

The galvanized iron (GI) conduits shall have minimum wall thickness of 1.65mm (i.e., 16 SWG) and shall have the diameter indicated on the Drawings. Damaged portions of galvanizing at joints shall be cleaned and painted with a silver-coloured rust inhibitive paint. Conduit shall be cut and threaded in such a manner that there are no sharp edges. Conduit bends shall be uniform and shall have minimum radius of 5 times the diameter of the conduit or shall be made through pull or junction boxes.

b. PVC Pipe

PVC pipe and specials shall conform to British Standard Specification BS 3505:1962 "Unplasticized PVC pipe (Type 1420) for Cold Water Supply" and shall be class B. The entire conduit system shall be completed by cutting the PVC pipes and jointing and sealing to respective specials with P.V.C. solution as recommended by the PVC pipe manufacturers.

c. Additional Requirements for Exterior Conduit

All joints between sections of conduit, conduit and specials, and conduit and switches or lights shall be made water proof in an approved manner. Except where otherwise indicated, conduit shall be supported at least every 0.914m. Drainage fittings or seep holes shall be provided at unavoidable low points where moisture can collect. A maximum of two 90-degree bends will be allowed between boxes. Conduits shall be buried underground at minimum of 457.2m below finish grade. Bearing of conduit shall be uniform throughout its length in bottom of trench. Backfilling shall be in 101.6x152.4mm layers, compacted to 95 percent of maximum density.

13.2.8 Conductors

a. General

Conductors shall be new and shall be of polyvinyl chloride (PVC) insulated copper unless otherwise specified. Wire connector of insulating material or solderless pressure connectors properly taped shall be utilized for all splices where possible soldered mechanical joints insulated with tape shall be kept to a minimum. Vinyl plastic tape of suitable quality is acceptable in lieu of rubber and friction tapes. The entire conduit system shall be completed and

anchored prior to installing the wiring.

b. Conductor Sizes

Conductor sizes for tube-well motor main cables shall be as indicated in the Drawings. Control circuit conductors shall not be smaller than number 12 AWG except that for circuits of more than 30.48m from panel to load centre number 10 AWG shall be used.

c. Conductor Insulation

In normally dry locations, conductor number 8 AWG or larger shall have rubber or thermoplastic insulation of a heat resistant grade RH, RW, RHH or THW. Conductors smaller than number 8 AWG shall have a heat resistant rubber insulation type RH or RH RW or thermoplastic insulation, type T or TW.

13.2.9 Boxes and Supports

Boxes shall be provided wherever required for pulling of wires, making connections, and mounting devices or fixtures. Boxes for metallic raceways shall be of the cast iron hub type when located in normally wet locations. Boxes in other locations shall be sheet steel except that non-metallic boxes may be used with non-metallic conduit system. Steel boxes shall be fabricated of structural quality flat rolled minimum 18-gauge sheet of steel free from irregularities, mill scale and surface corrosion shall be neatly and accurately formed with corners squared and sides jointed by welding. Each box shall have the volume required for the number of conductors enclosed in the box. Boxes for mounting lighting fixtures shall be not less than 4 inches. Cast iron boxes installed in wet locations and boxes installed flush with the outside of exterior surfaces shall be gasketed. Boxes for use with raceway systems shall not be less than 38.1mm deep. Exterior pull boxes, junction boxes, boxes for exterior electrical supply points, switch boxes and all other boxes required for exterior electrical work shall be weather proof, heavy duty, galvanized steel.

13.2.10 Lamp Fixture and Accessories

All incandescent lighting fixtures shall be suitable for bayonet base lamps. All accessories such as straps, mounting plates, nipples or brackets shall be provided as required for proper installation. The exterior light points shall be provided with all fittings, accessories, metal clad switches, weatherproof light fixtures, holders, bulbs and covers.

13.2.11 Electrical Supply Points (Outlet Connections)

Electrical supply points shall be provided where indicated on the Drawings. Electrical supply points shall have the types of receptacles suitable for the plugs of the equipment to be connected to these points. Where receptacles are not available to match the plugs of equipment, standard receptacles

shall be used and plugs on equipment supply leads shall be replaced by the contractor with plugs to match standard receptacles. Each electrical supply point shall be complete with a switch. Exterior electrical supply points shall be provided where indicated. Exterior electrical supply points shall be weather proof, complete with switch and of the type suitable for the plugs of the equipment to be connected to these points.

13.2.12 Flexible Connections

Flexible connections of short lengths shall be provided for all motors and equipment. The flexible connections shall be water tight.

13.2.13 Fuse Circuits and Fuse Boxes

The Contractor shall provide proper fuse boxes for each circuit. The fuse boxes and the switches shall be metal clad and suitable for the load for which the circuit is designed. All fuse boxes shall be complete with proper size fuse strips fitted to fuse bridges.

13.2.14 Power Switchgear Assemblies

Power switchgear assemblies shall be metal enclosed and air circuit breaker type. The type and make of the circuit breaker shall be subject to approval of the Engineer.

13.2.15 Exterior Switches

Except where otherwise indicated exterior switches shall be of the push button weatherproof type.

13.2.16 Testing

Before any electrical system is put into service, the entire system installation shall satisfactorily pass the tests prescribed by the Electricity Department and the following tests. The Contractor shall furnish all instruments and personnel required for the tests, and the Employer will furnish the necessary electric power.

a. Insulation Resistance

The insulation resistance shall be measured by applying voltage between earth and the entire system of conductor or any section thereof, with all fuses in place and all switches on. A direct current voltage of not less than twice the working voltage shall be applied. The insulation resistance of the installation measured as above shall not be less than 25 megaohms divided by the number of points in the circuit. The metal conduit shall be tested for electrical resistance. The electrical resistance of such conduits measured between the main switch and each point shall not exceed 2 ohms.

b. Operating Test

After the wiring system has successfully passed by the insulation resistance test, and at such time as the Engineer may direct, the Contractor shall conduct an operating test for approval. The equipment shall be demonstrated to operate in accordance with the requirements of this specification. The test shall be performed in the presence of the Engineer.

c. Earth Plate Resistance

Resistance to each earth plate shall be tested by a standard earth tester, not sooner than 72 hours after a rain and without prewetting ground. The resistance of each earth plate shall not be more than 10 ohms. The test shall be performed by the contractor in the presence of the Engineer. Earth plates having a resistance of more than 10 ohms shall be replaced and retested. The Contractor shall submit in writing to the Engineer upon completion of the project, the measured ground resistance of each earth plate, indicating the location of the earth plate and the resistance and the soil conditions at the time, the measurements were made.

13.2.17 Repair

The work shall be carefully laid out in advance. Cutting, channelling, chasing or drilling of floors, walls, partitions, ceilings or other surfaces as necessary for the proper installation, support or anchorage of the conduit, raceways or other electrical work shall be carefully done. Damage to building surfaces, piping and equipment (including pointing work) shall be repaired to its original condition by skilled mechanics of the trades involved at no additional cost to the Employer.

13.3 POWER TRANSFORMER

13.3.1 General

The power transformer shall be indoor type, oil immersed, self-cooled, designed and built to give efficient and reliable service at their full rated capacity on the climatic conditions given in the general information of these specification. Transformer s built to the following standard will be acceptable.

- BS 171-1970 or any other relevant latest British Standard
- VDE 0532

13.3.2 Construction

The transformer tank shall be constructed of welded sheet steel plates and provided with external radiating tubes.

The transformer shall be fully tropicalized for temperature rise, humidity, altitude etc. The local conditions shall be taken into account while following the above standards. The transformer shall be complete with oil filling, all

accessories and attachments detailed in these specifications or otherwise required and the contractor shall provide all details, drawings, data and complete test results for final approval before installation. The tank and radiating tubes shall be designed to withstand, without developing any deformation, pressure at least 25% greater than the maximum operating pressure. The steel plate cover shall be bolted to the tank, using gasket for perfect oil seal. Two earth terminals shall be provided at the base of the tank.

The oil preservation system shall utilize on expansion the conservative tank fitted with silica gel breather and oil level indicator.

The transformer core shall be built of high-grade electrical steel laminations, each lamination insulated to reduce eddy current losses. The core laminations shall be clamped and bolted effectively to reduce 'humming'.

The winding core shall be of high-grade electrolytic copper conductor, flat or round paper insulated, thoroughly dried and impregnated as desired.

The high voltage leads shall be brought out and terminated to glazed porcelain insulator bushings for external connection.

The low voltage three lines and neutral leads shall be brought out and terminated to glazed porcelain insulator bushings for connection to L.V. side by copper bus bars or cables. The transformer neutral shall be earthed.

Off-load operated tap changer shall be provided on the tank cover. The tapping shall be -7.5%, ±5%, ±2.5%. A clear marking illustrated by diagram shall be provided to indicate the tap positions.

The transformer shall be provided with the following accessories.

- Oil filling valve for vacuum filling of oil;
- Oil drain plug;
- Bi-directional rollers fixed to the base steel channel, for rolling in the directions of both centre lines of the transformer;
- Lifting lugs, for handling and un-tanking the transformer; and
- Dial type thermometer for indicating oil temperature and having two hands, one showing existing oil temperature and other showing maximum oil temperature reached since the hand was last reset.

13.3.3 Drawings and Data

The manufacturer shall supply complete structural Drawings showing plan and elevations with complete dimensions and all relevant details of technical data of the offered transformer.

13.3.4 Transformer Technical Data

The technical data for Power Transformer shall be as included in Table 13.1.

Table 13.1, Technical Data for Power Transformer

Sr. No.	Parameter	Data
1	KVA rating	As shown on Drawings
2	No load ratio	11kv/415 V
3	H.V. Winding	
	Line to line volts	11000
	Connections	Delta
4	L.V. Winding	
	Line to line volts	415
	Connections	Star
5	Vector Group	DY 11
6	Tapping on H.V side	-7.5%, ±5%, ±2.5%
7	H.V Termination	Bushing
8	L.V cable size	7x300 mm2
9	L.V Termination	Bushing
10	Impedance voltage	4.5% to 6%
11	Losses in watts	
	Iron at no load	to be furnished by Bidder
	Copper at full load	to be furnished by Bidder
12	Cooling	On
13	Temperature rise over 50°C ambient	
	Oil	40°C
	Winding	50°C

13.4 MEASUREMENT AND PAYMENT

13.4.1 Measurement

The measurement of each item shall be as per provisions of the bill of quantities.

13.4.2 Payment

The items will be paid for at the contract unit price which price and payment shall be full compensation for furnishing, installing and commissioning all machinery and equipment for electrical works, chlorination equipment etc. complete in all respects as shown in the Drawings including all labour, tools, equipment and incidental to complete the work.

PART-D, SEWERAGE SYSTEM

SECTION-14 EARTH WORK FOR SEWERS

14.1 SCOPE OF WORK

The work shall consist of furnishing all materials, equipment and labour for excavation, trenching and backfilling for sewers, drainage facilities, structures and all other appurtenances of sewage collection system, in accordance with Drawings to proper line and grade and refilling the trenches and dressing them to proper surface.

14.2 CLEANING AND GRUBBING

The sites of all excavations shall be cleared of all shrubs, plants, bushes, large roots, rubbish and other surface materials. All such materials shall be removed and disposed of in a manner, satisfactory to the Engineer. All trees and shrubbery, that are designated by the Engineer, or his representative shall be adequately protected and preserved in an approved manner.

14.3 EXCAVATION

14.3.1 General

The Contractor shall do all excavation of whatever substance encountered to the depth shown on the Drawings or as otherwise specified. Excavation shall include without classification the removal and disposal of all materials of whatever nature that would interfere with the proper construction and completion of the work and shall include the furnishing, placing and maintenance of supports for the sides of the excavations. The work shall also include all pumping, ditching, dewatering and other measures required for the removal and exclusion of water. During excavation, material suitable for backfilling shall be stock-piled in an orderly manner at a sufficient distance from the bank of the excavation to avoid over-loading and to prevent sides from caving. Top soil should be stock-piled separately for subsequent reuse as necessary. All excavated material unsuitable or not required for backfilling shall be removed and disposed of at a location approved by the Engineer.

For contract purposes hereunder, the earth excavation work has been classified into two categories, earth excavation in trenches, and earth excavation for structures.

14.3.2 Earth Excavation in Trenches

Except as otherwise provided herein, excavation for a sewer line shall be open cut trenches with vertical side and not more than 200 feet of any trench in advance of the end of the built sewer shall be opened at any time and unless written permission to the Contractor is given by the Engineer. The trench shall be excavated to its full depth for a distance permitted for the sewer to be laid. Trenches for sewer-lines and appurtenances shall be to the lines and grades shown on the drawing or as ordered in writing by the

Engineer as necessary for the proper completion of the work. Bell holes and depressions for joints shall be dug after the trench bottom has been graded. The pipe except for joints shall rest on the prepared bottom for its full length. Bell holes and depressions shall be only of such length, depth and width as required for properly making the particular type of joint. Stones shall be removed to avoid point bearing.

Where the bottom of the excavation is in material which, in the judgment of the Engineer by reason of its hardness cannot be excavated to provide a uniform bearing for the pipe, said material shall be removed to minimum of 6" below the grade of the bottom of the pipe, and the trench backfilled to the required pipe sub grade with sand or other material acceptable to the required depth or with concrete Class-E, if so ordered. In no case material removed from such excavations shall be used as backfill material unless approved by the Engineer. All instructions shall be in writing by the Engineer.

14.3.3 Earth Excavation for Structures

All earth excavation under this Contract, which is not included under the classification of "Earth Excavation in Trenches " shall be classified and paid for as earth excavation for structures.

The Contractor shall provide adequate timbering or shoring for excavations. Should the sides and ends of any excavations give way the contractor shall, at no extra cost, remove all disturbed ground. Any excavation carried outside the limits shown on Drawings and specified herein as the payment limits, shall not be treated as excavation and shall not be paid for.

When foundation level is reached, the Engineer's Representative will inspect the exposed ground and give directions as to what further excavation, if any, he considers necessary. The excavation should be done in such a manner, as to ensure that the work rests on a solid and perfectly clean foundation. If the Contractor allows any portion of such foundations to deteriorate due to exposure, he shall make good the foundation to the satisfaction of the Engineer without extra cost.

14.4 ALIGNMENT AND GRADE

The sewers are to be laid to the alignment and gradient shown on the Drawings, but subject to such modifications as shall be ordered by the Engineer from time to time to meet the requirements of the work. No deviations from the lines, depths of cutting or gradients of the sewers shown on the Drawings and sections shall be permitted except by express directions in writing of the Engineer.

14.5 SETTING OUT SIGHT RAILS

The sewer shall be constructed and laid to a true grade and in straight lines between curves as shown on the plan. The sewer shall be laid and

constructed to their proper levels with the aid of suitable boning rods and sight rails which shall be fixed according to the requirements of the Engineer at intervals not exceeding 40 feet, and also by levelling along the invert with levelling instrument. The sight rails and boning rods shall be provided, fixed and maintained by the Contractor who shall also provide and maintain suitable levelling instruments and equipment and shall set the positions and levels of the sewers and other work according to the Drawings and any instructions which he may receive from the Engineer. All sight rails and posts shall be well seasoned deodar timber of ample size and strength. The rails and boning rods shall be suitably and accurately planned and no warped or otherwise defective or damaged sight rails or boning rods shall be used. Sight rails shall be secured to the posts by strong steel clamps to the approval of the Engineer and in such a manner that they shall be fixed as immovable, in relation to the correct lines and levels. All boning rods and sight rails shall have the centre line accurately marked thereon, by a fine saw cut and shall be painted black and white to the requirements of the Engineer. All boning rods shall suitably be shooed with iron. At least four separate sight rails shall always be maintained in correct level and alignment along the line of sewer at every place where construction work is proceeding and the alignment and level of the sight rails shall be checked by the level and line at least twice every day to ensure that no disturbance or interference of the alignment and level have taken place. Whenever required the Contractor shall erect and maintain such additional sight rails as the Engineer shall direct. The Contractor shall, at all times, see that his workmen or other unauthorized persons are not allowed, accidentally or otherwise, to tamper or interfere with sight rails or other alignment or level marks.

All bends and curves shall be set out mathematically in a manner to be approved by the Engineer and the Contractor shall provide and maintain for the purpose such additional sight rail posts and other wrought and rough timber work, steel wire and other articles as the Engineer shall require from time to time.

14.6 SHEETING AND BRACING

If ordinary open-cut excavation is not possible or advisable, sheeting and bracing shall be furnished and installed in excavations to prevent damage and delay to the work and to provide working conditions, which are safe. The Contractor shall furnish and place all shoring, sheeting, wall braces, timbers and similar items necessary for the safety of work, the general public and adjacent property. Sheeting, shoring and wall bracing shall be removed as the work progresses and, in such manner, as to prevent damage to the finished work and adjacent structures and property. As soon as it is withdrawn all voids left by the sheeting and bracing shall be carefully filled with selected material and compacted. The Contractor shall be fully responsible for the safety of the work in progress, for the finished work, the workmen, the public expenses, as part of the work under the excavation items and at no extra

cost.

14.7 DEWATERING OF TRENCHES

As part of the work under the excavation items and at no extra cost, the Contractor shall build all drains and do ditching, pumping, well-pointing, bailing and all other work necessary to keep the excavation clear of ground water, sewage and storm water during the progress of the work and until the finished work is safe from injury, the Contractor shall provide all necessary pumping equipment for the dewatering work, as well as operating personnel, maintenance, power etc. all at no extra cost. All water pumped or drained from the work shall be disposed of in a manner satisfactory to the Engineer. Necessary precautions against water flooding shall be taken.

14.8 MAINTENANCE OF EXCAVATIONS

All excavation made hereunder shall be properly maintained while these are open and exposed. The Contractor shall provide warning lights, signs and similar items sufficient suitable barricades. The Contractor shall be responsible for any personal injury or property damage due to his negligence.

14.9 PROTECTION OF EXISTING FACILITIES

The Contractor shall take special care of existing sub-surface facilities likely to be encountered during the excavation for their protection, such as sewers, drain pipes, water mains electric cables, communication cables and the foundations of adjacent structures. The Contractor shall be responsible for any damage to any such facility and shall repair the same at his expense whether or not the facility has been shown on the drawing.

14.10 DISPOSAL OF SURPLUS EXCAVATED MATERIAL

All surplus material excavated by the Contractor shall be disposed of at locations approved by the Engineer. The disposal of surplus material shall not interfere with other works and shall not damage or spoil other materials. When it is necessary to haul earth material over street or pavements, the Contractor shall prevent such material from falling on the streets or pavements.

14.11 BACKFILLING

14.11.1 General

After the completion of sewer line, drainage facilities foundations, walls and other structures below the elevation of the final grade all voids shall be backfilled with suitable materials specified below.

14.11.2 Backfilling for Structures

Backfilling operations for structures shall be performed as part of the Contractor's work under the payment items for earth excavation and at no extra cost. Backfill material for foundations, walls and other structures shall

consist of excavated soil, which is free from stones and hard clods not larger than 3 inch in any dimension, and also free from trash, lumber and other debris. Backfill material shall have enough moisture for proper compaction and shall be compacted in an approved manner to 90 percent of maximum density for cohesive soils and 95 percent of maximum density for cohesion less soils. Backfill shall not be placed against foundation walls earlier than 4 days after placing of concrete or brick masonry.

14.11.3 Backfilling for Trenches

After the sewers have been constructed and tested as specified and to the satisfaction of the Engineer, the trench shall be backfilled. Utmost care shall be taken in doing this so that no damage shall be caused to the sewer and other underground utilities. After this has been laid the trench and other excavation shall be backfilled carefully in 150mm layers with earth as approved by the Engineer, each layer being watered to assist in the compaction unless the Engineer shall otherwise direct.

14.12 MAXIMUM DENSITY DETERMINATION FOR COMPACTED SOIL

The maximum density of the soil shall be determined in accordance with the latest revision of "American Society for Testing Materials (ASTM) Standard D 1557 Density Relations of Soils, using 6.8 kg Rammer and 450mm Drop".

14.13 TESTING DENSITY OF SOIL

The Engineer will make tests using the calibrated sand cone method/core cutter method to determine the density of soil in place in accordance with ASTM Designation D 2558, latest revision. If soil in place fails to meet the specified degree of compaction the areas represented by the failing tests shall be re-excavated and compacted to the specified density in the manner directed by the Engineer at no extra cost.

14.14 TOP SOIL

Top soil, which has been stock-piled during excavation, shall be used for the top 150mm of backfill, in locations as ordered by the Engineer. Top soil shall be saturated with water and after it has dried, shall be spread to the required final grade and of required density. The work shall be performed at no extra cost.

14.15 PROXIMITY TO BUILDINGS

Where buildings in the opinion of the Engineer near excavation are likely to be affected, the Contractor shall provide shoring to protect such buildings in addition to timbering of trenches. The Contractor shall be required to leave timbering inside trenches if so required by the Engineer for protection of these buildings at no extra cost.

14.16 LENGTH OF TRENCHES IN ADVANCE OF CONSTRUCTION

Unless otherwise directed in writing by the Engineer of the work not more than 200 ft in advance of constructed or laid sewer shall be left open at any time.

14.17 DISPOSAL OF FILTH AND GARBAGE

No night-soil, filth and garbage met with during the excavation shall be allowed to be deposited on side of road/street so as to cause nuisance or obstruction to traffic. The same shall be disposed of by the Contractor to a place to the satisfaction of the Engineer.

14.18 DISPOSAL OF SURPLUS EARTH

The Contractor shall dispose of all surplus excavated materials not required to be used on the work. This shall include surplus earth after refilling and compaction.

14.19 TUNNELING

14.19.1 Formation of Soil

Tunnelling shall only be permitted in strong hard and homogenous, clay formations, which are not likely to collapse under normal working conditions. The work shall not be permitted in running sand. In weaker formations such as mixture of clay and sand, which are liable to collapse when exposed to atmosphere, the roof shall be protected by adequate timbering and shoring. If the tunnel is subject to any sort of traffic, it shall be provided with adequate timbering and shoring for its roof and walls.

14.19.2 Length of Tunnel

Normally the length of tunnel without adequate support shall not exceed 3 feet. This length shall, however, be exceeded under the directions of the Engineer, where depth of tunnel below ground level is considerable to avoid any danger of collapse. The tunnel, however, shall be driven in longer length up to 150 feet, if drive casing is provided as the tunnel is being excavated.

14.19.3 Horizontal Boring Machines

When considered necessary by the Engineer, horizontal boring machines shall be employed for crossing sewers underneath highways and canals. Whenever such machinery is used, drive casing of steel pipes shall be driven to avoid any collapse of the tunnel.

14.19.4 Backfilling of Tunnels

Backfilling of tunnels shall be done with clean river sand through bore holes duly lined with casing pipes, to be provided in the roof of the tunnel at suitable locations as per directions of the Engineer. The backfilling shall be made after the construction inside has been duly completed as per directions of Engineer.

14.20 MEASUREMENT AND PAYMENT

14.20.1 Measurement

The measurement shall be made for the actual quantity of the work done in cubic foot or cubic metre (whichever is included in Bill of Quantities). The maximum width of the trenches allowed for payment for various pipe sizes are included in the Drawings.

14.20.2 Payment

The unit rate tendered in the Bill of Quantities for excavation of trenches for sewer lines shall be considered as full compensation for the work specified in this section and shall include all excavation, backfilling, compacting, constructing and removing all temporary arrangements, pumping and dewatering disposal of surplus materials, removal of soft soil from bottom of trenches, removing the surface material and all incidentals to complete this work in all respects.

SECTION-15 REINFORCED CEMENT CONCRETE PIPE SEWERS

15.1 SCOPE OF WORK

The work shall consist of furnishing all pipes, plant, labour, equipment, appliances and materials and in performing all operations required for installing and testing the sewer pipes of reinforced cement concrete in strict accordance with the specifications of this section and the applicable drawing and subject to the terms and conditions of the contract.

15.2 REINFORCED CEMENT CONCRETE PIPES

15.2.1 General

All reinforced concrete pipes furnished and installed under this contract shall conform to ASTM C76 "Reinforced Concrete Culvert, Storm Drain and Sewer Pipe" and as per provisions of these technical specifications, using structural steel reinforcement. Sulphate Resistance Cement shall be used for sewers.

15.2.2 Classes of Pipe

The reinforced cement concrete pipes to be furnished and installed under this contract shall be of the strength classes shown on the Drawings and designated in Bill of Quantities of the Bidding Documents.

The strength classes shall be identified as one or more of the following:

- Class-I
- Class-II
- Class-III
- Class-IV
- Class-V

The design requirements for these five classes of reinforced cement concrete pipe shall be as described in ASTM C76-2003, or its latest version, Tables I through V for the respective strength classes. Unless otherwise called for in other parts of these Bidding Documents or applicable variation order, all reinforced cement concrete pipes under this contract shall comply with the Wall B design requirements as set forth in said Tables I through V of ASTM Designation ASTM C76-2003, or its latest version.

15.2.3 Basis of Acceptance

RCC pipes shall be used conforming to ASTM C76-2003, or its latest version, Class III, Wall "B" and acceptance of same shall be determined on the basis of following test results:

a. Concrete Compressive strength

i Compressive strength of concrete used for the fabrication of the RCC pipe shall be minimum 4000 psi;

ii Compression test determining concrete compression strength may be made on concrete cylinder compacted and cured as pipe; and

iii All type pertaining information for conducting the compressive test is given in the specification ASTM C76-2003, or its latest version, which should be followed.

b. Inspection

i Whether the required quantity or steel reinforcement is provided and placed for the fabrication of RCC pipe as required by the Specification; and

ii Manufactured pipe for visual defects and imperfection such as diameter, wall thickness, length of pipe and smoothness of the inner/outer surface of the pipe.

c. Three Edge Bearing Test

i The three-edge bearing test shall be conducted as required by ASTM C76-2003, or its latest version; and

ii Test load expressed in pounds-force per linear foot per foot of diameter to produce a 0.01-inch crack. The dead load to produce 0.01-inch crack as desired by the ASTM C76-2003, or its latest version shall be 1000 lbs force per linear foot per foot of diameter.

d. Crushing Load Test

i The crushing load test on the manufactured pipe shall be conducted in compliance with ASTM C76-2003, or its latest version; and

ii Test load as desired by the specification shall ne 1,500 lbs force per linear foot per foot of diameter.

e. Marking

The following information shall be marked on each pipe:

i Pipe class and specification designation;

ii Name or trade mark of the manufacturer; and

iii Identification of plants.

The Contractor shall bear the cost of such tests and pay fees etc., and also pay for the carriage of such samples and all other expenses contingent to tests. The manufacture of the pipes at the factory shall be watched and tested by the authorized representative of the Engineer.

15.2.4 Materials

All materials used in the manufacture of reinforced cement concrete pipes for use under this contract shall conform to ASTM C76-2003, or its latest version, and also with the following specifications:

a. Cement

The Portland cement which is required to be used in the manufacture of reinforced concrete pipes to be furnished and installed under this contract shall conform to the requirements of ASTM Designation C-150 latest revision.

b. Aggregate

The course/fine aggregate to be used in the manufacture of concrete pipes to be furnished and installed under this contract shall be generally in accordance with the provisions of section of these specifications.

c. Steel Reinforcement

The material will conform to the specifications contained in relevant Section of these specifications.

15.2.5 Mixing of Concrete

The proper types and amounts of Portland cement, mineral aggregates and water shall be thoroughly mixed in an approved type of mechanical batch mixer which shall be kept in first class condition. Admixtures in the concrete will not be permitted.

15.2.6 Pipe Dimensions

The internal diameters and wall thickness of reinforced concrete pipes under this contract shall be as set forth in ASTM C76-2003, or its latest version, in Tables I through V for "Wall B" pipe as required and shown on the Drawings.

The lengths of reinforced concrete pipes under this contract shall be as required to provide the designated laying length shall be in full, and shall not be less than 6 feet, nor more than 8 feet, unless otherwise approved in writing by the Engineer. Only one laying length shall be permitted for each size of reinforced concrete pipe under this contract and pipes not of the approved uniform laying length shall not be used in the work.

15.2.7 Lift Holes not permitted

Lift holes in the walls of reinforced cement concrete pipes will not be permitted under this contract for the purpose of handling and laying. Other approved lifting methods shall be employed.

15.3 CERTIFIED PLANS AND DATA SHEETS

The Contractor shall submit in triplicate, for approval by the Engineer, certified plans and data sheets as required to provide complete information on all concrete sewer pipes, dimensions, type and dimensions of pipe ends, joint details, proposed concrete design mix for each different strength class of reinforced or non-reinforced concrete pipe and any other information needed to demonstrate full compliance with these specifications.

No concrete sewer pipe shall be delivered to the work site until the Engineer has formally approved the plans and data sheets and until all test requirements called for in the respective ASTM Standard Specifications ASTM C76-2003, or its latest version, and C-14 have been met.

15.4 JOINTS FOR CONCRETE PIPE SEWERS

15.4.1 General

Joints for concrete sewer pipes of more than 150mm diameter shall be Rubber Gasket joints as provided in the Drawings. No other types of joints will be permitted under this contract. For pipes of 150mm internal diameters collar joints will be used.

15.4.2 Rubber Gasket Joints

Rubber gasket joints shall be used for either tongue and groove or bell & spigot pipes.

Rubber gasket joints shall be made using specially designed rubber gaskets, made to fit the applicable tongue and groove or bell and spigot pipes and adequately tested under operating conditions. Special care must be taken in the selection and handling of the concrete pipes for use with rubber gasket joints, to ensure that pipe ends shall be smooth and concentric with tolerance which closely conforms to the requirements of the manufacturer of the rubber gaskets. The tongue or spigot end of each pipe shall be specially designed to perform groove or offsets to fit the manufacturer's rubber gasket design.

The rubber gasket joints shall conform to all applicable requirements of the latest revision of ASTM Designation C-443, entitled "Joints for Circular Concrete Sewer and Culvert Pipe, using Flexible Watertight Rubber Type Gaskets", except that the test pressure need not exceed 10 feet of head at which the completed sewers shall meet the infiltration or exfiltration limits set forth hereinafter.

The groove end of tongue and groove pipes of either the reinforced or non-reinforced concrete type, shall have at least one line of wire reinforcing of 8-gauge size placed in the centre of the groove.

The rubber gasket shall be installed on the pipe in accordance with the instructions of the gasket manufacturer. In general, the gaskets shall be pre-assembled to the pipe at the pipe manufacturing plant. The pipes shall be handled with special care at all times to prevent damage to the pipe ends. A lubricant shall be used for jointing the pipes as recommended by the rubber gasket manufacturer. Care shall be taken to avoid contamination of the gasket and lubricated surfaces with earth or other undesirable material during installation.

For either tongue and groove or bell and spigot pipes, mechanical means shall be used to pull the pipe home for all sizes of 12-inch or larger diameter in accordance with the recommendations of the rubber gasket manufacture. Pipes of 9 inch or smaller diameter may be coupled manually using a cross member and bar. Under no circumstances will bars alone be used nor shall any motor driven equipment be used to force the pipe home.

15.5 INSTALLATION OF CONCRETE PIPE SEWERS

15.5.1 Handling of Pipes

Concrete sewer pipes shall be handled with special care at all times during the manufacture, while transporting to the site of work, and while installing. Each pipe shall be carefully inspected before being laid and no cracked, broken or defective pipe shall be used in the work. Chipping of the tongue and groove or bell and spigot pipe ends, which in the Engineer's opinion may cause defective joints, shall be sufficient cause for the rejection of any concrete pipe.

15.5.2 Excavation and Backfill

The excavation and backfill for sewer installations shall be as specified in applicable provisions of these technical specifications and will be paid for under separate contract items as classified.

15.5.3 Trench Bedding

Wherever called for on the Drawings or where ordered in writing by the Engineer, the Contractor shall furnish and place bedding, and/or concrete encasement for the concrete pipe sewers under this contract. The bedding shall be as specified in applicable provisions of these technical specifications and will be paid for under separate contract item as classified, described and listed in the Bill of Quantities or and as called for in applicable variation order.

The concrete encasement shall be placed in accordance with the details and notations on the Drawings or as ordered in writing. Concrete work shall be as specified in applicable provisions of Item of these technical specifications and will be paid for under separate contract items as classified, described and listed in the Bill of Quantities or as called for in applicable variation orders.

15.5.4 Laying of Sewers

Neither any sewer pipe nor the bedding shall be laid or placed till the alignment of the sewer and its levels nor have gradients been carefully checked and tested with the trench excavation and found correct.

Each length of sewer pipe shall be checked for cracks and defects before placing in the line. Defects which in the opinion of the Engineer indicate imperfect placing, shall make the pipe liable to rejection. Each pipe shall be placed carefully to line and grade and in close contact with adjoining pipe. These specifications require rejection of the work if the sewer invert varies as much as 12mm from the proper elevation. As shown on Drawings, the bottom of the trench must be shaped to fit the pipe barrel, with holes left for the bells. If excavation has been carried below the correct grade, refilling must be done with satisfactory materials as approved by the Engineer at no extra cost.

The concrete pipe joints shall be of the types designated above and shall be made in accordance with the aforesaid specifications.

When laying is not in progress, the open pipe shall be closed with a tapered wooden plug to keep out foreign matter.

15.5.5 Pavement Restoration

The contractor shall restore paved surfaces which have been cut under this contract, as part of the work under the excavation items and at no extra cost to the Owner.

15.6 TESTS FOR INFILTRATION OR EXFILTRATION

15.6.1 General

All pipes built under this contract shall be tested for infiltration or exfiltration as specified below. The Contractor shall furnish labour, materials and equipment required for making the tests with no extra compensation over and above the agreed contract price for the sewers. The tests shall be made at times selected or approved by the Engineer. Sections of the completed sewer shall be isolated and measurements of the infiltration or exfiltration shall be made by approved methods.

15.6.2 Infiltration Tests

The sewers which are constructed with the ground water level above the crown of the pipe shall be tested for infiltration after the sewers have been installed and backfilling has been substantially completed. The tests and measurement shall be performed by the Contractor in the presence of and in a manner approved by the Engineer. The duration of the tests shall be only long enough to establish the true rate of infiltration. The amount of leakage over a 24 hours period will then be calculated from the result of the measured true rate of infiltration.

15.6.3 Exfiltration Tests

The sewers which are constructed with the ground water level below the crown of the pipe shall be tested for exfiltration by isolating a section of sewers between manholes by means of approved temporary type of water tight bulk heads. The method of testing for exfiltration shall be generally as follows:

a. After isolation of sewer section, it shall be filled with water to a level which is 1m above the crown of the sewer at the higher end of the isolated section under test. The level will not be more than 6 feet above the crown of the sewer pipe at its lower end.

b. The duration of the exfiltration test shall be one hour after the filling with water has been completed.

c. Determination of the amount of exfiltration shall be made by measuring the total loss of volume of water in the manholes.

d. The amount of exfiltration over a 24 hours period will then be calculated from the measured loss of volume during the test observation period.

15.6.4 Allowable Infiltration or Exfiltration

The calculated amount of infiltration or exfiltration over a 24 hours period shall not exceed 75 litre per mm of pipe diameter per km of sewer, which rate shall be applied to the actual sewer size and length tested to determine the allowable infiltration or exfiltration over the 24 hours period.

If the measured infiltration or exfiltration exceeds the specified allowable limit, then the Contractor shall locate the points of leakage and make necessary repairs so as to reduce the leakage to less than permissible maximum stated above.

15.7 MEASUREMENT AND PAYMENT

15.7.1 Measurement

Measurement for reinforced cement concrete pipes shall be made for the actual quantity of the work done in linear metre or linear feet (whichever is included in Bill of Quantities) of different sizes and strength installed tested and approved as authorized for payment under the Contract. The measurement will be made along the centre line of the pipe and between the inside walls of manholes or junction chambers.

15.7.2 Payment

The unit rate quoted in the Bill of Quantities for supplying, laying and jointing cement concrete sewer pipes, will be considered full compensation for the cost of pipes, charges for their carriage to site and testing before and after laying, labour charges for laying, jointing, etc. and cost of all incidentals for

completion of this item of work as per specifications laid down in this section. Payment for this item of work shall be made at the unit rate(s) quoted in the Bill of Quantities for various internal diameters of pipes.

SECTION-16 CONSTRUCTION OF MANHOLES

16.1 SCOPE OF WORK

The work consists of constructing manholes (including connection chamber) for sewerage at positions shown on the Drawings or where otherwise directed by the Engineer, and in accordance with the detailed Drawings supplied from time to time, complete in all respects.

16.2 MATERIALS

Brick masonry, Portland cement concrete, and other materials shall meet the specified requirements of the relevant sections of the specifications.

Manhole steps shall be of malleable iron conforming to BS 1247.

16.3 CONSTRUCTION REQUIREMENTS

Manholes shall be constructed with brick masonry of specified wall thickness laid in specified cement sand mortar, built on concrete slab. The cover shall be 1:2:4 reinforced cement concrete, fitted with Mild Steel angle frame which shall have reinforced cement concrete cover as shown in the Drawings. The outside of the walls shall be plastered with specified cement sand mortar, painted with two coats of bitumen. At the bottom of manholes for sewers, a proper channel as per Drawings, shall be constructed in the whole length of the manhole along with centre line of the sewers, to lead the sewage from one sewer to the other.

Malleable iron steps shall be installed inside the manhole, during the construction of the manhole walls. Cutting holes into the wall for the steps after construction will not be permitted. Top rung shall be 18" below the manhole cover and the lowest not more than 12" above the benching (floor).

16.4 MEASUREMENT AND PAYMENT

16.4.1 Measurement

Measurement shall be made for the actual number of manholes of the appropriate type constructed at site as per Drawings and specifications laid down in this section and to the approval of the Engineer. The depth / height of manhole for the purposes of measurement and payment shall be difference of level between the top of manhole (top of cover) and invert level of manhole.

16.4.2 Payment

The unit rate quoted in the Bill of Quantities for the construction of manhole shall be considered full compensation to cover the cost of all materials including form work for concrete, excavations, brick masonry, steps, frame and concrete cover, and connecting pipe with the manhole, and all labour

including curing, plastering, benching and bitumen painting etc. and all incidentals to completely construct them at site as per Drawings and specifications laid down in this section.

Payment shall be made for the actual number of manholes constructed and counted as above, at the appropriate rate quoted in the Bill of Quantities.

SECTION-17 PIPE BEDDING

17.1 SCOPE OF WORK

Wherever specifically called for by means of notes on the contract Drawings or by written order of the Engineer, the Contractor shall furnish and place sand or gravel/crushed stone bedding under sewer lines, drain pipes and other structures as a separate item of payment.

17.2 SOURCE OF BEDDING MATERIAL

Sand and gravel/crushed stone bedding material shall be from a source and of specifications approved by the Engineer.

17.3 PURITY AND STACKING

The sand and gravel/crushed stone shall be free from clay, salt, alkali, organic matter, shale, loam, soft flaky particles and other deleterious substances. It shall be stacked at the place designated by the Engineer and kept free from the admixture of deleterious materials mentioned herein. The sand shall have clay/silt contents not more than 5%.

17.4 PLACING OF BEDDING MATERIAL

The material for bedding shall be placed to the specified thickness and compacted by rammers of approved weight.

17.5 MEASUREMENT AND PAYMENT

17.5.1 Measurement

The measurement shall be made by volume for the actual quantity of the work done and the unit of measurement shall be cubic foot or cubic metre (whichever is included in Bill of Quantities).

17.5.2 Payment

Payment for this item of work shall be made for the actual quantity of work done as specified in this section, at the unit rate quoted in the Bill of Quantities.

PART-E, CIVIL WORKS

SECTION-18 EXCAVATION, BACKFILLING & DISPOSAL

18.1 SCOPE OF WORK

The work under this section consists of excavating, in all types of soil, lifting, transportation and disposal of the excavated material, back-fill and fill for building foundations, and under floors including all incidental work necessary for excavation to the required depth and dimensions and in accordance with the Drawings or as directed. The work shall be carried out in complete conformity with the specifications set-forth hereunder.

18.2 AUTHORIZED OUTLINES

Unless otherwise specified or directed in writing, all earthwork, i.e., excavation of trenches, pits, etc. for foundations, filling under floors, etc. shall be executed to the widths, depths, lengths, alignments grades and levels shown on the Drawings. If they are not indicated on the Drawings then the Contractor shall prepare the drawing showing the existing ground levels and the actual grades and levels of excavation for obtaining necessary approval from Engineer before excavating the ground.

Similarly, for all backfill and fill works the Contractor shall prepare drawings showing the existing ground levels and the actual finished level to ascertain the volume of fill for obtaining approval before the commencement of work.

18.3 CONSTRUCTION REQUIREMENTS

18.3.1 Excavation

a. General

All excavation, in any kind of soil encountered, shall be performed to the depths and widths indicated or as otherwise specified by the Engineer. During excavation, material suitable for backfilling shall be stockpiled in an orderly manner at a sufficient distance from the banks of the excavation to avoid overloading and to prevent sides from caving. Topsoil shall be stockpiled separately, for subsequent re-use as necessary. All excavated material unsuitable or not required for backfilling shall be removed and collected at a location approved by the Engineer.

It is anticipated that all excavation work under this Contract, will be earth excavation. The term "earth" as used herein shall include all materials which do not in the opinion of the Engineer, require blasting, barring or wedging of material for removal from its original bed.

Unless otherwise indicated or approved by the Engineer, excavation shall be open cut.

b. Timbering or Sheeting

The Contractor shall provide adequate timbering or sheeting for excavation where necessary, as part of the excavation work, to hold up the sides and ends of all excavations. Should the sides and ends of any excavation give away, the Contractor shall, at no extra cost to the Employer reinstate all disturbed ground.

If ordinary open-cut excavation is not possible or advisable, sheeting and bracing shall be furnished and installed in excavations generally in accordance with the details shown on Drawings to provide safe working conditions. The Contractor shall furnish and place all sheeting walls, braces, timbers, and similar items, necessary for the safety of the work, the general public and adjacent property. Sheeting and bracing shall be removed, as the work progresses in such manner as to prevent damage to finished work and adjacent structures and property. As soon as it is withdrawn, all voids left by the sheeting and bracing shall be carefully filled with selected material and compacted. The Contractor shall be fully responsible for the safety of work in progress, for the finished work, the workmen, the public and adjacent property. All sheeting and bracing shall be at the Contractor's expense, as part of the work under the excavation items and at no extra cost to the Employer.

The Engineer may order, in writing, any or all shoring, sheeting and piling to be left in place for safety reasons, whether such sheeting is shown on Drawings or not. If left in place, such sheeting shall be cut of at the elevation approved by the Engineer, and shall be paid separately.

c. Inspection of Foundations

When excavation up to foundation level is reached, as per Drawings, it is inspected by the Engineer and approved before start of any permanent construction. If safe foundation could not be obtained at the depth shown on the Drawings or at maximum depth of five feet below the ground level, the work shall be carried out as directed by the Engineer. Additional cost, if any approved by the Engineer, shall be paid in accordance with the provisions of the Conditions of Contract.

d. Disposal of Unsuitable/Surplus Materials

The unsuitable /surplus earth shall not be heaped within 5-feet of the top edge of any foundation. All surplus material excavated by the Contractor shall be disposed of at locations approved by the Engineer. The method of disposal shall not interfere with other works and shall not damage or spoil other materials. When it is necessary to haul earth material over streets or pavements, the Contractor shall prevent such material from falling on the

streets or pavements. The surplus material shall be disposed-of within the site without any additional cost.

e. Excavation to be kept Free of Water

All excavations shall be kept free from water from whatever source it may come, at all times, except where otherwise specified or permitted in writing by the Engineer.

As part of the works, under the excavation items, and at no extra cost to the Employer, the Contractor shall build all drains and do ditching, pumping, well pointing, bailing and other work necessary to keep the excavation clear of ground, sewage or storm water during the progress of the work and until the finished work is safe from injury. The Contractor shall provide all necessary pumping equipment for the dewatering works as well as operating personnel, maintenance, power etc. all at no extra cost to the Employer. All water pumped or drained from the work shall be disposed of in a manner satisfactory to the Engineer. Necessary precautions against flooding shall be taken.

f. Safety Measures

All excavations shall be properly maintained while they are open and exposed. Sufficient suitable barricades, warning lights, signs and similar items shall be provided by the Contractor. The Contractor shall be responsible for any personnel injury or property damage due to his negligence.

The Contractor shall take special precautionary and protective measures with existing subsurface facilities likely to be encountered during the execution of works such as sewers, drain pipes, water mains, conduits, electric cables, communication cables, foundations of adjacent structures etc. As part of the works, the Contractor shall shore up all buildings, walls, poles and other structures, the stability of which is liable to be endangered by the execution of the works. The Contractor shall be responsible for damage to any such facility and shall repair the same at his expense whether or not this facility has been shown on the Drawings.

g. Excess Excavation

In the event of any excavation being carried out wider or deeper than shown on the Drawings, it shall be filled in by the Contractor at his own expense to meet the required dimension and levels with concrete or any other material approved for such purpose.

The bottom and side slopes of excavation upon or against which structures or other required constructions are to be placed shall be finished accurately to the required grades and dimensions and, if required, shall be moistened

with water and tamped or rolled with suitable tools or equipment for the purpose of forming firm foundation. Whenever the natural foundation material is disturbed or loosened or excavated beyond the approved lines and grades the loose material shall be removed and the extra excavation made good at Contractor's expense with selected materials which shall be thoroughly compacted by tamping rolling in layers not exceeding 6-inch.

h. Classification of Material

No classification will be made for payment purposes of any material excavated as to its class, nature, origin or condition, unless an unusual obstruction or embedded matter or substance is encountered. If this occurs, it shall be submitted by the Contractor for evaluation of design and working out of a necessary treatment. New items shall be mutually agreed.

i. Transportation of Materials

All carts, trucks or other vehicles used by the Contractor for transportation of the material shall be suitably constructed or lined out to permit any leakage of soil while the vehicles are on the move. These would be so loaded and arranged as not to spill on the site and public roads. Whenever any vehicle so used is found leaking and unsuitable it shall be immediately withdrawn from the work.

j. Termite Control

The approved foundation trenches shall be treated with the termite control solution as provided in SECTION-19.

18.3.2 Compacted Backfill

a. Excavated Earth for Backfilling

All fill or refill around structures, i.e., within the slopes and limits of the established lines for excavation for the structures and below the natural surface level, shall be defined as "Back Filling".

Backfilling operations for structure shall be performed as part of Contractor's work under the payment items for earth excavation, and at no extra cost to the Employer. It comprises returning, transportation and filling the selected excavated material around foundations, and at back of walls etc., up to finished levels shown on the Drawings or as required in layers not exceeding 6 inches carefully rammed and consolidated (with addition of water if required) so as to achieve a maximum density of 90%. The backfilling earth shall be free from stones and hard clods, larger than 3 inches in any dimension and also free from trash, lumber and other debris.

No backfilling shall be made until the concrete foundations and footings etc.

have been inspected and approved. Earth to be used for filling must be free of all the organic impurities, debris or any other foreign matter. Earth which contains more than 1% of salts, particularly sulphates, will not be used in filling.

Testing shall be performed using the calibrated sand cone method to determine the density of soil in place. If soil in place fails to meet the specified degree of compaction it shall be removed, replaced with approved material and compacted to the specified density in the manner directed by the Engineer, in the areas represented by the failing tests at no additional cost to the Employer.

b. Borrow Earth for Backfilling

In case of non-sufficiency of excavated material and unsuitability of earth for back-filling, appropriate material conforming to these specifications shall be brought by the Contractor.

Where satisfactory materials for backfill are not available in sufficient quantity from required excavation, "Earth Borrow" shall be obtained from suitable sources at the Contractor's responsibility as a separate payment item. The necessary clearing and grubbing of borrow areas, disposal and burning of debris there from the developing of sources including any access roads for hauling and the necessary right-of-way, and the satisfactory drainage of the borrow areas, shall be considered as incidental items to borrow excavation. "Earth Borrow" under this separate payment item shall be furnished and placed by the Contractor only where specifically called for by the Engineer.

Filling shall be approved selected material from excavated or other predominantly granular material, free from slurry and organic or other unsuitable matter and capable of compaction by ordinary means

c. Sand Backfill

Special sand backfill is to be provided when specifically required by the Drawings or when ordered in writing by the Engineer. This work shall consist of removal of the excavated material to waste and provision in lieu of graded clean and fill, free of all foreign matter, such that 100% passes a ¾" screen with not more than 5% passing a No.4 sieve. This shall be compacted to 95% of the maximum density as determined by AASHTO T 180, Method D.

18.3.3 Filling Under Floors

18.3.4 Earth Filling

All fill or refill (from the excavated earth at site) about structures, i.e., above the natural surface level shall be defined as "filling under floors or embankment from excavated earth".

After the masonry has been laid up to the plinth level and the Damp

Concrete Proof Course, if required is laid the space between the walls shall be cleared of debris and loose earth shall be laid in layers of 6-innch and each layer watered and compacted until the filling is completed up to the base level of the floor as shown on the Drawings. Only sandy soil free from salt peter either from the materials excavated from the foundations if such materials is suitable and sufficient or suitable material brought from outside shall be used.

18.3.5 Sand Filling

All fill or refill, from the material provided and brought from outside the site (any lead), about structures, i.e., above the natural surface level shall be defined as "filling under floors with earth provided and brought from outside".

Unless otherwise specified the base of all ground floors shall be constructed through sand filling, done in layers not more than 4-inch thick and shall be rammed after saturation to such an extent that 4-inch layer is reduced to about 2.7" after compaction.

The required in situ density with respect to maximum density to optimum moisture content shall be in compliance with test 12 of B.S. 1377-1967.

Sand shall conform in all respect to the specifications for fine aggregate except for its grading, i.e., it shall pass through a sieve No. 16 and not more than 30% shall pass through a sieve No. 100.

18.4 MEASUREMENT AND PAYMENT

18.4.1 Measurement

The measurement shall be made in cubic feet or cubic metre (whichever is included in Bill of Quantities) of earth acceptably excavated and backfilled for trenches and structures within the lines and grades shown on the drawing or as directed by the Engineer duly compacted as required. The measurement of dewatering in trenches or structures shall be not be made and cost of this item shall be deemed included in the cost of excavation, backfilling and compaction.

Any excavation carried beyond the limits shown on the Drawings and specified herein as the payment limits, shall be treated as excess excavation and shall not be measured for payment.

18.4.2 Payment

Payment for this item of work shall be made for the actual quantity of work done as specified in this section, at the unit rate quoted in the Bill of Quantities.

Filling under floors from excavated earth or borrowed sand shall be measured and paid separates as per respected items included in the Bill of Quantities

SECTION-19 TERMITE CONTROL

19.1 SCOPE OF WORK

The work for anti-termite treatment includes injection of insecticide in sides and bottom of foundations or elsewhere as directed by the Engineer. The scope also covers treatment of all woodworks if any, with insecticides before installation in position. The contractor shall furnish all materials, labour and equipment to carry-out the termite treatment complete in all respects.

19.2 APPLICABLE STANDARDS

All methods of termite protection used herein shall be in accordance with the standard practice of National Pest Control Association, USA and the British Wood Preserving Association.

19.3 SUBMITTALS

Contractor shall prepare and submit, for the approval of Engineer, the following:

a. Qualification data of manufacturer;

b. Product data for termiticide to be used;

c. Detailed method statement describing the methodology maintained in applying termite control treatment;

d. After application of termiticide is completed, submit report for Employer's record and information, with minimum following information:

- Date and time of application.
- Moisture content of soil before application.
- Brand name and manufacturer of termiticide.
- Quantity of undiluted termiticide used.
- Dilutions, methods, volumes, and rates of application used.
- Areas of application.
- Water source for application.

6. Special warranty specified in this Section that will be submitted by manufacturer at date of Substantial Completion.

19.4 MATERIAL

An emulsible concentrate insecticide specially formulated to prevent infestation by termites shall be used. Fuel oil will be permitted as a diluent. A working solution of one of the following chemicals with clean potable water with ratio specified by the manufacturer shall be used.

- Imidacloprid 5.0%, Chloronicotinyl, Formulation SL/SC with clean water in maximum ratio of 1:120.

- Fipronil 2.5%, Formulation EC (Emulsified Concentrate) with clean water in maximum ratio of 1:250.

Insecticide shall be obtained from the Sole distributor, in sealed drums in quantity necessary for the requirement of works.

All mixing shall be done at site and mixing proportion of insecticide with water shall be verified by the Engineer.

Pure turpentine shall be used for dilution of insecticide, in approved proportion for application to woodwork where such application is required

19.5 QUALITY ASSURANCE

19.5.1 Manufacturer's Instructions

In addition to the requirements of these specifications, the manufacturer's instructions and recommendations for the work, including preparation of sub-strata and application shall be complied with.

19.5.2 Application

A professional operator shall be engaged who shall have license in accordance with regulation of governing authority for application of soil treatment solution.

19.5.3 Guarantee

The Contractor is to guarantee that the building shall be free from termites (white ants), wood bores and other pests, which cause damage to wood or other organic material for 10 years from the date of Substantial Completion.

In the event of any damage caused within the guaranteed period, the Contractor shall replace at his own cost such damaged material, finishes affected and suitably preserve and treat the entire premises with the best method known to the trade to prevent the spreading of termites.

19.6 METHOD OF APPLICATION

a. All mixing will be done at site and mixing proportion of insecticide with water shall be verified by the Engineer.

a. Insecticide solution shall be applied with approved spraying equipment maintaining a pressure of 150 psi to all applications to, on or in earth.

b. Soil treatment shall begin after all work of preparation of earth prior to laying of concrete. After application, no additional earth moving or work upon subgrade shall be done. No covering of earth of concrete shall be applied over soil treatment until at least 24 hours after treatment.

c. Insecticide solution shall not be applied during wet weather, or when the earth surface is excessively wet. Application shall be made to all areas/beneath concrete slab-on-grade, including sidewalks and

paving abutting building for the distance of at least 6.5 ft beyond building line. Solution shall be applied on amounts of not less than 0.5 litres per sq.ft. of area. If applied over gravel or sand fill, application shall not less than 0.7 litre per sq.ft. of areas. Insecticide shall penetrate to a depth of 1-inch minimum in porous earth at bottom and 2 inches to 3 inches at side of excavations.

d. Sides of foundation excavations and similar areas shall be treated with solution at a minimum rate of 0.5 litres per sq.ft. upon inner sides of such excavation and at all locations where concrete slabs for platforms and similar work about the building.

e. In the area of application sign shall be fixed to show that soil treatment has been applied. Such sign shall be removed when area is covered by other construction.

f. Care shall be exercised to ensure that no marks or damage occurs to the finished structure as a result of the work under this section.

g. All woodwork for the entire project is to be insecticide treated (before application of solignum) in the case of material to receive before treatments, insecticide shall be sprayed on all surfaces of all the wooden work viz, door frames, blocking, furring, planks, boards etc. before installation. Spraying shall be necessary after field sawing, jointing or installation of such material.

19.7 MEASUREMENT AND PAYMENT

19.7.1 Measurement

Measurement of acceptably completed works of termite control treatment will be made on basis of number of square feet or square metre (whichever is included in Bill of Quantities) area to be termite proofed as per instructions of the Engineer.

19.7.2 Payment

The payment will be made on the basis of measurement made as above and at the unit rate quoted in the Bill of Quantities and shall constitute full compensation for all the works related to the item.

No separate measurement and payment shall be made for termite control treatment on wood works and turpentine/water required for mixing insecticide solution.

SECTION-20 PLAIN & REINFORCED CONCRETE

20.1 SCOPE OF WORK

The work under this section of the specification consists of furnishing all plant, labour, equipment, appliances and materials and in performing all operations in connection with the supply, manufacturers, transporting, placing, consolidating and curing of plain & reinforced concrete and its constituents. Reinforcing steel does not form part of this section and is described in SECTION-21.

20.2 APPLICABLE STANDARDS

The work shall conform to requirements of latest editions of following standards, wherever applicable, unless otherwise specified.

20.2.1 Pakistan Standards

- PS 232, Portland cement (ordinary & rapid hardening)
- PS 243, Natural aggregates for concrete
- PS 279, Abrasion of coarse aggregates by the use of Los Angeles machine
- PS 280, Determination of aggregates crushing value
- PS 281, Organic impurities in sand for concrete aggregate
- PS 282, Material finer than No. 200 PS test sieve in aggregates
- PS 283, Soundness test for aggregates by the use of sodium sulphate or magnesium sulphate
- PS 284, Sampling aggregates for concrete
- PS 285, Sieve or screen analysis of fine and coarse
- PS 286, Description and classification of mineral aggregates
- PS 421, Sampling fresh concrete
- PS 422, Slump test for concrete
- PS 560, Making and curing concrete compression test specimen in the field
- PS 612, Sulphate-resistant Portland cement type 'A' and sampling fresh concrete in the laboratory
- PS 716, Mixing
- PS 717, Compacting factor test for concrete
- PS 746, Definitions and terminology of cements
- PS 849, Making and curing concrete compression test cubes

20.2.2 ASTM (American Society for Testing and Materials)

- ASTM C 33, Concrete Aggregates
- ASTM C 39, Test Method for Compressive Strength of Cylindrical Concrete Specimens

- ASTM C 40, Organic impurities in sand for concrete
- ASTM C 87, Effect of organic impurities in fine aggregates on strength of mortar
- ASTM C 88, Soundness of aggregates
- ASTM C 94, Ready mixed Concrete
- ASTM C 109, Compressive strength of hydraulic cement mortars
- ASTM C 117, Material finer than No. 200 (0.075mm) sieve
- ASTM C 123, Light weight pieces in aggregates
- ASTM C125, Concrete and concrete aggregates
- ASTM C 127, Specific gravity and absorption of coarse aggregate
- ASTM C 128, Specific gravity and absorption of fine aggregate
- ASTM C 13, Resistance to abrasion of small size coarse aggregate
- ASTM C 136, Sieve or screen analysis of fine and coarse aggregate
- ASTM C 142, Clay lumps and friable particles in aggregates
- ASTM C 143, Slump of Portland Cement Concrete
- ASTM C 150, Portland cement
- ASTM C 156, Water retention by concrete curing material
- ASTM C 171, Sheet material for curing concrete
- ASTM C 185, Air content or hydraulic cement mortar
- ASTM C 188, Density of hydraulic cement
- ASTM C 191, Time of setting of hydraulic cement by vicat needle
- ASTM C 260, Air entraining admixture for concrete
- ASTM C 289, Potential reactivity of aggregate
- ASTM C 309, Liquid membrane forming compounds for curing concrete
- ASTM C 494, Chemical admixtures for concrete
- ASTM C 535, Resistance to abrasion of large size coarse aggregates
- ASTM C 75, Aggregate sampling
- ASTM C 994, Preformed expansion joint filler for concrete
- ASTM C 1190, Concrete joint sealer (hot poured elastic type)
- ASTM C 1715, Preformed expansion joint filler for concrete paving and structural concrete
- ASTM D 1850, Concrete joint sealer (cold application type)
- ASTM E11, Wire cloth sleeves for testing purposes
- ASTM E 96, Water vapour transmission of materials in sheet form
- ASTM E 154, Materials for use as vapour barrier under concrete slabs
- ASTM E 337, Relative humidity by wet and dry bulk psychrometer

20.2.3 ACI (American Concrete Institute)

- ACI 211, Recommended practice for selecting proportions for normal and heavy weight concrete
- ACI 214, Quality control charts
- ACI 301, Specifications for structural concrete for building
- ACI 304, Recommended practice for measuring, mixing, transporting and placing concrete
- ACI 305, Hot weather concreting
- ACI 308, Recommended practice for curing concrete
- ACI 309, Recommended practice for consolidation of concrete
- ACI 315, Manual of standard practice of detailing reinforcement concrete structure
- ACI 318, Building code requirement of reinforced concrete
- ACI 347, Recommended practice for concrete formwork

20.2.4 British Standards

- BS 12, Portland cement, ordinary and rapid hardening
- BS 410, Test Sieves
- BS 812, Methods for the sampling and testing of mineral aggregates, sand fillers
- BS 822, Concrete aggregates from natural sources
- BS 1881, Methods of testing concrete
- BS 3148, Tests for water for making concrete
- BS 3837, Expanded polystyrene boards
- BS 3869, Rigid expanded polyvinyl chloride for thermal insulation.
- BS 4027, Sulphate – resisting Portland cement
- CP 8110, Structural use of concrete
- OP 114, Structural use of reinforced concrete in buildings

In addition, the latest editions of other Pakistan and British Standards, American Concrete Institute Standards, American Society for Testing and Materials Standards and other Standards as may be specified by the Engineer for special Materials and Construction are also relevant.

20.3 SUBMITTALS

a. Suitable templates or instructions or both shall be provided for setting out of items not placed in the forms. Embedded items and other materials for mechanical and electrical operations shall have been completed, inspected, tested and approved before concrete is placed.

b. For special concrete finish and for special methods of construction, formwork shop drawings shall be designed and prepared by the Contractor, at his own cost. Approval of shop drawings as well as that of actual samples of concrete finish shall be obtained before work is commenced.

c. The Contractor shall supply to the Engineer at fortnightly intervals, test certificates with the appropriate standard in respect of the samples of cement from the work-site. These tests shall be carried out in a laboratory approved by the Engineer.

d. The grading of the coarse and fine aggregates shall be tested at least once for every 100 tons supplied, to ensure that the grading is uniform and same as that of the samples used in the preliminary tests.

e. Where doubt exists as to the suitability of the water, it shall be tested in accordance with BS 3148.

f. The Contractor shall provide Mix design by weight for each class of concrete. Manufacture 12 test cylinder for each 3 mix design batches (6 Dia. x 12 high) inches in accordance with the Mix design batching by weight and test 3 cylinders each at 3, 7, 14 & 28 days intervals in the presence of Engineers Representative and submit all relevant data and results of tests for approval of the Engineer. The Contractor shall obtain approval from the Engineer in writing for each Mix design before producing the actual concrete for the Works.

g. 'Workability' of Concrete shall be determined by either the slump or compaction factor tests as directed by the Engineer and these shall be performed in accordance with the methods given ASTM C 143.

h. The slump or compaction factor for each class of concrete shall be determined during the preliminary Test mixes and the value obtained shall not be modified without the written consent of the Engineer.

i. Manufacturer's recommendations and instructions along with the sample of material shall be submitted to the Engineer for his approval.

j. The Contractor shall, at his own cost, make optimum mix design and testing for approval of the composition of non-shrinking grout and non-shrink second stage Concrete Grout, prior to Commencement of the work.

k. The Contractor shall be required to submit a sample of pre-cast unit for the approval of the Engineer: all pre-cast units shall strictly conform to the approved sample. The proposal for transporting and erecting pre-cast units in position shall also be submitted by the Contractor for the approval of the Engineer.

l. All submittals shall be made as per the requirements of relevant

section.

20.4 MATERIAL REQUIREMENTS

20.4.1 Aggregates

a. The sources of supply of all fine and coarse aggregates shall be as specified or approved by the Engineer.

b. All fine and coarse aggregates shall be clean and free from clay, loam, silt and other deleterious matter. If required, the Engineer reserves the right to have them washed by the Contractor at no additional expense. Coarse and fine aggregates shall be delivered and stored separately at site. Aggregates shall not be stored on muddy ground or where they are likely be become dirty or contaminated. They shall be placed on sloped hard strata to ensure well drained at all times.

c. Fine aggregate shall be hard coarse sand, crushed stone or gravel screenings and shall conform to requirements of PS 243 and/or BS 882 and or ASTM C-33. Only fine aggregate of grading zones 1 to 3 (BS 882) shall be used.

d. Coarse aggregate shall be crush stone of hard, durable material free from laminated structure and conforming to PS 243 and/or BS 882 and/or ASTM C-33, graded as included in Table 20.1, for use in mass concrete as in foundations.

Table 20.1, Gradation Requirements for Coarse Aggregate in Mass Concrete

Sr. No.	BS Sieve	Percent Passing by Weight
1	3-inch (76.20mm)	100
2	1.5-inch (38.10mm)	95-100
3	0.75-inch (19.05mm)	30-70
4	0.37-inch (9.52mm)	10-35
5	0.19-inch (4.76mm)	0-5

e. Coarse aggregate for all cast-in-place concrete other than mass concrete, as for foundations, shall be graded with the limits as included in Table 20.2.

Table 20.2, Gradation Requirements for Coarse Aggregate in other than Mass Concrete

Sr. No.	BS Sieve	Percent Passing by Weight
1	1.5-inch (38.10mm)	100
2	0.75-inch (19.05mm)	95-100
3	0.37-inch (9.52mm)	25-55
4	0.19-inch (4.76mm)	0-10

f. Wherever feasible, the nominal maximum size of aggregate for cast-

in place reinforced concrete slabs and other members shall be 3/4-inch. If there are difficulties in placing such a concrete the maximum size may be restricted to 1/2-inch. Provided the requirements for strength are satisfied, as approved by the Engineer.

g. Except where it can be shown to the satisfaction of the Engineer that a supply of properly graded aggregate of uniform quality can be maintained over the period of the work, the grading of the aggregates shall be controlled by obtaining the 3/4-inch maximum nominal size, the different sizes being stocked in separate stock piles and recombined in the correct proportion for each batch at the batching plant. The materials shall be stockpiled for a period before use so as to drain nearly to constant moisture content (as long as site and other conditions permit, preferably for at least a day). The grading of the coarse and fine aggregates shall be tested at least once for every 100 tons supplied, to ensure that the grading is uniform and same as that of the samples used in the preliminary tests.

20.4.2 Cement

a. The cement shall be fresh and of approved origin and manufacture. It shall be one of the following as may be specified by the Engineer.

b. Ordinary or Rapid Hardening Portland cement complying with the requirements of PS 232 or BS 12 or ASTM C-150.

c. Sulphate Resisting Portland/Cement complying with the requirements of P.S.612 or BS 4027 or ASTM C-150.

d. Unless otherwise specified. Ordinary Portland cement complying with the requirements of BS 12 shall be used.

e. For all fair faced concrete, it will be necessary to use approved cement with a view to obtain a light shade concrete as approved by the Engineer.

f. The Contractor shall supply to the Engineer at fortnightly intervals, test certificates with the appropriate standard in respect of the samples of cement from the work site. These tests shall be carried out in a laboratory approved by the Engineer.

g. Only one brand of each type of cement shall be used for concrete in any individual member of the structure. Cement shall be used in the sequence of receipt of shipment, unless otherwise directed.

h. There shall be sufficient cement at site to ensure that each section of work is completed without interruption. If the cement is supplied by the Employer, the Contractor should inform the Employer, of his requirements sufficiently in advance of its use in construction.

i. Cement reclaimed from cleaning of bags or from leaky containers shall not be used.

j. The contractor shall provide and erect (at his cost) a suitable plain, dry, well ventilated, weather proof and water proof shed of sufficient capacity to store the cement.

k. The cement shall be used as soon as possible after delivery and cement which the Engineer considers has become stale or unsuitable through absorption of moisture from the atmosphere or otherwise "shall be rejected and removed immediately from the site at the Contractor's expense. Any cement in containers damaged so as to allow the contents to spill or permitting access of the atmosphere prior to opening of the container at the time of concrete mixing shall be rejected and removed immediately from the site at the Contractor's expense.

l. The mixing together of different types of cement will not be permitted.

20.4.3 Water

Water shall be tested in accordance with PS 3148 and shall be used only from an approved source.

The Contractor shall supply sufficient water for all purposes, including mixing the concrete, curing and cleaning plant and tools. Where water can be shown to contain any sugar or an excess of acid, alkali or salt, the Engineer may refuse to permit its use.

20.4.4 Additive

All additives such as foaming and water proofing agents shall be from a manufacturer approved by the Engineer.

Air Entraining Admixtures conforming to ASTM C-260, and other Admixtures conforming to ASTM C-494 shall be used subject to approval of the Engineer.

20.4.5 PVC Water Stop

PVC Water Stop shall follow the requirements as included in SECTION-28.

20.4.6 Non-Shrink Grout

Grout for placement under base and bearing plates of machinery and equipment, for grouting anchor bars and dowels and for similar uses shall be as follows:

- Non-shrink grout of less than 1-inch thickness shall consist of one-part Portland cement and one part of clean sharp sand conforming to the requirements of these specifications and 1:22,000 to 1:15000 part of grained aluminium powder containing non-polishing agent.
- Non-shrink grout of 1-inch or more in thickness shall be proportioned as above except that 1-1/2 parts of 3/8-inch to ¼--inch pea gravel shall be added.

- The above-specified composition may be varied if required by the Engineer.
- Proportioning shall be done by weight.
- Mixing water shall be proportioned so as to provide a flow able mixture without segregation or bleeding. Dry packing will not be permitted.

20.4.7 Non-Shrink Second Stage Concrete Grout

Non-shrink second stage concrete grout shall be provided and placed in position where shown on the Drawings or as directed by the Engineer. Non-shrink concrete mix proportion shall be one-part cement two parts coarse clean sand and four parts of coarse aggregates meeting the requirements of these specifications and 1:22,000 to 1:15000 part of grained aluminium powder containing non-polishing agent. Proportioning shall be done by weight.

The above-specified composition may be varied if required by the Engineer.

20.4.8 Non-Shrink Concrete Grout for Stair Railing Column Post

Grout for placement in pockets for stair columns shall be non-shrink and shall be of strength 10,000 psi.

20.5 NOMINAL CONCRETE MIXES

20.5.1 Proportions of Mix

a. Cement and aggregates

The cement, fine aggregate and the coarse aggregate shall be weighed separately. The proportions of cement to fine aggregate and coarse aggregate shall be adjusted so as to provide the concrete of the required crushing strength when tested as set out in Table 20.3.

b. The Contractor shall prepare mix design of various grades of concrete for the approval or Engineer prior to starting concrete works. He shall regulate and arrange mixing of the ingredients of the concrete by weigh batching. The cost of designing the mix shall be borne by the Contractor.

c. Water Cement Ratio

The quantity of water used shall be just sufficient to produce a dense concrete of adequate strength and workability for its purpose. For all external work and foundations, the water/cement ratio should not exceed 0.55.

d. Workability

The workability shall be controlled by direct measurement of the water content, allowance being made for any water in the fine and coarse aggregates. The concrete shall be sufficiently workable to be placed and compacted, without difficulty, by the available means.

Workability shall be determined by either the slump or compaction factor tests as directed by the Engineer and these shall be performed in accordance with the methods given in PS 422 and PS 177 or ASTM C-143. The slump or compaction factor for each class of concrete shall be determined during the preliminary test mixes and the value obtained shall not be modified without the written consent of the Engineer. Unless otherwise permitted or specified, the concrete shall be proportioned and produced to have a slump of 3-inch or less if consolidation is to be by vibration. A tolerance of up to 1-inch above the indicated maximum shall be allowed for individual batches provided the average for all batches or the most recent 10 batches tested, whichever is fewer, does not exceed the maximum limit. Concrete of lower than usual slump may be used provided it is properly placed and consolidated.

20.5.2 Strength requirements for concrete

a. Concrete made with Portland cement shall comply with the strength requirements as included in Table 20.3.

Table 20.3, Strength Requirements for Portland Cement Concrete

Sr. No.	Concrete Class	Nominal Ratio*	Concrete Strength**
1	A	1:1:2	4500
2	B (or A3)	1:1.5:3	4000
3	C (or A1)	1:2:4	3000
4	D	1:3:6	2200
5	E (Lean Concrete)	1:4:8	1400

* Nominal Ratio is indicative only, Contractor to prepare mix design to achieve the cylinder strength for the corresponding class of concrete.

** Cylinder strength at 28-days after mixing and pouring in psi.

b. The strengths given in Table 20.3 are based on the assumption that average temperature is 20 degree C. Where accurate records of temperature are kept, allowance may be made for change of temperature or the cylinders may be tested at the equivalent maturity.

c. All structural concrete shall conform to BS 5328.

d. Unless otherwise stated, the types of concrete shall be classified on the basis of compressive strength requirements. The Contractor shall provide Mix Design by weight for each class of concrete.

Manufacture 12 test cylinders (6-inch diameter x 12-inch height) in accordance with the mix design, batching by weight, and test 3 cubes each at 3, 7, 14 & 28 days intervals in the presence of Engineer's Representative and submit all relevant data and results of tests for approval of the Engineer. The Contractor shall obtain approval from the Engineer in writing for each Mix design before producing the actual concrete for the works.

No payments for producing the mix design, manufacture of test cubes and testing shall be made. The Contractor shall include this cost in the relevant item of concrete.

20.6 DELIVERY, STORAGE AND HANDLING

Except where it can be shown to the satisfaction of the Engineer that a supply of properly graded aggregate of uniform quality can be maintained over the period of the work, the grading of the aggregates shall be controlled by obtaining the 3/4" maximum nominal size, the different sizes being stocked in separate stock piles and recombined in the correct proportion for each batch at the batching plant. The materials shall be stockpiled for a period before use so as to drain nearly to constant moisture content (as long as site and other conditions permit, preferably for at least a day).

The Contractor shall provide and erect (at his cost) a suitable plain, dry, well ventilated, weatherproof and water proof shed of sufficient capacity to store the cement.

