Government of Rajasthan

Urban Development & Housing Department, through
Jaipur Development Authority

BID DOCUMENT

FOR

Selection of a Bidder under Swiss Challenge Method for Rejuvenation of Amanishah Nallah (Dravyavati River), Jaipur (Rajasthan) including Area Development on Turnkey Basis, and its Operation & Maintenance (O&M) for a Period of 10 Years

Volume-I

Technical Bid

(8th December, 2015)

Issued on: 24/12/2015

Notice Inviting Bids (NIB) No. 17/2015-16

Notice Inviting Bid

Published on 24.11.2015



JAIPUR DEVELOPMENT AUTHORITY
Room No.N-108, 2nd Floor (Bank Building) Ram Kishore Vyas Bhavan, Indira Circle, JawaharLal Nehru Marg, Jaipur-302 004

No:- JDA/EE-07/2015/D-431 Dated: 23-11-2015

NOTICE INVITING BID
NIB No.: 17/2015-16

Online Bids are invited up-to **05.00 PM of 30-12-2015** for **"Rejuvenation of Amanishah Nallah (Daravyavati River) including Area Development Jaipur, Rajasthan on Turnkey Basis and its Operation and Maintenance (O&M) for period of 10 years (Project)".** Details may be seen in the Bidding Document at our office or the website of State Public Procurement Portal **www.sppp.rajasthan.gov.in**, **www.eproc.rajasthan.gov.in** and **www.jaipurjda.org**.

To participate in the bid, bidder has to be:

1. Registered on JDA website **www.jaipurjda.org**. For participating in the Bid, the Bidder has to apply for the Bid and pay the Bidding Document Fee, RISL Processing Fee and Bid Security Deposit, Online or alternately may submit B.G/D.D. of bid security amount physically with validity of 180 days.
2. Registered on e-procurement Portal of Government of Rajasthan **www.eproc.rajasthan.gov.in** for online e-Bid submission.

Raj.Samwad/C/15/4105 **Executive Engineer-7**

Corrigendum

Published on 02.12.2015



JAIPUR DEVELOPMENT AUTHORITY
Room No.N-108, 2nd Floor (Bank Building) Ram Kishore Vyas Bhavan, Indira Circle, JawaharLal Nehru Marg, Jaipur-302 004

No:- JDA/EE-07/2015/D-435 Dated: 01-12-15

Corrigendum

NIB for "Rejuvenation of Amanishah Nallah (Dravyavati River) including Area Development Jaipur, Rajasthan on Turnkey Basis and its Operation and Maintenance (O&M) for period of 10 years (Project)", was published vide NIB No. JDA/EE-07/2015/D-431 Dated 23-11-15. The Online Bids invited has been extended up to 11-01-2016 at 05.00 PM.

Details may be seen in the Bidding Document at our office or the website of State Public Procurement Portal **www.sppp.rajasthan.gov.in**, **www.eproc.rajasthan.gov.in** and **www.jaipurjda.org**.

Raj.Samwad/C/15/4256 **Executive Engineer-7**

DISCLAIMER

The information contained in this Bid Document or subsequently provided to Bidder(s), whether verbally or in documentary or any other form by or on behalf of the Employer or any of its employees or advisors, is provided to Bidder(s) on the terms and conditions set out in this Bid Document and such other terms and conditions subject to which such information is provided.

This Bid Document is not an agreement and is neither an offer nor invitation by the Employer to the prospective Bidders or any other person. The purpose of this Bid Document is to provide interested parties with information that may be useful to them in making their financial offers (Bids) pursuant to this Bid Document. This Bid Document includes statements, which reflect various assumptions and assessments arrived at by the Employer and the Project Proponent in relation to the Project. Such assumptions, assessments and statements do not purport to contain all the information that each Bidder may require. This Bid Document may not be appropriate for all persons, and it is not possible for the Employer, its employees or advisors to consider the investment objectives, financial situation and particular needs of each party who reads or uses this Bid Document. The assumptions, assessments, statements and information contained in the Bid Document, may not be complete, accurate, adequate or correct. Each Bidder should, therefore, conduct its own surveys, investigations and design, analysis and should check the accuracy, adequacy, correctness, reliability and completeness of the assumptions, assessments, statements and information contained in this Bid Document and obtain independent advice from appropriate sources.

Information provided in this Bid Document to the Bidder(s) is on a wide range of matters, some of which may depend upon interpretation of law. The information given is not intended to be an exhaustive account of statutory requirements and should not be regarded as a complete or authoritative statement of law. The Employer accepts no responsibility for the accuracy or otherwise for any interpretation or opinion on law expressed herein.

The Employer, its employees and advisors make no representation or warranty and shall have no liability to any person, including any Bidder under any law, statute, rules or regulations or tort, principles of restitution or unjust enrichment or otherwise for any loss, damages, cost or expense which may arise from or be incurred or suffered on account of anything contained in this Bid Document or otherwise, including the accuracy, adequacy, correctness, completeness or reliability of the Bid Document and any assessment, assumption, statement or information contained therein or deemed to form part of this Bid Document or arising in any way for participation in this Bid Stage.

The Employer also accepts no liability of any nature whether resulting from negligence or otherwise howsoever caused arising from reliance of any Bidder upon the statements contained in this Bid Document.

The Employer may in its absolute discretion, but without being under any obligation to do so, update, amend or supplement the information, assessment or assumptions contained in this Bid Document.

The issue of this Bid Document does not imply that the Employer is bound to select a Bidder or to appoint the Selected Bidder, as the case may be, for the Project and the Employer reserves the right to reject all or any of the Bidders or Bids without assigning any reason whatsoever.

The Bidder shall bear all its costs associated with or relating to the preparation and submission of its Bid including but not limited to preparation, copying, postage, delivery fees, expenses associated with any demonstrations or presentations which may be required by the Employer or any other costs incurred in connection with or relating to its Bid. All such costs and expenses will remain with the Bidder and the Employer shall not be liable in any

manner whatsoever for the same or for any other costs or other expenses incurred by a Bidder in preparation or submission of the Bid, regardless of the conduct or outcome of the Bidding Process.

The Bidders are prohibited from any form of collusion or arrangement in an attempt to influence the selection and award process of the Bid. Giving or offering of any gift, bribe or inducement or any attempt to any such act on behalf of the Bidder towards any officer/employee/ advisor/ representative of Employer or to any other person in a position to influence the decision of the Employer for showing any favour in relation to this Bid Document or any other Contract, shall render the Bidder to such liability/penalty as the Employer] may deem proper, including but not limited to rejection of the Bid of the Bidder and forfeiture of its Bid Security.

Laws of the Republic of India are applicable to this Bid Document.

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Section-1: Instructions to Bidders (ITB)

This section specifies the procedure to be followed by Bidders in the preparation and submission of their Bids. Information is also provided on the submission, opening, and evaluation of Bids and on the award of Contract.

Section-2: Bid Data Sheet (BDS)

This section consists of provisions that are specific to each stage of procurement and supplement the information or requirements included in Section-1: Instructions to Bidders.

Section-3: Evaluation and Qualification Criteria (EQC)

This Section contains the criteria to determine the lowest evaluated Bid and the qualifications of the Bidder to perform the Contract.

Section-4: Bidding Forms (BDF)

This Section contains the forms which are to be completed by the Bidder and submitted as part of its Bid.

PART-III: CONDITIONS OF CONTRACT AND CONTRACT FORMS

Section-6: General Conditions of Contract (GCC)

This Section contains the general clauses that govern the Contract. These General Conditions shall be the Conditions of Contract for Design, Build and Operate Contracts prepared by the Fédération Internationale des Ingénieurs-Conseil (FIDIC 2008). These Conditions are subject to the variations and additions set out in Section 8 (Particular Conditions of Contract).

Section-7: Particular Conditions of Contract (PCC)

This Section contains provisions which are specific to each Contract and which modify or supplement the GCC. Whenever there is a conflict, the provisions herein shall prevail over those in the GCC.

Section-8: Contract Forms (COF)

This Section contains forms, which, once completed, will form part of the Contract. The forms for Performance Security and Advance Payment Security, when required, shall only be completed by the successful Bidder after Contract award.

VOLUME-2 (PART-II: REQUIREMENT)

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This Section contains Specifications, and supplementary information that describe the Scope of Services, Specifications and Standards etc.

Section-9: Drawings

This Section contains Drawings good enough for Bidding purposes

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This Section contains Proponent's DPR

VOLUME-3 (PRICE BID)

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PART-1: BIDDING PROCEDURE

(Section 1 to 4)

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Section-1
Instructions to Bidders

This Section specifies the procedures to be followed by Bidders in the preparation and submission of their Bids. Information is also provided on the submission, opening, and evaluation of Bids and on the award of Contract.

Section-1: Instructions to Bidders

A. GENERAL	
1. Scope of Bid	1.1 In connection with the Invitation for Bids indicated in the Section-2: Bid Data Sheet (BDS), the Employer issues this Bid Document for Selection of a Bidder for the Project, scope of which is detailed in Section-5 (Employer's Requirements) and briefly described in Section-2 (BDS). 1.2 Throughout this Bid Document: a. the term "in writing" means communicated in written form and delivered against receipt; b. except where the context requires otherwise, words indicating the singular also include the plural and words indicating the plural also include the singular; and c. "day" means calendar day.
2. Source of Funds	2.1 Funds for implementation of the Project will be arranged and provided by Urban Development & Housing Department, Government of Rajasthan through Jaipur Development Authority
3. Fraud and Corruption	3.1 Employer observes the highest standards of ethics during the procurement and execution of such Contracts, and defines for the purposes of this provision the terms set forth below as follows: (i) **"corrupt practice"** means the offering, giving, receiving, or soliciting, directly or indirectly, anything of value to influence improperly the actions of another party; (ii) **"fraudulent practice"** means any act or omission, including a misrepresentation, that knowingly or recklessly misleads, or attempts to mislead, a party to obtain a financial or other benefit or to avoid an obligation; (iii) **"coercive practice"** means 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; (iv) **"collusive practice"** means an arrangement between two or more parties designed to achieve an improper purpose, including influencing improperly the actions of another party; (v) **"integrity violation"** means any act including corrupt, fraudulent, coercive, or collusive practice, abuse, and obstructive practice. (vi) **"obstructive practice"** means (a) deliberately destroying, falsifying, altering or concealing of evidence material to Employer's investigation; (b) making false statements to investigators in order to materially impede Employer's investigation; (c) failing to comply with requests to provide information, documents or records in connection with

	Employer's investigation; (d) 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 (e) materially impeding Employer's Contractual rights of audit or access to information. In pursuance of this policy, Employer: • will reject a Bid for award if it determines that the Bidder recommended for award has, directly or through an agent, engaged in corrupt, fraudulent, collusive, coercive, or obstructive practices or other integrity violations in competing for the Contract; • will terminate the Contract Agreement if it determines at any time that the selected Contractor engaged in corrupt, fraudulent, collusive, coercive, or obstructive practices or other integrity violations during the procurement or the execution of that Contract, without the Contractor having taken timely and appropriate action satisfactory to Employer to remedy the situation; • will sanction/impose remedial actions on Bidder, at any time, including declaring ineligible, either indefinitely or for a stated period of time, to participate in projects of the Employer, or administered or supported activities or to benefit from the Employer, administered or supported Contract, financially or otherwise, if it at any time determines that the such Bidder has, directly or through an agent, engaged in corrupt, fraudulent, collusive, coercive, or obstructive practices or other integrity violations; and • will have the right to require that a provision be included in Bid Documents and in projects of the Employer, requiring Bidders, suppliers and Contractors to permit the Employer or its representative to inspect their accounts and records and other documents relating to the Bid submission and Contract performance and to have them audited by auditors appointed by the Employer.
4. Eligibility Criteria	4.1 Bidder must be a legal entity duly registered/ incorporated under applicable laws of its country of origin or a consortium of legal entities (maximum 3 numbers) of which one would be the Lead Member. Single entity or Lead Member (in case of consortium) must have been registered/ incorporated in India In the case of a consortium: (a) all members/partners shall be jointly and severally liable, and (b) a Representative would be nominated who shall have the authority to conduct all business for and on behalf of any and all the members/parties of the consortium during the Bidding process and, in the event the consortium is awarded the Contract, during Contract execution.

	4.2 A Bidder shall not have a conflict of interest. Bidders found to have a conflict of interest shall be disqualified. A Bidder may be considered to be in a conflict of interest with one or more Bidder in the Bidding process if including but not limited to: (a) they have controlling shareholders in common; or (b) they receive or have received any direct or indirect subsidy from any of them; or (c) they have the same legal representative for purposes of this Bid; or (d) they have a relationship with each other, directly or through common third parties, that puts them in a position to have access to material information about or improperly influence the Bid of another Bidder, or influence the decisions of the Employer regarding this Bidding process; or (e) if a Bidder participates in more than one Bid in this Bidding process, either individually or as a member of Consortium it will result in the disqualification of all Bids in which it is involved. However, subject to any finding of a conflict of interest in terms of 4.2 (a) to (d) above, this does not limit the participation of a Specialist Technology Provider in more than one Bid; or (f) a Bidder or any affiliated entity, participated as a consultant in the preparation of the design or technical specifications of the works that are the subject of the Bid; or (g) a Bidder was affiliated with a firm or entity that has been hired (or is proposed to be hired) by the Employer for the Contract.
	4.3 Government-owned enterprises in the Employer's country shall be eligible only if they can establish that they (i) are legally and financially autonomous, (ii) operate under commercial law, and that they (iii) are not a dependent agency of the Employer
	4.4 Bidders shall provide such evidence of their continued eligibility satisfactory to the Employer, as the Employer shall reasonably request
	4.5 Any entity which has been barred by Central/ State Government in India/Government of the Country of the Bidder, or any entity controlled by them and under the Rajasthan Transparency Public Procurement Act (RTPPA), 2012 and Rules thereto from participating in Bidding process and the bar subsists as on Bid Due Date, shall not be eligible to submit its Bid for the Project. Bidder shall submit self declaration of no blacklisting in the format given in **Section-4 (Bidding Forms).**
5. Special Conditions to Consortium	5.1 Where Bidder is a Consortium, it shall be required to comply with the following additional requirements: a) The Bid shall contain the information required for each Member of Consortium

	b) Members of the Consortium shall nominate one member as the Lead Member (the **"Lead Member"**) who shall be incorporated in India under Companies Act 1956 and shall meet the Financial Eligibility entirely own-its-own. The Lead Member shall hold equity shareholding of at least 51% (fifty one percent) of the subscribed and paid up equity of the Contractor/Special Purpose Vehicle (the **"SPV"**) throughout the Contract period. Each of the other Member of the Consortium shall hold at least 15% (fifteen percent) of the subscribed and paid up equity share capital of the Contractor for entire Contract period. Nomination of Lead Member shall be supported by a Power of Attorney, as per the format specified in **Section-4 (Bidding Forms),** signed by the other member of the Consortium. c) Bid shall be signed by duly authorised signatory of the Lead Member and shall be legally binding on all members of the Consortium. d) Members of the Consortium shall enter into a Memorandum of Understanding (MoU)/ Consortium Agreement as per the format specified **in Section-4 (Bidding Forms)** for the purpose of submitting this Bid. e) Bid shall contain information about each Member of the Consortium Bidder and provide additional information whenever asked for.
B. CONTENTS OF BID DOCUMENT	
6. Sections of Bid Document	6.1 The Bid Document consist of 3 volumes and Parts I, II, and III, which include all the Sections indicated below, and should be read in conjunction with any Addenda issued in accordance with ITB 8. **TECHNICAL BID** **Volume-1** **PART–I (Bidding Procedures)** **Section-1:** Instructions to Bidders (ITB) **Section-2:** Bid Data Sheet (BDS) **Section-3:** Evaluation & Qualification Criteria (EQC) **Section-4:** Bidding Forms (BDF) **PART-III (Conditions of Contract and Contract Forms)** **Section-6:** General Conditions of Contract (GCC) **Section-7:** Particular Conditions of Contract (PCC) **Section-8:** Contract Forms (COF) **Volume-2** **PART-II (Requirements)** **Section-5:** Employer's Requirements (ERQ) **Section-9:** Drawings **Section-10:** Proponents DPR

	PRICE BID **Volume-3** **Section-11:** Price Bid
	6.2 The Employer is not responsible for the completeness of the Bid Document and their Addenda, if they were not obtained from the source stated by the Employer in the Bid Document.
	6.3 The Bidder is expected to examine all instructions, forms, terms, and specifications in the Bid Document. Failure to furnish all information or documentation required by the Bid Document may result in the rejection of the Bid.
7. Clarification of Bid Document, Site Visit, Pre-Bid Meeting	7.1 A Pre-Bid Meeting shall held on a date, time and venue as indicated in **Section-2 (BDS)** in order to clarify and discuss any provisions or requirements related to the Project/ Bid Document or any other related issue with the prospective Bidders. All prospective Bidders can participate in the Pre-Bid Conference. 7.2 Prospective Bidders requiring any clarification on the Bid Document shall submit its queries in writing or by -email at the address as indicated in **Section-2 (BDS)** or raise its queries during the pre-Bid meeting in accordance with ITB 7.4. 7.3 Attendance of Bidders in the Pre-Bid Meeting is not mandatory. Subsequent to the pre-Bid meeting, the Employer shall upload the response at www.jaipurjda.org/ www.eproc.rajasthan.gov.in, including a description of the query but without identifying its source. Should the Employer deem it necessary to amend the Bid Document as a result of a request for clarification, it shall do so following the procedure under ITB 8. 7.4 Employer shall endeavour to respond the queries raised or clarification sought by the prospective Bidders. However, the Employer reserves the right not to respond to any query or provide any clarification, in its sole discretion, and nothing in this clause shall be taken or read as compelling or requiring the Employer to respond to any query or to provide any clarification.
	7.5 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 and its operation & maintenance. The costs of visiting the Site shall be at the Bidder's own expense. Failure of the Bidder to visit and examine the Site of Works shall not absolve the Bidder of its responsibility to undertake its own survey, investigation and due diligence of the Project and the Authority would not be responsible to the same in any manner.
	7.6 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.
8. Amendment of Bid Document	8.1	At any time prior to the deadline for submission of Bids, the Employer may amend the Bid Document by issuing addenda.
	8.2	Any addendum issued shall be part of the Bid Document and shall be uploaded at www.jaipurjda.org/ www.eproc.rajasthan.gov.in
	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 19.
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 submitted by the Bidder and any communication between the Bidder and the Employer, shall be in English language.
11. Document Comprising the Bid	11.1	The Bid shall comprise 2 (two) covers (Cover-1 and Cover-2) submitted simultaneously, **Cover-1 comprises of Technical Bid (in PDF File)** and the **Cover-2 comprises of Price Bid (in MS-Excel File)** as per the provisions of ITB 11.3. Both covers comprising the Technical Bid and Price Bid shall be uploaded at www.eproc.rajasthan.gov.in**Error! Hyperlink reference not valid.**
	11.2	The Technical Bid (in PDF Format) shall comprise of the documents as indicated in **Section-2 (BDS).**
	11.3	Price Bid shall be in the MS-Excel File format of which is available on http://eproc.rajasthan.gov.in along with entire Bid Document. The components of Price Bid are given in **Section-2 (BDS).**
12. Letters of Bid, and Schedules	12.1	Technical Bid and Price Bid shall be prepared using the relevant forms furnished in **Section-4 (Bidding Forms).** The forms must be completed without any alterations to the text, and no substitutes shall be accepted. All blank spaces shall be filled in with the information requested.
13. Currencies of Bid and Payment	13.1	The prices shall be quoted by the Bidders in Indian currency i.e. Indian Rupee (INR)
14. Documents Establishing the	14.1	To establish its qualifications to perform the Contract in accordance with Section 3 (Evaluation and Qualification Criteria)

Qualifications of the Bidder		the Bidder shall provide the information requested in the corresponding information sheets included in Section 4 (Bidding Forms).
15. Bid Validity Period	15.1	Bids shall remain valid for a time period as indicated in **Section-2 (BDS).** A Bid valid for a period shorter/lesser than the Bid Validity Period shall be declared non-responsive by the Employer and shall be rejected.
	15.2	In exceptional circumstances, prior to the expiration of the Bid Validity Period, the Employer may request Bidders to extend the Bid Validity Period of their Bids. The request and the responses shall be made in writing. If Bid Validity Period is extended, the Bid Security shall also be extended beyond the deadline of the extended Bid Validity Period. A Bidder may refuse the request without forfeiting its Bid Security. A Bidder granting the request shall not be permitted to modify its Bid.
16. Bid Security	16.1	The Bidder shall furnish as part of its Bid a Bid Security for an amount as specified in the **Section-2 (BDS).**
	16.2	The Bidders shall have an option to provide Bid Security in the form of a Banker's Cheque/Demand Draft in favour of **"Secretary, Jaipur Development Authority"** payable at Jaipur or a Bank Guarantee in favour of **"Secretary, Jaipur Development Authority"** issued by a scheduled Bank in India having its branch in Jaipur as per format given in **Section-4 (Bidding Forms),** which can be invoked by Employer at any of the issuing Bank's branch at Jaipur. The validity period of the Banker's Cheque/Demand Draft shall not be less than 90 (ninety) days and in case of a Bank Guarantee, 240 (two hundred and forty) days from the Bid Due Date. The period of 240 days in case of Bank Guarantee shall be inclusive of a claim period of 60 (sixty) days, and may be extended as may be mutually agreed between the Employer and the Bidder from time to time.
	16.3	Any Bid not accompanied by a substantially compliant Bid Security shall be rejected by the Employer as nonresponsive.
	16.4	If a Bid Security is specified pursuant to ITB 16.2, the Bid Security of unsuccessful Bidders shall be returned as promptly as possible upon the Successful Bidder's furnishing the Performance Security pursuant to ITB 39.
	16.5	If a Bid Security is specified pursuant to ITB 16.2, the Bid Security of the successful Bidder shall be returned as promptly as possible once it has furnished the required Performance Security, made payment of cost of preparation of DPR to the Project Proponent and made irrevocable and non-refundable payment to PDCOR Ltd towards Project Closure Fee along with applicable taxes and has signed the Contract Agreement.

	16.6 The Bid Security may be forfeited: (a) if a Bidder withdraws its Bid during the Bid Validity Period (b) If the Bidder submits a conditional Bid which would affect unfairly the competitive provision of other Bidders who submitted substantially responsive Bids (c) if the successful Bidder fails to: (i) furnish a Performance Security in accordance with ITB 39; (ii) sign the Contract in accordance with ITB 38; or (iii) pay cost of preparation of DPR to the Project Proponent (iv) pay irrevocable and non refundable Project Closure Fee along with applicable taxes to PDCOR Ltd. (v) accept the arithmetical correction of its Bid in accordance with ITB 28; or (vi) adhere to any provision of code of integrity specified in the Bid Document.
17. Format and Signing of Bid	17.1 The Bidder shall prepare one Technical Bid and one Price Bid comprising the Bid as described in ITB 11.2 and ITB 11.3 respectively. 17.2 The Bidder shall provide all the information sought for submission of its Bid. 17.3 In order to enable consistency amongst the Bids and to facilitate smooth evaluation by the Employer, Bidding Forms (BDF) are given in **Section-4 (Bidding Forms)** in which the Bidders shall provide information/data for submission of their Bids. The Employer shall evaluate only those Bids that are received in the Bidding Forms complete in all respects and in line with the instructions contained in the Bid Document and more specifically mentioned in ITB 11.2.
	17.4 Technical Bid shall be typed or written in indelible ink and shall be signed and stamped on each page by a person duly authorized to sign on behalf of the Bidder, holding power of attorney as per the format as specified in Bidding Forms. All pages of the Bid, except for unamended printed literature, shall be signed or initialed by the person signing the Bid. 17.5 Technical Bid shall be in PDF format with all pages numbered serially along with an index. 17.6 Price Bid shall be submitted in MS-Excel File format of which is given on www.eproc.rajasthan.gov.in**Error! Hyperlink reference not valid.**
	17.7 Any amendments such as interlineations, erasures, or overwriting shall be valid only if they are signed and stamped by a person duly authorized to sign on behalf of the Bidder.

D. SUBMISSION AND OPENING OF BIDS	
18. Submission of Bids	18.1 Bid shall be submitted in two covers i.e. **(i) Technical Bid (in PDF File) and (ii) Price Bid (in MS-Excel File)**. Technical Bid and Price Bid shall contain all documents/information in the format and manner as detailed in ITB 11.2 and ITB 11.3. 18.2 Bid shall be submitted/uploaded online on www.eproc.rajasthan.gov.in only. Bidders must register on www.eproc.rajasthan.gov.in (Bidders already registered www.eproc.rajasthan.gov.in before 30-09-2011 must register again). 18.3 To participate in online Bidding process, Bidders must procure a Digital Signature Certificate (Type III) as per Information Technology Act-2000 using which they can digitally sign their Bids. Bidders can procure the same from any Controller of Certifying Authorities (CCA) approved certifying agency, i.e. TCS, Safecrypt, Ncode etc. Bidders who already have a valid Digital Signature Certificate (DSC) need not procure a new DSC. 18.4 Bid (Technical Bid and Price Bid) submitted/uploaded on www.eproc.rajasthan.gov.in shall be digitally signed with DSC of the Authorised Signatory. 18.5 After submission of Bid on www.eproc.rajasthan.gov.in the Bidders shall submit physically the following documents in original on the date, time and venue mentioned in **Section-2 (BDS):** (i) Demand draft/Banker's Cheque/Bank Guarantee for Bid Security (ii) Demand draft/Banker's Cheque for RISL Processing Fee (iii) Demand draft/Banker's Cheque for Bid Document Fee 18.6 Non-submission of the above documents shall lead to non-acceptance of the Bid submitted/uploaded by the Bidder.
19. Deadline for Submission of Bids (Bid Due Date)	19.1 Bids must be submitted/uploaded on http://eproc.rajasthan.gov.in no later than the Bid Due Date as indicated in the **Section-2 (BDS).** Bidders are requested to upload their Bids well in time so as to avoid 11th hour issues such as slow speed of internet, website hanging/ choking/slow downloading due to heavy load or any other unforeseen situation. 19.2 The Employer may, at its discretion, extend the Bid Due Date by amending the Bid 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.
20. Late Bids	20.1 The website (http://eproc.rajasthan.gov.in) shall not accept uploading of Bids after the Bid Due Date reckoned from the clock of the website. It shall be the Bidders' responsibility to ensure that the Bids are submitted on or before the Bid Due

	Date.
21. Withdrawal, Substitution, and Modification of Bids	21.1 A Bidder may withdraw, substitute, or modify its Bid – Technical Bid or Price Bid on www.eproc.rajasthan.gov.in as per the instructions/procedure mentioned at www.eproc.rajasthan.gov.in under section **"Bidder's Manual Kit"** at the website. 21.2 Bids withdrawn shall not be opened and processed further. 21.3 The Bidders are neither allowed to make any modifications or substitution to the Bid submitted nor withdraw the Bid at any point of time after the Bid Due Date till the expiry of Bid Validity Period or any extension thereof.
22. Bid Opening	22.1 The Employer shall open the Technical Bids at the address, date and time specified in the **Section-2 (BDS)** in the presence of Bidders designated representatives and anyone who choose to attend. Technical Bid of only those Bidders shall be opened/downloaded from www.eproc.rajasthan.gov.in who have submitted the original documents as mentioned in ITB 18.5. 22.2 The Price Bids shall remain unopened at the time of opening of Technical Bids. The schedule for opening of Price Bids shall be intimated to the eligible Bidders at appropriate time.
	22.3 First, Bids marked **"WITHDRAWAL"** shall be read out and the corresponding Bid shall not be opened.
	22.4 Second, Bids marked **"SUBSTITUTION"** shall be announced and recorded. Substitution Price Bid will remain unopened in accordance with ITB 22.2.
	22.5 Next, Bids marked **"MODIFICATION"** shall be opened. Only the Technical Bids, both Original as well as Modification, are to be opened, read out and recorded at the opening. Price Bids, both Original as well as Modification, will remain unopened in accordance with ITB 22.2.
	22.6 All other envelopes holding the Technical Bids shall be opened one at a time, and the following read out and recorded: (a) the name of the Bidder; (b) whether there is a modification or substitution; (c) the submission of original documents relating to Bid Document Fee, RISL Processing Fee, Bid Security; Only Technical Bids read out and recorded at Bid opening shall be considered for evaluation. No Bid shall be rejected at the opening of Technical Bids.
	22.7 The Employer shall prepare a record of the opening of Technical Bids that shall include, as a minimum: the name of the Bidder and whether there is a withdrawal, substitution, or modification. 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.

	22.8 At the end of the evaluation of the Technical Bids, the Employer will invite Bidders who have submitted substantially responsive Technical Bids and who have been determined as being qualified for award to attend the opening of the Price Bids. The date, time, and location of the opening of Price Bids shall be uploaded on www.eproc.rajasthan.gov.in. Bidders shall be given reasonable notice of the opening of Price Bids.
	22.9 The Employer shall notify Bidders in writing who have been rejected on the grounds of their Technical Bids being non-responsive to the requirements of the Bid Document and return their Price Bids unopened.
	22.10 The Employer shall conduct the opening of Price Bids of all Bidders who submitted substantially responsive Technical Bids, in the presence of Bidders` representatives who choose to attend at the address, date and time specified by the Employer. The Bidder's representatives who are present shall be requested to sign a register evidencing their attendance.
	22.11 Price Bids shall be downloaded and opened one at a time and the following read out and recorded: (a) the name of the Bidder; (b) whether there is a modification or substitution; (c) the Bid Price; and
	22.12 The Employer shall prepare a record of the opening of Price Bids. 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.
E. EVALUATION AND COMPARISON OF BIDS	
23. Confidentiality	23.1 Information relating to the examination, evaluation, comparison, and post qualification of Bids and recommendation of Contract award, shall not be disclosed to Bidders or any other persons not officially concerned with such process until information on the Contract award is communicated to all Bidders.
	23.2 Any attempt 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.
	23.3 Notwithstanding ITB 23, from the time of Bid opening to the time of award of Contract, if any Bidder wishes to contact the Employer on any matter related to the Bidding process, it may do so in writing.
24. Clarification of Bids	24.1 To assist in the examination, evaluation, and comparison of the Technical and Price Bids, the Employer may, at its discretion, ask any Bidder for a clarification of its Bid. 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 in the substance of the Technical Bid or Price Bid shall be sought, offered, or permitted, except to confirm the correction of arithmetic errors discovered by the Employer in the evaluation of the Price Bids, in accordance with ITB 28.
	24.2 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.
25. Deviations, Reservations, and Omissions	25.1 During the evaluation of Bids, the following definitions shall apply: (a) **"Deviation"** is a departure from the requirements specified in the Bid Document; (b) **"Reservation"** is the setting of limiting conditions or withholding from complete acceptance of the requirements specified in the Bid Document; and (c) **"Omission"** is the failure to submit part or all of the information or documentation required in the Bid Document.
26. Preliminary Examination of Technical Bids	26.1 The Employer shall examine the Technical Bid to confirm that all documents and technical documentation requested in ITB 11.2 and Bidding Forms have been provided, and to determine the completeness of each document submitted.
27. Responsiveness of Technical Bid	27.1 The Employer's determination of a Bid's responsiveness is to be based on the contents of the Bid itself, as defined in ITB 11.2.
	27.2 A substantially responsive Technical Bid is one that meets the requirements of the Bid Document without material deviation, reservation, or omission. A material deviation, reservation, or omission is one that, if accepted, would: **(a)** affect in any substantial way the scope, quality, or performance of the Works specified in the Contract; or **(b)** limit in any substantial way, inconsistent with the Bid Document, the Employer's rights or the Bidder's obligations under the proposed Contract; or **(c)** if rectified, would unfairly affect the competitive position of other Bidders presenting substantially responsive Bids.
	27.3 The Employer shall examine the Technical Bid in accordance with ITB 4, ITB 11.2 and other relevant provisions of ITB, in particular, to confirm that all requirements **of Section-4 (Bidding Forms)** have been met without any material deviation or reservation.
	27.4 If a Bid is not substantially responsive to the requirements of the Bid Document, it shall be rejected by the Employer and may not subsequently be made responsive by correction of the material

	deviation, reservation, or omission.
28. Nonmaterial Nonconformities	28.1 Provided that a Bid is substantially responsive, the Employer may waive any non-conformities in the Bid that do not constitute a material deviation, reservation or omission.
	28.2 Provided that a Technical Bid is substantially responsive, the Employer may request that the Bidder submits the necessary information or documentation, within a reasonable period of time, to rectify nonmaterial nonconformities in the Technical Bid related to documentation requirements. Requesting information or documentation on such nonconformities shall not be related to any aspect of the Price Bid. Failure of the Bidder to comply with the request may result in the rejection of its Bid.
	28.3 Provided that a Technical Bid is substantially responsive, the Employer shall rectify quantifiable nonmaterial nonconformities related to the Price Bid. To this effect, the Price Bid shall be adjusted, for comparison purposes only, to reflect the price of a missing or non-conforming item or component.
29. Qualification of the Bidder	29.1 The Employer shall determine to its satisfaction during the evaluation of Technical Bids whether Bidders meet the Eligibility Criteria as specified in ITB 4.1.
	29.2 The determination shall be based upon an examination of the documentary evidence of the Bidder's qualifications submitted by the Bidder, pursuant to ITB 11.2.
	29.3 An affirmative determination shall be a prerequisite for the opening and evaluation of a Bidder's Price Bid. A negative determination shall result into the disqualification of the Bid.
30. Correction of Arithmetical Errors	30.1 During the evaluation of Price Bids, the Employer shall correct arithmetical errors on the following basis: (a) if there is an error in a total corresponding to the addition or subtraction of sub-totals, the sub-totals shall prevail and the total shall be corrected accordingly; (b) 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) above.
	30.2 If the Bidder that submitted the lowest Evaluated Price Bid does not accept the correction of errors, its Bid shall be disqualified and its Bid Security may be forfeited.
31. Conversion to Single Currency	31.1 For evaluation and comparison purposes of Technical Bids, the currency (ies) of the Bid shall be converted into a single currency i.e. Indian Rupees. For the purpose of conversion the currency conversion rate with respect to INR shall be taken as on closing hours on Bid Due Date.
32. Margin of	32.1 Unless otherwise specified in the BDS, a margin of preference

Preference	shall not apply.
33. Evaluation of Price Bids	33.1 The Employer shall use the criteria and methodologies listed in this clause. No other evaluation criteria or methodologies shall be accepted/adopted.
	33.2 To evaluate the Price Bid, the Employer shall consider application of all evaluation criteria and factors indicated in Section 3 (Evaluation and Qualification Criteria).
34. Comparison of Bids	34.1 The Employer shall compare all substantially responsive Bids to determine the lowest evaluated Bid, in accordance with ITB 33.2.
35. Employer's Right to Accept Any Bid, and to Reject Any or All Bids	35.1 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.
F. AWARD OF CONTRACT	
36. Award Criteria	36.1 As per evaluation of Price Bids, if the Bid submitted by the Project Proponent is the lowest, it shall win the Project provided such lowest Price Bid of the Project Proponent is considered reasonable by the Employer. In case the Evaluated Price Bid of the Project Proponent is not the lowest, it shall be given an opportunity to match the lowest Evaluated Price Bid submitted by one of the participating Bidder provided the Evaluated Price Bid submitted by Project Proponent is within 15% of such lowest Evaluated Price Bid. It is clarified that if the difference between the Evaluated Price Bid of the Project Proponent and the lowest Evaluated Price Bid of one of the other participating Bidders is more than 15%, the Project Proponent shall no longer be a contestant in the Bidding competition. 36.2 In the event the Evaluated Price Bid of the Project Proponent is not within the 15% of the lowest Evaluated Price Bid then the Project shall be awarded to the Bidder who has submitted such lowest Price Bid provided such lowest Evaluated Price Bid is considered reasonable by the Employer.
37. Notification of Award	37.1 Prior to expiry of the Bid Validity Period, the Employer shall notify the successful Bidder, in writing, that its Bid has been accepted through issue of Letter of Acceptance (LoA).
	37.2 Until a formal Contract is prepared and executed, the Letter of Acceptance shall constitute a binding Contract.
38. Signing of Contract	38.1 Promptly after Letter of Acceptance, the Employer shall send the successful Bidder the Contract Agreement.
	38.2 Within twenty-eight (28) days of receipt of the Contract Agreement, the successful Bidder shall sign and return it to the

	Employer. 38.3 The Successful Bidder shall be required to implement, operate and maintain in accordance and in compliance with the terms and condition of Bid Document, Contract Agreement inter alia including Employer's Requirements (ERQ), General Conditions of Contract (GCC), and Particular Conditions of Contract (PCC).
39. Performance Security, DPR preparation cost and Project Closure Fee	39.1 Within twenty one (21) days of the issue of Letter of Acceptance (LoA), the successful Bidder shall furnish the Performance Security in the format as specified in **Section-8 (Contract Forms),** pay cost of preparation of DPR to the Project Proponent and pay irrevocable and non-refundable Project Closure Fee to PDCOR Ltd.
	39.2 Failure of the Successful Bidder (i) to furnish the above-mentioned Performance Security, (ii) to pay cost of preparation of DPR to the Project Proponent (iii) to pay irrevocable and non-refundable Project Closure Fee along with applicable taxes to PDCOR Ltd. (iv) 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 next lowest Evaluated Price Bid Bidder whose offer is substantially responsive and is determined by the Employer to be qualified to perform the Contract satisfactorily.

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Section-2
Bid Data Sheet

This section consists of provisions that are specific to each stage of procurement and supplement the information or requirements included in Section 1 - Instructions to Bidders

Secton-2: Bid Data Sheet (BDS)

A. GENERAL	
ITB 1.1	**Project Title:** - Rejuvenation of Amanishah Nallah *(Dravyavati River)* including Area Development on Turnkey Basis in Jaipur and its Operation and Management (O&M) for a Period of 10 Years under Swiss Challenge Method.
ITB 1.1	**About Amanishah Nallah (Dravyavati River):** (i) Amanishah Nallah (Dravyavati River) was the active river in Jaipur city of Rajasthan (India) which, over the time, turned in to a nallah (Amanishah Nallah) due to rapid urbanization and industrialization around the river. (ii) Amanishah Nallah originates from the western slopes of Nahargarh hills in Jaipur and flows through western side of Jaipur city from north to south. While flowing, it collects storm and waste water from Nahari ka Naka and Ambabari. Some portion of the walled city and newly developed areas of Jaipur discharge storm and waste water through Ganda Nallah and Sanganer town in the Amanishah Nallah. Further, it collects storm and waste water from Jawahar Nallah after flowing for about 35 km and ultimately discharges into Dhund River. The total length of Amanishah Nallah is 47.5 km. (iii) Presently sewage, waste water, industrial effluent, storm water is discharged in to Amanishah Nallah. Rising pollution levels and encroachments around Amanishah Nallah are causing health hazards and destroying the ecological system of the catchment area and Jaipur city.
ITB 1.1	**Project Background:** (i) Rajasthan Transparency in Public Procurement Act (RTTPA) 2012 and rules thereof provide for certain category of projects to be developed on Swiss Challenge Method. The Swiss Challenge Method (the **"SCM"**) is a method in which an unsolicited proposal for a government project is received and allows the third party to challenge the original proposal through open Bidding, and then let the Project Proponent counter-match the most advantageous/most competitive offer. (ii) The Consortium of the M/s Tata Projects Limited and M/s SUCG International Engineering Co. Ltd. (hereinafter referred to as the **"Project Proponent"**) submitted a proposal to Urban Development & Housing Department, Government of Rajasthan for Rejuvenation of Amanishah Nallah including Area Development on Turnkey Basis in Jaipur and its Operation and Management (O&M) for a Period of 10 Years under Swiss Challenge Method (hereinafter referred to as the **"Project"**). Initial proposal received from Project Proponent was accepted in principle and the Project Proponent was allowed to carry out detailed study and prepare Detailed Project Report (DPR) for the Project. (iii) Project Proponent carried out detailed study and submitted the DPR to the Employer. After examination of DPR, State Level Empowered Committee (SLEC) in its meeting held on 14.10.2015 granted its in principle approval to the DPR and to undertake the Project on Swiss

	Challenge Method. (iv) The DPR prepared and submitted by the Project Proponent shall be shared with the interested Bidders, during the Bidding process, to facilitate the interested Bidders to peruse the indicative Project details as contained in said DPR, as prepared by the Project Proponent, and prepare their respective Bid in terms of this ITB. However, by sharing the said DPR, the Employer shall not be assuming or deemed to be assuming, in any manner whatsoever, any responsibility or liability or obligation regarding the authenticity, accuracy, completeness, relevance or usefulness of the details provided there in. Each Bidder shall be individually and solely responsible for their Bids (including its accuracy and completeness) and would alone be accountable for the Bid submitted and the selected Bidder, upon award of the Project shall also, accordingly and consequently be liable, accountable and responsible for the due and proper implementation, operation and maintenance of the Project.
ITB 1.1	**Purpose of Issue of the Bid Document:** (i) As per rules for Swiss Challenge Method under RTTP Act 2012 and rules thereto Employer is required to carry out a transparent, open, competitive Bidding Process to give fair chance to Prospective Bidders to challenge the Bid of the Project Proponent and selection of a Bidder who will undertake implementation of the Project. (ii) After the Bids are received from Prospective Bidders, the Project Proponent shall be given an opportunity to match the lowest Evaluated Price Bid submitted by a Bidder provided the Evaluated Price Bid submitted by the Project Proponent is within the range of 15% of such lowest Evaluated Price Bid . For avoidance of doubt it is clarified that if the Evaluated Price Bid of the Project Proponent is more than 15% of the lowest Evaluated Price Bid, the Project Proponent shall no longer be a contestant in the Bidding competition. (iii) Project shall be awarded to the Project Proponent in case the Evaluated Price Bid of the Project Proponent is within the 15% of lowest Evaluated Price Bid and the Project Proponent agrees to match such lowest Evaluated Price Bid. If the Evaluated Price Bid of the Project Proponent is not within the 15% of the lowest Evaluated Price Bid then the Bidder who has submitted the lowest Evaluated Price Bid shall be considered for the award of the Project provided such lowest Evaluated Price Bid is considered reasonable by the Employer. (iv) However, if the Project is awarded to the Bidder, other than the Project Proponent, the said Successful Bidder shall be required to reimburse a non refundable sum, as specified u/s ITB 39.1 of Bid Data Sheet, to the Original Proponent towards the cost incurred by it in project investigation and studies (including the DPR). It is unequivocally and unconditionally being made clear by the Employer, that notwithstanding the payments by the Successful Bidder to the Project Proponent, the said Successful Bidder shall be solely responsible and liable, at its own cost and expense, for the due and proper implementation, operation and maintenance of the Project including for all the designs, drawings, specifications, implementation schedule, methodologies, studies, reports, investigations, assumptions and findings required, obtained, or relied

	upon for the Bid preparation or during the implementation, operation or maintenance of the Project. (v) The estimated cost of the Project as detailed under the DPR of the Project Proponent is an estimate as arrived at by the Project Proponent by applying its own skills, understanding and assumptions. Therefore the Employer by virtue of sharing the same with the interested Bidders is neither endorsing or validating the same in any manner. The interested Bidders are advised to make their own prudent assessment of the likely Project cost for the purpose of participating in this Bidding process.
ITB 1.1	**Brief of Employer's Requirement:** (i) Objective of the rejuvenation of Amanishah Nallah is to strengthen and improve the natural drainage system, to improve ecological and environmental conditions within and around Amanishah Nallah, protection against flood and to develop the Amanishah Nallah as water front to make it a central attraction in Jaipur city. (ii) In order to rejuvenate the Amanishah Nallah, several works/activities shall have to be undertaken by the Contractor and operation & maintenance of the infrastructure for a period of 10 Years. **Detailed Employer's Requirements including scope of work, Standard Specifications etc. are provided in Section-5 (Employer's Requirement)** brief of which is given below: a) Course Correction/Strengthening of Amanishah Nallah: This activity shall include restoration/construction of main channel section and protection of embankments, construction of falls at strategic locations to control velocity, construction of small check dams to retain water throughout the year as an effort to develop water front etc. b) Sewerage Interception, Treatment, Reuse and Disposal: This shall include interception of sewerage which is being freely discharged into the Amanishah Nallah, its treatment, reuse at nearby landscape and disposal of excess treated water into Amanishah Nallah to make it a water front throughout the year. c) Improving Water Quality Standard: This shall include treatment of waste water to the extent that it can be put into the rejuvenated Amanishah Nallah without any adverse impact on health, hygiene, environment and aesthetics of the area. d) Improving Water Availability: It shall include providing perennial water upto 1 meter depth in the channel section of Amanishah Nallah by construction of reservoirs at various locations etc**.** e) Land Area Development along the Amanishah Nallah: It shall include preparation of master plan of the proposed reclaimed land in and around the Amanishah Nallah including landscape plans. Develop public spaces (at least 3 meter wide walking space and 1 meter wide sitting space), mass sitting/gathering spaces, at least 2 meter wide tree plantation landscape bank, parallel road (wherever possible) of minimum width of 5.5 meter along with pedestrian footpath of 3 meter, provide arrangement for 24X7 surveillance through CCTV, common facilities etc.

	f) Operation and Maintenance for 10 Years: It shall include operation & maintenance of sewerage treatment interception network, pumping systems and treatment plants, collection of solid waste from surface of Nallah and the bank and its disposal to the designated area, maintenance of equipments, measurement and monitoring of all water and energy segments, overall operation & maintenance of the Project for a period of 10 years after the construction of the Project is completed.
ITB 1.1	**Project Period:** **Construction Period:** 2 Years 6 Months (30 Months) **Operation & Maintenance Period:** 10 Years after completion of Design-Build part of the Project
ITB 1.1	**Bidding Process:** Employer has adopted a single-stage, two-cover (Technical Bid and Financial Bid), open competitive **online Bidding process** under Rules framed for Swiss Challenge Method under Rajasthan Transparency in Public Procurement Act, 2012 (**"Bidding Process"**) for selection of a Bidder for award of the Project.
ITB 5.2	**Add:** Associate means, in relation to the Single Entity Bidder/Members (in case of Consortium), a legal entity who controls, is controlled by, or is under the common control with such Single Entity Bidder/Members in case of Consortium (the "Associate"). The expression "control" means, with respect to a legal entity, the ownership, directly or indirectly, of more than 50% (fifty percent) of the voting shares of such entity.
B. CONTENTS OF BID DOCUMENT	
ITB 7.1	Pre-Bid Meeting shall be held on a date, time and venue as indicated below: **Date & Time:** 28/12/2015 at 03:00 PM **Venue:** Manthan Hall, Jaipur Development Authority, Ram Kishor Vyas Bhawan, Indira Circle, JLN Marg, Jaipur 302004
ITB 7.2	All communications to the Employer, in the context of this Bidding procedure including raising pre-Bid queries, permission for site visit and related issues, unless specified otherwise, shall be addressed to: **Director Engineering (II)** **Jaipur Development Authority** **Ram Kishor Vyas Bhawan, Indra Circle, Jawaharlal Nehru Marg,** **Jaipur-302004** **Phone :** 0141- 2565628
C. PREPARATION OF BIDS	
ITB 10.1	**Add the following clauses at the end of 10.1:** (i) 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 English language attested & authenticated by competent authority in India/or an agency appointed by GoI/GoR/other State Government for such certified translation works. (ii) If the Bidder has submitting any documents, created or originating from outside the Republic of India, such as work experience certificate(s), financial detail(s), power of attorney(s), undertaking(s), documentary evidence(s), qualifying document(s), etc. (collectively "Foreign Documents") then the Bidder, before any such Foreign Document(s) are sent to India for the purpose of applying towards this Project, shall be required to get each and every page of such Foreign Document(s), duly authenticated/ embossed/ legalized/ notarised from the Indian Embassy/Indian High Commission situated in the country from where such Foreign Document(s) were created or are originating from. Such authentication/ embossment/ legalization/ notarisation from the Indian Embassy/Indian High Commission shall also apply to all such document(s) that are in a language other than English, which shall compulsorily be required to be translated (as the true translated copies of the original) by a duly certified/ authorized /qualified Translator, supported by the affidavit of the said translator, certifying the correctness of the English translation. In case of any inconsistency between the original Foreign Document and its English translation, the latter shall prevail and be held binding on such Bidder. However, in the case of Foreign Document(s) created or originating from countries that have signed, ratified and have made operational the Hague Convention abolishing the requirement of legalization for foreign public documents, 5 October, 1961 - "Hague Legalization Convention, 1961", the Bidders may affix an 'Apostle" sticker on each and every page of their Foreign Document(s) [including all commercial document(s) duly notarized]. Thereafter, the Bidder shall be compulsorily required to get all such "Appostilled" Foreign Document(s) approved, certified and attested from the Indian Embassy /Indian High Commission in that country where the 'Foreign Document(s)' were created or are originated from or the Ministry of External Affairs, Government of India, New Delhi and the Bidder/s shall follow any other norms/guidelines laid by the Ministry of External Affairs, Government of India, New Delhi. (iii) For the purpose of interpretation and evaluation of the Bid, the certified English language translation shall prevail.
ITB 11.2	The Technical Bid ***(in PDF Format)*** shall comprise of the following documents: **General Forms** • Letter of Technical Bid • Power of Attorney for Signing Authority • Board Resolution for Bidders (In Case of Consortium) • Power of Attorney for Lead Member of Consortium • Memorandum of Understanding/ Consortium Agreement • Self Declaration – No Blacklisting • Undertaking

	• Anti-Collusion Certificate • Bid Security, RISL Processing Fee, Bid Document Fee as per ITB 18.5 of Bid Data Sheet **Eligibility Forms** • Bidder's Qualification • Form ELI - 1: Bidder's Information Sheet • Form ELI - 2: JV/ Consortium Information Sheet • Form LIT –1: Pending Litigation and Arbitration • Form FIN - 1: Historical Financial Performance • Form EXP – 1: Contracts of Similar Size and Nature • Form EXP - 2: Construction Experience in Key Activities **Technical Forms** • TECH 1: Guaranteed Power Requirement & Power Cost • TECH 2: Land Loading for STP campuses • Tech Schedule-1: Method Statement • Tech Schedule-2: Construction Schedule • Tech Schedule-3: Sub Contracting for Sub Contractors • Tech Schedule-4: Quality Assurance and Quality Control Plan • Tech Schedule-5: Safety Plan • Tech Schedule-6:Environmental Quality Management Plan
ITB 11.3	**Price Bid:** Letter of Price Bid (to be uploaded by the Bidder with Technical Bid- Volume-I), and Price Bid is to be filled in by the Bidder in Excel sheet in Volume-III. The Price Bid consists of two parts as follows: (i) The Bidder shall quote its lump sum **<u>Design Build Cost</u>** for implementing the Project as envisaged in Bid document more precisely as defined in Employer's Requirements for Design-Build part of the Project. (*The payment schedule shall be as per the provisions described under PCC)* (ii) The Bidder shall quote **<u>O&M cost</u>** (other than Power cost) as follows: The Bidder shall quote Annual O&M Cost (other than Power Cost) of the Project components. This shall be a lump sum amount to be quoted at price level prevailing 28 days prior to Bid Due Date. (*However, it is clarified that the actual payments by Employer during the Operation Service Period shall be made as per the provisions described under PCC)* During project implementation on turnkey basis and O&M over 10 year period, all state and central duties, taxes, and other levies shall be paid by the Bidder/ Contractor and shall be factored in the Price Bid to be submitted by the Bidder.

ITB 15.1	Bid shall remain valid for a time period of 180 (one hundred eighty) days from the last date of submission of Bid (**"Bid Validity Period"**)
ITB 16.1	Bid Security Amount: Rs. 35 (Rupees Thirty Five Crore Only)
ITB 18.5	**Bid Security:** (i) The Bid shall be accompanied by Bid Security in the form and manner as specified in ITB 16. (ii) Scanned copy of Demand Draft/Banker's Cheque/Bank Guarantee for Bid Security shall be submitted/ uploaded on http://eproc.rajasthan.gov.in along with the Technical Bid. (iii) Original Demand Draft/Banker's Cheque/Bank Guarantee for Bid Security shall be submitted physically to the Employer on date, time and venue as mentioned in ITB 18.5. **RISL Processing Fee:** (i) The Bid shall be accompanied by RISL Processing Fee of Rs. 1,000/- (Rupees One Thousand Only). The RISL Processing Fee shall be in the form of Demand Draft/Banker's Cheque issued by a scheduled Bank in favour of **"Managing Director, RISL"** payable at **"Jaipur".** (ii) Scanned copy of Demand Draft/Banker's Cheque for RISL Processing Fee shall be submitted/ uploaded on http://eproc.rajasthan.gov.in along with the Technical Bid. (iii) Original Demand Draft/Banker's Cheque for RISL Processing Fee shall be submitted physically to the Employer on date, time and venue as mentioned in ITB 18.5. **Bid Document Fee:** (i) The Bid shall be accompanied by Bid Document Fee of Rs. 50,000 (Rupees Fifty Only). The Bid Document Fee shall be in form of Demand Draft/Banker's Cheque issued by a scheduled Bank in favour of **"Secretary, Jaipur Development Authority"** payable at Jaipur. (ii) Scanned copy of Demand Draft/Banker's Cheque for Bid Document Fee shall be submitted/ uploaded on http://eproc.rajasthan.gov.in along with the Technical Bid. (iii) Original Demand Draft/Banker's Cheque for Bid Document Fee shall be submitted physically to the Employer on date, time and venue as mentioned in ITB 18.5.
ITB 18.5	Original Demand Draft/Banker's Cheque/Bank Guarantee for Bid Security, RISL Processing Fee and Bid Document Fee shall be submitted on the date, time and venue as given below: **Date:** 11/01/2016 till 05:00 PM **Venue**: **Room No. N-108, IInd Floor (Bank Building),** Jaipur Development Authority, Ram Kishor Vyas Bhawan, Indira Circle, JLN Marg, Jaipur 302004
ITB 19.1	The last date for submission of online Bid (Bid Due Date) at http://eproc.rajasthan.gov.in is given below: **End Date (Bid Due Date):** 05:00 PM on 11/01/2016

ITB 22.1	Date, Time and Venue of opening of Technical Bids: **Date:** 13/01/2016 at 03:00 PM **Venue**: Manthan Hall, Jaipur Development Authority, Ram Kishor Vyas Bhawan, Indira Circle, JLN Marg, Jaipur 302004
ITB 22.3 22.4, 22.5	Deleted
ITB 39.1	**Performance Security:** (i) For securing the due and punctual performance of its obligations under the Contract Agreement the Selected Bidder shall furnish to the Employer, within 21 (twenty one) days of issue of Letter of Acceptance (LoA), but in any case prior to the execution of the Contract Agreement, Performance Security in the form of a bank guarantee for an amount equal to 5% (five percent) of Accepted Contract Amount from a Nationalised/Scheduled Bank, in favour of **"Secretary, Jaipur Development Authority"** payable at Jaipur, having a validity of Design Build Period plus Retention Period (one year) from the Commencement Date. (ii) After Retention Period the Employer shall partially release/return the Performance Security as specified in the PCC. **Project Closure Fee:** Accepted Contract Amount by the Selected Bidder shall include the following: (i) Design-Build Cost of the Project quoted by the Bidder (ii) 10 (ten) times the Annual Cost of O&M quoted by the Bidder (excluding power cost) The Successful Bidder shall also pay, within 21 (twenty) one days of issue of Letter Acceptance (LoA), but in any case prior to the execution of the Contract Agreement, irrevocable and non-refundable Project Closure Fee equivalent to 0.1% of the Accepted Contract Amount to PDCOR Ltd along with applicable taxes in the form of Demand Draft/Banker's Cheque issued in the favour of "**PDCOR Limited**" payable at Jaipur. **Cost of Preparation of DPR:** Project Proponent has prepared the Detailed Project Report (DPR) for the Project at its own cost. In case the Project is not awarded to the Project Proponent then the Selected Bidder shall pay, within 21 (twenty one) days of issue of Letter of Acceptance (LoA), but in any case prior to the execution of the Contract Agreement, the cost of preparation of DPR equivalent to 0.1% of the Accepted Contract Amount or Rs. 1.75 Crores (Rupees One Hundred Crore and Seventy Five Lakh Only) whichever is lower to the Project Proponent in form of Demand Draft/Banker' Cheque issued in favour of "Tata Projects Ltd".
ITB 40	Selected Bidder shall, in case of a Consortium, be required to incorporate a Special Purpose Vehicle (**"SPV"**) in form of a company under the Companies Act, 2013 (**"Contractor"**) within 21 (twenty one) days of issue of Letter of Acceptance (LoA) Which shall execute a Contract agreement (**"Contract Agreement"**) with Employer to implement the Project. Selected Bidder shall be the confirming party to the Contract Agreement.

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Section-3
Evaluation and Qualification Criteria

Section 3 - Evaluation and Qualification Criteria

This Section contains all the criteria that the Employer shall use to evaluate Bids and qualify Bidders. In accordance with ITB 29 and ITB 33, no other methods, criteria and factors shall be used. The Bidder shall provide all the information requested in the forms included in Section 4 (Bidding Forms).

Table of Criteria

1. Financial Evaluation

In addition to the criteria listed in ITB 33.2 the following criteria shall apply for evaluating the Price Bid of the Bidders:

(i) **Design Build Cost:**

Bidder shall be required to quote lump sum Design Build Cost for implementing the project in INR for the Design-Build part of the Works detailed in Employer's Requirements and Scope of Work in Section 5.

(ii) **O&M Cost:** Bidder shall be required to provide O&M services for the Project assets for a period of 10 (ten) years after the Design-Build Period.

(a) Annual O&M Cost: The Bidder shall quote annual cost for O&M (other than Power Cost) of the Project components. This shall be a lump sum amount to be quoted at price level prevailing 28 days prior to Bid Due Date. Annual O&M Cost (excluding cost of power) shall not be less than 1% of the Design Build Cost quoted by the Bidder. For the purpose of evaluation, price escalation of 7% shall be adopted and a discount factor of 10% shall be taken to find out the final multiplication factor. Accordingly, the Annual O&M Cost quoted by the Bidder shall be multiplied by a factor of 8.15 to work out the Evaluated O&M Cost for the entire Operation Service Period for calculating the Evaluated Price Bid.

(b) Power Cost: The total power requirement for operation and maintenance of the Sewage Treatment Plants (STP), Sewage Pumping Stations (SPS), street lighting, internal & external lighting system of buildings, pathways, illumination of public parks, security cameras, control centre, etc. will vary from Bidder to Bidder; therefore differential power consumption costs will be evaluated. It is presumed that the STPs would not run to design capacities initially. The inflow of sewage to STPs would increase only gradually. Bidder shall be required to quote the Total Guaranteed Power Requirements correlating the same with percentage of design capacity as indicated in the Tech Form-1.

For evaluation of Bids, the Evaluated Power Cost shall be determined as per form TECH 1.

(iii) **Land area requirement per MLD of STP:** The Bidder shall be required to quote the land area requirement per MLD of STP in Tech Form-2. If the requirement of land exceeds 500 sqm per MLD of STP, such excess land shall be loaded on the quoted Price Bid for Design-Build part of the Project @ Rs 22000/- per sqm of the excess land ("Loaded Land Cost"). Such increase in the quoted price shall be only notional for the limited purpose of determining Evaluated Price Bid.

While implementing the Project, if the requirement of land for setting up per MLD of STP is beyond the figure quoted by the Bidder, the Contractor shall be required to pay to JDA an amount @ Rs 44000/- per sqm for such excess land (actually required for the Project minus the quoted land area requirement

as per form TECH 2).

Therefore, the computation for arriving at the Evaluated Price Bid would be as under:

Evaluated Price Bid = Design Build Cost + Evaluated O&M Cost + Evaluated Power Cost + Loaded Land Cost

2. Qualification

Bidder must be a legal entity duly registered/ incorporated under applicable laws of its country of origin or a consortium of legal entities (maximum 3 numbers) of which one would be the Lead Member. Single entity or Lead Member (in case of Consortium) must have been registered/ incorporated in India. Bidder shall be required to fulfill the following Eligibility Criteria:

a) Technical Eligibility

(i) Civil Works

Single entity Bidder or any Member (in case of Consortium) must have experience of successfully completed following civil works/ projects during last 7 years preceding the Bid Due Date:

3 completed civil works/projects each having executed value of not less than **Rs. 600 crore**

OR

2 completed civil works/projects each having executed value of not less than **Rs. 750 crore**

OR

1 completed civil works/projects having executed value not less than **Rs. 1200 crore**

AND

(ii) Sewage Treatment Plants (STPs)

Single Entity Bidder or any Member (in case of Consortium) must have completed the following experience during last 7 years preceding the Bid Due Date:

Design and Build Contract including Design, Construction, Supply, Installation, Testing & Commissioning of STPs of cumulative capacity of atleast 100 MLD

AND

Design, Build and Operate (DBO) Contract including Design, Construction, Supply, Installation, Testing & Commissioning and O&M for atleast 3 years of a single STP of atleast 40 MLD capacity having the same technology that is being proposed by the Bidder for implementation of the Project

The Bidder may associate with one Specialist Technology Provider for proposed technological aspects related to the STPs. The experience of same shall be duly considered.

b) Financial Eligibility

Single entity Bidder or Lead Member (in case of Consortium) shall have:

Minimum Net Worth of **Rs. 300 crore** as on March 31, 2015

AND

Minimum Average Annual Turnover of **Rs. 1200 crore** in the last 3 financial years ended on March 31, 2015

AND

Bidder shall not have reported Negative Return on Equity (Profit Before Tax /Net worth) in the last 3 financial years ended on March 31, 2015

In computing the Technical Eligibility of the Single Entity Bidder/ Members (in case of Consortium Bidder), the Technical Eligibility of their respective Associates would also be eligible hereunder, provided that such entity whose Technical Eligibility is being claimed shall continue to be the Associate of the Single Entity Bidder/ Member (in case of Consortium) for the entire period of Contract Agreement.

2.1 Eligibility

Criteria	Compliance Requirements				Documents Submission Requirements
Requirement	Single Entity	Consortium Members			
		All Members Combined	Each Member	Lead Member	
Nationality					
Nationality in accordance with ITB Sub-Clause 4.1	must meet requirement	not applicable	not applicable	must meet requirement	Forms ELI - 1; ELI - 2 with attachments
Conflict of Interest					
No conflicts of interest in accordance with ITB Sub-Clause 4.2	must meet requirement	must meet requirement	must meet requirement	must meet requirement	Letter of Technical Bid
Government-owned Entity					
Bidder required to meet conditions of ITB Sub-Clause 4.3	must meet requirement	must meet requirement	must meet requirement	must meet requirement	Forms ELI - 1; ELI - 2 with attachments
Pending Litigation					
All pending litigation shall be treated as resolved against the Bidder and so shall in total not represent more than 50 percent of the Bidder's net worth calculated as the difference between total assets and total liabilities	must meet requirement by itself or as partner to past or existing JV/ consortium	not applicable	must meet requirement by itself or as partner to past or existing JV/ consortium	must meet requirement by itself or as partner to past or existing JV/ consortium	Form LIT - 1

2.2 Financial Requirements

Criteria	Compliance Requirements				Documents Submission Requirements
		Consortium Members			
Requirement	Single Entity	All Members Combined	Each Member	Lead Member	
		not applicable	must meet requirement	must meet requirement	Form FIN - 1 with attachments
Historical Financial Performance					
Return on investment (ratio of annual profit before taxes and the net worth of previous year) should be positive for the last 3 years i.e. FY13 to FY15	must meet requirement	not applicable	not applicable	must meet requirement	Form FIN - 1 with attachments
Bidder's Net Worth (Paid up Share Capital + Share/ Securities Premium + Reserves & Surplus (excluding revaluation reserves) – miscellaneous expenditure to the extent not adjusted or written off – Debit Balance of Profit & Loss A/C) should be atleast INR 300 crore as on 31-March-2015.	must meet requirement	not applicable	not applicable	must meet requirement	Form FIN - 1 with attachments
Average Annual Turnover					
Minimum average annual turnover of INR 1200 crore in the last 3 years (Financial Year 2012-13, 2013-14 & 2014-15) as per audited balance sheet	must meet requirement	not applicable	not applicable	must meet requirement	Form FIN – 1

2.3 Construction Experience

Bidder or Bidder's Associates, must satisfy the qualification criteria described below:

Criteria	Compliance Requirements				Documents Submission Requirements
Requirement	Single Entity	Consortium Members			
		All Members Combined	Each Member	Lead Member	
Contracts of Similar Size					
Single entity Bidder or any Member (in case of Consortium) must have experience of successfully completed following civil works/ projects during last 7 years preceding the Bid Due Date: • 3 completed civil works/projects each having executed value of not less than Rs. 600 crore OR • 2 completed civil works/projects each having executed value of not less than Rs. 750 crore OR • 1 completed civil works/projects having executed value not less than Rs. 1200 crore	must meet requirement	not applicable	Any member	not applicable	Form EXP - 1

Note: 1. Experience of the Bidder earned by him as the JV/ Consortium partner will be considered to the limit of its share in the completed works shown in that JV or consortium agreement.

2. For present price level of cost of completed and commissioned works, the previous year value shall be given weightage of 7% per year as follows:

Financial Year	2014-15	2013-14	2012-13	2011-12	2010-11	2009-10	2008-09	2007-08	2006-07	2005-06
Weightage	1.00	1.07	1.14	1.23	1.31	1.40	1.5	1.61	1.72	1.84

2.3.1 Construction Experience in Key Activities

Criteria Requirement	Compliance Requirements				Documents Submission Requirements
	Single Entity	Consortium Members			
		All Members Combined	Each Member	Lead Member	
For the above or other Contracts executed during the period, a minimum construction experience in the following key activities:	must meet requirements	not applicable	Any member	not applicable	Form EXP - 2
Single Entity Bidder or any Member (in case of Consortium) must have completed the following experience during last 7 years preceding the Bid Due Date, Design and Build Contract including Design, Construction, Supply, Installation, Testing & Commissioning of STPs of cumulative capacity of atleast 100 MLD					
Design, Build and Operate (DBO) Contract including Design, Construction, Supply, Installation, Testing & Commissioning and O&M for atleast 3 years of a single STP of atleast 40 MLD capacity having the same technology that is being proposed by the Bidder for implementation of the Project					
The Bidder may associate with one Specialist Technology Provider for proposed technological aspects related to the STPs. The experience of same shall be duly considered.					

Note: Experience of the Bidder earned by him as the JV/ consortium partner will be considered to the limit of its share in the completed works shown in that JV or consortium agreement.

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Section-4
Bidding Forms

General Forms

Letter of Technical Bid

Date:
Notice Inviting Bid No.:

To:
The Secretary/ Director Engineering II,
Jaipur Development Authority,
R.K. Vyas Bhawan,
Indira Circle, JLN Marg,
Jaipur, Rajasthan

We, the undersigned, declare that:

(a) We have examined and have no reservations to the Bidding Documents, including Addenda issued in accordance with Instructions to Bidders (ITB) 8;

(b) We offer to execute the project in conformity with the Bidding Documents, General Conditions of Contract (GCC), Particular Conditions of Contract (PCC), and Employer's Requirements (ERQ), which inter alia includes the following Works:

- Course Correction/Strengthening of Amanishah Nallah
- Sewerage Interception, Treatment, Reuse and Disposal
- Improving Water Quality Standard
- Improving Water Availability
- Land Area Development along the Amanishah Nallah
- Operation and Maintenance for 10 Years after Design-Build Completion

(c) Our Bid consisting of the Technical Bid and the Price Bid shall be valid for a period of 180 days from the date fixed for the Bid submission deadline in accordance with the Bidding Documents, and it shall remain binding upon us and may be accepted at any time before the expiration of that period;

(d) Our firm, including any Sub-Contractors or suppliers for any part of the Contract, have nationalities in accordance with ITB 4.1.[insert the nationality of the Bidder, including that of all parties that comprise the Bidder if the Bidder is a consortium or association, and the nationality of each Sub-Contractor and Supplier];

(e) We, including any Sub-Contractors or suppliers for any part of the Contract, do not have any conflict of interest in accordance with ITB 4.2;

(f) We are not participating, as a Bidder in more than one Bid in this Bidding process in accordance with ITB 4.2(e);

(g) We are not a government owned entity / We are a government owned entity but meet the requirements of ITB 4.5; *

(h) We accept the Swiss Challenge procurement process for this Bid.

(i) If our Bid is accepted, we commit to mobilizing key equipment and personnel in accordance with the requirements set forth in Section 5 (Employer's Requirements) and our technical proposal, or as otherwise agreed with the Employer.

(j) In case we are determined as substantially responsive and lowest evaluated Bidder, we undertake to form a company under Companies Act 2013 within 21 days of issue of Letter of Acceptance (applicable for Consortium Bidder only)

Name .....

In the capacity of .....

Signed .....

.....

Duly authorized to sign the Bid for and on behalf of .....

Date .....

.....

---

* *Use one of the two options as appropriate.*

Power of Attorney for Signing Authority

Know all men by these presents, We ---------- (name of the Bidder and address of the registered office) do hereby irrevocably constitute, nominate, appoint and authorize Mr./Ms. (name), ---------- who is presently employed with us, ---------- (name of the Single Entity Bidder/Lead Member in case of Consortium Bidder) and holding the position of ----------, as our true and lawful attorney (hereinafter referred as the **"Authorised Signatory"**) to do in our name and on our behalf, all such acts, deeds and things as are necessary or required in connection with or incidental to submission of our Bid for Bid under Swiss Challenge Method for Rejuvenation of Amanishah Nallah (Dravyavati River), Jaipur (Rajasthan) including Area Development on Turnkey Basis, and its Operation & Maintenance (O&M) for a Period of 10 Years (**"Project"**) issued by the Jaipur Development Authority, Jaipur (Rajasthan) (**"Employer")** including but not limited to signing and submission of all Bids, Bids and other documents and writings, participate in Pre-Bid and other conferences and providing information/responses to the Employer, representing us in all matters before the Employer, signing and execution of all Contracts including the Contract Agreement and undertakings consequent to acceptance of our Bid, and generally dealing with the Authority in all matters in connection with or relating to or arising out of our Bid for the said Project and/or upon award thereof to us and/or till entering into of the Contract Agreement with the Employer.

AND we hereby agree to ratify and confirm and do hereby ratify and confirm all acts, deeds and things done or caused to be done by our said Authorised Signatory pursuant to and in exercise of the powers conferred by this Power of Attorney and that all acts, deeds and things done by our said Authorised Signatory in exercise of the powers hereby conferred shall and shall always be deemed to have been done by us.

In witness whereof we, ……., the above named principal have executed this power of attorney on this …… day of ……., 2015

For

(Signature, name, designation and address)

Witnesses:
1.
2.

(Notarized)

Accepted

(Signature)
(Name, Title and Address of the Authorised Signatory)

Notes:

- The mode of execution of the Power of Attorney should be in accordance with the procedure, if any, laid down by the applicable law and the charter documents of the executants and when it is so required, the same should be under common seal affixed in accordance with the required procedure.
- Wherever required, the Bidder should submit for verification the extract of the charter documents and documents such as a board or shareholders' resolution/ power of attorney in favour of the person executing this Power of Attorney for the delegation of power hereunder on behalf of the Bidder.

Board Resolution for Bidders (In Case of Consortium)

(Form for Lead Member)

"RESOLVED THAT approval of Board be and is hereby granted to join Consortium with ---------- (name and address of the consortium members) for joint submission of Bids for Rejuvenation of Amanishah Nallah (Dravyavati River), Jaipur (Rajasthan) including Area Development on Turnkey Basis, and its Operation & Maintenance (O&M) for a Period of 10 Years Bid under Swiss Challenge Method (**"Project")** to Jaipur Development Authority, Jaipur (Rajasthan) (**"Employer"**).

"RESOLVED FURTHER THAT the **"Draft Memorandum of Understanding" (MoU)** to be entered into with the consortium partners (a copy whereof duly initialized by the Chairman is tabled in the meeting) be and is hereby approved."

"RESOLVED FURTHER THAT Mr. ----------(name), ---------- (designation) be and is hereby authorized to enter into an MoU, on behalf of the company, with the consortium members and to sign the Bid on behalf of the consortium for submission of the Bid and execute a power of attorney in favour of the Company as the Lead Member"

(Format for Other Members)

"RESOLVED THAT approval of Board be and is hereby granted to join Consortium with ---------- (name and address of the Lead Members) for joint submission of Bids for Rejuvenation of Amanishah Nallah (Dravyavati River), Jaipur (Rajasthan) including Area Development on Turnkey Basis, and its Operation & Maintenance (O&M) for a Period of 10 Years under Swiss Challenge Method (**"Project")** to Jaipur Development Authority, Jaipur (Rajasthan) (**"Employer"**).

"RESOLVED FURTHER THAT the **"Draft Memorandum of Understanding" (MoU)** to be entered into with the consortium partners (a copy whereof duly initialized by the Chairman is tabled in the meeting) be and is hereby approved."

"RESOLVED FURTHER THAT Mr. ----------(name), ---------- (designation) be and is hereby authorized to enter into an MoU with the consortium members and execute a power of attorney in favour of the ---------- as Lead Member"

Power of Attorney for Lead Member of Consortium

Whereas the Jaipur Development Authority, Jaipur (Rajasthan) (**"Employer")** has invited Bids for Rejuvenation of Amanishah Nallah (Dravyavati River), Jaipur (Rajasthan) including Area Development on Turnkey Basis, and its Operation & Maintenance (O&M) for a Period of 10 Years under Swiss Challenge Method ("**Project"**).

Whereas …….. *(name of lead member)* and …… *(names of other member)* (Collectively the **"Consortium")** being members of the consortium are interested to submit Bid for the Project in accordance with the terms and conditions of the Bid document.

Whereas, it is necessary for the members of the consortium to designate one of them as the Lead Member with all necessary power and authority to do for and on behalf of the Consortium, all acts, deeds and things as may be necessary in connection with the Consortium's Bid for the Project and its execution.

NOW, THEREFORE, KNOW ALL MEN BY THESE PRESENTS

We, …….. *(name of other members and addresses)* (hereinafter referred to as the **"Principal"**) do hereby irrevocably designate, nominate, constitute, appoint and authorise M/s. …….. *(name of* lead *member)* having its registered office at …….., being one of the member of the Consortium, as the Lead Member and true and lawful attorney of the Consortium (hereinafter referred to as the **"Attorney"**). We hereby irrevocably authorize the Attorney (with power to sub-delegate) to conduct all business for and on behalf of the Consortium and any one of us during the Bidding process and, in the event the Consortium is awarded the Project, during the execution of the Project and in this regard, to do on our behalf and on behalf of the Consortium, all or any of such acts, deeds or things as are necessary or required or incidental to the pre-qualification of the Consortium and submission of its Bid for the Project, including but not limited to signing and submission of all Bid, and other documents and writings, participate in pre-Bid conferences, respond to queries, submit information/ documents, sign and execute Contracts and undertakings consequent to acceptance of the Bid of the Consortium and generally to represent the Consortium in all its dealings with the Employer, and/ or any other Government Agency or any person, in all matters in connection with or relating to or arising out of the Consortium's Bid for the Project and/ or upon award thereof till the Contract Agreement is entered into with the Employer.

AND hereby agree to ratify and confirm and do hereby ratify and confirm all acts, deeds and things done or caused to be done by our said Attorney pursuant to and in exercise of the powers conferred by this Power of Attorney and that all acts, deeds and things done by our said Attorney in exercise of the powers hereby conferred shall and shall always be deemed to have been done by us/ Consortium.

IN WITNESS WHEREOF WE THE PRINCIPALS ABOVE NAMED HAVE EXECUTED

THIS POWER OF ATTORNEY ON THIS ……. DAY OF ……., 20.....…

For ……..

(Signature)

……..

(Name & Title)

For ……..

(Signature)

……..

(Name & Title)

For ……..

(Signature)

……..

(Name & Title)

For ……..

(Signature)

……..

(Name & Title)

Witnesses:

1.

2.

……

(Executants)

(To be executed by all the Members of the Consortium)

Notes:

- *The mode of execution of the Power of Attorney should be in accordance with the procedure, if any, laid down by the applicable law and the charter documents of the executant (s) and when it is so required, the same should be under common seal affixed in accordance with the required procedure.*
- *Also, wherever required, the Bidder should submit for verification the extract of the charter documents and documents such as a board or shareholders' resolution/power of attorney in favour of the person executing this Power of Attorney for the delegation of power hereunder on behalf of the Applicant.*

Memorandum of Understanding/ Consortium Agreement

(applicable in case of Consortium Bidder)

(On Non – judicial stamp paper of Rs 100/- if in India or such equivalent document duly attested by Notary Public)

This Memorandum of Understanding (MoU) entered into this ……..day of ……2015 at ……

Among

M/s ……. (hereinafter referred to as"…….. ") and having registered office at ……..as the Lead Member

And

M/s …….. (hereinafter referred to as" ……") and having registered office at …….. as the Other Member

And

M/s …….. (hereinafter referred to as" ……") and having registered office at …….. as the Other Member

And

M/s …….. (hereinafter referred to as" ……") and having registered office at …….. as the Other Member

The expressions of ----- *(name of lead member)* -------and ----- *(name of other members)* (which expression shall unless repugnant to the context or meaning thereof mean and indicate its successors and assignees) shall collectively be referred to as "The Consortium" and individually as **"the Member"**

Whereas the Jaipur Development Authority, Jaipur (Rajasthan) ("**Employer")** has issued Bid for Rejuvenation of Amanishah Nallah including Area Development and its Operation & Maintenance (O&M) for a Period of 10 Years on Turnkey Basis in Jaipur (Rajasthan) under Swiss Challenge Method (**"Project").**

AND WHEREAS the Members have studied the Bid document and had discussions and have agreed for formation of a Consortium for jointly Bidding for the said Project and formation of SPV in case the project awarded. Members have reached an understanding on the following points with respect to the Members' rights and obligations towards each other and their working relationship.

IT IS HEREBY AS MUTUAL UNDERSTANDING OF THE MEMBERS AGREED AND DECLARED AS FOLLOWS:

The Members shall jointly submit the Bid for the said Project

The Members shall incorporate a Special Purpose Vehicle (SPV) in form of a Company under Companies Act 2013 to execute and implement the Project in case the Project is awarded to the Consortium as per the terms & conditions, specifications and other obligations as per the Bid document.

M/s……*(name of lead member)* shall be the Lead Member of the consortium for all intents and purpose and shall be authorized for all or any of the acts, deeds or things necessary or incidental for submission of the Bid, responding to queries and submission of information/documents, execute and implement (in case the project awarded) the Project as per the terms & conditions, specifications and other obligations as per the Bid document with regard to the same on behalf of the Consortium and represent the

Consortium in its dealing with the Employer and receive instructions for and on behalf of any or all Members of Consortium.

In case the project awarded, all members of the consortium shall be jointly and severally liable for the execution and due performance of the Contract with the Owner in accordance with the Contract terms

All members of the consortium shall be bound by all acts, representations, deeds and things of the Lead Member with respect to the Bid document.

ROLES AND RESPONSIBILITIES

Following distribution of responsibilities shall be followed in the event of the Consortium Proposal is accepted by Owner.

S. No.	Member	Responsibility
1	Lead Member	
2	Other Member	
3	Other Member	

That, in case successful, M/s ------ *(name of lead member)*, M/s ---------- *(name of Other Members)* shall carry out all responsibilities as Contractor in terms of the Agreement with the Employer.

In case the Project awarded, The Lead Member shall have an equity shareholding of at least 51% (fifty one percent) of the subscribed and paid up equity of the Contractor/Special Purpose Vehicle (the **"SPV"**) throughout the Contract Period. Other Member of the Consortium shall hold at least 15% (fifteen percent) of the subscribed and paid up equity share capital of the Contractor for entire Contract Period.

That this Consortium Agreement shall be governed in accordance with the laws of India and Indian courts shall have exclusive jurisdiction to adjudicate disputes arising from the terms herein.

That this Consortium Agreement shall remain valid for the period of validity of the offer submitted by the Consortium and in case successful, till signing of the detailed Consortium/ SPV agreement for the due performance of the Contract with the Employer for the said Project.

In witness whereof the Parties affirm that the information provided is accurate and true and have caused this Consortium Agreement to be duly executed on the date and year above mentioned.

Signed by Authorised Signatory	**Witness**
Lead Member……..	
Other Member (1)…….	
Other Member (2)…….	

Note: - All witnesses and sureties shall be person of status and probity and their full names and addresses shall be stated below their signature

Self Declaration – No Blacklisting

(to be provided by Single Entity Bidder/each Member in case of Consortium Bidder)

(On judicial stamp paper duly attested by notary public)

Director (Engineering-II)
Jaipur Development Authority
Ram Kishor Vyas Bhawan, Indra Circle,
Jawaharlal Nehru Marg,
Jaipur-302004

In response to Bid under Swiss Challenge Method for Rejuvenation of Amanishah Nallah (Dravyavati River), Jaipur (Rajasthan) including Area Development on Turnkey Basis, and its Operation & Maintenance (O&M) for a Period of 10 Years, as an Authorised Signatory of …….. (name of Single Entity Bidder/Member in case of Consortium Bidder), I hereby declare that presently the ---------- (name of Single Entity Bidder/Member in case of Consortium Bidder), at the time of Bidding:

a) Is competent to get into a Contract as per the provisions of Indian Contract Act, 1872.

b) Possesses the necessary professional, technical, financial and managerial resources and competence required by the Bid document issued by Jaipur Development Authority (the **"Employer"**).

c) Has fulfilled our obligation to pay such of the taxes payable to the Union and the State Government or any local authority as specified in the Bid document.

d) Has an unblemished record and is not declared ineligible for corrupt & fraudulent practices and barred either indefinitely or for a particular period of time by any State/ Central Government/ Union Territory (UT)/ Public Sector Undertaking (PSU).

e) is not barred under the Rajasthan Transparency Public Procurement Act (RTPPA), 2012 and Rajasthan Transparency Public Procurement Rules (RTPPR), 2013 from participating in Bidding Process as on the date of submission of Bid.

f) does not have any previous transgressions with any entity in India or any other country during the last 3 (three) years.

g) does not have any debarment by any other procuring entity.

h) is not insolvent in receivership, bankrupt or being wound up, not have its affairs administered by a court or a judicial officer, not have its business activities suspended and is not the subject of legal proceedings for any of the foregoing reasons.

i) does not have, and our directors/officers/office bearers (*wherever applicable*) not have been convicted of any criminal offence related to their professional conduct or the making of false statements or misrepresentations as to their qualifications to enter into a procurement Contract within a period of 3 (three) years preceding the commencement of the Bidding Process, or not have been otherwise disqualified pursuant to debarment proceedings.

j) does not have a conflict of interest as mentioned in the Bid document which materially affect the fair competition.

k) will comply with the code of integrity as specified in the Bid document

If this declaration is found to be incorrect then without prejudice to any other action that may be taken as per the provisions of the applicable Act and Rules thereto prescribed by the Employer.

Thanking You,

For and on behalf of : ----------(name of the Single Entity Bidder/Member in case of Consortium Bidder)

Signature **:** ----------(Authorised Signatory)

Name of the Person :----------

Designation :----------

Seal of the Bidder : ----------

Date : ----------

Place : ----------

Undertaking

(to be provided by Single Entity Bidder/Lead Member in case of Consortium Bidder)

In response to Bid under Swiss Challenge Method for Rejuvenation of Amanishah Nallah (Dravyavati River), Jaipur (Rajasthan) including Area Development on Turnkey Basis, and its Operation & Maintenance (O&M) for a Period of 10 Years, We/I hereby declare/ confirm that if we are successful Bidder We/I shall follow the "Standard Specification for Civil Works" and "Quality Assurance/ Quality Control (QA/QC) Manual" issued by RUIDP and for items related to Electrical Works shall follow specifications published by PWD/CPWD and Indian Electricity Rules/ Acts etc. during the Design- Build period of the Contract.

For and on behalf of : ----------(name of the Single Entity Bidder/Member in case of Consortium Bidder)

Signature **:** ----------(Authorised Signatory)

Name of the Person :----------

Designation :----------

Seal of the Bidder : ----------

Date : ----------

Place : ----------

Anti-Collusion Certificate

(On letter head of the Single Entity Bidder/ each Member in case of Consortium Bidder)

We hereby certify and confirm that in the preparation and submission of this Bid, we have not acted in concert or in collusion with any other Bidder or other person(s) and also not done any act, deed or thing which is or could be regarded as anti-competitive.

We further confirm that we have not offered nor paid nor shall offer nor pay, directly or indirectly, any illegal gratifications, in cash or kind, to any person or agency in connection with the Bid.

For and on behalf of : ----------(name of the Bidder)

Signature **:** ----------(Authorised Signatory)

Name of the Person :----------

Designation :----------

Seal of the Bidder : ----------

Date : ----------

Place : ----------

Bid Security (Bank Guarantee Form)

.....***Bank's Name, and Address of Issuing Branch or Office.....***

Beneficiary: *.....Name and Address of Employer .....*

Date:.....

Bid Security No.: .....

We have been informed that . . . . . ***name of the Bidder***. . . . . (hereinafter called "the Bidder") has submitted to you its Bid dated . . . . . (hereinafter called "the Bid") for the execution of . . . . . ***name of Contract*** . . . . . under Notice Inviting Bids No. . . . . (“the NIB”).

Furthermore, we understand that, according to your conditions, Bids must be supported by a Bid guarantee.

At the request of the Bidder, we . . . . . ***name of Bank***. . . . . hereby irrevocably undertake to pay you any sum or sums not exceeding in total an amount of . . . . . .***amount in figures*** . . . . . (. . . . . .***amount in words*** . . . . .)upon receipt by us of your first demand in writing accompanied by a written statement stating that the Bidder is in breach of its obligation(s) under the Bid conditions, because the Bidder:

(a) has withdrawn its Bid during the period of Bid validity specified by the Bidder in the Letter of Technical Bid and Letter of Price Bid; or

(b) does not accept the correction of errors in accordance with the Instructions to Bidders (hereinafter “the ITB”); or

(c) having been notified of the acceptance of its Bid by the Employer during the period of Bid validity, (i) fails or refuses to execute the Contract Agreement, or (ii) fails or refuses to furnish the Performance Security, in accordance with the ITB or (iii) fails or refuses to furnish a domestic preference security, if required.

This guarantee will expire: (a) if the Bidder is the successful Bidder, upon our receipt of copies of the Contract Agreement signed by the Bidder and the performance security issued to you upon the instruction of the Bidder; or (b) if the Bidder is not the successful Bidder, upon the earlier of (i) our receipt of a copy of your notification to the Bidder of the name of the successful Bidder; or (ii) 28 days after the expiration of the Bidder’s Bid.

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

This guarantee is subject to the Uniform Rules for Demand Guarantees, ICC Publication No. 458[1].

. . . . . .Bank's seal and authorized signature(s) . . . . . .

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

[1]*Or 758 as applicable.*

Letter of Commitment and support by Specialist Technology Provider

To,

Director (Engineering-II)
Jaipur Development Authority
Ram Kishor Vyas Bhawan, Indra Circle,
Jawaharlal Nehru Marg,
Jaipur-302004

Sub: Selection of a Bidder under Swiss Challenge Method for Rejuvenation of Amanishah Nallah (Dravyavati River), Jaipur (Rajasthan) including Area Development on Turnkey Basis, and its Operation & Maintenance (O&M) for a Period of 10 Years ("**Project**")

Ref: Notice Inviting Bid ("**NIB"**) dated ....., a bid proposal (**Proposal**) has been submitted by ...../or by a consortium comprising of M/s.....(Lead Member); M/s and M/s.....((hereinafter referred to as the "**Bidder**").

Dear Sir,

1) In terms of the NIB, We, M/s....., a company duly incorporated under the laws of .....(country of incorporation) and having our registered office at (full address)....., have participated in the Proposal as a Technology Provider to the Bidder.

2) We understand that the bidder has used our experience as listed below for the purpose to qualify for the bid.

   List of Works carried out on our technology and considered for bid evaluation:

S. No.	Name of work / Location	Capacity of the plant	Technology adopted	Plant commissioned and in operation from
1				
2				
3				

We have studied and familiarised ourselves with the bid document for the "Project" and its requirements. We confirm that the details provided in the certificate related to these works is correct and we have been fully associated with the same. We undertake to:

(i) That in consideration of the Employer having allowed us to participate in the submission of our Proposal dated ....., accepting our Proposal for consideration & evaluation and in the event of our Proposal getting accepted and Letter of Award being issued to the Bidder, inter-alia, upon the faith of the Representations made by us therein, we hereby agree, undertake, commit, assure and covenant as under:

   (a) We shall in terms of and in compliance & adherence with the Proposal dated.....as obligated bring in, provide, make available and ensure the continued availability of all the technological support to the Bidder promptly and punctually, of such specifications, standards and quality, as represented and

offered in our Proposal so as to ensure the proper and timely implementation, commissioning , operation and maintenance of the Project in accordance with the terms and conditions of the Contract Agreement;

(b) We shall ensure that all our technical expertise support and co-operation, through the term of the Contract Agreement (including the operation and maintenance) , shall be made available and extended to the Bidder such that the Bidder is able to meet and maintain the performance standards and specifications mentioned under the Contract Agreement;

(c) In respect such technologies, methodologies, designs and drawings which is / are subject matter of any Intellectual Property Rights protection under the applicable laws in any jurisdiction and proposed to be deployed and employed in the Project, We shall immediately and in any case not later than .....days of execution of the Contract Agreement arrange to get all the requisite and required consents, permissions, authorisations, licenses or permits, as the case may be, for the use, deployment and employment of the said technology in the Project for the entire Project duration term and in case of early termination or upon expiry of the defined term for the period beyond that;

(d) We are aware that it is on the faith and reliance of our aforesaid undertakings, commitments and assurance of support that the Employer has agreed to accept our aforesaid Proposal for evaluation and issue letter of award, if found most preferred in terms of the NIB.

(e) In case, We or any of our representatives deployed for the Project, at any time, fails to make available the required technical support and assistance (*except for reasons of force majure*) to the Project, the Employer shall be entitled to take such action(s) as it may be advised against the Bidder and us including termination of the Contract Agreement and seeking indemnification from us.

Authorised Signatory for the bidder	Authorised Signatory for the Technology Provider

Eligibility Forms

Bidder's Qualification

To establish its qualifications to perform the Contract in accordance with Section 3 (Evaluation and Qualification Criteria) the Bidder shall provide the information requested in the corresponding Information Sheets included hereunder.

Form ELI - 1: Bidder's Information Sheet

Bidder's Information	
Bidder's legal name	
In case of JV/ Consortium, legal name of each partner	
Bidder's country of constitution	
Bidder's year of constitution	
Bidder's legal address in country of constitution	
Bidder's authorized representative (name, address, telephone numbers, fax numbers, e-mail address)	

Attached are copies of the following original documents.

- ❑ In case of single entity, articles of incorporation or constitution of the legal entity named above, in accordance with ITB 4.1
- ❑ Authorization to represent the firm or JV/ Consortium named in above, in accordance with ITB.
- ❑ In case of Consortium, letter of intent to form Consortium agreement, in accordance with ITB 4.1.
- ❑ In case of a government-owned entity, any additional documents not covered under 1 above required to comply with ITB 4.3.

Form ELI - 2: JV/ Consortium Information Sheet

Each member of a JV/ Consortium and Specialist Technology Provider must fill in this form

JV/ Consortium / Specialist Technology Provider Information	
Bidder's legal name	
JV/ Consortium Partner's or Specialist Technology Provider's legal name	
JV/ Consortium Partner's or Specialist Technology Provider's country of constitution	
JV/ Consortium Partner's or Specialist Technology Provider's year of constitution	
JV/ Consortium Partner's or Specialist Technology Provider's legal address in country of constitution	
JV/ Consortium Partner's or Specialist Technology Provider's authorized representative information (name, address, telephone numbers, fax numbers, e-mail address)	
Attached are copies of the following original documents. ❑ Articles of incorporation or constitution of the legal entity named above, in accordance with ITB 4.1. ❑ Authorization to represent the firm named above, in accordance with ITB. ❑ In the case of government-owned entity, documents establishing legal and financial autonomy and compliance with commercial law, in accordance with ITB 4.3.	

Specialist Technology Provider is a specialist enterprise engaged for highly specialized processes which cannot be provided by the main Contractor**.**

Form LIT –1: Pending Litigation and Arbitration

Each Bidder or member of a JV/ Consortium must fill in this form if so required under Criterion in Section 3 (Evaluation and Qualification Criteria).

Pending Litigation and Arbitration			
❑ **No pending litigation and arbitration.** ❑ **Below is a description of all pending litigation and arbitration involving the Bidder (or each member if Bidder is a Joint Venture/ Consortium).**			
Year	**Matter in Dispute**	**Value of Pending Claim in INR**	**Value of Pending Claim as a Percentage of Net Worth**

Form FIN - 1: Historical Financial Performance

(Single entity Bidder or Lead Member of Consortium must fill in this form)

Net Worth:

S. No.	Particulars	Amount (in Rs. Crores) as on 31st March 2015
1.	Paid up Share Capital	
	(i) Equity Share Capital	
	(ii) Preference Share Capital	
2.	Share/ Securities Premium	
3.	Reserves & Surplus (excluding revaluation reserves)	
4.	Miscellaneous expenditure to the extent not adjusted or written off	
5.	Debit Balance of Profit & Loss A/C	
	Total Net Worth **(1+2+3-4-5)**	

Turnover and Return on Equity:

Financial Year	Turnover (in Rs. Crores)	Return on Equity (Profit Before Tax/ Net Worth of previous year)
2014-15		
2013-14		
2012-13		

Note: -

Single Entity Bidder / Lead member in case of Consortium Bidder:

1. Shall submit its statutory auditor's certificate specifying Net Worth and Return on Equity (*calculated as per above formulas), T*urnover of relevant financial years in support of eligibility on Financial Criteria
2. Shall submit certified copy of audited annual reports for the last three financial years ended on March 31, 2015. The annual report shall include, but not limited to;
   a) Audited financial accounts including balance sheet, Profit and Loss accounts and cash flow statements
   b) Unabridged Annual reports
   c) Statement of accounting Policies

Form EXP – 1: Contracts of Similar Size and Nature

Fill up one (1) form per Contract.

Contract of Similar Size and Nature			
Contract No. . . . . .**of**.	**Contract Identification**		
Award Date		**Completion Date**	
Total Contract Amount		**Equivalent INR ----------**	
If partner in a JV/ Consortium Member or Sub-Contractor, specify participation of total Contract amount	**Percent of Total**	**Amount**	
Employer's Name **Address** **Telephone/Fax Number** **E-mail**			
Description of the similarity in accordance with Section 3			
3 completed civil works/projects each having executed value of not less than Rs. 600 crore **OR** 2 completed civil works/projects each having executed value of not less than Rs. 750 crore **OR** 1 completed civil works/projects having executed value not less than **Rs. 1200 crore**	(Bidder should describe the project and the exact scope of work performed by it in the project)		

Note: The experience claimed above shall be supported by a relevant certificate from the client/ authority/ employer of the project whose experience is being claimed.

Form EXP - 2: Construction Experience in Key Activities

Fill up one (1) form per Contract

Contract with Similar Key Activities			
Contract No. . . . . .**of**.	**Contract Identification**		
Award Date		**Completion Date**	
Total Contract Amount	**----------Equivalent INR -----**		
If partner in a JV/ Consortium Member or Sub-Contractor, specify participation of total Contract amount	**Percent of Total**	**Amount**	
Employer's Name **Address** **Telephone Number** **Fax Number** **E-mail**			
Description of the key activities in accordance with Section 3			
Design and Build Contract including Design, Construction, Supply, Installation, Testing & Commissioning of STPs of cumulative capacity of atleast 100 MLD	(Bidder should describe the project and the exact scope of work performed by it in the project)		
Design, Build and Operate (DBO) Contract including Design, Construction, Supply, Installation, Testing & Commissioning and O&M for atleast 3 years of a single STP of atleast 40 MLD capacity having the same technology that is being proposed by the Bidder for implementation of the Project	(Bidder should describe the project and the exact scope of work performed by it in the project)		
The Bidder may associate with one Specialist Technology Provider for proposed technological aspects related to the STPs. The experience of same shall be duly considered.			

Note: The experience claimed above shall be supported by a relevant certificate from the client/ authority/ employer of the project whose experience is being claimed

Technical Forms

TECH 1: Guaranteed Power Requirement & Power Cost

The Bidder shall quote the Total Guaranteed Power Requirement for operation and maintenance of the Sewage Treatment Plants (STP), Sewage Pumping Stations (SPS), street lighting, internal & external lighting system of buildings, pathways, illumination of public parks, security cameras, control centre, etc in column-C of the Table below.

Table: Present Value of Total Cost of Power for STPs and SPSs

Year of Operation Services	Presumed year wise Inflow of sewage (percent of design capacity)	Total Guaranteed Power Requirement to be quoted by the Bidder (KWH/day)	Annual cost of power (Rs) =Col C x 365 x 8.00	Escalation Factor @ 7 % for Power tariff	Discount Factor @ 10 % for PV	Evaluated Annual Power Cost (Rs) =Col D x Col E x Col F
A	**B**	**C**	**D**	**E**	**F**	**G**
1st Year	50-60			1.23	0.75	
2nd Year	61-70			1.31	0.68	
3rd year	71-80			1.40	0.62	
4th Year	81-90			1.50	0.56	
5th Year	91-99			1.61	0.51	
6th Year	100			1.72	0.47	
7th Year	100			1.84	0.42	
8th Year	100			1.97	0.39	
9th Year	100			2.10	0.35	
10th Year	100			2.25	0.32	
Evaluated Power Cost (sum total of Column G)						

Note:

1. *The guaranteed power requirement (in KWH per day) to be quoted by the Bidder shall take into account the variation in power requirement due to variation in sewage flow as a percentage of design capacity*
2. *As clarified in the Employer's Requirement, STPs of a combined design capacity of atleast 170 MLD are required to be setup*
3. *The Evaluated Power Cost shall be used for determining Evaluated Price Bid of the Bidder*
4. *The reimbursement to the Contractor for Power Cost during Operation Service Period*

shall be made by the Employer as per the actual rate per unit paid by the Contractor to JVVNL, excluding penalties, if any, due to default on the part of the Contractor. The reimbursement *shall be based on the actual average inflow of sewage in a month to all the STPs and SPSs installed and commissioned by the Contractor for the Project, subject to the Total Guaranteed Power Requirement quoted for that slab of inflow as a percentage of design capacity. Power generated and utilized by the Contractor during the Operation Service Period through their own arrangements e.g. DG sets/ solar/ gas etc. for the system would also be admissible for reimbursement (as per JVVNL rates) subject to the ceiling of Total Guaranteed Power Requirement*

5. *No reimbursement for power cost shall be admissible during Design-Build Period including commissioning and trial runs*

Signature of the Bidder

Seal of the Company

TECH 2: Land Loading for STP campuses

The Bidder shall be required to quote the land area requirement per MLD of STP as per technology adopted by him

Proposed STP No.	Design Capacity (MLD)	Technology Proposed	Area Requirement (sqm)	Area Requirement (sqm/ MLD)
A	B	C	D	E = D/B
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

We confirm that If the requirement of land exceeds 500 sqm per MLD of STP, such excess land shall be loaded on the quoted Price Bid for Design-Build part of the Project @ Rs 22000/- per sqm of the excess land. Such increase in the quoted price shall be only notional for the limited purpose of determining Evaluated Price Bid of the Bidder.

While implementing the Project, if the requirement of land for setting up per MLD of STP is beyond the figure quoted by the Bidder, he shall be required to pay to Employer an amount @ Rs 44000/- per sqm for such excess land (actually required by the Bidder minus the quoted land area requirement as per this TECH -2)

.

Signature of the Bidder

Seal of the Company

Tech Schedule-1: Method Statement

The Bidder shall provide a comprehensive statement of the methods that it proposes to adopt for completing the Design Build part, including descriptions of its proposed work methods, scheduling, mobilization of labor force and resources, quality assurance and quality control programs, etc., in order to demonstrate its overall understanding of requirements for successful completion of the Contract within the stipulated time period, and to demonstrate the Bidder's capability with respect to its construction methodology, proper planning of activities, procurement and deployment of necessary resources.

The Bidder's attention is drawn to the requirements set out in Section-5 Employer's Requirements, and the Bidder is requested to describe how it proposes to achieve the Milestone Targets that have been established to ensure that pro-rata progress is maintained on all sub-components of the Works throughout the execution period.

Details shall be furnished separately for the design and construction phase, and for the operations and maintenance phase.

Tech Schedule-2: Construction Schedule

The Bidder shall submit his proposed construction program in sufficient detail so as to demonstrate: the order in which he proposes to carry out the Design Build part (including each stage of design, procurement, manufacture, pre-delivery inspection and testing, delivery to Site, construction, erection, testing and commissioning); all major events and activities in the production of Construction Documents; the periods for the design reviews and approvals and for any other submissions, approvals and consents specified in the Employer's Requirements; the sequence of all tests specified in the Contract; etc.

Such construction program shall be developed on a commercially available project management software (such as Primavera, MS Project or equivalent) showing level-3 activities, together with bar charts and CPM diagrams which clearly illustrate the critical path, and the resources required to be provided by the Contractor to achieve the desired results.

The Bidder’s attention is drawn to the requirements set out in Section 5, Employer’s Requirements, and the Bidder is required to clearly demonstrate how he proposes to meet the Milestone Targets that have been established to ensure that pro-rata progress is maintained on all sub-components of the Works throughout the execution period.

Details shall be furnished separately for the design and construction phase, and for the operations and maintenance phase.