20.7 CAST-IN-SITU CONCRETE

20.7.1 Batching

a. All cement, including cement supplied in bulk, shall be batched by weight. A bag of cement may be taken as 110 lbs. with the prior approval of the Engineer.

b. Aggregates shall be batched by weight, due allowance being made for moisture content. The apparatus for weigh-batching may be an integral part of the mixer or a separate unit of a type approved by the Engineer. It shall be accurate within 2% and shall be checked for accuracy at least once a month.

c. The quantity of additives i.e. foaming and water proofing agents etc. shall be as prescribed by the manufacturer or as directed by the Engineer.

d. Where the batching plant is of the type in which cement and aggregates are weighed in the same compartment, the cement shall be introduced into the compartment between two sizes of aggregates.

e. Each batch shall be so charged into the mixer that some water will enter in advance of the cement and aggregates. Water shall

continue to flow for a period which may extend to the end of the first 25 percent of the specified mixing time. Controls shah, be provided to prevent batched ingredients from entering the mixer before the previous batch has been completely discharged.

20.7.2 Mixing

a. The concrete shall be mixed in an approved batch mixer conforming to the requirements of BS 305. It shall be fitted with the manufacturer's plate stating the rates, capacity and the recommended number of revolutions per minute and shall be operated in accordance therewith. It shall be equipped with a suitable charging mechanism and an accurate water measuring device.

b. Mixing shall continue for the period recommended by the mixer manufacturer or until there is apparently a uniform distribution of the materials and the mass is uniform in colour, whichever period is longer. If it is desired to use a mixing period of less than 1½ minute, the Engineer's approval shall be obtained in writing.

c. Controls shall be provided to ensure that the batch cannot be discharged until the required mixing time has elapsed. At least three quarters of the required mixing time shall take place after the last of the mixing water has been added.

d. The interior of the mixer shall be free of accumulations that will interfere with mixing action. Mixing blades shall be replaced when they have lost 10 percent of their original height.

e. Concrete shall be mixed only in quantities for immediate use. Concrete which has set shall not be re-tempered, but shall be discarded.

20.7.3 Transporting

a. The concrete shall be transported from the place of mixing to the place of final deposit as rapidly as practicable by means which will prevent segregation or loss of or addition to ingredients it shall be deposited as nearly as practicable in its final position so as to avoid re-handling or flowing. All skips vehicles, or containers used for transporting the concrete shall be thoroughly clean.

b. During hot or cold weather, concrete shall he transported in deep containers, on account of their lower ratios of surface area to mass, which reduces the rate of loss of water by evaporation during hot weather and loss of heat during cold weather.

20.7.4 Placing

a. Before placing of concrete, formwork shall have been completed, water shall have been removed reinforcement shall have been

secured in place; expansion joint material, and other embedded items shall have been kept in position; and the entire preparation shall have been approved.

b. No concrete is to be placed into the foundation trenches until the ground to receive the same has been examined and approved by the Engineer for this purpose.

c. Concrete shall be deposited continuously, or in layer of such thickness that no concrete will be deposited on concrete which has hardened sufficiently to cause the formation of seams or planes of weakness within the section. If a section cannot be placed continuously, construction joints shall be located as shown in the Contract Documents or as approved by the Engineer. Placing shall be carried out at such a rate that the concrete which is being integrated with fresh concrete is still plastic. Concrete which has partially hardened shall not be deposited Temporary spreaders in forms shall be removed when the concrete placing has reached an elevation rendering their services unnecessary. They may remain embedded in the concrete only if made of metal or concrete and if prior approval has been obtained.

d. The actual sequence of construction proposed by the Contractor shall he subject to the Engineer's approval before construction starts on any part of the structure, and this sequence shall not be varied without the Engineer's approval.

e. The concrete shall be placed as soon after it has been mixed as is practicable. Once the concrete has left the mixer, no more water shall be added, although the concrete may be mixed or agitated to help maintain workability. The concrete shall not be used if, through any cause, the workability of the mix at the time of placing too low for it to be compacted fully and to an acceptable finish by whatever means available.

f. The time between mixing and placing should be reduced if the mix is richer or the initial workability of the mix is lower than normal; if a rapid hardening cement or an accelerator is used, or if the work is carried out at a high temperature or exposed to a crying atmosphere.

g. The Contractor shall ensure that the delay between mixing and placing does not exceed 45 minutes under any circumstances. Any concrete which does not satisfy this requirement shall not be used.

h. The concrete shall be deposited as nearly as possible in its final position to avoid re-handling. In no circumstances may concrete be railed or made to flow along the forms by the use of vibrators. Concreting shall be carried on as a continuous operation using methods which shall prevent segregation or loss of ingredients.

i. The free fall of concrete shall not be allowed to exceed 5 ft. (1.5 m) and where it is necessary for the concrete to be lowered more than this depth, it is not to be dropped into its final position, but shall be placed through pipes fed by a hopper. When a pipe is used for placing concrete the lower end shall be kept inside, or close to the freshly deposited concrete. The size of the pipe shall be not less than 9-inch (225mm) diameter.

j. The workmen carrying concrete to the site, and all other workmen moving about on the reinforcement before the concrete is placed, shall move only along runways or planks placed for the purpose and no person shall be allowed to walk on the reinforcement itself.

k. Prior to the laying of concrete on load bearing masonry walls, bearing plates and at other points, as may be directed by the Engineer, the surface will be brought to a true, hard, smooth, level surface using cement sand mortar in the ratio of 1-part of cement to 3-parts of sand. Two layers of building paper will then be laid flat to separate the concrete from the surface on which it is to be laid.

20.7.5 Construction Joints

a. Concreting shall be carried out continuously up to construction joints, the arrangement of which shall be predetermined by the Engineer.

b. Joints not shown on the Drawings shall be so made and located as to least impair the strength of the structure and shall need prior approval of the Engineer. In general, they shall be located near the middle of the spans of slabs and beams unless a secondary beam intersects a main beam at this point, in which case the joint in the main beam shall be offset a distance equal to twice the width of the secondary beam. Joints in walls and columns shall not be at the underside of floor slabs or beams, and at the top of footings or floor slabs. Beams, brackets, columns, capital haunches and drop panels shall be placed at the same time as slabs. Joints shall be perpendicular to the main reinforcement.

c. All reinforcing steel shall be continued across joints. Key and inclined dowels shall be provided as directed by the Engineer. Longitudinal keys at least 1½-inch (40 mm) deep shall be provided in all joints in walls and between walls and slabs or footings.

d. When the work has to be resumed on a surface which has hardened, such surface shall be roughened in an approved manner which will expose the aggregate uniformly and will not leave laitance, loosened particles of aggregate or damaged concrete at the surface. Feather edges will be avoided.

e. The hardened concrete of construction joints and of joints between

footings and walls or columns, between walls or columns and beams or floors they support, joints in unexposed walls and all others not mentioned herein shall be dampened (but not saturated) immediately prior to placing of fresh concrete.

f. The hardened concrete of joints in exposed work, joints in the middle of beams and slabs; and joints in work designed to contain liquids shall be dampened (but not saturated) and then thoroughly covered with a coat of cement grout similar in proportions to the mortar in the concrete. The grout shall be as thick as possible on vertical surfaces and at least 150 mm thick on horizontal surfaces. The fresh concrete shall be placed before the grout has attained initial set.

g. Where the concrete has not fully hardened, all laitance shall be removed by scrubbing the wet surface with wire or bristles and brushed, care being taken to avoid dislodgment of particles of aggregate. The surface shall then be coated with neat cement grout. The first layer of concrete to be placed on this surface shall not exceed 6-inch (150 mm) in thickness, and shall be well rammed against old work, particular attention being paid to corners and closed spots.

20.7.6 Expansion Joints

Expansion joints shall be provided wherever indicated on the Drawings. In no case shall the reinforcement, corner protection angles, or other embedded items be run continuous or through an expansion joint. All expansion joints shall be carefully placed so as not to be displaced during concreting. The method of placing the expansion joints shall be strictly in accordance with the Drawings and as approved by the Engineer. All materials for use in the expansion joints shall have, prior approval of the Engineer before placing order for supply.

20.7.7 Embedded Items

a. The material, design and location of water stops in joints shall be as indicated in the Contract Documents. Each piece of re-moulded water stop shall be of maximum practicable length in order that the number of end joints will be held to a minimum

b. Joints at intersections and at ends of pieces shall be made in the manner most appropriate to the material being used. Joints shall develop effective water-tightness fully equal to that of the continuous water stop material, shall permanently develop not less than 50 percent of the mechanical strength of the parent section, and shall permanently retain their flexibility

c. Electric conduits and other pipes which are planned to be embedded shall not, with their fittings, displace more than four

percent of the area of the cross section of a column on which stress is calculated or which is required for fire protection. Sleeves, conduits, or other pipes passing through floors, walls, or beams shall be of such size or in such location as not to impair unduly the strength of the construction; such sleeves, conduits, or pipes may be considered as replacing structurally in compression the displaced concrete, provided that they are not exposed to rusting or other deterioration, are of uncoated or galvanized iron or steel not thinner than standard steel pipe, have a nominal inside diameter not over 50 mm and are spaced not less than three diameters on centres except when Drawings of conduits and pipes are approved by the Engineer embedded pipes and conduits other than those merely passing through, shall not be larger in outside diameter than one third the thickness of the slab, wall, or beams in which they are embedded nor so located as to impair unduly the strength of the construction. Sleeve pipes, or conduits of any material not harmful to concrete and within the limitations of this section may be embedded in concrete with the approval of the Engineer provided they are not considered to replace the displaced concrete.

d. All sleeves, inserts, anchors, and embedded items required for adjoining work or for its support shall be placed prior to concreting.

e. All Contractors whose work is related to the concrete or must be supported by it shall be given ample notice and opportunity to introduce and/or furnish embedded items before the concrete is placed.

f. Expansion joint material, water stops and other embedded items shall be positioned accurately and supported against displacement. Voids in sleeves, inserts, and anchor slots shall be filled temporarily with readily removable material to prevent the entry of concrete into the voids.

20.7.8 Mass Concrete

Mass-concrete shall be placed in layers approximately 18-inch thick. Vibrator heads shall extend into the previously placed layer.

20.7.9 Consolidation

a. All concrete shall be consolidated by vibration, spading, Roding or forking so that the concrete is thoroughly worked around the reinforcement, around embedded items and into comers of forms, eliminating all air or stone pockets which may cause honeycombing, pitting, or planes of weakness. Internal vibrators shall have a minimum frequency of 8000 vibrations per minute and sufficient amplitude to consolidate the concrete effectively. They shall be operated by competent workmen. Use of vibrators to transport

within forms shall not be allowed. Vibrators shall be inserted and withdrawn at points approximately 18-inch apart. At each insertion, the duration shall be sufficient to consolidate the concrete but not excessive so as to cause segregation, generally from 5 to 15 sec. A spare Vibrator shall be kept on the job site during all concrete placing operations.

Where the concrete is to have an as-cast finish, a full surface of mortar shall be brought against the form by the vibration process, supplemented, if necessary, by spading to work the coarse aggregate back from the formed surface.

b. If there is any tendency for the mix to segregate during consolidation, particularly if this produces excessive laitance, the mix proportions shall be modified to effect an improvement in the quality of the concrete to the satisfaction of the Engineer and in conformity with the provisions of SECTION-20.5.

c. Vibrator shall not be allowed to contact the formwork for exposed concrete surfaces.

d. Mechanical vibrators shall be of a type suited in the opinion of the Engineer to the particular conditions.

e. Over-vibration or vibration of very wet mixes is harmful and should be avoided.

20.7.10 Curing and Protection

a. Beginning immediately after placement, concrete shall be protected from premature drying, excessively hot or cold temperatures and mechanical, injury and shall be maintained with minimum moisture loss at a relative constant temperature for the period necessary for hydration of the cement and hardening of the concrete. The materials and methods of curing snail be subject to approval of the Engineer.

b. For concrete surfaces not in contact with forms, one of the following procedures shall be applied immediately after completion of placement and finishing:

- Ponding or continuous sprinkling;
- Application of absorptive mats or fabric kept continuously wet;
- Application of waterproof sheet materials approved by the Engineer;
- Application of other moisture-retaining covering as approved; and
- Application of a curing compound conforming to ASTM C 309.

The compound shall be applied in accordance with the recommendations of the manufacturer immediately after- any water sheen, which may develop after finishing has disappeared from the concrete surface. It shall

not be used on any surface against which additional concrete or other material is to be bonded unless it is proved that the curing compound will not prevent bond, or unless positive measures are taken to remove it completely from areas to receive bonded applications.

c. Moisture loss from surfaces placed against wooden forms or metal forms exposed to heating by the sun shall be minimized by keeping the forms wet until they can be safely removed. After form removal the concrete shall be cured until the end of the time prescribed for curing.

d. Curing in accordance. with sub-clause 'a' & 'b' above shall be continued for at least 10 days in the case of all concrete except concrete with rapid-hardening Portland Cement for which the period shall be at least 3 days. Alternatively, if tests are made of cylinders kept adjacent to the structure and cured by the same methods, moisture retention measures may be terminated when the average compressive strength has reached 70 percent of the minimum specified works cylinder strength.

   If one of the first four curing procedures of sub-clause 'b' is used initially, it may be replaced by one of the other procedures of that sub-clause any time after the concrete is one day old provided the concrete is not permitted to become surface dry during the transition.

e. When the mean daily outdoor temperature is less than 5 degree C (41 deg. F) temperature of the concrete shall be maintained between 14 and 20 degrees C (50 to 68 deg. F) for the required curing period of sub-clause 'd'.

   When necessary, arrangements for heating, covering insulation or housing the concrete work shall be made in advance of placement and shall be adequate to maintain the required temperature without injury due to concentration of heat. Combustion heaters shall not be used during the first 24 hours unless precautions are taken to prevent exposure of the concrete to exhaust gasses, which contain carbon dioxide.

f. During hot weather when necessary, provision for wind-brakes, shading for spraying, sprinkling, ponding or wet covering with a light-coloured material shall be made, in advance of placement. Such protective measures shall be taken as quickly as concrete hardening and finishing operation will allow.

g. Changes in temperature of the air immediately adjacent to the concrete during and immediately following the curing period shall be kept as uniform as possible and shall not exceed 3 deg. C (37 deg. F) in any one hour or 14 degree C (50 deg. F) in any 24-hour period.

h. During the curing period, the concrete shall be protected from damaging mechanical disturbances, such as load stresses, heavy shock and excessive vibrations. All finished concrete surfaces shall be protected from damage by construction equipment, materials or methods by application of curing procedures, and by rain or running water. Self-supporting structures shall not be loaded in such a way as to over stress the concrete.

20.7.11 Application of Non-Shrink Grout

Concrete surfaces to receive non-shrinking grout shall be roughened, cleaned and dampened.

Form shall be provided to retain the grout until sufficiently hard to support itself.

Grout shall he poured in place and thoroughly rodded or washed to prevent the formation of voids.

After non-shrink grout has received its initial set, it shall be kept damp for 24 hours.

20.7.12 Placing of Vapour Barrier

Vapour barrier shall be laid in position wherever shown on the Drawings.

The material shall be supplied in rolls and laid by rolling over the prepared surface at the levels and position in the areas shown on the Drawings. Where joint is necessary at the side or end of a sheet, this shall be a double weld folded joint made by placing the edges together and folding over twice continuously taking the top edge prior to concreting. The Contractor shall protect the film sheets from damages during laying and subsequent operations and shall replace at his own cost all damaged film sheets to the satisfaction of the Engineer.

20.8 WORKS IN EXTREME WEATHER

a. Unless adequate protection is provided and approval is obtained from the Engineer, concrete shall not be placed during rain.

Rainwater shall not be allowed to increase the mixing water nor to damage the surface finish.

b. When the temperature of the surrounding air is expected to be below 5^{o}C during placing or within 24 hours thereafter, the temperature of the plastic concrete, as placed, shall be no lower than 13^{o}C for sections less than 12-inch in any dimension nor 10^{o}C for any other sections.

When necessary concrete material should be heated before mixing and carefully protected after placing, in general, heating or mixing

water alone to about 60°C may be sufficient for this purpose. Dependence should not be placed on salt or other chemicals for the prevention of freezing. No frozen material or materials, containing ice shall be used. All concrete damaged by frost shall be removed. It is recommended that concrete exposed to the action of freezing weather should have entrained air and the water content, of the mix should not exceed 5.5 gallon/bag of cement.

If water or aggregate is heated above 38°C the water shall be combined with the aggregate in the mixer before cement is added. Cement shall not be mixed with water or with mixtures of water & aggregate having a temperature greater than 38°C.

c. During hot weather, the temperature of the concrete as placed shall not be so high as to cause difficulty from loss of slump, flash set, or cold joints and should not exceed 32°C. For massive concrete, this temperature should not exceed 21°C. When the temperature of the concrete exceeds 32°C, precautionary measures approved by the Engineer shall be put into effect. When the temperature of the steel is greater than 50°C, steel forms and reinforcement shall be sprayed with water just prior to placing the concrete. The ingredients shall be cooled before mixing, or flaked ice or well crushed ice of a size that will melt completely during mixing may be substituted for all part of the mixing water if, due to high temperature, low slump, flash set or cold joints are encountered.

Other precautions recommended by ACI Standard 305 shall also be adopted.

20.9 PRECAST CONCRETE

Precast concrete units shall be fair faced, cast to the sizes and dimensions as indicated on the Drawings. The concrete used for precast units shall conform to the specifications laid down for cast in situ reinforced cement concrete unless otherwise required and directed by the Engineer.

The Contractor shall be required to submit a sample of precast unit for the approval of the Engineer all pre-cast units shall strictly conform to the approved sample.

Pre-casting platform of the size and at the location approved by the Engineer shall be constructed. The concrete in one pre-cast unit shall be placed in one operation, in accordance with the details shown on the Drawings.

The material and design of formwork and the method of pre- casting the units shall be approved by the Engineer. The erection/installation and removal of the precast units from the pre-casting platform shall not be permitted until and unless they are properly cured to the satisfaction of the Engineer.

All precast units shall be smoothly finished to the required lines, grades, angles etc. Holes, grooves, pockets, hooks shall be provided as shown and/or as directed by the Engineer. The units shall be properly stacked on a platform without causing any cracks and damages. Curing of all the precast units shall be done in accordance with the relevant BS/approval of the Engineer.

20.9.1 Erecting Precast Units

All the precast units shall be transported and erected into position in a manner as approved by the Engineer.

The Contractor shall submit his proposal in this regard and obtain approval from the Engineer in advance.

The units shall be embedded or otherwise installed in their permanent positions as shown on the Drawings or as directed by the Engineer.

20.9.2 Lifting Beams

The Contractor shall use lifting beams at his own cost, for erecting pre-cast members where the Engineer so directs. Lifting beams shall be supplied and erected by the Contractor, at his own cost, at all points where lifting is necessary for maintaining the plant but is inaccessible to mobile cranes or alternatively, covered by overhead traveling cranes. The Contractor, however, is to supply the trolleys and erect them on the lifting beams, and to test operation of installed equipment.

20.10 CEMENT CONCRETE PAVEMENTS

For all concrete work relevant specifications of this section shall apply.

20.10.1 Side Forms and Construction

Side forms shall be of steel or any other suitable material and of a design as approved by the Engineer.

In general, only materials and methods that have proved their acceptability by past performance will be considered. All form shall be constructed so that they can be removed without hammering or prying against the concrete.

Horizontal joints in the forms will not be permitted. Forms shall be thoroughly cleaned and oiled with linseed/mineral oil or shall be given two coats of nitro-cellulose lacquer each time they are used.

The forms shall be set on a thoroughly compacted base true to line and level and firmly secured in position by appropriate methods. Conformity with the alignment and levels shown on the Drawings shall be checked as and when required by the Engineer. Where necessary corrections shall be made immediately before placing the concrete; where any form has been disturbed it shall be reset and rechecked.

Pavements shall be constructed in panels of sizes as shown on the Drawings.

The panels shall be laid alternately, the adjoining panels being concreted when the side forms are struck and the jointing materials placed, inspected and approved by the Engineer. Each panel is to be concreted in one operation and no interruptions shall be permitted during the operation. The concrete shall be tipped from the trolley slightly in advance of the working place and then shovelled into position. The spreading shall be carried out very carefully. Compaction shall be done by means of vibro-compactors or approved surface vibrators. If a vibro-compactor is used. it shall be operated on the concrete and will not be allowed to strike or displace the forms. The spreading and compacting of the successive layers shall proceed without interruptions and as quickly as practicable so as to ensure that the slab is monolithic throughout its depth.

The wearing surface shall be laid while the base concrete is still wet and screeded to line and level. When the initial set takes place the surface shall be trowelled smooth with a steel trowel to provide a dense closed surface.

All the joints shall be carefully formed as shown on the Drawings or as directed by the Engineer. The joint filler together with preformed groove shall provide complete separation of adjacent slabs. The joints shall all be sealed with bitumen as shown on the Drawings or/and as directed by the Engineer.

20.10.2 Protection and Curing

a. General Requirements

Concrete shall be protected adequately from injurious action sun, rain, flowing water and mechanical injury, and shall not be allowed to dry from the time it is placed until the expiry of the minimum curing periods specified hereinafter. Water curing shall be accomplished by keeping the surface of the concrete continuously wet by covering with water or with approved water saturated covering, where wood forms are left in place for curing.

They shall be kept sufficiently damp at all times to prevent openings at the joints and drying out of the concrete. All portions of the structure shall be kept moist for the full curing periods, specified hereinafter.

When liquid membrane curing compound is used the surface of the concrete shall be protected from traffic or other abrasive action that may break the membrane, for the full period of curing. The membrane curing compound shall be white coloured and shall be approved by the Engineer and shall comply with ASTM C 309, type 2.

b. Curing Periods

The curing period shall be at least 10 days, or as directed by the Engineer

c. Removal of Forms

The Contractor shall exercise great care in avoiding damage to joints, arises, dowel bars etc. while removing the forms. Under no circumstances will the use of pry bars between the forms and pavement be permitted. Side forms shall not be removed until at least 40 hours have elapsed from the time of completing the concreting of the slab which they contain. In no case shall forms be removed until the concrete has hardened sufficiently to permit removal without damage to the concrete. Concrete work shall be protected from damage during the removal of formwork and from injury resulting from the storage or movement of material during construction.

20.10.3 Finishing

All unformed surfaces shall be finished with a wood float except as otherwise specified. Visible vertical surfaces shall have all projections and irregularities removed. The entire surface shall be rubbed if required by the Engineer, with a No. 16 carborundum brick, or other abrasive until even, smooth and of uniform appearance, and shall be washed clean. Plastering of surface, application of cement or other coating will not be permitted.

All exposed corners shall be chamfered, 1-inch x 1-inch (25x25mm) unless otherwise mentioned or shown in the Drawings or directed by the Engineer. Concrete surface which will be covered with other materials shall be screeded without floating.

20.10.4 Spreading, Finishing and floating of concrete in pavements

a. General Requirements

The striking off, compacting and floating of concrete shall be done by mechanical methods, if approved by the Engineer. Where the Engineer determines that it is impracticable to use mechanical methods, manual methods of spreading, finishing and floating may be used on pavement lines as indicated on the Drawings.

b. Mechanical Methods

The concrete shall be spread uniformly between the forms, immediately after it is placed, by means of an approved spreading machine. The spreader shall be followed by an approved finishing machine equipped with two oscillating or reciprocating screeds. The spreading machine or the finishing machine shall be equipped with vibrating equipment that will vibrate the concrete for the full paving width. Internal vibrators shall be used adjacent to the longitudinal edge of the pavement. These vibrators shall be attached to the rear of the spreading machine onto the finishing machine. Vibrators shall not rest on new pavements or side forms or in contact with any dowel bars, and the arrangement of power supply to the vibrators shall be such that when the

motion of machine is stopped, vibration shall cease. The rate of vibration shall be not less than 8000 vibrations per minute. The concrete shall be spread to full width before being struck off and compacted so that the surface will conform to the finished grade and cross-section as shown on the Drawings and at the same time leave sufficient material for the floating operation. The spreading & finishing machine shall move over the pavement as many times and at such intervals as may be required by the Engineer to ensure thorough compaction.

Except as otherwise specified, after the pavement has been struck off and compacted, it shall be finished with an approved longitudinal float. The Contractor may use a longitudinal float composed of one or more cutting and smoothing Floats, suspended from and guided by rigid frame. The frame shall be carried by four or more visible wheels riding on and constantly in contact with the forms.

The Contractor may use a longitudinal float which works with a sawing motion, while held in a floating position parallel to the road centre line and passing gradually from one side of the pavement to the other. Movements ahead, along the centre line of the road, shall be in successive advances of not more than half the length of the float.

Instead of using other type of longitudinal float a single machine which will affect satisfactory compaction, finishing and floating may be used. This machine may be towed by a spreading machine: This combination, finishing floating machine shall be equipped with screeds and vibrators as hereinafter specified for spreading and finishing machine Floating shall be accomplished by means of a non-oscillating float held in a suspended position from the frame.

If any spreading, finishing and floating equipment is not maintained in full working order or if the equipment as used by the Contractor proves inadequate to obtain the results prescribed, such equipment shall be improved or satisfactory equipment substituted or added at the direction of the Engineer.

c. Manual Methods

When striking-off and compacting by manual methods is permitted, the concrete shall be levelled and then struck-off to such an elevation that, when properly compacted, the surface will conform to the required grade and cross-section. The strike board shall be moved forward with a combined longitudinal and transverse motion, the manipulation being such that neither ends is raised from the side forms during the process. While striking off, a slight excess of concrete shall be kept in front of the cutting edge at all times. Prior to tamping, the concrete along the forms shall be thoroughly spaded or vibrated. The entire area of pavement shall be tamped or vibrated a manner

that will ensure maximum compaction. The concrete shall be brought to the required grade and shape by the use of a tamper consisting of a heavy plank whose length exceeds the width of the pavement by 1 foot or by the use of a mechanical vibrating unit spanning the full width of the spread. The tamper shall be constructed with properly trussed roads to stiffen it and prevent sag and shall be shod with a heavy strip or metal for a tamping surface. The tamper shall be moved with a combined tamping and longitudinal motion, raising it form side form and dropping it so that the concrete will be thoroughly compacted and rammed into place. A small surplus material I is com acted and rammed into front of the tamper or vibrating unit and taming or vibrating shall continue until the true cross-section is obtained reed and the mortar flushes slightly to the surface. .

On grades in e. excess of 5 percent where hand methods are permitted, a little strike board shall follow at a speed of 25 ft to 50 ft per hour back of the heavy strike board, and shall be used in the same way, so as to remove waves caused by flow of concrete.

Where hand tamping is permitted, not less than two strike boards or tampers shall be used for production in excess of 350 cubic feet. After the concrete has been compacted, it shall be smoothed with a wooden float where necessary, as directed by the Engineer.

d. Longitudinal Floating

Manual floats shall be at least 12 ft. in length not less than 6 inches in width and shall be properly stiffened to prevent bending or warping. In using the float, it shall be held parallel to centre line of the pavement at all time and shall be moved laterally across the pavement from one side or edge to the other until all high areas are cut down and floated into depressions, leaving a surface that is smooth and true to grade. Batch transverse passage of the longitudinal manual float shall lap the proceeding passage by half.

e. First Straight Edge Testing

Immediately following final floating, the entire area of the pavement shall be tested with a 10-ft. (approx. 3-meters) straight edge. Any depressions found shall be immediately filled with fresh concrete which shall be struck off compacted and finished. High areas shall be worked down and refinished. The straight edge testing and re-floating shall continue until the pavement has the required surface contour.

f. Burlap, (Coarse Canvas) Dragging

After the first straight edge testing and when most of the water sheet has disappeared from the surface and just before the concrete becomes non-plastic, the surface shall be dragged with a strip of burlap (coarse canvas) 3

ft. to 10 ft. wide and having a length 4 ft. more than the width of the slab. The burl of shall be dragged along the surface of the pavement in a longitudinal direction. Burlap shall be clean and kept free from coatings of hardened concrete. It shall be moist at the time of use.

g. Second Straight Edge Testing

After the concrete has hardened sufficiently to permit walking on it, the surface of the pavement shall again be tested with a 10-ft. straight edge. Any portion of the pavement which shows a variation from the testing edge of more than 1/8 inch shall be corrected by cutting, or shall be removed and replaced at the expense of the Contractor.

20.10.5 Expansion and Contraction Joints

a. All the expansion and contraction joints shall be carefully formed as shown on the Drawings or as directed by the Engineer. As regards dowel bars and joint assemblies, such stakes, brackets or other devices shall be used, as necessary to keep the entire joint assembly in true vertical and horizontal position. The joint filler together with the preformed groove shall provide complete separation of adjacent slabs. The joints shall be sealed with the specified non-extruding sealing compound set in a 3/4-inch wide preformed chase as shown on the Drawings. The lie preformed chase shall be thoroughly cleaned of all dust, debris, stone or other hard material prior to its sealing. The riser of all joints shall be rounded to a radius as shown on the Drawings before the concrete hardens.

b. The joints sealing compound shall be hot poured bitumen or approved sealing compound for concrete pavements complying with BS-2499 for hot tropical climates and heavy-duty industrial site subject to severe exposure. All joints are to be filled with flexell expansion joint filler, or an approved elastic, compressible, durable and rot-proof equivalent of sufficient rigidity to enable it to be satisfactorily installed in the joint and resist deformation during the passage of the concreting equipment. The filler is to be of the same thickness as the joint width. Holes to accommodate the dowel bars shall accurately be drilled or punched out. Where shown on the Drawings, dowel bars of required diameter shall be placed at the specified spacing. The bars shall be lubricated with an approved lubricant. One' end of the dowel bar at expansion joints shall be provided with a closely fitting sleeve 3-inch long, consisting of bitumen coated plastic or other approved material to permit expansion. A loose plug 1 inch deep of approved compressible filling material shall be inserted into the sleeve as shown on the Drawings at the end of the bar. All the dowel bars shall be mild steel bars of

the size shown on the Drawings and shall conform to the requirements as specified in the SECTION-21, REINFORCEMENT.

c. Contraction joints shall be provided as shown on the Drawings.

d. The assembly and method of constructing the expansion joints/contraction joints shall be subject to the approval of the Engineer.

e. In general, all PVC water stops/hydrofoil shall be placed in the centre of the structural member. Each piece of the water stop-hydrofoil shall be of maximum practicable length. An ordinary sharp knife saw or any other sharp tool can be used to cut the water stop. Joints at inter sections and at ends of pieces shall be made in the manner most appropriate to the material being used. Joints shall develop effective water tightness fully equal to that of the continuous water stop material and shall permanently retain their flexibility. For straight line connection melting method of connection can be used by passing two water stops intended for connection against a heated iron or copper sheet. When they are melted, the two are combined.

f. After joining, the water stop should be allowed to cool.

g. For all other connections such as T-type or L-type, the welding method of joining should be used. Welding rod of same material as the water stop shall be used. The welding rod & the water stop shall be heated & melt at the same time, by means of heated air jetting from the hot jet gun.

20.11 TEST OF CONCRETE QUALITY

The Contractor shall provide samples of concrete for testing at the Engineer's direction. Proper facilities shall be provided for making and curing the test specimens. A competent person shall be employed by the Contractor whose first duty shall be to supervise all stages in the preparation and placing of the concrete. All test specimens shall be made at site and tests carried out under his direct supervision.

Cylinder test shall be performed in accordance with the discretion of the Engineer. The standard of acceptance for preliminary and works tests shall be as given below,

The usual test for concrete with maximum size of aggregate up to 1-112 inch is the 6-inch cylinder tested in compression. Details of the testing are given in ASTM C 39.

For all grades of concrete; preliminary cylinder strength test with the mixes and materials to be used shall be performed in accordance with ASTM C 31 before the work is begun and subsequently whenever any change is to be

made in the materials or in the proportions of materials to be used, or as required by the Engineer. The strengths shall comply with the standard of quality specified in accordance with Table 20.3 in accordance with ASTM C 39. The cost of such testing shall be borne by the Contractor.

Test sample shall be taken at the mixer or as directed by the Engineer. The test specimens shall be cured in accordance with ASTM C 31.

Records shall be kept of all test cylinders identifying the mix used the section of work for which the concrete was used and the date poured.

Five test cylinders are to be tested for compressive strength as specified in ASTM C 39. These tests shall be carried out at site or in a laboratory, approved by the Engineer. Two cylinders shall be tested at the age of seven days and three at 28 days and the strengths determined are to comply with the standard of quality specified. The laboratory tests shall be carried out by an independent organization, such as Government Testing' Laboratory or such other undertakings approved by the Engineer. The original test reports received from the 'above authorities should be submitted to the Engineer.

For all grades of concrete, the appropriate strength requirement shall be considered to be satisfied if none of the strengths of the cylinders is below the specified cylinder strength or if the average strength of the three cylinders is not less than the specified cylinder strength and the difference between the greatest and the least strength is not more than 20% of the average.

When the results of works cylinder tests show that the strength of any concrete is below the minimum specified* the Engineer may give instructions for the whole or part of the work concerned to be removed and replaced at the expense of the Contractor. The Contractor shall bear the cost of any other part of his, or any other contractor's worst, which has to be removed and replaced as a result of the defective concrete. If any concrete is held to have failed, the Engineer may order the proportions of that class of concrete to be changed in order to provide the specified strength.

20.12 FINISHING OF FORMED SURFACES

20.12.1 General

a. After removal of forms, the surfaces of concrete shall be given one or more of the finishes specified below in locations designated by the Contract Documents.

b. When finishing is required to match a small sample furnished to the Contractor, the sample finish shall be reproduced on an area at least 100 sq.ft. in an inconspicuous location designated by the Engineer before proceeding with the finish in the specified location.

c. Allowable deviations from plumb or level and from the alignment, profile grades, and dimensions are specified in clause 9. Tolerances

for concrete construction are defined as tolerances to be distinguished from irregularities in finish as described herein. The finish requirements for concrete surfaces shall be as generally specified in this clause and as indicated on the Drawings. Finishing of concrete surfaces shall be performed only by workmen who are skilled in concrete finishes. The Contractor shall keep the Engineer advised as to when finishing of concrete will be performed. Unless inspection is waived in each specific case, finishing of concrete shall be performed only in the presence of the Engineer. Concrete surfaces will be tested by the Engineer where necessary to determine whether surface irregularities are within the limits herein after specified, surface irregularities are classified as abrupt or gradual. Offsets caused by displaced or misplaced form sheeting or lining or section, or otherwise defective form lumber will be considered as abrupt irregularities, and will be tested by direct measurements. All other irregularities will be considered as gradual irregularities, and will be tested by use of a template, consisting of a straight edge or the equivalent thereof for curved surfaces. The length of the template 2 metre for testing of formed surfaces and 3 metre for testing of unformed surfaces.

20.12.2 As-cast Finishes

Unless otherwise specified or indicated on the Drawings the classes of finish shall apply as follows:

a. Rough form finish

No selected form facing materials shall be specified for rough form finish surfaces. The holes and defects shall be patched. Otherwise, surfaces shall be left with the texture imparted by the forms.

b. Fair face finish

Fair face finish applies to concrete formed surfaces, the appearance of which is considered by the Engineer to be of special importance, such as surfaces of structures prominently exposed to public inspection. Surfaces of concrete structures requiring fair face finish as shown in the Drawings. Surface irregularities, measured as described in sub-clause 7.2.1, 'Rough form finish', shall not exceed 4 mm for gradual irregularities and 6mm for abrupt irregularities, except that abrupt irregularities will not be permitted at construction joints. Abrupt irregularities at construction joints and elsewhere in excess of 6 mm and gradual irregularities in excess of 1/8 inch. (3mm) shall be reduced by grinding so as to conform to the specified limits. Abrupt irregularities at construction joints shall be ground on level of 1 to 20 ratio of height to length.

Unless otherwise approved, repair of imperfections in formed concrete shall be completed within 24 hours after removal of forms. The form facing material shall produce a smooth, hard, uniform texture on the concrete. It may be plywood, temperated concrete form grade hardboard metal, plastic paper, or other approved material capable of producing the desired fair face finish. The arrangement of the facing material shall be orderly and symmetrical, with the number of seams kept to the practical minimum. It shall be supported by studs or other backing capable of preventing excessive deflection. Material with raised grain, torn surfaces, worn edge, patches, dents, or other defects which will impair the texture of the concrete surface shall not be used. The holes and defects shall be patched. All fins shall be completely removed

c. Architectural Finish Concrete

Architectural finish to concrete formed surfaces as shown on the Drawings is required by the Engineer where the architectural appearance of surfaces of structures exposed to public view is of special consideration and importance. The Contractor shall use approved special material for formwork and design the forms in conformity with the specified architectural patterns, textures and finishes in order to obtain first class architectural finish on formed concrete surface without any defect, irregularities, blemishes, imperfections and encrustations.

i Sample approvals of precast & in-situ concrete

These samples will be reviewed and approved on the basis of colour, dimensional accuracy, and finish of surfaces and general appearance. The same requirements for sample approval will be required for both precast and in-situ concrete exposed surfaces.

ii Forms

The contractor must maintain the forms unusually tight and braces to prevent movement, mal-alignment and bleeding that will result in sand streaks, honeycomb, fins, stain or unsightly appearance.

It wood forms are chosen to be used by the Contractor they shall .be constructed of 3/4 inch. (20mm) minimum thickness plywood constructed in a fashion to allow many re-uses with all surfaces sealed with a polyurethane varnish.

Edges, surfaces and corners of forms shall be sealed to prevent loss of any matrix or unequal absorption of water. Corners of wood forms shall be filled with suitable compound and all contact surfaces sealed with a polyurethane varnish.

Re-use of forms shall be subject to approval of the Engineer.

iii Curing

Curing shall be done in shade (out of direct sunlight) and shall be for a minimum period of 4 days.

iv Finishing procedures:

Finishing procedures for filling air void in smooth finished concrete developed by a formed surface.

While the concrete surface is still damp (not more than three days after removal of forms), apply a thin coat of medium consistency neat cement slurry by means of bristle brushes to provide a bonding coat within any pit or blemishes in the parent concrete; avoid coating large areas of the finished surface. Before slurry has dried or changed colour, apply a dry (almost crumbly) grout comprised of one-part cement, of the type and brand of cement used in the original concrete, to one and one-half parts clean masonry sand with a fineness modulus of approximately 2.25 and complying with the gradation requirements of the ASTM Specifications C144. Mix proper amounts of white cement and colouring with the parent mortar to produce a satisfactory colour match with the parent concrete after hardening. Use samples previously prepared.

Apply the finishing grout uniformly with damp (neither dripping wet nor dry) pads of coarse burlap approximately 6-inch square used as a float. Scrub the grout well into the pits to provide a dense mortar in all the imperfections to be filled. Allow the mortar to partially harden, from one to two hours, depending upon the weather. Avoid direct hot sunlight. If the air is hot and dry, keep the concrete surface damp during this period using a fine fog spray. When the grout has hardened sufficiently so it can be scraped from the surface with the edge of a steel trowel without damaging the grout from the small pits of holes, cut off all that can be removed with a trowel without delay; next allow the surface to dry thoroughly and rub it vigorously with clean, dry burlap to completely remove any dried grout. No visible film of grout shall remain after this rubbing. Complete the entire cleaning and grouting operation for the grout to dry after it has been cut with the trowel, so it can be wiped off clean with the burlap.

On the day after the repair work, the concrete surfaces should again be wiped off clean with dry burlap to remove any inadvertent dust leave no built-up surfaces on the parent surfaces. Employ, if possible, a used piece of burlap containing old hardened mortar to act as a mild abrasive. Use of find abrasive stone if needed to remove any remaining built-up film without breaking through the surface film of the original concrete. Such scrubbing should be light and sufficient only to remove excess material without working up a lather of mortar or changing the texture of concrete. Following the final bagging or stoning operation, provide a thorough wash down with stiff bristle brushes to remove all extraneous materials and spray the concrete surface

with a fine fog spray periodically to maintain a continually damp condition for at least three days after application of the pit repair grout.

v Rust Stains

All rust stains are to be removed employing the following procedure:

The rust stain shall be soaked for 10 minutes with a solution of (0.055 lb.) 25gm of sodium citrate in (0.33lb) 150 gms water (brushing the solution at short intervals is satisfactory). Then the surface is sprinkled with crystals of sodium hydrosulfite and covered with a paste of Fuller's Earth and water. On a vertical surface, the paste is applied with a trowel, with the crystals first sprinkled on the paste so they will be in direct contact with the stain. The paste is allowed to dry for 10 minutes then scraped off and the treatment repeated if necessary.

vi Repairing of Formed Surfaces:

It is the intention of Specification to require, forms, mixture of concrete and workmanship so that concrete surfaces, when exposed, will require no patching. Any concrete which is not formed as required and conforming to approve samples or for any reason is out of alignment or level or shows a defective surface, shall be removed from the job by the Contractor at his expense unless the Engineer grants permission to repair the defective area. Permission to patch any such area shall not be considered as waiver of the Engineer's right to require a complete removal of defective work if the repair does not, in his opinion, satisfactorily restore the quality and appearance of the surface. The Engineer shall be the sole judge of acceptability of appearance.

vii Finishes of Unformed Surfaces

Where monolithic concrete floor finish is shown on the Drawings, placing shall proceed continu6usly for the full thickness of the course or RCC slab without change in concrete mix. Mixing water shall be the minimum required for proper area shall be kept damp for 7 days. Metal tools shall not be used in finishing a patch in a formed wail, which will be exposed.

Where as-cast finishes are specified, the quantity of patched area shall be strictly limited. The combined total of patched areas in as-cast surfaces shall not exceed 2 sq ft. in each 1000 sq.ft. of as-cast surface. This is in addition to form tie patches, if the project design permits ties to fall within as-cast areas.

Any patches in as-cast architectural concrete shall be indistinguishable from surrounding surfaces. The mix formula for patching mortar shall be determined by trial to obtain a good colour match with the concrete when both patch and concrete are cured and dry. After initial set, surfaces of patches shall be dressed manually to obtain the same texture as surrounding surfaces.

Patches in architectural concrete surfaces shall be cured for 7 days. Patches shall be protected from premature drying to the same extent as the body of the concrete.

viii Tie and Bolt Holes

After being cleaned and thoroughly dampened, the tie and bolt holes shall be filled solid with patching mortar.

ix Proprietary Materials

If permitted or required by the Engineer, proprietary compounds for adhesion or as patching ingredients may be used in lieu of or in addition to the foregoing patching procedures. Such compounds shall be used in accordance with the manufacturer's recommendations with prior approval of the Engineer.

20.13 TOLERANCES

Where tolerances are not stated in the Drawings for any Individual structure or feature thereof maximum permissible deviations from established lines, grades and dimensions shall conform to the following. The Contractor is expected to set and maintain concrete limits. These allowable tolerances shall not relieve the Contractor of the responsibility for correct fitting of indicated materials. Those tolerances are not cumulative.

a. Variation from the plumb (or the specified better for inclined walls)

i In the lines and surfaces of columns, piers, and walls and in arises.

In any 10 ft. (3 metre) of length or height:	1/4" (6 mm)
In any storey or 20 ft. (6 metre) maximum:	3/8" (10 mm)
Maximum for the entire length or height:	1" (25 mm)

ii For exposed corner columns, control joint grooves and other conspicuous lines.

In any bay or 20 ft. (6 metre) maximum	1/4" (6 mm)
Maximum for the entire length or height	1/2" (13 mm)

b. Variation from the level or from the grades indicated on the Drawings.

i In floors, ceilings, beams soffits and in arises.

In any 10 ft. (3 metre) of length	1/4" (6 mm)
In any bay or 20 ft. (6 metre) maximum	3/8" (10 mm)
Maximum for the entire length	3/4" (20 mm)

ii For exposed lintels, sills, parapets, horizontal grooves and other

conspicuous lines.

In any bay or 20 ft. (6 metre) maximum	1/4" (6 mm)
Maximum for the entire length	3/8" (10 mm)

c. Variation of the linear building lines from established position in plan and related position of columns, walls and partitions.

In any bay or 10 ft. (3 metre) maximum	1/2" (13 mm)
Maximum for the entire length	1" (25 mm)

d. Variation in the sizes and locations of sleeves, Floor openings and wall openings. ± 1/4" (± 6mm)

e. Variation in cross-sectional dimensions of columns and beams and in the thickness of slabs and walls.

Minus	1/4" (6mm)
Plus	1/2" (13mm)

f. Footings

i Variation in dimensions in plan Minus

Minus	1/2" (13 mm)

Plus (plus variation applied to concrete only, not to reinforcing bars or dowels). 2" (50mm)

ii Misplacement or eccentricity

2 percent of the footing width in the direction of misplacement but not more than (applies to Concrete only, not to reinforcing bars or dowels). 2" (15 mm)

iii Thickness

Decrease in specified thickness	5%
Increase in specified thickness	No limit

g. Variation in Steps

i In a flight of stairs

Rise	1/8" (3 mm)
Tread	1/4" (6 mm)

ii In consecutive steps:

Rise	1/16" (1.5 mm)

Tread	1/8" (3 mm)

h. Tolerances for Pre-Cast Concrete Constructions

Forms must be true to size and dimensions of concrete members shown on the Drawings and be so constructed that the dimensions of the finished products will be within the following limits at the time of placement of these units in the structure, unless otherwise noted on structural-architectural Drawings:

i	Overall dimensions of members	1/16" per 10 feet
ii	Cross-sectional dimensions	
Sections less than 3-inch		1/16" (1.5 mm)
Sections over 3-inch and less than 18-inch		1/8" (3 mm)
Sections over 18-inch		1/4" (6 mm)
iii	Deviations from straight line in long sections	
Not more than		1/8" per 10 feet
iv	Deviation from specified camber	1/16" per 10 feet

v Maximum differential between adjacent units in erected position 1/4" (6 mm)

20.14 ACCEPTANCE OF STRUCTURE

20.14.1 General

a. Completed concrete work which meets all applicable requirements will be accepted subject to the other terms of the Contract Documents.

b. Completed concrete work which fails to meet one or more of the requirements and which has been repaired to bring it into compliance will be accepted subject to the other terms of the Contract Documents.

c. Completed concrete work which fails to meet one or more of the requirements and which cannot be brought into compliance may be accepted or rejected as provided in these Specifications or in the Contract Documents. In this event, modifications may be required to assure that remaining work complies with the requirements.

20.14.2 Dimensional Tolerances

a. Formed surfaces resulting in concrete outlines smaller than permitted by the tolerances of SECTION-20.13 shall be considered potentially deficient in strength and subject to the provisions of SECTION-20.14.4.

b. Formed surfaces resulting in concrete outlines larger than permitted

by the tolerance of SECTION-20.13 may be rejected and the excess material shall be subject to removal. If removal of the excess material is permitted, it shall be accomplished in such a manner as to maintain the strength of the section and to meet all other applicable requirements of function and appearance. Permission is required if excess material is to be removed in accordance with this clause.

c. Concrete members cast in the wrong location may be rejected if the strength, appearance or function of the structure is adversely affected or if misplaced items interfere with other construction.

d. Inaccurately formed concrete surfaces exceeding the limits of SECTION-20.13 or SECTION-23 CONCRETE FORMWORK & ACCESSORIES and which are exposed to view, may be rejected and shall be repaired or removed and replaced if required.

20.14.3 Appearance

a. Architectural concrete with surface defects exceeding the limitations of SECTION-23 CONCRETE FORMWORK & ACCESSORIES shall be removed and replaced.

b. Other concrete exposed to view with defects which adversely affect the appearance of the specified finish may be repaired only be approved methods.

c. Concrete not exposed to view is not subject to rejection for defective appearance.

20.14.4 Strength of Structure

a. The strength of the structure in place will be considered potentially deficient if it fails to comply with any requirements which control the strength of the structure, including but not necessarily limited to the following conditions:

- Concrete strength requirements not considered to be satisfied in accordance with SECTION-20.5.2.
- Reinforcing steel size, quantity, strength, position or arrangement at variance with the requirements as listed under specification of 'Reinforcement' or in the contract documents.
- Concrete which differs, from the required dimensions or location in such a manner as to reduce the strength.
- Curing less than that specified.
- Inadequate protection of concrete from extremes of temperature during early stages of hardening and strength development.
- Mechanical injury, construction fires, accidents of premature removal of formwork likely to result in deficient strength.
- Poor workmanship likely to result in deficient strength.

b. Structural analysis and/or additional testing may be required when the strength of the structure is considered potentially deficient.

c. Core tests may be required when the strength of the concrete in place is considered potentially deficient.

d. If core tests are inconclusive or impractical to obtain or if structural analysis does not confirm the safety of the structure, load tests may be required and their result evaluated in accordance with British Standard, CP 110 or ACI 318.

e. Concrete work judged inadequate by structural analysis or by results of a load test shall be reinforced with additional construction if so directed by the Engineer or shall be replaced, at the Contractor's expense.

f. The Contractor shall pay all costs incurred in providing the additional testing and/or analysis required by this section.

g. All costs of additional testing and/or analysis which is made at the Employer request and which is not required by these Specifications, or by the Contract Documents shall also be borne by the Contractor.

20.15 MEASUREMENT AND PAYMENT

20.15.1 Measurement

Concrete will be measured for the number of cubic foot or cubic metre (whichever is included in Bill of Quantities) acceptably placed complete in all respects as per Drawings and in strict accordance with this section of specification.

Except otherwise specified herein or elsewhere in the Contract Documents, no measurement and payment will be made for the under mentioned specified works related to the relevant items of the Bills of Quantities. The cost thereof shall be deemed to have been included in the quoted unit rate of the respective items of the Bills of Quantities.

The rates quoted by the Contractor in the Bill of Quantities shall include work to be executed under this specification in any floor and at any height except where otherwise specifically stated in the relevant item of Bill of Quantities and the Contractor shall not be entitled to any claim or claim any compensation on this account:

- Providing, fixing, striking, etc. of formwork.
- Providing, placing and fixing of anchor bolts or any other embedded parts.
- Providing and installing all type of joints in concrete structure, including expansion joints.
- Providing and fixing water stoppers.

20.15.2 Payment

Payment will be made in accordance with the unit prices in the Bill of Quantities for the various items in accordance with the specifications and shall constitute full compensation for furnishing all materials, shuttering, equipment and labour and for performing all operation necessary to complete the work.

Concrete shall be measured as executed but no deductions shall be made for the following:

- Volume of any steel embedded in the concrete;
- Volume occupied by water pipes, conduits etc. not exceeding 10 square inches each in cross-sectional area; and
- Voids not exceeding 4 square inch in work given in square feet. If any void exceeds 4 square inch, total void shall be deducted.

Voids, which are not to be deducted as specified above refer only to openings or vents which are wholly within the boundaries of measured areas.

Openings or vents which are at the boundaries of measured areas shall always be subject to deductions irrespective of size.

Concrete work shall be classified and measured separately as listed under items of Bills of Quantities.

Junction between straight and curved works shall in all cases be deemed to be included with the work in which they occur.

SECTION-21 REINFORCEMENT

21.1 SCOPE OF WORK

The work under this section of specifications consists of furnishing, cutting, fabricating, bending and placing steel reinforcement as shown on the Drawings or as directed by the Engineer. The scope of this section of specification is covered with detailed specifications as laid down herein.

21.2 APPLICABLE STANDARDS

The work shall conform to requirements of latest editions of following standards, wherever applicable, unless otherwise specified.

21.2.1 Pakistan Standard

- PS 241, Tensile testing of steel
- PS 244, Bend test for steel
- PS 580, Rolled deformed steel bars (intermediate grade) for concrete reinforcement
- PS 605, Rolled deformed steel bars (hard grade) for concrete reinforcement
- PS 606, Rolled deformed steel bars (structural grade) for concrete reinforcement
- PS 607, General technical delivery requirement for steel

21.2.2 British Standard

- BS 693, General requirements for oxy-acetylene welding of mild steel
- BS 785, Hot rolled bars and hard drawn wire for the reinforcement of concrete
- BS 1856, General requirement for the metal arc welding of mild steel
- BS 4449, hot rolled steel bars for reinforcement of concrete
- BS 4461, Cold worked steel bars for reinforcement of concrete
- BS 4466, Bending dimensions and scheduling of bars for the reinforcement of concrete

21.2.3 ASTM Standard

- ASTM A 305, Minimum requirement for the deformations of deformed steel bars for concrete reinforcement
- ASTM A 615, Deformed billet steel bars for concrete reinforcement

21.2.4 ACI Standard

- ACI 315, Manual of standard practice for detailing reinforced concrete structure
- ACI 318, Building code requirements for reinforced concrete

In addition to the above, the latest editions of other Pakistan Standards, British standards, American Concrete Institute Standards, American Society for Testing and Materials Standards and other standard as may be specified by the Engineer for Special Material and construction are also relevant.

21.3 SUBMITTALS

The Contractor shall submit the following to the Engineer for approval before commencement of work:

- Bar bending schedule prepared by Contractor on the basis of approved Drawings for the approval of the Engineer.
- Results of all tests performed upon steel reinforcement bars obtained from the site of work as per directions of the Engineer.

21.4 MATERIAL REQUIREMENTS

Reinforcement for concrete shall conform to the respective Pakistan, British, ASTM, or other Standards as specified in the Drawings and in the Contract Documents or as may be specified by the Engineer.

Unless otherwise specified, all plain reinforcing bars shall comply with the requirements of BS 4449 for plain mild steel bars and shall have a minimum characteristic strength of 40,000 psi.

Unless otherwise specified, all deformed reinforcing bars shall comply with the requirements of BS 4461 for deformed cold worked new stock billet steel bars and shall have a minimum characteristic strength of 60,000 psi.

Steel wire mesh reinforcement shall conform to requirements of ASTM Designation A-185-64 or BS 4483. Standard Specifications for Welded Steel Wire Fabric for concrete reinforcement. It shall be used where shown on the Drawings.

Reinforcement shall be free from all loose or flaky rust and mill scale, or coating, including ice, and any other substance that would reduce or destroy the bond. Reduced section steel reinforcement shall not be used.

21.5 DELIVERY & STORAGE

21.5.1 Delivery

Steel reinforcement bars shall be kept in bundles firmly secured and tagged.

21.5.2 Storage

The method of storage shall be approved by the Engineer. Reinforcing bars shall be stored in racks or platforms above the surface of ground and shall be protected free from scaling, rusting, oiling, coatings, damage, contamination and structural defects prior to placement in works. Bars of different diameters and grades of steel reinforcement shall be kept separately.

21.6 BAR BENDING SCHEDULES

The Contractor shall prepare bar bending schedules of all the reinforcing steel bars and these bar bending schedules shall be submitted to the Engineer for approval. The Contractor shall obtain approval of the bar bending schedules before starting actual bar bending works.

21.7 FABRICATING, BENDING & PLACING

All metal for reinforcement shall be free from loose mill scale, loose rust, mud, oil, grease, or other harmful matter immediately before the concrete is placed.

Reinforcement is to be accurately placed as shown in the Drawings, and secured against displacement by using 16-gauge G.I wire ties or suitable slips at intersections and supported from the formwork by using concrete, metal or plastic chairs and spacers or hangers of an approved pattern. Where concrete blocks are used for ensuring the cover, they shall be made of mortar not leaner than 1 part of cement to 2 parts of sand.

Where the concrete surface will be exposed to the weather in the finished structure, the portions of all accessories in contact with the form work shall be galvanized or shall be made of plastic.

Bars used for concrete reinforcement shall be fabricated in accordance with the dimensions shown in the bar bending schedule approved by the Engineer. The cutting tolerance for all bars shall be ± 1 inch. (± 25 mm).

Where an overall or an internal dimension of a bent bar is specified in the schedule, the bending tolerance, unless otherwise stated, shall be as included in Table 21.1.

Table 21.1, Bending Tolerances for Reinforcement Bars

Sr. No.	Dimension of Bent Bars		Tolerance	
	Over Feet	Up to & Including Feet	Plus Inch	Minus Inch
1	-	3	1/5	1/5
2	3	6	1/5	1/5
3	6	-	1/5	1

Bars shall be placed to the tolerances as included in Table 21.2.

Table 21.2, Placement Tolerances for Reinforcement Bars

Sr. No.	Location of Bars	Tolerance
1	Concrete cover to formed surfaces	± 1/4" (± 6mm)
2	Minimum spacing between bars	± 1/4" (± 6mm)
3	Top bars in slabs and beams	
	Members 8 inch deep or less	± 1/4" (± 6mm)

Sr. No.	Location of Bars	Tolerance
	Members more than 8 inch but not over 24 inch deep	± 3/8" (± 10mm)
	Members more than 24 inch deep	± 1" (± 25mm)
4	Crosswise members spaced evenly within	± 2" (± 50mm)
5	Lengthwise members	± 2" (± 50mm)

Bars may be moved as necessary to avoid interference with other reinforcing steel, conduits, or embedded items. If bars are moved more than one bar diameter or enough to exceed the above tolerances, the resulting arrangement of bars shall be subject to approval of Engineer.

Vertical bars in columns shall be offset at least one bar diameter at lapped splices. To ensure proper placement, templates shall be furnished for all column dowels.

Reinforcement shall not be bent or straightened in a manner that will injure the material.

No bars shall be bent twice in the same place, nor shall they be straightened after bending.

Unless permitted, by Engineer reinforcement shall not be bent after being partially embedded in hardened concrete.

No splice of reinforcement shall be made except as shown on the working Drawings.

Welding shall be permitted for, bars only under suitable conditions and with suitable safeguards in accordance with BS 693, PS 1856, or AWS D12.1, provided the type of reinforcement bar has the required welding properties. Tack welding may be used to fix in position bars that cross each other, only with prior approval of the Engineer.

Exposed reinforcement intended for bonding with future extensions is to be effectively protected from corrosion Protection is also to be provided to reinforcement partly built into concrete where the exposed part is to be built into later concrete.

No concreting is to be carried out until the reinforcement has been checked and approved by the Engineer.

Welding shall be done as in section 'Structural Steel Works'. All detailing shall be done as per ACI standards ACI-315 and AC1-318.

Concrete clear cover for reinforcing steel shall be as provided in Drawings. All reinforcing steel shall be held firmly in place before and during the placing of concrete by means of wires and supports adequate to prevent displacement during the course of construction.

21.8 MEASUREMENT & PAYMENT

21.8.1 Measurement

The measurement for acceptably completed works of reinforcement according to bar bending schedules approved by the Engineer shall be made by weight computed on the bases of Table 21.3.

The Contractor shall not claim for the difference in the actual weights of bars and their standard weights given in Table 21.3.

Table 21.3, Standards Weights of Reinforcement Bars

Sr. No.	Nominal Bar Diameter, Inch	Bar No.	Weight, lb/ft
1	3/8	#3	0.376
2	1/2	#4	0.668
3	5/8	#5	1.043
4	3/4	#6	1.502
5	7/8	#7	2.044
6	1	#8	2.670
7	1-1/8	#9	3.400
8	1-1/4	#10	4.303

The rates quoted by the Contractor in the Bill of Quantities shall include work to be executed under these specifications in any floor and at any height except where otherwise specifically stated in the relevant item of Bill of Quantities and the Contractor shall not be entitled to any claim or claim any compensation on this account.

Providing and installing cover blocks, chairs, supports, hooks, spacers, binding wires, and laps not shown on Drawings including wastage and rolling margin and as such are not payable. Laps shown on Drawings shall be payable.

21.8.2 Payment

Payment will be made for acceptable measured quantity of reinforcement on the basis of unit rate per metric ton or kg (whichever is included in Bill of Quantities and shall constitute full compensation for all the works related to the item.

The rate quoted include all lead/lift required for steel fabrication & placement at/in any floor or at any height as per Drawings.

SECTION-22 SULPHATE RESISTANT CEMENT CONCRETE

22.1 SCOPE OF WORK

This work shall consist of providing sulphate resistant cement in place of Portland cement to all classes of concrete subject to the contact with soil having sulphate content more than 0.1% and with ground water having sulphate content more than 1500 ppm or as mentioned in the drawing or directed by the Engineer. Maximum Chloride Ion Concentration (as a percentage of weight of cement) arising from all sources including aggregates should not exceed 0.1 for pre-stressed concrete, 0.2 for any concrete using sulphate resistance cement and 0.35 for all other cement containing matter. All requirements of concrete with sulphate resistant cement are same as mentioned in SECTION-20, PLAIN & REINFORCED CONCRETE except amended in this section

22.2 MATERIAL REQUIREMENTS

Sulphate resistant cement where required shall be sulphate resistant cement type 'A' fully conforming to Pakistan standard specification PS 612:1967 and satisfying to requirements for fineness, chemical composition, strength, setting time and soundness etc. The average compressive strength of three mortar cubes prepared with 1:3 cement and standard silica sand mortar shall not be less than 20.0 N/mm sq. at seven days. The initial setting time shall not be less than 45 minutes and final setting time not more than 10 hours.

22.3 MEASUREMENT AND PAYMENT

22.3.1 Measurement

The quantity of concrete with sulphate resistant cement shall be measured exactly in same way as mentioned in SECTION-20 PLAIN & REINFORCED CONCRETE and subsequently paid as elaborated below.

22.3.2 Payment

The accepted quantity measured as provided above shall be paid only for the difference of cost for providing sulphate resistant cement in place of ordinary Portland cement at the contract unit price for particular pay item(s) as provided in the Bill of Quantities, which price and payment shall be full compensation for all the costs involved in the proper completion of the works.

SECTION-23 CONCRETE FORMWORK & ACCESSORIES

23.1 SCOPE OF WORK

The work under this section of the specifications consists of furnishing all plant, labour, equipment, appliances and materials and in performing all operations in any floor and at any height in connection with the supply and installation of formwork for the purpose of shuttering in concreting work, complete in strict accordance with this section of the specifications and the applicable Drawings and subject to the terms and conditions of the Contract.

23.2 APPLICABLE STANDARDS

The work shall conform to requirements of latest editions of following standards, wherever applicable, unless otherwise specified.

23.2.1 American Concrete Institute

- ACI 301, Specifications for Structural Concrete for Buildings
- ACI 318, Building Code Requirements for Reinforced Concrete
- ACI 347, Recommended Practice for Concrete Formwork

23.2.2 American Plywood Association:

- APA, High Density Overlaid Concrete Form, Class 1
- APA, Structural 1, Exterior Quality, Class 1
- APA, Plastic Overlaid Plywood Forms

23.2.3 American National Standard Institute

- A199.1, Construction and Industrial Plywood.

23.3 SUBMITTALS

a. Product's Data: Submit manufacturer's specifications and installation instructions for proprietary materials and items as required, including form coatings, manufactured form systems, ties and accessories.

b. Detail Shop Drawings: Submit data on sequence of the concrete placement, location of construction joints, camber details, bearing values of the soils supporting false-work under wet and dry conditions, the anticipated settlements as well as false-work release sequence.

23.4 MATERIAL REQUIREMENTS

23.4.1 Concrete Formwork

Unless otherwise specified construct formwork of plywood, metal, metal framed plywood faced or other panel type materials acceptable to

Engineer to provide continuous, straight, smooth surfaces. Provide formwork in the largest practice sizes to minimize number of joints and to conform to joint system indicated on Drawings. Provide form material with sufficient thickness to withstand pressure of newly placed concrete without bow or deflection. Provide wood forms of minimum thickness of 16 mm.

23.4.2 Forms of Unexposed Finish Concrete

Provide forms of plywood, lumber, metal or glass fibre reinforced plastic or other acceptable material.

23.4.3 Form Ties

Provide factory fabricated, adjustable length, removable or snap off metal form ties, designed to prevent form deflection and to prevent spalling concrete surfaces upon removal. Use Plastic cone type, with threaded steel rod. For water tanks or other water retaining structures use watertight form ties as recommended by the manufacturer.

Unless otherwise indicated, provide ties so that portion remaining within concrete after removal of exterior parts is at least 38 mm from the outer concrete surface. Provide form ties which will not leave a hole larger than 25 mm diameter in the concrete surface.

Form ties fabricated on Project Site and wire ties are not acceptable.

23.4.4 Form Release

Non staining, non-reactive, rust preventive guaranteed not to affect bond of subsequent surface applications to concrete.

23.5 DESIGN OF FORMWORK

Design, erect, support, brace and maintain formwork to safely support vertical and lateral loads applied, until such loads can be supported by the concrete structure. Carry vertical and lateral loads to ground by formwork system and in-place construction that has attained adequate strength for the purpose. Design and construct formwork of concrete members and structures to correct size, shape, alignment, elevation and position.

Design form and false-work to include assumed value of live load, dead load, weight of moving equipment operated on formwork, concrete mix, height of concrete drop, vibrator frequency, ambient temperature, foundation pressures, stresses, lateral stability and other factors pertinent to safety of structure during construction.

Design formwork to be readily removable without impact, shock or damage to cast in place concrete surfaces and adjacent materials.

Provide formwork sufficiently tight to prevent leakage of cement paste during concrete placement. Solidly butt joints and provide back-up material at joints as required to prevent leakage and fins.

Design forms according to ACI 318, Parts 1, 2, and 3 requirements as well as ACI 347 requirements for loads, lateral pressure, and allowable stresses; in addition to other design parameters.

23.6 DELIVERY AND STORAGE

23.6.1 Delivery

The delivery of formwork materials shall be done in such a manner that damage can be prevented.

23.6.2 Storage

Formwork should be stored, after cleaning and preparing for re-use if used before, in such a manner that access to all different materials is available.

Material which can be affected by weathering shall be stored in appropriate building or under covers and shade.

23.7 QUALITY ASSURANCE

Design, construct, erect, support, brace, maintain and remove forms according to ACI 318, Parts 1, 2, and 3 requirements as well as ACI 347 requirements for loads, lateral pressure and allowable stresses; in addition to other design parameters such as wind loads.

Construct formwork so that cast concrete surfaces will conform to the requirements of ACI 301, Chapter 4, Paragraph 4.3 Tolerances.

Maximum allowable deflection of forming surfaces from concrete pressure will be length/360 between supports.

Provide surveys as required to check the lines and levels of the completed formwork for exposed concrete before concrete is placed. Make the required corrections or adjustments to formwork to correct deviations which exceed the specified tolerances.

Check formwork during concrete placement to ensure forms, shores, false-work, ties and other features have not been unduly disturbed by concrete placement methods or equipment. Report in writing to the Engineer deviations from the allowable tolerances

23.8 EXECUTION

23.8.1 Inspection

Examine substrate and conditions under which concrete formwork is to be performed. Correct any unsatisfactory conditions. Proceed with the work after unsatisfactory conditions have been corrected in a manner acceptable to the Engineer.

23.8.2 Form Construction

a. General

Construct forms complying with ACI 347, to sizes, shapes, lines and dimensions indicated and required to obtain accurate alignment, location, grades, level and plumb work in the finished structures. Provide for openings, offsets, sinkages, keyways, recesses, mouldings, rustication, reglets, chamfers, blocking, screed, bulkheads, anchorages, inserts, and other features required. Use selected materials to obtain the required finishes.

Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush plates or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces where the slope is too steep to place concrete with bottom forms only. Kerf wood inserts for forming keyways, reglets, recesses, and the like, to prevent swelling and assure ease of removal.

Provide temporary openings where interior area of formwork is inaccessible for cleanout, inspection before concrete placement and placement of concrete. Securely brace temporary closures and set tightly to forms to prevent loss of concrete mortar. Locate temporary openings in forms at inconspicuous locations.

Form intersecting planes to provide true, clean out corners, with edge grain of plywood not exposed as form for concrete.

b. False-work

Erect false-work and support, brace and maintain it to safely support vertical, lateral and asymmetrical loads applied until such loads can be supported by in-place concrete structures. Construct false-work so that adjustments can be made for take up and settlement.

Provide wedges, jacks or camber strips to facilitate vertical adjustment. Inspect false-work and formwork during and after concrete placement operations to determine abnormal deflection or signs of failure and make necessary adjustments to produce work of required dimensions.

Provide shores and struts with positive means of adjustment capable of taking up formwork settlement during concrete placing operations, using wedges or jacks or a combination thereof. Provide trussed supports when adequate foundations for shores cannot be secured.

Support form facing materials by structural members spaced sufficiently close to prevent deflection. Fit forms placed in successive units for continuous surfaces to an accurate alignment, free from irregularities and within allowable tolerances. Provide camber in formwork as required for anticipated deflections due to weight and pressures of fresh concrete and construction loads for long span members without intermediate supports.

Provide temporary openings in wall forms and at other locations necessary to permit inspection and clean out.

c. Forms for Exposed Concrete

Drill forms to suit ties used and to prevent leakage of concrete mortar around tie holes. Do not splinter forms by driving ties through improperly prepared holes.

Do not use metal cover plates for patching holes or defect in forms.

Provide sharp, clean corners at intersecting planes, without visible edges or offsets. Back joints with extra studs or girts to maintain true, square intersections.

Use extra studs and bracing as required to prevent bowing of forms between studs and to avoid bowed appearance in concrete. Do not use narrow strips of form material which will produce bow.

Assemble forms in a way to be readily removed without damage to exposed concrete surfaces.

Form mouldings shapes, recesses and projections with smooth finish materials and install in forms with sealed joints to prevent displacement.

d. Corner Treatment

Form exposed corners to produce square, smooth, solid, unbroken lines, except as otherwise indicated.

Provide chambers for surfaces where indicated on Drawings.

Unless otherwise indicated, form chamfers using wood strips 19 x 19 mm; accurately formed and surfaced to produce uniformly straight lines and tight edge joints. Extend terminal edges to required limit and miter chamfer strips at changes in direction.

e. Provisions for other Trades

Provide openings in concrete formwork to accommodate work of other trades. Determine size and location of openings, recesses and chases required for such work. Accurately place and securely support built-in items into forms.

f. Cleaning and Tightening

Thoroughly clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt or other debris just before concrete placement. Re-tighten forms immediately after concrete placement as required to eliminate mortar leaks.

23.8.3 Form Coatings

Coat form contact surfaces with form coating compound before placing the reinforcement. Provide form coating compounds that will not bond with, stain, nor adversely affect concrete surfaces and will not impair subsequent treatment of concrete surfaces requiring bond or adhesion nor impede the wetting of surfaces to be cured with water or curing compounds. Do not allow excess form coating material to accumulate in the forms or to come into contact with surfaces against which fresh concrete will be placed. Apply in compliance with manufacturer's instructions.

Coat steel forms with a non-staining, rust preventive form oil or otherwise protect against rusting. Rust stained steel formwork is not acceptable.

23.8.4 Installation of Embedded Items

a. General

Set and build into the work anchorage devices and other embedded items required for other work that is attached to, or supported by, cast in place concrete. Use setting drawings, diagrams, instructions and directions provided by the suppliers of these items to be attached thereto.

b. Edge Forms and Screed Strips for Slabs

Set edge forms or bulkheads and intermediate screed strips for slabs to obtain required elevations and contours in the finished slab surface. Provide and secure units to support types of screed required.

c. Metal Inserts

Provide metal inserts for anchorage of materials or equipment to concrete construction, as required for the work.

Provide adjustable wedge inserts of malleable cast iron, complete with bolts, nuts and washers; 19 mm bolt size unless otherwise indicated.

Provide threaded inserts of malleable cast iron, furnish complete with full depth bolts; 19 mm bolt size, unless otherwise indicated.

Provide box out sections in concrete work as required for installation of equipment or other work.

Coordinate location of all required embedded weld plates and other items for attachment of precast concrete to cast in place concrete.

23.8.5 Shores and Supports

Shore floor directly under slab being placed so that loads from construction above will safely transfer directly to these shores. Space out shoring below this level in such a manner that no member will be excessively loaded or will

induce tensile stress in concrete members where no reinforcing steel is provided. Extend shores beyond minimum if required to ensure the proper distribution of loads and the safety of all concrete members.

Remove shores and reshore in a planned sequence to avoid damage to partially cured concrete, and to assure that the structure supported is not subjected to impact or loading eccentricities. Locate and provide adequate reshoring to safely support the work.

23.8.6 Removal of Forms

Formwork not supporting concrete, such as sides of beams, columns, walls, and similar parts of the work (vertical faces) may be removed not less than 24 hours after placing concrete provided that concrete is sufficiently hard and will not be damaged by form removal operations, and provided that curing and protection operations are maintained.

Formwork supporting weight of concrete, such as slabs and other structural elements must remain in place for the time period shown in ACI 347 (assuming design live load is less than dead load) and until concrete has attained design minimum 28-day compressive strength determined by field-cured specimens as defined below. Do not remove forms until the approval has been obtained from the Engineer.

Form facing material may be removed not less than 4 days after placement, provided shores and other vertical supports have been arranged to permit removal of form facing material without loosening or disturbing shores and supports and provided that concrete has achieved adequate compressive strength to safely support the load.

Use necessary means and precautions to protect workmen, passer-by, the installed work and material of other trades and complete safety of structure.

Cut nails as well as form ties off flush leaving surfaces smooth and clean.

Remove metal spreader ties on exposed concrete by removing or snapping off inside the wall surfaces and pointing up and rubbing the resulting pockets to match surrounding surfaces.

Flush holes resulting from spreader rods and sleeve nuts, using water, and solidly pack throughout the wall thickness with cement grout applied under pressure by means of grouting gun; grout shall be one part cement to 2-1/2 parts sand; apply grout immediately after removing forms.

23.8.7 Re Use of Forms

Clean and repair surfaces of forms to be reused in the work. Split, frayed, delaminated or otherwise damage form facing material will not be acceptable. Apply new form coating compound material to concrete contact surfaces as specified for new formwork.

When forms are extended for successive concrete placement thoroughly clean surfaces, remove fins and laitance, and tighten forms to close all joints. Align and secure joints to avoid offsets. Do not use patched forms for exposed concrete surfaces

23.9 MEASUREMENT AND PAYMENT

23.9.1 Measurement

No separate measurement shall be made for the works involved within the scope of this section of the specifications unless otherwise specifically stated in the Bills of Quantities.

23.9.2 Payment

No separate payment, unless otherwise included in the Bills of Quantities, shall be made. The cost thereof shall be deemed to have been included in quoted unit rates of relevant items of the Bills of Quantities.

SECTION-24 STRUCTURAL STEEL WORKS

24.1 SCOPE OF WORK

The work covered by this section, consists of supply of all material, labour, plant, equipment and appliances including welding, bolts, nuts, washers, anchor bolts, embedded parts etc., fabrication, erection and painting in accordance with the specifications, as per Drawings and as directed by the Engineer.

24.2 SUBMITTALS

a. Product Data: Submit manufacturer's product information, specifications and installation instructions for all structural steel components and accessories.

b. Shop Drawings: Submit complete shop drawings, including details and schedules for fabrication, assembly and erection of structural steel members, procedures, and diagrams. Include details of cuts, connections, camber, holes, and other pertinent data. Indicate welds by standard AWS symbols and show size, length, and type of each weld. Provide setting drawings showing all anchor bolt locations on plan with column grids. Show projection of each bolt above foundation concrete, length of threaded portion of each bolt and orientation of shear lugs.

c. Design Analysis and Calculations: Provide design analysis and calculations for structural steel members of which sizes are not shown, and connections for beams, girders and other steel member intersections.

d. Test Reports: Provide reports for tests conducted on shop- and field-bolted and welded connections. Include data on type(s) of tests conducted and test results.

24.3 MATERIAL REQUIREMENTS

Except otherwise stated in the Drawings, the material specifications shall conform to the following:

a. Structural steel shapes, plates and bars shall conform to the requirements of ASTM A36.

b. Cold-Formed Steel Tubing: Comply with requirements of ASTM A500, Grade B.

c. Hot-Formed Steel Tubing: Comply with requirements of ASTM A501.

d. Steel Pipe: Comply with requirements of ASTM A53, Type E or S, Grade B; or ASTM A501.

e. Build-up Members Fabricated from Plate or Bar stock: Comply with requirements of ASTM A529, A570 or A572; minimum 50,000 psi yield

strength.

f. Members Fabricated by Cold Forming: Comply with requirements of ASTM A607, Grade 50.

g. Galvanized Cold-Formed Members: Comply with requirements of ASTM A446, Grade D, galvanized to ASTM A525, Class G90.

h. Steel forging shall conform to the requirements of ASTM A235.

i. Steel casting shall conform to the requirements of ASTM A27, Grade 65-35, medium-strength carbon steel.

j. Galvanized Steel Sheet: Comply with requirements of ASTM A446, Grade C, galvanized to ASTM A525, Class G90.

k. Welding Electrodes for manual shielded metal arc welding shall conform to AWS A 5.1 latest edition or the A 5.5 latest edition. Equivalent locally manufactured electrodes may be used subject to the approval of the Engineer.

l. Common Bolts, Anchor Bolts, Nuts and Washers Bolts and Nuts shall conform to the requirements of ASTM A307.

m. High strength carbon steel bolts including nuts and washers shall conform to the requirements of ASTM A325 latest editions and of AISI B18.2

n. Cut Washers shall be of structural grade steel and shall conform to the dimension of the manufacturer's regular standard for plain washers for the size of bolts used.

o. Cast iron Shall conform to the requirements of latest edition of ASTM A 48.

p. Structural Steel Primer Paint: SSPC - Paint 2, red lead-iron oxide, oil alkyd.

24.4 TRANSPORTATION, HANDLING AND STORAGE

Stack materials out of mud and dirt and provide for proper drainage. Exercise care to avoid abrasions and other damage to shop primer paint. Protect from damage or soiling by adjacent construction operations. Keep steel members off ground by using pallets, platforms, or other supports. Protect material against corrosion and deterioration.

24.5 FABRICATION

24.5.1 Straightening of Material

Rolled material, before being worked upon must be straightened within tolerances, by ASTM specifications A6 Straightening, necessarily shall be done by mechanical means or by the application of a limited amount of localized heat. The temperature of heated areas, as measured by approved methods, shall not exceed 1100^{o}F for A514 steel or 1200^{o}F for other steels.

24.5.2 Cutting

As far as possible cutting must be done by shearing. Oxygen cutting shall be done where shear cutting is not possible and shall preferably be done by Machine. All edges shall be free from gauges, notches or burs. If necessary, the same shall be removed by grinding.

24.5.3 Holes Punching Drilling

Holes shall be punched where thickness of the material is not greater than the diameter of bolt +3 mm. Where the thickness of the material is greater the holes shall either be drilled or sub-punched and reamed to size. The die for all sub-punched holes and the drill to all sub-drilled holes shall be at least 1.58 mm smaller than the nominal diameter of the rivet or bolt. Holes for A514 steel plates over 13 mm thick shall be drilled.

24.5.4 Welding

a. General

The execution and inspection of welding will be done in accordance with the provisions of the American welding society code for welding in Building construction, D1.0. No welding for piping/electrical supports shall be made transversely to any tension flanges of trusses, beams or columns.

b. Automatic submerged Arc Welding

For all built-up members, i.e., sections fabricated from plates and flat bars or compound rolled sections, plate and box girders, where long continuous, welding is to be done, should be executed by Automatic submerged Arc Welding process in accordance with relevant AWS specifications.

Maximum and minimum size and lengths of fillet welds shall be in accordance with AISC specifications.

Surface to be welded shall be free from loose scale, slag, rust, grease, paint or any other foreign matter except mill scale which withstands vigorous wire brushing.

24.5.5 Tolerances

A variation of I mm is permissible in the overall length of members with both ends finished for Contact bearing. The bearing surfaces prepared to a common plane by mining.

Members without end finished for contact bearing which are to be framed to other steel parts of the structure shall have a variation from detailed length not greater than 3 mm.

24.6 SURFACE PREPARATION & PAINTING

24.6.1 Surface Preparation

All structural steel material i.e., rolled steel sections, plates, pipes, flat bars, chequered plates shall be cleaned free from loose scale, rust, burrs slag, etc. by means of sand blasting.

24.6.2 Painting

a. Immediately after surface preparation all material shall be given one prime coat of rust preventive paint.

b. After fabrication one shop coat of prime paint and then one coat of enamel paint shall be applied.

c. One final coat of enamel paint shall be applied after erection of all components.

d. The type of primer and enamel paints to be applied shall be as specified on the Drawings.

e. All other requirements for the specified paint system shall be in accordance with the paint manufacturer's specification recommendations.

f. The Contractor shall use the best quality of the type of paint specified and shall get the same approved by the Engineer.

g. Steel work/Surfaces not to be painted

- Steel work to be encased/embedded in concrete or surface in coated with contact with concrete or grout shall not be painted, but shall be given a cement wash after sand blasting.
- Machined finished surfaces shall not be painted but shall be coated with rust preventive compound, (approved by the Engineer) immediately after finishing. Such surfaces shall also be protected with wooden pads or other suitable means for transportation. Unassembled pins, keys, and bolt thread shall be greased and wrapped with moisture resistant paper.

24.7 INSPECTION AND TESTS

Manufacturer's Work Test Certificate for all material used shall be furnished by the contractor for Engineer's scrutiny and approval.

Rolling tolerance of all shapes and profile according to AISC shall be in accordance with the provisions of the American Society for Testing and Materials Designation A.6. These shall be checked by the Contractor before being worked upon and shall be rejected if found not within limits.

The Contractor shall arrange for analysis and test of all material rolled locally at a testing laboratory selected by the Engineer.

a. Inspection of Welding

The inspection of welding shall be performed in accordance with the American Welding Society specifications, as directed by the Engineer.

b. Rejection

Materials or workmanship not in reasonable conformance with the provisions of these specifications shall be rejected at any time during the progress of the work or the completion and erection at site.

24.8 MEASUREMENT AND PAYMENT

24.8.1 Measurement

Measurement for miscellaneous items shall be made as per the units included in the Bill of Quantities.

24.8.2 Payment

Payment shall be made for the number of units of items as provided the Bill of Quantities, measured as above, and at the Contract unit price to furnish, construct and shaping the item and shall constitute full compensation for all work related to that item.

SECTION-25 BRICK MASONRY

25.1 SCOPE OF WORK

The work under this section of the specifications consists of furnishing all plant, labour, equipment, appliances, scaffoldings and materials and performing all operations in connection with furnishing and installing brick masonry in position including Portland cement and sand for mortar & masonry, complete in strict accordance with this section of the specifications and applicable Drawings and subject to the terms and conditions of the Contract.

25.2 APPLICABLE STANDARDS

The work shall conform to requirements of latest editions of following standards, wherever applicable, unless otherwise specified:

- ACI 530, Building code requirements for masonry structures
- ACI 530.1, Specifications for masonry structures
- PS 208, Classification, strength and properties of bricks
- ASTM C67, Standard method for sampling and testing brick and structural clay tile
- ASTM C144, Standard specifications of aggregates for masonry mortar
- ASTM C150, Specifications for Portland cement

25.3 SUBMITTALS

The Contractor shall submit the following to the Engineer for approval before commencement of work:

- Methodology and sequence of work
- Specimen samples of bricks, aggregates for mortar or grout and Portland cement.
- Results of all tests performed upon the materials and masonry units obtained from the site of work as per directions of the Engineer.

25.4 MATERIAL REQUIREMENTS

25.4.1 Cement

Portland cement for mortar shall conform to the applicable requirements specified in the SECTION-20, PLAIN & REINFORCED CONCRETE.

25.4.2 Sand

Sand for mortar used in brickwork shall be furnished by the Contractor, and shall meet the requirements set forth in ASTM C144. The Fineness Modules of the sand shall range between 1.9 & 2.8 and the grading shall be within the limits

Sand shall be stored at the site in such a manner that it is not mixed with foreign matter. Methods employed by the Contractor for unloading, loading, handling and storage shall be subject to the approval of the Engineer. Sufficient quantity shall be maintained at the Site at all times to assure continuous work

25.4.3 Water

Water used in the manufacture of bricks and in the preparation of mortar shall be free from objectionable quantities of silt, organic matter, alkali, salts and other impurities, and shall conform to the applicable requirements as specified in the SECTION-20, PLAIN & REINFORCED CONCRETE.

25.4.4 Mortar

Mortar for all brickwork shall, except as otherwise specified in Drawings or directed by the Engineer, shall consist of one part Portland Cement to four parts of sand by volume for 4-1/2-inch thick walls, one part of cement to six parts of sand for 9-inch and over thick walls for building works and one part of cement to 5 parts of sand for other works. Where directed by the Engineer for increased workability, hydrated lime putty, approved by the Engineer, shall be added to the mortar but shall not exceed 25 percent, by volume of the dry cement.

Methods and equipment used for mixing mortar be such as will accurately determine and control the amount of each separate ingredient entering into the mortar and shall be subject to the approval of the Engineer. Mortar shall be mixed only in sufficient quantities for immediate use and all mortar not used within 30 minutes after addition of water to the mix shall be rejected. Re-tempering of mortar shall not be allowed. The mixers shall be thoroughly cleaned and washed at the end of each day's work.

25.4.5 Bricks

All bricks, except otherwise specified, shall be of first-class quality made from good brick earth, free from saline deposit and shall be hand moulded. They shall be thoroughly burnt without being vitrified, shall be regular, uniform in shape and size with sharp and square edges, parallel faces and of deep red or copper colour. First class bricks shall be homogeneous in texture and shall emit a clear ringing sound when struck, and shall be free from flaws, cracks, chips, stones and modules of lime. First class brick in an oven dried condition shall not absorb more than 1/5 of its weight of water when immersed one hour in water at 21 to 27 degrees centigrade and shall show no signs of efflorescence on subsequent drying. The average compressive strength of five representative first class bricks shall be not less than 2000 psi and not less than 1500 psi for any individual brick.

All bricks shall be manufactured by the Trench Kiln Method or other standard methods approved by the Engineer. The earth used in manufacturing bricks

shall be carefully selected and shall be free from objectionable quantities of lime, gravel coarse sand, roots, or other organic matter. Salts shall not exceed 0.3 percent and calcium carbonate shall not exceed 2.0 percent.

The moulds used in the manufacture of bricks shall be thoroughly sanded before each use and shall be sufficiently larger than the size of the bricks being manufactured to allow for shrinkage in drying and burning. Over-size, irregular and worn moulds shall be destroyed. Each finished brick for brick masonry shall be 9 inch by 4-1/2 inch by 3 inch in size and shall weigh between 3.2 to 4.2 kilograms. All bricks shall have a "frog" 1/4-inch-deep on one face.

Bricks of approved samples shall only be used in the works. If at any time during the progress of the work, use of sub-standard material is found by the Engineer, such work shall be rejected and the Contractor shall replace the rejected work at his cost

25.5 PLACING

The methods and equipment used for transporting the brick and mortar shall be such as will not damage the brick not delay the use of mixed mortar Brick shall not be placed during rains sufficiently heavy or prolonged to wash the mortar from the brick. Mortar already spread which becomes diluted by rain shall be removed and replaced before continuing with the work. All brick to be used in brick masonry shall be moistened with water for three to four hours before they are used by a method which will ensure that each brick is thoroughly and uniformly wetted. All bricks shall be free from water adhering to their surface when they are placed in the brick masonry.

Bricks shall be laid "frog" upward with mortar joints and in English and Flemish bond as shown on the Drawings or as directed by the Engineer. Both bed and vertical joints shall be 1/4 inch in thickness completely filled with cement mortar as specified herein, and each brick shall be bedded by firmly tapping with the handle of the trowel. All horizontal joints shall be parallel and all vertical joints in alternate courses shall be directly over one another. Excess mortar at the outer edges shall be removed and joints drawn straight with the edge of a trowel and a straight edge. All anchors and similar work required to be embedded in the brick masonry shall be installed as the work progresses. At the completion of the work all holes or defective mortar joints shall be cut out and repointed.

Where shown on the drawing the exterior faces of the walls shall be finished by striking the joints as the work proceeds. The joints shall be struck by raking the green mortar after the brick work has been laid and finishing the joint with a pointing tool. Horizontal joints shall be struck to form a weathered joint and vertical joint shall be struck with a V notch. Care shall be taken that the striking tools do not develop a cutting edge as the object of striking the joint is to

compress the mortar into the joints.

The exposed faces of all brick masonry shall be thoroughly cleaned and left bear with struck joints as specified above.

25.6 CURING

All brick masonry shall be water cured and shall be kept wet for at least seven days by an approved method which will keep all surfaces to be cured continuously wet. Method to be utilised by the Contractor for curing of brick masonry shall be subject to the approval of the Engineer. Water used for curing shall meet the requirements of the Specifications for water used in the manufacture of bricks.

25.7 REPAIR

If, after the completion of any brick masonry work, the brick is not in alignment or level, or does not conform to the lines and levels shown on the Drawings, or shows a defective surface, it shall be moved and replaced by the Contractor at his expense unless the Engineer grants permission, in writing, to patch or replace the defective area.

At the completion of the work, all holes and defective mortar joints shall be cut and repointed. Exposed masonry shall be protected against staining or other damages and excess mortar shall be cleared off the surfaces as the work progresses. All exposed masonry shall be clean, smooth, plumb and shall be of acceptable finish. In the event ordinary cleaning is not adequate, special methods such as sand blasting or otherwise as approved by the Engineer, shall be used to clean the surfaces

25.8 SCAFFOLDING

Contractor shall provide safe scaffolding of adequate strength for use of workmen at all levels and heights at his own expense. Scaffolding which is unsafe in the opinion of the Engineer shall not be used until it has been strengthened and made safe for use of workmen. Cost of scaffolding etc., shall be included by the Contractor in the unit rate for masonry items.

Damage to masonry from scaffolding or from any other cause shall be repaired by the Contractor at his own cost.

25.9 TOLERANCES

The nominal/standard dimensions of brick are 9-inch (length) x 4-1/2-inch (width) x 3-inch (thickness). No dimension of brick (width, height and length) shall differ from the specified standard dimension by more than 1/8 inch.

Moreover, all brick work shall be erected plumb and true to line and level having maximum variation in plumb in height up to 1/16 inch for 3-feet height and limited to 1 inch for the entire height.

25.10 MEASUREMENT AND PAYMENT

25.10.1 Measurement

The measurement for brick work shall be made in cubic feet or cubic metre (whichever is included in Bill of Quantities) of brick work provided within the limits as shown on the Drawings or as directed by the Engineer.

25.10.2 Payment

Payment for brickwork shall be made at the contract unit price per cubic feet or cubic metre (whichever is included in Bill of Quantities). Payment shall constitute full compensation for furnishing all materials, equipment and labour including all incidentals necessary to complete the work.

SECTION-26 DAMP PROOF COURSE

26.1 SCOPE OF WORK

The work under this section of the specifications consists of furnishing all plant, labour, equipment and materials and performing all operations in connection with furnishing damp proof course (DPC) in position complete in strict accordance with this section of the specifications, applicable Drawings and as specified in the Bill of Quantities.

26.2 MATERIAL REQUIREMENTS

All materials i.e., cement, sand, aggregate, water polythene sheet and bitumen shall conform to the specifications given in respective sections.

26.3 HORIZONTAL DPC

26.3.1 In Walls

Unless specified in the Drawings, the horizontal DPC. shall consist of 2-inch thick, Class-C cement concrete mixed with 2.5 kg of pudlo per bag of cement or other approved quality water proofing compound as per manufacturer's specifications two floats of hot bitumen 10/20 penetration grade and intervening layer of polythene sheet.

26.3.2 Under Floors

Same as in walls except bitumen layers to be laid on 1/2" - 3/4" blinding screed (1:6) to even out surface of Class-E hard core.

26.4 VERTICAL DPC

Unless specified in the Drawings, the vertical DPC shall consists of ½" thick cement sand plaster in 1:3, mixed with 2.5 kg of pudlo per bag of cement or other approved quality water proofing compound as per manufacturer's specifications and shall be applied at required levels as per Drawings and instructions by the Engineer, including two float of hot bitumen 10/20 penetration grade.

26.5 CONSTRUCTION REQUIREMENTS

The Contractor shall lay the DPC only when the level, quality of masonry work, etc. is approved.

The concrete work of DPC shall conform to the applicable requirements specified in SECTION-20, PLAIN & REINFORCED CONCRETE.

Horizontal DPC shall extend to the full width of the wall i.e., up to the external faces. No portion of doors opening, etc. shall be left while laying DPC. The period of curing of concrete shall be not less than 72 hours. Every care should be taken that concrete is not left dry during this period. The work of laying

DPC shall be carried out as follows unless otherwise described in Bill of Quantities:

- Placing 2-inch thick layer of Class-C cement concrete.
- Laying 2 coats of hot bitumen 10/20 penetration grade @ 20 lbs. per sq.ft. (each coat) over entire width and lengths of concrete after the concrete has been properly cured for at least 72 hours, and sand blinding where specified.
- Laying of polythene sheet 500 gauge over entire width and length of concrete after the concrete has been treated with 2 coats of hot bitumen.

The application of bitumen coating in case of vertical DPC shall be same as mentioned above.

26.6 MEASUREMENT AND PAYMENT

26.6.1 Measurement

Measurement shall be made in square feet or square metre (whichever is included in Bill of Quantities) of superficial area or surface damp proofed as per this section of specification and accepted by the Engineer.

26.6.2 Payment

Payment will be made for the number of square feet or square metre (whichever is included in Bill of Quantities) of superficial area damp proofed at the contract unit price and will include full compensation for furnishing and placing all materials and for all labour, equipment, tools and incidentals necessary to complete the work prescribed in the Bill of Quantities.

SECTION-27 CEMENT PLASTER

27.1 SCOPE OF WORK

The work under this section of the specifications consists of furnishing all plant, labour, equipment, appliances, and materials and in performing all operations in connection with providing and installation of cement plaster, and specified external rendering complete in strict accordance with this section of the specifications and the applicable Drawings and subject to the terms and conditions of the Contract.

27.2 APPLICABLE STANDARDS

The work shall conform to requirements of latest editions of following standards, wherever applicable, unless otherwise specified.

27.2.1 Pakistan Standard

- PS 232, Ordinary Portland Cement

27.2.2 ISO (International Organization for Standardization)

- R 597 Definitions and terminology of cement.
- R 679 Method of testing strength of cements, compressive and flexural strength of plastic mortar (Rilem - (embureau method).
- P 680 Chemical analysis of cement & main constituents of Portland Cement.
- R 681 Chemical analysis of cements-mixer Constituents of Portland cement.
- R 682 Chemical analysis of cements - determination of sulphur as sulphide.

27.2.3 ASTM (American Society for Testing and Material)

- ASTM C144, Aggregate for Masonry mortar
- ASTM C631, Bonding Compounds for interior plastering

27.2.4 BSI (British Standards Institution)

- BS 812, Methods for sampling and testing of mineral aggregates, sands and fillers.
- BS 1199, Sands for external renderings Internal plastering with lime and Portland cement and floor screeds.
- BS 1369, Metal lathing (steel) for plastering.
- BS 5262, External rendered finishes.
- BS 5492, Internal plastering.

27.3 SUBMITTALS

Sample of materials shall be submitted to the Engineer for his approval prior to use in the works.

27.4 MATERIAL REQUIREMENTS

Portland cement for mortar shall conform to the applicable requirements specified in the SECTION-20, PLAIN & REINFORCED CONCRETE.

Sand for plaster shall comply with the requirements of BS 1199, BS 1200 or the Pakistan Standard "Sand for Plaster" as directed by the Engineer.

Water for plaster shall conform to the applicable requirements specified in the SECTION-20, PLAIN & REINFORCED CONCRETE.

All materials and workmanship for plaster not explained in these specifications, shall comply with the requirements of relevant BS CP 211 and CP 221 or as directed by the Engineer.

27.5 PROPORTIONING AND MIXING

Except as may be otherwise shown on surfaces specified, all plaster work, both internal and external shall be Ordinary Portland Cement plaster of the required thickness and cement/sand ratio as shown on the Drawings.

Measurement of materials by volume shall be by containers of known capacity to maintain consistent proportions. No lumpy or caked material shall be used. Mixing equipment boxes and tools shall be clean. Materials shall be proportioned as specified on the Drawings or as directed by the Engineer. Mixing shall be continuous until all ingredients are evenly distributed and thoroughly mixed.

Only limited water shall be added for proper workability and such quantity of mortar shall be prepared which can be consumed in thirty minutes after preparation. Preparation of mortar in bulk quantity for use during the entire day or for any other time more than that stipulated above is expressly prohibited. Re-tempering shall not be permitted and all mortar which has begun to stiffen shall be discarded.

Plaster ingredients shall be thoroughly mixed either by hand on a clean cement concrete platform or by a mechanical mixer, as directed by the Engineer.

Additives for controlling the setting and working characteristics of plaster or for imparting anticorrosion, fungicidal or water proofing properties, shall be added to the plaster strictly in accordance with the particular manufacturer's written instructions. Good quality hair or manila fiber in reasonably well distributed proportion may be to the plaster to assist application and reduce droppings. No additives shall be used except as specified in the Contract Documents

27.6 PREPARATION OF SURFACE TO BE PLASTERED

Plastering shall not commence until all electric conduits, drainage and sanitary pipes, inlets to tanks, brackets, clamps, doors and window frames and all sorts of inserts and embedded items are fixed in position. It shall be the responsibility of the Contractor to make sure that all such work is carried out by other contractors before starting of plaster work. Chiselling and repairing of cement plaster shall not be permitted without the approval of the Engineer.

Concrete surface to be plastered shall be cleaned to remove all grease, form oil and other surface impurities which will otherwise adversely affect the adhesion of plaster to the surface concerned. The surface of all concrete ceilings, beams and columns shall be lightly hacked by approved means to give the required key for plastering.

All masonry surface to be plastered shall be cleaned to remove all matter which will otherwise adversely affect the adhesion of plaster to the surface concerned. The surface shall be washed with clean water and kept damp for 24 hours before further treatment, the surface thus prepared shall be treated uniformly with cement and sand slurry. The slurry to be used shall be one-part cement to one-part sand by volume with water added to make a stiff. Spatter dash of slurry shall be applied on surface to receive plaster and be left to cure for three days.

27.7 APPLICATION OF PLASTER

The plaster of a thickness less than the specified thickness shall be rejected. If the plaster is to be more than ½-inch thick, it shall be done in two coats. The surface of first coat shall be made rough before the second coat is applied. Plaster shall not have wavy surface and shall be perfectly in plumb. The edges and corners shall represent a straight line. The plaster shall be kept wet continuously for at least ten days. No extra payment shall be allowed for jambs, junctions, corners, edges, round surfaces or plaster required due to any unevenness in the work done by the Contractor. The plaster work is to cover all conduits, pipes etc. fixed in the walls and ceiling. Wherever specified, metal lath shall be nailed firmly before plastering is commenced. The plaster surface shall be tested frequently with a 10-feet straight edge and plumb bob.

Plaster containing cracks, blisters, pits, discolouration or any defects shall not be acceptable. Any plaster giving hollow sound or loose plaster shall be removed and replaced with plaster in conformity with these specifications and as additionally directed by the Engineer. Contractor shall cut out and patch all defective work at his own cost. All damaged plaster shall be patched as directed by the Engineer. Patching plaster shall match appearance of and shall be finished level with adjoining plaster.

27.8 METAL LATH

Before plastering, wherever brick masonry meets with reinforced concrete members, 6-inch wide continuous strip of expanded metal lath shall be nailed to the masonry and the reinforced concrete member covering the point completely to prevent cracking of the joint

Metal lathing shall be fabricated from sheet steel, and shall be of uniform quality and tree from flaws broken strands, cracks and corrosive pitting, shall he rectangular and true to shape and shall comply with BS-1369.

All lathing shall be galvanized. Where plastering material depends entirely on the lathing for its key, these shall be not less than two complete mesh openings per 1.12-inch in one direction and the width of the aperture shall not be less than 0.2-inch.

Sheet shall be not less than 1.60 kg/m^2 when fabricated, using 0.7mm thick steel sheet. Where used on smooth surfaces to form a key, it shall be not less than 1.20 kg/m^2 when fabricated, using 0.5mm thick steel sheet. Typing wire shall be 1.2mm diameter galvanized annealed iron wire.

27.9 BEADS & PROFILES

Angle beads, corner beads, stop beads, architrave beads, depth gauge beads, edging profiles, plaster dividing profiles, interior angle profiles, plaster borders and the like shall all be manufactured from sheet steel and galvanized after fabrication, all beads & profiles shall be perforated at edges to ensure good adhesion of the plaster work. Thickness and dimensions shall suit particular locations and plaster work thickness.

Nails for fixing lathing shall be galvanized and have either clout heads or small flat heads to suit particular locations.

All angle beads, stop beads, architrave beads, depth gauge beads, and the like are to be fixed in accordance with the manufacturer's instructions.

27.10 CLEANING AND PROTECTION

Rubbish and debris shall be removed as necessary to make way for work of other trades and as directed by the Engineer. As each room or space is completed all rubbish, debris, scaffolding and tools should be removed to leave the room clean.

Prior to plastering, all doors/windows, finished metals etc. should be covered by sheet of plastic or tarpaulin to protect them from damage.

Protect finished, plaster from injury by any source. Contractor shall also protect walls, floors and work of other trades from plaster materials.

27.11 TOLERANCES

Surfaces of plaster work shall be finished with a true plane to correct line and level unless otherwise specified and with walls reveals plumb and square.

Maximum permitted tolerances shall not exceed 1/8-inch in 6-feet variation from plumb or level in any exposed line or surface and 1/16-inch variation between planes of abutting edges or ends.

27.12 POINTING WORK

Joints of masonry work to be pointed shall be properly raked to 1/2-inch depth, cleaned and wetted.

For struck pointing the mortar shall be filled in the joints flush with masonry with a pointing trowel and then pressed with proper pointing tools to form weathered and struck horizontal and triangular or V-notched vertical joints.

For flush pointing after pressing mortar in the joints these shall be tilled up with mortar and finished level with edges.

After pointing the face of the work shall be cleared of all surplus mortar. No washing shall be done till the pointing has set. All defects shall he treated at Contractor's expense. All work shall be kept wet for 10 days and protected from extreme temperatures and weather.

27.13 MEASUREMENT AND PAYMENT

27.13.1 Measurement

Except otherwise specified herein or elsewhere in the Contract Documents, no measurement and payment will be made for the under mentioned specified works related to the relevant items of the Bill of Quantities. The cost thereof shall be deemed to have been included in the quoted unit rate of the respective items of the Bill of Quantities.

- Metal lath over reinforced concrete and masonry joint.
- Joints, junctions, corners, drip course, edges and rounding.
- More than one layer due to any unevenness in the finished works.
- Cutting & patching of all defective works.
- Surface preparation, cleaning and protection as specified.
- Water proofing agent for water proof plaster.
- Angles beads, corner beads, stop beads, architrave beads, depth gauge edging profiles, plaster dividing profiles, interior angle profiles and plaster borders used in. plaster works as shown on Drawings.

Measurement shall be made of cement plastering for the actual area in square feet or square metre (whichever is included in Bill of Quantities) in accordance with this section of specification or as directed by the Engineer.

27.13.2 Payment

Payment shall be made for the number of square feet or square metre (whichever is included in Bill of Quantities) of surface area cement plastered at the contract unit price and shall constitute full compensation for furnishing all materials, equipment and labour including all incidentals necessary to complete the work in strict accordance with this section of specification.

SECTION-28 POLYVINYLECHLORIDE WATERSTOP

28.1 SCOPE OF WORK

The work comprises of providing all labour, tools, equipment, to install, place and fabricate in position and locations rubber water stops together with all jointing and sealing materials as per recommendations, specifications of the Manufacturer and instructions. All embodiment in concrete, lapping, turning, sealing shall ensure absolute water tightness subjected to any pressures. The workmanship and operation shall be perfect and guarantee leak proof at places wherever used in the structure.

28.2 MATERIAL REQUIREMENTS

Polyvinyl chloride water-stop shall be extruded from an elastomeric plastic compound, the basic resin of which shall be polyvinyl chloride (PVC). The compound shall contain such additional resins, plasticizers, stabilizers or other materials needed to ensure that when the material is compounded and extruded to the shapes and dimensions shown, it will have physical characteristics as included in Table 28.1.

Table 28.1, Material Requirements for PVC Water Stopper

Sr. No.	Parameter	Test Method	Criteria
1	Tensile Strength	ASTM C 638	Min. 1750 psi
2	Ultimate Elongation	ASTM C 638	Min. 350%
3	Low Temperature Brittleness	ASTM D 746	No Failure @ -37°C
4	Stiffness in Flexure	ASTM D 747	Min. 400 psi
5	Specific Gravity	ASTM D 792	Max. 1.37
6	Hardness, Shore A	ASTM D 2240	70-80

28.3 CONSTRUCTION REQUIREMENTS

Splices in the continuity or at the intersections of runs of PVC waters-stops shall be performed by heat sealing the adjacent surfaces in accordance with the manufacturer's recommendations or as directed. A thermostatically controlled electric source of heat shall be used to make all splices. The correct temperature at which splices should be made will differ with the material used but should be sufficient to melt but not char the plastic. After splicing, a remoulding iron with ribs and corrugations to match the pattern of the water-stop shall be used to reform the ribs at the splice. The continuity of the characteristic components of the cross-section of the water-stop design (ribs, tabular centre axis, protrusions, and the like) shall be maintained across the splice.

The expansion joints wherever indicated on Drawings shall have centre bulb rubber water stops or its equivalent as indicated on Drawings to be cast

integrally with the in-situ-concrete of retaining walls, beams, columns, slabs or at any locations marked on the Drawings incorporating junction places or as straight lengths with separate intersection pieces to be jointed at Site as per Manufacturer's recommendations and Specifications. The water stops shall be installed so as to hold them securely in their correct position during the placement of concrete. The concrete shall be fully and properly compacted around the water stops to ensure that no voids or porous areas remain. Where reinforcement is present adequate clearance shall be left between water stops and the reinforcement to permit proper compaction of concrete. No holes shall be made through any water stops. Hot or cold vulcanizing for jointing places of water-stops at site shall be done with the prior Approval in accordance with the Manufacturer's recommendations and specifications.

28.4 MEASUREMENT AND PAYMENT

28.4.1 Measurement

Polyvinylchloride water stop of the size and gauge as shown on the Drawings will be measured for the number of linear feet or linear metre (whichever is included in Bill of Quantities) acceptably placed in the work. In computing the quantities, no allowance will be made for laps.

28.4.2 Payment

Payment will be made in accordance with the unit prices in the Bill of Quantities for the item as measured above in accordance with the specifications and shall constitute full compensation for furnishing all materials, shuttering, equipment and labour and for performing all operation necessary to complete the work.

SECTION-29 ALUMINIUM WORKS

29.1 SCOPE OF WORK

The work under this section of specification includes furnishing all labour, equipment, appliances and materials and performing all operations in carrying out the work of anodized aluminium doors, windows (other than curtain wall type doors and windows) ventilators, louver and fly screen. All related items such as sealants, rubber gasket for glazing, netting, rollers, latches, fastenings, glazing, anchor bolts and all items supplied by other trades and customarily built in and/or installed in strict accordance with this section of the specifications and the applicable Drawings and subject to the terms and conditions of the Contract.

29.2 APPLICABLE STANDARDS

The work shall conform to requirements of latest editions of following standards, wherever applicable, unless otherwise specified.

29.2.1 ISO (International Organization for Standardization)

- ISO 1804, Doors Terminology
- ISO 6442, Door leaves, Measurement of defects of general flatness.
- ISO 6443, Door leaves, Measurement of dimensions and defects of squareness.
- ISO 6444, Door Leaves, Test of behaviour under humidity variations (successive uniform climates)
- ISO 6612, Windows & Doors, Wind resistance tests.
- ISO 6613, Windows & Doors, Air permeability test.

29.2.2 BSI (British Standard Institution)

- BS 1227, Hinges
- BS 4873, Aluminium alloy windows.

29.3 GENERAL

Aluminium doors and windows shall be of profile, pattern and design shown on Drawings and manufactured by reputable manufacturer approved by the Engineer. The contractor shall provide manufacture literature completely describing the product, instructions for installation and maintenance.

All the sections used for doors, windows, ventilators & fly screens shall be of best quality aluminium products such as equal and unequal angles, channels, tubes, corrugated strips, mouldings etc., in accordance with International standards conforming to ASTM B 308 & B 221.

All doors, windows & ventilators shall be of type and size indicated on Drawings and shall conform to the requirements shown and specified herein.

Contractor shall arrange tests and analysis if directed by the Engineer of scaled models of each window type at the maker's works or any laboratory specified by the Engineer for the material supplied by him to be tested in the presence of the Engineer's Inspector, to whom test certificates, proof sheets, etc. shall be furnished. The models shall be submitted to the Engineer for approval prior to testing. Nevertheless, neither the fact that the materials have been tested in the presence of the inspector nor that the Engineer may have been furnished with test certificates in lieu of sending an inspector to the works shall affect the liberty of the Engineer to reject, after delivery of materials found not in accordance with these specifications.

The contractor shall submit shop drawings which shall show full construction details, quantities. and locations, fastenings and attachment to adjacent construction and materials. Shop drawings shall be submitted at the proper time to allow for checking, revisions, agreement and permit manufacturer's product delivery and start of site work to suit the building programme. The Contractor shall submit representative samples of finished windows, anchoring mechanism, embedded parts, fastenings, glass panes, accessories and other materials for the Engineering approval.

After approval of shop drawings and tests etc., the contractor shall submit at his own cost one mock-up sample of each type of aluminium works complete with glazing, all components assembly method and required fittings and accessories prior to be actual fabrication of the bulk. The samples shall be returned to the contractor for incorporation in the works after installation of at least 80% of the works.

Fabricate and assemble all work in the shop of the approved manufacturer to reduce field fabrication to a minimum unless otherwise directed by the Engineer.

The glass shall conform to specification laid down under section 'Glazing' and shall be free from all blemishes, bubbles, distortions and other flaws of any kind and shall be properly cut to size as shown on Drawings, so as to fit the grooves in door and window members. All the glass shall be best quality of approved manufacture.

The structural shape of the Aluminium members shall be of uniform quality, colour and temper, clean, round, commercially straight and free from injurious defects.

All doors, windows and ventilators shall be fabricated as a complete unit, fully airtight and watertight, including rubber gasket for glazing, rollers, latch, anodized in specified colour, inclusive of glass sheet, necessary holes for fixing, door locks, door closures and window locking requirements, all as

approved by the Engineer.

Contractor shall, on request, get certificate signed by the manufacturer stating that each lot has been sampled, tested and inspected and has met the requirements in accordance with these specifications, and the same shall be furnished to the Engineer.

29.4 MATERIAL REQUIREMENTS

The frames/shutters of anodized aluminium doors, windows, ventilator and louvers shall be formed from rolled, strip or extruded aluminium and be as per Drawings. Fastenings bolts and screws shall be made from hardened aluminium.

Fasteners shall be stainless steel of a type selected to prevent galvanic action with the components fastened.

Gaskets shall be vinyl glazing channel gasket to commercial standard CS-230-60.

Hardware shall be manufacturer's standard hardware flush to match door and windows finish Joint sealant shall be approved elastomer.

The finish shall be in approved colour in accordance with the standards of Aluminium Association.

Minimum coating should not be less than 23-25 micron.

29.5 WORKMANSHIP

The Contractor shall be responsible for the protection and installation of all items furnished. All items shall be installed plumb and square and shall be solidly anchored in a good workman like manner in accordance with the manufacturer's instruction and as specified herein. The Contractor shall be responsible for the protection of installed items from damage by other trades. All items shall be left in operating, neat and clean condition, free from dirt, finger marks, etc. The Contractor shall be responsible for final cleaning before the final acceptance.

The glass panes shall firmly be secured in the rebates with the rubber gasket. Ensure that the beads and grooves are clean, dry and unobstructed at the time of glazing. The complete unit shall be airtight and watertight on completion. No doors windows ventilator louvers shall be considered complete until and unless the finger prints and other stains and marks have been removed from the surface of glass and aluminium.

29.6 PRODUCT DELIVERY AND STORAGE

Deliver doors, windows, ventilator and louvers in a manner preventing damage to units. Store materials off the ground under cover in a manner preventing deterioration or damage.

All embedded parts and anchor bolts shall be delivered to the site carefully and keeping the fabricated shape and configuration. All these parts shall be suitably marked for identification.

29.7 ERECTION

Rawl plugs and anchoring bolts shall he embedded into the concrete or block masonry for holding the doors, windows, ventilators and louvers in their correct positions.

Care shall be taken to install the doors and windows, ventilators and louvers in line and plumb & solidly anchored in a workman like manner in accordance with the Drawings. Should any scale or scratch appear on the surface of doors, windows, ventilators and louvers the contractor shall at his own expense and at the Engineer's direction have all exposed surfaces cleaned to bare bright specified

All works shall be installed in strict accordance with the manufacturer's instructions.

29.8 PROTECTION AND CLEANING

Temporary protection shall be achieved by applying water soluble protective coating capable of withstanding the action of lime mortar.

Apply coating in the manufacturer's plant to the exposed surfaces of all components.

Before application of coating, remove all fabrication compounds, moisture and dirt accumulations.

29.9 DEFECTIVE WORK

In the event of non-conformance to specifications and Drawings the aluminium work shall be rejected by the Engineer and the Contractor shall remove and replace the rejected works by new work of same specifications.

29.10 GUARANTEE

The manufacturer shall furnish his standard written guarantee against leakage of rain, excessive infiltration of dust and air and all defects in materials and workmanship covering all work under this section.

Such guarantee shall be in addition to and not in lieu of all other liabilities which manufacturers and the Contractor may have by law or by other provisions of the Contract Documents.

29.11 MEASUREMENT AND PAYMENT

29.11.1 Measurement

Measurement and payment for doors, windows, and ventilators shall be in

square feet or square metre (whichever is included in Bill of Quantities) of net openings in the walls where aluminium doors, windows and ventilators have been acceptably fixed complete including glazing, in all respects as per relevant Drawings or as directed by the Engineer.

29.11.2 Payment

Payment shall be made on the basis of measurement as measured above at the contract unit price for all supply of items and means of fixing, cutting, shaping, glazing, and all other operations required for the complete erection and commissioning to the full satisfaction of the Engineer.

SECTION-30 GLAZING

30.1 SCOPE OF WORK

The work under this section of the specifications consists of furnishing all labour, equipment, tools, appliances, scaffoldings and providing glass gaskets, sealants, compound and other materials required for performing all operations in connection with the installation and setting of all types of glass, glazing and glass blocks complete in every respect in accordance with the Drawings or as directed by the Engineer.

30.2 APPLICABLE STANDARDS

The work shall conform to requirements of latest editions of following standards, wherever applicable, unless otherwise specified:

- BS-952, Glass for glazing
- BS-5051, Security glazing Part I & II
- CP-152, Glazing

30.3 SUBMITTALS

Contractor shall submit samples for each type of glass, minimum 12-inch x 12-inch in size with protective edges. Samples of glazing sealant minimum 0.1 litre specified types shall be submitted. Samples of minimum of three glass blocks shall also be submitted.

Contractor shall submit 12-inch long sample each type of glazing gasket.

Contractor shall also submit printed materials manufacturers installation instructions for specified glazing gaskets, compounds sealants and accessories including description of required equipment and procedures and precautions to be observed.

30.4 MATERIAL REQUIREMENTS

30.4.1 General

Glass shall be free from all blemishes, bubbles, distortions and other flaws of any kind and shall be properly cut to fit the rebates so as to have a uniform clearance of 1.6 mm round the panes between the edges of glass and the rebates. All glass shall be of best quality manufacture as approved by the Engineer.

Each type of glass shall have the manufacturer's label on each pane, and the labels shall remain on the glass until final cleaning.

Spacer shims (distance pieces) shall he plasticized polyvinyl chloride (PVC). Thickness shall be equal to space shown on Drawings between glass and rebates, bead or cleat. Depth shall give not less than ¼ inch cover of glazing sealant.

30.4.2 Glass

Glass for windows and ventilators and louvers shall be of thickness and size as shown on the Drawings of approved quality.

a. Plain / Tinted Glass.

Glass for doors and windows shall be Local Float Glass where the sheet glass is to be used and for double glazing imported order made double layer vacuum glass of appropriate thickness tinted as selected and as approved by the Project Manager.

b. PSG Heat-strengthened glass or PSG Tempered glass

It is manufactured by heating up flat glass to a temperature of around 700°C and then blowing air on to its surface, quenching it down swiftly and uniformly. It can be divided into two types depending on the degree of heat treatment, heat-strengthened glass or tempered glass. PSG heat-strengthened glass in manufactured by controlling the tensile stress caused by heat treatment process with in a certain range of temperature. PSG tempered glass has an impact strength which is 5 times higher than that of the annealed flat glass of the same thickness, as well as 3 to 4 times higher resistance to weight.

30.4.3 Rubber Acrylic Glazing Sealant

Contractor shall provide material coloured to match frame in which glass is installed. Provide only compounds known to be fully compatible with surfaces which they will contact as follows:

- Two component polysulfide glazing sealant.
- One component acrylic glazing sealant.
- Acrylic-latex glazing sealant consisting of modified latex rubber and acrylic emulsion, non-hardening, non-staining and non-bleeding.
- Cleaners, Primers and sealer as recommended by the sealant manufacturer.

30.4.4 Accessories

a. Vinyl Glazing Bead

It shall be for external windows and entry doors and shall be in accordance with glass manufacturer's recommendation.

b. Glazing Sealant

It shall be tape or ribbon of polymerized butyl or mixture of butyl and polyisobutylene compounded with inert fillers and pigments, solvent based, 95 percent solids thread or fabric reinforced, paintable, non-staining.

c. Setting Blocks

It shall be chloroprene (Neoprene) 70 to 90 durometer hardness, compatible with sealant used, channel shaped and of the necessary height for proper perimeter clearance.

d. Channels. Gaskets and Spacer's

It shall be chloroprene (Neoprene), 40 to 50 durometer hardness compatible with sealant used.

30.5 DELIVERY, STORAGE AND HANDLING

Contractor shall deliver materials in manufacturers original, unopened containers clearly labelled with manufacturer's name and address, material, brand, type, class and rating as applicable. Contractor shall store the materials in original unopened containers with labels intact/protected from ground contact and from elements which may damage glass. Contractor shall handle the materials in a manner to prevent breakage of glass and damage to surfaces.

30.6 INSTALLATION OF GLAZING

Glazing shall comply with the recommendations of glass and glazing materials manufacturers.

Examine each piece of glass and discard and replace glass with edge damage or face imperfection. All glazing shall be wind tight and fully water tight on completion.

Clean glazing channels and other framing members indicated to receive glass. Remove coatings which are not firmly bonded to the substrate. Remove lacquer from metal surfaces wherever electrometric sealants are to be used. Apply primer and sealer to joint surfaces wherever recommended by the sealant manufacturer and as shown on the Drawings.

Trim and clean excess glazing materials from surrounding surfaces immediately after installation and eliminate stains and discolorations.

Cure glazing sealants and compounds in compliance with manufacturer's instructions to obtain high early bond strength internal cohesive strength and surface durability.

While glazing operation is in progress care shall be taken to avoid breakage or damage to the glass and adjoining glazing. The Contractor shall make good at his own cost, all glass broken by his workmen while cleaning or carrying out other operations. On the completion of the glazing work, all glass that has been set by the Contractor shall, if it becomes loose, within the maintenance period, be re-fixed at Contractor's expense.

No glazing shall be considered complete until and unless paint and other stains have been removed from the surface of the glass and checked by the Engineer for water tightness.

30.7 PROTECTION AND CLEANING OF GLAZING

Remove all smears, labels and excess glazing sealant, leave clean inside and outside tree from scratches. The Contractor shall be responsible for the protection of installed glass. Before final acceptance, damaged or broken glass shall be removed and replaced with new glass at no additional expense to the Employer. All glass surfaces shall be washed clean both inside and outside within two weeks prior to final acceptance by the Employer.

30.8 MEASUREMENT AND PAYMENT

30.8.1 Measurement

No separate measurement shall be made of glazing of doors/windows, ventilators.

30.8.2 Payment

No separate payment, unless otherwise included in the bill of quantities, shall be made for doors, windows, and ventilators.

SECTION-31 PAINTING

31.1 SCOPE OF WORK

The work under this section of the specifications consists of furnishing all materials, plant, labour, equipment, appliances and performing all operations in connection with surface preparation, mixing, painting concrete works, plaster works, gates, frames, walls, ceilings and all such surfaces as shown on the Drawings and/or as directed by the Engineer.

31.2 APPLICABLE STANDARDS

Latest editions of following British Standards are relevant to these specifications, wherever applicable:

- BS 245, Specification for mineral solvents (white spirits and related hydrocarbon solvents) for paints and other purposes
- BS 2521, Lead-based priming paint for woodwork
- BS 2523, Lead based priming paint for iron and steel
- BS 2569, Sprayed metal coatings
- BS 4800, Paint colours for building purposes
- CP 231, Painting of building
- CP 3012, Cleaning and preparation of metal surfaces

31.3 GENERAL

Except as otherwise specified, all painting shall be applied in conformity with BS CP 231 "Painting of Building" as applicable to the work.

The Contractor shall repair at his own expense all damaged or defective areas of shop-painted metal works and structural steelwork. Metal surfaces against which concrete to be placed will be furnished shop-painted and shall cleaned prior to being embedded in concrete.

Except as otherwise specified, all concrete and plastered surfaces are to be painted.

The Engineer will furnish a schedule of colours for each area and surface. All colours shall be mixed in accordance with the manufacturer's instructions.

Colours of priming coat and body coat where specified, shall be lighter than those of finish coat. The Engineer shall have unlimited choice of colours.

Samples of all colours, and finishes shall be prepared in advance of requirement so as not to delay work and shall be submitted to the Engineer for approval before any work is commenced. Any work done without such approval shall be redone to the Engineer's satisfaction, without additional expense to the Employer. Samples of each type of paint shall be on separate 1-ft. x 1-ft. x 1/8-inch tempered hard board panels. Manufacturer's colour

chart shall be submitted for colour specifications and selection.

31.4 MATERIAL REQUIREMENTS

All materials shall be acceptable, proven, first grade products and shall meet or exceed the minimum standards of approved manufacturers.

Colours shall be pure, non-fading pigments, mildew-proof sun-proof, finely ground in approved medium. Colours used on plaster and concrete surfaces shall be lime-proof. All materials shall be subject to the Engineer's approval.

The plastic emulsion/weather shield paint or similar as approved by the Engineer shall be used where specified on the drawing as directed by the Engineer.

The synthetic enamel paints and primers for structural steel or metal works shall be the best available for its type and shall be approved by the Engineer prior to its procurement.

All material shall be delivered to site in their original unbroken containers or packages and beef the manufacturer's name, label, brand and formula and will be mixed and applied in accordance with his directions.

31.5 DELIVERY STORAGE AND CONTAINER SIZES

Paints shall be delivered to the site in sealed containers which plainly show the type of paint, colour (formula or specifications number) batch number, quantity, and date of manufacture, name of manufacturer and instructions for use. Pigmented paints shall be supplied in containers not larger than 20 litres. All materials shall be stored under cover in a clean storage space which should be accessible at all times to the Engineer. If storage is allowed inside the building, floors shall be kept clean and free from paint spillage.

31.6 SURFACE PREPARATION

All oil, grease, dirt, dust, loose mill scale and any other foreign substance shall be removed from the surface to be painted, polished and white washed by the use of a solvent and clean wiping material. Following the solvent cleaning, the surfaces shall be cleaned by scrapping, chipping. blasting, wire brushing or other effective means as approved by the Engineer.

In the event the surfaces become otherwise contaminated in the interval between cleaning and painting, recleaning will be done by the Contractor at no additional cost.

All the surfaces to be painted shall be free from dust, dirt, fungus, lichen, algae etc. Oil paint, varnish and lime wash should always be removed by scraping and washing.

No work in this section shall be allowed until all surfaces or conditions have been inspected and approved by the Engineer.

31.7 APPLICATION

All paint and coating materials shall be in a thoroughly mixed condition at the time of application. All work shall be done in a workman like manner, leaving the finished surface free from drips, ridges, waves, laps, and brush marks. All paints shall be applied under dry and dust free condition unless approved by the Engineer. Paint shall not be applied when the temperature of the metal or of the surrounding air is below 7 degrees centigrade. Surfaces shall be free from moisture at the time of painting.

All primary paint shall be applied by brushing. The first coat of paint shall be applied immediately after cleaning. When paint is applied by spraying, suitable measures shall be taken to prevent segregation of the paint in the container during painting operation.

Effective means shall be adopted for removing all free oil and moisture from the air supply lines of the spraying equipment.

Each coat of paint shall be allowed to dry or harden thoroughly before the succeeding coat is applied. Surfaces to be painted that will be inaccessible after installation shall be completely painted prior to installation.

Only as much material should be mixed as can be used up in one hour. Over-thinning will not be permitted. After the first coat the surfaces will be soaked evenly four or five times and the second coat shall be applied after leaving for at least overnight.

Where shown on Drawings all exterior finishes shall be painted with weather resistant paint in approved colours as per manufacturer's specifications.

Plastic emulsion paint of the approved make and shade shall be applied to surfaces as shown on Drawings or as specified by the Engineer.

Polyvinyl Distemper of the approved make and shade shall be applied to surfaces as specified.

31.8 FINISHES

The finished coating film shall show uniform coverage throughout and shall be reasonably free from brush marks, runs, sags or noticeable colour variations. Edges, where coating ends, change colour or change thickness shall be clean and straight.

The completed coating shall be compared with sample areas. The completed coating shall be at least as smooth (free from orange feel effect, overspray, embedded or partially embedded particles, craters, pinholes, holes etc.) as the approved sample areas.

The thickness of the coating shall be checked by the Engineer at random locations by cutting out sections on concrete or plaster surfaces. The cut-out sections shall be patched by the contractor, using the same material and

thickness used originally. Porosities shall be marked and patched with the basic primer material or with a mixture of basic primer material and finely divided filler or with a proprietary patching compound compatible with coating. Any moisture on the surface of the coating shall be allowed to dry thoroughly before patching. In addition, all porosities and imperfections which become evident after applying subsequent coats shall be repaired. This repairing shall be done with basic coating material or with a proprietary patching compound compatible with specific coating, except for the top coat, where only basic coating material shall be used. The completed coating shall be free of porosity visible to the naked eye.

31.9 JOB CONDITIONS

Observe manufacturer's recommended minimum and maximum temperature but do not apply paint or finish to any surface unless ambient temperature is 10°C or above and less than 43°C. Non painting shall be done above 90% relative humidity.

Adequately protect all finished work.

Remove and replace all items of finish hardware, device plates, accessories, lighting fixtures or other removable items.

In no case shall any finish hardware or other finished item that is already fitted into place be painted, unless otherwise specified.

31.10 QUALITY ASSURANCE

All paint for any one surface shall be top quality, of one manufacturer of the specified. Deep tone accent colours shall be used and the unavailability of final coat colours may be the basis for rejecting materials for any one surface.

31.11 MEASUREMENT AND PAYMENT

31.11.1 Measurement

Measurement for painting shall be made in square feet or square metre (whichever is included in Bill of Quantities) of painted area acceptably completed in all respects as per Drawings and in strict accordance with this section of specification or as directed by the Engineer.

31.11.2 Payment

Payment will be made for the number of square feet or square metre (whichever is included in Bill of Quantities) of painted area measured as above at the Contract unit price and shall constitute full compensation for all work and all other incidentals to complete the work.

SECTION-32 CERAMIC TILE WORK

32.1 SCOPE OF WORK

The work covered under this section comprises of providing and laying best quality local made glazed/matt ceramic tiles of approved size and pattern wherever required or shown on the Drawings or mentioned in the Bill of Quantities.

32.2 MATERIAL REQUIREMENTS

32.2.1 General

The work shall conform to requirements of latest editions of following standards, wherever applicable, unless otherwise specified:

- BS 1281, Glazed ceramic tiles and tile fittings for internal wall
- BS CP 212, Fixing methods and workmanship.

32.2.2 Joint Filling

Joint Filler shall be white Portland cement grout which shall bond to dry tile, shall be non-shrinking, stain resistant, permanent in colour, and shall not inhabit fungus and bacterial growth. It shall be odourless and non-toxic, of smooth consistency for easy preparation and neat, rapid installation, and shall contain non-metallic material. Grout shall be water resistant and shall not wash out under water.

32.2.3 Adhesives

Adhesives for ceramic tiling as specified in the British Code of Practice CP 212 or Dry Bond Floor and wall thin set mortar as manufactured by Shabbir Tile and Ceramics Limited or equivalent approved.

32.2.4 Samples and Tests

The samples shall be furnished in sizes and colours and adequate in number for testing in an approved laboratory.

32.3 WORKING DRAWINGS

The Contractor shall prepare working Drawings on the basis of working Drawings for all the ceramic tile work to be carried out. These Drawings will show clearly the sizes, method of fixing, jointing and the anchorage to be used in the process and the Contractor shall get approval in writing well in time before the actual start of the work.

32.4 CONSTRUCTION REQUIREMENTS

32.4.1 In Cement Sand Mortar

Surfaces to receive the ceramic tiling shall be clean and free of dirt, dust, oil, grease or other objectionable matter. Setting beds and tile shall be installed

with their respective surfaces to true planes, level or pitched to off-sets as required by the Drawings, so that the surface of the completed tiling work will be at the elevations and grades shown. Re-tempering of mortar will not be permitted. Tiles shall be laid out from the centre lines of each space outward and adjustments made along walls, partitions and borders, if any, so as to symmetries the pattern with a minimum of cut tiles.

Joint between tiles shall be of uniform width and the same as the tile installed. Fractional changes in dimensions without varying the uniformity of joint widths shall be permitted. Tile shall be cut with a suitable cutting tool and rough edges shall be rubbed smooth. Cut-tile misfits shall be laid to the straight edges. Straight edges shall be accurately set to the lines established and reset at suitable intervals to keep the joints parallel over the entire area.

Over the existing bed a topping of 1-1/2" thick PCC 1:2:4 shall be laid. Scratch coats for application as foundation coats shall be not less than 5/8" thick and shall be composed by volume of 1-part Grey Portland Cement to 3 parts dry sand, mixed with the minimum amount of water necessary to produce a workable mass. Mortar for scratch coats shall be used within one hour after mixing and re-tempering will not be permitted. Scratch coats shall be applied in sufficient quantity and with sufficient pressure to cover the entire area and to form good keys, shall be deeply scoured or scratched and cross-scratched, shall be protected and kept moist during the curing period. Scratch coats shall be thoroughly damp-cured, and an interval of not less than 24 nor more than 48 hours shall be permitted between application of scratch coats and application of float coats.

Float coats shall be composed by volume of 1-part Grey Portland cement to 2 parts dry sand, mixed with a minimum amount of water necessary to produce a workable mass. Float coats shall be applied in sufficient quantity to entire area and to form a good key, shall be brought out flush with the temporary screeds or guide strips so placed as to give a true even surface at the proper distance from the finish suitable for reception of tiles.

Joints shall be straight, level perpendicular and of even width throughout. Vertical joints shall be maintained plumb for the entire height of the tile work. Each tile shall be brought to true level and plane by uniformly applied pressure under a straight edge or rubber faced block. Tiles that are out of true plane or misplaced shall be removed and reset. Damaged or defective tile shall be replaced. The tile shall be installed as follows:

- Wall tile shall be set by trowelling a skim coat of neat Portland cement on the float coat or by applying a skim coat to the back of each tile unit and immediately floating the tile into place. After tile has set remove mortar using a minimum of water. Replace damage tiles.
- After the tiles have been thoroughly set, joints shall be grouted full

with a plastic mix of neat, white cement immediately after a suitable area of tile has been set. The joints shall be struck flush and excess mortar shall be cut off and wiped from the mortar joints after grout has been cleaned from the surface shall be roughened at once and filled flush with the tile edge, before the mortar begins to harden. Tile skirting and coves shall be solidly backed with mortar.

32.4.2 In Thin Set Mortar

Tiles laid in Thin Set Mortar shall be applied as per details shown on Drawings and shall consist of a P.C.C. base of specified thickness. Tiles shall be set by trowelling a skin coat of Dry Bond Mortar on the base coat and combed with a notched edge of trowel. Back butter each tile unit to ensure 100% mortar coverage and float the tile into place, tapping the tile to ensure maximum bond strength. All other installation requirements shall be as per specifications mentioned above.

32.5 MEASUREMENT AND PAYMENT

32.5.1 Measurement

Measurement shall be made in square feet or square metre (whichever is included in Bill of Quantities) of ceramic tile work acceptably placed complete in all respects as per Drawings and in strict accordance with this section of specification or as directed by the Engineer.

32.5.2 Payment

Payment will be made for the number of square feet or square metre (whichever is included in Bill of Quantities) of ceramic tile work as above at the contract unit price and shall constitute full compensation for all work including material, labour, plant, equipment, and all other incidentals to complete the work.

SECTION-33 TERRAZZO WORK

33.1 SCOPE OF WORK

The work covered by this section of the specifications, consist of furnishing all plant, labour, equipment, appliances and materials and in performing all operations complete in strict accordance with this section of the specifications and the applicable drawings and subject to the terms and conditions of the contract. The work under the section include precast terrazzo tiles flooring and in situ terrazzo flooring, dada or skiting.

33.2 APPLICABLE STANDARDS

Unless otherwise specified, terrazzo work shall be in conformity with British standard Code of Practice C.P. 204 In Situ Flooring Part 1, 'General' and Part 3 "Terrazzo Flooring" as applicable to the work shown on the Drawings and specified in the Bill of Quantifies.

33.3 SUBMITTALS

All materials used for terrazzo work shall be submitted to the Engineer for obtained approval. Same materials should also be tested and this shall be got done by the Contractor at its own expense from a laboratory approved by the Engineer.

33.4 MATERIAL REQUIREMENTS

Cement, Sand, Aggregate and Water for Concrete shall conform to specification as included in SECTION-20 PLAIN & REINFORCED CONCRETE.

Marble Chips shall be crushed marble and shall be best quality white or coloured sound and hard local marble chips approved by the Engineer and of the as mentioned in the Bill of Quantities or as required by the Engineer.

Dividing Strips shall be glass, brass or marble strips 4-5 mm thick and 1-1/2" wide or as specified in the Bill of Quantities.

Angle Clips for precast toilet partitions shall be chromium plated steel or stainless steel clips as shown on drawings.

Bolts of precast toilet partitions shall be 5/16" inch bars bolts chrome-plated, with acorn heads, fitted to wall anchors.

Terrazzo Tiles Terrazzo tiles shall be first grade, mechanically compressed type conforming to PS-531. Tiles shall be 12"x12"x0.88" / 30.0x30.0x2.2cm with a toping of 0.4" or 10.00mm thickness composed of 1:2 cement & marble chips. The base being 1:3 cement mortar. The colour, quality and size of chips shall be as per Project Manager's approval.

The Compound used for all cleaning of terrazzo shall be an approved neutral chemical cleaner free from acid and alkali or any other material that will

affect the colour or otherwise damage the terrazzo and shall not affect the conductivity of terrazzo floors.

33.5 EXECUTION

33.5.1 In Situ Terrazzo Flooring

The floor shall consist of a wearing surface to consistency and net thickness as specified in Bill of Quantities, laid over 1:2:4 under bedding concrete of the specified thickness. The net uniform thickness specified for wearing surface shall be that obtained after grinding and polishing. The 1:2:4 concrete shall be mixed and laid in the manner specified for cement concrete floor using a minimum quantity of water.

The concrete shall be levelled with a trowel and straight edge consolidated and finished with steel trowels to an even but rough surfaces. The top layer of cement and marble chips mixed in the proportion of 1:2 (1 cement and 2 marble chips) shall be laid over it within 12 hours. The cement and marble chips must be mixed dry in such quantities that are sufficient for a unit area of one specified shade. Water shall be added to only such quantities that can be mixed thoroughly and consumed in less than 30 minutes, the quantity of water being the minimum for workability.

Mixing must to be done on water tight platform and any mix not used within 30 minutes shall be discarded and removed from the Site. A layer of cement and marble chipping mixture should be well trowelled into the surface of the base concrete before filling to the top level of the screeds. The layer should be well compacted and all voids shall be filled in. A layer of neat cement, of the specified colour shall then be well-trowelled into a plain smooth surface. Floors shall be laid in panels of sizes as shown on drawings and in Bill of Quantities or as directed by the Project Manager. Dividing strips, as specified shall be provided and fixed to exact levels making an allowance for grinding.

Three days after laying, the top layer must be evenly and smoothly machine ground with Carborundum blocks of coarse, medium and fine grades so as to ensure that all marble chipping are evenly exposed all over the surface.

If marble chips are not evenly exposed the Contractor shall pull down the sin face and relay it at his own cost. The surface after grinding shall be left undisturbed and cured for 2 to 3 weeks after which it shall be cleaned of dirt and dust gently by rubbing with pumise stone or washing soda in sufficient water. Three days after the surface has been cleaned, it shall be rubbed hard with 1:10 solution of oxalic acid using fell. The surface shall then be cleaned and washed with plenty of water. After the surface has dried a final gloss shall be given by polishing surface to the satisfaction of the Project Manager.

33.5.2 Terrazzo Dado & Skirting

marble chips and cement shall conform to specifications for floor. Mixing shall

be done in the same manner and proportion. The plastered surface over which the dado/skirting is to be applied shall be well roughened and watered, cement mortal of specified ratio shall then be plastered over this well roughened surface to indicated thickness. Before the base course had set, the layer of terrazzo mixture of the specifications for flooring shall be well trowelled into the surface of the base to a thickness which after, grinding shall result in the finished thickness as per Bill of Quantities. A layer of neat cement of the specified colour shall then he well trowelled into the surface leaving a plain smooth surface. After 24 hours the Contractor shall start finishing as for floors specified above, Terrazzo skirting shall be provided around all terrazzo floors unless otherwise shown. Skirting and dado shall be straight, level and in plumb. Intersections at floors shall be straight and flush. They shall be with 1/4 radius coved at floor unless otherwise shown.

33.5.3 Terrazzo on Stairs

The stair risers and treads shall be finished according to exact sizes including the terrazzo making allowance for grinding of terrazzo.

33.5.4 Terrazzo Finished Precast Partitions of Urinals

Partitions walls of urinals shall be precast R.C.C. slabs finished will) l/'l" thick polished terrazzo on both faces. The finished thickness of these walls shall be 3" or as shown on drawings and BOQ R.C.C. slab shall conform to the specification for "Concrete" and terrazzo as per this section. Fixing of these partitions of floor walls. etc. shall be as directed by the Project Manager and as shown on Drawings.

33.5.5 Terrazzo Tile Works

The terrazzo tiles will be laid to the required levels and grades over a bedding of cement mortar comprising of 1 part of cement and 3 parts of sand by volume. I thickness of cement sand bedding screed shall be as per Bill of Quantities.

The curing period of the bedding shall be as directed by the Project Manager. As large an area of bedding shall be spread at one time as can be covered with tiles before the mortar has set. Surplus mortar shall be removed. The thickness of bedding in any space shall not be less than 1/2" / 12.5mm.

Floor and wall surfaces to receive the tiles shall be thoroughly cleaned of all dirt, dust, oil and other objectionable matters. Tiles shall be laid out from the Centre line of each space in an outward direction and the pattern should be made symmetrical with a minimum number of cut tiles. Joints between the tiles shall be of uniform width. Tiles shall be cut with a suitable cutting tool and rough edges shall be nibbed smooth. Tiles shall be laid to the straight edges.

After seven days the terrazzo tile floors shall be machine ground to a true

even surface using various grades of abrasive stones as required and directed by the Project Manager. After the first grinding the floor shall be grouted with the same colour composition as used for its manufacture. The grout shall be of the consistency of thick cream and shall be brushed over the floor to fill in the joints and after 72 hours the grouting coat shall be removed by grinding till a smooth and even surface is obtained. Area and portion of the floor inaccessible for the grinding machine shall be ground and rubbed by hand. The final gloss shall be given by polishing the surface to the satisfaction of the Project Manager.

The tiled floor shall be kept wet for at least 72 hours and no one should be allowed to walk on the tiles during that period.

33.6 MEASUREMENTS & PAYMENTS

33.6.1 Measurement

Except otherwise specified herein or elsewhere in the Contract Documents, no measurement and payment will be made for the under mentioned specified works related to the relevant items of the Bill of Quantities. The cost thereof shall be deemed to have been included in the quoted unit rate of the respective items of the Bill of Quantities.

- Grinding, washing polishing and finishing of Terrazzo work.
- Under bedding and screening.
- Preparation of concrete surface for Terrazzo works.
- Cement concrete base.

Measurement shall be made of cement plastering for the actual area in square feet or square metre (whichever is included in Bill of Quantities) in accordance with this section of specification or as directed by the Engineer.

33.6.2 Payment

Payment shall be made for the number of square feet or square metre (whichever is included in Bill of Quantities) of acceptable measured quantify of Terrazzo Work at the contract unit price quoted in the Bill of Quantities and shall constitute full compensation for furnishing all materials, equipment and labour including all incidentals necessary to complete the work in strict accordance with this section of specification.

SECTION-34 DETAILED TECHNICAL SPECIFICATIONS (DTS) FOR ELECTRICAL WORKS AND DG SETS

34.1 SCOPE OF WORK:

1.1. The scope of services covers the design, detailed engineering, preparation of construction drawing, manufacture, acceptance testing at manufacturer's works or at any accredited agency, supply, packing, forwarding and delivery from manufacturer's works/ place of storage to erection site including transit insurance, unloading, storage at site, moving from place of storage to place of installation, assembly, erection, testing, commissioning & performance demonstration and handing over along with all necessary spares of original ratings & specifications on Design, Build & Operate basis. Inland and overseas transit insurance, transport, testing at site shall be Contractor scope. Tender Bill of Quantities (BOQ) and Drawings are for reference purpose only which is the minimum requirements for the water supply system including raw water Intake, various Headwork/ Sub-Headwork with/ without water treatment facility as applicable; Contractor to ensure that design & equipments are as per specification requirements.

1.2. The Contractor shall prepare design calculations based on parameters/ design criteria indicated in the specifications. The Contractor shall prepare detailed engineering and construction purpose drawings to make his/ her own estimate of ratings & quantities (minimum requirements as per price schedule, technical data sheets, reference drawings & other relevant details) for entire electrical systems including all items, systems such as equipments, cables/ cabling system, lighting, ventilation, earthing, lightning protection, main & auxiliary power distribution, instruments, civil works required for completion of Works.

1.3. Contractor shall take due care of the site Seismic conditions while design of all equipments/ components used in entire electrical systems covered in this specification. Contractor shall furnish list of additional design parameters considered in design to fulfill above requirement.

1.4. Design and detailed engineering of the materials procured by Contractor is included in scope.

Contractor shall submit design drawings/ calculations of each system which is included in scope to Purchaser/ Purchaser's representative for final review/ approval. All design documents/ calculations prepared by Contractor shall be as per ISO documentation i.e., with duly singed by qualified authorities and

stamped. Design documents/ calculations prepared by Sub-Contractors shall be approved by Contractor and stamped copy of approval along with no-deviation sheet from Sub-Contractor shall be submitted by the Contractor to Purchaser/ Purchaser's representative for final review/ approval.

1.5. Expert or manufacturer supervision for SUB-Contractor supplied material shall be provided by Contractor and included in offer.

1.6. Contractor shall be solely responsible for any shortages or damages in transit for his supply scope, handling and/ or in storage of any materials and erection of the equipment, supply of erection tools at site. Contractor shall ensure that it will not affect any activity or project schedule. Any demurrage, other such charges claimed by the transporters, railways etc. shall be to the account of the Contractor.

1.7. Contractor shall identify activities and mile stones of the work forecasted for next month with optimistic and pessimistic dates of work completion. Contractor shall prepare program evaluation and review techniques to identify critical path of project and activity sequences. The project schedule shall be prepared and updated fortnightly in MS Project.

1.8. Nothing in this specification shall be constructed to relieve the Contractor of his/ her responsibilities towards following best engineering practices established in the country.

1.9. Obtaining approval including load sanction/ release LESCO (Lahore Electric Supply Company), No Objection Certificates from LESCO relevant government agencies, statutory authority, as applicable is included in Contractor's scope.

1.10. All necessary legal fees required for various applications to LESCO, relevant government agencies, statutory authorities shall be paid by the Purchaser. The LESCO deposit required to be paid for load sanction/ release shall also be borne by the Purchaser.

1.11. The Contractor's scope shall include measurement of soil resistivity at site by Wenner's four electrode method as per ISO: 3043-1987 (Reaffirmed in 2006) at minimum four locations at site. The earthing shall be designed for the actual mean soil resistivity value obtained.

1.12. Even if all components of a system included in this specification are not explicitly identified and/ or listed herein, these shall be supplied under this contract to ensure completeness of the system and facilitate proper operation and easy maintenance of the plant. Any and all other works not indicated above but necessary/ required to complete the system in all aspects, are included in the

Contractor's scope.

1.13. The Contractor shall include start up spares, essential spares, recommended spares and a set of special tools necessary for operation, routine maintenance of equipment supplied for a period as specified in this contract.

1.14. Whether specifically called for or not, all accessories required for normal and satisfactory operation (as deemed by the Purchaser) of the equipment shall be considered to be a part of the Contractor's basic scope of supply and/ or work and no claims whatsoever, for extra payment on these grounds, will be accepted.

1.15. Contractor should visit site and get him/ her ascertained regarding the scope of work for the complete Electrical works before submission of quote/ offer for the pumping stations for 24 x 7 Water Supply.

1.16. Contractor's scope shall include design, engineering, manufacture, supply, testing, commissioning and handover of following electrical equipment/ systems as per tender specifications, BOQ, reference drawings and other relevant details for the following pumping stations for 24 x 7 Water Supply for WASA.

1.16.1. Tariff metering equipment as applicable (as per LESCO) & electric supply connection including necessary liaison works (Tariff metering equipment & electric supply connection shall be provided by LESCO for which necessary liaison shall be done by the Contractor).

1.16.2. 415 V Metal Enclosed Switchgears including Power & Motor Control Centre (PMCC) including Starter Panels, PDBs, Sub DBs, Lighting DBs, Receptacles for utilities. Local Start/ Stop Push Button Stations shall be provided near those motors which are not controlled from a Local Console/ Panel.

1.16.3. LV Capacitor Banks with control panel consisting of automatic power factor correction (APFC) relay to improve the plant power factor up to 0.99. APFC panels shall be provided on both bus sections of the PCC/ MCC.

1.16.4. Cabling system shall consists of various HV/ LV grade, XLPE/ PVC insulated, multi-stranded Al/ Cu, GI round wire/ flat strip armoured power, control cables, GI ladder/ perforated type Cable Trays & associated accessories including support structures.

1.16.5. Provision for continuous monitoring of electrical Power & Energy parameters like Voltage, Current, Power Factor, Frequency, Kilo Watts, Kilowatt-Hours etc.