Tech Schedule-3: Sub-Contracting for Sub-Contractors

The Bidder shall enter in this Schedule a list of the sub-components and approximate value (in terms of percentage) of the work for which he proposes to use Sub-Contractors, together with the names and addresses of the proposed Sub-Contractors including Specialist Technology Provider. The Bidder shall also enter a statement of similar works previously executed by the proposed Sub-Contractors, including description, location and value of work, year completed, and name and address of the Employer/ Employer's Representative. Notwithstanding such information the Bidder, if awarded the Contract, shall remain entirely and solely responsible for the satisfactory completion of the Works.

Components Proposed to be Executed through Sub-Contracts	**Approximate Value (% only)**	**Name and Address of Proposed Sub-Contractor**	**Whether Specialist Technology Provider or Not**	**Statement of Similar Works Executed within last 10 years (Documentary Proof to be Enclosed)**

Tech Schedule-4: Quality Assurance and Quality Control Plan

The Bidder shall provide his proposed Quality Assurance and Quality Control (QAQC) Plan which describes the type, frequency and procedure of tests to be done on sites; type, frequency and procedure of tests to be done at manufacturers' locations outside the sites; all parameters to be measured in these tests; permissible limits of such parameters; details of laboratories to be established at sites; details of testing equipments & machines and their calibration schedules; details of the Bidder's internal systems for assuring quality control at the manufacturers' outside the sites; details of qualifications and experience of the Quality Control professionals to be deployed for the entire project; and the systems of Quality Audit to be instituted for systematic and professional management as well as adherence with the highest standards of quality of all construction works.

The Bidder shall provide separate descriptions of its proposed QA/QC plan during the Design Build phase and the subsequent operations and maintenance phase.

The Bidder shall also provide copies of the company's standard rules and regulations regarding quality assurance and quality control procedures for works in general and works of a similar nature.

Tech Schedule-5: Safety Plan

The Bidder shall describe his proposed Safety Plan which shall be developed to ensure zero fatal accidents and zero hazardous incidents/occurrences in all construction works, including descriptions of the company's standard policies and procedures regarding its site organization and procedures, methods and frequency of conducting safety audits at the Site(s), record keeping and reporting, providing safety training for its personnel, issue and mandatory use of safety equipment, details of the qualifications and experience of the Bidder's safety officers to be deployed at the Site(s), etc.

The Bidder shall provide separate descriptions of its proposed safety plan during the design and construction phase, and the subsequent operations and maintenance phase.

The Bidder shall also provide copies of the company's standard rules and regulations regarding safety procedures.

Tech Schedule-6: Environmental Quality Management Plan

The Bidder shall provide details of its proposed environmental management plan in sufficient detail so as to demonstrate the procedures that will be used to ensure that the environmental concerns and requirements as set forth in Section 5, Employer's Requirements, are satisfactorily met.

The Bidder shall provide separate descriptions of its proposals for minimizing any adverse environmental impacts/effects during the design and construction phase, and the subsequent operations and maintenance phase.

PART-III
CONDITIONS OF CONTRACT
AND
CONTRACT FORMS

(Section 6 to 8)

FIDIC® Conditions of Contract for
DESIGN, BUILD AND OPERATE PROJ ECTS

General Conditions of Contract and
Particular Conditions of Contract
First Edition 2008

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SECTION-6: GENERAL CONDITIONS OF CONTRACT (GCC)

SECTION-6: GENERAL CONDITIONS OF CONTRACT (GCC)

1 General Provisions	
1.1 Definitions	In the Conditions of Contract (these Conditions"). which include Particular Conditions and these General Conditions, the following words and expressions shall have the meanings stated. Words indicating persons or parties include corporations and other legal entities, except where the context requires otherwise.
	1.1.1 Accepted Contract Amount" means the amount accepted in the Letter of Acceptance for the Design-Build of the Works and the provision of the Operation Service, including the amount of the Asset Replacement Fund. 1.1.2 "Asset Replacement Fund" means the fund provided for under Sub Clause 14.18 [Asset Replacement Fund]. 1.1.3 "Asset Replacement Schedule" means the schedule referred to in Sub-Clause 14.5 [Asset Replacement Schedule] prepared by the Contractor covering the identification and timing of asset replacements. 1.1.4 "Auditing Body" means the independent and impartial body appointed to conduct the Independent Compliance Audit in accordance with Sub-Clause 10.3 [Independent Compliance Audit]. 1.1.5 Base Date means the date 28 days prior to the latest date for submission of the Tender. 1.1.6 "Commencement Date" means the date notified under Sub-Clause 8.1 [Commencement Date]. 1.1.7 "Commercial Risk" means a risk which results in financial loss and/or time loss for either of the Parties, where insurance is not generally or commercially available. 1.1.8 "Commissioning Certificate" means the certificate issued by the Employer's Representative to the Contractor under Sub-Clause 11.7 [Commissioning Certificate] marking the end of the Design-Build Period under Sub-Clause 9.12 [Completion of Design-Build] and the commencement of the Operation Service Period. 1.1.9 "Commissioning Period" means that period 01 time when cornmi3sioning tests are being carried out. 1.1.10 "Contract" means the Contract Agreement, the Letter of Acceptance, the Letter of Tender, these Conditions, the Employer's Requirements, the Schedules, the Contractor's Proposal, the Operating Licence, and the further documents (if any) which are listed in the Contract Agreement or in the Letter of Acceptance. 1.1.11 "Contract Agreement" means the Contract Agreement (if any) referred to in Sub-Clause 1 .6 [Contract Agreement]. 1.1.12 "Contract Completion Certificate" means the certificate issued by the Employer's Representative under Sub-Clause 8,6 [Contract Completion Certificate]. 1.1.13 "Contract Completion Date' means the date contained in the Contract Completion Certificate as being the date on which

	the Operation Service has been completed. 1.1.14 "Contract Data" means the pages completed by the Employer entitled Contract Data which constitute Part A of the Particular Conditions. 1.1.15 "Contract Period' means the Design-Build Period plus the Operation Service Period. 1.1.16 "Contract Price' means the price defined in Sub-Clause 14.1 [The Contract Price], and includes adjustments in accordance with the Contract. 1.1.17 "Contractor' means the person named as Contractor in the Letter of Tender accepted by the Employer and the legal successors in title to this person. 1.1.18 "Contractors Equipment" means all apparatus, machinery, vehicles and other things required for the execution and completion of the Works and the remedying of any defects. However, Contractor's Equipment excludes Temporary Works, Employer's Equipment (if any), Plant, Materials and any other things intended to form or forming part of the Works. 1.1.19 "Contractor's Documents" means the calculations, computer programs and other software, drawings, manuals, models and other documents of a technical nature supplied by the Contractor under the Contract; as described in Sub-Clause 5.2 [Contractor's Documents] 1.1.20 "Contractor's Proposal" means the document entitled proposal, which the Contractor submitted with the Letter of Tender, as included in the Contract. 1.1.21 "Contractor's Personnel" means the Contractor's Representative and all personnel whom the Contractor utilises on Site, including the staff, labour and other employees of the Contractor and of each Subcontractor, and any other personnel assisting the Contractor in the execution of the Works and provision of the Operation Service. 1.1.22 "Contractor's Representative" means the person named as such by the Contractor in the Contract or appointed from time to time by the Contractor under Sub-Clause 4.3 [Contractor's Representative] who acts on behalf of the Contractor. 1.1.23 "Cost" means all expenditure reasonably incurred (or to be incurred) by the Contractor, whether on or off the Site, including overhead and similar charges, but does not include profit. 1.1.24 "Cost Plus Profit" means Cost plus the applicable percentage agreed and stated in the Contract Data. Such percentage shall only be added where the Sub-Clause states that the Contractor is entitled to Cost Plus Profit. 1.1.25 "Country" means the country in which the Site (or most of it) is located, where the Permanent Works are to be executed. 1.1.26 "Cut-Off Date" means the date, at the end of a specified period stated in the Contract Data, after the Time for Completion of the Design-Build or any extension thereto

	granted under Sub Clause 9.3 [Extension of Time for Completion of Design-Build].
	1.1.27 "DAB" means the person or three persons so named in the Contract, or other person(s) appointed under Sub-Clause 20.3 [Appointment of the Dispute Adjudication Board] or Sub-Clause 20.4 [Failure to Agree Dispute Adjudication Board], or Sub-Clause 20.10 [Disputes Arising During the Operation Service Period].
	1.1.28 "day" means a calendar day.
	1.1.29 "Design-Build" means all work to be performed by the Contractor under the Contract to design, build, test and complete the Works and obtain the Commissioning Certificate issued in accordance with Sub-Clause 9.12 [Completion of Design-Build].
	1.1.30 "Design-Build Period" means the period from the Commencement Date to the date stated in the Commissioning Certificate.
	1.1.31 "Dispute" means any situation where (a) one Party makes a claim against the other Party; (b) the other Party rejects the claim in whole or in part: and (c) the first Party does not acquiesce, provided however that a failure by the other Party to oppose or respond to the claim, in whole or in part, may constitute a rejection if, in the circumstances, the DAB or the arbitrator(s), as the case may be, deem it reasonable for it to do so.
	1.1.32 "Employer" means the person named as Employer in the Contract Data and the legal successors in title to this person.
	1.1.33 "Employer's Equipment" means the apparatus, machinery and vehicles (if any) made available by the Employer for the use of the Contractor in the execution of the Works and/or the Operation Service, as stated in the Employer's Requirements, but does not include Plant which has not been taken over by the Employer.
	1.1.34 "Employer's Personnel" means the Employer's Representative, the assistants referred to in Sub-Clause 3.2 [Delegation by the Employer's Representative] and all other staff, labour and other employees of the Employers Representative and of the Employer; and any other personnel notified to tie Contractor, by the Employer or the Employer's Representative, as Employer's Personnel.
	1.1.35 "Employer's Representative" means the person appointed by the Employer to act as Employer's Representative for the purposes of the Contract and named as such in the Contract Data, or other person appointed from time to time by the Employer and notified as such to the Contractor under Sub-Clause 3.4 [Replacement of the Employer's Representative].
	1.1.36 "Employer's Requirements" means the document entitled Employer's Requirements, as included in the Contract, and any additions and modifications made thereto in accordance with the Contract. Such document specifies the purpose, scope, and/or design and/or other technical criteria for the execution of the Works and provision of the Operation

	Service. 1.1.37 "Exceptional Event" means an event or circumstance which is (a) beyond a Party's control; (b) which the Party could not reasonably have provided against before entering into the Contract; (c) which having arisen, such Party could not reasonably have avoided or overcome; and (d) which is not substantially attributable to the other Party. 1.1.38 "FIDIC" means the Fédération Internationale des Ingénieurs-Conseils, the International Federation of Consulting Engineers. 1.1.39 "Final Payment Certificate Design-Build' means the payment certificate issued for the Design-Build under Sub-Clause 14.12 [Issue of Final Payment Certificate Design-Build]. 1.1.40 "Final Payment Certificate Operation Service' means the payment certificate issued for the Operation Service under Sub-Clause 14.15 [Issue of Final Payment Certificate Operation Service]. 1.1.41 "Final Statement Design-Build' means the Statement defined in Sub- Clause 14.11 [Application for Final Payment Certificate Design-Build]. 1.1.42 "Final Statement Operation Service" means the Statement defined in Sub-Clause 14.13 [Application for Final Payment Certificate Operation Service]. 1.1.43 "Financial Memorandum" means the document which details the Employer's financial arrangements and is attached to or forms part of the Employer's Requirements. 1.1.44 "Foreign Currency' means a currency in which part (or all) of the Contract Pi ice is payable, but not the Local Currency. 1.1.45 "Goods" means Contractor's Equipment, Materials, Plant and Temporary Works, or any of them as appropriate. 1.1.46 "Interim Payment Certificate" means a payment certificate issued under Clause 14 [Contract Price and Payment], other than the Final Payment Certificates. 1.1.47 "Laws" means all national (or state) legislation, statutes, ordinances and other laws, and regulations and by-laws of any legally constituted public authority. 1.1.48 "Letter of Acceptance" means the letter of formal acceptance, signed by the Employer, of the Letter of Tender, including any annexed memoranda comprising agreements between and signed by both Parties. If there is no such Letter of Acceptance, the expression "Letter of Acceptance means the Contract Agreement and the date of issuing or receiving the Letter of Acceptance means the date of signing the Contract Agreement. 1.1.49 "Letter of Tender" means the document entitled Letter of Tender, which was completed by the Contractor and includes the signed offer to the Employer for the execution of the Works and provision of the Operation Service. 1.1.50 "Local Currency" means the currency of the Country. 1.1.51 "Maintenance Retention Fund" and "Maintenance Retention

	Guarantee" mean the fund and guarantee respectively provided for under Sub-Clause 14.19 [Maintenance Retention Fund]. 1.1.52 "Materials" means things of all kinds (other than Plant) whether on the Site or otherwise allocated to the Contact and intended to form or forming part of the Works, including the supply-only Materials (if any) to be supplied by the Contractor under the Contract. 1.1.53 "Notice" means a written communication identified as a Notice and issued in accordance with the provisions of Sub-Clause 1.3 [Notices and Other Communications]. 1.1.54 "Operating Licence" means the licence referred to in Sub-Clause 1.7 [Operating Licence] by which the Employer grants a royalty-free licence to the Contractor to operate and maintain the Works during the Operation Service. 1.1.55 "Operation Management Requirements" means the set of procedures and requirements, provided by the Employer, included in the Employer's Requirements for the proper implementation of the Operation Service. 1.1.56 "Operation and Maintenance Plan" means the plan for operating and maintaining the facility, submitted by the Contractor, and agreed and included in the Contract 1.1.57 "Operation Service" means the operation and maintenance of the facility as set out in the Operation Management Requirements. 1.1.58 "Operation Service Period" means the period from the date stated in the Commissioning Certificate as provided for under Sub-Clause 10.2 [Commencement of Operation Service] to the date stated in the Contract Completion Certificate. 1.1.59 "Party" means the Employer or the Contractor, as the context requires. 1.1.60 "Performance Security' means the security under Sub-Clause 4.2 [Performance Security]. 1.1.61 "Permanent Works" means the permanent works to be designed, executed and operated by the Contractor under the Contract. 1.1.62 "Plant" means the apparatus, machinery and vehicles intended to form or forming part of the Permanent Works. 1.1.63 "Provisional Sum" means a sum (if any) which is specified in the Contract by the Employer as a Provisional Sum, for the execution of any part of the Works or for the supply of Plant, Materials or services under Sub Clause 13.5 [Provisional Sums]. 1.1.64 "Rates and Prices" means the rates and prices inserted in the Schedules for U e design, execution and completion of the Works and for the provision of the Operation Service as incorporated in the Contract. 1.1.65 "Retention Money" means the accumulated retention monies which the Employer retains under Sub-Clause 14.3

	[Application for Advance and Interim Payment Certificates]. 1.1.66 "Retention Period" means the period of 1 year after the date stated in the Commissioning Certificate for the completion of outstanding work. 1.1.67 1 1.67 "Risk of Damage" means a risk which results in physical loss or damage to the Works or other property belonging to either Party, other than a Commercial Risk. 1.1.68 "Schedules" means the document(s) entitled Schedules, completed by the Contractor and submitted with the Letter of Tender, as incorporated in the Contract. Such documents shall include the Asset Replacement Schedule, and may also include data, lists, Schedules of Payments and/or prices, and guarantees. 1.1.69 "Schedule of Payments" means those Schedules (if any) incorporated in the Contract showing the manner in which payments are to be made to the Contractor. 1.1.70 "Section" means a part of the Works specified in the Contract Data as a Section (if any). 1.1.71 "Section Commissioning Certificate" means a certificate issued by the Employer's Representative to the Contractor under Sub-Clause 11.7 [Commissioning Certificate]. 1.1.72 "Site" means the places where the Permanent Works are to be executed and to which Plant and Materials are to be delivered, and where the Operation Service is to be provided, and any other places as may be specified in the Contract as forming part of the Site. 1.1.73 "Statement" means a financial Statement submitted by the Contractor as part of an application, under Clause 14 [Contract Price and Payment], for a payment certificate. 1.1.74 "Subcontractor" means any person named in the Contract as a subcontractor, or any person appointed as a subcontractor, for a part of the Works; and the legal successors in title to each of these persons. 1.1.75 "Tender" means the Letter of Tender and au other documents which the Contractor submitted with the Letter of Tender, as incorporated in the Contract. 1.1.76 "Tests on Completion of Design-Build" means the tests which are specified in the Contract or agreed by both Parties or instructed as a Variation, and which are to be carried out under Clause 11 [Testing] before the Works or a Section (as the case may be) are deemed to be fit tor purpose as defined in the employer's Requirements. 1.1.77 "Tests Prior to Contract Completion" means the tests (if any) which are specified in the Contract and any other such tests as may be agreed by the Employer's Representative and the Contractor or instructed as a variation and which are to be carried out under Clause 11 [Testing] before the expiry of the Contract Period. 1.1.78 "Time for Completion of Design-Build" means the time for completing the Design-Build or a Section thereof (as the case may be) under Sub-Clause 9.2 [Time for Completion of

	Design-Build], as stated in the Contract Data (with any extension under Sub-Clause 9.3 [Extension of Time for Completion of Design-Build]), calculated from the Commencement Date. 1.1.79 "Temporary Works" means all temporary works of every kind (other than Contractor's Equipment) required on Site for the execution, completion and operation of the Works. 1.1.80 "Unforeseeable" means not reasonably foreseeable by an experienced contractor by the date for submission of the Tender. 1.1.81 "Variation" means any change to the Employer's Requirements or the Works, which is instructed or approved as a Variation under Clause 13 [Variations and Adjustments]. 1.1.82 "Works" means the Permanent Works and Temporary Works or either of them as appropriate and the facility to be operated by the Contractor during the Operation Service Period. 1.1.83 "year" means 365 days.
1.2 Interpretation	In the Contract, except where the context requires otherwise: (a) words indicating one gender include all genders: (b) words indicating the singular also include the plural and words indicating the plural also include the singular; (c) provisions including the word "agree", "agreed" or "agreement" require the agreement to be recorded in writing: (d) "written" or "in writing" means hand-written, type-written, printed or electronically made, and resulting in a permanent record: (e) "shall" means that the Party or person referred to has an obligation under the Contract to perform the duty referred to; and (f) "may" means that the Party or person referred to has the choice of whether to act or not in the matter referred to. The marginal words and other headings shall not be taken into consideration in the interpretation of these Conditions.
1.3 Notices and Other Communications	Wherever these Conditions provide for the giving or issuing of a Notice or other communication including approvals, certificates, consents, determinations, instructions and requests, such Notice or communication shall be: (a) where it is a Notice, identified as a Notice and include reference to the Clause under which it is issued; (b) where it is another form of communication, identified as such, and include reference to the Clause under which it is issued where appropriate; (c) in writing and delivered by hand (against receipt), sent by mail or courier, or transmitted by using any of the agraed systems of electronic transmission as stated in the Contract Data; and (d) delivered, sent or transmitted to the address for the recipients communications as stated in the Contract Data. However: (i) if the recipient gives Notice of another address, communications and Notices shall thereafter be delivered accordingly; and

	(ii) if the recipient has not stated otherwise when requesting an approval or consent, it may be sent to the address from which the request was issued. Notices and other communications shall not be unreasonably withheld or delayed. When a certificate is issued to a Party, the certifier shall send a copy to the other Party. When a Notice is issued to a Party, by the other Party or the Employer's Representative, a copy shall be sent to the Employer's Representative or the other Party, as the case may be.
1.4 Law and Language	The Contract shall be governed by the law of the country (or other jurisdiction) stated in the Contract Data. If there are versions of any part of the Contract which are written in more than one language, the version which is in the ruling language stated in the Contract Data shall prevail. The language for communications shall be that stated in the Contract Data. If no language is stated there, the language for communications shall be the ruling language of the Contract.
1.5 Priority of Documents	The documents forming the Contract are to be taken as mutually explanatory of one another. For the purposes of interpretation, the priority of the documents shall be in accordance with the following sequence: (a) the Contract Agreement (if any), (b) the Letter of Acceptance, (c) the Letter of Tender, (d) the Particular Conditions Part A — Contract Data, (e) the Particular Conditions Part B — Special Provisions, (f) these General Conditions, (g) the Employer's Requirements, (h) the Schedules, and (i) the Contractor's Proposal and any other documents forming part of the Contract. If an ambiguity or discrepancy is found in the documents, the Employer's Representative shall issue any necessary clarification or instruction.
1.6 Contract Agreement	The Parties shall enter into a Contract Agreement within 28 days after the Contractor receives the Letter of Acceptance, unless they agree otherwise. The Contract Agreement shall be based upon the sample form included in the tender documents. The costs of stamp duties and similar charges (if any) imposed by law in connection with entry into the Contract Agreement shall be borne by the Employer.
1.7 Operating Licence	Together with the Letter of Acceptance, the Employer shall issue to the Contractor the Operating Licence or equivalent legal authorisation to enable the Contractor to operate and maintain the Works during the Operation Service Period. The Operating Licence shall automatically come into full force and effect upon the issue of the Commissioning Certificate upon completion of the Design-Build under Sub-Clause 9.12 [Completion of Design-Build] and shall remain in force until the issue of the

	Contract Completion Certificate under Sub-Clause 8.6 [Contract Completion Certificate]. The Operating Licence shall only extend to those parts of the Site which it is required o occupy for the purposes of carrying out the Works and Operation Service as set out in the Contract. The Operating Licence granted pursuant to this Sub-Clause shall not operate nor be deemed to operate as a tenement or a demise of the Site or any part thereof. The Contractor shall not have or be entitled to any estate right, title, or interest in the Site. The licence will immediately terminate upon the termination of the Contract for whatever reason.
1.8 Assignment	Neither Party shall assign the whole or any part of the Contract or any benefit or interest in or under the Contract. However, either Party: (a) may assign the whole or any part with the prior agreement of the other Party, at the sole discretion of such other Party: and (b) may, as security in favour of a bank or financial institution, assign its right to any monies due, or to become due, under the Contract.
1.9 Care and Supply of Documents	Each of the Contractor's Documents shall be in the custody and care of the Contractor, unless and until taken over by the Employer. Unless otherwise stated in the Contract, the Contractor shall supply to the Employer's Representative six copies of each of the Contractor's Documents. The Contractor shall keep, on the Site, a copy of the Contract, publications named in the Employer's Requirements, the Contractor's Documents, and Variations and other communications given under the Contract. The Employer's Personnel shall have the right of access to all these documents at all reasonable times. If a Party becomes aware of an error or defect of a technical nature in a document which was prepared for use in executing the Works, the Party shall promptly give Notice to the other Party of such error or defect.
1.10 Errors in the Employer's Requirements	Notwithstanding the Contractor's obligations to scrutinize the Employer's Requirements under Sub-Clause 5.1 [General Design Obligations], if the Contractor finds an error in the Employer's Requirements, he shall immediately give a written Notice to the Employer's Representative advising him of the nature and details of the error and requesting instruction regarding its rectification. After receiving this Notice, the Employer's Representative shall, without prejudice to other rights and obligations of the Parties, promptly confirm to the Contractor: (a) whether or not there is an error in the Employer's Requirements as stated in the Contractor's Notice: (b) whether or not an experienced contractor should have discovered the error when scrutinising the Employer's Requirements under Sub-Clause 5.1 [General Design Obligations]; and (c) the measures which the Employer's Representative requires the Contractor to take to rectify the error.

	If the Contractor suffers delay and/or incurs cost as a result of an error in the Employer's Requirements, and an experienced contractor exercising due care would not have discovered the error when scrutinising the Employer's Requirements under Sub-Clause 5.1 [General Design Obligations], the Contractor shall be entitled, subject to Sub-Clause 20.1 [Contractor's Claims], to: (i) an extension of time for any such delay, if completion is or will be delayed under Sub-Clause 9.3 [Extension of Time for Completion of Design-Build]; and (ii) payment of any such Cost Plus Profit, which shall be included in the Contract Price.
1.11 Employer's Use of Contractor's Documents	As between the Parties, the Contractor shall retain tl ie copyright ard other intellectual property rights in the Contractor's Documents and other design documents made by (or on behalf of) the Contractor. The Contractor shall be deemed (by signing the Contract) to give to the Employer a non-terminable transferable non-exclusive royalty-free licence to copy, use and communicate the Contractor's Documents, including making and using modifications of them. This licence shall: (a) apply throughout the actual or intended working life (whichever is longer) of the relevant part of the Works; (b) entitle any person in proper possession of the relevant part of the Works to copy, use and communicate the Contractor's Documents for the purposes of completing, operating, maintaining, altering, adjusting, repairing and demolishing the Works; (c) in the case of Contractor's Documents which are in the form of computer programs and other software, permit their use on any computer on the Site and other places as envisaged by the Contract, including replacements of any computers supplied by the Contractor; and (d) enable the Employer to relet the Contract as provided for under Sub-Clause 15.2 [Termination for Contractor's Default]. The Contractor's Documents and other design documents made by (or on behalf of) the Contractor shall not, without the Contractor's consent, be used, copied or communicated to a third party by (or on behalf of) the Employer for purposes other than those permitted under this Sub-Clause.
1.12 Contractor's Use of Employer's Documents	As between the Parties, the Employer shall retain the copyright and other intellectual property rights in the Employer's Requirements and other documents made by (or behalf of) the Employer, The Contractor may, at his cost, copy, use, and obtain communication of these documents for the purposes of the Contract. They shall not, without the Employer's consent, be copied, used, or communicated to a third party by the Contractor, except as necessary for the purposes of the Contract.
1.13 Confidential Details	The Contractor shall disclose all such confidential and other information as the Employer's Representative may reasonably require in order to verify the Contractor's compliance with the Contract.

	The Contractor shall treat the details of the Contract as private and confidential, except to the extent necessary to carry out his obligations under the Contract. The Contractor shall not publish, permit to be published, or disclose any particulars of the Contract in any trade or technical paper or elsewhere without the previous consent in writing of the Employer. The said consent shall not be unreasonably withheld. The Employer shall treat all information designated by the Contractor as confidential, as confidential, and shall not disclose it to third parties, except as maybe necessary when exercising his rights under Sub-Clause 15.2 [Termination for Contractors Default].
1.14 Compliance with Laws	The Contractor shall, in performing the Contract, comply with applicable Laws. Unless otherwise stated in the Employer's Requirements: (a) the Employer shall have obtained (or shall obtain) the planning, zoning, building permit, or similar permission for the Permanent Works and for the Operation Service, and any other permissions described in the Employers Requirements as having been (or being) obtained by the Employer: and the Employer shall indemnify and hold the Contractor harmless against and from the consequences of any failure to do so; (b) the Contractor shall give all notices, pay all taxes, duties and fees, and obtain all further permits, licences and approvals, as required by the Laws, in relation to the design, execution and completion of the Works and Operation Service and the remedying of any defects: and the Contractor shall indemnify and hold the Employer harmless against and from the consequences of any failure to do so; and (c) the Contractor shall at all times and in all respects comply with, give all notices under, and pay all fees required by any licence obtained by the Employer in respect of the Site or the Works or Operation Service, whether relating to the Works or Operation Service on or off the Site.
1.15 Joint and Several Liability	If the Contractor constitutes (under applicable Laws) a joint venture, consortium or other unincorporated grouping of two or more persons: (a) these persons shall be deemed to be jointly and severally liable to the Employer for the performance of the Contract; (b) these persons shall notify the Employer of their leader who shall have authority to bind the Contractor and each of these persons; and (a) the Contractor shall not alter his composition or legal status without the prior consent of the Employer.
2 The Employer	
2.1 Right of Access to the Site	The Employer shall give the Contractor ri9ht of access to, and possession of, all or part of the Site within the time (or times) stated in the Contract Data. The right and possession may not be exclusive to the Contractor. If, under the Contract, the Employer is required to give the Contractor possession of any foundation, structure, plant or means of access, the Employer shall do so in the time and manner

	stated in the Employer's Requirements. However, the Employer may withhold any such right or possession until the Performance Security has been received. If no such time is stated in the Contract Data, the Employer shall give the Contractor right of access to, and possession of, the Site within such times as may be required to enable the Contractor to proceed in accordance with the programme submitted under Sub-Clause 8.3 [Programme]. If the Contractor suffers delay and/or incurs cost as a result of a failure by the Employer to give any such right or possession within such time, the Contractor shall give Notice to the Employer's Representative and shall be entitled subject to Sub-Clause 20.1 [Contractors Claims] to: (a) an extension of time for any such delay, if completion is or will be delayed, under Sub-Clause 9.3 [Extension of Time for Completion of Design-Build]; and (b) payment of any such Cost Plus Profit, which shall be included in the Contract Price. After receiving this Notice, the Employer's Representative shall proceed in accordance with Sub-Clause 3.5 [Determinations] to agree or determine these matters. However, if and to the extent that the Employer's failure was caused by any error or delay by the Contractor, including an error in, or delay in the submission of, any of the Contractor's Documents, the Contractor shall not be entitled to such extension of time or cost.
2.2 Permits, Licences or Approvals	The Employer shall provide, at the request of the Contractor, such reasonable assistance as to allow the Contractor to obtain: (a) copies of the Laws of the Country which are relevant to the Contract but are not readily available; and (b) any permits, licences or approvals required by the Laws of the Country, including details of the information required to be submitted by the Contractor in order to obtain such permits, licences or approvals: (i) which the Contractor is required to obtain under Sub-Clause 1.14 [Compliance with Laws]; (ii) for the delivery of Goods, including clearance through customs; and (iii) for the export of Contractor's Equipment when it is removed from the Site.
2.3 Employer's Personnel	The Employer shall be responsible for ensuring that the Employer's Personnel and the Employer's other contractors on the Site: (a) co-operate with the Contractor's efforts under Sub-Clause 4.6 [Co-operation]: and (b) take actions similar to those which the Contractor is required to take under sub- paragraphs (a), (b) and (c) of Sub-Clause 4.8 [Safety Procedures] and under Sub-Clause 4.18 [Protection of the Environment].
2.4 Employer's	The Employer's arrangements for financing the design, execution and operation of the Works, including the provision of the Asset

Financial Arrangements	Replacement Fund, shall be detailed in the Financial Memorandum. if the Employer intends to make any material changes to the financial arrangements or has to do so because of changes in his financial or economic situation, the Employer shall give Notice to the Contractor, with detailed particulars. Within 28 days after receiving any request of the Contractor the Employer shall give reasonable evidence that financial arrangements have been made and are being maintained which will enable the Employer to pay the Contract Price.
3 The Employer's Representative	
3.1 Employer's Representative's Duties and Authority	The Employer shall appoint the Employers Representative prior to the signing of the Contract, who shall be suitably qualified and experienced and who shall carry out the duties assigned to him in the Contract. The Employers Representatives staff shall include suitably qualified engineers and other professionals who are competent to carry out these duties. The Employer s Representative shall have no authority to amend the Contract. The Employers Representative may exercise the authority attributable to the Employer's Representative as specified in or necessarily to be implied from the Contract. The Employer undertakes not to impose further constraints on the Employer's Representative's authority, except as agreed with the Contractor. However, whenever the Employer's Representative exercises a specified authority for which the Employer's approval is required, then (for the purposes of the Contract) the Employer shall be deemed to have given approval. Except as otherwise stated in these Conditions: (a) whenever carrying out duties or exercising authority, specified in or implied by the Contract, the Employer's Representative shall be deemed to act for the Employer; (b) the Employer's Representative has no authority to relieve either Party of any duties, obligations or responsibilities Under the Contract; and (c) any approval, check, certificate, consent, examination, inspection, instruction, Notice, proposal, request, test or similar act by the Employer's Representative (including absence of disapproval) shall not relieve the Contractor from any responsibility he has under the Contract, including responsibility for errors, omissions, discrepancies and non -compliances.
3.2 Delectation by the Employer's Representative	The Employer's Representative may from time to time assign duties and delegate authority to assistants, and may also revoke such assignment or delegation. These assistants may include independent inspectors (other than the Auditing Body) appointed to inspect and/or test itcms of Plant and/or Materials and/or workmanship or moritor the provision of the Operation Service. The assignment, delegation or revocation shall be iii writing and shall not take effect until copies have been received by both Parties. However, unless otherwise agreed by both Parties, the Employer's

	Representative shall not delegate the authority to determine any matter in accordance with Sub-Clause 3.5 (Determinations). Assistants shall be suitably qualified persons, who are competent to carry out these duties and exercise this authority, and who are fluent in the language for communications defined in Sub-Clause 1.4 [Law and Language]. Each assistant, to whom duties have been assigned or authority has been delegated, shall only be authorised to issue instructions to the Contractor to the extent defined by the delegation. Any approval, check, certificate, consent, examination, inspection, instruction. Notice, proposal, request, test or similar act by an assistant, in accordance with the delegation, shall have the same effect as though the act had been an act of the Employer's Representative. However: (a) any failure to disapprove any work, Plant, Materials or any part of the Operation Service shall not constitute approval, and shall therefore not prejudice the right of the Employer's Representative to reject the work, Plant, Materials or any part of the Operation Service; and (b) if the Contractor questions any determination or instruction of an assistant, the Contractor may refer the matter to the Employer's Representative, who shall promptly confirm, reverse or vary the determination or instruction.
3.3 Instructions of the Employer's Representative	The Employer's Representative may issue to the Contractor (at any time) instructions which may be necessary for the execution of the Works and the remedying of any defects, all in accordance with the Contract. The Contractor shall only take instructions from the Employer's Representative, or from an assistant to whom the appropriate authority has been delegated under this Clause. If an instruction constitutes a Variation, Clause 13 [Variations and Adjustments] shall apply. The Contractor shall comply with the instructions given by the Employer's Representative or delegated assistant on any matter related to the Contract. These instructions shall he given in writing. If the Contractor considers that any instruction of the Employer's Representative does not comply with applicable Laws or is technically impossible, he shall immediately notify lie Employer's Representative in writing. The Employer's Representative shall then either confirm or amend such instruction.
3.4 Replacement of tire Employer's Representative	If the Employer intends to replace the Employers' representative, the Employer shall, not less than 42 days before the intended date of replacement, give Notice to the Contractor of the name, address and relevant experience of the intended replacement Employer's Representative. The Employer shall not replace the Employer's Representative with a person against whom the Contractor raises reasonable objection by Notice to the Employer, with supporting particulars.
3.5 Determinations	Whenever these Conditions provide that the Employer's Representative shall proceed in accordance with this Sub-Clause to agree or determine any matter, the Employer's Representative shall consult with each Party in an endeavour to reach agreement. !f

	agreement is not achieved, the Employer's Representative shall make a fair determination in accordance with the Contract, taking due regard of all relevant circumstances. The Employer's Representative shall give Notice to both Parties of each agreement or determination, with supporting particulars. Each Party shall give effect to each agreement or determination unless and until revised under Clause 20 [Claims, Disputes and Arbitration].
4 THE CONTRACTOR	
4.1 Contractor's General Obligations	The Contractor shall design, execute and complete the Works and provide the Operation Service in accordance with the Contract and shall remedy any defects in the Works. When completed, the Works shall be fit for the purposes for which the Works are intended as defined in the Contract, and the Contractor shall be responsible for ensuring That the Works remain fit for such purposes during the Operation Service Period. The Contractor shall provide the Plant and Contractor's Documents specified in the Contract, and all Contractors Personnel, Goods, consumables and other things and services, whether of a temporary or permanent nature, required to meet the Contractors obligations under the Contract. The Works shall include any work which is necessary to satisfy the Employer's Requirements, Contractor's Proposal and Schedules, or is implied by the Contract, and all works which (although not mentioned in the Contract) are necessary for stability or for the completion, or safe and proper operation, of the Works. The Contractor shall be responsible for the adequacy, stability and safety of all Site operations, of all methods of construction and of all the Works during both the Design- Build Period and the Operation Service Period. The Contractor shall, whenever required by the Employer's Representative, submit details of the arrangements and methods which the Contractor proposes to adopt for the execution of the Works. No significant alteration to these arrangements and methods shall be made without this having previously been notified to the Employer's Representative. The Contractor shall attend all meetings as reasonably required by the Employer or the Employer's Representative.
4.2 Performance Security	The Contractor shall obtain at his cost the Performance Security for proper performance of the Contract, in the amounts and currencies set out in the Contract Data. If no amount is stated in the Contract Data, this Sub-Clause shall not apply. At the end of the Retention Period, the Contractor is entitled to a reduction of the amount of the Performance Security, as stated in the Contract Data. The Contractor shall deliver the Performance Security to the Employer within 28 days after receiving the Letter of Acceptance, and shall send a copy to the Employer's Representative. The Performance Security shall be issued by an entity and from within a country (or other jurisdiction) approved by the Employer, and shall be based on the sample form included in the tender documents, or

	in another form approved by the Employer. The Contractor shall ensure that the Performance Security is valid and enforceable until the issue of the Contract Completion Certificate. If the terms of the Performance Security specify its expiry date, and the Contractor has not become entitled to receive the Contract Completion Certificate by the date 28 days prior to the expiry date, the Contractor shall extend the validity of the Performance Security until the Works and the Operation Service have been completed (or alternatively, until the Contractor has been entitled to receive the Contract Completion Certificate). Failure by the Contractor to maintain the validity of the Performance Security shall be grounds for termination r accordance with Sub-Clause 15.2 [Termination for Contractor's Default]. The Employer shall not make a claim under the Performance Security except for amounts to which the Employer is entitled under the Contract in the event of: (a) failure by the Contractor to extend the validity of the Performance Security as described in the preceding paragraph. in which event the Employer may claim the full or, in case of an earlier reduction, the reduced amount of the Performance Security; (b) failure by the Contractor to pay the Employer an amount due, as either agreed by the Contractor or determined under Sub-Clause 3.5 [Determinations] or Clause 20 [Claims, Disputes and Arbitration, within 42 days after this agreement or determination; (c) failure by the Contractor to remedy a default within 42 days after receiving the Employers Notice requiring the default to be remedied; or (d) circumstances which entitle the Employer to terminate under Sub-Clause 15.2 [Termination for Contractor's Default, irrespective of whether Notice of termination has been given. The Employer shall indemnify and hold the Contractor harmless against and from ail damages, losses and expenses (including legal fees and expenses) resulting from a claim under the Performance Security which the Employer was not entitled to make. The Employer shall return the Performance Security to the Contractor within 21 days after receiving a copy of the Contract Completion Certificate.
4.3 Contractors Representative	The Contractor shall appoint the Contractors Representative and shall give him all authority necessary to act on the Contractor's behalf under the Contract. Unless the Contractor's Representative is named in the Contract, the Contractor shall, prior to the Commencement Date, submit to the Employer's Representative for consent the name and particulars of the person the Contractor proposes to appoint as Contractor's Representative. If consent is withheld or subsequently revoked, or if the appointed person fails to act as Contractor's Representative, the Contractor shall similarly submit the name and particulars of another suitable person for such appointment. The Contractor shall not, without the prior consent of the Employer's Representative, revoke the appointment of the Contractor's

	Representative or appoint a replacement. The whole time of the Contractor's Representative shall be given to directing the Contractor's performance of the Contract. If the Contractor's Representative is to be temporarily absent from the Site during the execution of the Works or provision of the Operation Service, a suitable replacement person shall be appointed, subject to the Employer's Representative's prior consent, and the Employer's Representative shall be notified accordingly. The Contractor's Representative shall, on behalf of the Contractor, receive instructions under Sub-Clause 3.3 [Instructions of the Employer's Representative. The Contractor's Representative may delegate any powers, functions and authority to any competent person, and may at any time revoke the delegation. Any delegation or revocation shall not take effect until the Employer's Representative has received prior Notice signed by the Contractor's Representative, naming the person and specifying the powers, functions and authority being delegated or revoked. The Contractor's Representative and all these persons shall be fluent in the language for communications defined in Sub-Clause 1.4 [Law and Language].
4.4 Subcontractors	The Contractor shall not subcontract the whole of the Works. Unless otherwise agreed, the Contractor shall not subcontract the provision of the Operation Service. The Contractor shall be responsible for the acts or defaults of any Subcontractor, his agents or employees, as if they were the acts or defaults of the Contractor. Unless otherwise stated in the Particular Conditions: (a) the Contractor shall not be required to obtain consent to suppliers of Materials, or to a subcontract for which the Subcontractor is named in the Contract; (b) the prior consent of the Employer's Representative shall be obtained to other proposed Subcontractors; and (c) the Contractor shall give Notice to the Employer's Representative not less than 28 days' prior to the intended date of the commencement of each Subcontractors work, and of the commencement of such work on the Site. If any Subcontractor s entitled under any contract or agreement relating to the Works to relief from any risk on terms additional to or broader than those specified in the Contract, such additional or broader events or circumstances shall not excuse the Contractors non-performance or entitle him to relief under the Contract.
4.5 Nominated Subcontractors	In this Sub-Clause, "nominated Subcontractor" means a Subcontractor named as such in the Employers Requirements or whom the Employer's Representative, under Clause 13 [Variations and Adjustments], instructs the Contractor to employ as a Subcontractor. The Contractor shall not be under any obligation to employ a nominated Subcontractor against whom the Contractor raises reasonable objection by Notice to the Employer's Representative as soon as practicable, with supporting particulars.

4.6 Co-operation	The Contractor shall, as specified in the Contract or as instructed by the Employers Representative, allow appropriate opportunities for carrying out work to: (a) the Employers Personnel; (b) any other contractors employed by the Employer; and (c) the personnel of any legally constituted public authorities; who may be employed in the execution on or near the Site of any work not included in the Contract. Any such instruction shall constitute a Variation if and to the extent that it causes the Contractor to incur Unforeseeable cost. Services for these personnel and other contractors may include the use of Contractor's Equipment, Temporary Works or access arrangements which are the responsibility of the Contractor. The Contractor shall be responsible for his construction and operation activities on the Site, and shall co-ordinate his own activities with those of other contractors to the extent (if any) specified in the Employer's Requirements. If, under the Contract, the Employer is required to give to the Contractor possession of any foundation, structure plant or means of access in accordance with Contractors Documents, the Contractor shall submit such documents to the Employer's Representative in the time and manner stated in the Employer's Requirements.
4.7 Setting Out	The Contractor shall set out the Works in relation to original points, lines and levels of reference specified in the Contract or notified by the Employer's Representative. The Contractor shall be responsible for the correct positioning of all parts of the Works and shall rectify any error in the positions, levels, dimensions or alignment of the Works. The Employer shall be responsible for any errors in these specified or notified items of reference, but the Contractor shall use reasonable efforts to verify their accuracy before they are used. If the Contractor suffers delay and/or incurs cost from executing work which was necessitated by an error in these items of reference, and an experienced contractor could riot reasonably have discovered such error and avoided this delay and/or cost, the Contractor shall give Notice to the Employer's Representative and shall be entitled subject to Sub-Clause 20.1 [Contractors Claims] to: (a) an extension of time for any such delay, if completion is or will be delayed, Under Sub-Clause 9.3 [Extension of Time for Completion of Design-Build); and (b) payment of any such Cost Plus Profit, which shall be included in the Contract Price. After receiving this Notice, the Employer's Representative shall proceed in accordance with Sub-Clause 3,5 [Determinations] to agree or determine (i) whether and (if so) to what extent the error could not reasonable, have been discovered, and (ii) the matters described in sub-paragraphs (a) and (b) above related to this extent.
4.8 Safety Procedures	The Contractor shall:

	(a) comply with all applicable safety regulations; (b) take care for the safety of all persons entitled to be on the Site; (c) use reasonable efforts to keep the Site and Works clear of unnecessary obstruction so as to avoid danger to these persons: (d) provide fencing, lighting, guarding and watching of the Works until the issue of the Contract Completion Certificate; and (e) provide any Temporary Works (including roadways, footways, guards and fences) which may be necessary, because of the execution of the Works, for the use and protection of the public and of owners and occupiers of adjacent land.
4.9 **Quality Assurance**	The Contractor shall institute a quality assurance system to demonstrate compliance with the requirements of the Contract. The system shall be in accordance with the details stated in the Contract. The Employers Representative shall be entitled to audit any aspect of the system. Details of all procedures and compliance documents shall be submitted to the Employers Representative for information before each design, execution and operation stage is commenced. When any document of a technical nature is issued to the Employer's Representative, evidence of the prior approval by the Contractor himself shall be apparent on the document itself. Compliance with the quality assurance system shall not relieve the Contractor of any of his duties, obligations or responsibilities under the Contract.
4.10 **Site Data**	The Employer shall have made available to the Contractor for his information, prior to the Base Date, all relevant data in the Employer's possession on sub-surface, hydrological and climatic conditions at the Site, including environmental aspects. The Employer shall similarly make available to the Contractor all such data which come into the Employer's possession after the Base Date. The Contractor shall be responsible for interpreting all such data. To the extent which was practicable (taking account of cost and time), the Contractor shall be deemed to have obtained all necessary information as to risks, contingencies and other circumstances which may influence or affect the Tender or Works or the provision of the Operation Service. To the same extent, the Contractor shall be deemed to have inspected and examined the Site, its surroundings, the above data and other available information, and to have been satisfied before submitting the Tender as to all relevant matters, including (without limitation): (a) the form and nature of the Site, including sub-surface conditions; (b) the hydrological and climatic conditions; (c) the extent and nature of the work and Goods necessary for the execution and completion of the Works and the remedying of any defects; (d) the Laws, procedures of regulatory and other authorities and about practices of the Country; and (e) the Contractor's requirements for access, accommodation, facilities, personnel, power, transport, water and other services.

4.11 Sufficiency of the Accepted Contract Amount	The Contractor shall be deemed to: (a) have satisfied himself as to the correctness and sufficiency of the Accepted Contract Amount; and (b) have based the Accepted Contract Amount on the data, interpretations, necessary information, inspections, examinations and satisfaction as to all relevant matters referred to in Sub-Clause 4.10 [Site Data], and any further data relevant to the Contractor's design. The Accepted Contract Amount covers all the Contractor's obligations under the Contract (including those under Provisional Sums, if any) and all things necessary for the proper design, execution and completion of the Works, the remedying of any defects and the provision of the Operation Service.
4.12 Unforeseeable Physical Conditions	In this Sub-Clause, "physical conditions' means natural physical conditions and man-made and other physical obstructions and pollutants, which the Contractor encounters at the Site when executing the Works, including sub-surface and hydrological conditions but excluding climatic conditions. If the Contractor encounters adverse physical conditions which he considers to have been Unforeseeable, the Contractor shall give Notice to the Employer's Representative as soon as practicable. This Notice shall describe the physical conditions, so that they can be inspected by the Employer's Representative, and shall set out the reasons why the Contractor considers them to be Unforeseeable. The Contractor shall continue executing the Works, using such proper and reasonable measures as are appropriate for the physical conditions, and shall comply with any instructions which the Employer's Representative may give. If an instruction constitutes a Variation, Clause 13 [Variations and Adjustments] shall apply. If and to the extent that the Contractor encounters physical conditions which are Unforeseeable, gives such a Notice, and suffers delay and/or incurs cost due to these conditions, the Contractor shall be entitled subject to Sub-Clause 20.1 [Contractors Claims] to: (a) an extension of time for any such delay, if completion is or will be delayed, under Sub-Clause 9.3 [Extension ot Time for Completion of DG sign-Build}; and (b) payment of any such Cost, which shall be included in the Contract Price. After receiving such Notice and inspecting and/or investigating these physical conditions, the Employer's Representative shall proceed in accordance with Sub- Clause 3.5 (Determinations] to agree or determine (i) whether and (if so) to what extent these physical conditions were Unforeseeable, and (ii) the matters described in sub- paragraphs (a) and (b) above. However, before additional Cost is finally agreed or determined under (ii), the Employer's Representative may also review whether other physical conditions in similar parts of the Works (if any) were more favourable than could reasonably have been foreseen when the Contractor submitted the Tender. If and to the extent that these more favourable conditions were encountered, the Employer's

	Representative may proceed in accordance with Sub-Clause 3.5 (Determinations] to agree or determine the reductions in Cost which were due to these conditions, which may be included (as deductions) in the Contract Price and payment certificates. However, the net effect of all adjustments under sub-paragraph (b) and all these reductions, for at the physical conditions encountered in similar parts of the Works, shall not result in a net reduction in the Contract Price. The Employer's Representative may take account of any evidence of the physical conditions foreseen by the Contractor when submitting the Tender, which may be made available by the Contractor, but shall not be bound by any such evidence.
4.13 **Rights of Way and Facilities**	The Contractor shall bear all costs and charges for special and/or temporary rights-of-way which he may require, including those for access to the Site. The Contractor shall also obtain, at his risk and cost, any additional facilities outside the Site which he may require for the purposes of the Works.
4.14 **Avoidance of Interference**	The Contractor shall not interfere unnecessarily or improperly with: (a) the convenience of the public; or (b) the access to and use and occupation of all roads and footpaths, irrespective of whether they are public or in the possession of the Employer or of others. The Contractor shall indemnify and hold the Employer harmless against and from all damages, losses and expenses (including legal fees and expenses) resulting from any such unnecessary or improper interference.
4.15 **Access Route**	The Contractor shall be deemed to have been satisfied as to the suitability and availability of access routes to the Site. The Contractor shall use reasonable efforts to prevent any road or bridge from being damaged by the Contractor's traffic or by the Contactors Personnel. These efforts shall include the proper use of appropriate vehicles and routes. Except as otherwise stated in these Conditions: (a) the Contractor shall (as between the Parties) be responsible for any maintenance which may be required as a result 01 ms use of access routes; (b) the Contractor shall provide all necessary signs or directions along access routes, and shall obtain any permission which may be required from the relevant authorities for his use of routes, signs and directions, (c) the Employer shall not be responsible for any claims which may arise from the use or otherwise of any access route; (d) the Employer does not guarantee the suitability or availability of particular access routes; and (e) Costs due to non-suitability or non-availability, for the use required by the Contractor, of access routes shall be borne by the Contractor.
4.16 **Transport of Goods**	Unless otherwise stated in the Particular Conditions: (a) the Contractor shall g:ve Notice to the Employers

	Representative not less than 21 days prior to the date on which any Plant or a major item of other Goods will be delivered to the Site; and (b) the Contractor shall be responsible for packing, loading, transporting, receiving, unloading, storing and protecting all Goods and other things required for the Works or provision of Operation Service; and (c) the Contractor shall indemnify and hold the Employer harmless against and from all damages, losses and expenses (including legal fees and expenses) resulting from the transport of Goods, and shall negotiate and pay all claims arising from their transport.
4.17 Contractor's Equipment	The Contractor shall be responsible for all Contractors Equipment. When brought on to the Site, Contractor's Equipment shall be deemed to be exclusively intended for the execution of the Works and provision of the Operation Service. The Contractor shall not remove from the Site any major items of Contractor's Equipment without the consent of the Employer's Representative. However, consent shall not be required for vehicles transporting Goods or Contractors Personnel oft Site.
4.18 Protection of the Environment	The Contractor shall take all reasonable steps to protect the environment (both on and ott the Site) and to limit damage and nuisance to people and property resulting from pollution, noise and other results of his operations. The Contractor shall ensure that emissions, surface discharges and effluent from the Contractor's activities shall not exceed the values indicated in the Employer's Requirements, and shall not exceed the values prescribed by applicable Laws.
4.19 Electricity, Water and Gas	Except as stated below, the Contractor shall be responsible for the provision of all electricity, water and other services he may require. The Contractor shall be entitled to us for the purposes of the Works and provision of the Operation Service such supplies of electricity, water, gas and other services as may be available on the Site and of which details are given in the Employer's Requirements. In such a case the Contractor shall take over in his own name and shall be responsible for payment of the electricity, water, gas and other services to the utility provider. The Contractor will be allowed to take over the existing service entry and provision points and shall be responsible for taking and recording such information as is necessary for the utility providers to correctly charge the Contractor from the Commencement Date.
4.20 Employer's Equipment and Free-Issue Materials	The Employer shall make the Employers Equipment (if any) available for the use of the Contractor in the execution of the Works in accordance with the details, arrangements and prices stated in the Employer's Requirements. Unless otherwise stated in the Employer's Requirements: (a) the Employer shall be responsible for the Employer's Equipment, except that (b) the Contractor shall be responsible for each item of Employers Equipment whilst any of the Contractor's Personnel is operating

	it, driving it, directing it or in possession or control of it. The appropriate quantities and the amounts due (at such stated prices) for the use of Employer's Equipment shall be agreed or determined by the Employer's Representative in accordance with Sub-Clause 20.2 [Employer's Claims] and Sub-Clause 3.5 [Determinations]. The Contractor shall pay these amounts to the Employer. The Employer shall supply, free of charge, the "free-issue materials" (if any) in accordance with the details stated in the Employer's Requirements. The Employer shall, at his risk and cost, provide these materials at the time and place specified in the Contract. The Contractor shall then visually inspect them, and shall promptly give Notice to the Employer's Representative of any shortage, defect or default in these materials, Unless otherwise agreed by both Parties, the Employer shall immediately rectify the notified shortage, defect or default. After this visual inspection, the free-issue materials shall come under the care, custody and control of the Contractor. The Contractor's obligations of inspection, care, custody and control shall not relieve the Employer of liability for any shortage, defect or default not apparent from a visual inspection.
4.21 **Progress Reports**	During the Design-Build Period, monthly progress reports, in a format agreed with the Employer's Representative shall be prepared by the Contractor and submitted to the Employer's Representative in one original and five copies, unless otherwise stated in the Employer's Requirements. The first report shall cover the period up to the end of the first calendar month following the Commencement Date. Reports shall be submitted monthly thereafter, each within 7 days after the last day of the period to which it relates. Reporting on progress shall continue until the Contractor has received the Contract Completion Certificate. Details of the content of the progress reports for the Design-Build Period and the Operation Service Period shall be as specified in the Employer's Requirements. Unless otherwise stated or agreed, each progress report shall include: (a) charts and detailed descriptions of progress, including each stage of design, Contractors Documents, procurement, manufacture, delivery to Site, construction or replacement, erection, testing, commissioning, trial operation and provision of Operation Service; (b) photographs showing the status of manufacture or replacement and of progress on the Site: (c) for the manufacture or replacement of each main teni of Plant and Materials, the name of the manufacturer, manufacture location, percentage progress, and the actual or expected dates of: (i) commencement of manufacture, (ii) Contractor's inspections, (iii) tests, and

	(iv) shipment and arrival at the Site; (d) the details described in Sub-Clause 6.10 [Records of Contractors Personnel and Equipment]; (e) copies of quality assurance documents, test results and certificates of Materials; (f) list of Variations, Notices given under Sub-Clause 20.1 [Contractor's Claims] and Notices given under Sub-Clause 20.2 [Employer's Claims]; (g) safety, statistics, including details of any hazardous incidents and activities relating to environmental aspects and public relations; and (h) comparisons of actual and planned progress, with details of any events or circumstances which may jeopardise the completion in accordance with the Contract, and the measures being (or to be) adopted to overcome delays. The particular reporting requirements during the Operation Service Period shall be as specified in the Employer's Requirements.
4.22 **Security of the Site**	The Contractor shall be responsible for the security of the Site. Unless otherwise stated in the Particular Conditions: (a) the Contractor shall be responsible for keeping unauthorised persons off the Site; and (b) authorised persons shall be limited to the Contractor's Personnel and the Employer's Personnel, and to any other personnel notified to the Contractor, by the Employer or the Employer's Representative, as authorised personnel of the Employer's other contractors on the Site.
4.23 **Contractor's Operations on Site**	The Contractor shall confine his operations to the Site, and to any additional areas which may be obtained by the Contractor and agreed by the Employer's Representative as working areas. The Contractor shall take all necessary precautions to keep Contractor's Equipment and Contractor's Personnel within the Site and these additional areas, and to keep them off adjacent land. At all times the Contractor shall keep the Site free from all unnecessary obstruction, and shall store or dispose of any Contractor's Equipment or surplus materials. The Contractor shall promptly clear away and remove from the Site any surplus material, wreckage, rubbish and Temporary Works which are no longer required. Upon the issue of a Commissioning Certificate, the Contractor shall clear away and remove, from that part of the Site and Works to which the Commissioning Certificate refers, all Contractor's Equipment, surplus material, wreckage, rubbish and Temporary Works. The Contractor shall leave that part of the Site and the Works n a clean and safe condition. The Contract Completion Certificate shall not be issued until the Contractor has removed any remaining Contractor's Equipment, surplus rndterial, wreckage, rubbish and Temporary Works from the Site which are not required. The Contractor shall leave the Site and the Works in a clean and safe condition.

4.24 Fossils	All fossils, coins, articles of value or antiquity, and structures and other remains or items of geological or archaeological interest found on the Site shall be placed under the care and authority of the Employer. The Contractor shall take reasonable precautions to prevent Contractor's Personnel or other persons from removing or damaging any of these findings. The Contractor shall, upon discovery of any such finding, promptly give Notice to the Employer's Representative, who shall issue instructions for dealing with it. If the Contractor suffers delay and/or incurs cost from complying with the instructions, the Contractor shall give a further Notice to the Employer's Representative and shall be entitled, subject to Sub-Clause 20.1 [Contractor's Claims], to: (a) an extension of time for any such delay, if completion is or will be delayed, under Sub-Clause 9.3 [Extension of Time for Completion of Design-Build]; and (b) payment of any such Cost, which shall be included in the Contract Price. After receiving this further Notice, the Employer's Representative shall proceed in accordance with Sub-Clause 3.5 [Determinations] to agree or determine these matters.
4.25 Changes in the Contractor's Financial Situation	If the Contractor becomes aware of any change in the Contractor's financial situation which will or could adversely affect his ability to complete and fulfill all his obligations under the Contract, he shall immediately give Notice to the Employer with detailed particulars. Within 28 days of receiving such Notice, the Employer shall advise the Contractor of what action he intends to take and/or what action the Employer requires the Contractor to take. In any event, the Contractor shall provide the Employer annually with his audited financial statements and reports.
5 Design	
5.1 General Design Obligations	The Contractor shall carry out, and be responsible for, the design of the Works. Design shall be prepared by qualified designers who are engineers or other professionals who comply with the criteria (if any) stated in the Employer's Requirements. Unless otherwise stated in the Contract, the Contractor shall submit to the Employer's Representative for consent the name and particulars of each proposed designer and design Sub Contractor. The Contractor warrants that he, his designers and design Subcontractors have the experience and capability necessary for the design. The Contractor undertakes that the designers shall be available to attend discussions with the Employer's Representative at all reasonable times. Upon receiving Notice under Sub-Clause 8.1 [Commencement Date], the Contractor shall scrutinise the Employer's Requirements (including design criteria and calculations, if any) and the items of reference mentioned in Sub-Clause 4.7 Setting Out]. Within the period stated in the Contract Data, calculated from the Commencement Date, the Contractor shall give Notice to the Employer's Representative of any error, fault or other defect found

	in the Employer's Requirements or these items of reference. After receiving this Notice, the Employers Representative shall determine whether Clause 13 [Variations and Adjustments] shall be applied, and shall give Notice to the Contractor accordingly. If and to the extent that (taking account of cost and time) an experienced contractor exercising due care would have discovered the error, fault or other defect when examining the Site and the Employer's Requirements before submitting the Tender, the Time for Completion shall not be extended and the Contract Price shall not be adjusted. If the Contractor finds any error, fault or other defect in the Employer's Requirements after the period stated in the Contract Data, then Sub-Clause 1.10 [Errors in the Employer's Requirements] shall be applicable.
5.2 Contractor's Documents	The Contractors Documents shall comprise trio technical documents specified in the Employer's Requirements, documents required to satisfy all regulatory approvals, and the documents described in Sub-Clause 5.5 As Built Documents] and Sub-Clause 5.6 [Operation and Maintenance Manuals]. Unless otherwise stated in the Employers Requirements, the Contractor's Documents shall be written in the language for communications defined in Sub-Clause 1.4 [Law and Language]. The Contractor shall prepare all Contractor's Documents, and shall also prepare any other documents necessary to instruct the Contractor's Personnel. The Employer's Personnel shall have the right to inspect the preparation of all these documents, wherever they are being prepared. If the Employer's Requirements describe the Contractor's Documents which are to be submitted to the Employer's Representative for review leading to consent and/or for approval, they shall be submitted accordingly, together with a Notice as described below. The Employer's Representative gives his consent to a document when he is satisfied that the Contractor's Documents conform to the Employer's Requirements. In the following provisions of this Sub-Clause, (i) "review period" means the period required by the Employer's Representative for review leading to consent and (if so specified) for approval, and (ii) 'Contractor's Documents" exclude any documents which are not specified as being required to be submitted for review leading to consent and/or for approval. The Contractor's Documents which require approval from the Employer's Representative shall be as listed in the Contract Data. Unless otherwise stated in the Employer's Requirements or agreed with the Employer's Representative, each review period shall not exceed 21 days, calculated from the date on which the Employer's Representative receives a Contractor's Document and the Contractor's Notice. This Notice shall state that the Contractor's Document is considered ready for review leading to either approval (if so specified) or consent with regard to conformity with the Employer's Requirements, in accordance with this Sub-Clause and for use. The Notice shall also state that the Contractor's Document complies with the Contract, or the extent to which it does not comply.

	The Employer's Representative may, within the review period, give Notice to the Contractor that a Contractor's Document fails (to the extent stated) to conform with the Contract. if a Contractor's Document so fails to conform, it shall be rectified, resubmitted and reviewed (and, if specified, approved) in accordance with this Sub-Clause, at the Contractor's cost. If such re-submission and review causes the Employer to incur additional costs, the Contractor shall, subject to Sub-Clause 20.2 [Employer's Claims], pay these costs to the Employer. For each part of the Works, and except to the extent that the prior approval or consent of the Employer's Representative shall have been obtained: (a) in the case of a Contractor's Document which has (as specified) been submitted for the Employer's Representative's approval or consent: (i) the Employers Representative shall give Notice to the Contractor that the Employers Representative gives his consent that the Contractors Document conforms with the Employers Requirements or is approved, or that it does not (to the extent stated) comply with the Contract; (b) execution of such part of the Works shall not commence until the Employers Representative has either approved or given his consent to the Contractors Document; and (iii) the Employers Representative shall be deemed to have approved the Contractors Documents or given his consent that the Contractors Documents conform to the Employers Requirements upon the expiry of the review periods for all the Contractor's Documents which are relevant to the design and execution of such part, unless the Employer's Representative has previously notified otherwise in accordance with sub-paragraph (i); (c) execution of such part of the Works shall not commence prior to the expiry of the review periods for all the Contractor's Documents which are relevant to its design and execution; (d) execution of such part of the Works shall be in accordance with those Contractor's Documents for which the Employers Representative has given his consent a to the conformity with the Employer's Requirements, (and, if specified, approved); and (e) if the Contractor wishes to modify any design or document which has previously been submitted for review (and. if specified, approval), the Contractor shall immediately give Notice to the Employer's Representative, accompanied by a written explanation of the need for such modification. Thereafter, the Contractor shall submit revised documents to the Employer's Representative in accordance with the above procedure. Any such consent and/or approval (where specified) (under this Sub-Clause or otherwise) shall not relieve the Contractor from any obligation or responsibility.
5.3 Contractor's Undertaking	If the Employer's Representative reasonably instructs that further Contractor's Documents are required, the Contractor shall prepare them promptly at his own cost. The Contractor undertakes that the

	design, the Contractor's Documents, the execution and the completed Works will be jr accordance with: (a) the Laws of the Country; and (b) the documents forming the Contract, as alterr1 or modified by variations.
5.4 Technical Standards and Regulations	Unless otherwise stated, the design, the Contractor's Documents, the execution and the completed Works shall comply with the Country's technical standards, building, construction and environmental Laws, Laws applicable to the product being produced from the Works, and other standards specified in the Employer's Requirements, applicable to the Works, or defined by the applicable Laws. All these Laws shall, in respect of the Works and each Section, be those prevailing when the Commissioning Certificate is issued in accordance with Sub-Clause 11.7 [Commissioning Certificate]. References in the Contract to published standards shall be understood to be references to the edition applicable on the Base Date, unless stated otherwise. If changed or new applicable standards come into force in the Country after the Base Date, the Contractor shall give Notice to the Employer's Representative and (if appropriate) submit proposals for compliance. In the event that: (a) the Employers Representative determines that compliance is required; and (b) the proposals for compliance constitute a variation, then the Employers Representative shall initiate a Variation in accordance with Clause 13 [Variations and Adjustments].
5.5 As-Built Documents	The Contractor shall prepare, and keep up-to-date, a complete set of "as-built" records of the execution of the Works, showing the exact as-built locations, sizes and details of the work as executed. These records shall be kept on the Site and shall be used exclusively for the purposes of this Sub-Clause. At least two copies shall be supplied to the Employer's Representative prior to the commencement of the Tests on Completion of Design-Build. In addition, the Contractor shall supply to the Employer's Representative as-built drawings of the Works, showing all Works as executed, and submit them to the Employer's Representative for review under Sub-Clause 5.2 [Contractor's Documents]. The Contractor shall obtain the consent of the Employer's Representative as to their size, the referencing system, and other relevant details. Prior to the issue of the Commissioning Certificate, the Contractor shall supply to the Employer's Representative the specified numbers and types of copies of the relevant as-built drawings, in accordance with the Employer's Requirements. The relevant work shall not be considered to be completed for the purposes of issuing the Commissioning Certificate under Sub-Clause 11.7 [Commissioning Certificate] until the Employer's Representative has received these documents.
5.6	Prior to the commencement of the Commissioning Period, the

Operation and Maintenance Manuals	Contactor shall supply to the Employer's Representative two copies of all operation and maintenance manuals in sufficient detail for the Employer to operate, maintain, dismantle, reassemble, adjust and repair the Plant and the Works. The Contractor shall supply the balance of the required operation and maintenance manuals prior to the issue of the Commissioning Certificate. The Works or any Section shall not be considered to be completed for the purposes of issuing the Commissioning Certificate under Sub-Clause 11 .7 [Commissioning Certificate] until the Employer's Representative has received those documents.
5.7 Design Error	It errors, omissions, ambiguities, inconsistencies, inadequacies or other defects are found in the Contractor's Documents, they and the Works shall be corrected at the Contractor's cost, notwithstanding any consent or approval under this Clause.
6 Staff and Labour	
6.1 Engagement of Staff and Labour	Except as otherwise stated in the Employer's Requirements, the Contractor shall make arrangements for the engagement of all staff and labour, local or otherwise, and for their payment. housing, feeding and transport.
6.2 Rates of Wages and Conditions of Employment	The Contractor shall pay rates of wages and observe conditions of labour which are not lower than those established for the trade or industry where the work is carried out. If no established rates or conditions are applicable, the Contractor shall pay rates of wages and observe conditions which are not lower than the general level of wages and conditions observed locally by employers whose trade or industry is similar to that of the Contractor.
6.3 Persons in the Service of Employer	The Contractor shall not recruit, or attempt to recruit, staff and labour from amongst the Employers Personnel.
6.4 Labour Laws	The Contractor shall comply with all the relevant labour Laws applicable to the Contractor's Personnel, including Laws relating to their employment, health, safety, welfare, immigration and emigration, and shat allow them all their legal rights. The Contractor shall require the Contractor's Personnel to obey all applicable Laws, including those concerning safety at work.
6.5 Working Hours	No work shall be carried out on the Site on locally recognised days of rest or outside the normal working hours stated in the Contract Data, unless: (a) otherwise stated in the Contract; (b) the Employer's Representative gives consent; (c) the work is unavoidable, or necessary for the protection of life or property or for the safety of the Works, in which case the Contractor shall immediately advise the Employer's Representative; or (d) required for the proper fulfillment of the requirements of the Operation Service Period.
6.6 Facilities for Staff	Except as otherwise stated in the Employer's Requirements, the Contractor shall provide and maintain all necessary accommodation and welfare facilities for the Contractor's Personnel. The Contractor

and Labour	shall also provide facilities for the Employer's Personnel as stated in the Employer's Requirements. The Contractor shall not permit any of the Contractor's Personnel to maintain any temporary or permanent living quarters within the Site of the Works, save where the Employer has given the Contractor permission in writing.
6.7 **Health and Safety**	The Contractor shall at all times during the Contract Period take all reasonable precautions to maintain the health and safety of the Contractor's Personnel. In collaboration with local health authorities, the Contractor shall ensure that medical staff, first aid facilities, sick bay and ambulance service are available at all times at the Site and at any accommodation for Contractor's and Employer's Personnel, and that suitable arrangements are made for all necessary welfare and hygiene requirements and for the prevention of epidemics. The Contractor shall appoint an accident prevention officer at the Site, responsible for maintaining safety and protection against accidents. This person shall be qualified for this responsibility, and shall have the authority to issue instructions and take protective measures to prevent accidents. Throughout the execution and operation of the Works, the Contractor shall provide whatever is required by this person to exercise this responsibility and authority. The Contractor shall send details of any accident to the Employer's Representative as soon as practicable after its occurrence. The Contractor shall maintain records and make reports concerning health, safety and welfare of persons, and damage to property, as the Employer's Representative may reasonably require.
6.8 **Contractor's Superintendence**	For the complete Contract Period, the Contractor shall provide all necessary superintendence to plan, arrange, direct, manage, inspect, test and monitor the design and execution of the Works and the provision of the Operation Service in accordance with his obligations under the Contract. Superintendence shall be given by a sufficient number of persons having adequate knowledge of the language for communications (defined in Sub-Clause 1.4 [Law and Language]) and of the operations to be carried out (including the methods and techniques required, the hazards likely to be encountered and methods of preventing accidents), for the satisfactory and safe execution of the 'Works and the provision of the Operation Service.
6.9 **Contractor's Personnel**	The Contractors Personnel shall be appropriately qualified, skilled and experienced in their respective trades or occupations. The Employers Representative may require the Contractor to remove (or cause to be removed) any person employed on the Site or Works, including the Contractors Representative if applicable, who: (a) persists in any misconduct or lack of care; (b) carries out duties incompetently or negligently: (c) fails to conform with any provisions of the Contract; or (a) d) persists in any conduct which is prejudicial to safety, health, or Ure protection of the environment. If appropriate, the Contractor shall then appoint (or cause to be appointed) a suitable replacement person.

6.10 Records of Contractor's Personnel and Equipment	During the Design-Build Period, the Contractor shall submit, to the Employer's Representative, details showing the number of each class of Contractors Personnel and of each type of Contractor's Equipment on the Site. Any changes to the Personnel or Equipment shall be notified at the end of each calendar month to the Employer's Representative. During the Operation Service Period, any changes to the Personnel or Equipment shall be notified at the end of each calendar month to the Employer's Representative.
6.11 Disorderly Conduct	The Contractor shall at all times take all reasonable precautions to prevent any unlawful, riotous or disorderly conduct by or amongst the Contractor's Personnel, and to preserve peace and protection of persons and property on and near the Site.
7 Plant, Materials, and Workmanship	
7.1 Manner of Execution	The Contractor shall carry out the manufacture and/or replacement and/or repair of Plant, the production and manufacture of Materials, and all other activities during the execution of the Works and provision of the Operation Service: (a) in accordance with the applicable Laws in the manner (if any) specified in the Contract; (b) in a proper workmanlike and careful manner, in accordance with recognised good practice: and (c) with properly equipped facilities and non-hazardous Materials, except as otherwise specified in the Contract.
7.2 Samples	The Contractor shall submit the following samples of Materials, and relevant information, to the Employers Representative for review in accordance with the procedures for Contractor's Documents described in Sub-Clause 5.2 [Contractor's Documents]: (a) manufacturers standard samples of Materials and samples specified in the Contract, all at the Contractor's cost; and (b) additional samples instructed by the Employer's Representative as a Variation. Each sample shall be labelled as to origin and intended use in the Works.
7.3 Inspection	The Employer's Personnel and other persons authorised by the Employer shall at all reasonable times: (a) have full access to all parts of the Site and to all places from which natural Materials are being obtained; (b) during production, manufacti.re and construction (at the Site and elsewhere), operation and maintenance, be entitled to examine, inspect, measure and test the Materials and workmanship, and to check the progress of manufacture of Plant and production and manufacture of Materials; and (c) carry out other authorised duties and inspections. The Contractor shall give the Employer's Personnel and other persons authorised by the Employer full opportunity to carry out tflese activities, including providing access, facilities, permissions and safety equipment, No such activity shall relieve the Contractor

	from any obligation or responsibility. The Contractor shall give Notice to the Employer's Representative whenever any work is ready and before it is covered up, put out of sight, or packaged for storage or transport. The Employer's Representative shall then either carry out the examination, inspection, measurement or testing without unreasonable delay, or promptly give Notice to the Contractor that the Employer's Representative does not require to do so. If the Contractor fails to give the Notice, he shall, if and when required by the Employer's Representative, uncover the work and thereafter reinstate and make good, all at the Contractor's cost.
7.4 **Testing**	This Sub-Clause shall apply to all tests on Plant, Materials and workmanship specified in the Contract. The Contractor shall provide all apparatus, assistance, documents and other information, electricity, equipment, fuel, consumables, instruments, labour, materials, and suitably qualified and experienced staff, as are necessary to carry out the specified tests efficiently. The Contractor shall agree, with the Employer's Representative, the time and place for the specified testing of any Plant, Materials and other parts of the Works. The Employer's Representative may, under Clause 13 [Variations and Adjustments], vary the location or details of specified tests, or instruct the Contractor to carry out additional! tests. If these varied or additional tests show that the tested Plant, Materials or workmanship is not in accordance with the Contract, the cost of carrying out this Variation shall be borne by the Contractor, notwithstanding other provisions of the Contract. The Employer's Representative shall give Notice to the Contractor not less than 24 hours prior to the tests, of the Employer's Representative's intention to attend the tests. If the Employers Representative does not attend at the time and place agreed, the Contractor may proceed with the tests, unless otherwise instructed by the Employers Representative, and the tests shall then be deemed to have been made in the Employers Representatives presence. If the Contractor suffers delay in carrying out the tests and/or incurs cost from complying with these instructions or as a result of a delay for which the Employer is responsible, the Contractor shall give Notice to the Employer's Representative and shall be entitled, subject to Sub-Clause 20.1 [Contractor's Claims], to: (a) an extension of time for any such delay, if completion is or will be delayed, under Sub-Clause 9.3 [Extension of Time for Completion of Design-Build]; and (b) payment of any such Cost Plus Profit, which shall be included n the Contract Price. After receiving this Notice, the Employers Representative shall proceed in accordance with Sub-Clause 3.5 [Determinations] to agree or determine these matters. The Contractor shall promptly forward to the Employer's Representative duly certified reports of the tests. When the specified tests have been passed, the Employer's Representative shall

	endorse the Contractor's test certificate, or issue a certificate to him, to that effect. If the Employer's Representative has not attended the tests, he shall be deemed to have accepted the readings as accurate.
7.5 Rejection	If, as a result of an examination, inspection, measurement or testing, any Plant, Materials, or workmanship is found to be defective or otherwise not in accordance with the Contract, the Employer's Representative may reject the Plant, Materials, design or workmanship by giving Notice to the Contractor, with reasons. The Contractor shall then promptly make good the defect at the Contractor's cost and ensure that the rejected item complies with the Contract. If the Employer's Representative requires this Plant, Materials, or workmanship to be retested, the tests shall be repeated under the same terms and conditions. If the rejection and retesting cause the Employer to incur additional costs, the Contractor shall, subject to Sub-Clause 20.2 [Employer's Claims 1' pay these costs to the Employer.
7.6 Remedial Work	At any time during the Contract Period, notwithstanding any previous test or certification, the Employer's Representative may instruct the Contractor to: (a) repair, remove from the Site and replace, any Plant or Materials which is not in accordance with the Contract; (b) remove and re-execute any other work which is not in accordance with the Contract; and (c) execute any work which is urgently required for the safety of the Works or the provision of the Operation Service, whether because of an accident, unforeseeable event or otherwise. The Contractor shall comply with the instruction within a reasonable time. which shall be the time (if any) specified in the instruction, or immediately if urgency is specified under sub-paragraph(C). Except to the extent that the Contractor may be entitled to payment for the work required under sub-paragraph(c), the Contractor shall bear the cost of such remedial work. If the Contractor fails to comply with the instruction, the Employer shall be entitled to employ and pay other persons to carry out the work. Except to the extent that the Contractor would have been entitled to payment for the work, the Contractor shall, subject to Sub-Clause 20.2 [Employer's Claims], pay to the Employer all costs arising from this failure.
7.7 Ownership of Plant and Materials	Each item of Plant and Materials shall, to the extent consistent with the Laws of the Country, become the property of the Employer at whichever is the earlier of the following times, free from liens and other encumbrances: (a) when it is delivered to the Site; (b) when the Contractor is paid the value of the Plant and Materials under Sub-Clause 9.9 [Payment for Plant and Materials in Event of Suspension]; and (c) when the Contractor is paid the value of the Plant and Materials under Sub-Clause 14.6 [Payment for Plant and Materials

	intended for the Works].
7.8 Royalties	Unless otherwise stated in the Employers Requirements, the Contractor shall pay all royalties, rents and other payments for: (a) natural Materials obtained from outside the Site; and (b) the disposal of material from demolitions and excavations and of other surplus material (whether natural or man-made), except to the extent that disposal areas within the Site are specified in the Contract.
8 Commencement Date, Completion and Programme	
8.1 Commencement Date	The Employer's Representative shall give Notice stating the Commencement Date to the Contractor not less than 14 days prior to the Commencement Date. Unless otherwise stated in the Particular Conditions, the Commencement Date shall be within 42 days after the Contractor receives the Letter of Acceptance.
8.2 Time for Completion	The Contractor shall complete the whole of the Design-Build and each Section (if any), in accordance with Sub-Clause 9.2 [Time for Completion of Design-Build], or as extended under Sub-Clause 9.3 [Extension of Time for Completion of Design-Build], and shall provide the Operation Service for The period stated in the Contract Data.
8.3 Programme	The Contractor shall submit a detailed time programme to the Employer's Representative within 28 days after receiving the Notice under Sub-Clause 8.1 [Commencement Date]. The Contractor shall also submit a revised programme whenever the previous programme is inconsistent with actual progress or with the Contractor's obligations. Each programme shall include: (a) the order in which the Contractor intends to carry out the Works, including the anticipated timing of each stage of design, Contractor's Documents, procurement, manufacture, inspection, delivery to Site, construction, erection, testing, commissioning and trial operation; (b) the period of Operation Service; (c) the periods for reviews under Sub-Clause 5.2 [Contractors Documents] and for any other submissions, including the supply of samples in accordance with Sub-Clause 7.2 [Samples], approvals and consents specified in the Employer's Requirements; (d) the sequence and timing of inspections and tests specified in the Contract, and (e) a supporting report which includes: (i) a general description of the methods which the Contractor intends to adopt for both the Design-Build arid the Operation Service; (ii) details showing the Contractors reasonable estimate of the number of each class of Contractor's Personnel and of each type of Contractor's Equipment, required on the Site for each major stage; and (iii) the Contractor's proposed manning schedule for the Operation Service.

	Unless the Employers Representative, within 21 days after receiving a programme, gives Notice to the Contractor stating the extent to which it does not comply with the Contract, the Contractor shall proceed in accordance with the programme, subject to his other obligations under the Contract. The Employers Personnel shall be entitled to rely upon the programme when planning their activities. If, at any time, the Employer's Representative gives Notice to the Contractor that a programme fails (to the extent stated) to comply with the Contract or to be consistent with actual progress and the Contractor's stated intentions, the Contractor shall submit, within 14 days, a revised programme to the Employer's Representative in accordance with this Sub-Clause.
8.4 **Advance Warning**	Each Party shall endeavour to advise the other Party in advance of any known or probable future events or circumstances which may adversely affect the work, increase the Contract Price or delay the execution of the Works or the Operation Service. The Employers Representative may require the Contractor to submit an estimate of the anticipated effect of the future events or circumstances, and/or a proposal under Sub-Clause 13.3 [Variation Procedure].
8.5 **Delay Damages**	If the Contractor fails to complete the Design-Build in accordance with the requirements of Sub-Clause 9.2 [Time for Completion of Design-Build], he shall pay delay damag3s as detailed in Sub-Clause 9.6 [Delay Damages relating to Design-Build]. If the Contractor fails or is unable to provide the Operation Service for the complete period specified in the Contract, or parts of the Operation Service, and such failure is: (a) due to a cause for which the Contractor is responsible; and (b) results in the Employer losing revenue or income which the Employer would normally have expected to receive during the Operation Service Period; or (c) results in the Employer suffering any other loss which he would not have suffered but for such failure, then the Contractor shall pay to the Employer compensation in accordance with Sub-Clause 10.6 [Delays and Interruptions during the Operation Service].
8.6 **Contract Completion Certificate**	Performance of the Contractors obligations in respect of the Contract shall not be considered to have been completed until the Contract Completion Certificate has been signed by the Employer's Representative and issued to the Contractor, stating the date on which the Contractor completed his obligations in respect of both the Design-Build and the Operation Service (Contract Completion Date). The Employer's Representative shall, subject to Sub-Clause 11.8 [Joint Inspection Prior to Contract Completion], Sub-Clause 10.8 [Completion of Operation Service] and Sub-Clause 4.23 [Contractors Operations on Site], issue the Contract Completion Certificate to the Contractor. with a copy to the Employer, within 21 days after the last day of the Contract Period. No extension of the Operation Service Period shall be allowed except by written agreement between the Parties. Only the Contract Completion Certificate shall be deemed to constitute the Employers acceptance of the Contractors completion

	of his obligations under the Contract. Following the issue of the Contract Completion Certificate the Employer shall be fully responsible for the care, safety, operation, servicing and maintenance of the Works.
8.7 Handback Requirements	The Contractor shall ensure that the Works comply with the hardback requirements specified in the Employer's Requirements prior to the issue of the Contract Completion Certificate.
8.8 Unfulfilled Obligations	After the Contract Completion Certificate has been issued, each Party shall remain liable for the fulfillment of any obligation under the Contract which remains unperformed at that time. For the purposes of determining the nature and extent of unperformed obligations, the Contract shall be deemed to remain in force.
9 Design-Build	
9.1 Commencement of Design-Build	The Contractor shall commence the design and execution of the Works within 28 days of the Commencement Date, and shall then proceed with the Design-Build with due expedition and without delay.
9.2 Time for Completion of Design-Build	The Contractor shall complete the whole of the Design-Build of the Works, and each Section (if any), within the Time for Completion of Design-Build of the Works or Section (as the case may be) as set Out in the Contract Data, including: (a) passing the Tests on Completion under Sub-Clause 11.1 [Testing of the Works] (b) completing all work which is stated in the Contract as being required under Sub-Clause 11.5 [Completion of the Works and Sections]; and (c) preparation and delivery to the Employer's Representative of Contractor's Documents required under Sub-Clause 5.2 [Contractor's Documents].
9.3 Extension of Time for Completion of Design-Build	The Contractor shall be entitled, subject to Sub-Clause 20.1 [Contractors Claims], to an extension of the Time for Completion of Design-Build if and to the extent that completion for the purposes of Sub-Clause 11.5 [Completion of the Works and Sections] is or will be delayed by any of the following causes: (a) a Variation (unless an adjustment to the Time for Completion of Design-Build has been agreed under Sub-Clause 13.3 [Variation Procedure]); (b) a cause of delay giving an entitlement to extension of time under a Sub-Clause of these Conditions: (c) exceptionally adverse climatic conditions; (d) Unforeseeable shortages in the availability of personnel or Goods caused by epidemic or governmental actions; or (e) any delay, impediment or prevention caused by or attributable to the Employer, the Employer's Personnel, or the Employer's other contractors on the Site. If the Contractor considers hirn3elf to be entitled to an extension of the Time for Completion of Design-Build, the Contractor shall give Notice to the Employer's Representative in accordance with Sub-Clause 20.1 (Contractor's Claims]. When determining each

	extension of time, the Employer's Representative shall review previous determinations and may increase, but shall not decrease, the total extension of time. If a Dispute regarding an extension of time has been referred to the DAB, the Contractor shall be immediately entitled to any extension of the Time for Completion of Design-Build which is decided by the DAB under Sub-Clause 20.6 [Obtaining Dispute Adjudication Board's Decision].
9.4 **Delays Caused by Authorities**	If the following conditions apply during the Design-Build Period, namely: (a) the Contractor has diligently followed the procedures laid down by the relevant legally constituted pubic and/or local authorities in the Country; (b) these authorities delay or disrupt the Contractor's work; and (c) the delay or disruption was Unforeseeable, then this delay or disruption will be considered as a cause of delay under sub paragraph (b) of Sub-Clause 9.3 [Extension of Time for Completion of Design-Build].
9.5 **Rate of Progress**	If, in the opinion of the Employer's Representative, at any time during the Design-Build Period: (a) actual progress is too slow to complete within the Time for Completion of Design-Build; and/or (b) progress has fallen (or will fall) behind the current programme under Sub-Clause 8.3 [Programme], other than as a result of a cause listed in Sub-Clause 9.3 [Extension of Time for Completion of Design-Build], then the Employers Representative may instruct the Contractor to submit, under Sub-Clause 8.3 [Programme], a revised programme and supporting report describing the revised methods which the Contractor proposes to adopt in order to expedite progress and complete within the Time for Completion of Design-Build. Unless the Employer's Representative notifies otherwise, the Contractor shall adopt these revised methods, which may require increases in the working hours and/or in the numbers of Contractor's Personnel and/or Goods, at the risk and cost of the Contractor. If these revised methods cause the Employer to incur additional costs, the Contractor shall, subject to Sub-Clause 20.2 [Employer's Claims], pay these costs to the Employer, in addition to delay damages (if any) under Sub-Clause 9.6 [Delay Damages relating to Design-Build] below.
9.6 **Delay Damages relating to Design-Build**	If the Contractor fails to comply with Sub-Clause 9.2 [Time for Completion of Design-Build, the Contractor shall, subject to Sub-Clause 20.2 [Employer's Claims], pay delay damages to the Employer for this default. These delay damages shall be the amount stated in the Contract Data, which shall be paid for every day which shall elapse between the relevant Time for Completion and the date stated in the Commissioning Certificate. However, the total amount due under this Sub-Clause shall not exceed the maximum amount of delay damages (if any) stated in the Contract Data. These delay damages shall be the only damages due from the

	Contractor for such default, other than in the event of termination under Clause 15 [Termination by Employer] prior to completion of the Works. These damages shall not relieve the Contractor from his obligation to complete the Design-Build and the Operation Service, or from any other duties, obligations or responsibilities which he may have under the Contract.
9.7 Suspension of Work	The Employers Representative may at any time instruct the Contractor to suspend progress of part or all of the Works. During such suspension, the Contractor shall protect, store, secure and maintain such part or the Works against any deterioration, loss or damage. The Employer's Representative shall also notify the cause for the suspension. If and to the extent that the cause is the responsibility of the Contractor, the following Sub- Clauses 9.8, 9.9 and 9.10 shall not apply.
9.8 Consequences of Suspension	if, during the Design-Build Period, the Contractor suffers delay and/or incurs cost from complying with the Employer's Representative's instructions under Sub-Clause 9.7 [Suspension of Work] and/or from resuming the work, the Contractor shall give Notice to the Employer's Representative and shall be entitled, subject to Sub-Clause 20.1 [Contractor's Claims 1' to: (a) an extension of time for any such delay, if completion is or will be delayed, under Sub-Clause 9.3 [Extension of 77me for Completion of Design-Build]; and (b) payment of any such Cost, which shall be included in the Contract Price. After receiving this Notice, the Employer's Representative shall proceed in accordance with Sub-Clause 3.5 [Determinations] to agree or determine these matters. The Contractor shall not be entitled to an extension of time for, or to payment of the Cost incurred in, making good the consequences of the Contractor's faulty design, workmanship or materials, or of the Contractor's failure to protect, store or secure in accordance with Sub-Clause 9.7 [Suspension of Work].
9.9 Payment for Plant and Materials in Event of Suspension	The Contractor shall be entitled to payment of the value (as at the date of suspension) of plant and/or Materials which have not been delivered to Site, it: (a) the work on Plant or delivery of Plant and/or Materials has been suspended for more than 28 days; and (b) the Contractor has marked the Plant and/or Materials as the Employer's property in accordance with the Employer's Representative's instructions. Payment for Plant and/or Materials made pursuant to this Sub-Clause shall, if requested by the Employer's Representative, be subject to the production of satisfactory evidence by the Contractor that the said Plant and/or Materials are fully owned by the Contractor and are not subject to any retention of title by the supplier.
9.10 Prolonged	If the suspension under Sub-Clause 9,7 [Suspension of Work] has continued for more than 84 days, the Contractor may request the

Suspension	Employer's Representative's permission to proceed. If the Employers Representative does not give permission within 28 days after being requested to do so, the Contractor may, by giving Notice to the Employer's Representative, treat the suspension as an omission under Clause 13 [Variations and Adjustments] of the affected part of the Works. If the suspension affects the whole of the Works, the Contractor may give Notice of termination under Sub-Clause 16.2 [Termination by Contractor].
9.11 Resumption of Work	After the permission or instruction to proceed is given, the Contractor and the Employer's Representative shall jointly examine the Works and the Plant and Materials affected by the suspension. The Contractor shall make good any deterioration or defect in or loss of the Works or Plant or Materials, which has occurred during the suspension. The Employers Representative shall make a written record of au making good required to be caned out by the Contractor.
9.12 Completion of Design-Build	The Design-Build shall not be considered as complete until all of the following are achieved: (a) the Works have been fully designed and executed n accordance with the Employers Requirements and other relevant provisions of the Contract: (b) the Works have passed the Tests on Completion of Design-Build in accordance with Sub-Clause 11.1 Testing of the Works]; (c) Contractor's Documents in accordance with Sub-Clause 5.5 [As-Built Documents] and Sub-Clause 5.6 [Operation and Maintenance Manuals] have been supplied and approved by the Employer's Representative: and (d) the Commissioning Certificate required under Sub-Clause 11.7 [Commissioning Certificate] has been issued stating the date upon which the Design-Build has been completed and the Operation Service shall commence.
9.13 Failure to Complete	Should the Contractor fail to complete the Design-Build prior to the Cut-Off Date, the Employer may, at his sole option, either: (a) permit the Contractor to continue the Design-Build for a further named period, with an absolute right to re-apply this Sub-Clause in the event that the Contractor fails to complete the Design-Build within the extended period: or (b) terminate the Contract in accordance with Sub-Clause 15.2 [Termination for Contractor's Default] and, if he so chooses, complete the work and subsequently execute the Operation Service himself or by engaging others. In either case, the Employer will be entitled to recover from the Contractor any direct loss incurred, including any loss resulting from the delayed operation of the Works, subject to the limitations contained n Sub-Clause 9.6 [Delay Damages Relating to Design-Build] and Sub-Clause 17.8 [Limitation of Liability].
10 Operation Service	
10.1 General Requirements	The Contractor shall comply with the Operation Management Requirements as provided for in the Contract and any revisions thereof which are agreed during the Contract Period.

	The Contractor shall follow the requirements of the Operation and Maintenance Plan and the operation and maintenance manuals. No significant alteration to such arrangements and methods shall be made without the prior approval of the Employer's Representative. During the Operation Service, the Contractor shall be responsible for ensuring that the Works remain fit for the purposes for which they are intended. The operators and maintenance personnel for the Works, including plant operators, shall have the appropriate experience and qualifications to perform the Operation Service. The names, with details of their qualifications and experience, of all operation and maintenance personnel shall be submitted to the Employer for approval, and no such personnel shall be engaged prior to receiving such approval.
10.2 Commencement of Operation Service	Unless otherwise stated in the Employers Requirements, the commencement of the Operation Service shall be from the date stated in the Commissioning Certificate issued under Sub-Clause 11.7 [Commissioning Certificate]. The Operation Service shall not commence until the Design-Build of the Works or any Sections has been completed in accordance with Sub-Clause 9.12 [Completion of Design-Build]. Should the Commissioning Certificate, or any Notice attached or pertaining thereto, contain requirements or restrictions over and above those in the Contract, the Contractor shall comply with such requirements and/or restrictions, and, to the extent that the Contractor suffers additional Cost as a result, and subject to the provisions of Sub-Clause 20.1 (Contractor's Claims], he shall be reimbursed by the Employer unless such requirements or restrictions were as a result of a fault or failure of the Contractor. The Contractor shall thereafter provide the Operation Service in compliance with the Operation Management Requirements and in accordance with Sub-Clause 5.5 (As Built Documents] and Sub-Clause 5.6 [Operation and Maintenance Manuals]. If the Contractor wishes to modify a document which has previously been submitted and approved, the Contractor shall immediately notify the Employers Representative, and shall subsequently submit revised document(s) to the Employer's Representative for review accompanied by a written explanation of the need for such modification. The Contractor shall not implement any proposed modification in accordance with subparagraph (d) of Sub-Clause 5.2 [Contractors Documents] until such modification has been reviewed by the Employer's Representative, and consent to proceed has been given in writing. However, any such approval or consent, or any review (under this Sub-Clause nr otherwise) shall not relieve the Contractor from any obligation or responsibility.
10.3 Independent Compliance Audit	At least 182 days prior to the commencement of the Operation Service, the Employer and the Contractor shall jointly appoint the Auditing Body to carry out an independent and impartial audit during the Operation Service. The terms of appointment of the Auditing Body shall be included in the Employer's Requirements, and the

	purpose will be to audit and monitor the performance of both the Employer and the Contractor during the Operation Service in compliance with the Operation Management Requirements. If the Parties cannot agree on the appointment of the Auditing Body, the matter shall be referred to the DAB by the Parties. The DAB shall make the appointment and notify the Parties accordingly. The Auditing Body shall commence its duties on the same date as the Operation Service commences. Payment of the Auditing Body shall be made from the Provisional Sum included in the Contract for that purpose. Both Parties shall cooperate with the Auditing Body and give due regard to the matters raised in each report issued by the Auditing Body.
10.4 Delivery of Raw Materials	The Employer shall be responsible for the free issue and supply and delivery to the Site (or other designated place) of the raw materials, fuels, consumables and other such items specified in the Employers Requirements. The Employer shall be responsible that all such items are fit for purpose and comply with the requirements of the Contract in respect of quality, purpose and function. In the event that any such item or product is not delivered in accordance with the agreed delivery programme or deviates from the specified quality, and such delay or deviation causes the Contractor to suffer additional COSI, the Contractor shall be entitled to give due notice to the Employer of the nature of the costs which he has incurred and, subject to Sub-Clause 20.1 [Contractor's Claims], be entitled to recover his Cost Plus Profit. The provisions of this Sub-Clause shall not apply in cases where delays are due to: (a) breakdown, maintenance, repair, replacement or other operational failure under the responsibility of the Contractor; (b) health, safety and environmental risks carried by the Contractor; or (c) any act or omission of the Contractor under the Contract.
10.5 Training	The Contractor shall carry out the training of Employer's Personnel in the operation and maintenance of the Works to the extent specified in the Employer's Requirements. The programme and scheduling of the training shall be agreed with the Employer, and the Contractor shall provide experienced training staff, and all training materials as stated in the Employer's Requirements. The Employer shall be responsible for providing the training facilities and nominating and selecting suitable personnel for training.
10.6 Delays and Interruptions during the Operation Service	Delays and interruptions during the Operation Service shall be agreed and determined as follows: (a) Delays or Interruptions caused by the Contractor If there are any delays or interruptions during the Operation Service which are caused by the Contractor or by a cause for which the Contractor is responsible, the Contractor shall compensate the Employer for any losses including loss of revenue, loss of profit and overhead losses. The amount of

	compensation due shall be agreed or determined according to Sub-Clause 3.5 [Determinations, and the Employer shall be entitled to recover the amount due by making a corresponding deduction from the next payment due to the Contractor. However, the total amount of compensation payable by the Contractor to the Employer shall not exceed the amount stated in the Contract Data. There will be no extension of the period of the Operation Service as a result of any such delay or interruption. (b) Delays or Interruptions caused by the Employer If there are any delays or interruptions during the Operation Service which are caused by the Employer or by a cause for which the Employer is responsible, the Employer shall compensate the Contractor for any cost and losses including loss of revenue and loss of profit. The amount of compensation due shall be agreed or determined according to Sub-Clause 3.5 [Determinations], and the Employer shall pay the amount due by making a corresponding adjustment to the next payment due to the Contractor. In any event other than in the case of election by the Employer to terminate for his convenience pursuant to Sub-Clause 15.5 [Termination for Employer's Convenience], the total amount of compensation payable by the Employer to the Contractor shall not exceed the amount stated in the Contract Data. There will be no extension of the period of the Operation Service as a result of any such delay or interruption. (c) Suspension by the Employer The Employer's Representative may at any time during the Operation Service instruct the Contractor to suspend progress of the Operation Service. During such suspension, the Contractor shall protect, store, secure and maintain the Plant against any deterioration, loss or damage. If the need to suspend the Operation Service by the Employer is due to any failure of the Contractor or circumstances for which the Contractor is responsible under the Contract, the provisions of paragraph (a) of this Sub- Clause shall apply. If the need to suspend the Operation Service is a result neither of any failure by the Contractor nor of circumstances for which the Contractor is responsible under the Contract, the provisions of paragraph (b) of this Sub-Clause shall apply. If a suspension, which is due neither to any failure by the Contractor nor to circumstances for which the Contractor is responsible under the Contract, has continued for more than 84 days, the Contractor may request the Employer's Representative's permission to proceed. If the Employers Representative does not give permission within 28 days after being requested to do so, the Contractor may give Notice of termination under Sub-Clause 16.2 (Termination by Contractor]. After the permission or instruction to proceed is given, the Contractor and the Employer's Representative shall jointly examine the Works. The Contractor shall make good any deterioration or defect in the Plant and the Employer's Representative shall make a written record of all making good

	required to be carried out by the Contractor. I the suspension is due neither to any failure by the Contractor nor to circumstances for which the Contractor is responsible under the Contract, the Contractor shall be entitled to be paid the Cost Plus Profit of making good the Works prior to re-commencing the Operation Service.
10.7 Failure to Reach Production Outputs	In the event that the Contractor fails to achieve the production outputs required tinder the Contract, the Parties shall jointly establish the cause of such failure. (a) If the cause of the failure lies with the Employer or any of his servants or agents, then, after consultation with the Contractor, the Employer shall give written instruction to the Contractor of the measures which the Employer requires the Contractor to take. If the Contractor suffers any additional cost as a result of the failure or the measures instructed by the Employer, the Employer, subject to Sub-Clause 3.5 [Determinations] and Sub-Clause 20.1 [Contractors Claims], shall pay the Contractor us Cost Plus Profit. (b) If the cause of the failure lies with the Contractor then, after due consultation with the Employer, the Contractor shall take all steps necessary to restore the output to the levels required under the Contract. If the Employer suffers any loss as a result of the failure or the measures taken by the Contractor, the Contractor, subject to Sib-Clause 3.5 [Determinations], shall pay the Employer the performance damages specified in the Contract Data. Unless otherwise stated in the Contract Data, if the failure continues for a period of more than 84 days and the Contractor is unable to achieve the required production output, the Employer may either: (i) continue with the Operation Service at a reduced level of compensation determined in accordance with Sub-Clause 3.5 [Determinations]; or, (ii) if the production outputs fail to reach the minimum values required in the Contract Data, give Notice to the Contractor not less than 56 days prior to terminating the Contract, in accordance with Sub-Clause 15.2 [Termination for Contractor's Default]. In such an event, the Employer shall be free to continue the Operation Service himself or by
10.8 Completion of Operation Service	Unless the Parties have mutually agreed to prolong the Operation Service, the obligation of the Contractor to operate and maintain the Plant under the Operation Service shall cease at the end of the period stated in the Contract as the Operation Service Period. Notwithstanding the foregoing, other services to be performed by the Contractor must be completed before the Contractor will be entitled to receive the Contract Completion Certificate in accordance with Sub-Clause 8.6 [Contract Completion Certificate]. Pre-conditions which must be fulfilled by the Contractor before the Contract Completion Certificate will be issued are: (a) Inspection in accordance with Sub-Clause 11.8 [Joint Inspection

	Prior to Contract Completion]; (b) Testing in accordance with Sub-Clause 11.9 [Procedure for Tests Prior to Contract Completion]; (c) Updating Operation and Maintenance manuals providing performance records and data in accordance with Sub-Clause 5.6 [Operation and Maintenance Manuals]; and (d) Remedying defects found during inspection in accordance with Si ih-Clause 11.8 [Joint Inspection Prior to Contract Completion].
10.9 Ownership of Output and Revenue	During the Operation Service, any production output and revenue shall be the exclusive property of the Employer.
11 Testing	
11.1 Testing of the Works	The Contractor shall carry out the Tests on Completion of Design-Build in accordance with this Clause and Sub-Clause 7.4 [Testing], after providing the documents in accordance with Sub-Clause 5.5 [As-Built Documents] and Sub-Clause 5.6 [Operation and Maintenance Manuals]. The Contractor shall give Notice to the Employers Representative not less than 21 days prior to the date after which the Contractor will be ready to carry out each of the Tests on Completion of Design-Build. Unless otherwise agreed, Tests on Completion of Design-Build shall be carried out within 14 days after this date, on such day or days as the Employer's Representative shall instruct. Unless otherwise stated in the Particular Conditions, the Tests on Completion of Design-Build shall be carried out in the following sequence and are further detailed in the Employers Requirements: (a) pre-commissioning tests, which shall include the appropriate inspections and ("dry" or "cold") functional tests to demonstrate that each item of Plant can safely undertake the next stage, (b); (b) commissioning tests, which shall include the specified operational tests to demonstrate that the Works or Section can be operated safely and as specified, under all available operating conditions; and (c) trial operation, which shall demonstrate that the Works or Section perform reliably and in accordance with the Contract. The Employer shall be the sole beneficiary of any revenue or benefit resulting from the Tests on Completion of Design-Build. During trial operation, when the Works are operating under stable conditions, the Contractor shall give Notice to the Employer's Representative that the Works are ready for any other Tests on Completion of Design-Build, including performance tests to demonstrate whether the Works conform with criteria specified in the Employer's Requirements and with the Schedule of Guarantees. Trial operation shall not constitute Commencement of the Operation Service under Sub-Clause 10.2 [Commencement of Operation Service]. In considering the results of the Tests on Completion of Design-Build, the Employer's Representative shall make allowances for the effect of any use of the Works by the Employer on the performance

	or other characteristics of the Works, As soon as the Works, or a Section, have passed each of the Tests on Completion of Design-Build described in sub-paragraph (a), (b) or (c) above, the Contractor shall submit a report certified by the Contractor of the results of these Tests to the Employer's Representative.
11.2 Delayed Tests on Completion of Design-Build	If the Tests on Completion of Design-Build are being unduly delayed by the Employer, Sub-Clause 7.4 [Testing] (fifth paragraph) shall be applicable. If the Tests on Completion of Design-Build are being unduly delayed by the Contractor, the Employer's Representative may by Notice require the Contractor to carry out such Tests within 21 days after receiving the Notice. The Contractor shall carry out such Tests on the day or days within that period as the Contractor may fix and of which he shall give Notice to the Employers Representative. If the Contractor fails to carry out the Tests on Completion of Design-Build within the period of 21 days, the Employer's Personnel may proceed with the Tests at the risk and cost of the Contractor. The Tests on Completion shall then be deemed to have been carried out in the presence of the Contractor and the results of the Tests shall be accepted as accurate.
11.3 Retesting of the Works	If the Works, or a Section, fail to pass the Tests on Completion of Design-Build, Sub Clause 7.5 [Rejection] shall apply, and the Employers Representative or the Contractor may require the failed Tests, and Tests on Completion of Design-Build on any related work, to be repeated under the same terms and conditions.
11.4 Failure to Pass Tests on Completion of Design-Build	If the Works, or a Section, fail to pass the Tests on Completion of Design-Build repeated under Sub-Clause 11.3 [Retesting of the Works] the Employer's Representative shall be entitled to: (a) order further repetition of Tests on Completion of Design-Build under Sub- Clause 11.3 [Retesting of the Works]; or (b) issue a Notice under Sub-Clause 15.1 [Notice to Correct].
11.5 Completion of the Works and Sections	Except as stated in Sub-Clause 11.11 [Failure to Pass Tests Prior to Contract Completion], the Works shall be deemed by the Employer to be completed when: (a) the Works have been completed in accordance with the Contract, including the matters described in Sub-Clause 9.2 [Time for Completion of Design-Build] and Sub-Clause 5.6 [Operation and Maintenance Manuals] and except as allowed in sub-paragraph (i) below; and (b) a Commissioning Certificate has been issued, or is deemed to have been issued, in accordance with this Sub-Clause. The Contractor may apply by Notice to the Employer's Representative for a Commissioning Certificate not earlier than 14 days before the Works will, in the Contractor's opinion, be complete and ready for commencement of the Operation Service Period. If the Works are divided into Sections, the Contractor may similarly apply for a Commissioning Certificate for each Section. The Employer's Representative shall, within 28 days after receiving the Contractor's application: (i) issue the Commissioning Certificate to the Contractor, stating

	the date on which the Works or Section were completed in accordance with the Contract, except for any minor outstanding work and defects which will not substantially affect the use of the Works or Section for their intended purpose (listing such outstanding work and defects which are to be remedied); or (ii) reject the application, giving reasons and specifying the work required to be done by the Contractor to enable the Commissioning Certificate to be issued. The Contractor shall then complete the work referred to in sub-paragraph (ii) above before issuing a further Notice under this Sub-Clause. If the Employer's Representative either fails to issue the Commissioning Certificate or reject the Contractor's application within the period of 28 days, and if the Works or Section (as the case may be) are substantially in accordance with the Contract, the Commissioning Certificate shall be deemed to have been issued on the last day of that period.
11.6 Commissioning of Parts of the Works	The Employers Representative may, at the request of the Contractor, issue a Section Commissioning Certificate for any part of the Permanent Works. If a Section Commissioning Certificate has been issued for a part of the Works, the delay damages thereafter for completion of the remainder of the Works shall be reduced. Similarly, the delay damages for the remainder of the Section (if any) in which this part is included shall also be reduced. For any period of delay after the date stated in this Section Commissioning Certificate, the proportional reduction in these delay damages shall be calculated as the proportion which the value of the part so certified bears to the value of the Works or Section (as the case may be) as a whole. The Employer's Representative shall proceed in accordance with Sub-Clause 3.5 [Determinations] to agree or determine these proportions. The provisions of this paragraph shall only apply to the daily rate of delay damages under Sub-Clause 9.6 [Delay Damages relating to Design-Build], and shall not affect the maximum amount of these damages (if any).
11.7 Commissioning Certificate	Performance of the Contractor's Design-Build obligations, including care of the Works, shall not be considered to have been completed until the Commissioning Certificate has been signed by the Employer's Representative and delivered to the Contractor, stating the date on which the Contractor, in the opinion of the Employer's Representative, completed all such obligations in accordance with the Contract (subject to the outstanding works and defects listed in accordance with Sub-Clause 11.5 [Completion of the Works and Sections]), The Employers Representative shall issue the Commissioning Certificate to the Contractor within 28 days after the application by the Contractor for the Commissioning Certificate subject to the provisions of Sub-Clause 11.5 [Completion of the Works and Sections]. Only the Commissioning Certificate shall be deemed to constitute acceptance of the Works.