1.16.6. Earthing for HV/ LV equipments and lightning protection system for

all buildings in the plant premises. The general design shall be on the basis of following codes and standards (their latest amendments) in line with design criteria & specification requirements.

a) ISO 3043 Code of practice for Safety Earthing

b) ISO/ IEC 62305 Code of Practice for the protection of buildings and allied structures against lightning.

c) CEA guidelines 2010Measures related to safety & electric supply.

1.16.7. Lighting system for all indoor & outdoor areas of plant(s). The lighting system will be controlled by lighting panels installed in respective plant/ station areas, which will be fed from the main lighting DB.

34.2 DC SYSTEM:

a) 24/ 30V or 110V DC in built DC power pack unit shall be provided wherever applicable.

b) 24/ 30V or 110V DC Battery & Battery Charger (with inbuilt DCDB) shall also be provided wherever applicable.

34.3 DIESEL GENERATORS WITH AMF & SYNCHRONISING PANEL.

All necessary and supplementary items & equipment required for completeness, safe & efficient operation of the system, even though these may not have been mentioned in this specification. Spares & consumables for successful commissioning, establishment of performance guarantee and five years of trouble-free & safe operation of the plant.

1.17 Submission of drawings & documentation as specified under ''General Technical & Particular Requirement'' section for Electrical equipment/ systems.

1.18. Contractor's scope shall also include all civil works required for electrical equipment/ structure such as equipment foundations, indoor & outdoor trenches, equipment support structures, two pole structures, flow meter chamber, control rooms, all excavation works including those for earthing, cabling etc, de-tanking area, soak pits, burnt oil pits, chamber etc.

1.19. It is not the intent to completely specify all details of design and construction herein.

Nevertheless, the Electrical system shall conform to high standard of engineering, design and workmanship in all respects and shall be capable of performing satisfactorily in continuous commercial operation under the specified environmental conditions.

1.20. Purchaser reserves the right to issue addendum to the technical specification to indicate modification/ changes in the requirements, if so

required at a later date.

34.4 PROJECT INFORMATION:

34.4.1 Site / Environmental Conditions

- Ambient temperature : 45°C (site specific)
- Relative Humidity : 5 - 95%
- Area Classification : Non Hazardous / Hazardous
- Seismic Data : As per ISO 1893 (latest Issue)

34.4.2 Nominal System Voltage

Incoming AC power supply voltage to the plant premises is derived based on Load Demand as per GERC norms as follows:

Contract Demand	Supply Voltage
Not exceeding 100 KVA up to 1 MVA	415V
Exceeding 1 MVA KVA & up to 4 MVA	415V and 11 KV,
Exceeding 4 MVA	11 KV & above

34.4.3 Plant Power/ Control Supply Distribution Voltage:

Plant Power Distribution Voltage:	415V, 3 Phase, 4 Wire, 50 Hz, AC
General Lighting & Space Heating:	240V, 1 Ph, 2 Wire, 50Hz, AC
Control, Protection & Emergency Lighting:	24/ 30 or 110V, 2 Wire DC (as applicable)
Voltage Transformer Secondary:	110 V, 3 Ph, 50 Hz, AC
Voltage Variation:	10%,
Frequency Variation:	5% and
Combined Voltage & Frequency Variation:	10%

34.4.4 System Earthing

132 kV, 3 Ph AC system:	Neutral Grounding Resister
11 kV, 3 Ph AC system:	Neutral Solidly Earthed
415 V, 3 ph, AC system:	Neutral Solidly Earthed
240 V, 1 ph, AC system:	Neutral Solidly Earthed

34.5 DESIGN CRITERIA FOR ELECTRICAL EQUIPMENT / SYSTEM

34.5.1 General

The design criteria, given below has to be followed by the Contractor for designing/ sizing of electrical equipments covered under Contractor's battery limits; However it is to be noted by the Contractor that, following this design criteria does not relieve the Contractor from adherence to the standards, regulatory requirements & best engineering practices.

ESTIMATION OF LOAD/ MAX DEMAND: The following considerations are to be

followed to arrive at the maximum electrical demand.

a. Load Factor

a)	Main motors	0.9
b)	Auxiliary load (valve actuators, Crane/ Hoist, etc.)	0.4
c)	Lighting load	1.0

b. Diversity Factor

a)	Main motors	1.0
b)	Auxiliary load (valve actuators, Crane/ Hoist, etc.)	1.1
c)	Lighting load	1.1

Power factor of Motors : As per the Manufacture's Data sheets

Efficiency of Motors : As per the Manufacturer's Data sheets

34.5.2 INCOMER SIZING/ SELECTION:

The capacity of the incomer(s) will be calculated based on the total simultaneous maximum demand (calculated based on the load factors and diversity given above, PF, efficiency).

Additional 20% contingency shall be considered for deriving incomer sizing.

% voltage dip at motor terminal shall not exceed 15% i.e. with the use of appropriate starter & considering largest motor starting & base load (all other loads except the highest rating motor are running); the % voltage dip during starting at motor terminal shall not exceed 15%.

a) The Voltage dip and fault level calculations needs to be calculated based on following actual data collected from nearest Substation and Grid.

   i. The fault level of HV bus from which power supply will be taken to the plant.

   ii. Impedance of HV Overhead Line Conductor/ HV Cable interconnecting the HV bus of Substation and HV switchboards of the Plant

b) For the per unit calculation purpose, minimum starting current for various types of starter applications shall be considered as following:

   i. DOL Starter – 6 times the rated current.

   ii. Star- Delta Starter – 3 times the rated current.

   iii. Auto Transformer Starter (ATS) – 3 times the rated current.

   iv. Soft Starter – 3 times the rated current.

34.5.3 SWITCHGEAR SIZING/ SELECTION:

Switchgear shall be sized/ selected considering the following:

a) Rating suitable for carrying full load current of the equipment.

b) Suitability for Short Circuit Rating for 1 sec duration.

c) Switchgear for motors shall be suitable for motor duty application.

Switchgear for all the motor feeders shall be as per Type-2 co-ordination.

Motor starter selection shall be done as follows:

a) Direct On Line (DOL) Starter – For motors rated up to 5.5 kW

b) Star- Delta Starter - For motors rated above 5.5 kW to 15 kW

c) Auto Transformer Starter (ATS) - For motors rated above 15 kW to 75 kW

d) Soft Starter – For all low/ medium voltage motors above 75 kW rating.

e) In-panel de-ration of minimum 20% or as provided in Manufacturer's catalogue, whichever is higher shall be considered.

a. Bus Bar Sizing:

a) The Contractor shall furnish calculations after award of contract, establishing the adequacy of the bus bar sizes to meet the continuous and short time current ratings as calculated.

b) The bus-bars shall be sized considering the following criteria:

i. Sleeving made of insulating material on all bus bars.

ii. Design ambient temperature 50ºC.

iii. Final temperature of the bus-bars complying with requirements of ISO 8623 & IEC 60947. Reduced temperature rise limit by 5K (for indoor panels) & 10K (for outdoor panels) to that of mentioned in ISO 8623 & IEC 60947 shall be considered to satisfy the final temperature.

iv. Bus bars being inside the panel; De- ration for enclosure and ventilation.

v. Bus bar suitability for carrying rated current continuously.

vi. Configuration of bus bars and Proximity effect

vii. Bus bars shall withstand the short time rating of the panel for 1 sec duration.

34.5.4 POWER FACTOR IMPROVEMENT:

APFC Panel shall be sized considering following design criteria:

Minimum 8 steps in an APFC relay shall be considered.

Capacitor shall be All Poly Propylene (APP), double layer type.

Fixed type capacitor bank, with manual & auto switching and components as indicated in reference electrical Single Line Diagram(s) shall be provided in each mains incomer (LV) panel for transformer no load compensation.

For each bus section of the Main LV PCC/ MCC panel, separate APFC panel-based on above design criteria to be provided. Other requirements of APFC panel & its components shall be as per requirement provided in this specification.

Total capacity & capacitor bank sizes shall be as given in Table below:

Capacity	5 kVAr	10 kVAr	15 kVAr	25 kVAr	50 kVAr	100 kVAr
* kVAr	# Nos.	# Nos.	# Nos.	# Nos.	# Nos.	# Nos.

(*) = Contractor has to calculate the capacitor rating based on the system power factor (0.85 or actual, whichever is lesser - to be corrected for 0.99. Rating of APFC panel shall be based on 50% of running load on each bus section & not on the connected load basis. Number of stages/ steps in a particular APFC panel shall be decided by the Contractor such that minimum 8 steps & maximum 16 steps shall be provided in a particular panel. CT changeover scheme when only one transformer is running to be considered.

CABLE SIZING: The Contractor shall ensure that cable and wires associated with the power distribution and control systems, plant wiring and all other installations throughout the Works are adequately rated for their use.

The following main aspects shall also be considered while deciding the final size of the cables-

a) Supply voltage and frequency

b) All cables shall be selected to carry the corresponding full load current under site conditions.

c) Route length and disposition of cables

d) Maximum allowable temperature rise under normal full load condition based on the material of cable insulation (XLPE/ PVC).

e) Maximum short circuit current duration (fault clearing time) and final temperature of cable during short circuit current flowing through the cable.

f) For Cables emerging from ACB outgoing, fault clearing time shall be considered as 0.16 second (for Tie feeders if any it shall be 0.5 second)

g) For Cables emerging from MCCB outgoing, fault clearing time shall be considered as 0.01 second

h) Cable from metering kiosk to PCC incomer, fault clearing time shall be 1sec

i) Contractor to note that, the above fault clearing times are minimum to be considered & fault clearing time shall be considered as per actual relay co-ordination study.

j) Appropriate de-rating factors as per cable manufacturer ' s catalogue and enlisted below shall be considered for sizing the cable:

   i. Ambient Air Temperature (minimum 50ºC).

   ii. Ambient ground temperature (minimum 40ºC to be considered)

   iii. Laid in Air/ ducts/ directly in ground etc.

   iv. Depth of cable burial (minimum 750 mm for LT and 900 mm 11kV HV)

   v. Thermal Resistivity of Soil (minimum 150ºC Cm/ W to be considered)

   vi. No. of cables in a group-touching each other or separated by a distance vii. No. of cable trays in tier

   viii. Any other de-ration factors as applicable & as per Manufacturer's catalog.

k) % voltage dip at motor terminal shall not exceed 15% i.e. with the use of appropriate starter & considering largest motor starting & base load (all other loads except the highest rating motor are running) The Voltage dip calculations, minimum starting current for various types of starter applications shall be considered as following:

   i. DOL Starter – 6 times the rated current.

   ii. Star- Delta Starter – 3 times the rated current.

   iii. Auto Transformer Starter (ATS) – 3 times the rated current.

   iv. Soft Starter – 3 times the rated current.

l) In running condition, cumulative voltage drop (at 100% rated load) shall not exceed 5% (measured at load end) for the LV loads.

m) LV cables shall be 1.1 kV grade, multi-stranded Copper/ Al conductor, XLPE insulated, colour coded, inner and outer extruded PVC sheathed, galvanized steel round wire/ flat strip armoured cables.

n) Cables up to & including 4.0 sq.mm shall be Cu multi-stranded conductor with galvanized steel round wire armoured & balance cables shall be Al multi-stranded conductor with galvanized steel round wire/ flat strip armoured.

o) Single core cable shall have non magnetic material armouring.

p) Control cables shall be Cu multi-stranded conductor with galvanized steel round wire/ flat strip armoured. For cables above 7 cores, minimum two spare cores shall be considered.

34.5.5 ILLUMINATION SYSTEM:

Illumination for various indoor & outdoor areas shall be conforming to the requirements mentioned below:

All lighting fixtures for indoor and outdoor shall be of LED only.

The illumination levels to be considered for the design of lighting system for various areas shall be as following. These are the illumination levels achieved at Work plane. Work plane height shall be considered as 0.76 m from FGL.

Area	Illumination Level (Lux) - Average values
Office rooms	300
Switchgear rooms	250
Control rooms	300
Chemical and general stores	150
All other indoor areas	150
Outdoor platforms and walk ways	50
Outdoor plant areas	20
Switchyard & Transformer Area - General - On Equipment	 10 30
Roads	15

Critical lighting shall be designed such that at all junctions, exit passages & strategic locations the Lux level shall be maintained above 10 Lux. Installite fixtures with built in battery backup shall be considered.

Lighting design shall be performed using DiaLux Software Version 4.5 or its latest version/ Original Equipment Manufacturer (OEM) validated software. The Validation Report along with software and data files shall be acceptable to Purchaser/ Purchaser's representative.

Various design factors shall be considered as following:

a) Maintenance Factor:

i) Outdoor area: 0.6 (0.7 for LED)

ii) Indoor areas: 0.7 (0.8 for LED)

b) Reflectance Factors:

i) Wall 30%

ii) Ceiling 10%

iv) Floor 30%

c) Uniformity (Min. / Avg.)

50% Minimum for indoor and 30% for outdoor

1.1.1 EARTHING & LIGHTNING PROTECTION SYSTEM:

The safety earthing and lightning protection system will be generally on the basis of following codes and standards (including their latest editions).

a) ISO 3043 -1987 (Reaffirmed in 2006): Code of practice for Safety Earthing.

b) IEEE 80 - 2000.

c) ISO/ IEC 62305 - 2013: Code of Practice for the protection of buildings and allied structures against lightning.

d) CEA guidelines - 2010: Measures related to safety & electric supply.

The fault levels considered shall be as follows:

System Voltage	Fault level in kA (*)
11 kV	18.4 kA for 1 sec
415 V	50 kA for 1 sec

(*) Contractor to design on the basis of actual impedance and adequacy calculations for sufficiency of earth conductor size shall be provided.

Following factors shall be considered for sizing the earthing conductor:

a) Design Ambient Temperature 50C

b) Allowable temperature rise for steel welded joints 500C

c) Fault clearing time 1 Second

d) Overall earthing resistance to be achieved as per ≤ 1 Ohm for transmission

IEEE std 80 – 2000 substation.

≤ 5 Ohm for distribution substation.

Measurement of soil resistivity shall be done using Wenner ' s four (4) electrode method as described in ISO 3043 -1987(Reaffirmed in 2006) including its latest amendment.

The soil resistivity of the plant area has not yet been measured; the same should be carried out during detailed engineering by successful Contractor.

After soil resistivity measurement; length of conductor, number of earth electrodes and no. of test pits shall be finalized based on these design criteria & the requirements specified in earthing requirements.

1.1.2 DRAWINGS / DOCUMENTS FOR REFERENCE

The electrical Single Line Diagram(s)/ PLC system architecture for water supply project including raw water intake & various headwork/ sub-headwork with/ or without water treatment facility (as applicable) form part of this specification and should be used for reference purpose only.

The equipment/ switchgear component ratings & requirements shown in the reference electrical Single Line Diagram(s) are minimum requirements & after award of contract, Contractor has to get approval for the equipment selection with the approval for sufficiency calculations.

1.1.2.1 The fault levels considered shall be as follows:

System Voltage	Fault level in kA (*)
11 kV	18.4 kA for 1 sec
415 V	50 kA for 1 sec

(*) Contractor to design on the basis of actual impedance and adequacy calculations for sufficiency of earth conductor size shall be provided.

1.1.2.2 Following factors shall be considered for sizing the earthing conductor:

a)	Design Ambient Temperature	50C
b)	Allowable temperature rise for steel welded joints	500 C
c)	Fault clearing time	1 Second
d)	Overall earthing resistance to be achieved as per IEEE std 80 – 2000	≤ 1 Ohm for transmission substation.
		≤ 5 Ohm for distribution substation.

Measurement of soil resistivity shall be done using Wenner ' s four (4) electrode method as described in ISO 3043 -1987(Reaffirmed in 2006) including its latest amendment.

The soil resistivity of the plant area has not yet been measured; the same should be carried out during detailed engineering by successful Contractor.

After soil resistivity measurement; length of conductor, number of earth electrodes and no. of test pits shall be finalized based on these design criteria & the requirements specified in earthing requirements.

34.5.6 Drawings/Document for Reference

The electrical Single Line Diagram(s)/ PLC system architecture for water supply project including raw water intake & various headwork/ sub-headwork with/ or without water treatment facility (as applicable) form part of this specification and should be used for reference purpose only.

The equipment/ switchgear component ratings & requirements shown in the reference electrical Single Line Diagram(s) are minimum requirements & after award of contract, Contractor has to get approval for the equipment

selection with the approval for sufficiency calculations.

SECTION-35 GENERAL TECHNICAL & PARTICULAR REQUIREMENTS FOR ELECTRICAL EQUIPMENT/ SYSTEMS:

35.1 415V METAL ENCLOSED SWITCH BOARDS:

35.1.1 Applicable Standards

The design, manufacture and performance of equipment shall conform to the latest standards specified below. In case of conflict between standards and this specification, this specification shall govern.

Metal enclosed switchgear- General requirements

Factory Built Assemblies of SWGR and control gear for Voltages up to and including 1000V AC & 1200VAC ISO: 3427

ISO: 8623 / BS: 5486 / IEC: 439

Air Break Switches ISO: 13947-P3 / BSEN6049 / IEC: 947-3

Miniature Circuit BreakersISO: 8828 / BSEN: 60898

Low Voltage FusesISO: 13703 / BS: 1362 / IEC: 269-1

Contactors ISO: 13947/ BSEN: 60947 4 / IEC: 947-1

Starters ISO: 13947/ BSEN60947-4/ IEC: 292-1 to 4

Control Switches & Push buttonsISO: 6857 / BSEN: 60947

Current Transformer ISO: 2705 / BS: 7626

Voltage Transformer ISO: 3156 / BS: 7625 / IEC: 44, 186

Indicating instruments ISO: 1248 / BS: 89 / IEC: 51

Marking and Identification of Conductors and Apparatus Terminals

ISO: 11353 / BS: 159

A.C. Electricity Meters ISO: 722, 8530 / BS: 5685 / IEC 145,211

Degree of Protection ISO: 13947 / IEC: 947-P1

Selection installation and maintenance of switchgear and control gear

Code of practice for phosphating iron and steel

Specification for copper rods and bars for electrical purposes

Control transformers for switchgear and control gear voltage not exceeding

1000V AC

ISO: 10118

ISO: 6005 / BS: 3189

ISO: 613

ISO: 12021

35.1.2 Constructional Features:

The switchgear shall be metal enclosed, modular type suitable for indoor/ outdoor installation, dust & burning proof, self standing floor/ plinth mounting with a height not exceeding 2300 mm and shall have following features:

a) Panels shall be complying to Form-4 as per ISO 8623: 1993, Part I/ IEC 439-1

b) Breaker up to 1250A shall be installed in two tiers and above 1250A, it shall be mounted in single tier.

c) Minimum clearance between live parts shall be phase to phase 25.4 mm & phase to neutral 20 mm at any location & shall be complying with the BIL for the panel.

d) Switchgear shall be divided into distinct vertical sections each comprising :

   i. A completely enclosed bus bar compartment running horizontally.

   ii. Enclosed vertical bus bars serving all modules in vertical section.

   iii. A separate horizontal enclosure for all auxiliary power and control buses.

   iv. Vertical cable alley of minimum 250 mm wide covering entire height e) Operating devices shall be incorporated only in the front of switchgear.

f) Each shipping section shall have metal sheets at both ends

g) Cable alley shall be provided with suitable hinged doors

h) All doors shall be with concealed type hinges and captive screws

i) Each vertical section shall be equipped with a space heater controlled by thermostat

j) Each switchgear cubicle shall be provided with interior lighting with 11W CFL luminaries inclusive of lamp with door limit - on/ off switch.

k) A power socket (240 V AC, 5/ 15 A) shall be provided in the interior of each cubicle with On-Off switch.

l) All identical equipment and corresponding parts be fully interchangeable without any modifications

m) Main and Auxiliary Buses:

   i. Switchgear bus bars shall be of uniform cross section throughout the length and made of Electric grade Aluminium (91 E- 63401)

ii. All bus bars shall be covered with heat shrinkable black PVC sleeves. Coloured polyester tapes for phase identification shall be provided at suitable locations.

iii. Bus bar shall be adequately supported to withstand stresses developed due to short circuits.

iv. Bus bar joints shall be provided with contact grease at the joints and shall be complete with tensile steel bolts, washers and nuts

v. The exposed bus live parts in the cable alley shall be totally covered against accidental contact by a shroud (and not by sleeve) to protect the workmen working on the switchgear.

vi. Vertical bus bars shall have Short Circuit rating same as main bus bar and shall be suitable for all connected load of vertical section.

vii. Neutral bus bar size shall be 50% of phase bus bar.

viii. Termination on bus bars at ACB, MCCBs shall be as per IEC60947-2. For terminations on MCCBs, where phase-phase and phase to earth clearance are not possible, Cu spreaders of suitable size shall be used along with the use of separators.

ix. Bus bar supports shall only be WASA irrespective of bus bar size. The span between the two insulators shall be adequate. Joint positions and insulators shall be properly adjusted so that they don't interfere.

x. For the Main PMCC, Contractor shall ensure that incoming feeders from transformer shall be suitably designed for terminating bus duct. Contractor shall consider the necessary arrangement (dummy panel, adapter panel, rear extension etc.) if required, for terminating the bus-duct. Phase transposition, if required, will be done in the Main PMCC.

xi. Wherever Cu bus bars are provided, it shall be tinned copper & not bare Cu.

n) All mounting accessories like base channels, cross angles if required, nuts, bolts etc. shall be supplied by the Contractor.

o) All the indoor switchgear panels shall be suitable for IP-54 degree of ingress protection for the enclosure. Outdoor panels shall be with minimum IP-55, degree of protection

p) All panels shall be made up of CRCA sheet steel of following thickness

   i. Load bearing members: 2.5 mm.

   ii. Doors and partitions: Doors - 2.0 mm, Partition - 1.5 mm.

   iii. Mounting plate: 2.0 mm.

   iv. Gland plate: 3.0 mm for both incomer and outgoing. For single core cable these plates shall be non magnetic.

q) All the panel wiring shall be done with PVC FRLS, multi-stranded copper wires

r) Feeder shall have hinged open-able (more than 105˚) type door with panel locks. All bus-bar covers and other panel covers shall be screw fixed.

s) Suitable barriers of FRP material shall be provided between two terminals connected to different voltage supplies.

t) All doors and detachable components shall be earthed with flexible green coloured (with Yellow coloured band) PVC sheathed 2.5/ 4.0 sqmm. multi-stranded Copper cable.

u) The equipment shall be given tropical and fungicidal treatment.

v) Each compartment & component shall be provided with name plates (with white letters on Black background) at front, inside & rear side.

w) Equipment nameplates shall be fixed by screws/ rivets and shall not be pasted.

x) Metallic Shrouding shall be provided for the isolation of main and vertical bus; as well as to avoid accidental contacts with live parts.

y) Drawing pocket shall be provided on the inside of incomer feeder door.

z) Provision for Top/ Bottom cable entry shall be made to suit the site condition.

aa) Lifting hooks/ eyes shall be provided in each shipping section of the equipment and shall be removable type.

bb) All the panels shall be provided with 20% extra power & control terminals.

cc) All unused contacts of the circuit breaker, protection, auxiliary, control relays shall be wired up to the terminal block.

dd) All terminals of different control voltages shall be separate from each other.

ee) Stud type terminals and ring type lugs shall be used for control cables.

ff) All the control/ power wiring shall be dressed neatly & the wire running through troughs shall be provided with covers

gg) Switchgear shall be easily extensible on both sides by the addition of vertical sections after removing the end covers. It shall be provided with a metal sill frame made of structural steel channel section properly drilled for mounting the switchgear along with necessary mounting hardware. Hardware shall be zinc plated or passivated. It shall be provided with labels on the front and rear indicating the switchgear designation.

hh) Any operating handle of switchgear shall not be more than 1800 mm and not lower than 300 mm from base of the panel.

i) For individual feeder modules arranged in multi tier formation, it is essential that the modules are integral multiples of the unit size to provide for flexibility in changes if any at site. For safety isolation of the vertical bus bars, insulating barrier with cut outs shall be provided to allow the power slab contacts to engage with vertical Bus bars. A vertical cable alley shall be sufficiently wide for motor control modules and for circuit breaker control modules.

jj) A horizontal separate enclosure for all auxiliary power and control buses, as required shall be located so as to enable easy identification, maintenance and segregation from the main power buses. Tap off connections from these buses shall be arranged separately for each vertical section.

kk) All equipment associated with a single circuit shall be housed in a separate module compartment of the vertical section.

ll) For draw out type modules, only the handles of control and selector switches, push buttons, knobs & cut outs for lamps and meters shall be arranged on the front doors of the respective compartments to permit operation without opening the door.

mm) On circuit breaker controlled circuits, protective relays shall be mounted on the front door of the compartment. All other equipment pertaining to a circuit shall be mounted on the withdrawal chassis. All cut outs shall be provided with gaskets for the purpose of dust proofing.

nn) Current transformers shall not be directly mounted on the buses. Current transformer on circuit breaker controlled circuits shall be mounted on the fixed portion of the compartment.

oo) In breaker compartments, external cable connections shall be carried out in separate cable compartments for power and control

cables.

pp) After isolation of the power and control connections of a circuit, it shall be possible to safely carry out maintenance in a compartment with the Bus bars and adjacent circuit live.

qq) The withdrawals chassis shall move on suitable guides and on suitably plated steel or stainless steel rollers or balls to facilitate easy withdrawal.

rr) Cable alleys shall be provided with suitable hinged doors. It shall be possible to safely carryout maintenance work on cable connections to any one circuit with the Bus bars and adjustment circuits live. Adequate number of slotted cable support arms shall be provided for cleating the cables.

ss) Rear of single front switchgear shall be provided with removable panels. It shall be possible for one person to remove and fix the removable panel.

tt) All doors shall be provided with concealed type hinges and captive screws.

uu) The draw out contacts shall be only between copper/copper alloy/ aluminum fuses, which are silver or tinplated. The contact design shall be such that there should be no arcing/ deformation under the associated peak short circuit current.

vv) Switchgear shall be designed in such a way that all components equipment and Bus bars operate satisfactorily without exceeding their respective maximum permissible rise in temperature under ambient temperature conditions prevailing within the switchgear cubical, with reference to ambient temperature outside the switchgear cubical.

ww) Provision of ventilating louvers shall be provided with fine-screened brass or GI meshes to prevent entry of vermin and dust.

xx) The various types of modules indicating the control requirements of each type together with the list of component equipment required for each type shall be as follows:

i. Incoming circuit - Draw Out type air circuit breaker for above 630A/ Fixed type MCCB for 630A & below

ii. Outgoing feeder - ACB/ MCCB/ MPCB

iii. Auxiliary services - Starters, capacitors, Distribution Boards and other auxiliary load

yy) Physical size of compartment for each type of control and current rating shall be so chosen that all the basic and additional equipment

can be housed in the compartment. No equipment associated with any particular circuit shall be permitted to be mounted in any other circuit module.

4.1.3. Power Distribution Board (PDB) configuration shall be two no. *A TPN MCCB I/Cs and six no.

*A TPN MCCB O/G feeders. The O/G feeders shall be supplying to Sub DBs. The configuration of Sub Distribution Board (SDB) shall be *A FP MCCB I/C and 2 nos. 63A TPN

MCB & 12 nos. 20A SP MCBs as outgoing feeders. (*A) shall be decided during detailed engineering.

4.1.4. Separate instrument's compartment for indicators of flow meter (s), energy meter, level & pressure controller (if any) shall be provided as per actual requirement of suitable size.

35.1.3 Control Voltages:

Following control voltages shall be used in LV panels

a) All ACBs tripping/ Closing shall be suitable for 110/ 240V AC (24/ 110VDC) as applicable. The trip coil and closing coils of ACBs shall operate satisfactorily under the following conditions of supply voltage:

   i. Closing coils- 85 % to 110 % of rated voltage

   ii. Trip coils- 70 % to 110 % of rated voltage.

b) Indications/ Annunciator for LV Main PCC/ MCC- 110/ 240V AC (24/ 110VDC)

c) Indications for auxiliary DBs - 240V AC

d) Space heater, 5/ 15A socket, panel illumination lamp etc- 240V AC derived from AC bus e) 240V AC, 110V AC and other voltages shall be segregated to avoid mix-up of voltages.

f) Control transformers suitably rated of voltage ratio 415/ 240/ 110 V on the Incomer/ Bus shall be provided. For the control transformers, fuses shall be provided on the 415 V side and MCBs on the 240/ 110V side. The control transformer shall be cast resin type only.

35.1.4 Painting:

a) All sheet steel work shall be paint through 7 tank electrostatic powder coating process in accordance with the required procedure and with the applicable standards. The switchgear enclosure shall be powder coated with shade as per RAL-7032.

b) The final finished thickness of paint film on sheet steel enclosure shall not be less than

80 microns. Finished painted appearance of equipment shall present an aesthetically pleasing appearance, free from dents and uneven surfaces.

35.1.5 Interchangeability:

All identical equipment and corresponding parts including chassis of draw out modules of the same size shall be fully interchangeable without having to carryout modifications. For trouble free interchangeability, the draw out arrangements shall be designed such that normal dimensional variations are taken care of by self-aligning feature of the modules.

35.1.6 Drawings & Documents:

Prior to fabrication of the switchgear, the Contractor shall submit following for Purchaser Representative's approval - the dimensional drawing and design calculations indicating bus bar size, short circuit rating of all the electrical component used, internal wiring, components mounting details etc. The Contractor shall submit manufacturers catalogues of the electrical components installed in the switchgear.

35.1.7 Inspection:

At all reasonable times during production and prior to dispatch of the switchgear to site, the Contractor shall arrange and provide all the facilities at their plant for inspection & testing of switchgear.

35.1.8 Earthing:

a) Al/ GI earth bus bars of adequate size shall be provided for the entire length of the panel.

The framework of the enclosure shall be connected to this earth bus. Provisions shall be made for connection form this earth bus to the main earthing bus bar coming from the earth pit on both side of the switchgear.

b) The earth continuity conductor of each incoming and outgoing feeder shall be connected to this earth bus bar. The armour of cables shall be properly connected with earthing clamp and the clamp shall be ultimately bonded with the earth bus bar.

35.1.9 Labels & Name Plate:

a) Engraved PVC labels shall be provided on all incoming and outgoing feeders. Single line circuit diagram showing the arrangements of circuit inside shall be pasted on inside of the panel door and covered with transparent laminated plastic sheet.

b) A nameplate with the switchgear designation in bold letters shall be fixed at top of the central panel. A separate nameplate giving feeder details shall be provided for each feeder module door.

c) Inside the feeder compartments the electrical components, equipments, accessories like switchgear shall be provided with stickers shall suitably identify control gear, lamps, relays etc.

d) Engraved nameplates shall preferably be of 3-ply (Red-White-Red or Black-White-Black) lamicoid sheet however black engraved perplex sheet nameplates shall also be acceptable. Engraving shall be done with square grove cutters.

e) Nameplate shall be fastened by counter sunk screws and not by adhesives.

35.1.10 Danger Notice Plates:

a) The danger notice plate shall be affixed in a permanent manner on operating side of the switchgear.

b) The danger notice plate shall indicate danger notice in Gujarati, Hindi and English.

c) The danger notice plate, in general shall meet to requirements of local inspecting authorities.

d) Caution name plate, "Caution Live Terminal" shall be provided at all the points where the terminals are likely to remain live and isolation is possible only at remote end i.e. incomer to the switchboard.

e) The danger notice plate shall be made from minimum 1.6 mm thick steel sheet and after due pretreatment to the plate, the same shall be painted white with vitreous enamel paint on both front and rear surface of the plate.

f) The letters, figures, the conventional skull and bones shall be positioned on the plate as per recommendations of latest edition of ISO 2551-1982.

g) The said letters, the figures and the sign skull and bonds shall be painted in signal Red color as per latest edition of ISO 5 - 1978.

h) The danger plate shall have rounded corners. Locations of fixing holes for the plate shall be decided to suit the design of the switchgear enclosure.

35.1.11 Cable Entry:

a) The panel shall have provisions of cable entry from top/ bottom. The removable cable gland plate shall be provided to make entry dust and vermin proof.

b) The panel shall have provisions for fixing the multi-core cable glands.

c) The cable glands support plates shall be 3 mm thick.

d) Cable entries to the panel shall be from the bottom unless otherwise specified. Cable gland shall be double compression screwed type and made of brass.

35.1.12 Mountings:

a) All equipments in front of panel shall be of flush mounting type.

b) All equipment shall be so mounted that the removal and replacement may be accomplished individually without interruption of services of others.

c) All equipment inside the panel shall be so located that their terminals and adjustments are readily accessible for inspection or maintenance.

d) The centerline of switches, push buttons and indicating lamps shall be matched to give a neat and uniform appearance. Likewise the top lines of all meters, relays and recorders etc. shall be matched.

It is important to note that when pumping station is idle and transformer is required to be kept energized under no load/ part (miniscule) load condition, the necessary LV fixed capacitor bank (approx. 5% of transformer rating) shall be provided in PMCC (transformer LV incomer) panel and shall be manually/ automatically switched on to maintain power factor more than 0.95 but less than 0.99 (near unity). All the components for fixed type Capacitor bank (to be mounted in Main LV PMCC) panel shall be as indicated in typical electrical Single Line Diagram attached with the specifications. This is a complete responsibility of the Contractor to maintain the power factor under idle condition of pumping station. Any power factor adjustment charges levied by power utility shall be recovered from the Contractor along with 5 % lump sum administrative charge by the Owner.

35.1.13 Air Circuit Breaker (ACB):

a) All the incomers & bus coupler ACBs shall be 4P EDO type. All other ACBs shall be TPN EDO type.

b) All the ACBs shall have Ics=Icu=Icw=100%

c) Up to and including 630 A, Fixed Type FP/ TPN MCCB shall be considered, while above 630A FP/ TPN, fully draw out type ACB shall be considered in line with the electrical Single Line Diagram requirements.

d) All ACBs shall be provided with additional 6 NO + 6 NC contacts, exclusively for Purchaser's use.

e) All the ACBs (except for APFC panel) shall be provided with microprocessor based O/L+ S/C + inbuilt E/F protections.

f) ACBs/ MCCBs for APFC panel shall be provided with thermal

magnetic based O/L+ S/C + E/F protections.

g) Each ACB shall be provided with – On, Off, Trip, Spring Charged, Trip Coil Healthy, Service & Test Position indication lamps.

h) For incomer feeders R, Y & B Phase indication lamps shall be provided.

i) All ACBs shall be Schneider make 'Masterpact NW'/ Siemens '3WL'/ L&T 'C Power' OR Equivalent from the approved make list.

j) Circuit breaker shall be horizontal withdrawal type, comprising three/ four identical poles operated through a common shaft.

k) It shall be suitable for switching duty of transformer and motors and other devices.

l) It shall be possible to push in and withdraw the breaker easily and without much effort.

Insulating plugs and sockets for power as well as for control circuits shall be of robust design and fully self-aligning. Plugs and sockets for power circuits shall be silver faced, insulated with PVC or other insulating material.

m) The breaker shall have three distinct positions namely services, test and fully withdrawn positions. In test position, it shall be possible to operate the circuit breaker without energizing the power circuits. Separate limit switches each having a minimum of four (4) contacts shall be provided for both service and test position of the circuit breaker. These contactors shall be rated for 10 Amp, 240 volts AC.

35.1.14 Operating Mechanism:

a) The EDO type ACB shall be power operated by a motor charged spring operated mechanism & MDO type shall be manual type spring operated mechanism.

b) The operating mechanism shall have anti-pumping features under every method of closing. The operating mechanism shall normally be operated by Local/ Remote electrical control, when the breaker is in service position. Shunt trip coils shall perform electrical tripping.

c) The main poles of the breaker shall operate simultaneously. Also there shall not be any objectionable rebound of the moving contact in the fixed contacts.

d) The mechanism shall be such that any failure of auxiliary spring shall not prevent tripping. When the breaker is in closed position, failure of any auxiliary spring shall not cause damage to the CB or danger the operation.

e) A mechanical indicator shall be provided on the breaker operating

mechanism to indicate open and closed position of the breaker. This shall be visible to a man standing in front of the cubical with the door closed.

f) It shall be possible to operate the breaker mechanically. This shall be possible only after opening the cubical door. Provision shall be made for local electrical control also when the breaker is in the test position by a control switch on the cubical doors.

g) All working parts of the mechanism shall be of corrosion resistance material. All split pins; bolts, nuts and other parts shall be properly pinned and locked to prevent loosening with repeated operation of the breakers.

h) Auxiliary switch containing 6 NO +6 NC potential free contacts rated for 10 Amp 240 V AC (Inductive breaking).

35.1.15 Spring Charged Mechanism:

a) Spring operated mechanism shall be complete with motor, opening spring, closing spring with limit switch for automatic charging and all necessary accessories to make the mechanism a complete operating unit.

b) The breaker operation shall be independent of the motor, which shall be used only for tensioning/ compressing of the spring.

c) The closing operation shall automatically charge the tripping spring. The closing, opening shall get charged immediately after a closing operation is performed.

d) Motor used shall be preferably universal type operated on AC supply. The Motor shall operate satisfactory at all values "between" 85% to 110% of rated voltage.

35.1.16 Mechanical/ Electrical Interlocking:

a) Mechanical interlock arrangement shall be provided between two incomer breakers.

Interlocking arrangement shall be robust, heavy-duty type and sturdy in construction.

b) Interlocking between two-incomer breakers shall be provided in such a way that in normal condition bus coupler shall be in " OFF " position so that both the transformer can be kept charged and the total load can be divided equally between two circuits.

c) During fault, maintenance or any other abnormal condition while one of the transformer is not in working mode, the bus coupler shall be in " ON "position so that total load can be supplied by the remaining transformer circuit.

d) Interlock shall be Mechanical and Electrical type. In case if one of the interlock fails the other way can be used for interlocking purpose.

35.1.17 Moulded Case Circuit Breakers (MCCB)

a) The MCCBs shall conform to IEC 947 & the latest applicable standards.

b) All MCCBs shall be of fixed type unless otherwise specified in the specifications elsewhere.

c) MCCBs shall be of four pole/ triple pole with neutral construction arranged for simultaneous four/ three-pole manual closing and opening and for automatic instantaneous tripping on short circuit.

d) All the incomer & bus coupler MCCBs for Main LT PMCC panels shall be FP type with microprocessor based O/L+S/C+inbuilt E/F release & all outgoings MCCBs shall be TPN with thermal magnetic based O/L+S/C+ E/F releases.

e) All MCCB's shall be Schneider make Compact NSX/ Siemens- Sentron 3VL OR equivalent from the approved make list.

f) For achieving the Earth Fault protection in thermal magnetic (TM) based MCCBs, external CBCT, Earth Fault relay & shunt trip provision shall be considered as part of complete TM based MCCB.

g) The ON, OFF and TRIP positions of the MCCB shall be clearly indicated by using LED indications.

h) MCCBs shall be with Ics = Icu = 100%

i) MCCB shall be capable of withstanding the thermal stresses caused by overloads and locked rotor currents of values associated with protective relay settings of the motor starting equipment and the mechanical stresses caused by the peak short circuit current of value associated with the switch gear rating.

j) All the MCCBs shall be of current limiting type and shall provide a cut off in 4-8 milli seconds for prospective currents during faults.

k) All the MCCBs shall be provided with rotary operating handle with door interlock.

l) MCCB terminals shall be shrouded and designed to receive cable lugs for cable sizes relevant to circuit ratings.

m) All MCCBs shall be provided with additional 2 NO + 2 NC contacts, exclusively for Purchaser's use.

n) All the switchgear selection for motor feeders shall be Type-2 co-ordinated.

Entire LV system shall be fuse less type & fuses shall be used only for VT/ Control

Transformer primary side. MCBs shall be provided on secondary of PT/ Control transformer

35.1.18 Miniature Circuit Breaker (MCB):

a) MCB shall be hand operated, air break, quick make, quick break type.

b) Operating mechanisms shall be mechanically trip-free from the operating knob to prevent the contacts being held closed under overload or short-circuit conditions.

c) Each pole shall be fitted with a bi-metallic element for overload protection and a magnetic element for short-circuit protection. Multiple pole MCBs shall be mechanically linked such that tripping of one pole simultaneously trips all the other poles. The magnetic element tripping current classification shall be of the type suitable for the characteristics of the connected load. Where this is not specified, it shall be Type C.

d) The short circuit rating shall be not less than that of the system to which they are connected.

35.1.19 Direct-On-Line Starters:

Direct on line motor starter shall have following components/ features:

a) Direct-on-line starters shall be suitable for Class AC-3 utilization category as per ISO:

13947 (Part 4), unless otherwise mentioned in tender.

b) DOL starter shall have MCCB/ MPCB, Overload Relay with SPP, Contactor etc.

c) Type 2 Co-ordination shall be ensured.

35.1.20 Automatic Star-Delta Starters:

Automatic star-delta motor starters shall have following components/ features:

a) Three sets of contactors one for the line, one for the star point and one for the delta, and a timer to automatically change the connections from star to delta.

b) Star Delta Starters shall consist of MCCB/ MPCB, Overload Relay with SPP, Contactors, electronic timer etc.

c) Star-delta contactors shall be electrically interlocked to permit starting of the motor in the proper sequence, namely star contactor closing, line contactor closing, timer energized after time delay, timer contact de-energizing the star contactor, and delta contactor closing.

d) Star-delta starters shall be suitable for AC-3 utilization category as per ISO: 13947 (Part unless otherwise mentioned in tender.

e) Type Coordination shall be ensured.

35.1.21 Reversing Starters:

Motor Reversing starter shall have following components/ features:

a) Forward and reverse contactors, electrically interlocked with each other.

b) Reversing starters shall be suitable for Class AC-4 duty as specified in applicable standards, unless otherwise mentioned in tender.

35.1.22 Auto Transformer Starter (ATS):

Auto Transformer starter shall have following components/features:

a) Auto transformer shall be air cooled type having three (3) tappings of 50%, 65% and 80%. The same should be wound with Copper wire. The size of the wire should be determined to suit the associated motor rating. The tapping requirement indicated is minimum required & Contractor to ensure proper tapping selection based on motor starting requirement.

b) Stamping of reputed make and winding wire with 'B' class insulation should be used.

This should also be suitable for minimum 6 starts per hour. Core shall be of CRGO material.

c) Maximum temperature rise should not be more than 115°C. Kordnoffer circuit (Closed Transition type) should be adopted in ATS panel. There shall be an acrylic/ Hylam sheet over & below the transformer. Also to absorb humming rubber sheet shall be provided below auto transformer.

d) Auto transformer shall be vacuum impregnated.

e) Testing of transformers should withstand full load starting current for six starts per hour, each kick of 15 seconds duration as per relevant ISO.

f) ATS shall be provided with thermal overheat protector in each coil of transformer from overheating. Thermal overheat protector rating shall be 900°C with 10% tolerance.

g) ATS shall consist of MCCB/ MPCB, Overload Relay, and Contactors etc.

35.1.23 Soft Starters

Fully automatic microprocessor based soft starters with built-in bypass terminals for pump control application shall be considered for the motors

above 75 kW. The features/ requirements of the starters shall be as per following but not limited to:

a) The soft starter shall be designed, built and tested according to the latest editions of applicable IEC standards/ IEC 947-4-UL, CE.

b) Input Voltage – 3Ph, 415V, ±10%

c) Input Frequency – 50 Hz, ±5%

d) Control Voltage – 100 - 240 V AC

e) Ambient Conditions:

   i. Temperature- 50 Deg C. (Operating range -5 to 70°C)

   ii. Relative Humidity of 5 to 95%

   f) Control Method - Torque Control/ Reduced Voltage/ Ramp

g) Motor Protection - Thermal overload protection

h) Starter Protection - S/C, Phase imbalance, Phase failure, Phase reversal, O/ V, U/ V, Locked rotor, excessive starts per hour for application, Phase loss input/ output, Motor output loss.

i) EMC standard – IEC 61000-4-2 level-3, IEC 61000-4-3 level-3

j) Built-in communication port for RS 485.

k) Type 2 Co-ordination shall be ensured.

l) The soft starter shall be complete with the following acceleration and deceleration settings & display requirements as a minimum-

   i. Starting Torque: Initial torque shall be adjustable from 0-100% of maximum locked rotor torque.

   ii. Ramp Time: The time between starting torque and maximum torque shall be adjustable between 1 to 60 seconds. The time between maximum torque & stop shall be adjustable between 2 to 120 seconds

   iii. The current limit feature shall have the following characteristics:

   The maximum allowed current during start shall be adjustable from 150% to 500% of soft-starter maximum current rating.

   Starting torque shall be fixed at 40% when utilizing the current limit function.

   iv. Voltage Ramp start & Full voltage DOL start shall be possible.

   v. For stop function – Linear torque control, Quadratic Torque

Control, Voltage ramp control, soft break etc. functions shall be provided.

vi. The soft-starter shall be provided with a functional ground to remove and/ or minimize electrical noise injected on the soft starter control board.

vii. Normally open output relays shall be provided for faults and status indications.

viii. Normally closed contacts for fault relays shall be provided as an option.

ix. The soft-starter shall be provided with a 2-position dip switch to select between the normal in-line connection (3-lead motor) and inside the delta (6-lead or 12-lead delta wound motors).

x. The soft-starter shall be controlled completely through solid state design algorithms. No moving electromechanical contacts shall be allowed.

xi. All adjustments shall be made from the front of the soft starter through keyboard (soft keys)

xii. The Soft starter shall have in-built/ remote display parameters. With following display

- Three Phase Currents
- Three Phase Voltages
- Shaft Power in kW / HP (selectable)
- Motor thermal capacity
- Motor Energy consumption (kWh)
- Power factor
- Run time in hours

The Soft starter shall have following fault indications

- Line failure
- Phase imbalance
- Over temperature – Motor
- Over temperature – Soft Starter
- Shorted Thyristor
- Open Thyristior
- Locked Rotor
- Motor output loss
- Overload - Shaft Torque
- Underload - Shaft Torque

- Over voltage
- Under voltage
- Excessive Starts
- Phase reversal

xiv. Shaft Power measurement without the use of external electro mechanical sensors.

xv. Shaft overload and under load protection shall be available through the controller, even in a by-pass configuration.

xvi. When fault conditions are detected, the controller shall inhibit starting or shut down SCR pulse firing.

xvii. The standard feature pump control shall be implemented to provide closed loop control of a motor to match the specific torque requirements of centrifugal pumps for both starting and stopping. This shall aid in eliminating the phenomenon commonly referred to as "water hammer".

xviii. The soft-starter shall be designed for three-phase control with two anti parallel SCRs in each phase. SCR-Diode combination shall not be acceptable.

- The PCB shall provide digital microprocessor control and supervision of all controller operation, including SCR pulse firing control.
- The PCB power supply shall be self-tuning to accept control power input from 100 to 240 or 380 to 500 V AC, 50/ 60 Hz.
- The SCR firing circuitry shall incorporate an RC snubber network to prevent false SCR firing.
- When fault conditions are detected, the controller shall inhibit starting or shut down SCR pulse firing.

xix. SCRs shall have the following minimum repetitive peak inverse voltage ratings:

- 200 to 525V: 1600 V
- 200 to 690V: 1800V

m) Soft Starter shall be ABB make PSTB 840-600-70/ Schneider make Alistart-48 or better from the approved make list.

35.1.24 Contactors:

The power contactors used in switchboard shall have following features:

a) The contactors shall confirm to ISO 13947 & the latest applicable standards

b) The power contactors shall be of, air break, single throw, triple pole, electromagnetic type.

c) The insulation class of contactor's coil should be B or higher.

d) Operating coils of all contactors shall be suitable for operation on 110/ 240 V, single phase, 50 Hz, AC supply.

e) Contactors shall be provided with at least two pairs of NO and NC auxiliary contacts.

f) Contactors shall not drop out at voltages down to 70 % of coil rated voltage.

g) All the switchgear selection for motor feeders shall be Type- 2 coordinated.

h) Motor starters shall be complete with auxiliary relays, timers and necessary indications.

35.1.25 Relays:

a) Main protective relays shall be Numerical type. They shall be suitable for semi-flush mounting with only flanges projecting on the front with connections from the rear.

b) All relays shall be enclosed in rectangular shaped, dustproof cases and shall be suitable for flush mounting.

c) All protective relays shall be in draw out cases with built in test facilities.

d) Auxiliary relays and timers shall be rated to operate satisfactorily between 70 % and 110 % of the rated voltage

e) Test block and switches shall be located just below each relay for testing unless otherwise specified. All auxiliary relay and timers shall be supplied in non-draw out cases.

f) All protective relays shall be provided with at least two pair of potential free output contacts, exclusively for Purchaser's use.

g) Relay cases shall have adequate number of terminals for making potential free connections, to the relay coils and spare contacts. Paralleling of contacts if any shall be done at the terminals on the casing of the relay.

h) Each relay shall have provision for easy isolation of trip circuit for the purpose of testing and maintenance.

i) All relays shall with stand out a test voltage of 2 KV, 50 Hz RMS voltages for one minute.

j) Auxiliary seal in units provided on the protective relay shall be shunt reinforcement type.

k) 250 kW & above rated motors shall be breaker controlled with motor protection relay Siemens '7SK 80' OR equivalent from approved make list.

35.1.26 Thermal Overload Relays

a) Starters shall be complete with a three element, positive acting, ambient temperature compensated, time lagged thermal overload relay with adjustable settings. The setting range shall be properly selected in accordance with the rating of the motor.

b) Thermal overload relays shall be hand reset type

c) 'Stop' push button of the starter and hand-reset device shall be separate from each other.

d) Overload relay hand reset push button shall be brought out on the front of the compartment door. Overload relay shall be provided with at least 1 'NO' and 1 'NC' or one changeover contact.

35.1.27 Timers

Thermal/ Electronics timer for change over in star-delta and ATS panel should be provided.

35.1.28 Switch And Contactor Ratings:

Switch and contactor rating for various motor starter modules shall be selected by the Contractor, based on the specifications. Contractor shall also select appropriate ratings & ranges for thermal overload relays. These details shall be subject to the Purchaser's approval.

35.1.29 Single Phasing Preventers:

a) Single phasing preventer relay shall be provided to protect motors against single phasing.

b) It should operate satisfactory from 320/ 480V. Timing range of delay start 0 - 45 seconds.

c) Toggle switch for Auto SPP by pass should be provided on front of unit.

d) The relay shall not operate for supply voltage unbalance of ± 5%. After sensing single phasing, the relay shall operate with a time delay of 2 to 3 secs.

e) The relay shall not operate for a 3- phase power supply failure. The relay shall be of the hand-reset type with a hand-reset push button. Resetting shall be instantaneous and independent of the adjusted time delay in the tripping of the unit. Visual indication for the operation of the relay shall be provided.

f) The relay shall be suitable for application to protect reversible and non reversible motors.

g) The relay operation shall be independent of the motor KW rating, the loading conditions prior to the occurrence of the single phasing

and RPM of the motor.

h) The relay shall be of the fail-safe type and shall operate to trip the motor when the relay internal wiring is accidentally open circuited.

35.1.30 Power & Control Wiring Connections:

a) Terminals for both incoming and outgoing cable connections shall be suitable for 1.1kV grade Al/ Cu conductor XLPE armoured cable and shall be suitable for connections of solder less sockets for the cable size.

b) Main PMCC incomer feeder shall be suitable for bus duct connections using Aluminum Bus bars

c) Both control and power wiring shall be suitable for Bus Duct/ Cable termination as per guidelines mentioned in transformer specifications.

d) Both control and power terminals shall be properly shrouded. Power terminals shall be of stud type.

e) 20% spare terminals shall be provided on each terminal block. Sufficient terminals shall be provided on each terminal block so that not more than one out going wire is connected to per terminal.

f) Suitable barriers of enclosures shall preferably separate terminals strips for power and control from each other.

g) Wiring inside the modules for power, control, protection and instruments etc shall be done with use of 1.1 kV grades, multistranded Cu, PVC FRLS wiring.

h) Power wiring inside the starter module shall be rated for full current rating of respective contactor but not less than 4.0 Sq. mm. 2.5 Sq. mm copper wire shall be used for current transformer circuits.

i) Other control wiring shall be done with 1.5 Sq. mm copper conductor wires.

j) Wires for connection to the door shall be flexible. All conductors shall be crimped with solder less sockets at the ends before connections are made to the terminals.

k) There shall be control transformer for control power supply (110/ 240V AC) and separate control bus.

l) Particular care shall be taken to ensure that the layout of wirings is neat and orderly.

Identification ferrules shall be filled to all the wirings terminations for ease of identification and to facilitate checking and testing.

m) Washers shall be used for all Copper and Aluminum connections.

n) Final wiring diagram of power and control circuit with ferrules nos. shall be submitted along with the panel as one of the documents against the contract.

35.1.31 Terminals

a) The outgoing terminals and neutral shall be brought to a cable alley suitably located and accessible from the panel front.

b) The current transformer for instruments metering shall be mounted on the disconnecting type terminal blocks. No direct connection of incoming or outgoing cables to internal components of the distribution board is permitted; only one conductor may be connected in one terminal.

35.1.32 Wire Ways:

a) The horizontal PVC wire way with screwed covers shall be provided at the top to take interconnecting control wiring between different vertical sections.

35.1.33 Indicating Instruments:

a) All analogue indicating meters shall be 144 x 144 mm size taut band with 240º Scale. All indicating meters shall be provided as per enclosed electrical Single Line Diagram.

b) Ammeters for motor feeders shall have suppressed scale up to 6 times beyond full load.

c) Dials shall be parallax free and white with black numbers and letterings & pointer shall be of knife-edge type. Such instruments shall be provided with zero adjustor accessible from the front.

d) Instruments shall have an accuracy class 1.0 or better.

e) Instrument dials shall be white with black numbers and lettering.

f) Ammeter and current coils of wattmeter's and ammeters shall continuously withstand 120 % of rated current and 10 times the rated current for 0.5 second without loss of accuracy.

g) Voltmeters and potential coils of voltmeters shall withstand 120% rated voltage continuously and twice the rated voltage for 0.5 seconds without loss of accuracy.

35.1.34 Metering Instruments:

a) Multifunction meters shall be provided for incomers, main pump motor feeders and outgoing feeders of 250A & above. Size of the MFM shall be 96 x 96 sq. mm & provided with following metering features:

i. Current, Voltage, Energy (kWh), MD (kW, kVA), PF & Hz etc.

ii. MFM shall be L&T make 'Quasar'/ Siemens OR equivalent.

iii. MFM shall be with accuracy class 1.0 or better & having RS 485 communication port.

b) Multifunction meters shall be suitable for operation from the secondary of CTs and VTs.

They shall be provided with a separate 3 phases, 4 wires type test terminal blocks for testing of meters without disturbing CT and VT secondary connections.

c) Current coils of meters shall have a continuous overload capacity of 120 % for both accuracy as well as thermal limits. Also the coil shall withstand at least 10 times rated current for 0.5 second without loss of accuracy.

35.1.35 Current Transformers:

a) Current transformers shall be of cast resin type. Insulation Class shall be Class 'E' or better.

b) Current transformer shall have a short time withstand rating equal to the short time withstand rating of the associated switchgear for one second for breaker feeders.

c) Unless otherwise specified, the minimum performance requirement of current transformers is as follows:

i. Measuring CTs -15 VA, accuracy class 1.0 or better.

ii. Protective CTs - 15 VA, accuracy class 5P20.

d) The above mentioned burdens are minimum required & it will be Contractor's responsibility to coordinate the current transformer burden with the requirements of relays, instruments and leads associated with that particular current transformer. Contractor has to provide sufficiency calculations for the same.

e) Current transformer (CT) shall have polarity markings indelibly marked on each transformer and at the lead terminations at the associated terminal block

f) CT shall be able to withstand the thermal and mechanical stresses resulting from the maximum short circuit current

g) Test links shall be provided in both secondary leads of the CTs to easily carry out current and phase angle measurement tests.

h) Identification labels giving type, ratio, output and serial numbers shall be provided.

35.1.36 Voltage Transformers:

a) Voltage transformers shall be of cast resin type. Insulation Class shall

be Class 'E' or better.

b) Unless otherwise specified, the minimum performance requirements of Voltage transformers are as follows:

   i. Measuring VTs - 50 VA per phase and accuracy class 1.0

   ii. Protective VTs - 50 VA per phase and accuracy class 3P.

   iii. Dual purpose VTs - 100 VA and dual accuracy class 1.0/ 3P for metering and protection respectively. VA is per phase.

   iv. The above mentioned burdens are minimum required & Contractor has to provide sufficiency calculations for the same.

c) All secondary windings of voltage transformers including open delta windings shall be rated for 110 V /√3, 110V/ 3 per phase.

d) Voltage transformer shall have a continuous over voltage factor of 1.2 and short time over voltage factor as follows:

   i. 1.5 for 30 seconds in case of effectively earthed system.

   ii. 1.9 for 8 hours in case of non-effectively earthed system.

e) Voltage transformers shall be complete with suitable rated primary, fuses. Primary fuses shall have a rupturing capacity equal to the rupturing capacity rating of the associated switchgear. All the secondary circuits of the VT shall be protected by MCBs.

f) It shall be possible to replace voltage transformers without having to de-energize the main bus bars.

g) The terminals of VT secondary and tertiary windings, which are required to be connected to earth, shall be earthed by an isolating link without a fuse.

h) Identification labels giving type, ratio, output and serial numbers shall be provided.

35.1.37 Push Buttons:

a) Push buttons shall have two normally open and two normally closed contacts unless otherwise specified. The contacts shall be able to make and carry 5A at 110V DC and shall be capable of breaking 1A inductive load at 110V DC. They shall be provided with inscription plates engraved with their functions.

b) Emergency stop' push buttons shall be of Mushroom type, lockable in the pushed position and shall be shrouded to prevent accidental operation. Key shall not be required for the operation of the push button.

c) The Internal wiring and terminal blocks shall meet the relevant requirements.

35.1.38 Auxiliary Transformers:

Any auxiliary voltage required for any of the component inside the switchgear shall be derived from the main supply by providing adequately rated auxiliary transformer mounted inside.

35.1.39 Indicating Lamps: Indicating lamps shall be:

a) Clustered LED type and of low watt consumption.

b) Provided with series resistors.

c) Provided with translucent lamp covers of colors 'Red', 'Green' and Amber' etc. as required.

d) Indicating lamp shall be of the double contact, bayonet cap type rated for operation at either 110 V AC or at the specified AC/ DC system voltage as applicable.

35.1.40 Control & Selector Switches: Control and selector switches shall be:

a) Rotary type with enclosed contacts.

b) Adequately rated for the purpose intended (Minimum acceptable rating is 10A continuous at 230V AC and 1A (inductive break) 220V DC.

c) Provided with escutcheon plates clearly marked to show the positions.

d) Control switches shall be spring return to normal type & provided with pistol grip type handles.

e) Selector switches shall be maintained contact stay put type. Switches in ammeter circuits shall be of break type contact. Selector switches shall be provided with oval handles.

35.1.41 Space Heaters:

a) Adequately rated anti-condensation space heaters shall be provided, one for each control panel, for each switchboard and for each marshalling kiosk.

b) Space heater shall be of the industrial strip continuous duty type, rated for operation on a 240 V, 1 phase, 50 Hz, AC system.

c) Each space heater shall be provided with a single pole MCB with overload and short circuit release, a neutral link and a control thermostat to cut off the heaters at 350 C.

d) Space heater indicated in the breaker modules represents the space heater for each vertical section of the switchboard. Where breakers are mounted in two-tier formation, then only one space

heater with associated MCB and thermostat is adequate for the vertical section

35.1.42 Cubicle Lighting/ Receptacle:

a) Each control cabinet, marshalling box, etc. shall be provided with interior lighting by means of 11 W CFL luminaries with door operated On/ Off switch.

b) A 240 V, 1 phase, AC receptacle (socket) plug point shall be provided in the interior of each panel with a MCB.

Routine and Acceptance Tests to be conducted by the manufacturer at their own risk and cost in presence of Purchaser/ Purchaser's representative during inspection & testing at manufacturer's works:

a) Following Routine tests as per ISO: 13947 and IEC: 60947 standards & other specified relevant ISO standards shall be performed by the manufacturer and witnessed by Purchaser/ Purchaser's representative on LV Switchgear panel complete with the accessories.

i. Dielectric test on main circuit.

ii. Test on auxiliary and control circuit.

iii. Measurement of insulation resistance of the main circuit.

iv. Tightness of main circuit.

v. Design and visual check.

vi. Dimensional check and BOM verification.

vii. High Voltage test on power & control circuit.

viii. Functional & mechanical operation test of all components.

ix. Measurement of thickness of sheet steel & paint.

x. Verification of wiring as per approved schematic.

b) Following Type Tests reports as per ISO: 13947 and IEC: 60947 to be submitted for the same rating & type of LV Switchgear panel conducted in past for review of Purchaser at the time of inspection & testing of equipment. Type test reports should be valid and not be older than the 5 years.

i. Dielectric test on main and auxiliary circuit.

ii. Temperature rise test.

iii. Making and Breaking test of switching elements.

iv. Degree of protection test.

v. Short circuit withstand test.

vi. Electromagnetic compatibility test.

c) Certified copies of all type and routine test certificates and Calibration Certificates of measurement instruments which are used during inspection shall be submitted for the Purchaser's review/ approval before dispatch of the switchgear.

35.1.43 Test Certificates:

a) Testing of switchgear shall be carried out at factory or at site as per standard in presence of Purchaser/ Purchaser's representative.

b) The test results shall be recorded on prescribed forms. The certificates for the test carried out at factory or at site shall be submitted in duplicate to the Purchaser/ Purchaser's Representative for approval. Components and equipment that are not fully interchangeable are liable for rejection. Contractor shall replace all such non interchangeable equipment at his cost.

35.1.44 Drawings/ Documents:

After award of contract, Contactor has to submit drawings/ documents for Purchaser's approval as mentioned below but not limited to:

a) General arrangement diagram showing dimensions of enclosure, length, widths and depth of enclosure and bill of quantity indicating the rating, make of each components and quantity.

b)

b) Complete assembly drawings of the switchboard/ distribution board/ MCC showing plan, elevation and typical sectional views and location of cable boxes and control cable terminal blocks for external wiring connections, etc.

c) Foundation plan showing the location of channel sills, foundation, anchor bolts and anchors, floor plans and openings.

d) Schematic power and control wiring diagrams with bus bar rating with material, instrument & control transformers, switchgear rating, control interlocks, relays, instruments, space heaters details etc.

35.2 LOCAL PUSH BUTTON STATIONS

35.2.1 Constructional Features

The constructional features of the local push button stations shall be as follows:

a) Metal enclosed, weatherproof, suitable for mounting on wall or steel structures. The enclosure shall be die cast aluminum or sheet metal of 2 mm thickness.

b) Dust and vermin proof.

c) Provide a degree of protection of not less than IP55.

d) Metal parts shall be given tropicalising treatment as per standards and painted with one coat of epoxy primer and two coats of light gray epoxy paint.

e) Provided with inscription plates of rear engraved Perspex with white letters on black background. The letter size shall be 6 mm.

f) Provided with two earthing terminals suitable for earthing wire /strip.

g) Provided with removable undrilled gland plate and cable glands for two nos. 5C x 2.5 mm² Copper conductor, XLPE insulated, armoured cable. The cable entry shall be from the bottom.

h) Earthing shall be provided by 8 SWG GI wire and connected to earthing system.

35.3 APFC PANEL WITH CAPACITOR BANKS

Scope of this specification covers design, manufacture, testing at manufacturer's works, supply, packing, forwarding and delivery from place of storage/ manufacturer's works to erection site including transit insurance, unloading, storage at site, assembly, erection, testing, installation, commissioning and performance demonstration of the following equipment with associated accessories.

35.3.1 Capacitor Banks:

a) The type of capacitors shall be All Polypropylene type double layer conforming to ISO 13585 - 1994 & having following specifications:

Supply	3 phase, 3 wire
Rated voltage	415 V
Rated frequency	50 Hz.
Permissible over voltage	1.1 Vn
Permissible over current:	1.5 In
Temperature category:	50° C

b) The capacitor shall be vacuum impregnated with liquid dielectric having high thermal stability.

c) The capacitors shall have Low Dielectric Loss of 0.5 W / kVAr. d) Each capacitor bank shall be provided with the 7% detuned filter.

e) * kVAr is net reactive compensation required to maintain 0.99 PF at 415 V Bus, i.e. excluding compensation required for detuned filters.

f) Bushing should have high mechanical strength & method of fixing should be proper so that no leakage occurs.

g) Auto/ Manual switch shall be provided in the APFC panel. For manual switching, every capacitor bank feeder shall be provided with ON & OFF push buttons along with the ON & OFF indications.

h) Minimum current rating under site conditions, of circuit breakers, contactors and cables shall be at least 150% of rated capacitor current, to take care of harmonics.

i) Contactor for switching of capacitor banks shall have AC-6b utilization category according to IEC 60947-4-1 & sized accordingly.

j) All the components shall be suitable for capacitor duty application.

k) The capacitor banks shall be complete with all parts that are necessary or essential for efficient operation. Such parts shall be deemed to be within the scope of supply whether specifically mentioned or not. Capacitor shall be designed to improve the power factor to 0.99 lagging

l) It shall be complete with the required capacitors along with the supporting post insulators, steel rack assembly, Al/ Cu bus bars, Al/ Cu connecting strips, foundation channels, fuses, fuse clips, etc. The steel rack assembly shall be hot dip galvanized.

f) Capacitor switching and automatic power factor correction panel shall be designed in such a way that power factor of 0.99 lagging shall always be maintained. Timings to cut in capacitors shall be provided in such a manner to facilitate capacitor discharging before next switching and shall also avoid hunting due to temporary fluctuations of load. The timer shall be provided in both auto and manual mode.

g) The Automatic power factor correction panel and capacitor panel are integral type, prewired including power connections. Due consideration shall be given for adding/removal of capacitor or other components and maintenance considerations. Contractor shall submit General Arrangement drawings of capacitor and capacitor control panel, with description of power factor control panel with its components.

h) For control circuit 415/ 240/ 110V AC control transformer shall be considered. VA burden to be decided by the Contractor.

i) Minimum clearance between live parts shall be phase to phase 25.4 mm & phase to neutral 20 mm.

j) Bus bars shall be sleeved with coloured heat shrinkable sleeves. All

the Bus bar supports shall be WASA type only.

k) Degree of protection shall be IP-42 for the enclosure, epoxy painted, powder coated with colour shade RAL-7032 for exterior & interior with minimum thickness 80 micron.

l) All necessary auxiliary contactors are included in scope.

m) Contractor shall note that verification of double layer construction shall be done on any one of the capacitor bank during inspection by opening the capacitor bank at no extra cost.

n) The cubicle shall be fabricated out of 2.0 mm thick cold rolled sheet steel & shall comprise of :

i. Isolating ACB/ MCCB

ii. Contactors with overload element

iii. Sequencing devices, timers and auxiliary relays for automatic sequential switching of capacitor units in and out of circuit.

iv. Auto-manual selector switch

v. Microprocessor based Automatic Power Factor Correction (APFC) Relay minimum 10 stage relays.

vi. Push button for opening and closing the power circuit

vii. Red and Green lamps for capacitors ON/ OFF indication

viii. Protective relays to protect the healthy capacitor units when one unit fails in a series connection

ix. Space heater and cubicle lighting & receptacles.

35.3.2 Principle of Operation:

On deviations from set power factor, the power factor controller shall release command signals to switch on/ switch off capacitor bank stages and maintain the set power factor.

35.3.3 APFC Relay:

APFC relay shall have following standard features:

a) The Automatic Power Factor Correction relay shall be of microprocessor based type and shall automatically switch ON/ OFF the capacitor banks to attain the value of "pf" close to the set value.

b) Switching shall follow first in first out (FIFO) method to ensure uniform use of all capacitor banks. At least eight steps shall be provided for switching.

c) To measure/ monitor power factor and VAR continuously. Status of

switching step shall be displayed through LED.

d) Following adjustment shall be available in APFC Relay.

i. Power factor

ii. Dead band capacitive region with respect to set power factor (PF).

iii. Inductive region with respect to set PF

iv. Operating time for programmable switching steps.

v. Auto/ manual selector switch.

vi. Manual step control.

e) All control knobs, LEDs for display and selector switches shall be mounted on the front face of relay casing/ panel.

f) It should be fully programmable. There should be a choice for customer to select operating sequence up to 4 to 5 which will have maximum number of steps of capacitors equal to fourteen (14). The sequence shall be arithmetic 1, 2, 3…..13, 14.

g) Operating time selection of time interval designation between switching stages shall be possible using time selector switches. The device shall take care that any stage which has just been switched out will only be reconnected by the pulse counter, after 60 sec. has elapsed so that it has safely discharged. This is a requirement for 415 V capacitors

h) Loss of voltage element- This would prevent abnormal switching surges on loss of supply. Also it would control the switching On/ Off surges.

i) Dead band features- Relay response sensitivity adjustable using dead band so that hunting is prevented.

j) Auto/ Manual control- This would help testing and commissioning at site as well as ease in operation when either mode fails during service time.

35.3.4 Performance Tests:

a) Contractor shall carry out all routine tests as specified in relevant ISO/ IEC standards on all major components and furnish copies of test reports for Purchaser's approval.

Wherever required, Contractor shall conduct the necessary type tests in the presence of Purchaser/ Purchaser's representative.

b) Contractor shall also carry out all routine and functional tests as specified in the relevant ISO on the assembled switchgear panels

in the presence of the Purchaser's representative at works before dispatch and furnish copies of test reports for approval. If required stage inspection will be carried out by the Purchaser.

c) During inspection, Contractor shall furnish copies of routine test report for all bought out items for Purchaser's approval.

d) Primary Injection Test for various currents & time settings shall be provided in routine test.

e) All the components shall be tested for their entire operating range & certification for the same shall be provided at the time of inspection.

35.3.5 Maintenance Requirements:

a) As far as possible the switchgear shall be so designed that no special tools are necessary for installation and maintenance. However, if special tools are required, the Contractor shall supply one complete set of such tools along-with the equipment.

b) Contractor shall furnish detailed inter panel wiring diagrams, internal wiring diagrams, detailed component layout drawings to carry out maintenance work.

35.3.6 Drawings/ Documents Required:

a) Dimensioned general arrangement drawings of capacitor and capacitor control panel.

b) Justification for number of steps for switching.

c) Fully dimensioned general arrangement drawings of capacitor and capacitor control panel with elevation side view, sectional view and foundation details.

d) Complete schematic and wiring diagrams for capacitor control panel.

35.4 CABLES & CABLING SYSTEM

The scope shall be inclusive of supply, installation, testing & commissioning of power, control cables, cable terminations, cable accessories, stripping of cable insulation, supplying and fixing of Aluminium lugs for aluminium cables & tinned plated copper lugs for copper cables and crimping the same to the conductor, supply and fixing of double compression cable glands including all labour supply and consumable material required for jointing/ termination. The rate shall also include the laying of cable in ground/ in cable trays / cleating to structure etc.

35.5 APPLICABLE STANDARDS:

The cables shall confirm to the latest applicable standards specified below.

In case of conflict between standards and this specification, this specification shall govern.

PVC insulated cables (for voltage up to 1100 V)	ISO/BS: 694
HRPVC & PVC insulated cables heavy duty	ISO/BS: 1554
Cross linked polyethylene insulated PVC sheathed cables	ISO/BS: 7098
Low frequency cables and wires with PVC insulation and sheath	IEC: 189-1 & IEC-189-2
PVC insulation and sheath of electric cables	ISO/BS: 5831
Polyethylene insulation and sheath for electric cables	ISO/BS: 6474
Conductors for insulated electric cables	ISO/BS: 8130
Methods of test for cables	ISO/BS: 10810
Specification for drums of electric cables	ISO/BS: 10418
Specification for PVC insulated cables for electricity supply	BS: 6346
Specification for PVC insulation and sheath of electric cables	BS: 6746

35.5.1 Constructional Features

a) HV power cables shall conform to 11kV Earthed grade (E), three core, stranded, Aluminium conductor, screened by extruded semi-conducting compound, cross-linked poly ethylene (XLPE) insulated, cores screened with non-magnetic metallic tape laid up with inner and outer extruded PVC sheath compound Type-ST2 and galvanized steel strip armouring. The cables shall generally conform to ISO/BS 7098-1985 with relevant parts thereof.

b) Armouring shall confirm to latest version of ISO/BS: 3975.

c) LV Power cables shall be 1.1kV grade, 4/ 3.5/ 3 Core, multi-stranded, Al/ Cu conductor, XLPE insulated, extruded inner & outer PVC sheath compound type ST2 and galvanized wire (up to 6 sq mm)/ steel strip (>6 sq mm) armoured cables. All single phase, Lighting cables, UPS cables shall have 100% Neutral.

d) All the control cables shall be 1.1kV grade, no. of cores (as per requirement/ application with minimum 2 spare cores for 7C & above) multi-stranded, Copper conductor, XLPE insulated, extruded inner PVC & outer PVC FRLS sheath compound type ST2 and galvanized steel round wire armoured.

e) All control cables shall be with following specific requirements:

   i. Copper conductor stranded class 2.

   ii. XLPE Insulated

   iii. Provided with inner extruded PVC and outer PVC FRLS sheath of extruded black PVC compound.

   iv. Galvanized steel armouring in the form of GI round wire.

v. Core identification shall be by printed numerals.

vi. The insulation over the individual conductor core will be colour coded.

vii. Minimum 2 spare cores for above 7C.

f) The DC power supply cable shall be two core, multistranded copper conductor, armoured cables with inner extruded PVC & outer PVC FRLS sheath. All control wiring shall be PVC FRLS insulated.

g) All the power, control cables used in the Hazardous area shall be flame proof type suitable for the intended application.

h) Earthing Cable shall be Single core multi-stranded Cu, 1.1 kV grade, XLPE insulated, un-armoured green coloured outer sheath with yellow strips/ band cable to be laid in trays, underground, trenches etc. as applicable.

i) Submersible Cables: Multi core flexible Cu conductor XLPE insulated & PVC sheathed heavy duty cable suitable for submersible application (in case of submerged pumps) shall be manufactured as per governing standards. High purity electrolytic grade, annealed Cu conductor shall be used. Cables shall be extruded inner & outer PVC sheathed. PVC compound shall be dielectric grade & shall be impervious to water, oils & grease etc. Similarly double PVC sheathing shall also be done as per ISO/BS: 5831/ 1984. Flexible inner sheath & high abrasion resistant flexible outer sheath is required for these cables. Double PVC sheathing shall be done so as to withstand abrasion & prevent ingress of water along the interstices of the cable. Core identification shall be by printed numerals. Conductors shall be as per ISO/BS 8130. Cable shall be constructed as per relevant ISO/BS/ IEC standards.

35.5.2 Cable Colours:

a) All cable cores shall be colour coded throughout their length and shall be so connected between switchboard, distribution board, plant and accessories, that the correct sequence or phase colours are preserved throughout the system.

b) The colour coding should be as follows:

i. 3 phase Red, Yellow and Blue

ii. single phase or dc supply Red and Black

iii. earth Green/Green with Yellow coloured band

iv. control Gray (DC)

35.5.3 Cable Conductors;

a) Cables up to 4.0 sq.mm shall be Cu multi-stranded conductor with galvanized steel round wire armoured & balance cables shall

be Al multistranded conductor with galvanized steel round wire/ flat strip armoured.

b) Single core cable shall have non magnetic material armouring.

c) Lighting final distribution circuits shall be of a minimum cross-section of 1.5 mm2.

d) Small control cables shall be of a minimum cross-section of 1.5 mm2.

e) Internal wiring of control panels shall be of a minimum cross-section of 1.5 mm2 flexible and multistranded.

f) Control cabling shall be of a minimum cross-section 1.5 mm2 for external use and 1.0 mm2 for internal use.

g) Cable Sizing shall be done as per design criteria specified in specifications.

35.5.4 Cable Numbering

All cables shall be allocated a unique number which shall be fixed to each end of the cable using a corrosion resistant label. Necessary loop at both ends shall be provided for future use and cables of different categories shall be tagged with the following subscripts and three digit number.

HV power	HV-P_ _ _
LV power	P_ _ _
Control	C_ _ _
Instrumentation	I_ _ _
Protection	PR_ _ _
Telecommunication	T_ _ _

35.5.5 Cable Terminations

a) Cable Lugs

i. Cable lugs shall be of tinned copper, solder less crimping type for Cu cables & AL lugs for the AL cables.

ii. The current rating of the lugs shall be same as that of the respective cable conductors.

iii. Bi-metal strip/ Bi-metallic lug shall be used whenever two different metals are to be connected together.

iv. Double holes extended neck (long barrel neck) type lugs shall be used in case of cables above 185 sq. mm.

v. Anticorrosion/ anti-oxidation compounds shall be used for crimping lugs. This shall especially be ensured for Al cable terminations & bimetallic terminations shall be used wherever required.

vi. If termination is done with crimping tool employing crimping die then forming dies shall be used to make the sector shaped conductor into a round conductor before crimping the lugs on the conductor. The lug must not be crimped directly on the sector conductor. Before crimping the lug, the conductor shall be thoroughly cleaned and special jelly applied over it to prevent further oxidation.

b) Cable Glands

i. Glands shall generally be of the double compression hexagonal type brass glands. Earth continuity of brass glands shall be assured.

ii. Double compression type cable glands shall be used. Cable glands shall be brass casting, machine finished and Nickel-plated to avoid corrosion and oxidation. Rubber components used in cable gland shall be of neoprene.

iii. For single core cables, gland shall be with brass ring.

iv. Glands for single core cables shall be constructed from non-magnetic materials.

v. Cable glands shall be with metric threads.

vi. Where holes for cable entries are not provided it shall be the responsibility of the Contractor to mark out and drill such holes. Burrs and swarf shall be removed, care being taken to ensure that swarf and filings, etc do not enter the equipment.

vii. For non-hazardous areas cable glands in situations where moisture may be present shall be double seal weatherproof type, gland shrouds shall be used and entry shall be sealed.

viii. For dry indoor situations, standard industrial glands with shrouds are acceptable.

ix. For hazardous areas, glands conforming to IEEE standard shall be used with double seal and shroud.

c) Trefoil Clamps for Single Core Cables:

i. All the single core cables shall be laid in trefoil formation only.

ii. The grouping & sequencing of three single core cables arranged in trefoil formation shall be done in such a way to ensure balanced current distribution.

iii. Trefoil clamp of suitable size & having non magnetic material shall be used.

iv. The Trefoil groups shall be held in trefoil clamps at an interval not exceeding 3.0 meters.

v. In addition to trefoil clamps as mentioned above, the trefoil groups of cables shall be additionally tied by means of 3.0 mm dia. nylon cord clamp at an interval not exceeding 750 mm.

d) Wherever applicable, supply & installation provision of bimetallic strip for connection between Al to Cu strip & GI to Cu strip shall be provided.

35.5.6 Cable Drums:

a) Cables shall be supplied in non-returnable wooden drums. The wood used for construction of the drum shall be properly seasoned and free from defects and wood preservative shall be applied to the entire drum. All ferrous parts shall be treated with a suitable rust preventive coating to avoid rusting during transit or storage.

b) Before winding the cables on drums, Contractor shall obtain Purchaser's approval for the drum lengths. Cable ends shall be sealed by non-hygroscopic sealing caps.

c) Contractor has to ensure reference of an arrow and suitable accompanying wording which shall be stenciled on the sides of the drums indicating which way it should be rolled. The number on each drum shall be either branded at the end of the drum or stamped on the metal attached to an end of the drum. The cable shall be placed on the drum in such a manner that it will be protected from injury during transit. Each end of the cable shall be firmly and properly secured to the drum. The drum shall be securely blocked in position so that the cable will not be displaced during transit. Cable ends shall be sealed by non-hygroscopic sealing caps.

d) It shall be the Contractor's responsibility to prepare the drum cutting schedule so that cable wastage is minimum while cutting.

e) Contractor shall obtain Purchaser's approval for the drum lengths.

f) The following information shall be given on the drums as a minimum:

i. Drum identification number

ii. Voltage grade

iii. Type of cable.

iv. Number of cores and cross-sectional area

v. Cable quantity

vi. Purchaser's order number and item number

vii. Total weight of cable and drum

35.5.7 Tests Before and After Laying of Cables at Site

Following Routine & acceptance tests on each drums as per ISO/BS 10810, ISO/BS 7098 standard & other specified relevant standards shall be performed by the manufacturer and witnessed by Purchaser/ Purchaser's Representative.

a) For 1.1 kV Power & Control cables:

i. Dimensional & visual check

ii. Conductor resistance test

iii. Insulation Resistance Test

iv. High voltage test

b) For 11 kV power cables:

i. Design and visual check

ii. Conductor resistance test

iii. Very low frequency AC HV test (instead of DC test)

iv. Insulation resistance including P.I. at rated voltage

v. Capacitance and tan delta

vi. AC leakage current

vii. Partial discharge measurement

c) All HV cables shall be subjected to DC or AC (preferably DC) high voltage test after terminating but before commissioning as per Table 6.0 in ISO/BS: 1255 (Code of practice for Installation & Maintenance of Power Cables up to and including 33kV).

d) Cables shall be checked for insulation resistance before and after jointing. The voltage rating of the Megger for cables of different voltage grades shall be as indicated below.

Voltage Grade	Megger rating
1.1kV	500V
11kV	1000V

e) Following tests in the presence of Purchaser/ Purchaser's representative shall be carried out at site before commissioning of cables.

i. Insulation Resistance test between phases and phase to Neutral and phase to earth.

ii. Continuity test of all the phases, neutral and earth continuity conductor.

iii. Sheathing continuity test.

iv. Earth resistance test of all the phases and neutral.

f) Cable Gland:

i. Cable glands required for glanding all cables at both ends shall be supplied by Contractor.

ii. A minimum of 20% of cable glands shall be supplied as spare.

iii. Cable glands shall be of SS 316 and double compression type suitable for armoured cables.

iv. All cable glands shall be weatherproof to IP-66. Flameproof glands wherever required shall be supplied with Ex (d) certification suitable for Gas Groups IIA / IIB / IIC.

v. All cable glands shall be with LSF shrouds.

vi. For all field items and junction box end, NPT threaded cable glands shall be used and for control room / control panel end, cable glands shall be ET threaded types.

g) Junction Boxes:

i. In order to make the most economic use of cable tray and trench capacity, multicore / multipair cabling shall be utilised in order to connect instrumentation groups by using suitably located junction boxes.

ii. The junction boxes shall have weather protection suitable for the area in which they are to be installed and for the type of circuit.

iii. They shall be readily accessible for maintenance and clearly labeled.

iv. Junction box shall be constructed of die cast aluminium and provide degree of protection IP 65.

v. Wires and terminals for the digital and analog signals shall be segregated within junction boxes.

35.5.8 Drawings/ Documents Required

a) As a part of the Bid, Contractor shall furnish the following :

i. General information

ii. Principal technical data

b) After award of contract it shall be the responsibility of Contractor to work out a detailed layout for the complete plant cabling system. The layout drawing shall be furnished for the approval of Purchase/ Purchaser's representative before commencement of installation including cable trays, cable racks/ trenches, accessories, tray supports, conduits etc.

c) Contractor to submit following drawings/ details after award of contract

i. Cable Sizing calculations

ii. Details of Installation of cables in trenches, on cable trays, directly buried etc at all locations inside the plant.

iii. Cable routing lay out inside and outside the plant with route marker provided at 30 meter interval.

iv. Bill of quantities of cables, lugs and glands.

v. HV Cable termination and mounting Kit Layout drawing.

d) Following Type Tests reports as per relevant standard to be submitted for the same rating & type of Cables conducted in past for review of Purchaser/ Purchaser's Representative by the Contractor at the time of inspection & testing of equipment. Type test reports should be valid and not be older than the 5 years.

i. Annealing test

ii. Tensile test

iii. Wrapping test

iv. Test for thickness of insulation & sheath

v. Physical test for insulation & sheath

vi. Tensile strength and elongation at break of insulation and sheath

vii. Loss of mass test

viii. Ageing in air oven

ix. Shrinkage test

x. Heat shock test

xi. Insulation resistance test

xii. High voltage test

xiii. Flammability test

35.5.9 Cable Tray & Accessories:

a) Cable trays shall be of Galvanised Steel/ Fiber Reinforced Plastic and of ladder/ perforated/ solid type, complete with all necessary coupler plates, elbows, tees, bends, reducers, stiffeners and other accessories and hardware as detailed in the relevant drawings. All hardware (i.e. bolts, nuts, screws, washers, etc) shall be hot dip galvanized.

b) Cable trays of ladder and perforated types and the associated accessories such as coupler plates, tees, elbows etc., shall be fabricated from 14 gauge (2.0 mm thick) mild steel sheets. Cable tray covers shall be fabricated from 16 gauge perforated (1.60 mm thick) M.S. sheets.

c) The cable trays shall be supplied in standard lengths of 2500 mm and clear inside widths of trays shall be as follows:

   i. Perforated type trays: 150, 300, 450 and 600 mm.

   ii. Ladder type trays: 300, 450, 600 and 750 mm

d) Cable trays, accessories and covers shall be painted with one shop coat of red oxide zinc chromate primer and two site coats of aluminium alkyd paint for indoor use.

e) For outdoor use, cable trays, accessories and covers shall be either galvanized or made of aluminium as specifically mentioned in the layout drawings.

f) For use in corrosive atmospheres both indoors and outdoors, the cable trays, accessories and covers shall be as per serial no. (e) above.

g) The spacing of rungs for ladder type of trays shall be 250 mm unless otherwise noted.

h) All finished cable trays and accessories shall be free from sharp edges, corners, burrs and unevenness.

35.6 EARTHING & LIGHTNING PROTECTION SYSTEM

35.6.1 Scope

a) The scope includes collection of data, design of the system as per relevant National/International Standards preparation of layout drawing supply of earthing conductors, earth electrode, earthing strips installation and approval to the satisfaction of electrical inspector under this tender specification.

b) Earthing system shall be provided to ensure equipment safety, personnel safety and facilitate designed operation of protective switching during earth fault conditions in the associated system.

35.6.2 Applicable Standards

The earthing and lightning protection system shall conform to the CEA guidelines and the latest applicable standards indicated below:

a) Code of Practice for Earthing : ISO/BS: 3043

b) Code of Practice for the Protection of : ISO/BS: 2309

c) Building and allied structure against

35.6.3 Earthing & Lightning system:

a) The design basis for designing earthing conductor is indicated under design criteria for electrical system. Earthing system shall be provided for complete plant i.e. pumping stations, switchyard and all electrical equipments as per the latest edition including all official amendments and revisions of ISO/BS-3043 and CEA guidelines.

b) All materials and fittings used in the earthing installation shall conform to the relevant Pakistan Standards or shall be approved by the Engineer's representative.

c) Contractor has to carry out soil resistivity test at, at least 4 locations for which locations shall be provided by Purchaser's representative. Testing to be done at each site.

d) Soil resistivity shall be carried out by Wenner four electrode method as described in ISO/BS 3043. Contractor has to carry out the test in presence of Purchaser's representative & test shall be carried out keeping electrode spacing as 1, 2, 4, 6, 8, 10, 15, 25 M (each, along all 8 directions) as per normal practice and report has to be submitted. Polar curves shall be used for measurement of mean soil resistivity, which shall be used in finding earthing resistance at a particular location. Mean soil resistivity values shall be approved by Purchaser's representative.

e) The Contractor shall base his earthing calculations on actual measurement carried out by him in the presence of Purchaser/ Purchaser's Representative.

f) Galvanized Iron flat / wire shall be used as earthing conductor.

g) The conductor sizes & types shall be as per specified in the Technical schedules in Volume- II, Section A3. Contractor to note that, the sizes indicated are minimum required & earthing conductor sizes shall be approved by the Purchaser/ Purchaser's representative on the basis of adequacy calculations submitted by Contractor.

h) The underground joints in the system shall be properly welded or brazed and the bolted type connection shall be made with structures/ equipments. Petroleum jelly shall be applied to contact surface of the bolted joints, which will be covered with bituminous compounded and tapes.

i) Earthing conductor shall be protected against mechanical damages considering the installation conditions.

j) The earthing system shall comprise one or more earth electrodes, earthing grid or a combination of these in order to obtain the required earth electrode resistance of less than one (1) Ohms/ or as per IEEE Std 80 -2000.

k) For equipment earthing, two earthing leads will be used if rated voltage of the equipment is 250 volts & above and one earthing lead will be provided for equipment rated below 250 volts.

l) The earthing conductors in outdoor areas shall be installed at a minimum depth of 600 mm below FGL.

m) For each 11 KV DP/ FP Structure, minimum 2 nos. of CI plate type earthing electrodes shall be provided. The earth plate shall be buried in specifically prepared earth pit- 3 mtr. below ground with alternate layers of charcoal and salt, 40 NB GI pipe with funnel with a wire mesh for watering and bricks masonry block and CI Cover complete as per ISO/BS 3043 with necessary length of double GI earth flat 25x6 mm bolted with lug to the plate complete connected to the required point of DP with end socket as per direction and duly tested by earth tester conforming to ISO/BS as per drawing and specifications complete with 600 x 600 x 6.0 mm CI earth plate.

n) For each transformer neutral, minimum 2 nos. of Cu plate type earthing electrodes shall be provided. The earth plate shall be buried in specifically prepared earth pit 3 mtr. below ground with alternate layers of charcoal and salt, 40 NB GI pipe with funnel with a wire mesh for watering and bricks masonry block CI Cover complete as per ISO/BS/IEEE 3043 with necessary length of double Copper earth flat 25x6 mm bolted with lug to the plate complete connected to the transformer neutral with end socket as per direction and duly tested by earth tester conforming to ISO/BS/IEEE as per drawing and specifications complete with 600 x 600 x 3.15 mm Copper earth plate.

o) For other equipment & area, Earth electrodes shall be of heavy duty galvanized mild steel of not less than 40 mm NB and minimum 3000 mm long. Where multiple rods are used they shall be separated

by a distance of not less than the driven length.

p) Each earth electrode pipe shall be welded at the top to a mild steel plate to which the earthing strips shall be connected. These connections shall each be housed in individual inspection chamber set which shall project 100 mm above the finished ground level and shall allow disconnection for testing of individual electrodes. The chamber shall be permanently marked `Electrical Earth'.

q) All materials used for the earth electrode installation shall be purpose made for the application and site conditions and shall be approved by the Purchaser's Representative.

r) All civil works, such as excavation, boring, provision of charcoal & salt in adequate quantity, backfilling for the installation of the earth electrodes and the earth pit/ inspection pit shall be in the scope of Contractor.

s) After the earth installation has been completed the Contractor shall demonstrate to the Purchaser/ Purchaser's Representative that the resistance of the electrodes to earth and the continuity of the earth network are within the limits specified. Any additional earth electrodes and test instruments required for the tests shall be provided by the Contractor.

t) Main Equi-potential Bonding Conductor: Main equi-potential bonding conductors shall be provided to connect the earth electrode system to conductive parts forming the Works.

u) Circuit Protective Conductors: An independent circuit protective conductor shall be provided for each circuit and may comprise one or any of the following as appropriate:

i. a separate core within a multicore cable

ii. a separate conductor installed within a conduit or trunking. Steel conduit or trunking shall not be used as a circuit protective conductor.

iii. The metal sheath of an armoured cable. The sheath shall be bonded to the metal work of the apparatus and to the apparatus earth bar, if any.

iv. the copper sheath of a mineral insulated copper sheathed cable

v. An independent earthing conductor MS or GS run adjacent to the circuit it protects.

vi. The size of the circuit protective conductor shall be

calculated in such a manner as not to take into consideration the contribution of any other parallel or fortuitous earth paths.

vii. The armoring of the supply cable shall not form the sole means of earthing a switchboard or large electrical load.

35.6.4 Important Instructions for Earthing:

a) Each pole of lightning arrestors shall be earthed with separate earth pit.

b) Two-earth conductor shall connect outdoor CT secondary winding to earth grid.

c) The switchyard fencing shall be earthed at every alternate block and the switchyard gate shall be earthed with flexible GI wire.

d) All the earthing material with laying etc. shall be included in the scope.

e) The entire plant will have an earth grid laid in trenches/ trays/ buried in the ground outside. The main earthing grid shall be embedded at a minimum depth of 600 mm below FGL which shall be connected to earth electrodes.

f) All interconnections of the earthing grid conductors will have welded type joints except at electrodes with disconnecting facility and at equipment with bolted connections. All indoor earthing grids will be suitably interconnected to the external earthing grid.

g) Each steel/ RCC column of the building will be interconnected to the floor-earthing grid.

Steel columns, steel strips / conduits, cable trays etc. will not be used as earth continuity conductors.

h) Disconnecting type facility shall be provided between Earthing grid & each earth electrode.

i) All connection between the conductors shall be welded/ brazed type. Metallic pipe, conduit, structures shall be bonded to lightning protection conductors to prevent the side flashover. But no metallic pipe, conduit, structure shall be used as air termination conductor or down conductor.

j) The down conductors shall be fixed with embedded brass posts (on concrete columns) with nuts & bolts used for fixing the saddle/ clamp (direct drilling of down comer and fixing with screw shall not be acceptable).

k) Cleats for 'earthing and lightning protection systems' shall be of GI.

l) The lightning protective conductor shall not be connected with the earthing above ground however both the systems shall be interconnected below ground.

m) The earth pits may require boring & drilling in the soil & the same shall be considered in Contractor's scope.

n) Earth electrode with disconnecting facility shall be provided so that the resistance of the independent earth electrode may be measured.

o) Internal earth Bus of each panel shall be connected to both ends to the earthing system by means of earthing conductor.

p) Metallic frames of all current carrying equipment, structures supporting and adjacent to current carrying conductors, lightning protection system conductors, metallic structures, metallic stairs, hand rails, fences shall be connected to a single earthing system. Neutral points of various systems shall be connected to the dedicated treated earth pits and these earth pits shall be interconnected to each other below ground.

q) All connections in the equipment earth conductors buried in ground (or otherwise) shall be cad welded/ brazed, whereas connection at equipment end shall be of bolted type. All connections shall be of low resistance. All bimetallic connection shall be treated with suitable compound to prevent moisture ingression. For Bimetallic bolted connection, bimetallic washers shall be used. All bolted joints shall have minimum two bolts to ensure proper surface contact. Termination of stranded conductors at earth inserts shall be with ring type/ lugs.

r) Galvanized conductors shall be touched up with zinc-rich paint where holes are drilled at site for bolting to equipment/structure.

s) Suitable earth risers approved by the Engineer shall be provided above finished floor/ ground level, if the equipment is not available at the time of laying of the main earth conductor. The minimum length of such risers inside the building shall be 200 mm and outdoor shall be 500 mm above ground level.

t) Metallic conduits and pipes shall be connected to the earthing system unless specified otherwise.

u) All cable trays will be earthed at minimum two places by suitable sized GI flats to main earthing system earth conductor. The cable trays shall also be earthed at a regular interval of not more than 10 meters by 25 x 3 mm GS flat.

v) Earthing Pits:

i. Adequate number of earthing pits shall be provided in conjunction with earthing grid for the earthing system. The minimum spacing between two adjacent earthing pits shall not be less than length of the electrode (minimum 3 m) and shall be kept 1500 mm away from footings of the structure.

ii. Earthing pits shall be located in ground, which has a reasonable chance of remaining moist. Arrangement comprising of GI pipe with top funnel with wire mesh shall be made to facilitate pouring of water to keep earthing pit wet.

iii. A galvanized iron strip of adequate size (as per calculations) shall be provided from plate electrode to about ground level to facilitate jointing with earth conductors. Each earth electrode ending at the pit shall be connected to suitable linking strips to connect and disconnect the earthing suitably.

iv. Earthing chamber shall be of RCC/ brick chamber of 600 mm x 600 mm, with removable 6 mm thick MS chequered plates. The covers shall have holes for handling. Earthing pits (chambers) shall be painted Green and the earth-pit number shall be marked on it.

v. Earthing cables crossing other metallic structures such as conduits pipelines etc shall be minimum 300 mm away from such structures.

vi. Earthing conductors shall be protected against mechanical damage.

vii. All earth lead connections shall be as short and direct as possible and shall be without kink.

viii. The main earth loop in plant area shall be generally routed along cables. When equipments are located away from main earth loops, suitable sub-loops shall be run up to them for deriving connections for individual equipment. The entire earthing system shall fully comply with the CEA guidelines and requirements.

ix. The Contractor shall have to carry out any changes as desired by the Electrical inspector or the Engineer in charge, in order to make installation conforming to the CEA guidelines 2010.

35.6.5 Lightning Protection

a) The lightning protection system need will be established by calculating the risk factor value of each building, structure etc. as per procedure given in ISO/BS/IEEE 2309-1989 and if found necessary the same shall be provided by the Contractor.

b) For Lightning protection of Civil Structures including RCC Buildings, fixing of 25x6 mm GI earth strip to roof as per ISO/BS/IEEE/ IEC std, saddle clamp, down comer connector etc. as required with all hardware shall be in Contractor's scope. Structural Columns (which are used as down comers for lightning protection system) bottom shall be connected to the earth pit with 25x6 mm bare GI strip.

35.6.6 Galvanizing

a) Wherever galvanizing has been specified, the hot dip process shall be used. The galvanized coating shall be of uniform thickness. Weight of Zinc coatings for various applications shall not be less than those indicated below

Fabricated Steel

i.	Thickness less than 2 mm, but not less than 1.2 mm	340 gms/ sq.m
ii.	Thickness less than 5 mm, but not less than 2 mm	460 gms/ sq.m
iii.	Thickness 5 mm and over	610 gm/ sq.m

b) Burrs shall be removed before galvanizing. Any site modification of galvanized parts should be covered well by zinc rich primer and aluminium paint.

c) Contractor shall ensure to use calibrated test equipment having valid calibration test certificates from standard laboratories traceable to National Standards.

35.6.7 Drawings/ Documents Required

The Contractor should prepare Layout drawings, after award of contract and before commencement of work for Purchaser's approval, showing the location of earthing grid, electrodes, interconnection grids and earthing leads to various equipment, down comers, isolating links etc. should be accompanied by design calculations.

35.7 LIGHTING & VENTILATION SYSTEM

35.7.1 Scope

a) The scope of the Contractor shall include design, supply and installation of all equipment necessary for a complete lighting and

receptacle system. The lighting system includes Lighting fixtures (indoor/ outdoor), lamps, lighting panels (LP), switchboards, Receptacles, JBs, cables/ wires for lighting/ receptacles, conduits etc. The supply of street light/ flood light poles as per ISO/BS/IEEE 2713 or ISO/BS/IEEE 3713 is also included in the Contractor's scope.

b) The various types of lighting fixtures with lamps shall be installed based on the mounting arrangement shown in the typical drawings enclosed with the specification. Installation scope shall include all material to mount the fixtures in proposed manner.

c) The various types of lighting fixtures as per specified in this specifications shall be assembled, installed, tested & commissioned by the Contractor.

d) The type of lighting fixtures and receptacles, illumination level and approximate quantity required shall be generally as per design criteria.

e) Lighting system installation shall be as per the tender specifications

f) It shall be the responsibility of the Contractor to work out complete detailed requirement of lighting and receptacle system for the whole plant and staff quarters including area lighting as per specification and accordingly procure and install them.

35.7.2 General Requirements

The Lighting system includes following items.

a) Lighting fixtures complete with Lamps and accessories. Only LED fixtures shall be used for both indoor & outdoor applications (Except for High mast lighting).

b) Lighting system equipment

c) Light control switches, receptacle units with control switch units, lighting wires, conduits, earth wires and other similar items necessary to complete lighting system.

d) Lighting fixture supports, street lighting poles and flood light towers/ poles.

e) Lighting main distribution board, lighting panels

f) Multi core cables for street, boundary and flood lighting

35.7.3 Lighting Layout

a) It shall be the responsibility of the Contractor to work out a detailed layout for the complete plant in order to provide the levels of illumination as indicated in the relevant standards

b) The types of fixtures to be used in various areas are also indicated in the above mentioned drawing. The Contractor shall be responsible for measuring the levels of illumination and uniformity after installation and establish compliance with the specification.

c) The lighting system will comprise the following:

i. Normal A.C Lighting: Normal lighting in all indoor and outdoor areas will be operated on 230V, 1Phase, 50 HZ A.C supply

ii. Emergency Lighting: Emergency Lighting shall be designed such that at all junctions, exit passages & strategic locations, Lux level shall be maintained above 10 Lux. Emergency light fitting shall be 240 V self contained 2 x 10 W LED fixtue with built in Ni-Cd battery having charging facility and six hours back-up time. The emergency light fittings shall be provided at strategic locations of each house/area. Emergency fixtures shall come in service when AC supply fails. Pump room and Electrical room shall be considered for Emergency lighting.

35.7.4 Applicable Standards:

The design, manufacture and performance of equipment shall conform to the latest standards specified below. In case of conflict between the standards and this specification, this specification shall govern.

a) Lighting Fixtures & Accessories for General & High mast

Electrical lighting fittings general and safety requirements : ISO/BS/IEEE: 1913/ BS: 4533

Code of practice for industrial lighting : ISO/BS/IEEE: 6665

Code of Practice for Interior Illumination : ISO/BS/IEEE 3646

Code of Practice for Lighting of Public Thoroughfares : ISO/BS/IEEE 1944

Calculation of co-efficient of utilization : ISO/BS/IEEE: 3646 (Part - III)

Testing procedure of photometric testing for LED luminaires LM 79

Testing procedure on the lifespan of LEDs LM 80

National Lighting Code SP72

Method of Measurement of Lumen Maintenance of Solid State Light (LED) Sources ISO/BS/IEEE:16105

Method of Electrical and Photometric Measurements of Solid-State Lighting (LED) Products

ISO/BS/IEEE:16106

Limits of Harmonic Current Emissions ISO/BS/IEEE 14700-3-2

DC or AC supplied electronic control gear for LED modules performance requirements IEC 62384

Lamp control gear: particular requirements for DC or AC supplied electronic control gear for LED modules

Environmental Testing: Test Z- AD: composite IEC 61347-2-13

temperature/ humidity cyclic test

Electro Magnetic compatibility (EMC)- Limits for	IEC 60068-2-38
Harmonic current emission— (equipment input current ≤ 16 A per phase)	IEC 61000-3-2
EMC Immunity requirement	IEC 61547
LED modules for general Lighting-Safety requirements	IEC 62031
Classification of degree of protections provided by enclosures (IP Codes)	IEC 60529
Fixed general purpose luminaries	IEC 60598-2-1
General Lighting - LEDs and LED modules –	ISO/BS/IEEE:16101 / IEC TS
Terms and Definitions	62504
LED Modules for General Lighting Part 1 Safety Requirements	ISO/BS/IEEE:16103(Part1)
LED Modules for General Lighting Part 2 Performance Requirements	ISO/BS/IEEE:16103(Part2)
Safety of Lamp Control Gear, Part 2 Particular Requirements Section 13 D.C. or A.C. Supplied Electronic Control gear for Led Modules	ISO/BS/IEEE:15885(Part2/Sec13)
Industrial lighting fittings with metal :	ISO/BS/IEEE: 1777
Reflectors	
Decorative lighting fittings :	ISO/BS/IEEE: 5077
Dust proof electric lighting fittings :	ISO/BS/IEEE: 4012
Dust tight electric lighting fittings :	ISO/BS/IEEE: 4013
Flood lights :	ISO/BS/IEEE: 10322/BS: 4533
Luminaries for street lighting :	ISO/BS/IEEE: 10322 Part 5
Water tight electric lighting fittings :	ISO/BS/IEEE: 3553/ BS: 4533, 5225(I)
High pressure mercury vapour lamps :	ISO/BS/IEEE: 9900/BS: 3677/ IEC: 188
Screw less terminal and electrical :	ISO/BS/IEEE: 10322
connections for lighting fittings	
High pressure sodium vapour lamps :	ISO/BS/IEEE: 9974
Emergency lighting units :	ISO/BS/IEEE: 9583
Ignition proof enclosures, dust-tight for :	ISO/BS/IEEE: 11005
elect. equipment	
Luminaries :	ISO/BS/IEEE: 10322(Part I to V)

Lighting System Equipment:

Arrangement for busbars, main connections and auxiliary wiring and marking :	ISO/BS/IEEE: 5578/ 11353/ BS: 159
Enclosed distribution fuse boards and cutouts for voltages not exceeding 1000V :	ISO/BS/IEEE: 2675/BSEN 60439
General requirements for switchgear :	ISO/BS/IEEE: 13947 and control gear for voltages not exceeding 1000 V

Code of practice - installation and : ISO/BS/IEEE: 10118/BS: 6423

Maintenance of switchgear BS 6626, BS 6867

Factory built assemblies of switchgear : ISO/BS/IEEE: 8623/BS-5486/ IEC: 439 and control gear for voltages up to and including 1000 V AC and 1200 V DC

Miniature air break circuit breakers for : ISO/BS/IEEE: 8828/BSEN 60898

AC circuits

HRC cartridge fuse links up to 650 V : ISO/BS/IEEE: 9224/BS: 88/ IEC: 269

'D' Type fuses : ISO/BS/IEEE: 8187

Current transformers : ISO/BS/IEEE: 2705/BS: 7626/ IEC: 185

Voltage transformers : ISO/BS/IEEE: 3156/BS: 7625/

IEC: 186

Direct acting electrical indicating : ISO/BS/IEEE: 1248/BS: 89/IEC: 51

Instruments

A.C. electricity meters : ISO/BS/IEEE: 722/BS 5685

Electrical relays for power system : ISO/BS/IEEE: 3231/BS: 142/

protection IEC: 255

Switches for domestic and similar : ISO/BS/IEEE: 3854/BS: 3676

Purposes

Three pin plugs and socket outlets : ISO/BS/IEEE: 1293/BS: 546

Boxes for enclosure of electrical : ISO/BS/IEEE: 5133(1) Accessories

Rigid steel conduits for electrical wiring : ISO/BS/IEEE: 9537/BS: 31

Accessories for rigid steel conduits for : ISO/BS/IEEE: 3837/BS-31 electrical wiring

Flexible steel conduits for electrical : ISO/BS/IEEE: 3480

Wiring

Rigid non-metallic conduits for electrical : ISO/BS/IEEE: 9537/BS: 4607(2)

installations

Fittings for rigid non-metallic conduits : ISO/BS/IEEE: 3419/BS: 4607(2) PVC insulated cables for working : ISO/BS/IEEE: 694

voltages up to and including 1100 V

Tubular steel poles : ISO/BS/IEEE: 2713

Specification for copper rods and bars : ISO/BS/IEEE: 613 for electrical

purposes

Code of practice for phosphate iron : ISO/BS/IEEE: 6005/ BS: 3189

and steel

Fittings for rigid steel conduits for : ISO/BS/IEEE: 2667 electrical wiring

National Building Code of Pakistan (NBC) : NBC 2005

35.7.5 Other Design considerations for Lighting

a) Lighting panels shall be provided in various areas and circuit wiring to the lighting fixtures shall be made from lighting panels. Lighting panel shall comprise of Four pole MCB + RCCB (100 mA) for incomer and SP MCB's for each outgoing single phase circuits.

b) The wiring for lighting circuits in indoor areas will be done by wires run in GI conduits.

For outdoor lighting, wiring will be done by using armoured cables.

c) Lighting cable from Main lighting DB (MLDB) to Lighting panels shall be Al conductor, XLPE insulated, 1.1KV grade, laid in cable trays otherwise cleated along the wall/ column/ beam.

d) For lighting fixtures (Pump room) 1100V grade, 4C x 2.5 sq. mm. PVC insulated, multi stranded copper conductor armoured/ unarmoured cables shall be used.

e) For lighting fixtures (For Office, electrical room, toilets etc. areas) 1100V grade, FRLS PVC, multi-stranded Copper conductor wires of area not less than 1.5 sq mm laid in min. 20 mm dia GI conduit (above false ceiling) shall be used.

f) For 5/15A decorative sockets (For Office, toilets etc. areas) 1100V grade, FRLS PVC, multi-stranded copper conductor wires of area not less than 2.5/ 4.0 sq. mm. Cu laid in minimum 20 mm dia. GI conduit shall be used.

g) Wiring shall be concealed in wall below false ceiling with concealed switch board. Minor civil work like chasing wall, cut outs for conduit, switch board, Lighting Panel in wall, entries for tray, conduits etc. is in scope.

h) Lighting cable from MLDB to Lighting Panels and Lighting Panels to street light fixtures, shall be Al conductor, XLPE insulated, armoured, 1.1 KV grade, laid in cable trays otherwise cleated along the wall/ column/ beam and buried in the ground.

i) The point wiring for lighting/ receptacle/ exhaust fan/ wall mounted fan/ ceiling fan shall include conduits, conduit accessories, FRLS PVC insulated multistranded Copper conductor wires and earthing wires,

pull boxes, ceiling rose, clamps, cleats, hardware, accessories, anchor fasteners etc. It shall include wiring from lighting panel to switchboard and receptacles & switchboard to lighting fixtures. Sheet metal switchboard embedded in wall shall be considered for receptacles and lighting switchboards on wall shall be considered for lighting.

j) For power sockets in wall/ furniture, PVC switch box of approved make with switch plate & accessories and 16 Amp piano modular switches and 5/15A sockets etc. as applicable shall be considered. For all types of point wiring the receptacles with switches shall be included in the point wiring rate.

k) Lighting switchboard consisting of (*) no. of 6A piano switch without indicator, 1 no. 6A piano switch with indicator, 1 no. white coloured cover plate for (*) module (4/ 6/ 8/ 12 module), 1no. 2/ 3 pin shuttered socket of 5/ 15A and metal flush box.

l) Decorative socket switchboard consisting of (*) no. of 16A piano switch with indicator, (*) no. 2/ 3 pin shuttered socket of 5/ 15A and metal flush box, 1 no. white coloured cover plate for (*) module (4/ 6/ 8/ 12 module).

m) Lighting fixtures and fans will be grouped on the circuit wherever required. However, separate circuits shall be used for receptacles wiring.

n) Lighting Control Philosophy as per mentioned below shall be observed. From each switch –

   i. Max. 2 (3 in case unavoidable) normal LED light fixture.

   ii. Max. 4 (5 in case unavoidable) for LED down lighters

o) All indoor, outdoor & street light fixtures shall be controlled directly from respective Lighting Panels, through MCB.

p) Each lighting panel/ Receptacle DB shall have minimum 2 spare circuits of 10/ 16A SPN outgoing feeders. A circuit consists of R, Y, and B Phase each.

q) Lighting for staircase shall be controlled with flushed modular switch. The conduit for main staircase shall be concealed. Lighting for all staircases shall be with 2 way switch

r) Contractor shall note that any chasing in walls or cutouts or openings such as fixing of LPs, DBs, switchboards, concealing conduit in wall etc. in walls required shall be made before plastering of brickwork wherever applicable and installation rates quoted shall be inclusive of chasing, cutting & making the plaster as per standard practice.

s) Lighting for street light fixtures/ flood light fixtures shall be carried out with cables. The supply of cables, junction boxes, street light poles & structural steel required for mounting fixtures/ LPs etc. are in the scope of Contractor. The cable wiring shall include supply & installation of cable required from LP to the junction box mounted on street lighting pole / near indoor fixture and also between junction box mounted inside pole/near indoor fixture to control gear box and same for flood lighting, supply and installation of all termination accessories such as lugs, cable glands etc. DBO Contractor's scope shall also include excavation, preparation of soil bedding, supply and installation of protection cover, back-filling, supply and installation of cable route markers etc.

t) Point Wiring for lighting/ raw power receptacle/ emergency lighting:

i. Point wiring covers the wiring between a circuit of the lighting panel to switchboard and then from switchboard to lighting fixtures connected to that circuit of the lighting panel.

ii. For receptacle circuits point wiring shall cover wiring between circuit of the lighting panel to receptacles connected to that circuit of the lighting panel.

iii. The scope of the Contractor shall include the supply, erection, testing and commissioning of the above LPs/ DB boards for supply of power to the various sockets required for computers, raw power points etc. The point wiring rate from these DBs shall include supply of wires, conduits, cleats/ clamps etc. as may be required and shall be in the scope of electrical Contractor.

iv. The conduit point wiring rate for exhaust fan shall include conduits/ casing capping, conduit/ casing capping accessories, Switch boards, PVC insulated wires and earthing wires, pull boxes, ceiling rose, clamps, cleats, hardware, sheet metal switchboards fabricated out of 16 SWG. sheet steel housing 5 Amp piano switches. It shall include wiring from EXHAUST FAN DB/ RDB to switchboard & switchboard to exhaust fan as applicable. Neutral for individual circuit shall be run separate from DB to individual receptacles.

v. All mounting accessories like base channels, cross angles if required, nuts, bolts etc. shall be supplied by the Contractor under the scope of this contract.

vi. Required no. of 1-Ph & 3-Ph, industrial receptacles with respective 2P/ 4P ELCB (30mA) & 3/ 5 pin plug shall be provided for maintenance purpose.

vii. Receptacle & its ELCB shall be mounted in prefabricated CRCA box of 16 SWG, epoxy painted with shade 631of ISO/BS/IEEE-5. Earthing studs shall be provided for connecting external earthing with receptacle box.

viii. The Configuration of Industrial receptacle units shall be as per following – Combination 240V, 1-Ph, 50Hz, 3 pin, 15A Industrial receptacles with RCBO (30 mA). 415V, 3-Ph, 50Hz, 32/63A Industrial receptacles with respective RCBO (30 mA).

u) Lighting Fixtures and Accessories:

i. General

Normal supply voltage, phase and frequency	240 V, 1 ph, 2 wire, 50 Hz,
Variation in supply	
Voltage (AC & DC)	±10 %
Frequency	±5 %
Combined voltage & frequency	±10 %
Design ambient air temperature	50^0C

ii. The Luminaires shall be designed so as to facilitate easy maintenance, including cleaning, replacement of lamps/starters etc.

iii. Connections between different components shall be made in such a way that they will not work loose by small vibration.

iv. For each type of Luminaires the Contractor shall furnish the utilization factor tables to indicate the proportion of the light emitted by the bare lamps which falls on the working plane.

v. All Luminaires shall be supplied complete with lamps suitable for operation on a supply voltage and the variation in supply voltage, frequency and combined voltage and frequency of 10%, 5% and 10% respectively.

vi. The Luminaires and accessories shall be designed to have low temperature rise.

The temperature rise above the ambient temperature shall be as indicated in the relevant Standards.

vii. The Luminaires shall have a sturdy and corrosion resistant high pressure Die cast Aluminium housing with weatherproof gasket for lamp and control gear accessories. The Housing shall be Epoxy coated, without any cracks or thorough holes, made in a single piece of die-cast LM6 aluminium alloy. The luminaires shall be totally enclosed, dust tight and water proof.

viii. Heat sink used should be aluminium extrusion having high conductivity. The dimensions of luminaires shall be optimum and adequate to permit sufficient heat dissipation, through the body itself, so as to prevent abnormal temperature rise inside the lantern and consequential damage to the cover and gasket materials, LEDs, lenses and electronic drivers. Heat sink must be thermally connected to MCPCB/ LED light source.

ix. The Luminaire Housing shall be suitable for termination of Cable with Double Compression Cable Glands

x. The optical system shall consists of individual PC lenses on high power LEDs designed & tested to achieve typical street lighting distribution from the LED lantern. These lenses provided for individual LEDs are to be fixed on lens plate in order to have consistent light distribution from luminaires. Luminaires should conform to the photometric Distribution / requirements of Cut-Off / Semi Cut – off light distribution and optics as classified in ISO/BS/IEEE 1944.

xi. Suitable number of LED lamps shall be used in the luminaires. The manufacturer shall submit the proof of procurement of LEDs from OEMs at the time of testing

xii. The Luminaires shall be provided with high tensile heat resistant toughened glass of minimum 0.8mm thickness or UV resistant polycarbonate cover fixed with stainless Steel screws.

xiii. An extruded silicon loop gasket shall be provided in the lantern body to ensure a weather proof seal between the cover and the metal housing to exclude the entry of dust, water, insects, etc. Luminaire should conform to degree of protection of IP 65 or above. Felt gasket will not be accepted.

xiv. Year of Manufacture, Batch No., Serial Number or Identification No. Luminaire Manufacturer's Name / Logo, Wattage and Frequency should be embossed on the housing.

xv. LED luminaires, should conform to the various National / International standards for safety & performance. Manufacturer should provide test reports as per LM 79 & LM80. Lumen maintenance report as per LM 80 guidelines shall be submitted for the LEDs used along with the BID.

xvi. Luminaires should conform to the ISO/BS/IEEE standards for Safety & Performance and test certificates as per ISO/BS/IEEE 16107 should be provided by the manufacturer. In case of luminaires are imported, the CONTRACTOR shall conform to test parameters as per UL or equivalent standards.

xvii. The electrical component of the LED and LED driver must be suitably enclosed in sealed unit to function in environment conditions mentioned earlier.

xviii. All the connecting wires inside the Luminaire shall be low smoke halogen free, fire retardant cable.

xix. Adequate protection against Overloading, Short Circuit, Over Voltage, over temperature, Under Voltage, String Open shall be provided within the Luminaires

xx. Design of the thermal management shall be done in such a way that it shall not affect the properties of the diffuser.

xxi. The equipment should be compliant to IEC 60598-1, IEC 62031 and IEC/ PAS 62612 depending on the type of luminaire.

xxii. All the material used in the luminaires shall not contain any toxic material/ metal like mercury; shall be halogen free and fire retardant confirming to relevant standards.

xxiii. The Manufacturer shall have all the relevant testing facilities certified by an accredited laboratory and shall be offered for inspection to the Employer for verification of the required parameters and tests. CONTRACTOR shall confirm the same in the BID.

xxiv. The control gear shall comply with the provisions of IEC 61347-2-13, IEC 62031 and IEC 62384 as appropriate.

xxv. The LED lighting fixtures offered shall comply with the following requirements;

Sr. No.	Parameter	Design Requirement / Value
1.	Type	Dimmable LED Luminaires complete with all accessories for Street Lighting
2.	Rated Voltage	230 V
3.	Expected Frequency	50 Hz +/- 3%
4.	Operating Voltage Range	150 V to 270 V
5.	Power Factor	> 0.90
6.	Operating Temperature Range	0 Deg C to 50 Deg C
7.	Working Humidity	10% - 90% RH
8.	Driver Type	Constant Current based Electronic Driver
9.	Driver Efficiency	> 92%
10.	Driver Life	>20000 hrs.
11.	Protection required in Driver module	
a.	Short Circuit	To be provided by the contractor
b.	Over Voltage	To be provided by the contractor
c.	Over Temperature	To be provided by the contractor
d.	Under Voltage	To be provided by the contractor
e.	String Open Protection	To be provided by the contractor
12.	Luminaires IP Protection	Minimum IP 65 for Outdoor Fixtures
13.	Minimum Surge Protection	>4 KV
14.	THD	≤ 15%
15.	Power Factor	≥ 0.9
16.	Rated Minimum LED Life (L70)	50000 Burning Hours
17.	Rated Minimum Driver Life	20000 Burning Hours
18.	CRI	>70
19.	Junction temperature rise	< 85 Deg C
20.	Solder point temperature	< 70 Deg C
21.	Maximum temperature rise for Driver	<30 Deg C at 45 Deg C ambient
22.	Make of LED	Cree / Nichia/ Philips / Osram
23.	Make of Driver	Cree / Nichia/ Philips / Osram
24.	Operating Hours	Dusk to Dawn (max 12 Hrs.)
25.	Efficacy of Luminaires	>92lm/W
26.	Colour Temperature	5000K – 6000K
27.	Illumination Regulation	<5%
28.	Material used for following	
a.	Housing	Die cast aluminium/ extruded Aluminium body

Sr. No.	Parameter	Design Requirement / Value
		with powder coated finish
b.	Heat Sink	Aluminium extrusion
c.	Clip / Fasteners	Stainless steel.
d.	Diffuser	Toughened glass (0.8mm thick)/ UV stabilized Poly carbonate material
29.	Maximum temperature of Heat sink	<70 Deg C
30.	IK protection of Optic Cover	>IK05
31.	Wires used Inside Luminaires	Cu conductor, low smoke halogen free, fire retardant e-beam cable
32.	Cable gland IP protection	IP 65

xxvi. Each luminaires shall have a terminal block suitable for loop-in, loop-out and T-off connection by 230/ 415 V, 1 core, FRLS PVC insulated Copper conductor wires up to 4 sq. mm in size. In outdoor areas the termination at the luminaires shall be suitable for 1100 V, PVC insulated, Cu/ Al conductor, armoured cables of sizes up to 6/ 16 sq. mm conductor. Terminals shall be of stud or clamp type. The internal wiring should be completed by means of stranded Copper wire of minimum 1 sq. mm size and terminated on the terminal block. Terminal blocks shall be mounted with minimum two fixing screws.

xxvii. Mounting facility and conduit knock-outs for the luminaires shall be provided.

v) Earthing

i. Each luminary shall be provided with an earthing terminal suitable for connection to the earthing conductor of 12 SWG GI wire.

ii. Where separate control gear box is provided for housing the accessories the same shall be provided with an earthing terminal suitable for connecting earthing conductor of 12 SWG GI wire.

iii. All metal or metal enclosed parts of the luminaries/control gear box shall be bonded and connected to the earthing terminal so as to ensure satisfactory earthing continuity.

iv. Earthing of each pole shall be carried out with one dedicated earth electrode. The earth electrode can either be a GI coil type or GI pipe/ rod type electrode. The GI rod/ Pipe electrode shall be 2.5 m deep and can be hammered directly into the ground where ordinary soil is

present. For Hard strata, preparation similar to that mentioned in latest version of ISO/BS/IEEE 3043 or the latest version of Rural Electrification Corporation (REC) manual can be carried out. For GI Coil earthing, preparation as per REC manual shall be followed. The earth electrode shall be connected with two 25X6 sq.mm GI strips to the two distinct earth boss on the pole.

w) Painting/ Finish:

i. All surfaces of the Luminaries/Control gear box housing accessories shall be thoroughly cleaned and degreased. It shall be free from scale, rust, sharp edges and burrs.

ii. When enamel finish is specified, it shall have a minimum thickness of 2 mils for outside surface and 1.5 mils for inside surface. The finish shall be non-porous and free from blemishes, blisters and fading.

iii. The luminaire housing shall be stove-enamelled/epoxy stove-enamelled-vitreous enamelled or anodised as indicated under various types of fittings.

iv. The surface shall be scratch resistant and shall show no sign of cracking or flaking when bent through 90 deg. over 1/2" dia. mandrel.

v. The finish of the luminaries shall be such that no brigHV spots are produced either by direct light source or by reflection.

vi. External control gear box provided for housing accessories shall be painted or galvanised.

35.7.6 Outdoor/ Street Lighting Luminaries:

a) LED luminaires:

i. Street light LED luminaires shall be outdoor weather proof type for illumination of main roads, traffic islands etc.

ii. The luminaires shall be of semi-cut off with cast aluminium housing, acrylic or prismatic cover, polished aluminium reflectors, complete with integral mounted control gear, neoprene gaskets and with rear pipe entry.

iii. The luminaires shall be suitable up to 70/150/ 250 watts LED lamps and for mounting heights from 4 metres to 12 metres.

b) Metal Halide luminaires (For High Mast Only As Applicable):

i. Street light MH luminaries shall be outdoor weather proof type for illumination of main roads, traffic islands etc.

ii. The luminaries shall be of semi-cut off with cast aluminium housing, acrylic or prismatic cover, polished aluminium reflectors, complete with integral mounted control gear, neoprene gaskets and with rear pipe entry.

iii. The luminaries shall be suitable up to 150/ 250 watts MH lamps and for mounting heights from 4 metres to 12 metres.

c) Post Top Lantern:

i. Post top lantern luminaries shall be generally outdoor weather proof type for illumination of walkways, gate posts, gardens etc.

ii. The luminaries shall have cast aluminium spigot finished with corrosion proof paint for mounting, opal acrylic or high density polyethylene (HDP) diffuser bowl, complete with integral mounted control gear, neoprene gaskets, earthing terminal etc.

35.7.7 External Light Poles-Street Light/ High Mast Flood Light (where applicable)

a) All the Poles shall be designed to withstand the maximum wind speed as per ISO/BS/IEEE 875.

The top loading i.e., area and the weight of fixtures are to be considered to calculate maximum deflection of the pole and the same shall meet the requirement of BSEN 40-3:2000, pr EN-40-3-3.

b) These poles shall be coated with bituminous preservative paint on the inside as well as embedded outside surface. Exposed outside surface shall be painted with one coat of red lead oxide primer. After completion of installation two coats of aluminium paint shall be applied. One steel ladder shall be provided separately. The length of each step of the ladder shall be at least 300 mm and spacing between two adjacent steps not more than 300 mm.

c) The supply of poles shall be complete with fixing bracket/ necessary pipe reducer for fixing the fitting and also include the necessary associated pole mounted junction boxes. The required sizes of poles and the junction box shall be as indicated in the attached drawings.

b) The pole shaft may have Octagonal or Conical cross section and shall be continuously tapered with single longitudinal welding as applicable. There shall not be any circumferential welding.

c) All Octagonal or Conical pole shafts shall be provided with the

rigid flange plate of suitable thickness with provision for fixing foundation bolts. This base plate shall be fillet welded to the pole shaft at two locations .i.e. from inside and outside.

d) The welding of Octagonal or Conical pole shaft shall be done by Submerged Arc Welding (SAW) or using high end MIG/ TIG Welding process. The welding shall be carried out conforming to approved procedures. The welding shall be done as per qualified MMAW process approved by Third Party Inspection agency.

e) The Octagonal or Conical poles shall have integrated Junction box with open able door of adequate size (approximate 600mm length) at the elevation of 750 mm from the base plate.

f) The door shall be hinged type with mechanical interlock, dust proof, weather proof and vandal resistance and shall ensure safety of inside connections and components. The door shall be flushed with the exterior surface and shall have suitable locking arrangement. There shall also be suitable arrangement for the purpose of earthing.

g) The door of the integral Junction Box shall permit clear access to the components inside viz., termination strips, connectors, MCBs, cables etc.

h) The Octagonal or Conical pole shall be adequately strengthened at the location of the door to compensate for the loss in section.

i) Material for Octagonal or Conical Poles shall be HT Steel Conforming to grade S355JO; Base plate shall be FE 410 conforming to ISO/BS/IEEE 226/ ISO/BS/IEEE 2062; and Foundation Bolts shall be of EN.8 grade.

j) Aesthetic appearance - All the grooves and carvings of the pole unit shall be free from any kind of distortion for a pleasing aesthetic appearance.

k) The Octagonal or Conical poles shall be hot dip galvanized as per is 2629/ ISO/BS/IEEE 2633/ ISO/BS/IEEE 4759 standard with average coating thickness of 70 micron. The galvanizing shall be done in single dipping.

l) The Octagonal Poles shall be bolted on a pre-cast foundation with a set of foundation bolts for greater rigidity.

m) Top Mountings -The galvanized mounting bracket shall be supplied along with the Poles for Installation of the luminaires.

n) The Octagonal or Conical pole manufacturing & galvanizing unit shall be ISO/BS/IEEEO 9001: 2000 & ISO/BS/IEEEO 14001 certified to ensure consistent quality & environmental protection.

o) Electrical connections - Four way connectors shall be provided along with Slide lock suitable for connecting 1.1 kV grade, 4 C x 16 sq.mm Al cable. It shall also in-house 1 no. 6 amps DP MCB, 2.5 sq.mm connectors for looping with 2.5 Sq.mm Copper wires for connecting to the luminaire through 1.1 kV grade, 3 core X 2.5 mm^2 PVC insulated copper conductor flexible un-armoured Cable from the terminal block to the fixture within the pole. All the cables laid through the pipe shall be without any joint.

p) Two nos. Earth Boss shall be provided at the bottom of the pole (diagonally opposite) suitable for connecting 25X6 mm GI/ CU earth strip for earthing of the poles. Similar Earth Boss suitable for connecting 4 sq.mm copper wires shall be provided on the control plate inside the Junction Box for earthing of the electrical components.

q) Two nos. 50 mm NB HDPE sleeves of suitable length shall be provided through the foundation up to the Junction Box for entry of power cable.

r) The Contractor shall carry out all the relevant tests and inspection in the presence of the Employer or Third Party Agency, as may be selected by the Employer, before the dispatch of the poles at no extra cost to the Employer.

s) The CONTRACTOR shall inform the EMPLOYER at least Fifteen (15) days in advance, about the manufacturing schedule so that arrangement can be made for inspection. EMPLOYER reserves the right to waive the inspection at any stage.

t) All the material/ equipment/ accessories shall be supplied with manufacturer's test certificates.

u) CONTRACTOR shall submit the Proposed Product Catalogue, Detail Data sheet, spare parts list and drawing of Pole & Bracket along with the BID for each product quoted.

v) High mast shall be outdoor weather proof type for illumination of main roads and area lighting, wherever found necessary.

w) The high mast shall be continually tapered, polygon cross section, telescopically jointed steel fabricated construction. The mast shall be hot dip galvanised internally and externally. Weather proof door shall be provided near the base to permit access to winch, cables, plug, socket etc. The mast shall be designed for wind speeds depending upon wind pressure and direction as per relevant Pakistann Standards. Foundation bolts shall be included in the scope of supply.

x) The moving platform shall be of steel construction hot dip galvanised

and designed to hold the number of flood light luminaires specified. The control gear boxes shall be cast aluminium weather proof type mounted on the moving platform. The moving platform shall be raised or lowered with the help of winch, pulley system and stainless steel wire ropes. The winch shall be suitable for hand operation or alternate by electric power.

y) The mast shall be suitable for mounting numbers of luminaires as required. The standard mast heights are generally from 16 to 30 meters.

z) CONTRACTOR shall arrange for all the tools and equipments including M20 concrete foundations shall be provided for all the poles. Approx dimension of the foundation for evaluation purpose is 600X600X1700 mm. However, CONTRACTORs shall design as per the stability requirement and Soil bearing Capacity of each location. The Poles shall be bolted on a pre-cast foundation with minimum four foundation bolts for greater rigidity.

35.7.8 Emergency Light Luminaries

a) Emergency light fitting shall be 240 V self contained 2 x 11 W fixture with built in Ni-Cd battery having charging facility and six hours back-up time. The emergency light fittings shall be provided at strategic locations of each house / area.

b) Emergency fixtures shall come in service when AC supply fails.

c) Pump room and Electrical room shall be considered for Emergency lighting.

d) In addition to above emergency fixtures, every pump station shall be provided with two nos. of portable emergency luminary, which shall be with CRCA sheet steel enclosure, complete with metalized mirror reflector, leak proof re-chargeable battery rated for two hour discharge, battery charger, charger-on lamp, push button switches, automatic changeover switch/relay, two metre length cord with plug, mounting pads and other accessories required for satisfactory operation of the luminaries.

e) The luminaries shall be suitable for connection to 240 V, 50 Hz single phase supply. On failure of normal AC supply the luminary shall start automatically and on restoration of AC supply the luminary shall switch off automatically.

35.7.9 Accessories for Luminaries:

a) The Routine test on each of the offered Luminaire shall be carried out by the CONTRACTOR before dispatch. Following tests shall be carried out as Routine tests by the CONTRACTOR for the offered

Luminaires;

(i) Visual and Dimensional check

(ii) Checking of documents of purchase of LED

(iii) Insulation resistance test

(iv) HV test

(v) The Reverse polarity

b) Acceptance test shall be carried out by EMPLOYER or EMPLOYER's Representative on a sample of the lot offered for Acceptance. The Lot shall be different from the lot from which the Type test samples have been drawn. The cost of the testing shall be borne by the CONTRACTOR. Following tests shall be carried out as Acceptance tests by the CONTRACTOR for the offered Luminaires;

(i) Visual and Dimensional check

(ii) Checking of documents of purchase of LED

(iii) Insulation resistance test

(iv) HV test

(v) Over voltage protection

(vi) Surge protection

(vii) Reverse polarity

(viii) Lux measurement

(ix) Test for IP 65 protection

c) Following Type tests reports shall be provided by the CONTRACTOR for the offered Luminaires along with the BID;

(i) Resistance to humidity

(ii) Insulation resistance test

(iii) HV test

(iv) Over voltage protection

(v) Surge protection

(vi) Reverse polarity

(vii) Temperature rise Test

(viii) Ra (Colour Rendering Index) measurement test

(ix) Lux measurement

(x) Fire retardant Test

(xi) Test for IP 65 protection

(xii) Endurance Test,

(xiii) Life Test

(xiv) Photometric Measurements Test Report (IES LM 79)

(xv) LED Lumen Maintenance Test Report (IES LM 80)

(xvi) Vibration test as per ANSI

35.7.10 Lighting System Equipment:

a) Main Distribution Boards and Lighting Panels:

i. Main Lighting distribution board (MLDB) shall have MCCB as incomer & outgoing feeder with thermal magnetic release for O/L+S/C+E/F protections.

ii. This MLDB shall feed to different Lighting Panels/ Lighting DBs for further distribution.

iii. Where ever MLDB is not applicable, lighting feeder of appropriate rating shall be derived from the local distribution board. This feeder will feed to local LP catering to lighting requirements of that particular area.

b) Constructional Features:

i. Boards and panels shall be sheet steel enclosed and shall be fully dust and vermin proof, providing a degree of protection of IP-54 for indoor. Outdoor panels shall in addition be completely weather-proof with a sloping canopy for protection against rain and providing a degree of protection of IP-55. The sheet steel used for frame, frame enclosures, doors, covers and partitions shall be cold rolled 2.0 mm thick.

ii. The lighting panel for outdoor lighting shall have a programmable timer for automatic control of lighting along-with contactor, MCB, auto/ manual selector switch.

iii. All boards and panels shall be provided with hinged doors for access to equipment. Doors shall be gasketed all round with neoprene gaskets.

iv. A slotted metallic sheet shall be provided inside. Only the MCBs operating knobs shall project out of the metallic sheet slots for safe operation and neat appearance. Incomer to lighting panels shall be provided with Four pole MCB + RCCB

v. All accessible live connections/metals shall be shrouded and it shall be possible to change individual MCBs from the front of the boards/ panels without danger of contact with live metal.

vi. For floor mounting type distribution boards, adequately sized mounting channels shall be supplied and for wall/column/structure mounting type panels suitable mounting straps shall be provided.

vii. Adequate interior cabling space and suitable removable cable entry plates shall be provided for top/ bottom entry of cables through glands and or conduits as required. Necessary number of glands to suit the specified cable sizes shall be provided. Cable glands shall be screwed on type and made of brass.

viii. Two earthing terminals shall be provided to suit the earthing conductor.

ix. All sheet steel parts shall undergo rust-proofing process which should include 7 tank processing. The steel works shall then be painted with two coats of Zinc - chromate primer and two coats of final epoxy based finish paint of colour 63I as per ISO/BS/IEEE 5.

c) Busbars:

i. Busbars shall be of copper conductor of hard drawn (HD) and high conductivity.

ii. Busbars shall be provided with at least the minimum clearances in air as per applicable standards.

iii. Busbars shall be adequately sized for the continuous current rating such that the maximum temperature of the bus bars, bus bar risers/droppers and contacts does not exceed 85 C under site reference temperature.

iv. The bus bars, bus bar connections and bus bar supports shall have sufficient strength to withstand thermal and electro-mechanical stresses of the MCB's let through/cut-off current associated with the specified short-circuit level of the system.

v. Busbar supports shall be WASA type. Separate supports shall be provided for each phase of the bus bars.

vi. The neutral bus of the main 3 phase, 4 wire distribution board shall be 100% of the phase busbars.

d) Panels/ Boards' Component & Lighting Accessories:

i. MCB/ ELCB :

MCBs shall be C curve type for lighting panels.

For all the lighting panels RCCBs shall be with 100 mA sensitivity & for all receptacles RCBO sensitivity shall be 30 mA.

ii. MCCB :

MCCB requirements shall be as per specified in the LV switchgear requirements & as specified above.

iii. Indicating Instruments and Meters:

Whenever required, instruments and meters shall be of the flush mounting type. They shall be suitably mounted so as to provide for easy access to CTs and small wiring.

Instruments shall be of minimum 96 mm square size, shall have provision for zero adjustment outside the cover and black numerals on white dial.

Ammeter/Voltmeter selector switches having 3 positions and off, with stay-put contacts rated 10A shall be provided when specified.

Potential fuses shall be provided at the tap-off point from the bus bars for the voltmeters.

iv. Instrument Transformers:

Current and voltage transformers shall be of cast resin type, with insulation class B, & accuracy class 1.0 unless otherwise specified, it shall be the responsibility of the Contractor to ensure that the VA burden of the instrument transformer is adequate for the meters connected to it.

Test links shall be provided in both secondary leads of the CTs to easily carry out current and phase angle measurement tests. Facilities shall be provided for short-circuiting and grounding the CTs at the terminal blocks.

Voltage transformers shall be provided with suitably rated primary and secondary fuses.

v. Indicating Lamps:

Indicating lamps shall be of the clustered LED type, low watt consumption.

vi. Internal Wiring

Panels/ boards shall be supplied completely wired, ready for the external connections at the terminal blocks. Wiring shall be carried out with 1.1 kV grade, FRLS PVC insulated, multistranded Copper conductors. Conductors of adequate sizes shall be used to suit the rated circuit current.

Cross Ferruling i.e., engraved identification ferrules, marked to correspond with the wiring diagram shall be fitted at both ends of each wire.

All wiring shall be terminated on terminal blocks. Terminal blocks shall be one piece moulded rated 500 V, of reputed make of approved list, preferably stud type for higher current ratings such that wires are connected by cable-lugs and complete with nuts and washers. Terminals shall be adequately rated for the circuit current, the minimum rating shall be 20 A.

Terminals for circuits with voltage exceeding 125 V shall be shrouded.

Terminals shall be numbered and provided with identification strip for identification of the circuit.

Terminal blocks for CT secondary lead wires shall be provided with shorting and disconnecting/earthing facilities.

vii. Labels & Diagram Plate:

All door mounted equipment as well as equipment mounted inside the switchboard/panels shall be provided with individual labels with equipment designation/rating. Also the boards/panels shall be provided on the front with a label engraved with the designation of the board/ panel.

Labels shall be made of non-rusting metal, 3-ply lamicoid or engraved acrylic

Inside the door of the 1 phase ways lighting panels a circuit diagram/ description shall be fixed for reference and identification.

viii. Conduits:

Rigid steel/ non-metallic conduits and their associated fittings as required shall conform to applicable standards. The minimum size of conduit shall be 20 mm for surface installation and 25 mm for concealed installation.

Steel conduits shall be seamed by welding and hot dip galvanised. They shall be supplied in standard lengths of 5 metre.

Supply of conduits shall include all associated fittings like couplers, bends and tees as required for lighting system installation work.

ix. Junction Boxes:

Junction boxes with terminals shall be supplied for branching and terminating lighting cables when required for outdoor areas, three (3) phase receptacles etc.

The junction boxes shall be dust and vermin proof and shall be fabricated from 14 SWG sheet steel and shall be complete with removable cover plate with gaskets, two earthing terminals each with nut, bolt and washer. Boxes shall be additionally weather proof.

The boxes shall have provision for wall, column, pole or structure mounting and shall be provided with cable/ conduit entry knock outs, terminal blocks, and HRC fuses as required.

The terminal blocks, with specified number of terminals, shall be mounted securely on brackets welded to the back sheet of the box. The terminals shall be 600 V, grade, one piece construction complete with terminals, insulation barriers, galvanised nuts, bolts and washers and provided with identification strips of PVC. The terminals shall be made of Copper alloy and shall be of box clamp type.

The boxes shall be painted with one shop coat of red oxide zinc chromate primer followed by a finishing coat of paint.

x. Lighting Poles and Flood Light Pole Mounting:

Lighting poles for street lights and flood lights shall be of stepped tubular steel poles construction as per applicable standard. These poles shall be coated with bituminous preservative paint on the inside as well as embedded outside surface. Exposed outside surface shall be painted with one coat of red lead oxide primer. After completion of installation two coats of aluminium paint shall be applied.

Poles for mounting flood lights shall be supplied whenever required and as per typical attached drawing. Unless

otherwise specified, poles shall be painted with red lead oxide primer and two coats of aluminium paint. One steel ladder shall be provided separately. The length of each step of the ladder shall be at least 300 mm and spacing between two adjacent steps not more than 300 mm.

The supply of poles shall be complete with fixing bracket/necessary pipe reducer for fixing the fitting and also include the necessary associated pole mounted junction boxes.

The required sizes of poles and the junction box shall be as indicated in the attached drawings.

Outdoor JBs shall be minimum IP 55 protected.

Cable entry for street lighting junction boxes shall be from bottom.

Rain water canopy shall be provided at the top for the outdoor JBs. Terminal strip shall be provided for looping loop out of cables.

Street lighting JB shall consist of terminal strip (3 ways) for looping in & loop out of cables. The JB shall be provided with 6A MCB (C- Curve type) for isolation of lighting fixture, as well as sufficient arrangement (earthing studs) for termination of 2 nos. earthing connections.

xi. Ceiling Fans/ Wall Mounted Fans:

Ceiling/ Wall mounted fans shall be suitable for operation on 240 V, 1 phase,

50 Hz supply and shall be complete with standard mounting accessories such as suspension rods, top and bottom caps etc for ceiling fans and easy accessibility for wall mounted fans. The fans shall be supplied with appropriate speed regulators.

Exhaust fans, where ever required shall also be provided. The exhaust fan with all parts shall be according to ISO/BS/IEEE: 2312- 1967 & its latest amendment with IP-55 specification. The exhaust fan shall have epoxy powder coating with specially pretreated components for better resistance to corrosion and acid alkali flumes. The exhaust fan shall have totally enclosed highly efficient heavy duty motor with pressure die cast aluminum rotor mounted on two ball bearings.

The fans shall generally conform to the applicable

standards indicated in Tender. Details regarding blade sweep and suspension requirements shall be as per Project layout drawing/price schedule.

35.8 DC SYSTEM

35.8.1 Scope:

DC system (as applicable) shall include the following:

a) One set of 24/ 30 or 110 V DC, maintenance free rechargeable sealed lead acid batteries of adequate AH capacity shall be provided for control of electrical switchgears in the Plant.

b) Batteries shall be provided with battery charger cum DC distribution board. Battery charger shall include a float & float cum boost charger, indicating lamps and annunciations.

35.8.2 Sealed Maintenance Free Lead Acid Battery

a) Applicable Standards: The sealed maintenance free lead acid battery shall conform to the latest applicable standards specified below. In case of conflict between standards and this specification this specification shall govern.

Sealed lead acid: ISO/BS/IEEE: 1651, 1652 BS: 6290

b) The sealed batteries shall be a starved electrolyte type with electrolyte immobilized in a micro-porous material to allow recombining of generated oxygen internally. The battery shall be completely explosion resistant, shall tolerate freezing and shall not allow gases to escape during normal charging conditions. The battery shall not require any watering and be maintenance free.

c) Positive Plates: Positive plates shall be either of cast solid in pure lead in one piece with plante formation and shall have adequate mechanical strength or of tubular plate which shall consist of a suitable bar with spines cast of suitably alloyed lead to give adequate mechanical strength or of pasted positive plates consisting of either pure lead, low anti- monial lead alloy or lead calcium positive grids; having double separation with a glass wool retainer mat or any other suitable material placed against the surface of the positive plates for good service life.

d) Negative Plates: The negative plates shall normally be of the box type. End negative plates, if of box type may be of the half pasted type. Pasted plates shall have adequate mechanical strength and shall be so designed that the active material is maintained in intimate contact with the grid under normal working conditions.

e) Containers: The containers shall be made of plastics, or fiber

reinforced plastics (FRP). The container shall be spill proof, leak proof, explosion resistant and increased safety type enclosure.

f) Vent Plug: The vent plug shall be for safety pressure vent and of self resealing type.

g) Separators: The plate separator shall consist of a micro-porous matrix which shall serve as the mobiliser for the electrolyte. The battery separator shall maintain the electrical insulation between the plates and shall allow the electrolyte to permeate freely.

h) Connectors and Terminal Posts: Inter-cell and inter-tier connectors and terminal posts shall be of Copper. Terminal posts shall be designed to accommodate external bolted connection conveniently and positively. Each terminal post shall have two bolt holes of the same diameter, preferably at right angles to each other. The bottom hole shall be used to terminate the inter-cell connection. The top hole shall be left for terminal connections. All the metal parts of the terminals shall be lead coated. The junction between terminal posts and cover and between cover and container shall be so sealed as to prevent any seepage of electrolyte.

i) Electrolyte: The electrolyte shall be battery grade sulphuric acid conforming to latest editions of relevant standards. The sealed battery shall be transported with the electrolyte immobilized, sealed and fully charged.

j) Accessories: The battery shall be complete with accessories and devices, including but not limited to the following:

   i. Battery racks

   ii. Set of inter cell, inter-tier and interbank connectors as required for the complete installation.

   iii. One Voltmeter with suitable range and leads for measuring cell voltage

   iv. Insulated wrencher.

k) One set of terminals and cable boxes with glands for connecting cable as required.

l) Battery Racks: Battery racks shall be constructed from good quality teak wood and painted with two coats of approve alkali resisting paint. The construction of the racks shall be suitable for fixing to a flat concrete floor. The racks shall be rigid, free standing type and free from warp and twist. The completed racks shall be suitable for being bolted end to end to form a continuous row. Insulators shall be provided below the legs of the stands.

m) Capacity: The standard ampere-hour capacity at ten hour rate of discharge of the battery has been based on the requirements of loads as applicable and the minimum ambient temperature specified. Contractor shall guarantee that the capacity of the battery offered by him is adequate for the duty specified (all loads being coincident from the instant of supply failure even at the minimum ambient temperature as specified) assuming that the battery is fully charged to

i. 2.15 V at the start of the cycle

ii. 1.75 V/ cell at the end of the cycle.

n) The Battery sizing basis shall be IEEE 485 & the Contractor to note that the Battery sizing shall be done considering design ambient temperature of 50ºC & following factors.

i. Design Factor- Min. 1.1

ii. Aging Factor- Min. 1.25

iii. Temperature Correction Factor- Min. 1.1

o) Cell Identification: Each cell shall be marked in a permanent manner to indicate the following information:

i. Cell number

ii. Type of positive plate

iii. Ah capacity at 10 hour rate

iv. Type of container

v. Manufacturer's name

vi. Month and year of manufacture.

p) Drawings/ Document: The complete battery layout drawing shall be furnished as part of the tender and also after award of contract for Purchaser's approval.