11.8 Joint Inspection Prior to Contract Completion	Not less than two years prior to the expiry date of the Operation Service Period, the Employer's Representative and the Contractor shall carry Out a joint inspection of the Works and, within 28 days of the completion of the joint inspection, the Contractor shall submit a report on the condition of the Works identifying maintenance works (excluding routine maintenance works and the correction of defects), replacements and other works required to be carried out to satisfy the requirements of the Operation and Maintenance Plan after the Contract Completion Date. The Contractor shall submit a programme for carrying out such works over the remainder of the Operation Service Period. Following receipt of the Contractor's report, the Employer's Representative may, throughout the remainder of the Operation Service Period, instruct the Contractor to carry Out all or part of the works identified in the Contractors report. The quoted sums from the Asset Replacement Fund will be added to the monthly payments upon replacement of items of Plant in accordance with the Schedule of replacement prepared at Tender stage and the provisions of Sub-Clause 14.18 (Asset Replacement Fund]. Other works shall be carried out at the Contractor's cost. Upon satisfactory completion of the items identified in this Sub-Clause the Employer shall instruct the Contractor to commence the Tests Prior to Contract Completion in accordance with Sub-Clause 11.9 [Procedure for Tests Prior to Contract Completion].
11.9 Procedure for Tests Prior to Contract Completion	The Tests Prior to Contract Completion ("Tests") are to be carried out by the Contractor who shall provide all necessary labour, materials, electricity, fuel and water, other than items identified as being the responsibility of the Employer under Sub-Clause 10.4 [Delivery of Raw Materials], and undertake any required remedial works as may be required. The Tests are to be carried out in accordance with the Employers Requirements. The Tests shall be carried Out towards the end of the Operation Service Period. The Employer shall give Notice to the Contractor not less than 21 days prior to the date after which the Tests shall be carried out. Unless otherwise agreed, such Tests shall be commenced within 14 days after this date, on the day or days determined by the Employer's Representative. The results of the Tests shall be compiled and evaluated by the Employer's Representative and the Contractor. The Contractor shall make the results of any tests, inspections or monitoring available to the Employer's Representative within 7' days of their receipt. Any effect on the results of the Tests which can reasonably be shown to be due to prior use of the Works by the Contractor during the Operation Service Period shall be taken into account in assessing such results. As soon as the Contractor has completed the Tests, the Contractor shall notify the Employer's Representative that the Works are complete and ready for final inspection. Upon the Employer's Representative being satisfied that the Contractor has satisfied the requirements of the Tests regarding such final inspection, the Employer's Representative shall notify the Employer and the

	Contractor prior to the issue of the Contract Completion Certificate.
11.10 Delayed Tests Prior to Contract Completion	If the Employer incurs cost as a result of any unreasonable delay by the Contractor in carrying out the Tests Prior to Contract Completion ("Tests'), the Employer shall be entitled, subject to Sub-Clause 20.2 [Employer's Claims], to payment of any such cost which shall be recoverable from the Contractor by the Employer, and may be deducted by the Employer from any monies due, or to become due, to the Contractor. If the Contractor fails to commence the Tests on the day or days determined under Sub-Clause 11.9 [Procedure for Tests Prior to Contract Completion], the Employer's Representative shall give Notice to the Contractor that unless the Tests are commenced within 1i days of this Notice the Employer's Representative may order that the Tests be undertaken by others on behalf of the Employer. In such event, the Contractor shall be bound by the results of such Tests as being accurate and the Employer shall be entitled to deduct the costs associated with the undertaking of the Tests by others from any monies due, or to become due, to the Contractor. If, for reasons not attributable to the Contractor, the Tests Prior to Contract Completion of the Works, or any Section, cannot be completed during the Contract Period (or any other period agreed upon by both Parties), then the Works or Section shall be deemed to have passed the Tests.
11.11 Failure to Pass Tests Prior to Contract Completion	If the Works or a Section thereof, fails to pass the Tests Prior to Contract Completion (Tests') und& Sub-Clause 11.9 [Procedure for Tests Prior to Contract Completion], the Employers Representative shall be entitled to: (a) order further repetition of Tests under Sub-Clause 11.12 [Retesting Prior to Contract Completion]; (b) reject the Works or a Section thereof (as the case may be), in which event the Employer shall have the same remedies against the Contractor as provided under Clause 15 [Termination by Employer], or (c) issue a Contract Completion Certificate, if the Employer so requires. The Contract Price shall then be reduced by such an amount as ma be agreed by the Employer and the Contractor (in full satisfaction of such failure only), and the Contractor shall then proceed in accordance with his other obligations under the Contract. In the event of (c) above, if the Works, or a Section, fail to pass any of the Tests and the Contractor proposes to make adjustments or modifications to the Works or such Section, the Contractor may be instructed by (Or on behalf of) the Employer that right of access to the Works or Section cannot be given until a time that is convenient to the Employer. The Contractor shall then remain liable to carry out the adjustments or modifications and to satisfy this Test, within a reasonable period of receiving Notice by (or on behalf of) the Employer of the time that k convenient to the Employer. However, if the Contractor does not receive this Notice during the relevant Contract Period, the Contractor shall be relieved of this obligation and the Works or Section (as the case may be) shall be deemed to

	have passed the Tests. If the Contractor incurs additional cost as a result of any unreasonable delay by the Employer in permitting access to the Works or Plant by the Contractor after issue of the Contract Completion Certificate, either to investigate the causes of a failure to pass any of the Tests or to carry out any adjustments or modifications, the Contractor shall be paid the additional Cost Plus Profit, as determined or agreed in accordance with Sub-Clause 3.5 [Determinations], caused by such a delay.
11.12 Retesting Prior to Contract Completion	If the Works, or a Section, fail to pass the Tests Prior to Contract Completion: (a) sub-paragraph (b) of Sub-Clause 12.1 [Completion of Outstanding Work and Remedying Defects] shall apply; and (b) the Employer may require the failed Tests, and the Tests Prior to Contract Completion on any related work, to be repeated under the same terms and conditions. If such failure and retesting results from a default of the Contractor and causes the Employer to incur additional costs, such costs shall be recoverable from the Contractor by the Employer, subject to Sub-Clause 20.2 [Employer's Claims], and may be deducted by the Employer from any monies due, or to become due, to the Contractor. The Employer's Representative may carry out such additional tests, inspections and monitoring as he deems necessary. The costs of such tests, except where such tests are carried Out for the purpose of remedying any damage, defect or failure to meet standards that are the responsibility of the Contractor under the Contract, shall be borne by the Employer.
12 Defects	
12.1 Completion of Outstanding Work and Remedying Defects	The requirements regarding the completion of outstanding work and the remedying of defects are as follows: (a) Design-Build Period: In order that the Works and Contractor's Documents, and each Section, shall be in the condition required by the Contract, the Contractor shall: (i) complete any work which is outstanding on the date stated in the Commissioning Certificate as soon as practicable after such date, and not later than one year after such date; and (ii) execute all work required to remedy defects or damage, as may be notified by (or on behalf of) the Employer. Final payment for the Design-Build Period, in accordance with Clause 14 [Contract Price and Payment], will not be certified until the above requirements have, in the opinion of the Employer's Representative, been met. If a defect appears or damage occurs, the Contractor shall be notified accordingly, by (or on behalf of) the Employer. (b) Operation Service Period: The Contractor shall be responsible for repairing and making good any damage or defect occurring during the Operation Service Period, whether such defect or damage is notified by the Employer or his Representative, or observed by the Contractor himself.

	The Contract Completion Certificate issued under Sub-Clause 8.6 [Contract Completion Certificate] will not be issued until all defects and damage and all outstanding work, including all such items identified during the joint inspection made in accordance with Sub-Clause 11.8 [Joint Inspection Prior to Contract Completion], have been completed.
12.2 **Cost of Remedying Defects**	All work required to repair defects or damage shall be executed at the risk and cost of the Contractor, except: (a) where it is attributable to any act by the Employer or the Employers Personnel or agents; or (b) where it is as a result of an event that is covered under Clause 18 [Exceptional Risks]. Where the Contractor is required to remedy a defect or damage to the Works under sub-paragraphs (a) or (b) of this Sub-Clause, the Contractor shall notify the Employer's Representative and shall be entitled to a Variation under Clause 13 [Variations and Adjustments].
12.3 **Failure to Remedy Defects**	If the Contractor fails to remedy any defect or damage arising during either the Design-Build Period or the Operation Service Period within a reasonable time, a date may be fixed by (or on behalf of) the Employer's Representative, on or by which the defect or damage is to be remedied. The Contractor shall be given reasonable Notice of this date. If the Contractor fails to remedy the defect or damage by such date and the necessity for such work is due to the Contractor subject to Sub-Clause 12.2 [Cost of Remedying Defects], the Employer may (at his sole discretion): (a) require the Employers Representative to determine and certify a reasonable reduction in the Contract Price or the Rates aid Prices submitted for the Operation Service Period in accordance with Sub-Clause 3.5 [Determinations]; or (b) if the defect or damage is such that the Contractor has been unable to commission the Works or continue providing the Operation Service and the Employer has been deprived of substantially the whole of the benefit of the Works or parts of the Works. the Employer shall be entitled to terminate the Contract in respect of such parts of the Works as cannot be put to the intended use in accordance with the provisions of Clause 15 [Termination by Employer]. In the event of (b) above occurring, the Employer shall, notwithstanding the provisions of Sub-Clause 15.4 [Payment after Termination for Contractors Default]: (i) during the Design-Build Period, be entitled to recover from the Contractor all sums paid for such parts of the Works plus financing costs together with the cost of dismantling the same, clearing the Site and returning Plant and Materials to the Contractor: or, if the Employer chooses to complete the Works himself or by engaging others, the Employer shall be entitled to recover the extra costs, if any, of completing the Works after allowing for any sum due to the Contractor under Sub-Clause 15.3 [Valuation at Date of Termination for Contractors Default]. If there are no such extra costs, the Employer shall pay any

	balance to the Contractor; and (ii) during the Operation Service Period, not be liable to make any further payments to the Contractor until the costs of operation and maintenance, completion and remedying of any defects and all other costs incurred and to be incurred by the Employer have been established.
12.4 Further Tests	If the work of remedying any defect or damage may affect the performance of the Works, the Employers Representative may require the repetition of any of the tests described in the Contract. The requirement shall be made by Notice within 28 days after the defect or damage is remedied. These tests shall be carried out in accordance with the terms applicable to the previous tests, except that they shall be carried out at the risk and cost of the Party liable, under Sub-Clause 12.2 [Cost of Remedying Defects], for the cost of the remedial work.
12.5 Removal of Defective Work	If the defect or damage cannot be remedied expeditiously on the Site and the Employer gives consent, the Contractor may remove from the Site for the purposes of repair such items of Plant as are defective or damaged. This consent may require the Contractor to increase the amount of the Performance Security by the full replacement cost of these items, or to provide other appropriate security.
12.6 Contractor to Search	The Contractor shall, if required by the Employer‘s Representative, search for the clause of any defect, under the direction of the Employers Representative. Unless the defect is to be remedied at the cost of the Contractor under Sub-Clause 12.2 [Cost of Remedying Defects], the Cost Plus Profit of the search shall be agreed or determined by the Employers Representative in accordance with Sub-Clause 3.5 [Determinations I and shall be included in the Contract Price.
13 Variations and Adjustments	
13.1 Right to Vary	Variations may be initiated by the Employer’s Representative at any time prior to issuing the Commissioning Certificate, either by an instruction to the Contractor by the Employers Representative or by a request for the Contractor to submit a proposal. A Variation shall not comprise the omission of any work which is to be carried out by others. The Contractor shall execute and be bound by each Variation; unless the Contractor promptly gives Notice to the Employer’s Representative stating (with supporting particulars) that (i) the Contractor cannot readily obtain the Goods required for the Variation, (ii) it will reduce the safety or suitability of the Works for the purposes for which they were intended under the Contract (ii) it will have an adverse impact on the achievement of the Schedule of guarantees; or (iv) it will have an adverse effect on the provision of the Operation Service under the Contract. Upon receiving this Notice, the Employer’s Representative shall cancel, confirm or vary the instruction and the Contractor shall execute and be bound by it. If the Employer or the Employer’s Representative wishes to instruct a Vanaton during the Operation Service Period, he shall give the Contractor written details of his requirements. The Contractor shall

	then proceed in accordance with Sub-Clause 13.3 [Variation Procedure] sub-paragraphs (a), (b) and (c). However, the Contractor shall not be obliged to proceed with the Variation until the matters covered in Sub-Clause13.3 [Variation Procedure] sub-paragraphs (a), (b) and (c) have been agreed between the Employer and the Contractor.
13.2 Value Engineering	The Contractor may, at any time, submit to the Employer's Representative a written proposal, which (in the Contractor's opinion) will, if adopted: (a) accelerate completion of the Works; (b) reduce the cost to the Employer of executing, maintaining or operating the Works; (c) improve the efficiency or value to the Employer of the completed Works; (d) improve the efficiency of the Operation Service being provided; or (e) otherwise be of benefit to the Employer. The proposal shall be prepared at the cost of the Contractor and shall include the items listed in Sub-Clause 13.3 [Variation Procedure].
13.3 Variation Procedure	If the Employer's Representative requests a proposal, prior to instructing a Variation, the Contractor shall respond in writing as soon as practicable, either by giving reasons why he cannot comply (if this is the case) or by submitting: (a) a description of the proposed design and/or work to be performed and a programme for its execution: (b) the Contractor's proposal for any necessary modifications to the programme according to Sub-Clause 8.3 [Programmej and to the Time for Completion; and (c) the Contractor's proposal for adjustment to the Contract Price. The Employer's Representative shall, as soon as practicable after receiving such proposal (under Sub-Clause 13.2 [Value Engineering] or otherwise), respond with approval, disapproval or comments. The Contractor shall not delay any work whilst awaiting a response. Each instruction to execute a Variation, with any requirements for the recording of costs, shall be issued by the Employer's Representative to the Contractor, who shall acknowledge receipt. Upon instructing or approving a Variation, the Employer's Representative shall proceed in accordance with Sub-Clause 3.5 [Determinations] to agree or determine adjustments to the Contract Price and the Schedule of Payments. These adjustments, except adjustments made under Sub-Clause 13.6 [Adjustments for Changes in Legislation] and Sub-Clause 13.7 [Adjustments for Changes in Technology], shall include reasonable profit, and shall take account of the Contractor's submissions under Sub-Clause 13.2 [Value Engineering] if applicable.
13.4 Payment in Applicable	If the Contract provides for payment of the Contract Price in more than one currency, then whenever an adjustment is agreed, approved or determined as stated above, the amount payable in

Currencies	each of the applicable currencies shall be specified. For this purpose, reference shall be made to the actual or expected currency proportions of the cost of the varied work, and to the proportions of various currencies specified for payment of the Contract Price.
13.5 Provisional Sums	Each Provisional Sum small only be used, in whole or in part. in accordance with the Employer's Representative's instructions, and the Contract Price shall be adjusted accordingly. The total sum paid to the Contractor shall include only such amount for, the work, supplies or services to which the Provisional Sum relates, as the Employer's Representative shall have instructed. For each Provisional Sum, the Employer's Representative may instruct: (a) work to be executed (including Plant, Materials or services to be supplied) by the Contractor and valued under Sub-Clause 13.3 [Variation Procedure]: and/or (b) Plant, Materials or services to be purchased by the Contractor, for which there shall be included in the Contract Price: (i) the actual amounts paid (or due to be paid) by the Contractor; and (ii) a sum for overhead charges arid profit, calculated as a percentage of these actual amounts by applying the relevant percentage rate (if any) stated in the appropriate Schedule. it there is no such rate, the percentage rate stated in the Contract Data shall be applied. The Contractor shall, when required by the Employer's Representative, produce quotations, invoices, vouchers and accounts or receipts in substantiation.
13.6 Adjustments for Changes in Legislation	Adjustments to the execution of the Works or provision of the Operation Service necessitated by a change in Law shall be dealt with as a Variation and as provided for under Clause 13 [Variations and Adjustments]. Either Party may, by written Notice to the other, require that adjustments shall he made to the provision of the Contract as are necessary to enable the Contractor to comply with changes in Law. The Contract Price and programme for design, execution and operation of the Works shall be adjusted to take account of any increase or decrease in cost resulting from a change in the Laws of the Country (including the introduction of new Laws and the
14 Contract Price and Payment	
14.1 The Contract Price	The Contract Price shall be the amount or amounts submitted by the Contractor for the Design-Build and the Operation Service including the Asset Replacement Fund, priced at the Base Date, and due to be paid to the Contractor in accordance with the Contract together with any adjustments as provided for under Clause 13 [*Variations and Adjustments*] or arising as a result of claims under Clause 20 [*Claims, Disputes and Arbitration*]. The Contractor shall pay all taxes, duties and fees required to be paid by him under the Contract and the Contract Price shall not be adjusted for changes in any of these costs, except as provided for in Sub-Clause 13.6 [*Adjustments for Changes in Legislation*] and to

	the extent allowed for under Clause 20 [*Claims, Disputes and Arbitration*].
14.2 **Advance Payment**	The Employer shall make an advance payment, as an interest-free loan for mobilisation and design, when the Contractor submits a guarantee in accordance with this Sub-Clause that shall be based on the sample form included in the tender documents or in another form acceptable to the Employer. The amount of the advance payment and the applicable currencies shall be as stated in the Contract Data. Unless and until the Employer receives this guarantee, or if no advance payment is stated in the Contract Data, this Sub-Clause shall not apply. The Employer's Representative shall issue an Interim Payment Certificate for the advance payment under Sub-Clause 14.7 [*Issue of Advance and Interim Payment Certificates*] after receiving an application under Sub-Clause 14.3 [*Application for Advance and Interim Payment Certificates*] and after the Employer receives (i) the Performance Security in accordance with Sub-Clause 4.2 [*Performance Security*] and (ii) a guarantee in amounts and currencies equal to the advance payment. This guarantee shall be issued by an entity and from within a country (or other jurisdiction) approved by the Employer, and shall be based on the sample form included in the tender documents or in another form approved by the Employer. The Contractor shall ensure that the guarantee is valid and enforceable until the advance payment has been repaid, but its amount may be progressively reduced by the amount repaid by the Contractor as indicated in the Interim Payment Certificates. If the terms of the guarantee specify its expiry date, and the advance payment has not been repaid by the date 28 days prior to the expiry date, the Contractor shall extend the validity of the guarantee until the advance payment has been repaid. The advance payment shall be repaid through percentage deductions in Interim Payment Certificates. Unless other percentages are stated in the Contract Data: (a) deductions shall commence in the Interim Payment Certificate in which the total of all certified interim payments (excluding the advance payment and deductions and repayments of retention) exceeds ten percent (10%) of the Accepted Contract Amount for the Design-Build less Provisional Sums; and (b) deductions shall be made at the amortisation rate of one-quarter (25%) of the amount of each Interim Payment Certificate (excluding the advance payment and deductions and repayments of retention) issued during the Design-Build Period. If the advance payment has not been repaid prior to the issue of the Commissioning Certificate or prior to termination under Clause 15 [*Termination by Employer*], Clause 16 [*Suspension and Termination by Contractor*] or Clause 18 [*Exceptional Risks*] (as the case may be), the whole of the balance then outstanding shall immediately become due and payable by the Contractor to the Employer.

14.3 Application for Advance and Interim Payment Certificates	When submitting the advance payment guarantee required under Sub-Clause 14.2 [*Advance Payment*], the Contractor shall include his application for the advance payment. The Contractor shall thereafter submit a Statement in one original and five copies to the Employer's Representative after the end of each month (unless otherwise stated in the Contract), in a form approved by the Employer's Representative, showing in detail the amounts to which the Contractor considers himself to be entitled, together with supporting documents. The Statement shall include the following items, as applicable, which shall be expressed in the various currencies in which the contract Price is payable: (a) the estimated contract value of the Works executed and the Contractor's Documents produced up to the end of the month (including Variations but excluding items described in sub-paragraphs (b) to (j) below); (b) any amounts to be added and deducted for changes in legislation, changes in cost and changes in technology, in accordance with Sub-Clause 13.6 [*Adjustments for Changes in Legislation*], Sub-Clause 13.7 [*Adjustments for Changes in Technology*] and Sub-Clause 13.8 [*Adjustments for Changes in Cost*]; (c) any amount to be deducted for retention, calculated by applying the percentage of retention stated in the Contract Data to the total of the above amounts, until the amount so retained by the Employer's Representative reaches the limit of Retention Money (if any) stated in the Contract Data; (d) any amounts to be added and deducted for the advance payment and repayments in accordance with Sub-Clause 14.2 [Advance Payment]; (e) any amounts to be added and deducted for Plant and Materials in accordance with Sub-clause 14.6 [Payment for Plant and Materials intended for the Works]; (f) any amounts due for Plant, Materials or services purchased by the Contractor under Sub-Clause 13.5 [Provisional Sums]; (g) amounts due for the Operation Service; (h) amounts due from the Asset Replacement Fund; (i) adjustments due for the Maintenance Retention Fund; (j) any other additions or deductions which may have become due under the Contract or otherwise, including those under Clause 20 [Claims, Disputes and Arbitration]; and (k) the deduction of amounts certified in all previous Interim Payment Certificates
14.4 Schedule of Payments	If the Contract includes a Schedule of Payments for the Design-Build Period and/or the Operation Service Period specifying the instalments in which the Contract Price and/or the Rates and Prices will be paid, then, unless otherwise stated in this Schedule. (a) the instalments quoted in the Schedule of Payments shall be the estimated values for the purposes of Sub-Clause 14.3 [*Application for Advance and Interim Payment Certificates*];

	(b) Sub-Clause 14.6 [*Payment for Plant and Materials intended for the Works*] shall not apply; and (c) if these instalments are not defined by reference to the actual progress achieved in executing the Works, and if actual progress is found to differ from that on which the Schedule of Payments was based, then the Employer's Representative may proceed in accordance with Sub-Clause 3.5 [Determinations] to agree or determine revised instalments which shall take account of the extent to which progress differs from that on which the instalments were previously based. If the Contract does not include a Schedule of Payments for the Design-Build Period and/or the Operation Service Period, the Contractor shall submit non-binding estimates of the payments which he expects to become due during each quarterly period. The first estimate shall be submitted within 42 days after the Commencement Date. Revised estimates shall be submitted at quarterly intervals until the Contract Completion Certificate has been issued.
14.5 Asset Replacement Schedule	Payments from the Asset Replacement Fund shall be made in accordance with the provisions of Sub-Clause 14.18 [Asset Replacement Fund]. On no account will payments be made for assets replaced which are not identified in the Asset Replacement Schedule unless they have been instructed as a Variation under Clause 13 [Variations and Adjustments], If Assets are replaced in advance of the date given in the Asset Replacement Schedule, payment will not be released until the date stated in the Schedule has been reached If Assets are not replaced on or before the scheduled date, payment will not be released until such replacements have been effected. Any monies remaining in the Asset Replacement Fund at the time of issue of the Contract Completion Certificate will be disbursed between the Parties as described in Sub-Clause 14.18 [Asset Replacement Fund].
14.6 Payment for Plant and Materials intended for the Works	If this Sub-Clause applies, Interim Payment Certificates shall include, under 'sub-paragraph (e) of Sub-Clause 14.3 [Application for Advance and Interim Payment Certificates], (i) an amount for Plant and Materials which have been sent to the Site for incorporation in the Permanent Works, and (ii) a reduction when the contract value of such Plant and Materials is included as part of the Permanent Works under sub paragraph (a) of Sub-Clause 14.3. If the lists referred to in sub-paragraphs (b)(i) or (c)(i) below are not included in the Contract Data, this Sub-Clause shall not apply. The Employers Representative shall determine and certify each addition if the following conditions are satisfied: (a) the Contractor has: (i) kept satisfactory records (including the orders, receipts, costs and use of Plant and Materials) which are available for inspection; and

	(ii) submitted a statement of the cost of acquiring and delivering the Plant and Materials to the Site, supported by satisfactory evidence; and either: (b) the relevant Plant and Materials: (i) are those listed in me Contract Data for payment when snipped; (ii) have been shipped to the Country, en route to the Site, in accordance with the Contract; and (iii) are described in a clean shipped bill of lading or other evidence of shipment, which has been submitted to the Employer's Representative together with evidence of payment of freight and insurance, any other documents reasonably required, and a bank guarantee in a form and issued by an entity approved by the Employer in amounts and currencies equal to the amount due under this Sub-Clause. This guarantee may be in a similar form to the form referred to in Sub-Clause 14.2 [Advance Payment) and shall be valid until the Plant and Materials are properly stored on Site and protected against loss, damage or deterioration: or (c) the relevant Plant and Materials: (i) are those listed in the Contract Data for payment when delivered to the Site; and (ii) have been delivered to and are properly stored on the Site, are protected against loss, damage or deterioration, and appear to be in accordance with the Contract. The additional amount to be certified shall be the equivalent of eighty percent (80%) of the Employer's Representative determination of the cost of the Plant and Materials (including delivery to Site), taking account of the documents mentioned in this Sub-Clause and of the contract value of the Plant and Materials. The currencies for this additional amount shall be the same as those in which payment will become due when the contract value is included under sub-paragraph (a) of Sub- Clause 14.3 [Application for Advance and Interim Payment Certificates]. At that time, the Interim Payment Certificate shall include the applicable reduction which shall be equivalent to, and in the same currencies and proportions as, this additional amount for the relevant Plant and Materials.
14.7 Issue of Advance and Interim Payment Certificates	No amount will be certified or paid until the Employer has received and approved the Performance Security provided for in Sub-Clause 4.2 [Performance Security. Upon receipt of the Contractor's application for the advance payment, the Employers Representative shall, within 14 days of receiving the application, issue to the Employer an Interim Payment Certificate in respect of such payment, with a copy to the Contractor. Thereafter, in respect of interim payment applications the Employer's Representative shall, within 28 days after receiving a Statement and supporting documents, issue to the Employer an Interim Payment Certificate which shall state the amount which the Employer's Representative fairly determines to be due, with supporting particulars, and shall include any amounts due to or from the Contractor in accordance

	with a decision by the DAB made under Sub-Clause 20.6 [Obtaining Dispute Adjudication Board's Decision]. However, prior to issuing the Commissioning Certificate, the Employers Representative shall not be bound to issue an Interim Payment Certificate in an amount which would (after retention and other deductions) be less than the minimum amount of Interim Payment Certificates (if any) stated in the Contract Data. In this event, the Employer's Representative shall give Notice to the Contractor accordingly. An Interim Payment Certificate shall not be withheld for any other reason, although: (a) if anything supplied or work done by the Contractor is not in accordance with the Contract, the cost of rectification or replacement may be withheld until rectification or replacement has been completed; and/or (b) if the Contractor was or is failing to perform any work or obligation in accordance with the Contract, and had been so notified by the Employers Representative, the value of this work or obligation may be withheld until the work or obligation has been performed. The Employers Representative may in any Payment Certificate make any correction or modification that should properly be made to any previous Payment Certificate. An Interim Payment Certificate shall not be deemed to indicate the Employer's Representatives acceptance, approval, consent or satisfaction of the Works.
14.8 **Payment**	The Employer shall pay to the Contractor: (a) the advance payment within 21 days after receiving the documents 'n accordance with Sub-Clause 4.2 [Performance Security] and Sub-Clause 14.2 [Advance Payment] and the Payment Certificate for the advance payment issued in accordance with Sub-Clause 14.7 [Issue of Advance and Interim Payment Certificates]; (b) the amount certified in each Interim Payment Certificate within 56 days after the Employer's Representative receives the corresponding Statement and supporting documents, including any amounts due in accordance with a decision by the DAB which have been included in the Interim Payment Certificate; and (c) the amounts certified in the Final Payment Certificate Design-Build and the Final Payment Certificate Operation Service within 56 days after the Employer receives each such Final Payment Certificate, including any amounts due in accordance with a decision by the DAB which have been included in the Final Payment Certificate. Payment of the amount due in each currency shall be made into the bank account, nominated by the Contractor, in the payment country (tor this currency) specified in the Contract.
14.9 **Delayed Payment**	If the Contractor does not receive payment in accordance with Sub-Clause 14.8 [Payment], the Contractor shall be entitled to receive financing charges compounded monthly on the amount unpaid di Irma the period of delay. This period shall be deemed to commence

	on the date for payment specified in Sub-Clause 14.8 [Payment], irrespective (in the case of its sub-paragraph (b)) of the date on which any Interim Payment Certificate is issued. Unless otherwise stated in the Contract Data, these financing charges shall be calculated at the annual rate of three percentage points above the discount rate of the central bank in the country of the currency (or currencies if more than one) of payment, and shall be paid in such currencies. The Contractor shall be entitled to this payment without formal Notice or certification, and without prejudice to any other right or remedy.
14.10 Payment of Retention Money	When the Commissioning Certificate has been issued, the first half of the Retention Money shall be certified by the Employer's Representative for payment to the Contractor. If a Section Commissioning Certificate is issued for a Section, the relevant percentage of the first half of the Retention Money shall be certified and paid to the Contractor. Such amount shall be included for payment in the next Interim Payment Certificate following the issue of the Commissioning Certificate. The Contractor shall be entitled to include the second half of the Retention Money in the Final Statement Design-Build.
14.11 Application for Final Payment Certificate Design- Build	Within 28 days after the end of the Retention Period, the Contractor shall submit to the Employer's Representative one original and five copies of the Final Statement Design - Build with supporting documents showing: (a) the value of all work done in respect of the Design-Build; and (b) any further sums which the Contractor considers to be due to him under the Contract in respect of the Design-Build. Together with the Final Statement Design-Build, the Contractor shall submit a written undertaking that the Statement is in full and final settlement of all matters under or in connection with the Contract relating to the Design-Build. If the Employer's Representative disagrees with or cannot verify any part of the Final Statement Design-Build, the Employer's Representative and the Contractor shall attempt to agree such matters, and the Contractor shall re-submit his Final Statement based on the agreement with the Employer's Representative. The Employer's Representative shall then issue a Final Payment Certificate Design-Build under Sub-Clause 14.12 [Issue of Final Payment Certificate Design-Build] for the agreed amount. If the Parties cannot agree on such matters, or if the Contractor has failed to submit his application for payment within the said 28 days, the Employer's Representative shall issue an Interim Payment Certificate under Sub-Clause 14.7 [Issue of Advance and Interim Payment Certificates] for the amount which he considers to be due to the Contractor, If the Contractor is dissatisfied with the amount certified, he may refer the matter to the DAB for a decision in accordance with Clause 20.6 [Obtaining Dispute Adjudication Board's Decision].
14.12 Issue of Final	Within 28 days of receiving the Final Statement Design-Build, or the resubmitted Final Statement (as the case may be), and the written

Payment Certificate Design-Build	undertaking from the Contractor in accordance with Sub-Clause 14.11 [Application for Final Payment Certificate Design-Build], the Employers Representative shall issue to the Employer, with a copy to the Contractor, the Final Payment Certificate Design-Build stating: (a) the amount which is finally due for the Design-Build; and (b) after giving credit to the Employer for all amounts previously paid by the Employer and all sums to which the Employer is entitled in respect of the Design-Build, the balance (if any) due from the Employer to the Contractor or from the Contractor to the Employer, as the case may be. Upon receipt of the Final Payment Certificate Design-Build, the Employer shall pay the Contractor the amount, if any, due in accordance with the provisions of Sub-Clause 14.8 [Payment].
14.13 Application for Final Payment Certificate Operation Service	Within 56 days after receiving the Contract Completion Certificate, the Contractor shall submit to the Employer's Representative one original and five copies of the Final Statement Operation Service with supporting documents showing: (a) the value of all work done in respect of the Operation Service including authorised expenditure from the Asset Replacement Fund; and (b) any further sums which the Contractor considers to be due to him under the Contract including any unused monies from the Maintenance Retention Fund. Together with the Final Statement Operation Service, the Contractor shall submit a written discharge according to the requirements of Sub-Clause 14.14 [Discharge].
14.14 Discharge	When submitting the Final Statement Operation Service, the Contractor shall submit a written discharge which confirms that the total of the Final Statement Operation Service, together with the Final Statement Design-Build submitted according to Sub-Clause 14.11 [Application for final Payment Certificate Design-Build] represents full and final settlement of all monies due to the Contractor under or in connection with the Contract. This discharge may state that it becomes effective only after payment due under the Final Payment Certificate Operation Service has been made and the Performance Security referred to in Sub-Clause 4.2 [Performance Security] has been returned to the Contractor.
14.15 Issue of Final Payment Certificate Operation Service	Within 28 days of receiving the Final Statement Operation Service and the written discharge from the Contractor in accordance with Sub-Clause 14.13 [Application for Final Payment Certificate Operation Service] and Sub-Clause 14.14 [Discharge] respectively, the Employer's Representative shall issue to the Employer, with a copy to the Contractor, the Final Payment Certificate Operation Service stating: (a) the amount which is finally due for the Operation Service: and (b) the amount which is finally due for the Contract: and (c) after giving credit to the Employer for all amounts previously paid by the Employer and all sums to which the Employer is entitled in respect of the Contract, the balance (if any) due from the Employer to the Contractor or from the Contractor to the

	Employer, as the case may be. If the Employers Representative disagrees with or cannot verify any part of the Final Statement Operation Service, the Employer's Representative and the Contractor shall attempt to agree such matters, and the Employer's Representative shall issue a Final Payment Certificate Operation Service for the agreed amount. If the Parties cannot agree on such matters, the Employer's Representative shall issue a Final Payment Certificate Operation Service for the amount which he considers to be due to the Contractor. If the Contractor is dissatisfied with the amount certified, he may refer the matter to the DAB for a decision in accordance with Clause 20.6 [Obtaining Dispute Adjudication Boards Decision]. Upon receipt of the Final Payment Certificate Operation Service, the Employer shall pay the Contractor in accordance with the provisions of Sub-Clause 14.8 [Payment].
14.16 Cessation of Employer's Liability	The Employer shall not be liable to the Contractor for any matter or thing under or in connection with the Contract or execution of the Works, except to the extent that the Contractor shall have included an amount expressly for it in the Final Statement Design-Build or the Final Statement Operation Service. However, this Sub-Clause shall not limit the Employer's liability under his indemnification obligations, or the Employer's liability in any case of fraud, deliberate default or reckless misconduct by the Employer. Furthermore, if the Contractor has not submitted any matter to the Dispute Adjudication Board under Sub-Clause 20.6 [Obtaining Dispute Arbitration Board's Decision] within 56 days of receiving notification from the Employer's Representative of the amounts included for payment in either the Final Certificate Design-Build or the Final Certificate Operation Service, then he will be deemed to have accepted the amounts so certified, and the Employer shah be deemed to have no further liability to the Contractor, subject only to that payment due under the Final Payment Certificate Operation Service has been made and that the Performance Security referred to in Sub-Clause 4.2 [Performance Security] has been returned to the Contractor.
14.17 Currencies of Payment	The Contract Price shall be paid in the currency or currencies named in the Contract Data. Unless otherwise stated in the Particular Conditions, if more than one currency is so named, payments shall be made as follows: (a) if the Accepted Contract Amount was expressed in Local Currency only: (i) the proportions or amounts of the Local and Foreign Currencies, and the fixed rates of exchange to be used for calculating the payments, shall be as stated in the Contract Data, except as otherwise agreed by both Parties; (ii) payments and deductions under Sub-Clause 13.5 [Provisional Sums] and Sub-Clause 13.6 [Adjustments for Changes in Legislation] shall be made in the applicable currencies and proportions; and (iii) other payments and deductions under sub-paragraphs (a) to

	(d) of Sub- Clause 14.3 [Application for Advance and Interim Payment Certificates) shall be made in the currencies and proportions specified in sub- paragraph (a)(i) above; (b) payment of the damages specified in the Contract Data shall be made in the currencies and proportions specified in the Contract Data; (c) other payments to the Employer by the Contractor shall be made in the currency in which the sum was expended by the Employer, or in such currency as may be agreed by both Parties; (d) if any amount payable by the Contractor to the Employer in a particular currency exceeds the sum payable by the Employer to the Contractor in that currency, the Employer may recover the balance of this amount from the sums otherwise payable to the Contractor in other currencies; and (e) if no rates of exchange are stated in the Contract Data, they shall he those prevailing on the Base Date and determined by the central bank of the Country.
14.18 Asset Replacement Fund	The Asset Replacement Fund is to provide the necessary funding for the replacement of items cf Plant identified in the Asset Replacement Schedule as required for the continued efficient operation of the Works for the duration of the Operation Service Period. In each application for an Interim Payment Certificate during the Operation Service Period made in accordance with Sub-Clause 14.3 [Application for Advance and Interim Payment Certificates], the Contractor shall be entitled to include any monies from the Asset Replacement Fund which, according to the Asset Replacement Schedule, have become due following the replacement of the scheduled items by the Contractor. Under no circumstances will the amount payable from the Asset Replacement Fund be increased from the amount due according to the Asset Replacement Schedule, irrespective of the value or amount of replacements which have been made. For any items which have not been replaced by the date or other operational milestone identified in the Asset Replacement Schedule, payment will not be released until such replacement has been effected. In the event that there is money remaining in the Asset Replacement Fund upon completion of the Contract due to planned replacements, which by mutual agreement of the Parties, are not required or used, such amount shall be shared equally between the Parties, and the Contractor shall be entitled to include his share of such amount in his Application for Final Payment Certificate Operation Service made in accordance with Sub-Clause 1.13 [Application for Final Payment Certificate Operation Service]. The Asset Replacement Fund shall not cover the cost of: (a) routine maintenance items associated with the correction of defects; (b) replacement of Plant and Material which have a life expectancy of less than five years; (c) providing spares between scheduled dates for major plant

	replacement; or (d) the replacement of Plant and Materials which are not identified in the Asset Replacement Schedule. The cost of meeting the requirements of sub-paragraphs (a) to (d) above shall be borne by the Contractor and be deemed to be included in the Contract Price. The Contractor shall give Notice to the Employer's Representative at least 28 days prior to his intention to replace any item of Plant identified in the Asset Replacement Schedule. The Employer shall authorise release of funds from the Asset Replacement Fund in accordance with the amounts certified by the Employers Representative in each applicable Interim Payment Certificate. Funds will only be disbursed from the Asset Replacement Fund to the values and in accordance with the time scales for replacement identified in the Asset Replacement Schedule. Where items of Plant require replacement at times earlier than the scheduled replacement times given in the Asset Replacement Schedule, the appropriate funds shall not be released until the scheduled replacement date has been reached. If the Contract Price is subject to adjustments for changes in cost according to Sub-Clause 13.8 [Adjustments for Changes in Cost], the amounts due from the Asset Replacement Fund shall be adjusted on the same basis as other costs. In the event of a termination of the Contract under Clause 15 [Termination by Employer], or Clause 16 [Suspension and Termination by Contractor], any amount remaining in the Asset Replacement Fund, including any accrued interest, shall be deemed to be to the account of the Employer and shall not be disbursed to the Contractor.
14.19 Maintenance Retention Fund	During the Operation Service Period, a Maintenance Retention Fund shall be created by deducting five percent (5%) from the value of each interim payment, determined by the Employer's Representative in accordance with Sub-Clause 14.7 [Issue of Advance and Interim Payment Certificates, due to the Contractor, commencing with the first payment following the issue of the Commissioning Certificate, and continuing until the last Interim Payment Certificate is issued or until the amount in the Maintenance Retention Fund has reached the value (if any) stated in the Contract Data, whichever is the earlier. If the Contractor so chooses, the Maintenance Retention Fund may be replaced by a Maintenance Retention Guarantee in a form and with an entity approved by the Employer. However, the value of the Guarantee shall not exceed the maximum amount of the Maintenance Retention Fund stored in the Contract Data. The Contractor shall ensure that the Maintenance Retention Guarantee remains valid and in force until the issue of the Contract Completion Certificate. If the maintenance required under the Contract has not been carried out, the Employer may, after giving due Notice to the Contractor, carry out such maintenance himself and apply any amounts standing to the credit of the Maintenance Retention Fund in so doing. Where such amounts are insufficient to cover the Employer's

	whole costs of carrying out the maintenance, the unrecovered costs shall be set off against any payment due to the Contractor under the Contract, or to the extent that no such payment is due, shall become a debt due by the Contractor to the Employer. Following the issue of the Contract Completion Certificate under Sub-Clause 8.6 (Contract Completion Certificate], all funds remaining in the Maintenance Retention Fund shall be included in the Final Payment Certificate Operation Service and paid to the Contractor with the final payment.
15 Termination by Employer	
15.1 **Notice to Correct**	If the Contractor fails to carry out any obligation under the Contract, the Employer's Representative shall by Notice require the Contractor to make good the failure and to remedy it within the time specified in the said Notice.
15.2 **Termination for Contractor's Default**	The Employer shall be entitled to terminate the Contract if the Contractor: (a) fails to comply with Sub-Clause 4.2 [Performance Security] or with a Notice under Sub-Clause 15.1 [Notice to Correct], (b) abandons the Works or otherwise plainly demonstrates the intention not to continue performance of his obligations under the Contract, (c) without reasonable excuse fails: (i) to proceed with the Works in accordance with Sub-Clause 9.1 (Commencement of Design-Build] or Sub-Clause 10.2 [Commencement of Operation Service]; or (ii) to comply with a Notice issued under Sub-Clause 7.5 [Rejection] or Sub-Clause 7 6 [Remedial Work], within 28 days after receiving it; (d) subcontracts the whole of the Works or assigns the Contract without the required agreement or subcontracts the Operation Service or any parts of the Works in breach of Sub-Clause 4.4 [Subcontractors]; (e) either gives Notice to the Employer under Sub-Clause 4.25 [Changes in the Contractor's Financial Situation] from which the Employer reasonably concludes that the Contractor will be unable to complete or fulfill his obligations under the Contract or, if the Contractor fails to give such a Notice, but the Employer in any event reasonably concludes that the Contractor will be unable to complete or fulfill his obligations under the Contract due to the Contractor's financial situation; (f) becomes bankrupt or insolvent, goes into liquidation, has a receiving or administration order made against him, compounds with his creditors, or carries on business under a receiver, trustee or manager for the benefit of his creditors, or if any act is done or event occurs which (under applicable Laws) has a similar effect to any of these acts or events; (g) gives or offers to give (directly or indirectly, either before or during the currency of the Contract) to any person any bribe, gift, gratuity, commission or other thing of value, as an inducement or reward:

	(i) for doing or forbearing to do any action in relation to the Contract; or (ii) for showing or forbearing to show favour or disfavour to any person in relation to the Contract: or if any of the Contractors Personnel, agents or Subcontractors gives or offers to gives (directly or indirectly) to any person any such inducement or reward as is described in this sub-paragraph (g). However, lawful inducements and rewards to Contractors Personnel shall not give a right to termination; (h) fails to complete the Design-Build by the Cut-Off Date stated in the Contract Data or, if no such date is given, then a period of 182 days after the Time for Completion of Design-Build. In any of these events or circumstances, the Employer may, not less than 14 days after giving Notice to the Contractor, terminate the Contract and expel the Contractor from the Site unless the Contractor cures the event or circumstance within the said 14 days. However, in the case of sub-paragraph (f) or (g), the Employer may by Notice terminate the Contract immediately. The Employers election to terminate the Contract shall not prejudice any other rights of the Employer, under the Contract or otherwise. The Contractor shall then leave the Site and deliver any required Goods, all Contractor's Documents, and other design documents made by or for him, to the Employers Representative. However, the Contractor shall use his best efforts to comply immediately with any reasonable instructions included in the Notice (I) for the assignment of any subcontract, and (ii) for the protection of life or property or for the safety of the Works. After termination, the Employer may complete the Works and/or arrange for any other entities to do so. The Employer and these entities may then use any Goods, Contractor's Documents and other design documents made by or on behalf of the Contractor. The Employer shall then give Notice that the Contractor's Equipment and Temporary Works will be released to the Contractor at or near the Site. The Contractor shall promptly arrange their removal, at the risk and cost of the Contractor. However, if by this time the Contractor has failed to make a payment due to the Employer, these items may be sold by the Employer in order to recover this payment. Any balance of the proceeds shall then be paid to the Contractor.
15.3 **Valuation at Date of Termination for Contractor's Default**	As soon as practicable after a Notice of termination under Sub-Clause 15.2 [Term/nation for Contractor's Default] has taken effect, the Employer's Representative shall proceed in accordance with Sub-Clause 3.5 [Determinations] to agree or determine the value of the Works, Goods and Contractor's Documents, and any other sums due to the Contractor for work executed in accordance with the Contract.
15.4 **Payment after Termination for Contractor's Default**	After a Notice of termination under Sub-Clause 15.2 (Termination for Contractor's Default] has taken effect, the Employer may: (a) proceed in accordance with Sub-Clause 20.2 [Employer's Claims]; (b) withhold further payments to the Contractor until the costs of

	design, execution, completion and remedying of ally defects, damages for delay in completion (if any), and all other costs incurred by the Employer, have been established; and/or (c) recover from the Contractor any losses and damages incurred by the Employer and any extra costs of completing the Works, after allowing for any sum due to the Contractor under Sub-Clause 15.3 [Valuation at Date of Termination for Contractors Default]. After recovering any such losses, damages and extra costs, the Employer shall pay any balance to the Contractor.
15.5 Termination for Employers Convenience	If at any time the Employer elects to terminate the Contract for reasons other than those specified in Sub-Clause 15.2 [Termination for Contractors Default], and subject to the applicable Law of the Contract, he shall notify the contractor in writing, with a copy to the Employer's Representative. Such termination shall be deemed to be termination for the convenience of the Employer, Upon issuing a Notice to terminate under this Sub-Clause, the Employer shall immediately make arrangements to return the Performance Security to the Contractor, and the termination shall take effect 28 days after the date the Contractor receives the Notice, or 28 days after he receives the Performance Security, whichever is the later. Upon issuing the Notice, the Employer shall immediately cease to have any right of use of any of the Contractor's Documents, and shall forthwith return all and any such Contractor's Documents to the Contractor. The Employer shall not terminate the Contract under this Sub-Clause in order to execute or operate the Works (Or any part thereof) himself, or arrange for the Works (or any part thereof) to be executed by another contractor.
15.6 Valuation at Date of Termination for Employer's Convenience	As soon as practicable after a Notice of termination under Sub-Clause 15.5 [Termination for Employer's Convenience) has taken effect, the Employer's Representative shall proceed in accordance with Sub-Clause 3.5 [Determinations] to agree or determine the value of the Works, Goods and Contractor's Documents, and any other sums due to the Contractor for work executed in accordance with the Contract.
15.7 Payment after Termination for Employer's Convenience	After termination for the Employer's convenience under Sub-Clause 15.5 [Termination for Employers Convenience], the Contractor shall proceed in accordance with Sub Employer's Clause 16.3 [Cessation of Work and Removal of Contractor's Equipment] and shall be paid in accordance with Sub-Clause 16.4 [Payment on Termination].
16 Suspension and Termination by Contractor	
16.1 Contractor's Entitlement to Suspend Work	If the Employer's Representative fails to certify in accordance with Sub-Clause 14.7 [Issue of Advance and interim Payment Certificates], or the Employer fails to comply with Sub-Clause 2.4 [Employer's Financial Arrangements] or Sub-Clause 14.8 [Payment], the Contractor may, not less than 21 days after giving Notice to the Employer, suspend work (or reduce the rate of work) unless and until the Contractor has received the Interim Payment Certificate, reasonable evidence or payment, as the case may be and as described in the Notice. The Contractors action shall not prejudice his entitlements to financing charges under Sub-Clause 14.9

	[Delayed Payment) and to termination under Sub-Clause 16.2 [Termination by Contractor]. If the Contractor subsequently receives such Interim Payment Certificate, evidence or payment (as described in the relevant Sub-Clause and in the above Notice) before giving a Notice of termination, the Contractor shall resume normal working as soon as is reasonably practicable. If the Contractor suffers delay and/or incurs cost as a result of suspending work (or reducing the rate of work) in accordance with this Sub-Clause, the Contractor shall give Notice to the Employers Representative and shall be entitled, subject to Sub- Clause 20.1 [Contractors Claims], to: (a) an extension of time for any such delay, if completion is or will be delayed, under Sub-Clause 9.3 [Extension of Time for Completion of Design-Build]; and (b) payment of any such Cost Plus Profit, which shall be included in the Contract Price. After receiving this Notice, the Employers Representative shall proceed in accordance with Sub-Clause 3.5 [Determinations] to agree or determine these matters.
16.2 Termination by Contractor	The Contractor shall be entitled to terminate the Contract if: (a) the Contractor does not receive the reasonable evidence within 42 days after giving Notice under Sub-Clause 16.1 [Contractor's Entitlement to Suspend Work] in respect of a failure to comply with Sub-Clause 2.4 [Employer's Financial Arrangements]: (b) the Employers Representative fails, within 56 days after receiving a Statement and supporting documents, to issue the relevant Payment Certificate; (c) the Contractor does not receive the amount due under an Interim Payment Certificate within 42 days after the expiry of the time stated in Sub-Clause 14.8 [Payment] within which payment is to be made (except for deductions in accordance with Sub-Clause 20.2 [Employer's Claims]); (d) the Employer substantially fails to perform his obligations under the Contract, (e) the Employer fails to comply with Sub-Clause 1 .6 [Contract Agreement] or Sub-Clause 1 .8 [Assignment]; (f) a prolonged suspension affects the whole of the Works as described in Sub- Clause 9.10 [Prolonged Suspension]; or (g) the Employer becomes bankrupt or insolvent, goes into liquidation, has a receiving or administration order made against him, compounds with his creditors, or carries on business under a receiver, trustee or manager for the benefit of his creditors, or if any act is done or event occurs which (under applicable Laws) has a similar effect to any of these acts or events. In any of these events or circumstances, the Contractor may, not less than 14 days after giving Notice to the Employer, terminate the Contract unless the Employer cures the event or circumstance within the said 14 days. However, in the case of sub paragraph (f) or (g), the Contractor may by Notice terminate the Contract

	immediately. The Contractors election to terminate the Contract shall not prejudice any other rights of the Contractor, under the Contract or otherwise.
16.3 Cessation of Work and Removal of Contractor's Equipment	After a Notice of termination under Sub-Clause 16.2 [Termination by Contractor] or Sub-Clause 18.5 [Optional Termination, Payment and Release] has taken effect, the Contractor shall, unless the Employer cured the event or circumstance within the 14-days Notice period, promptly; (a) cease all further work, except for such work as may have been instructed by the Employers Representative for the protection of life or property or for the safety of the Works or protection of the environment. For all such instructed work, the Contractor shall be entitled to be paid Cost Plus Profit and shall be relieved of further liabilities under Sub-Clauses 4.8 [Safety Procedures] and 4.18 [Protection of the Environment]; (b) hand over to the Employer the Contractor's Documents, Plant, Materials and other work, for which the Contractor has received payment; and (c) remove all other Goods from the Site, except as necessary for safety, and leave the Site.
16.4 Payment on Termination	After a Notice of termination under Sub-Clause 16.2 [Termination by Contractor has taken effect, the Employer shall promptly: (a) return the Performance Security to the Contractor; (b) pay the Contractor in accordance with Sub-Cause 18.6 [Optional Termination, Payment and Release]; and (c) pay to the Contractor the amount of any loss of profit or other loss or damage sustained by the Contractor as a result of this termination.
17 Risk Allocation	
17.1 The Employer's Risks during the Design-Build Period	Subject to the provisions of Sub-Clause 17.8 [Limitation of Liability], the risks allocated to the Employer and for which the Employer is liable during the Design-Build Period are divided into: (a) The Employer's Commercial Risks, which are: (i) the financial loss, delay or damage allocated to the Employer under the Contract or for which the Employer is liable by law, unless otherwise modified under the Contract; (ii) the right of the Employer to construct the Works or any part thereof on, over, under, in or through the Site; (iii) the use or occupation of the Site by the Works or any part thereof, or for the purpose of design, construction or completion of the Works other than the abusive or wrongful use by the Contractor; and (iv) the use or occupation by the Employer of any part of the Permanent Works, except as may be specified in the Contract; and (b) The Employer's Risks of Damage, which are:

	(i) damage due to any interference, whether temporary or permanent, with any right of way, light, air, water or other easement (other than that resulting from the Contractor's method of construction) which is the unavoidable result of the construction of the Works in accordance with the Contract; (ii) fault, error, defect or omission in any element of the design of the Works by the Employer or which may be contained in the Employer's Requirements, other than design carried out by the Contractor pursuant to his obligations under the Contract; (iii) any operation of the forces of nature (other than those allocated to the Contractor in the Contract Data) against which an experienced contractor could not reasonably have been expected to have taken adequate preventative precautions; and (iv) The Exceptional Risks under Clause 18 [Exceptional Risks].
17.2 The Contractor's Risks during the Design-Build Period	Subject to the provisions of Sub-Clause 17.8 [Limitation of Liability, the risks allocated to the Contractor and for which the Contractor is liable during the Design-Build Period are all the risks other than those listed under Sub-Clause 17.1 [The Employer's Risks during the Design-Build Period], including the care of both the Works and the Goods.
17.3 The Employers Risks during the Operation Service Period	Subject to the provisions of Sub-Clause 17.8 [Limitation of Liability], the risks allocated to the Employer and for which the Employer is liable during the Operation Service Period are divided into: (a) The Employers Commercial Risks, which are: (i) the financial loss, delay or damage allocated to the Employer under the Contract or for which the Employer is liable by law, unless otherwise modified under the Contract; (ii) the use or occupation by the Employer of any part of the Permanent Works, except as may be specified in the Contract; and (iii) the use or occupation of the Site by the Works or any part thereof, or for the purpose of operating and maintaining the Permanent Works; and (b) The Employer's Risks of Damage, which are: (i) damage due to any interference, whether temporary or permanent, with any right of way, light, air, water or other easement (other than that resulting from the Contractor's methods of operation and maintenance) which is the unavoidable result of operating and maintaining the Permanent Works in accordance with the Contract; (ii) fault, error, defect or omission in any element of the design of the Works by the Employer or which may be contained in the Employer's Requirements, other than design carried out by the Contractor pursuant to his obligations under the Contract; (iii) any operation of the forces of nature against which an

	experienced contractor could not reasonably have been expected to have taken adequate preventative precautions; and (iv) The Exceptional Risks under Clause 18 [Exceptional Risks.
17.4 The Contractor's Risks during the Operation Service Period	Subject to the provision of Sub-Clause 178 [Limitation of Liability), the risks allocated to the Contractor and for which the Contractor is liable during the Operation Service Period are: (a) all risks resulting or arising from the design (excluding any design allocated to the Employer under Sub-Clauses 17.1 (b)(ii) and 1 7.3(b)(ii)) or construction of the Works, or the Materials used therein, notwithstanding any testing carried out by or approved or witnessed by the Employer or the Employer's Representative during the Design-Build Period; and (b) all risks resulting or arising from the operation and maintenance of the Perm3nent Works and the care of the Works excluding [he Employer's Risks listed under Sub-Clause 17.3 [The Employer's Risks during the Operation Service Period].
17.5 Responsibility for Care of the Works	Unless the Contract is terminated in accordance with these Conditions, the Contractor shall take full responsibility for the care of the Works and Goods from the Commencement Date until the Commissioning Certificate for the whole of the Works is issued pursuant to Sub-Clause 11.7 [Commissioning Certificate). If the Contract is terminated in accordance with these Conditions, the Contractor shall cease to be responsible for the care of the Works from the date of expiry of the Notice of termination. The Contractor shall also be responsible for the care of the Permanent Works during the Operation Service Period in accordance with the requirements of the Operating Licence pursuant to Sub-Clause 1.7 [Operating Licence]. The Contractor shall also be responsible for the care of any part of the Permanent Works for which a Section Commissioning Certificate has been issued. The Contractor shall also take full responsibility for any outstanding work which he shall have undertaken to complete during the Operation Service Period until all such outstanding work is completed.
17.6 Consequences of the Employer's Risks of Damage	Subject to the provisions of Sub-Clause 18.4 [Consequences of an Exceptional Event], if any of the risks allocated as an Employer's Risk under Sub-Clause 17.1 [The Employer's Risks during the Design-Build Period] arid 17.3 [The Employer's Risks during the Operation Service Period] occurs and results in damage to the Works or other property or Goods or Contractors Documents, the Contractor shall promptly give Notice to the Employer's Representative, and shall thereafter rectify such loss and/or damage to the extent required by instruction of the Employer's Representative, Such instruction shall be deemed a Variation. In the event of the allocation of the risk not being governed by any other term of the Contract, and such risk occurs during the Design-Build Period and the Contractor is delayed and/or incurs cost from rectifying this damage, the Contractor shall give a further Notice to the Employer's Representative and shall be entitled to:

	(a) an extension of time for any such delay, if completion is or will be delayed, under Sub-Clause 9.3 [Extension of Time for Completion of Design-Build]; and (b) payment of Cost Plus Profit, which shall be included in the Contract Price. If the event occurs during the Operation Service Period, sub-paragraph (b) of this Sub-Clause shall apply, but sub-paragraph (a) of this Sub-Clause shall not apply. The Employer's Representative shall proceed En accordance with Sub-Clause 3.5 [Determinations] to determine the amounts due.
17.7 Consequences of the Contractor's Risks resulting in Damage	If any of the risks allocated as a Contractors risk under Sub-Clause 17.2 [The Contractor's Risks during the Design-Build Period] and 17.4 [The Contractor's Risks during the Operation Service Period] occurs and results in damage to the Works or other property or Goods, the Contractor shall promptly give Notice to the Employer's Representative, and shall thereafter rectify such damage to the extent required by the Employer's Representative. All such work of replacement, repair or rectification shall be carried out by the Contractor at his own cost.
17.8 Limitation of Liability	Neither Party shall be liable to the other Party for any loss of use of any Works, loss of profit, loss of contract or for any other indirect loss or damage which may be suffered by the other Party in connection with the Contract, other than under Sub- Clause 10.6 [Delays and Interruptions during the Operation Service], Sub-Clause 16.4 [Payment on Termination], Sub-Clause 17.9 [indemnities by the Contractor], Sub- Clause 17.10 [Indemnities by the Employer] and Sub-Clause 17.12 [Risk of Infringement of Intellectual and Industrial Property Rights]. The total liability of the Contractor to the Employer, under or in connection with the Contract. shall not exceed the sum stated in the Contract Data or (if a sum is not so stated) the Accepted Contract Amount. This Sub-Clause shall not limit any liability in any case of fraud, deliberate default or reckless misconduct by the defaulting Party.
17.9 Indemnities by the Contractor	The Contractor shall indemnify and hold harmless the Employer, the Employer's Personnel, and their respective agents, against and from all claims, damages, losses and expenses (including legal fees and expenses) in respect of: (a) bodily injury, sickness, disease or death, of any person whatsoever arising out of or in the course of or by reason of the Contractors design, execution, completion or operation and maintenance of the Works. unless attributable to any negligence, willful act or breach of the Contract by the Employer, the Employer's Personnel, or any of their respective agents: and (b) damage to or loss of any property, real or personal (other than the Works), to the extent that such damage or loss; (i) arises out of or in the course of or by reason of the Contractors design, execution and completion or operation and maintenance of the Works, or (ii) is attributable to any negligence, willful act or breach of the

	Contract by the Contractor, the Contractor's Personnel, their respective agents, or anyone directly or indirectly employed by any of them. The Contractor shall also indemnify the Employer against all errors in the Contractor's design of the Works and other professional services which result in the Works not being fit for purpose or result in any loss and/or damage for the Employer.
17.10 Indemnities by the Employer	The Employer shall indemnify and hold harmless the Contractor, the Contractor's Personnel, and their respective agents, against and from all claims, damages, losses and expenses (including legal fees and expenses) in respect of: (a) bodily injury, sickness, disease or death, or loss of or damage to any property other than the Works, which is attributable to any negligence, willful act or breach of the Contract by the Employer, the Employer's Personnel, or any of their respective agents; and (b) the Employer's Risks as set out in Sub-Clauses 17.1 [The Employer's Risks during the Design-Build Period] and 17.3 [The Employer's Risks during the Operation Service Period].
17.11 Shared Indemnities	The Contractor's liability to indemnify the Employer, as aforesaid, shall be reduced proportionately to the extent that the Employer's Risks may have contributed to the said damage, loss or injury. Similarly, the Employer's liability to indemnify the Contractor, as aforesaid, shall be reduced proportionately to the extent that the Contractor's risks may have contributed to the said damage, loss or injury.
17.12 Risk of Infringement of Intellectual and Industrial Property Rights	In this Sub-Clause, "infringement" means an infringement (or alleged infringement) of any patent, registered design, copyright, trademark, trade name, trade secret or other intellectual or industrial property right relating to the Works: and claim' means a claim (or proceedings pursuing a claim) alleging an infringement. Whenever a Party does not give Notice to the other Party of any claim within 28 days of receiving the claim, the first Party shall be deemed to have waived any tight to indemnity under this Sub-Clause. The Employer shall indemnify and hold the Contractor harmless against and from any claim alleging an infringement which is or was: (a) an unavoidable result of the Contractors compliance with the Employers Requirements; or (b) a result of any Works being used by the Employer: (i) for a purpose other than that indicated by, or reasonably to be inferred from, the Contract; or (ii) in conjunction with anything not supplied by the Contractor, unless such use was disclosed to the Contractor prior to the Base Date or is stated in the Contract. The Contractor shall indemnify and hold the Employer harmless against and from any other claim which arises out of or in relation to (I) the Contractor's design, manufacture, construction or execution of the Works, (ii) the use of Contractor's Equipment, or (iii) the proper use of the Works. If a Party is entitled to be indemnified under this Sub-Clause, the

	indemnifying Party may (at its cost) conduct negotiations for the settlement of the claim, and any litigation or arbitration which may arise from it. The other Party shall, at the request and cost of the indemnifying Party, assist in contesting the claim, This other Party (and its Personnel) shall not make any admission which might be prejudicial to the indemnifying Party, unless the indemnifying Party failed to take over the conduct of any negotiations, litigation or arbitration upon being requested to do so by the other Party.
18 Exceptional Risks	
18.1 Exceptional Risks	An exceptional risk is a risk arising from an Exceptional Event which includes, but is not limited to: (a) war, hostilities (whether war be declared or not), invasion, act of foreign enemies; (b) rebellion, terrorism, revolution, insurrection, military or usurped power, or civil war, within the Country; (c) riot, commotion or disorder within the Country by persons other than the Contractor's Personnel and other employees of the Contractor and Subcontractors; (d) strike or lockout not solely involving the Contractor's Personnel and other employees of the Contractor and Subcontractors; (e) munitions of war, explosive materials, ionising radiation or contamination by radio-activity, within the Country, except as may be attributable to the Contractors use of such munitions, explosives, radiation or radio-activity; and (f) natural catastrophes such as earthquake, hurricane, typhoon or volcanic activity which are Unforeseeable or against which an experienced contractor could rot reasonably have been expected to have taken adequate preventative precautions.
18.2 Notice of an Exceptional Event	If a Party is or will be prevented from performing any of its obligations under the Contract due to an Exceptional Event, then it shall give Notice to the other Party of such event or circumstance and shall specify the obligations, the performance of which is or will be prevented. The Notice shall be given within 14 days after the Party became aware, or should have become aware, of the event or circumstance constituting an Exceptional Event. The Party shall, having given Notice, be excused performance of such obligations for so long as such Exceptional Event prevents it from performing them. Notwithstanding any other provision of this Clause, the obligations of either Party to make payments to the other Party under the Contract shall not be excused by an Exceptional Event.
18.3 Duty to Minimise Delay	Each Party shall at all times use all reasonable endeavors to minimise any delay in the performance of the Contract as a result of an Exceptional Event. A Party shall give Notice to the other Party when it ceases to be affected by an Exceptional Event.
18.4 Consequences of an Exceptional	If the Contractor is prevented from performing any of his obligations under the Contract due to an Exceptional Event of which Notice has been given under Sub-Clause 18.2 [Notice of an Exceptional Event]

Event	and suffers delay and/or incurs cost by reason of such Exceptional Event, the Contractor shall be entitled, subject to Sub- Clause 20.1 [Contractor's Claims], to: (a) an extension of time for any such delay, if completion is or will be delayed, under Sub-Clause 9.3 [Extension of Time for Completion of Design-Build]; and (b) if the event or circumstance is of the kind described in sub-paragraphs (a) to (e) of Sub-Clause 18.1 [Exceptional Risks] and, in the case of sub-paragraphs (b) to (e), occurs in the Country, payment of any such Cost. If the Exceptional Event occurs during the Operation Service Period, sub-paragraph (a) of this Sub-Clause 18.4 will not apply. After receiving this Notice, the Employer's Representative shall proceed in accordance with Sub-Clause 3.5 [Determinations] to agree or determine these matters.
18.5 Optional Termination, Payment and Release	If the execution of substantially all the Works in progress is prevented for a continuous period of 84 days by reason of an Exceptional Event of which Notice has been given under Sub-Clause 18.2 [Notice of an Exceptional Event], or for multiple periods which total more than 140 days due to the same notified Exceptional Event, then either Party may give to the other Party a Notice of termination of the Contract. In this event, the termination shall take effect 7 days after the Notice is given, and the Contractor shall proceed in accordance with Sub-Clause 16.3 [Cessation of Work and Removal of Contractor's Equipment]. Upon such termination, the Employer's Representative shat determine the value of the work done and issue a payment certificate which shall include: (a) the amounts payable for any work carried out for which a price is stated in the Contract; (b) the Cost of Plant and Materials ordered for the Works which have been delivered to the Contractor, or of which the Contractor is liable to accept delivery. This Plant and Materials shall become the property of (and be at the risk of) the Employer when paid for by the Employer, and the Contractor shall place the same at the Employers disposal; (c) any other Cost or liability which in the circumstances was reasonably incurred by the Contractor in the expectation of completing the Works; (d) the Cost of removal of Temporary Works and Contractors Equipment from the Site and the return of these items to the Contractors works in his country (or to any other destination at no greater cost); and (e) the Cost of repatriation of the Contractor's staff and labour employed wholly in connection with the Works at the date of termination.
18.6 Release from Performance under the Law	Notwithstanding any other provision of this Clause, if any event arises outside the control of the Parties (including, but not limited to, an Exceptional Event) which makes it impossible or unlawful for either or both Parties to fulfill its or their contractual obligations or which, under the law governing the Contract, entitles the Parties to

	be released from further performance of the Contract, then upon Notice by either Party to the other Party of such event: (a) the Parties shall be discharged from further performance, without prejudice to the rights of either Party in respect of any previous breach of the Contract; and (b) the sum payable by the Employer to the Contractor shall be the same as would have been payable under Sub-Clause 18.5 [Optional Termination, Payment and Release] if the Contract had been terminated under that Sub-Clause.
19 Insurance	
19.1 General Requirements	Without limiting his or the Employer's obligations or responsibilities under the Contract, the Contractor shall effect and maintain all insurances for which he is responsible with insurers and in terms, both of which shall be subject to approval by the Employer, such approval shall not be unreasonably withheld or delayed. The insurances required to be provided herein are the minimum required by the Employer, and the Contractor may, at his own cost, add such other insurances that he may deem prudent. Whenever required by the Employer, the Contractor shall produce the insurance policies which he is required to effect under the Contract. As each premium is paid, the Contractor shall send a copy of each receipt of payment to the Employer. If the Contractor fails to effect and keep in force any of the insurances required under Sub-Clause 19.2 [Insurances to be provided by the Contractor during the Design-Build Period], or tails to provide the policies or receipts as aforementioned, then, and in any such case, the Employer may effect and keep in force such insurances and pay any premium as may be necessary and recover the same from the Contractor from time to time by deducting the amount(s) so paid from any monies due to the Contractor or otherwise recover the same as a debt from the Contractor. If either the Contractor or the Employer fails to comply with the conditions attaching to the insurances effected pursuant to the Contract, the Party so failing to comply as aforesaid shall indemnify the other Party against all losses and cairns arising from such failure. The Contractor shall also be responsible for the following: (a) notifying the insurers of any changes in the nature, extent or programme for the execution of the Works; (b) notifying the insurers of any changes in the nature, extent or programme for the provision of the Operation Service; and (c) the adequacy and validity of the insurances in accordance with the Contract at all times during the performance of the Contract. The permitted deductible limits allowed in any policy shall not exceed the amounts stated in the Contract Data. Where there is a shared liability the loss shall be borne by each Party in proportion to its liability under Clause 17 [Risk Allocation] or Clause 18 [Exceptional Risks], provided the non-recovery from insurers has not been caused by a breach of this Clause by the Contractor. In the event that non-recovery from insurers has been

	caused by such a breach of Contract by the Contractor, the Contractor shall bear the loss suffered.
19.2 Insurances to be provided by the Contractor during the Design-Build Period	The Contractor shall provide the following insurances during the Design-Build Period: (a) The Works The Contractor shall insure and keep insured in the joint names of the Contractor and the Employer from the Commencement Date until the date of issue of the Commissioner, "Certificate: (i) the Works, together with Materials and Plant for incorporation therein, for their full replacement value with deductible limits not exceeding those stated in the Contract Data. The insurance cover shall extend to include loss and damage of any part of the Works as a consequence of failure of elements defectively designed or constructed with defective material or workmanship; and (ii) an additional sum of fifteen percent (15%) of such replacement value (or such sum as may be specified in the Contract Data) to cover any additional costs incidental to the rectification of loss or damage, including professional fees and the cost of demolition and removal of debris. The insurance cover shall cover the Employer and the Contractor against all loss or damage from whatever cause arising until the Commissioning Certificate is issued, Thereafter, the insurance shall continue until the date o issue of the Final Payment Certificate Design Build in respect of any incomplete work for loss or damage arising from any cause occurring prior to the date of the Commissioning Certificate, and for any loss or damage occasioned by the Contractor in the course of any operation carried out by him for the purpose of complying with his obligations under Clause 12 [Defects]. The insurance cover provided by the Contractor for the Works may exclude any of the following: (1) the cost of making good any part of the Works which is defective (including defective material and workmanship) or otherwise does not comply with the Contract, provided that it does not exclude the cost of making good any loss or damage to any other part of the Works attributable to such defect or non-compliance. (2) indirect or consequential loss or damage including any reductions in the Contract Price for delay. (3) wear and tear, shortages and pilferages. (4) the Employers Risks set out in Sub-Clause 17.1 [Employers Risks during the Design-Build Period] unless otherwise stated in the Contract Data regarding the risks in sub-paragraph (b)(iii) thereof. (5) the Exceptional Risks set out in Sub-Clause 18.1 [Exceptional Risks) unless, otherwise stated in the Contract Data regarding the risks in sub-paragraph (f) thereof. (b) Contractors Equipment The Contractor shall insure in the joint names of the Employer

	and the Contractor the Contractors Equipment and other things brought onto Site by the Contractor to the extent specified in the Contract Data. (c) Liability for breach of professional duty The Contractor shall insure the legal liability of the Contractor arising Out of the negligent fault, defect, error or omission of the Contractor or any person for whom the Contractor is responsible in the carrying out their professional duties in an amount not less than that stated in the Contract Data. Such insurance shall contain an extension indemnifying the Contractor for his liability arising out of negligent fault, defect, error or omission in the carrying out his professional duties which result in the Works not being fit for the purpose specified in the Contract and resulting in any loss and/or damage to the Employer. The Contractor shall maintain this insurance for the period specified in the Contract Data. (d) injury to persons and damage to property The Contractor shall insure, in the joint names of the Contractor and the Employer, against liabilities for death or injury to any person, or loss of or damage to any property (other than the Works) arising out of the performance of the Contract and occurring before the issue of the Final Payment Certificate Design-Build, other than loss or damage caused by any event covered under Sub-Clause 17.1 [Employer's Risks during the Design-Build Period] or Sub- Clause 18.1 [Exceptional Risks]. The insurance policy shall include a cross liability clause such that the insurance shall apply to the Contractor and the Employer as separate insureds. Such insurance shall be effected before the Contractor begins any work on the Site and shall remain in force until the issue of the Final Payment Certificate Design-Build and shall be for not less than the amount specified in the Contract Data. (e) Injury to employees The Contractor shall effect and maintain insurance against liability for claims, damages, losses and expenses (including legal fees and expenses) arising from injury, sickness, disease or death of any person employed by the Contractor or any other of the Contractor's Personnel. The Employer and the Employers Representative shall also be indemnified under the policy of insurance, except that this insurance may exclude losses and claims to the extent that they arise from any act or neglect of the Employer or of the Employers Personnel. The insurance shall be maintained in full force and effect during the whole time that the Contractor's Personnel are assisting n the execution of the Works. For any person employed by a Subcontractor, the insurance may be effected by the Subcontractor, but the Contractor shall be responsible for the Subcontractors compliance with this Sub-Clause. (f) Other insurances required by Law and by local practice

	Other insurances required by Law and by local practice (if any) shall be detailed in the Contact Data and the Contractor shall provide such other insurances in compliance with the details given, at his own cost.
19.3 Insurances to be provided by the Contractor during the Operation Service Period	The Contractor shall provide the following insurances during the Operation Service Period: (a) Fire extended cover for the Works The Contractor shall provide, in the joint names of the Employer and the Contractor, fire extended cover insurance for the Works as specified in the Contract Data for the Operation Service Period. Notwithstanding any other provision in The Contract, the Operation Ser “e shall not commence until the fire extended cover insurance is effected and the terms and details have been approved by the Employer. The terms of the policy shall be submitted to the Employer for his approval no later than 28 days before the date upon which the Commissioning Certificate is due to be issued, and shall come into force on the date stated in the Commissioning Certificate. (b) Injury to any person and damage to property The Contractor shall ensure that an insurance as required under Sub-Clause 19.2 (d) [Injury to persons and damage to property] be effected prior to the issue of the Commissioning Certificate and maintained until the issue of the Contract Completion Certificate. Such insurance shall be for an amount and in terms as specified in the Contract Data. (c) Injury to employees The Contractor shall ensure that an insurance a required under Sub-Clause 19.2(e) [Injury to employees] be effected prior to the issue of the Commissioning Certificate and maintained until the issue of the Contract Completion Certificate, or the last of his or any of his Subcontractors employees have left the Site, whichever is the later. (d) Other insurances required by Law and by local practice Other insurances required by Law and by local practice (if any) shall be detailed in the Contract Data and the Contractor shall provide such insurances in compliance with the details given, at his own cost. (e) Other optional operational insurances Other optional insurances required (if any) shall be detailed in the Contract Data and the Contractor shall provide such other insurances in compliance with the details given, at his own cost.
20 Claims, Disputes and Arbitration	
20.1 Contractor’s Claims	If the Contractor considers himself to be entitled to any extension of the Time for Completion of Design-Build and/or any additional payment, under any Clause of these Conditions or otherwise in connection with the Contract, he must comply with the following procedures: (a) Notices

	The Contractor shall give Notice to the Employer's Representative, describing the event or circumstance giving rise to the claim as soon as practicable, and not later than 28 days after the Contractor became aware, or should have become aware, of the event or circumstance. The Notice shall state that it is given under this Sub-Clause. If the Contractor fails to give Notice of a claim within such period of 28 days, the Time for Completion of Design-Build shall not be extended, the Contractor shall not be entitled to additional payment, and the Employer shall he discharged from all liability in connection with the claim. However, if the Contractor considers there are circumstances which justify th3 late submission, he may submit the details to the DAB for a ruling. If the DAB considers that, in all the circumstances, it is fair and reasonable that the late submission be accepted, the DAB shall have the authority to overrule the relevant 28-day limit and, if it so decides, it shall advise the Parties accordingly. If the Contractor has submitted his Notice of claim within the 28-day limit or the DAB has ruled that the late Notice was acceptable, then the Contractor shall proceed in accordance with the provisions of this Sub-Clause. (b) Contemporary records Following the giving of Notice, the Contractor shall keep such contemporary records as may be necessary to substantiate any claim. Contemporary records shall be kept on Site unless agreed otherwise with the' Employer's Representative Without admitting the Employer's liability, the Employer's Representative may, after receiving any Notice under this Sub-Clause, monitor the record-keeping and/or instruct the Contractor to keep additional contemporary records. The Contractor shall permit the Employer's Representative to inspect all these records, and shall (if instructed) submit copies to the Employer's Representative. (c) Details and particulars Within 42 days after the Contractor became aware (or should have become aware) of the event or circumstance giving rise to the claim, or within such other period as may he allowed by the DAB under paragraph (a) above, or proposed by the Contractor and approved by the Employer's Representative, the Contractor shall send to the Employer's Representative a fully detailed claim which includes full supporting particulars of the contractual or other basis of the claim and of the extension of time and/or additional payment claimed. The Contractor shall also provide the Employer's Representative with any additional particulars which the Employer's Representative may reasonably require. If the Contractor fails to provide the contractual or other basis of the claim within the said 42 days or other time allowed or approved, the Notice given under paragraph (a) above shall be deemed to have lapsed and shall no longer be considered as a valid Notice. If the Contractor considers there are circumstances which justify a late submission, he may submit the details to the DAB for a ruling. If the DAB considers that, in all the

	circumstances, it is fair and reasonable that the late submission be accepted, the DAB shall have the authority to overrule the given 42-day limit and, if t so decides, it shall advise the Parties accordingly If the event or circumstance giving rise to the claim has a continuing effect: (i) the fully detailed claim shall be considered as interim; (ii) the Contractor shall send further interim claims at 28-day intervals, giving the accumulated delay and/or amount claimed, and such additional particulars as the Employer's Representative may reasonably require; and (iii) the Contractor Shall send a final claim within 28 days after the end of the effects resulting from the event or circumstance, or within such other period as may be proposed by the Contractor and approved by the Employer's Representative. (d) Employer's Representative's response Within 42 days after receiving a fully detailed claim or any further particulars requested by the Employer's Representative, or within such other period as may be agreed by the Employer's Representatk'e and the Contractor, the Employer's Representative shall proceed in accordance with Sub-Clause 3.5 [Determinations] to agree or determine (i) the extension (if any) of the Time for Completion of Design-Build (before or after its expiry) in accordance with Sub- Clause 9.3 [Extension of Time for Completion for Design-Build], and/or (ii) the additional payment (if any) to which the Contractor is entitled under the Contract with detailed comments. He may also request any necessary additional particulars, but shall nevertheless give his response on the contractual or other aspects of the claim within the 42 days after receiving the fully detailed claim from the Contractor. If the Employer's Representative does not respond in accordance with the foregoing procedures and timetable, either Party may consider that the claim has been rejected by the Employer's Representative, and either Party may refer the matter to the DAB in accordance with Sub-Clause 20.6 [Obtaining Dispute Adjudication Board's Decision]. Each Payment Certificate shall include such amounts for any claim as have been reasonably substantiated as due under the relevant provision of the Contract. Unless and until the particulars supplied are sufficient to substantiate the whole of the claim, the Contractor shall only be entitled to payment for such part of the claim as he has been able to substantiate. If either Party is dissatisfied with the determination of the Employer's Representative, either Party may, within 28 days after receiving the determination, issue to the Employer's Representative and the other Party, a Notice of dissatisfaction, and thereafter proceed in accordance with Sub- Clause 20.6 [Obtaining Dispute Adjudication Board's Decision]. If no Notice of dissatisfaction is issued by either Party within the said 28 days, the determination of the Engineer's Representative shall

	be deemed to have been accepted by both Parties. The requirements of this Sub-Clause are in addition to those of any other Sub- Clause which may apply to a claim. If the Contractor fails to comply with this or another Sub-Clause in relation to any claim, any extension of time and/or additional payment shall take account of the extent (if any) to which the failure has prevented or prejudiced proper investigation of the claim, unless the claim is excluded under the paragraph (a) of this Sub-Clause.
20.2 Employer's Claims	If the Employer considers himself to be entitled to any payment under any Clause of these Conditions or otherwise in connection with the Contract, the Employer or the Employer's Representative shall give Notice and particulars to the Contractor. The Notice shall be given as soon as practicable after the Employer becomes aware, or should have become aware, of the event or circumstances giving rise to the claim. The particulars shall specify the Clause or other bass of the claim, and shall include substantiation of the amount to which the Employer considers himself to be entitled in connection with the Contract. The Employer's Representative shall then proceed in accordance with Sub-Clause 3.5 [Determinations] to agree or determine the amount (if any) which the Employer is entitled to be paid by the Contractor. If either Party is dissatisfied with the determination of the Employer's Representative, either Party may, within 28 days after receiving the determination, issue to the Employer's Representative and the other Party, a Notice of dissatisfaction, and thereafter proceed in accordance with Sub-Clause 20.6 [Obtaining Dispute Adjudication Board's Decision]. If no Notice of dissatisfaction is issued by either Party within the said 28 days, the determination of the Engineer's Representative shall be deemed to have been accepted by both Parties. The amount determined by the DAB may be included as a deduction in the Contract Price and Payment Certificates. The Employer shall only be entitled to set off against or make any deduction from an amount certified in a Payment Certificate, or to otherwise claim against the Contractor, in accordance with this Sub-Clause.
20.3 Appointment of the Dispute Adjudication Board	Disputes arising during the Design-Build Period shall be adjudicated by a DAB in accordance with Sub-Clause 20.6 [Obtaining Dispute Adjudication Board's Decision]. The Parties shall jointly appoint a DAU by me date stated in the Contract Data. The DAB shall comprise, as stated in the Contract Data, either one or three suitably qualified persons ("the members'). It the number is not so stated and the Parties do not agree otherwise, the DAB shall comprise three persons. If the DAB is to comprise three persons, each Party shall nominate one member for the approval of the other Party. The Parties shall consult both these members and shall agree upon the third member, who shall be appointed to act as chairman. However, if a list of potential members is included in the Contract, the members shall be selected from those on the list, subject to their

	being able and willing to accept appointment to the DAB. The agreement between the Parties and either the sole member ("adjudicator") or each of the three members shall incorporate by reference the General Conditions of Dispute Adjudication Agreement in these General Conditions, with such amendments as are agreed between them. The terms of the remuneration of either the sole member or each of the three members shall be mutually agreed upon by the Parties when agreeing the terms of appointment. Each Party shall be responsible for paying one-half of this remuneration. If at any time the Parties so agree, they may appoint a suitably qualified person or persons to replace any one or more members of the DAB. Unless the Parties agree otherwise, the appointment will come into effect if a member declines to act or is unable to act as a result of death, disability, resignation or termination of appointment. The replacement shall be appointed in the same manner as the replaced person was required to have been nominated or agreed upon, as described in this Sub-Clause. However the appointment of any member may only be terminated by mutual agreement of both Parties, and not by the Employer or the Contractor acting alone. Unless otherwise agreed by both Parties, the appointment of the DAB (including each member) shall expire upon the issue of the Commissioning Certificate under Sub-Clause 9.12 [Completion of Design-Build] or 28 days after the DAB has given its decision to a Dispute under Sub-Clause 20.6 [Obtaining Dispute Adjudication Board's Decision}, whichever is the later.
20.4 Failure to Agree Dispute Adjudication Board	If any of the following conditions apply, namely: (a) the Parties fail to agree upon the appointment of the sole member of the DAB by the date stated in the first paragraph of Sub-Clause 20.3 [Appointment of the Dispute Adjudication Board]; (b) either Party fails to nominate a member (for approval by the other Party), or fails to approve a member nominated by the other Party, of a DAB of three persons by such date; (c) the Parties fail to agree upon the appointment of the third member (to act as chairman) of the DAB by such date, or (d) the Parties fail to agree upon the appointment of a replacement person within 42 days after the date on which the sole member or one of the three members declines to act or is unable to act as a result of death, disability, resignation or termination of appointment, then the appointing entity or official named in the Contract Data shall upon the request of either or both of the Parties and after due consultation with both Parties, appoint this member of the DAB. This appointment shall be final and conclusive. Each Party shall be responsible for paying one-half of the remuneration of the appointing entity or official.
20.5 Avoidance of Disputes	If at any time the Parties so agree, they may jointly refer a matter to the DAB in writing with a request to provide assistance and/or informally discuss and attempt to resolve any disagreement that may have arisen between the Parties during the performance of the

	Contract. Such informal assistance may take place during any meeting, Site visit or otherwise. However, unless the Parties agree otherwise, both Parties must be present at such discussions. The Parties are not bound to act upon any advice given during such informal meetings, and the DAB shall not be bound in any future Dispute resolution process and decision by any views given during the informal assistance process, whether provided orally or in writing. If a Dispute of any kind whatsoever arises between the Parties, whether or not any informal discussions have been held under this Sub-Clause, either Party may refer the Dispute in writing to the DAB according to the provisions of Sub-Clause 20.6 [Obtaining Dispute Adjudication Boards Decision].
20.6 Obtaining Dispute Adjudication Boards Decision	If a Dispute (of any kind whatsoever) arises between the Parties in connection with, or arising out of, the Contract or the execution of the Works during the Design-Build Period, including any Dispute as to any certificate, determination, instruction, opinion or valuation of the Employer's Representative, either Party may, within 28 days of issuing a Notice of dissatisfaction under Sub-Clause 20.1(d) [Contractor's Claims] or Sub-Clause 20.2 [Employer's Claims], refer the Dispute in writing to the DAB for its decision, with copies to the other Party and the Employer's Representative. Such reference shall state that it is given under this Sub-Clause. The other Party shall then have 21 days to send a response to the DAB with copies to the referring Party and the Employer's Representative. If the dissatisfied Party has not formally referred the matter to the DAB within the said 28-day period, the Notice of dissatisfaction shall be deemed to have lapsed and no longer be considered to be valid. For a DAB of three persons, the DAB shall be deemed to have received such submissions on the date when they are received by the chairman of the DAR. Both Parties shall promptly make available to the DAB all information, access to the Site, and appropriate facilities, as the DAB may require for the purposes of making a decision on such Dispute. The DAB shall not act as arbitrator(s). Within 84 days after receiving the other Party's response or, if no such response is received, within 105 days after receiving the reference. or within such other period as may be proposed by the DAB and approved by both Parties, the DAB shall give its decision in writing to both Parties and the Employer's Representative, which shall be reasoned and shall state that it is given under this Sub-Clause. The decision shall be binding on both Parties and the Employer's Representative, who shall promptly comply with it notwithstanding that a Party gives a Notice of dissatisfaction with such decision as described below. Unless the Contract has already been abandoned, repudiated or terminated, the Contractor shall continue to proceed with the Works in accordance with the Contract. If either Party is dissatisfied with the DAB's decision, then either Party may, within 28 days after receiving the decision, give Notice to the other Party of its dissatisfaction. If the DAB fails to give its decision within the penod prescribed in this Sub-Clause, then either Party may, within 28 days after this period has expired, give Notice

	to the other Party oi t dissatisfaction. In either case, the dissatisfied Party shall send a copy of the Notice to the chairman of the DAB. In either event, this Notice of dissatisfaction shall state that it is given under this Sub- Clause, and shall set out the matter in Dispute and the reason(s) for dissatisfaction. Except as stated in Sub-Clause 20.9 [Failure to Comply with Dispute Adjudication Board's Decision], neither Party shall be entitled to commence arbitration of a Dispute unless a Notice of dissatisfaction with respect to that Dispute has been given in accordance with this Sub-Clause. If the decision of the DAB requires a payment by one Party to the other Party, the DAB may require the payee to provide an appropriate security in respect of such payment. If the DAB has given its decision as to a matter in Dispute to both Parties, and no Notice of dissatisfaction has been given by either Party within 28 days after it received the DAB's decision, then the decision shall become final and binding upon both Parties.
20.7 Amicable Settlement	Where Notice of dissatisfaction has been given under Sub-Clause 20.6 Obtaining Dispute Adjudication Boards Decision], both Parties shall attempt to Settle the Dispute amicably before the commencement of arbitration. However, unless both Parties agree otherwise, arbitration may be commenced on or after the twenty-eighth day after the day on which Notice of dissatisfaction was given, even if no attempt at amicable settlement has been made.
20.8 Arbitration	Unless settled amicably, and subject to Sub-Clause 20.9 [Failure to Comply with Dispute Adjudication Boards Decision], any Dispute in respect of which the DAB's decision (if any) has not become final and binding shall be finally settled by international arbitration. Unless otherwise agreed by both Parties: (a) the Dispute shall be finally settled under the Rules of Arbitration of the International Chamber of Commerce; (b) the Dispute shall be settled by three arbitrators appointed in accordance with these Rules; and (c) the arbitration shall be conducted in the language for communications defined in Sub-Clause 1.4 [Law and Language] unless otherwise stated in the Contract Data. The arbitrator(s) shall have full power to open up, review and revise any certificate, determination, instruction, opinion or valuation of the Employers Representative, and any decision of the DAB. relevant to the Dispute. Nothing shall disqualify the Employer's Representative from being called as a witness and giving evidence before the arbitrator(s) on any matter whatsoever relevant to the Dispute. Neither Party shall be limited in the proceedings before the arbitrator(s) to the evidence or arguments previously put before the DAB to obtain its decision, or to the reasons for dissatisfaction given in its Notice of dissatisfaction. Any decision of the DAB shall be admissible in evidence in the arbitration. Arbitration may be commenced prior to or after completion of the Works. The obligations of the Parties, the Employer's Representative and the DAB shall not be altered by reason of any arbitration being conducted during the progress of the Works.

20.9 Failure to Comply with Dispute Adjudication Board's Decision	In the event that a Party fails to comply with any decision of the DAB, whether binding or final and binding, then the other Party may, without prejudice to any other rights it may have, refer the failure itself to arbitration under Sub-Clause 20.8 [Arbitration] for summary or other expedited relief, as may be appropriate. Sub-Clause 20.6 [Obtaining Dispute Adjudication Boards Decision] and Sub-Clause 20.7 [Amicable Settlement] shall not apply to this reference.
20.10 Disputes Arising during the Operation Service Period	Disputes arising during the Operation Service Period which cannot be resolved between the Parties shall be settled by a one-person DAB (Operation Service DAB"). Such person shall be jointly agreed and appointed by the Parties at the time at issue of the Commissioning Certificate, If the Parties cannot agree on the person who shall be the Operation Service DAB, then the person shall be appointed according to the provisions of Sub-Clause 20.4 [Failure to Agree Dispute Adjudication Board]. Such person shall be appointed for a term of five years. At the end of each five-year period, a new Operation Service DAB shall be agreed and appointed, If both Parties and the previously appointed person agree, the same Operation Service DAB may be re-appointed for a second (or third or fourth, as the case may be) five-year term. The agreement between the Parties and the Operation Service DAB shall incorporate by reference the General Conditions of Dispute Adjudication Agreement contained in these General Conditions, with such amendments as are agreed between them. The terms of remuneration of the Operation Service DAB shall be mutually agreed upon by the Parties when agreeing the terms of appointment. Each Party shall be responsible for paying one-half of this remuneration. The procedure for obtaining a decision from the Operation Service DAB shall be in accordance with the provisions of Sub-Clause 20.6 [Obtaining Dispute Adjudication Board's Decision], and the DAB shall give its decision no later than 84 days after receiving the other Party's response or, if no such response is received, within 105 days after receiving the reference and the supporting documentation from the Party referring the Dispute.. The appointment of the Operation Service DAB shall expire five years after the date 01 its appointment unless such appointment is extended for a further five years as aforementioned. If either Party is dissatisfied with the decision of the Operation Service DAB, the provisions of Sub-Clauses 20.6 [Obtaining Dispute Adjudication Board's Decision], 20.7 [Amicable Settlement], 20.8 [Arbitration] and 20.9 [Failure to Comply with Dispute Adjudication Board's Decision] shall apply.
20.11 Expiry of Dispute Adjudication Board's Appointment	If a Dispute arises between the Parties in connection with, or arising out of, the Contract or the execution of the Works and there is no DAB in place, whether by reason of the expiry of the DAB's appointment or otherwise: (a) Sub-Clause 20.6 [Obtaining Dispute Adjudication Board's Decision] and Sub-Clause 20.7 [Amicable Settlement], or Sub-

	Clause 20.10 [Disputes Arising during the Operation Service Period], as the case may be, shall not apply; and (a) (b) the Dispute may he referred directly to arbitration under Sub-Clause 20.8 [Arbitration].

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GENERAL CONDITIONS OF DISPUTE ADJUDICATION AGREEMENT

for the Dispute Adjudication Board and the Operation Service Dispute Adjudication Board

1 Definitions	Each 'Dispute Adjudication Agreement' is a tripartite agreement by and between: (a) the 'Employer; (b) the 'Contractor"; and (c) the 'Member' who is defined in the Dispute Adjudication Agreement as being: (i) the sole adjudicator or sole Member of the DAB ('Dispute Adjudication Board') or the Operation Service DAB (as appropriate), and where this is the case, all references to the "Other Members" hereinafter do not apply; or (ii) one of the three persons who are jointly called the DAB and, where this is the case, the other two persons are called the "Other Members". The Employer and the Contractor hr. entered (or intend to enter) into a contract, which is called the "Contract" and is defined in the Dispute Adjudication Agreement. In the Dispute Adjudication Agreement, words and expressions which are not otherwise defined shall have the meanings assigned to them in the Contract.
2 General Provisions	Unless otherwise stated in the Dispute Adjudication Agreement, the Agreement shall take effect on the latest of the following dates: (a) the Commencement Date defined in the Contract; (b) when the Employer, the Contractor and the Member have each signed the Dispute Adjudication Agreement; or (c) when the Employer, the Contractor and each of the Other Members any) have respectively each signed a dispute adjudication agreement. This employment of the Member is a personal appointment. At any time, the Member may give not less than 7Odays' Notice of resignation to the Employer and to the Contractor, and the Dispute Adjudication Agreement shall terminate upon the expiry of this period. The language to be used in all communications, reports, decisions and during all meetings and hearings relating to the business of either the DAB or the Operation Service DAB shall be the language for communications stated in the Contract Data.
3 Warranties	The Member warrants and agrees that he/she is and shall be impartial and independent of the Employer, the Contractor and the Employer's Representative. The Member shall promptly disclose, to each of them and to the Other Members (if any), any fact or circumstance which might appear inconsistent with his/her warranty and agreement of impartiality and independence.

	When appointing the Member, the Employer and the Contractor relied upon the Members representations that he/she is: (a) experienced in the work which the Contractor is to carry out under the Contract; (b) experienced in the interpretation of contract documentation; and (c) fluent in the language for communications which is stated in the Contract Data. If there is a challenge of a DAB Member by either Party or, in the case of a three- person DAB, jointly by the other Members, for lack of independence, notwithstanding any disclosure made or not made by that Member under Clause 4 [General Obligations of the Member] of these General Conditions of Dispute Adjudication Agreement, the challenging Party or Members (as the case may be) may refer the alleged lack of ii dependence to the appointing entity named in the Contract Data under Sub-Clause 20.4 [Failure to Agree Dispute Adjudication Board] of the General Conditions of Contract. If the appointing entity considers it to be prudent or necessary, it may refer the matter to an independent professional person or body (such as the International Chamber of Commerce) to review and assess the challenge. If such person or body is of the opinion that the Member in question is no longer independent as required by the terms of the Dispute Adjudication Agreement, the Member shall be removed from the DAB and the appointing entity shall, without delay, appoint a new Member. Any costs or fees due to the independent person or body shall be shared equally between the Parties.
4 General Obligations of the Member	The Member shall: (a) have no interest, financial or otherwise, in the Employer, the Contractor or Employers Representative, nor any financial interest in the Contract except for payment under the Dispute Adjudication Agreement; (b) not previously have been employed as a consultant or otherwise by the Employer, the Contractor or the Employer's Representative, except in such circumstances as were disclosed in writing to the Employer and the Contractor before they signed the Dispute Adjudication Agreement; (c) have disclosed in writing to the Employer, the Contractor and the Other Members (if any), before entering into the Dispute Adjudication Agreement and to his/her best knowledge and recollection, any professional or personal relationships with any director, officer or employee of the Employer, the Contractor or the Employers Representative, and any previous involvement in the overall project of which the Contract form IS part; (d) not, for the duration of the Dispute Adjudication Agreement, be employed as a consultant or otherwise by the Employer, the Contractor or the Employer's Representative, except as may be agreed in writing by the Employer, the Contractor and the Other Members (if any); (e) comply with the annexed Procedural Rules for Dispute

	Adjudication Board Members" ("Rules") and with Sub-Clause 20.5 [Avoidance of Disputes] of the General Conditions of Contract; (f) not give advice to the Employer, the Contractor, the Employer's Personnel or ti e Contractors Personnel concerning the conduct of the Contract, other than in accordance with the Holes; (g) not, while a Member, enter into discussions or make any agreement with the Employer, the Contractor or the Employer's Representative regarding employment by any of them, whether as a consultant or otherwise, after ceasing to act under the Dispute Adjudication Agreement; (h) ensure his/her availability for all Site visits and hearings as are necessary; (i) become conversant with the Contract and with the progress of the Works (and of any other parts of the project of which the Contract forms part) by studying all documents received which shall be maintained in a current working file; (j) treat the details f the Contract and all the DAB's activities and hearings as private and confidential, and not publish or disclose them without the prior written consent of the Employer, the Contractor and the Other Members (if any); and (k) be available to give advice and opinions, on any matter relevant to the Contract when requested by both the Employer and the Contractor, subject to the agreement of the Other Members (if any).
5 General Obligations of the Employer and the Contractor	The Employer, the Contractor, the Employer's Personnel and the Contractor's Personnel s rail not request advice from or consultation with the Member regarding the Contract, otherwise than in the normal course of the DAB's activities under the Contract and the Dispute Adjudication Agreement, or when both Parties jointly agree to refer a matter to the DAB in accordance with Sub-Clause 20.5 [Avoidance of Disputes] of the General Conditions of Contract. The Employer and the Contractor shall be responsible for compliance with this provision by the Employer's Personnel and the Contractor's Personnel respectively. The Employer and the Contractor undertake to each other and to the Member that the Member shall not, except as otherwise agreed in writing by the Employer, the Contractor, the Member and the Other Members (if any): (a) be appointed as an 1 arbitrator in any arbitration under the Contract; (b) be called as a witness to give evidence concerning any Dispute before arbitrator(s) appointed for any arbitration under the Contract; or (c) be liable for any claims for anything done or omitted in the discharge or purported discharge of the Member's functions, unless the act or omission is shown to have been in bad faith. The Employer and the Contractor hereby jointly and severally

	indemnify and hold the Member harmless against and from claims from which he/she is relieved from liability under the preceding paragraph. Whenever the Employer or the Contractor refers a Dispute to the DAB or the Operation Service DAB under Sub-Clause 20.6 [Obtaining Dispute Adjudication Board's Decision) or Sub-Clause 20.10 [Disputes Arising during the Operation Service Period) of the General Conditions of Contract, which will require the Member to make a Site visit and attend a hearing, the referring Party shall provide appropriate security for a sum equivalent to the reasonable expenses to be incurred by the Member. No account shall be taken of any other payments due or paid to the Member.
6 Payment	The Member shall be paid as follows, in the currency named in the Dispute Adjudication Agreement: (a) retainer fee per calendar month, which shall be considered as payment in full for: (i) being available on 28-days notice for all Site visits and hearings: (ii) becoming and remaining conversant with all project developments and maintaining relevant files, files in accordance with sub-paragraph (i) of Clause 4 hereof [Genera! Obligations of the Member); (iii) all office and overhead expenses including secretarial services, photocopying and office supplies incurred in connection with his/her duties; and (iv) all services performed hereunder except those referred to En sub- paragraphs (b) and (c) of this Clause. During the periods when each Operation Service DAB is acting, the retainer fee shall be paid monthly until the end of the month in which the appointment expires or is otherwise terminated, or the Member resigns. (b) a daily fee which shall he considered as payment in full for: (i) each day or part of a day up to a maximum of two days' travel time in each direction for the journey between the Member's home end the Site, or another location of a meeting with the Other Members (if any); (ii) each working day on Site visits, hearings or preparing decisions: and (iii) each day spent reading submissions in preparation for a hearing. (c) all reasonable expenses including necessary travel expenses (air fare in less than first class, hotel and subsistence and other direct travel expenses, including visa charges) incurred in connection with the Members duties, as well as the cost of telephone calls, courier charges, faxes and telexes: a receipt shall be required for each item in excess of five percent (5% of the daily fee referred to in sub-paragraoh (b) of this Clause. (d) any taxes properly levied in the Country on payments made to

	the Member (unless a national or permanent resident of the Country) under this Clause 6. The retainer and daily fees shall be as specified in the Dispute Adjudication Agreement. Unless it specifies otherwise, these fees shall remain fixed for the first 24 calendar months, and shall thereafter be adjusted by agreement between the Employer, the Contractor and the Member, at each anniversary of the date on which the Dispute Adjudication Agreement became effective. If the parties fail to agree on the retainer fee or the daily fee, the appointing entity or official named in the Contract Data shall determine the amount of the fees to be used. The Member shall submit invoices for payment of the monthly retainer and air fares quarterly in advance. Invoices for other expenses and for daily fees shall be submitted following the conclusion of a Site visit or hearing. All invoices shall be accompanied by a brief description of activities performed during the relevant period and shall be addressed to the Contractor. The Contractor shall pay each of the Member's invoices iii full within 56 days after receiving each invoice and shall apply to the Employer (in the Statements under the Contract) for reimbursement of one-half of the amounts of these invoices. The Employer shall then pay the Contractor in accordance with the Contract. If the Contractor fails to pay to the Member the amount to which he/she is entitled under the Dispute Adjudication Agreement, the Employer shall pay the amount due to the Member and any other amount which may be required to maintain the function of the DAB, and without prejudice to tne Employer's rights or remedies. In addition to all other rights arising from this default, the Employer shall be entitled to reimbursement of all sums paid in excess of one-half of these payments, plus all costs of recovering these sums and financing charges calculated at the rate specified in Sub-Clause 14.9 Delayed Payment of the General Conditions of Contract. If the Member does not receive payment of the amount due within 70 days after submitting a valid invoice, the Member may (i) suspend his/her services (without Notice) until the payment is received, and/or (ii) resign his/her appointment by giving Notice under Clause 7 hereof.
7 Default and Termination	At any time: (i) the Employer and the Contractor may jointly terminate the Dispute Adjudication Agreement by giving 42-days' Notice to the Member; or (ii) the Member may resign as provided for in Clause 2 hereof. If the Member fails to comply with the Dispute Adjudication Agreement, the Employer and the Contractor may, without prejudice to their other rights, terminate the Agreement by Notice to the Member. The Notice shall take effect when received by the Member. If the Employer or the Contractor fails to comply with the Dispute Adjudication Agreement, the Member may without prejudice to his/her other rights, terminate the Agreement by Notice to the Employer and the Contractor. The Notice shall take effect when

	received by them both. Any such Notice, resignation and termination shall be final and binding on the Employer, the Contractor and the Member. However, a Notice by the Employer or the Contractor, but not by both, shall be of no effect. If the Member falls to comply with any of his/her obligations under Clause 4 (a) to (d) above, he/she shall not be entitled to any fees or expenses hereunder and shall, without prejudice to the Employer's and the Contractor's other rights, reimburse each of the Employer and the Contractor for any fees and expenses received by the Member and the Other Members (if any), for proceedings or decisions (if y) of the DAB or the Operation Service DAB which are rendered void or ineffective by the said failure to comply. If the Member fails to comply with any of his obligations under Clause 4 (e) to (k) above, he shall not be entitled to any fees or expenses hereunder from the date and to the extent of the non-compliance and shall, without prejudice to their other rights, reimburse each of the Employer and the Contractor for any fees and expenses already received by the Member, for proceedings or decisions (if any) of the DAB or the Operation Service DAB which are rendered void or ineffective by the said failure to comply.
8 Disputes	Any Dispute or claim arising out of or in connection with this Dispute Adjudication Agreement, or the breach, termination or invalidity thereof, shall be finally settled by institutional arbitration. If no other arbitration institute is agreed, the arbitration shall be conducted under the Rules of Arbitration of the International Chamber of Commerce by one arbitrator appointed in accordance with these Rules of Arbitration.

PROCEDURAL RULES FOR DISPUTE ADJUDICATION BOARD MEMBERS

1. Unless otherwise agreed by the Employer and the Contractor, the DAB shall visit the Site at intervals of not more than 140 days, including times of critical construction events, at the request of either the Employer or the Contractor. Unless otherwise agreed by the Employer, the Contractor and the DAB, the period between consecutive visits shall not be less than 70 days, except as required to convene a hearing as described below.
2. The timing of and agenda for each Site visit shall be as agreed jointly by the DAB, the Employer and the Contractor, or in the absence of agreement, shall he decided by the DAB. The purpose of Site visits is to enable the DAB to become and remain acquainted with the progress of the Works and of any actual or potential problems or claims, and, as far as reasonable, to endeavour to prevent potential problems or claims from becoming Disputes.
3. Site visits shall be attended by the Employer, the Contractor and the Employers Representative and shall be co-ordinated by the Employer in co-operation with the Contractor. The Employer shall ensure the provision of appropriate conference facilities and secretarial and copying services. At the conclusion of each Site visit and before leaving the Site, the DAB shall prepare a report on its activities during the visit and shall send copies to the Employer and the Contractor.
4. The Employer and the Contractor shall furnish to the DAB one copy of all documents which the DAB may request, including Contract documents, progress reports, variation instructions, certificates and other documents pertinent to the performance of the Contract. All communications between the DAB and the Employer or the Contractor shall be copied to the other Party. If the DAB comprises three persons, the Employer and the Contractor shall send copies of these requested documents and these communications to each of these persons.
5. If any Dispute is referred to the DAB in accordance with Sub-Clause 20.6 [Obtaining Dispute Adjudication Board's Decision] or Sub-Clause 20.10 (Disputes Arising during the Operation Service Period] of the General Conditions of Contract, the DAB shall proceed in accordance with the said Sub-Clauses 20.6 and 20.10, and these Rules, or as otherwise agreed by the Employer and the Contractor in writing. Subject to the time allowed to give Notice of a decision and other relevant factors, the DAB shall:
   (a) act fairly and impartially as between the Employer and the Contractor, giving each of them a reasonable opportunity of pitting us case and responding to the other's case; and
   (b) adopt procedures suitable to the Dispute, avoiding unnecessary delay or expense.
6. The DAB may conduct a hearing on the Dispute, in which event it will decide on the date and place for the hearing and may request that written documentation and arguments from the Employer and the Contractor be presented to it prior to or at the hearing.
7. If, within 14 days after giving its decision, the members of the DAB find and agree that such decision contained errors of fact or principle, the Chairman of the DAB (or the sole Member if applicable) shall advise the Employer and the Contractor of the error and issue an addendum to its decision in writing to both Parties.
8. If, within 14 days of receiving a decision from the DAB, either Party believes that such decision contains an ambiguity, that Party may seek clarification from the DAB in writing with a copy of such request to the other Party. Within 14 days of receiving such a request, the DAB shall respond with a copy to the other Party, and if the DAB is of the opinion that the decision did contain an error or ambiguity, it may correct its decision by issuing an addendum to its original decision.

9. Except as otherwise agreed in writing by the Employer and the Contractor, the DAB shall have power to adopt an inquisitorial procedure, to refuse admission to hearings or audience a hearings to any persons other than representatives of the Employer, the Contractor and the Employer's Representative, and to proceed in the absence of any party who the DAB is satisfied received Notice of the hearing; but shall have discretion to decide whether and to what extent this power may be exercised.
10. The Employer and the Contractor empower the DAB, among other things, to:
    (a) establish the procedure to be applied in deciding a Dispute;
    (b) decide upon the DAB's own jurisdiction, and as to the scope of any Dispute referred to it;
    (c) conduct any hearing as it thinks fit, not being bound by any rules or procedures other than those contained in the Contract and these Rules;
    (d) take the initiative in ascertaining the facts and matters required for a decision,
    (e) make use of its own specialist knowledge, if any;
    (f) decide upon the payment of financing charges in accordance with the Contract;
    (g) decide upon any provisional relief such as interim or conservatory measures; and
    (h) open up, review and revise any certificate, decision, determination, instruction, opinion or valuation of the Employer's Representative, relevant to the Dispute.
11. The DAB shall not express any opinions during any hearing concerning the merits of any arguments advanced by the Parties. Thereafter, the DAB shall make and give its decision in accordance with Sub-Clause 20.6 [Obtaining Dispute Adjudication Board's Decision] of the General Conditions of Contract, or as otherwise agreed by the Employer and the Contractor in writing.
12. If the DAB comprises three persons:
    a. it shall convene in private after a hearing, n order to have discussions and prepare its decision;
    b. it shall endeavour to reach a unanimous decision: if this proves impossible the applicable decision shall be made by a majority of the Members, who may require the minority Member to prepare a written report for submission to the Employer and the Contractor; and
    c. if a Member fails to attend a meeting or hearing, or to fulfil any required function, the other two Members may nevertheless proceed to make a decision, unless:
        (i) either the Employer 0i the Contractor does not agree that they do so; or
        (ii) the absent Member is the chairman and he/she instructs the other Members not to make a decision.

SECTION-7: PARTICULAR CONDITIONS OF CONTRACT (PCC) 1
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SECTION-7: PARTICULAR CONDITIONS OF CONTRACT (PCC)

Particular Conditions Part A — Contract Data

INTRODUCTION

The following Sub-Clauses in the General Conditions make direct reference to the Contract Data and require that specific information is provided.

The document assumes that all information in the Contract Date will be provided by the Employer and included in the tender documents. If the Employer requires tenderers to provide any of the information required in the Contract Data, this must be clearly stated in the tender documents.

The Conditions of Contract comprise, as a minimum, the General Conditions and the Particular Conditions Part A — Contract Data, arid failure by the Employer to provide the information and details required in the Contract Data will mean that either the Contract Documents are incomplete with vital information missing, or that the fall-back provisions to be found in some of the Sub- Clauses in the General Conditions will automatically take effect.

The following Particular Conditions of Contract (PCC) shall supplement the General Conditions of Contract (GCC). Whenever there is a conflict, the provisions herein shall prevail over those in the GCC. The Particular Conditions of Contract shall therefore be read in conjunction with General Conditions of Contract.

PART A - CONTRACT DATA

SUB-CLAUSE	DATA TO BE GIVEN	DATA
1.1.24	Cost Plus Profit	Cost + 10%
1.1.32	Employer's Name and Address	Urban Development & Housing Department, Government of Rajasthan, through Jaipur Development Authority, RK Vyas Bhawan, Indira Circle, JLN Marg, Jaipur, Rajasthan, India
1.1.35	Employer's Representative	Director (Engineering-II) Jaipur Development Authority, RK Vyas Bhawan, Indira Circle, JLN Marg, JAIPUR.
1.1.70	Section	Section means the part of Works scheduled to be completed as per Sub-Clause 9.6 of Particular Conditions of Contract Part B
1.1.83	Works	The expression "Works" shall be read as "Works" or "Project"
1.1.78	Time for Completion of Design-Build	2 years and 6 months from Commencement Date
1.3 (c)	Agreed Systems of Electronic Transmission	By facsimile or electronic mail only
1.3 (d)	Address of Employer's Representative for communication	Director (Engineering-II) Jaipur Development Authority, RK Vyas Bhawan, Indira Circle, JLN Marg, JAIPUR.
1.3 (d)	Address of Contractor for Communication	Contractor to provide after signing of Contract Agreement
1.4	Contract shall be governed by the law of	Union of India and State of Rajasthan or any government instrumentality. In case of conflict, the Laws of Union of India shall prevail.
1.4	Ruling Language	English
1.4	Language for Communication	English
2.1	After signing of Contract Agreement, the Contractor shall be given right of access to part of the Site within:	As per Sub-Clause 2.1 of Particular Conditions of Contract Part B
4.2	Performance Security (as percentages of Accepted Contract Amount in currencies)	5% of the Accepted Contract Amount

SUB-CLAUSE	DATA TO BE GIVEN	DATA
4.2	Reduction in Performance Security at the end of Retention Period	50%
5.1	Period for notification of errors, faults and other defects	21 (twenty one) days from the date of receiving Notice from the Employer's Representative under Sub-Clause 8.1
5.2	Contractor's Documents requiring approval	As stated in Employer's Requirement in Section 5 All surveys, investigations, designs and drawings, construction drawings related to the Design & Build part Operation & Maintenance Manual for Operation Service Period
6.5	Normal working hours on the Site	9.00 hours to 18.00 hours with one hour break. However, O&M services shall be performed round the clock to meet Employer's Requirements.
8.2	Period of Operation Service	10 (ten) years from the date stated in Commissioning Certificate.
9.2	Time for Completion of Design-Build	2 years and 6 months from Commencement Date.
9.2	Time for Completion of each Section	As per Sub-Clause 9.2 of Particular Conditions of Contract, Part B.
9.6	Delay damages	0.045 percent of Accepted Contract Amount for Design-Build per day of delay which shall elapse between the stipulated date of completion of Design-Build part of the Contract and the date of issue of Commissioning Certificate.
9.6	Maximum amount of delay damages	10% of Accepted Contract Amount for the Design-Build part of the Contract
10.6 (a)	Maximum compensation payable by the Contractor	100% of the amount payable to the Contractor during the month under consideration.
10.6 (b)	Maximum compensation payable by the Employer	No compensation shall be payable by the Employer.
10.7	Performance damages	As per Employer's Requirements, Section-5.
10.7	Minimum production output required	As per Employer's Requirements, Section-5.
10.7 (b)	Period of Failure	84 days
13.5	Percentage rate to be applied to Provisional Sums	10% which shall include statutory deductions on payments
13.8	Adjustment for changes in costs	No price adjustment shall be admissible for the Design Build part of works. Annual cost for Operation Service part of the

SUB-CLAUSE	DATA TO BE GIVEN	DATA
		project shall be subject to adjustment as per Clause 13.8 of Particular Conditions of Contract Part B
14.2	Amount of Advance Payment (percent of Accepted Contract Amount)	10% of the Accepted Contract Amount of Design-Build Part in two installments of 5% each as per Sub-Clause 14.2 of Particular Conditions of Contract, Part B
14.2	Percentage deductions for repayment of Advance Payment	As per Sub-Clause 14.2 of Particular Conditions of Contract, Part B
14.3(c)	Percentage of Retention	5%
14.3(c)	Limit of Retention Money	5% of Contract Price.
14.6 (b) (i)	Plants and Materials	Nil
14.6(c) (i)	Plant and Materials for payment when delivered to the Site	Payments for Plant and Material when delivered to the site shall be as stated in Sechudle-1 “Schedule of Payments” Particular Conditions of Contract, Part B.
14.7(b)	Minimum Amount of Interim Payment Certificate	2% (two percent) of Accepted Contract Amount for Design-Build part of the Contract.
14.9	Financing charges for delayed payment:	6% per annum for the period of delay.
14.17	Currencies for payment of Contract Price	INR
14.17	Proportion of Currencies	All payments only in INR
14.17	Currencies for Payment of Damages	All payments only in INR
14.19	Amount of Maintenance Retention Fund	5% of Accepted Contract Amount of Operation Service
17.8	Total liability of the Contractor shall not exceed	Accepted Contract Amount
19.2(a) (i)	Deductible Limits	Nil
19.2 (c)	Amount of professional liability insurance	INR 10.00 crore
19.2 (c)	Period for which professional liability insurance required	Until issue of Final Payment Certificate for Design-Build
19.2 (d)	Amount of insurance required for injury to persons and damage to property	Minimum INR 2.00 crore (Rs two crore) for each occurrence with unlimited number of occurrences up to Contract Completion Date
19.2 (f)	Other insurances required from the Contractor	As required under the law, for example under Workmen Compensation Act
19.3 (a)	Amount of fire extended	as per cost of Design Build in Contract Price

SUB-CLAUSE	DATA TO BE GIVEN	DATA
	cover insurance required	
19.3 (d)	Other insurances required from the Contractor	As required under the law, for example under Workmen Compensation Act
20.3	Date for appointment of DAB	28 days from the Commencement Date
20.3	The DAB shall comprise	of one (1) member
20.4	Appointing entity (official) for DAB members, if not agreed, shall be:	Addl. Chief Secretary, UDH, GoR
20.8	Place of Arbitration	Jaipur
20.8(a)	Arbitration to be administered by:	As per Sub-Clause 20.8 (a) of Particular Conditions of Contract, Part B.

PART B -SPECIFIC PROVISIONS

The Particular Conditions of Contract (PCC) Part B - Specific Provisions, covers amendment/addendum to the General Conditions of Contract (GCC - Section 7). In case of conflict between GCC and Particular Conditions of Contract, the provisions herein shall prevail over those in the GCC.

SUB-CLAUSE	SECTION	SPECIFIC PROVISION
1.1	Definitions	Unless otherwise specifically stated, or unless the context requires otherwise, capitalized terms in this Part B and in the Schedules to the Section 7: Particular Conditions of Contract are as defined under Sub-Clause 1.1 of the General Conditions of Contract and under Section 5 - Employer's Requirements. 'Bid' and 'Tender' shall have the same meaning, as defined in Section 1- Instructions to Bidder.
1.1.57	Operation Service	Replace the expression "Operation Service" by "Operation Service" or "Operation & Maintenance Service"
1.1.58	Operation Service Period	Add following: The Works installed or constructed and commissioned by the Contractor will be put to Operation Services in accordance with Sub-Clause 9.12 [Completion of Design-Build] and the Commissioning Certificate issued under Sub-Clause 11.7 [Commissioning Certificate]. The Operation Service of entire system shall commence only after Completion of Design-Build Period and after issue of the Commissioning Certificate .
1.1.83	Year and Month	Amend the Definition as: "Year means three hundred and sixty five [365] days and "month" means thirty [30] days
1.5	Priority of Documents	"Delete sub paragraphs (a) to (i) in Sub-Clause 1.5 and substitute with the following: a. Contract Agreement; b. Letter of Acceptance; c. Price Bid; d. Technical Bid; e. Addenda Nos . . . . . (if any); f. Particular Conditions – Part A; g. Particular Conditions – Part B; h. General Conditions of Contract; i. Employer's Requirements; j. Schedules; k. Contractor's Proposal and; l. Any other document/s forming part of the Contract.
1.6	Contract Agreement	In the first paragraph replace the word "Employer" by the word "Contractor" Add the following at the end of paragraph: Following actions shall have been taken by the Contractor

SUB-CLAUSE	SECTION	SPECIFIC PROVISION
		before entering in to Contract Agreement (i) Furnishing of Performance Security pursuant to Sub-Clause 4.2 [Performance Security] , (ii) Pay to Project Closure Fee to PDCOR Ltd along with applicable taxes as required under ITB (iii) Pay to Project Proponent the fee for preparing DPR as required under ITB (iv) Incorporating an SPV under Companies Act, 2013 by JV/Consortium8.. The Memorandum and Articles of Association of the company should incorporate following provisions in its Articles: (i) JV Partner's share holding ratio in Company will be broadly the same as indicated in JV agreement while submitting bid. (ii) No change/sale/dilution in shareholding ratio of JV partner in company will be allowed during Contract execution period. (iii) Directors on the Board of Company will be broadly in the same proportion as that of shareholding of JV partners. (iv) No changes in the Memorandum and Article of Association, as to the above issues, can be made without prior written consent of Employer.
1.14	Compliance with Laws	Add sub clause (d), (e) and (f) as follows: (d) Preparing applications in accordance to standard procedures for obtaining all statutory clearances and approvals required from Government of Rajasthan and/or Government of India, including all environmental clearances, permission from highway and railway authorities, inland waterway authorities, forest authorities and any other such authorities as may be required. (e) Employer shall by or before the Commencement Date, grant, or arrange for the benefit of the Contractor, the rights and authority to repair or replace the facilities, to carry out earth work, construct the course correction works, development works, lay sewers, construct STP/SPS/civil structures, install equipment and machinery on its behalf to carry out its obligations under this Contract. . (f) Employer shall procure, obtain and maintain all consents to enable the Contractor to perform its duties and its obligations under the Contract for the duration of the Contract. Employer's Representative shall deal directly with the departments of the government or statutory authorities on behalf of the Contractor on all matters that require consultation and discussion with such department and shall ensure that the Contractor is able reasonably to perform its duties under the Contract. The Contractor will

SUB-CLAUSE	SECTION	SPECIFIC PROVISION
		provide all reasonable assistance in procuring consents.
2.1	Right of Access to the Site	Para-2 of Clause 2.1 shall be replaced with the following: The Employer shall give the Contractor right of access to, and possession of, the Site or parts of the Site within such time as may be required to enable the Contractor to proceed in accordance with the programme approved by the Employer's Representative under Sub-Clause 8.3 [Programme] for at least three months. Add the following paragraph at the end of the sub-clause 2.1: Contractor will get all the utilities shifted through line department to whom these utilities belong. Contractor will get the cost estimates from line department and make payments to such line agencies after securing approval from Employer and Employer shall reimburse such amounts to the Contractor as per actual payment made by the Contractor to the line department.
2.3	Employer's Personnel	Add following sub clauses after sub clause (b): (c) The day-to-day management control, work requirements, responsibilities and related terms and conditions pertaining to the Employer's Personnel deputed to the Contractor shall be in accordance with Section – 5, Employer's Requirement. (d) The Employer, its sub-contractors, employees and consultants (other than the Contractor), in exercising their rights of access to the Project Facilities within the Site, shall comply at all times with: • All governing Laws, relevant permits set forth in GCC Sub-Clause 1.14 and 2.2 and other permits for the services and all relevant health and safety requirements; • Instructions and directions issued by the Contractor which are necessary to ensure compliance by the Contractor with any governing Laws and any relevant health and safety requirements applicable to their respective activities in the Service Area.
2.4	Employer's Financial arrangements	The existing Sub-Clause shall be replaced with the following: "Employer shall arrange funds for the Works as required at various stages"
2.5	Overall Project Management	Add following sub clause 2.5: Employer through its representative will be responsible for review and approval of the detailed engineering design submitted by the Contractor and supervision of the works, disbursement of the Contractor's Payments, taking decision regarding completion of the works and achievement of the respective obligations by each party.

SUB-CLAUSE	SECTION	SPECIFIC PROVISION
3.1	Employer's Representative's Duties and Authority	Insert the following after the second paragraph: Employer's Representative shall have no authority to approve the (i) Detailed engineering design (ii) Time extensions (iii) Variation.
3.6	Management Meetings	Insert sub-clause 3.6 after sub-clause 3.5: The Employer's Representative or the Contractor's Representative may require the other to attend management meetings in order to review the progress with reference to the agreed work program and for making arrangements for remaining work. The Employer's Representative shall record the proceedings of such management meetings and make available copies of the proceedings to all those who attend the meetings with a copy to the Employer. In the proceedings so recorded, the responsibilities for any actions to be taken shall be in accordance with the Contract.
4.2	Performance Security	In the third paragraph the figure of "28 days" be read as "21 days" The fourth paragraph of the Sub-Clause shall stand deleted. The existing last paragraph shall standz replaced by the following: The Employer shall refund 50% of Performance Security to the Contractor within 7 (seven) days of expiry of Retention Period; 25% of Performance Security shall be refunded within 30 days of expiry of 50% of Operation Service Period and remaining 25% within 60 days of issue of Contract Completion Certificate.
4.18	Protection of Environment	Insert the following at the end of Sub-Clause: The Contractor shall comply with all applicable national, State and local environmental Laws and regulations. The Contractor shall: (a) establish all operational systems for managing environmental impacts; (b) carry out all of the monitoring and mitigation measures as per law and regulatory statutes. Requirement. (c) Contractor shall submit monthly reports on the implementation and monitoring of such measures to the Employer. (d) Contractor shall comply with recommendations made by NEERI.
4.19	Electricity, Water and Gas	The existing Sub-clause shall stand replaced by the following: Entire cost of electrical power, water, gas and other services utilized during the Design-Build Period shall be borne by the Contractor. After the Design-Build Period and during the entire Operation Service Period, Contractor shall continue to bear

SUB-CLAUSE	SECTION	SPECIFIC PROVISION
		the cost of utility services except electrical power. The cost of electrical power shall be admissible for reimbursement (Sub-Clause 13.8 of PCC Part B) as per terms and conditions of Contract limited to the Guaranteed Power Requirement quoted by the Contractor in form TECH 1. If for any reason the power generated by the standby generators is used, the unit cost of the power used from them shall also be paid at par with the JVVNL rates for the month as charged
4.21	Progress Reports	Insert following after Sub-Clause (h): (i) Monitoring of the obligations in Sub-Clauses 4.18, 6.4, 6.7, 6.12, and 6.13.
4.26	Contract Management	Add sub-clause 4.26 as follows: Contractor will use the suitable computer operated software to manage the contract.
5.6	Operation and Maintenance Manuals	Insert the words “28 days” at the beginning of the Sub – Clause and read “prior” in place of “Prior” in the first sentence.
6.4	Labour Laws	Insert the following at the end of the Sub-Clause: The Contractor shall not make employment decisions based upon personal characteristics unrelated to job requirements. The Contractor shall base the employment relationship upon equal opportunity and fair treatment, and shall not discriminate with respect to aspects of the employment relationship, including recruitment and hiring, compensation (including wages and benefits), working conditions and terms of employment or retirement, and discipline. The Contractor shall provide equal wage and benefits to men and women for work of equal value or type. The Contractor shall not employ forced labour, which consists of any work or services, not voluntarily performed, that is exacted from an individual under threat of force or penalty, and includes any kind of involuntary or compulsory labour, such as indentured labour, bonded labour, or similar labour-contracting arrangements.
6.7	Health and Safety	Insert the following at the end of the Sub-Clause: The Contractor shall conduct health and safety programs for workers employed under the project, and shall include information on the risk of sexually transmitted diseases, including HIV/AIDS in such a program.
6.12	Child Labour	Add Sub-Clause 6.12 as follows: The Contractor shall not employ any child to perform any work, including work that is economically exploitative, or is likely to be hazardous to, or to interfere with, the child’s education, or to be harmful to the child’s health or physical,

SUB-CLAUSE	SECTION	SPECIFIC PROVISION
		mental, spiritual, moral, or social development. "Child" means a child below the statutory minimum age specified under applicable national Laws.
7.3	Inspections	Add following paragraph at the end of sub clause: The Employer shall be entitled to monitor on a regular basis the Contractor's performance of the services and may request any technical documents and reports necessary to do so provided that such requests would not hinder the Contractor in performing its obligations under the Contract. The Employer shall have access to the Project Facilities to inspect the facilities during business hours upon reasonable advance notice to the Contractor. Employer shall be entitled to delegate such inspection rights to a third party provided that the same conditions shall apply.
9.2	Time for completion of Design Build	Add following paragraph at the end of sub clause: If the contractor is not able to complete the Design-Build work within the stipulated time for completion or the extended time for completion, Contractor shall submit an application for extension of time for Design-Build completion at least 28 days before the expiry of stipulated or extended time of completion. The Employer will extend the Contract provisionally to keep the Contract alive without prejudice to the right of Employer to take any other action as per the Contract provisions.
9.6	Delay damages relating to Design-Build	Add a new paragraph below the first paragraph of the Sub-clause which shall read as under: The contractor shall be liable to pay interim delay damage which shall be adjusted in delay damages as may be finally decoded after completion of Design-Build part of the Contract. The interim delay damages shall be computed in the following manner: **Interim Compensation during Design-Build Period:** The work shall, through-out the stipulated period of completion of the contract, be proceeded with all due diligence time being essence of the contract, on the part of the Contractor. To ensure good progress during the execution of work, the contractor shall be bound to complete 2.0% of the whole of the work before 1/5th of the whole time allowed under the contract has elapsed, 25% of the work before 2/5th of such time has elapsed, 55% of the work before 3/5th of such time has elapsed, 85% of the work before 4/5th of such time has elapsed and 100% by the stipulated completion date. If the contractor fails to complete the work in accordance with this time schedule in terms of cost in money, and the delay in execution of work is attributable to the Contractor, the Contractor shall be liable to pay compensation to Employer at every time span as below:-

<table>
<tr><th colspan="2">SUB-CLAUSE</th><th>SECTION</th><th colspan="5">SPECIFIC PROVISION</th></tr>
<tr><td></td><td>1</td><td>Time Span of full Stipulated period</td><td>1/5th (……..days)</td><td>2/5th (…..days)</td><td>3/5th (…….days)</td><td>4/5th (…….days)</td><td>Full (…..days)</td></tr>
<tr><td></td><td>2</td><td>Work to be completed in terms of % of contract amount for Design and Build Part</td><td>2.0%</td><td>25%</td><td>55%</td><td>85%</td><td>100%</td></tr>
<tr><td></td><td>3</td><td>Compensation payable by the contractor for delay attributable to the contractor at the stage</td><td>2.0% of Scheduled work which was to be executed up to the time span under consideration but remained unexecuted on the last day of (1/5th) time span.</td><td>4 % of Scheduled work which was to be executed up to the time span under consideration but remained unexecuted on the last day of (2/5th) time span.</td><td>6.0% of Scheduled work which was to be executed up to the time span under consideration but remained unexecuted on the last day of (3/5th) time span.</td><td>8% of Scheduled work which was to be executed up to the time span under consideration but remained unexecuted on the last day of (4/5th) time span</td><td>10% of Scheduled work which was to be executed up to the time span under consideration but remained unexecuted on the last day of (5/5th) time span.</td></tr>
<tr><td colspan="8">In case the delay in execution of work is attributable to the contractor, the span wise compensation as laid down in the clause shall be mandatory. However, in case the slow progress in one time span is covered up within original stipulated period then the amount of such compensation levied earlier shall be refunded. The Employer shall review the progress achieved in every time span, and grant stage wise extension in the case of slow progress with compensation if the delay is attributable to contractor, otherwise without compensation.</td></tr>
<tr><td colspan="2">11.8</td><td>Joint Inspection Prior to Contract Completion</td><td colspan="5">At the end of first paragraph, add the following:
“The Contractor’s report shall be subject to approval of Employer’s Representative”</td></tr>
<tr><td colspan="2">12.1(a) iii</td><td>Completion of outstanding work and Remedying Defects</td><td colspan="5">Add a new Sub-Clause as follows:
(iii) on the completion of Design-Build part of the Contract the Contractor shall fully restore pathways, other local infrastructure, and any property to at least their pre-project condition .</td></tr>
<tr><td colspan="2">12.7</td><td>Contractor’s other obligations</td><td colspan="5">Add a new Sub-Clause which shall read as under:
“The Contractor shall hand over to the Employer all relevant records, reports, Intellectual Property and other licenses pertaining to Works and its design, engineering, construction, operation and maintenance, including all programmes (software included) and manuals pertaining thereto and complete ‘as- built’ drawings along with</td></tr>
</table>

SUB-CLAUSE	SECTION	SPECIFIC PROVISION
		applicable permits. This shall be an essential condition to be fulfilled by the Contractor for issue of Contract Completion Certificate by the Employer. The Contractor shall provide all necessary training and capacity building to Employer's personnel for operation & maintenance works. The Contractor shall also provide reasonable advice and assistance as the Employer may reasonably require for operation of the facilities created under the Works for at least six months after the Contract Completion Date'
13.8	Adjustment for change in costs	Add following paragraph under the existing paragraph: Adjustment for Operations Service Period shall be governed in accordance to the adjustments for change in costs as provided in the following formula: **Labour** $V_L = 0.75 \times P_L / 100 \times R \times (I_{L1} - I_{L0}) / I_{L0}$ V_L = Increase or decrease in the cost of work during the quarter under consideration. R = Value of the work done during the quarter under consideration excluding the cost of materials supplied by the department. I_{L0}= Base Price which is Consumer Price Index for Industrial labour for jaipur issued by Labour Bureau, Shimlaon the base date. IL1= Final price (average for the quarter under consideration)which is Consumer Price Index for Industrial labour for Jaipur issued by Labour Bureau, Shimla. P_L= Percentage of labour components to be adopted as 85%. (Note: In case of revision of minimum wages by the Government or other competent authority, nothing extra would be payable except the price escalation permissible under this Clause). **(B) Other Material:** $V_M = 0.75 \times P_M / 100 \times R \times (I_{M1} - I_{M0}) / I_{M0}$ VM= Increase or decrease in the cost during the quarter under consideration due to change in rates of material. R= The value of the work done during the quarter under consideration excluding the cost of materials supplied by the department. I_{M0}= Base price which is Wholesale price index (all commodities) published in Reserve Bank of India Journalon the base date. I_{M1}=Final price (average for the quarter under consideration) which is the wholesale price index (all commodities) published in Reserve Bank of India Journal. P_M=Percentage of other material components to be

SUB-CLAUSE	SECTION	SPECIFIC PROVISION
		adopted as 15% **Power Cost:** The reimbursement to the Contractor for Power Cost shall be made by the Employer as per the actual rate per unit paid by the Contractor to JVVNL, excluding penalties levied by JVVNL, if any, due to default on the part of the Contractor. The reimbursement shall be based on the actual average inflow of sewage in a month to all the STPs and SPSs installed and commissioned by the Contractor for the project, subject to the Total Guaranteed Power requirement quoted for that slab of inflow as a percentage of design inflow. Power generated and utilized by the Contractor during Operation Service Period through its own arrangements e.g. DG sets/solar/gas etc. for the system would also be admissible for reimbursement (as per JVVNL rates) subject to the ceiling of Total Guaranteed Power Requirement.
14.2	Advance Payment	Delete the text of Sub-Clause 14.2 in its entirety and replace it with the following: "The Employer will, if requested by the Contractor, make interest-free mobilization advance payments to the Contractor to assist in defraying the initial expenses that will necessarily be incurred by the Contractor for mobilization and design. The total of such advance payments, and the number and timing of instalments, shall be as stated in the Contract Data Particular Conditions of Contract Part A. The Employer's Representative shall issue an Interim Payment Certificate for the first installment after (i) execution of the Form of Agreement by the parties hereto (ii) provision by the Contractor of the Performance Security in accordance with Sub-Clause 4.2 and (iii) provision by the Contractor of an unconditional and irrevocable bank guarantee in amounts and currencies equal to the advance payment. Such bank guarantee shall be issued either by a Nationalized or Scheduled Bank located in India and acceptable to the Employer. The issuing branch shall be located in Jaipur, Rajasthan, and the Employer shall have the right to invoke the bank guarantee by presenting in the branch office of such bank in Jaipur. The guarantee shall remain effective until the advance payments have been repaid, but its amount shall be progressively reduced by the amounts repaid by the Contractor as indicated in Interim Payment Certificates. The mobilization advance payments shall be made in installments as stated in the Appendix to Tender, subject to the conditions described below. The advance payments shall be used by the Contractor exclusively for mobilization expenses, as per the programme approved by the Employer's Representative.

SUB-CLAUSE	SECTION	SPECIFIC PROVISION
		For this purpose, the Contractor shall open a dedicated Contract Bank Account in a bank located in Jaipur, Rajasthan, and the Employer will transfer or deposit the advance payments directly into the Contractor's Contract Bank Account. The Contractor will not be permitted to use these funds for any purpose other than for expenditures under the Contract, and the Employer will be entitled to verify that the transactions from this account are used exclusively for the purposes for which they are intended. In case the advance payment is not utilized by the Contractor as per the approved programme and within the stipulated period to the satisfaction of the Employer's Representative, default proceedings as per Clause 15, General Conditions, shall be initiated against the Contractor. The Employer will make payment of the first installment of the mobilization advance only after the Contractor has fulfilled the following conditions: (a) Established the dedicated Contract Bank Account (b) Mobilized the Project Manager for the Contract. (c) Established and staffed a completely equipped and functional design office at Jaipur. (d) Mobilized the survey and subsoil investigation crews to the Site and commenced the surveys and subsoil investigations. (e) Submitted a list of proposed subcontractors and their respective agreements for approval by the Employer's Representative. (f) Submitted the proposed "Submission and Anticipated Approval Program" for construction documents for approval by the Employer's Representative. (g) Submitted the proposed construction programme for approval by the Employer's Representative. (h) Submitted, for approval by the Employer's Representative, mobilization/ deployment schedules, in the formats provided in Section 7, for: (i) Contractor's key personnel required for managing, executing and supervising the Works, (ii) Contractor's Plant, Machinery and Equipment required for executing the Works; and (iii) Procurement Schedule for major materials and equipment to be incorporated into the Permanent Works. (i) Submitted a Cash Flow Forecast for approval by the Employer's Representative. (j) Submitted a list of proposed quarries, suppliers and manufacturers, along with their credentials, for approval by the Employer's Representative. (k) Submitted details of funds mobilized by himself as per the Cash Flow Forecasts.

SUB-CLAUSE	SECTION	SPECIFIC PROVISION
		It is expected that the Contractor will also mobilize sufficient funds, which should normally be not less that the advance provided by the Employer, so that adequate cash flow is maintained at all times during execution. The Contractor is required to maintain liquidity from its own sources, and the advance from the Employer is only intended to facilitate the Contractor's mobilization and enhance activities on Site. After the first installment of the advance payment has been utilized as per the approved programme, and to the satisfaction of the Employer's Representative, the Contractor may then apply for the second installment. The Employer will make payment of the second installment after the Contractor has successfully fulfilled the following conditions: (a) Actual deployment of: (i) such Personnel, (ii) Machinery and Equipment, and (iii) placing of orders for major materials and equipment to be incorporated into the Permanent Works, as per the approved deployment schedules. (b) Established the fully furnished Site office(s). (c) Established and staffed, with qualified personnel, completely equipped testing laboratory(s) at Site for quality control purposes. (d) Placed confirmed orders for supply of major items of material and equipment which is to be incorporated into the Permanent Works as per the approved procurement schedule. (e) Procured initial quantities of (f) sewer pipes, cement, steel, shuttering materials, etc., required for executing the civil works in accordance with the approved schedule. (g) Completed erection of any concrete batching plant required for controlled mixing of the concrete for executing civil works. (h) Commenced construction work at the Site in accordance with the approved construction program. Each installment of the mobilization advance shall be repaid in 12 (twelve) equal monthly payments, each in the amount of 8.33% (eight and one third percent) of the actual amount of the installment, by way of deduction from the Interim Payment Certificates. Deductions will start from the Interim Payment for the 7th (seventh) month following the month in which the advance was paid, and will end with a deduction from the Interim Payment for the 18th (eighteenth) month after payment of the advance, as per the following schedule:

<table>
<tr><th>SUB-CLAUSE</th><th>SECTION</th><th>SPECIFIC PROVISION</th></tr>
<tr><td></td><td></td><td>
<table>
<tr><th>Interim Payment for the Work Done during the Month After Payment of Advance</th><th>Deduction from Interim Payment (Percent of Advance Amount)</th><th>Cumulative Recovery of Advance (Percent of Advance Amount)</th></tr>
<tr><td>0 to 6</td><td>No Recovery</td><td>0%</td></tr>
<tr><td>7</td><td>8.33%</td><td>8.33%</td></tr>
<tr><td>8</td><td>8.33%</td><td>16.67%</td></tr>
<tr><td>9</td><td>8.33%</td><td>25.00%</td></tr>
<tr><td>10</td><td>8.33%</td><td>33.33%</td></tr>
<tr><td>11</td><td>8.33%</td><td>41.67%</td></tr>
<tr><td>12</td><td>8.33%</td><td>50.00%</td></tr>
<tr><td>13</td><td>8.33%</td><td>58.33%</td></tr>
<tr><td>14</td><td>8.33%</td><td>66.67%</td></tr>
<tr><td>15</td><td>8.33%</td><td>75.00%</td></tr>
<tr><td>16</td><td>8.33%</td><td>83.33%</td></tr>
<tr><td>17</td><td>8.33%</td><td>91.67%</td></tr>
<tr><td>18</td><td>8.33%</td><td>100.00%</td></tr>
</table>
Provided that if the advance payments have not been fully repaid prior to (i) the time when the total amount of all Interim Payment Certificates reaches ninety percent (90%) of that portion of the Contract Price related to execution of the Design Build Works (excluding the advance payments, deductions, repayment of retention and Provisional Sums), or (ii) 24 months after the Commencement Date, or (iii) issue of the Taking-Over Certificate for the Works, or (iv) termination under Clauses 15, 16 or 19 (as the case may be), whichever event occurs first, then the whole of the balance then outstanding shall immediately become due and payable by the Contractor to the Employer. The Employer may, at its sole discretion, encash the Bank Guarantee given by the Contractor as security for such advance, if the Contractor fails to pay such dues to the Employer within a reasonable time."
</td></tr>
<tr><td>14.4</td><td>Schedule of Payments</td><td>The last paragraph of Sub-Clause shall stand replaced with the following:
Schedule of Payment shall be as per Schedule-I appended with this Particular Condition Of Contract Part B. Interim payments for Design-Build part of the Contract (subject to the breakup specified in Schedule of Payment, Schedule I) shall be admissible as per further detailed breakup submitted by the Contractor and approved by Employer</td></tr>
<tr><td>15.2</td><td>Termination for Contractor's</td><td>Add sub clause (i) & (j) after sub clause (h)as follows:
(i) amends the Memorandum and Article of Association of the company without prior written consent of the</td></tr>
</table>

SUB-CLAUSE	SECTION	SPECIFIC PROVISION
	default	Employer. (j) fails to retain/keep engaged the Specialist Technology Provider (whose credentials were considered to assess Eligibility of the Bidder/ Contractor) during the Design-Build Period for any reasons whatsoever.
15.4	Payment after termination for Contractor's default	Add following paragraph at the end of sub-clause(c): Under this sub-clause, the Employer will be entitled to recover from the contractor all costs, losses and damages incurred or suffered by the Employer as a result of termination under sub clause 15.2. This amount will be deducted from the amount determined to be due to the Contractor in accordance with sub clause 15.3. If the amount due to the Employer exceeds the amount determined to be due to the contractor under sub clause 15.3, then the balance due to the Employer will be recovered by the Employer from the Contractor from any sum/s or securities available with the Employer. Should such sum/s or securities also fall short of the amount recoverable from the Contractor, Employer shall take action as per applicable Law GoI/GoR.
20.8	Arbitration	The word "international" appearing in first paragraph shall stand deleted. The expression "Unless otherwise agreed by both Parties" at the end of first paragraph shall be replaced by the sentence " The arbitration shall be in accordance with Indian Arbitration and Conciliation Act 1996 and the arbitral panel shall comprise of three arbitrators; each party nominating its arbitrator and the two such nominated arbitrators to select the Presiding Arbitrator. The language for proceedings of arbitration, documents and communication shall be English and the awards shall be made in writing. Sub clauses (a), (b) and (c) shall stand deleted.

SCHEDULE-I SCHEDULE OF PAYMENTS

PAYMENTS UNDER THE CONTRACT

The payments to be made to the Contractor shall comprise of two parts

1. Payment for Design-Build
2. Payments for Operation Services.

PART-I PAYMENT FOR DESIGN-BUILD:

Payments to Contractor shall be subject to adjustment on account of excess land requirement quoted by the Contractor for setting up STPs beyond the limit of 500 sqm per MLD of STP fixed by the Employer. The rate for adjustment shall be Rs 44000/- per sqm of excess land required/quoted by the Contractor.

Payment shall be subject to recoveries on account of Interim Compensation/delay damages imposed on the Contractor in accordance with Sub-Clause 9.6 of Particular Conditions of Contract Part B.

The Design-Build part of the contract shall stand divided in to four parts for payment purposes; the breakup of payments shall be as indicated against each part in Table-1 hereunder:

Table-1: Parts of Design-Build and limits of payment against each

S.NO.	DESCRIPTION OF WORK	BREAK UP IN % OF ACCEPTED CONTRACT AMOUNT FOR DESIGN-BUILD PART
Part A	Survey, Investigation, Planning and Design	0.50
Part B	Rejuvenation works of Nallah	52.50
Part C	Dry Weather Flow Collection and Treatment	27.50
Part D	Peripheral Development and Other Miscellaneous Works	19.50

For determining the extent of payment admissible to the Contractor at particular stage (milestone) during execution of work, detailed breakup as stipulated in Tables 2 to 5 shall apply.

Table-2: Payment Schedule of Survey, Investigation, Planning and Design (Part A of Table-1)

S.NO.	DESCRIPTION OF MILESTONE	ADMISSIBLE PAYMENT IN % OF APPLICABLE BREAKUP FOR PART A AS INDICATED IN TABLE-1
1	**Survey, Investigation, detailed designs and drawings**	**50.00**
i	Surveys & Investigations	5.00
ii	Detailed hydraulic designs of Nallah, Sewage interception, SPS and STPs	20.00
iii	Architectural and Structural Designs and drawings of above works	20.00
iv	All other Miscelleneous architectural and Strucutural designs, drawings	5.00
2	**Master Development Plan**	**50.00**
i	Market Analysis & Product Mix	15.00
iii	Master Development Plan	35.00

Table-3A: Payment Schedule for Rejuvenation works of Nallah (Part B of Table-1)

S.NO.	DESCRIPTION OF MILESTONE	ADMISSIBLE PAYMENT IN % OF APPLICABLE BREAKUP FOR PART B AS INDICATED IN TABLE-1
1	Site Clearance	**10**
2	Earthwork, Lining, Turfing and all other strengthening /development works	**90**

Table-3B: Further Break up of admissible payment indicated in Table 3A for Rejuvenation works of Nallah

S.NO.	DESCRIPTION OF MILESTONE	BREAKUP IN PERCENTAGE OF S.NO. 1 OF TABLE 3A	BREAKUP IN PERCENTAGE OF S.NO. 2 OF TABLE 3A
1	Reach-1 Nahargarh hill - Bhuteshwar Mahadev (Mileage- 2.8 km)	5.00	1.00
2	Reach-2 Bhuteshwar Mahadev – Mazar Dam (Mileage- 5.1 km)	5.00	2.00
3	Reach-3 Mazar Dam-Sikar road crossing NH-11 (Mileage- 7.65 km)	10.00	2.50
4	Reach-4 Sikar road crossing to Jaipur Jhotwara Railway line (Mileage- 9.60 km)	5.00	2.50
5	Reach-5 Jaipur- Jhotwara Rail way line – N.B.C (Jaipur Khatipura Road)- (Mileage- 11.35 km)	5.00	2.00
6	Reach-6 N.B.C – Jaipur Ajmer Road NH-8 (Mileage- 13.95 km)	12.50	5.00
7	Reach-7 Ajmer road – near Neerja Modi school crossing (Mileage- 17.65 km)	12.50	10.00
8	Reach-8 Neerja Modi school crossing – Jaipur airport-Sanganer Airport crossing (Mileage- 25.30 km)	12.50	25.00
9	Reach-9 Sanganer Bridge - Gullar Dam (Mileage- 26.55 km)	12.50	5.00
10	Reach-10 Gullar Dam - Confluence of Jawahar nagar (Mileage- 32.75km)	5.00	15.00
11	Reach-11 Confluence of Jawahar nagar - Ramchandrapura Dam (Mileage- 34.80 km)	5.00	5.00
12	Reach-12 Ramchandrapura Dam-Goner Road crossing (Mileage- 41.30 km)	5.00	15.00
13	Reach-13 Goner Road crossing to end (Mileage- 47.50 km)	5.00	10.00

Table 4A : Payment Schedule for Dry Weather Flow Collection and Treatment (Part C of Table-1)

S.NO.	DESCRIPTION OF MILESTONE	ADMISSIBLE PAYMENT IN % OF APPLICABLE BREAKUP FOR PART B AS INDICATED IN TABLE-1
1	Sewer lines, interceptors and other conveyance system	**27.50**
2	STPs including lift stations (with all civil, electrical, instrumentation and mechanical works)	**72.50**

Table-4B: Further Break up of admissible payment indicated in Table 4A for Dry Weather Flow Collection and Treatment

S.NO.	DESCRIPTION OF MILESTONE	BREAK UP IN % OF S.NO. 1 OF TABLE 4A
Part C-1	**Sewer lines, interceptors and other conveyance system**	
(i)	Supply of Pipes and stacking of material at site	**40.00**
(ii)	Laying, Jointing, Hydro- Testing of sewer pipes and road restoration, Interception chambers including construction of manholes & Outfall Structures- Reach 1 to 4	**15.00**
(iii)	Laying, Jointing, Hydro- Testing of sewer pipes and road restoration, Interception chambers including construction of manholes & Outfall Structures- Reach 5 to 9	**20.00**
(iv)	Laying, Jointing, Hydro- Testing of sewer pipes and road restoration, Interception chambers including construction of manholes & Outfall Structures- Reach 10 to 13	**25.00**
S.NO.	**DESCRIPTION OF MILESTONE**	**BREAK UP IN % OF S.NO. 2 OF TABLE 4A**
Part C-2	STPs including lift stations (with all civil, electrical, instrumentation and mechanical works)	
(i)	Completion of Civil Works	40.00
(ii)	Supply and storage of Mechanical, Electrical, Instrumentation and other items/ equipments	30.00
(iii)	Installation, Testing, Trial Run and Commissioning of SPS, STP	30.00

Table 5: Payment Schedule for Peripheral Development and Other Miscellaneous Works (Part D of Table-1)

S.NO.	DESCRIPTION OF MILESTONES	ADMISSIBLE PAYMENT IN % OF APPLICABLE BREAKUP FOR PART D AS INDICATED IN TABLE-1
1	Plantation	2
2	Landscaping	10
3	Other facilities- Roads	35
4	Electrical Works	20
5	Surveillance	6
6	Solid Waste Management	2
7	Weather Station	2
8	Flow Measurement	2
9	Kutcha Nallah Strengthening and screens	2
10	Useful Buildings	10
11	Tools, Tackles and Spares	2
12	Monitoring and Measuring Equipments	2
13	Miscellaneous	5

The Successful Bidder shall submit a further break up of prices for each of the parts stated in above Schedule I: Schedule of Payments Sub-Clause 14.4 of PCC Part B. Such breakup shall be submitted after completing Survey, Investigation, Planning and Design (Part A of Schedule I). Such breakup shall be submitted by the Contractor to fully justify its proposal. This break up shall be approved by the Employer after satisfying himself regarding its justification to avoid any front loading and appropriateness. The payments to the Contractor while executing the Works (Design-Build Part) shall be made on the basis of such approved breakup.

Part-II: PAYMENT FOR OPERATION SERVICES

Payment for Operation Services shall be subject to Adjustment for Change in Costs as per Sub-Clause 13.8 of Particular Conditions of Contract Part-B. Such adjustments shall be made on quarterly basis. However, monthly payments towards Operation Services shall be made to the Contractor on prorate basis without taking in to account the Adjustment for Change in Costs which shall be made at the end of the quarter as aforementioned.

The reimbursement for power consumption shall be in accordance with Sub-Clauses 4.19 and 13.8.

All recoveries as may be applicable as per Sub-Clauses 10.6 and 10.7 shall be made while making payments for Operation Services to the Contractor.

SECTION-8: CONTRACT FORMS (COF) 1
Letter of Acceptance 2
Contract Agreement 4
Performance Security 5
Advance Payment Security 6

SECTION-8: CONTRACT FORMS (COF)

This Section contains forms which, once completed, will form part of the Contract. The forms for Performance Security and Advance Payment Security, when required, shall only be completed by the successful Bidder after contract award.

Letter of Acceptance

[on letterhead paper of the Employer]

(To be issued by Employer to the 'Successful Bidder' upon completion of bid evaluation process and approval by the Competent Authority)

No---------- ***date----------.***

Name of Contract **Rejuvenation of Amanishah Nallah (Dravyavati River), Jaipur (Rajasthan) including Area Development on Turnkey Basis, and its Operation & Maintenance (O&M) for a Period of 10 Years**

To: .....

Date: .....

Your Reference: .....

Our Reference .....

We thank you for your Bid dated..... for the design, execution and completion of the Works comprising the above named Contract and remedying of defects, therein so that they are fit for the purposes defined in the Contract, and for the Operation and Maintenance thereof under license for the period of 10 years, all in conformity with the terms and conditions contained in the Contract as amended by the attached Memorandum, signed by you and ourselves.

We have pleasure in accepting your Bid (as corrected/adjusted in accordance with the Memorandum) for the Accepted Contract Amount and other Reimbursements/ Adjustments against STP land loadings as follows

1. Accepted Contract Amount

S. No.	Description	Accepted Contract Amount
1	Amount of Design-Build of the Works	.....INR
2	Amount of Annual Cost for Operation Services (Operation & Maintenance) excluding cost for power	.....INR
3	Total Amount of Operation Service (excluding power) (Value of S.No. 2 x 10)	.....INR
	Accepted Contract Amount (Value of S.No. 1+3)	**.....INR**

2. Reimbursement of Power Cost: The Power Cost for the Operation Service Period shall be reimbursed to the Contractor in accordance with Bid Document.

3. Adjustments against STP land loadings: Adjustment shall be applicable in case of Land loading as per submitted Bid.

You are required to take following actions:

- Incorporate a new company (in case of consortium) under the Companies Act, 2013, with the shareholding pattern as prescribed in Bid document, in the form of a Special Purpose Vehicle to act as Contractor for executing the Agreement and for implementing the Works in accordance with the terms thereof within 21 (Twenty One) days from the date of issuance of this LoA and submit all necessary documents, as required by Employer, to verify such incorporation;
- Furnish the Performance Security within 21 (twenty one) days in accordance with the Conditions of Contract, using for that purpose the Performance Security Form included in Section 8 (Contract Forms) of the Bidding Document. The amount of Performance Security shall be 5% of the Accepted Contract Amount;
- Pay Project Closure Fee to PDCOR Ltd equivalent to 0.1 (zero point one) percent of Accepted Contract Amount plus applicable taxes within 21 days of the issue of this LoA through a Bank Draft from a Scheduled Bank in favour of PDCOR Ltd. payable at Jaipur;
- Pay the cost of preparation of DPR equivalent to 0.1% of the Accepted Contract Amount or Rs. 1.75 Crores (Rupees One Hundred Crore and Seventy Five Lakh Only) whichever is lower to the Project Proponent (*If Project Proponent is not selected as a Successful Bidder*) in form of Demand Draft/Banker' Cheque issued in favour of "Tata Projects Ltd", within 21 (twenty one) days of issue of Letter of Acceptance (LoA);

In consideration of you properly and truly performing the Contract, we agree to pay you the Accepted Contract Amount or such other sums to which you may become entitled under the terms of the Contract, at such times and as prescribed by the Contract.

We acknowledge that this Letter of Acceptance creates a binding Contract between us, and we undertake to fulfill all our obligations and duties in accordance with the terms of this Contract.

Signed by

Signature

For an behalf of:

Date:

Attachment: Contract Agreement

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.
    m. Contract Agreement;
    n. Letter of Acceptance;
    o. Price Bid;
    p. Technical Bid;
    q. Addenda Nos . . . . . (if any);
    r. Particular Conditions – Part A;
    s. Particular Conditions – Part B;
    t. General Conditions of Contract;
    u. Employer's Requirements;
    v. Schedules;
    w. Contractor's Proposal and;
    x. Any other document/s forming part of the Contract.
3. In consideration of the payments to be made by the Employer to the Contractor as indicated 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.

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 indicated above.

Signed by for and on behalf of the Employer in the presence of	Signed by for and on behalf the Contractor in the presence of
Witness, Name, Signature, Address, Date	Witness, Name, Signature, Address, Date

Performance Security

.....Bank's Name, and Address of Issuing Branch or Office.....

Beneficiary:..... ***Name and Address of Employer.....***

Date:..... **Performance Guarantee No.:** .....

We have been informed that . . . . . ***name of the Contractor***. . . . . (hereinafter called "the Contractor") has entered into Contract No. . . . . ***reference number of the Contract***. . . . . dated . . . . . .with you, for the execution of . . . . . ***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 Contractor, we . . . . . ***name of the Bank***. . . . . hereby irrevocably undertake to pay you any sum or sums not exceeding in total an amount of . . . . . ***name of the currency and amount in figures***[1]. . . . . (. . . . . ***amount in words***. . . . .) such sum being payable in the types and proportions of currencies in which the Contract Price is payable, upon receipt by us of your first demand in writing accompanied by a written statement stating that the Contractor is in breach of its obligation(s) under the Contract, without your 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], and any demand for payment under it must be received by us at this office on or before that date.

This guarantee is subject to the Uniform Rules for Demand Guarantees, ICC Publication No. 458[3], except that subparagraph (ii) of Sub-article 20(a) is hereby excluded.

. . . . . .

Seal of Bank and Signature(s)

Note: *All italicized text is for guidance on how to prepare this demand guarantee and shall be deleted from the final document.*

1 *The Guarantor shall insert an amount representing the percentage of the Contract Price specified in the Contract and denominated either in the currency(ies) of the Contract or a freely convertible currency acceptable to the Employer.*

2 *Insert the date twenty-eight days after the expected completion date. 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 Employer's written request for such extension, such request to be presented to the Guarantor before the expiry of the guarantee."*

3 *Or 758 as applicable*

Note to Bidder:

If the institution issuing the performance security is located outside the country of the Employer, it shall have a correspondent financial institution located in the country of the Employer to make it enforceable.

Advance Payment Security

.....Bank's Name, and Address of Issuing Branch or Office.....

Beneficiary: *.....Name and Address of Employer .....*

Date: *.....*Advance Payment Guarantee No.: *.....*

We have been informed that . . . . . ***name of the Contractor***. . . . . (hereinafter called "the Contractor") has entered into Contract No. . . . . ***reference number of the Contract***. . . . . dated . . . . . .with you, for the execution of . . . . . ***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 . . . . . ***name of the currency and amount in figures***[1]. . . . . (. . . . . ***amount in words***. . . . .) is to be made against an advance payment guarantee.

At the request of the Contractor, we . . . . . ***name of the Bank***. . . . . hereby irrevocably undertake to pay you any sum or sums not exceeding in total an amount of . . . . . ***name of the currency and amount in figures***[1]. . . . . (. . . . . ***amount in words***. . . . .) upon receipt by us of your first demand in writing accompanied by a written statement stating that the Contractor is in breach of its obligation under the Contract because the Contractor used the advance payment for purposes other than the costs of mobilization in respect of the Works.

It is a condition for any claim and payment under this guarantee to be made that the advance payment referred to above must have been received by the Contractor on its account number . . . . . ***Contractor's account number***. . . . . at . . . . . ***name and address of the Bank***. . . . . .

The maximum amount of this guarantee shall be progressively reduced by the amount of the advance payment repaid by the Contractor as indicated 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 percent (90%) of the Contract Price has been certified for payment, or on the . . day of . . . . . ., . . .[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, ICC Publication No. 458[3].

. . . . . .

Seal of Bank and Signature(s)

Note: *All italicized text is for guidance on how to prepare this demand guarantee and shall be deleted from the final document.*

[1] *The Guarantor shall insert an amount representing the amount of the advance payment 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.*

[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 Employer's written request for such extension, such request to be presented to the Guarantor before the expiry of the guarantee.*

[3] *Or 758 as applicable.*

Note to Bidder: *If the institution issuing the advance payment security is located outside the country of the Employer, it shall have a correspondent financial institution located in the country of the Employer to make it enforceable.*

Government of Rajasthan

Urban Development & Housing Department, through
Jaipur Development Authority

BID DOCUMENT

FOR

Selection of a Bidder under Swiss Challenge Method for Rejuvenation of Amanishah Nallah (Dravyavati River), Jaipur (Rajasthan) including Area Development on Turnkey Basis, and its Operation & Maintenance (O&M) for a Period of 10 Years

Volume-2
Technical Bid
(Part-II: Requirement)

(8th December, 2015)

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SECTION 5
EMPLOYER'S REQUIREMENTS

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5.1 General Requirements

5.1.1 Project City

Jaipur, the resonant capital of Rajasthan is also known as the "Pink City" because of the color of the buildings in the old city. Built on a dry lakebed it is a city of forts, palaces, golden sands, warm people and rich culture. The altitude of Jaipur is 486 m. The climate in summer is hot with a mean high of 45.0° C and a mean low of 25.8° C, while in winter the mean high is 22.0° C and mean low is 8.3° C. The main languages in Jaipur are Hindi, Rajasthani, English, Urdu and Sindhi.

The city is surrounded by the Nahargarh hills in the north and Jhalana in the east, which is a part of Aravalli hills - ranges. To the south and the west of the city are also prevailing hillocks but they are isolated and discontinuous in formation. The southern end of the city is open to plain and stretches far and wide towards Sanganer and beyond.

Jaipur has a convenient external transport, with developed highways, railways, and aviation net work. The city lies on Delhi-Ahmedabad rail route of Western Railway. The NH-8 and NH-11 intersect at Jaipur and NH-12 leading to Jabalpur starts from Jaipur. Jaipur lies at a distance of about 260 km from Delhi, 135 km from Ajmer, 225 km from Agra and 245 km from Kota. Jaipur receives over 650 millimeters (26 inches) of rainfall annually. Most rains occur in the monsoon months between June and September when there are frequent, heavy rains and thunderstorms, but flooding is not common. Temperatures remain relatively high throughout the year. The population of Jaipur City is 30,46,163 as per 2011 census.

5.1.2 Project Site

Jaipur city is naturally drained by Amanishah Nallah (originally known as “Dravyawati River” and Dhund River. Both form a fork like drainage pattern in the confluence zone just outside the (U1 boundary) in southeast part of the city.

Amanishah Nallah is the major drain of Jaipur city. This drainage zone controls the major drainage system in the western outskirts of Jaipur city. It originates from Nahargarh hill in the west of the city and after draining through city area, it crosses National Highway 11 near Ambabary. On the downstream it crosses Jaipur-Ajmer Railway track. After sweeping through the western outskirts of Jaipur, it crosses National Highway 8, and after collecting the drainage of C-Scheme, Shyam Nagar, Gopalpura and Sanganer areas it meets the Dhund River near Goner village in South side of the city. This Nallah travels a distance of about 47.5 Kms from the origin point to confluence Point of Dhund River.

Earlier this Nallah was a natural seasonal river catering to rain water flow only. The city grew with the time and many settlements took place along the river. These settlements started to discharge their waste into the river and this river gradually converted into a Nallah. With the pressure of population growth, people started to settle into the drain regime and even at some places public has encroached the land in the bed of Nallah.

The Nallah as it exists today is in irregular shape. This has prompted people to settle along the Nallah in an irregular manner and even waterways have been encroached at various places by dumping the non-utilizable building material and other waste material in to the Nallah bed. As a result flow has been obstructed in Nallah at various places causing environmental nuisance in the surroundings. Even during the rainy season it creates havoc in nearby slums and habitations. City administration has to tackle this situation in almost every rainy season by shifting the peoples from this area. Court has issued the directions to maintain a minimum required flow

section for the drain, so that flooding could be avoided in the drain.

The total catchment area is 233 sq km. The head and tail reaches are considered highly permeable (open area, sandy soil) and middle reaches are considered as impermeable (built up area, roads, paved area). The entire length of Nallah has been divided into different reaches for convenience. Jaipur city has observed a severe rain fall and consequent flood on 19th July 1981. The rain fall in 24 hrs was32.8 cm at Jaipur observatory and 38.8 cm at Sanganer. The flood was carried through the Nallah which created a havoc and had damaged many properties at that time

There are three dams existing on the course of Nallah. The first in it's initial reach is Mazar dam at km 5.8, which is a earthen dam with spillway. The catchment area of the dam is 23.5 sq km. The total storage capacity is at MWL (RL 454.5M) is287 mcft or 8.12 MCM the spillway crest is at RL451.5 m up to which the capacity is 3.88 MCM. The spilling capacity of the spillway is 28 cumec. The dam is basically a flood absorption dam. It has no under sluice to empty it. The peak inflow flood assessed as per SUHG method works out to be 7.7 MCM. The second and third dams along the course of Nallah is Gular dam at km 6.55 and Ramchandrapura dam at km 34.8. Both the dams are earthen dams with spillway and meant for flood absorption. Both these dams have very low storage capacities as 0.2 MCM and 0.4 MCM respectively.

The present section of Nallah is non uniform along it's length. At some places it is quite narrow and at some places quite wide. Since it carries sewage it gives a shabby look, bed odor and has become an environmental hazard for the Jaipur city. In addition to sewage huge quantum of debris are lying in it's bed

Hon'ble High Court has ordered that the minimum width of the Nallah in it's head reaches is to be kept as 150 feet and 210 feet in it's tail reaches.

5.1.3 Description of the Works

5.1.3.1 Background

The Consortium of the M/s Tata Projects Limited and M/s SUCG International Engineering Co. Ltd. (hereinafter referred to as the "Project Proponent") submitted a proposal to Urban Development & Housing Department, Government of Rajasthan for Rejuvenation of Amanishah Nallah including Area Development on Turnkey Basis in Jaipur and its Operation and Management (O&M) for a Period of 10 Years under Swiss Challenge Method (hereinafter referred to as the "Project"). Initial proposal received from Project Proponent was accepted in principle and the Project Proponent was allowed to carry out detailed study and prepare Detailed Project Report (DPR) for the Project.

Project Proponent carried out detailed study and submitted the DPR to the Employer. After examination of DPR, State Level Empowered Committee (SLEC) in its meeting held on 14.10.2015 granted its approval to the DPR and to undertake the Project on Swiss Challenge Method.

5.1.3.2 Objective of the Project

Major objectives of the project are:

- Develop Amanishah Nallah as a center of attraction and an important natural asset for the city of Jaipur;
- Stop raw sewage or effluent entering into natural available stream by intercepting and treating such effluent;
- Use the treated sewage to rejuvenate the flow into the existing Nallah;
- Ensure perennial water flow in Nallah;

- Restoration of Ground Water Recharge of erstwhile Dravyawati river;
- Ensure a better management of floods and reduce risk thereof in the nearby commercial and habitable areas;
- Develop land parcels within or adjoining areas of the Nallah for public use and for social and commercial infrastructure;
- Develop a Master Plan for the reclaimed areas.

5.1.3.3 Project Description

Major works proposed for the Project are as follows:

- Course Correction/ Strengthening of Amanishah Nallah

  River rehabilitation includes ground preparations, lining, embankment works, protection & prevention, and development of other peripheral structures, landscaping, etc.

- Sewerage Interception, treatment and disposal

  Local residents discharge untreated sewage in to the Nallah. This is proposed to be checked by intercepting the sewage from existing drains/sewer lines lying within 0.5 km of the center of the Nallah, providing limited collection main (along the banks of the Nallah only) and putting up the treatment plant as detailed in later sections for treating such intercepted sewage and discharging treated effluent in to the Nallah.

- Value Creation and Monetization

  It is also proposed to prepare a comprehensive Business Plan along with land use plan and detailed Master Plan of the precious land areas reclaimed from Nallah sections and other existing land parcels in and around the Nallah. Primary objective of this exercise will be to highlight to the government significant value addition for the city in direct monetary terms and other intrinsic benefits that will accrue from the Nallah improvement works. This plan will act as road map for the Employer to use newly developed assets as per the market needs and value creation through Nallah improvement.

5.1.4 Scope of Work

The detailed Scope of Work for the Contract has been described in separate chapter to this document followed by further technical details of different components in the subsequent Subsections.

5.1.5 Trial Run of the System

After execution of the works the Contractor shall make trial runs of the individual components. A continuous operation of the component for a period of 7 days to the satisfaction of the Employer's Representative will be deemed to demonstrate satisfactory completion of trial run for the individual component. The cost of electricity, chemicals and other consumables for operation and maintenance of the System during the period of this trial run will be borne by the Contractor. The costs towards the Contractor's Representative and other operating personnel during the said period of trial run, along with cost of tools and spare parts, which are required for operation and maintenance of the plant and equipment during the trial run period shall also be borne by the Contractor and shall be included in Contract Price. In the event that the System or any of the facilities do not satisfactorily achieve the required performance standards during this period, the trial run period shall be extended until such time as the Contractor has satisfactorily rectified any deficiencies as may be necessary to satisfy the performance requirements, at the risk and cost of the

Contractor.

5.1.6 Commissioning of the System

On completion of the Trial Run, commissioning of the System shall be done by the Contractor. The total time allotted for commissioning of the full system is 60 days. The commissioning of the system shall be considered as fully achieved after the full system has run continuously for a period of 15 days without any breakdown to the satisfaction of Employer's Representative. If continuous run is not achieved fully to the satisfaction of Employer's Representative, the Contractor has to do the needful to achieve the same at his cost. All the costs thereof, including the cost of staff, maintenance, and any other consumables for operation and maintenance of the system during the period of commissioning except for the chemicals used and electricity consumed during the commissioning period shall be borne by the Contractor. The cost of the consumable chemicals and electricity will be borne by the Employer.

5.1.7 Operation and Maintenance

The Contractor shall be responsible for operation and maintenance of the System for the period specified in the Appendix to Bid, and as described in Subsection 15. Notwithstanding the above, the Contractor shall be required to rectify any deficiencies which are attributable to defects in the workmanship or quality of materials, Plant or equipment during the Contract Period, as described in Clause 12 of Section 2, Conditions of Contract.

5.1.8 Facilities, Details and Data made available by Employer

5.1.8.1 Facilities to Contractor

Spaces and accommodation: The Contractor shall be allowed to use the spaces available with the Employer after permission of the Employer's Representative. The Contractor shall be free to use them for establishing his offices, laboratories, staff quarters, storage spaces or workshop as long as they do not interfere with the layout of the works to be carried out under the Project.

There may be some encroachments on some of these spaces and buildings which may take some time in clearance, for which the Employer will not be held responsible. The prospective Contractors are advised to familiarize themselves with the existing situation and make their own evaluation/assessment before submitting the bid.

The Contractor shall be responsible to arrange and pay for whatever modifications the structures may require for his use and also for providing necessary facilities like access road, water, sanitation and electricity. He will be responsible to maintain a clean and healthy environment at the locations taken by him and will be responsible for conduct of his personnel using such buildings/premises.

5.1.8.2 Details and Data

The project proponent has prepared a detailed technical report which is enclosed with the bids. The Employer does not, however, guarantee either the sufficiency or accuracy of the data provided, and the Contractor shall be wholly responsible to carry out confirmatory additional surveys, soil investigations, particular testing, and all other things necessary for proper planning and detailed design. In case of discrepancies found requiring up gradation of the provisions elaborated in the subsequent Subsections, the Contractor shall be required to provide full details of the investigations and analysis for approval of the Employer's Representative.

5.1.9 Construction Documents

The Contractor shall supply to the Employer's Representative 3 (three) copies each of the initial design calculations for the process and sizing of all components of the System including architectural, structural, mechanical, electrical and instrumentation equipment, supported by flow diagrams and general arrangement drawings for approval. It is a matter of high priority that the Contractor ensures the submission and finalization of such designs and drawings in the stipulated time schedules as elaborated elsewhere. It is the intention of the Employer to ensure that the approval of such submissions is made expeditiously and in time. The Contractor is therefore required to setup his design office in Jaipur (fully equipped and staffed) to enable continuous submission, interaction and for securing timely clearances. The Employer intends to keep a team of experts available constantly during the initial six months to review and comment/approve the submissions expeditiously.

The Employer shall arrange to send observations if necessary within 14 (fourteen) days of submission of the design and drawings for modifications to the Contractor. The Contractor shall incorporate all necessary comments of the Employer's Representative in the above design and drawings, if any, and shall re-submit further 3 (three) copies each of the revised design and drawings within 14 (fourteen) days for final approval of the Employer's Representative. The Contractor shall thereafter submit 6 (six) copies each of the approved design and 6 (six) copies each of the approved drawings together with one copy each of the reproducible tracings. This ensures approval of the final design/drawing within one month of first submission. If the submissions require more than one round of revision on account of incomplete compliance from Contractor, the delay will be on account of the Contractor. If new observations are given by the Employer's Representative, the Contractor shall be entitled to take an additional 14 day period for compliance.

Further design calculations and drawings shall be submitted in sequence as per a schedule to be drawn and agreed upon mutually, immediately after submission of the general arrangement drawings. For each component of the system, and for the system as-a-whole, these documents shall cover:

- Process design, system design and layout of all the project components
- Site Plans
- Layout Plans
- Architectural Drawings/Renderings
- Foundation Plans
- L-sections and cross section of Nallah
- Entire plan for the development with landscaping and master plan of reclaimed area of land
- Detailed structural design and good for execution drawings pertaining to all components of the System
- Drawings showing the size, position and other necessary details of all mechanical and electrical equipment and fixtures
- Wiring diagrams, pressure control and motor control gear particulars
- Details of foundations, position of openings, etc., for the pumps, motors, starting cubicles, LT/HT panels, etc.
- Power systems including sub stations/ switch yard and associated drawings (e.g. single line diagram, general arrangement and sections, etc.)
- Route survey, tower spotting, geo-technical survey, foundation design for

different soil types, lattice tower structure design

- Construction drawings for erection of 33 KV overhead single circuit tower line
- Elementary diagram and manufacturers' shop and part drawings for each equipment.
- Services like internal illumination and ventilation, building water supply, sanitation and plumbing, service roads, landscaping, area lighting, etc.
- Any other design and drawings required to comply with the Employer's Requirements as described in this Section.

The documents and drawings shall be in sufficient details for review of the Employer's Representative. The scale of the drawings has to be chosen in consultation with the Employer's Representative. The drawings shall be of standardized sizes as instructed by the Employer's Representative and shall contain the following basic information in the title block:

- Project name
- Name and number of the Contract
- Contractor's name
- Number and title of the drawing
- Date and scale
- Draftsman's name
- Name of the designer and draftsperson responsible
- Revision Number (R0 for drawing submitted initially and R1, R2, etc., for drawings submitted subsequently).

A blank space 90 x 50 mm shall be provided immediately above the title block for the approval stamp. If required in the document elsewhere, the detailed design and the execution drawings shall be submitted only after verification by an institute approved by the Employer. The Contractor shall be responsible for preparation of working drawings and the construction documents for works, as specified in the Contract.

5.1.10 Quality Assurance and Specification of Materials

The Employer stresses on highest standards for the works (construction, equipment supply and erection). The Contractor has to follow a Quality Assurance/Quality Control Manual and General Specification of works issued by Rajasthan Urban Infrastructure (available on www.ruidp.org or available with Employer also) which details the minimum level of controls to be exercised for ensuring quality of works. An undertaking from the Contractor has to be submitted to the Employer for adhering to the Quality Assurance/Quality Control Manual as aforesaid. The minimum measures taken by the Contractor shall be as per the Manual/Subsection but not limited to it. Contractor shall prepare detailed plan for this Contract for Quality Assurance and Quality Control and get it approved from the Employer's Representative. The Contractor shall deploy adequate number of suitable experts whose sole responsibility shall be to strictly implement the QA/QC plan and conduct necessary tests to ensure highest quality standards. All other measures that the Contractor may feel necessary or as may be directed by the Employer's Representative shall be followed.

5.1.11 Pre-dispatch Inspections Outside the Employer's Country

In the event the Contractor proposes to procure material from outside of the Employer's country which requires pre-dispatch inspection of the Employer's Representative, the Contractor shall have to arrange and provide for the cost of

travel to the Manufacturer's place, accommodation, local transport and food for three representatives of the Employer. Such costs will be incorporated in the tendered cost of such items and no separate payment will be made for the same.

5.1.12 Safety Assurance

The Contractor shall take all measures required to maintain highest safety standards on the site. The measures taken will include all but will not be limited to the relevant provisions of the Indian Standards. The Contractor shall prepare a safety plan for the project and have it approved from the Employer's Representative. The Contractor shall deploy a safety officer on each important site to ensure compliance.

5.1.13 Operation and Maintenance Manual

The Contractor, before commencement of the Tests on Completion, shall submit 6 (six) copies of the operation and maintenance manuals for the project components, containing descriptions, illustrations, sketches, drawings, sectional drawings, sectional arrangement view and manufacturer's parts numbers to enable the connections, functions, operation and maintenance of all components of the complete System to be easily followed and for all parts to be easily identified to facilitate ordering of the replacement parts. Exploded views of the items/ works where appropriate shall be used for clarity. The Contractor shall provide the contact address and telephone number (Hotline) of key personnel of the manufacturer in the manual who could be contacted by the Employer's Representative whenever required.

The operation manual shall also include the following:

- Technical data of all equipment and their performance
- Instructions for servicing and overhauling
- Particulars of lubricating oil and grease to be used, also alternative indigenous commercial lubricating oils suitable for use
- Performance curves for all units regarding efficiency loading and output
- Performance curves for the motors
- List of tools mounted on wall panels
- List of spares provided in the spare box
- Spare parts list, with manufacturer's part numbers
- Operator's log
- List of the photographs of the plant and machinery as fabricated by the manufacturer

The maintenance manual shall also include the following:

- Procedures for maintenance
- Preventive maintenance procedures for all the equipment
- Emergency maintenance management of the plant and equipment

The Contractor shall submit the O&M manual at least for the following items:

- Nallah
- Roads and signages
- Recharge Wells
- Street Lights
- Cameras

- Automation
- Other Buildings
- STPs
- Landscaping
- Horticulture and Plants
- Public Spaces- including Toilets, Drinking Water Zone, Parking, Solid Waste Management, vendor zones
- Surveillance
- and any other miscellaneous items

5.1.14 Tests on Completion of Work

The Contractor shall carry out the tests on completion before taking over as stipulated in elsewhere in the document.

5.1.15 Failure to Pass Tests after Completion

The performance criteria, as specified in this Section, are the minimum acceptable criteria below which the works failing to pass tests after completion shall be rejected.

5.1.16 Training of Employer's Personnel

The Contractor shall be responsible to provide practical training on all aspects of the operation, maintenance and repair of the Plant, equipment and facilities to all personnel selected by the Employer who will ultimately be responsible for the operation, maintenance and repair of the Plant and its facilities. For this purpose the Contractor shall provide a comprehensive training program for the Employer's personnel during the entire period of the trial run and commissioning, and for as long thereafter as may be reasonably required to ensure that the designated personnel are adequately trained to take up their responsibilities. The Contractor has to provide a full time trainer who is skilled in imparting training and who is familiar with all the normal and special operational conditions of the mechanical, electro-mechanical, electrical, instrumentation and control equipment of the Work.

The Contractor shall submit separately, as a part of his technical proposal, details of his proposed training program, the facilities required, and the qualifications, experience and responsibilities of the training personnel to be provided. All costs for the Contractor's personnel and the training facilities required for the training, and any incidental training expenses, shall be included in the Contract Price. All costs of the Employer's personnel shall be borne by the Employer.

In addition, the Contractor has to provide refresher training to Employer's designated staff or advanced training during the Contract period. The objective of training is to pass on lessons learnt during O&M period and to pass on knowledge and skills to operate and maintain the system independently. The training costs, transport, accommodation and per diem of the trainers shall be borne by the Contractor.

The full program shall be drawn out by the Contractor and got approved from the Employer's Representative.

5.1.17 Facilities to be provided for the Employer and his representatives

The Contractor shall provide and upkeep the following facilities for the Employer and Employer's Representative. The cost for these facilities shall be included in the Contract Price.

Office Buildings at minimum two locations (as may be finalized by the Employer during Project implementation) of floor area not less than 50 square meters each or

combined, with provision of toilets and pantry. The Employer's Representative will provide the layout of the office building within 10 days of issuance of the Letter of Acceptance. The office building shall be equipped with office furniture (at least 3 tables, 6 chairs, necessary filing and drawing cabinets, etc., at each location), and each location shall be provided with a Canteen, electricity, stand-by generator set, one telephone, air conditioner, fan, computer and LaserJet printer A4 size.

5.1.18 Important Inputs Required From Contractor

5.1.18.1 Field Offices

The Contractor shall be required to set up necessary number of field offices for supervision of the works. He shall establish at least two offices in the Project area within 14 days of issue of Letter of Award.

5.1.18.2 Design Office in Jaipur

The Employer requires a high level of input for the initial investigation and design phase and requires the Contractor to be prepared with all necessary inputs so as to not lose time at the beginning of the Contract in these activities including approval of various designs and drawings. It is expected that the Contractor shall mobilize the necessary manpower and equipment of desired expertise and base them at Jaipur immediately after receipt of the Letter of Award (but not later than 14 days) issued to him.

The Contractor should make the office functional in this period. The office will have required furniture, computers, printers, plotters and other office requirements. It shall have design team of qualified personnel for preparing and submitting the necessary design and drawings for all activities. The office shall also have a conference room for discussions and reviews.

5.1.18.3 Topographical Survey and Soil Investigation Agency

The Contractor is required to carry out topographical surveys and soil investigations. The Contractor should be ready with the qualified agencies that he intends to deploy for the purpose and ensure that the work starts within a fortnight of the Letter of Award. He shall also conduct additional investigations as are normally necessary to ensure full and satisfactory designs and safety. It is expected that the surveys will be carried out with Total Stations and necessary software will be used for creating the required drawings.

5.1.18.4 Field Laboratories

The Contractor shall be required to establish field laboratories (minimum two in number) suitably equipped to carry out tests as stipulated in the QA/AC Manual, including all specialized equipment which will be required for testing the material and equipment being supplied under the Contract. Suitable trained laboratory staff shall be employed by the Contractor with full facility of computerized record keeping. The minimum equipment to be provided in the laboratory shall be as listed in elsewhere in the document. Additional equipment as may be deemed necessary may be added to the same in due course on requirement of the Employer/Contractor. The Employer's Representative shall however permit special tests to be conducted through standard test house at the Contractor's cost.

In addition to the equipment in the laboratory, the Contractor shall also provide field testing equipment as directed by the Employer's Representative on the various sites where work is in progress.

5.1.19 Supervisory Staff for Contractor

The Employer lays great importance on the quality and authority delegated to the

Contractor's key staff deployed in the field to execute and supervise the works. The Contractor is required to ensure deployment of qualified and experienced staff in sufficient numbers on site to ensure quality. The general requirement shall be as below:

5.1.19.1 Contract Manager

He shall be a person who shall be the overall in-charge for the Contract and shall be deployed with head quarter at Jaipur. He shall be delegated with Power of Attorney to sign on behalf of the Contractor on all issues related to Contract and for all financial matters thereof including receipt of payments. He should be a senior level (Director/Vice President) staff member of the Lead firm (in case of a consortium).

5.1.19.2 Senior Managers

There shall be at least one Senior Manager for each of the major component of the Contract. The Senior Manger shall have following minimum qualifications:

- Education: B.E. (relevant discipline)
- Experience: Minimum 15 years of general field supervision of Contracts and minimum 8 years experience in supervision in construction/erection of similar works.

5.1.20 Supervisory Staff, Foremen and other Support Staff

There shall be supervisory staff with following minimum qualifications deployed in sufficient numbers to ensure day to day quality supervision of the work:

- Education: B.E. in relevant discipline with minimum 8 years experience in relevant field or Diploma Holder in relevant discipline with 12 years field experience in relevant field.
- The Contract Manager and Senior Manager will be deployed after approval of their CVs by the Employer. Initially the CVs of key personnel to be deployed will be submitted in the bid. The Contractor shall be expected to arrange and maintain a fleet of experienced workers and foremen and other support staff as required on sites in sufficient numbers.

5.1.21 Transport Facilities for the Inspection Staff of the Employer

The Contractor shall provide for local transport facilities for the supervisory staff engaged by the Employer within the Project area. No extra cost will be paid for the same.

5.1.22 Handing over of Site to Contractor

Employer shall make sure that the Contractor does not face any hindrance in maintaining progress of work on account of availability of site for implementing the Project. The site shall be made available to the Contractor so that he shall have enough space available with him to carry out works for at least next three months unhindered as per the approved Work Plan. In the event that some local obstruction/objection arises which would impede the progress of the Works in any one area, the Contractor shall be required to deploy his resources to other unaffected areas in order to maintain the progress of work so that the overall completion of the whole of the Works is not affected.

5.1.23 Completeness of the Offer

The Contractor shall be fully responsible to ensure that the whole of the Works, including each individual component, is designed and constructed in a manner so that the system as a whole operates as a fully integrated system which is capable of

achieving the required output in an efficient and economical manner, and to include all plant, equipment and accessories required for the safe and satisfactory operation of the facilities. To achieve this, the Contractor shall ensure that each individual component performs in a manner which is complimentary to that of all other components. Any accessories which are not specifically mentioned in the specifications, but which are usual or necessary for completion of the Works and successful performance of the System and facilities shall be provided by the Contractor within the Contract Price. The Contractor shall, to the maximum extent practical and feasible, endeavor to standardize on the manufacture and supply of plant and equipment so as to minimize the operation and maintenance requirements. The Contractor shall ensure that his designs are "maintenance-friendly" and that all items of plant and equipment are designed and installed in a manner which will facilitate routine and periodic maintenance operations.

Particulars regarding the performance requirements and the detailed scope of the Works are elaborated in the Section 4, Employer's Requirements.

5.1.24 Time for Completion

The whole of the Work, including mobilization, reconnaissance, survey, sub-soil investigations, design, manufacturing, transportation, construction, installation, trial runs, testing and commissioning is to be completed within the scheduled Time for Completion as set out in the RFP. The duration of the Trial Run and test period is 30 days and the Commissioning Period is 60 days; both periods are included within the scheduled time for completion. The physical completion of the System and facilities shall be achieved before commissioning. Commissioning of the System will be deemed to be completed after the System has been operated trouble free for 15 working days; any intervening breakdown period will not be considered as a part of this period.

5.1.25 Milestones

The Employer wishes to ensure consistent prorata progress on all components of the Contract during the entire Contract period. The key milestones set out in table below, or such other milestones as may be proposed by the Contractor and agreed by the Employer, are proposed to be adopted for periodic review of the progress of various components. These milestones will be the stages when the decisions regarding any delay in the implementation will be taken with a view towards the application of the provisions of Clause 8.0 of the Conditions of Contract.

5.1.25.1 Milestone Chart for STP

Sl. No.	Work Description	Time from Date of LoA (months)				
		6	12	18	24	30
1	Mobilization:					
	i. Establish design office	100%				
	ii. Establish site offices	100%				
	iii. Set up laboratory	100%				
	iv. Site surveys and investigations	100%				
	v. Finalization of work plan	100%				
2	Planning and Design:					
	i. Process design	100%				
	ii. Site Plans	100%				
	iii. Equipment Selection	100%				
	iv. Layout Plans	100%				
	v. Foundation Plans	100%				
	vi. Architectural Drawings	100%				
	vii. Structural Designs and drawings	100%				
	viii. Mechanical Drawings	100%				
	ix. Electrical Drawings	100%				
	x. Pipeline Plan and Section	100%				
	xi. Access Road and Structures	100%				
	xii. Power Transmission Line	100%				
	xiii. Power Substations	100%				
	xiv. Instrumentation	80%	100%			
	xv. Miscellaneous Details	80%	100%			
3	Sewage Pump Stations and STPs:					
	i. Mobilize construction equipment	100%				
	ii. Orders for plant and equipment	Start	100%			
	iii. Civil works (including reservoirs)	Start	40%	85%	100%	
	iv. Receipt of plant and equipment		5%	70%	100%	
	v. Erection of plant and equipment			Start	100%	
	vi. Mechanical and electrical installation			Start	100%	
	vii. Trial run and commissioning				Start	100%

Sl. No.	Work Description	Time from Date of LoA (months)				
		6	12	18	24	30
4	Power Supply Systems for STP and SPS :					
	i. Obtain design approvals					
	ii. Mobilize construction equipment	100%				
	iii. Place orders for towers, substations	Start	100%			
	iv. Receive materials	Start	40%	100%		
	v. Erect and install		Start	50%	100%	
	vi. Energize, test and commission			Start	100%	

5.1.25.2 Milestone Chart for Nallah and other Works

Sl. No.	Work Description	Time from Date of LoA (months)				
		6	12	18	24	30
1	Nallah course correction and strengthening works					
	i. Site clearance 5.1 to 34.8km	100%				
	ii. Site clearance 34.8 to 47.5 km	100%				
	iii. Remodeling of spillway of Mazar dam civil works	50%	100%			
	iv. Remodeling of spillway of Mazar dam gate work	Start	80%	100%		
	v. Fixing center line and setting out works	100%				
	vi. Earthwork km 5.1 to 34.8(both base and top sections)	25%	50%	90%	100%	
	vii. Earthwork km 34.8 to 47.5(both base and top sections)	-	30%	90%	100%	
	viii. Cement concrete lining km 5.1 to 34.8 km along with falls, check dams and ground water recharge structures	10%	30%	50%	70%	100%
	ix. Strengthening work in upper section 5.1 km to 34.8 km(Turfing, steps, pedestrian pathway)	10%	30%	50%	75%	100%
	x. Stone pitching work km 34.8 to 47.5km		5%	40%	70%	100%

Sl. No.	Work Description	Time from Date of LoA (months)				
		6	12	18	24	30
	xi. Joining of lining with existing structures and other related works		15%	40%	70%	100%
	xii. Diversion of rain water drains			25%	50%	100%
2	Other facility works					
	i. Road, footpath and boundary wall		25%	50%	75%	100%
	ii. Cement concrete roads		25%	50%	75%	100%
	iii. Utility buildings				50%	100%
	iv. Drinking water facility works				50%	100%
	v. Railings				50%	100%
	vi. Vendors space and parking space				50%	100%
	vii. Plantation				50%	100%
	viii. Landscaping				50%	100%
	ix. Weather station				-	100%
	x. Other instruments and equipments				-	100%
	xi. Solid waste management works				100%	

5.1.26 Safety Equipment to the Site Engineer

The Contractor shall provide the Site Engineer with the safety equipment at each site office. The Contractor shall replace each item after it wears out and becomes unsuitable for use.

5.1.27 First Aid at Office and work site

The Contractor shall make his own arrangements for treatment of casualties on the Site in such first-aid units as may be thought necessary. The Contractor shall be responsible for providing such first-aid units and their management and operation and the removal by ambulance of injured or sick employees to nearby hospitals. The first-aid service shall cover the Contractor's own personnel as well as that of the Employer and all Sub Contractors.

5.1.28 Site Safety

- The Contractor shall at all times in the conduct of his work and that of his Sub Contractors adhere to the established rules and regulations concerning all safety matters at Site such as the recommendations contained in the "Manual of Accident Prevention in Construction", published by the Associated General Contractors of America, Inc., or other internationally recognized recommendations to the extent that such provisions do not conflict with the applicable laws. This is especially important wherever it is necessary to enable the free passage of the public through the Site.

- The Contractor's Safety Officer shall have the qualification and the Employer's Representative to issue instructions to the Contractor's personnel regarding protection measures to prevent accidents.
- The Contractor shall provide the public with adequate information on all risks with respect to the construction works. If the general public sustains any kind of bodily injury or death, the Contractor shall be responsible for providing all necessary medical care and compensation as admissible under the Law.
- During implementation of the Project the Contractor shall erect, maintain and subsequently remove sufficient barricades, guards, lighting, sheeting, shoring, temporary sidewalks and bridges, danger signals as well as temporary covering of potential accident areas, as approved by the Employer's Representative.
- All open excavations along pipe lines and elsewhere shall be protected sufficiently to keep away the livestock, and ensure the safety of workmen and members of the public and be in accordance with the directives of the police and the other local regulations.
- The Contractor shall be responsible for ensuring that all persons working in the vicinity of power lines are aware of the relatively large distance that high voltage electricity can "short" to earth when cranes or other large masses of steel are in the vicinity of power lines.
- Where work is to be carried out in the proximity of buildings, bridges, tanks or other structures, the Contractor shall take all necessary precautions, including shoring and strutting, where necessary, to ensure the safety of the structures that are at risk.
- The Contractor shall be responsible for all damages or injury which may be caused on any property by trespass by the Contractor's or his SubContractor's employees in the course of their employment, whether the said trespass was committed with or without the consent or knowledge of the Contractor.

5.1.29 Protection of Overhead and Underground Services

- The Contractor shall be responsible for any damage to known services (i.e. overhead services that are visible within the Site and underground services shown on the drawings) and he shall take all necessary measures to protect them. All work or protective measures shall be subject to approval of the Employer's Representative. In the event of a service being damaged he shall inform the Employer's Representative, the Contractor shall not repair any such service unless instructed to do so.
- Contractor shall map the underground utilities. Where no underground services are shown on the drawings or scheduled but the possibility of their presence can reasonably be inferred, the Contractor shall, in collaboration with the Employer's Representative, ascertain whether any such services exist within the relevant section of the Site. The Contractor shall complete such an investigation well in advance of the start of construction work in the said section and he shall submit a report in good time to enable the Employer's Representative to make whatever arrangements are necessary for the protection, removal or diversion of the services before any construction activities commences.
- As soon as any underground service not shown on the drawings is discovered, it shall be deemed to be a known service and the Contractor shall be held responsible for any subsequent damage to it. If such a service is damaged during the course of its discovery, the cost of making good such damage will be met by the Employer unless he establishes that the Contractor did not exercise reasonable diligence and that the damage was avoidable in which case the cost

of repair shall be borne by the Contractor.

- Where the Employer's Representative elects to carry out on its own account any alterations or protective measures, the Contractor shall co-operate with and allow such Employer's Representative reasonable access and sufficient space and time to carry out the required work.

5.1.30 Signboards

- Signboards shall be placed at each of the project offices, at important locations and at each zone, in English, information about the project and Employer, and the names Contractor in a form and size to be agreed by the Employer's Representative. They shall be of durable construction capable of withstanding the effects of the climate until the end of the Design-Build Period.
- The Contractor shall keep the signboards in good repair for the duration of the contract and shall remove them on completion of the Contract.
- Besides these signboards the Contractor shall not, except with the written authority of the Employer's Representative, exhibit or permit to be exhibited on the Site any form of advertisement.

5.1.31 Site Drainage

- The Contractor shall keep each Section of the Works well drained until the Employer's Representative certifies that it is substantially complete and shall ensure that, so far as is practicable, all work is carried out in the dry. Site areas shall be kept well drained and free from standing water except where this is impracticable having regard to methods of Temporary Works properly adopted by the Contractor.
- The Contractor shall provide, operate and maintain in sufficient quantity such pumping equipment, well points, pipes and other equipment as may be necessary to minimize damage, inconvenience and interference and shall construct, operate and maintain all temporary coffer-dams, sumps, ditches, drains and other temporary works as may be necessary to remove water from the Site while construction is in progress. Such Temporary Works and construction equipment shall not be removed without the approval of the Employer's Representative.
- Notwithstanding any approval by the Employer's Representative of the Contractor's arrangements for the removal of water, the Contractor shall be responsible for the sufficiency thereof and for keeping the Works safe at all times and for making good at his own expense any damage to the Works.
- The Contractor shall be responsible to keep the Site clear of water at whatever pump rate is found necessary.
- The Contractor’s site drainage facilities shall not cause pollution in any local water courses, he shall be responsible for any legal action resulting from pollution events.

5.1.32 Detours and Traffic Control

- The Contractor shall program his work in such a way that, wherever the temporary closure of street sections to public through fare cannot be avoided, the duration of traffic diversion can be kept as short as possible. No streets shall be closed and no detours shall be introduced and no traffic diverted until the Contractor's proposals have been approved by the Employer's Representative and the appropriate Government authorities, such as the Public Works Department.

- Where work is to be carried out in public roads, the Contractor shall give notice to the Employer's Representative sufficiently in advance of the date on which he wishes to commence such work.
- The Contractor shall be responsible for obtaining the permission of the line Departments including the Police for activities he intends to carry out on public roads. Two copies of the Contractor's proposals to the relevant authorities shall be submitted to the Employer's Representative. One copy of all obtained approvals shall be submitted to the Employer's Representative.
- The Contractor's attention is drawn to the fact that processing of the documentation required by the local authorities prior to the cutting of existing public roads takes approximately 30 days. During the Monsoon period (June to September) no road cuttings are normally allowed.
- Detours shall be selected in such a way that the inconvenience to the affected traffic as well as to the inhabitants of the affected areas is kept to a minimum.
- The Contractor shall furnish, install and maintain at all times during the execution of the Works all necessary traffic signs, barricades, lights, signals and other traffic control devices, including flagging and other means of guiding traffic through the work zone. Traffic control shall be managed in accordance with prevailing rules and regulations, and with the approval and to the satisfaction of the Employer's Representative.
- All devices mentioned above shall be in conformity with the requirements of the line department. All traffic signs and control devices to be furnished and installed by the Contractor shall be approved by the Employer's Representative for their location, position, visibility, adequacy and manner of use under specific job conditions.
- All traffic control devices necessary for the initial stage of construction shall be properly placed and be operational before any construction is allowed to start. When work of a progressive nature is involved, the necessary signs shall be moved concurrently where they are needed.
- If the Employer's Representative determines that proper provisions for safe traffic control are not being provided or maintained, he may restrict construction operations affected by such defective signs or devices until such provisions are established or maintained, or may altogether order suspension of the Work until a proper traffic control is achieved. In case of serious or willful disregard by the Contractor of the safety of the public or his employees, the Employer's Representative may take necessary steps to rectify the situation and deduct the cost thereof from monies due or becoming due to the Contractor. The Contractor shall be responsible for all resulting delays.
- The Contractor shall designate or otherwise employ personnel to furnish continuous surveillance of the traffic control operations. The designated personnel shall be available day and night to respond to calls involving damage due to traffic accidents.
- At sections where traffic is in operation and when ordered by the Employer's Representative, the movements of the Contractor's equipment from one place of work to another shall be subject to traffic control. During rush hours movement of larger vehicles, such as trucks, cranes, dumpers, etc. through main thoroughfare are not permitted by the police. Spillage resulting from hauling operations along or across the road way shall be removed immediately at the Contractor's expense.

5.1.33 Provision of Temporary Services

- When the execution of the Works requires the temporary disconnection of existing public utilities, the Contractor shall provide the affected users with temporary services in at least the same standard as the original services.
- For water supply he may install temporary lines or arrange for regular supply by tankers. The amount of water to be provided for the interruption period for a specific area shall be assessed by the Contractor. The Contractor shall submit to the Employer's Representative, for its approval, the recommended volume of water to be provided.
- When forced to disconnect existing sewers/drainage facility, the Contractor shall install temporary pipes of adequate size to carry off sewage/drainage. No sewage/drainage shall be allowed to flow upon the ground surface or into the trench excavation.
- No valve or other controls in public service facilities shall be operated by the Contractor without approval of the Employer's Representative and the relevant authorities. All users affected by such operation shall be notified by the Contractor at least one hour before the operation and advised of the probable time when service will be restored.