35.8.3 Battery Chargers:

a) The battery charger and DC Distribution board shall conform to the latest applicable standards specified below. In case of conflict between the standards and this Specification, this Specification shall govern Basic climatic and mechanical durability tests for components for electronic and electrical equipment Environmental tests for electronic and electrical equipment Metal clad base material for printed circuits for use in electronic and telecommunication equipment Transformers and inductors (power, audio, pulse and switching) for electronic equipment ISO/ BS/ IEEE:9000

b) Requirements: The Battery Charger shall be microprocessor based & shall have two chargers mainly- i) Float Charger ii) Float cum Boost Charger.

c) The float & float-cum-boost type battery charger shall comprise silicon controlled rectifiers (SCRs) connected in a full wave bridge circuit. Each battery charger shall be suitable for float charging the battery under normal conditions and boost charging the battery when it has discharged during service conditions. The changeover from float to boost mode and vice versa shall be automatic. Microprocessor shall be MU 1000C or Equivalent makes from the approved makes.

d) The rectifier transformer shall be dry type and double wound with required number of taps. The DC output voltage during float charging shall be stabilized within ±1% of the set DC bus voltage for AC input voltage variation of ±10%, frequency variation of ± 5% and DC load variation from 0 - 100%. The voltage regulation shall be achieved by a constant voltage regulator having fast response SCR control. The ripple content shall be within ±1% of DC output nominal voltage with battery disconnected and shall be designed to have voltage regulation of ±1%. Also in any mode of operation, the maximum harmonics in the charger output shall not exceed 5%.The setting of the output DC bus voltage shall be adjustable between ± 10% of nominal rated voltage. There shall be provision for manual control if auto mode fails. Line surge suppressers shall be provided.

e) If the spare float charger supplying DC load fails, the load shall be fed from the point of connection at the tapping of the battery via adequately rated blocking diodes. Two blocking diodes in series shall be provided to take care of short circuit of any one diode

f) For boost charging the discharged battery after a mains failure, the rectifier shall charge the battery at high rate limited to the maximum boost charging voltage. The boost charging shall come on only when selected for boost mode manually. In auto control, the DC output current shall be stabilized within ±2% for AC input voltage and frequency variation of ±10% and ±5% respectively. There shall be provision for manual control if auto-mode fails. The boost charge voltage and current settings shall be adjustable between 70 to 100% of maximum boost charge voltage and between 30 to 100% of maximum boost charging current.

g) Boost charging time for charging the battery to full capacity from fully discharged condition shall not exceed 8 hours.

h) In the float charging mode, the charger shall be designed for supplying:

i. The DC loads of control, indication and annunciation circuits that remain energized during normal operation and the momentary closing and trip coil loads of circuit breakers, vacuum contactors; and

ii. The float charging current of the battery.

iii. 25% margin over the above load.

i) Battery charging equipment complete with all accessories shall be housed in a free standing sheet steel cubicle having degree of protection of IP 42. Sheet steel used for construction shall be 2 mm thick. The units shall be wired using 1100 V grade, FRLS PVC insulated, multi-stranded Copper conductor cables.

j) During boost charging the DC bus load shall be connected via two diodes in series connected to the tap cell of the battery. This is to take care in case of failure of standby charger supplying DC load.

k) All printed circuit cards shall be plug-in type, interlocked to prevent insertion in a wrong slot. Each card shall have LED indication on its front plate to indicate normal condition and readily marked test pins.

l) All components shall be accessible to the maintenance technician for easy disassembly and replacement. Access to parts of equipment shall be with minimum danger from all hazards.

m) All components and modules shall be clearly and unambiguously marked and all wiring colour coded and tagged

n) Each battery charger shall be provided with accessories that include, but not limited to the following:

i. Electronic controller comprising of power supply card, soft start cum current limit card, auto trickle mode card with facility for setting trickle charge current and monitoring battery current, error amplifier cards and pulse generating cards for achieving the DC output voltage stabilization of ±1% and also for achieving current limiting feature. The electronic controller shall have protection features with indications for under-voltage, over-voltage, earth fault, set output voltage and phase failure or voltage unbalance. The controller shall also be suitable for boost charging the battery in case of float-cum-boost charger.

ii. Boost charge current limiter with potentiometer to adjust the setting

iii. Silicon controlled rectifiers connected in full wave bridge circuit with ripple control devices and transient suppression network.

iv. 240 V AC compact fluorescent lamp fixture for internal lighting with MCB

v. Automatic voltage regulator unit with Manual/ Auto control switch

vi. Double wound, dry type, three phase suitably rated mains transformer with fuse protection and with one set of power factor correction capacitors to maintain a power factor of 0.85 (lag).

vii. Electronic controller comprising of power supply card, soft start cum current limit card, auto trickle mode card with facility for setting trickle charge current and monitoring battery current, error amplifier cards and pulse generating cards for achieving the DC output voltage stabilization of ±1% and also for achieving current limiting feature. The electronic controller shall have protection features with indications for under-voltage, over-voltage, earth fault, set output voltage and phase failure or voltage unbalance.

viii. Adequately sized necessary built-in accessories shall be provided such that on failure of the controller in auto mode the voltage can be effectively controlled manually.

ix. Filter circuit comprising of smoothing choke and condensers complete with HRC fuse with trip indication for filter condenser circuit

x. Coarse and fine control potentiometers for manual control

xi. Selector switch for mode of charging i.e. float charging / boost charging

xii. Off-load tap changing switch for changing the taps of the transformer

xiii. DC voltmeter with fuses and a three position selector switch

xiv. DC ammeter with shunt

xv. AC ammeter with selector switch for incoming AC power

xvi. AC voltmeter with selector switch for incoming AC power

xvii. MCB for incoming AC supply along with surge suppressers

xviii. MCB on DC output side with kick fuses and alarm contacts

xix. Voltage dropping diodes in load circuit during boost charging mode

xx. DC under voltage relay and earth fault relay

xxi. AC/ DC switching relays for alarm and indication circuits including buzzer

xxii. Cubicle space heater suitable for 230 V AC, 1 ph, 50 Hz supply, with MCB and thermostat

xxiii. Each battery charger shall be provided with the following alarms / indications:

AC and DC supply 'ON'

AC and DC supply fail

Modes of charging

Over voltage

Under voltage on DC side

Earth fault on DC side

AC/ DC MCB trip

o) The DC circuit switching shall be through DC MCBs only.

p) Power Electronic Components:

i. Diode and thyristors shall be of mono-crystalline type silicon, capable of providing continuous output at specified voltages. It shall have high power efficiency.

ii. If many diode or thyristor assemblies are connected in parallel, care shall be taken to ensure that each rectifier or thyristor operates within its rating and shares the load uniformly.

iii. Each diode or thyristor built in a multi-built assembly shall be provided with a short circuit protection to avoid complete shut-down of the equipment because of a fault on single unit. Suitable fuses shall be provided for such protection.

iv. Necessary spare capacity shall be built in the equipment to continuously supply full load even with one unit out of circuit.

v. The diodes or thyristors shall be protected against overvoltage due to chopping surges with the aid of snubbers (i.e resistor-capacitor combination and Metal oxide variator

35.8.4 DC Distribution Board:

a) The distribution board shall be of floor mounting design. Entry for

incoming and outgoing cables shall be from the bottom. Bus bars shall be of Copper. Incomers, bus coupler and outgoing circuits shall be controlled by suitably rated double pole MCBs suitable for DC application.

b) Constructional features, pre-treatment, painting and other aspects shall comply with the specifications for LV switchboard.

c) An earth busbar of 25x3 mm copper flat shall be provided along the length of the DB at the bottom. Two nos. earthing terminals shall be provided on the external face of the board for connection to the earthing grid.

35.8.5 Tests

a) The batteries, chargers and distribution boards and their components shall be subjected to routine/ acceptance tests as per the applicable standards. For battery & battery charger, following tests are also to be carried out:

i. Visual checks for dimensions and general arrangement.

ii. Wiring checks.

iii. Functional checks.

iv. IR Test.

v. Capacity test.

vi. Test for voltage charging and discharging.

vii. Ampere-hour and watt-hour efficiency test.

viii. Hipot test, excluding electronic controller, at 2 kV AC for one minute.

b) Certificates of type tests carried out on similar equipment not older than 5 years shall be furnished by Contractor.

1.1.3 DRAWINGS/ DOCUMENTS REQUIRED:

After award of contract Contractor has to submit the below mentioned drawings/ documents for Purchaser's approval :

a) Dimensioned general arrangement drawings

b) Fully dimensioned general arrangement drawings of battery and battery charger with elevation, side view, sectional view and foundation details

c) Complete schematic and wiring diagrams.

d) Detailed BOM for the complete panel, with details of switchgear, controller, components etc.

SECTION-36 SAFETY EQUIPMENTS/ REQUIREMENTS AND MISCELLANEOUS ITEMS:

Following safety procedure and practice should be provided by Contractor in switchgear room/ sub-station as per latest edition of GOP MRS SPECS 1967 VOL-1. 5216.

900 mm wide antiskid insulating mat as per ISO/BS/IEEE 15652 and of reputed make to be spread in front of the 11kV, 415V switch gear panels & power DBs, DCDB etc.

First aid box with all the standard contents.

First aid chart made of cloth for electrical shock treatment printed in English, Hindi and Gujarati duly framed with front glasses.

Charts/ drawings duly framed with front glass.

HV and LV power supply single line diagrams in adequate sizes approved by Purchaser/ Purchaser's representative & in line with the local electrical inspector.

Routine maintenance schedule for High Voltage Switchgear, Distribution Transformers, Low voltage Switchgears, APFC panels, Fire Alarm System, UPS system etc.

Provision of portable type Class A, B, C, and D type fire extinguishers at various locations in line with the statutory requirements.

36.1 FIRE SAFETY

The requirement of hand appliance in switchgear room, electrical equipment room shall be provided as per Clause 4.0 of Fire Protection Manual by Regional Tariff Committee, 10th edition 1988.

Water Sealing & Fire Barriers at appropriate locations as specified in this specifications & good engineering practices.

36.2 DEGREE OF PROTECTION

The enclosures of the control cabinets, junction boxes and Marshalling boxes, panels etc. to be installed shall provide minimum degree of protection as detailed here under

a) Installed outdoor – IP 55

b) Installed indoor – IP 54

The degree of protection shall be in accordance with ISO/BS/IEEE 13947 (Part I)/ IEC 947 (Part I)/ ISO/BS/IEEE 2063/ IEC 529

36.3 ELECTRICAL EQUIPMENT FOR HAZARDOUS AREAS

The electrical equipments for hazardous areas shall be selected as per ISO/BS/IEEE 5572. Following factors shall be considered for proper selection of electrical equipments for use in Hazardous Area.

36.3.1 Area Classification (Zone):

Gas Classification (Group) – The characteristics of the gas or vapour involved in relation to the ignition or energy and safe gap data

Temperature Classification - The ignition temperature of the gas or vapour involved or lowest value of the ignition temperature, if more than one combustible material is present.

Environmental conditions – In which apparatus is to be installed. The selected electrical apparatus shall be adequately protected against corrosive and solvent agencies water ingress, thermal and mechanical stresses as determined by the environmental condition.

SECTION-37 INSTALLATION, TESTING & COMMISSIONING – ELECTRICAL EQUIPMENT:

37.1 GENERAL:

In accordance with the specific installation instructions, as shown in Contractor's drawings or as directed by the Engineer In Charge the Contractor shall unload, erect, install, wire, test and place into commercial use of all electrical equipment included in the contract. Equipment shall be installed in a neat manner so that it is level, plumb, and properly aligned and oriented.

The Contractor shall furnish all supervision, labour, tools, equipment, rigging materials and incidental materials such as bolts, wedges, anchors, concrete inserts etc. required to completely install, test and adjust the equipment.

Drawings, instructions and recommendations shall be correctly followed in handling, settling, testing and commissioning of all equipment and care shall be exercised in handling to avoid distortion to stationary structures, the marring of finish, or damaging of delicate instruments or other electrical parts.

The Contractor shall erect and commission the equipment as per the instructions of the Purchaser/ Engineer In Charge and shall extend all co-operations to him.

In case of any doubt/ misunderstanding as to correct interpretation of drawings or instructions, necessary clarification shall be obtained from the Engineer's Representative. The Contractor shall be held responsible for any damage to the equipment consequent to not following instructions correctly.

The Contractor shall move all equipment into the respective buildings through regular doors or floor openings provided specifically for the equipment. The Contractor shall make his own arrangement for lifting of equipment.

Where assemblies are supplied in more than one section, the Contractor shall make all necessary mechanical and electrical connections between sections including the connections between bus bars/ wires. The Contractor shall also carry out the adjustments/ alignments necessary for proper operation of the circuit breakers. All insulators and bushings shall be protected against damage during installation. Insulators or bushings chipped, cracked or damaged due to negligence or carelessness shall be replaced by the Contractor at his own expenses.

The Contractor shall take utmost care in handling instruments, relays and other delicate mechanisms. Wherever the instruments or relays are supplied separately, they shall be mounted only after the associated control panels have been erected and aligned. The blocking material/ mechanism employed for the safe transit of the instruments and relays shall be removed

after ensuring that the panels have been completely installed and no further movement of the same would be necessary. Any damage to relays and instruments shall be immediately reported to the Engineer In charge.

Equipment furnished with finished coats of paint shall be touched up by the Contractor if their surface is spoiled or marred while handling.

Foundation work and grouting of fixing bolts or channels for all transformers, switchgear, motors, and control panels shall be carried out by the Contractor.

37.2 POWER/ DISTRIBUTION TRANSFORMERS

Inspection, storage, installation, testing and commissioning of transformers shall be in accordance with the latest Pakistann Standards Code of Practice ISO/BS/IEEE: 10028. All commissioning tests as applicable, vide Appendix B of ISO/BS/IEEE: 10028 (Part II) shall be carried out. Fire Wall of 4 Hr fire rating shall be provided between two transformers.

37.3 HV/ LV SWITCHGEAR CONTROL PANELS

Switchgear control panels shall be installed in accordance with the latest Pakistann Standard Code of Practice 10118. The switchgear panels shall be installed on finished surface or concrete or steel sills. The Contractor shall be required to install and align any channel sills which form part of the foundations. Tape or compound shall be applied where called for. The base of outdoor type units shall be sealed in an approved manner to prevent ingress of moisture.

Following minimum clearances shall be observed while finalizing the HV/ LV panel layouts-

a) Minimum clearance of 1.0 meter shall be maintained from the rear of the panel to the nearest wall /structure.

b) Minimum clearance of 2.0 meter between panels facing opposite to each other.

c) Side clearance for LV panels shall be either ≤ 200mm or ≥ 800 mm.

d) For HV metal enclosed, indoor panels, Minimum 1 meter clearance from all sides & 1.5 meter in the front.

Emergency Exit doors shall be provided for electrical room, complying with the requirements of NBC 2005 latest edition.

After installation of all power and control wiring, the Contractor shall perform operating tests on all switchgear and panels to verify the proper operation of switchgear/ panels and the correctness of the interconnections between various items of equipment. This shall be done by applying normal a-c or d-c voltage to the circuits and operating the equipment. Megger tests for

insulation, polarity checks on the instrument transformers, operation tests on equipment, and installation tests shall be carried out by the Contractor who shall also make all necessary arrangements for proper functioning of the equipment.

37.4 EARTHING AND LIGHTNING PROTECTION SYSTEM

The Contractor shall install copper/ steel conductors, braids, etc., required for the system and individual equipment earthing. All work such as cutting, bending, supporting, painting/ coating, drilling, brazing/ soldering/ welding, clamping, bolting and connecting onto structures, equipment frames, terminals, rails or other devices shall be in the Contractor's scope of work. All incidental hardware and consumables such as fixing cleats/clamps, anchor fasteners, lugs, bolts, nuts, washers, bituminous compound, welding rods, anti-corrosive paint as required for the complete work shall be deemed to be included by the Contractor as part of the installation work.

The quantities, sizes, material of earthing conductors and electrodes to be installed as per requirement. Routes of the conductors and locations of electrodes shall be shown in the earthing layout drawings, which are to be prepared by Contractor & approved by Purchaser's representative.

The work of embedment of earthing conductor in RCC floors/ walls along with provision of earth plate inserts/ pads/ earth risers shall be done by the Contractor when the floors are cast or during construction of walls. Contractor's scope of installation shall also include, laying the conductors in position with 60 mm concrete cover, making welded connections to inserts/pads/risers above the floor near the equipments. The embedded conductors shall be connected to reinforcing rods wherever necessary.

If the tap connections (earthing leads) from the floor embedded main earthing grid to the equipment are more than 500 mm long then the same shall be embedded in floor by the Contractor where required, together with associated civil work such as excavation/chasing, concreting and surfacing. The concrete cover over the conductor shall not be less than 60 mm.

Installation of earth conductors in outdoor areas, buried in ground, shall include excavation of earth up to 600 mm deep 450 mm wide, laying of conductors at 600 mm depth, brazing/ welding as required, of main grid conductor joints as well as risers of length 500 mm above ground at required locations and then backfilling material to be placed over buried conductor shall be free from stones and other harmful mixtures. Backfill shall be placed in layers of 150 mm, uniformly spread along the ditch, and tampered utilizing pneumatic tampers or other approved means. If the excavated soil is found unsuitable for backfilling, the Contractor shall arrange for suitable material from outside.

Installation of earth connection leads to equipment and risers on steel

structures/ walls shall include laying the conductors, welding/ cleating at specified intervals, welding/ brazing to the main earth grids risers, bolting at equipment terminals and coating welded/ brazed joints by bituminous paint. Galvanized conductors shall be touched up with zinc rich paint where holes are drilled at site for bolting to equipment/ structure.

Electrodes shall be installed in constructed earth pits, and connected to main buried earth grid, The scope of work shall include excavation, construction of the earth pits including all materials required for construction of earth pits, placing the rod and fixing test links on those pipe/ rod/ plate electrodes in test pits and connecting to main earth conductors.

Installation of lightning conductors on the roofs of buildings shall include laying, anchoring, fastening and cleating of horizontal conductors, grouting of vertical rods wherever necessary, laying fastening/ cleating/ welding of the down comers on the walls/ columns of the building and connection to the test links to be provided above ground level.

Installation of the test links shall include mounting of the same at specified height on wall/column by suitable brackets and connections of the test link to the earth electrode.

Whenever main earthing conductor crosses cable trenches, they shall be buried below the trench floor.

Suitable earth risers shall be provided above finished floor/ ground level. If the equipment is not available at time of laying of the main earth conductors, the minimum length of such riser inside the building shall be 200 mm and outdoors shall be 500 mm above ground level. The risers to be provided shall be marked in project drawings.

Earth leads and risers between equipment earthing terminals and the earthing grid shall follow as direct and short a path as possible.

An earthing mat shall be provided under each operating handle of the isolator and operating mechanism of HV breakers. Operating handle of the isolator and supporting structure shall be bonded together by a flexible connection and connected to the earthing grid.

A separate earth electrode bed shall be provided adjacent to structure supporting lightning arrestors. Each connection shall be as short and as straight as practicable. For arrestors mounted near transformers, earth conductors shall be located clear off the tank and coolers.

Wherever earthing conductors passes through walls, galvanized iron/PVC sleeves shall be provided for the passage of earthing conductor. The pipe ends shall be sealed by the Contractor by suitable water proof compound.

37.4.1 Earthing Connections:

a) All connections in the main earth conductors buried in earth/

concrete and connection between main earthing conductor and earth leads shall be of welded type.

b) Connection between earth leads and earthing terminal provided on the equipment shall be bolted type.

c) All bimetallic connections shall be treated with suitable compound to prevent moisture ingression.

d) Metallic conduits and pipes shall be connected to the earthing system.

e) Lightning protection system down conductors shall not be connected to other earthing conductors above ground level. Also no intermediate earthing connection shall be made to lightning arrester and transformer earthing leads which shall be directly connected to pipe electrode.

37.4.2 Earth Electrodes:

a) Electrodes shall as far as practicable, be embedded below permanent moisture level.

b) Test pits with concrete covers shall be provided for periodic testing of earth resistance.

Installation of pipe electrodes in test pits shall be suitable for watering. The necessary materials required for installation of test pits shall be supplied and installed by Contractor. The installation work shall also include civil work such as excavation and connection to main earth grid.

c) Earth pits shall be treated with salt and charcoal. In case found necessary, then with the approval of Purchaser's representative, Back fill compound of suitable composition may be used. Back fill material shall not be water soluble & shall retain moisture & enhance conduction around electrode. Back fill compound shall be low resistance & non corrosive earth enhancement compound which shall provide safe discharge path to fault current & lightening current.

d) Ohmic value shall be within safe limits & it shall be stable & not fluctuating.

e) Soil, salt and charcoal placed around the electrode shall be finely graded, free from stones and other harmful mixtures. Backfill shall be placed in layers of 250 mm thick uniformly spread and compacted. If excavated soil is found unsuitable for backfilling, the Contractor shall arrange for a suitable soil from outside.

37.5 INSTALLATION OF CABLE RACKS AND CABLE TRAYS

37.5.1 General

a) Lines and grade for trays may be measured from building steel and finished floor elevations. Change in line or grade, or the addition of offsets by means of cutting standard tray sections and inserting additional tray fittings to match with the existing arrangement shall be considered as a normal part of the work.

b) Where embedded steel inserts in concrete floors/ walls for welding the supports for cable racks/ trays are not available, Contractor shall provide suitable anchor fasteners at no extra cost.

c) Cable shall be clamped to the cable trays at every 750 mm distance.

d) Flexible metallic conduits shall be used for termination of connection to equipment such as motors, limit switches and other apparatus.

37.5.2 Cable Trays

All the cable tray shall be hot dipped galvanized with minimum galvanization thickness as per mentioned in this specifications.

a) Cable tray shall be of perforated sheet steel with formed flanges and of minimum thickness not less than 1.25 mm for trays up to 100 mm width, not less than 1.5 mm for trays from 100 mm to 150 mm width and not less than 2.0 mm for trays from 150 mm to 300 mm width.

b) All the cable trays above 300 mm width shall be of ladder type with minimum thickness of 2.5 mm.

c) Cable tray for use in areas where chlorine gas may be present shall be constructed from U-PVC or GRP. Cable tray supports shall be of a compatible finish with the associated cable tray.

d) All cable trays tees, intersection units, bends, turns and sets shall be prefabricated (made by the manufacturer) and shall be of a matching design to the main section of cable tray.

e) Tray shall only be joined by couplers supplied by the manufacturers. The joint shall be secured in accordance with the manufacturer's instructions.

f) Cable tray supports supplied by a manufacturer or made up on Site shall have adequate strength to maintain rigid support to the fully laden cable tray along its entire length and shall ensure that the deflection of any one section does not exceed 15 mm at mid span.

g) Wherever possible, cable trays shall be installed in full lengths without cutting. Should it be necessary to cut or drill a length of tray, the bared ends or damaged section of the tray shall

immediately be given a coat of zinc rich cold galvanized paint. All site manufactured accessories, supports and metal fittings required to ensure correct installation of the cable trays shall be similarly treated.

h) All cables shall be firmly secured to the tray using purpose made saddles, as approved by the Purchaser's Representative, together with proprietary nylon fasteners and/or cable cleats. Following installation of cables, the tray shall remain rigidly supported and the deflection of any section shall not exceed 15 mm at mid span. All brackets and tray work shall be suitable for withstanding a temporary weigh of 125 kgs.

i) Cable trays shall not be cut to allow the passage of cables through the surfaces of the tray

j) The sizing of the cable tray shall provide a minimum of 20% spare capacity.

k) The tray shall be run at least 300 mm clear of plumbing and mechanical services.

l) Bends in the installation shall take account of the minimum bending radii of cables to be installed.

m) All the cable trays shall be supplied with cable tray supports (of adequate size) at no more than 1.2 meter interval.

n) Other cable tray details & cabling system shall be as per typical drawings attached with the specifications.

37.5.3 Cable Trunking – Metal

a) Cable trunking shall be manufactured from mild steel of not less than 1.25 mm and shall be hot dipped galvanized. The Contractor shall ensure that the size of the trunking is adequate for the number of cables to be installed together with 50% spare capacity and shall in any case be 50 mm x 50 mm minimum size.

b) Segregation of cables shall be carried out if required using continuous sheet steel barriers with the bottom edge welded to the trunking.

c) The trunking shall have two return flanges for rigidity. Where necessary, additional strengthening straps shall be fitted internally. The cover shall overlap the trunking and be made of the same gauge. Fixing screws for covers shall be recessed and be of the self retaining `quick fix' type. All bends, tees and intersections shall be of the gusset type and shall, wherever possible, be purpose made by the manufacturer and of a matching design to the main trunking.

d) Cables shall be retained in the trunking when the cover is removed by means of straps.

Internal connecting sleeves shall be fitted across joints in the trunking and earth continuity ensured by bonding each section of trunking to a continuous earth wire.

e) Non-flammable fire barriers shall be inserted where the trunking passes through walls or floors. Conduit connections to trunking shall be made by flanged couplings and male bushes.

f) Trunking shall be supported at intervals not greater than 2 meter horizontally or 2.5 meter vertically.

g) Crossings over expansion joints shall be made in flexible conduit.

h) Should it be necessary to cut or drill a section of trunking or a trunking fitting the bared ends shall immediately be given a coat of zinc rich cold galvanizing paint.

i) Cable and conduit/ trunking runs shall be determined by the Contractor and agreed by the Purchaser's Representative before any work is started. The run shall be at least 300 mm clear of plumbing and mechanical services.

j) Conduit/trunking systems erected outside a building shall be weatherproof.

37.6 CABLE INSTALLATION

37.6.1 General:

a) Cable installation shall be in accordance with ISO/BS/IEEE 1255: 2001- latest edition

b) Cables shall be installed in such a way that the minimum bending radii are not reduced when installed or during installation. Cables shall not be installed in ambient temperatures below that recommended by the cable manufacturer.

c) Cables grouped together shall have insulation capable of withstanding the highest voltage present in the group.

d) Cables of different categories shall be installed so as to maintain satisfactory clearances for safety and in order to reduce the possibility of electrical interference. The following Table details the distances in mm that shall be maintained between the different categories of cable.

Table of Separation Distances in mm between different Categories of Cable

Cable Category	HV Power	LV Power	C&I/ Protection	Tele-communication

HV Power	N/A	300	600	600
LV Power	300	N/A	300	300
C&I/ Protection	600	300	N/A	200
Tele- communication	600	300	200	N/A

e) These separations are minimum and special circumstances such as the presence of high current flows, or harmonic content may necessitate larger separation distances.

f) A distance of minimum 300mm shall be maintained between the cables to be laid on trays/ conduits carrying low voltage AC and DC signals and a distance of minimum 600 mm shall be maintained between cables carrying HV and LT signals.

g) In order to make economic use of the cable support system, cables shall be arranged in groups of 50 mm maximum overall diameter. These groups shall be securely tied to the cable support system at intervals not exceeding 900 mm for horizontal runs and 300 mm intervals on vertical runs.

h) In order to make the most economic use of cable tray and duct capacity, multicore cabling shall be utilized in order to connect instrumentation groups by using suitably located sub-distribution junction boxes. The junction boxes shall be suitable for the area in which they are to be installed and for the type of circuit. They shall be readily accessible for maintenance and clearly labeled junction boxes shall be constructed of die cast Aluminium and provide degree of protection IP 65.

i) Where practical a separate cable support system shall be provided for power and non- power cables. Where this is not practical a separation as per indicated in above table shall be maintained between power and non-power cables when run on the same support system.

j) Heavy duty galvanized iron cable tray and ladder racking shall be used for cable support systems. FRP/ GRP cable support systems shall be used in areas used for the storage and handling of chlorine. These systems shall be used to route cables around walls and within cable trenches. Cables shall be securely fixed to the support systems. Bundling of cables shall be permitted where allowance for this practice has been made in sizing the cables.

37.6.2 Laying of Cables:

a) Each instrumentation and power supply cable shall be terminated to individual panel/ terminal box.

b) Identification of each cable shall be by proper ferrules at each junction as per cable schedule to be prepared by Contractor.

c) Cables shall be laid in accordance with layout drawings and cable schedule which shall be prepared by Contractor and submitted for approval.

d) All cable routes shall be carefully measured and cables cut to the required lengths, leaving sufficient amount for the final connection of the cable to the terminals on either end.

e) Various cable lengths cut from the cable reels shall be carefully selected to prevent undue wastage of cables.

f) A loop of 1.0 meter shall be left near each field instrument before terminating the cable.

g) Cables shall be complete uncut lengths from one termination to the other.

h) Separate cables shall be used for digital and analog signals.

i) All cables shall be identified close to their termination point by cable numbers as per cable interconnection schedules.

j) Identification tags shall be securely fastened to the cables at both the ends.

k) Cable shall be rigidly supported on structural steel and masonry, using individually cast or malleable iron galvanized clips, multiple cable supports or cable trays.

l) The Contractor shall take the actual measurement of the cables and the associated accessories such as cable trays, conduits etc required at site, prior to the placement of order on the cables.

37.6.3 Cables Laid Direct in Ground

a) Buried cable up to 1.1 kV shall have a laid at a minimum depth of 750 mm measured from FGL to the top of the highest cable. On crossing roadways the cable shall be run through a PVC-U duct of minimum diameter 100 mm with a minimum of 1000 mm cover and encased on all sides by 150 mm of concrete.

b) Cables of greater than 1.1kV shall be buried at a minimum depth of 1 meter.

c) The bottom of the cable trench shall be freed of sharp stones and such like and 75 mm of sieved sand laid below the cable. After cable laying 75 mm of sieved sand shall be laid above the cable. For HV cables sand bedding shall be of 150 mm & cables shall be

covered with half round Hume pipes of twice the diameter of cable.

d) Interlocking cable protective covers, minimum 1 m long x 300 mm wide, marked 'Danger-Electric Cable' in English and the vernacular shall be laid on top of the sieved sand. Covers shall extend the whole length of the cable trench and shall overlap cables by a minimum of 50 mm.

e) Warning tape shall be laid a minimum of 200 mm above the protective covers.

f) Cables are to be installed without tees or through joints unless otherwise approved by the Purchaser's Representative. Single core cables shall be run in trefoil formation.

37.6.4 Cables Laid in Underground Ducts

a) Underground ducts shall be constructed of impact resistant PVC-U and laid at a minimum depth of 750 mm, ducts shall be surrounded by at least 75 mm of sieved sand except at road crossings where it shall be 1.0 meter deep and encased on all sides by 150 mm of concrete.

b) The Contractor shall ensure that sufficient draw-in points have been provided and that adequate room has been allowed for installation of cables. Drawstrings shall be provided in all ducts to enable additional cables to be installed when required.

c) Where cables pass in or out of any duct entries into or within buildings such entries, together with any spare ducts shall be sealed against the ingress of moisture by means of duct stoppers and bituminous compounds or by any other method approved by the Purchaser's Representative. The stopper shall have a fire resistance of at least 30 minutes. Single core cables in trefoil formation shall pass through the same duct and shall not be separated. However, for two different trefoil formations, they shall be laid in separate ducts.

37.6.5 Cables installed in Conduit

a) Conduits shall be galvanized heavy gauge solid drawn or welded screwed steel type and be in accordance with ISO/BS/IEEE 9537, Part 2 or BS 4568. Accessories shall either be malleable cast iron screwed type or pressed steel and galvanized.

b) A space factor of 40% shall not be exceeded, but in any case conduit of less than 20 mm diameter shall not be permitted. The tubing shall be perfectly smooth inside and out and free from flaws and imperfections of any kind. Both ends of every length of tubing

shall be properly reamed with all sharp edges removed before erection.

c) Where a number of conduits converge, malleable cast iron or heavy gauge sheet steel adaptable boxes shall be employed in order to avoid crossings. Conduits shall be connected by means of male brass bushes and couplings.

d) Where conduits are greater than 25 mm, straight through joint boxes shall be of the trough type. Where conduit and/ or fittings are attached to equipment casings, the material or case of the casing shall be tapped for a depth of not less than 10 mm or male bushes and flanged couplings shall be used.

e) Heavy hexagonal lock nuts shall be used at all positions where running joints are required and care shall be taken to ensure that they seat firmly and evenly on to the mating faces of coupling or other adjacent accessories. All junction boxes, draw-in boxes, and inspection fittings, shall be so placed that the cables can be inspected and, if necessary, withdrawn and re-wired throughout the life of the installation.

f) Generally not more than two bends or offsets or one coupling will be permitted without a suitable inspection accessory. Fish wires shall not be left in conduits after erection. The whole of the installation shall be arranged for a loop-in type of system with joints being carried out at switches, isolators, etc. Intermediate joints in the cable will only be allowed by arrangement with the Purchaser/ Purchaser's Representative.

g) Ends of conduits which are liable to be left open for any length of time during building operations shall be plugged to prevent the ingress of dirt, cement, etc. and covers, either temporary or permanent, shall be fitted on all boxes.

h) Generally, conduits shall not cross expansion joints of buildings, but where they cannot be installed in any other manner then a flexible conduit shall be used across the expansion joint. A total 150 mm movement shall be allowed.

37.6.6 Surface Installation

a) Surface conduits shall be secured and fixed by means of distance spacing saddles or approved purpose made clips at every 500mm, which allow the conduits to be taken directly into accessories without sets or bends. Conduits shall be run in a square and symmetrical manner. An efficient means shall be adopted to provide for the drainage of condensation and the runs shall be properly ventilated. All surface conduit runs shall be marked out for approval

by the Purchaser's Representative before the installation is carried out. Where large multiple parallel conduit runs would occur, use may be made of galvanized cable trunking. Conduits installed on structural steelwork shall be secured at spacing not exceeding those for surface conduit by girder clips, otherwise fixing shall be as for surface conduits on walls, drilled and tapped to the metalwork. Power driven fixings shall only be used with the express permission of the Purchaser's Representative. Any drilling or access which is required through any structural member of the building shall be agreed with the Purchaser/ Engineer in Charge before carrying out the work.

b) Exposed threads and places where galvanizing has been damaged shall be cleaned and then painted with two coats of an approved metallic zinc based paint. This treatment shall be applied as the work proceeds.

37.6.7 Concealed Installation

a) Concealed conduits shall be securely fixed to prevent movement before laying of screeds, floating of plaster, casting of columns or other building operations necessary after the conduit installation. Crumpets or similar fixings shall be used for attaching the conduit to blockwork, etc. Building nails will not be accepted.

b) At least 15 mm cover shall be allowed for finishes over the conduit. Where this cover cannot be maintained then expanded metal shall be fitted with the conduit. Conduit cast into reinforced concrete floors shall be fixed to the steel reinforcing with binding wire and the conduit boxes filled with expanded polystyrene or enclosed in a plastic bag to prevent the ingress of concrete when poured. Where possible, the conduit boxes shall be fixed to shuttering to give a flush finish.

c) Conduit installed in voids, false ceilings, and other concealed routes shall be installed as specified for the surface conduits. Wiring shall be carried out after the false ceiling or permanent ducts have been completed. Conduit installed in floors shall be sealed against ingress of moisture.

d) The conduit installation shall be inspected by the Purchaser's Representative before the building operation conceals the work.

37.6.8 Cable Installed in Flexible Conduit

a) Flexible conduit shall be of the waterproof galvanized type or PVC wire-wound type with cadmium plated mild steel couplings. Lengths of flexible conduits shall be sufficient to permit withdrawal, adjustment or movement of the equipment to which it is attached

and shall have a minimum length of 300 mm. Flexible conduit shall not be used as a means of providing earth continuity. A single earth conductor of adequate size shall be installed external to the conduit complete with earth terminations.

b) Where conversion from rigid conduit to flexible metallic conduit is to be made, the rigid conduit shall terminate in a through type box and the flexible conduit shall extend from this box to the equipment, the earth continuity cable shall be secured to the box and to the piece of equipment by properly designed earthing screws. The use of lid facing screws, etc., will not be permitted. Adapters shall incorporate a grub screw or a gland to prevent the flexible conduit becoming loose.

37.6.9 Cable Clipped Direct

a) All cable hangers, clips, cleats and saddles shall be of an approved type and appropriate to the type and size of cable installed. Their spacing shall be such as to ensure a neat appearance and prevent sagging of the cables at all times during their installed life.

37.6.10 Cable Installed in Internal Floor Trench

a) In shallow trenches (maximum depth 500 mm)

b) In shallow trenches used for electrical services only, cables may be laid in a neat and orderly manner on the floor of the trench. One layer only shall be allowed. Additional cables shall be installed on the walls of the trench in an acceptable manner & such a way that, in no case the distance between two different types of cable shall not be less than the separation distance tabulated above.

c) Where the trench is shared by other services, cables shall be installed on the walls of the trench in an acceptable manner & such a way that, minimum separation distance of 300mm shall be maintained.

d) All other trenches including walk through service ducts

e) Cable trenches & cable installation shall be in accordance with the attached typical cabling system drawings.

f) Where other services are present the cables shall be segregated from them by separation distances as mentioned above and wherever possible kept above `cold' wet services. Cables should not be run if at all possible above or in close proximity to `hot' services.

g) The cabling shall be installed in such a manner as to allow access to the other services for normal maintenance without disturbance of the electrical installation

37.6.11 Cable Terminations and Joints

a) Power Cable Terminations

i. Power cables shall be terminated in suitable boxes arranged for bolting to switchgear, motor starters and motors.

ii. Cores shall have either crimped lugs or sleeves to match either post terminals or bolted clamp terminals.

iii. Each cable entry into a terminating box shall be made through a suitable gland, which shall have provision for securing the armour where applicable. Where single core glands are required these shall be of the non-magnetic type and the associated box bottom plate, where the core passes through, shall not have a continuous magnetic path.

iv. Adequate provision shall be made to bond the cable armouring to the box and/or switchgear casing of a suitable size to withstand the prospective short circuit fault current of the system, glands shall be fitted with earth bonding tags where intimate screwed contact between gland and cable box is not possible.

v. Where cable glands are exposed to the weather these shall be protected by heat shrink plastic sleeve or purpose moulded sleeves covering the gland continuously from overall sheath to the gland neck.

vi. Where terminations of multicore type have to be made on to items of Plant which have to be dismantled for maintenance, these shall be made off through glands into an adaptable box containing terminals and flexible single cores taken into the equipment via flexible waterproof plastic covered conduit, and a separate earth core linking the box to the equipment.

vii. Where single core cables are glanded to or pass through cabling plates the gland plate or cabling plate shall be constructed of non-magnetic material.

b) Power Cable Joints:

i. Through joints shall only be allowed with the approval of the Purchaser's Representative. Where such joints are necessary in thermoplastic and elastomeric cables, the cables shall be jointed with epoxy or acrylic resin cold setting compound, which has been premeasured and pre-packed ready for use. The boxes shall preferably be of split, moulded plastic type with filling vents for compound. Bonding straps shall be fitted with armour clamps across the joint and inspected by the Purchaser/ Purchaser's Representative prior to filling the box with

compound. Wrapped pressure type joints will not be accepted.

c) Multi-core or Control Cable Terminations:

i. A sufficient number of terminals shall be provided to terminate all cable cores. For control and auxiliary wiring an additional 20% of this number shall be provided as spares.

ii. Not more than one core of internal or external wiring shall be connected on any one terminal. Where duplication of terminal blocks is necessary, purpose-made solid links shall be incorporated in the design of the terminal blocks.

iii. Terminals which remain energized when the main equipment is isolated shall be suitably screened and labeled.

iv. Terminal blocks for different voltages or circuit type shall be segregated into groups and distinctively labeled.

37.6.12 Cable Fixings

a) Ties and strapping shall be suitable for securing cable and cable groups to cable tray or ladder. They shall be resistant to chemical and marine corrosion. Plastic coated metal ties used in order to obtain corrosion resistance shall not be acceptable. Nylon ties shall be resistant to the effects of ultra-violet light and shall be self-extinguishing.

b) Large single cables shall be secured with cable clamps or cable cleats.

37.6.13 Cable Identification

At each end of each cable, in a uniform and visible position a label shall be fixed on the cable in accordance with the cable schedule. Labels shall be made of PVC and shall be indelibly marked to the approval of the Purchaser's Representative. The label shall be retained using proprietary nylon strips passing through two fixing holes at either end of the label. If the cable gland is not normally visible, then the label shall be fixed inside the panel by means of screws.

37.6.14 Marking Locations of Underground Cables

a) The location of all underground cables shall be engraved on brass or other non- corrodible plates to be fixed to the exterior surface of all walls of buildings 300 mm above ground level and directly above the point where cables pass through the wall.

b) Cable route markers as per the attached drawing shall be

installed at an interval not more than 30 meter & at bending/ road crossings the interval shall be at every 10 meter.

c) The minimum depth for laying of underground cable route markers shall be as per indicated in the typical drawings attached with this tender.

37.6.15 Additional Requirements for Cable Installations

a) The Contractor shall install, test and commission the cables specified in the specification. Cables shall be laid directly buried in earth, on cable racks, in built up trenches, on cable trays and supports, in conduits and ducts or bare on walls, ceiling etc. as per drawings, which are to be prepared by Contractor & approved by Purchaser's representative. Contractor's scope of work includes unloading, laying, fixing, jointing, bending, and termination of the cables & all related accessories. The Contractor shall also supply the necessary materials and equipment required for jointing and termination or the cables.

b) All apparatus, connections and cable work shall be designed and arranged to minimize risk of fire and any damage which might be caused in the event of fire. Wherever cables pass through floor or wall openings or other partitions, suitable bushes of an approved type shall be supplied and put into position by the Contractor.

c) Standard cable grips and reels shall be utilized for cable pulling. If unduly difficult pulling occurs, the Contractor shall check the pull required and suspend pulling until further procedure has been approved by the Engineer's Representative. The maximum pull tension shall not exceed the recommended value for the cable measured by the tension dynamometer. In general, any lubricant that does not injure the overall covering and does not set up undesirable conditions of electrostatic stress or electrostatic charge may be used to assist in the pulling of insulated cables in conduits and ducts.

d) After pulling the cable, the Contractor shall record cable identification with date pulled neatly with waterproof ink in linen tags. Identification tags shall be attached securely to each end of each cable with non-corrosive wire. The said wire must be non-ferrous material on single conductor power cable. Tags shall further be attached at 10 meter intervals on long runs of cables on cable trays and in pull boxes. Cable and joint markers and RCC warning covers shall be provided wherever required.

e) Sharp bending and kinking of cables shall be avoided. The bending radius for various types of cables shall not be less than those

specified below:

i.	11 kV, XLPE insulated, multicore armoured cables	15 times the overall dia of the cable
ii.	1.1 kV, XLPE insulated, multicore armoured cables	12 times the overall dia of the cable
iii.	(If shorter radius appears necessary, no bend shall be made until clearance and instructions have been received from the Purchaser/ Engineer in charge)	

f) Power, control and instrumentation cables shall be laid in separate cable racks/ trays.

g) Where groups of HV, LV and control cables are to be laid along the same route, suitable barriers to segregate them physically shall be provided.

h) Where cables cross roads and water, oil, gas or sewage pipes, the cables shall be laid in reinforced spun concrete or steel pipes. For road crossings the pipe for the cables shall be buried at no less than one meter depth.

i) Cables laid in ground shall be laid on a 75 mm riddled earth bed. The cables shall then be covered on top and at their sides with riddled earth of depth of about 150 mm. This is then gently filled up to a depth of about 100 mm above the top of uppermost cable to provide bedding for the protective cable covers which are placed centrally over the cables. The protective cable covers for LV cables may be of earthenware and for HV cables of reinforced concrete. The RCC covers shall have one hole at each end, to tie them to each other with GI wires to prevent displacement. The trench is then backfilled with the excavated soil and well rammed in successive layer of not more than 300 mm in depth, with the trenches being watered to improve consolidation wherever necessary. To allow for subsidence, it is advisable to allow a crown of earth not less than 75 mm in the centre and tapering towards the sides of the trench.

j) In each cable run some extra length shall be kept at a suitable point to enable one or two straight through joints to be made, should the cable develop a fault at a later date.

k) Cables on cable racks, on cable trays and conduits shall be formed to avoid bearing against edges of trays, racks, conduits or their supports upon entering or leaving trays, racks or conduits. Cables shall be racked or laid directory into cantilevered cable trays where practicable, but in some cases it may be necessary that cables are pulled or threaded into trays. To facilitate visual tracing, cables in trays shall be laid only in single layers and unnecessary crossing of

cables shall be avoided. Cables on trays shall finally be clamped in an approved manner.

l) Cable splices will not be permitted except where permitted by the Purchaser/ Purchaser's Representative. Splices shall be made by Contractor for each type of wire or cable in accordance with the instructions issued by cable manufacturer's and the Engineer's Representative. Before splicing, insulated cables shall have conductor insulation stepped and bound or penciled for recommended distance back from splices to provide a long leakage path. After splicing, insulation equal to that on the spliced conductors shall be applied at each splice.

m) Jointing of cables shall be in accordance with relevant Pakistan Standards Codes of Practice. Materials and tools required for cable jointing work, including cold setting bituminous compound shall be supplied by the Contractor. Cables shall be firmly clamped on either side of a straight through joint at a distance of not more than 300 mm away from the joints. Identification tags shall be provided at each joint at all cable terminations.

n) At cable terminal points where the conductor and cable insulation will be terminated, terminations shall be made in a neat, workmanlike and approved manner by men specialized in this class of work.

o) Control cable termination shall be made in accordance with wiring diagrams, using colour codes established by the Purchaser's Representative for the various control circuit, by code marked wiring diagram.

p) When control cables are to be fanned out and cabled together with cord, the Contractor shall make connections to terminal blocks, and test the equipment for proper operation before cables are corded together. If there is any question as to the proper connection, the Contractor shall make a temporary connection with sufficient length of cable so that the cable can be switched to another terminal without splicing. After correct connections are established through operating the equipment, cables shall be cut to their correct lengths, connected to terminals in the specified manner, and corded together where necessary to hold them in place in a workmanlike manner.

q) Cable seals shall be examined to ascertain if they are intact and that cable ends are not damaged. If the seals are found to be broken the cable ends shall not be jointed until after due examination and testing by the Purchaser/ Purchaser's Representative. Before jointing is commenced, insulation resistance

of both sections of cables to be jointed shall be checked by megger.

r) After installation and alignment of motors, the Contractor shall complete the conduit installation, including a section of flexible conduit between motor terminal box and trench/ tray. The Contractor shall install and connect the power, control and heater supply cables as per equipment manufacturer's drawings.

s) Metal sheath and armour of the cable shall be bonded to the earthing system of the station. The size of conductor for bonding shall be appropriate with the system fault current.

37.7 LIGHTING SYSTEM INSTALLATION

This covers the requirements of installation of the following:

a) Lighting fixtures complete with lamps and accessories

b) Main Lighting distribution board

c) Lighting panels

d) Receptacles and lighting control switches

e) Point wiring

f) Street lighting poles and flood light towers

g) Multi core cables for street and boundary lighting

h) Maintaining equipment/ materials during storage and being responsible for the equipment/ material until they are handed over to Purchaser.

i) Installation, testing and commissioning shall be carried out in accordance with the drawings and as stipulated in this specification.

37.7.1 Applicable Standards for lighting system installation

Electrical wiring installations	ISO/BS/IEEE: 732 (System voltage exceeding 650 V)
Code for practice for interior illumination (Part-1)	ISO/BS/IEEE: 3646/ BS: 8206
Code of practice for street lighting installation	ISO/BS/IEEE: 1944
Code of practice for industrial lighting	ISO/BS/IEEE: 6666
Code of practice for fire safety of building	ISO/BS/IEEE: 1646
Boxes for enclosure of electrical accessories	ISO/BS/IEEE: 5133(Part-1)
Guide for safety procedures and practices in electrical work	ISO/BS/IEEE: 5216
Ceiling roses	ISO/BS/IEEE: 371

37.7.2 Lighting Fixtures

a) The installation of lighting fixtures shall be based on the mounting arrangement shown in the drawings. The rates quoted for installation shall include all materials required to mount the fixtures. Hooks in RC slabs for suspension of high bay fixtures shall be provided wherever not already provided. Cost of supply and installation of such hooks shall be included in the cost of installation of lighting fixtures. Rate for installation of lighting fixtures shall include cost of installation of control gear box wherever applicable.

b) Installation of receptacles and switches shall be carried out suitably. Switch shall be mounted in flush with the front cover plate. Cost of supply and installation of necessary hardware shall be included in the lump sum rates quoted for installation of receptacles/ switches.

c) Lighting distribution boards shall be installed at the suitable location. Installation shall include supply and installation of base channels, foundation bolts, etc.

d) Outdoor lighting distribution boards shall be installed on a concrete plinth. The top of plinth shall be 1000 mm (min.) above the grade level. Cost of construction of concrete plinth shall be included in Contractor's scope. No cement and steel will be supplied by Purchaser. Installation cost of lighting distribution board shall include cost of installation of earthing conductor from LDB to the nearest earthing grid.

37.7.3 Point Wiring:

a) Contractor has to prepare the detailed conduit layout drawing showing primary & secondary point wiring points. Point wiring also covers the wiring of the associated control switches of lighting fixtures/control switches of receptacle units.

i. Primary Point Wiring:

Primary point wiring covers the wiring between a circuit of the lighting panel to the junction box of the first lighting fixture/receptacle unit and between junction boxes of the subsequent lighting fixture connected to that circuit of the lighting panel. In some cases where there are junction boxes, the primary point covers the wiring between junction box and the first lighting fixture/receptacle unit in that circuit.

ii. Secondary Point Wiring:

Secondary point wiring covers the wiring of the remaining

lighting fixtures/receptacle unit other than that covered under primary point of that circuit in the lighting panel. Secondary point wiring also covers the wiring of the associated control switches of lighting fixtures/control switches and control switches of receptacle units.

b) Supply and Installation of Conduit Point Wiring:

i. The point wiring shall include supply of necessary materials for the conduit wiring such as galvanized rigid steel conduit, galvanized M.S. fixing saddles with spacer plates, nylon/fiber fixing plugs, galvanized M.S. fixing screws, 12 SWG galvanized steel earthing wire, FRLS PVC insulated Copper conductor wires, control switches and pulling, termination of the earthing/ FRLS PVC insulated wires as required, installation of control switches, drilling holes in brick walls/ RCC roof slabs for taking the wiring conduits and refinishing and any other works/material necessary for making point wiring complete in all respects.

ii. Wires used for conduit point wiring of lighting fixtures/ceiling fans, 5A receptacles and receptacles above 15A shall be 1.1 kV grade, FRLS PVC insulated, single core, multi stranded Copper conductor wires of sizes not less than 1.5 sq. mm and 2.5 sq. mm respectively. Wires shall conform to ISO/BS/IEEE: 694 and shall bear the ISO/BS/IEEEI mark.

iii. Contractor shall take into consideration necessary galvanized MS fixing clamps when the wiring conduits are to be supported from steel roof truss/structural members.

c) Supply & Installation of cabling for Street and Flood Lighting:

i. Work includes supply and installation of cables required between LDB and junction box mounted on street lighting pole/flood lighting tower and also between junction box mounted on flood light tower to metal enclosed control gear box located near flood light fixture, supply and installation of all the termination accessories such as crimping type cable lugs and double compression cable glands at each junction box and fixture, termination, testing and commissioning of cables. Contractor's scope of work also includes excavation, preparation of riddled soil bedding, supply and installation of protective covers over the cable, backfilling, ramming, supply and installation of route markers, supply and installation of HDPE / Hume pipes for road crossing, etc, supply and

installation of necessary cleating arrangement for cabling on flood light tower, supply of labour, supervision, welding equipment, all tools and tackles and testing equipment as required.

ii. Contractor shall plan and cut the cables in such a way that there is no wastage and no cable jointing is required in any run. However, should any joint become necessary the same shall be provided by the Contractor and a joint marker shall also be provided at no extra cost. Earthing of street light pole/flood light tower, lighting fixtures, etc. are included under Contractor scope.

d) Point wiring shall also include/ hold good for the following:

i. Supply and installation of lighting control switches and switchboxes complete with fixing accessories.

ii. Drilling holes in brick/ RCC wall and roof for taking cable or conduit, sealing and refinishing with cement plaster.

iii. Testing, commissioning and handing over the lighting system in commercial working condition.

iv. Marginal shifting of any fixture/accessory from the location indicated in the lighting layout drawings.

37.7.4 Outdoor Lighting (Street and Flood Lighting)

The following shall be deemed to be included as part of the installation work for outdoor lighting point wiring.

a) Installation of multicore/ single core cables between LDB and junction box mounted on street light pole/flood lighting tower, from junction box to metal enclosed control gear box.

b) Supply and installation of crimping type cable lugs, double compression type cable glands at each junction box and fixture, termination, testing and commissioning of cables.

c) Contractor's scope shall also include excavation and preparation for buried cables.

Supply and installation of route markers, supply and installation of HDPE/ Hume pipes for road crossing shall also be included in the scope of installation of point wiring.

d) Supply and installation of necessary cleating arrangement for cabling on flood light poles.

e) Contractor shall provide necessary foundation for erecting street light pole/ flood light tower and install the same. Contractor shall prepare foundation drawings with necessary details & Purchaser

Representative's approval shall be obtained.

f) Contractor shall plan and cut the cables in such a way that there is no wastage and no cable jointing is required in any run. However, should any joint become necessary, the same shall be provided by the Contractor and joint marker shall also be provided at no extra cost.

g) Earthing of street light pole/flood light tower, lighting fixtures, control gear boxes, junction boxes, etc. are also included in the scope of installation of point wiring. Contractor shall earth street light pole/flood light poles and junction box with 25x3 mm G.S. flat tap off from the 25x3 mm M.S. flat earthing grid along the street lighting included in scope. The Contractor shall interconnect earthing grid to plant main earthing grid at first and last pole of each feeder circuit and at one intermediate pole.

h) Installation of lighting Poles and Towers for Outdoor Lighting (Street and Flood Lighting)

   i. Work includes supply and installation of street light poles and flood light towers including associated junction boxes with fuses, links and terminals for junction boxes and junction boxes near each flood light fixtures.

   ii. All street light poles and towers shall be painted with one shop coat of red oxide oil primer followed by two coats of aluminium alkyd paint.

Installation of Lighting Distribution Board, Lighting Panels (AC & DC), 230 V, AC 1- Ph Distribution Boards.

Installation of above items shall include necessary foundation channels, bolts/ nuts, etc. for grouting lighting distribution boards, iron brackets/ grouting brackets, bolts/nuts for wall/ column mounted panels and associated civil works.

Details of work requirements are covered in lighting installation notes and details and typical drawings which form the part of specification. Any changes, if necessary due to site conditions/requirements shall be carried out after obtaining approval of Purchaser/ Purchaser's Representative. The changes carried out shall be marked clearly in the layout drawings by Contractor and 'AS BUILT DRAWING' shall be prepared by the 'Contractor' and this shall be forwarded to Purchaser's site / design office.

a) Wiring:

   i. Wiring shall be carried out strictly as per project drawings and technical specification. All exposed conduit wiring shall have provision for easy inspection. Where cable wiring is specified cable

shall be cleated on to the wall as close to the ceiling as possible. In all types of wiring due consideration shall be given for neatness and appearance.

ii. Wherever DC emergency lighting is provided, emergency lighting wires shall run in a separate conduit. Colour of the wires used shall be as follows; white for positive, black for negative.

iii. Wherever lighting system has three phase distribution, separate conduits shall be used for different phases. For easy identification of phases and neutral wires the following colour wires shall be used.

R - Phase - Red

Y - Phase - Yellow

B - Phase - Blue

N – Neutral - Black

b) There shall be a circuit breaker on each live conductor of supply mains at the point of entry.

c) Conductors not arranged for connection to the same system or supply different phases of the same supply, shall be kept apart throughout their entire run.

d) Receptacles and lighting fittings in general shall be fed from different Circuits. Five amps receptacles for toilet or small rooms can be fed from the lighting circuit with proper isolating arrangement.

e) Each final sub-circuit from a lighting panel shall be controlled by a single pole switch connected to the live conductor.

f) For long conduit wiring runs, inspection/ pull boxes shall be provided at intervals not exceeding 10 meter. Such facilities shall also be provided at conduit bends.

37.7.5 General Practices for lighting

a) All receptacles and switches to be installed in offices and control rooms shall be flush mounted within the wall and those in other areas shall be wall or column mounted.

b) Ceiling roses shall not embody fuse terminals as an integral part. For voltages exceeding 250 volts, a ceiling rose or any similar attachment shall not be used.

c) All exposed metal parts of the plug, when the plug is in complete engagement with the socket outlet, shall be in effective electrical connection with the earthing pin.

37.7.6 Earthing for lighting

Conduits and fittings shall be earthed by 12 SWG GI wires run along the length of the conduit and secured by means of suitable clamps efficiently fastened to conduit tip. To achieve perfect electrical continuity, the conduits shall be bonded effectively on either end of a coupling and other joints.

a) Conduits shall be earthed at the ends adjacent to switch boards at which they originate or otherwise at the earth clip, clamp or gland, in effective electrical contact with the conduit.

b) For outdoor lighting poles & mast 8 SWG GI earth wire shall be run buried in ground at a depth of 600 mm along-with lighting cables and shall be terminated up to the junction box on the pole and 12 SWG wire shall be taken up to the pole fitting. In case of lighting poles where the main earth grid is far away from the pole, local pits shall be provided for pole earthing.

SECTION-38 PRE COMMISSONING TESTS ON ELECTRICAL EQUIPMENT/ SYSTEMS TO BE CARRIED OUT AFTER INSTALLATION:

38.1 GENERAL:

Pre-commissioning tests in addition to mentioned in the specification requirements for various equipments but not limited to following shall be carried out by Contractor in presence of Purchaser/ Purchaser's representative. Commissioning shall be carried out only after obtaining satisfactory results, acceptable to Purchaser/ Purchaser's representative.

38.2 ELECTRICAL EQUIPMENT:

11 KV Equipment (Lightning Arrestors, AB Switch/ Isolators & Insulators etc):

a) Visual checks for cracks in insulators.

b) Earth secured continuity check

c) IR Test with 5KV Megger

1.1.4 POWER/ DISTRIBUTION TRANSFORMER

a) Insulation resistance test HV side, LV side and HV - LV.

b) Magnetizing current test.

c) Winding resistance test.

d) Voltage Ratio & Tap continuity test at all tap.

e) Vector group test.

f) Magnetic Balance Test.

g) Buchholz Relay Test (if any)

h) Neutral CT Test (if any)

i) Winding Temperature Indicator/ Oil Temperature Indicator Test

j) Polarization Index Test (For LV windings 3.3 KV and above)

k) Local/ Remote operations of OLTC (if any)

l) Operational tests of RTCC panel (if any) as per schematic drawing.

m) No load test and performance observations

38.2.1 HV Metal Enclosed Switchgear:

a) IR values of power and control circuits

b) Local/ Remote operations in test as well as service position including all electrical interlocks

c) Control circuit and operational tests as per schematic drawing.

d) Tripping through relays and trip circuit health.

e) Anti pumping device operation

f) Protection system operation stability and sensitivity by primary injection testing method including testing of metering circuits

g) HV Test on switchboard

h) Panel indication, annunciation, space heater circuits

i) Spare contact for customer use

j) Termination correctness & proper installation.

38.2.2 LT Metal Enclosed Switchgears

a) IR Values of power & control circuits.

b) Mechanical charging - closing - tripping of breaker.

c) Electrical charging - closing - tripping of breaker.

d) Trip circuit healthiness and tripping through relays.

e) Remote closing/ Tripping/ Interlocks circuits

f) Indication/ Annunciation/ Panel space heater circuit/ Spare contacts for customer use

g) Secondary injection testing of protective relays/ releases.

h) CT testing for polarity, ratio, IR values and magnetization for class PS characteristics

i) PT testing for ratio, IR values.

j) IR Values of breaker.

k) Testing of modules for DOL/ Star-Delta/ ATS/ Soft Starter starting or any other starting method as per the schematic drawings applicable.

38.2.3 Power and Control Cables

a) IR Values before Hi-pot

b) Hi-pot Test - Measurement of leakage current

c) IR Values after Hi-pot

38.2.4 Induction Motors:

a) IR Values

b) Polarization Index Test

c) Interlocks and simulation tests local / remote operations

d) No load test

38.2.5 Control Panels for Miscellaneous Equipment:

a) IR Values of all power circuits

b) Operational test and scheme - wiring testing as per control schematics

38.2.6 Lighting System:

a) Visual inspection for operating problems

b) System activation -burning in the lamps for 100 Hrs

c) Measuring light level & reflectance.

38.2.7 Earthing System:

a) Earthing resistance of each electrode.

b) Earthing resistance of grid.

Technical Specification for Diesel Generator

38.3 DIESEL STANDBY GENERATOR:

38.3.1 Applicable Standards

The Diesel Standby Generator and its components shall conform to the latest applicable standards specified below:

Diesel Engines for General Purposes The Electrical Performance of Rotating Electrical Machinery : BS 5514 / ISO 3046 BS 5000

Rotating Electrical : Machines ISO/BS/IEEE 4722

Circuit breakers : ISO/BS/IEEE-13118, BS-5311, IEC-56 & 694, BSEN-60942 (P-2)

Air break switches air break :

disconnectors, air break switch ISO/BS/IEEE-13947 (P-3), BS- EN60947, IEC-60947-3

disconnectors and fuse combination

units for voltage not exceeding

1000 V AC or 1200 V DC

Current transformer : ISO/BS/IEEE-2705/BS-7626, IEC-

60185

Voltage transformer : ISO/BS/IEEE-3156/BS-7625/IEC 60186

Electrical Relays : ISO/BS/IEEE-3231, 3842/BS-142/IEC-

60255

Contactors for voltage not :

exceeding 1000 V ac or

1200 VDC ISO/BS/IEEE-13947 Part-IV/ BSEN-

60947-4-1/ IEC-60947-4-1

Control Switches : ISO/BS/IEEE-6875/BSEN-60947 /

IEC-60947-4-1

High Voltage Fuse ISO/BS/IEEE-9385/BS-2692/ IEC-

60282

Low Voltage Fuse : ISO/BS/IEEE-13703/BS-1362 IEC-269-

1

Electrical direct acting :

indicating instruments ISO/BS/IEEE-1248/BS-89/IEC-6005

A.C. electricity metres of :

induction type voltage greater than1000 volts ISO/BS/IEEE722, 8530/BS-5685 / IEC-

60145, 60211

Resistance wire, tapes and :

stripes for heating elements ISO/BS/IEEE-3725

38.3.2 General Requirements:

The diesel engine and generator shall be skid mounted and shall be located in a room near Treatment plant substation building. The diesel engine shall draw cooling air directly from outside the room through a weatherproof, acoustically treated duct. The exhaust system shall be insulated to minimize the amount of heat entering the room and to prevent injury to personnel. The silencer shall be of the 'residential' type and be located externally.

The generation voltage shall be 415V for DG capacity less than 2MVA and generation voltage shall be 11kV for D.G capacity more than 2MVA. In case more than one D.G set is required for achieving the required capacity they shall be operated in parallel with necessary synchronizing arrangement. At no point DG sets will be operating parallel with grid.

The diesel engine fuel shall be stored in an above ground bulk storage steel tank to be located adjacent to the generator room at a site accessible for filling to local road tankers. The storage tank shall be sized to store fuel for one (1) day running of the engine at full load. The tank shall be provided with fittings to permit the visual observation of fuel level and filling by local tanker operators. A level meter shall also be mounted in the tank so that remaining fuel volume can be monitored at the generator / substation PLC and the operator stations in the SCADA room.

The fuel storage tank shall be located in a bund capable of holding not less than 125 % of the maximum storage tank contents. Fuel transfer pumps shall be provided to automatically transfer fuel from the bulk storage tank to a high level 990 litres day tank located in the generator room or generator skid mounted day fuel tank. A semi-rotary hand pump shall be provided to permit transfer of fuel in the event of a failure of the transfer pump. Any leakage from the pumps shall be routed to the bund.

A system shall be provided within the generator room to detect fire, to raise a local audible alarm (manually silenced locally) and if a high level day tank is used, to automatically dump the day fuel back to the bulk storage tank.

The system shall be constructed such that leakage of water, fuel or oil within the generator room shall be routed to a local sump where a detector shall be provided to raise an alarm.

The system shall be constructed such that the leakage of fuel or the accumulation of water within the fuel storage bund shall be detected and shall raise an alarm.

All alarms shall be conveyed to the central HMI through the PLC.

38.3.3 Diesel Generating Set Automatic Control

AMF Diesel Generator Set capable of automatic starting and picking the load within 30 seconds shall be provided to cater for emergency loads and lighting during mains power failure. Diesel generating set for use in auto mains failure mode shall have a three position automatic / off / manual selection and shall operate as follows:

a. Automatic mode

On occurrence of mains failure the following sequence shall be followed. Mains to Generator changeover

- mains failure detected
- delay of 10 seconds
- generator is started and run up to speed
- time delay of 50 seconds
- mains supply is switched off
- generator supply is switched on

Generator to Mains changeover

- mains healthy detected
- manual changeover signal received,
- generator supply is switched off
- mains supply is switched on

- generator runs for 2 minutes and stops

All timer settings shall be adjustable.

If mains power is restored during the initial one minute delay then the power shall be monitored for a further one minute and if it is still healthy, mains power shall be restored. The generator shall be stopped after a further 2 minutes of running on no load. If the generator fails to start after an initial period of cranking, two further attempts shall be made with an appropriate interval between each attempt. If the engine fails to start after three attempts the system shall shut down and a local and remote alarm shall be annunciated.

b. Manual mode:

The generator shall run to the dictates of manual controls on the generator. No automatic changeover of mains to generator supply or vice versa shall take place. The generator shall be loaded by manual switching if required.

38.3.4 Alternator for Diesel Generating Set:

The generation voltage shall be 415V for capacity less than 2MVA and generation voltage shall be 11kV for capacity more than 2MVA.

Alternator shall be 4 pole, 3 phase ,50 Hz, 0.8 P.F, salient pole, revolving field, brushless type, self-regulating continuously rated and manufactured in accordance with ISO/BS/IEEE 4722, BS 5000 : Part 99 or IEC 60034-1. They shall be totally enclosed, screen protected, fan ventilated and vertical drip-proof conforming to IP 23.The Alternator shall be complete with excitation system, AVR and all necessary auxiliaries. The alternator shall be driven by diesel engine detailed below and shall match the same in all respects. The terminal box shall be dustproof with IP 54 degree of protection. The terminal box shall be suitably sized to terminate the size and number of cables involved. Alternators shall be capable of withstanding a 10% overload for 1 hour in any 12 hour Period under the specified conditions of temperature, humidity and atmospheric pressure.

Alternator windings shall be of Class H insulation with Class F temperature rise and tropicalised. The alternator shall have pre-packed grease lubricated ball or roller bearings and provided with facilities for regreasing whilst in service.

The alternator shall be foot mounted on a common bed frame with the prime mover close coupled to the engine flywheel housing. The direction of alternator rotation when viewed from the driven end shall be clockwise and phase voltage sequence UVW. The alternator vibration level shall not exceed the values defined in ISO/BS/IEEE 12075.

The alternator shall be capable of maintaining a short circuit current of three times full load current for a period of 10 seconds. The alternator shall be fitted with an anti-condensation heater. No individual harmonic shall exceed 1%

and the total harmonic shall not exceed 3%. The alternator, its neutral and control panel shall be earthed as per relevant standards.

The alternator rotor assembly shall comprise exciter rotor, full wave silicon bridge rectifier surge protection device and salient pole rotating field system. The rotor shall be fitted with interconnected pole face damping windings. Voltage regulation shall be maintained to within ±2.5% for a power factor of 0.8 to unity, including hot to cold variations. The steady state frequency droop between no load and full load shall not exceed 5%.Transient voltage deviation following a step load of 60% of rated at a power factor of between 0.4 and zero shall not exceed 15% with a voltage recovery time to 97% rated voltage not exceeding 0.5 second. The set shall be capable of continuous operation with a phase current imbalance of 33% of rated current whilst maintaining the output voltage within ±5% of rated.

38.3.5 Diesel Engine for Generating Set:

Engine shall be four strokes, direct injection, and turbocharged industrial machines. They shall be fitted with renewable wet cylinder liners if water cooled and shall be direct coupled to the alternator and mounted on a common rigid steel bedplate.

Engines shall be rated for continuous duty at site ambient conditions with an inherent O/ L Capacity of 10% for 1 hour in any 12 hours. The engine shall be capable of running at full load for not less than 180 hours without maintenance adjustments and 10000 hours between major overhauls. The maximum operating speed shall be 1 500 rpm. The range of manual adjustment shall not be less than ±5% of rated speed. The performance of engine governors under load conditions shall be to Class A2 in accordance with BS 5514: Part 4.

Engine governors shall be suitable for remote control load sharing between identical engine units. In addition to any electrical over speed trips, there shall be a mechanical device which shall operate at 120% of the rated speed. Re-setting of the over speed trip shall be possible by hand only. The steady state output speed drop between no load and full load shall not exceed 5%. The transient output speed deviation shall not exceed 10% for a step of 60%. Engines shall be designed to run on fuel oil complying with ISO/BS/IEEE 1460 or BS 2869, Class A2.Engines shall be cooled by means of a water jacket, heavy duty air blast radiator with integral radiator header tank, circulating pump and engine driven pusher type fan. The fan shall draw air in from the vicinity of the engine block and discharge it through the radiator core. The radiator shall be mounted on the same bedplate as the engine and alternator on suitable vibration isolators and be arranged so that it is located directly behind automatic louvers set into the external wall of the engine room. A thermostatically operated by-pass valve shall be fitted in the cooling system to maintain an optimum operating temperature during starting and running conditions. Drain cocks shall be provided so that all the water can be drained from the system. A separate oil cooler shall be used for cooling

the engine oil. A thermostatic by- pass valve shall be incorporated. Engine lubrication shall be by a closed circuit wet sump, forced feed system supplied by an engine driven pump fitted with pressure regulating and relief valves, sump suction filter and changeover renewable micro-felt full flow line filters. A hand operated semi-rotary oil pump shall be installed to carry out initial priming or to fill or empty the sump as required. The sump shall be fitted with an easily accessible drain point. The oil shall be of the grade recommended by the engine manufacturer. The starting system shall comprise 12 or 24 V heavy duty lead acid batteries (positioned on a floor mounted stand adjacent to the engine) connected by heavy duty flexible butyl rubber cables. Batteries shall be sized to give six consecutive starts of the engine at 0C. An engine driven alternator and charging system shall be provided. An automatic mains energised battery charger shall be provided, with sufficient capacity to maintain the battery in a condition to fulfill the starting requirements. Barring (hand turning) equipment shall be provided so that the engine can be manually rotated for maintenance purposes. It shall be arranged so that normal starting of the engine is inhibited whilst the hand turning equipment is connected. Twin heavy duty air intake filters in accordance with ISO/BS/IEEE 3169 or BS 7226 suitable for operating in dust laden atmospheres shall be fitted. The filters shall be of the paper element with pre-cleaner type. Turbocharger filters shall be fitted. Breathers shall be fitted with washable filters which are easily accessible for maintenance.

Instrumentation shall be provided to monitor speed, oil pressure, oil temperature (sets larger than 250 kVA), water temperature and battery charge current. The bedplate shall be of heavy gauge steel construction, stress relieved and free from distortion.

Machined surfaces shall be incorporated for mountings and for leveling. Anti-vibration mountings shall be fitted between the bedplate and the floor to prevent vibrations being transmitted to the building. The mountings shall be adjustable for leveling purposes and shall be designed to resist horizontal movement of the diesel set.

The fuel System shall comprise an engine driven feed pump with duplex filters, 990 litres day tank with supporting structure or generator skid mounted day fuel tank, with all interconnecting pipe work, flexible engine connection pipe etc.

38.3.6 Diesel Generator Control Panel:

a. The control panel shall be separately mounted on anti vibration mountings and shall

b. Comprise the following:

c. Breaker incorporating short circuit and overload trip

d. Earth fault protection for the Alternator

e. Alternator Over & Under Voltage Protection

f. Voltage Controlled Over Current Relay

g. voltmeter and seven position selector switch

h. ammeter and 4 Position selector switch

i. frequency meter

j. Power Factor Meter

k. kWh Meter

l. engine temperature and oil pressure gauge

m. service hours run indicator

n. key switch start and stop control

o. operational status indicator

p. anti-condensation heater and thermostat

q. alternator anti-condensation heater controls

r. mains fed battery charger

s. Auto start on mains power supply failure facility

t. Fails to Start (Alarm)

u. Over / Under Voltage Alarm

v. Battery Charger Fault (Alarm)

w. Low fuel Oil Level (Alarm)

x. Over Load (Alarm)

y. Low Lube Oil Pressure (Trip)

z. High Water Temperature(Trip)

aa. High Lube Oil Temperature (Trip)

bb. Electrical Protection Relays (Trip).

A reset button shall be provided to cancel the alarm /shut-down condition prior to re-starting. Simple operating instructions shall be detailed on the fascia of the control panel.