5.1.34 Protection of Adjoining Property and Reinstatement upon Completion

- The Contractor shall be responsible and take all measures in order to protect adjoining property including buildings, electrical and telephone poles, bridges and culverts, retaining walls, compound walls and fences, and other structures. Prior to the commencement of the activities, the Contractor shall assess the probability and extent of unavoidable damages, if any, to the building and properties and submit his assessment to the Employer's Representative. The Employer's Representative may make his own opinion and if required may order arrangements for protection or repair of such likely unavoidable damage in which event the Contractor shall complete the activities at its own cost.
- Contractor shall remove all temporary works constructed for the diversion of the traffic and make the site clear for the routine traffic.

5.1.35 Coordination with Other Authorities and Statutory Services

As far as possible the Contractor shall acquaint himself with the actual location of all existing public utilities such as sewers, water mains, drains, cables for electricity, telephone lines, lighting poles, masts, etc., before commencing any activities likely to affect the existing utilities. The Contractor shall with the assistance of the Employer obtain such information directly from the responsible authorities as early as possible.

5.1.36 Notices, Permits

Well in advance of the programmed start of any work which may affect traffic or any existing utilities the Contractor shall give advance information to the Employer's Representative indicating the type, the exact location, the programmed starting time and the expected duration of the activities and shall provide whatever particulars may be required by the authorities to issue any required permits and make all necessary arrangements. The Employer will provide necessary permissions.

5.1.37 As-Built Drawings and GIS Data Creation

- Such approved Working Drawings as have been selected by the Employer's Representative shall be correctly modified for inclusion in the As-Built Drawings incorporating such variations to the Works as have been ordered and executed.

Such drawings shall show the actual arrangement of all structures and items of equipment installed under the Contract. The Contractor shall submit 1 (one) reproducible copy and 3 (three) prints of all As-Built Drawings clearly named as such to the Employer's Representative for approval before applying for the Taking-Over Certificate for the respective Section of the Works. After approval of the As-Built Drawings the Contractor shall supply an electronic copy of the drawing together with a licensed copy of the drafting software.

- During the course of the Works, the Contractor shall maintain a fully detailed record of all changes from the approval to facilitate easy and accurate preparation of the As-Built Drawings.
- Irrespective of the other contractual prerequisites no Section of the Works will be considered substantially completed until the respective As-Built Drawings have been submitted by the Contractor and approved by the Employer's Representative.
- In parallel with the preparation of As-Built Drawings, the Contractor shall produce GIS data of the constructed works. The Contractor conduct all necessary survey work, and shall ensure that vertical and horizontal measurements shall be captured at an accuracy of +/- 0.1m at a 95% confidence level, using the most suitable and cost-effective field data collection technology and methodology. All horizontal and vertical survey measurements will be referenced to the present Survey of India GIS geo-reference.
- The Contractor shall survey the three-dimensional position (x, y, z) of all point and line assets constructed under this project, e.g., pipelines, bridge crossings, manholes, chambers, valves, meters, hydrants, plugs, reducers, and tees. Nodes shall be created to clearly delineate different pipe sections in terms of material and/or diameter and to allow for future development of a hydraulic model in the GIS platform. Nodes shall also require a three-dimensional position, and through this, the position of the ends of a pipeline segment shall be defined. Point and line data (i.e., the pipeline) should be consistent with the attributes of the existing Survey of India GIS. However, the Employer's Representative may require the Contractor, at no additional cost, to create new attributes to include non-survey data, e.g., valve model, name of the manufacturer, images or plans, etc. Prior to the field survey, the Contractor shall submit to the Employer's Representative, for approval, the GIS design in terms of themes, feature types and attributes.
- The Contractor shall develop a checklist of QC checks for each type of deliverable and will be responsible for ensuring that these QC checks are performed. The Contractor shall assign a GIS quality officer to manage the quality review process. This officer shall be independent of the capture and production teams.
- The Contractor shall be required to integrate the GIS deliverables with the existing pipe network data, i.e., ensure that the GIS data connects with any existing GIS system. This may entail revising GIS data of existing pipes at connection points. GIS data for the project will be delivered in an ArcGIS compliant file geo-database.

5.1.38 Construction Program and Progress of Works

5.1.38.1 Construction Program

Contractor shall prepare Construction Program as part of SIP. Construction Program shall be in the form of a Critical Path Method (CPM) Diagram showing, sequences, dependencies, durations and dates for execution of all major items including sectional completion following the sub-divisions in the Bills of Quantities for the execution of the Works within the periods stated in the Contract. It shall be

supported by:

- Data of the construction methods
- Equipment Utilization Schedule
- Manpower Utilization Schedule
- Subcontracting Schedule
- Mobilization/Demobilization Schedule

The CPM diagram incorporating the above mentioned schedules shall be prepared using Microsoft Project, or similar approved project management software, and shall be presented in hard copy and electronic form to the Employer's Representative as part of SIP.

In carrying out the Works due attention shall be paid to all measures which can reasonably be taken in order to diminish the inconvenience which the work may cause to services and access to property.

5.1.38.2 Updating, Monitoring and Reporting Progress

The Contractor shall monitor the progress of the Works including information provided by his Sub-Contractors and suppliers, as necessary, for purpose of network planning, scheduling and updating and shall confirm the actual progress on each current activity shown on applicable CPM networks. The CPM networks shall form part of the Monthly Progress Report and shall indicate changes of schedule, if any in network activity duration and start/finish imposed dates. It shall also be provided in electronic form.

The Contractor shall prepare written explanatory notes on the particular activities which are overrunning or going to overrun against the schedule. If any such overrunning work is on the critical path, the Contractor shall state what corrective actions will be taken by him to bring it back on the schedule.

5.1.38.3 Detailed Fortnightly Program

The Contractor shall submit at the end of each working week a detailed bar chart program for the next fortnight. The program shall identify where further drawings or instructions are to be issued by the Employer's Representative to avoid disruption to the progress of the Works.

5.1.38.4 Progress Reports

The Contractor shall submit 5 copies of Monthly Progress Reports to the Employer's Representative in defined format approved by Employer's Representative, containing the following information:

- physical progress for the report month and estimated progress for the next month;
- CPM networks and explanatory notices as described in 17.1;
- updated S-curves for physical progress at different sections of the Works
- any report which may be specifically requested by the Employer's Representative.

These monthly progress reports shall be submitted not later than 7 days after the end of the report month.

5.1.38.5 Record / Progress Photographs

The Contractor shall arrange each month sufficient number of photographs as Record Photographs of progress of works and shall provide the electronic files. Contractor shall include progress photos in the progress reports.

5.1.38.6 Materials/ Plant Certificates and Inspections

Where certificates are required by the Specifications or relevant Reference Standard, the original and one copy of each such certificate shall be provided by the Contractor.

Certificates shall be clearly identified by serial or reference number and shall include information required by the relevant Reference Standard or Specification clause.

The timing for submittal of certificates shall be as follows:

- manufacturer's and supplier's test certificates shall be submitted as soon as the tests have been completed and in any case not less than 7 calendar days prior to the time that the materials represented by such certificates are needed for incorporation into the Permanent Works
- certificates of tests carried out during the construction or on completion of parts of the Permanent Works shall be submitted within 7 days of the completion of the test.

All material under the contract is divided in 3 categories.

Category A: The Drawing will be approved by the Employer before manufacturing and Testing. The material will be inspected by the Employer or by an Inspecting agency approved by the Employer at the manufacturer's premise before packing and dispatching. The Inspection charges of the agency will be borne by the Employer but initially the Contractor shall pay the inspection charges. The Contractor shall include in their next bill the inspection charges and the same will be reimbursed by the Employer from the Provisional Sum. The Contractor shall provide the necessary equipments and facilities for tests and the cost thereof shall be borne by the Contractor. In case of failure of any item during third party inspection, no charges shall be reimbursed to the Contractor for the same.

Category B:- The drawings of the Equipment will be submitted and to be approved by the Employer prior to manufacture. The material has to be tested by the manufacturer and the manufacturer's test certificates are to be submitted and approved by the Employer before dispatching of the Equipment. Notwithstanding the above, the Employer, after examination of the test certificates, reserves the right to instruct the Contractor for retesting, if required, in the presence of Contractor's representative.

Category C: The material may be manufactured as per standards and delivered to the site.

For material / Equipment under category "A" and "B", the Employer will provide an authorization for packing and shipping after inspection.

The testing, approval for dispatching shall not absolve of the Contractor's obligation for satisfactory performance of the plant. Employer will take the decision on category of inspections.

5.1.38.7 Site Records

Daily records of on-site testing and inspection shall be kept on forms of approved format. Test results shall be certified by the responsible member of the Contractor's

staff. All test certificates and inspection records (including any from suppliers or other outside testing agencies) shall be clearly identified with the appropriate part of the Works to which they refer, and they shall be submitted to the Employer's Representative together with the respective Certificate.

Once each month, or at such other intervals as the Employer's Representative may require, the Contractor shall submit in an approved form a summary of all quality control inspections and tests performed at Site and elsewhere in the intervening period.

Test results shall be summarized in tabular form or graphically or both in a way that best illustrates the trends, specific results and specification requirements. Where the tests show that the specified requirements were not achieved, the report shall describe the action that was taken.

Each report shall also contain a forecast of quality control work likely to be carried out during the period to be covered by the succeeding report.

The Contractor shall keep detailed and up-to-date inventories in an approved form of goods and materials already approved by the Employer's Representative for which Certificates have been issued as well as of all other goods and materials subject to quality control which are on order, delivered, found faulty, lost during the work or found to be surplus to requirements. The Employer's Representative shall have access to these records at all times.

5.1.38.8 Daily Log Book

The Contractor shall keep a Daily Log Book at each location where major construction activities are taking place. This Daily Log Book shall be in a form approved by the Employer's Representative and shall contain, but not be limited to, the following major items of information:

- name of Contractor and Package No.
- date
- weather conditions (max./min., temperature, hours and intensity of rainfall)
- work carried out during the day per Section (description, quantities)
- major equipment used per section (on contractual work, on extra work ordered, approximate operating time on either)
- strength of labor force per Section (on contractual work, on extra work ordered, hours worked on either)
- delays (cause, effects such as idle time etc.)
- unusual events (earthquakes, floods, fires, storms, accidents, strikes, rallies, etc.)
- visitors at Site.

Each daily log shall be signed by the responsible Site Manager of the Contractor and "noted" by the Employer's Representative.

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5.2 Scope of Work

5.2.1 Preamble

This is a single–point responsibility Design, Build and Operate Contract (DBO) involving design, supply, construction, operation and maintenance of "Rejuvenation of Amanishah Nallah (Dravyawati River) including Area Development". The Proponent has carried out surveys, investigations and preliminary designs of the important components. The details of the various components have been presented in the subsequent subsections and elsewhere in the document. The main parameters and specifications decided upon and laid out in the document are to be honored and maintained. However, detailed design and preparation of working drawings are required to be done before construction and procurement commences, and form a part of the Contractor's responsibility. The Contractor is responsible for ensuring that the Project when commissioned fulfills the objectives for which it has been designed. The Contractor is required to double check the stipulations, surveys, investigations and design of the system independently. He may propose upgrades where he feels that a change is required to achieve the objectives. He will however not be entitled to ask for reduction in any of the parameters or specifications claiming them to be excessive or superfluous.

It is the intent of the Employer to construct a facility using the highest standards for construction and supply of Plant and equipment to enable a sustained, reliable system for performance over next 50/100 years.

5.2.2 General Scope of Work

The scope of work under this part of the Contract includes the design and construction of all Works for Nallah course correction/strengthening, interception of sewage treatment plants, area development works and other works listed herein or any other works necessary to achieve the above objective and complete the system as per the specifications and Employer's Requirements, including operation and maintenance of the entire system for 10 years. The limits of the Contract shall be from 0/0 chainage (north of Mahalbagh) to 47.5 km chainage (confluence point of Dhund river).

Dravyawati river is the new name given to Amanishah Nallah which originates from the hills of Nahargarh fort and travels through the city of Jaipur through thickly populated residential colonies. The Nallah carries storm water during monsoon season draining into it all along it's length, about 12 big drains joins the Nallah at various points. In additions to storm water drains, large no(about 75 in number) of untreated sewage carrying drains also joins the Nallah at various locations.

The total length of Nallah is 47.5 km measured from origin to it's confluence point up to Dhund river. The difference in elevation from zero chainage to chain 47.5 km is 134 m which gives a slope of 1 in 354.48 m. which is quite steep and unstable. The total catchment area is 233 sq km. The head and tail reaches are considered highly permeable (open area, sandy soil) and middle reaches are considered as impermeable (built up area, roads, paved area). The entire length of Nallah has been divided into different reaches for convenience.

Generally the following activities shall be carried out for each component of this Contract, but shall not be limited to:

- **Investigations, Surveys and Submissions**
    - Setting up fully equipped/staffed field offices to carry out the required surveys and investigations and preparing the necessary designs and drawings at the very start of the Contract. The design offices shall interact with the Employer's

staff to ensure team work for early submission and approval of the design and drawings required

- Carrying out necessary topographical survey/sub soil investigations for the drain line, pumping stations, road works and other development works within the limits of the Contract in consultation with the Employer's Representative so as to verify and check the data provided in the document
- Carrying out required subsoil investigations for design of foundations including the tests for determination of safe load. Carrying out various other subsoil investigations such as the type of soil, the strata, and the level of ground water, optimum moisture content, soil resistivity and chemical composition, bearing capacity, etc., as may be required
- After carrying out all required field surveys and investigations Contractor shall plan, design and prepare the engineering drawings for the project and will be submitted to the Employer's Representative for approval
- Carrying out required waste water quality analysis
- Preparation of system designs where required (e.g. Nallah, interceptor sewers, sewage pumping stations, sewage treatment plants, area development and associated works, power supply system, automation, local SCADA systems for monitoring and control, communications, surveillance etc.) for approval of the Employer's Representative
- Planning, design and preparation of the working drawings for the proposed Works. Preparation and submission of the L-sections, layout plans and cross sections and conceptual drawings etc. and all other drawings at appropriate scale and details for planning and construction of all components of the project
- Submission of documents (designs, drawings, data sheets, etc.) and samples required according to the Contract for approval by the Employer's Representative of all design and drawings, material to be used, equipment specifications, etc., prior to construction
- Submission of the design, drawings, catalogs and the technical data sheets of all the equipment, electrical system design of the electrical components and substations and 33kV transmission lines taking into account the interfaces to the other project components
- Preparation and submission of General Arrangement Drawing (GAD) and Architectural Elevation drawings of all structures proposed to be constructed for approval
- Preparation of the structural design and drawings (including reinforcement detailing) for all the Works taking into consideration the functional reliability and structural safety of the buildings
- Preparation and submission of all detailed working drawings on the basis of conceptual designs and plans approved by the Employer's Representative

- **Works**
  - Setting up of suitably equipped/manned field offices for supervision of the works for the Contractor's staff and the Employer's Representative
  - Development of suitable storage spaces for construction material and equipment to be received for the works
  - Identification of suitable quarries/sources for construction material and get

them approved from the Employer's Representative

- Setting up and staffing with qualified engineers/ technicians, of suitable laboratories for following the Quality Assurance Program
- Setting up of suitable labor camps with all water and sanitation arrangements and other facilities required under the relevant Labor laws
- Implementation of all the environmental and relevant social mitigation measures as required
- Making arrangements for equipment and material required for maintaining safety of the sites and the workmen on site (helmets, boots, jackets, safety belts, gloves, scaffolding, barricading, etc.)
- Submission of initial work program and updating the same every month for approval by the Employer's Representative.
- Site clearance and leveling of site. Layout of the works as per the approved drawings.
- Disposal of surplus soils as directed by Employer's Representative, construction of civil components of all the units, and maintaining the construction site in orderly manner
- Carrying out tests on materials received and finished works and maintaining complete records and registers required on site as per the QA/QC Manual of RUIDP
- Manufacturing, shop testing, pre-dispatch inspection, packaging, transportation to site, providing transit insurance, storage, handling at site, installation, sectional testing, pre-commissioning testing, trial runs and commissioning of all components of the system including the pipes, fittings, hydraulic, mechanical, electrical, inclusive of 33kV transmission lines (new and upgradation), electro-mechanical and instrumentation equipment
- Providing spares, tools and tackles
- Remedying the defects during the Contract period
- Site Clearance and tidying up and restoration of the premises after completion of the Works
- Submission of 'As Built' drawings and Operation and Maintenance Manuals

- **Operation and Maintenance, Preventive Maintenance and Repair of Complete System for 10 Years**
- **Training of the Employer's Staff on all aspects of Operation and Maintenance of the Full System**
- **Handing Over of the Full System at the End of the O&M Period to Employer**

5.2.3 Major Components of the Contract

The following is a brief description of the major components of the Contract. This is to be complemented and read with the details provided in the subsequent subsections of this document.

5.2.3.1 Part A- Survey, Investigations and Design

As this is a DBO contract, the Contractor shall be responsible for designing the project components. The overall design section is broadly divided into two part:

- Survey, Investigations and Designs for the Project Components

- Master Plan of the Reclaimed Area

(A) Survey, Investigations and Designs for the Project Components

Detailed survey, investigations are covered in the respective subsections of the project components. The Contractor shall broadly design the following components of the project:

- Re-verification of Hydraulic design of Nallah for 100 year recurrence period- as the Nallah sections are fixed under this Contract, the responsibility of the Contractor shall be to re-verify and fine tune the complete hydraulics of the system, further detailing is mentioned in the relevant subsections
- Structural design of Nallah section and other Ancillary structure
- Study of present sewerage system infrastructure of Jaipur city
- Interception of sewage, Sewage Pumping Stations, Collection Pipe
- Structural Design of Sewer Lines
- Hydraulic, Architectural and Structural Design of proposed Sewage Treatment Plants
- Architectural and Structural Design of various other buildings
- Roads, intersections and public spaces
- Traffic Planning
- Street and Campus Lighting
- Surveillance
- Mechanical and Electrical system
- Automation and Instrumentation
- Other components as required to complete the job

(B) Master Plan of the Reclaimed Area

Current project and development proposal does not include / scope details of any/or all Land Use. Master planning exercise would be taken up further to the execution of this Project. Depending on the development and final size, location and character of these land parcels (Execution would be done based on detailed engineering by the successful Contractor), which would include participatory approach by the people at large. A program will be adopted to develop the released spaces. The proposed Master Planning exercise will include following steps. The Contractor shall prepare Master Plan of the reclaimed area from the project area and he has to broadly carry out the following works in this task:

- Market survey
- Location assessment
- Need assessment
- Product mix
- Business Plan and strategies for development
- Master Plan
- Landscape plan

5.2.3.2 Part B: Nallah related Works

(A) Unlined Section (0.0 - 5.1 km)

- Construction of approx. 17 nos. of Gabion structures with maximum 0.3 m height

in unlined cross sections from 0/0 to 5/10 km initial stretch of Nallah

- Site clearance, earth work in cutting and embankment
- Re-modelling of spillway structure at Mazar Dam

(B) Course Correction Work (5.1 km to 47.5 km)

The work includes construction of Nallah from 5.1 km to 47.5 km in required sufficient section to discharge the highest flood generated by rain over a 100 years recurrence period. This includes :

- Site Clearance this includes removal of trees, shrubs, vegetation, hyacinth, silt removal etc.
- Demolishing of existing structures which are obstructing construction
- Dredging and cleaning of Gular dam and Ramchandrapura dam
- Earth work required for re-sectioning of Nallah to provide desired section in various reaches to pass the 100 years frequency flood

(C) Strengthening of Nallah (5.1 km to 34.8 km)

- Cement concrete lining in minimum M25 grade and 20 cm thick in trapezoidal section upto of the lower side slope of Nallah (Base Section)
- Stone pathway at the junction of Base Section and Upper Section on both flanks
- Alternate panels of turfing and stone steps 10m wide in Upper Section on both flanks
- Falls as appropriate place so as to keep the bed slope as 1 in 500
- Check dams at appropriate place so as to keep the depth of flow minimum 30 cm
- Masonry wall of at least 1m height at the top of the slope of Upper Section

(D) Strengthening of Nallah (34.8 km to 47.5 km)

- Stone pitching minimum 23 cm thick all along the length in both base of Upper Section
- Masonry wall of at least 1m height at the top of the slope of Upper Section
- Falls as appropriate place so as to keep the bed slope as 1 in 500
- Check dams at appropriate place so as to keep the depth of flow minimum 30 cm

(E) Ground Water Recharge Structures

- Construction of Ground Water Recharge Structure at every confluence point of storm water drain with the Nallah
- Ground Water Recharge Structures at every check dam

(F) Road and foot path

- A 5.5 M wide road having bituminous top along with 3 m wide foot path is to be provided on both the flanks of Nallah at the top of earthen section along the Nallah in length where ever it is possible and land is available.

(G) Joining of lined section with Other structures

- The lined sections shall have to be joined to upstream side existing structures by constructing flared walls made of stone masonry with cement pointing in a gradual slope of say 1 in 3, similarly the lined section will be joined back with flared masonry wall on it's downstream.

5.2.3.3 Part C: Sewerage Works

The Objective of this part of the work is

- To prevent any inflow of untreated waste (Dry weather Flow) into the Amanishah Drain.
- To withdraw 50.0 MLD sewage from the existing outfall sewer in the area to reduce the load on the existing outfall.
- To treat the collected waste water and the sewage withdrawn from the outfall to the standard laid down ensuring no nuisance during treatment in the area.
- To deliver the treated effluent to suitable points within the proposed lined section of the drain from Ch 5.1 km to Ch 34.8 km in a manner to ensure continued water flow in the entire bed width within the drain section of sufficient depth as stipulated and of quality appropriate to meet the class D of CPHEEO standards for streams suitable for aquaculture.

The subsequent sub sections provide philosophy, redundancies and detailed specifications for the materials/equipment generally required in such works. However, since as per the contract, the Contractor is to design his own system, only the specifications for items which are required by his design and approved by the Employer's Representative will be used. The details for the items not covered in these specifications but required in the plant as per Contractor design will be submitted by the Contractor and approved by the Employer's Representative.

The scope of work under this Contract in this part includes the design and construction of all Works for the sewage treatment system as described in subsequent paras, sufficient to collect entire dry weather flow in various drains, sewer lines not connected to any treatment plants within the catchment of the Amanishah Drain and at least 50 MLD sewage from the existing outfall collecting sewage from the catchment and delivering the same to existing Delawas STP and deliver desired flows of treated effluent to the Amanishah Drain (modified as per works described in Part I of the contract). The above objective has to be achieved as per the standards as laid out elsewhere by the Employer.

5.2.4 Preventing untreated Dry Weather Flow in Amanishah Drain:

Ensure that no untreated dry weather flow enters into the Amanishah Drain. The list of the observed locations where such waste water finds entry in the drain as prepared by the Proponents of the Contract are listed in the statement at end of this subsection. The Contractor should however confirm the data for his assessment. The inflow has to be tapped and connected to a proposed collection main to run along the alignment of the Amanishah Drain on both the banks. This shall flow towards the downstream until it is picked up as the tapping point of sewage treatment plants to be proposed and provided for in this contract.

Ideally there should be no dry weather flow in the drains entering the Amanishah Drain and the waste water should be collected through sewerage system and connected to a STP. Major part of the catchment has been sewered but still some areas need to be sewered and new areas will also develop. However, till then the expected dry weather flows in the drains has to be estimated and for next 30 years and provided for. The major portion of the dry weather flow collected flow under the B2 by pass where it was measured as about 100 MLD.

The providing of the sewerage system in the catchment area is not a part of this contract but there are areas which have been sewered and are transferring untreated sewage into the tributary drains. Connecting such outlets directly to the collection mains will be a part of this contract.

The entry point of the drain to the Amanishah Drain has to be so designed that during monsoon when the inflow is high, it ensures to trap the bottom flow for connection to the parallel collection pipes and the surplus flow passes to the Amanishah Drain in a proper stream lined inflow inlet. This inlet should however ensure that the dry weather flow in the Amanishah Drain at that point does not flow back into the inlet and into the parallel collection pipes. The inlet has also to ensure that no floating material flows into the Amanishah Drain or the collection pipes. Suitable protection has to be provided to ensure this. Arrangements for cleaning the floating material trapped has to be provided for along with access to transport vehicle.

There is a sewerage system which collects sewage from major part of the catchment of the Amanishah Drain and the outfall goes to the Delawas STP. There are two STP of 62.5 MLD capacity each there which are operating at full capacity and yet there is surplus flow reaching which Is by passed untreated to the downstream. The volume of excess is grossly estimated to be around 50 MLD. The layout of the existing sewerage system is enclosed at Drawing No. 1 in Section-9 (Volume-2).

(A) Interception of Sewage

Collection Pipes of Double Walled Corrugated HDPE pipes sufficient to carry any inflow that might be coming to Amanishah Drain will be provided on both sides of the Amanishah Water way. The objective will be to connect any dry water flow source to this pipe which collects and takes it to points chosen by the Contractor for collecting and pumping the collected waste water to a STP proposed by him. The size shall be calculated to allow the flows within the Interception pipe by gravity. The pipes will be provided with manholes as per the Sewerage/storm water flow norms and will be laid in gradient so as to maintain gravity flow.

In general the scope of laying sewer is as follows:

- Laying, jointing and testing and commissioning of collection main to run along the alignment of the Amanishah Drain on both the banks to tap the untreated dry weather flow
- Laying, jointing and testing and commissioning of collection main for tapping of 50 MLD sewage from existing network to Amanishah Nallah confluence point/ inlet sump of proposed STP
- Construction of manholes, erection of Vent pipes and other ancillary structures required to complete the network

(B) Sewage Pumping and Sewage Treatment Plants

The objective of providing the STP and allied pumping systems is:

- To collect all untreated waste water in the catchment of the Amanishah Drain that finds its way to it and treating the same and ensuring that no untreated waste water finds its way into it.
- To draw about 50 MLD sewage from the existing outfall sewer leading to Delawas and treating the same. This is aimed to avoid overloading of the outfall and to provide sewage for effluent required to full fill the subsequent demand of maintaining flow in the water body system in Amanishah Drain
- To ensure that there is enough treated effluent flowing in all sections of the Amanishah drain (5.1 km – 34.8 km) to have at least 3 cms water column over the check dam or fall in the basin to provide a continuous water fall.

The technology for treatment has to be suitable for ensuring the objectives which may be listed as below:

- Minimum Land Requirement
- Minimum operating Cost including power cost
- Reliable treatment Process to provide desired treatment at all times including the fluctuation in flow quantities and inflow characteristic
- To ensure that there is no nuisance of sound, odor, aerosols or air pollution in the nearby vicinity as the it will be high value commercial and residential areas.
- Any supernatant or liquid waste shall be recycled into the inflowing sewage for treatment and no liquid waste shall be passed into the environment.
- The treated sludge will have to be thickened followed by dewatering by use of centrifuges/belt press and converted to fully digested sludge cakes with moisture content limited to 20.0 % (+/- 2%) ready for transport from the site for disposal.

Land Requirement

It is important that the proposed plant is compact and uses minimum land. It is proposed to allow land upto 500 sq mts./MLD capacity of the STP. This should include all units necessary for the plant like power supply, raw sewage intake, pumping station, pretreatment, treatment process, sludge treatment, storage, access roads for all important installations and parking, laboratory, office and plantation etc. complete. Any excess land requirement will be loaded @ Rs. 20,000/- per sq. meters in the evaluation of the offer.

The scope of STPs includes but is not limited to:

- Process design, hydraulic flow chart, equipment design,
- Preparation of GAD and architectural designs followed with structural and working drawings after approval.
- Submission of equipment data, catalogue, drawing and specifications for approval
- Construction of all components after approval of designs and designs including supply and erection of equipment
- Ancillary works
- Preparation of developmental plans and landscaping and drawings
- Drainage plans & designs
- Other designs / plans required for campus area development e.g. Administrative Block – including furnishing, Provision of security cabins, store room
- Construction of boundary wall (1.75 m high) for campus with main and other side gates with cow guards.
- Provision of furniture to the offices
- Horticulture and landscaping
- Providing internal roads
- Providing storm water drainage within campus

Civil Works

The civil works envisaged shall be as following, but not limited to:

- Construction of the pumping stations suitable to accommodate all pumps, motors, drives and its accessories, switchgears, panels, DCDB's, PLC system, voice communication etc
- Providing and installation of all safety equipment to ensure safety of the working staff for any eventuality that may occur (including fire and electrical shocks).

- All civil works for trenching and laying of cables, fencing around sub-station and preparation of ballast ground floor of new sub-station area.
- Construction of foundation for transformers and other structures of sub- station. The transformer foundation shall house oil pit, oil drain pipe, collection chamber and valve.
- Construction of a partition wall between two transformers.
- Providing access stairs for the roof.
- Providing lighting fixtures along with cabling, distribution boards, switches, starters, and other accessories for indoor and outdoor areas of:

  a) the area of pumping and sub-station.

  b) at respective pump/motor floor areas, switchgear rooms, PLC control room, battery room, office areas, lobbies, staircases and other areas.
- Providing pipe supports and thrust blocks/anchors for delivery pipes, valves and manifold pipes, valve and meter chambers.
- Providing double door entrance for the PLC control room
- Providing lavatories for managerial and operating staff.
- Providing water cooler of 40/80 liter capacity for drinking purposes.
- Providing drainage arrangements with drainage sumps.
- Providing First Aid Kit.
- Fire extinguishers

Mechanical Equipment

The works included are as defined below but shall not be limited to:

- Proper number of submersible/ centrifugal pumps with working and standby, including all accessories
- delivery piping along with dual plate check valve, motor operated valves, motor operated sluice valve, with necessary supports
- dual plate check valve
- kinetic air valve
- scour valve with piping
- Bearing cooling water system with piping and accessories, if required

Common equipment

- Providing an crane of suitable capacity.
- Dewatering pump set with flexible piping
- Drain pump sets with piping
- Fire extinguishers
- Providing ventilation system in pump house and electrical rooms
- Air conditioner for PLC room
- Specified spare parts
- Specified tools, clamps and test equipment

Electrical

The power supply will be taken from the Jaipur Vidyut Vitaran Nigam Limited (JVVNL). The supply should be taken on independent 33 KV feeders from the Sub

Stations located at nearest points of proposed STPs.

The works component included are as defined below but shall not be limited to:

- New 33kV single circuit lattice tower overhead lines from existing substation to each STP location
- 33kV outdoor substation consists of lightning arresters, current transformers, voltage transformers, disconnectors, fuses, insulators, ACSR conductor, clamp and connectors with necessary metering and protection arrangement including steel structure
- 33kV indoor switchboard consists of two VCB incomers with line PT, one VCB bus-coupler and two VCB outgoing feeders with necessary metering and protection arrangement
- 33/3.45kV, Dyn11, ONAN transformers with OLTC and RTCC panel
- 3.3/0.433kV, Dyn11, ONAN auxiliary transformers
- LV variable frequency drives
- Neutral grounding resistor on 3.3kV side
- 3.3kV indoor switchboard with necessary metering and protection arrangement
- 3.3kV capacitors
- Soft (reactance) starters for 3.3kV motors
- LV switchboard/ distribution board/ lighting panel
- Battery, battery charger and DCDB
- MV and LV cables
- LV capacitors with APFC panel
- Local/ remote Push Button stations
- Lighting system
- Cabling system
- Earthing and lightning protection system
- Safety equipment
- Fully automatic and fail safe operation of the pumping system to meet the varied flows of sewage in most efficient manner shall be provided.

Instrumentation

The following list is not comprehensive and the scope of Contract shall not be limited by list but shall include all necessary instruments, hardware, software, cabling, earthing, lightning protection, etc., which shall be required for proper monitoring and control of the pumping station

- Level measuring system and level switch in each compartment of the reservoir
- Temperature scanners for motor winding and bearing temperatures and pump bearing temperatures for each pump-motor set
- Portable temperature measuring system for motor and pump bearing temperatures
- Pressure measurement system using transmitter for measuring pressure in the clear water pumping main
- Pressure gauges on discharge of each pump
- Flow switches and sight flow glasses for monitoring flow in each motor/pump bearing cooling water return lines, if required

- Providing and installing full bore electromagnetic flow meters on the pumped sewage/effluent manifold; one flow meter at each STP. Room shall be provided for installation of the flow meters. Control panel shall be provided at STP control along with battery and battery charger for flow meter.
- Portable sound level meter
- Portable vibration meter
- PLC based Instrument control panel with all necessary hardware and software for monitoring and control of the clear water pumping station. The PLC shall be provided with all hardware and software for interfacing with the local PC based SCADA system to be located in the administrative building in the STP
- Battery and battery charger for the I&C system
- Instrumentation and control cables

5.2.4.2 Part D: Miscellaneous Works

(A) Plantation

A 2 meter wide strip of land on both the flanks is to be provided in between the masonry dowel and the road. For planting of trees, which are to be planted with in the strip at a distance of 3 meters all along the length of Nallah.

(B) Landscaping

At least 65000 sq m land is to be improved by providing landscaping works. The landscaping works may include some area with lawns, some ornamental plants, some fountains, waterfalls, small water bodies, ornamental lights, walk ways/jogging ways, kids play ground food courts, space for social /community festivals space for yoga and meditation, sitting space on benches etc.

(C) Other facilities to be provided on the Nallah

The other facilities which are to be provided are listed as under:

- Shall have appropriate arrangement for crossing the utilities pipes and cables between two ends
- Necessary civil works required for bringing additional rain water streams into the Nallah wherever possible are to be provided
- All intersection points of approaching roads to the Nallah are to be developed for traffic management and as center point of activities.
- Necessary arrangement for vendors at intersection points shall be made
- Necessary arrangement for vendors and other commercial centers along the Nallah in public spaces shall be done to take care of visitors requirement which should include parking space provided with cement paver tiles also.
- Necessary arrangement for accessibility of trucks and other cleaning equipments to the bottom and any other part of the Nallah are to be made, a3.5 m wide cement road having a gradient of at least 1 in 10 can be provided for this purpose at an interval of 1.5km along the Nallah
- Drinking water facilities are to be provided at appropriate places along the Nallah, which should include a water storage tank, a platform fitted with taps and drainage arrangement for waste water
- Garden benches made of iron of appropriate size (at least 1.5 m long) are to be provided along the pedestrian path way provided along the road on both the flanks. The proponent has assessed that about 1352 benches would be needed.

(D) Electrical Works

The whole water front shall be well illuminated all along the Nallah, public space, buildings, treatment plant campus as per the standards of lux level in public area

(E) Surveillance

- Shall have surveillance arrangement 24x7 with CCTV cameras
- Appropriate software and connectivity system with integrated solutions shall be provided for surveillance and security aspects.

(F) Solid Waste Management

Appropriate arrangement for collection of solid waste which include provision for dust bins of appropriate size, organic waste converter with shade and efficient arrangement for it's disposal

(G) Weather Station

An automatic weather station is to be established at an appropriate place along the Nallah which should be fully equipped with number of instruments such as Thermo hydrograph, Self recording Rain gauge, Pan evaporimeter, Sunshine hours recorder, Wind data logger etc.

(H) Measurement of flowing water

Following equipments are to be provided:

- Cup type water current meter- 11 nos, one in each reach of Nallah
- Digital water level recorder 11 nos, one in each reach of Nallah

(I) Strengthening of connecting kutcha Nallah & provision of screens

Kutcha Nallah meeting Amanishah Nallah shall be made pucca under this contract upto 500 meters from Amanishah Nallah finalized edge.

Coarse screens shall be provided of suitable design as approved by Employer's Representative at all places in the end of the Nallah before joining Amanishah to trap the floating material specially during rains to protect Amanishah from any nuisance.

(J) Useful buildings

- Public toilets consisting of 6 WC seats and 4 urinals, (separate arrangement for ladies and gents for each block of size 300 sq ft. shall be constructed along the Nallah to take care of current need of slums or colonies who are using the Nallah for open defecation and can use these toilets after development of Nallah as a water front. The proponent has assessed that about 45 toilet block would be needed. Contractors are advised to have their own assessment
- security cabins at least 50 no along the length of Nallah each having a plinth area of 50 sq ft each
- Operation & maintenance office building cum emergency response center having a plinth are of 1500 sqm
- Public awareness and exhibition centre, It is proposed to establish an Exhibition centre for the awareness of public to Know about the status of Amanishah Nallah 'before construction' and 'post construction'. The size of the building should be at least 1000 sqm
- Storage yard of size 9200 sqm is to be provided with a plinth and tin shed above it for storage of material during construction and O&M
- Field quality testing labs, A suitable size temporary field quality control lab should be established. The lab should be shifted as the work goes ahead, the distance

of the lab from actual work site should not be more than 300 meters any time :

(K) Tools, Tackles and Spares

- Providing mechanical equipments, such as amphibious Tool Carriers, Dredger, Weed harvester etc.

(L) Providing monitoring and measurement equipments

- Measurement of energy consumptions per categories
- Measurement of water consumptions per categories
- Measurement of river/flood levels

(M) Trial Run

After execution of the works the Contractor shall make trial runs of the individual components. A continuous operation of the component for a period of 7 days to the satisfaction of the Employer's Representative will be deemed to demonstrate satisfactory completion of trial run for the individual component. The cost of electricity, chemicals and other consumables for operation and maintenance of the System during the period of this trial run will be borne by the Contractor. The costs towards the Contractor's Representative and other operating personnel during the said period of trial run, along with cost of tools and spare parts, which are required for operation and maintenance of the plant and equipment during the trial run period shall also be borne by the Contractor and shall be included in Contract Price. In the event that the System or any of the facilities do not satisfactorily achieve the required performance standards during this period, the trial run period shall be extended until such time as the Contractor has satisfactorily rectified any deficiencies as may be necessary to satisfy the performance requirements, at the risk and cost of the Contractor.

(N) Commissioning of the System

On completion of the Trial Run, commissioning of the System shall be done by the Contractor. The total time allotted for commissioning of the full system is 60 days. The commissioning of the system shall be considered as fully achieved after the full system has run continuously for a period of 15 days without any breakdown to the satisfaction of Employer's Representative. If continuous run is not achieved fully to the satisfaction of Employer's Representative, the Contractor has to do the needful to achieve the same at his cost. All the costs thereof, including the cost of staff, maintenance, and any other consumables for operation and maintenance of the system during the period of commissioning except for the chemicals used and electricity consumed during the commissioning period shall be borne by the Contractor. The cost of the consumable chemicals and electricity will be borne by the Employer.

5.2.4.3 Part E: Operation and Maintenance

Under this Contract, the Contractor is required to operate and maintain the entire, water way, Drain water inlets to the collection pipes and into the main water way during monsoons, the sewage pumping stations, the collection pipes and the other connecting pipes, sewage treatment plants, sewage effluent disposal to the water way and disposal of sludge cakes to disposal sites, periodic testing of the treatment quality, the communication system, 33kV tower/ pole lines, 33 kV switchyards, electrical, instrumentation and control systems, all ancillary buildings, campus area, roads and ancillary civil structures along water way and road for the entire period specified in the Contract (as at the commencement date of O&M period and all the additions, alterations done under this Contract thereafter) for the purpose of

collecting all dry weather flow that may enter the Amanishah Drain, 50 MLD sewage from the existing outfall sewer to Delawas, treating the same to the required standards and maintaining water flow in the water way of at least quality required to maintain aquaculture and disposing the sludge to suitable land fill sites. It also includes the responsibility of passing all flood water through the water way during monsoons.

During operation and maintenance the Contractor shall ensure that all the dry weather flow is treated to the required output parameters as specified by Employer's Representative.

Without limiting the Contractor's obligations during the Operations and Maintenance Period, the Contractor shall;

- Assist the Employer in identifying any additional clearances that are to be required to be obtained by the Employer for the fulfillment of the obligations of the Contractor under the Conditions of Contract
- Provide all required consumables and spares required for functioning of equipment, except power.
- The charges for power shall be made by the Employer directly to the RSEB after verification of the same by the Contractor. The Contractor shall be responsible for sorting out any differences in the billed amount he may have with the RSEB. The Contractor shall be responsible to see that his power consumption is within the limits agreed under the contract and any excess will be recovered from him as per contract conditions.
- The chemical consumables used under the Contract will be provided by Contractor
- Arrange all the necessary manpower for the operation and maintenance of the facility
- Be responsible to treat sewage to the desired levels and ensure full water body flow in the water way.
- Make all necessary arrangements for the tools and plant, spares, machinery and transportation vehicles necessary for operation and maintenance
- Procure and store all required materials/consumables, equipment, lubricants, inventory for repair and maintenance required for operation and maintenance, and maintain proper stock register for the same
- Be responsible for providing all Operation and Maintenance Services
- Be responsible for the security of the facility and comply with applicable laws and/or statutory requirements as may be applicable in the land from time to time
- Plan, manage, co-ordinate and carry out the treatment and pumping of sewage as per the instructions given by the Employer's Representative from time to time
- Maintain adequate stores and inventory, as per the operation and maintenance manual, for timely repairs
- Maintain and operate all civil structures, mechanical, electrical and instrumentation control equipment in pumping stations, sewage treatment plant, sewers, roads and communication systems
- Be responsible to ensure that there is no nuisance on account of negligence in the operation and or due to process failure of any sort
- Be responsible for most efficient use of chemicals
- Be responsible for most efficient use of power in running of plant and machinery
- Be responsible for the implementation of the environmental and social mitigation

measures as specified

- Be responsible for the Residue Management Disposal of Hazardous Substances or Hazardous Waste, and providing necessary Residue Disposal Facility Information to the appropriate agency
- Maintain operating and maintenance/repair records of all civil structures, mechanical, electrical and instrumentation control equipment in pumping stations, water treatment plant, water transmission mains and communication systems
- Maintain inspection book at each pumping stations and STP
- Maintain drinking water supply facilities in pump house building, STP campus and all its units
- Be responsible for submission of monthly report

5.2.5 Training Employer Staff

The Contractor shall be responsible for holding one training course each year of O&M for a period of 7 days to about 20 trainees deputed by the Employer. The course material will have to be finalized with the Employer and the Contractor shall have to provide the necessary faculty and material for all employees. The course shall include both class room lectures and on-site training in various sections. The training will be designed to enable the trainees to understand full implications of satisfactory operations and preventive maintenance.

The Contractor shall also provide full on-the-job operation training to employees assigned by the Employer to be associated with the maintenance on permanent basis. The number of such employees shall be fixed by the Employer.

5.2.6 Submission of O&M Manual and Completion Drawings

The Contractor shall provide as built completion drawings and operation and maintenance manuals at the completion of the works as detailed in subsequent subsections. He shall also make a review of the maintenance experience at the end of the O&M period, including enumerating all major events and lessons learned and changes suggested in the original O&M manual.

5.2.7 Handing Over of the Plant at End of O&M Period

The complete system shall be handed over by the Contractor to the Employer at the end of the O&M period. The system has to be handed over with all equipment and systems in a properly maintained and fully functional condition, fair wear and tear excepted. The Contractor shall make a full inventory of the items of installations and hand them over, including new replacements for any spare parts or tools that were procured under the Contract and used/consumed by the Contractor during the O&M period. All replacement spare parts shall be Manufacturer's original equipment only.

5.2.8 Interfaces of the Contract Work

As the ownership of the land in the project area belongs to Rajasthan Housing Board (RHB), Public Health Engineering Department (PHED) and Jaipur Municipal Corporation (JMC); the Employer will facilitate in getting necessary clearances if required for project activities.

The Contractor shall be responsible for following activities/ works for following other departments of the state government:

- Ground Water Department (GWD): construction/ digging tube wells for construction purposes only
- PHED: drinking water supply connections from nearest existing pipeline for project

- JVVNL: Availing 33kV connection from nearest sub stations upto proposed STPs
- JMC: needs to consulted for sewage tapping from existing sewer lines and secondary information for existing infrastructure
- Forest: permissions may be needed for works in initial unlined reaches of the Nallah
- Rajasthan State Pollution Control Board (RSPCB): consent to establish, operate and Environmental Clearances shall be needed for STPs
- Water Resources Department (WRD): consultation and permission shall be needed for works proposed for irrigation properties
- Railways/ NHAI/PWD/Army: permission shall be needed in execution of the project in their respective properties
- NEERI: The Contractor shall comply the recommendations of NEERI after consultation with the Employer

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5.3 Survey, Investigation and Master Planning of Reclaimed Area

5.3.1 Survey, Investigation, Planning & Design

Contractor is advised to make some confirmatory field survey at his own, Prior to starting of the work at site. He will collect the field data through these surveys and use them for planning and design of project components/ structures. A total station survey map of existing land prepared by project proponent is enclosed at **Drawing no 3 of Section 9 of Volume 2.** In general the following works, surveys and investigation; but not limited to; have to be done by the Contractor:

5.3.1.1 Survey & Investigation

- Setting up fully equipped/staffed field offices to carry out the required surveys and investigations and preparing the necessary designs and drawings at the very start of the Contract. The design offices shall interact with the Employer's staff to ensure team work for early submission and approval of the design and drawings required.
- Contractor shall have to procure GIS base map of project area. The maps shall have the information of various features of project area such as:
    a) Land use / Land cover (LULC map)
    b) Catchment area boundaries
    c) Digital Elevation Model Map (DEM)
    d) Water shed map
- Carry out necessary topographical survey/sub soil investigations for the drain line, pumping stations, STPs, road works and other development works within the limits of the Contract in consultation with the Employer's Representative so as to verify and check the data provided in the document.
- Carry out longitudinal level survey in full stretch of Nallah, taking spot levels at an interval of every 25 mtr distance with a maximum level difference of 1.00 mtr. This also includes the Nallah bed cross section survey Nallah at every 25 m interval upto the 50 m distance in both side from centerline of the Nallah. Levels are to be taken at a distance of 5 meter or nearer so that the X-section depicts the actual shape of Nallah. The L-section and X- section should be plotted on proper scale vertical scale. All drawing shall be submitted on minimum A-1 or bigger size sheet with readable contents as acceptable to Employer's Representative.
- Carry out Plane table/ Total station survey along the Nallah in full length. Survey will cover the area upto a minimum distance of 500 mtr in both side from center line of Nallah. Survey should show the level contours at an interval of 1.00 mtr level, detail of all existing structure such as buildings, poles, trees, drains and any other type of permanent structures in the survey area. The designed Nallah section shall be than superimposed on this map.
- Carrying out various other subsoil investigations such as the type of soil, the strata, and the level of ground water, optimum moisture content, soil resistivity and chemical composition etc., as may be required.
- Carrying out required soil bearing Capacity (SBC) for design of all type of civil structures, foundations at required places where any civil structure to be constructed.
- Specific survey & investigation requirements are also mentioned in relevant subsections.

5.3.1.2 Planning & Design

- After carrying out all required field survey and investigations Contractor shall prepare a master plan and will be submitted to the Employer's Representative for approval.
- Based on field survey data; Contractor shall design and prepare the engineering drawings for the project components and submit it to the Employer's Representative for approval.
- The Nallah section in all stretches of full length have been designed and mentioned elsewhere in the tender document. But Contractor shall redesign the Nallah section for high flood of 100 years recurrence period, based on the field data collected by the survey. The new designed Nallah section will be checked by department and may be considered for the construction; if redesigned section worked out smaller than as proposed in tender document. Contractor has to justify the new design with the applicable engineering standards and take the approval of Employer's Representative.
- Based on field survey data; Contractor shall be prepared architectural/ engineering plans of all project components and submitted them to department for approval.
- The foundations of all load bearing structures shall be designed for field investigated SBC or 8 T/sqm; whichever is lower.
- If structures are proposed on filled up soil strata, necessary measures shall have to be taken for structural satiability/ strength.
- Particular design & drawings requirements of various components of the project are also mentioned in the sub sections of this Section 5.

5.3.1.3 General Preparatory Works

- Setting up of suitably equipped/manned field offices for supervision of the works for the Contractor's staff and the Employer's Representative.
- Development of suitable storage spaces for construction material and equipment to be received for the works.
- Identification of suitable quarries/sources for construction material and get them approved from the Employer's Representative.
- Setting up, and staffing with qualified engineers/ technicians, of suitable laboratories for following the Quality Assurance Program.
- Setting up of suitable labor camps with all water and sanitation arrangements and other facilities required under the relevant Labor laws.
- Implementation of all the environmental and relevant social mitigation measures as required.
- Making arrangements for equipment and material required for maintaining safety of the sites and the workmen on site (helmets, boots, jackets, safety belts, gloves, scaffolding, barricading, etc.)
- Submission of initial work program and updating the same every month for approval by the Employer's Representative.
- Site clearance and leveling of site. Layout of the works as per the approved drawings.
- Disposal of surplus soils as directed by Employer's Representative, construction of civil components of all the units, and maintaining the construction site in orderly manner.

- Carrying out tests on materials received and finished works and maintaining complete records and registers required on site as per the QA/QC Manual.
- Manufacturing, shop testing, pre-dispatch inspection, packaging, transportation to site, providing transit insurance, storage, handling at site, installation, pre-commissioning testing, trial runs and commissioning of all components of the system hydraulic, mechanical, electrical etc.
- Providing spares, tools and tackles.
- Remedying the defects during the Contract period
- Site Clearance and tidying up and restoration of the premises after completion of the Works
- Submission of 'As Built' drawings and Operation and Maintenance Manuals

5.3.2 Master Planning of Reclaimed Land

This part of the contract is related with the preparation of Master Plans for reclaimed land in the project area after execution of complete work.

After completion of construction of all project components the final area of reclaimed land could be assessed. Contractor shall require to prepare the Master Plan for the uses of this area. The activities required for the Master Planning of this reclaimed area are, but not limit to. The Master Planning will have these major phases:

5.3.2.1 Interact (0+1 Month) Phase

- As suggested by the title, this stage will be full of interaction between the Employer and Contractor.
- At the start of the Master Planning the Contractor shall host an inception workshop to:
  a. Refine the Approach and Methodology;
  b. Agree the dates for Deliverables;
  c. Discuss the project area map with all details of reclaimed land
  d. Highlight any Data Gaps;
  e. Discuss and agree the vision for Master plan;
  f. Assessment of requirements of any surveys at this stage.

5.3.2.2 Planning (0+2 Month) Phase

- After the Inception Workshop the Contractor shall closely work with the client in developing a robust design brief for the Amanishah Nallah Master Plan and Evaluate suitable locations along the fringes of the Nallah for Market Analysis. The plan will focus on:
  a. Land Use Mix required at each location.
  b. A broad framework of development based on the detailed market research for reclaimable land from Amanishah Nallah and sites adjoining to the Amanishah Nallah area.
  c. Identification of the product mix for each areas.
  d. Assessment of the site constraints and opportunities and help in identifying the short, medium and long term objectives for the identified sites.
  e. Preparation of the framework of Master Plan, land allocations and a detailed design brief for each area.

- Site Visits and Regional Analysis will be integral part of planning, however the analysis will be at a strategic level and would consider the impact zone of 5km radius from the site boundary for:
    a. water
    b. waste
    c. power
    d. telecom
    e. transport and access
- Preparation and submission of reports on:
    a. Detailed Market Analysis
    b. Master Plan Vision

5.3.2.3 Integrate (0+3 months) Phase

At this stage the Contractor shall work on consolidation of progressive requirement and available areas for development of infrastructure and submit the base information for approval to Employer. The team will focus on the following key tasks at this stage;

- Collection of infrastructure related data at AN.
- Analysis and preparation of requirements based on the available infrastructure related data.
- Where required further investigation i.e. soil investigation report, hydrological data etc shall be conducted by Contractor.
- Summary presentation of progressive requirement and available options for the selected location for development of township and related infrastructure.

5.3.2.4 Innovate (0+5 months) Phase

- Assessment of the social and cultural aspects related to the site and its vicinity.
- Preparation of Concepts and Strategies for the proposed development. The master plan and concept note will be based on the following:
    a. Local building regulations and bye laws of town planning/municipality of National Building Code
    b. Optimum area utilization o Mine expansion strategy o Manpower requirements
    c. Men and material movement
    d. Topographical and Geotechnical aspects
    e. Site drainage
    f. Site accessibility
    g. Power & water distribution network to optimize consumption of natural resources.
- Preparation of draft Master Plan Concept report for 2- 3 options for the proposed solution at selected location. This will include;
    a. Preparation of initial layout and facilities for the selected area.

b. Consolidation of available options for development of infrastructure and submit the base information for approval.

c. The team will host a meeting with Client to present the options to the client and once the options are approved the team will generate a report and share with the Client.

d. The team will prepare a broad level business plan for entire for both a) and b) before proceeding for the further stages.

5.3.2.5 Implement (0+8 months) Phase

- After approval of draft Master Plan by Employer, Contractor shall undertake the preparation of detail final Master Plan for the project area.
- Out of the complete project area Contractor shall prepare a concept plan for Pilot Project areas (as defined by Employer) on the approved concept plan, which will include but will not be limited to the following:
- Preparation of a layout master plan indicating proposed overall land use and provide details of:
  a. Area required for each land use type (Residential, commercial, Institutional, recreation/open space, relocated units etc.) as a percentage of total area
  b. Road network, transportation and vehicular access
  c. Utility and infrastructure provision – in terms of land parcels
  d. Social and community facilities
  e. Urban Design framework, Streetscape and Building massing Plan
- Assessment of infrastructure requirement and trunk infrastructure lay out of the following:
  a. Water supply
  b. Sewerage
  c. Power supply
  d. Telecom
  e. Solid waste management
  f. Preparation of development control guidelines and regulation for Township as well as for the plot level.
- The master plan, will be discussed with the Employer's Representative, and upon approval by the Employer, Contractor shall prepare landscape and horticulture plan for the identified land along the Nallah, along with detailed drawings/ specifications and BOQ.
- The Contractor shall prepare Phasing Plan for the Nallah, to indicate for various project components, physical and social infrastructure etc. the year of development, which will be in concurrence to the phasing plan already prepared for Employer.

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5.4 Nallah Works

5.4.1 General

The scope of work under this part of the project includes the design and construction of all Works required for constructing the improved flow channel section as described in subsequent paras, this should be sufficient to discharge the highest flood generated by rain over a 100 years recurrence period. The above objective has to be achieved as per the engineering standards or as laid out elsewhere by the Employer.

As the development has been proposed as water front development, it is important that a perennial source of water supply shall be maintained for the Nallah. In present conditions Nallah receives rain water only in Monsoon season i.e. June to August. So in absence of any other source of fresh water, it is proposed to maintain the clear water flow through the secondary treated water of sewerage system in the Nallah. A drawing showing layout plan of the Nallah along with existing STP locations is enclosed at **Drawing no 4 of Section 9 of Volume 2.**

Net effective treated water required for the Amanishah water front will take care of evaporation and seepage losses from the Nallah. It has been calculated that 10-12 MLD of water will be used to meet various losses in the Nallah. In addition, to create reasonable flow conditions in Nallah 40-80 MLD flow of water will be required (varies in different reaches).

It has been calculated that sufficient waste water is currently diverted to Amanishah Nallah and the same can be treated and supplied to Amanishah Nallah to maintain it as a perennial water front.

Out of the proposed development it has been estimated that around 87 Ha land will be reclaimed from the current inundation situation. As most of the channel has been designed in cutting with some excess material available, it is proposed that any such excess will be used for filling of such areas as per the priority agreed with the agency. It is expected that 30-35 lakh cum filling can be done in these areas (with an average of 2 m fill). In addition to above filling will be required for embankments of outfall structures (82). There will be approximately 3 lakh cum filling will be required for the same. In addition rest of the excess excavated quantity will be available for selling to the nearby private parties who will require the same for filling of their land.

Catchment Area: The Catchment area of Amanishah Nallah has been divided into 13 sub-catchments based on the physiographical conditions e.g. crossings of roads, railway lines, existing Nallah and its tributaries etc. Refer Drawing No. 1 in Section-9 of Volume-2.

Key Features of Proposed Channel Section: An optimized channel section has been proposed to meet all the hydraulic as well as the river front landscape feature requirements for the Amanishah Nallah as presented here.

Various components of the sections are described in Drawing No. 5 Section-9 of Volume-2 and Annexure No. 4 & 5 of this Section).

The single trapezoidal section has been designed for 100 year of flood discharge. Main features of the proposed channel section are as follows:

- The main channel shall be in trapezoidal section with side slope in the ratio of 1.5 H: 1V.
- The sections shall be designed in such a way that it doesn't increase the depth

of flow beyond 3.1 m in main channel section. This constraint shall vary the bottom width of the channel from 18 m to 102 m depending upon the inflow discharge at that section.

- After the main section a provision of footpath as a pedestrian walk-way of 4 m wide has been provisioned on both sides of the section along with a sitting place having benches.
- Further to it the compacted earthen embankment with grass or steps has been proposed both sides. The height of the embankment will vary from place to place depending upon the nearby ground level. The side slope will be in the ratio of 3H: 1V. This section will not receive any impact during peak flow discharge. This space can be utilized for sitting as river front feature looking towards the main flow section. This section has been provided with alternate 10 m wide panels of (a) grass turf and (b) masonry steps with concrete bed on both sides of the Nallah.
- On top of the embankment tree plantation has been provisioned in 2 m strip as green belt all along the Amanishah Nallah and provide the stability to the embankment.
- Immediately on the end of green strip, boundary wall of 0.5 m thick stone masonry has been proposed with 1 m or 1.5 heights at various distances. (From Ch 5.1 KM to 26.55 KM 1 m high and from 26.55 onwards to 47.5 Km it is 1.5 m high.
- A service road of 5.5 m wide has been proposed after the green strip for the movement of vehicles along the Amanishah Nallah wherever Government land exists. A length of 16KM has been proposed to be constructed under current proposal.
- Existing slope of channel section is varying in different reaches identified in the Amanishah Nallah flow path. To keep the velocity in control, optimum slopes have been provided. This constraint has necessitated providing a fall structure in the flow path for dissipation of kinetic energy of the flooding water.
- In order to make a water front and for aesthetic considerations small check dams of 0.7 / 1.0 m height and 1.5 m of top width are introduced at suitable locations in the Nallah bed. Considering the nature of public space, and likely popularity of the proposed water front as a family destinations water depth and in turn check dam height have been decided. It is expected that small children will play around and lot of casual public activities will happen around the proposed water front. Therefore the depth of water has been kept as the most optimum to keep the water front feel and safety both. These check dams are proposed to be constructed as hollow sections to pass the possible utility services across the Nallah in future. The Check Dam will serve following major purposes:
    - To establish a feel of continuous water body.
    - To serve as a conduit for future utility services
    - To minimize the impact of the flow over the fall.
    - To act as a path way for crossing the Amanishah Nallah during non-rainy period by pedestrians and bicycle riders.

Design of Fall: Starting from origin to end point at 47.5 KM, Nallah has an overall drop of around 170 m, giving an average slope of 0.36%, which is considered high for such flow regime. This slope keeps on changing over different reaches selected for the design. This steep slope induces higher velocities flow during peak flood discharge. To keep the velocity of flow in desired range, the slope

needs to be reduced to 1 in 500. Since sectional area has its own constraints of land availability, the only option remains is reduction in the slope of the bed. Thus the falls have to be constructed in order to maintain the velocity of flow.

Nallah section shall be constructed in trapezoidal section with two side steps Dry Weather Flow will run in the lowest drain channel only and this may rise in upper section of drain during flood in rainy season. A minimum 4.0 m wide path way shall be constructed at middle level. Flow may rise in higher level during the flood and erode the side slopes of Nallah. The upper side slopes will be constructed with some protection work and stepping. Generally, but not limited to, the following activities shall be carried out for this part of the work, but shall not be limited to, site clearance, earth works, flow diversion works, cement concrete lining, embankment works, protection & prevention etc.

5.4.2 Site Clearance

5.4.2.1 General Cleaning

To execute the construction works at site, following activities has to be done prior to start the construction as:

- As Nallah is under running condition and waste water flow is continuous in the Nallah. Work cannot be taken up in full stretch in a single stroke. Contractor shall require to implement the work in small stretches of the drain by diverting the flow temporarily from that stretch
- Contractor has to construct all temporary arrangement required to divert the Nallah flow and after completion of the work site has to be cleared complete to maintain the flow in main channel of the Nallah. Contractor shall have to remove the thick vegetations, trees, shrubs, debris and existing structures etc. to prepare the bed of Nallah as per approved design. The excess waste material will have to be removed from the site and disposed off in scientific and safe manner as directed by Employer's Representative.
- Contractor shall be required to execute the earth work in all type of soil as exists at the site. The earth work is in cutting at some locations and it is also in filling for embankment. Contractor is advised to visit the site for proper assessment of work
- Contractor is required to dewater from the submergence land area and removal of hyacinth.

5.4.2.2 Dredging and Desilting

The submergence areas of Mazar Dam, Gular Dam and Ramchandrapura Dam are having huge amount of garbage, debris, silt, Hyacinth lying in it, which shall have to be cleaned, the silt deposited in it’s bed is also to be removed so as to restore the storage capacities of these dams

5.4.2.3 Dewatering

At many places sewage is accumulated in small pits as ponds which may either be channelized in to the diversion channel or if the quantum is more, dewatering may also have to resorted to. The sewage and rain water may get accumulated in the submergence of all the three dams in the course of Nallah i.e. Mazar, Gular and Ramchandrapura Dams, which may require dewatering. The Contractor should have his own assessment of quantity of dewatering and make suitable arrangement of dewatering.

5.4.2.4 Disposal of Excess and Waste Material

The excess waste material will have to be removed from the site and disposed off in scientific and safe manner as directed by Employer's Representative.. The excessive dragged material shall be in accordance with clause 4.1.1 of I.S. 4701 – 1982 code of Practice for earth work on Nallah.

5.4.3 Course Correction and strengthening Works

The total Nallah length is divided in two major sections:

(a) 0.0 to 5.1 km (Unlined Section)

(b) 5.1 to 34.8 km (cement concrete Lined Bed Section)

(c) 34.8 to 45.7 km (stone pitching section)

5.4.3.1 Centerline Marking

- Contractor shall establish Permanent/temporary bench marks for executing the Works. Temporary Bench Marks shall be set up at every 0.5 km, interval at convenient locations along the Nallah to serve as reference levels.
- The centre line of the Nallah and the reference line for all alignments for demarcation purpose shall be laid by dug-belling on the ground. The reference line shall comprise the base line properly dug belled on the ground with the numbered concrete / masonry R.D. pillars suitably spaced.
- Centre line of the Nallah shall be marked by fixing pillars / stone at 30m intervals.
- The zones of full cutting section, full filling section, partial cutting and filling sections shall be separated by conspicuous demarcation in the field.

  The curves stipulated in construction drawings shall be carefully laid in the field by adopting approved method of curve layout. The curve shall be marked on the ground by fixing pegs at very close intervals and joining the peg-point by dug-belling to a suitable depth.

  The locations of different structures indicated in construction drawing shall also be clearly marked on the ground along the alignment of the Nallah. The control structure locations of off- taking Nallahs shall also be clearly demarcated, so that unnecessary excavation or filling at these locations can be avoided.
- To ensure accuracy in execution of cutting, the Nallah embankment, spoil banks and the structures, their layout shall be given in an appropriate manner with pegs and pillars, suitably placed in relation to outer dimensions of these elements.

5.4.3.2 Civil Works

(A) 0.0 - 5.1 km (Unlined Section)

- The first reach i.e. km 0.0 to 5.1 km which is having very steep slope hence reducing velocity in this reach is a must, therefore some gabion structures are to be constructed which may comprise of big stone boulders packed in wire crates are to be placed at suitable locations.
- Construction of approx. 17 nos. of Gabion structures with maximum 0.3 m height in unlined cross sections from 0/0 to 5/10 km initial stretch of Nallah
- Site clearance, earth work in cutting and embankment

- Remodelling of spillway of Mazar dam

  Mazar dam is located in the initial reaches of Nallah at km 5.1. It is an earthen dam meant for flood absorption. The dam is having a storage capacity of 8.1 MCM at it's MWL (RL 454.5) and at FRL it's capacity is 3.88 MCM. The FRL is at RL 451.5 m. The spillway crest is about 5 m high from the ground level. Since it is a flood absorption dam it's full utility would be if the dam is kept empty prior to incoming of a 1006 year return flood having a volume of about 7.7 MCM (computed by SUHG method). There is possibility that when a 100 year flood event occurs the dam might be full up to FRL due to small flood occurrences earlier. In that case the dam would absorb only a flood capacity available above crest level i.e. 8.1-3.88= 4.22 MCM only against the flood volume of 7.7 MCM, rest of the water shall spill below with a slow rate of 28 cumec only and the dam may get over topped (in 1981 the dam was breached). Hence it is necessary to lower down the crest and a steel gate is placed on it so that the dam can be emptied in advance whenever a flood warning is received from meteorological department in 24 hours, so as to absorb the peak flood which is likely to come, also the flow through the spillway can be regulated with the help of gate. It is desired that the crest is lowered by at least 2 meters and thus raising the spilling capacity such that it can be emptied in 24 hrs if needed in the event of heavy food warning is received.

  A flood routing study keeping the existing MWL as same shall have to be carried out to fix the rout flow discharge.

  The Nallah have to be saved from carrying very high flood coming from upstream of Mazar dam.

  Contractor shall design the dam section and gate for full capacity. He will submit this design to Employer's Representative after got approved from IIT.

(B) 5.1 to 47.5 km (Lined Bed Section)

The work includes construction of Nallah in various sections from chainage 5.1 km to 47.5 km in sufficient section to discharge the highest flood generated by rain over a 100 years recurrence period. This includes:

Earth Work

- The Nallah section has been designed to pass a 100 year frequency flood computed by the Project Proponent by rational method in it's various reaches, reach wise discharge computed is attached at **Annexure 2**. The Nallah should have a trapezoidal base section and a trapezoidal upper section with a 3 m wide berm at the junction of base section and upper section as shown in enclosed **Drawing no. 5 of Section 9 of Volume 2.** Both base section and upper section put together should be able to pass a 100 year frequency flood computed as per synthetic unit hydrograph method (SUHG) method, dimensions given in **Annexure-3 of this Section 5.** To convert the Nallah section to the design section, huge quantum of earthwork involving cutting and filling is required to be done. The longitudinal section (level at 200 m interval)of the Nallah is enclosed at **Drawing nos 15 to 35 of Section 9 of Volume 2** and cross section of Nallah showing existing section superimposed by the design section at 1 km interval are attached with the Bid Document at **Drawing no 36 to 39 of Section 9 of Volume 2**. Contractors are advised to have their own assessment of quantum of cutting and filling required to be done. The bed width, side slopes, depth of flow in various reaches for both base and upper section are given at **Annexure 4 & 5 of this Section 5.** No

change in these dimensions is permissible.

- The earth work is to be done from km 5.1 to tail i.e. 47.5 km. No earthwork is required to be done in upstream of Mazar dam, except some landscaping work. The earth from cutting locations is to be carried to nearest locations requiring filling. The lead could vary from 250 m to 5 km within the channel section. At the filling location the dumped earth shall have to be spread in 20 cm thick loose layers by machines. The filling reaches are to be compacted by mechanical means using pneumatic tyred / sheep foot rollers- in layers of 20 cm loose compacted to attain a density of 95% of proctors density. Moisture level of earth during compaction shall have to be maintained at O.M.C., computed during proctors test at the field laboratory. Little extra earth on inner edges shall be laid over the design section as the roller may not compact the edges properly. The earth laid at the inner edge of the section shall have to be removed along the inner slope as per design section, which is called LIP cutting.
- The slopes after lip cutting should be compacted with slope compactors.
- The earth excavated in excess of requirement of filling shall have to be carried to a suitable place as directed by the Employer's Representative, where it shall be dumped and spread as directed. If this dumping is required for reclamation of land than it shall have to compacted also in layers as per specification , otherwise simply spreading would be enough. The lead of such disposal could be around 10 -15 km
- The entire earth work is to be done by earth moving machines.

Entire work is to be done strictly as per specifications given in this section elsewhere.

- **Pumping & Dewatering:**

Work may require pumping out the excess water from the site for working at the site.

- **Cement Concrete bedding/Lining and strengthening:-**

Base section (The portion of Nallah section which is below the berm is termed as base section):

- The surface which is supposed to receive lining should be rendered and dressed to give a smooth surface
- The Nallah from km 5.1 to 34.8 is proposed to be lined with cement concrete in situ lining 20 cm thick having M25 grade (as shown in Drawing No. 6 of Section 9 (Volume-2), laid with paver machine after lip cutting of slopes and rendering of slopes to an even surface, for it's base section below the berm all along it's wetted perimeter. The channel section has been designed using manning's formula with value of N as.015. The velocities in these section varies from 2.3 m/s to 5.15 m/s , which is more than permissible in normal course. Ideally the width of channel should have been increased but due to constrain of availability of land it is not possible, hence under this compulsion the grade of concrete has been made richer to M25 so as to withstand higher velocities. Any admixers to improve the strength of concrete can be permitted with the approval of Employer's Representative. However if any damage occurs to lining it shall have to be repaired up to acceptable norms under O&M provisions of the contract without any extra payment. The lining is to be done strictly as per technical specifications attached with the Bid document.

No change in dimensions of Nallah section (lined) is permissible, however the thickness/ grade of concrete can be made more than prescribed but cannot be lowered if so desired by the Contractor with the permission of Employer's Representative.

- **Upper Section**

  - Since the upper section would be used to pass a 100 year return flood computed as per SUHG, it should also be suitably strengthened. Lining is not proposed in this section. Reach wise design section for upper section is given at Annexure-5 of this Section 5. The height varies from place to place depending up on N S L. As per design the velocities in upper reach works out to be varying from 2.41 m/s to 4.06 m/s, which is much more than permissible, ideally the width of channel should have been increased but again the constrain is availability of land hence under compulsion some additional strengthening measure are to be taken. It is proposed to provide alternate panels of 10 m wide having grass turfing/stone steps made of pink color Karauli stones laid above masonry steps which in turn laid above cement concrete1:3:6 (as shown in drawing no 5 of Section 9 (Volume-2). The berm 4 m wide on both flanks should act as pedestrian path way hence this should also be paved with pink color masonry stone tiles (Jodhpur stone) laid in C.M. 1:6 laid over a layer of 100 mm thick cement concrete 1:4:8 (as shown in drawing no 5 of Section 9 (Volume-2).The width of these panels is not permitted to be increased, however if the Contractor wants to reduce the width of these panels he can do so with the permission of Employer's Representative. This arrangement of grass turfing/stone steps and pedestrian pathway in upper section is to be done all along the length from **km 5.1 to 34.8** This arrangement would serve dual purpose of providing strength to the earthen banks as well as to give an aesthetic view. However if any damage occurs to unlined section/stone steps, it shall have to be repaired by the Contractor up to satisfaction of Employer's Representative out of Maintenance provision without any extra payment.

- **Construction of Check Dams:**

  - Number of Stone masonry check dams has to be constructed to maintain a minimum 10 cm high water column in the each stretch of Nallah. The height of check dams may be kept 0.7 to 1.0m, the top width may be kept as 1.5 m minimum so as to provide a path way for cycle movers. Typical Section is shown in Drawing No. 7 of Section 9 (Volume-2). The section may be kept hollow to accommodate possible utility services in future.

- **Construction of Falls:**

  - Contractor shall maintain a maximum bed slope of as 1 in 500 has to be maintained in Nallah. Contractor shall be constructed number of Drop / falls structures at appropriate places in complete Nallah stretch. The structures will be constructed in stone masonry and cement concrete as structural safe for high flood conditions.

- **Boundary wall with entry gates:**

  - A stone / brick Masonry wall of at least 1m height with stone cladding at all faces.

(C) Strengthening of Nallah (34.8 km to 47.5 km)

- **Stone pitching**: The reach of the Nallah from km 34.8 to 47.5 i.e. up to tail, is proposed to be lined with stone pitching 23 cm thick all along it's wetted

perimeter in **both base and upper section**. Lip cutting of slopes and rendering for achieving even surface is to be done in this also as per specifications mentioned for C.C lining. If any damage occurs to the lining during floods it shall have to be repaired up to satisfaction of Employer's Representative out of O&M provisions without any extra payment. All fall structures, check dams and masonry parapet is to provided in this reach also. The work is to be done as per specifications given in this section elsewhere.

- **Boundary wall: -** A stone / brick Masonry wall of at least 1m height with stone cladding at all faces and MS railing of minimum 1.50m height at top shall be constructed at outer edge of Nallah in both side.
- **Construction of Falls: -** as mentioned in 5.4.3.2(B) above.

5.4.4 Ground Water Recharge Structures

Ground Water Recharge Structures will have to be constructed near every check dam with the approval of design from Employer's Representative.

5.4.5 Joining of lined section with other structures

The lined sections shall have to be joined to upstream side existing structures by constructing flared walls made of stone masonry with cement pointing in a gradual slope of say 1 in 3, similarly the lined section will be joined back with flared masonry wall on it's downstream after obtaining approval of design from Employer's Representative. Cross section of existing bridges are shown in **Drawing no 8 to 14 of Section 9 of Volume 2.** The detailed specifications for masonry and pointing given elsewhere of this Section 5 shall apply.

5.4.6 Diversion of Kutcha rain water Nallah to Amanishah Nallah

All existing Kutcha rain water Nallah within a vicinity of 500 m from the main Nallah are to be diverted to main Nallah and shall to be lined in length of 500 m and a screen is to be provided at the entry point.

5.4.7 Specifications of Works

5.4.7.1 Earth Work – General

Drawing showing the typical section of the Nallah annexed (Refer Drawing No. 5 of Section 9 (Vol-2) to these specifications provides such details as would enable the Contractor to execute the work in general conformity there-with under. These drawings will be supplemented by such additional, general and details drawings or directions as may be considered necessary or desirable as the work progresses. Where details shown on these drawings differ from the requirements of these specifications, the requirement of specifications shall govern. The Contractor shall do no work without proper drawings. He shall check all drawings and specifications carefully and advise the Employer's Representative if any errors and omissions are discovered where upon the Employer's Representative will prepare and lodge such revised additional drawings and specifications as may be required to suit the stage of work. All such additional, general and detailed drawings whether original or revised lodged in the office of the Employer's Representative and signed by him for purpose of identification shall be open for inspection by the Contractor under the same terms and conditions as provided in agreement.

All works of the contract shall be executed as per the specific and relevant clause / clauses of relevant I.S. code unless otherwise specified. Materials used should, confirm to the desired standards prescribed in the relevant codes. Wherever a para of I. S. code is cited in specification, it goes without saying that the latest

revision of the specification subsequently, shall apply. For purpose of relevancy or otherwise of any provision of the I. S. code referred to, the decision of Employer's Representative shall be final and binding.

5.4.7.2 Excavation For Nallah

- The excavation may be carried out manually or mechanically and as per specification drawing and direction of Employer's Representative.
- The excavation for Nallah in all kinds of soil shall be done according to the dimensions and grades shown on the drawing. Proud equivalent to thickness of the lining on sides and in bed on the underside of the lining shall be left unexcavated temporarily and the removal of this proud shall be done just before trimming and placement of lining.
- All areas to be excavated for Nallah sections shall be pre-wetted so that at the time of excavation moisture content shall be about optimum. However in case the excavated material from Nallah is not to be used for embankment, such pre-wetting is not necessary.
- All useful earth from excavation shall be used for filling the banking section, with varying leads and with all lifts either manually or mechanically. Excavated materials which is not useful for banking or which is in excess after meeting the banking requirement of the reach shall be disposed as specified at Para 8.1 and 8.2 of I. S. Code 4701 – 1982 either by head lead or by mechanical means or by both in spoil bank or at any specified place with all lifts and with varying leads.
- The re-gradation for tail channel and approach channel for structures and diversion of drains / Nallahs shall be done according to the dimension and grade as shown on the drawings or as instructed by Employer's Representative.
- The Contractor shall not be entitled to any additional rate above the rates quoted in the bid on account of the requirement for allowing additional time for drying, stock piling and rehandling the excavated material which have been deposited temporarily and stockpiled.
- When cutting on cross sloping ground the contactor shall cut a catch water drain on the higher side to prevent water from flowing down the cutting slope. No separate payment will be made for the work as the same is deemed to have included in the unit rate of excavation of soil.

5.4.7.3 Excavation of Soil

Excavation of all kinds of soil shall comprise of all kinds of excavations in dry, wet, saturated or submerged conditions of soil such as ordinary soil, vegetable or organic soil, turf, sand, silt, slushy soil, loam, clay, mud, peat, black cotton soil, hard soil, loose or compact moorum, soft / stiff / heavy / hard shale or clay, stony earth, soil inter spread with boulders

Excavation for Nallah shall confirm to provisions of relevant I. S. codes. Side slopes are to be provided as per the approved drawings, specification and provision of I. S. code.

5.4.7.4 Over Excavation

The Nallah shall be excavated to exact designed section in all kinds of soil. No over excavation will be allowed in such reaches.

In the Nallah section where expansive type of soil such as CH type of soil is

encountered and over which concrete lining cannot be directly laid, the Nallah prism shall be over excavated to the extent as directed by the Employer's Representative and such over excavated section shall be filled with suitable cohesive non-swelling (CNS) type of soil to be placed in uniformly compacted layers as directed by the Employer's Representative. The over excavation made in such strata, shall be filled with cement concrete with sufficient compaction.

5.4.7.5 Dewatering Trenches and Wet Excavation

Subsoil water met within Nallah excavation shall be diverted to nearby drain/Nallah by cutting an open channel within the Nallah section to be excavated. When the drain/Nallah bed is higher than the subsoil water level met with, pumping shall be resorted to for dewatering below the drain-Nallah bed level.

No distinction shall be made as to whether the material being excavated is dry, moist, saturated or submerged. Care should be taken to discharge the drained water not to cause damage to works, crops or any other property. No separate payment shall be made for dewatering by pumping or by any other method.

5.4.7.6 Embankment

(A) Preparation of Surfaces Under Embankments

The preparation of surfaces under embankment shall be in accordance with clause 6.1 & 6.5 of I.S. 4701-1982.

Before commencing the work, the toe of the slope on each side of the Banks shall be lock- spitted (dog belled) and marked by pegs firmly driven into the ground at intervals of 15 metre, profiles made by bamboos, earth, or other convenient materials and strings shall be set up for the guidance of the workmen about 15 metres apart over straight reaches and about 7.5 meters apart at curves.

Except in areas of rock, the areas under Nallah embankments shall be pre-wet by sprinkling water before cleaning, grubbing or excavation operations or embankments construction begin. The moisture content shall be optimum to a depth of one metre below the original ground surface or to impervious material whichever is less as directed by the Employer's Representative. Whenever possible all water shall be added uniformly in one application. Areas, on the sides of the Nallah banks upon which the Employer's Representative may direct spoil banks to be constructed will not require application of water.

The Contractor is cautioned to control carefully the application of water and to check on the depth and amount of water penetration during application so as to avoid over watering, accumulation of water in depressions or excessive run off.

If at any location on embankment foundations, before and during embankment construction there is excessive moisture as determined by the Employer's Representative, steps shall be taken to reduce the moisture by excavating drains, by allowing adequate draining time or by any other approved means.

The Contractor shall not be entitled for any additional allowance above the unit prices bid in the schedule on account of the requirement for excavating drains or allowing additional time for drying, delays or increased costs due to poor traffic ability on the embankment foundations or on the haul roads, reduced efficiency of the equipment the Contractor elects to use or on account of any other operational difficulties caused by overweight wet embankment foundation or haul roads.

Where the ground surface under any embankment is not suitable as determined by the Employer's Representative for a foundation for the embankment, the Contractor shall strip the area under the embankment of such unsuitable material

to such depths as may be directed. The material so removed shall be disposed off as provided in paragraph 3.3. Before beginning the construction of embankments the surface area of ground to be occupied shall be cleared of all roots and vegetable matter of any kind stripped to a suitable depth. The stumps shall be pulled or otherwise removed, and the roots grubbed. The stumps and roots removed shall be suitably disposed if.

The depth to which top soil is to be removed shall be adequate to remove all perishable material and any soil which may become unstable on saturation or may interfere with development of proper bond between foundation and embankment. It is not necessary to remove all the soil containing fine hair like roots but only the rather heavy mat. The underline table may offer as a guide for lines for finding depth of stripping.

Type of vegetable cover in the soil depth of stripping

- Soil containing light 5.0 to 7.5 centimeters grass cover
- Agricultural Lands To bottom of ploughed zone 15.0 to 20.0 centimeters

The ground surface under all Nallah embankments excepting rock surface, where it is below the full supply level in the Nallah shall be scarified making open furrows not less than 20 centimeters deep below natural ground surface at intervals of not more than 1.0 (one) metre. However, where the ground surface is below the bed level of the Nallah the entire surface of the foundation of embankments. shall be stripped to a depth of not less than 20 (Twenty) centimeters.

(B) Construction of Embankments

General

Nallah embankment shall be constructed to top widths and side slopes as shown on the drawings duly providing for 2% settlement allowance in compacted embankment section. The embankment shall be built to heights as directed above those shown on the drawings. The top of all the Nallah embankments shall be graded to be suitable for a road way in accordance with subparagraph.

Before commencing the construction work, initial levels of the ground on which banks are to be formed shall be taken. After completing the construction of embankment final cross section levels shall be taken and the volume shall be arrived at and payment shall be made to that quantity only.

From the materials deposited in embankments the cobbles, gravel and stones of size greater than 40 mm should be removed to ensure proper compaction.

In area where required excavation does not furnish suitable or adequate material for constructing embankments, material shall be obtained from areas where material in excess of that required to construct the adjacent embankment is available.

Where the original ground surface is below the grade of the Nallah and where construction of a fill below the bottom of the Nallah is prescribed such fill shall be placed as a compacted embankment. Where the original ground surface is below the base of a structure, the fill required to form a suitable foundation for the structure shall be placed as compacted embankment.

Roads And Ramps

In conjunction with construction of Nallah embankments, the Contractor shall construct operation and maintenance roads and earth ramps adjacent to the Nallah and structures where shown on the drawings. Suitable material from

required excavation shall be placed as embankment for the roads and ramps. If sufficient material is not available from required excavation the Employer's Representative may direct excavation from borrow areas.

- **Depositing**

Spoil from the pits shall be deposited on bank to each sections as are shown on the relevant plans specified or ordered by the Employer's Representative. Ramming breaking clods and smooth surface sectioning shall be necessary. A spoil bank with a neat straight toe, even slopes and even top surface shall be formed as the depositing proceeds.

- **Embankment to be Compacted**

Before the materials for the 1st layer of embankment is placed, the foundation of the embankment shall be prepared and shall be moistured and compacted in the manner hereinafter specified for each layer of compacted embankment to be placed thereon. The embankments shall be compacted to the elevation and to the top widths and side slopes shown on the drawings or prescribed by the Employer's Representative.

The layers having thickness not more than 20cm shall be placed in rows approximately parallel to the axis of the bank. The base of embankment at every height is to be made to its full width of each zone as shown in the drawing plus offsets of not less than 0.45 metres beyond the finished profile on either side for compaction., No additions will be allowed to the slope for full design section of the bank after the bank is raised. **The embankment shall be compacted to 95% proctors density using pneumatic tyre rollers, frog rammers or vibratory plate compactor or power roller.**

(C) Earth fill Material

Nallah embankment shall be constructed to the top width and side slopes as shown on the drawings. Suitable excavated material available from the Nallah cutting, proud cutting, removal of ramps and excavation for structures shall be used for construction of banks. If suitable and adequate material for constructing embankment is not available from excavations the desired material shall be obtained from borrow area designated for the purpose as per the instruction of the Employer's Representative.

The planning for execution should be such that all the useful excavated materials are utilized in embankment prior to utilization of borrow earth from outside. The embankment earth shall be borrowed only after getting written instruction of the Employer's Representative.

Only suitable materials as per specification shall be excavated, loaded and conveyed to the point of placement in the embankment. Unsuitable material if conveyed shall be removed and disposed clear of the work site as directed by the Employer's Representative at the cost of the Contractor.

(D) Placing Earth fill

- The embankment shall be constructed with earth fill of required materials as per drawing and specification. The fill shall be free from lenses, pockets, streaks or layer of materials differing substantially in texture or gradation from the surrounding materials. The useful excavated materials shall be classified as ‘impervious’ and ‘semi pervious’ by the Employer's Representative. Care shall be taken to utilize the impervious materials towards the water side of the embankment and semi pervious materials towards outer zone of the

embankment as per drawing.

- Construction of embankment shall begin at the toe of the fill and in no case shall embankment be widened by material dumped from the top. The material shall be placed in the earth fill in the continuous horizontal layers not more than 15 Cm. in thickness after being rolled as herein specified.

  The thickness of the layer shall be adjusted by the Employer's Representative; if the Contractor satisfies the Department that the particular type of compactors used by him give the required density by carrying out trial compaction and requisite tests. Initially the earth in the embankment fill shall be laid in a grater width than the designed section. Adequate extra width of about 0.6 M. on either side of the embankment shall be provided so that the earth fill, up to lines of the finished slopes, shall have the required compaction as per the drawing and specification. Such extra width shall be removed and utilized in the upper layers of embankment along with slope dressing, for which no additional payment shall be made as it is deemed to have been included in bid price of earthwork in embankment in the bill of quantities.

- No fresh layer shall be laid until the previous layer is properly watered and compacted as per the requirement. If in the opinion of the Employer's Representative, the surface of i.e. prepared foundation or the rolled surface of any layer of earth fill is too dry or smooth to bound properly with the layer of materials to be placed thereon, it shall be moistened or worked with harrow, scarifier or other suitable equipment in an approved manner to a sufficient depth to provide a satisfactory bonding surface before the next succeeding layer of earth fill materials is placed. If the rolled surface of any earth fill is found to be too wet for proper compaction of the layer of earth fill materials to be placed thereon, it shall be raked up and allowed to dry or be worked with harrow, scarifier or any other suitable equipment to reduce the moisture content to the required amount and then it shall be compacted before the next succeeding layer of earth-fill materials is placed.

- The materials shall be deposited in rows parallel to the axis and spread in the uniform layers and clods shall be broken maximum upto 5 cm. The work of spreading and compaction shall be so adjusted as not to interfere with each other and in such a way that neither of the operations is held up because of non-completion of rolling and watering. The excavation and placing operation shall be such that the material when compacted shall be blended sufficiently to secure the best practicable degree of compaction, im-permeability and stability. The surface of banking shall at all time of construction be maintained true to required cross section.

- During construction a small transverse slope from centre towards edges should be given to avoid pools of water forming due to rains.

- When compacting the soil against the rock abutment or walls of masonry or concrete structures, the construction surface of the embankment shall be sloped away from the rock or masonry or concrete structures leaving a minimum distance of 0.6 M. and at an inclination of 3:1. If the foundation surface is too irregular to allow the use of large roller directly against the structure or rock out crop, the roller shall be used to compact the soil, as close to the structure or the out crop as possible and the portion of the embankment directly against the rock or the structure shall be compacted with pneumatic hand tampers in thin layers. The moisture content of the earth-fill placed against the rock or the structure shall be slightly above the optimum to allow it to be compacted in to all irregularities of the rock and this shall be determined

by the field laboratory. In placing the earth- fill under rock foundation, the foundation shall first be prepared as detailed earlier.

5.4.7.7 Weather Conditions

Embankment materials shall be placed only when the weather conditions are satisfactory to permit accurate control of the moisture content in the embankment materials. Before closing work on embankment, in any continuous reach prior to setting of monsoon, the top surface shall be graded and rolled with a smooth wheeled roller to facilitate run off. Prior to resuming work, the top surface shall be scarified and moistened or allowed to dry as necessary and approved by the Employer's Representative for resumption.

The Contractor, shall provide suitable protection works to protect the slope from erosion due to rain water. No payment what-so-ever shall be made for providing such protection work and rectifying the monsoon damages.

5.4.7.8 Moisture Control

The water content of the earth fill material prior to and during compaction shall be distributed uniformly throughout each layer of materials and it shall be between -2% to + 2% of the optimum moisture content. Moisture determination of soil as well as needle moisture determination of soil shall be carried out as per I.S. 2720-1983.

Laboratory investigations may impose some restriction on the lower limits of the practicable moisture contents on the basis of studies on consolidation characteristics of soil in embankment. Here-in-after, the term range of optimum practicable moisture content shall refer to the value as described above. As far as practicable, the material shall be brought to the proper moisture content in the borrow area before excavation. If additional moisture is required it shall be added preferably at the borrow area, and only in limited cases / extent, if required, on the embankment by sprinkling water before rolling of a layer. If more moisture is present than required, the material shall be spread and allowed to dry before starting rolling. Moisture control shall be strictly adhered to. The moisture content shall be relatively uniform throughout the layer of material. If necessary, ploughing, disc-harrowing or blending with other materials may have to be resorted to obtain uniform moisture distribution, if the moisture content is more or less than the range of optimum practicable moisture content, or if it is not uniformly distributed throughout the layer, rolling and adding of further layer shall be stopped. Further work shall be started again only when the above conditions are satisfied.

In order to have proper control of moisture content in the earth fill, no earth work shall be done during rainy days. No compensation shall be made to the Contractor due to held up of work for rain or fog.

5.4.7.9 Compacting Earth Materials

(A) General

Where compaction of earth materials are required, the materials shall be deposited in horizontal layers and compacted as specified in this paragraph. The excavation, placing moistening and compacting operations shall be such that the materials will be uniformly compacted to the required density throughout the required section, and will be homogeneous, free from lenses, pockets, streaks, voids, laminations or other imperfections.

Having decided on the filling materials to be used standard compaction test will be conducted on the materials proposed for embankment to indicate best type of

equipment to be used and the moisture content at which compaction should be done, thickness of layer and number of passes etc.

(B) Compacting Clay and Silty Materials

Where compaction of earth materials containing appreciable amount of clay or silt is required the compaction shall be carried out in accordance with clause 6.6. of I.S. 4701-1982. The materials shall be deposited in horizontal layers. The thickness of each horizontal layer before compaction shall not be more than 20 centimeters (loose layer) and the layer shall be to full width of the embankment. The excavating and placing operation shall be such that the materials when compacted will be blended sufficiently to secure the highest practicable density and best im-permeability and stability. If the surface of any compacted layer of earth fill is too dry or too smooth to bond properly with the layer of material to be placed thereon, it shall be moistened and/or scarified in an approved manner to provide a satisfactory bonding surface before the next succeeding layer is placed. All the rollers used on any one layer of fill shall be of the same type and same weight.

Prior to and during compaction operations, the embankment materials shall possess **optimum moistures content** as required in clause 6.6.4 of I.S. 4701 - 1982. The embankment materials shall have optimum moisture content required for the purpose of compaction and this moisture content shall be fairly uniform throughout the layer. In so far as practicable the moistening of the material shall be performed at the site of excavation but such moistening shall be supplemented as required by sprinkling water at the site of compaction, if necessary. If the moisture content is greater than optimum for compaction, the compaction operations shall be delayed until such time as the material has dried to the optimum moisture content or to the level directed by Employer's Representative. The moisture content of soils shall be determined in accordance with I.S. 2720 {Part - III) 1982.

Where hand or power tampers are used to compact soils in confined areas such as under pipes and at the joints of bank connections with the structures, they shall be equipped with suitably shaped heads to obtain the required density.

The dry bulk density of the soil portion in compacted embankment materials shall be not less than 95 % of the maximum dry bulk density at optimum moisture content obtained in accordance with I.S.2720 (Part - VII} 1980 Indian Code of Practice for determination of moisture content, dry density relation using light compaction.

The dry density of soil in field shall be determined in accordance with I.S. 2720 (Part - XXVIII) 1974. Indian Code of Practice for determination of dry density of soil in place by sand replacement or by I.S. 2720 (Part - XXIX) 1975 Indian Code of Practice for determination of dry density of soils in place by the core cutter method.

Moisture content of soil shall be determined in accordance with I.S. 2720 (Part - II) 1973 Indian Code of Practice for determination of moisture content.

The optimum moisture content is the moisture content that corresponds to the laboratory maximum dry density determined in accordance with I.S. 2720 (Part - VII) 1973.

The above compaction tests will be conducted by Contractor in the presence of departmental officers and the Contractor shall ensure compaction, till the Employer's Representative or his authorized representative is satisfied that the

maximum dry density at optimum moisture content is obtained, and permits the laying of next layer.

(C) Rollers and Other Compacting Equipment

The earth compacting equipment may be used for compacting the soils as detailed in Appendix-C of IS-4701:1982:

The compacting equipment shall confirm to relevant Indian specification below:

- Smooth wheeled roller should conform to I.S.5502-1969.
- Sheep Foot roller should conform to I.S. 4616-1968.
- Pneumatic tyred roller should conform to I.S. 5501-1969.
- Vibratory plate compactor should conform to I.S. 5889-1970. (5) Vibratory roller should conform to I.S. 5500-1977.

The methods of compaction shall conform to clauses 7 of I.S. 4701-1995,

(D) Rolling

When each layer of material has been prepared to have the proper moisture content uniformly distributed throughout the material, it shall be compacted by passing the tamping roller. The exact number of passes for each layer to obtain specific density shall be designated by Field Laboratory tests and tests conducted on the borrowed material. The layers shall be compacted in strips over lapping not less than 0.6 M. Rolling shall commence at edges and progress towards centre longitudinally. The rollers of loaded vehicles shall travel in a direction parallel to the axis of the Nallah. Turns should be made carefully to ensure uniform compaction. Rollers shall always be pulled.

(E) Tamping

Rollers will not be permitted to operate within one meter of concrete and masonry structures. In the following locations where compaction of the earth fill materials by means of roller is impracticable or undesirable the earth fill shall be specially compacted as specified further below.

- Portions of the earth fill in embankment adjacent to masonry structures and embankment foundations designated on the drawing as specially compacted earth fill.
- Earth fill in embankment adjacent to steep abutments
- Earth fill at specially designated locations.

Earth fill for tamping shall be spread in layers of not more than 10 (ten) cm in thickness when loose and shall be moistened to have the required moisture content, as specified. When each layer of materials has been conditioned to have the required moisture content, it shall be compacted to the specified density by special rollers, pneumatic/hand tampers or by other approved methods. The moisture control and compaction shall be equivalent to that obtained in the earth fill actually placed in the embankment in accordance with the specifications.

(F) Testing

Density tests shall be carried out after rolling to ascertain the state of compaction which should be measured in terms of dry density. Standard proctor density tests shall be carried out at regular intervals to account for variations in the borrow area material. Not less than three tests shall be conducted to indicate variation in the standard proctor density attained in the laboratory.

Density test shall be conducted for each layer laid to ascertain whether

compaction is attained as specified.. In case the tests show that the specified densities are not attained, suitable action shall be taken either by moisture correction or by additional rolling, so as to obtain the specified density which shall be checked again by taking fresh tests at the same locations. The test locations should be so chosen as to represent the whole layer under test. Each layer should be tested for proper compaction before a fresh layer is allowed over it.

The density to be attained after compaction should be at least 95% of Proctor density pre- determined by Laboratory tests..

(G) Slope Dressing

The slopes of particular reach of the Nallah which has been completed in the manner described earlier shall be dressed neatly to the designed line and grade. Extra earth work done at sides are to be dressed and reused in the embankment.

5.4.7.10 List of Applicable IS Codes

Earth Work		
(1)	Method of Measurement of building and Civil Engineering Works Part – I Earth Work	1200 - 1992 (Part – I)
(2)	Safety code for piling and other deep foundations	5121 – 1994
(3)	Code of practice Design Installation, observation and maintenance of uplift pressure pipes for Hydraulic structures on permeable foundation	6532 – 1992
(4)	Safety code for excavation works	3764 – 1992
(5)	Code of practice for Protection of slope for reservoir embankments	8237 – 1990
(6)	Code of Practice for earth work on Nallahs	4701 – 1982
(7)	Guidelines for lining of Nallahs in expansive soils	9451 – 1991
(8)	Method of test for soils Part – II Determination of water content	2720 – 1973 (Part – II)
(9)	Method of test for soils Determination of Water content Dry density relation using light compaction	2720 – 1995 (Part – VII)
(10)	Method of test for soils Determination of dry density of soils in place by the sand replacement method	2720 – 1974 (Part – XXVIII)
(11)	Method of test for soils Determination of dry Density of soils in place by the core cutter method	2720 - 1975 (Part – XXIX)
(12)	Classification & identification of soils for general Engineering purpose (first revision)	1498 – 1970
(13)	Safety code for working with construction machinery	7293 – 1996
(14)	Filtration media – sand & gravel	8419 – 1990(Part – I)
(15)	Under drainage arrangements of lined Nallahs	4558 – 1995
(16)	Pre-cast cement concrete slabs for Nallah lining	3868 – 1995
(17)	Methods of tests of soils	2720 - 1997(Part – I to X)
(18)	Method of load test on soils (Second revision)	1888 – 1999
(19)	Method for standard penetration tests for soils (First revision)	2131 – 1997
(20)	Method of sampling and preparation	4332-1995

5.4.8 Preparation of Sub-Grade for Concrete Lining

Provision of this paragraph shall apply to the preparation of sub-grade upon which concrete lining is to be placed.

- The work of trimming the Nallah section upto the bottom of concrete lining/

bottom of filter materials to be provided as the case may be and preparing sub-grade for concrete lining includes removal of proud from the slope and bed of the Nallah. Wherever rock is over-excavated, the item of trimming and preparation of sub-grade includes filling the over-excavated portion with suitable semi pervious materials, watering and compaction and trimming upto bottom level of the concrete lining. Along the Nallah alignment the rain cuts on inner slope of the banks shall be filled up with approved excavated materials and shall be compacted adequately to required line and grade and level. The material required for filing the over excavation in rock and rain cuts, if not available during excavation in soils to be done under this item, shall be hauled from stockpiles or borrow area to be arranged by the Contractor and placed in position.

- If at any point material has been excavated beyond the pay line required to receive the concrete lining, the excess excavation shall be refilled in horizontal layer with selected material moistened, if required, and compacted using rollers and slope compactors. Where placing and compacting bedding material is on a sloping foundation, the layers may be placed parallel to the surface of the foundation. If at any point the foundation material is disturbed or loosened during the excavation process or otherwise it shall be moistened, if required, and thoroughly compacted by tamping, rolling or by other approved methods to form firm foundations for placing the concrete lining.
- If, at any place, placement of bedding material below the concrete lining is required, due care shall be taken by the Contractor to wet the surfaces of excavation and embankment to a depth of 15 cm or to depth upto impermeable layer below, whichever is less, as per direction of the Employer's Representative.
- In the Nallah section requiring bedding material below the concrete lining, due care shall be taken by the Contractor to place the bedding materials on scientifically approved surface adequately wet as described above, in layers not exceeding 15 cm in depth in a single operation and compacted till the bedding material attains a height where it can be trimmed to form a true and even surface upon which the concrete for lining is to be placed. Each layer of bedding material shall be moistened and thoroughly compacted.
- All loose materials likely to be present at the end panel of existing lining adjacent to which lining is to be placed under these specifications shall be removed and all voids beneath the existing lining shall be refilled and compacted thoroughly. No extra payment shall be made to the Contractor on this account.
- Suitable material trimmed from the Nallah shall be judiciously utilized in Nallah embankment, road embankments or in back filling of the structures or used as a bed material as per direction of the Employer's Representative. The trimmed materials which cannot be utilized in proper place during one continuous operation shall be stock piled along the right of way where designated by the Employer's Representative.
- In all the preparation of sub grade for concrete lining shall confirm to clauses 4.1, 4.2, 4.3, 4.4 and 4.5 of I.S 3873-1978 J Indian code of Practice for laying in situ cement concrete lining Nallah.)

5.4.8.1 Tolerance In Preparation of Sub-Grade

Excavated profile provides the final base for lining and tolerance departure from lines shown on the drawings shall be as indicated here below:

± 20 mm on straight section

± 50 mm on tangents

± 100 mm on curves

Departure from levels shown on the drawings

20 mm

The above tolerances shall be negotiated gradually through smooth transition in a length of 50 m. and no over-run in concrete quantity shall be paid to the Contractor.

5.4.8.2 Cast-In-Place Concrete Lining

The work shall generally conform to IS 3873. All concrete for lining shall be governed by IS: 456-2000. The concrete shall be of controlled grade with suitable admixtures of approved air entraining agents, using well graded aggregates with maximum size of aggregates of 20 mm. Ordinary Portland Cement or Portland Pozzoiana/slag Cement shall be used. Design mix and actual cement level required shall be communicated from time to time to the Contractor in writing by the Employer's Representative.

5.4.8.3 Batching of Concrete

The Contractor shall notify the Employer's Representative 24 hours before batching concrete. Unless inspection is waived in each case, batching shall be performed only in the presence of Employer's Representative.

The Contractor shall provide, maintain and operate the equipment as required to accurately determine and control the prescribed amounts of the various materials entering the concrete mixers. The quantities of cement sand and each size of coarse aggregate entering each batch of concrete shall be determined by individual volume measurement or by weight as the case may be. Cement has to be weighed / measured in volume separately from the aggregates. Sand and coarse aggregate may be weighed with separate scales and hoppers.

The grading of aggregates shall be controlled by obtaining the coarse aggregate in different sizes and blending them in the right proportions, the different sizes being stacked in separate stock piles, the materials shall be stock piled a day before use. The grading of coarse and fine aggregates will be checked as frequently as directed by the Employer's Representative, Water shall be added by weight or measured by volume in calibrated tanks. The amount of added water shall be adjusted to compensate for any observed variations in the moisture contents. Determinations of moisture content in the aggregate shall be in accordance with I.S 2386 (Part -III) 1963 (Indian Standard Method of test for aggregate for concrete Part -111). The amount of surface water carried by aggregates will be determined in accordance with IS 456-1978.

5.4.8.4 Mixing

The concrete ingredients shall be thoroughly mixed in mechanical mixers designed to positively ensure uniform distribution of all the component materials. Mixing shall be done as per clause 9 of I.S 456-2000. The mixer should comply with I.S. 1791-1985 (I.S Specifications for batch type concrete mixers).

The concrete as discharge from the mixer, shall be uniform in composition and consistency from batch to batch. Workability shall be checked at frequent intervals as per I.S.1199-1959. Mixers shall be examined regularly by the Employer's Representative for changes in condition due to accumulation of hardened

concrete or mortar or to wear of blades. The mixing shall be continued until there is a uniform in color and consistency and to the satisfaction of the Employer's Representative. If there is aggregation after unloading the concrete should be remixed.

5.4.8.5 Transportation of Concrete

- Transportation shall be handled from the place of mixing to the place of final depositing as rapidly as practicable by use of equipments such as transit mixers which shall prevent initial setting, segregation or loss of any of the ingredients. It shall be transported and compacted in its final position within 30 minutes of its discharge from the mixer.
- If segregation occurs during transport, the concrete shall be remixed before being placed, after observing the time requirements as above.

5.4.8.6 Placing and Compaction

- Concrete shall be placed only in the presence of a duly authorized representative of the Employer's Representative. Concrete shall be placed and compacted before initial setting time and shall not be subsequently disturbed.
- Placing of concrete shall not be started until all formwork, installation of parts to be embedded, if any, and preparation of surface upon which concrete is to be laid, have been completely inspected by the Employer's Representative. All absorptive surfaces against which concrete is to be laid shall be moistened adequately so that moisture shall not be withdrawn from freshly placed concrete. The surfaces, however, shall be free from standing water and mud.
- Concrete shall be deposited in all cases as neatly as practicable directly from mechanized paver in its final position and shall not be caused to flow in a manner to permit segregation. Excessive separation of the coarse aggregate caused by allowing the concrete to fall freely from too great a height or at too great an angle from the vertical shall not be permitted and where such separation would otherwise occur the Contractor shall provide suitable means to convey the concrete without allowing such separation.

5.4.8.7 Mechanical Placing

- For efficient placing and finishing of the concrete lining on slopes and in bed, concrete lining machines such as slip form paver or concrete paver finisher of approved quality and design shall be used.

  The equipment of operations for foundation trimming sub-grade preparation, concrete production, concrete delivery, joint production, curing compound placement and other associated activities supporting the placement of the Nallah lining shall be matched with the lining equipment capability so as not to impede the specified placement rate of each lining operation. The overall equipment deployment shall be such as to ensure the completion of Nallah lining within scheduled period specified in the contract.

  Concrete Nallah lining shall be done in the Nallah prism as shown in the drawing. Mixing of concrete is to be done in a stationery or mobile weigh batching plant installed at suitable place / places and concrete is to be conveyed to work spot in transit mixers to be moved on Nallah banks and unloaded at site in the hopper of the paver. The concrete in bed and side is to be placed with mechanized paver finisher. The concrete from transit mixer is to be unloaded into hopper and conveyed to other bank, through side discharge conveyor then placed with paver in bed and side and vibrated. Joints will be done with Groove cutter attached to the paver. Panels shall be

as per drawing or as directed by Employer's Representative. The above mechanized procedure is to be followed for side lining where slant length is 2.70 M. or above. In case where Nallah bed width is less than 2.00 M. and where bed lining is not possible to be-tackled with the above mechanized paver, concrete shall be laid by conventional method i.e. mixing by concrete mixtures and laying the concrete manually in alternative panels of 3 M. length as per drawing or as directed by Employer's Representative, duly using steel form work to the required thickness of concrete and vibrated with mechanical pan vibrators. The concrete for side lining, where the slant length is less than 2.70 M. shall be laid by using appropriate equipment with steel guided form work and vibrated by mechanical vibrator fitted to gantry. If the concrete is laid manually on slopes, compaction by suitable method, as approved by Employer's Representative shall be adopted.

- Concrete when deposited shall unless otherwise specified have a placement temperature of not less than 15°C and not more than 32°C.
- Concrete shall be so laid as to facilitate placing, vibrating, finishing and curing operations. The side lining concrete shall be screeded up the slope, while the concrete is being vibrated ahead of the screed. Concrete required for keys as shown on the drawings shall be laid integrally along with the side slope lining.

  Alternatively, the Contractor can select to use longitudinally operating self aligning, slip form machine with built in vibrators attached to the slip forms, so as to effectively compact and finish the slope and bed concrete lining.

5.4.8.8 Finishing

The finishing in lining shall be in accordance with relevant Clause of I.S 3873-1978.

- All exposed concrete surfaces shall be cleaned of impurities, lumps of mortar or grout and unsightly stains. The finished surface shall be even; smooth and free from pockets and equivalent to that obtainable by effective use of long handle steel trowel. Where the surface produced by lining machine meet the specified requirements, no further finishing operation shall be required. Surface irregularities, when tested with a straight edge of 1.5 metre length shall not exceed 6 mm in Nallah bed for bottom slab and 1 2 mm in that laid on side slopes.
- The surface of concrete finished against form shall be smooth and be free from projections, honeycombing and other objectionable defects. Immediately on removal of forms, ridges or lips shall be removed and undesirable local bulging on exposed surfaces shall be remedied by tooling and rubbing.
- Repairs to concrete surface and additions where required shall be made by cutting regular openings into the concrete and placing fresh concrete to the required lines, chopped openings shall be sharp and shall not be less than 75 mm in depth.

  The top portion of the side slopes of the Nallah lining extending 1-1/2 meter vertical below the top of the lining shall receive a nonkid, longitudinal brisk finish as approved by the Employer's Representative.

5.4.8.9 Curing

- The concrete lining on slopes including curvatures portion at junction of slope and bed lining shall be cured with specifications given in section 4.2.19. The concrete lining in Nallah bed shall be cured with water in accordance with the specifications given in section 4.2.19. If water curing of lining in the Nallah bed

is not carried out to the satisfaction of the Employer's Representative as per specifications, the Contractor shall be directed to switch over to liquid membrane forming curing compound for curing for which no extra payment shall be made to the Contractor.

- All equipment, material etc, needed for curing and protection of concrete shall be at site and ready for installing before actual concreting begins. Detailed plans, methods and procedures of curing and protection of concrete lining shall be got approved in writing from the Employer's Representative sufficiently in advance of the actual concreting. The equipment and method proposed to be utilized shall be provided for adequate control and avoid interruption for damage to the work of other agencies.
- The Precast slab for Nallah lining shall be cured by keeping them immersed in water for seven days and by sprinkling water for another 21 days with straw canvass, hessian or similar materials cover over slab.
- Unformed top surface of invert of the Nallah shall be kept continuously moist by covering it completely with wet burlap as soon as the concrete has hardened sufficiently. The burlap shall be kept continuously wet by spraying water for at least 12 hours. Thereafter curing by ponding shall be resorted to. Concrete to be cured with water shall be kept wet by ponding for at least 21days. Water lost by evaporation shall be replenished periodically to keep the surfaces, continuously submerged under water. The period of 21days specified above shall be increased to 28 days when pozzolana has been used in the concrete as part replacement of cement.
- The concrete in Nallah slope shall be cured by sprinkling water on them so as to keep them always moist. Use of perforated pipes laid all along the length shall be preferred. The curing shall be done at least for 21 days when OPC is used and if PPC is used it should be for 28 days.
- When the curing of concrete in the Nallah bed is not found satisfactory the Employer's Representative may ask the Contractor to resort to membrane curing without any extra cost to department.

5.4.8.10 Testing of Concrete and Acceptance of Work

Testing of concrete shall be carried out by the Contractor on representative samples taken at the site of laying the concrete in accordance with relevant clauses of I.S. 1119.

(A) Sampling Procedure and Frequency

Sampling Procedure: A random sampling procedure shall be adopted to ensure that each concrete batch has a reasonable chance of being tested, i.e. the sampling should be spread over the entire period of concreting and should cover all mixing units.

Frequency: The minimum frequency of sampling of concrete of each grade shall be in accordance with clause 15.2 of IS: 456-2000.

(B) Test Specimen

Three test specimens shall be made from each sample for testing at 28 days. Additional cubes may be required for various purposes, such as to determine the strength of concrete at 7 days or at the time of striking formwork, or to determine the duration of curing or to check the testing cubes cured by accelerated methods as described in IS: 9013. The specimen shall be tested as described in 1S:516.

(C) Test Strength of Samples

- The test strength of the sample shall be the average of three specimens. Individual variation shall not be more than 15 percent of the average.
- Testing shall be carried out at the testing laboratories set up at the site or at any other laboratory that the Employer's Representative may decide upon and the results given thereby shall be considered as correct and authentic and acceptable to the Contractor.

(D) Acceptance Criteria

Acceptance criteria will be as per clause 16 and clause 17 of IS: 456-2000.

(E) Tolerance

The tolerances for concrete lining shall be as given below.

- Departure from Established alignment :-

  ± 20mm on straight reaches

  ± 20mm on straight reaches

  ± 50mm on partial curves on tangents.
- Departure from Established grade :- ± 20 mm
- Any departure from alignment or grade shall be uniform and no corrections in assignment be made in less than 50 m.

APPLICABLE IS CODES FOR CONCRETE WORK

(VI)	CONCRETE	
(1)	Method of Measurement of building and Civil Engineering works Part – II cement concrete works	1200 - 1968 (Part – II)
(2)	Code of practice for plain and reinforced concrete	456 – 2000
(3)	Methods of tests for strength of concrete	516 – 1959
(4)	Code of practice for laying in situ cement concrete lining on Nallahs	3873 – 1993
(5)	Specification for Admixtures for concrete	9103 – 1979
(6)	Methods of Sampling and Analysis of concrete	1199 – 1959
(7)	General requirements for Concrete Vibrators – immersion type	2505 – 1992
(8)	General requirement for concrete vibrator screed board type (first revision)	2506 – 1985
(9)	Code of practice for use of immersion vibrator for consolidating concrete (first revision)	3558 – 1983
(10)	Method for testing performance of batch type concrete mixer	4634 – 1990
(11)	Form vibrators for concrete	4656 – 1991
(12)	Ready mixed concrete (First revision)	4926 – 1990
(13)	Code of practice for sealing joints in concrete lining on Nallahs	5256 – 1992
(14)	Vibrating plate compactor	5889 – 1994
(15)	Concrete Pavers	7245 – 1991
(16)	Concrete slump test apparatus	7320 – 1992
(17)	Method of making curing and determining compressive Strength of accelerated cured concrete test specimen	9013 – 1979
(18)	Guidelines for concrete mix design	10262 – 1982

5.4.9 Stone Masonry for Structures

5.4.9.1 Materials

(A) Stone For Masonry

The stone shall be best procurable and free from any admixture of white earth. It shall be dug out from the quarry a sufficient time in advance, to harden well, before being placed in the work. The dimensions shall be 46cm X 30cm X 20cm. The stones shall be laid as per approved drawing. The crushing strengths of the stones shall be 40 Kgs/Sq.cm.

The approval of the quarries by the Employer's Representative shall not be construed as constituting approval of all or any of the stones collected from the deposits and the Contractor shall be held responsible for suitability of the stone used in the work.

(B) Sand For Masonry

The sand shall consist of natural sand, crushed stone or crushed gravel sand, or a combination of any of these.

The sand shall be hard, durable, clean and free from adherent coatings and organic matter and shall not contain clay balls or pellets as specified further below;

The sand shall not contain any harmful impurities, such as iron pyrites, alkalines, salts, coal, mica shale or similar laminated or other materials in such form or in such quantities as to affect adversely the hardening, the strength, the durability or the appearance of the mortar applied.

Unless found satisfactory, as a result of further tests as may be specified by the Employer's Representative or unless these evidence of the performance is offered which is satisfactory to him, the maximum quantities of clay, fine silt, fine dust and organic impurities in the sand shall not exceed the following limits.

- Clay, fine silt and fine dust Not more than 5 per- (determined in accordance with cent by weight. Appendix C of I.S 386, 1 963 and also I.S 2386 (Part II) 1963.
- Organic impurities (determined Below that indicated in accordance with I.S 2386 by comparison with (Part-II) 1963. the standard solution specified in 6.2.2 of I.S 2386 (Part II) 1963.

Sand shall generally conform to specification given in paragraph 4.2.6 except that the sand for mortar shall confirm to the grading as given in clause 4 of I.S. 2116-1980.

A sand whose grading falls out-side the specified limits due to excess or deficiency of coarse or fine particles, may be processed to comply with the standard by screening through suitably sized sieves and /or blending with required quantities of suitable sized sand particles.

If the sand brought to site is not clean, it must be washed clean in water. Fine dirt sand, or sea sand, or sand containing saline impurities shall on no account be used.

5.4.10 Mortar

5.4.10.1 Preparation of Mortar

Unless Otherwise Specified The Cement Mortar Used In Masonry Work Shall Be cement mortar mix 1:4 (one cement four sand by volume).

Mixing shall be done thoroughly preferably in a mechanical mixer. In such case the cement and sand in the specified proportion shall be mixed dry thoroughly in the mixer operating manually or by power.

Water shall then be poured gradually and wet mixing continued at least for 2 minutes. Water should not be more than that required for bringing the mortar to the required working consistency of 90 to 1 30 millimeters as required in clause 9:1.1 of I:S. 2250-1981. The mix shall be clean and free from injurious kind of soil, acid, alkali, organic matter or deleterious substances.

5.4.10.2 Time of Use of Cement Mortar

Cement mortar shall be used as soon as possible after mixing before it has begun to set, within 30 minutes after the water is added to the dry mixture.

Mortar unused for more than 30 minutes should not be used and shall be removed from the site of work. The cost of such wasted mortar shall be borne-by Contractor.

5.4.10.3 Tests of Mortar

Mortar test cubes shall be cast for the mortar used on the work and shall be tested in accordance with Appendix-A of I.S. 2250-1965 code of practice for preparation and use of Masonry mortar. Such cubes shall develop a compressive strength of at least 75 Kgs. / square metre for mortar mix 1:4.

Mortar not conforming to the specifications will be rejected and-the cost of such wasted mortar shall be borne by the Contractor.

All masonry surface shall be treated as specified to prevent loss of masonry or mortar until the required curing period is elapsed or until prior to placement of other masonry or concrete or back fill against surfaces. The Contractor shall make his own arrangements to procure and convey water for curing.

All masonry built with cement mortar shall be kept watered continuously for a minimum period of two weeks from the date of construction. Watering shall be done carefully so as not to wash out the mortar, joints or disturb the masonry in any manner.

If the Contractor fails to do curing to the satisfaction of the Employer's Representative of the work, the latter will either make arrangement to cure the masonry at the risk and cost of the Contractor or order the masonry to be pulled down. The masonry so pulled down should be rebuilt by the Contractor at his own cost.

5.4.10.4 List of Applicable Codes

Building Stones		
(1)	Method of Test for Determination of strength properties of natural building stones	1221 - 1974 (Part – I to Part – IV)
	Part- I Compressive Strength Part – II Transverse Strength Part – III Tensile Strength Part – IV Shear Strength	
(2)	Method of Measurement of Buildings and Civil Engineering Works method. (Part – IV, stone masonry)	1200 – 1976
Masonry		
	Method of Measurement of building and Civil	1200 - 1976
	Engineering works Part – XII plastering and pointing	(Part – XII)

5.4.11 Plastering with Cement Mortar

5.4.11.1 Preparation of Surface

The roughening of the background improves the bond of plaster. All joints shall be thoroughly raked. After roughening the surface, care shall be taken to moisten the surface sufficiently before plastering as otherwise freshly exposed surface may tend to absorb considerable amount of water from the plaster. The surface shall be wetted evenly before applying the plaster. Care shall be taken to see that the surface is not too dry as this may cause lack of adhesion or excessive suction of water from the plaster. A fog spray may be used for this work. As far possible, the plaster work shall not be done under hot sun.

5.4.11.2 Laying of Plastering with Cement Mortar 12/20 mm Thick

The mortar used for plastering shall be stiff enough to cling and hold when laid. To ensure even thickness and true surface, plaster shall be applied in patches of 150 mm x 150 mm of the required 12 mm thickness at not more than 2 meters intervals horizontally and vertically over the entire surface to serve as guides. The surface of these guides shall be truly in the plane-of the to be finished plaster surface and truly in plumb. The mortar shall then be applied to the surface to be plastered between the guides with a trowel. Each trowel full of mortar shall overlap and sufficient pressure shall be used to force it into thorough contact with the surface. On relatively smooth surfaces, the mortar shall be dashed on with the trowel to ensure adequate bond. The mortar shall be applied to a thickness slightly more than that specified, using a string, stretched out between the guides. This shall then be brought to a true surface by working with a long wooden float with small motion. The surface shall be periodically checked with a string stretched across it. Finally the surface shall be rendered smooth with a small wooden float, over working shall be avoided, All corners, edges and junctions shall be brought truly lo a line with any necessary rounding and chambering.

If it is necessary to suspend the work at the end of the day, it shall be left in a clean horizontal or vertical line not nearer than 150 millimeters from any corner or edges or on parapet tops or on coping etc. When recommencing the work, the edges of the old work shall be scraped clean and treated with cement slurry before the new plaster is laid adjacent to it. After the first coat is done it shall be kept undisturbed for the next 24 hours and thereafter kept moist and not to be permitted to dry until the final rendering is applied.

After the plaster has sufficiently hardened cement slurry with cream like consistency shall be applied as thinly and evenly and rubbed to a fine condition. The finished surface shall be cured with water for a minimum period of 14 days.

Should the mortar crack or perish, the plastering shall be removed and redone at the Contractor’s expense or should Contractor fail to cure the work to the satisfaction or the Employer's Representative the later may cure the work at the risk and cost of the Contractor.

All portions which sound hallow when tapped or found to be soft or otherwise defective shall be cut out in regular shape and redone as directed by the Employer's Representative at the Contractor's expense.

5.4.12 Pointing To C.R. Masonry/ Laterite Masonry With Cement Mortar

5.4.12.1 Preparation of Surface

The joints in the masonry shall be raked out to a depth not less than the width of the joint or as directed when the mortar is green. Joints shall be brushed clean of dust and loose particles with a stiff brush. The area shall then be washed and the

joint thoroughly wetted before pointing is commenced.

5.4.12.2 Flush Pointing With Cement Mortar For Coursed Rubble/Laterite Masonry

The pointing to be done shall be flush pointing with cement mortar. The mortar shall be pressed into the raked out joints according to the type of pointing required. The mortar shall not be spread over the corners, edges or surface of the masonry. The pointing shall then be finished as detailed below. The mortar shall be finished off flush and level with the edges of the stones, so as to give a smooth appearance. The edges shall be neatly trimmed with a trowel and a straight edge. When finished the mortar pointing shall be restricted to the width of the joints and all superfluous mortar shall be removed with a trowel. The work shall be executed as rapidly as possible (and not again touched after it has begun to set) and kept wet for a minimum period of 14 days thereafter. The pointing shall also be cured for 14 days.

5.4.12.3 Specifications for Stone Pitching

Providing and laying Pitching of 230 mm thick including boulder apron laid dry in front of toe of embankment complete as per drawing and Technical specifications for the reaches 12 and 13 i.e. from Chainage 34.8 KM to Nallah end at 47.5 KM. Spec. No.: MORT & H – 2504.

Specifications of stones to be used confirming to IS 4515, brief specifications as under:

- The stones used should be sound hard and durable, should be able to withstand weathering and water action.
- Stones should be round, sub-angular with large base, natural river stone or blasted rock pieces.
- The size should be almost uniform in all sides, thickness of lining is to be kept 23 cm.
- Before laying of stones, the sub grade should be prepared, the specifications of sub grade should be same as that for concrete lining. Sub grade of the Nallah should be divided into compartments by stone masonry or concrete ribs. The compartments should have dimensions of not more than 15 m along the length of the canal. The spacing of ribs cross in the section of the canal should be so chosen as to divide the canal bed and slope symmetrically about the centre line and in such a manner that ribs are provided at the junction of the slope and bed and at the upper extremity of the slope. The ribs along the slope of the bank should be continuous. The stone should be hand placed and hammer dressed to remove all projections. The voids must be filled with smaller chips of stone.
- The pitching has to be done in entire section in reaches 12 and 13 as explained above. The section includes - bed, side slopes, pathways and further slope from pathway to top of Nallah.

5.4.12.4 Joining of Lined Section with Other Structures

The lined sections shall have to be joined to upstream side existing structures by constructing flared walls made of stone masonry with cement concrete face towards water side in a gradual slope of say 1 in3, similarly the lined section will be joined back with flared masonry wall on it's downstream. The proponent has assessed that there are about 30 such structures where these flared walls shall have to be constructed both on upstream and downstream junctions. specification for masonry and concrete are same as mentioned above.

5.4.13 Demolition of Existing Structures and Repairs of Damages to Structures

There are some existing structures along the course of Nallah which may have to be demolished (with the permission of Employer's Representative) as they would be coming in the way of construction required. The Contractor should make his own assessment of number of such structures.

Although remodeling of any other structure is not in the scope of work, but some works might be incidental to fulfill the objective of the work. Some of the road culverts crossing the Nallah might get damaged during construction which shall have to be repaired and brought to it's original shape. some water supply pipe lines and electrical poles might be coming in the way as obstruction to construction, all these shall have to be relayed as per direction of the Employer's Representative. Therefore the Contractors are advised to assess requirement of any such work and keep provisions accordingly

5.4.14 Ground Water Recharge Structures at Near Check Dam Location

Similar to recharge structures at junction of storm water drains , recharge structures are to be constructed near check dams also, by constructing 3-4 small pits with a iron grill cover with a filter bed. The recharge structures design drawings shall have to be got approved from Employer's Representative.

5.4.15 Civil Works Required for Diverting Rain Water Streams

At some places few existing rain water streams are not connected to Nallah, which are now to be diverted towards Nallah. Necessary civil works required for bringing additional rain water streams in to the Nallah wherever possible are to be provided.

Applicable Codes and Specifications (Brickworks and Other Civil Works)

IS: 110	Ready mixed paint, brushing, grey filler, for enamels for use over primers
IS: 269	Specification for 33 grade ordinary Portland cement
IS: 280	Specification for mild steel wire for general engineering purposes
IS: 383	Specification for coarse and fine aggregates from natural sources for concrete
IS: 412	Expanded metal steel sheets for general purposes
IS: 712	Specification for building limes
IS: 730	Specification for hook bolts for corrugated sheet roofing
IS: 733	Wrought aluminum and aluminum alloys, bars, rods and sections
IS: 1124	Method of test for determination of water absorption, apparent specific gravity and porosity of natural building stones
IS: 1322	Bitumen felts for water proofing and damp proofing
IS: 1398	Specification for packing paper, waterproof, bitumen laminated
IS: 1542	Specification for sand for plaster
IS: 1580	Specification for bituminous compounds for water-proofing and caulking purposes
IS: 1597	Code of practice for construction of stone masonry : Part 1 Rubble stone masonry
IS: 1659	Specification for block boards
IS:1661	Code of practice for application of cement and cement-lime plaster finishes
IS:1834	Specification for hot applied sealing compound for joint in concrete

IS:1838	Specification for preformed fillers for expansion joint in concrete pavements and structure (non-extruding and resilient type) : Park 1 Bitumen impregnated fibre
IS:2074	Ready mixed paint, air drying, red oxide- zinc chrome, priming
IS:2116	Specification for sand for masonry mortars
IS:2185	Specification for concrete masonry units (Parts 1,2 & 3)
IS:2250	Code of practice for preparation and use of masonry mortars
IS:2339	Aluminum paint for general purposes, in dual container
IS:2394	Code of practice for application of lime plaster finish
IS:2395	Code of practice for painting concrete, masonry and plaster surfaces (Parts1 & 2)
IS:2571	Code of practice for laying in-situ cement concrete flooring
IS:2572	Code of practice for construction of hollow concrete block masonry
IS:2645	Specification of integral cement waterproofing compounds
IS:2690	Specification for burnt clay flat terracing tiles : Part 1 Machine made
IS:2691	Specification for burnt clay facing bricks
IS:2750	Specification for steel scaffoldings
IS:2835	Flat transparent sheet glass
IS:3036	Code of practice for laying lime concrete for a water-proofed roof finish
IS:3068	Specification for broken brick (burnt clay) coarse aggregates for use in lime concrete
IS:3384	Specification for bitumen primer for use in water-proofing and damp- proofing
IS:3495	Method of test for burnt clay building bricks: Part 1 to 4
IS:3696	Safety code of scaffolds and ladders (Parts 1 & 2)
IS:3935	Code of practice for composite construction
IS:4443	Code of practice for use of resin type chemical resistant mortars
IS:4631	Code of practice for laying epoxy resin floor toppings
IS:4832	Specification for chemical resistant mortars (Part II)
IS:4860	Specification for acid resistant bricks
IS:4948	Specification for welded steel wire fabric for general use
IS:5410	Cement paint, colour as required
IS:6041	Code of practice construction of autoclaved cellular concrete block masonry
IS:6042	Code of practice for construction of light weight concrete block masonry
IS:8042	Specification for White Portland Cement
IS:9862	Specification for ready mixed paint, brushing, bituminous, black, lead-free, acid, alkali, water and chlorine resisting
IS:10005	SI units and recommendations for the use of their multiples and of certain other units.
BS: 476 (Part–20)	Methods for determination of the fire resistance of elements of construction(General Principles)
BS : 476	Methods for determination of the fire resistance of load bearing

(Part–21)	elements of construction
BS: 476 (Part–22)	Methods for determination of the fire resistance of non-load bearing elements of construction
Part – IV	National Building code of India, 2005

5.4.16 Technical Specification for Head Regulator Gate at Mazar Dam

The materials shall conform to the specifications as mentioned in the approved drawings and as per direction of the Employer's Representative. The Contractor shall go through the approved drawings thoroughly and bring to notice of the Employer's Representative immediately of any discrepancy or deficiency before taking up fabrication. The Employer's Representative shall not be responsible if any problem arises due to discrepancy in the drawings noticed during or after fabrication. The Contractor shall be fully responsible for smooth operating of the gates under all conditions. The gates shall be capable of being operative at any opening under all conditions of unbalanced operations and shall be free from vibrations at all conditions of gate operation. The leakage through the gates shall not exceed the permissible limits.

5.4.17 Metal Work, Fabrication And Machine Work

5.4.17.1 General Workmanship

All fabrication work under the contract shall be done in accordance with the specifications and works shall be performed and completed in a through workman like manner as per the practice in manufacture and fabrication of materials of the type covered by the specification. The work, shall in all cases, be of the highest quality and carefully performed to the specification of the Employer's Representative. All materials and workmanship furnished by the Contractor be free from injurious defect. He shall replace free of cost to the Employer's Representative, any defect in material or workmanship noticed during erection and shall bear all cost of the modification in the field of any defect for which he is responsible. Workmanship shall conform to the latest standards, laid down in Indian Standard specification.

All members shall be free of twists, bends or other deformations and all surfaces that will be in contact shall be thoroughly cleaned before assembling. Parts shall be adjusted to line and fit and shall be firmly bolted or otherwise held securely together so that surfaces are in close contact before drilling, reaming or welding is commenced.

If weight limitations and transport clearances do not permit anchorages and miscellaneous embedded parts, they shall be fabricated into sub-assemblies. The Contractor shall submit a drawing showing the sub-assemblies into which he proposes to fabricate the gates, anchorages, miscellaneous assemblies and embedded parts and hoists for transporting them to site.

Plates with laminations discovered during cutting, welding or at any other time shall be rejected. Minor surface imperfections can be repaired wherever possible with the prior approval of the Employer's Representative. Materials not supplied or workmanship not performed in accordance with the approved drawings and / or with the specifications shall be rejected and replaced.

All parts of the gates, hoists shall be fabricated in accordance with the specifications and approved drawing. The Contractor shall take special care in fabrication of the parts affecting strength, rigidity and water tightness of the gates. The seal bases shall be finished after the plates have been welded to the skin plate and the finished surfaces of the seal bases shall be in the same plane within

the tolerances as specified elsewhere.

5.4.17.2 Fits and Tolerance

Fits used for difference components shall be according to the best modern shop practice. Due consideration shall be given to the special nature of function of the parts and to the corresponding accuracy required to secure proper operation. The fits shall be in accordance with the Indian Standard "Guide for the Selection of the Fits (First Revision) IS: 2709.

5.4.17.3 Screw Threads

The threads for bolts and nuts shall have metric threads of International Standards Organization and conforming to Indian Standards "ISO Metric Screw Threads Diameter Pitch Combination IS: 4218 Part II.

5.4.17.4 Machine Finish

The type of finish, unless otherwise specified shall be that most suitable for the part to which it applies and shall be smooth, average or rough as defined under Indian Standard "Assessment of Surface Roughness (With Amendment No.1 to 3) IS:3073. A smooth finish (Three Delta, that is 0.20 to 0.8 micrometers) will be required for all surfaces in sliding / rolling contact, an average or commercial finish (Two Delta, that is 1.6 to 6.3 micrometers) for surfaces in contact where a tight joint is required and a rough finish (Single Delta, that is 12.5 to 25 micrometers) for all other machined surfaces which are not in contact, but which require finished for dimensional accuracy.

5.4.17.5 Fabrication of Structural Steel

The Structural Steel Work For The Equipments Covered By The Specifications shall confirm to the requirements of "Reamed work and shall conform to the following requirements unless otherwise called for in these specifications.

5.4.17.6 Straightening

Before being laid off or worked in any manner, structural materials shall be straight without twist, bends or kinks and if straightening is necessary, it shall be done by methods that will not injure or mark the materials. Heating or hammering shall not be permitted. All steel surfaces to be welded shall be cleared of dirt, rust and mill scale prior to fabrication.

5.4.17.7 Shearing, Chipping and Gas Cutting

Shearing, chipping and gas cutting shall be done carefully by torch or by arc and all portions of the work which shall be exposed to view shall present a neat appearance. Gas cutting shall be mechanically controlled. Re-entrant cuts and copes in beams and channels shall be filled before cutting.

5.4.17.8 Planning or Finishing Edges

Planning or finishing of the sheared or cut edges of plates or rolled shapes shall not be required except otherwise specified for welded edges or as shown on the Contractor's drawings, approved by the Employer's Representative.

5.4.17.9 Welded Edges

The edges of plates or shapes to be joined by welding shall be properly formed to suit the selected type of welding. Sheared edges of plates and shapes to be joined by welding shall machined or chipped to sound metal before welding.

5.4.17.10 Bent Plates And Shapes

Where bending of plates or forming shapes is required, these shall be bent to the proper curvature by cold forming. Heating and hammering to correct curvature shall not be permitted.

5.4.17.11 Drilling and Reaming

Holes shall be accurately located drilled and reamed perpendicular to the face of the member and if necessary a template shall be used. Holes in material 20mm, or less in thickness shall be sub-punched or sub-drilled before assembly and reamed to full size during assembly. Holes in materials more than 20mm in thickness shall be sub-drilled 3mm. smaller than the normal diameter of the rivet of bolt before assembly and reamed to full size during assembly.

Counter boring shall be done carefully to meet the requirements for clearance and fill the weld studs. Anchor bolt holes shall be punched or drilled out to full size. All holes shall be made by the following methods.

5.4.17.12 Punching

Punching of holes to full size shall not be permitted. For sub-punching, the diameter of the punch shall be 4.5mm. smaller than the nominal diameter of the bolt used and the diameter of the punch shall not be more than 2.50mm. larger than the diameter of punch. All holes shall be clean cut without any burn or ragged edges or burrs.

5.4.18 Accuracy of Punching, Drilling and Reaming

5.4.18.1 Before Assembly

The accuracy of all holes shall be such that during assembly, a cylindrical pin 3 mm. less in diameter than the normal size of the holes shall be entered perpendicular to the face of the member.

5.4.18.2 During Assembly

The accuracy of reaming and drilling during assembly shall be such that not less than 85 percent of any group of continuous holes in the same plane shall show no offset greater than 0.5 mm. between adjacent thickness of materials, unless a greater degree of accuracy is called for on the drawings approved by the Employer's Representative or in these specifications.

5.4.18.3 Welded Studs

Welded studs wherever used shall be welded in place with automatic end-welding guns. Templates of sufficient thickness to afford good alignment shall be used to accurately locate the studs during the welding cycle and to locate matching holes in other materials. Bushing shall be used for template holes, if necessary to ensure angular alignment of the studs and location, accuracy required for proper fit of parts to be assembled.

5.4.19 Patterns

The price bid shall include the cost of all necessary pattern. Patterns shall remain the property of the Contractor. While making patterns, care shall be taken to avoid sharp corners or abrupt changes in cross section and ample fillets shall be used. The Contractor shall provide pattern thickness as will conform to his standard foundry practice and as may be necessary to ensure that all metal thickness of the finished castings shall be in accordance with the dimensions shown on the Contractor’s drawings approved by the Employer's Representative.

5.4.20 Weldings

5.4.20.1 Preparation For Welding

Members to be joined by welding shall be cut accurate to size, and where required shall be rolled or pressed to the proper curvature in accordance with the dimensions shown on the Employer's Representative's drawings. The edges of the member to be joined by welding shall be sheared, flame cut or machined to suit the required type of welding and to allow through penetration. The cut surface shall expose sound metal, free from laminations, surface defects caused by shearing or flame cutting operations and other injurious defect. The surfaces of plates to be welded shall be free from rust, grease and other foreign matter for a distance of at least 50mm, back from the edge of the weld. In assembling and during welding the components parts of built up members shall be held in place with sufficient and proper clamps or other adequate means to keep all parts in proper position.

5.4.20.2 Welding Technique

All welding shall be performed by electric arc process using coated electrodes or other means whereby the atmosphere is excluded from the molten metal and where applicable, automatic machines with correct precision control shall be used. After being deposited, the weld shall be cleaned of slag or flux and shall show uniform section, smoothness of weld metal, feature edges without overlap and free from porosity and clinkers. Visual inspection at the edges and ends of welding shall indicate good fusion with the base metal. When weld metal is deposited in successive layers, each layer except the last shall be peened moderately with a tool before the next layer is applied. Particular care shall be taken in aligning and separating the edges of members to be joined by butt welding, so that complete penetration and fusion at the bottom of the joint shall be ensured. All pin holes, cracks and other defects shall be repaired by chipping or grading the defects to sound metal and re-welding. Where fillet welds are used, the member shall fit closely and shall be held together during welding. The welding rods used for manual welding shall be of heavily coated type and shall be suitable for all position welding where required. While welding precaution shall be taken to minimize stresses due to expansion and contraction and distortion due to heat by using the proper sequence in welding i.e., by peening the welds while hot or by other satisfactory methods.

Rectification of distortions by blows after welding shall not be permitted. Welds shall not be primer coated until they have been inspected and approved by the Employer's Representative. The welding shall conform to Indian Standard "Code of practice for use of Metal Arc welding for general construction in mild steel IS: 816. All skin plate welds shall be continuous and water tight and shall develop the full strength of plate. The electrodes shall conform to the "Indian Standard Specifications for covered Electrodes for Metal Arc welding of structural steel for welding products other than sheets and for welding sheets (Part-I and II) IS: 814.

The Contractor shall prepare shop and field welding procedure including stress relieving and preheat requirements and shall submit this procedure to the Employer's Representative for approval. The procedure shall be in accordance with the best modern welding practice and shall be such as to minimize residual stresses and distortion of the finished members of the structure. Approval of any procedure, however, shall not relieve the Contractor of the sole responsibility for producing a finished product meeting all requirements of these specifications. Welds in contact with rubber seal shall be ground flush, all corners and corner welds in contact with rubber seal shall be rounded.

5.4.20.3 Approval Test of Welding Process

Specification of the welding procedure that are proposed to be used shall be established and recorded and a copy of such procedure, specifications together with certified copies of reports of results of tests made in accordance with the procedure specifications shall be furnished by the Contractor. The procedure specifications shall confirm to the Indian Standard "Approval Tests for welding procedure Part-I Fusion Welding of Steel IS: 7307 (Part-II).

5.4.20.4 Qualification of Welders

All welders assigned to the work shall have passed qualification test for welders. If at any time, work of the welder appears to be questionable, such welder shall be required to pass additional qualification test conforming to Indian Standard "Code of Practice for Training and Testing of metal Arc welders "IS:817 and Indian Standard" Approval test for welding procedure part-I Fusion welding of steel IS: 7307 (Part-I).

5.4.21 Erection of Bolts, Nuts, Washers and Other Fasteners

Erection of bolts, washers and other fasteners shall be furnished in the amount of 15 percent the bolts, nuts, washers and other fasteners whichever is greater, in excess of the nominal nature of each size and length required for complete installation of equipment.

Bolts in tension shall have net section at root of thread 15 percent in excess of the net section required in tension.

5.4.22 Wastage of Steel

There shall be some wastage of steel section and plates during fabrication & cutting losses. It is the responsibility of the Contractor for minimizing such losses & the cost of such lost steel shall be deemed to have been included in the Bid price. Contractors also shall not be compensated for the wastage of steel under price variation clause.

5.4.23 Cleaning, Surface Preparation And Painting

The Contractor shall furnish, prepare and supply all materials for cleaning surface preparation and painting of metal work as hereinafter specified. The cost of furnishing, preparing and supplying all materials which are required for cleaning, surface preparation, painting and coating operations including supply of all labour, tools and equipments shall be included in the rate quoted.

5.4.24 Cleaning And Surface Preparation (Method-A And Method-B)

Method-A: The weld surfaces shall be de-slagged and weld splatters, burrs and other objectionable surface irregularities shall removed carefully. All rust, mill scale and other foreign substances shall be removed from the surfaces by scrapping, chipping, vigorous wire brushing, blasting or other effective means. Care shall be taken to avoid excessive brushings of steel. All oil, grease, dirt and all other contaminants shall then be removed by the use of clean mineral spirits, xylol or white gasoline and clean wiping materials.

Method-B: In case rust forms of the surfaces become otherwise contaminated in the interval between cleaning and painting, re-cleaning shall be carried out by the same method as herein above specified for the respective items. Surfaces of stainless steel, Nickel, Bronze and machined surfaces adjacent to metal work being cleaned or painted shall be protected by masking tape or by other suitable means during the cleaning and painting operation.

5.4.25 Paint Materials And Painting

5.4.25.1 Gate Leaf

All the surfaces (except non-ferrous surfaces and machined mating ferrous surface) of the gate leaves for all the gates shall be after cleaning as per section 9.7.2.2.1 above, applied with 1(one) coat of Epoxy Base Primer followed by 2(two) coats of COAL TAR EPOXY. The Epoxy Base Primer and coal tar epoxy paint shall generally conform to the particular given in the relevant IS Codes or as directed by the Employer's Representative. The first coat of the Epoxy Base Primer shall be applied within 4 hours of cleaning. The dry filling thickness (DFT) of each coat of zinc rich primer shall be at least 50 microns. The dry filling thickness (DFT) of each coat of coal tar epoxy paint shall be at least 100 microns.

5.4.25.2 Embedded Parts

The surfaces (except non-ferrous surface and machined mating ferrous surfaces) of all the embedded parts for all the gates after cleaning as per the relevant foregoing para shall be coated as under :

- All the exterior ferrous surfaces of the embedded parts which are to come in contact with concrete shall be given 2(Two) coats of cement wash mixed with 5% potassium dichromate. The first coat shall be applied immediately after cleaning and second immediately before pouring concrete.
- The ferrous, unfinished surfaces of the embedded parts (except stainless steel) which will be exposed to water or atmosphere shall be painted with the same paint materials (viz. Epoxy Base Primer and Coaltar epoxy paint) and coated in same manner as specified for the gate leaves vide foregoing section 9.7.3.1.

5.4.25.3 Hoists And Other Parts

- All the exterior surfaces of the hoist stem (screw hoist) machined mating finished surfaces shall be given one coat of Epoxy Base Primer at a coverage rate of approximately 6 square meters per litre. This shall be followed by two coats of aluminum paint of suitable grade at a coverage rate at 5 square meter per litre per coat, without thinning. The hoist stems, couplings and stem retaining device shall be given four or more coats of red lead priming paint to achieve a total dry film thickness of 0.15 mm.
- Miscellaneous items such as hoist support frames and girders, control cabinets, ladders hand railings, gratings etc. shall be given 2 coats of Alkyd priming paint or machinery grade paint or aluminum paint as directed by the Employer's Representative. The exterior surfaces of the bought out items like electric motors, gear boxes etc. which are shop coated by the manufacturer shall be given one additional coat of the same paint as original shop coat or one coat of Alkyd priming paint or machinery paint or Aluminum paint as directed by the Employer's Representative.

5.4.25.4 Application Procedure

- Painting shall not be done when the ambient temperature is less than 10 degrees C and when relative humidity is more than 80%.
- Primer coats shall be applied without any time lag after the cleaning and surface preparation as per clause 9.7 above and care shall be taken to ensure that paint is not applied to damp surface.
- Painting shall be discontinued during rain and dust storm and shall not commence until the surfaces are perfectly dry and clean.

- Welds and adjacent parent metal shall not be painted or touched up prior to de-slagging inspection and approval.
- All materials shall be in a thoroughly mixed conditions at time of application and shall not be thinned unless otherwise specified. When paint is applied by spraying, suitable means should be provided to prevent segregation during the painting operation.
- Any warming of the paint materials shall be performed by means of hot water bath and except as specifically provided. Paints shall not be heated to a temperature higher than 380C.
- Each coat of paint shall completely and uniformly cover the surface and shall be free from runs and sags. Each coat shall be allowed to dry or harden sufficiently as per manufacturers recommendations before the next coat is applied.
- The detail application procedure indicating method of preparing and applying etc. shall be evolved in consultation with the paint manufacturer which shall be followed by the Contractor.
- Surface to be painted that will be inaccessible after installation shall be completely painted as per schedule prior to installation.

5.4.25.5 Repair and Protection of Coatings

Metal work that has been shop painted or field painted should be handled with care so as to preserve the coatings in best practicable condition. Before proceedings with a fresh coat the Contractor shall clean and repair all areas of the previous coat which are defective or damaged. Previous coat on the areas where the coating is loose, weakly bonded blistered, abended or otherwise defective shall be removed to clean metal by scrapping, chipping, power wire brushing or other effective means. Areas thus prepared shall be cleaned of all dust, dirt and other contaminations using clean rags and clean solvent. These surfaces shall then be repainted in accordance with the painting schedule. Hair line cracks or areas where the thickness of coating is less than specified but which are otherwise damaged shall be cleaned of all dust and other contaminations if any, and shall be recoated with additional paint to build the coating to specified DFT. All repaired areas of paint will be required to pass acceptance tests performed by the Employer's Representative. The cost of cleaning and painting of damaged and defective areas shall be borne by the Contractor.

5.4.26 Inspection of Paint Materials and Acceptance Test for Paint Coatings

The Contractor shall use the paint materials made by reputed manufacturers whose paint have been successfully used on the underwater high head gates of other comparable hydro project in India. The particulars of the paint product intended to be used and name of the manufacturers shall be furnished to the Employer's Representative for approval prior to making any use of any paint materials in the works.

All paint and coating materials shall be made available for sampling at least 30 days prior to use and no paint or coating materials shall be used until they have been tested and/or approved by the Employer's Representative.

So far as practicable as determined by the Employer's Representative, the Contractor shall make arrangements with the Government for inspection of paint material at the factory of the Contractor. The Contractor shall provide facility and assistance as required for procuring representative test samples which will be taken by the Employer's Representative. With all materials, the Contractor shall

furnish detailed information regarding specification. The replacement of the paint materials and expenses incurred for this replacement, if the analysis discloses anomalies, shall be borne by the Contractor and no payment on this account will be made to him. Preparation of the paint materials used and their labeling shall comply with the rules applicable. The safety rules required during their application shall be strictly observed.

Before starting on work, the Contractor shall submit reference metallic test plates of size 200X300X2mm. These test plates shall be prepared according to the specifications and shall receive the specified paint materials with the exact utilization shades selected and specified number of coats.

Upon completion, the coating appearance shall be in accordance with the specification and the test plates supplied. The Contractor shall check thickness of coats both during application of paint and finally after their completion. The Employer's Representative shall check thickness of coats after their drying time in a number of areas of 1sqm representing together 20% of the total surface of the coating. Within each area of 1sqm the Employer's Representative will select 8 elementary surfaces of 100csqm each for paint coat application when 10 consecutive measurement of thickness will be affected. The average of measurement over 100csqm each shall not be smaller by more than 10% of the specified thickness. If, over 100csqm these tolerances are not met with, the coating thickness will be measured on two more adjacent elementary surfaces.

The Contractor shall have to bring up the thickness of the coating wherever it is recognized to be insufficient. The thickness measuring unit shall be calibrated and cross checked by both the Employer's Representative and the Contractor.

5.4.27 Shop Tests And Inspections

5.4.27.1 General

All materials and components of the equipments offered under the specifications shall be tested by the Contractor prior to fabrication. After fabrication the equipment shall be assembled in the shop and shop tests shall be performed by the Contractor to ensure accuracy in fabrication and workmanship. The Contractor shall carry out such tests as may be required by the Employer's Representative in order to determine that the gates, hoist will fulfill the functions for which they have been designed. The Contractor shall be responsible for all modifications and adjustments required for the work as a result of such tests. The test shall be repeated, if necessary, until they are successfully carried out to the satisfaction of the Employer's Representative.

5.4.27.2 Tests of Materials

All materials, supplied parts and assemblies thereof being used in the work to be done under these specifications shall be of tested quality and all works performed shall be subjected to rigid inspection and no article or material or supply shall be dispatched until all tests analysis and sub-inspection have been completed and certified copies of reports of results and analysis have been accepted by the Employer's Representative.

5.4.28 Shop Assembly And Tests

5.4.28.1 General

The gates hoists along with hoist bridge shall be completely assembled in the shop for inspection and to ensure that all parts to be connected are fitted properly and that all the dimensions, clearances and tolerances called for in these specifications and / or shown in the drawings of Employer's Representative are

obtained. Any template or layout plates required to ensure correct matching of holes in connecting parts for erection shall be furnished by the Contractor to the Employer's Representative. The gates and the hoists shall be assembled in a vertical / inclined position to ensure proper alignment and holes for field connections shall be carefully drilled or reamed while the gates are being shop assembled. The gates shall be shop assembled as considered necessary to check fabrication and all parts shall be carefully match marked to facilitate erection at site.

5.4.29 Interchangeability

Where possible all similar items and removable parts of similar equipments of gates, hoists and their embedded parts shall be interchangeable with each other.

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5.5 Dry Weather Flow Collection and Treatment

5.5.1 Collection Network

Collection Pipes of Double Walled Corrugated HDPE pipes sufficient to carry any inflow that might be coming to Amanishah Drain will be provided on both sides of the Amanishah Water way. The objective will be to connect any dry water flow source to this pipe which collects and takes it to points chosen by the Contractor for collecting and pumping the collected waste water to a STP proposed by him. The size shall be calculated to allow the flows within the Interception pipe by gravity. The pipes will be provided with manholes as per the Sewerage/storm water flow norms and will be laid in gradient so as to maintain gravity flow.

5.5.1.1 Technical Specifications of Sewer lines and appurtenances

(A) HDPE Pipes

This specification covers the requirements for manufacturing, supplying testing at works of High Density Polyethylene Pipes used for Sewerage.

- **Applicable Codes**

The manufacturing, testing, supplying and testing at work sites of HDPE pipes shall comply with all currently applicable statutes, regulations, standards and Codes. In particular, the following standards, unless otherwise specified herein, shall be referred. In all cases the latest revision of the Codes shall be referred to. If requirements of this Specification conflict with the requirements of the standards / Codes, this Specification shall govern:

Code No.	Title/Specification
IS 2530-1963	Methods of test for polyethylene moulding materials and polyethylene compounds
IS 4905-1968	Methods for random sampling
IS 14333: 2001	High Density Polyethylene Pipes for Sewerage-Specification
IS 7328-1992	High density polyethylene materials for moulding and extrusion Specification
IS 7634-Part 2-1975	Laying & Jointing of Polyethylene (PE) Pipes
IS 8008: Part 2-2003	Part 2: Specific Requirements for 900Bend.
IS 8008: Part 3- 2003	Part 3: Specific Requirements for 900 Tee.
IS 8008: Part 4-2003	Part 4: Specific Requirements for Reducers.
IS 8008: Part 6-2003	Part 6: Specific Requirements for Pipe ends.
IS 8008: Part 9-2003	Part 9: Specific Requirements for End Caps.
IS 8360 Part 1: 1977	Specification for fabricated high density polyethylene (HDPE) fittings for potable water supplies – Part 1 : General requirements.
IS 8360 Part 2: 1977	Part 2 Specific requirements for 90 0Tees.
IS 8360 Part 3: 1977	Part 3 Specific requirements for 90 0 bends.

Others Codes not specifically mentioned here but pertaining to the use of HDPE pipes form part of these Specifications.

- **Designation**

Pipes shall be designated as per IS 14333, according to the grade of material, followed by pressure rating and nominal diameter, for example, PE 80 PN 2.5 DN 225 indicates a pipe pertaining to material grade 80 having a pressure rating 2.5 MPa and outside nominal diameter 225 mm.

- **Colour**

  The colour of the pipe shall be black.

- **Raw Materials**

  6.1.5.1 Certificate for having passed the full scale rapid crack propagation test as per ISO 13478. High density Polyethylene (HDPE) used for the manufacture of pipes shall conform to designation PEEWA-45-T-006 of IS 7328 or conforming to designation PEEWA-45- T-012 of IS 7328 with the exception that melt flow rate (MFR) shall not be less than 0.20 g/10 min. and not exceed 1.10-g/10 min. In addition the material shall also conform to clause 5.6.2 of IS 7328.

  The specified base density shall be between 940.0kg/ m^3 and 958.4kg/ m^3 (both inclusive) when determined at 27°C according to procedure prescribed in IS 7328. The value of the density shall also not differ from the nominal value by more than 3 kg/ m^3 as per 5.2.1.1 of IS 7328. The compounded material supplied by the raw material supplier shall modify the density for compounded material as per the clause 5.2.1.1 of IS 7328.

  The resin shall be compounded with carbon black. The carbon black content in the material shall be within 2.5 ±0.5% and the dispersion of carbon black shall be satisfactory when tested as per IS 2530.

  The percentage of anti-oxidant used shall not be more than 0.3 percent by mass of finished resin. The anti-oxidant used shall be physiologically harmless and shall be selected from the list given in IS 10141.

  Reworked Material No addition of Reworked/ Recycled Material from the manufacturer's own rework material resulting from the manufacture of pipes is permissible and the vendor is required to use only 100% virgin resin compound.

  The manufacturer will procure pre-compounded material from the raw material supplier. The supplier will provide the following:

  - Certificate for having passed the full scale rapid crack propagation test as per ISO 13478
  - Details of the compounded elements of carbon black and antioxidants.
  - The density of the virgin polymer and the compounded material.

- **Anti-Oxidant**

  The percentage of anti-oxidant used shall not be more than 0.3 percent by mass of finished resin.

- **Reworked Material**

  No addition of Reworked/ Recycled Material from the manufacturer's own rework material resulting from the manufacture of pipes is permissible and the vendor is required to use only 100% virgin resin compound.

- **Maximum Ovality of Pipe**

  The outside diameter of pipes, tolerance on the same and ovality of pipe shall be as given in table 2 of IS 14333. Ovality shall be measured as the difference between maximum outside diameter and minimum outside diameter measured at the same cross section of the pipe, at 300 mm away from the cut end. For pipes to be coiled the ovality shall be measured prior to coiling. For coiled pipes, however, re-rounding of pipes shall be carried out prior to the measurement of ovality.

- **Wall Thickness**

  The minimum & maximum wall thickness of pipe for the PE80 shall be as given in

table 4 in IS: 14333.

- **Length of Straight Pipe**

  The length of straight pipe used shall be 5 m to 20 m as agreed by Employer's Representative. Short lengths of 3 meter (minimum) up to a maximum of 10% of the total supply may be permitted.

- **Coiling**

  The pipes supplied in coils shall be coiled on drums of minimum diameter of 25 times the nominal diameter of the pipe ensuring that kinking of pipe is prevented.

- **Workmanship / Appearance**

  Pipes shall be free from all defect including indentations, delaminating, bubbles, pinholes, cracks, pits, blisters, foreign inclusions that due to their nature degree or extent detrimentally affect the strength and serviceability of the pipe. The pipe shall be as uniform as commercially practicable in colour opacity, density and other physical properties as per relevant IS Code or equivalent International Code. The inside surface of each pipe shall be free of scouring, cavities, bulges, dents, ridges and other defects that result in a variation of inside diameter from that obtained on adjacent unaffected portions of the surface. The pipe ends shall be cut clearly and square to the axis of the pipe.

- **Fittings and Specials**

  All HDPE fittings/ specials shall be Injection moulded fittings as per IS: 8008 (Part I to IX). All fittings/specials shall be fabricated or injection moulded at factory only. General requirement of Injection moulded HDPE fittings conforming to IS: 8008 Part I.

- **Bends**

  HDPE bends shall be conforming to IS: 8008 Part II Specifications.

- **Tees**

  HDPE Tees shall be conforming to IS: 8008 Part III Specifications..

- **Reducers**

  HDPE Reducers shall be conforming to IS: 8008 Part IV Specifications.

- **Flanged HDPE Pipe Ends**

  HDPE Stub ends shall be square ended conforming to IS: 8008 Part I & IX Specifications. Stub ends will be welded on the pipe. Flange will be of slip on flange type as described below.

- **Slip-on Flanges**

  Slip-on flanges shall be metallic flanges covered by epoxy coating or plastic powder coating. Slip-on-flanges shall be conforming to standard mating relevant flange of valves, pipes etc. Nominal pressure rating of flanges will be PN10.

- **Inspection and Testing**

  The material will be inspected and tested by the Inspectors to be nominated by the Employer. The following tests shall be conducted:

  - Physical Dimensions and visual inspection: The Manufacturers test reports as elaborated in Clause 5 of these specifications shall be provided for review.
  - Density: The density will be tested as per the provisions of Annex-A of IS 7328. It should match to the density claimed by the raw material supplier for

compounded material / specifications.

- MFR test as per clause 9.2.4 of IS 14333. MFR shall also be within 30% of the MFR of the material used in manufacturing pipes.
- Carbon black content / dispersion test as per clause 9.2.4 of IS 14333
- Hydraulic Characteristics: As per Clause 8.1 of IS 14333
- Reversion Test: As per Clause 8.2 of IS 14333

Sampling

The stipulations of IS 14333 will be followed.

Measurement

The net length of pipes as laid or fixed shall be measured in running meters correct to a cm. Specials shall be excluded and measured and paid separately under the relevant item. The portion of the pipe at the joints (inside the joints) shall not be included in the length of pipe work. Excavation, refilling, masonry and concrete work wherever required shall be measured and paid for separately under relevant items of work.

Requirement for the HDPE Pipe Supplier

The manufacturer of HDPE pipes from whom the pipes will be procured in the contract should have been in the business of production of HDPE pipes as per IS 14333 for at least 3 years. He should have current accreditation under ISO 9000 and should also posses BIS license (minimum 3 years). He must have supplied at least 2.0 km of such pipes under one contract which should have been commissioned to the satisfaction of the client.

The Contractor should submit the following data / certificates regarding HDPE pipes along with the Qualification bid.

- Brand Name, Manufacturers capacity, previous supply details etc.,
- Details of ISO 9000 / 14000 accreditation.
- Manufacturer's recommendation and Pressure testing procedure.

Fusion Equipment

The Contractor should have automatic superior quality fusion welding machines with hydraulic jacks, surface cleaning planner, and digitally controlled heating mirror and hydraulic power pack for doing the installation and a list of equipments, detailed welding procedure, pressure testing procedure etc. should be submitted along with the offer.

(B) HDPE Pipes and Specials – Laying and Jointing

The Sewerage system proposed to be laid will have Y and T connections for connecting properties. The Y's and T's will be installed along with the main sewer. These Y and T like all other fittings will be supplied by the Contractor such that they can be part of the main sewer and jointed to it in the same fashion as the pipes. They will be located so as to provide a right alignment for the proposed manhole in the consumer chamber by aid of using suitable specials. The slope of the connecting pipes to the consumer man hole should be not be less than 1 in 50.

The system will be connected to manholes at suitable locations.

Handling, Transportation Storage and Lowering of Pipes

During handling, transportation, storage and lowering, all sections shall be handled by such means and in such a manner that no distortion or damage is

done to the section or to the pipes as a whole.

The following procedures should be followed so as to eliminate potential damage to pipes and fittings and to maintain:

- Maximum safety during unloading, lifting and lowering.
- Pipes must not be stored or transported where they are exposed to heat sources likely to exceed 60oC.
- Pipes shall be stored such that they are not in contact with direct sunlight, lubricating or hydraulic oils, petrol, solvents and other aggressive materials
- Scores or scratches to a depth of greater than 10% or more of wall thickness are not permissible; any pipes having such defects should be strictly rejected.
- PE pipes should not be subjected to rough handling during loading and unloading operations. Rollers shall be used to move, drag the pipes across any surface.
- Only polyester webbing slings should be used to lift heavy PE (>315mm) pipes by crane. Under no circumstances, chains, wire ropes and hooks be used on PE pipes.
- Pipes shall not be dropped to avoid impact or bump. If any time during handling or during installation, any damage, such as gouge, crack or fracture occurs, the pipe shall be repaired if so permitted by the Employer's Representative before installation.
- Straight lengths should be stored on horizontal racks giving continuous support to prevent the pipe taking on a permanent set
- The truck used for transportation of the PE pipes shall be exclusively used of PE pipes only with no other material loaded – especially no metallic, glass and wooden items. The truck shall not have sharp edges that can damage the Pipe.
- Pipes manufactured at factory are to be carried to the site of work directly or stacked suitably and neatly along the alignment/road side/elsewhere near by the work site or as directed by the Employer's Representative.
- Damages during transit, handling, storage will be to the Contractor’s account and replacement for such pipes has to be made by the Contractor without any extra cost as directed by the Employer's Representative.

Method of Fusion

Method of jointing between the pipes to pipes and pipes to specials shall be with fusion welding using automatic or semi automatic, hydraulically operated, superior quality heat fusion machines which will ensure good quality heat fusion welding of HDPE pipes The most widely used method for joining individual lengths of large diameter polyethylene pipe (>75mm) is by heat fusion of the pipe ends This technique produces a permanent, economical and flow-efficient joint. Field-site heat-welding may be made readily by trained Contractors using specially developed heat fusion machines. The Fusion Jointing between HDPE pipes and specials shall be done as per the latest IS: 7634 part- II

General Guidelines for Fusion-Welding

The welding area has to be protected from unfavorable welding conditions such as moisture, wind, dirt, excessive surface temperature and low temperatures < 5 degree C and intensive UV radiation. If the pipe is exposed to such UV radiation, the pipe ends are to be thoroughly scrapped (by planning tool) before the welding procedure is adopted.

Heating Pressure	0.15 N/sq. mm
Welding Temperature	200-220 deg. C

The seven steps involved in making a heat fusion joint are:

- Securely fasten the components to be joined
- Square cut the surface of the pipe end
- Face the pipe ends
- Align the pipe profile
- Melt the pipe interfaces
- Join the two profiles together
- Hold under pressure and release

Heat fusion cycle and parameters are given in Annex A in ISO 11414 – the users are requested to follow this guideline for a good weld.

Caution: An additional 10 to 60 minutes cooling time may be required (depending on pipe size) after removing the pipe from the fusion equipment before subjecting the pipe for bending, burying, pressure testing or similar handling.

Bead Removal

In some pipe system usage, the bead from the heat fusion process may be undesirable. Inside beads may create minor flow turbulence of liquids or may become an obstacle on which solids in the fluids may become lodged. Furthermore, outside beads may be a hindrance to relining operations. Equipments are available to remove the bead. The bead removal shall not affect the performance of the pipe and the weld

However, it must be noted that the friction factor (‘c’ value; ‘k’ value) as given elsewhere in the manual takes cognizance of the inside bead. Hence the bead does not effect the design parameters for flow rates in PE pipes.

Fusion Equipment

The user is cautioned for the proper procurement of the welding equipment and the Inspection agencies shall necessarily be assured that the welding contracting company has the proper machine for a good field weld. Few of the necessary performance requirements of the machine are given below. Detailed data available in ISO 12176-1

The heat fusion equipment shall incorporate a facility for supporting the heating plate and planning tool (necessary to square cut the pipe end) when in use. The machine shall be robust enough to stand normal field use.

The design of the heat fusion machine shall allow the heating plate to be removed and the pipe ends closed after heating, without damaging the heating surfaces, within a time frame of maximum of 6 secs upto d<250mm and 12 secs for d>250mm.

The clamp alignment system shall be such that there shall be perfect axial alignment of the pipe surface – during heating and during pressurizing the pipe ends after heating, is assured.

The guide elements of the machine shall be such that the gap between the pipe ends shall not exceed 0.25mm for d<250mm and 0.5mm d>250mm

Heat-welding machines can be manual, hydraulic or pneumatic. However, a locking system to hold the fusion force is to be ensured in all the systems.

All the systems shall be protected against over pressure. It shall be capable of maintaining the required interface force on the pipe or fittings end as long as

necessary

There shall be a display of the pressure applied.

- **Trained Manpower for Fusion Welding**

Only trained and technically qualified for the welding method are to be employed for the welding operation

It is necessary that the manufacturer certified person need only be authorized for heat-welding. These persons shall carry at all the time in the field during site work, a valid and authentic certificate that the person performing welding has been so trained.

The certificate shall be issued to only those persons trained by the Pipe manufacturer where a minimum of three samples of heat welded Pipe pieces of size >160mm OD have failed in Ductile mode at the welded joint when tested as per ISO 13953. The certificate shall carry the details of such test results.

- **Testing**

The sewer line laid will be tested in the following manner including the house connection pipes

- **Leak Testing**

This low-pressure air testing practice detects damaged piping or improper jointing by measuring the rate at which air under pressure escapes from an isolated section of sewer.

The rate of air loss indicates the presence or absence of damaged piping or leaking joints. This practice is not intended to show total system water leakage limits and shall not be used as a quantitative measure of leakage under service conditions for infiltration or ex-filtration.

This practice provides assurance of initial condition and quality of workmanship of properly-installed sewer pipe.

This practice provides procedures for testing non-pressure plastic pipe sewer lines, using low-pressure air to prove the integrity of the installed material and the construction procedures.

This practice is performed on lines after all connections and service laterals have been plugged and braced adequately to withstand the test pressure. The time between completion of the backfill operation and low-pressure air testing may be specified by the Employer's Representative.

This practice is used as a preliminary test, which enables the installer to show the condition of a buried line prior to final backfill, paving, and other construction activities.

This standard does not purport to address all of the safety problems, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use

- **Air Test Method-Gravity Sewer**

All sanitary sewer lines, including service connections, shall be substantially watertight and shall be tested for excessive leakage upon completion and before connections are made to the service by others.

For gravity flow sewers, the sewer shall be subjected to ex-filtration testing, by the ASTM F1417 (low pressure air) test method regardless of pipe material.

The requirements set forth for maximum leakage shall be met as a condition for

acceptance of the sewer section represented by the test. All testing shall be performed by the Contractor without any direct compensation being made therefore, and the Contractor shall furnish all necessary equipment and materials, including plugs as required.

Nominal Pipe Diameter	HDPE pipe PE - 80 & PN-2.5		Max. Length of Stretch to be tested
	Inside Pipe Diameter (inch)	Shortest time allowed for the air pressure drop to 1 PSI	
90	3.48	3 min 21 Sec	up to 120 m
110	4.26	4 min 6 Sec	up to 120 m
125	4.84	4 min 40 Sec	up to 120 m
140	5.42	5 min 13 Sec	up to 120 m
160	6.2	5 min 58 Sec	up to 100 m
180	6.97	6 min 43 Sec	up to 100 m
200	7.75	7 min 27 Sec	up to 80 m
225	8.72	8 min 23 sec	up to 80 m
250	9.69	9 min 19 sec	up to 60 m
		10 min 08 sec	60 to 80 m
280	10.85	10 min 27 sec	up to 60 m
		12 min 42 sec	60 to 80 m
315	12.21	11 min 45 sec	up to 40 m
		12 min 03 sec	40 to 60 m
		16 min 05 sec	60 to 80 m

The Table above contains the values of pressure rating and allowable minimum time required to drop the pressure from 0.36 kg/csqm to 0.26 kg/csqm (Gravity Sewer Lines):

Source: ASTM F1417 – 11a "Standard practice for installation acceptance of plastic Non – pressure sewer lines using low – pressure Air

Note: 1 PSI = 0.0703 kg/csqm

In the event of test failure on any test section, testing shall be continued until all leakage has been detected and corrected to meet the requirements. All repair work shall be subject to approval of the Employer's Representative. Introduction of sealant substances by means of the test water will not be permitted.

Unsatisfactory repairs or test results may result in an order to remove and replace pipe as the Employer's Representative considers necessary for test conformance. All repair and replacement work shall be at the Contractor's expense.

- **Deflection Test**

Deflection tests shall be performed on all flexible gravity sewer pipes. The test shall be conducted after the sewer trench has been backfilled to the desired finished grade for a minimum of 30 days.

The deflection test shall be performed by pulling a rigid ball or pointed mandrel through the pipe without the aid of mechanical pulling devices. The ball or mandrel shall have a minimum diameter equal to 92.5 % of the actual inside diameter of the pipe. The maximum allowable deflection shall not exceed 5 % of the pipe's internal diameter. The line will be considered acceptable if the mandrel can progress through the line without binding. The time of the test, method of testing, and the equipment to be used for the test shall be subject to the approval of the City.

All testing shall be performed by the Contractor at its expense without any direct compensation being made therefore, and he shall furnish all necessary equipment and materials required

In the event of test failure on any test section, the section shall be replaced, with all repair work subject to approval of the City. The replaced section shall be re-tested for leakage and deflection in conformance with the specifications contained herein. All repairs, replacement, and re-testing shall be at the Contractor's expense

- **Flow Test**

After completion of entire network of the sewer line, flow test to be carried out

- **Marking**

- All pipes shall be marked at maximum interval of 1 m.
- The marking shall indicate at least the following information.
- Manufacturer's name & / or trade mark.
- The dimensions (nominal outside diameter X nominal wall thickness)
- The designation of pipes material (PE 80)
- The nominal pressure (PN) – 2.5
- The production period (date or code)
- Double wall corrugated (DWC) HDPE pipes:

- **Scope**

This specification covers the requirements for successfully designing, manufacturing, supplying, laying, jointing and testing at works and site of double wall corrugated (DWC) High Density Polyethylene (HDPE) Pipes used for drainage and Sewerage.

- **Applicable Codes**

The manufacturing, testing, supplying and testing at work sites of HDPE-DWC pipes shall comply with IS 16098 Part-II: 2013 and all currently applicable statutes, regulations, standards and Codes. In particular, the following standards, unless otherwise specified herein, shall be referred. In all cases the latest revision of the Codes shall be referred to. If requirements of this Specification conflict with the requirements of the standards / Codes, this Specification shall govern:

Code No.	Title/Specification
IS 4905:1968	Methods for random sampling.
IS 5382:1985	Specification for rubber sealing rings for gas mains, water mains and sewers (first revision). Type-I & Type-VI
IS 12235	Methods of test for thermoplastics pipes & fittings.
(Part 1): 1986	Method of measurement of outside diameter.
(Part 5):1986	Reversion test
(Part 8):1986	Internal hydrostatic pressure test
IS 16098 Part-II:2013	Structured wall plastics pipes for non pressure drainage and Sewerage- specifications.

Others Codes not specifically mentioned here but pertaining to the use of HDPE-DWC pipes form part of these Specifications.

- **Designation**

Pipes shall be designated as per IS 16098:2013, according to the grade of material, followed by stiffness classes (SN) and Nominal diameters e.g. 200 mm SN-8.

- **Materials**

The material from which the pipe is produced shall consist substantially of polyethylene (PE), to which may be added only those additives that are needed to facilitate the manufacture of these pipes and fittings confirming to requirement of this standards. A pipe of fittings with a smooth internal & profiled external surface forming a finished double walled profile shall come under this standard.

When sealing rings are retained by means of retaining devices (rings or caps), the devices may be made from polymers, provided they conform to the same functional dimensions and test requirements as applied to sockets with either loose or fixed sealing rings.

The manufacturer's own rework material conforming to the requirements given in 3.25 of IS:16098 is permissible. No other rework material shall be used.

- **Dimensions**

✓ ***Mean inside Diameter***

The mean inside diameter, at any point and tolerances shall be as given in Table 5 of IS: 16098 and shall be measured according to the method given in IS 12358 (Part 8).

✓ ***Wall Thickness***

The nominal wall thickness, e, shall be in accordance with Table 5 of IS: 16098. Tolerances in inside diameters shall be those given in IS: 16098.

✓ ***Length of pipe***

Effective length of pipes (Le) with sockets shall be not less than that specified by the manufacturer when measured as shown figure to of IS: 16098 2013.

The lengths may be supplied as agreed to between the purchaser and the manufacturer.

- **Dimensions of pipes & spigots of pipes & fittings**

The nominal size and minimum mean inside diameter for DN-ID series are specified in Table-5. The outside diameters of the DN-ID series pipes and spigots intended to have jointing dimensions as pipes and /or fittings according to this standard shall comply with the outside diameters and tolerances as specified by the manufacturer. However, the guidelines for pipes, spigots and fittings not intended to have jointing dimensions as pipes and /or fittings according to this standard, the tolerances of the outside diameter of pipes and spigots fittings shall be + 0.3mm/ (-) 0.6mm of the nominal size of outside diameter.

- **Inspection and Testing**

The material will be inspected and tested by the Inspectors to be nominated by the Employer. The sampling procedure to be adopted and the criteria for conformity shall be as given in IS: 16098. The following tests shall be conducted:

✓ ***Type Tests***

Type tests are intended to prove the suitability and performance of a new technique or a new size of pipe. Type testing shall be in accordance with tables 15 to 18 as applicable of IS: 16098 2013. All tests are to be carried out either in an in-house laboratory or at an authorized third party laboratory.

Physical Characteristics:

❖ **Appearance**

The structured outer layer of finished pipes and fittings shall be uniformly corrugated. The inner layer shall be smooth and plain. Both layers shall be free from any visual defects such as cracks, blisters, foreign inclusions and any other visual irregularities which may cause harm to its construction integrities. The inner surface may reflect slight shallow undulations. Colour of Finished Pipes.

The inner and outer layer of pipes and fittings shall be coloured throughout. The outside layer of pipes and fittings should preferably be black, orange brown or grey.

❖ **Mechanical Characteristics**

The pipes shall be designated in the following nominal ring stiffness classes (SN):

- DN ≤ 500 : SN 4, SN 8 or SN 16
- DN > 500 : SN 2, SN 4, SN 8 or SN 16

For DN ≤ 500, the manufacturer's guaranteed minimum stiffness between the SN values, of a component may be used for calculation purposes only. Such pipes shall be classified and marked as the next lower stiffness class.

❖ **Ring Flexibility**

When tested in accordance with the test method using the indicated parameters, and visually inspected without magnification, requirements in (a) and (b) shall be satisfied during the test and requirements (c) to (d) shall be satisfied after the test.

a. There shall be no decrease of the measured force;
b. There shall be no cracking in any part of the wall structure;
c. There shall be no wall delamination except possible delamination between the outside and inside wall of double wall pipes occurring in reduced welding zone in the ends of test piece. Process aiding profile of material other than the pipe material is not subject to this requirement;
d. There shall be no other types of rupture in the test piece; and
e. Permanent buckling in any part of the structure of the pipe wall including depressions and craters, shall not occur in any direction.

✓ ***Marking***

❖ **General**

Marking shall be labelled, printed or formed directly on the pipe or fitting, in such a way that after storage, weathering and handling the legibility shall be maintained. Marking shall not initiate cracks or other types of defects which adversely influence the performance of the pipes or the fitting.

Minimum Required Marking

❖ **Pipes**

Each pipes shall be marked at intervals of maximum 3 m, at least once per pipe, with the following information:

- Manufacturer's name/Trade-mark;

- Diameter series, nominal size;
- Stiffness class;
- Material; and
- Lot number/batch number containing information regarding period of manufacture.

❖ **Fittings**

Each fitting shall be marked with the following information:

- Manufacturer's name/Trade-mark;
- Diameter series, nominal size;
- Nominal angle;
- Stiffness class;
- Material; and
- Lot number/batch number containing information regarding period of manufacture.

BIS Certification Marking each pipe or fittings may also be marked with the standard Mark

The use of the Standard mark is governed by the provisions of the Bureau of Indian Standards Act, 1986 and the Rules and Regulations made there under. The details of conditions under which the licence for the use of the Standard Mark may be granted to manufacturers or producers may be obtained from the Bureau of Indian Standards.

Requirement for the HDPE-DWC Pipe Supplier

The manufacturer of HDPE-DWC pipes from whom the pipes will be procured in the contract should have been in the business of production of HDPE-DWC pipes as per IS 16098 2013 for at least 2 years. He should have current accreditation under ISO 9000 and should also posses BIS license (minimum 2 years). He must have supplied at least 2.0 km of such pipes under one contract which should have been commissioned to the satisfaction of the client.

The Contractor should submit the following data / certificates regarding HDPE-DWC pipes along with the Qualification bid:

- Brand Name, Manufacturers capacity, previous supply details etc.
- Copy of valid ISO 9000 /14000 accreditation. (If any)
- Copy of valid BIS accreditation for manufacture of HDPE-DWC pipe as per IS 16098 2013.
- Manufacturer's recommendation and Pressure testing procedure.

✓ ***Joints***

Elastomeric sealing rings shall be free from substances that can have a detrimental effect on the pipes or fittings used in conjunction with pipes.

The design of the profile and dimensions of the sealing ring is left to the manufacturer, as long as the pipe with the sealing ring meets the requirements of this standard. Where the design of the socket is such that the ring is not firmly fixed in position, the housing for the ring shall be so designed as to minimize the possibility of the ring being dislodged during insertion of the pipe (or spigot or fitting) to complete the joint. Elastomeric sealing rings shall be in accordance with one of the type (Type 1 to Type 6) of IS 5382. The manufacturer should specify the type of sealing ring (namely Type 1, 2, 3, 4, 5

or 6) that is being offered.

NOTE — A test report or conformity certificate may be obtained from the manufacturer of the sealing ring for conformity to IS 5382.

- ✓ ***Connecting Corrugated Polyethylene Pipe to Other Pipe Materials***

It is not unusual for corrugated polyethylene pipe to be connected to other types of pipe materials. Available options depend on the joint duality required throughout the system and the particular combination of pipe materials. In most storm sewer applications, the pipe can be jointed by heating the pipe ends together, wrapping them with a geotextile, and pouring a concrete collar around them. Although such a connection is dependent on Contractor expertise, it will generally limit soil intrusion but not provide a watertight joint. Watertight connections between different materials will require additional fittings and adapters. If those options are not acceptable, a manhole can be used to make the transition.

Pipe manufacturers are a valuable resource during the project planning stage since they are familiar with adapters that work well with their own products.

- ✓ ***Plain End Pipe Couplers***

Soil Tight Split Coupler – This is a clam Shell type coupler used in Non-Water Tight application. They are used on perforated or solid style CPP pipes at site where the native soil is stiff and cohesive enough to reduce the possibility of a loose soil infiltration into the pipe that could create a flow restriction.

Silt Tight Split Coupler – These are Calm Shell type coupler to which a gasket material has been added for the purpose of restricting Silt Infiltration into the pipe at a coupling joint. This non-water tight gasket material meets ASTM-D-1056, Grade 2A2 or ASTM-F-477. The installer should take care to remove all dirt and foreign matter from the pipe ends and gasket material to ensure a secure fit.

- ✓ ***Bell & Spigot Couplers With "O" Ring Gaskets***

These couplers to impede or prevent the infiltration or infiltration of liquids in NON-PRESSURE application.

Bell & Spigot Couplers with "O" Ring Gaskets:- These couplers are produced on the pipe during the pipe extrusion process. Bell & Spigot pipes are available in 20-foot lengths, each coupler Spigot End comes with a non-pressure pipe water leak restriction gasket manufactured per ASTM-D-477. Should gravity flow pressure tests be required per ASTM-F-1417, one should not test until the pipes have been backfilled or restrained for safety.

Shear gasket gravity flow seal couplers: - These pliable couplers with stainless steel clamp- Grip Compression bands have been used for years connecting clay, concrete, steel and plastic pipes in all types of environments. They are impervious to normal water / sewer, chemicals, fungus growth and all other associated in – ground hazards. As with any coupler, before applying, insure that no foreign matter jeopardizes contact between the two surfaces.

Mastic Wrap Coupler:- Wrap around style mastic couplers have an outer layer of cross laminated polyethylene plastic and an under layer adhesive surface of rubberized mastic material. In between these two surface layers is a high strength shear and puncture resistant layer of woven polypropylene. This center third layer provides toughness against puncture as well as stretch resistance under earth load shifts or settlements. The Mastic wrap coupler is mechanically sealed by stainless steel screw type hose clamp compression

bands. These adjustable compression clamp bands are easily secured using simple tools such as screwdrivers, nut drivers, or socket wrenches. Proper tension on those bands will provide a seal against infiltration and exfiltration in gravity flow, non-pressure pipes. Each mastic coupler comes with three hose clamp compression bands or ties located within the coupler. There is one compression strap located in the heat joint corrugation pipe valley, and one strap in the first valley on each side of the heat joint. Proper compression tension on each strap (centered over a corrugation valley) will forcibly apply the mastic surface around the corrugation crests and walls to provide a seal. Enough tension should be applied to substantially sink the compression straps into the corrugation valleys below the corrugation crests in order to have a leak resistant seal. Prior to applying the mastic side to the pipe be sure to clean the pipe of soil/dust particles that could interfere with the mastic seal making contact with the pipe surface. Mastic couplers can also be used to couple corrugation pipes manufactured with different corrugation designs of the same pipe size as well as to couple pipes to other pipes made from a different raw material base.

- ✓ ***Delivery Inspections***

  Contractor along with Project manage or his representative make every effort to ensure order accuracy and quality. As a final check, the IPIU/DSC should conduct a personal inspection at delivery to verify that the correct product and the expected quantity is received. Pipe corrugations, gaskets, pipe ends, couplers or other joints, and any accessories should be visually inspected for damage that may have occurred during transportation

- ✓ ***Product Identification***

  Product markings on Crumpler Plastic Pipe will include the following information to facilitate jobsite inspection.

  - Nominal pipe size
  - Manufacturer's name Date code
  - Application standard(s)

- ✓ ***Unloading***

  The Contractor should set aside an area for products to be stored on site.

  This area should be flat, free of large rocks, rough surfaces and debris.

  It should also be out of the way of construction traffic.

  Pipe may be delivered either palletized or loose, depending on the type and quantity of product.

  Pallets may be unloaded with a backhoe, forklift or other piece of equipment and a nylon sling or cushioned cable.

  The sling should be wrapped around the pallet at the third points as it lifts the pallet onto the ground. As an alternative to using a sling to unload full pallets, the pallet may be opened and lengths of pipe unloaded individually be carefully rolling single lengths of loose pipe from the delivery truck onto the front end loader, then onto the ground.

  Alternately, the pipe can also be lifted using a nylon sling or cushioned cable at the third points.

  End handling with a forklift MUST NOT be used as pipe damage will occur.

  Due to joint weight, larger diameter pipes should not be off loaded by hand.

- ✓ ***Job Site Storage***

  Reasonable care should be used in handling pipe.

  The pipe should not be dropped, dragged or bumped against other pipe or objects.

  Palletized pipe should remain in the pallet for jobsite storage.

  Non-palletized pipe can be stockpiled for temporary storage in a flat debris-free area out of the way of construction traffic.

  Begin the stockpile with secured timbers spaced the width of the proposed stockpile at a distance not exceeding the third points.

  For pipe with attached bells, a recommended stacking method is to alternate the direction of the pipe lengths so that the bells are not stacked on each other.

  As upto three pipes can be laid before alternating directions. Subsequent layers should follow the same pattern as the first but with fewer sticks of pipe in each row.

  For smooth interior pipe, storage space can be minimized by nesting smaller diameters into large diameter pipe.

  Factory installed gaskets on the spigot should be protected by positioning them between corrugations.

- ✓ ***Stringing the Pipe***

  Placing the pipe and accessories along the open trench, or “stringing” Can save handling time.

  Each pipe length should be laid on a level surface as near as possible to the trench on the side opposite the excavated trench material; allow some space between pipe to protect pipe ends.

  The pipe should be out of the way of any equipment in a location that will allow excavation to proceed uninterrupted.

- ✓ ***Workmanship / Appearance***

  Pipes shall be free from all defect including indentations, delaminating, bubbles, pinholes, cracks, pits, blisters, foreign inclusions that due to their nature degree or extent detrimentally affect the strength and serviceability of the pipe. The pipe shall be as uniform as commercially practicable in colour opacity, density and other physical properties as per relevant IS Code or equivalent International Code. The inside surface of each pipe shall be free of scouring, cavities, bulges, dents, ridges and other defects that result in a variation of inside diameter from that obtained on adjacent unaffected portions of the surface. The pipe ends shall be cut clearly and square to the axis of the pipe.

- ✓ ***Lowering, Laying of Pipes***

  Each pipe shall be thoroughly checked for any damages before laying and only the pipes which are approved by the Employer's Representative shall be laid.

  While installing the pipes in trenches, the bed of the trench should be level and free from sharp edged stones. In most cases, the bedding is not required, as long as the sharp and protruding stones are removed. However, in rocky strata sand bedding shall be provided as per the drawings provided by the Employer's Representative and should be fine sand and for the road crossing concrete encasement shall be provided as indicated in the bedding drawing in

consultation with the Employer's Representative.

As PE pipes are flexible, long lengths of fusion-jointed pipes having joints made above ground can be rolled or snaked into narrow trenches. Such trenches can be excavated by narrow buckets

During the pipe laying of continuous fusion jointed systems, due care and allowance should be made for the movements likely to occur due to the thermal expansion/contraction of the material. This effect is most pronounced at end connections to fixed positions (such as valves etc) and at branch connections. Care should be taken in fixing by finishing the connections at a time the length of the pipe is minimal (lower temperature times of the day.)

For summer time installations with two fixed connection points, a slightly longer length of PE pipe may be required to compensate for contraction of the pipe in the cooler trench bottom.

The final tie-in connections should be deferred until the thermal stability of the pipeline is achieved.

The flexibility of polyethylene pipes allows the pipe to be cold bend. The fusion jointed PE pipe is also flexible as the plain Pipe. Thus the total system enables directional changes within the trench without recourse to the provision of special bends or anchor blocks. However, the pipe should not be cold bend to a radius less than 25 times the OD of the pipe.

PE pipe is lighter than water. Hence care should be taken for normal installations where there could be a possibility of flooding of the trench thus the trench shall be kept free of water till the jointing has been properly done

When flooded, some soils may lose cohesiveness, which may allow the PE pipe to float out of the ground. Several design checks are necessary to see if groundwater flotation may be a concern. Obviously, if the pipeline typically runs full or nearly full of liquid, or if groundwater is always below the pipe, flotation may not be a significant concern.

However, weights by way of concrete blocks (anchors) are to be provided so that the PE pipe does not float when suddenly the trench is flooded and the soil surrounding the pipe is washed away. Thus site conditions study is necessary to ensure the avoidance of flotation.

Pipe embedment backfill shall be stone-free excavated material placed and compacted to the 95% maximum dry density.

- ✓ ***Jointing of Pipes***

The pipe shall have a jointing system that shall provide for fluid tightness for the intended service conditions. Appropriate jointing for HDPE pipe as specified above shall be selected considering site and working condition, pressure and flow of liquids

- ✓ ***Measurement***

The net length of pipes as laid or fixed shall be measured in running meters correct to a cm. Specials shall be excluded and measured and paid separately under the relevant item. The portion of the pipe at the joints (inside the joints) shall not be included in the length of pipe work. Excavation, refilling, masonry and concrete work wherever required shall be measured and paid for separately under relevant items of work.

- ✓ ***Requirement for the HDPE Pipe Supplier***

The manufacturer of corrugated double wall HDPE pipes from whom the pipes will be procured in the contract should have been in the business of production

of corrugated double wall HDPE pipes as per ISO 21138 - 3 for at least 2 years. He should have current accreditation under ISO 9000. He must have supplied at least 1.0 km of such pipes under one contract which should have been commissioned to the satisfaction of the client.

The Contractor should submit the following data / certificates regarding HDPE pipes along with the Qualification bid.

- Brand Name, Manufacturers capacity, previous supply details etc.,
- Details of ISO 9000 / 14000 accreditation.
- Manufacturer's recommendation and Pressure testing procedure.

✓ ***Marking***

As per the provision of clause ISO – 21138 – 3, each straight length of the pipe shall be clearly marked following information:

- The manufacturer's name and trade mark
- Nominal pipe size
- Data code
- Applicable standard

(C) Unplasticized Poly Vinyl Chloride (PVC-U) Pipes

This specification covers the requirements for manufacturing, supplying testing at works of Unplasticized Polyvinyl Chloride (PVC-U) Pipes used for Sewerage.

Applicable Codes

The manufacturing, testing, supplying and testing at work sites of PVC-U pipes shall comply with IS 15328:2003 and all currently applicable statutes, regulations, standards and Codes. In particular, the following standards, unless otherwise specified herein, shall be referred. In all cases the latest revision of the Codes shall be referred to. If requirements of this Specification conflict with the requirements of the standards / Codes, this Specification shall govern:

Code No.	Title/Specification
IS 4905:1968	Methods for random sampling.
IS 4985:2000	Unplasticized PVC pipes for potable water supplies — Specification (third revision).
IS 5382:1985	Specification for rubber sealing rings for gas mains, water mains and sewers (first revision).
IS 12235	Methods of test for unplasticized PVC pipes for potable water supplies:
(Part 1): 1986	Method of measurement of outside diameter.
(Part 5):1986	Reversion test
(Part 8):1986	Internal hydrostatic pressure test
IS 14182:1994	Solvent cement for use with unplasticized polyvinyl chloride pipe and fittings — Specification
IS 15328:2003	Unplasticized non-pressure polyvinyl chloride (PVC-U) pipes for use in underground drainage and sewerage systems— Specification

Others Codes not specifically mentioned here but pertaining to the use of PVC-U pipes form part of these Specifications.

- **Designation**

  Pipes shall be designated as per IS 15328:2003, according to the grade of material, followed by stiffness classes (SN) and Nominal diameters e.g. 160 mm SN-4.

- **Materials**

  The material from which the pipe is produced shall consist substantially of polyvinyl chloride, to which may be added only those additives that are needed.

  The material shall contain a minimum of 0.3 percent of rutile grade titanium dioxide.

  When sealing rings are retained by means of retaining devices (rings or caps), the devices may be made from polymers other than PVC-U, provided they conform to the same functional dimensions and test requirements as applied to sockets with either loose or fixed sealing rings.

  The manufacturer's own rework material conforming to the requirements given in 3.21 of IS:15328 is permissible. No other rework material shall be used.

- **Dimensions**

  ✓ ***Mean Outside Diameter***

  The mean outside diameter, outside diameter at any point and tolerances shall be as given in Table 1 of IS: 15328 and shall be measured according to the method given in IS 12235 (Part 1).

  ✓ ***Wall Thickness***

  The nominal wall thickness, e, shall be in accordance with Table 2 of IS: 15328. Tolerances in outside diameters shall be those given in IS 4985.

  ✓ ***Length of pipe***

  Effective length (Le) of pipes with sockets is considered to be the distance between ends minus the socket depth as shown in Fig. 1 of IS: 15328.

  The lengths may be supplied as agreed to between the purchaser and the manufacturer.

  ✓ ***Dimensions of Integral Sockets and Spigots Ends***

  The basic dimensions shall be in accordance with Tables 3 and 4, and Fig. 2, 3, 4 and 5 of IS: 15328.

  ✓ ***Inspection and Testing***

  The material will be inspected and tested by the Inspectors to be nominated by the Employer. The sampling procedure to be adopted and the criteria for conformity shall be as given in Annex F of IS: 15328. The following tests shall be conducted:

  ✓ ***Type Tests***

  Type tests are intended to prove the suitability and performance of composition of pipe, such tests, therefore, need to be applied in polymer composition. The manufacturer has to produce test certificate from a National Laboratory conducted during last one year with the same material ingredients as used for the pipe being supplied. The manufacturer will produce the certificate regarding the material used.

Physical Characteristics

- **Appearance**

  When viewed without magnification, the internal and external surfaces of the pipe shall be smooth, clean and fee from grooving, blistering and any other surface irregularity, which is likely to prevent conformance of the pipe with this standard. Slight shallow longitudinal grooves or irregularities in the pipe shall be permissible, provided the wall thickness remains within permissible limits. The pipe wall shall not contain impurities or pores. The pipe ends shall be cleanly cut and reasonably square to the axis of the pipe.

- **Colour**

  The colour of the pipes shall be dark (any shade of brown). The pipe shall be uniformly coloured throughout the entire wall. Slight variations in the appearance of the colour are permitted.

- **Vicat Softening Temperature**

  The Vicat softening temperature, when determined according to Annex A of IS: 15328, shall not be less than 790C.

- **Longitudinal Reversion**

  The longitudinal reversion, when tested according to the method prescribed in IS 12235(Part 5), shall not exceed + 5 percent. In the case of socket ended pipe, this test shall be carried out on the plain portion of the pipe taken at least 100 mm away from the root of the socket. The pipe shall not exhibit any blisters, bubbles or cracks on completion of the test.

Mechanical Characteristics

- **Resistance to External Blows at O°C**

  When tested according to the method prescribed in Annex B of IS: 15328, the pipe shall have a true impact rate of not more than 10 percent. In case of socket-ended pipes, this test shall be carried out on the plain portion of the pipe taken at least 100 mm away from the root of the socket.

- **Ring Stiffness**

  When tested according to the method described in Annex C of IS: 15328, the ring stiffness of the pipe shall be as stated in Table 5 of IS: 15328.

- **Resistance to Internal Hydrostatic Pressure (Type Test)**

  When tested according to the method described in 1S 12235 (Part 8) the pipe shall not fail (seep, crack, bulge or burst) during the prescribed test duration of the test and shall meet the requirements given in Table 6 of IS: 15328.

- **Marking**

  Each pipe shall be clearly and indelibly marked in ink/ paint or hot embossed on white base at intervals of not more than 3 m, but at least once per pipe, in the colour differs from the basic colour of the pipe. The marking shall be legible without magnification. The marking shall not initiate cracks or other types of defects which adversely influence the performance of the pipe. Marking by indentation reducing the wall thickness not more than 0.15 mm shall be deemed to conform to this clause without infringing the requirements for the wall thickness given in 6.1.2. of IS 15328. The markings shall include the following:

- Identification of the source of manufacture or trade-mark,
- The nominal pipe diameter,
- Stiffness class of pipe,
- Insertion depth of end for joint to be marked on perimeter of pipe on both the ends by 10 mm thick red colour.
- Batch No. /Lot No. or date of manufacture.

❖ **Requirement for the PVC-U Pipe Supplier**

The manufacturer of PVC-U pipes from whom the pipes will be procured in the contract should have been in the business of production of PVC-U pipes as per IS 15328 for at least 3 years. He should have current accreditation under ISO 9000 and should also posses BIS license (minimum 3 years). He must have supplied at least 2.0 km of such pipes under one contract which should have been commissioned to the satisfaction of the client.

The Contractor should submit the following data / certificates regarding GRP pipes along with the Qualification bid:

- Brand Name, Manufacturers capacity, previous supply details etc.,
- Copy of valid ISO 9000 /14000 accreditation.
- Copy of valid BIS accreditation for manufacture of PVC-U pipe as per IS 15328.
- Manufacturer's recommendation and Pressure testing procedure.

Joints

❖ **Elastomeric Sealing Rings**

Elastomeric sealing rings shall be free from substances (for example, plasticizers) that can have a detrimental effect on the polyvinyl chloride of the pipes or fittings used in conjunction with the pipes.

The design of the profile and dimensions of the sealing ring is left to the manufacturer, as long as the pipe with the sealing ring meets the requirements of this standard. Where the design of the socket is such that the sealing ring is not firmly fixed in position, the housing for the ring shall be so designed as to minimize the possibility of the ring being dislodged during insertion of the pipe (or spigot of a fitting) to complete the joint.

Elastomeric sealing rings shall be in accordance with one of the types (Type 1 to Type 6) of IS 5382. The manufacturer has to, however, specify the type of sealing ring (namely Type 1, 2, 3, 4, 5 or 6) that is being offered.

❖ **Solvent Cemented Joints**

The solvent cement used shall conform to the requirements laid down in IS 14182.

(D) Precast RCC Manholes

It is proposed to provide circular manholes. The general construction of the manhole shall be RCC Precast manholes as per the drawings attached. However the general specification for Pre-cast RCC manholes is also given here. The Contractor shall be responsible to ensure procurement and placement of the precast elements in position without any damage. The jointing of the various elements will be made so as to achieve the required water tightness. RCC pre-cast and RCC cast in situ elements shall be tested in accordance with the provisions of IS 456:2000.

The manholes shall generally conform to I.S. 4111.RCC works shall generally confirm to IS.456-2000. The location of manhole shall be as per the drawing or layout given by the Employer's Representative or as directed by the Employer's Representative. The Manhole dimensions and other details shall be as per the drawings **(Refer drawing no 40 of Section 9 of Volume 2)**. The Contractor, while constructing the manholes, shall suitably provide HDPE pipe connection lines for the house sewer connection to prevent the undue breaking of man hole or road in future, as directed by the Employer's Representative. The location of manholes shall be as per drawing or layout given by the Employer's Representative. The vent shaft connection shall be as per the drawing.

Pre-cast RCC M – 40 manhole & sewer chambers shall be procured / constructed simultaneously with the laying of sewers as per drawing and detailed specification.

RCC precast manholes shall be constructed as per drawings.

In case of Pre-cast RCC manholes, design mix concrete of grade M-40 shall only be used for the pre-cast manhole elements as per drawings.

The Contractor shall provide steel reinforcement as per design requirement in each Pre-Cast M-40 Grade Circular Rings including Starter Base Wall at the bottom of the manhole chamber, subject to a minimum of nominal reinforcement as per Code of “Practice of Plain and Reinforced Concrete” IS:456 2000. No extra payment shall be made to the Contractor on this part. The Contractor should therefore take provisions accordingly.

The drawings of the pre-cast eccentric conical piece and circular rings are based on the departmental designs. Contractor may study the design, drawings and specifications carefully and if felt necessary, may increase the sectional thickness, reinforcement or the grade of concrete suitably. No extra payment shall be made to the Contractor over the rates quoted by the Contractor for any modifications / changes proposed by him. The Contractor shall be fully responsible for the structural safety of the pre-cast manhole elements /components.

Any data or information received by the Contractor, from the department or otherwise, shall not relieve the Contractor from his responsibility for the design and execution and structural stability of the pre-cast elements.

(E) Eccentric Conical Piece in M40 Grade

- **General**

The work involves construction of Pre-cast RCC M-40 grade circular manhole chamber of designated diameter 1500mm for various invert depths including required excavation of earth in all types of soils such as murrum, sand, sandy silt, black cotton soil, hard soil, kankar etc. disposing of surplus excavated material within a lead of 50 meter. The work includes laying of 150 mm thick plain cement concrete 1:4:8 (1 cement : 4 coarse sand : 8 graded stone aggregate 20 mm nominal size) 1600/1800/2100 mm diameter bedding in foundation, providing and laying of plain cement concrete 1:2:4 (1 cement: 2 coarse sand : 4 graded stone aggregate) in channel & circular starter base wall up to 50 mm above outer dia. of sewer pipe and P&F in position of 125 mm thick 150/225 mm high Pre-Cast M-40 grade cement concrete ring at bottom and consecutive standard size 300 mm high rings. The work includes P&F pre-cast reinforced cement concrete eccentric conical piece of M40 grade, 125 mm thick having 560 mm and 1000/1200/1500 mm internal diameter at top & bottom respectively, fitted with Ferro-cement cover of 33 kg cast iron double seal ring & frame (heavy-duty) etc to withstand for class AA loading including supply and fixing of Ferro-cement footsteps and sealing of all joints with cement mortar 1:1 complete job as per detailed specifications, drawings and directions of Employer's Representative.

The height of the M-40 grade cement concrete circular rings of manhole can be increased only after the approval of Employer's Representative subject to a maximum height of 1.20 m for which no extra payment shall be made to the Contractor.

- **Top Eccentric Conical Piece**

Providing and fixing of Pre-cast RCC M-40 grade concrete eccentric conical piece for manhole manufactured using Weight Batching Plant.

Only Design Mix Concrete of Grade M-40 shall be used.

Shape: Eccentric frustum of cone of designated diameter and thickness as per the enclosed drawings and specifications

Testing: Apart from the usual strength test one of the concrete mix non-destructive test for strength of the concrete is to be carried out on sample piece of pre-cast manhole elements as per the instruction of Employer's Representative.

- **Circular Rings**

Providing and fixing of Pre-cast M-40 grade cement concrete circular rings for manhole chambers manufactured by using Weight Batching Plant.

Only Design Mix Concrete of Grade M-40 shall be used.

Shape: Circular in shape with end keys at top and bottom of designated diameter, height and thickness as per the enclosed drawings and specifications. The height of rings can be increased in the multiples of 30cms after inspection and approval of Employer's Representative.

Testing: Apart from the usual strength test one of the concrete mix non-destructive test for strength of the concrete is to be carried out on sample piece of pre-cast manhole elements lot as per the instruction of Employer's Representative.

The Contractor shall be responsible for the quality of the works during the executions of works with good Engineering practices. He shall, therefore, have his own independent and adequate setup for ensuring the same.

(F) PE Manholes

- **Scope**

This specification establishes the design, material, manufacturing and testing requirements for manholes fabricated from PE components.

- **Reference Specifications**

This specification references the standard American Society of Testing and Materials (ASTM) standard specifications, which are made a part hereof by such reference and shall be the latest edition and revision thereof.

ASTM D3261	Standard Specification for Butt Heat Fusion Polyethylene(PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing
ASTM D3350	Standard Specification for Polyethylene Plastic Pipes and Fittings Materials.
ASTM F714	Standard Specification for Polyethylene (PE) Plastic Pipe(SDR-PR) Based on Outside Diameter.
ASTM F894	Standard Specification for Polyethylene (PE) Large Diameter Profile Wall Sewer and Drain Pipe.
ASTM F1759	Standard Practice for Design of High Density Polyethylene Manholes in Subsurface Applications.

Definitions

Base:	The bottom surface of the MH either flat or shaped (benched).
Chimney:	A reduced diameter portion of the MH extending from the riser to the underside of the MH top (usually a cast iron frame and grate).
DVS certified	Deutscher Verband fur Schwei(3>en (German Welding Standards).
Fabricator:	The firm responsible for creation of shop drawings, and the accumulation of all components and the execution of the works to create the manhole produced in accordance with this specification and the shop drawings.
Inspector:	The authorized representative of the purchaser entrusted with the duty of inspecting the manhole or components used in the fabrication of the manhole, and witnessing tests performed under this specification.
Inspection:	Inspection of the components or the complete fabrication, by the inspector.
Manufacturer	The firm producing the riser pipe and stub out pipes.
Purchaser	The person, firm, corporation or government agency engaging in a contract or agreement to purchase a PE fabrication according to this specification.
Riser	The vertical body of the manhole.
Stub out	Short sections of PE pipe that are part of the manhole fabrication that are to be attached to the sewer connections to the manhole in the field. Stub outs may start inside the riser ID or they may be continuous extending through the MH.

Design Requirements

The manhole riser's performance limits are based on ring deflection, ring (hoop) and axial stress (or strain), and ring and axial buckling. Evaluation of suitability for service is to be performed in accordance with ASTM F1759 - Standard Practice for Design of High Density PE Manholes in Subsurface applications. Suitability for service is affected by the ground water level, and the characteristics and uniformity of the embedment materials. Confirmation of the 'suitability for service' and the 'as constructed' embedment is the responsibility of the Employer or his representative.

When the MH is to be installed in a location that is exposed to live loads, a live-load cap shall be designed to support these vehicular (or other loads); the cap foundation ring must be placed on well compacted embedment materials surrounding the manhole riser. The cap itself must be physically separated by several inches, as specified on the project drawings, from the PE manhole riser.

Delivery Storage and Handling

Delivery:	Manholes shall be prepared for standard commercial shipment unless otherwise specified. Delivery vehicles should be provided with a clean, flat bed, free of sharp objects. Care must be taken to prevent slippage or excessive bowing of the manholes. The load shall be well secured to prevent rubbing. Nylon straps, not chains or ropes, shall be used to secure the load. Do not rest manholes on the socket. Avoid contamination from chemicals such as diesel oil.

Storage:	All Materials should be carefully inspected at the time of receipt of delivery and any defects should be noted and reported immediately. Manholes should be placed on firm, flat ground to support the weight of the manhole and the lifting equipment. For safety it is recommended that manholes be stored away from heat sources. Protect all materials and equipment from theft, vandalism, accidental damage and contamination.
Handling:	Manholes can be unloaded from the truck by using a boom and sling arrangement that places lifting loads on the riser and not on the stub-outs. Chains or hooks should not be used.

- **Material Requirements**

Riser:	The riser shaft and chimney (if applicable), shall be made of PE plastic compound meeting the requirement of cell classification PE 334433C or E or higher as defined in ASTM D3350 (latest edition). The riser shaft shall be made of closed profile pipe meeting the requirement of ASTM F894. The chimney shall be made of closed profile pipe meeting the requirements of ASTM F894 or solid wall pipe meeting the requirements of ASTM F714.
Stub outs	Stub out pipe shall meet the requirements of closed profile wall pipe meeting the requirements of ASTM F894 or solid wall pipe meeting the requirements of ASTM F714, as applicable. When requested, the Manufacturer shall certify that the pipe materials used to manufacture manholes meet these requirements.
PE Plate	PE weld extrusion rod or pellets shall be produced from resin compounds meeting the same cell PE 334433C or E classification as that used to make the pipe components. Plate or PE blocks used as part of the fabrication shall meet the requirements of ASTM D3261.
Other:	Materials other than those specified above may be used as part of p'f3 =the manhole appurtenances (ladders, grates, etc.). Appurtenance materials shall be as agreed between the Manufacturer and Purchaser.