38.3.7 Synchronizing Panel

Whenever two sets are required to operate together, necessary synchronizing panel complete with circuit breaker, synchroscope, relays, meters etc shall be provided. The Panel shall be floor standing, CRCA Sheet steel enclosed.

38.3.8 Acoustic Enclosure

a) The DG Set shall be provided with acoustic enclosure, fully

integrated, weather proof with superior finish for long and durable life.

b) The acoustic enclosure shall be CRCA sheet steel enclosed with necessary panels and doors, inside lining of fire retardant foam /glass wool as acoustic material.

c) The sound level shall be restricted to 75 dB at a distance of 1 meter, under full load, free field conditions as per relevant standards.

d) The acoustic enclosure shall be certified to meet the emission norms.

38.3.9 Bulk Fuel Storage Tanks

Tanks and fittings, etc shall conform to ISO/BS/IEEE 803 or BS 799: Part 5. The tank shall be constructed in mild steel and the fittings in materials other than:

- Yellow brass, including low grade alloys of copper and zinc.
- Lead and zinc.
- Galvanized metals.
- Natural rubber.

An ullage volume above maximum contents level of the tank shall not be less than 5% of the maximum volume of the fuel. The maximum fuel surface level below the point of entry of the vent shall not be less than 100 mm. The internal surface shall be cleaned and treated with temporary preservative, soluble in fuel oil, before shipment. The following fittings shall be included:

(a) 600 mm diameter manhole complete with portable cover situated in the top of the tank complete with ladder to the interior.

(b) Dipstick, calibrated in litres with guide tube and striker plate.

(c) Local indication of fuel level to be given at a position where it can be easily read during fuel delivery.

(d) Filling pipe work and fittings complete with isolation valve and captive end cap. The filling point to be at the top of tank to prevent siphoning.

(e) Outlet pipe situated at the raised end of the tank not less than 150 mm above tank bottom, complete with check valve, isolating valve and end cap.

(f) Drain pipe situated at lowest point in tank complete with isolating valve and captive end cap.

(g) Inlet fittings for overflow pipe from daily service tank or tanks (where specified).

(h) Vent pipe situated at high level in the tank. The pipe shall rise continuously from the tank and terminate with an inverted `U' bend

and vermin screen.

(i) External ladder for horizontal tanks more than 2 m diameter.

38.3.10 Drawings / Documents Required:

All Drawings, data, technical particulars, calculations, detailed literature, catalogues Test certificates etc shall be submitted along with the bid/ after award of contract.



Punjab Rural Municipal Services Company (PRMSC)

PUNJAB RURAL SUSTAINABLE WATER SUPPLY AND SANITATION PROJECT (PRSWSSP), ENGINEERING DESIGN AND CONSTRUCTION SUPERVISION

TECHNICAL SPECIFICATIONS

CONSTRUCTION OF TUBE-WELLS

Punjab Rural Sustainable Water Supply and Sanitation Project
Engineering Design and Construction Supervision

TECHNICAL SPECIFICATIONS

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1 TUBE-WELL

1.1 Construction of Tube-Wells

1.1.1 Scope

The work covered shall consist of well drilling, installation of components, shrouding, development and testing including all plant, labour, equipment & other miscellaneous works necessary for the satisfactory completion of the tube-well as specified and approved by The Engineer/ Engineer-in- Charge.

Before proceeding with the work, the Contractor shall submit a complete work plan for performing the work. This will include but not limited to manpower, Plant and equipment and schedule of performance for completion of work.

The Contractor shall employ at site a fulltime competent Supervision staff for overall supervision of the work.

1.1.2 Drilling

1.1.2.1 General

The Contractor shall drill bore hole for the tube-well at the designated location established by the Engineer-in-Charge. The Contractor shall prepare the site for the construction of the tube-well and shall provide for water for construction requirements, the disposal of water, cuttings and refuse from the operations away from the tube-well.

1.1.2.2 Drill Conditions

General overall conditions related to the groundwater at the site of tube-well if available will be made known to the Contractor. The contractor is expected to make his own assessment of the character, quality and the conditions that may be encountered and shall take full responsibility for performance of work as specified.

1.1.2.3 Drilling Procedure

The borehole shall be drilled either by direct or reverse circulation rotary method. The diameter of the drilling bit shall depend on the bore size as specified on drawings or as directed by the Engineer- in-Charge. The bore hole shall be drilled straight and plumb so that the pump and tube- well casing may, be installed concentric with the hole and within the tolerance specified for plumbness of the casing. Waste materials from the drilling operation shall be disposed of in a manner approved by the Engineer-in-Charge.

The Contractor shall be responsible for protecting the tube-wells from contamination with foreign materials until the completion of the tube-well. The Contractor shall bear any expense that may result from any damage to tube-well, tools, or equipment that may be caused by caving, washing, or other disturbances within the tube-wells.

To prevent sloughing and caving of surface material and/or the hole, the Contractor shall furnish and install a boring casing pipe with a minimum diameter 2 inches greater than the bit diameter from not-less than 8 inches above the ground surface to bottom of the hole. The casing pipe shall be new or used pipe of adequate strength for the purpose. After the drilling

is completed, the casing pipe shall be removed by the Contractor and shall remain his property.

The use of drilling fluid additives or other suitable materials specially approved by the Engineer-in- Charge may be applied in stabilizing the bore hole. The casing shall be removed by the Contractor after the installation of pump housing pipe along with the strainer in the bore hole. However, in case of the tube-wells where shrouding material is to be provided around the periphery of the strainer (or around the strainer and the pump housing pipe) and the inner walls of the bore hole the casing shall be removed in 1.5 to 3 meter stages as shrouding is placed.

If in the opinion of the Engineer-in-Charge, it is necessary to discontinue work on any bore hole because it is out of line more than the specified limit or on account of jammed tools, or caving ground, or because of negligence on the part of the Contractor, the Contractor shall drill another bore hole at an alternative location designated' by the Engineer-in-Charge. The Contractor will not be entitled to payment for any work done or materials furnished for bore holes abandoned as a result of his operation or negligence.

1.1.2.4 Data and Records

The Contractor shall keep an accurate drilling log of each borehole including a description of all materials encountered and their location in the bore hole. A Hydrogeologist or geologist as The Engineer's representative shall be present during drilling and shall supervise the borehole logging of the hole preparing descriptive geological log. All documentation shall be countersigned by the Engineer's Representative.

All records and data shall be kept by the Contractor on forms approved by the Engineer-in-Charge. The Contractor shall deliver to the Engineer-in-Charge the original of all records completed in all respects.

1.1.2.5 Sampling

Representative ditch samples or cuttings of the material penetrated shall be taken at every 5 ft. (1.5 m) depth of borehole or at each change in lithology encountered whichever is less, or as directed by the Engineer's Representative at site. Special care shall be exercised to determine the thickness and location of each change in material encountered and to obtain satisfactory samples. Immediately upon taking the sample, each sample shall be placed in a plastic or cloth bag or specified partitioned wooden box, or other approved container, properly marked for identification, and plainly labelled with the depth of the top and bottom of the section of the bore hole represented. The containers shall be furnished by the Contractor. The method of obtaining, processing, and storing the samples will be subject to approval by the Engineer-in-Charge. The Contractor shall deliver all samples to the Engineer-in-Charge at the site of the tube-wells, except that when requested to do so by the Engineer-in-Charge, the Contractor shall deliver specified samples to the Engineer's field headquarters without delay, so as to preserve the moisture contents of the samples retrieved.

1.1.3 Installation of Tube-Well Components

1.1.3.1 General

Installation shall consist of all work required in connection with the erection of pumping housing

pipe, blind pipe, reducer, screen and bail plug/ sand trap required. For each tube-well as specified herein, or on the Drawings or as directed by the Engineer-in-Charge shall include, but not limited to storing, fabricating and installing all the tube-well components including concentric reducers.

1.1.3.2 Materials

(i) Pump Housing Pipe

The housing pipe made of mild steel, PVC or fiberglass may have the same diameter as that of the other components or it may be bigger in which case tapered joint/reducer shall be used for connection of the housing pipe with the lower part of tube-well.

The mild steel pump housing pipes shall be new and shall be either seamless (Type S Grade 8 ASTM A- 53), longitudinal welded (Type E Grade 8 ASTM A-53) or special seam fusion welded (Grade 8 ASTM A-139) mild steel of designated diameters and thickness indicated in the drawings.

PVC housing pipe shall conform to BSS-3505/1968, Fiberglass pipe ASTM D-2992, D-2412, D-2444, D-638, D-2584.

All these pipes shall be free from dents, injuries, scars and oval ties. The pump housing pipe shall be installed to extend above ground level as approved by the Engineer-in-Charge in addition to the housing as specified below ground level.

(ii) Well Blind Pipes

Well blind pipes shall be of designated diameters as indicated in the drawings, which shall be fabricated in conformity with the specifications designated here above for pump housing pipes.

Fibre glass well blind pipes whenever used shall be new and shall consist of glass reinforced plastic pipe and couplings manufactured from thermo setting epoxy resins and glass fibre by either centrifugal casting process or by a filament winding process, both using continuous filaments and without the addition of fillers or pigments of any kind.

Glass fiber used in the manufacture of pipe and couplings shall be continuous filament, electrical glass. The glass shall have a finish suitable for use and compatible hardener Each glass fiber or filament shall be thoroughly coated with epoxy resin.

All fiberglass casing pipe and couplings shall be round and straight of uniform quality and workman- ship, and free from all defects including indentations, delamination, bends, cracks, blisters, porosity, dry spots, resin segregation and resin starved areas which due to their nature, degree or extent, detrimentally affect the strength and serviceability of the pipe and couplings. The impregnation of the glass fiber with resin shall be such that when the pipe is slotted no fraying or looseness of glass fibers shall be evident. All pipe ends shall be cut at right angles to the axis of the pipe and any sharp edges shall be removed. The inside of the pipe and couplings shall be smooth and uniform. Acetone rub tests may be employed to check resin nature and curing.

Pipe sections may be furnished with integrally fabricated couplings as specified herein- after, with plain or tapered ends for connection in the manufacturer's plant to separate coupling halves or with threaded ends for connection by means of threaded couplings. The Contractor shall be responsible for the co-ordination of all casing components to ensure proper connection to adjoining sections of the tube-well casing and the MS Pump housing casing.

Couplings for fiberglass casing pipe may be threaded, mechanical or Key type couplings of a design to be approved by the Engineer-in-Charge. The couplings shall be manufactured of the same materials used in the manufacture of the fiberglass pipe separate components for attachment to the pipe section in the manufacturer plant.

All threaded pipe sections shall be field connected by the use of threaded fiberglass couplings. Thread geometry shall conform to the applicable sections of ASTM Standard: D -1694 or equivalent.

Key-type couplings shall consist of male and female halves designed for joining & locking together by means of key-Strip inserted in grooves in the coupling halves. The wall thickness at the groove on the male or spigot end of the pipe may be up to a minimum of 0.15 inches. Key strip and locking strips shall be fiberglass, plastic or other non-corrosive material capable of withstanding shearing and bearing stresses equivalent to the minimum axial tensile load for the couplings.

(iii) Reducer

In case where the size of the pump housing pipe is larger than the size of the strainer, the Mild steel pump housing pipe is connected with strainer or blind pipe by means of a reducer. The reducer shall be provided and made of the same material and of the same thickness as used for pump housing pipe specified above. The upper end of the reducer shall be suitable for welding to the pump housing pipe and the lower end shall be designed for connection to the specified size and type of the well blind pipe.

(iv) Bail Plug/Sand Trap

Bail plug/Sand trap shall be of the same material and thickness as followed for well casing. Sand trap shall be provided with a base plate, welded at one end of the pipe. A steel hook bent in the form of 'U' shall be bolted to the base plate to sustain suspended length casing including the strainer and blind pipe. Bail plug/Sand trap shall be one to three meters long in size or as indicated in the drawing.

(v) Well Screen

Well screen shall be either brass, PVC or fiberglass suitable for gravel pack tube-well and strong enough for location at a depth as shown' on the drawings, below ground level.

The strainer shall have smooth, sharp-edged slots free of burrs, chipped edges, or broken are as on the interior or exterior surfaces of the pipe. The slots shall be machine cut having not more than 1.6 mm width. The width of the slot shall be dependent on the particle sizes of the sand. The open area of slotted casing shall be as approved by the Engineer-in-Charge. The slots or groups of slots shall be distributed in a uniform pattern around the periphery of the pipe. The openings shall be free from jagged edges irregularities or anything that will

accelerate or contribute to clogging or corrosion.

Factory slotted casing to be delivered to the work site *for joining* and placement in the well.

1.1.3.3 Fabrication

The depth of pump housing pipe will be established by the Engineer-in-Charge depending on the future water levels and draw down anticipated. Length of the specified diameter of steel pipe shall be provided to extend the pump housing/casing from the elevation of the top of the pump housing pipe to the depth established by the Engineer-in-Charge.

Adjoining sections of Mild steel pump housing pipe shall be assembled by field welding. The ends of the casing sections shall be lathe turned or other-wise prepared for joining. All fields welding shall be performed by the electric arc method, using heavily coated welding rods suitable for all position welding. After being welded, the welds shall be cleaned of slag and shall show uniform smooth surface without over-lap, porosity and clinker. The pump housing pipe shall be connected to the tube-well casing (slotted and blind pipe) by means of a concentric tapered reducer.

The length and sizes of tube-well casing (slotted and blind pipe) to be installed shall be specified for the tube-well by the Engineer-in-Charge and shall be sufficient to extend from the bottom of the housing pipe to the top of the bail plug. Bail plug shall be provided at the bottom of the tube-well casing. The tube-well casing shall consist of sections for installation opposite water yielding formations and plain pipe sections or bail plug opposite non-water yielding formations as directed by the Engineer-in-Charge.

1.1.3.4 Installation

The Contractor shall install the entire pump housing and tube-well casing assembly straight, plumb, and concentric in the drilled hole to permit the installation of the pump in such a manner that it will operate adequately and without damage. The methods employed by the Contractor in the installation of the casing and in obtaining or correcting the verticality & straightness of the pump housing/ casing shall be subject to the approval of the Engineer-in-Charge. Centralizers, spacers or other suitable devices shall be attached to the tube-well casing so that it will be cantered in the drill hole throughout its entire length an held in such position while gravel shrouding is being placed. Centralizers shall be attached to the pipe in a manner that ensures that the pipe is accurately cantered in the drill hole. The detailed design of centralizers and the method of attachment to the pipe shall be subject to the approval of the Engineer-in-Charge. Unless otherwise directed by the Engineer, centralizers shall be spaced not more than 60 ft. along the overall length of screen and casing assembly.

The Contractor shall install the pump housing casing so that the deviation of its axis from the vertical shall not exceed 4 inches (100 mm) at the bottom of the pump housing casing. Measurements for determination of verticality and straightness of the pump housing casing shall be made by the Contractor in the presence of the Engineer-in-Charge upon completion of the gravel shrouding.

Straightness shall be determined by lowering a section of pipe 40 ft. long or a dummy of the same length to the bottom of the pump housing casing. The minimum diameter of the pipe or dummy shall be 1 inch less than the inside diameter of the pump housing casing. If a dummy

is used, it shall consist of a rigid spindle with three cylindrical rings, each ring having a height of at least 12 inches. The rings shall be true cylinders and shall be located at each end and in the centre of the dummy. The central shaft of the dummy shall be rigid so that it will maintain the alignment of the axis of the cylindrical rings. The pump housing casing shall be sufficiently straights so the pipe or dummy can be passed freely throughout the entire length of the pump housing casing. Plumbs, pipes and dummies used in these tests shall be approved by the Engineer-in-Charge.

Any tube-well failing to meet the specified requirements for straightness, verticality and concentricity shall be abandoned, and the Contractor shall construct a new well at his own expense at an alternative site designated by the Engineer-in-Charge.

After completion of installation of the pump housing casing and approval of the installation by the Engineer-in-Charge, the Contractor shall paint the letter and number designation of the tube-well on that portion of the pump housing casing which projects above the ground surface. All paint, brushes, stencils and other materials required shall be furnished by the Contractor. The characters shall not be less than 6 inches shall be painted with lines I inch wide, and shall be positioned on the casing in accordance with the Engineer's instructions.

1.1.4 Gravel Shrouding

1.1.4.1 General

Gravel shrouding shall consist of all work required in connection with supply and placing of gravel shrouding in annular space between the walls of the drilled hole and the outside of the pump casing. The work shall include, but not limited to development of source, excavation, stock piling, grading, washing, storing, transporting and placing of' gravel shrouding as specified herein or as directed by the Engineer-in-Charge.

1.1.4.2 Gravel Source

The Contractor may obtain gravel from any source or location subject to the approval of the Engineer- in-Charge provided that the gravel meets the requirements of the specifications. The Department will not be responsible for the amount of work involved or the amount of materials wastage in order to obtain the required amount of gravel of proper gradation.

1.1.4.3 Specifications

The gravel shrouding shall be clean, washed, water worn, hard, well rounded of siliceous material, without flaky particles, free from gypsum and shale, and under no circumstances shall contain > 5% calcareous material. The gravel supplied shall be subject to inspection and screening in the field to ensure proper gradation suitable to the formation. The gravel shall be reasonably graded and shall conform to the following Table 1 requirements or as specified by the Engineer-in-Charge.

Table 1: Gravel Grading Requirements

US Standard Screen Number	Sieve Size (mm)	Percentage Passing
No.4	4.75	100
No. 8	2.36	75-91
No.10	2.00	59-75

US Standard Screen Number	Sieve Size (mm)	Percentage Passing
No.12	1.70	38-54
No. 16	1.18	16-32
No.20	0.85	0

1.1.4.4 Placing of Gravel

Gravel shall be placed at constant rate using tremie pipe, hoppers or other similar devices to provide a continuous and uniform gravel flow so as to minimize segregation of particle sizes. When tremie pipe or hoppers are used, gravel shall be introduced in the annular space between the pump housing and the edge of the hole at two points located 180 degrees apart. The tremie pipe, when used, shall be of suitable size and lowered to the bottom· of the well on two opposite sides of the bore hole and calculated quantity of gravel shall be poured in the pipe through a funnel and the pipe shall be raised by 6 ft. {1.80 meters) interval.

In all cases water shall be circulated steadily during gravel placement by inserting the drilling rod into pump housing and operating the circulation pump on the drilling rig. The water level in the annular space outside the pump housing shall be maintained at or above natural surface level by return flow from the cutting bit. Temporary casing, if used, shall be carefully withdrawn in 6 ft. to 10 ft. {1.5 m to 3.0 m) interval during placement of gravel shrouding and the gravel shall be introduced so that each stage of the hole above bottom of the casing is completely filled before the casing is withdrawn to the next stage.

The process of placement of gravel shrouding and withdrawing the temporary casing shall be continued to the ground level or up to level approved by the Engineer-in-Charge. As guidance the process of shall be continued until the bottom of temporary casing is at least 10 ft. above top of the topmost screen. Above this point temporary casing shall be removed or left at the option of the Contractor provided that no payment shall be made to the Contactor for temporary casing left in place except when it is of new material and is an acceptable substitute for an appropriate length of pump housing casing.

1.1.5 Development and Testing

1.1.5.1 General

Development and testing shall consist of all work including power supply required in connection with the development of the tube-well to produce the design capacity of sand free water with a minimum drawdown, and the testing of the tube-well to determine the effectiveness of the development operations as specified herein. Development and testing shall include, but not be limited to surging, back washing and pumping the tube-well at higher than rated capacity, testing the tube-well for specific capacity, sand content and degree of development, and disinfection and sealing of the tube- well.

The Contractor shall be required to sound the well to determine whether excess material has accumulated at the bottom of the well at the following stages of the work;

a) On completion of the casing and screen installation
b) Before the starting of the development and
c) After completion of development and testing

If it is found at any stage mentioned above that the well contains more than 2 ft. of sand or other material in the bail plug, the Contractor shall clear the well down to a level approximately 2 ft. above the bottom plate of the bail plug. Water obtained in development and testing shall be disposed of by the Contractor in an approved manner.

1.1.5.2 Development

The development procedure and methods used for development of the tube-well shall be established by the Contractor subject to approval by the Engineer-in-Charge and the development operations shall be witnessed by the Engineer-in-Charge from their initiation to their completion. The Contractor shall maintain a complete record of the development operation and shall make regular periodic measurements of discharge rates, sand content and water level measurements.

The procedures used shall include backwashing and pumping at 1.5 times the rated capacity and may include surging or similar procedures determined by the Contractor. The Contractor shall notify the Engineer-in-Charge following the completion of the 6 hours pumping, period that the tube-well is ready for testing. In wells where bentonite or other formation stabilizing agents are used, the Contractor shall undertake a program of cleaning the well with phosphates or other dispersing agents in a manner and with chemical dosages as approved by the Engineer-in-Charge prior to starting normal development work.

1.1.5.3 Testing

The contractor shall test each tube-well under the direction of the Engineer-in-Charge as described herein. Upon completion of the development operations the tube-well shall be permitted to recover for a minimum period of one hour. During this recovery period, the tube-well shall be sounded. If the comparison of the depth by sounding and the length of the casing string indicates that there is more than 6.00 feet of material in the tube-well, it shall be cleaned to within 2.0 feet of the bottom of the casing by bailing.

At the end of the first five minutes of pumping, the sand content of the water shall be determined by using a 40 inches Imhoff cone or other device approved by the Engineer-in-Charge. The sand content of the water at this time shall be less than 100 mg/litre. A second sand content determination shall be made 10 minutes after the start of pumping. The sand content at this time shall be less than 30 mg/I. If the sand content tolerances are exceeded at this time, or at any subsequent time up to the time of final acceptance of the installation, sand content determinations, water level, and discharge measurements during the remainder or the one-hours and test period shall be made as directed by the Engineer-in-Charge.

When the sand test has been satisfactorily completed, the tube-well shall be further developed for 4 hours by surging and backwashing with the test pump at five to ten minute intervals. Following the development period, the tube-well shall again be pumped for a period of one hour during which time the sand test shall be repeated. The specific capacity of the tube-well shall be determined from the water level measurements and flow rates obtained, during the pumping periods. If the specific capacity obtained from the second pump test is found to be more than 10 percent greater than that obtained in the first pump test, the development shall be continued as directed by the Engineer-in- Charge.

Upon satisfactory completion of the above one hour pumping period the tube-well shall

be permitted to recover for a period of one hour. Upon the completion of this recovery period, a four-hour multiple step pump test shall be performed by pumping the tube-well for one hour at each of approximately four equal increments.

1.1.5.4 Summary

The following Table 2 is a short summary of the development and testing procedure:

Table 2: Development and Testing Procedure.

Activity	Duration
Development	4 Hours
Testing	
Recovery	1 hours
Pumping Period (Sand Test)	1 hours
Development	3 hours
Pumping period (Retest)	1 hours
Recovery	2 hours
Step pumping	4 hours (one hour each of the rated capacities 35%, 70%, 105%, & 140%)
Pumping period (Constant discharge test)	4 hours (140 %) of rated capacity measurement of final specific capacity sounding of well depth removal of foreign material above 2 feet by a suitable method approved by the Engineer

1.1.5.5 Equipment

The Contractor shall furnish all necessary equipment for testing the tube-well, including a water lubricated or oil lubricated test pump, a valve for fine adjustment of the discharge, an electric measuring device to determine the drawdown during each stage of the test and Imhoff cones to measure sand content. If oil lubricated test pumps are used, the contractor shall exercise all reasonable precautions to keep the leakage of lubricating oil into the tube-well at a minimum and shall promptly remove all oil which collects on the water surface in the tube-well by the addition of detergents or other suitable chemicals proposed by Contractor and approved by the Engineer-in- Charge and pumping the emulsified oil from the tube-well. In the event the Contractor fails to keep the leakage of oil into the tube-well within acceptable limits or to promptly remove oil accumulations from the tube-well, the Engineer-in-Charge will order the use of oil lubricated test pumps discontinued and the Contractor shall use water lubricated pumps for testing of the tube-wells. The actual depth of setting for the test pump will be determined by the Engineer-in-Charge after the tube-well has been developed. Piping, gauges, orifices, meters, wire boxes or other measuring devices shall be furnished, installed and removed by the Contractor and will remain his property. All measuring devices and testing equipment shall be subject to approval by the Engineer-in-Charge.

1.1.5.6 Measurement and Data

The Contractor shall take drawdown and discharge measurements and other pertinent data during each test at intervals as specified by the Engineer-in-Charge. All such data shall be recorded on forms approved by the Engineer-in-Charge, and the original of such forms shall be delivered to the Engineer- in-Charge at the completion of the development and testing operations.

1.1.5.7 Disinfection

After development and testing of the tube-well has been satisfactorily completed, and when approved by the Engineer-in-Charge, the Contractor shall disinfect the tube-well by dispersing chlorine solution throughout the entire depth of the well to obtain a minimum chlorine content of 50 mg/I. The procedure and equipment used to introduce and disperse the chlorine in the tube-well shall be subject to approval by the Engineer-in-Charge.

1.1.5.8 Sealing

Upon completion of the tube-well the Contractor shall seal the tube-well with a¼ inch thick steel plate cap welded to the pump housing at few points using Arc welding, or by some other method approved by the Engineer-in-Charge. Compliance with this requirement will not relieve the Contractor of his responsibility for the safeguarding of any part of the tube-well completed until the Certificate of Acceptance is issued for the entire tube-well installation.

1.1.5.9 Approval of Materials

As soon as practicable but within 30 days after receipt of notice to proceed and before any materials or equipment are purchased, the Contractor shall submit for approval by the Engineer-in-Charge a complete schedule, in triplicate, of materials and equipment to be incorporated in the work, together with the names and addresses of the manufacturers and their catalogue cuts, diagrams, drawings, and such other descriptive data as may be required by the Engineer-in-Charge. No consideration will be given to partial lists submitted from time to time. Approval of materials and equipment under deviations from the specifications shall not be granted unless the attention of the Engineer-in-Charge has been directed to the specific deviations. Laboratory results and certifications, specified or otherwise required, shall be submitted prior to delivery of the material and equipment to site.

1 SEWAGE SUBMERSIBLE PUMP

1.1 Scope

This Section covers the requirements for designing, manufacturing/fabrication, testing at the manufacturer's works, furnishing, installing, painting, testing and commissioning at Site, placing in satisfactory operating conditions, and warranty one-year satisfactory operation of non-clogging, vertical shaft, close coupled, centrifugal type submersible sewage pump. The specifications of necessary piping, suction elbow, bends, valves, supports/thrust blocks, control panels, cables, devices, valves and appurtenances as shown on the Drawings or as required for the satisfactory operation of the System are included in the bill of quantities (BOQ) and relevant section of these specifications.

1.2 List Of Abbreviations

API	American Petroleum Institute
ASTM	American Society for Testing and Materials
ASME	American Society of Mechanical Engineers
AWS	American Welding Society
BOQ	Bill of Quantities
BS	British Standard
DN	Nominal Diameter
DIN	Deutsches Institut für Normung
EN	European Standard
HDPE	High Density Polyethylene
HI	Hydraulic Institute
ISO	International Organization for Standardization
MSS	Manufacturers Standardization Society
NEMA	National Electrical Manufacturers Association
NPSH	Net Positive Suction Head
PLC	Programmable Logic Controller
PN	Pressure Rating

1.3 General

The work will include but not be limited to the followings:

- Designing, manufacturing, testing at manufacturer's workshop, supplying at site, installation, testing, commissioning, guarantee and maintenance for one year during defect Liability Period

of close coupled, non-clogging, vertical shaft, centrifugal type submersible, sewage cum storm water pumps with suitable AC induction, totally enclosed, 4 pole, 3-Ph, 400 V, 50 Hz, insulation class F, ingress protection IP 68, to be installed in wet well, including electrical cable up to 15 m and control cable up to 15 m, motor control unit, pressure gauge discharge side, 01 Nos. sluice valve, 01 No non-return valve including factory inspection during casting of pumps and final inspection at test bed, erection & maintenance tools and spare parts. All equipment shall be from reputed approved manufacturers.

- Design, supply and installation of brand new 400V, 50 Hz, 3 phase, insulation class F, IP-68 with efficiency class (IE-2) suitable for operating pumps described above. The motors shall be from reputed manufacturer subject to approval of the Engineer.
- Design, supply and installation of motor control unit/motor control center consisting of metallic box, auto star delta starter, circuit breaker, magnetic contactor, thermal overload relay, on/off switch, control fuse, auto level control with ultrasonic sensor, control wire, under/over voltage relay, electronic over current relay, phase failure relay, indication lamps, digital ampere meter, volt meter, hour run meter, dry running protection thermistor relay, high temperature protection, phase reversal protection, along with pump controller with built-in Micro processer connectable to analog & digital sensors, automatic control for alternate operation of pumping units at predetermined time, wiring and necessary items for moisture in oil monitoring for mechanical seals, level switches for dry running protection, temperature and vibration monitoring of pumping units, electrical and control cables of 15 m each, complete in all respects. All the equipment shall be from reputed manufacturers subject to approval of the Engineer.

- Manufacture, test, supply and installation of sluice valves as shown in the drawings.
- Manufacture, test, supply and installation of discharge piping, along with all flanges, their coating and lining including reducers, tee, elbows etc.
- Manufacture, test, supply and installation of non-return valves as shown in the drawings.

1.4 Applicable Standards

Latest edition of the following applicable standards:

BS EN 545	Ductile Iron Pipes, Fittings, Accessories and their Joints for Water Pipelines - Requirements and Test Methods
BS EN 598	Ductile Iron Pipes, Fittings, Accessories and their Joints for Sewerage Applications - Requirements and Test Methods
HI	Hydraulic Institute Standards for Rotodynamic (Centrifugal) Pumps
HI 1.3	Rotodynamic (Centrifugal) pumps for Design and Application
HI 1.4	Rotodynamic (Centrifugal) pumps for manuals describing installation, operation and maintenance
HI 14.6	Rotodynamic Pumps for Hydraulic Performance Acceptance Tests

API 682	Pumps-Shaft Sealing Systems for Centrifugal and Rotary Pumps
ASTM A815~S31803	Duplex Stainless Steel
ASME B73.1	Specification for Horizontal End Suction Centrifugal Pumps for Chemical Process
ASME B16.5	Pipe flanges and flanged fittings NPS 1/2 through NPS 24
ASME B16.47	Large diameter steel flanges NPS 26 through NPS 60
ASTM - A 276	Standard Specification for Steel Castings, Carbon for General Application
ASTM - A 36	Standard Specification for Carbon Structural Steel
ASTM A 216	Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service
ASTM A 240	Heat Resisting Chromium and Chromium - Nickel Stainless Steel Plates
ASTM A 276	Standard Specification for Stainless Steel Bars and Shapes
ASTM A 743	Castings, Iron - Chromium, Iron – Chromium - Nickel, Corrosion Resistant, for General Application
ASTM B 62	Composition Bronze or Ounce Metal Castings
ASTM B 148	Nickel - Aluminium Bronze
ASTM A193	Specification for Alloy-Steel and Stainless-Steel Bolting for High Temperature or High-Pressure Service and Other Special Purpose Applications
ASTM A194	Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both
ASTM A 890	Specification for Castings, Iron-Chromium-Nickel-Molybdenum Corrosion Resistant, Duplex (Austenitic/Ferritic) For General Application
ISO 10204	Metallic Products-Types of inspection documents
ISO 1940	Mechanical vibration — Balance quality requirements of rigid rotors
ISO 3661	End-suction centrifugal pumps -- Baseplate and installation dimensions
ISO 2858	End-suction centrifugal pumps (rating 16 bar) Designation, nominal duty point and dimensions
ISO 3069	End-suction centrifugal pumps -- Dimensions of cavities for mechanical seals and for soft packing
ISO 5198	Centrifugal, mixed flow and axial pumps -- Code for hydraulic performance tests -- Precision grade

ISO 5199 / 2858	Specification for Horizontal End Suction Centrifugal Pumps for Chemical Process
ISO 7005	Metallic flanges – Cast Iron and Steel
ISO 9905	Technical specifications for centrifugal pumps-Class I
ISO 9906	Rotodynamic Pumps-Hydraulic performance acceptance tests
ISO 9908	Technical specifications for centrifugal pumps- Class III
ISO 10441	Flexible couplings for mechanical power transmission — Special purpose applications
ISO 11342	Mechanical Vibration — Methods and criteria for the mechanical balancing of flexible rotors
ISO/DIS 14414	Pump system energy assessment
ISO 14617-9	Graphical symbols for diagrams – Part 9: Pumps, compressors and fans
ISO 14691	Petroleum and natural gas industries — Flexible couplings for mechanical power transmission — General purpose applications
ISO/DIS 21049	Pumps - Shaft-sealing systems for centrifugal and rotary pumps
ISO 20361	Liquid pumps and pump units -- Noise test code - Grades 2 and 3 of accuracy
ISO 17769-2	Liquid pumps and installation -- General terms, definitions, quantities, letter symbols and units - Part 2: Pumping system
MSS-SP-55	Quality standard for steel castings for valves, flanges and fittings and other piping Components-Visual method for evaluation of surface irregularities
DIN 24255	End-suction centrifugal pumps, also known as standard water pumps, with a rated pressure (PN) of 145 psi
AWS D1.1	Structural welding code — Steel
AWS D1.6	Structural welding code — Stainless Steel

Any other applicable Standards subject to approval of the Engineer.

1.5 Pump Operation

The pumps shall start with the sluice valves closed on discharge side. When the pump motors reach synchronous or rated speed, the valves shall be opened. The non-return valve shall open following the sluice valve. During the stopping sequence of the pumps, under normal working conditions, the sluice valves shall close first and the pump motor shall be switched-off after that. Under emergency conditions or during a power outage, the non-return valve shall automatically close as soon as the pump stops to avoid reverse rotation.

1.6 Pumps Design Criteria

The pumps shall be designed in accordance with applicable requirements of Hydraulic Institute Standards or other internationally recognized pump manufacturing standards subject to approval of the Engineer.

The Contractor shall verify the design heads of the pumping system, accordingly prepare system head curves and superimpose the pump performance curve on it, verify the arrangement and sizes of the station piping, the design duties of each equipment, analyse system pressure losses, check hydraulic transients for normal and emergency conditions etc. and submit to the Engineer detailed reports/designs for approval before any material procurement.

Each equipment shall be suitable for rendering intended duties individually as well as part of the whole system under the Project's requirements, climatic and environmental conditions.

The Contractor shall ensure during design review and shop testing stages that all pumps shall operate near their best efficiency points individually as well as operating in parallel as part of the whole system.

1.7 Pump Manufacturer's Qualifications

Based on the pumping requirements of the Project, the Contractor shall refer to the reputed pump manufacturers having relevant experience in designing and manufacturing of pumps with sewage and storm water pumping media with characteristics which could satisfy the actual requirements of the project.

The Contractor shall submit complete details, technical brochures, list of standards, list of testing/inspection tools, details of the test bed facilities available with his proposed pump manufacturer and list of projects where the manufacturer has supplied such pumps with similar type and materials of construction as specified in these specifications. The proposed pump manufacturer shall be approved after review of the data by the Engineer and Employer.

1.8 Submittals

The Contractor shall submit all the following documents/drawings, copies of the applicable Standards (latest editions) and all other submittals as required in both soft and hard form for review and approval of the Engineer:

- Shop drawings: General assembly, components, dimensions, thicknesses of casings, impellers, weights, clearances and methods of assembly including material specifications.
- Product Data: Provide manufacturer's literature including general assembly, certified pump curves showing performance characteristics with pumps and system operating points indicated, NPSH curves, power curves, controls, wiring diagrams, and service connections.
- System design and pressure loss calculations of pumping station, suction/discharge piping and rising main to confirm the specified design heads and to ensure required flow and actual design head operating at the best efficiency point.
- Design calculations of the system along with system performance curves as per actual Site condition.

- Proposed system operation description.
- Manufacturer's Installation Instructions: Including handling, storage, start-up and shut-down instructions for pumping system.
- Details of motor control units.
- Manufacturer's Certificate: Certifying that pumps meet or exceed specified requirements at specified operating conditions. Submit summary and results of shop tests performed in accordance with DIN EN ISO 9906 Grade 1B or HI 14.6 Grade 1B in presence of the Engineer and Employer. The material test certificates shall be submitted as per the requirements of ISO EN 10204 (3.1).
- Manufacturer's Quality Assurance and Quality Control Programme. To assure full control of fabrication processes, it is mandatory to use written procedures for operations and submit to the Engineer.
- Test certificates regarding hydrostatic testing of casing, pump-motor alignment and dynamic balancing of impellers.
- Field Reports: Submit as directed by the Engineer.

1.9 Materials

1.9.1 General

- All the pump parts, unless otherwise specified shall be of standard materials of the manufacturer, suitable for the specified operating conditions approved by the Engineer.
- All materials shall be new and of first-class quality, suitable for the purpose, free from defects and imperfections.
- Materials of pumps and valves shall be compatible with the corrosive and abrasive properties of the pumped water.

1.9.2 Pumps

- **Type and Description**:

Each pumping units to be furnished under this package shall consist of vertical shaft, non-clogging, centrifugal type submersible pump close coupled to a suitable squirrel cage, induction type, vertical electric motor, class F, IP 68. The pumping units shall be suitable for indoor operation. The pumps shall be suitable for parallel operation. The pumps shall have stable head/capacity curve that continuously rises to shutoff. The pump shall be capable of continuous submerged operation installed in a wet well pit installation and connected permanently to outlet pipes.

- **Head, Capacities and Speeds:**

The pump design parameters are provided for reference. The data provided herein below is subject to verification of the contractor.

Design head	30 ft (approx.)
Efficiency of pumps	Not less than 60% with efficiency class (IE-2)
Pump Speed	Less than 1500 rpm

- **Efficiency**:

The best efficiency of the pumps at the rated head shall not be less than 60% with efficiency class (IE-2).

1.9.3 Component Materials

- **Casing and Impeller:**

The pump casing shall be designed for the maximum discharge pressure plus allowance for head increase at pumping temperature and hydrostatic test pressure at ambient temperature, with a 3 mm minimum corrosion allowance and to produce smooth flow with gradual changes in velocity. The casing shall be made of Cast iron ASTM A 48 Class 35, EN GJL 250 or better, subject to approval of the Engineer. Pump casing shall be easily removable from the motor for full inspection of impeller. The chemical composition and mechanical properties of pump casing shall be stated on the manufacturer's drawings.

The discharge connections shall be flat-face or raised-face flanges, faced and drilled to conform to Class 150 as per standard ANSI rating. The pump casing shall be provided with wearing ring to adjust the clearance between impeller and casing or it shall be provided with removable and renewable wearing rings where there are close-running clearances between the impeller and the casing The wearing rings shall be press-fit and held to the impeller with locking pin.

The impeller furnished shall be the multivane radial flow type with free passage size of not less than 80 mm, shall be of Ductile Cast iron (A536 GR 65-45-12) or better subject to approval of the Engineer, carefully selected for resistance to corrosion and pitting and shall be fastened to the shaft in such a manner as to make it readily removable. The impeller shall be capable of running against closed valve. The design must ensure that long fibers, rags pass freely through the pump without getting caught and without causing clogging or jamming. Impeller shall be individually secured against axial movement in either direction along the shaft. The impeller shall be statically and dynamically balanced.

The Contractor shall guarantee each impeller against excessive cavitation for a period of two (2) years from the date the pump is placed in service.

- **Shaft**:

The shaft shall be of stainless steel AISI 431 or better, subject to approval of the Engineer, suitably heat treated, rigid design type and of ample size to operate without vibration throughout the range of normal and reverse runaway speed. Actual critical speeds shall not encroach upon specified operating speed range. Preferably, its first critical speed shall be at least 20% higher than normal operating speed. The critical speed shall be confirmed by test standard data. Water deflectors shall be provided on the shaft to prevent water from passing along the shaft and entering the pump bearings. A shaft protecting sleeve shall be provided on the shaft. A shaft protecting sleeve shall be provided on the shaft. The material of the sleeve shall be of stainless steel AISI 304 subject to approval of the Engineer.

A suitable coupling shall be furnished between the pump and the motor as per manufacturer's standard design. The design of the coupling and the means of attaching the coupling to the pump shaft shall be such as to facilitate the maintenance of the pump whenever necessary.

- **Mechanical Seals**:

Two hydraulically balanced seals installed in tandem arrangement complete with all required auxiliaries and oil reservoir shall be provided. The seals shall be oil-lubricated and the seal springs shall be operating in the oil fully protected against contact with the pumped liquid. The oil chamber shall provide a reliable sealing between the pumped liquid and the motor.

The material of the primary seal faces shall be Silicon Carbide-Silicon Carbide and material of the secondary seal shall be Silicon Carbide-Carbon.

The seals shall allow for rotation in either direction. The seal area design shall prevent air pocket formation around the seal. All static seals at watertight joints shall be of nitrile O-ring type.

- **Pump Bearings**:

The pump shaft shall be supported by bearings of approved design. The bearings shall be grease-lubricated, angular contact ball or roller-bearing type. One bearing on the pump shall be of the thrust type, designed to withstand the unbalanced hydraulic thrust. Suitable fittings shall be furnished for the type of lubrication provided.

Bearings shall be designed for a nominal L10 life time of 50,000 hr at best efficiency point.

- **Pump Drive:**

Suitable Electric motors, constant speed, vertical shaft induction type, close coupled, IP 68, insulation class F, with efficiency class (IE-2), submerged operation shall be provided. Motor housing shall be of cast iron. The rotor shall be solid cast and dynamically balanced. Shaft ends shall be conical for safe securing of impeller. Shaft bearings shall be open or shielded design greased for life. Power and control cables shall be clamped against tensile loads and have a serviceable inlet to the motor sealed by compressed rubber ring elements.

The motor shall have internal protection devices consisting of thermos-switches embedded in the stator windings.

Design of power cable shall be according to NEMA Standards. The length of the power cable shall be sufficient in order to reach the junction box without the needs to splice it with another cable.

The power provided by the motor shall be adequate e.g. providing enough power to ensure that pump is not overloading throughout the pump performance curve from 0 to max flow.

- **Foundations:**

The reinforced concrete foundations of the pumping units shall be so designed that the computed amplitude of vibrations at the top of the foundations and elastic deflections due to machinery loads shall remain within the permissible limits prescribed by the machinery manufacturers.

The natural frequency of the whole of the foundations or parts thereof and all structures adjacent thereto shall not coincide with the operating frequency of the vibrating plant to avoid resonance condition. The foundation's natural frequency shall be at least 10% less than the frequency of vibrating equipment.

1.10 Operation and Maintenance Manual

The Contractor shall submit soft and hard copies of O&M manual for review and approval of the Engineer.

Submit step-by-step instructions describing how the Pumping Disposal Station (Plant) is prepared for start-up from a zero state. They shall include instructions for the receipt and storage of all consumables including chemicals, lubricants, fuels etc. and their transfer from storage to the Plant in preparation for start-up.

A. Description of unit and component parts
   - Complete nomenclature and commercial number of replaceable parts
   - Metallurgy of Parts and their equivalence according to ASTM International Standards
   - Function, normal operating characteristics, and limiting conditions
   - System curves, performance curves, Engineering data and tests

B. Operating procedures:
   - Start-up, break-in, routine and normal operating instructions.
   - Regulation, control, stopping, shut-down and emergency instructions.
   - Summer and winter operation instructions
   - Special operating instructions.

C. Maintenance Procedures
   - Routine operations/maintenance (daily, weekly, monthly or annual).
   - Guide to "Trouble-shooting".
   - Disassembly, repair and reassembly.
   - Alignment, adjusting and checking.

D. Servicing and lubrication schedule.
   - List of lubricants required and their schedule for applying.

E. Manufacturer's printed operation and maintenance instructions.
F. Description of sequence of operation by control and pump manufacturers.
G. Original manufacturer's parts list, illustrations, assembly drawings and diagrams required for maintenance.
   - Predicted life of parts subject to wear.
   - Items recommended to be stocked as spare parts for five years of trouble-free operation.

H. As-installed control diagrams by controls manufacturer.
I. Coordination drawings.
J. As-installed color coded piping diagrams.
K. List of original manufacturer's spare parts, manufacturer's current prices and recommended quantities to be maintained in storage.

L. Other data as required under pertinent sections of Specifications.
M. Content, for each electric and electronic system, as appropriate:
    1. Description of system and component parts.
        - Function, normal operating characteristics, and limiting conditions.
        - Performance curves, Engineering data and tests.
        - Complete nomenclature and commercial number of replaceable parts.
    2. Circuit directories of panel boards.
        - Electrical service
        - Controls
        - Communications
    3. As-installed color coded wiring diagrams.
    4. Operating procedures:
        - Routine and normal operating instructions.
        - Sequences required.
        - Special operating instructions.
    5. Maintenance procedures:
        - Routine Operations
        - Guide to "trouble-shooting".
        - Disassembly, repair and reassembly.
        - Adjustment and checking
    6. Manufacturer's printed operating and maintenance instructions.
    7. List of original manufacturer's spare parts, manufacturer's current prices, and recommended quantities to be maintained in storage.
    8. Other data as required under pertinent sections of the Specifications.
N. Additional requirements for operating and maintenance data.

1.11 Guarantee

All items to be furnished shall be guaranteed for a period of one year from the date of Preliminary Acceptance against defective materials, design, performance or workmanship. Any deficiency mentioned above or in the Specifications shall be replaced or corrected by the Contractor as directed by the Engineer at no additional expense to the Employer.

1.12 Quality Assurance

- Manufacturer’s Quality System certification to ISO 9001:2008
- Inspection/testing of the casting of pump components as mentioned in 1.14 hereunder.
- Performance tests in accordance with DIN EN ISO 9906 Grade 1B or HI 14.6 Grade 1B or equivalent.

Maintain one copy of approved documents and drawings on Site.

1.13 Tests

1.13.1 General

The Manufacturer shall have available all means required, all materials, machinery, inspection equipment to carry out testing operations in his workshop.

Water to be used shall be specified by the Manufacturer's Test Procedure which has to be submitted to the Engineer prior to testing. The tests shall be carried out on non-lined/painted parts, the seats and the ball or gate shall be thoroughly cleaned. No grease shall be left on those parts which involve the seats. All blanking devices used for the hydraulic or pneumatic test shall not be prejudicial to the soundness of the valve ends. Test data and pressure shall be recorded during the entire testing time.

The diagrams shall clearly show all information helping to identify them, particularly, for each test they shall show:

- the nominal diameter, the rating and the identification tag of the valve
- the test type
- the duration
- the signature (clearly readable) of the person in charge of the test.

The Manufacturer shall test all valves in accordance with the requirements of API Standard 6D and of this Specification.

1.13.2 Shop Tests

The shop inspection of all the pumping units shall be carried out by the Engineer and Employer’s representative as described herein below:

First Inspection: Inspection for checking any defect in the casted parts, checking of the documentation according to the applicable standards, verification of the thicknesses of pump casing, impellers and other components, ultrasonic/radiographic testing to detect any flaws, verification of metallurgy of the pump casings, impellers and shaft etc. shall be carried out during casting, foundry operations according to international standards (latest applicable) to ensure conformance to the specified materials/requirements by the Engineer’s and Employer’s representatives.

Second Inspection: The pumps shall be assembled completely in the shop to ensure correct fitting of all parts and shall be match marked before transportation, unless the pumps are transported completely assembled, to ensure correct assembly in the field. The pump casings shall be tested hydrostatically in the presence of the Engineer’s and the Employer’s representatives under a pressure equal to 150 percent of either the sum of the pump shut off head plus the maximum suction head or the maximum working pressure whichever is greater. The hydrostatic test pressure shall be held for not less than 30 minutes after all leaks have been stopped.

The pumps shall be tested at test bench in accordance with DIN EN ISO 9906 Grade 1B or HI 14.6 Grade 1B in the presence of the Engineer’s and the Employer’s representatives to check the performance of pump at the specified parameters.

No kind of repair shall be done in any casted parts without prior approval of the Engineer. Any component found defective after conduction of non-destructive testing shall be rejected and that component shall be re-casted. The pumps shall be tested as mentioned above by and at the expense of the Contractor to establish that the materials and the performance requirements of these Specifications and the Contractor's guarantees have been fulfilled. The pump shall be tested in the manufacturer's shop and the performance tests shall be made with the entire pumping unit. Readings shall be taken at a minimum of five capacity points, including one point with plus or minus 1 percent of specified capacity. The tests shall be conducted in accordance with the accepted practices at full speed and unless otherwise specified, the procedure and instruments used shall be duly calibrated and conform to the latest applicable standards, subject to approval of the Engineer.

The tests shall be carried out in the presence of the representatives of the Employer and the Engineer. All the travelling, boarding, lodging other expenditures shall be borne by the Contractor.

- The tests shall cover but not be limited to:
- Determination of the total head.
- Determination of flow rate of water pumped.
- Measurement of the speed of rotation.
- Measurement of input to the pump and output of the motor.
- Determination of efficiencies of pump and pumping unit.
- Preparation of characteristic curve showing system head, pump head, capacity, NPSH required, power and pumping unit efficiency.
- Measurement of reverse runaway speed
- Determination of NPSH required.
- Cavitation testing.
- Measurement of increase in temperature of pump/motor.

Any other tests as required by the Employer / Engineer shall be conducted during the Shop Inspection according to applicable standards and to the satisfaction of the Employer / Engineer.

1.13.3 Operational Tests

Operational tests shall be performed by the Contractor on the pump before the pump is placed in service.

- **Genera**l:

Within two weeks after the operation of the pump has been approved by Employer / Engineer, as provided in the Contract, the pumps shall be tested by and at the expense of the Contractor to determine whether the equipment meets the guarantees. If so desired by the Employer/Engineer, the tests shall be repeated one month before the expiry of the Maintenance Period.

- **Provision in Case of Damage or Wear**:

Prior to the tests, the interior of the pump shall be inspected by the Engineer’s Representative and the Contractor. Should such inspection disclose any damage or wear has taken place, the Contractor shall replace at his own cost.

- **Capacity and Efficiency Tests**:

The capacity and efficiency of the pumps on the system head curves shall be determined for as many different heads within the range of operating heads as possible. The capacities and efficiencies at the guaranteed conditions shall be determined from smooth curves drawn through the test points.

- **Conduct of the Tests**:

The tests shall be conducted in accordance with latest applicable standards of DIN EN ISO 9906 Grade 1B, HI 14.6 Grade 1B or equivalent.

- **Determination of Rate of Flow**:

The rate of flow of water through the pumps shall be determined by the properly calibrated rate of flow indicator or other suitable method agreed upon by the Contractor and the Engineer.

- **Determination of Total Head**:

Total head on the pump (H) shall be the difference between the pressure elevation at the pump discharge and the pressure elevation near the entrance to the suction elbow, both corrected for velocity head. All measurements shall be determined by the instruments furnished with pumps or as follows:

The pressure elevation "a" at the pump discharge shall be measured with the discharge pressure gauge furnished by the Contractor or other suitable method agreed upon by the Engineer and the Contractor.

The velocity head "b" at the pump discharge shall be based on the mean velocity at the piezometer section. The mean velocity shall be determined by dividing the rate of flow by the area at the piezometer section.

The pressure elevation "c" at the pump inlet shall be measured with the suction pressure gauge furnished by Contractor or by other suitable method agreed upon by the Engineer and the Contractor.

The velocity head "d" at the pump inlet shall be based on the mean velocity at the piezometer section. The mean velocity shall be determined by dividing the rate of flow by the area of the passage at the piezometer section.

The total head on the pump (H) shall then be equal to (a+b) - (c+d).

- **Determination of Power:**

The electrical input to the motor shall be measured by using accurate, sensitive and calibrated, test instruments connected to the permanently installed instrument transformers or as directed by the Engineer. The input to the pumps shall be the measured input to the motor minus the mechanical and electrical losses in the motor. The losses in the motor shall be determined by separate tests in accordance with the latest standards and test codes of the Institute of Electrical and Electronic Engineers, Inc; and the American National Standards Institute or specified in the relevant specifications.

- **Determination of Efficiency Curve**:

The efficiency curve of the pump shall be determined from smooth curves of the input, head and rate of flow of water, all as determined in accordance with the above sub-paragraphs.

- **Runaway Tests:**

The pumps shall be subject to runaway tests & witnessed by the Engineer. The tests shall be performed under normal operating conditions by interrupting the power supply.

- **Cavitation Tests:**

Cavitation tests will be performed and witnessed by the Engineer's Representative. The tests will be performed under normal operating conditions to check for the vapor formation to avoid wear and tear.

In addition to any specific tests required on items of plant, as detailed elsewhere in these specifications, the following tests shall be carried out:

Pumps shall be tested for adequate performance including hydraulically and electrically to demonstrate that they function as designed.

All pipe work, valves, etc., shall be pressure tested at 150 percent of design pressure.

Load tests shall be carried out on all lifting equipment at 125% of rated load.

All electrical installations shall be tested.

All alarm systems, overloads and safety equipment shall be tested for simulated conditions.

Greasing and lubrication systems shall be tested.

All switchboard, motor control centers, control panels and distribution boards shall be tested for proper installation and functioning.

The performance of the pumps shall be tested to conform to rating curves.

Any other tests required by the Engineer.

1.14 Execution / Installation

- Install in accordance with manufacturer's instructions and recommendations.
- Provide access space around pumps for service. Provide space not less than as recommended by manufacturer.
- Decrease from line size with long radius reducing elbows or reducers if required.
- Support piping adjacent to pump such that no weight is carried on pump casings. Provide supports or thrust blocks under elbows and bends on pump suction and discharge wherever necessary and subject to approval of the Engineer.
- All suction and discharge piping shall be installed so as to prevent vibrations and strain in the pumps, valves and fittings and subject to approval of the Engineer.
- Provide drains for bases and seals, piped to and discharging into floor drains.
- Lubricate pumps before start-up.

- Qualified supervisor/millwright shall check, align, and certify base mounted pumps prior to start-up.
- All of the works shall be carried out under strict observance of the health, safety and environmental protection regulations and standards valid for the construction site.
- Handling of equipment and materials shall be carried out with utmost care and most skilful labor. Handling equipment shall be suitable for the intended purpose and for the size and weight of the goods to be handled.

5 HYPOCHLORINATOR

5.1 Scope

This specification sets the minimum acceptable requirements for the supply, installation, commissioning and testing of Hypo chlorinator which includes dosing pump, in case of difference between this specification and the listed international standards then the most stringent requirements shall prevail.

5.2 Standards and Codes

Hypo chlorinators including dosing pump shall comply with the latest revision of the following standards and other relevant standards noted elsewhere in this specification.

ASME B73.3	Specification for Seal less Horizontal End Suction Centrifugal Pumps for Chemical Process
NEMA MG-1	Motors and Generators
NSF/ANSI 61	Drinking Water System Components
AWWA M20	Chlorination/Chloramination Practices And Principles
ISO 7393-2:2017	Water quality — Determination of free chlorine and total chlorine — Part 2: Colorimetric method using N,N-dialkyl-1,4-phenylenediamine, for routine control purposes
US EPA method 334.0	Quality control protocol for chlorine residual monitoring
ASTM D 1998	Standard Specification for Polyethylene Upright Storage Tanks
ASME B73.3	Specification for Seal less Horizontal End Suction Centrifugal Pumps for Chemical Process

5.3 Components and Specifications

5.3.1 Hypochlorinator

Hypochlorinators shall be Mechanical Diaphragm Dozing Pump used to add hypochlorite solutions to water. Hypochlorinator are solution chemical feeders that introduce chlorine into the water supply as hypochlorite solution. It is often necessary to increase or decrease the amount of chlorine added to the water as conditions change. Motor-driven types of Hypochlorinators shall be fully automatic by use of a secondary electrical control circuit actuated by a switch/solenoid valve.

The components and specifications shall include the following:

Parameter*	Least Required Value/Standard
Casing	Aluminum with epoxy / acid proof coating
Flow Rate	2-4 L/hr
Pressure	10 bar max.
Diaphragm Material	Composite PTFE
Pump Head Material	PTFE
Check Valve	PTFE
Valve Ball	Ceramic
Suction Lift	1.5 meters minimum
Power Supply	230 V AC. ± 10 %, 50 Hz, single phase
Inverter Controls	Yes
Insulation Protection	IP 65 / NEMA 4X
Duty Cycle	Continuous
Operating Temperature	60^{o}C maximum
Accuracy	± 2 % of set point
Control Panel Protection	Adhesive polyester film, weather proof and resisting UV ray.
Foundation	On Ground with enough space around the pump to facilitate pump maintenance and adjustment. Titanium Anchor Bolts. Canopy will be required if installed outdoors
Features	Capable of integration into process control systems Flow rate can be varied using electrical or pneumatic stroke adjustment, or alternatively, by motor speed (frequency converter) Easy to read Back Lit LCD Display Display percentage of motor speed & flow rate Built-in Diaphragm Failure Detection System with Alarm Priming / degassing valve

** These are general parameters whereas detailed parameters will be presented by the manufacturer/ supplier at the time of submission of technical data sheet for approval by the Engineer.*

5.3.2 Dosing Tank

Hypochlorite solution will be stored in dozing tank. General parameters are given below and in case of some advance parameters proposed by any vendor, the same shall prevail

Parameter*	Least Required Value/Standard
Material	Cross-linked Poly Ethylene (XLPE) or High Density Poly Ethylene (HDPE)
Capacity	At least 200 Liters
Wall Thickness	The minimum wall thickness shall be in accordance with ASTM D 1998
Fittings	PVC. Do not use stainless steel or Alloy C-276 due to nickel content reaction
Plumbing	Flexible, Hypo-resistant connections to allow for lateral and vertical tank contraction and expansion and to reduce vibration stress. Connections shall be on lower third of side wall of the tank.
Colour	Black, white, blue or grey colour or insulation with mastic coating required in outdoor applications to minimize bleach degradation and maximize chemical half-life.
Foundation	Smooth concrete, asphalt or steel foundation
Storage Temperature	Product should not exceed 100^{o}F at delivery or during storage to reduce decomposition of the chemical and maintain ASTM D 1998 Parameters. Ideal Temperature is 60^{o}F (15^{o}C).
Manway	Fume-tight manway cover
Precautions	All cut edges (i.e., manway) shall be trimmed to have smooth edges.

** These are general parameters whereas detailed parameters will be presented by the manufacturer/ supplier at the time of submission of technical data sheet for approval by the Engineer.*

5.4 Inspection and Testing Plan

Prior to delivery, the manufacturer shall provide the Engineer with a comprehensive Inspection and Testing Plan (ITP) for their approval. The ITP shall detail all the certificates and documents that shall be provided by the manufacturer, together with details of the type testing and batch release testing that they have previously undertaken and shall undertake. Where the manufacturer cannot themselves undertake the required testing, they shall employ an independent third-party laboratory to undertake the testing on their behalf.

5.4.1 Inspection Requirements

The manufacturer shall ensure that all the applicable codes and standards are available at their facility for the Engineer's reference during any visit or inspection. The manufacturer shall provide full assistance and co-operation for any inspection, when required by the Engineer. When requested, the manufacturer shall provide access to and copies of all material certificates and inspection and test results obtained in the course of quality verification.

5.4.2 Acceptance Criteria

- The following criteria requirements shall be fulfilled by the manufacturer in order for the Hypo chlorinator to be approved and accepted by the Engineer.
- Prior to delivery, the manufacturer shall provide the Engineer with copies of all the type test results and certification required by this specification.
- Application and operational training of the Client staff to be provided by the official trainer(s) of the Original Equipment Manufacturer (OEM) in Pakistan. The training will cover all aspect of the instrument operation and application in detail including instrument setting, calibration, measurements, preventive maintenance, result interpretation etc.
- The Engineer may reject Hypo chlorinator if it does not successfully pass the required tests or fully comply with the requirements of this specification.

5.5 Method of Measurement

The quantity to be measured in numbers.

6 MS FLANGES

6.1 Scope

This specification sets the minimum acceptable requirements for providing, transportation, fixing and jointing of MS flanges to join the valves (sluice valve, air valve and fire hydrant) with HDPE pipe line. In case of difference between this specification and the listed international standards then the most stringent requirements shall prevail.

6.2 Applicable Standards and Codes

MS Flanges shall comply with the latest revision of the following standards and other relevant standards noted elsewhere in this specification.

ASTM A105 Standard Specification for Carbon Steel Forgings for Piping Applications

ASTM A370 Standard Test Methods and Definitions for Mechanical Testing of Steel Products

ASME B16 Pipe Flanges and Flanged Fittings

6.3 Materials

The steel shall be made by the open-hearth, basic oxygen, or electric-furnace process and shall be fully killed. A sufficient discard shall be made from source material to secure freedom from injurious piping and undue segregation. The material shall be forged as close as practicable to the specified shape and size. Except for flanges of all types, hollow cylindrically shaped parts may be machined from hot-rolled bar, forged bar, or seamless tubular materials provided that the axial length of the part is approximately parallel to the metal flow lines of the stock. Other parts (up to and including NPS) not including flanges may be machined from hot-rolled or forged bar.

6.4 Heat treatment

Heat Treatment is not a mandatory requirement of this specification except for the following piping components:

- Flanges above Class 300
- Flanges of special design where the design pressure at the design temperature exceeds the pressure-temperature ratings of Class 300, Flanges of special design where the design pressure or design temperature are not known. Heat treatment when required shall be annealing, normalizing, or normalizing and tempering or quenching and tempering as defined below:

6.4.1 Annealing:

The procedure for annealing shall consist of allowing the forgings immediately after forging or rolling, to cool to a temperature below 1000°F [538°C]. They shall then be reheated to a temperature between 1550°F [843°C] and 1700°F [927°C] to refine the grain (a group thus reheated being known as an “annealing charge”) and allowed to cool uniformly in the furnace.

6.4.2 Normalizing:

The procedure for normalizing shall consist of allowing the forgings, immediately after forging or rolling, to cool to a temperature below 1000°F [538°C]. They shall then be uniformly reheated to a temperature between 1550°F [843°C] and 1700°F [927°C] to refine the grain (a group thus reheated being known as a “normalizing charge”) and allowed to cool in air.

6.4.3 Tempering:

The procedure for tempering shall consist of heating the forgings to a temperature between 1100°F [593°C] and the lower transformation temperature for a minimum of 1⁄2 h/in. [1⁄2 h/25.4 mm] of maximum section thickness.

6.4.4 Quenching:

The procedure for quenching shall consist of either (1) fully austenitizing the forgings followed by quenching in a suitable liquid medium or (2) using a multiple stage procedure whereby the forging is first fully austenitized and rapidly cooled, then reheated to partially reaustenitize, followed by quenching in a suitable liquid medium. All quenched forgings shall be tempered as prescribed above.

6.5 Chemical Properties:

the steel shall conform to the chemical requirements specified in Table 6.1:

Table 6.1: Chemical Requirements

Element	Composition, %
Carbon	0.35 max
Manganese	0.60–1.05
Phosphorus	0.035 max
Sulfur	0.040 max
Silicon	0.10–0.35
Copper	0.40 max[A]
Nickel	0.40 max[A]
Chromium	0.30 max[A,B]
Molybdenum	0.12 max[A,B]
Vanadium	0.05 max
Columbium	0.02 max

NOTE: For each reduction of 0.01 % below the specified carbon maximum (0.35 %), an increase of 0.06 % manganese above the specified maximum (1.05 %) will be permitted up to a maximum of 1.35 %.

[A] The sum of copper, nickel, chromium and molybdenum shall not exceed 1.00 %.

[B] The sum of chromium and molybdenum shall not exceed 0.32 %.

6.6 Mechanical Properties:

The material shall conform to the mechanical property requirements prescribed in Table 6.2 and Table 6.3.

For the purpose of determining conformance with Table 6.2 and Table 6.3 specimens shall be obtained from production forgings after heat treatment, when heat treatment is required, or from separately forged test blanks prepared from the stock used to make the finished product. Such test blanks shall receive approximately the same working as the finished product. The test blanks shall be heat treated with the finished product.

For normalized, normalized and tempered, or quenched and tempered forgings, the central axis of the test specimen hall correspond to the 1/4 T plane or deeper position, where T is the maximum heat-treated thickness of the represented forging. In addition, for quenched and tempered forgings, the mid length of the test specimen shall be at least T from any second heat-treated surface. When section thickness does not permit this positioning, the test specimen shall be positioned as near as possible to the prescribed location.

Table 6.1: Mechanical Requirements

Tensile strength, min, psi [MPa]	70 000 [485]
Yield strength, min, psi [MPa][B]	36 000 [250]
Elongation in 2 in. or 50 mm, min, %:	
Basic minimum elongation for walls 5/16 in. [7.9 mm] and over in thickness, strip tests.	30
When standard round 2-in. or 50-mm gage length or smaller proportionally sized specimen with the gage length equal to 4D is used	22
For strip tests, a deduction for each 1/32 -in. [0.8-mm] decrease in wall thickness below 5/16 in. [7.9 mm] from the basic minimum elongation of the percentage points of Table 4	1.50[C]
Reduction of area, min, %[D]	30
Hardness, HB, max	187

[A] For small forgings.

[B] Determined by either the 0.2 % offset method or the 0.5 % extension-underload method.

[C] See Table 6.3 for computed minimum values.

[D] For round specimens only.

Table 6.2: Computed Minimum Values

Wall Thickness		Elongation in 2 in. or 50 mm, min, %
in.	mm	
5/16 (0.312)	7.9	30.00
9/32 (0.281)	7.1	28.50
1/4 (0.250)	6.4	27.00
7/32 (0.219)	5.6	25.50
3/16 (0.188)	4.8	24.00
5/32 (0.156)	4.0	22.50
1/8 (0.125)	3.2	21.00
3/32 (0.094)	2.4	19.50
1/16 (0.062)	1.6	18.00

Note: The above table gives the computed minimum elongation values for each 1/32-in. [0.8-mm] decrease in wall thickness. Where the wall thickness lies between two values shown above, the minimum elongation value is determined by the following equation:

$$E = 48T + 15.00$$

where:

E = elongation in 2 in. or 50 mm, %, and

T = actual thickness of specimen, in. [mm].

6.7 Testing

Testing shall be performed in accordance with Test Methods and Definitions ASTM A370. The largest feasible round specimen as described in Test Methods and Definitions ASTM A370 shall be used except when hollow cylindrically shaped parts are machined from seamless tubulars. The gage length for measuring elongation shall be four times the diameter of the test section. When hollow cylindrically shaped parts are machined from seamless tubular materials, strip tests may be used.

The Engineer may make a product analysis on forgings supplied to this specification. Samples for analysis may be taken from midway between center and surface of solid forgings, midway between inner and outer surfaces of hollow forgings, midway between center and surface of full-size prolongations, or from broken mechanical test specimens. The chemical composition thus determined shall conform to Table 6.1 within the tolerances stated in Table below:

Table 6.3: Permissible Variations in Product Analysis

	Permissible Variations over the Maximum Limit or Under the Minimum Limit, %				
	200 in.^{2} [1290 cm^2] and Under	Over 200 to 400 in.^{2} [1290 to 2580 cm^2], incl	Over 400 to 800 in.^{2} [2580 to 5160 cm^2], incl	Over 800 to 1600 in.^{2} [5160 to 10 320 cm^2] incl	Over 1600 in.^{2} [10 320 cm^2]
Carbon	0.02	0.03	0.04	0.05	0.05
Manganese:					
Up to and including 0.90	0.04	0.05	0.06	0.07	0.08
0.91 and over	0.06	0.07	0.08	0.08	0.09
Phosphorus	0.008	0.010	0.010	0.015	0.015
Sulfur	0.010	0.010	0.010	0.015	0.015
Silicon	0.03	0.04	0.04	0.05	0.06
Copper	0.03	0.03	0.03	0.03	0.03
Nickel	0.03	0.03	0.03	0.03	0.03
Chromium	0.04	0.04	0.04	0.04	0.04
Molybdenum	0.01	0.01	0.01	0.01	0.01
Vanadium	0.01	0.01	0.01	0.01	0.01
Columbium	0.01	0.01	0.01	0.01	0.01

NOTE: Product cross-sectional area (taken at right angles to the axis of the original ingot or billet) is defined as either:

(a) maximum cross-sectional area of rough machined forging (excluding boring),

(b) maximum cross-sectional area of the unmachined forging, or

(c) maximum cross-sectional area of the billet, bloom, or slab.

6.7.1 Hardness Tests:

Except when only one forging is produced, a minimum of two forgings shall be hardness tested per batch or continuous to ensure that forgings are within the hardness limits. When only one forging is produced, it shall be hardness tested as to ensure it is within the hardness limits. Testing shall be in accordance with Test Methods and Definitions A 370. The Engineer may verify that the requirement has been met by testing at any location on the forging, provided such testing does not render the forging

useless.

6.7.2 Hydrostatic Tests:

Forgings manufactured under this specification shall be capable of passing a hydrostatic test compatible with the rating of the finished forging. Such tests shall be conducted by the forging manufacturer only when specified by the Engineer.

6.8 Acceptance Criteria

The forgings shall be free of injurious imperfections, as defined below, and shall have a workmanlike finish. At the discretion of the inspector representing the Engineer, finished forgings shall be subject to rejection if surface imperfections are scattered but appear over a large area in excess of what is considered a workmanlike finish. Unless otherwise specified in the purchase order, the fittings shall be cleaned to remove all scale and processing compounds prior to final surface examination. The cleaning process shall not injure the surface finish, material properties, or the metallurgical structure. The cleaned fittings shall be protected to prevent recontamination. Protective coatings on socket weld and butt-welding fittings shall be suitable for subsequent welding without removal of the coating. When specified in the purchase order, parts may be furnished in the as-formed or as-forged condition.

6.9 Installation

6.9.1 Flanged Connections:

Properly installed flanged connections provide a transition fitting to join alternate piping materials, a mechanical means to connect to valves and other equipment, and when joining

piping systems where frequent dismantling may be required. The grooved face of the flange provides a liquid tight seal on the gasket when flanges are properly assembled, supported, and proper torque is applied to the bolts.

6.9.2 Gaskets:

Full face 1/8” thick elastomeric material with a Shore A Durometer hardness of 50-70; gasket material selected must be compatible with application and fluids conveyed. Variations in gasket material and shore hardness may affect sealing torque required.

6.9.3 Flange Dimensions:

Flange ring bolt hole dimensions conform to ANSI B 16.5 Class 150 bolt pattern. Threaded flange hubs are tapered iron pipe size threads per ANSI B2.1. Socket flange hubs conform to ASTM D2467 tapered socket dimensions.

6.9.4 Bolts and Bolt Torque:

Select proper bolt size, quantity, length, and washers for the specific sizes of flanges and equipment being assembled. Always use two (2) wide flat washers per bolt (one under the head and one under the nut). Threads should be clean and well lubricated.

6.9.5 Flange Assembly:

Once the flange hub is correctly joined to the pipe and allowed to cure properly, and the piping system is supported properly, the method for joining two flanges is as follows:

Make sure the system is properly supported and aligned, and that mating surfaces of flanges being joined are not separated. Do not use bolts to align the system or to pull flanges together.

- **WARNING:** STRESS INDUCED FROM MISALIGNMENT OR IMPROPER SUPPORT WILL DAMAGE THE FLANGE.

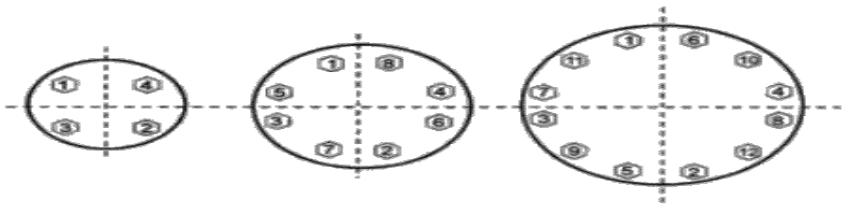
With the gasket in place, align all bolt holes of mating flanges by rotating the flange ring into position.

Insert all bolts, flat washers (two standard flat washers per bolt), and nuts.

Be certain the faces of the mating surfaces are flush against the gasket prior to bolting down the flanges.

Using the illustrated bolt-tightening sequence shown below, tighten all the nuts by hand until snug. Once snug by hand, tighten the bolts diametrically opposite each other (180°) using the sequence shown with a torque wrench. Apply uniform pressure across the flange by tightening in stages of 5 ft-lb increments until final torque values shown in the following table are obtained. Do not overtighten.

- **WARNING:** OVER TORQUING WILL DAMAGE THE FLANGE.



Torque sequence chart Bolt information table

Size	No. of Bolt Holes	Bolt Dia. (in.)	Bolt Size (UNC x Length)	Recommended Torque (Ft./Lbs.)
1/2	4	½	2	15-20
3/4	4	½	2	15-20
1	4	½	2¼	15-20
1¼	4	½	2¼	15-20
1½	4	½	2½	15-20
2	4	5/8	3	20-30
2½	4	5/8	3¼	20-30
3	4	5/8	3¼	20-30
4	8	5/8	3½	20-30
5	8	3/4	3¾	25-35
6	8	3/4	4	30-50
8	8	3/4	4½	30-50
10	12	7/8	5	53-75
12	12	7/8	5	53-75

UNC=Unified National Course

Care must be taken to avoid bending stresses to the flange when mating to raised faced flange, metallic flange, stationary flanged objects or wafer-style valves. The plastic flange, attached pipe, fitting, and or valve must be supported properly to eliminate stress on the plastic flange.