- **Fabrication Requirements**

Joints & Connections: All joints and connections between PE components shall be made by means of extrusion welding or fusion (heat, or socket) welding.

Where heat or socket fusion is used, it shall meet the requirements of ASTM F2620-Standard Specification for Heat Fusion of Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing.

Where extrusion welding is used, it shall be undertaken by joining technicians under the direction of DVS certified extrusion-welding trainers.

The manhole fabrication shall be factory leak tested with air or water to assess the integrity of all joints /connections. The factory test shall be completed in accordance with a documented testing procedure unless otherwise agreed to by the Manufacturer and the Purchaser.

The testing may be witnessed by the Purchaser's Inspector when the Purchaser so specifies on the purchase order. The inspector shall have free access to the inspection area of the manufacturer's plant. The fabricator shall furnish a certificate of compliance to these specifications upon request to do so in the purchase order.

- **Marking Requirements**

  Pipe used in the fabrication of a PE MH shall be marked in accordance with the requirements of the applicable pipe specification. The orientation of the riser shall be selected to maintain as much of the pipe marking string as possible.

  The MH shall have an affixed label adjacent to any locations where pressure gauges were located used to pressure test the fitting, indicating that the fabrication met the pressure testing requirements.

  Each extrusion weld made during fabrication of the MH assembly shall be identified using either an indenting tool or with a stamp (with initial(s) particular for each Contractor) applied on the extrusion weld seam. Root weld shall be identified in the same way, the only difference being the mark placement on the side of the weld. The identification shall consist of the Contractor's initials; the maximum depth of indent/stamp shall be 1/16" (approx 1.5 mm).

- **Weholite Manhole MS M 2312011**

  All fabricated MH's shall be identified with the Sales Order number, the nominal pipe size(s), RSC(s) or the riser, the location of production and date of production (e.g. HYYMMDD), and "Made in Canada", by permanent label affixed to the MH. In addition marking shall indicate drawing number.

  The MH shall be legibly marked in such a way as to not lower its quality and shall remain legible after installation and inspection.

- **Joining Methods**

  PE Pipe shall be extrusion welded to PE manhole(s) by manual extrusion welding techniques on both the interior and exterior of the manhole. When the PE mainline pipe is a closed profile pipe, several extrusion jointing details are possible. One of the following joint types shall be used for joining pipes.

  Interior (or exterior) v-welded joint. This joint is suitable for direct burial of gravity flow pipes subject to long term positive head up to 5 psi.

  Interior and exterior v-welded joint. This joint is suitable for direct burial of pipe subject to long term positive head exceeding 5 psi.

  Full wall welded joint. This joint is suitable for direct burial of pipe subject to long-term positive head exceeding 5 psi.

- **Interior and Exterior V-Welded Joint**

  External band clamps may be used to assist with pipe alignment. The external clamp shall be placed by the Contractor under the direction of the pipe manufacturer's Field Service Technicians. Temporary internal braces or jacks may also be used to assist with pipe wall alignment. Pipe ends shall be positioned to align the "Profile cut" notches and to provide the maximum amount of surface contact between adjacent pipe faces while minimizing or eliminating the space between pipe ends. Welding is completed using the manual extrusion welding procedure recommended by the pipe manufacturer on the wall of the pipe profile. In most cases the internal v-weld will be completed and then the external alignment band clamp will be removed to complete the exterior v-weld. It will be necessary to provide access to the weld 'work area' by removing temporarily the bedding material under the joint. Once all the extrusion welding work is completed at the joint, the bedding material must be replaced and compacted in accordance with the contract requirements.

- **Full Wall Welded Joint**

  External band clamps may be used to assist with pipe alignment. The external

clamp shall be placed by the Contractor under the direction of the pipe manufacturer's Field Service Technician(s) or other approved persons. Temporary internal jacks may be placed to assist with pipe alignment. Pipe ends shall be positioned to align the 'Profile cut' notches and to provide a suitable equally spaced gap between pipe ends. Extrusion welding is completed by the pipe manufacturer's Field Service Technician(s) or other approved party(s) using semi-automated extrusion welding equipment and procedure.

(G) Manhole Frame and Cover

- **Steel Fibre Reinforced Concrete (SFRC)**

The selection of samples per lot for testing, failure percentage, no. of test, Concrete mix curing, etc shall be as per IS 12592 (part-I) for Pre-Cast Concrete Manhole Cover. The load of class AA shall be as per IRC guidelines.

The Manhole cover shall be heavy duty whereas for Road Side Chamber Cover and frame shall be medium duty in Steel Fibre Reinforced Concrete (SFRC) and shall confirm to IS 12592 (Part I & II) except for the scraper manhole. The inspection and testing for these shall be done by Third Party agency also in the presence of Employer's Representative or his representative. The load test shall be done in accordance with Table 1 of IS 12592 (Part – I).The cover & frame shall be manufactured as shown in drawing. The frame of manhole opening shall be in Cast Iron whereas manhole cover is in SFRC as shown in drawing.

- **Ductile Iron Manhole Covers**

✓ ***Standards***

The manhole top (cover and frame) shall comply with EN 124:1994 class D 400 (test load: 400kN). It shall be manufactured from spheroidal graphite cast iron complying with grade 500-7 or 400-18 of ISO 1083. Offers are to clearly state which grade of spheroidal graphite cast iron is being offered.

✓ ***Frame***

The clear opening of the frame is to be 600mm X 900mm and depth not less than 100mm. On removal of cover, the frame opening is to be completely clear, with no central support member.

✓ ***Cover***

The frame shall have keyholes and piercing slots for the removal of the cover. The cover shall be of the slide out type and not of the lift off type and shall be removed by lifting one end then sliding out rather than direct vertical lift, thus reducing the effort needed for removal. The cover shall be ergonomically designed to allow smooth and easy removal of the cover by a sliding out action carried out by one operative only. The cover shall slide out without the danger of falling into the manhole. For the 600mm x 900mm frame, the cover shall be in two double triangular sections. Each double triangular section shall be removable by sliding out as one section. The pairs of triangles shall be loosely bolted together for safety.

✓ ***General***

The manhole top shall not vibrate and generate noise when subjected to vehicular traffic. The manhole tops supplied shall be clearly cast and free from air holes, sand holes and any other defects. All items shall be free from any voids that may result from shrinkage, gas inclusion or any other cause. Furthermore all covers and frames shall be neatly dressed and carefully fettled.

✓ ***Coating***

The manhole tops shall be supplied with a protective black coating. The coating shall be smooth and shall not flow when exposed to high temperatures and shall not be so brittle as to chip off at low temperatures. The minimum thickness of the protective coating shall be 50 microns.

✓ ***Markings***

All covers are to be marked as per clause 9 of EN 124:1994, including cast symbols certifying quality compliance. Furthermore each cover shall also bear the name WSC marked in letters having a minimum height of 3 cm.

✓ ***Quality Assurance***

Only suppliers who have in operation at their manufacturing facilities a quality assurance system in accordance with ISO 9001:2008, with certification for production function, will be considered. For this reason manufacturers are to submit certifications to this regard, from accredited inspectors with the tender documents.

FRP Manhole Covers

FRP Manhole Covers are made using thermoset material for long term durability. The material comprises of cross-linked polyesters combined with Fibreglass reinforced materials to sustain against wear-n-tear for heavy load vehicular traffic. It is 40% lighter than traditional Precast Concrete and Cast Iron covers. Provides upto 5 times more compressive strength. This resilient material withstands constant exposure to weather or sun without sacrificing security or aesthetics.

❖ **Standard Sizes Available**

Square	Rectangle
450mm x 450mm	450mm x 600mm
600mm x 600mm	450mm x 900mm
900mm x 900mm	600mm x 900mm

Gully Grating:	Round
450mm x 450mm	530mm Dia Clear opening
600mm x 600mm	600mm Dia Clear Opening
900mm x 1200mm	900mm Dia Clear Opening

Other Custom Sizes are also available as per requirement of site.

5.5.2 Sewage Pumping Stations

Sewage Pumping Stations shall have to be installed to lift sewage (dry weather flow) from the drains flowing into the Amanishah Drain, the Collection Pipe along Amanishah Drain, from the existing outfall sewer to Delawas and also for pumping treated effluent from the STP to its proposed destination on the Amanishah Drain. It is proposed to have wet sumps with submersible pumps. The design of the SPS shall generally follow the stipulations in the latest version of Manual on Sewerage and Sewage Treatment System published by the CPHEEO.

5.5.2.1 Location

The location of SPS should be selected to ensure that it is protected from flooding. The site selected should have adequate space and should have access in all weathers. Due considerations should be given to its visual impact, particularly the vent tube, odors, noise problem etc. It should be suitably located keeping in view

the location of source, destination and power supply system.

5.5.2.2 Design

The design of all SPS shall be based on the projected daily discharge for next ten years to be lifted.

(A) Inlet System

It will constitute of an inlet system from the source drain/sewer and the construction as required to tap into them and connecting sewer that will come and terminate in an Inlet Channel, a sump, pumping system and delivery system to the destination.

- **For Existing Drain**

In case of the inlet on a drain, it will have to constitute of structure in the drain that will be capable of taking in the entire dry weather flow during period other then monsoon. It shall also ensure that there is no back flow from the Amanishah water way to be constructed into the SPS inlet system. The system has the two objectives:

To pick up full dry weather flow and transfer to SPS

To allow passage of the monsoon flow into the Amanishah Drain after ensuring that there is no floating mater that goes into it and no large material goes into the Drain. Thus the flow going to the drain has to also pass through coarse screens. The coarse screens can be placed on this main drain. The contributing drain should also which be converted into a proper lined drain from before the coarse drain and to the connection to Amanishah Drain.

- **From Existing Sewer**

In such case the sewage as required should be taken from the selected manhole. It should be ensured that a minimum dry weather flow remains in the parent sewer to maintain self cleansing velocity. The sewage taken should pass through coarse screens before entering the SPS.

- **Treated Effluent**

This should be allowed to go into Amanishah Nallah.

5.5.2.3 Particular Specifications

Particular specifications of the SPS components are as follows:

(A) Inlet Channel

The inlet channel should have at least two stream with gates at entry to isolate flow in either of them. Coarse screen will have to be installed in them unless the sewage has already passed the coarse screen in the drain from where it has been tapped and screens are also not required when pumping treated effluent.

The Coarse screens will be provided in each stream. They will be provided with openings of 40 -50 mm between bars for manual cleaning and 25 mm spacing for mechanical cleaning. Generally coarse screens will be manually operated for pumping streams with 100 lps or less flow and mechanically operated for > 100 lps flow. In case of mechanical screens, at least one additional manual screen will be provided as stand by. Appropriate arrangement will be made to bifurcation of the flows between the two sections of sump and for mechanical removal of the screenings from the channel. Proper access will be provided to the screens.

The inlet channel should have a free fall in the sump when it is full to its design

capacity.

5.5.2.4 Pump Sump

(A) Capacity of Sump

The sump should either have two parallel wells or a single sump with a divider wall and be interconnected through a gate.

The capacity of the sump shall be decided taking into consideration the number of start per hour of the pumping cycle. It should not have more than 6 cycles / hour. The total sump capacity should be not more than 30 minutes of average flow. The volume required should be below the bottom level of the incoming channel.

The depth of the wet well required is also governed by the depth of submergence needed for the submersible pump set, the height of the submersible pump set and the floor clearance required.

The floor should have benching like a hopper with a minimum slope of 1 vertical to 1 horizontal to enable suspended solids to drain into the hopper and pumped out without depositing on the entire flow. In the case of submersible pump, the floor shall provide horizontal access to permit easy installation of present and future pumps

(B) Structural Design Criteria

In respect of civil structural design, all wet wells shall be designed to withstand soil water pressure as though it is at ground level itself irrespective of actual water level, to take care of contingencies of flooding and marooning of the stations. In addition, the stability of the base slab shall be checked for resisting moment by considering the weight of the slab alone and neglecting the weight of the sidewalls. Pressure relief valves for soil water uplift should not be encouraged in wet wells and IS: 456 & IS: 3370 shall be followed. All civil works in contact with sewage shall be constructed with either brick work or RCC and in both cases sulphate resistant cement alone shall be used. In RCC, Fusion Bonded Epoxy coated reinforcement steel having not less than 175 to 300 microns shall be used for reinforcement.

Epoxy coating will be done over the inner face of the screen well / grit well 1 m above the maximum sewage water level.

The structure will be designed using a mix M25 or richer.

(C) Switch Room

The switch room can be located over the sump or can be placed separately. The land is very expensive and minimum land should be used. The switch room will house the power distribution panel and pump panels and the automation instrument panel. The switch room should provide an almira for storing records, and minimum furnishing for operating staff. The room will be properly illuminated and ventilated with fan also. The switch room can be RCC framed structure with hollow concrete bricks.

The pumping stations will be provided with fencing main gates, illumination inside the pumping station and outside also, furniture for attendant and storage space for record keeping. Proper ventilation will be provided in the switch room. All opening will either be provided with railings or grating to prevent any accidents.

(D) Ventilation

The Pump sump shall be provided with a separate ventilating system and shall be sized to provide a minimum of 10 air changes per hour. Ventilation systems shall

be capable of matching inside air temperature to outside air and shall be automatic. Ventilation shall be accomplished by the introduction of fresh air into the pump station under positive pressure. The air shall be filtered to remove particulates inside the pumping station. The outgoing air should be released in a manner so as to not be nuisance to the residents.

(E) Delivery System

The internal piping in the pumping station and upto the common header if provided will be MS/DI pipes of suitable diameter and thickness duly painted keeping into account the possibility of corrosion and pressures on the system.

In case the delivery from pump can be directly terminated separately in destination receiving station, no valves need to be provided on the same.

Electrically operated sluice valves and an NRV on individual delivery pipe of the pump if the deliveries go and merge with a common header. A main valve and NRV on the common header if it merges with flows of other pumping stations.

The long delivery pipes shall be HD pipes. The long delivery pipes will have to be provided with air release and air/vacuum release valves and surge protection system as required.

The design velocity for pipes in short delivery upto about 600m can be kept upto 2.7 m/s at peak load and not less than 1 m/s at lean flows as far as possible.

Electromagnetic/ultrasonic flow meters on delivery in the header pipe.

(F) Data Acquisition and Fully Automatic Operation of Pumps

The SPS shall be of fully Automatic operation with manual over ride. The SPS are linked to any of the STP and the operational data from each of the SPS shall be transmitted to the related STP by use of SCADA. The system will comprise of following:

- Data acquisition:
- Programmable Logic control system
- Data recording and transmission SCADA
- Alarms

The following data will be acquired on line:

Data Acquisition

- The online data to be acquired at each pumping station
- Electro-Magnetic Flow Meter at the Header
- Pressure in Header
- Ultrasonic Level Measurement at Sump
- Continuous Online Total Suspended Solids Analyzer
- Pumps in operation log
- Power Meter

Logic Control

The logic control system will be pre-programmed for operating the pumps based on the progressive change in the data related to level in sump, sequence of operation of the pumps. The key to the whole issue is to recognize the pre-set programming which may have to be validated for different seasons like monsoon, normal and drought. For this purpose, these controllers are referred to as programmable logic controllers (PLCs). These are custom designed. They also generate visual and audio alarm for very high levels and very low levels.

- **Onward transmission of Data**

The data acquired at each SPS shall be transmitted to a control centre where a` log will be generated in the control station in the connected STP.

- **Alarms**

The system should provide alarm for very low level and very high level as visual indicators and audio in both the SPS and related STP control room.

Visual Alarm should also be given for pumps out of order.

5.5.2.5 Technical Specifications

(A) Civil Works

- **Survey Work**

The Contractor shall carry out detailed survey work and submit both soft and hard copies of contour drawings with spot levels with 10 m x 10 m grid to the Employer

Necessary information such as reference to the location as proposed for the pumping station by the Contractor, with respect to site boundary.

- **Geo-technical Investigation**

The Contractor shall carry out Geotechnical Investigation work at the proposed location of pumping station.

The no. of bore holes to be taken, depth of boring etc. shall be decided in consultation with the Employer's Representative.

The Contractor has to provide the hard and soft copies of the test reports.

- **Hydraulic Design**

Hydraulic design and layout plan of the Lift station – shall be carried out by the Contractor.

While designing, the Contractor shall consider the invert level of the existing sewer/ Nallah, the length of connecting pipe, IL of incoming gravity sewer at inlet and the survey and soil investigation details.

Drop from the invert level of connecting sewer to the inlet Chamber of pump house shall be 0.5 m.

The Contractor shall have to submit the design calculations (both soft and hard copies).

All above arrangements are under scope of work of this project. Contractor shall also consider necessary shutoff / diversion / temporary pumping arrangement for connection / diversion of existing sewer to the inlet chamber of proposed pumping station. Contractor shall consider all cost of above works in the quoted price and nothing extra shall be paid on this account.

The Contractor shall provide the detailed layout plan, hydraulic flow diagrams and supporting design calculations and references wherever required.

- **Structural Design**

The Contractor shall have to submit the structural design calculations (both soft and hard copies), General Arrangement and Structural working drawings. These design/drawings should be vetted from IIT.

The design of units shall be governed by the survey details, geotechnical investigation details like safe bearing capacity, settlement, depth of water table below ground level, seismic forces etc. Horizontal struts may be allowed if required, however it should not create hindrance in the operation and

maintenance of the overall system.

All concrete and steel structures in contact with Sewage / Treated Sewage / Sewage gas (i/c free-board area) shall be provided with corrosion protection as per specifications or as directed by Employer's Representative.

- **Construction of Pumping Station and annex buildings**

There shall be a valve chamber with scouring arrangement, attached to the sump to accommodate common header, valves and other accessories.

Sump shall be open to sky with necessary staircase to access to the sump. One no. of RCC staircase shall be provided in wet sump and MS ladder (one no.) shall also be there to maintain accessibility.

The Contractor shall provide sufficient ventilation arrangement in sump/pump house.

The sump/pump house shall be designed to keep adequate space between pumps and walls.

The flooring in the machine – bearing parts shall be by ironite / Metallic Hardener flooring.

The pump foundations shall withstand the static as well as vibratory forces of the pumps.

Connection of sewerage of toilet block to the nearest disposal point.

Sizes of various buildings shall be as per requirement,

(B) Mechanical Equipments for Pumping Station

The components to be designed, supplied, installed, tested and commissioned by the Contractors shall include but not being limited to –

- Design and installation of submersible pumps with motors, valves, piping and instrumentation complete as per requirement.
- The Contractor shall provide pumps with working and standby as per CPHEEO guidelines e.g. average, factorized average and peak flow combinations for the pumping station. All the pumps shall be of similar characteristics, suitable for parallel operation. Head of the pump shall be based on the design calculations.
- There will be one common header, the size shall be designed as per Pump arrangement/requirement and rising main designed for peak flow capacity. Material of Common header/rising main shall be DI K-7 (min). Individual delivery line shall be provided with necessary valves, non return valves, sluice valves, dismantling joints and instrumentation etc. Further common header shall be provided with a separate sluice valve. After common header, there will be one no. of Electromagnetic flow meter. In the main Delivery line, Sluice Valve/Isolation Valve/Scour Valve shall be provided as per norms/site conditions along with dismantling joints of suitable size. The head of the pumps shall be as per design requirement. Contractor should also submit necessary design calculations as per the proposed alignment.
- Flow measuring devices - One no. of electromagnetic flow meter of suitable size for rising main from pumping station, shall be provided
- Sluice Gates shall be provided on seating side. Electrically operated CI sluice gates of required size and no., shall be provided.
- Connection point of proposed sewer to the main inlet chamber of pump house isolation sluice gates on both sides of manual and mechanical screen channels

- Contractor shall provide two no. of screen channels (1 working + 1 standby), each designed for peak flow.
- Material of the construction of screen shall be stainless steel (SS 304).
- Required no. of Isolation gates shall be provided on both sides of screen channels. Gates shall be electrically operated CI sluice gates.
- Power, control and instrumentation systems, associated accessories and cabling, earthing etc.
- Surge protection systems
- EOT cranes suitable capacity for installation or maintenance of pumps and motors
- One no, of DG set of full design load capacity

(C) Electrical, Instrumentation and Automation

The Contractor shall have to do the design, shop testing, supply, transport, storing at site, erecting, testing and commissioning all electrical equipments, instruments and automation system, required for the pumping station & rising main (within the pumping station premises) as per general specifications, specific specifications for electrical work, typical power distribution scheme and as per specifications of control system architecture. Operation of the plant shall be fully automatic control through DCS based automation system.

(D) Raw Sewage Rising Main

From the proposed lift station, sewage will be pumped through a rising main up and shall comply the followings:

Hazen William coefficient for DI (K-7) rising main shall be taken as per CPHEEO manual. Contractor shall design the head of pumps considering all above conditions.

The scope of work of rising main includes design, manufacturing, supply, laying and jointing, of pipeline as per specifications, testing as per manufactures specification and as per CPHEEO manual, commission and Trial run including operation and maintenance.

The scope of work shall include but not to be limited to.

- Submission of design calculation along with alignment and L-section with location of different types of valves and appurtenances.
- Contractor shall also prepare a hindrance plan, according to which the route shall be finalized in consultation with Employer's Representative.
- Excavation for trenches in ordinary soil/ hard dense soil/ hard dense soil mixed with boulders/saturated soil. For laying pipeline below ground a minimum clear cover of 1.0 m shall be maintained.
- Wherever the pipeline is laid with an embankment to provide minimum specified cover, the embankment shall be so constructed so that it does not create pounding of water.
- Providing scouring arrangement at suitable location (as per site conditions) and of size (area of each valve should not be less than 1/3rd of the area of pipe line) for smooth cleaning of the pipe line whenever is required into the nearby disposal point. Min. No. of valves provided should be such that entire pipeline can be drained out in 3 hrs. A dismantling pipe with flexible joints, RCC / brick work valve chamber and disposal pipe for required length, shall also be provided along with each scour valve. Necessary scour protection shall also be provided to the disposal point in the drain.

- Detailed drawing proposed to be used shall be presented to Employer's Representative for approval.
- Providing, Testing and installation of kinetic double air valves of required size (as per CPHEEO manual) and at required locations as per design requirements. Kinetic double air valves shall be provided at all convexities of L-sections. Detailed drawing of air valves proposed to be used shall be presented to Employer's Representative for approval.
- Providing Expansion Joints as per specifications where the pipeline is exposed to atmosphere.
- Construction of thrust blocks/fixity block of Min. grade M 25 RCC at required locations for deflection in horizontal and vertical alignment of pipeline.
- Construction of RCC/brick chambers (with SFRC covers) to house all type of valves to be installed on rising main.

(E) General Utilities

For the proper functioning of the proposed works of pumping station, connection with sewer lines, screens and rising main, the other general utilities necessary, shall also be included under this Contract but not be limited to the following are :

- Access to the site from the main road
- Main gate, Site development and general site fill etc.
- Internal road network, connection of internal road to main peripheral road, construction of boundary wall, horticulture, landscaping, storm drainage, outdoor lighting, water supply and sanitation, storm water drainage, waste disposal etc.
- Electric substations and distribution of power supply to all Street and yard lighting and fire hydrant system for pumping station and other units
- Miscellaneous buildings, maintenance facilities, workshop etc.
- Telephone and other modern means of communication for pump house with various units of the complex i.e. main substation, DG room, control room, office building, store etc.
- Necessary silt trap to be provided at a suitable location with continuous silt removing mechanism.

(F) Safety Equipment

Safety Equipments should be provided at pumping station. Contractor shall also take care of safety compliance as applicable from time to time as per safety rules/Factory act/Indian Electricity regulations/manuals/manufacturer's special instructions. Contractor shall also follow standard safety code.

5.5.3 Sewage Treatment Plants

The second part of the contract relates to dealing with the dry weather flow entering the Amanishah Drain at intermediate locations.

5.5.3.1 Influent and Effluent Parameters

The influent sewage quality is estimated to be of following parameters:

S. No.	Parameter	Value
1	pH	6.5 – 8.0
2	BOD @ 25^0 C	200 - 300 ppm
3	COD	350 – 500 ppm
4	TSS	300 – 400 ppm

S. No.	Parameter	Value
5	Oil and grease	10 – 20 ppm
6	Total Nitrogen	40 – 50 ppm
7	Total Phosphorous	6 – 8 ppm
8	Coliform (MPN/100 ml)	10^9 - 10^{10}

The treated effluent should meet the following characteristics

S. No.	Parameter	Value
1	pH	6.5 – 8.0
2	BOD @ 25^0 C	< 10.0 ppm
3	COD	< 50 ppm
4	TSS	< 10.0 ppm
5	Oil and grease	< 5 ppm
6	Total Nitrogen	< 10 ppm
7	Total Phosphorous	< 2 ppm
8	Coliform (MPN/100 ml)	10

It is proposed to have the water body which should have water quality to meet the standards for aquaculture i.e. as per the class D stipulated by the CPHEEO as

pH 6.5 to 8.5

DO > 4.0 ppm

Free Ammonia < 1.2 ppm

The Contractor shall have to provide additional treatment as required to the effluent from STP to meet this standard in the entire stretch of the water front.

The water front should have water in the entire width of the finished drain and it will therefore be necessary to provide for small check dams and falls. It should also be ensured that there is a continuous flow of water over the check dams so as to provide a good aesthetic view and maintain a good level of DO. The minimum depth of the water to be maintained should be 30 cms in the entire length with at least 3 cm over the check dam level and over the proposed falls. The Contractor shall have to propose the locations and heights of the check dams for approval of the Employer.

This water body can be used as a source for using the water for suitable purposes (horticulture, construction, flushing in group houses with separate pumping and hydrants)..

5.5.3.2 Capacity of STP

The Contractor is to provide STP for treating sewage/waste water which shall include:

All dry weather flow finding it's way into the Amanishah Drain is to be prevented from entering the drain, collected and treated in STP to required standards. The capacity of collection of waste water from the drain should be adequate to cater for all possible dry weather flow during next 10 years with provision for extending the same for 30 years. The inlet system has to be designed so as to:

- To By – pass surplus water during monsoon to the Amanishah drain without treatment.
- It is, however expected that the dry weather flow will reduce with better coverage of sewerage systems and waste water will be collected through sewers. It is proposed to construct collection drain pipes on both sides of the Amanishah Drain in parallel to collect the waste from these inlet chambers. The waste in the open drains will flow by gravity in these collection drain pipes upto a point selected by the Contractor on the alignment of the drain pipes for

pumping it out for treatment.

- Minimum 50 MLD sewage is to be tapped from the existing outfall sewer leading to the Delawas STP. The Contractor shall be free to tap into this outfall at locations of his choice subject to availability of space for pumping station and ensuring that remaining flow in the existing outfall is adequate to maintain self cleansing velocity at peak.
- The Contractor is to work out the location and capacity of the STP he needs to provide for meeting the above requirement and also to provide for additional demand to maintain 24 hrs flow of water in full width of lined drain (Ch 5.1 km to 34.8 km) proposed to be constructed under this project at minimum stipulated depth.
- The capacity and location of STP will be governed by availability of raw sewage and the need for maintaining flow in the full lined length of the drain and also meet the need for use of the recycled effluent in the site development along the banks, construction activity and use in flush and washing in nearby group housing and evaporation and seepage losses.
- A minimum capacity of treating 170 MLD waste water will have to be provided even if the Contractor assesses a need of lesser capacity at his end to meet the stipulated requirements.

Sludge

The sludge produced should be well digested aerobic sludge in cakes with 20% (+/- 2%) or less moisture content.

5.5.3.3 Design Philosophy

The sewage treatment plants to be Designed, Build, Tested and Commissioned by the Contractor shall comply with the guidelines contained in "Manual on Sewerage and Sewage Treatment" Latest Edition published by the Central Public Health & Environmental Engineering Organization (CPHEEO), Ministry of Urban Development, Government of India. The Technical Standards and Specifications contained in this contract shall be read along with the following standard specifications (latest versions) published by the Bureau of Indian Standard listed below: The list is not exclusive and the Contractor shall be responsible to follow the appropriate standards:

- IS 6280 – 1971 – Sewage Screens
- IS 8413 – 1982 – Biological Treatment Equipment – Part II and its modifications
- IS 10037 – Part I – 1981 & Part II & III – 1983 – Sludge dewatering equipments
- IS 10261 – Requirements for settling tank for waste water
- IS 105533 – Part I, II, III – Chlorination Plants
- IS 5600 – 1970 - Sewage and Drainage Pumps
- IS 6279 – 1971 – Grit Removal devices

(A) General Quality Standards

The term "General Quality Standard" means a standard of performance which,

- is competent, efficient, economical and in accordance with internationally accepted techniques used in the sewer disposal and civil works construction industries;
- is in accordance with professional engineering, accounting and consulting standards, as applicable, recognized by national or international professional

bodies;

- is in accordance with sound management, commercial, technical, design and engineering practices;
- employs appropriate technology and safe and effective equipment, machinery and methods;
- is in accordance with national and local standards and codes in the Employer's Country;
- protects the interests of the Authorities;
- is in accordance with the Applicable Law;
- is in accordance with the technical specifications and design standards of the Employer as provided to the Contractor;
- is in accordance with the applicable Environmental Assessment and Environmental Management and Mitigation Plan; and
- is in accordance with the Design-Build Documents as approved by the Employer.

In the event of any conflict or inconsistency between any standards that comprise the General Quality Standard, local and national standards in the Employer's Country shall prevail over international standards.

The Contractor shall, at all times, carry out the Services in accordance with the Technical Standards as specified and, where a specific technical standard of quality of performance has not been specified, the Contractor shall perform the Services to the standard of "General Quality Standards".

If the Employer is subjected to fines or penalties as a result of the Contractor's breach of these Technical Standards, such fines or penalties shall be paid by the Contractor.

(B) Design-Build Services

In respect of the Design-Build Services, the Contractor shall ensure that the design of the STP is prepared by qualified designers who are professionally recognized to design the Sewage Treatment Plant and allied services.

The Contractor warrants that the Contractor and its designers have the experience and capability necessary for the design.

The offers shall be based on the Contractor's own design and operating philosophy which is to be based on the selected modern treatment technologies and should be within the overall framework and guidelines specified in the bid document and its specifications. The Contractor's design for the entire facility shall be such that the project shall

5.5.3.4 Sewage Treatment Process

It is intended to leave the choice of the treatment process to the Contractor so as to achieve the objective standards. The Contractor should however fulfill the experience and satisfactory performance of the process as laid out in the qualifications requirements:

(A) General Stipulations

All components (including but not limited to equipment such as pumps, blowers, screens, diffusers, inline devices; instruments such as flow meters; and distribution and collection channels or pipes) shall be provided with appropriate isolation devices such as valves, gates, or other devices in order to allow isolation, drainage, cleaning, calibration, servicing, and maintenance of such components.

Bypasses shall be provided around all flow meters and other in-line instrumentation such that the instrument can be isolated and removed for calibration and maintenance without interrupting the flow, regardless of whether or not such bypasses are shown in any drawings included in the Tender Document.

Where necessary, equipment shall be provided with acoustic, sound-dampening enclosures to limit ambient noise during normal operation to the limits. Such enclosures shall include ventilation and/or cooling provisions as necessary to prevent overheating and ensure operation of equipment at optimal temperature.

All equipment shall be arranged and buildings and structures designed to permit safe and easy access to and removal of all equipment.

Fixed runways, lifting eyes, cranes, trolleys, hoists, and/or other appropriate devices and means shall be provided to permit safe and easy removal of all mechanical, electrical, and instrumentation equipment and components for maintenance or any other purpose. Overhead bridge cranes with 3-way electric movement shall be provided for aeration tank pumps and blowers, in Digester Control Room for Gas Compressor. Lifting systems shall be of sufficient capacity to allow lifting of entire assembled equipment units (e.g. pumps, blowers, or other) one unit at a time.

All liquid or sludge flow distribution shall be accomplished using one of the following options only:

- non-submerged (i.e. with a positive free fall from weir invert to the downstream water surface) overflow weirs,
- non-submerged downward opening overflow weir gates, or
- PLC-based automatic feedback flow control using inline flow measurement and
- modulated flow control valves with electrical actuators.

All gas flow distribution shall be using PLC-based automatic feedback flow control using inline flow measurement and modulated flow control valves with electric actuators.

Any other means of flow distribution shall not be acceptable.

All structures, whether liquid-holding or not, shall be designed such that they can be fully and completely drained and will not float or move when empty, because of groundwater buoyancy or any other reason. The structures shall be designed to counteract any possible floatation without the use of any type of groundwater pressure relief valves.

The floors of all liquid-holding structures (including but not limited to channels, tanks, basins, reactors, clarifiers, etc.) shall be appropriately sloped and trenches and drain sumps shall be provided at the bottoms of such slopes to facilitate complete drainage of liquid. Appropriate drain pipes and valves connected to the drain sump(s) shall be provided for all structures. Where the drain pipe connects to the structure, the top-of-pipe elevation shall be at least 150 mm lower than the lowest floor elevation for the structure. The drain piping shall be routed from the structure being drained to the Filtrate Pump house and shall be continuously sloped downward in the direction of flow with a minimum slope of 0.5 percent. For liquid-holding structures, the drain piping and fittings shall be sized such that the entire contents of a full single tank can be drained by gravity in no more than six (6) hours. The Filtrate pump house, Pumps, and other related equipment and controls shall be designed and sized to allow draining of the structure with the largest volume from full to empty within six (6) hours. The highest design water

level (with alarm system) in the Filtrate pump house wet well shall be at least 300 mm lower than the lowest pipe invert elevation amongst all drain pipes connecting to the wet well.

Non-liquid-holding areas, structures, or buildings where leakage or other wet activities can occur, whether in normal use or during maintenance, shall be provided with covered drainage channels which shall direct the spillage and any washings shall be suitably drained to the sump of Filtrate pump house.

All channels below ground level carrying process liquid shall be fully covered with solid non- skid GRP cover plates (not grating) designed for human traffic live loads at a minimum, and heavy vehicle live loads wherever the channel crosses traffic paths. Other channels of which top of wall (TOW) is less than 1.0 m above ground level, suitable hand railing shall be provided as per the site requirement.

All interconnecting channels shall be designed for peak flows.

Inlets into tanks, reactors, or other structures via pipes, channels, valves, or gates shall be designed such that the incoming flow does not cause any damage or excessive wear whatsoever to the structure or any equipment in the vicinity under any hydraulic condition, including but not limited to the condition when the structure is empty.

All piping shall be fully and adequately supported and braced to comply with all applicable codes and standards. Pipe supporting hardware shall also be of corrosion-resistant material. The design of pipe supports and anchors shall fully account for static and dynamic vertical, lateral, longitudinal, and seismic loads, fluid flow, and thermal expansion. Seismic bracing, thrust restraints and/or thrust blocks, and appropriate expansion joints or loops shall be provided as needed. Pipe lengths and joints shall be assembled and arranged for ease of removal in such a way that individual runs can be changed without dismantling adjacent pipes, by providing dismantling joints at regular intervals.

For liquids and sludge, the minimum velocity of full flow in pipes or conduits shall not be less than 0.6 m/s and the maximum shall not be more than 1.5 m/s for pump suction and not more than 1.8m/sec on delivery side of horizontal pump and in case of submersible pump not more than 2.1 m/s for pumped discharge. All mixed liquor and sludge pipes shall have minimum 200 mm diameter and shall be provided with appropriate cleanouts and flushing arrangements for safe and easy flushing using high-pressure water. The normal pipeline peak flow velocity for gases shall not be more than 25.0 m/s.

For liquids and sludge, the minimum velocity of flow in open channels or partial flow in pipes or conduits shall not be less than 0.6 m/s and the maximum shall be no more than 1.5 m/s.

All underflow sludge service pipes shall be provided with appropriate means for safe and easy drainage of the pipes when not in service.

All pipes shall be colour banded and suitably labelled with the stream designation and direction of flow at suitable minimum 5- meter intervals throughout their run, as per site requirement.

All piping shall be arranged without clutter and shall be functional and neat in appearance.

Where piping is installed in ducts, it shall be supported not less than 150 mm above the floor.

All piping routed under any type of structure or equipment shall be fully and

completely encased in cement concrete, with the encasement thickness beyond the outer diameter of the pipe being at least 200 mm on all sides. The encasement shall extend along the pipe length for a minimum horizontal distance of 1500 mm in each direction beyond the footprint of the overlying structure or equipment.

All piping connecting to, entering, or exiting any and all structures shall be provided with appropriate restrained flexible connections and/or joints at all such interfaces with structures to allow for differential movement between pipe and structure in all directions without stressing or breaking the pipes.

Appropriate restrained flexible connections and/or joints shall be provided for all pipes where they connect to any and all of the following:

Equipment such as pumps, blowers, or inline devices, Valve

(B) Wall, Floor, or Roof Penetrations

Where piping or other materials susceptible to damage from ultraviolet radiation are employed, they shall be protected from such radiation through the use of appropriate additives and/or coatings and shall be physically shielded from direct sunlight at all times in their normal service locations using enclosures, covers, canopies, roofs, and/or other similar means.

Platforms, handrails/guardrails, ladders, and stairs shall be provided where necessary for proper, safe, and easy access to and/or operation of valves, gates, instruments, control panels, and other devices, equipment, or structures.

All units should be interconnected at the operating level by proper walkway so that all the units can be accessed without going down to ground level.

Appropriate sampling ports and/or sampling valves shall be provided to allow easy, safe sampling of all process streams without spillage or contamination and without the need to interrupt normal operation.

The influent flow meter and influent sampling location shall be selected such that the true influent flow and characteristics will be measured without inclusion of in-plant recycles or other extraneous streams. Separate flow measurement and sampling shall be provided for the recycle streams.

Foam, scum, fats, oil, grease, or any other floating material removed from any location in the plant shall be completely removed from the process flow path along with waste, digested, and/or dewatered solids leaving the plant and shall under no circumstances be recycled or returned to any location in the plant.

(C) Plant Layout and Hydraulic Profile

The General plant and process requirements shall governed by the stipulations in the latest CEPHEEO Manual and the stipulations adopted in the reference plant used for prequalification (provided the plant has performed satisfactorily). The Contractor shall provide independent detailed and optimized layout and hydraulic design, which shall fully comply with the requirements and constraints specified.

The Contractor’s layout and hydraulic design shall comply with the following specific constraints and all other requirements described in the Tender Document:

- The entire treatment process right from inlet point till final discharge location after treatment within the plant boundary shall be by gravity alone. Intermediate pumping in this flow path shall not be permitted.
- For all structures containing water, process liquid, or sludge, the minimum freeboard (distance by which top of wall is higher than the maximum level of

structure contents) shall be 0.5 m unless specified otherwise. The maximum level of structure contents for this purpose shall be considered under the following conditions occurring simultaneously:

- Maximum/high flood level in receiving water body/structure
- Operating flow equal to design peak hour flow
- One unit of each unit process out of service

All weirs in the plant, including variable height weirs on weir gates, shall remain unflooded/unsubmerged, with a minimum 75 mm free fall from the weir invert to the downstream water surface level under the following conditions occurring simultaneously:

- Maximum/high flood level in receiving water body/structure
- Operating flow equal to design average flow
- One unit of each unit process out of service
- All Parshall flumes shall remain unflooded/unsubmerged up to the design peak hour flow.

All new plant components shall be fully contained within the designated site boundaries and shall be placed so as to easily and logically accomplish all specified interfaces with existing components. Contractor's proposed site layout shall clearly show the space allocated for all plant components, including those components and/or unit processes that may be designated for future construction or installation. Setbacks and clearances from the site boundary shall be provided as appropriate and as required by law. All existing utilities (including but not limited to water, sewer, and power, whether overhead or underground and whether physically located on the site or not) that must be relocated to accommodate the Contractor's proposed and approved site layout shall be relocated by the Contractor. Contractor shall be fully responsible for all applicable permits, approvals, public notifications and processes, and any other paperwork or procedures required, and shall fully coordinate the entire process with the Employer as well as all other agencies, entities, and stakeholders that may be involved.

The plant layout shall fully comply with the following:

- Minimum clear distance provided to permit safe and convenient access for operation and maintenance shall be 5 m between adjacent treatment units or fixed structures and 500 mm between individual equipment units.
- For each set of mechanical equipment (e.g. pumps, blowers, etc.), an appropriately-sized adjacent open area shall be provided as a maintenance bay down area to allow safe and easy performance of maintenance tasks, as per manufacture's requirements.
- All electrical equipments installed open in the sky shall be located above the high flood level elevation of the site.

For all components under this contract, the capacity to be provided shall be designed, constructed, and operated using multiple identical units or modules to ensure reliability, redundancy, and appropriate turndown for optimum capacity utilization and process efficiency. The minimum number of working and standby units or modules required for each component shall be as listed in 1.8 Sewage Treatment Process layout & facilities description. For equipment not listed in the above reference, the following redundancy requirements shall be met:

- For process pumps, blowers, and compressors: Provide 100% standby unit.

Standby units shall be permanently installed with piping and valves such that each standby unit can be put into operation in place of any of its designated duty/working units by opening and closing appropriate valves, without the need for installation or uninstallation of additional components. Contractors are encouraged to provide energy efficient blowers for Aeration tanks with documentary evidence of successfully operation of such units.

- For submersible mixers: Provide one uninstalled standby unit (in storage) for every set of 3 duty/working units or part thereof.
- For process air diffusers: Provide standby units in store, equal to 5% of the total number of duty/working units, distributed uniformly throughout the diffuser grid(s) including full diffuser assemblies (iebase, orifice, membrane, and membrane retaining mechanism).
- The design shall further ensure that all such units receive equal flow or loading at all times when in operation.
- The design shall ensure that multiple modules of various unit processes are fully integrated and can operate as a single plant and a single process stream – multiple parallel plants will not be allowed. Such integration shall be accomplished by means of common collection and distribution channels, boxes, or header pipes in between unit processes that combine the flow from multiple modules of the upstream unit process and redistribute it to multiple modules of the downstream unit process. Designs where each module operates independently of other modules will not be permitted.

Though, it is not the intent to stipulate the units of treatment process to be provided. The general list of units that is required is mentioned:

S.N.	**Unit Description**
1	Collection Sump
2	Sewage Pumping Station If Required
3	Inlet Chamber
4	Coarse Screens
5	Fine Screen Channel
6	Pumping Station
7	Detractor Tank
8	Parshall Flume
9	Distribution Chamber
10	Biological Unit Proposed Anoxic Treatment Aerobic Treatment Settling Zone
11	Sludge Sump
12	Return Sludge Pumping System
13	Process Air Blower Units
14	Gravity Sludge Thickener Unit With Distribution Chamber As Required
15	Construction of A Centrifuge Plant To Handle The Stabilized Sludge
16	Treated Effluent Disposal Pipe Upto Chlorination Tank
17	Chlorination Tank
18	Sump For Storage Of Effluent For Pumping
19	Pumping Station For Effluent Disposal To Destination Point
20	Aeration Unit At Destination If Required.
21	Transformer Unit Space With Fencing

S.N.	Unit Description
22	Switch Gear Room
23	Administrative Office
24	Storage
25	Utilities (Water Supply, Sanitation, Fire Fighting
26	Security Guard
27	Compound Wall With Main Gate And Side Gait

The number of Units and standby will be as per the Plant capacity and decided while final design approval.

Since the process shall be proposed there may not be any need for some of the components mentioned above or maybe additional components are required to be provided, It shall be so done and the details will be approved at the time of detailed engineering submitted by the Contractor.

(D) Head Works/ Inlet Works

- **Diversion Chamber**

Proposed Diversion Chamber constructed in RCC shall be provided with proper tapping arrangement so that only required flow of sewage is diverted to the proposed plant and flow to other phase STPs is not disturbed.

Influent flow to the new facilities shall be controlled using a PLC-based feedback control loop to modulate the flow control valve. The diversion chamber shall be provided with a SS hand railing.

- **Inlet Chamber**

Raw sewage from diversion chamber shall be conveyed to inlet chamber by gravity flow via pipe. Inlet chamber shall be designed for peak flow. Electrically operated (with manually override) Inlet / Outlet Isolation Sluice Gates shall be provided for controlling the flow from Inlet Chamber to Coarse and Fine Screen Channels. Bypass channel designed for peak flow from inlet chamber to the final discharge location shall be provided. Sluice gate shall be provided for controlling the flow from Inlet Chamber to the By-pass channel. The inlet chamber shall be provided with SS hand railing.

- **Coarse and Fine Screens Channels**

The raw sewage from the inlet chamber shall flow by gravity to Coarse and Fine Screen Channels. Screening shall be done in two stages and Contractor shall have to provide automatic mechanical coarse screens to remove particles larger than 50 mm size and in second stage there shall be fully automatic mechanical fine screens to remove particles larger than 6mm. The screen shall be supplied with shaftless screw conveyor to convey the screenings to the automatic screening press and discharge system that compacts, dewater and discharges the screenings through chute to the screenings storage system. The screens and shaftless screw conveyor shall be in SS 316 construction. The screen shall be movable bars / perforated band having a design life of 15 – 20 years.

The Mechanical Screens shall be in continuous operation under normal conditions with all working screen during design flow and minimum flow. The individual Screen Channels shall be provided with electrically operated (with manually override) Inlet/ Outlet Isolation Sluice Gates. Wastewater from each screens shall flow to combined channel for further distribution into grit chambers. Electrically operated (with manually override) Inlet/ Outlet Isolation Sluice Gates shall be provided for controlling the flow from combined channel to grit chambers.

The design criteria for Coarse and Fine Screen Channels is given below :

S.N.	Description	Requirements
A	Coarse &cFine Screen Channel	
i	Total Design Flow average	As per Design
ii	Total Design Flow peak	As per Design
iii	Quantity	Coarse screens- 2 Nos. (1 Working + 1 Standby) Fine screens- 2 Nos. (1 Working + 1 Standby)
iv	Material of Construction of Screen Channel	RCC M30 (minimum)
v	Length of channel at the upstream	Minimum 3.0 times the width of the channel.
	of the screen mechanism	
vi	Maximum Liquid Depth at peak flow	As per design
vii	Free Board	0.5 m (Minimum)
viii	Allied Works	Suitable RCC platform of minimum 1.2 m width with chequered Tiles shall be constructed along the screen chamber to reach the screens for closer inspection of all screens and conveyor system. Access Staircase of RCC with metallic topping flooring on steps and 1m high SS hand railing shall also be provided. Isolation of the screens from the flow shall be through electrically operated (with manually override) sluice gates, placed in the upstream and downstream of the screen chamber. The design flow velocity through Sluice Gates shall not exceed 1.0 m/s. 1.0 m high peripheral railing of stainless steel as per specification shall be provided. Manual operations of sluice gates at a suitable elevation along the local operating platform is also required. The level sensing instrument for automatic operation of mechanical screen and allied accessories, local control panel near screen, shaft less screw conveyor, compactor, grit washer and discharge chute shall be provided.
ix	Angle of Inclination of screen	45º to Horizontal (maximum)
x	Velocity (through Screen)	1.0 m/sec (maximum) at Design flow
xi	Control system	The screens shall have controls for manual start & stop, automatic start and stop, high level switch, high level alarm, Overload protection switch and Overload alarm etc
xii	Inlet and Outlet	The electrically operated (with manual override)

S.N.	Description	Requirements
	gates	Inlet & Outlet Sluice gates with extended spindle shall be provided at the inlet and outlet of the Screens Channel. The design flow velocity through Sluice Gates shall not exceed 1.0 m/s.

(E) Grit Chambers

Degritting is required for removal of all grit and other inorganic solids of specific gravity 2.65 and above partical size of equal to above 0.15 mm and above from wastewater. Degritting shall be accompanied with grit washing to ensure that grit is free from organic matter before disposal.

Grit Separators are to be provided after the screening and before the biological treatment. There shall be three numbers (2 W+1S) **vortex** type grit separator each designed for half of peak flow. The grit chamber should have a low head loss. The vortex type grit chamber consisting of Tank in which the flow shall enter tangentially creating a vortex flow pattern is required. The constantly rotating stirrer helps support the wastewater circulation with the grit chamber maintain a constant velocity of rotation even under dry weather conditions. The radiant rotation of solid shall be collected within the center of grit chamber and shall pass to the grit collection tank. The centrifugal or airlift pumps shall deliver the collected solids from grit collection tank into grit classifier of grit washer (located in grit building) wherein solids can be separated and dewatered and organic particles can be removed.

The Contractors are to note that the silt & grit removed from grit chamber, does not form a part of the TSS in the incoming wastewater quality indicated in the tender document. Accordingly sludge calculations shall be done by Contractors.

The grit separators shall be designed according to the following guidelines:

- Specific Gravity of Grit 2.65
- Retention time in Grit Chamber 60 seconds
- A grit storage hopper with proper slope towards bottom shall be provided for effective grit storage for the designed flow.
- Grit removal efficiencies - The grit removal device shall be capable of removing the following at the specified hydraulic peak flow rate, and no decrease in efficiency will be allowed at flows less than this design rate
- 95% of the grit greater than 150 microns in size,
- 85% of the grit greater than 100 but less than 150 microns in size, and
- The grit removed shall contain less than 3 % organic matter on dry basis of an average particle size between of more than 150 microns but less than 100 microns
- The wastewater from Grit Chambers shall flow to common channel for further distribution to the primary clarifiers. Electrically operated (with manually override) Inlet/ Outlet Isolation Sluice Gates shall be provided for controlling the flow from grit chambers to the combined channel
- The design criteria for grit chamber is given below :

Sr.No.	Description	Requirements
A	Grit Chambers	
i	Total Design Flow average	-

Sr.No.	Description	Requirements
ii	Total Design Flow peak	-
iii	Quantity	2 nos. (1Working + 1 Standby)
iv	Material of Construction	RCC M30 (Minimum)
v	Assumed size of grit particle	0.15 mm and above
vi	Specific gravity of particle	2.65

(F) Parshall Flume

The wastewater from Grit Chambers shall flow to common channel connected to the Parshall flume. De-gritted sewage shall flow through a Parshall Flume Channel equipped with Ultrasonic Flow Meter. The Parshall Flume shall be designed as per the CPHEEO standards. The outlet flow from the Grit Chamber shall be measured by the parshall flume with proper clear distance of at least ten times the throat width on the upstream for steady state of flow and at least five times the throat width downstream of channel and fitted with an ultra-sonic level measuring device to provide local and remote read out of the flow into the plant.

The Parshall Flume Channel shall be connected with the Primary Clarifier Distribution Chamber. The design criteria for Parshall Flume is given below :

Sr.No.	Description	Requirements
i	Design peak Flow	-
ii	No. of Units	1 No.
iii	Material of Construction	RCC M30 (Minimum)
iv	Design of Parshall Flume	As per CPHEEO standards
v	Size of each Unit	As per Contractor's design
vi	Liquid depth	As per Contractor's design
vii	Free board	0.50 m. (minimum)
viii	Flow meter	Ultrasonic type

(G) Primary Scum Pit

Scum generated in Primary Clarifiers shall be collected through suitable size DI pipes in primary scum pit. From primary scum pit the scum shall be pumped to thickened sludge sump.

The design criteria for Primary Scum Pit and Pump is given below :

Sr.No.	Description	Requirements
i	Type of Pump	Submersible
ii	Qty	-
iii	Capacity of Each Pump	As per design
iv	Head	As per Contractor's design
v	Location	Near primary clarifier
vi	Allied Works	Access Staircase of RCC with metallic topping flooring on steps and 1m high SS hand railing shall be provided.

(H) Raw Sludge Sump and Pump house

The raw sludge sump and pump house shall have wet well / sump and dry well which shall be constructed in RCC up to 500 mm above the ground level. The wet shall have 1.0 m height SS hand railing around it. The dry well and part of the pump house building constructed above the G.L (for panel room) shall have RCC framed structure with brick walls 230 mm thick. The height of the pump house building shall be minimum 9.0 m from the floor of the dry well up to the soffit of the beam. The floor of the panel room shall be 500 mm above the G.L. and the roof /

ceiling shall be common with that of dry well.

Raw Sludge Sump and Pump house is provided for collection and distribution of the sludge generated in Primary Clarifier. Raw sludge from the Primary Clarifiers shall be withdrawn by gravity to the raw sludge sump and from where it shall be pumped to Gravity Sludge Thickener Inlet Distribution Chamber through Raw Sludge Pumps. These pumps shall be of solids handling Progressing Cavity type. The Raw Sludge Pumps shall be provided with Variable Frequency Drives. Inter connection shall be provided from the header of the sludge pump house into the sludge withdrawal line of Primary clarifier for removal of blockage.

The design of raw sludge pumps shall be on the basis of thickening the raw sludge to the specified dry solids concentration within the clarifier. The design capacity shall be large enough to allow intermittent pumping with the minimum pumping time fraction specified. However, the design shall also provide adequate turndown capability to allow continuous pump operation while maintaining the same average flow rate required to achieve the specified dry solids concentration.

The Raw Sludge Sump and Pump house consists of sludge pump room with basement floor (pump room) and ground floor (electrical control panel level). The areas of windows, ventilators shall be minimum 20% of the ceiling area / floor area. Fire protection equipment shall be provided inside the pump house.

The design criteria for Raw Sludge Sump and Pump house is given below :

Sr.No.	Description	Requirements
A	Raw Sludge Sump and Pump house	
i	Quantity	1 No (Basement floor + Ground Floor structure)
		Basement – Pump Room
		Ground Floor – Panel Room
ii	Type	Preferably Rectangular in Shape
iii	Material of Construction	RCC M30 (minimum) upto 500 mm above Ground Floor level and thereafter in Brick work with RCC M 25 beam, column, and roof framing structure.
iv	Size of the Pumps House	The size of the pump house shall be designed to accommodate minimum 5 nos. sludge pump sets, and 1no. De-watering pump set with starter panels and other accessories shall be housed in the control panel.
v	Minimum Plan Area	-
vi	Floor Height	6.0 m (Minimum)
vii	Allied Works	The Raw Sludge Sump and Pump house shall include all accessories and associated works including all interconnecting piping works for the sludge pumps, specials, appurtenances, supporting structures. Mechanical Ventilation system, Fire fighting system shall also be provided.
viii	Raw Sludge Pumps	Solid handling Progressing Cavity pump with drive motors and control panel complete with all standards accessories.
ix	Pump-Motor units :	
	(a) Quantity	-

Sr.No.	Description	Requirements
	(b) Pump Capacity (cum/hr)	As per Design
x	Material of Construction of Pumps and its associated Accessories.	-

(I) Secondary Scum Pit

Scum generated in Secondary Clarifiers shall be collected through suitable size DI pipes in scum pit and from scum pit the scum shall be pumped to the sump of thickened sludge sump and pump house.

Sr.No.	Description	Requirements
A	Secondary Scum Pumps	
i	Type of Pump	Submersible
ii	Qty	-
iii	Capacity of Each Pump	As per design
iv	Head	As per design
v	Allied Works	Access Staircase of RCC with Chequered Tile on steps with SS railing shall also be provided

(J) Chlorine Contact Tanks

Wastewater from filtration system shall be conveyed to a common inlet channel from where the wastewater shall be further distributed to individual chlorine contact tanks. Wastewater shall be disinfected in chlorine contact tanks before final discharge to remove pathogens and coliform bacteria. Electrically operated (with manually override) Sluice Gates at the inlet of all the individual compartments shall be provided for controlling the flow from common inlet channel to the individual compartments.

Design criteria for chlorine contact tank is as given below

No.	1 with three compartments
Material of Construction	RCC, Baffled
Hydraulic Retention Time(at peak Flow)	30.0 minutes
Chlorine Dose (minimum)	10.0 mg/l

Treated wastewater/effluent from each chlorine contact tank shall flow to a common channel from where it shall flow by gravity for final discharge or reuse purpose.

(K) Chlorination Building

Building shall be RCC framed structure in M25 grade. There will be 230mm thick brick walls duly plaster from inside & outside. It shall be a single storey building. Minimum ceiling height up to soffit of the beam shall be 4000 mm.

The Chlorination Building shall house Vacuum Chlorinators operating on working and stand-by basis, Chlorine Tonners operating online, and offline and a Caustic Soda Tank filled with commercial grade 45% caustic Soda for emergency immersion of Chlorine Tonner in case chlorine leak is detected. Chlorine Dosing Booster Pumps shall be provided for chlorine solution dosing.

Material of Construction	RCC framed structure in M25 with brick walls
Plan area	As required
Height	4.5 m (minimum) up to the soffit of the beam
Vacuum Chlorinators	

Nos.	As required
Capacity	30 Kg/ hour (minimum)

(L) Chlorine Tonners

An Emergency Chlorine Scrubber and all associated systems and controls shall be provided as specified to contain and neutralize any chlorine gas leaks.

(M) Electric Panel Room

The Electric Panel room shall have RCC framed structure and the brick panel walls shall be 230 mm thick. Minimum carpet area shall be 75 sq.m. The plinth level of the building shall be 500 mm above the G.L. The ceiling height up to the soffit of the roof beam shall be minimum 4000 mm.

(N) Sludge Dewatering System

The sludge dewatering system shall have Centrifuge feed sump, Centrifuge feed pump house, Centrifuge Building and Sludge drying beds. The centrate/ supernatant from sludge dewatering units shall flow to the inlet chamber via Filtrate Pump House.

(O) Centrifuge Feed Sump, Pump House and Building

The digested sludge from anaerobic digesters shall be collected in the centrifuge feed sump for further pumping to sludge dewatering system i.e. centrifuge.

Centrifuge building shall be a two storey building with RCC framed structure and brick panel walls of 230 mm thick. The minimum carpet area shall be 240 sqm. The ceiling height at each storey shall be minimum 5000 mm up to the soffit of beam.

On the ground floor of this building, the centrifuge feed pump house shall be provided to withdraw the digested sludge from digester and store the same in centrifuge feed sump and then pump to sludge dewatering system i.e. centrifuge system. Digested sludge shall be pumped to mechanical dewatering system consisting of centrifuges. Additionally, sludge drying beds shall be provided as a backup for 25% in case of unavailability of mechanical sludge dewatering equipment.

The centrifuge feed pump house consists of sludge pump room with ground floor (Pump and electrical control panel level). Fire protection equipment shall be provided inside the pump room.

The design criteria for Centrifuge Feed Pump House is given below :

S.N.	Description	Requirements
A	Centrifuge Feed Pump House	
i	Quantity	1 No (Ground Floor structure) Ground Floor – Pump Room Panel Room 1 No Sludge Sump with 4 hours capacity
ii	Type	Preferably Rectangular in Shape
iii	Material of Construction	RCC M25 with beam, column, and roof framing structure and 200 mm solid concrete blocks for side walls
iv	Size of the Pumps House	The size of the pump house shall be designed to accommodate centrifuge feed pumps, polydosing pumps, service water pumps and de-watering pumps with starter panels, control panel and other accessories housed in the pump house.
v	Allied Works	The Centrifuge feed pump house shall include all

S.N.	Description	Requirements
		accessories and associated works including all interconnecting piping works for the sludge pumps, specials, appurtenances, supporting structures. Mechanical Ventilation system, Fire fighting system shall also be provided
vi	Centrifuge Feed Pumps	Progressive Cavity Pump with drive motors and control panel complete with all standards accessories.
vii	Solid concentration of inlet sludge	4%
viii	Specific gravity of sludge	1.05
ix	Minimum diameter	200 mm pumping main to avoid chockage
x	Pump-Motor units :	-
	Quantity	As per Contractor's Design
	Pump Capacity (cum/hr)	As per Contractor's Design
	Motor Capacity Head	
xi	Material of Construction of Pumps and its associated Accessories.	-
xii	Other Allied Works	All internal piping, valves and specialty items as applicable. Pipe supports and appurtenances up to the terminal point. Discharge pressure gauges, for each of the pump of suitable range along with necessary accessories like isolating sluice valves, NRV etc. Progressive Cavity Pump with motors suitable for operation of 415 V +- 10% for pumps with control panels, space heaters (if required), complete with all standard accessories including motor terminal box and cable glands. All suction and delivery piping shall be DI K7 Pipes. All valves on suction side of pumps shall be manually operated and on delivery side motorized (with manual override) sluice valves. The minimum size of the pipe shall be 200 mm. All other valves shall be electrically operated with manual override.

Centrifuge and all associated/ancillary equipment required for proper operation and performance shall be provided at first floor of the building as specified, including but not limited to a complete polymer system, dewatered sludge conveyors, sludge storage/loading bins/hoppers, and truck access and loading facilities. Design, sizing, construction, and operation of the dewatering units and related equipment, including but not limited to solids and hydraulic loadings, shall be adequate to ensure that all specified performance requirements, including but not limited to dewatered sludge concentration and solids capture, are fully met under the specified dewatering operating schedule.

The design criteria for centrifuge is given below:

S.N.	Description	Requirements
A	Centrifuge	
i	Design Flow	Digested Sludge from Anaerobic digester as per Contractor's design
ii	Quantity	As per requirements
iii	Type	Centrifuge
iv	Operating Hours	12 hours/day and 6 days/week
v	Solids Concentration in the Cake	20%(minimum)
vi	Minimum Solids Capture	90%
vii	Drive Motor Rating	As per manufacturer's specifications
B	Polymer Dosing System	
i	Type	Dry polymer with batch tanks
ii	Polyelectrolyte Requirement	3.0 kg/ton dry solids (Minimum)
iii	Poly Solution Strength	0.2% w/w
iv	No. Polymer Dosing Tanks	3Nos (2 Working + 1 Standby)
v	Capacity	Minimum 151.0 cum
vi	No. Polymer Dosing Pumps	Minimum 4 Nos (2 Working + 2 Standby)
vii	Type	Hydraulic Double Diaphragm type dosing pumps
viii	Capacity	As per poly dosing requirement
ix	Pressure	2 kg/csqm
x	MOC of Pump	As per Specifications
xi	No. of Agitator	1 no./tank
xii	Type of Agitator	Turbine type
xiii	MOC of Agitator	SS 316
xiv	Agitator Speed	100 RPM +- 5
xv	All piping of the Dosing system	Polypropylene

The Contractor shall provide and erect one polymer storage tank of capacity 9.0 KL (or as per the design requirement) and two Nos. polymer batching tanks each of size 150 KL (or as per the design requirements) along with all accessories such as fasteners, foundation and lifting lugs, gasket, name plate SS 316, level indicator – board and float type, FRP baffles, Ladder, etc.

Material of construction shall be FRVE as Liner + FRP (with Isophthalic resin). Design temperature shall be 65 ^{O}C and working temperature shall be 15 ^{O}C to 35 ^{O}C. Design pressure shall be 1.25 times the static head of the liquid stored in it and hydrostatically tested with full water depth. The manufacturing of FRP tanks shall be according to British Standards BS :4994. The Contractor shall submit the designs and fabrication drawings for approval of Employer's Representative.

(P) Decanting Device (in case of SBR/Cyclic Process)

The decanting device shall be of Stainless Steel 304 with suitable arrangement for movement for which accessories like gear box, drive, scum guard, down comers, collection pipe, bearings shall be provided to suit the proposed technology & to give guaranteed parameters of effluent.

- The maximum design travel rate shall be as per design of proposed

technology.

- There should be Maximum 1 decanter per basin.
- The hydraulic design based on design flow rates as given above shall be as per proposed technology.

Each Decanter mechanism shall be inclusive of local control boxes with manual operation selection and function buttons, communication to main PLC

(Q) Utility Buildings

Plant Water Pump house

The Plant Water Pump house shall be provided to distribute the disinfected treated waste water for various in-plant uses such as chlorine ejector, cleaning, washing and fire fighting etc. Contractor shall submit detailed estimates of in-plant water use flows as well as complete wet well and pump sizing calculations based on these estimates.

The pump house shall be suitable for installation of submersible pumps. The sump shall be constructed in RCC as liquid retaining structure. The sump shall 1.0 m height SS hand railing all around. The top slab of sump shall be minimum 500 mm above the FGL.

There shall be RCC framed structure with outer brick walls of 230 mm thick over the sump. Height of the roof / ceiling up to the soffit of the beam shall be minimum 4000 mm. This structure shall house panels and other electrical / mechanical fittings.

Sump shall be of suitable size to accommodate minimum two nos of submersible pumps to handle the plant water requirement such as gardening, flushing, cleaning of equipments etc. Part of treated effluent shall flow into this sump directly from the outlet effluent channel of CCT. On the opposite side of the inlet to the sump a weir of suitable width and depth shall be constructed to allow excess treated water to flow into the effluent channel. On the inlet side a 1.20 m wide RCC slab shall be constructed over the sump with 1.0 m high pipe railing. The sump shall be designed and constructed as water retaining structure. A clear space of 1 m shall be provided between pumps for easy access to the pump. A clear space of 1.5 m shall be provided from the end walls.

Necessary internal electric wiring, light and fan fixtures and fitting with light/power points shall be included in the Contract price.

Sr.No.	Description	Requirements
A	Plant Water Sump	
i	Design Flow	As per Contractors design + 10% overload
ii	Quantity	1 No.
iii	Type	Preferably Rectangular in Shape
iv	Material of Construction	RCC M30 up to 500 mm above GL and in M25 above top slab of the sump
v	Capacity of Sump	Minimum 10 Minute Hydraulic Retention time at Design Flow
vi	Allied Works	The Plant Water sump shall include all accessories and associated works including all interconnecting piping works for the plant water pump, specials, appurtenances, supporting structures..The top of the Sump shall be provided with minimum1.2 m wide clear walkway with hand railing
B	Plant Water Pumps	Submersible pumps and control panel complete

Sr.No.	Description	Requirements
		with all standards
i	Pump-Motor units	
	Quantity	2 nos(1working +1 standby)
	Pump Capacity (cum/hr)	As per Contractors design
	Head	As per manufacturer's recommendation
	Motor Capacity	
ii	Material of Construction of Pumps and its associated Accessories.	-

- **Filtrate Sump and Pump House**

The pump house shall be suitable for installation of submersible pumps. The sump shall be constructed in RCC as liquid retaining structure. The sump shall have covered RCC slab with openings for removing / lowering pump assembly in the sump. The top slab of sump shall be minimum 500 mm above the FGL.

There shall be RCC framed structure with outer brick walls of 230 mm thick over the sump having roof size as 4 m x 4 m. Height of the roof / ceiling up to the soffit of the beam shall be minimum 4000 mm. This structure shall house panels and other electrical / mechanical fittings.

The Filtrate pump house shall be provided as specified to collect the filtrate from various units such as effluent filter back wash, supernatant from gravity sludge thickener and anorabic digesters, centrate from centrifuge and filtrate from Sludge drying beds shall be pumped back to the inlet chamber.

All components including but not limited to the wet well and the pumps shall be adequately sized to accommodate all continuous, periodic, and intermittent recycles as well as periodic maintenance-related draining of various structures within the time intervals specified in Article2.6 Design requirements. Contractor shall submit detailed mass -balance-based estimates of all in-plant recycle flows including frequencies and durations as well as complete wet well and pump sizing calculations based on these estimates.

The design criteria for Filtrate sump and pump house is given below:

S.No.	Description	Requirements
A	Filtrate Sump	
i	Design Flow	As per Contractor design + 10 % overload
ii	Quantity	1No.
iii	Type	Preferably Rectangular in Shape
iv	Material of Construction	RCC M30 up to 500 mm above GL and in M25 above top slab of the sump
v	Capacity of Sump	Minimum 5 Minute Hydraulic Retention time at Design Flow
vi	Allied Works	The filtrate sump shall include all accessories and associated works including all interconnecting piping works for the filtrate pump, specials, appurtenances, supporting structures. The top of the Sump shall be provided with minimum 1. 2 m wide clear walkway with hand railing Submersible pumps with drive motors and control panel complete with all standards
B	Filtrate Pumps	
i	Pump-Motor units :	
	Quantity	2 Nos (1W +1 S)

S.No.	Description	Requirements
	Pump Capacity (cum/hr)	As per Contractor design
	Head	As per Contractor design
	Motor Capacity	As per manufacturer's recommendation
ii	Material of Construction of Pumps and its associated Accessories.	-

Administrative Building

Administrative building shall be RCC framed structure with brick panel walls and shall have entrance porticos. All brick walls shall be 230 mm thick, except for partition walls of toilets which shall be 115 mm thick. The ceiling height up to the soffit of beam shall be 3500 mm.

The administrative block shall be a two storey building having Laboratory at ground floor and office at first floor.

The ground floor shall have Laboratory, two rooms and toilets, one each for men and women of appropriate size. Each of these toilets shall have one WC, wash basin, towel rail, mirror, soap dispenser and other features of required specifications as directed by the Employer's Representative. Men toilet shall have 2 urinals also. Two nos. Triple layered polyethylene water storage tanks of size 1 KL each shall be provided at the top of the building.

The laboratory shall be provided with the following:

- A platform projecting 750 mm from the wall one at about 150 mm height from floor l Level and the other at sill level. The upper platform shall be of RCC. The platforms shall be covered with Granite stone on top surface.
- Ceramic tiles on the walls all along the RCC platforms upto the 750 mm.
- Two laboratory sinks on the RCC platform and one wash basin along the opposite wall. The sinks and wash basin shall have direct water supply connection and not from the service tank.
- The space below the platform shall have cabinet/ cupboards for keeping laboratory materials.
- The first floor shall have two rooms and one meeting room, pantry and toilets one each for men and women. The size of toilets and facilities shall be similar to that provided at ground floor / laboratory. One SS sink with two CP drinking water taps shall be provided in the pantry. In addition to above, one room and meeting room shall also have attached toilets having one WC, One urinal, one WB and all other fixtures. A septic tank and soak pit shall be provided for the collection of sewerage from the toilets.
- The outer face of the building shall be provided with aluminum cladding system comprising of PVDF/Dura glass 5000 coated 4 mm thick approved aluminum composite panels as per specifications and as approved by the Employer's Representative.
- Before commencing the construction of the office, the Contractor shall submit to the Employer's Representative for his approval a drawing of the proposed building showing all architectural and finishing details. After approval of these details, Contractor shall submit structural designs and drawings.
- The Contractor shall furnish the rooms as the Employer's Representative directs and the equipment, furniture, furnishings and fittings to be supplied shall be new items and also of approved make.
- All the operating expenses, water, lights and other charges shall be regarded

as an inclusive cost of the Contractor's operating costs and part of the contract price.

The Administrative Block shall have the following facilities (minimum):

- Furniture including tables, chairs, etc as per the space management and as directed by Employer's Representative,
- Copy, Email, Fax, Print, Scan multipurpose machine - 1 No.,
- Two Desktop of approved configuration installed with required operating software's,
- Two UPS of size as directed by Employer's Representative,
- Internet connection with telephone connection,
- Split type air conditioner of capacity 2 Tons – 6 Nos.,
- Two 1 KL triple layered polyethylene water storage tank at the roof top,
- Water supply, sanitary, electricity fittings, power back-up, etc.
- The Contractor shall be responsible for maintenance of building and housekeeping, during the entire contract period including O & M.

Store Room and Workshop

Store room and workshop building shall be a single storey building in RCC framed structure with brick walls as 230 mm thick. The minimum ceiling height up to the soffit of beam shall be 5000 mm. The flooring shall be of cement concrete with metallic hardener topping.

Fire Fighting Pump house

The firefighting equipment including pumps and piping with fire hydrant shall be provided in the fire fighting pump house. The system shall be complete with motor and diesel driven fire pump including Jockey pumps.

The pump house shall be suitable for installation of pumps. The sump shall be constructed in RCC as liquid retaining structure.

This shall be RCC framed structure with outer brick walls of 230 mm thick over the sump. Height of the roof / ceiling up to the soffit of the beam shall be minimum 4000 mm. This structure shall house panels and other electrical / mechanical fittings.

(R) Architectural Concepts and Designs

An Architectural Design Basis Report will be submitted to the Employer's Representative including proposals for the following scheme components: shape, form, color, and basic materials for interior and exterior architecture along with an appropriate landscaping scheme. All schemes will be supported by architectural statement explaining the factors considered in the design.

Architecture work shall include walls, roof, flooring and floor finish, roof water proofing, down water pipes, windows, ventilators, doors, glazing, equipment access doors, painting and other ornamental works. The Contractor shall get all Architectural, Structural and RCC drawings and design calculations, etc approved by Employer's Representative prior to construction of works at site.

The minimum architectural requirements for buildings are given below in tabular form.

(S) Plant development infrastructure works

Internal Roads and Side Drains

Internal roads, culverts (if required), and storm water drainage within the plant

shall be provided. Internal road within the STP site shall be conforming to the layout. The plant roads shall have 6.0 m and 4.0 m wide bituminous portion and 1 meter wide shoulders on either side. Shoulders top shall have factory made interlocking paver blocks 80 mm thick in M 40 CC laid over 50 mm thick compacted bed of fine sand, filling the joints with fine sand etc all complete. The reduced level of internal roads shall be kept in accordance with the approach road to STP area and formation levels in the plant area.

Storm water side drains shall be designed and constructed only along one side of the road. These drains shall be covered with factory made perforated concrete covers.

Adequate longitudinal and cross gradients shall be provided in the road for efficient and quick drainage of storm water. Required longitudinal slope shall be maintained in road side drain also. Connection of road side storm water drain to the nearby natural drain for final discharge of the storm water generated within the plant premises shall be made.

- **Pipes and Ducts for Road Crossings**

RCC pipes and ducts carrying utilities like cables, water and sewerage lines, storm water, etc shall have minimum one meter cover while laid under roads. Access chambers and manholes shall have size not less than 600 mm x 1000 mm and be provided at intervals as directed by Employer's Representative. All such pipes and ducts shall be designed structurally for calculated imposed loads and the design be got approved by Employer's Representative.

- **Cable and Pipe Trenches**

As far as possible, the alignment of the cable route shall be decided after taking into consideration the present and likely future requirements of other services like drains, water supply pipelines, etc. This aspect shall be brought to the notice of the Employer's Representative while planning the works and approval be taken.

Cable trenches should be constructed in such a manner that sharp bends are avoided, however, at the same time route should be kept shortest. Separate trenches shall be provided for LV/MV and HV cables, however, if there is restricted space then provision for fixing different level cable trays be made and LV/MV cables shall be laid above HV cables.

Cable and pipe trenches shall generally be constructed in reinforced concrete, however, 500 mm x 500 mm size or smaller trenches, not on fill may be constructed in 350 mm thick brick masonry in 1:4 cement mortar. The brick trenches will be plastered internally with cement mortar 1:4 and externally in cement mortar (1:3) as directed by Employer's Representative. The cable trench work shall have recess (monolithic with drain structure) for placing top covers. Necessary fasteners shall be fixed at the time of construction itself for supporting the cables or cable trays.

Trenches within the buildings or plant areas not exposed to direct rain shall be covered with M.S chequered plates, suitably painted and those outside the buildings shall be covered with factory made precast concrete covers as directed by Employer's Representative. The trenches shall be suitably sloped to drain rain water to a designated outlet point connected to the plant sewerage or storm water drain system. In case the location of trench does not permit direct connection with plant drainage system then a catch pit should be constructed at the lowest point with necessary dewatering arrangement.

(T) Potable Water Supply & Fire Fighting System

Potable Water Supply

Water Supply connections are to be taken from PHED networks. The new connection shall be through 25 mm MDPE pipeline of required length. The Contractor shall design and construct distribution network of suitable size (including water appurtenances like sluice valve, scour valve, air valve, non return valve etc), connecting all the water storage tanks / structures and additional connection points for cleaning purpose.

Fire Fighting System

The Contractor shall design and construct suitable fire fighting system along with pump sets and other accessories for meeting the fire fighting requirement of buildings located in the plant area. Final treated effluent shall be the source of water supply for firefighting purposes. The final treated effluent shall be conveyed to the fire fighting pump house in which all pumping machinery shall be installed. Delivery head for the pump should be sufficient to supply the water to all structures and to meet the fire fighting requirement. Fire hydrant shall be provided near all the units of buildings/ pump houses/ panel rooms conforming to the directions of Employer's Representative. All fire fighting network shall be of pressurized HDPE pipes class PN-12 and material classification PE-100 conforming to IS:4984.

Staircase, Walkway Platforms, Hand Railings and ground pathways

RCC staircase shall be provided at all locations for accessing the elevated RCC walkway platforms. RCC walkway platforms of minimum 1200 mm wide shall be provided in a continuous manner interconnecting all the treatment units. The aim behind constructing continuous walkway platform is to allow the person to inspect all the plant units, from inlet chamber to SST, without getting down and climbing at intermediate units again and again. The RCC walkway platforms around and across the treatment units shall be designed for all possible loading conditions.

Handrail shall be provided with stainless steel AISI 304 SS handrail and balustrade system having 38mm dia tube handrail (1.5mm gauge) connected with unified stem keys in bead blasted finish to 12x54 mm stain finish flat vertical member erected with chemical grout to be fixed on the top of floors/ staircase at maximum distance of 1500 mm with infill of two horizontal midrail of 22 mm dia and as approved and directed by Employer's Representative.

All ground pathways interconnecting buildings, treatment units, pump houses and other structures shall be minimum 1500 mm wide.

Fencing, Gate and Security Room

PVC coated galvanized steel chain link fencing of minimum 2.1 m height above the FGL, as shown in the layout plan, shall be provided around the new plant boundary to restrain unauthorized entry having maximum mesh size of 50 x 50 mm along with stainless steel posts for supporting the fence, all works as per ASTM B6, F567, F668 and AASHTO M-181 standards. The minimum thickness of galvanized wire and PVC coating over it shall be 3 mm and 1.5 mm respectively thus making finished thickness of fencing wire as 4.5 mm. Color of fencing material will be as per the approval of the Employer's Representative.

One no. MS heavy duty gate (minimum 5.0 m wide and 2.1 m high) fixed on RCC pillars and painted as per approval of the Employer's Representative shall be provided.

One no. security guard room of minimum 10 sqm area along with toilet shall be

provided near main gate. The security guard room / cabin shall be constructed in brickwork with RCC roof.

(U) Land Development, Horticulture, Arboriculture and Landscaping

Contractor shall do the land development of the new plant area during construction based on the topography of the area and shall also provide pipe network made of polypropylene pipes and fittings conforming to ASTM F2389 with hydrants at 50 meter intervals or as directed by Employer's Representative for horticulture purpose. The source of water supply shall be the final treated effluent pumped from service water pump house. Suitable pumping arrangement and network shall be designed and constructed for horticulture purposes.

The Contractor shall from the date of commencement of contract, furnish all materials, labour, and related items necessary to complete the work indicated and specified herein. The work shall include the following but not limited to this:

- Green belt plantation;
- Lawns;
- Indoor Plantation Works for Admin Building along with decorative pebbles;
- Static Water fountain with all necessary civil works;
- Pathways with interlocked paver blocks of specified design and shade;
- Sprinkler system for lawns

The landscape Contractor shall be generally responsible for the entire site but in particular to works listed above. Along with site management, the responsibilities will include landscaping works and arboriculture works and maintaining the same.

Plants and shrubs suitable for similar type of conditions shall be sourced by the Contractor from available nurseries, unless otherwise specified. Seeds shall be acquired from reputed organizations and hybrid seeds will be used where possible – particularly for flower varieties. The Contractor shall submit the list of type of plants and shrubs proposed to be planted in the area along with layout plan showing plantation to the Employer's Representative for approval. No plant material shall be changed without the consent of the Employer's Representative.

Those plants that are not up to the standards, and do not meet specifications shall be replaced by the Contractor at no extra cost to the Employer. When the plants are to be replaced either for filling gaps or poor quality, then the Contractor shall replace with plants of equal height , size and age of the plants in that area.

In addition, the Contractor shall also be responsible for filling gaps, thinning and transplanting, or replanting where plants may need to be replaced. Along with other planting, the Contractor shall also be responsible for improving soil conditions for planting. This may include import /export of sand/soil to/from site. The Contractor shall also clear vacant area from existing grasses, keep the site clean and maintain the already planted areas free of weeds, pests or insects that cause diseases. All weeds, unwanted grasses and plant material will be cleared up to 1000mm from the edge of planting of newly created and already existing horticultural works (such as boundary trees).

Planting of trees, shrubs and plants shall include digging of pits, mixing the top soil with manure and filling in the pit before and after planting, backfilling, staking with 1 meter long stake to prevent excess movement of the plant, adequate watering immediately after planting and during the growing season, mulching of open soil around the plantation with straw or hay at regular intervals and necessary protection.

All plants proposed to be planted by edge of building in front façade of building should be planted with special care so as to ensure the following:

- The painting/cladding of walls is not soiled and kept clean at all times,
- Watering is done with care so as to ensure water is not entering windows or muddy water is not splashed on walls.
- All plants growing over the height of windows should be trimmed below window height.

Lawns: The area for planting the lawn shall be maintained free from weeds, whatever may be the nature of soil, complete surface shall be trenched over to a depth of 300 – 450 mm. Grading and final leveling of the lawn shall be completed at least 2 weeks prior to the actual sowing. The soil itself shall be ensured to the satisfaction of Employer's Representative to be a good fibrous loam, rich in humus. Pest/termite prevention chemicals to be mixed if required. Top soil shall be mixed with farm yard manure or coco-peat and mixed with river sand in ratio of 15% manure, 25% river sand, 35% red soil and 25% excavated earth and leveled to maintain positive drainage or specified slopes.

Carpet lawns will be used and nodes of specified grass shall be dibbled not more than 50mm apart on above mentioned soil conditions. The carpets will be laid next to each other in an even pattern to ensure that all lawn area is covered. After laying of carpet, it should be lightly pressed into the ground to ensure that it is does not shift, and to ascertain that the roots are in soil. Positive slopes will be maintained to ensure that there will be no low lying areas in center where water logging or pools are created.

In the absence of rain, lawn shall be watered daily - heavily, soaking the soil thoroughly to a depth of at least 150 mm. Edges shall be kept neat and must be cut regularly with the edging shears. Fertilizer / manure shall be fed once a month. The Contractor shall carefully remove unsightly weeds as and when observed.

(V) Sign and Warning Boards

All buildings and treatment units shall be provided with sign boards as directed by Employer's Representative indicating the name and function of these.

All the signboards displaying name of the technical units and directions shall be written in English and Hindi.

At the start of construction work the Contractor shall erect signboards one at the entry of the construction site and another near the temporary site office displaying all the project related information like name of the work, client, funding agency, value of the works, start and completion date as per contract, capacity of the plant, number of units and other details as directed by Employer's Representative. The size of the board shall be decided in consultation with the Employer's Representative.

Necessary sign and warning boards shall be supplied and erected at the locations to be specified by Employer's Representative. The size of the board shall be 1200 mm x 1200 mm minimum or as directed by Employer's Representative. The signboard shall be partially reflective Flex type on SS Grade 304 minimum 1.2 mm thick supported with frame of aluminum channels / double back channels minimum 3 mm thick through aluminum rivets. The signboard shall be subsequently attached to the post(s) through steel bolts. The posts shall be 75 mm diameter galvanized steel with welded top cap in case the signboard is supported on one post only, however, if two posts are used to support the signboard the diameter of each shall be minimum 40 mm and thickness 1.6 mm. The steel posts shall be embedded in RCC footing of size as approved by the

Employer's Representative or as per the design. The total height of the post shall be 1800 mm + size / depth of the signboard. For larger size boards, more than 1200 mm x 1200 mm, the Contractor shall submit the designs and drawings, wind load calculations, etc for approval of Employer's Representative prior to its construction.

(W) Vehicle parking shed near administrative building

The Contractor shall fabricate and install car sheds for occupants' vehicles. The car sheds shall cover the four to six car parking spaces and about ten two wheeler parking spaces.

The car shed structure shall be of made of welded galvanized steel members (Cantilever design). The clear spacing between each column shall not exceed 3 meters and the clear height shall be 2.5 meter at least.

Each steel column shall be 6" diameter galvanized pipe and minimum 3mm thickness and shall be embedded in the foundation and welded to the foundation steel properly. The foundation shall be made of reinforced concrete, 100 cm long X 100 cm wide X 100 cm deep at least. The reinforcement bars shall be 16 mm in thickness in two layers. A steel cap shall be in the form of cuboid 30 X30 cm with 10 cm height to cover the point of intersection of the pipe with ground.

All the steel purlins, girders shall be made of steel galvanized pipes, 2" in diameter and minimum 2 mm thickness. All the steel members open ends shall be closed with steel sheet of similar size and finish.

The shed frame shall be covered with FRP corrugated sheets and fitted to steel purlins and girders with steel rivets.

The whole steel structure shall be coated with a layer of primer and then spray painted with matt synthetic enamel paint of approved make. The color of corrugated sheets shall be green in color or any other color approved by the Employer's Representative.

The shed area shall be paved with interlocking paver blocks 80 mm thick and constructed in CC M40.

(X) Monitoring of the Commissioning and Operation of the Plant

The tests on commissioning and the monitoring of the operation shall be done as elaborated in the Sub section on O&M. The Contractor shall have to meet the requirements.

(Y) Power consumption in the STP & SPS

The Contractor shall quote his maximum limit of power consumption for various % of the operation of STP. In case the overall consumption of power exceeds the same, the actual power charges for the excess power will be recovered from the Contractor as per the stipulations in the O&M sub-section.

5.5.3.5 Data Acquisition and Automatic Operation of STP & SPS

The Contractor is to propose the sewage treatment process to meet the output requirements. It is the intent of the Employer to get a automated treatment plant with on line data acquisition and PLC operated system with manual over ride in order to ensure effluent of the stipulated standard consistently. The process will involve the following steps for the individual process units of the plant which can be integrated in more than one unit within the plant as per the process requirement or can be independent for each other.

The data and the operation details should be consolidated and displayed on the console. The same console should also include the data received from the linked

SPS. The console should also provide continuous real time information about the in operation/closed/out of order status of various elements of various units.

The main segments of the automation shall be:

- Data acquisition
- Programmable logic control system
- Data recording and transmission SCADA
- Alarms

(A) Data Acquisition

The data required to be acquired on line will depend upon the process proposed, but the need in various units generally in STP are listed to stipulate the requirement level:

At Inlet

- Ultrasonic Differential Level Measurement at Screens
- Ultrasonic Open Channel Flow Measurement at Parshall Flume
- Continuous Online pH Measuring System
- Continuous Online Total Suspended Solids Analyzer
- Indicative BOD Analyzer

After Primary Clarifier

- Continuous Online Total Suspended Solids Analyzer

At Primary Sludge Pump House

- Electro-Magnetic Flow Meter at the Header
- Pressure Transmitter on Header
- Ultrasonic Level Measurement at Sump

At Aeration Unit

- Online Continuous Dissolved Oxygen Measuring System

At Return Sludge Pump House

- Electro-Magnetic Flow Meter at inlet to Thickner
- Electro-Magnetic Flow Meter at inlet to Aeration Tank – Separate for each stream
- Ultrasonic Level Measurement at Sump
- Pressure Transmitter on Header

At Secondary Clarifier

- Continuous Online Total Suspended Solids Analyzer

Post Filtration/Disinfection

- Online Residual Chlorine Measuring System
- Indicative BOD Analyzer
- Continuous Online Total Suspended Solids Analyzer

At Digestors and Gas Holders

- Temperature Element and Temperature Transmitter
- Gas Flowmeter (Thermal Mass Flow Measurement System) for Measuring

Quantity of Gas

- Measurement of CO_2, CH_4 and H_2S Gas Concentration

On the water way in Amanishah Drain

The water way is to be monitored at least six location by online instrumentation at sites. The sites will be selected by the Employer's Representative after considering the location and configuration of the STP proposed by the Contractor. The following on line sensor will be provided at each such site and data transmitted to one of the SPS:

- Online Continuous Dissolved Oxygen Measuring System
- The instruments will be provided as per the units proposed to be adopted by the Contractor.

(B) Programmable Logic Control System

Suitably designed PLC systems will operate the, inlet, Screens, SPS, Aeration System, sludge handling systems and handling the supernatant from sludge thickener, filtration or any other unit in process need.

(C) Data recording and transmission SCADA

The data generated in the STP, SPS and collected from the monitoring points on the Amanishah Drain shall be transmitted to a central control station which will collect data from all the SPS. The periodic reporting formats for daily, monthly and annual reports will be developed in consultation with the Employer's Representative and followed.

5.5.3.6 Civil and Building Works

(A) Standard Specifications

The "*Standard Specifications (Civil Works)*" issued with the bid document sets out the specifications that shall be followed for construction of general civil works under this Project. In case of any deficiency the relevant Indian Standards will be referred to. The specifications for additional specialized items of civil works shall be as set out in Part B, Particular Specifications, of this Section.

In the event of any discrepancy between the provisions of the Standard Specifications and the Particular Specifications, then the provisions of the Particular Specifications will prevail.

(B) Particular Specifications

Specific Civil/Structural Work Requirement

✓ ***Design Submissions***

Complete detailed design /hydraulic calculations & drawings of foundations and superstructure together with general arrangement drawings and explanatory sketches shall be submitted to the Employer. Separate calculations for foundations or superstructures submitted independent of each other shall be deemed to be incomplete and will not be accepted. Though no GA drawings of all units are required along with the bid, a schematic layout /GAD shall be submitted along with the bid. The design considerations described herewith establish the minimum basic requirements of plain and reinforcement concrete structures, masonry structures and structural steel works. However, any particular structure shall be designed for the satisfactory performance of the functions for which the same is being constructed. The Contractor shall also take care to check the stability of partly.

✓ ***Design Standards***

All designs shall be based on the latest International or Indian Standard (IS) Specifications or Codes of Practice. The design standards adopted shall follow the best modern engineering practice in the field based on any other international standard or specialist literature subject to such standard reference or extract of such literature in the English language being supplied to and approved by the Employer or Employer's Representative. In case of any variation or contradiction between the provision of the IS Standards or Code and the specifications given with the submitted bid document, the provision given in the Specification shall be followed.

✓ ***Design Loadings***

All buildings and structures / underground structures shall be designed to resist the worst combination of the following loads/stresses under test and working conditions these include dead load, live load, wind load, seismic load, stresses due to temperature changes, shrinkage and creep in materials, dynamic loads and uplift pressure.

A. Dead Load: This shall comprise all permanent construction including walls, floors, roofs, partitions, stairways, fixed service equipment and other items of machinery. In estimating the loads of process equipment all fixtures and attached piping shall be included, but excluding contents shall be considered. The following minimum loads shall be considered in design of structures:

S.No.	Parameter		Load
1	Weight of water	10.0	KN /cum
2	Weight of soil (irrespective of strata available at site and type of soil used for filling etc) However, for checking stability against uplift, actual weight of soil as determined by field test shall be considered	20.0	KN/cum
3	Weight of plain concrete	24.0	KN/cum
4	Weight of reinforced concrete	25.0	KN/cum
5	Weight of brickwork (exclusive of plaster)	22.0	KN/cum
6	Weight of plaster to masonry surface	18.0	KN/cum
7	Weight of granolithic terrazzo finish or rendering screed, etc	24.0	KN/cum
8	Weight of sand (filter media)	25.0	KN/cum
9	Roof Treatment	25.0	KN/cum
10	Brick bat coba for toilet filling	20.0	KN/cum

B. Live Load: Live loads shall be in general as per IS 875. However, the following minimum loads shall be considered in the design of structures.

S.N.	Location	Live Load
1	Floor supporting Pumping Machinery	1000 kg/sq.m
2	Storage, Maintenance Bay, Air Blower	750 kg/sq.m
3	Platform, Staircase, Corridors, Walkways	500 kg/sq.m
4	Toilet	200 kg/sq.m
5	Roof Slab	150 kg/sq.m

In the absence of any suitable provisions for live loads in IS Codes or as given above for any particular type of floor or structure, assumptions made must receive the approval of the Employer's Representative prior to

starting the design work. Apart from the specified live loads or any other loads due to material stored any other equipment load or possible overloading during maintenance or erection/construction shall be considered and shall be partial or full whichever causes the most critical condition.

C. Wind Load: Wind loads shall be as per IS: 875- 2002 Part-III.

D. Dynamic Load: Dynamic loads due to working of plant items such as pumps, blowers, compressors, switchgears, traveling cranes, etc shall be considered in the design of structures.

E. Other Loads: In addition to earth pressure and water pressure etc., the surcharge of 1 Ton/sq.m shall be taken into account in the design for channels, tanks, pit etc.

F. Earthquake Load: This shall be computed as per IS: 1893 – 2000.

G. Joints: Movement joints such as expansion joints, complete contraction joints, partial contraction joints and sliding joints shall be designed to suit the structure as per relevant IS code provisions. Expansion joints of suitable gap at intervals not more than 30 m shall be provided in walls, floors and roof slabs of water retaining structures.

Construction joints shall be provided at right angles to the general direction of the member. The locations of construction joints shall be decided on convenience of construction. To avoid segregation of concrete in walls, horizontal construction joints are normally to be provided at every 2 m height, GI 18 guage/PVC water stops of suitable type and minimum 230 mm width, 6 m thick shall be used for walls and base slabs.

- **Water Retaining Structures**

Liquid retaining/conveying structures including the members covering the same (such as roof of a chamber, channel etc.) shall be designed by uncracked method of design as per BIS: 3370 and 6494. Basement RC walls and slabs below ground shall also be designed by uncracked method of design as liquid retaining structures. Shear shall be checked by working stress method as per BIS: 456. Minimum temperature and shrinkage reinforcement shall be 0.3% in each direction.

All underground or partly underground liquid containing structures shall be designed for the following conditions:

Liquid depth up to full height of wall: no relief due to soil pressure from outside to be considered.

Structure empty (i.e. empty of liquid, any material, etc) full earth pressure including saturated condition and surcharge pressure wherever applicable to be considered.

Structures shall be designed for uplift in empty conditions as per water table indicated in the geotechnical report or high flood level, whichever is maximum. No reduction factor for the uplift force shall be considered.

The dead weight of the empty structures should provide a safety factor of not less than 1.2 against uplift pressures during construction and in service.

Wall shall be designed under operating conditions to resist earthquake forces from earth pressure mobilization and dynamic water loads;

Underground or partially underground structures shall be checked against stresses developed due to any combination of full and empty compartments with

appropriate ground/uplift pressures from below to base slab

The walls and base slabs shall be designed for saturated earth/water pressure corresponding to high flood level or finished plot level whichever is higher.

For design purpose, sub soil water level is to be considered as 2 meter below the average natural ground level. (Uplift pressure on the foundation shall be considered as per water table at site, in the rainy season. However, for design purpose, minimum water table shall be considered at 2 m below the average ground level

- **Foundation**

  - The minimum depth of foundations for all structures, equipment's buildings and frame foundations and load bearing walls shall be as per IS: 1094.
  - The earth fill above virgin ground level till formation level shall be taken as a surcharge load and shall be added in the loads coming on foundations appropriately
  - Care shall be taken to avoid the foundations of adjacent buildings or structure foundations, either existing or not within the scope of this Contract Suitable adjustments in depth, location and sizes may have to be made depending on site conditions. No extra claims for such adjustments shall be accepted by the Employer.
  - Special attention is drawn to danger of uplift being caused by the ground water table
  - Plinth level of all structures/top of tanks shall be at least (1000) mm above high flood level.

- **Design Requirements**

  The following are the design requirements for all reinforced or plain concrete structures:

  - All blinding and leveling concrete shall be minimum 100 mm thick in concrete grade M10 for Building & 150 mm thick in concrete grade M15 for Water Retaining Structures as per IS -3370 (Part- 1)-2009 latest version..
  - All structural reinforced concrete shall be with a maximum 25 mm aggregate size for footings and base slabs and with a maximum 20 mm aggregate size for all the Water Retaining Structures & other structural members.
  - All liquid retaining structures shall be designed as per IS: 3370. The minimum grade of concrete shall be M30 using Sulphate resistant Cement.
  - All Buildings, Pipe Pedestals, Thrust Block, Pump Foundation & other structures shall be designed as per IS-456. The minimum grade of concrete shall be M20.
  - The maximum free water cement ratio shall not exceed 0.5 for all liquid retaining structures.
  - The amount of reinforcement in each of the two directions at right angles within each surface zone should not be less than the minimum specified as IS:3370 or IS:456 whichever is applicable for the type of structure.
  - Use of pressure relief valves to reduce uplift pressure due to ground water table shall not be allowed.
  - All buildings shall have a minimum 1.0 m wide, 100mm thick plinth protection paving in M15 grade concrete or stone slabs/tiles. All plinth protection shall be supported on well-compacted strata.

  The following minimum thickness shall be used for different reinforced concrete

members irrespective of design thickness.

S.No	Civil Member	Width (mm)
1	Walls for liquid retaining structures	200
2	Base Slab of liquid retaining structures	350
3	Wall foundation (At Junction of Base Slab & Wall) of liquid retaining structures	400
4	Roof Slab of liquid retaining structures	150
5	Walls of Launders	150
6	Base slab of Launders	125
7	Floor slabs including roof slabs, walkways canopy slabs	100
8	Walls of cables/pipe trenches, underground pits, etc	125
9	Footing – Edge Thickness	250
10	Footing – At the Face of Column	450
11	Column	300 (width)
12	Parapets, chajja	100
13	Precast trench cover	75
14	Beam	300 (width)

- ✓ ***Minimum Cover to Reinforcement***

S.No	Member		Diameter (mm)
1	Slab	Free Face	20
		Face in contact with earth	30
2	Beam	Top /Bottom	40
		Side	30
		Face in contact with earth	40
3	Column and pedestal	Super Structure	40
		Face in contact with earth	40
4	Retaining wall, Basement and Pit wall	Free side	30
		Face in contact with earth	30
5	Liquid Retaining Structure	Face in contact with liquid	40
		Face in contact with earth	40
		Free face	40
	Foundation	Bottom	60
		Top	60

- ✓ ***Minimum Bar Diameter***

S.No	Member	Diameter (mm)
1	Major Foundation	10
2	Block Foundation Main Bars	8
3	Block Foundation – Tie Bars	8
5	Column, Pedestal – Main Bars	12
6	Column, Pedestal – Ties	8
7	Beam – Main Bars	12
8	Beam – Anchor Bars	10
9	Beam – Stirrups	8

10	Slab – Main Bars	8
11	Slab – Distribution Bars	8
12	Wall – Main Bars	10
13	Wall – Distribution Bars	8
14	Minor elements such as chajjas, Lintel Beams etc	8

✓ ***Bar Spacing***

S.No	Member	Minimum(mm)	Maximum (mm)
1	Foundations	125	200
2	Slabs	100	300
3	Stirrups for Beams	100	300
4	Ties for Columns, Pedestals	100	300
5	Walls	100	300

• Bar spacing shall be provided in multiple of 25 mm.

The design submitted by the Contractor shall be proof checked from the nearest IIT / Engineering college (Approved by the Employer's Representative), for which the scrutiny charges shall be borne by the Contractor. The delay in checking designs by the third party as above shall be treated as the delay on the part of the Contractor for operation of the tender clause.

Materials in General

The term “materials” shall mean all materials, goods and articles of every kind whether raw, processed or manufactured and equipment and plant of every kind to be supplied by the Contractor for incorporation in the Works.

Expect as may be otherwise specified for particular parts of the works the provision of clauses in “Materials and Workmanship” shall apply to materials and workmanship for any part of the works. All materials shall be new and of the kinds and qualities described in the Contract and shall be at least equal to approved samples.

As soon as practicable after receiving the order to commence the works, the Contractor shall inform the Employer’s Representative of the names of the suppliers from whom he proposes to obtain any materials but he shall not place any order without the approval of the Employer’s Representative which may be withheld until samples have been submitted and satisfactorily tested. The Contractor shall thereafter keep the Employer’s Representative informed of orders for and delivery dates of all materials.

Materials shall be transported handled and stored in such a manner as to prevent deterioration damage or contamination failing which such damaged materials will be rejected and shall not be used on any part of the Works under this contract.

✓ ***Cement***

The Cement shall be Sulphate Resistant Cement grade - 43 in all water retaining structures and SRC 43 grade cement for other structures, confirming to the relevant B.I.S. codes and approved by the Employer’s Representative. Manufacturers Test Certificate shall have to be furnished. Minimum cement consumption for RCC M20 shall be considered as 350 kg/cum and for RCC M25 shall be 380 kg/cum. mixing of fly ash in the concrete shall not be considered. Approved Manufacturers of Cement of reputed firm with ISO certification shall be used

✓ ***Reinforcement Steel***

Reinforcement Steel shall confirm to BIS Specification 432-1966 (with up to

date revision) and B.I.S. Specification 1786-1985 (with up to date revision). All Reinforcement Steel will be TMT Grade approved by the Employer.

✓ ***Minimum Cement Content***

The minimum cement content for each grade of concrete shall be as per table below.

S.No	Grade of Concrete	Minimum Cement Content in Concrete (Kg/cum of finished concrete)
1	M15	240
2	M20	300
3	M25	300
4	M30	320

Please refer clause no. 8.2.4 Table no: 5 for reinforced concrete of IS code 456 – 2000 (latest version)

Samples and Tests of Materials

The Contractor shall submit samples of such materials as may be required by the Employer and shall carry out the specified tests directed at the site or at the supplier's premises or at the laboratory approved by the Employer or the Employer's Representative. Samples shall be submitted and tests carried out sufficiently early to enable further samples to be submitted and tested if required by the Employer.

The Contractor shall give the Employer seven days' notice in writing of the date on which any of the materials will be ready for testing or inspection at the supplier's premises or at a laboratory approved by the Employer. Employer or the Employer's Representative shall attend the test at the appointed place within seven days of the said date on which the materials are expected to be ready for testing or inspection according to the Contractor, failing which the test may proceed in his absence unless instructed by the Employer's Representative to carry out such a test on a mutually agreed date in his presence.

The Contractor shall in any case submit to Employer within seven days of every test such number of certified copies (3) of the test results as the Employer's Representative may require.

Approval by the Employer's Representative as to the placing of orders for materials or as to samples or tests shall not prejudice any of the Employer's Representative powers under the Contract. The provisions of this clause shall also apply to materials supplied under any nominated sub-contract.