NOTE:

- Bolt length based on connecting two (2) flanges, two (2) flat washers, and nut. Actual Bolt lengths required and torque values necessary to seal will vary based on type of equipment being joined. Adjustments will need to be made when assembling flanges to accommodate valves and other equipment. Reference ASME B16.5 and ASME NM-1 as applicable.
- Certain applications may require flange bolts to be re-torqued at least 24 hours after gasket installation depending on flange materials being joined (i.e. transition from PVC to HDPE), and gasket material selected. Work with gasket manufacturer for proper material selection and other gasket design recommendations prior to installation. When evaluating gasket material, be certain to include any surge pressure that could be caused by opening valves and starting pumps. Use primer and appropriate heavy-bodied solvent cement for materials being joined and allow to cure properly prior to flange assembly.

6.10 Inspection and Testing

Prior to delivery and after delivery of MS Flanges it shall be ensured by the Engineer that mating/contact surfaces are free from any damages.

6.11 Method of Measurement

The quantities to be measured for shall be in numbers.

7 LEVEL INDICATOR

7.1 Scope

This specification sets the minimum acceptable requirements for the supply and fitting of Hydrostatic Level Indicator for use in water supply applications. In case of difference between this specification and the listed international standards then the most stringent requirements shall prevail. All level transmitter shall be calibrated and their results shall be recorded before installation in the field. Level transmitter shall be mounted such that they can be read easily from ground or access platform level.

7.2 List of Abbreviations

IEC	International Electrotechnical Commission
EN	European Standard

7.3 Applicable Standards and Codes

The following latest edition codes, standards and recommended practices shall govern:

IEC 60770-1	Measuring accuracy
IEC 60529	Degree of Protection (IP 68)
EN 61000-6- 2, 3 / EN 61326-2- 3	EMC (Environmentally-weighted Material Consumption)

7.4 Components and Specifications

Hydrostatic level indicators along with level display unit will be used in overhead water tanks for water level measurements. It measures the liquid levels in tanks. The components and specifications shall include the following:

7.4.1 Level Transmitter

- Type : Submersible transmitter
- Material : Ceramic sensor in a stainless-steel housing 316L.
- Measuring Principle : piezo-resistive
- Measuring Range : 0-20 mH_2O
- Accuracy : 0.3%
- Make : European/North American or approved equivalent
- Cable Length : 30 m
- Insulation Protection : IP68
- Operating Temperature : -20 – 70 ^oC
- Response time : <5ms
- Isolation : > 10MΩ @ 300V
- Current Surge rating : 50A @ 8/20 µs (wire to wire)
- Insulation Protection : IP68
- Humidity : 0-100% RH
- Output signal : 4-20 mA with HART

7.4.2 Warranty

All equipment to be furnished shall be warranted for a period of one (1) year.

All warranted equipment shall have defect liability period of one (1) year after taking over.

7.5 Inspection and Testing Plan

Prior to delivery, the manufacturer shall provide the Engineer with a comprehensive Inspection and Testing Plan (ITP) for their approval. The ITP shall detail all the certificates and documents that shall be provided by the manufacturer, together with details of the type testing and batch release testing that they have previously undertaken and shall undertake. Where the manufacturer cannot themselves undertake the required testing, they shall employ an independent third-party laboratory to undertake the testing on their behalf. All Digital and Analog, indicators, gauges shall be subject to routine tests in accordance with relevant international standards. Test certificates shall be provided against each item of equipment.

7.5.1 Inspection Requirements

The manufacturer shall ensure that all the applicable codes and standards are available at their facility for the Engineer's reference during any visit or inspection. The manufacturer shall provide full assistance and co-operation for any inspection, when required by the Engineer. When requested, the manufacturer shall provide access to and copies of all material certificates and inspection and test results obtained in the course of quality verification.

7.6 Acceptance Criteria

The following criteria requirements shall be fulfilled by the manufacturer in order for the Hydrostatic Level Indicator to be approved and accepted by the Engineer.

- Prior to delivery, the manufacturer shall provide the Engineer with copies of all the type test results and certification required by this specification.
- Application and operational training of the Client staff to be provided by the official trainer(s) of the original equipment manufacturer (OEM) in Pakistan. The training will cover all aspect of the instrument operation and application in detail including instrument setting, calibration, measurements, preventive maintenance, result interpretation etc.
- The Engineer may reject Level indicator if it does not successfully pass the required tests or fully comply with the requirements of this specification.

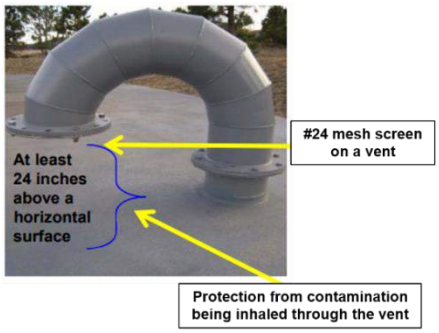
7.7 Method of Measurement

The quantity to be measured in numbers

8 CAST IRON AIR VENT

8.1 Scope

This specification sets the minimum acceptable requirements for providing and fixing Cast Iron 6 " dia air vent on roof of overhead tank. In case of difference between this specification and the listed international standards then the most stringent requirements shall prevail.



Typical Cast Iron Air Vent

Fig 8.1

8.2 List of Abbreviations

ASTM American Society for Testing and Materials

AWWA American Water Works Association

8.3 Applicable Standards and Codes

Cast Iron Air Vent shall comply with the latest revision of the following standards and other relevant standards noted elsewhere in this specification.

ASTM A74 Standard Specification for Cast Iron Soil Pipe and Fittings

ASTM A1111 Standard Specification for Cast Iron Closet Flanges for Use with Cast Iron Soil Pipe and Fittings

AWWA C100 Standard Specifications for Cast Iron Water Pipes and Special Castings

8.4 Materials

Required arrangement for air vent should be as follows and typical drawing of air vent is shown above fig 8.1:

Sr. No.	Details	Air Vent
01	Size of air vent	06” Diameter
02	Type of air vent	Downturned vent
03	Material of air vent	Cast Iron
04	Mesh Screen Size on opening of air vent	#24 mesh non-corrodible screen
05	Distance of vent from slab	At least 24 inches above a horizontal surface

8.5 Inspection and Testing Plan

After installing C.I air vent, Mesh Screen Size and distance of vent from horizontal surface i.e. top slab of OHR shall be critically inspected.

10 PENSTOCK GATE

10.1 SCOPE

The work covered by this section consists of design, manufacture, shop testing, providing, fixing and commissioning of motorized operated penstock gate (including gear and automatic switch) with Cast Iron (CI) shutter and frame/channel on bottom, top and two sides through which gate travels including non-magnetic Stainless-Steel spindle with square thread, CI head stock and wheel. In case of difference between this specification and the listed international standards then the most stringent requirements shall prevail. The Contractor shall provide all labor, material, equipment, and transportation for the satisfactory completion of the Works and maintain the equipment during Defect Liability Period.

The following equipment shall be installed.

1. One (1) set of Cast Iron gate equipment for each inlet having size with clear opening 310mm x 310mm
2. Electrically/Manually operated hoisting system for the penstock gate
3. Hoisting platforms, access ladder and railings etc.
4. Embedded metal parts for the gate which shall consist of seal bearing plates, seals, sill beam, guide/frame along with stiffener plates, anchor bolts, alignment studs with nuts and washers etc.
5. The Contractor shall submit shop drawings, data and perform all other work specified.

10.2 LIST OF ABBREVIATIONS

AGMA	American Gear Manufacturer's Association
AISC	American Institute of Steel Construction, Inc.
ANSI	American National Standards Institute
AISI	American Iron and Steel Institute
AWS	American Welding Society
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
AWWA	American Water Works Association
BHN	Brinell Hardness No.
BS	British Standard
SS	Stainless Steel
CRES	Corrosion Resisting Steel
DN	Nominal Diameter
IEEE	Institute of Electrical and Electronics Engineers
NEMA	National Electrical Manufacturers Association
OBE	Operating Basis Earthquake
TSGP	Technical Specifications for Gates and Penstocks
UDL	Uniformly Distributed Loads

U.S. Fed. Spec. Federal Specifications Board

10.3 Applicable Standards and Codes

The following latest edition codes, standards and recommended practices shall govern:

ISO 19569-4 Specific principles for shutoff devices as penstocks, sluice gates, stop log etc.

BS 7775 Penstocks for use in water and other liquid flow applications. Specification.

AWWA C501 Standard for Cast-Iron Sluice Gates

10.4 CONTRACTOR'S DRAWINGS AND DATA

The general arrangement of the Equipment shall conform to the Tender Drawings. The Tender Drawings are not intended to define the detailed design of the Equipment to be furnished and installed but are merely illustrative to show the general layout of the Equipment except where limiting or mandatory dimensions, elevations, tolerances and similar features are indicated. Alternative details and arrangements will be considered if, in the judgment of the Engineer, those are not inferior to the details and arrangement shown on the Tender Drawings

Before proceeding with the manufacture of Equipment, the Contractor shall submit general assembly drawings, subassembly drawings, detail drawings, calculations, design criteria, design data, catalogue pages, specifications and similar engineering documents required to demonstrate fully that all parts will conform to the provisions and intent of these Specifications and to the requirements of their installation, operation, and maintenance.

10.4.1 Detailed Drawings

Detailed Drawings shall include the following:

- General arrangement drawings for embedded parts: These drawings shall show all final dimensions, tolerances, and details of field connections.
- General arrangement drawings for gates: These drawings shall show all final dimensions and tolerances, surface finishes, details of field connections and final weights.
- General arrangement drawings of the hoists for the Gate Equipment: These drawings shall show all final dimensions and tolerances, details of field connections, final weights and loads on foundation bolts.
- Slot, top and sill beam details showing seal contact with the embedded sealing faces.
- Typical seal details.
- Seal splice and seal corner details.
- Structural detail drawings of each gate.
- Hoist platform and access ladder details.
- Details of the hoist gear box, stem rod, bushing, bearing and couplings.

10.4.2 Mechanical Design Data

The calculations, design data, etc. shall include the following:

- Weight and centre of gravity calculations
- Required hoisting/operating force calculations

- Speed reduction and gear box calculations.

10.5 MATERIAL SPECIFICATIONS

1. For main components of gate like shutter, frame etc.	BS EN 1561, "Founding. Grey cast irons" ASTM-A48, Class 30 "Standard Specification for Gray Iron Castings"
2. Brass	ASTM B927, "Standard Specification for Brass Rod, Bar, and Shapes" ASTM B36, "Standard Specification for Brass Plate, Sheet, Strip, And Rolled Bar"
3. Spindle	ASTM-A276, "Specification for Stainless and Heat Resisting Steel Bars and Shapes, "Type: Series 316L.
4. Head Stock	BS EN 1561, "Founding. Grey cast irons" ASTM-A48, "Standard Specification for Gray Iron Castings"
5. Bolts and Nuts	ASTM-F593, "Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs" ASTM-A307, "Specification for Low-carbon Steel Externally and Internally Threaded Standard Fasteners," and ASTM-A325. "Specifications for High-Strength Bolts for Structural Steel Joints Including Suitable Nuts and Plain Hardened Washers,"
6. Permanent self - lubricating bearings and washers with rated coefficient of friction less than 0.15.	"Lubrite" A cast bronze alloy (ASTM-B22, "Specification for Bronze Castings for Bridges and Turntables," Alloy E) with self-lubricating inserts.
7. Bronze Bushings, Sleeve type Bearings and other Lubricated Wearing Parts	SAE Standard Specification No. 64 for Phosphor Bronze.
8. Steel Pipe	ASTM-A53, "Specification for Welded and Seamless Steel Pipe" Welded Grade.
9. Expansion Anchors	According to manufacturer's published data.
10. Concrete Anchor Studs	According to manufacturer's published data.
11. Gears and Speed Reducers.	AGMA Standard.

12. Bronze Strips and Bars	ASTM-B 103 “Specifications for phosphor Bronze Plate, Sheet, Strip and Rolled Bar”.

10.6 Test of Materials

Materials shall be new and of first-class quality, suitable for the purpose, free from defects and imperfections, and of the grades, classes and types listed herein, or their equivalents. However, while selecting the materials the Contractor shall keep in view water analysis results and may propose materials having better qualities to resist the chemicals present in the water/ All materials or parts used in the Gate Equipment shall be tested, in conformity with applicable methods prescribed by the ASTM, or such other organization. When requested, tests shall be made in the presence of the Engineer. Certified material test reports shall be furnished to the Engineer as soon as possible after the tests are made. The test certificate shall identify the component for which the material is to be used and shall contain all information necessary to verify compliance with the Specifications

10.7 Design Criteria and Working Stresses

10.7.1 General

Based on the requirements of the Project, the Contractor shall refer to the reputed manufacturers having relevant experience in designing and manufacturing cast iron gates. The proposed gate manufacturer shall be approved after checking his past experience, inspection of his shop facilities and quality of manufacturing by the Engineer.

The design of Equipment shall be based on the guidelines of the U.S. Army Corps of Engineers and U.S. Bureau of Reclamation, Technical Specifications for Gates and Penstocks (TSGP), American Water Works Association Standard AWWA C 501, AWWA C 560, British Standard BSS 7775 except as modified and supplemented by the design criteria described as follows.

10.7.2 Design Loads

The Gate Equipment shall be designed for the applicable loads described hereunder.

- **Dead Loads**

The dead load shall include the weight of the components, machinery elements, equipment, protective devices and contained fluids. Eccentricity of loading shall also be taken into account.

- **Hydrostatic Loads**

Components of Gate Equipment subject to water pressure shall be designed for hydrostatic loads corresponding to the maximum differential pressure expected during the life of the Project.

- **Friction**

The friction forces considered in the design shall be based on the applicable coefficients of friction taken from the following table:

	Maximum	Minimum
Bronze on Cast Iron	0.5	0.15
Cast Iron on Cast Iron	1.0	0.2

Corrosion-resisting steel on carbon steel, non-lubricated	0.5	0.1
Corrosion-resisting steel on carbon steel, lubricated	0.18	0.08
corrosion-resisting steel	Not acceptable	
Bronze on corrosion-resisting steel, non-lubricated	0.5	0.15
Bronze on corrosion-resisting steel, lubricated	0.2	0.07
"Lubrite" on corrosion-resisting steel	0.2	0.06
Anti-friction bearings	As recommended by bearing manufacturer.	

- **Seismic Loads**

All components of gates shall be designed to withstand safely the seismic forces computed by using the following seismic coefficients and design factors:

OBE: An operating basis earthquake (OBE) equivalent to a horizontal ground acceleration equal to 0.2 g acting simultaneously with a vertical acceleration equal to 1/3 of horizontal acceleration.

- **Live Loads**

The live loads on walkways and catwalks transmitted to the gates and hoists shall be taken as uniformly distributed loads (UDL) equal to 500 Kg/m^2 (100 lbs/ft^2). In addition to this UDL, any superimposed concentrated loads likely to be placed on the walkway and catwalks shall be also considered.

10.7.3 Load Combinations and Conditions

The detailed design of Equipment shall be based on the most critical loading conditions applicable to major components. The manufacturer would be required to investigate the following loading conditions and load combinations for the final design of the Gate Equipment.

- **Normal Loading**

For gate leaf assembly: Dead weight, friction, hoisting and maximum hydrostatic loads when the gate is resting on the sill, being lifted, partially opened or being closed, with maximum water pressure.

For mechanical hoist/operating system: Dead weight, live, friction and rated hoist/ operating loads.

- **Exceptional loading**

For Gate: Loading when the gate is jammed.

For mechanical hoist / operating system: Normal loading plus seismic forces for OBE.

10.7.4 Working Stresses

- **Factor of Safety - Mechanical Components**

All gate and frame thicknesses of casted parts shall be designed against a minimum factor of safety of 5 with regard to the ultimate tensile, compressive and shear strength of the material.

- **Allowable Stresses:**

Summary of allowable stresses is given here as under:

Fy = Yield Stress

Fu = Ultimate Stress

Fa = Allowable Stress

	Type of Stress	Load Cases		
		Normal	**Exceptional**	**Extreme**
1.	For structural members			
	Bending	0.6 Fy	0.8 Fy	0.95 F
	Shear	0.4 Fy	0.5 Fy	0.60 Fy
	Tension	0.45 Fy	0.5 Fy	0.60 Fy
	Bearing pressure (machined surfaces)	0.8 Fy	0.85 Fy	0.90 Fy
	Combined stresses	0.75 Fy	0.95 Fy	No
	Buckling			
	- AISC value	1.0 Fa	1.3 Fa	1.4 Fa
	Hertzian stresses (MPa)	5.35 BHN	5.86 BHN	6.38 BHN
		(BHN=Brinell Hardness No.)		
2.	For all mechanical and electrical components	0.33 Fy OR 0.2 Fu whichever is less	0.67 Fy OR 0.4 Fu whichever is less	0.90 Fy OR 0.55 Fu whichever is less

10.7.5 3. Design Criteria for Gate Hoist

- **Loads**

The loads used in hoisting system design shall include the following:

-Suspended weight of gate including weight of hoist, fittings and side seal friction.

Load due to operating motor maximum torque. Maximum motor torque used for design purposes shall be the maximum torque which the motor can develop over its entire speed range with an impressed voltage equal to 110 percent of its rated voltage.

- **Efficiencies**

For design calculation, efficiencies of operating machinery components shall be assumed as no greater than the following:

- Speed reducer with worm gear 60 percent
- Speed reducer (triple reduction) 70 percent
- Gear and pinion 95 percent
- Bearings 96 percent
- **Operating Speed**

The hoisting speed for the gates shall not be less than 100mm/minute for hand operated hoist. For motorized hoist the speed of stem type hoisting systems shall not be less than 300mm / min. The operating force on handle shall not be more than 9 kg for manually operated hoist for single person.

- **Shafting**

Shafting shall be designed in accordance with Clause D "Working Stresses". A shock or fatigue factor of 1.25 shall be used for shafting, except for speed reducers, which conform to applicable AGMA standards.

- **Gears**

Gear design shall be in accordance with applicable AGMA standards.

- **Walkways and Catwalks**

Walkway flooring shall be designed for a uniformly distributed live load of 500 kg/m^2 (100 lbs./ft^2) plus a superimposed concentrated load of the heaviest piece of hoisting equipment or sub-assembly. Stair treads and their fastenings shall be designed for a concentrated live load of 450 kg (1000 lbs.).

- **Hoist Platform**

The platform shall be designed to suit the proposed equipment. All mechanical components supported directly on the structural members of the hoist platform. Platform shall be tied down to concrete structure by means of anchor bolts designed to resist all possible loading cases.

10.8 MINIMUM DIMENSIONS

10.8.1 Material Thickness

1.	Cast Iron gate, ribs and Frame	25 mm
2.	Plate thickness on any structural member except cast iron	12 mm
3.	Webs of rolled shapes	12 mm
4.	Embedded metal with exposed surfaces	12 mm
5.	Completely embedded metal	12 mm
6.	Diameter of CRES bolts or screws on gate structures	10 mm

7. Diameter of anchor bolts

   for frame or embedded part 16 mm

8. Bronze/brass bar for sealing 20 mm

10.8.2 Weld Size

Min. fillet weld, leg length 6 mm

10.9 ELECTRICAL FEATURES

10.9.1 General

Electrical equipment shall conform to all applicable IEEE, ANSI, and NEMA Standards. Conduit and wiring installation shall conform to ANSI-C1 (NFPA-70), "National Electrical Code", considering the tropical conditions of the location.

10.9.2 Electrical Voltage Ratings

Electrical voltage ratings of power supply shall be as follows:

- **Motors**

400 V, 50 Hz, 3-phase ac for motors rated 1/2 hp and above.

230 V, 50Hz, single-phase ac for motors rated less than 1/2 hp.

- **Controls, Lights, and Heaters**

230 V, 50Hz, single-phase ac.

110 V, dc.

10.9.3 Motors

- **General**

Motors shall be of the squirrel cage induction type designed for full voltage starting and operation with rise up to 85°C above 50°C. ambient temperature. They shall be classified as totally enclosed externally air cooled. All motors shall be capable of furnishing the required output for the required hoisting cycle without reaching injurious temperatures, with the combined variations of voltage and frequency not exceeding 10% of rated voltage and frequency, provided the frequency variation does not exceed 5%. The motors shall conform to the requirements of NEMA Publication No. MG-1, "Motors and Generators". Following are general requirements.

- **Insulation**

All motors shall have Class F insulation of the sealed type suitable for application in humid or damp tropical locations.

- **Terminal Boxes**

Terminal boxes shall be of cast metal or rugged sheet metal covers with gasket. They shall be designed and mounted so that they can receive conduit from the top, bottom, or either side.

- **Bearings**

Bearings shall be ball or roller type in accordance with NEMA Publication MG-1, Par. MG1-14.37 and as required for each application. Ball and roller bearings may be of the sealed, permanently lubricated type.

10.9.4 Main Disconnecting Switches

The main disconnecting switches shall be 3-pole, non-fusible, 600 V, heavy-duty safety switches or non-automatic circuit breakers. The switches shall be provided with pressure-type line terminals for incoming power cables.

10.9.5 Motor Starters

The motor starters selected shall be capable of meeting the starting and continuous running requirements of the connected load. The motor starters and associated control devices shall conform to the requirements of NEMA Publication No. ICS " Industrial Controls and System. Motor starter auxiliary contacts and associated circuit shall be provided as required.

10.9.6 Electrical Wiring and Terminals

Internal wiring of enclosures, panels, switches housings, etc. shall be complete and ready for operation. Wiring shall be neatly arranged, grouped, properly supported, enclosed in conduits or otherwise protected as required, and terminated.

10.10 WORKMANSHIP

10.10.1 General

Components and spare parts shall be interchangeable wherever possible. Surface finish of machined parts shall be adequate for their functional requirements.

10.10.2 Electric Welding

- **General**

All welds shall be made continuous and watertight. All butt welds shall be full penetration welds welded from both sides.

- **Preparation of Base Material**

Members to be joined by welding shall be cut to shape and size by mechanical means such as shearing, machining, grinding, or by gas or arc cutting, to suit the conditions. Design of welded joints and selection of weld filler metal shall allow thorough penetration and good fusion of the weld with the base metal.

- **Welding Qualifications**

The qualification of welders for all welding, including weld repairs shall conform to the relevant AWS Standard Specifications. The Contractor shall furnish the facilities, all equipment, materials and other articles required to perform qualification tests of his welders and welding operators.

- **Weld Finish**

Welds shall in general display good appearance and a surface. All welds, which require non-destructive examinations, shall be dressed by chipping and grinding as required for good interpretation by the selected weld examination methods.

10.10.3 Castings

Castings shall be free from injurious defects and shall be satisfactorily cleaned for their intended use. All parts in the sluice gates and accessories shall be machined accurately on the mating and bearing surfaces. Surfaces of castings, which do not undergo machining, shall be dressed for good appearance and painting. The location of existing defects shall be

determined, and all defects, which impair the strength or utility of the casting, shall be removed. The structure of the castings shall be homogeneous and free from excessive non-metallic inclusions. An excessive concentration of impurities or separation of alloying elements at critical points in a casting shall make it liable for rejection.

10.10.4Non-destructive Testing

- **General**

Unless otherwise indicated, all nondestructive tests shall be in accordance with ASTM/ASME Standards.

- **Examination of Welds**

All butt welds on skin plate and beam flanges, and all welds on other main components shall be given complete non-destructive examination by ultrasonic & magnetic particle methods, supplemented by radiographic examination. Supplemental radiographic examinations shall include examination of areas where interpretations by other methods is unclear or where the integrity of the weld is doubtful.

- **Examination of Castings**

All the cast iron gates shall be inspected/tested by the Engineer for any defects in the casting prior to any repair and machining work. All major castings shall be given a complete ultrasonic examination and a radiographic examination insofar as practicable. Where radiographic examination is not practicable due to configuration or accessibility, the castings shall be examined by dye penetrant or magnetic particle methods in addition to the ultrasonic method.

10.10.5 Structural Work

Design and fabrication of structural parts shall conform to the applicable provisions of the AISC "Specification for the Design, Fabrication, and Erection of Structural Steel for Buildings," of the AISC "Code of Standard Practice for Steel Buildings and Bridges."

10.10.6 Machine Work

- **General**

All tolerances, allowances, and gauges for metal fits between plain (non-threaded) cylindrical parts shall conform to ANSI-B4.1. "Preferred Limits and Fits for Cylindrical Parts," for the class of fit. All drilled holes for bolts, which are intended to match other drilled holes, shall be accurately located and drilled from templates.

- **Finished Surfaces**

All surfaces that require machining for their intended function, or those that are usually machined according to good shop practice shall be machined. Surface finish qualities shall be adequate for the intended use and shall be indicated on the Contractor's drawings and shall be in accordance with ANSI-B46.1. "Surface Texture". Compliance with specified surface will be determined by sense of feel and by visual inspection of the work compared to standard roughness specimens, in accordance with the provisions of ANSI B-46.1.

- **Unfinished Surface**

So far as practicable, all work shall be laid out to secure proper matching of adjoining unfinished surfaces. Where there is a large discrepancy between adjoining unfinished surfaces they shall be chipped and ground smooth, or machined, to secure proper alignment. Unfinished surfaces shall be true to the lines and dimensions and shall be chipped or ground

free of all projections and rough spots. Depressions or holes not affecting the strength or usefulness of the parts may be filled in an approved manner.

- **Tolerances**

All tolerances shall be selected by the Contractor to correspond to the accuracy required for the proper operation of the equipment considering the nature and function of the part. All tolerances shall be indicated on the Contractor's drawings and submitted for review. It shall be the Contractor's responsibility to establish finer shop tolerances, if necessary, to meet the specified design or operational requirements or for interchangeability of spare parts.

10.11 Structures and Embedded Parts

10.11.1 Structures

The structure of each item of the Equipment and embedded parts shall basically be of casted construction unless otherwise approved by the Engineer.

10.11.2 Sealing System

Each Gate Unit shall be provided with a sealing system consisting of bronze seals mounted on the gate and SS seal bearing plates fixed in the frame structures. Seals shall not be mounted on embedded parts.

The sealing system the gates shall consist of side, bottom and top seals of bronze whereas seal bearing plates shall be stainless steel. The sealing system shall be continuous providing a tight closed sealing line without gaps when the gate is closed. Seal bearing plates shall be of an adequate width to ensure that seals remain on seal plates under all possible working conditions. These working conditions shall cater for the most unfavourable combinations of all factors causing relative position change.

10.11.3 Guiding System

Guiding system shall perform one or more of the following functions:

When the gate is handled above the working area, the guiding system shall ensure that the gate is in the required position and shall correctly engage the frame when lowered.

When the gate is handled in its working area the guiding system shall ensure that the gate remains engaged with the frame.

10.11.4 System for Alignment and Anchorage of Embedded Parts/Frame

All embedded parts shall be fixed and aligned with studs/anchors adequately spaced and attached with wall thimble.

10.11.5 Embedded Parts for Gate Equipment

- **General**

Embedded parts of the Equipment shall include all the metal parts, which are to be embedded in concrete or otherwise permanently attached to the civil structure.

Each set of embedded parts supplied and installed by the Contractor shall include the following:

- **Frame**

A complete frame/guide channel shall include one sill beam, two side seal bearing plates and top seal bearing plates.

- **Seal Bearing Plates, Guide Plates**

The side, top and sill seal bearing plates and guide plates shall be of CRES.

10.12 INSTALLATION

10.12.1 Installation of Embedded Parts

Each set of embedded parts shall be assembled, brought to line and grade within the applicable tolerances and firmly secured in place on the wall thimble with SS anchor bolts/studs. The SS anchor bolts/studs shall be located with care so that no subsequent bending or forcing is required to match them with the corresponding holes in the frame and guide members. SS Anchor bolts/studs shall be adjusted and firmly tightened to hold the frames and guides securely in position. Top seal bearing plate shall be so designed and installed that when the gate is lifted against full head, water shall not discharge from the top

10.12.2 Installation of Gates

The gates shall be installed as shown on the approved drawings. The bottom of the gate when erected shall be in true alignment to ensure a tight even bearing of the seal on the embedded sill beams. The sides of the gate shall be in true alignment so that the seal when installed will have a tight and even bearing on the embedded sealing surfaces.

10.12.3 Installation of Gate Hoists

Each gate hoisting equipment complete with all accessories shall be assembled and installed as per approved shop drawings.

10.12.4 Installation of Hoist Platform, Deck and Access Ladder

All hoist platform parts shall be accurately assembled and erected. All of the material shall be handled carefully so that no part will be bent, broken or otherwise damaged. At bolted connections, the bolts shall be drawn tight, and where required, the threads shall be burred or spot-welded so that nuts cannot become loosened. Where required, bolt holes shall be renamed in the field to provide a light-driving fit.

10.12.5 INSPECTION AND TESTING

All equipment, apparatus, material and supplies forming part of the Equipment shall be subjected to inspection and tests at the place of manufacture of the Contractor in the presence of a representative of the Engineer for conformity to the requirements of the Specifications. Field tests shall be conducted under the supervision of the Engineer. The Contractor shall submit a schedule of the specified testing programme to the Engineer for his approval.

Records and Reports: Records of all tests shall be kept by the Contractor. All test reports shall be signed by the Contractor and shall be in the format approved by the Engineer.

Final Acceptance Tests: After the entire Equipment has been completely assembled at the Site and placed in satisfactory operation, it shall be tested at or near full head by the Contractor to determine whether or not the requirements of the Specifications have been fulfilled. The gate shall be operated for complete opening and closing cycle.

Before final assembly of the gate slide and frame, all seating surfaces shall be cleaned thoroughly of all foreign materials and all adjustments made. With the gate fully closed, the clearance between the seating surfaces shall be checked with the feeler gauge and it shall be as per AWWA C 501. The sluice gate shall be shop operated from the fully closed to the fully open position to verify that the assembly is workable. A shop leakage test meeting the requirements of section 6.8 of AWWA C501 shall be made

10.13 Painting

10.13.1 Scope

The Contractor shall furnish and apply all paints as specified herein, before packing and transportation, with the exception of those parts or surfaces that are expressly designated as unpainted. Surfaces to be painted shall receive the preparatory treatment and number of coats prescribed in the painting schedule. The applicable provisions of the SSPC shall apply unless specifically covered otherwise in this clause.

10.13.2 Standard Products

All materials, supplies, and articles furnished shall be the standard products of recognized and reputed manufacturers.

10.13.3 Surface Preparation

Surfaces to be painted shall be cleaned before applying paint or surface treatment. All oil, grease, dirt, rust, loose mill scale, weld spatter, slag or flux deposit, old weathered paint, and other foreign substances shall be removed as hereinafter specified. The removal of oil and grease shall, in general, be accomplished before mechanical cleaning is started. Where specified, blast cleaning shall be done in accordance with SSPC-SP-10. Where required, imperfections and holes in surfaces and open joints between matching surfaces shall be filled or obliterated in an approved manner. Any required wash treatment shall be done in accordance with the paint manufacturer's instructions.

10.13.4 Colours

Colors shall be as directed. Alternate coats of paints having the same color shall be tinted in order to ensure that all surfaces are properly coated with the specified number of paint coats.

10.13.5 Painting Schedule

Surface		Method of Surfaces Preparation	Coats
1.	Ferrous Metal Subject to Continuous Immersion in Water.	SSPC-SP10, Near White Blast Cleaning	Two (2) coats of epoxy zinc-rich primer paint, total dry film thickness not less than 75 microns. Two (2) coats of low VOC (Volatile Organic Compound), two components high build high solids surface tolerant epoxy, each coat having minimum 150 microns dry film thickness.
2.	Ferrous Metal subject to intermittent immersion and splash, exposed to unfavorable	SSPC-SP10, Near White Blast Cleaning.	Two (2) coats of pigmented epoxy primer paint, total dry film thickness not less than 75 microns. Two (2) coats of low VOC (Volatile Organic Compound), two components high build high solids surface

	atmosphere or humid environment.			tolerant epoxy, each coat having minimum 150 microns dry film thickness.
3.	Ferrous Metal Expected not to Come in Contact with Water.		SSPC-SP10, Near White Blast Cleaning except galvanized surfaces.	Two (2) coats of Silicone Aluminum Paint, total dry film thickness not less than 30 microns.
4.	Ferrous Metal Embedded in Concrete, Welding (erection) pads, erection studs: embedded parts surfaces in contact with concrete.		Clean	None
5.	Corrosion Resistant Steel Surfaces.			
	a.	Seal Plates	Clean thoroughly, and grind smooth if required	None
	b.	Other	Clean	None
6.	Galvanized Surfaces		ASTM A123 and A153	Galvanize per ASTM A123 and A153

10.13.6 Paint Materials

The make of the paints to be used shall be selected by the supplier. The suppliers shall submit his proposed paint schedules together with applicable paint specifications for approval.

10.14 PARTICULAR DETAILS OF PENSTOCK GATE EQUIPMENT

10.14.1General

Slide type penstock gate equipment with manual/motorized stem rod type hoisting system shall be provided.

10.14.2Slide Type Penstock Gate Equipment

The gate equipment shall be complete with all parts and components required for installation and operation in accordance with the Specifications. The following equipment shall be provided.

Slide type penstock gate with bronze/brass bottom, side & top sealing.

Electrically/manually operated Stem Type Hoist

Hoisting Platforms, Access ladder and Railings.

Embedded metal parts which shall consist of all embedded parts including guide channel, top & side seal bearing plates, sill beam, anchor bolts/studs with nuts and washers.

10.14.3 Design Loading Conditions

The gates shall be designed for the loading conditions specified above in clause 1.7. The gate slide and frame shall be designed for the maximum head indicated with a minimum safety factor of 5 with regard to tensile, compressive and shear strength. All surfaces forming joints or bearings shall be machined.

10.14.4 Fabrication

Surfaces of the slide that come into contact with the seat facings shall be machined accurately. Seating faces shall be made of strips of rolled sections of stainless steel. They shall be secured firmly in finished grooves in the frame so as to ensure that they remain in place, free from distortion and loosening, during the life of the gate.

- **Skin-plate Structure**

The gate shall be one piece casting consisting of skin plate strengthened by horizontal and vertical stiffeners (ribs) conforming to ASTM A 48 Class 30. The ribs shall provide sufficient reinforcement to withstand the design head. With the gate in the partially open position, the slide must have sufficient beam strength to transmit the total water pressure to the sides of the gate opening.

The lifting lugs or rectangular pocket of sufficient strength shall be cast integrally with the slide to receive the stem block for connecting the bottom end of the stem to the slide.

Special care shall be exercised in the casting of all parts affecting the strength, rigidity and water tightness of the gate.

Each gate leaf shall be completely assembled in the shop and be free of twists, bends and open joints. Pockets or depressions that may hold water shall be provided with effective drains.

- **Seals**

Brass or bronze seals shall be attached to gate with countersunk bolts. Side, top and sill seals shall bear against stainless steel/CRES bearing surfaces. Sill beam steel strip, top and side seal bearing plates shall have hardness not less than 150 BHN. Complete leak proof seal corner blocks shall be provided.

10.14.5 Embedded Parts

- **General**

The gate shall be provided with one set of embedded parts which shall include sill beam with top SS plate, stainless steel/CRES seal bearing plates for side & top and SS anchor bolts/studs with nuts and washers. The top edge of side seal bearing plates shall be tapered. Top seal bearing plate shall be so designed and installed that when the gate is lifted against full head, water shall not discharge from the top.

- **Guides**

Guide frame shall be of cast iron ASTM A 48 Class 30. Guides shall be machined on all bearing and contact surfaces. The guides shall be of such length as to support at least full vertical length of the slide when slide is in the open position. Guides shall be capable of withstanding the entire thrust produced by water pressure with a safety factor of 5.

The width of the guide slots shall be such that it will provide ample clearance for gate movement and will restrict the lateral movement of the gate. The seating faces shall be machined to a finish of 63 µin (0.0016mm) in conformance with ANSI/ASME B46.1.

10.14.6 Gate Hoist and Control

- **General**

Manually/electrically operated stem type hoist shall be provided for gate. Each gate shall have an independent local control panel. The Contractor shall design the system and shall start fabrication after approval by the Engineer. The hoist shall consist of the following equipment:

- **Worm-gear Reducers**

The worm-gear reducers shall be standard, high-grade reduction units suitable for the service intended, and the proportioning of all parts therein shall be in accordance with the best engineering practice. Either cylindrical or double envelope-type worm-gear reducers will be acceptable. The reducers shall be standard, regularly produced commercial units, manufactured in accordance with standard practice for heavy-duty worm-gear speed reducers. The worm-gear shaft shall extend through the housing on one end for the attachment of flexible coupling and on other end for fixing of motor assembly and also handle for manual operation of the gate. Keyways shall be cut to suit all flexible couplings. Worm shaft and gear shaft openings shall be provided with seals or packing glands. The gear reduction ratio shall be selected such that one-man effort will be required to lift the gate manually

- **Stem Rod**

Material of the stem rods shall be ASTM A 276 Type 300/400 series. Square / acme thread should be accurately machined on the stem rods. Slenderness ratio (l / r) of stem rods shall not exceed 120. Intermediate brackets can be used to control the slenderness ratio of stem rods within specified limits.

- **Drive Shafts**

The lengths of the drive shafts will depend upon the length of the worm-gear output shaft.

- **Flexible Couplings**

The flexible couplings shall be fully enclosed, dustproof, geared type, shall be bored for tight fits on the shafts and shall have torque ratings suitable for the load transmitted.

- **Lubricating Fittings**

Lubricating fittings shall be provided for parts needing lubrication.

- **Bearings and Bearing Blocks**

Bearings and bearing blocks shall be of standard well known manufacturer like SKF or other equivalent known make.

- **Shafting**

Shafting shall have provision for longitudinal movement. Lateral shaft deflections shall not be more than 0.25 mm (0.01 in) per foot length of shaft and angular shaft deflection shall not exceed 0.26 deg. per meter (0.08 deg. per foot).

10.14.7 Hoisting Platform

Hoisting platform shall be furnished for the gate to support the gate and all hoist loads. The hoisting platform shall be galvanized/painted and shall consist of structural steel framework and chequered plate flooring and access step ladder.

10.14.8 Hand railing

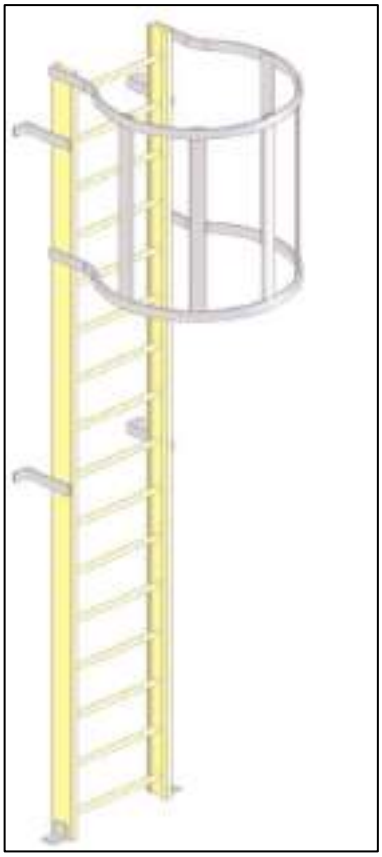
Hand railing of DN 50 (2 in dia) schedule 40 galvanized/painted steel pipe shall be provided along the opening side of all the hoist platforms, catwalks, walkways, piers and steps.

10.14.9 Gate Position Indicator, Gate Locking Arrangement and Limit Switches

A gate position indicator shall be provided and installed with the gate so that the operator, while working on the hoist, can easily see and read the position of the gate. Position indication shall be shown by a pointer on a 300 mm (12 in) diameter circular graduated scale. The Contractor shall design and provide required mechanism of speed reduction so that total travel of the gate can be calibrated on the scale. Limit switches shall be provided for indication of full opening & closing of the gate during both operations i.e. manual & motorized.

11 MS LADDER

11.1 Scope



The work covered by this section consists of providing and installation of MS ladder including painting in strict accordance with this section of the specifications and the applicable drawings and as directed by Engineer.

11.2 Materials

MS ladders will be provided with a round safety cage as per OSHA standards to limit the risk of a person falling from the ladder as shown in Figure. It is important to note that it may still be possible to fall from this ladder and should a higher degree of safety be required a vertical safety line with line shuttle should be fitted.

The safety cage should be designed to start from 2.2m up to 3m from the ladder base and must run at least 1.1m above the ladder platform.

This will allow personal access underneath the cage. The ladder RUNGS at the base can be fitted with a rung cover to prevent unauthorized access.

The maximum climbing height for a single ladder should be 10m. Should the ladder extend over 10m then the individual ladder heights must be 6m or less. The flights must be staggered and have a rest platform of at least 700mm square. Handrail must be provided around the platform at 1100mm for the top rail and a gap of no more than 450mm for the intermediate handrail.

MS ladder shall consist but not limited to the following:

Ladder : Mild Steel Standoff brackets from 50mm x 10mm bar

Stiles : 50mm x 10mm flat bar

Rung : 20mm solid round bar

Ladder width 454mm

Finish : Three Coats Enamel Paint as approved by the Engineer

Safety Cage: Distance to lowest hoop between 2.2m and 3m.

Strap : 50mm x 10mm rectangular bar

Finish : Three Coats Enamel Paint as approved by the Engineer

12 MALLEABLE IRON STEPS

12.1 Scope

This specification sets the minimum acceptable requirements for providing and fixing malleable iron step in precast manholes in strict accordance with this section of the specifications and the applicable drawings and as directed by the Engineer. In case of difference between this specification and the international standards then the most stringent requirements shall prevail.

12.2 Applicable Standards and Codes

The following latest edition codes, standards and recommended practices shall govern:

ASTM A220	Standard Specification for Pearlitic Malleable Iron
ISO 5922	Standard Specification for Malleable cast iron

12.3 Materials

Malleable Iron shall be manufactured in accordance with ASTM A220 or ISO 5922.

12.4 Dimensions & Weight

Malleable iron steps shall have minimum dimensions 8"x8"x2" | 1½" Thickness and weight not less than 7.5 kg as approved by the Engineer.

12.5 Submittals

Before installing malleable iron steps in manholes, the Contractor shall provide sample for approval by the Engineer.

12.6 Method of Measurement

The quantities to be measured for shall be in number

1 SEWAGE SUBMERSIBLE PUMP

1.1 Scope

This Section covers the requirements for designing, manufacturing/fabrication, testing at the manufacturer's works, furnishing, installing, painting, testing and commissioning at Site, placing in satisfactory operating conditions, and three-years extended warranty for satisfactory operation of non-clogging, vertical shaft, close coupled, centrifugal type submersible sewage pump. The specifications of necessary piping, suction elbow, bends, valves, supports/thrust blocks, control panels, cables, devices, valves and appurtenances as shown on the Drawings or as required for the satisfactory operation of the System are included in the bill of quantities (BOQ) and relevant section of these specifications.

1.2 List Of Abbreviations

API	American Petroleum Institute
ASTM	American Society for Testing and Materials
ASME	American Society of Mechanical Engineers
AWS	American Welding Society
BOQ	Bill of Quantities
BS	British Standard
DN	Nominal Diameter
DIN	Deutsches Institut für Normung
EN	European Standard
HDPE	High Density Polyethylene
HI	Hydraulic Institute
ISO	International Organization for Standardization
MSS	Manufacturers Standardization Society
NEMA	National Electrical Manufacturers Association
NPSH	Net Positive Suction Head
PLC	Programmable Logic Controller
PN	Pressure Rating

1.3 General

The work will include but not be limited to the followings:

- Designing, manufacturing, testing at manufacturer's workshop, supplying at site, installation, testing, commissioning, guarantee and maintenance for one year during defect Liability Period of close coupled, non-clogging, vertical shaft, centrifugal type submersible, sewage cum storm water pumps with suitable AC induction, totally enclosed, 4 pole, 3-Ph, 400 V, 50 Hz, insulation class F, ingress protection IP 68, to be installed in wet well,

including electrical cable up to 15 m and control cable up to 15 m, motor control unit, pressure gauge discharge side, 01 Nos. sluice valve, 01 No non-return valve including factory inspection during casting of pumps and final inspection at test bed, erection & maintenance tools and spare parts. All equipment shall be from reputed approved manufacturers.

- Design, supply and installation of brand new 400V, 50 Hz, 3 phase, insulation class F, IP-68 with efficiency class (IE-2) suitable for operating pumps described above. The motors shall be from reputed manufacturer subject to approval of the Engineer.
- Design, supply and installation of motor control unit/motor control center consisting of metallic box, auto star delta starter, circuit breaker, magnetic contactor, thermal overload relay, on/off switch, control fuse, auto level control with ultrasonic sensor, control wire, under/over voltage relay, electronic over current relay, phase failure relay, indication lamps, digital ampere meter, volt meter, hour run meter, dry running protection thermistor relay, high temperature protection, phase reversal protection, along with pump controller with built-in Micro processer connectable to analog & digital sensors, automatic control for alternate operation of pumping units at predetermined time, wiring and necessary items for moisture in oil monitoring for mechanical seals, level switches for dry running protection, temperature and vibration monitoring of pumping units, electrical and control cables of 15 m each, complete in all respects. All the equipment shall be from reputed manufacturers subject to approval of the Engineer.

- Manufacture, test, supply and installation of sluice valves as shown in the drawings.
- Manufacture, test, supply and installation of discharge piping, along with all flanges, their coating and lining including reducers, tee, elbows etc.
- Manufacture, test, supply and installation of non-return valves as shown in the drawings.

1.4 Applicable Standards

Latest edition of the following applicable standards:

BS EN 545	Ductile Iron Pipes, Fittings, Accessories and their Joints for Water Pipelines - Requirements and Test Methods
BS EN 598	Ductile Iron Pipes, Fittings, Accessories and their Joints for Sewerage Applications - Requirements and Test Methods
HI	Hydraulic Institute Standards for Rotodynamic (Centrifugal) Pumps
HI 1.3	Rotodynamic (Centrifugal) pumps for Design and Application
HI 1.4	Rotodynamic (Centrifugal) pumps for manuals describing installation, operation and maintenance
HI 14.6	Rotodynamic Pumps for Hydraulic Performance Acceptance Tests
API 682	Pumps-Shaft Sealing Systems for Centrifugal and Rotary Pumps
ASTM A815~S31803	Duplex Stainless Steel
ASME B73.1	Specification for Horizontal End Suction Centrifugal Pumps for Chemical Process
ASME B16.5	Pipe flanges and flanged fittings NPS 1/2 through NPS 24

ASME B16.47	Large diameter steel flanges NPS 26 through NPS 60
ASTM - A 276	Standard Specification for Steel Castings, Carbon for General Application
ASTM - A 36	Standard Specification for Carbon Structural Steel
ASTM A 216	Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service
ASTM A 240	Heat Resisting Chromium and Chromium - Nickel Stainless Steel Plates
ASTM A 276	Standard Specification for Stainless Steel Bars and Shapes
ASTM A 743	Castings, Iron - Chromium, Iron – Chromium - Nickel, Corrosion Resistant, for General Application
ASTM B 62	Composition Bronze or Ounce Metal Castings
ASTM B 148	Nickel - Aluminium Bronze
ASTM A193 Purpose	Specification for Alloy-Steel and Stainless-Steel Bolting for High Temperature or High-Pressure Service and Other Special Applications
ASTM A194	Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both
ASTM A 890	Specification for Castings, Iron-Chromium-Nickel-Molybdenum Corrosion Resistant, Duplex (Austenitic/Ferritic) For General Application
ISO 10204	Metallic Products-Types of inspection documents
ISO 1940	Mechanical vibration — Balance quality requirements of rigid rotors
ISO 3661	End-suction centrifugal pumps -- Baseplate and installation dimensions
ISO 2858 duty	End-suction centrifugal pumps (rating 16 bar) Designation, nominal point and dimensions
ISO 3069	End-suction centrifugal pumps -- Dimensions of cavities for mechanical seals and for soft packing
ISO 5198	Centrifugal, mixed flow and axial pumps -- Code for hydraulic performance tests -- Precision grade
ISO 5199 / 2858	Specification for Horizontal End Suction Centrifugal Pumps for Chemical Process
ISO 7005	Metallic flanges – Cast Iron and Steel
ISO 9905	Technical specifications for centrifugal pumps-Class I
ISO 9906	Rotodynamic Pumps-Hydraulic performance acceptance tests
ISO 9908	Technical specifications for centrifugal pumps- Class III
ISO 10441	Flexible couplings for mechanical power transmission — Special purpose applications

ISO 11342	Mechanical Vibration — Methods and criteria for the mechanical balancing of flexible rotors
ISO/DIS 14414	Pump system energy assessment
ISO 14617-9	Graphical symbols for diagrams – Part 9: Pumps, compressors and fans
ISO 14691	Petroleum and natural gas industries — Flexible couplings for mechanical power transmission — General purpose applications
ISO/DIS 21049	Pumps - Shaft-sealing systems for centrifugal and rotary pumps
ISO 20361	Liquid pumps and pump units -- Noise test code - Grades 2 and 3 of accuracy
ISO 17769-2	Liquid pumps and installation -- General terms, definitions, quantities, letter symbols and units - Part 2: Pumping system
MSS-SP-55	Quality standard for steel castings for valves, flanges and fittings and other piping Components-Visual method for evaluation of surface irregularities
DIN 24255	End-suction centrifugal pumps, also known as standard water pumps, with a rated pressure (PN) of 145 psi
AWS D1.1	Structural welding code — Steel
AWS D1.6	Structural welding code — Stainless Steel

Any other applicable Standards subject to approval of the Engineer.

1.5 Pump Operation

The pumps shall start with the sluice valves closed on discharge side. When the pump motors reach synchronous or rated speed, the valves shall be opened. The non-return valve shall open following the sluice valve. During the stopping sequence of the pumps, under normal working conditions, the sluice valves shall close first and the pump motor shall be switched-off after that. Under emergency conditions or during a power outage, the non-return valve shall automatically close as soon as the pump stops to avoid reverse rotation.

1.6 Pumps Design Criteria

The pumps shall be designed in accordance with applicable requirements of Hydraulic Institute Standards or other internationally recognized pump manufacturing standards subject to approval of the Engineer.

The Contractor shall verify the design heads of the pumping system, accordingly prepare system head curves and superimpose the pump performance curve on it, verify the arrangement and sizes of the station piping, the design duties of each equipment, analyse system pressure losses, check hydraulic transients for normal and emergency conditions etc. and submit to the Engineer detailed reports/designs for approval before any material procurement.

Each equipment shall be suitable for rendering intended duties individually as well as part of the whole system under the Project's requirements, climatic and environmental conditions.

The Contractor shall ensure during design review and shop testing stages that all pumps shall operate near their best efficiency points individually as well as operating in parallel as part of the whole system.

1.7 Pump Manufacturer's Qualifications

Based on the pumping requirements of the Project, the Contractor shall refer to the reputed pump manufacturers having relevant experience in designing and manufacturing of pumps with sewage and storm water pumping media with characteristics which could satisfy the actual requirements of the project.

The Contractor shall submit complete details, technical brochures, list of standards, list of testing/inspection tools, details of the test bed facilities available with his proposed pump manufacturer and list of projects where the manufacturer has supplied such pumps with similar type and materials of construction as specified in these specifications. The proposed pump manufacturer shall be approved after review of the data by the Engineer and Employer.

1.8 Submittals

The Contractor shall submit all the following documents/drawings, copies of the applicable Standards (latest editions) and all other submittals as required in both soft and hard form for review and approval of the Engineer:

- Shop drawings: General assembly, components, dimensions, thicknesses of casings, impellers, weights, clearances and methods of assembly including material specifications.
- Product Data: Provide manufacturer's literature including general assembly, certified pump curves showing performance characteristics with pumps and system operating points indicated, NPSH curves, power curves, controls, wiring diagrams, and service connections.
- System design and pressure loss calculations of pumping station, suction/discharge piping and rising main to confirm the specified design heads and to ensure required flow and actual design head operating at the best efficiency point.
- Design calculations of the system along with system performance curves as per actual Site condition.
- Proposed system operation description.
- Manufacturer's Installation Instructions: Including handling, storage, start-up and shut-down instructions for pumping system.
- Details of motor control units.
- Manufacturer's Certificate: Certifying that pumps meet or exceed specified requirements at specified operating conditions. Submit summary and results of shop tests performed in accordance with DIN EN ISO 9906 Grade 1B or HI 14.6 Grade 1B in presence of the Engineer and Employer. The material test certificates shall be submitted as per the requirements of ISO EN 10204 (3.1).
- Manufacturer’s Quality Assurance and Quality Control Programme. To assure full control of fabrication processes, it is mandatory to use written procedures for operations and submit to the Engineer.

- Test certificates regarding hydrostatic testing of casing, pump-motor alignment and dynamic balancing of impellers.
- Field Reports: Submit as directed by the Engineer.

1.9 Materials

1.9.1 General

- All the pump parts, unless otherwise specified shall be of standard materials of the manufacturer, suitable for the specified operating conditions approved by the Engineer.
- All materials shall be new and of first-class quality, suitable for the purpose, free from defects and imperfections.
- Materials of pumps and valves shall be compatible with the corrosive and abrasive properties of the pumped water.

1.9.2 Pumps

- **Type and Description**:

Each pumping units to be furnished under this package shall consist of vertical shaft, non-clogging, centrifugal type submersible pump close coupled to a suitable squirrel cage, induction type, vertical electric motor, class F, IP 68. The pumping units shall be suitable for indoor operation. The pumps shall be suitable for parallel operation. The pumps shall have stable head/capacity curve that continuously rises to shutoff. The pump shall be capable of continuous submerged operation installed in a wet well pit installation and connected permanently to outlet pipes.

- **Head, Capacities and Speeds:**

The pump design parameters are provided for reference. The data provided herein below is subject to verification of the contractor.

Design head	30 ft (approx.)
Efficiency of pumps	Not less than 60% with efficiency with a capacity of 0.25 Cusec
Pump Speed	1500-3000 rpm
pump	40 m3/hr
Pump Speed	1450 rpm

- **Efficiency**:

The best efficiency of the pumps at the rated head shall not be less than 60% with motor efficiency class (IE-2 or above).

1.9.3 Component Materials

- **Casing and Impeller:**

The pump casing shall be designed for the maximum discharge pressure plus allowance for head increase at pumping temperature and hydrostatic test pressure at ambient temperature, with a 3 mm minimum corrosion allowance and to produce smooth flow with gradual changes

in velocity. The casing shall be made of Cast iron ASTM A 48 Class 35, EN GJL 250 or better, subject to approval of the Engineer. Pump casing shall be easily removable from the motor for full inspection of impeller. The chemical composition and mechanical properties of pump casing shall be stated on the manufacturer's drawings.

The discharge connections shall be flat-face or raised-face flanges, faced and drilled to conform to Class 150 as per standard ANSI rating. The pump casing shall be provided with wearing ring to adjust the clearance between impeller and casing or it shall be provided with removable and renewable wearing rings where there are close-running clearances between the impeller and the casing The wearing rings shall be press-fit and held to the impeller with locking pin.

The impeller furnished shall be the multivane radial flow type with free passage size of not less than 40-50 mm 80mm for 40m3/hr pump, shall be of Ductile Cast iron (A536 GR 65-45-12) or better subject to approval of the Engineer, carefully selected for resistance to corrosion and pitting and shall be fastened to the shaft in such a manner as to make it readily removable. The impeller shall be capable of running against closed valve. The design must ensure that long fibers, rags pass freely through the pump without getting caught and without causing clogging or jamming. Impeller shall be individually secured against axial movement in either direction along the shaft. The impeller shall be statically and dynamically balanced.

The Contractor shall guarantee each impeller against excessive cavitation for a period of two (2) years from the date the pump is placed in service.

- **Shaft**:

The shaft shall be of stainless steel AISI 431 or better, subject to approval of the Engineer, suitably heat treated, rigid design type and of ample size to operate without vibration throughout the range of normal and reverse runaway speed. Actual critical speeds shall not encroach upon specified operating speed range. Preferably, its first critical speed shall be at least 20% higher than normal operating speed. The critical speed shall be confirmed by test standard data. Water deflectors shall be provided on the shaft to prevent water from passing along the shaft and entering the pump bearings. A shaft protecting sleeve shall be provided on the shaft. A shaft protecting sleeve shall be provided on the shaft. The material of the sleeve shall be of stainless steel AISI 304 subject to approval of the Engineer.

A suitable coupling shall be furnished between the pump and the motor as per manufacturer’s standard design. The design of the coupling and the means of attaching the coupling to the pump shaft shall be such as to facilitate the maintenance of the pump whenever necessary.

- **Mechanical Seals**:

Two hydraulically balanced seals installed in tandem arrangement complete with all required auxiliaries and oil reservoir shall be provided. The seals shall be oil-lubricated and the seal springs shall be operating in the oil fully protected against contact with the pumped liquid. The oil chamber shall provide a reliable sealing between the pumped liquid and the motor.

The material of the primary seal faces shall be Silicon Carbide-Silicon Carbide and material of the secondary seal shall be Silicon Carbide-Carbon.

The seals shall allow for rotation in either direction. The seal area design shall prevent air pocket formation around the seal. All static seals at watertight joints shall be of nitrile O-ring type.

- **Pump Bearings**:

The pump shaft shall be supported by bearings of approved design. The bearings shall be grease-lubricated, angular contact ball or roller-bearing type. One bearing on the pump shall be of the thrust type, designed to withstand the unbalanced hydraulic thrust. Suitable fittings shall be furnished for the type of lubrication provided.

Bearings shall be designed for a nominal L10 life time of 50,000 hr at best efficiency point.

- **Pump Drive:**

Suitable Electric motors, constant speed, vertical shaft induction type, close coupled, IP 68, insulation class F or higher, with efficiency class (IE-2 or above), submerged operation shall be provided. Motor housing shall be of cast iron. The rotor shall be solid cast and dynamically balanced. Shaft ends shall be conical for safe securing of impeller. Shaft bearings shall be open or shielded design greased for life. Power and control cables shall be clamped against tensile loads and have a serviceable inlet to the motor sealed by compressed rubber ring elements.

The motor shall have internal protection devices consisting of thermos-switches embedded in the stator windings.

Design of power cable shall be according to NEMA Standards. The length of the power cable shall be sufficient in order to reach the junction box without the needs to splice it with another cable.

The power provided by the motor shall be adequate e.g. providing enough power to ensure that pump is not overloading throughout the pump performance curve from 0 to max flow.

- **Foundations:**

The reinforced concrete foundations of the pumping units shall be so designed that the computed amplitude of vibrations at the top of the foundations and elastic deflections due to machinery loads shall remain within the permissible limits prescribed by the machinery manufacturers.

The natural frequency of the whole of the foundations or parts thereof and all structures adjacent thereto shall not coincide with the operating frequency of the vibrating plant to avoid resonance condition. The foundation's natural frequency shall be at least 10% less than the frequency of vibrating equipment.

1.10 Operation and Maintenance Manual

The Contractor shall submit soft and hard copies of O&M manual for review and approval of the Engineer.

Submit step-by-step instructions describing how the Pumping Disposal Station (Plant) is prepared for start-up from a zero state. They shall include instructions for the receipt and storage of all consumables including chemicals, lubricants, fuels etc. and their transfer from storage to the Plant in preparation for start-up.

A. Description of unit and component parts

- Complete nomenclature and commercial number of replaceable parts
- Metallurgy of Parts and their equivalence according to ASTM International Standards
- Function, normal operating characteristics, and limiting conditions
- System curves, performance curves, Engineering data and tests

B. Operating procedures:
   - Start-up, break-in, routine and normal operating instructions.
   - Regulation, control, stopping, shut-down and emergency instructions.
   - Summer and winter operation instructions
   - Special operating instructions.

C. Maintenance Procedures
   - Routine operations/maintenance (daily, weekly, monthly or annual).
   - Guide to "Trouble-shooting".
   - Disassembly, repair and reassembly.
   - Alignment, adjusting and checking.

D. Servicing and lubrication schedule.
   - List of lubricants required and their schedule for applying.

E. Manufacturer's printed operation and maintenance instructions.
F. Description of sequence of operation by control and pump manufacturers.
G. Original manufacturer's parts list, illustrations, assembly drawings and diagrams required for maintenance.
   - Predicted life of parts subject to wear.
   - Items recommended to be stocked as spare parts for five years of trouble-free operation.

H. As-installed control diagrams by controls manufacturer.
I. Coordination drawings.
J. As-installed color coded piping diagrams.
K. List of original manufacturer's spare parts, manufacturer's current prices and recommended quantities to be maintained in storage.
L. Other data as required under pertinent sections of Specifications.
M. Content, for each electric and electronic system, as appropriate:
   1. Description of system and component parts.
      - Function, normal operating characteristics, and limiting conditions.
      - Performance curves, Engineering data and tests.
      - Complete nomenclature and commercial number of replaceable parts.
   2. Circuit directories of panel boards.
      - Electrical service
      - Controls
      - Communications
   3. As-installed color coded wiring diagrams.
   4. Operating procedures:
      - Routine and normal operating instructions.
      - Sequences required.
      - Special operating instructions.

5. Maintenance procedures:
    - Routine Operations
    - Guide to "trouble-shooting".
    - Disassembly, repair and reassembly.
    - Adjustment and checking
6. Manufacturer's printed operating and maintenance instructions.
7. List of original manufacturer's spare parts, manufacturer's current prices, and recommended quantities to be maintained in storage.
8. Other data as required under pertinent sections of the Specifications.

N. Additional requirements for operating and maintenance data.

1.11 Guarantee

All items to be furnished shall be guaranteed for a period of one year from the date of Preliminary Acceptance against defective materials, design, performance or workmanship. Any deficiency mentioned above or in the Specifications shall be replaced or corrected by the Contractor as directed by the Engineer at no additional expense to the Employer.

1.12 Quality Assurance

- Manufacturer’s Quality System certification to ISO 9001:2008
- Inspection/testing of the casting of pump components as mentioned in 1.14 hereunder.
- Performance tests in accordance with DIN EN ISO 9906 Grade 1B or HI 14.6 Grade 1B or equivalent.

Maintain one copy of approved documents and drawings on Site.

1.13 Tests

1.13.1 General

The Manufacturer shall have available all means required, all materials, machinery, inspection equipment to carry out testing operations in his workshop.

Water to be used shall be specified by the Manufacturer's Test Procedure which has to be submitted to the Engineer prior to testing. The tests shall be carried out on non-lined/painted parts, the seats and the ball or gate shall be thoroughly cleaned. No grease shall be left on those parts which involve the seats. All blanking devices used for the hydraulic or pneumatic test shall not be prejudicial to the soundness of the valve ends. Test data and pressure shall be recorded during the entire testing time.

The diagrams shall clearly show all information helping to identify them, particularly, for each test they shall show:

- the nominal diameter, the rating and the identification tag of the valve
- the test type
- the duration
- the signature (clearly readable) of the person in charge of the test.

The Manufacturer shall test all valves in accordance with the requirements of API Standard 6D and of this Specification.

1.13.2 Shop Tests

The shop inspection of all the pumping units shall be carried out by the Engineer and Employer's representative as described herein below:

First Inspection: Inspection for checking any defect in the casted parts, checking of the documentation according to the applicable standards, verification of the thicknesses of pump casing, impellers and other components, ultrasonic/radiographic testing to detect any flaws, verification of metallurgy of the pump casings, impellers and shaft etc. shall be carried out during casting, foundry operations according to international standards (latest applicable) to ensure conformance to the specified materials/requirements by the Engineer's and Employer's representatives.

Second Inspection: The pumps shall be assembled completely in the shop to ensure correct fitting of all parts and shall be match marked before transportation, unless the pumps are transported completely assembled, to ensure correct assembly in the field. The pump casings shall be tested hydrostatically in the presence of the Engineer's and the Employer's representatives under a pressure equal to 150 percent of either the sum of the pump shut off head plus the maximum suction head or the maximum working pressure whichever is greater. The hydrostatic test pressure shall be held for not less than 30 minutes after all leaks have been stopped.

The pumps shall be tested at test bench in accordance with DIN EN ISO 9906 Grade 1B or HI 14.6 Grade 1B in the presence of the Engineer's and the Employer's representatives to check the performance of pump at the specified parameters.

No kind of repair shall be done in any casted parts without prior approval of the Engineer. Any component found defective after conduction of non-destructive testing shall be rejected and that component shall be re-casted. The pumps shall be tested as mentioned above by and at the expense of the Contractor to establish that the materials and the performance requirements of these Specifications and the Contractor's guarantees have been fulfilled. The pump shall be tested in the manufacturer's shop and the performance tests shall be made with the entire pumping unit. Readings shall be taken at a minimum of five capacity points, including one point with plus or minus 1 percent of specified capacity. The tests shall be conducted in accordance with the accepted practices at full speed and unless otherwise specified, the procedure and instruments used shall be duly calibrated and conform to the latest applicable standards, subject to approval of the Engineer.

The tests shall be carried out in the presence of the representatives of the Employer and the Engineer. All the travelling, boarding, lodging other expenditures shall be borne by the Contractor.

- The tests shall cover but not be limited to:
- Determination of the total head.
- Determination of flow rate of water pumped.
- Measurement of the speed of rotation.
- Measurement of input to the pump and output of the motor.
- Determination of efficiencies of pump and pumping unit.
- Preparation of characteristic curve showing system head, pump head, capacity, NPSH required, power and pumping unit efficiency.

- Measurement of reverse runaway speed
- Determination of NPSH required.
- Cavitation testing.
- Measurement of increase in temperature of pump/motor.

Any other tests as required by the Employer / Engineer shall be conducted during the Shop Inspection according to applicable standards and to the satisfaction of the Employer / Engineer.

1.13.3 Operational Tests

Operational tests shall be performed by the Contractor on the pump before the pump is placed in service.

- **General**:

Within two weeks after the operation of the pump has been approved by Employer / Engineer, as provided in the Contract, the pumps shall be tested by and at the expense of the Contractor to determine whether the equipment meets the guarantees. If so desired by the Employer/Engineer, the tests shall be repeated one month before the expiry of the Maintenance Period.

- **Provision in Case of Damage or Wear**:

Prior to the tests, the interior of the pump shall be inspected by the Engineer's Representative and the Contractor. Should such inspection disclose any damage or wear has taken place, the Contractor shall replace at his own cost.

- **Capacity and Efficiency Tests**:

The capacity and efficiency of the pumps on the system head curves shall be determined for as many different heads within the range of operating heads as possible. The capacities and efficiencies at the guaranteed conditions shall be determined from smooth curves drawn through the test points.

- **Conduct of the Tests**:

The tests shall be conducted in accordance with latest applicable standards of DIN EN ISO 9906 Grade 1B, HI 14.6 Grade 1B or equivalent.

- **Determination of Rate of Flow**:

The rate of flow of water through the pumps shall be determined by the properly calibrated rate of flow indicator or other suitable method agreed upon by the Contractor and the Engineer.

- **Determination of Total Head**:

Total head on the pump (H) shall be the difference between the pressure elevation at the pump discharge and the pressure elevation near the entrance to the suction elbow, both corrected for velocity head. All measurements shall be determined by the instruments furnished with pumps or as follows:

The pressure elevation "a" at the pump discharge shall be measured with the discharge pressure gauge furnished by the Contractor or other suitable method agreed upon by the Engineer and the Contractor.

The velocity head "b" at the pump discharge shall be based on the mean velocity at the piezometer section. The mean velocity shall be determined by dividing the rate of flow by the area at the piezometer section.

The pressure elevation "c" at the pump inlet shall be measured with the suction pressure gauge furnished by Contractor or by other suitable method agreed upon by the Engineer and the Contractor.

The velocity head "d" at the pump inlet shall be based on the mean velocity at the piezometer section. The mean velocity shall be determined by dividing the rate of flow by the area of the passage at the piezometer section.

The total head on the pump (H) shall then be equal to (a+b) - (c+d).

- **Determination of Power:**

The electrical input to the motor shall be measured by using accurate, sensitive and calibrated, test instruments connected to the permanently installed instrument transformers or as directed by the Engineer. The input to the pumps shall be the measured input to the motor minus the mechanical and electrical losses in the motor. The losses in the motor shall be determined by separate tests in accordance with the latest standards and test codes of the Institute of Electrical and Electronic Engineers, Inc; and the American National Standards Institute or specified in the relevant specifications.

- **Determination of Efficiency Curve**:

The efficiency curve of the pump shall be determined from smooth curves of the input, head and rate of flow of water, all as determined in accordance with the above sub-paragraphs.

- **Runaway Tests:**

The pumps shall be subject to runaway tests & witnessed by the Engineer. The tests shall be performed under normal operating conditions by interrupting the power supply.

- **Cavitation Tests:**

Cavitation tests will be performed and witnessed by the Engineer’s Representative. The tests will be performed under normal operating conditions to check for the vapor formation to avoid wear and tear.

In addition to any specific tests required on items of plant, as detailed elsewhere in these specifications, the following tests shall be carried out:

Pumps shall be tested for adequate performance including hydraulically and electrically to demonstrate that they function as designed.

All pipe work, valves, etc., shall be pressure tested at 150 percent of design pressure.

Load tests shall be carried out on all lifting equipment at 125% of rated load.

All electrical installations shall be tested.

All alarm systems, overloads and safety equipment shall be tested for simulated conditions.

Greasing and lubrication systems shall be tested.

All switchboard, motor control centers, control panels and distribution boards shall be tested for proper installation and functioning.

The performance of the pumps shall be tested to conform to rating curves.

Any other tests required by the Engineer.

1.14 Execution / Installation

- Install in accordance with manufacturer's instructions and recommendations.
- Provide access space around pumps for service. Provide space not less than as recommended by manufacturer.
- Decrease from line size with long radius reducing elbows or reducers if required.
- Support piping adjacent to pump such that no weight is carried on pump casings. Provide supports or thrust blocks under elbows and bends on pump suction and discharge wherever necessary and subject to approval of the Engineer.
- All suction and discharge piping shall be installed so as to prevent vibrations and strain in the pumps, valves and fittings and subject to approval of the Engineer.
- Provide drains for bases and seals, piped to and discharging into floor drains.
- Lubricate pumps before start-up.
- Qualified supervisor/millwright shall check, align, and certify base mounted pumps prior to start-up.
- All of the works shall be carried out under strict observance of the health, safety and environmental protection regulations and standards valid for the construction site.
- Handling of equipment and materials shall be carried out with utmost care and most skilful labor. Handling equipment shall be suitable for the intended purpose and for the size and weight of the goods to be handled.

13 BRICK DRAIN

13.1 Scope of Work

The work shall include construction of brick masonry drains for the conveyance of domestic wastewater, including excavation, subgrade preparation, PCC bedding, brick masonry, plastering, curing, and provision of covers (if required), complete in all respects.

13.2 Excavation

1. Excavation shall be carried out to the required width, depth, and alignment as per drawings.
2. Trench sides shall be properly dressed and trimmed.
3. Loose soil shall be removed and the bottom shall be properly compacted.
4. Any excess excavation shall be backfilled with approved material and compacted.

13.3 Subgrade Preparation

1. The foundation bed shall be leveled and compacted to achieve adequate bearing capacity.
2. Soft or unsuitable material shall be removed and replaced with approved fill.
3. Proper alignment and levels shall be maintained using string lines and leveling instruments.

13.4 Plain Cement Concrete (PCC) Bedding

1. PCC shall be provided under the drain walls and bed.
2. Mix ratio: **1:3:6 (Cement : Sand : Aggregate)**.
3. Minimum thickness: **75 mm (3 inches)**.
4. Concrete shall be properly mixed, placed, compacted, and cured for at least **7 days**.

13.5 Brick Masonry

1. First-class burnt clay bricks conforming to relevant standards shall be used.
2. Bricks shall be soaked in water before laying.
3. Mortar ratio: **1:4 (Cement : Sand)**.
4. Joints shall be properly filled and not exceed 10 mm in thickness.
5. Brickwork shall be constructed true to line, level, and plumb.
6. Wall thickness shall be:
7. 115 mm (4.5") for small drains
8. 230 mm (9") where structurally required

13.6 Internal Plaster

1. Internal surfaces shall be plastered with **12 mm thick cement mortar (1:3)**.
2. The plaster shall be smooth finished to minimize friction losses.
3. Proper curing shall be ensured for at least **7 days**.

13.7 Hydraulic Requirements

1. Drains shall be designed to maintain a **minimum self-cleansing velocity of 2 ft/sec (0.6 m/s)**.
2. Longitudinal slope shall generally range between **0.5% to 1%**, depending on site conditions.
3. Sudden changes in gradient shall be avoided.
4. Drop structures shall be provided where natural slope is steep.

13.8 Covers (If Covered Drain)

1. Drains may be covered with:
2. Precast RCC slabs, or
3. Recycled Plastic Covers (RPC), as specified.
4. Covers shall be removable for maintenance.
5. Load capacity shall be adequate for pedestrian or light vehicular traffic, as required.

13.9 Outfall & Disposal

1. Drains shall discharge into approved wastewater ponds, trunk drains, or watercourses.
2. Proper erosion protection and energy dissipation measures shall be provided at the outfall.

13.10 Curing & Protection

1. Brick masonry and concrete shall be cured properly.
2. Newly constructed drains shall be protected from damage until completion.
3. Work shall comply with relevant engineering standards and local authority specifications.