Orientation

The works shall be laid out within the confines of the site in order to be compatible with the existing infrastructural facilities, inlet and outlet pipe work/channels and nearby water bodies. Underground services requiring to be relocated in order to accommodate the proposed site layout shall be relocated by the Contractor to alignments approved by the Employer's Representative.

Buildings and Structures

All the building and structure works shall generally comply with the following Employer's Requirements unless otherwise specified elsewhere:

All building works shall be of reinforced concrete framework.

All external walls shall be in 230 mm thick brick masonry built in cement mortar (1:5). Transoms and mullions of 115 mm x 230 mm size with four numbers 6 mm bars and 6 mm links at 150 mm c/c shall be provided to form panels not

exceeding 3,500 mm x 3,500 mm in size. All internal partition walls except for toilets shall be in 230 mm thick brick masonry built in cement mortar 1:5 with transoms and mullions as in (b) above. Toilet partition walls shall be in 115 mm thick brick masonry built in cement mortar 1:4 and shall have transoms and mullions as in (b) above and shall form panels not exceeding 1,200 mm x 1,200 mm in size.

Finishes to concrete liquid retaining structures shall be:

- F1 - External surfaces, buried
- F2 - External surfaces exposed and up to 300 mm below ground level
- F2 - Internal surfaces

Finishes to other concrete structures shall be:

- F1 – Buried
- F1 - Exposed, where plastering is specified
- F2 – Exposed

All internal masonry surfaces finish shall have 12 mm thick plain faced cement plaster in cement mortar (1:4) with neat cement finish on top. Over this, one coat of primer and two coats of plastic emulsion paint of approved quality and shade shall be provided.

All external masonry and concrete with rough board finish shall have 20 mm thick sand faced cement plaster in two coats, base coat 12 mm thick in cement mortar 1:4 and finishing coat 8 mm thick in cement mortar 1:4. Waterproofing compound of approved make and quality shall be added to the cement mortar in proportions as specified by the manufacturer.

All external surfaces above ground level shall have one coat of primer and two coats of waterproof cement based paint of approved quality and shade. A coat of silicone water repellent paint shall also be applied thereon.

Toilet areas, walls and ceilings, shall have one coat of primer and two coats of plastic emulsion paint. Toilet floor slab shall be filled with brick bat coba (broken bricks in lime) and provided with waterproofing as per the specifications of an approved specialist waterproofing company. The finished floor level in toilet areas shall be 25 mm below general finished floor level elsewhere in the building.

The flooring in all areas except toilets and staircases, pumping stations, chlorination building, centrifuge building, workshop, store room D.G. room shall be in 250 mm x 250 mm x 20 mm thick marble mosaic tiles of approved make unless otherwise specified, shade and pattern and placed in cement mortar 1:4 to give overall thickness of 50 mm. Half tile skirting shall also be provided in these areas.

The flooring in the pumping stations, chlorination building, centrifuge building, workshop, D.G.room shall be 60mm thick cement flooring with metallic concrete hardener topping, under layer of 42mm thick cement concrete 1:2:4 (1 cement : 2 coarse : 4 graded stone aggregate 16mm thick nominal size) and top layer of 18mm thick metallic concrete hardener consisting of mix 1:2 (1 cement : 2 stone aggregate 6mm nominal size) by volume & mixed with metallic hardening compound of approved quality @ 3 kg/sqm including cement slurry and rounding off edges.

The flooring in Contractor’s room, loading/unloading bay, MCC cum Panel room shall be in 25mm thick Kota stone slab of approved shade and pattern and placed over 20 mm thick base of cement mortar 1:4 to give overall thickness of 45 mm. Half tile skirting shall also be provided in these areas.

Toilet areas shall have 450 mm x 450 mm x 25 mm thick polished Kota stone tiles placed in cement mortar 1:4 to give an overall thickness of 50 mm. 2100 mm high

dado, in 150 mm x 150 mm x 6 mm thick glazed tiles (approved make, shade and pattern) placed in cement mortar 1:3 shall also be provided in these areas.

The flooring along with skirting in administration cum laboratory building shall be 20 mm thick mirror polished, machine cut granite slab of approved shade and pattern placed in cement mortar (1:4). 150mm high skirting shall be provided in these areas. Granite stone shall be provided for laboratory platforms fixed over double sandwiched cuddappa support as directed and the edges of granite is to be embedded into the wall.

The toilet facilities shall include at least:

- 3 Nos. Water closets with white porcelain Orissa pan minimum 580 mm long with low level flushing cistern of 10 litres capacity.
- 4 Nos. urinals of sizes 600 mm x 400 mm x 300 mm flat back type in white porcelain separated by a marble partition of size 680 mm x 300 mm.
- 3 Nos. wash basins of size 510 mm x 400 mm in white porcelain with inlet, outlet and overflow arrangements.
- 3 Nos. mirror of size 400 mm x 600 mm wall mounted type fitted over wash basins.
- 2 Nos. plastic liquid soap bottles
- 2 Nos. chromium plated brass towel rails minimum 750 mm long.
- All stopcocks, valves and pillar cocks shall be heavy duty chromium plated brass.
- All fittings such as `P' or `S' traps, floor traps, pipes, down take pipes etc.
- The sewage from toilet blocks shall be led to the wet well of terminal sewage pumping station if present or included under this contract or to the closest gravity sewer.
- All staircases shall have 25 mm thick chequered mosaic tiles for treads and 25 mm thick plain mosaic tiles for risers of approved make and shade and half tile skirting set in cement mortar in 1:4 to give an overall thickness of 50 mm.
- All concrete stairs shall have aluminum nosing over 2 mm thick rubber strip of width same as nosing for the full length of the tread. Nosing shall be fixed with countersunk screws. Stairways shall be provided to permit access between different levels within buildings. Staircase shall be minimum 1000mm wide unless specified otherwise. Staircases in general shall not be steeper than 40°. Staircases having space constraints may be steeper than 400. The maximum vertical run for a single flight of stairs shall be 3.0 M.
- All roof tops and overhead tanks shall be made accessible with ladder provision. Vertical step ladders fitted with landing point extensions will be permitted where considered appropriate by the Employer's Representative to access areas not frequently visited.
- Steel staircases shall be constructed of standard channel stringers with M.S. grating treads 25mm thick with non skid nosing. Steel Ladders shall be minimum 600mm wide and shall not exceed 6m of straight run. The ladders shall be painted with epoxy paint.
- All hand railing shall be provided with G.I "C" Class Pipe confirming to latest Indian standards. The minimum height of hand railing shall be 1m.
- The reinforced concrete roofs shall be made waterproof by application of an approved roof polythene / bitumen membrane / brick bat coba. The finished roof surface shall have adequate slope to drain quickly the rain water to R.W down take inlet points.

- All roof floors shall have minimum 750 mm height solid concrete block parapet wall where accessible is provided and shall have minimum 300 mm height solid concrete block parapet wall where accessible is not provided.
- For roofing drainage, cast iron or uPVC rainwater down takes with C.I. bell mouth or u PVC bend and C.I. or uPVC grating at top shall be provided. For roof areas up to 40 sq m minimum two nos. 100 mm diameter down take pipes shall be provided. For every additional area of 40 sq m or part thereof, at least one no. 100 mm dia. down take pipe shall be provided.
- Top surfaces of chajjas and canopies shall be made waterproof by providing a screed layer of adequate slope or application of an approved roof membrane and sloped to drain the rain water.
- Building plinth shall be minimum 450 mm above average finished ground level around building or high flood level whichever is more.
- All doors, windows, rolling shutters shall have lintels above. Chajja protection to lintels on external walls shall be such as to prevent the rain water splashing into the building. Chajja projection of minimum 750 mm for rolling shutters, 600 mm for doors and 450 mm for windows shall be provided to prevent the rain water splashing into the building. Chajja shall be projected 150 mm on either side from size of doors/windows/rolling shutters. All windows and ventilators shall have 25 mm thick Kota stone sills bedded in cement mortar (1:3).
- All doors and windows shall be painted with two coats of synthetic enamel paint over a priming coat (ready mixed Zinc Chromate Yellow primer of approved brand and manufacturer confirming to I.S.: 127-106, 341 and 340).

All doors, windows and ventilators shall be made of aluminum confirming to latest version of IS: 1948. All fixtures for doors, windows and ventilators shall also be of aluminum. Aluminum grills shall be provided in all the windows. Doors shall be in two panel and both panels shall be glazed/unglazed. Minimum weight of aluminum doors & windows shall be as follows

Single Glazed Window : (Weights indicated shall be aluminum) Open able Outer Frame: Weight 0.70 kg/Rmt

Shutter Frame: Weight 0.97 kg/Rmt

Intermediate Mullion: Weight 0.97 kg/RMt. Beading: Weight 0.31 kg/Rmt

Fixing Louvers windows/ventilators Outer Frame: Weight 0.46 kg/Rmt

Double Glazed Window

Outer Frame: Weight 0.72 kg/Rmt Shutter Frame: Weight 0.97 kg/ Rmt

Intermediate Mullion: Weight 0.98 kg/ Rmt Beading: Weight 0.31 kg/ Rmt

Sliding Windows

Bottom & Top Frame: Weight 0.70 kg/m Shutter Frame: Weight 0.42 kg/m

Interlocking Section: Weight 0.47 kg/m

Aluminum Door

Outer Frame: Weight 2.508 kg/Rmt Shutter Frame: Weight 2.508 kg/Rmt Bottom Stile: Weight 2.508 kg/Rmt Glazing shall be 5.5 mm thick glass.

Openings of the windows & ventilators shall be minimum 25% of the external wall area.

Ventilator shall be provided where height of floor is more than 3m.

All windows and ventilators shall have wire mesh. Frame of doors, windows and ventilators shall be of aluminum of standard rolled section. Doors, Windows and Ventilators shall be of size as per schedule to be submitted by the Contractor for

approval of Employer's Representative. The minimum size shall be as per below:

- Door of opening size 1.2m x 2.1m
- Door of opening size 0.75m x 2.1m for toilets
- Glazed windows of minimum size 1.2m x 1.2m
- Ventilators of minimum size 0.6m x 0.6m

Rolling shutters shall be made of 80 x 1.25 mm MS laths. Rolling shutter shall be of minimum size 3m wide x 3.0m high. Rolling shutter shall be provided in MCC cum panel room, chlorine toner shed, at entry and exit of the pump house for access to pumps, motors, valves, panels and as wherever required.

All concrete channels and ducts used for conveying liquid shall have inside finish of type F2. The width of concrete channels shall not be less than 500 mm. All open channels shall be provided with Stainless Steel Type 304 hand railings or concrete walls to a minimum height of 1 m from the access surface elevation. All concrete surfaces of structures conveying raw sewage or primary effluent shall be protected with Epoxy Coating as specified in Clause 10.21.

Kerbs to be provided below the hand railing on the catwalks/pathways should be as per relevant sections of Factory Act. It shall not be less than 150mm.

All exposed surfaces of inserts embedded in concrete shall be painted with two coats of enamel paint over one coat of red oxide zinc chrome primer. Surfaces in contact with concrete shall not be painted.

All structural steel members shall be painted with two coats of enamel paint over one shop and one field coat of red oxide zinc chrome primer.

All rooms in the treatment plant buildings shall be provided with appropriate sign boards indicating the function of the rooms involved written in Marathi and English Languages.

The design of buildings shall reflect the climatic conditions existing on site. Process buildings shall as far as is possible permit the entry of natural light, and the use of glazed paneling shall be kept to a minimum and preference given to wall openings protected by weather canopies.

Emergency exit doorways shall be provided from all buildings in order to comply with local and international regulations. Stairways and paved areas shall be provided at the exit points.

Toilet blocks in process buildings and control blocks shall be provided with a sink with two drinking water taps of 20 mm size with adequate inlet and outlet connections.

All the walkways in shall have minimum 1 m width and shall be covered with mosaic tiles.

Hand railings shall be made up of G.I “C” Class Pipe confirming to latest Indian standards.

For structures containing water or process liquid, the top of the wall shall be at least 0.5m higher than the maximum water surface level calculated at high flood level and peak plant flow. The top level of internal plant roads and approaches shall be at least 0.5m above the site High Flood Level.

If the High flood level is more than Ground Level then road shall be constructed on the earthen embankment. Earthen embankment shall be constructed with side slope of at least 2 horizontal to 1 vertical. Stone pitching shall be provided at both sides of the embankment as per IS: 8237. Top width of embankment shall be taken as 6.0m. Top level of embankment shall be 0.5m above high flood level. Excavated earth from the plant can be used for embankment construction and if

required, extra earth can be borrowed from the borrow pit as approved by Employer's Representative.

- **Roadways, Pathways & Hard standings**

Internal roads shall be provided around the treatment plant to link in with the existing units and the approach road and permit access to the plant for necessary maintenance, delivery of consumables and personnel access. All roads shall be of asphalt macadam and minimum 3.75 meters wide. Vehicular access shall be provided for all Plant structures and buildings. All roads shall be provided with drainage and shall be constructed to prevent standing water. Hard standing areas with shading facility shall be provided to permit the parking of vehicles involved in the delivery of consumables from blocking site roadways during unloading or loading..

- **Site Drainage**

The Contractor shall provide a site drainage system. The system shall comprise of the following:

Storm Water Drainage Foul Drainage (if any)

✓ ***Storm Water Drainage***

Storm water drains adjacent to the existing and proposed roads (under this Contract) shall be sized for a rainfall intensity of 50 mm/hr, allowing for 100% runoff. Drains adjacent to roads shall be in stone masonry in CM (1:4) of appropriate thickness, topped with 75 mm thick M10 concrete and internally flush pointed in cement mortar (1:4), 20 mm thick. The minimum width of drain shall be 450mm.

The storm water drainage system shall also be designed to cater the run-off from the existing plot areas and structures, if necessary depending upon the site topography.

✓ ***Foul Drainage***

The foul drainage system shall accept discharge from toilets, washrooms, offices and the laboratory. The foul drainage system shall be conveyed to the nearest public sewer wherever exist or to a pumping station or a new soak pit followed by septic tank shall be constructed.

✓ ***Cable and Pipe work Trenches***

Cable and pipe work trenches shall generally be constructed in reinforced concrete. However, 500 mm x 500 mm size or smaller trenches, not on fill may be constructed in 200 mm thick solid cement concrete blocks over 150mm thick M 15 PCC base. The trenches will be 20mm thick plastered internally with cement mortar (1:4) and externally in cement mortar (1:3).

All floor cut-outs and cable ducts, etc. shall be covered with M20 precast concrete covers (Heavy Duty) or MS grating as per direction of Employer's Representative in outdoor areas and M.S. chequered plates, suitably painted of adequate thickness in indoor areas. All uncovered openings shall be protected with hand railing. The pipe, cable trenches shall be suitably sloped to drain off rainwater to a suitable location.

Layout of trenches outside the buildings shall allow space for construction of future trenches where necessary with due consideration for planning for future developments. This aspect shall be brought to the notice of the Employer's Representative while planning the works.

- **Pipes and Ducts**

  R.C.C ducts for drainage shall have minimum 1 metre pre-cast cover (M20 concrete, Heavy duty) while laid under roads. Access shafts of size not less than 600 mm x 1000 mm shall be provided.

  All drains (except storm water drains adjacent to roads) shall be covered and designed structurally for appropriate loads.

- **Main Gate**

  Proposed treatment plant shall have minimum one main gate to access the plant irrespective of existing gate at the premises of existing plant site. Minimum width of main gate shall be 6m. Main gate shall have 1.5m wide wicket gate. Main gate shall have as external framework of GI pipes and internal framework of MS flats. Gate shall be fixed on RCC columns. The design and pattern of gate with drawing shall be submitted for approval of the Employer's Representative. The gate shall have all necessary hinges, locking arrangement, rolling arrangement and painting complete, as approved by the Employer's Representative.

- **Landscaping**

  The site shall be landscaped once the works are substantially complete. Landscaping area shall be marked in the layout plan of STP.

  Landscaping shall include planting of suitable trees and development of lawn/grassed areas. Landscaping in general shall meet ecological and environmental conditions of the site. Road widths shall determine the size of the tree height and spread to be selected for planting. Trees suitable for local conditions shall be selected as approved by the Employer's Representative. Medicinal and fruit trees shall be avoided. Landscaping shall be maintained in good condition till the completion of the contract.

- **Tree Planting**

  Pits dug a few days in advance of actual planting shall be allowed to weather and be filled with top soil mixed with manure. Size of the pit shall be as per standard requirement. Only one tree shall be planted in each pit. A guard made of bamboo with wire mesh or bricks or M.S. ring as approved by Employer's Representative, shall be provided.

- **Earth Work And Excavation**

  - ✓ ***General***

    Applicable provisions of Conditions of contract shall govern work under this section. The Contractor shall report any water conditions encountered and will be given directions as to the type of procedure to be adopted in such cases. The Indian Standards wherever referred to herein shall be the latest edition of such Standards.

  - ✓ ***Excavation for Foundation, Trenches, Pits, etc.***

    All foundation trenches shall be excavated to the full-widths and depths shown on the drawings or to such greater or smaller depths as may be found necessary or so ordered to him.

    Should any excavation be taken down below the specified levels, the Contractor shall fill in such excavation at his own cost with concrete as specified for foundations, well rammed in position until it is brought up to the level. The Contractor shall notify to the Employer when the excavation is completed and no concrete or masonry shall be laid until the Employer has

approved of the soil for each individual footing, rafts, etc.

The Contractor shall keep the site clear of water at all times. To this end he shall provide arrangements for building or pumping of water as required. All foundation pits shall be refilled to the original surface of the ground with approved material, which shall be suitably consolidated. No extra will be paid for bailing out water collected in excavation due to rains, ordinary springs etc.

- ✓ ***Earth Filling***

The space around the foundations in the trenches or sites shall be cleared of all trash and loose debris and filled with approved excavated earth, all clods being broken. Filling shall be done in 200 mm layers; each layer to be moistened and well rammed. This shall be done in step with the foundation masonry or foundation concrete work the difference between the tops of masonry and filling not exceeding a day's work. The top of filling shall be finished off 150 mm above ground level to allow for settlement only pit or depressions occurring within twelve months of completion shall be filled up and rammed by the Contractor or his own expense.

- ✓ ***Shoring, Planking & Shuttering***

Shoring shall be done when sides of excavation do not stand up by themselves and sloping or stepping is not feasible or economical.

The shoring shall consist of vertical planks 38 mm to 50 mm thick and of Available width and required length. The planks shall be held by walling, vertical places and struts, and this to form a frame. The struts shall be not more than 1.5 m. apart, and the timber shall be sufficiently strong not to wrap. The planks shall be held tight by means of wedges between them and walling. The planks shall be driven in by cutting the earth beneath their toes or driving each plank separately after removing the wedges. The planks shall be driven in vertically and shall be set touching one another.

The shoring shall be adequate to prevent caving in of the trench walls of subsidence of areas adjacent to the trench. In narrow trenches of limited depth, a simple form of shoring shall consist of a pair of 40 to 50 mm thick and 30 cm wide planks set vertically at intervals and firmly strutted. For wider and deeper trenches a system of wall plates (Wales) and struts of heavy timber section is commonly used. Continuous sheeting shall be provided outside the wall plates to maintain the stability of the trench walls. The number and the size of the wall plates shall be fixed considering the depth of trench and type of soil. The cross struts shall be fixed in a manner to maintain pressure against the wall plates which in turn shall be kept pressed against the timber sheeting by means of timber wedges or dog spikes.

- ✓ ***Wet Foundation***

As soon as water is encountered in foundations, a sump shall be dug for removing the water. The bottom level of this sump shall be kept 500 mm or more below the lowest level of the excavation. The difference between the levels of the bottom of the excavation and of the sump shall be kept constant as excavation depth is increased. If the excavation is to be taken to a substantial depth and a large quantity of water is encountered, two sumps shall be excavated and deepened alternatively so that the pump does not require to be stopped whilst the sump is deepened.

- ✓ ***Earthwork in Site Levelling***

All materials required for the purpose of filling shall be taken from high areas

and stockpile, which are to be levelled to specified reduced level as required. Roots, sods, wood or other organic matter shall not be placed in the fill. Before a new layer is laid the existing ruts or other unevenness in the surface of the layer shall be removed and the surface of the layer shall be scarified and roughened by borrowing and ploughing to obtain bond with the material to be placed. The materials shall be placed continuous horizontal layers not greater than 200 mm thickness. The earth fill shall be kept slightly sloping from center to the edges to avoid formation of pools during the rain.

- **Concrete**

  - ✓ ***General***

    Applicable provisions of Conditions of Contract shall govern work under this section.

    All concrete work, plain or reinforced shall be carried out in strict accordance with this specification and any working drawing or instructions given from time to time to the Contractor. The Contractor's rates shall allow for wastage in all materials as well as for all tests of materials and for concrete. No concrete shall be cast in the absence of the Employer's Representative or any other person duly authorized by him. The Contractor's Engineer shall personally check that both the formwork and reinforcement have been correctly placed and fixed, and shall satisfy himself that all work preparatory to the casting is completely ready, before calling the Employer's Representative for final inspection and approval and for which purpose at least 24 hours' notice shall be given by the Contractor. The Indian Standards wherever referred to herein shall be the latest edition of such Standards.

  - ✓ ***Cement***

    Cement shall be ordinary Portland cement as per I.S. 269 or Sulphate Resistance Cement as per IS 12330. Cement tests shall have to be carried out at Contractor's expense as and when directed.

  - ✓ ***Aggregate***

    The fine and coarse aggregate shall conform to IS: 383 & IS: 456. The necessary test indicated in IS – 383 and IS – 456 shall have to be carried out to ensure the acceptability and shall meet prior approval of the Employer.

  - ✓ ***Reinforcement***

    The epoxy coated reinforcement conforming to IS 13620 or latest relevant Indian Standards shall be of tested quality. It shall also comply with relevant part of IS. 456. All epoxy coated reinforcement shall be clean and free from dirt, oil, paint, grease, mill scale or loose or thick rust at the time of placing. The reinforcement shall be bent to the shapes shown on the drawings prior to placing and all bars must be bent cold. The Steel shall be placed in such a way that it is rigidly held in position while concrete is being cast. The correct clearance from the form shall be maintained by either precast mortar blocks or by metal supporting chairs to be supplied by the Contractor free of charge. The intersections of rods crossing one another shall bound together with soft pliable wire No. 16 S.W.G. at frequent intervals so that reinforcement will not be displaced during the process of depositing concrete. The loops of binding wire should be tightened by pliers.

  - ✓ ***Water***

    Water shall conform to IS: 456, clean and free from alkali, oil or injurious

amounts of deleterious material. As far as possible, the water should be of such quality that is potable. If any chemical analysis of the water is necessary and ordered the same shall be got done at approval laboratory at the Contractor's expense.

- ✓ ***Concrete Proportioning***

  The concrete proportion shall be as indicated on the approved drawings and shall conform to IS: 456.The minimum cover to main reinforcement shall be 25 mm or the diameter of the bar whichever is greater. In the case of surfaces exposed to corrosive action as in sumps, the cover shall be increased up to 50 mm as directed.

  Type of joints, spacing of joints, use of all jointing materials and other features pertaining to the provision of movement joints in liquid retaining structures shall be got approved prior to commencement of construction. All reinforced concrete work shall be thoroughly and efficiently vibrated during laying by use of vibrators.

  For liquid retaining structures M:30 grade (SRC) shall be used, the same shall be deemed to be satisfactorily watertight if the external faces show no signs of leakage and remain apparently dry over the period of observation of 7 days after allowing a period of 7 days for absorption after filling. Covered tank, where all faces are not accessible for inspection, shall be kept filled with water for 7 days and thereafter the drop of water over the next 7 days shall not exceed totally a depth of 12.5 mm per day. Approved corrective measures, if necessary, shall be undertaken by the Contractor at his own expense. The Contractor shall use appropriate water proofing compound during the process of pouring of concrete in required proportion.

- ✓ ***Workmanship***

  All concreting work shall be carried out according to the IS: 456 'Indian Standard Code of Practice for Plain and Reinforced Concrete for general Building Construction'. It should, however, be note that for Over 60 cum of concrete placed or for every one day's work a minimum of 6 (six) cubes shall be cast for test purposes and tested at the Contractor's expense in an approved laboratory.

- ✓ ***Formwork***

  The formwork shall conform to IS: 456. Centering; only steel / plywood centering shall be used

- ✓ ***Curing***

  The concrete shall be cured according to IS: 456 or as directed.

- ✓ ***Concrete Finish***

  The concrete surface on removal of form work shall be such that no finishing is necessary. If however the surface is not satisfactory, the Contractor shall, if so instructed, remove unwanted projecting parts by chipping and smoothening the surface with cement at his own expense and coated with corrosion resistance epoxy paint.

- ✓ ***Construction Joints / Water Stops***

  These shall be in accordance with IS: 456 or as shown on the approved drawings.

  The centering for forming, the construction joint shall be firmly fixed and

adequately slotted for reinforcement extending beyond the joint. If any concrete has set, care shall be taken not to disturb the reinforcing steel in casting the second half of a member with a construction joint and thereby crack the concrete previously placed. The PVC joints shall be of the 'rebated' or 'keyed' type and shall have a minimum width of 300 mm inclined 'feather' or 'straight joints' shall not be permitted. The Joints/Water stops shall be got approved by the Employer's Representative before their placement into the structure.

- ✓ ***Expansion Joints***

  Expansion joints shall be provided at positions shown on the approved drawing or as directed and shall comply strictly with the details shown on construction drawings. Reinforcement shall not extend across any expansion joint and the break between the two sections MUST be complete. Unless otherwise specified, the gap shall be filled with an elastic joint filler consisting of the following ingredients (by weight), preheated to a temperature of 190 (375 F).

  a. Very find sand 60%
  b. Hot bitumen emulsion 33%
  c. Cement 5%
  d. Fine chopped hemp 2%

- ✓ ***Contractor's Supervision***

  The Contractor shall provide constant and strict supervision of all the item of construction during progress of work, including the proportioning and mixing of the concrete and bending and placing of reinforcement. Before any important operation such as concreting or stripping of formwork is begun, adequate notice shall be given.

- ✓ ***Laying Cement Concrete in Foundations & Under Floors***

  Before laying the concrete, the bottom and sides of the trench up to the proposed height of the concrete shall be moistened. The concrete shall be tamped immediately after laying.

- ✓ ***Protective Epoxy Paint Treatment***

  Epoxy Paint of standard specifications manufactured/purchased from a reputed firm approved by IS shall be applied to the outside Concrete surface of R.C.C. Underground sump and all mild steel works within and near the sump. The coverage capacity of layers shall be at 125 Microns D.F.T. 7.60 sq. mt. /Litre.(Exposed steel inserts, embedded in concrete and ladders, submerged in water shall be provided with epoxy paint 360 microns)

- ✓ ***Chases, Holes, Recesses and Inserts***

  All chases, holes and recesses for foundation bolts, various services and other requirements must be formed as shown on the drawings or as directed by the Employer's Employer's Representative during the execution of the work, without extra charge. The Contractor shall fix all necessary inserts in the concrete for support of hangers for pipes and cables, ceiling clamps for lights and fans or for duct etc. If any of the inserts are to be supplied by other agencies not extra payment will be made to the Contractor for placing the inserts position.

✓ ***Load Testing of Structures***

Load tests shall be carried out in accordance with IS: 456, if required by the Employer's Representative.

✓ ***Testing and Commissioning***

All water retaining structures shall be tested before commissioning and trial run as per the specifications in CPHEEO Manual on Sewerage and Sewage treatment (latest edition) and as per relevant IS Code. All the structures are to be checked for water tightness and the sole responsibility of arranging the necessary equipments and apparatus lies with the Contractor at his own cost. Any damage during testing shall be Contractor's responsibility and shall be rectified by him free of cost. Water for testing shall be arranged by the Contractor at his own cost.

Brick Work

✓ ***General***

Applicable provisions of Conditions of Contract shall govern the work under this section. The Contractor shall build the whole of brickwork shown on the drawings with first-class bricks in cement mortar. The Indian Standard wherever referred to herein shall be the latest edition of such Standards.

✓ ***Materials***

Bricks	The bricks used shall generally conform to IS: 1077
Cement	The cement used shall conform to IS: 269
Sand	The sand used shall conform to IS: 1344
Water	The water used shall be clean and free from injurious amounts of deleterious materials. As far as possible, the water should be of such quality that it is potable

✓ ***Mortar Proportion***

Unless otherwise specified, the proportions of cement-sand-mortar by volume for various classes of work shall be as under:

Type of work	Cement	Sand
Ordinary brickwork for building	1	5
Brickwork in pillars	1	4
Half-brick thick or brick-on edge partition wall	1	4

✓ ***Workmanship***

The cement and sand shall be thoroughly mixed dry in specified proportions. Water shall then be added by a sprinkler just sufficient to make a stiff and workable paste. The mortar shall be used within half an hour of mixing. The mortar, which is unused within half an hour of mixing, shall be removed from the site.

✓ ***Brick-work***

All the bricks shall be kept in water till they are completely soaked & only thoroughly soaked bricks shall be used in the work. The Contractor shall set out & build all brickwork to the respective dimensions, thickness and height, as shown on the drawings.

The Contractor shall build all brickwork uniformly, no one portion being raised more than 1 meter above another at one time. The Contractor shall keep wet all brickwork for at least 10 days after laying. The surface of unfinished work

shall be cleaned and thoroughly wetted before joining new work to it.

In curved brickwork, the bricks shall be dressed to shape obtain joints redial to the curve. The joints shall not exceed 12 mm in thickness and should extend the full thickness of the curved brickwork.

✓ ***Damp-proof Course***

Damp-proof course shall be provided at positions where ever necessary. In masonry walls of buildings, it shall normally be placed above the external ground level. It shall be laid for the full width of solid walls and shall be prepared as specified.

A layer of cement concrete 1:2:4 (cement: sand: coarse aggregate) mix, and of specified thickness shall be provided. If a damp-proof course requiring the use of bitumen felt is specified, bitumen used shall conform to IS: 1322 and workmanship shall conform to IS: 1609. All exposed surface of the damp-proof course shall be finished fair and smooth. The external edge shall be chamfered if specified, and shall be finished flush with masonry surface.

Floors and Pavements

✓ ***General***

Applicable provisions of Conditions of Contract shall govern work under this section. The Indian Standards wherever referred to herein shall be the latest edition of such standards.

✓ ***Types of Floors and Pavements***

The principal types of floors and pavements considered in this specification are as under:

- Cast-in-situ artificial stone flooring (plain)
- Natural stone slab flooring
- Pre-cast artificial stone flooring (Plain/Textured)

✓ ***Materials***

❖ **Cement**

Ordinary Portland cement and white and colored cement shall conform to IS: 269.

❖ **Lime**

Where lime is required to be used, it shall conform to IS: 712 and slaking of lime shall be done according to IS: 1635.

❖ **Aggregates**

The aggregates shall conform to IS: 383. Fine aggregates shall range in size from 1.5 mm to 6

unless specified otherwise. Not more than 5 percent of grains shall pass IS sieve 15 (0.151 mm mesh) and not more than 10 per cent shall pass IS sieve 30 (0.296 mm mesh). Coarse aggregate shall all pass through 19 mm mesh, unless specified otherwise and shall be graded as directed. The coarse aggregate for concrete pavements for approaches and driveways shall all pass through 25 mm ring and shall be formed by mixing 80% of 25 mm to 12 mm size and 20% of 12 mm to 6 mm size. The above proportion shall be altered to suit workability if so approved.

❖ **Natural Stone Slabs**

The stone slabs if used shall be best quality obtainable from Neemuch, Kotah, Shahabad, Tandur or other places as specified and shall be hard, even durable, uniform in color and free from cracks, flakes and other defects. No stone shall be thinner at its thinnest part than 25

unless otherwise specified; the stones shall be 300 mm x 300 mm in size dressed square and with straight edges. The top surface of stones shall be smooth or polished as specified and edges dressed to a true fir or chisel dressed as directed.

❖ **Water**

Water shall be clean and free from injurious amounts of deleterious materials. As far as possible, water shall be of potable quality.

❖ **Cast in situ Artificial Stone Flooring**

Grey and colored artificial stone is to be composed of 4 parts of fine stone chips 12 mm and below 2 parts of sand and properly screened to one part of cement. The topping in all cases and to consist of clean and fine sand and cement (2:1) and sufficient skin thickness to be kept and finally trowelled with neat cement finish perfectly smooth to satisfaction. In the case of dados and skirting the total thickness is to be 19 mm of which the bottom layer is to be 12 mm and the toping 6 mm thick in all cases both the layers are to be laid simultaneously without hiatus so that it will in effect be one complete layer; the mixing be made in two different lots.

❖ **Natural stone slab flooring**

The stone slabs shall be evenly and firmly bedded to the required level and slopes as directed. Unless otherwise specified, the thickness of joints shall not exceed 6 mm for unpolished stone slabs and 1 mm for polished stones. The joints shall be raked out to an adequate depth and pointed flush or slightly sunk, as directed, with cement-sand mortar of 1:2 proportions. The stone slabs shall be laid to pattern which shall be approved prior to ordering the stones. The flooring shall be kept wet with wet sand or water for at least seven days. The flooring shall be well washed and shall be perfectly clean and free from all mortar stains etc. when completed

Plastering and Pointing

✓ ***General***

Applicable provisions of Conditions of Contract shall govern work under this section. The Indian Standards wherever referred to herein shall be the latest edition of such Standards.

✓ ***Cement Plaster Materials***

Cement shall confirm to IS: 269 and Sand shall confirm to IS: 1542. Other materials, tools and Accessories, they shall confirm to relevant IS codes listed above and to the requirements specified in IS: 1661.

✓ ***Proportioning and thickness of Cement Plasters:***

The proportions of materials, number of coats and thickness of each coat shall be as a specified or as directed.

- ✓ ***Workmanship***

  Unless otherwise specified, all plasterwork shall be carried out as per IS: 1661 "Code of Practice for Cement and Cement-Lime Plaster Finished on Walls and Ceilings". Special finishing textures to the plaster shall be executed according to Clause 16 of IS: 1661 and/or as directed.

- ✓ ***Curing***

  After the completion of the work, the pointed face shall be kept well wetted for at least for 10 days in the case of Cement Pointing.

Painting and Glazing

- ✓ ***General***

  Applicable provisions of Conditions of Contract shall govern work under this section. The Indian Standards wherever referred to herein shall be the latest edition of such standards.

- ✓ ***Painting of Iron and Steel Work***

  Painting of iron and steel work shall generally be carried out as per IS: 1447 (Part I).

- ✓ ***Preparation of Surfaces***

  The surface to be painted shall be cleaned free of dirt, oil rust, mill scale and be thoroughly dry before painting. Cleaning, degreasing, and descaling wherever necessary shall be carried out as specified in IS: 1477 (Part I) and the method adopted for surface preparation shall have prior approval.

- ✓ ***Primer Coat***

  Unless otherwise specified, the primer coat for steel and iron work shall be of Red Lead paint, conforming to IS: 102. The Red Lead primer shall be applied by means of approved brushes. The Red Lead paint shall be allowed to dry sufficiently hard before the application of the succeeding coat A red lead painted surface shall not however be left exposed permanently, as it is liable to heavy chalking. The primer coat shall be applied as specified in IS: 1477 (Part-I) and the number of coats shall be as necessary for as directed.

- ✓ ***Finish Coat***

  The type of intermediate and finish coat and the number of coats to be applied shall be as necessary or as directed. Intermediate and finish coats may be oil bound bituminous, aluminum or other types of paints. Aluminum conforms to IS: 165. The intermediate and finish coats for structural steel work, sheet metal work and cast iron work shall be applied as specified in IS: 1477 (Part-I).

Glazing Materials

- ✓ ***Glass***

  All glass used in the work shall be best quality glass free from specks, bubbles, smokes, wanes, air holes and other defects, Unless other-wise specified, sheet glass shall be transparent and of the following weights. For panes up to 600 mm x 600 mm in size, glass weighing not less than 7.97 kg/sq.m. shall be used for panes 750 mm x 750 mm to 900 mm x 900 mm size, the weight of glass shall be 9.76 kg/sq.m. Unless other-wise specified, for sizes of glass above 900 mm x 900, plate glass shall be used.

✓ ***Putty***

Putty for use on wooden frames shall conform to IS: 419 and on metal frames to IS: 420.

✓ ***Workmanship***

All glass be cut according to the sizes required as per drawings. Glazing of metal doors, windows and ventilators shall conform to IS: 1081 and glazing of timber doors, windows, and ventilators shall conform to IS: 1003, unless specified otherwise. For glazing wooden doors and windows, the wooden frame, particularly the rebate, shall be well oiled to prevent oil from putty being sucked in by wood. The Contractor shall thoroughly clean all glass and replace all putty or glass damaged during the work.

Miscellaneous Steel and Iron Work

✓ ***General***

Applicable provisions of Conditions of Contract shall govern work under this section.

The Indian Standards wherever referred to herein shall be the latest edition of such Standard.

✓ ***Iron Grills***

The grills for Windows, verandahs, balconies, etc. shall be of mild steel or wrought iron as specified for the work. The design of grills and shapes and sizes of various components shall be as approved. The edges, angles and corners shall be clean and true to shape. The joints shall be mechanically inter-locked and overlapping areas spot welded in such a way that the grill is rigid.

Where moulded grills are specified, the moulded work shall be as approved, and shall have clean, straight and sharply defined profiles. The Contractor shall do the necessary cutting, fitting, drilling, tapping, scribing etc. required to fix grills to adjacent surfaces. The grills shall be fixed plumb, in line and level. Unless otherwise specified, grills shall be painted with two coats of red lead paint conforming to IS: 102 before they are fixed.

✓ ***Rolling Shutters***

Rolling shutters, where specified shall be of the size to suit the openings and shall be positioned as shown on the drawings and/or as directed.

The rolling shutter shall be fabricated from 18 B.G. Steel and machine rolled with 75 mm rolling contras with effective bridge depth of 12 mm lath sections, interlocked with each other and ends locked with malleable cast iron. The guides shall be either rolled or pressed deep channel sections 75 mm deep and 25 mm wide fitted with necessary fittings and fixtures.

The suspension shaft shall be formed from solid drawn seamless tubes 60 mm O.D. of wall thickness of 25 mm in 3 segments coupled 2 with 2 pairs C.I. dog-tailed flange coupling forming one complete unit eliminating deflection in the center to a minimum.

The springs shall be imported high tensile English flat springs 50/60 mm breadth and 1.6/1.8 mm thickness hardened and tempered. These shall be fitted inside the fabricated housing on either ends, which counterbalance the shutter curtain. The ball bearings shall be double row self aligning ball bearing fitted inside C.I. housing fixed on side brackets holding the suspension shaft at either end. The suspension of the curtain shall be belted in specially fabricated

cages formed from MS flats, and plates all are welded. The hood cover shall be made of 20 gauge G.P. sheets with necessary stiffeners and framework to prevent sag, the bottom lock plate shall be made of 3 mm thick M.S. plate and 95 mm wide reinforced with angle/T iron of suitable section with 6 mm dia. M.S. rivets interlocked with last stride of curtain.

The locking arrangement shall consist of hasp and staple on the bottom plate, lockable from both sides. Unless otherwise specified, for overall area of rolling shutters up to 9 sq. m. pull and push type hand-operated shutters shall be used, for area between 9 and 12 sq. m. Pull and Push type shutters shall be provided with ball bearings; for area larger than 12 sq. m, Mechanical Gear type shutters shall be supplied.

✓ ***Collapsible Gates***

Collapsible gates shall be of the size and type as specified by the Employer's Employer's Representative. The gates shall be manufactured out of M.S. channel pickets of size 20 mm x 10 mm and flats 20 mm x 6 mm. The top runner flat shall be at least 50 mm x 12 mm in section. The bottom guide shall consist of a channel or two angles of specified size laid in the flooring to guide the free movement of the gate. The gate shall move in the guide channel on rollers of adequate size fixed at the top and bottom of the gate as specified. The gate shall be painted with one coat of red lead paint conforming to IS : 102 before fixing in position.

- **Woodwork and Joinery**

✓ ***Wood***

All wood required to be used, shall be dry, well-seasoned, Bulsar teak wood and shall be free from knots, cracks or any other kind of defects frames for doors and windows.

✓ ***Jointing Materials***

All nails, screws, fixtures shall be of standard quality as approved by the Employer.

✓ ***Cutting Edges***

Cutting edge for well to be fabricated as per the drawing approved by Employer's Employer's Representative The structural steel to be used, should confirm to IS: 226-1961 and IS: 2062-1962. The steel shall be free from defects as mentioned

in IS: 226-1962 and shall have a smooth uniform finish. Material shall be free from loose mile scale, rusting or other defects affecting its strength and durability. The test certificates shall have to be submitted for the structural steel used in cutting edge.

- **Illumination**

All internal and external areas shall be provided with lighting. The illumination levels to be achieved shall be as follows:

AREA	**LUX**
Office and labs	300 Lux
Switchgear Room	200 Lux
Control Room	300 Lux
Pump House	200 Lux
DG set room	200 Lux
Chemical and general store	150 Lux

Chemical Plant room	200 Lux
Other indoor areas	100 Lux
Outdoor plant from and	50 Lux
Building entrance	100 Lux
Indoor Plant Area	200 Lux
Outdoor Plant Area	50 Lux
Transformer Area	100 Lux
Roads	10 Lux

Fluorescent luminaries shall be used primarily for internal lighting. High pressure vapour or metal halide type luminaries shall be used in indoor application where their use is appropriate. If mercury or metal halide is used in indoor then they should be supplemented with fluorescent luminaries to assure that minimum illumination levels are maintained following momentary power dips. All other internal areas shall be lit with fluorescent luminaries. Where specific recommendations of lux level are not covered above, illumination level in such areas shall be finalized in consultation with Employer.

Employer shall be required to measure levels of illumination after completion of lighting installation work and short fall in illumination level shall be made good by the Contractor. Complete set of calculations showing, room, index, copy MF shall be given during detailed engineering.

Switches / sockets of piano type shall be used in general and in offices of staff, control room, MMI room, decorative modular switches shall be used. Suitable fans shall be provided in rooms/ plant areas as per standards. For exhaust fans it must be provided in panel rooms, pump rooms, chemical rooms, stores, toilets and at least 20 air changes per hour must be maintained.

The following type of lighting fixtures shall be proposed:

- Decorative type 2x36W fixtures for fluorescent luminaries inside office/ administrative buildings and control rooms.
- Corrosion resistant fixture with canopy made of FRP for fluorescent luminaries for corrosive areas like chlorine handling or chemical store or area with corrosive smell/gases etc.
- Industrial type vitreous enameled fixture for fluorescent luminaries inside 415V switchgear, MCC room and pump house.
- In outdoor process areas, lighting fixtures shall be sodium vapour type subjected to minimum of IP protection class.
- All outside lights as plant field lights, building outside lights, flood lights etc. which are to be switched on only during night hours should be controlled through photo cell/ clock switch installed at a central place. All lights shall have minimum IP65 protection class.
- Street lighting wiring shall be through buried underground.
- All bulb fittings (except fluorescent lamps) will have screw type caps.
- For outdoor lighting, the lighting feeder shall be operated through a Contractor, controlled by photocell/ clock switch and shall also have a manual by pass switch.
- Luminaries shall be installed to permit ease of maintenance i.e. it shall not be necessary to shut down plant in order to carryout maintenance or to access luminaries located over areas of water etc. The Contractor shall provide all equipment necessary to carryout maintenance on the lighting installation and

demonstrate its operation to the satisfaction of Employer

- Indoor lighting circuit will be arranged in such a way that 50% lighting can be put off in each room through switches. All lighting circuits will be wired with 2.5sq.mm. Stranded copper
- wire or through 2.5 sq.mm. armoured cable laid in cable trays. Sub circuit from switch to fixture could be wired with1.5 sq.mm. stranded copper wire in MS conduits or armoured copper cable of similar size provided total voltage drop in any lighting distribution board to last lighting point shall not exceed 2%. All lighting circuits will have separate neutral, separate earth from Lighting Distribution Board. For illumination of roads, outdoors areas where operation of equipment or units required and substation area, lighting fixtures of appropriate type (such as street lighting type, flood lighting type, post top lanterns etc.) incorporating high pressure sodium vapour lamps shall be proposed. Street light poles shall not have less than 7500 mm height above the finished road level and the arm shall not project more than 1200 mm along the road width. Poles of bigger heights may also be used if some outdoor areas are to be illuminated. Poles of 4 / 4.5 Mtrs using post top lantern may be used in gate office walk way or in front of office area. Complete area, streets, lanes, boundary shall be covered with street lighting.

✓ ***Receptacles (Lighting & Small Power)***

Decorative and industrial type units of above shall be proposed in all plant areas, offices, stores, workshop, plant room and they shall be located at least two numbers in each room. Distance between two receptacles shall not be more than 8 – 10 mtr. All small 5 amps 5 pin lighting & small power sockets shall be wired by multi stranded copper wire of 2.5 sq. mm laid in rigid MS conduits along with earth wire of1.5 sq.mm flexible copper wire or equivalent size armoured cables. All wiring shall be coded with Red, Yellow, Blue & Black as per the phase used. If required, wiring can be done alternatively through armoured copper cables of similar size laid in MS perforated trays of minimum 2.0 mm thick.

Three phase power receptacles (convenience outlets) suitable for operation of 415V,3 Phase 4 wire, 50 Hz power supply shall be proposed. In indoor areas one such unit shall be provided to cover areas of 20 meter radius (or at least one in each room housing plant items) and in outdoors areas on such unit shall be provided at 50 meter interval. Actual requirement of such units shall be finalized by MMC during detailed engineering. One three phase receptacle shall be provided near entrance of each building for utilities like welding.

Single phase 15 Amp 5 Pin / 6 Pin receptacles will be provided in each room and in halls they will be provided in such a way that with 15 meter cord we should reach every place in building. These shall be wired with 4 sq. mm copper earth wire in MS

rigid conduits along with 2.5 sq. mm earth wire. Not more than two sockets shall be looped in one circuit. Alternatively they can also be connected through armoured cable of 4 sq. mm running in appropriate cable trays.

Separate lighting panels and lighting distribution boards shall be installed and they shall not take tapping for power from motor control centers or power distribution boards.

Piping Work

✓ *Cast Iron Pipes & Fittings*

All protection and bedding of sewers work shall be carried out in strict accordance with the specification and methods laid out in the CPHEEO manual.

❖ Applicable Codes

The manufacturing, testing, supplying, jointing and testing at work sites of cast iron pipes and fittings shall comply with all currently applicable statutes, regulations, standards and codes. In particular, the following standards, unless otherwise specified herein, shall be referred. In all cases, the latest revision of the codes shall be referred to. If requirements of this specification conflict with the requirements of the code of standards, this specification shall govern.

IS:210	Specification for grey iron casting
IS: 290	Specification for coal tar black paint.
IS: 638	Specification for sheet rubber jointing and rubber insertion jointing.
IS:782	Specification for caulking lead
IS:1387	General requirements for the supply of Metallurgical material
IS: 1537	Specification for vertically cast iron pressure pipes for water, gas and sewage.
IS:1536	Specification for centrifugally cast (spun) iron pressure pipes for water, gas and sewage
IS: 1538	Specification for cast iron fittings for pressure pipes for Water, gas and sewage.
IS: 1500	Method for Brinell hardness test for grey cast iron.
IS: 2078	Method for tensile testing of grey cast iron.
IS:5382	Specification for rubber sealing rings for gas mains, water mains, and sewers
IS: 6587	Specification for spun hemp yarn.
IS: 3114	Code of practice for laying of cast iron pipes.

❖ Mild Steel ERW Pipe

The manufacturing, testing, supplying, jointing and testing at work sites of mild steel pipes and fittings shall comply with all currently applicable status, regulations, standards and codes. In particular, the following standards, unless otherwise specified herein, shall be referred. In all cases, the latest revision of the codes shall be referred to. If requirements of this specification conflict with the requirements of the code standards, Employer's Representative decision shall be final.

❖ Materials

a.	IS:226	Specification for structural steel (standard quality).
b.	IS: 2062	Specification for structural steel (fusion welding quality).
c.	IS: 6631	Specification for steel pipes for hydraulic purposes.
d.	IS:3589	Specification for electrically welded steel pipes for water, gas and sewage (150 mm to 2000 mm nominal dia).
e.	IS:6392	Specification for steel pipe flanges
f.	IS:814	Specifications for electrodes for metal arc welding of structural steels: Part 2 welding sheets.

❖ **Code of Practice**

a.	IS: 5822	Code of practice for laying of electric welded steel pipes.
b.	IS: 11906	Recommendations for cement mortar lining for mild steel pipes and fittings for transportation of water.
c.	IS:10221	Code of practice for coating and wrapping of underground mild steel pipelines.
d.	IS: 816	Code of practice for use of metal arc welding for general construction in mild steel.

✓ ***HDPE Pipes***

These pipes have been used for carrying the effluent from distribution boxes to Feeding boxes of the Reactors. These pipes shall meet specifications as per IS: 4984.

✓ ***Jointing***

HDPE pipe shall be jointed properly with HDPE socketted specials to get smooth inner side surface without any extrusion to avoid any obstruction to the flow of wastewater. If in any particular case butt welding has to be done, smooth inner surface of pipe without intrusion inside shall be ensured.

✓ ***Glazed Stone Wares Pipes***

The drain pipes and filtrate pipes are to be made up of GSW. The GSW pipes to be provided should be of IS Specifications. They should be properly laid to proper gradient and as per drawings and approved by Employer's Representative.

✓ ***Valves***

❖ **Gate (Sluice) Valves**

Gate Valves shall be either solid wedge or knife gate unless specifically defined on the drawings.

The materials used for the manufacture of each component shall be the best available for the specific purpose and shall not, in any case be inferior to the following:

Cast Iron	IS. 210 Grade 20
Stainless Steel	IS. 1570 Grade, B.S. 970 Type EN, ASTM A 473.
Gun Metal	BS.1400-LG 2 -C or the equivalent Indian Standard.
Cast Steel	Plain Carbon Steel complying with IS. 1570 Grade, or BS: 970 Grade 431 S 29.

Valve Bodies shall be in cast steel for sewage treatment plants, Spindle shall conform to Stainless Steel and Valve Gates shall conform to Stainless Steel

❖ **Specifications Referred**

The specifications contained herein are not exhaustive and for such items of works which may arise and which are not covered by this specification, or by the relevant Indian Standards, the provisions in the P.W.D. Handbook Vol. I and II (latest edition) shall apply. A list of few important Indian Standards is given below: Wherever reference to the Indian Standards mentioned below or otherwise appears in this specification, it shall be taken as a reference to the latest version of the standard.

IS No.	**Description**
General	
IS : 456	Code of Practice for Plain and Reinforced Concrete for

IS No.	**Description**
	General Building Construction
IS 3764	Safety code for excavation
IS : 1200	Method of measurement of building and engineering (Part 1 to 28) works
IS : 3385	Code of practice for measurement of Civil Engineering works.
IS : 1642	Fire safety of buildings (General): Details of Construction Code of Practice.
IS : 4082	Recommendations on stacking and storing of construction materials at site.
Sand	
IS: 2116	Sand for Masonry, Mortar
IS: 1542	Sand for Plaster
Aggregates	
IS: 383	Aggregates, Coarse and fine from National Sources for Concrete.
IS: 515	Aggregates for use in Mass Concrete Natural and Manufactured.
Cement	
IS : 12330	Specification for sulphate Resisting Portland cement.
IS : 1489	Specification for Portland pozzolana cement
IS : 12269	Specification for 53 grade ordinary Portland cement.
Concrete Plain& Reinforced	
IS : 457	Code of practice for general construction of plain and reinforced concrete for dams and other massive structures.
IS: 3370	Concrete Structures for the Storage of liquids (Part I & Part II, III & IV)
IS : 432	Specification for mild steel and medium tensile steel (Part 1 and 2) bars and hard drawn steel wires for concrete reinforcement
IS : 1786	Specification for high strength deformed steel bars and wires for concrete reinforcement.
IS : 4326	Code of practice for earthquake resistant design and construction of building.
IS : 10262	Recommended guidelines for concrete mix design.

- **Code for Construction safety**

IS No.	**Description**
IS : 3696	Safety code for scaffolds and ladders. (Parts I and III)
IS : 7969	Safety code for handling and storage of building materials.
IS : 8989	Safety code for erection of concrete framed structures.
Brickwork	
IS : 1077	Common Burnt Clay Building Bricks.
Paving and Floor Finishes	
IS : 1237	Flooring Tiles, Cement Concrete
IS : 1443	Cement Concrete Flooring Tiles, Laying and Finishing of
Plastering & Pointing	
IS : 1661	Cement and Lime, Plaster Finishes on Walls and

IS No.	Description
	Ceilings
Roof Coverings	
IS : 459	Asbestos Cement Sheets, Unreinforced Corrugated Sheets
IS : 730	Fixing Accessories for Corrugated Sheet Roofing
Steel & Iron Work	
IS : 226	Structural Steel (Revised)
IS : 800	Use of Structural Steel in General Building Construction, code of Practice for Pipes & Fittings Pipes
IS : 3486	Cast Iron Spigot & Socket Drain Pipes
IS : 1538	Cast Iron fittings for Pressure pipes for water, Gas & Sewage
IS : 1536	Centrifugally Cast Iron Pressure Pipes for water, Gas & Sewage.
IS : 458	Concrete pipes with or without reinforcement
IS : 783	Code of practice for laying Concrete pipes.
IS : 3114	Code of practice for laying of C.I. Pipes
IS : 1726	C.I. Manhole covers and frames intended for use in drainage works.

This list does not necessarily cover all the Standards referred to.

❖ **Furniture to be Supplied for Central Control Centre & Laboratory**

Room	Tables	Chair	Stools	Pelmets / curtains on door and windows	Steel Almirah in wall	Racks
Administrative Block & Laboratory	5	15	10	Yes	6	15
Rest room	1	6		No	1	
Store	1	3	2	No	1	1
Control Room	1	3	3	No	1	
Dining Room	1	4	1			
Security Room	1	3	3			
MCC Room	1	2	1			

One executive revolving chair shall be provided in the laboratory and the plant manager's room. Executive non revolving chairs shall be provided in Engineer's room.

The Furniture shall be of good quality and as approved by Employer's Representative.

Dining room, rest room and control room shall have plastic chairs of good quality.

Furniture to be supplied at each STP

- 2 Nos of steel Almirah of size 78" x 36" x 19" with 4 fix shelves making 5 compartments. Almirah should be made of 22 gauge steel whereas doors and shelves should be made in 20 gauge steel. Almirah should have two way locking device with duplicate CP keys. Almirah should be spray painted with 2 coats of metallic paint of approved colour over a coat of approved primer. Welding etc. should be grinded smooth and holes filled with filler before primer

coat.

- 5 Nos of steel Office table of size 762mm in height (1825 x 1220 one number, 1525 x 915 two numbers, 1220 x 762 two numbers). Table should be made of steel frame consisting of 18 gauge 25m square tubes. The board should be 18/19 thick pre-laminated on both sides wood finish IS marked. Table should have two drawers on one side and other side one cupboard with separate locks. Outer body of cabinet shall be in 22 gauge sheet, drawer in 24 gauge, front of drawer is 20 gauge, sliding range is 18 gauge. the welding marks should be properly grinded having smooth finish. All holes, scratch etc. should be filled with filler before priming coat. The table should be spray painted with 2 coats of metallic paint of approved colour over a coat of approved primer.
- 1 Nos of executive revolving chair having tilting and push back mechanism with PU arms. It should have thick cushion in seat and back mounted over 12mm ply(low back) covered with superior quality of tapestry over pressed steel bone. It should have superior quality double PVC ball wheel five legged, dully powder coat finish etc. complete in all respect.
- 5 Nos of steel office chairs made of steel frame of 1" x 14 gauge pipe duly powder coated epoxy finish. Cushion should be 3" thick in seat and 2" thick in back. Cushion should be covered with approved quality tapestry and should be mounted on 12mm thick moulded ply. Chair should have PU arms etc. and it should be complete in all respect.
- 5 Nos of small table of 900 x 750 x 750mm in size. Table should be made of good quality wood. Legs shall be min. 40 x 40 mm in section. Top should be made using 18/19 m thick wooden planks. Planks should be supported using batten frame of wood. Legs shall be stiffened using wooden battens of 25 x 40mm minimum section. Table should be French polished over a coat of primer.
- 5 Nos of Tubular steel chairs of approved quality with 300mmx300mmx12mm (thick) single side pre-laminated white writing table fixed to right handrail with cane seat and back. The chairs shall have no left arm. The writing table shall be fixed at 250mm higher than the seat. The seat shall be 350mm wide and 400mm deep and fixed at a height of 400mm from ground level. The back shall be of same size as that of the seat. the chair shall be painted with two coats of white synthetic enamel paint over two coats of primer of approved quality complete.

Laboratory Equipments at Each STP

The tendered shall supply following laboratory equipment.

- Analytical Balance
- Autoclave
- Dissolved Oxygen Sampler
- Drying Oven (Hot Air)
- Hot Plates
- Incubator 20°C (BOD)
- Microscope, Binocular with oil immersion and movable stage counting cell
- Membrane Filter Assembly
- Muffle Furnace
- pH Meter portable
- Refrigerator (200 ltr.)

- Sludge Sampler
- Soxhlet extraction unit
- Turbidity meter
- Vacuum pump
- Water bath (thermostat controlled)
- Glassware and analytical chemicals as required
- HACH COD Apparatus
- Colori-meter.& necessary equipment for measurement of Nitrogen and phosphorous

5.5.3.7 Mechanical Works

Technical Specifications for Electro-Mechanical Works

(A) General

All works shall be carried out in accordance with the requirements of:

- IE Rules
- State Electricity Board
- Rules and regulations of Local authorities, and
- The standards in this specification

The Contractor is responsible for applying and obtaining necessary statutory approvals and shall ensure workmanship of good quality and shall assign qualified supervisor / engineers and competent labour who are skilled, careful and experienced in carrying out similar works.

General Engineering Specifications and Practice for Electro-mechanical Works

The following General engineering specifications and practice shall be adopted/adhered to for the Sewage Pumping Station and Sewage treatment plant:

- Supply, Installation, Testing of the mechanical and electrical equipments, pipes, fittings & other accessories.
- Adequate measure shall be taken to prevent dry running of the pump. Low level to trip the pump shall be above the top of pump casing. The sump floor shall have slope towards suction pit / channel. Care shall be taken especially for underground sludge sumps to provide suction pit of adequate size for emptying the sump for ease of maintenance.
- Effective liquid depth of units shall be considered between levels corresponding to lowest level switch and highest level switch. Flooded suction requires that lowest level switch shall not be lower than the elevation of discharge flange of pump.
- Monorail and chain pulley block (manually operated) shall be provided for all pump houses (both underground and above ground) for capacity upto 7.5 MLD Plants and EOT shall be provided for Plants more than 7.5 MLD, Blower room, etc. as required of adequate capacity (minimum 1.5 times the weight of the heaviest equipment). Monorail shall be extended outside pump house / building to facilitate loading / unloading of equipment directly on vehicle, for which ramp approach shall be given.
- All pump areas / pedestals shall be provided with kerb walls and suitable arrangement for collection of leakage and connection to the nearest piping/unit, keeping in mind the process requirement, shall be provided. In dry

wells necessary drain collection pit and dewatering pump of sufficient capacity and head requirement having auto operation with low and high level switches shall be provided in all pump houses, especially underground pump house for this purpose.

- All motors shall have running indication.
- Motors of all pumps and blowers shall be covered with canopy.
- Mixers in chemical solution tanks (without baffle) shall be located off-centre to avoid vortex.
- All chemical dosing pumps shall be provided with pulsation dampeners. Metering pumps shall have bypass with valves and external pressure safety valves.
- Common delivery header and suction header of pumps (and blowers) shall be provided with a blind flange on one end.
- Aeration blowers shall be located inside the blower room with necessary acoustic hoods complying with statutory and safety norms.
- Flow measurement shall be provided at all chemical dosing lines as well as Air Blower discharge lines.
- Knife Gate valves shall be provided for sludge application.
- Flushing connections shall be provided for all sludge handling units and sludge lines.
- The clear distance between adjacent pump / blower pedestal shall be minimum 1000mm. The clear distance from pedestal to internal face of walls shall not be less than 1500mm. The clear distance from pedestal to internal face of walls on motor side of the pumps shall not be less than 2000mm.
- Minimum clearance of 500mm shall be provided around pumps, blowers, equipment pedestal for paving etc.
- Safety shower and eye wash facility, service water connection shall be provided near chemical handling areas, especially chlorination and polyelectrolyte area.
- All instrument indication facility shall be readable from grade.
- All below grade valves (including sludge outlets of clarifiers and thickeners) shall be operable from grade by providing extended spindle and hand wheel arrangement.
- Epoxy lining in polyelectrolyte tanks and other units as required shall be provided. Complete wetted surface including free board and top of walls shall be lined.
- Large tanks shall be able to be segregated for manual desludging, whenever required along with drain piping.
- Operating platforms shall be provided for operation of any equipment or valve causing inconvenience to operate from ground/floor level. For operating height above 1.5m operating platform shall be provided. Platform shall have minimum width of 900mm with galvanized grating / chequered plate.
- Main control room housing PLC/SCADA shall be located in the first floor such that entire STP is preferably visible to the Contractor through glazed windows. The control room layout shall be planned after taking into consideration the space requirement of various PLC/SCADA panels, HMI, etc. It shall be housed in administration/office building. It shall be properly air conditioned and shall be provided with false ceiling. Control room shall be aesthetically appealing.

- All the sludge withdrawal valves of Primary Clarifier, Thickener and Digester shall be electrical actuator operated with auxiliary open/close limit switches and position transmitter for open/close position feedback.
- H.T. & L.T. Room for electric Sub-station to serve the proposed Sewage pumping station and Sewage treatment plant.
- Laboratory, Main Control Room housing PLC/SCDA system along with necessary office furniture.
- Water distribution network for drinking purpose/service water within the plant premises and sewage disposal
- All interconnecting pipes, channels, valves, fixtures, appurtenances.
- Setting up of the testing arrangement as per requirement. Getting of successful test results & obtaining approval from authorized Lab / Agency of the Pollution Control Board and relevant Authorities.
- Operation Maintenance of the entire system including consumables for the specified period. Supply, erection, testing, commissioning of various mechanical, electrical & instrumentation equipment required for the smooth working of the Sewage pumping station and Sewage treatment plant, including the 10 years O & M during guarantee period.

General Mechanical Equipments

Design, supply, erection, commissioning and testing of all mechanical equipments based on chosen technology of Sewage treatment process, shall generally comprise of:

- Bar Screen with frame and scrapper
- CI Sluice Gate
- Air blowers with motor and related accessories.
- Air distribution assembly.
- Mech. arrangements for clarifier. if required
- Sludge return pumps with motor and related accessories.
- Sludge Loading pumps with motor and related accessories.
- Agitator for equalization tank, if required.
- Sludge dewatering System-Filter press/Centrifuge
- Drainage sump pumps
- Loading/Unloading System for Pump House
- Flow measuring System
- Level measuring System for well and Tank.
- All Pipe-works and valves
- Chlorine dosing pump/UV Disinfection System.
- DG Set for Power back-up.
- Fire fighting system.
- Ventilation inside the Pump & Control room, as per requirement.

(B) Any other equipment required

Technical specifications of Mechanical Works for the proposed Sewage treatment plant:

Screening System

All Sewage Pumping Stations shall be provided with Mechanical screens as working and Manual Screen as Standby with conveyor system.

The screens shall be made with welded stainless steel (AISI410) frame.

Bye bass arrangement shall be provided on the upstream side, to avoid overflow of the screen channel in case of sudden power failure.

Drainage facility shall also be provided in the individual screen channels to empty these channels for maintenance purposes.

Individual screen channel should be designed to provide a velocity of min. 0.6 m/sec at average design flow.

The effective area of opening of the screen should be such as to produce a velocity through the screen opening not exceeding 0.9 m/sec. at maximum expected flow.

The top of the screen shall be at least 500 mm above the expected highest flow level.

Sluice Gate

- The gates shall be as per IS:13349/AWWA C 501 or relevant BS/DIN/ISO at their Latest revision.
- The gates shall be CI with rising type spindles.
- The unbalanced head shall never be more than 15 m. The gates shall be manually/Electrically operated.
- The gates shall be installed primarily in the screen chambers for isolation of flow for maintenance purposes.

Submersible Motor Sewage Pump

✓ ***General***

The pump shall be vertical, submersible, non-clog, single stage, bottom suction, monoblock type driven by single speed submersible motor suitable for pumping all kinds of sewage / sludge / storm water containing plastics and fibrous materials. The pumps must have fitted with in-built cutting and tearing system for foreign matters. The speed of the pump should not be more than 1450 r.p.m. The motor output power must have at least 15% margin over pump input power at duty point and the motor will never be overloaded throughout the entire pump operating range as shown in the performance curve. The pump performance must be stable from zero discharge to run out condition.

The design, manufacture and performance of the submersible pump-motor sets shall comply with the latest applicable Indian / International Standards. In particular, the equipment must conform to the latest revision of applicable specification. The pump shall be capable of developing the required total dynamic head at rated capacity and will be suitable for parallel and continuous operation. The head-capacity curve of the pump shall be continuously rising towards the shut-off with highest head at shut-off. The impeller of the pump shall preferably be of non-overloading type. The pump shall be designed to be protected against reverse direction of rotation due to the sewerage returning through the pump. The set rotor assembly weight and

unbalanced hydraulic thrust of the impeller shall be carried out by the thrust bearings provided in pump assembly. The pump shall operate trouble free, smooth and without any undue noise and vibrations. The magnitude of peak-

to-peak vibration at shop and at site installation will be limited to 75 microns and 50 microns respectively at the bearing housing.

The pump installation design should be such as to facilitate automatic installation and removal of pumps without having entry into the sewage pit. Profile gasket should be provided in automatic coupling system so as to avoid metal-to-metal contact between pump and delivery pipe bend to ensure leak proof joint.

- ✓ ***Constructional Features***

  - ❖ **Casing**

    The pump casing, made of cast iron shall be hydrostatically tested at 1.5 times the shut-off head with maximum impeller size. The pump casing shall be of robust construction and the liquid passage in the casing shall be finished smooth.

  - ❖ **Impeller**

    The non-clog, semi open / vortex type impeller will be both statically and dynamically balanced and will be keyed and positively held on the motor shaft. The impeller will also be secured against damages, if the direction of rotation should reverse due to liquid flowing backward through the pump. The impeller shall be capable of handling soft solids of minimum diameter 100 mm. The leading edge of the vanes shall be rounded and cut back to prevent rags, stringy materials etc. from impinging on the impeller vanes.

  - ❖ **Shaft**

    The shaft, made of stainless steel shall be finished to close tolerance at the impeller and bearing diameters. The impeller shall firmly be secured to the shaft by key and / or nuts. The size of the shaft shall be calculated on the basis of maximum combined stresses. While designing the shaft the critical speed of the shaft must be taken into account which shall be at least 20% above / below the operating speed. The rotor shall be dynamically balanced to avoid any vibration during operation.

  - ❖ **Seal**

    The pump shall have two mechanical seals in tandem arrangement. The lower mechanical seal shall have SiC / SiC face combination. Upper mechanical seal shall have with Carbon / TC face combination.

  - ❖ **Bearing**

    Maintenance free antifriction deep grooved, permanently grease filled ball / roller bearings should be provided and this should take care of axial and radial thrust at any point of operation.

  - ❖ **Motor**

    The motor should be dry, squirrel cage type, suitable for 3 ph, 415 ± 10% volt, 50 Hz supply, designed, manufactured and tested conforming to IS: 325. The motor should be rated for continuous duty with IP68 protection and class ‘F’ insulation or better. However, the motor frame size shall be liberally designed to restrict the temperature rise as per class ‘B’ insulation.

    All squirrel cage induction motors shall be provided with electrolytic grade copper winding for stator and the rotor of the motor shall be of copper bars only.

  - ❖ **Internal Protection Features for Pump sets (above 15 KW motor)**

The pump sets shall at the minimum be provided with the following internal protections. The leads of all the protecting sensors shall be brought out from the motor with separate control cables.

- **Winding Temperature**

  The motors shall be provided with 3 sets of PT 100 type thermostats embedded in the winding to protect it from getting overheated.

- **Bearing Temperature**

  For detection of mechanical faults, both bearings, at drive end and non-drive end shall be provided with PT 100 type temperature sensors for monitoring the bearing temperature, protection and annunciation.

- **Moisture Sensors**

  The motors shall be provided with a resistance type sensor to sense entry of any moisture in the motor chamber. It shall operate on 230 V AC supply.

- **Monitoring Seal Leakage Chamber**

  The pump set shall be provided with a float switch type sensor assembled in the seal leakage collection chamber. In the event of any leakage this sensor will give the tripping signal. The contacts of the float switch shall be rated for operation on 230 V 6A AC.

- **Material of Construction**

Casing	:	Cast Iron, IS : 210, FG 260
Impeller	:	2.5% Ni-Cast Iron, IS : 210, FG 260
Shaft	:	Stainless Steel, AI SI : 410
Motor housing	:	Cast Iron, IS : 210, FG 260
Stator/Rotor core	:	CRGO Steel
Stator/Rotor winding	:	Electrolytic grade copper wire/bar
Fasteners	:	Stainless Steel, AISI : 316
Auto coupling system	:	Cast Iron, IS : 210, FG 260
Lifting chain, Guide pipe	:	Stainless Steel, AISI : 410

- **Scope of Supply**

  The scope of supply will include Submersible Pump set along with Automatic coupling, Delivery bend and Cable, Guide pipe & chain of required length.

- **Painting**

  The pump set shall be painted with zinc rich epoxy primer plus two coats of epoxy paint. The paint shall be spray applied and dried in a painting booth to avoid ingress of foreign particles especially when the painted surface is not completely dry.

- **Inspection & Testing at Manufacturer's Works**

  The manufacturer will submit their QAP for Employer's Representative's approval including the following inspections and testings which will be carried out at the manufacturer's works.

- **Hydrostatic Test**

  The pump casing will be hydrostatically tested for any leakage, with water at a pressure 1.5 times of closed valve pressure with maximum impeller size or 2.0 times of pump duty point pressure whichever is higher. Unless

otherwise stated the minimum duration of testing will be 30 minutes.

- **Statistical Balancing**

  All major rotating components must be statically balanced individually.

- **Dynamic Balancing**

  In addition to static balancing of individual component the whole rotor assembly of pump must be dynamically balanced at rated operational speed.

- **Performance Test**

  Each assembled pump shall be shop tested by the manufacturer to determine the following characteristics as furnished in the characteristics curve.

  Capacity Vs. Total Dynamic Head Curve

  Capacity Vs. Brake Horse Power (KW) curve

  Capacity Vs. Efficiency (%) curve

  Capacity Vs. NPSHR curve

  And also recording of

  Vibration level

- **Bearing Temperature**

  The above tests for each pump for its full operating range at rated speed shall be conducted in accordance with the latest revision of IS/BS/DIN/ISO specifications and/or Hydraulic Institute Standards USA.

  During pump testing, reading to the extent possible, shall be taken correspond to its full working range from its closed valve condition to 30% increase of the rated output or corresponding to the output at its minimum head specified, whichever is higher.

  Each pump performance shall be documented by obtaining concurrent readings showing motor voltage and amperage, pump suction head, pump discharge head, pump discharge etc. Such readings shall be documented for at least seven pumping conditions including one at the shut-off head and each power load shall be checked for proper current balance.

  The curves produced from the above readings shall be used to determine the capability of pump sets to meet the guaranteed performance at site.

  Bearing temperatures shall be determined by PT 100 or equivalent type temperature detector. A running time of at least 30 minutes shall be maintained for this test at shut off head if sufficient water is not available for a complete test.

  After the test runs have been performed to the satisfaction of the Client or his representative that the pumping equipment complies with the stipulated specifications the Client shall be provided with the Manufacturer's Test Certificates.

  All instruments and equipment required for such test shall be provided by the manufacturer and the instruments shall be calibrated and certified by an approved independent testing authority not more than 15 days prior to the test in which they will be used.

  In the event of any pump failing to meet the specified test requirements, it shall be modified and retested until the requirements are attained.

- **Non-Destructive Tests**

  Physical and Chemical tests of the major components of each pump must be done. These tests shall be conducted in accordance with relevant IS/BS/DIN/ISO standard

  Prior to testing the tests and major components' identifications along with the actual standard to be followed, shall be submitted for Client's approval and only those, which will pass the tests successfully, shall be used for the manufacture of end product. All material test certificates to be submitted before machining operation to the Client for his approval and finally these 'Approved' test certificates will be produced during pump performance testing.

- **Visual Inspection**

  Pumps shall be offered for visual inspection to the Client before dispatch. The pump assembly/ any component shall not be painted before inspection.

- **Testing At Site**

  All pump sets shall be tested at site in the presence of manufacturer's expert. The QH parameters can be measured, if space permits.

Monorail Crane With Chain Pulley Block

Monorail Crane shall be used for lifting of Submersible motor pumps as and when required for maintenance.

Monorail mounted hand operated chain pulley block shall be as per the requirement of BS:3243/ Equivalent.

It shall be of required capacity having adequate chain length.

The load chain shall conform to BS:2902/Equivalent.

Guide shall be provided for effective guidance to the load chain and a stripper for effective disengagement of chain from wheel.

Pipe Works

Pipes carrying sewage shall be of ductile iron with flange or spigot and socket joints according to individual circumstances.

Pump delivery line flow velocity shall be set at < 2.1 m/sec and individual delivery pipe & common header diameters shall be selected accordingly.

All pipe work and fittings etc. shall conform to the appropriate Indian Standards and shall be to a class in excess of the maximum pressure they shall attain in service including any surge pressure and shall be supplied by an approved manufacturer. All pipelines shall be tested at 1.5 times the design working pressure.

The pipe works shall include all pipes and fittings for connection to the rising main upto the stipulated length outside the pump house building. The pipes and fittings shall be as per latest revision of IS:1536/IS:1537/IS:1538/BS:4622/ IS 8329/ IS 9523 / Equivalent and must be suitable to withstand the pressure tested to at least double the close valve pressure.

The diameter and length of the pipes shall be determined from the specified velocity of the sewage water and size of the pump house. The delivery pipe of the pump shall be connected with the pump through enlarger immediately after the pump so as to restrict the velocity of sewage water in the pipe line at delivery side.

Each delivery pipe line shall include one puddle collar at the exit of the wet well.

All the pipe lines shall be protected with anticorrosive paints of required quality to suit the site climatic condition.

Necessary rubber insertion of suitable thickness shall be provided at all the flanged joints complete with supply and erection of necessary number of bolts, nuts, washers of suitable sizes.

- **Valves**

Each Sewage pump shall be fitted with a reflux valve and a sluice valve on the delivery side of the pump.

All the sluice valves shall be as per IS:14846/BS 5150/DIN 3352 at their latest revision and rising spindle type, flat face, bolted bonnet with solid wedge disc.

The valves above and including 400 DN shall be provided with spur/bevel gear arrangement for operation and be fitted with by-pass arrangement.

The pressure rating of the valve shall be as per the Design working pressure. Wherever specifically mentioned the valve shall be fitted with extended spindle, head stock along with hand wheel for easy operation from the operating platform.

The reflux valve ensures that backflow, from the rising main through the pump, does not occur when the pump is not operating. The Reflux valves shall be of Double flanged with hinged single/multi swinging disc complete with bypass arrangements. The reflux valve shall be of flat face bolted cover and shall be fitted with renewable body and disc seat. The reflux valve shall be as per IS:5312/BS:5153/ISO 2531 at their latest revision. The pressure rating of the valve shall be as per Design working pressure.

The valves on the discharge pipe work are to be mounted in a separate Valve Chamber. This allows the Contractor in operation and maintenance of valves easier to carry out. The separate valve pit also allows a suitable accessible point for the attachment of pressure gauges to check the performance of the pumps.

The Air Release Valve shall be Single air valve (Large Orifice) confirming to IS-14845/2000 for automatically releasing/admitting air that may accumulate under pressure in a section of pipe line at the time of initial charging or draining of main.

The pressure rating of the valve shall be as per Design working pressure and end connections shall be flanged as per IS specifications. The Air release valve shall be fitted with isolating sluice valve of same size.

- **Air Blower**

Air blowers shall be either of positive displacement or centrifugal with pressure vessel type complete with motor, base plate, inlet filter, intake silencer and off-load starting system outlet silencer, anti-vibration damper, flexible coupling, filter restriction indicator, non-return valve, pressure relief valve, V-belt system or direct drive coupling. The casing rotor shall be of cast iron construction. Bearings and gears shall be grease lubricated. Motor speed shall be 1500 rpm.

The capacity of the air blower shall be of required airflow rate and pressure to maintain required level of dissolved oxygen in the aeration tanks in operation.

- **Chemical Dosing**

Chemical dosing pumps shall be complete with plastic suction and delivery piping, solution tank, mixing tank and feed arrangement. Pumps shall be complete with motor control center, cabling and connection.

- **Diesel generating set**

The Diesel Generating set shall be of A.C type with totally enclosed air cooled multi cylinder, AMF Panel, alternator, 3 Phase, 415V, 50 Hz 0.8 p.f. for developing

suitable BHP at 1500 rpm. The DG shall be designed with 10% overload with standard accessories, self excited self regulated, screen protected alternator with static excitation system running at 1500 RPM as per IS 4722_1968 with voltage regulation +/_ 5 %.

Both the engine and alternator shall be directly coupled on a common fabricated steel base plate with anti vibrating pad with control panel comprising of standard meters, switchgears, indicators connected with suitable wires/cables. The complete set shall be enclosed in acoustic enclosure made of 18 SWG CRCA Sheet, sound absorbing material, Rockwool covered from inside with ¾ mm holes perforated sheet to restrict sound level upto 75 dB at 1.0 m

The engine shall be supplied with first filling of oil, diesel etc. obtaining necessary approval from Electrical Inspector as per specification.

- **Wheel Barrow**

Wheel barrows of Polyethylene moulded construction shall be supplied for carting up screenings. The wheel barrows shall have rubber tyred wheels. The moulded units shall be bought out items from ISO : 9000 certified manufactures.

- **Screenings Container**

Portable galvanized steel container shall be provided to store the screenings until the time of pick up. The container shall have a capacity of approximate 2.5 cum and shall be of a convenient height to permit the discharge of screenings manually. The container shall have hinged covers and its design shall permit their being lifted by an overhead hoist or packer truck. The container shall have four wheels of about 200 mm diameter and two of which shall be swivel castors. The maximum height of a container including wheels shall not be more than 660 mm. The sides shall be fabricated of 12 gauge H.T. steel and the bottom of the container shall be of 5 mm plate steel. The container shall be reinforced with 50 x 50 x 6 angle.

- **Exhaust Fan**

Exhaust fans shall be provided at the places specifically mentioned for ventilation purpose. The cast aluminum alloy blades shall have high efficiency aerofoil section. Blades shall be directly mounted on motor shaft, dynamically balanced and shall conform to IS:2312. The means provided for securing the fan mounting or fan casing to the wall shall be such as to provide a secure fixing without damage to the fan or wall.

The drive motors shall be TEFC, squirrel cage, induction type suitable for 240 Volts $\pm$ 10%, 1 phase OR 415 Volts $\pm$ 10%, 3 phase, 50 Hz AC supply with IP54 enclosure and class B insulation.

Suitable designed guards shall be provided at the inlet and outlet side to prevent accidental contact. No inflammable material shall be used in the construction of fan. Moulded parts, if used, shall be of such materials as to withstand the maximum temperature attained in the adjacent component parts.

The fan shall have protective insulation may be of all insulated construction or have either double insulation or reinforced insulation. Each fan should be provided with a 10 sq.mm mesh bird screen. The sheet used for the cowl shall be 14 gauge.

The finish will be stove enameled glossy paint/epoxy paint with specially pre-treated components to enhance corrosion resistance.

The number and size of exhaust fan will be determined taking into account 12 complete changes of air per hour to the service area.

(C) Particular Specifications

General Requirements

✓ ***Material***

All materials incorporated in the Work shall be the most suitable for the service conditions and duty concerned. They shall be new and of reputed make / approved quality, free from imperfections and selected for long life and minimum maintenance. Non–destructive tests, if called for in the Specification, shall be carried out. All submerged moving parts of the Plant, or shafts and spindles or faces etc. in contact with them shall be of corrosion resistant materials. All parts in direct contact with various chemicals, shall be completely resistant to corrosion, or abrasion by these chemicals, and shall maintain their properties without aging due to the passages of time, exposure to light or any other cause. All materials shall conform to the material standards as per BIS or any equivalent standard.

✓ ***Workmanship***

Workmanship and general finish shall be of first class quality and in accordance with best workshop practice. All welds shall be as per IS, BS, ASME standards. All tolerances and clearances shall be as per good and sound engineering practices. Should any material be not considered acceptable by the Employer's Representative, it shall be replaced.

✓ ***Design Features***

As far as practicable, all designs shall be as per latest concept and practices. The equipment shall be new, of robust design for a long reliable operating life. These shall be capable of 24 hours per day continuous operation for prolonged period in the climatic and working conditions prevailing at the site and with a minimum of maintenance. Particular attention shall be given to extra temperature and the rating of electrical and mechanical equipment, cooling systems and the choice of lubricants shall be for the temperatures as specified.

Paints used shall be the manufacturers' standard and shall be suitable for duty as described. The equipment shall be designed to provide easy access to and replacement of component parts which are subject to wear without the need to replace whole units. All parts in contact with water shall have a life from new to replacement for 15 years minimum and new to repair of not less than five years.

Design features shall include the protection of equipment against damage caused by vermin, dirt, dust and dampness and to reduce risk of fire. Equipment shall operate without undue vibration. Noise reduction measures shall be adopted such that levels of 75 dB (A) at 3 meters are not exceeded. Parts shall be designed to withstand the maximum stresses under the most severe conditions of normal service. Materials shall have a high resistance to change in their properties due to the passage of time, exposure to light, temperature and any other cause which may have a detrimental effect upon the performance or life of the Plant.

All rotating elements shall be dynamically and statically balanced.

All equipment shall have name plates specifying the makes, model, rating and other pertinent information.

✓ ***Lubrication***

The equipment shall be lubricated by long life lubricants such that working life

is not less than 3000 operation hours or as recommended by equipment manufacturer.

A complete schedule of recommended oils and other lubricants shall be furnished by the Contractor. The number of different types of lubricants shall be kept to a minimum. The schedule and the name of the supplier of the lubricants shall be submitted to the Employer's Representative for approval.

Lubricants shall be oil and grease. The Contractor shall indicate indigenously available equivalent lubricants, with complete specification.

Where the lubricant is grease, preference shall be given to a pressure system which does not require frequent adjustment or recharging. Preferably, life lubricated grease packed bearings shall be used.

Where more than one special grease is required, a grease gun for each special type shall be supplied and permanently labeled.

- ✓ ***Name Plates***

Each equipment of the Plant shall have permanently attached to it a nameplate and rating plate in a conspicuous position, Upon these shall be engraved or stamped, the manufacturers name, type and serial number of the equipment, details of the loading and duty at which the equipment has been designed to operate, and such diagrams as may be required by the Employer's Representative. All indicating and operating devices shall have securely attached to them or marked upon them designations as to their functions and proper manner of use.

- ✓ ***Painting***

  - ❖ **At Manufacturer's Works**

The Contractor shall be responsible for the cleaning, preparation for painting, and priming or otherwise protecting, as specified, all parts of the Plant/ Equipment at the place of manufacture prior to packing.

Parts may be cleaned but surface defects may not be filled in before testing at the manufacturer's works. Parts subject to hydraulic test shall be tested before any surface treatment. After testing, all surfaces shall be thoroughly cleaned and dried out, if necessary by washing with an approved de-watering fluid prior to surface treatment. Except where the specification provides to the contrary, all painting materials shall be applied in strict accordance with the paint manufacturer's instructions.

Steel and cast iron parts shall be sand blasted to near white cleaning before painting. Edges, sharp corners etc. shall be ground to a curve before sand blasting. A primer coat of a zinc rich epoxy resin based coating with at least 75 microns dry film thickness is to be provided. In addition, the parts for wet duty are to be provided with an adequate number of coats of coal tar epoxy polyamine coating to a dry film thickness of 175 microns excluding primer coating.

  - ❖ **At Site**

Immediately on arrival at the site, all items of Plant shall be examined for damage to the paint coat applied at the manufacturer's works. Any damaged portions shall be cleaned down to the bare metal, all rust removed, and the paint coat made good with similar paint.

After erection, such equipment/ items which are not finish painted shall be done so. Items that have been finish painted at the manufacturer's works shall be touched up for any damaged paint work. For finish painting, two

coats of synthetic enamel conforming to IS: 2932 shall be applied. Dry film thickness of each coat shall be at least 25 microns.

The dry paint film thickness shall be measured by Electrometer or other instruments approved by the Employer's Representative. In order to obtain the dry film thickness specified, the Contractor shall ensure that the coverage rate given by the paint manufacturer will enable this thickness to be obtained. Strength of adhesion shall be measured with an adhesion tester and this value shall not be less than 10 kg/csqm. Painted fabricated steel work which is to be stored prior to erection shall be kept clear of the ground and shall be laid out or stacked in an orderly manner that will ensure that no water or dirt can accumulate on the surface. Suitable packing shall be laid between the stacked materials. Where cover is provided, it shall be ventilated.

❖ **Galvanizing**

Wherever galvanizing has been specified the hot dip process shall be used And electro-galvanized parts, equipment shall not be permitted. The galvanized coating shall be of uniform thickness. Weight of zinc coatings for various applications shall not be less than those indicated below:

a) Fabricated steel : 460 gms/sq. m

b) Fasteners : 300 gms/ sq. m

Galvanizing shall be carried out, after all drilling, punching, cutting, bending and welding operations have been carried out. Burrs shall be removed before galvanizing. Any site modification of galvanized parts should be covered well be zinc rich primer and aluminum paint.

❖ **Supports for Pipe Work & Valves**

All necessary supports, saddles, slings, fixing bolts & foundation bolts shall be provided to support the pipe work. Valve and other equipment mounted in the pipe work shall be supported independently of the pipes to which they connect.

All valves to be installed in straight lines shall be installed between the flanges with a dismantling joint or SS expansions bellow at one side of the valve. The dismantling joint must allow a minimum clearance of 20 mm. The pressure rating of the dismantling joint / expansion below shall be same as that of the valve.

Mechanical & Manual Coarse Screens & Conveyor

✓ ***Manual Screen***

The mechanical screen shall be inclined bar screen, rake type and of sturdy design to take care of all sorts of materials envisaged in the gravity sewer. The effective opening for the sewage to pass through shall not exceed 75 mm in one direction. The maximum velocity through the bars/ openings shall not exceed 1 m/s. The freestanding height of dead-plate above the freeboard of the screen chamber shall not be less than 0.5m for easy maintenance.

The trash screen shall be rectangular in shape. The screen shall be fabricated out of stainless steel SS 304 of not less than 8mm thick and 75 mm wide in section. The screen shall be rigidly fixed to the frame and provided with 2 sets of cleaning rakes.

❖ **Mechanical Automatic Screens**

The scope of supply shall provide complete automatic mechanical screen

systems with all accessories and appurtenances, including, but not limited to:

- Mechanically operated screen;
- Screenings collection, (dewatering) sweeping, washing and disposal system;
- Automatic screen control system;
- Electrical & Instrumentation for compliance of Automatic System (Electrical wiring between all screen components, instruments, control devices and the local control panels and the screen controls);

❖ **Downstream Water Level**

Contractors should state the maximum and/or minimum allowable water levels downstream of the screen in order to pass the required flow. To reduce the height of the screen above ground level, the screen might be located at a level such that there is a constant static water level in the screen chamber due to downstream tank water levels.

❖ **Guaranteed Flow Rate and Head Loss**

The screen shall effectively screen all flows up to the design flow. The Contractor shall guarantee the following screen performance parameters:

- Clean water flow rate capacity (l/s) at the maximum allowable water depth downstream of the screen
- Clean water head loss at the max flow rate and maximum allowable water depth downstream of the screen
- Maximum sewage flow rate capacity (l/s) at the maximum allowable water depth downstream of the screen based on their expected screen blinding in sewage

❖ **Screening Arrangements**

Screening shall be done to remove particles larger than 75 mm size. Suitable number of automatically operated mechanical coarse screens will be proposed in accordance to the size of the STP. (stainless steel grade – SS316) of opening size 75mm & for Screening out floating materials such as plastic pouches, bags, rags, floating debris, weeds, paper wastes and other floating materials from the raw sewage coming from the pumping mains.

Fully automatic mechanical screen along with the level sensing instrument for automatic operation of screen mechanical and allied accessories, (local control panel near screen,) shaft less screw conveyor with/cum compactor are to be provided.

The fixed as well as movable bars/ perforated band, mechanism, support frame, fixings discharge chute shall be manufactured from stainless steel grade 304 for long life in the aggressive sewage environment.

❖ **Automatic Screen Clearing and Screenings Removal**

The screen shall be provided with the necessary controls and sensors to anticipate blockage of the screen, and automatically clear the screen and remove the accumulated screenings from the screen surface. The screen shall operate automatically when the upstream water level increases beyond a pre- set limit and it shall stop when the upstream level decreases to pre-set low level.

❖ **Screenings Conveyance, Compaction and Dewatering**

The conveyor shall be common to the mechanical and manual screens. The conveyor system shall be a combination of a horizontal conveyor and upward inclined conveyor (if required) and shall have a capacity to transfer the maximum screenings anticipated at the peak flow. The conveyor provided for discharge of screenings shall be inter-locked with all the screenings discharging on to the conveyor so that it operates when the screenings are discharged on to it and stops automatically after a time lag when the screen stops discharging the screenings on top the conveyor.

Numbers	One
Conveyor type	Horizontal
Capacity	To handle screenings of peak flow of 125 MLD
Speed	15 m / minute (maximum)
Type	Troughed
Belt	3 ply Z duck, 3 mm top, 1.5 mm bottom, rubber cover CR M –24

The screening system shall be supplied with a duty and standby shaft less screw conveyor that will be used to convey the screenings to the automatic screenings press and discharge system that compacts, dewaters and discharges the screenings through a chute to the screenings storage system.

❖ **Screen Washing System**

The Contractor shall supply and install spray washing system that effectively cleans the screen area and screening press. The Contractor shall provide a high-pressure clean water supply for the washing system.

❖ **Dewatered Screenings Discharge Chute**

The screenings discharge chute shall terminate 1.5 meters above ground level. A plastic screenings bag shall be secured around the chute, thereby creating a totally enclosed screenings collection system.

❖ **Screen Covers**

All screenings equipment shall be supplied with integral stainless steel covers that prevent access to moving and wash water sprays. The covers need to be airtight to ensure that no odours emanate from the screen.

❖ **Portable Screenings Container**

Portable screenings containers made of galvanized steel duly epoxy painted shall be provided to store the screenings until time of pick up. The container shall have capacity of approximate 5 cum and shall be of a convenient height to permit the discharge of screenings directly into the container without having to transfer the screenings manually. The containers shall have hinged covers and their design shall permit them being lifted by an overhead hoist or packer truck. The container will have four wheels each of about 20 cm diameter and two of which shall be swivel castors. The maximum height of container including wheels shall be 0.6m. The sides shall be constructed of minimum 12 gauge steel. The bottom of container shall be made minimum of 6mm plate steel. The containers shall be reinforced with 50mm x 50mm x 5mm angle iron.

❖ **Electrical Motor**

The motor shall be TEFC type with IP 55 protection & Class F insulation

and shall be suitable for operation on 3 phase, 415V + 10% and frequency of 50Hz + 5%. Motors shall be premium efficiency motors in accordance with IE3 as defined in IEC 60034-30. The power rating of motor shall be at least 125% of maximum power requirement.

❖ **Control Panel**

The Control Panel shall have IP 65 protection, painted with Epoxy paint and shall be comprise:

- Mushroom Head Emergency stop.
- Overload relays for motor protection.
- MCB's, HRC Fuses and Glass Fuses.
- Circuitry to operate the screen with level sensors.
- Selector Switch to operate the screen on JOG mode.

❖ **Access**

Safe access shall be provided to all screen equipment and instruments to allow for cleaning, inspection and maintenance activities.

❖ **Corrosion Resistance**

All metal parts of the screen equipment that are in contact with the sewage shall be constructed of a suitable grade of corrosion resistant stainless steel, aluminum or plastic.

❖ **Design Life**

The design life of major components shall be 15-20 years.

❖ **Installation, Testing, Commissioning and Training**

It is the Contractor's responsibility to install the screen system correctly and achieve the required operation. The Contractor shall provide a representative who has knowledge and experience in the proper installation, start-up and operation of the screen equipment to inspect the final installation and supervise the commissioning tests.

✓ ***Mechanical fine Screens and conveyor***

The Contractor quote for either step type or traveling band type. The screen shall trap all plastic bags, rags, pouches etc., The effective opening for the sewage to pass through shall be 6 mm in one direction. The screen shall be factory assembled, tested, transported to site in fully assembled condition, and shall be installed at the site for preventing of misalignments.

The maximum velocity through the bars / openings shall not exceed 1 m / second at peak flow. Similarly, the topmost elevation of the circular screen shall also be likewise adopted. The design shall ensure passage of sewage right up to the floor elevation through the screens without interruptions or accumulation of grit

Contractor shall quote for only one type of screen based on his experience. The type of screen offered by the Contractor shall be successful in operation in a sewage treatment plant at least for a period of five (5) years.

❖ **Fine Band Screen**

The specification of fine band screen if adopted shall be as follows:

- The Fine Band Screen shall consist of continuously moving perforated Stainless steel panels. The machine shall be arranged to pivot out of

the channel.

- The aperture size shall not exceed 10 mm.
- The frame shall consist of two lateral stainless steel 316 plates connected by means of cross braces.
- The machine shall work on the endless chain principle and incorporate chain wheels at the top and bottom. The top wheels shall be keyed on to the main drive shaft. The bottom wheels shall be carried on stub shafts incorporating a fully sealed, pre- and self-lubricated bearing of suitable synthetic material.
- The chain shall be of stainless steel with the screen panel directly attached.
- The screen panels shall be minimum 3mm thick in SS 316 construction and shall incorporate maximum 10 mm diameter perforations. These panels shall be carried on the chains. The panel shall be specially formed to give a very rigid construction and shall create steps to enable larger screenings to be removed.
- The seals shall be Polypropylene sealing brushes and incorporated at each side and across the bottom of the screen to prevent screenings from by-passing the screen panels.
- Screening shall be discharged on the downstream side of the unit and shall be removed from the screen panels by suitable means. The brush if used for removal of screenings shall be polypropylene.
- Screenings are delivered down an enclosed chute/guide plate to enable discharge of screenings to the belt conveyer.
- The entire assembly shall be enclosed in reinforced fibre glass housing. A hinged front cover shall be provided to give necessary access to the assembly components.
- The drive to the main shall be fitted with an anti-condensation heater. The motor shall be flanged to a shaft mounted gear unit giving the final output speed. This shall produce a linear speed for the screen panels of about 3 m / min.
- The drive shall be protected from mechanical overload by an electrical current sensing device in the screen control panel.
- Suitable sensing device shall be provided to annunciate screen jamming and trip the drive.

❖ **"Step Type" Fine Bar Screen**

Mechanically operated step type bar Screen completely made of Stainless steel not exceeding 10mm clear spacing between the bars shall be provided in the screen channel.

The screen shall include discharge chute as required to discharge the screenings on the belt conveyor.

❖ **Material of construction**

The fixed as well as movable bars, mechanism, support frame, fixing discharge chute shall be manufactured from stainless steel.

❖ **Screen construction**

The fine bar screen shall be a complete unit comprising of main frame with an integral mechanism containing movable bars located in between fixed

bars without engagement of external mechanism / rake mechanism for pulling out the screened material.

The mechanism comprising of movable bars located between fixed bars shall gradually move the screened material upward in the form of a mat and deliver screenings to the guide /discharge chute.

The fixed as well as movable bars shall contain a series of steps to prevent the screenings from falling back into the main flow.

The drive arrangement shall be through an electric motor or hydraulic system and shall be suitable for automatic operation controlled by a level sensor.

The screen shall be capable of being tilted out of the sewage flow up to horizontal position for the purpose of cleaning & maintenance.

❖ **Control Panel**

The control panel shall have IP 55 protection, painted with Epoxy paint and shall be comprising of

- Mushroom Head emergency stop
- Overload relays for motor protection
- MCB's, HRC Fuses and Glass Fuses
- Circuitry to operate the screen with Ultrasonic type level sensors.
- Selector Switch to operate the screen on JOG mode
- Provision to run the screen with a Timer in case of failure of level sensor

❖ **Hydraulic Unit**

The Hydraulic Unit shall be comprised of

- Epoxy painted Oil Tank, Pump, Motor Direction Control Valve and Counter Balance Valve of suitable capacity
- The Hydraulic Pump shall be protected by Filter element and Low oil level indicator.
- A Pressure Relief Valve shall control the Hydraulic System.

❖ **Testing**

The Fine bar screen shall be Factory assembled and subjected to following tests at the manufacture's premises

Dimensional Check: The overall dimensions of the screen shall be conforming to the approved drawing.

Operational Test: The complete screen including its mechanism, Electro – motor / hydraulic operating mechanism level probing system and control panel shall be integrated and mechanically operated to verify free movement and satisfactory working.

✓ ***Belt conveyor***

The conveyor system shall be a horizontal conveyor and shall have a capacity to transfer the maximum screenings anticipated at the peak flow. The horizontal conveyor parts shall be freestanding above the maximum sewage elevation at peak flow by at least 0.5m.

Numbers One

Conveyor type Horizontal

Capacity	To handle screenings of peak flow of Design capacity
Speed	15 m / minute (maximum)
Type	Troughed
Belt	3 ply Z duck, 3 mm top, 1.5 mm bottom, rubber cover CRM–24

- **Grit Removing Equipment**

Grit chambers shall be of vortex type with centre drive and independent washer or classifier. Grit Basin equipment, complete with all accessories including, but not necessarily limited to, gear motor, turntable, propeller drive tube, axial flow propeller shall be provided.

✓ ***Vortex type with central drive grit removal system***

The Vortex Grit Basin equipment shall be installed in concrete basins. The equipment to be supplied shall be suitable for installation in these basins. The grit chamber shall be designed to operate on the vortex principle. Drives, bearings, and support equipment for grit mechanism shall be supported by and readily accessible from a concrete walkway above the water surface.

✓ ***Cyclonic Grit Separator***

The grit chambers shall conform to the following construction, operation guidelines and have the accessories as indicated below:

Vortex Type Grit removal chamber with low head loss systems shall be proposed for this project. Each grit chamber shall be complete with the minimum equipment but not limited to gear motor, gear head, axial flow propeller and scrapper with drive, grit removal pump and auxiliary equipment required for operation. The grit removal unit shall have low head loss and shall be capable of removing grit from raw waste or process water and depositing the grit in a storage hopper. An integral grit transporting means shall be provided to transport the grit from the storage hopper to the disposal means. To minimize the possibility of clogging, all internal openings in the piping to the grit pumping device as well as the grit pumping device shall be large enough to pass a 100 mm sphere. No bends or elbows will be allowed in the piping on the suction side of the grit pump. All drives, lubrication and bearings shall be readily accessible from walkways above the operating water level. To minimize the possibility of organic capture, the floor of the grit separation chamber shall be flat and there shall be no greater than a 80 mm opening for grit to pass through to the storage hopper. Sloping floors in the upper chamber will not be allowed due to reduced grit removal efficiency and extra construction costs. To ensure the efficient transport of the grit and simultaneous lifting and discharge of the organic material, the bottom of the upper chamber covering the storage hopper shall be constructed suitable corrosion proof / or thick steel plate , free from rotation, and shall be flat. The grit moving across the bottom of the chamber shall be hydraulically scoured by an air lift pump or a propeller pump. The grit shall pass from the removal chamber through an opening in the transition plate and drop into a grit storage hopper. The flow in the removal chamber shall travel between the inlet and the outlet a minimum (270°), providing maximum travel of the liquid for effective grit removal. The Grit Chamber shall handle all flows equal to or less than a hydraulic peak flow of Q peak. The influent flume, transporting the liquid waste to the grit chamber, shall be of the size and shape shown on the contract drawings to assure that grit does not settle in the inlet flume and to provide for proper operation of the grit chamber. A grit storage hopper with a 60° sloped bottom shall be provided with effective grit storage for the designed flow, grit

pump will be either an air lift educator pump or a turbo grit pump close-coupled, vacuum primed type with curved multi vane impeller. Grit Classifier / Washer shall be rake or Shaft less screw type. The material of construction of all wetted parts shall be in SS 316.

✓ ***Operating Conditions***

The grit chamber shall operate on the vortex principle. To maximize grit removal efficiency, the grit chamber hydraulics shall incorporate a toroidal flow path enhanced by a slow vortex.

The grit removal device shall be capable of removing the following at the specified hydraulic peak flow rate, and no decrease in efficiency will be allowed at flows less than this design rate.

- 90-95% of the grit greater than 150 microns in size,

- 75-85% of the grit greater than 100 but less than 150 microns in size,

The displacement type blower shall have the capacity to provide sufficient quantities of air at the required pressure to ensure efficient operation of the air wash/airlift system.

✓ ***Grit Trap***

Item Description	MOC
Air Lift Pump	Stainless Steel
Geared Motor Assembly	STD
3 Way Valve	Stainless Steel
Screw Classifier	Stainless Steel

Air blowers for Oxygenation

The blowers shall be provided for providing adequate oxygen into the aeration tank. The air requirements shall be calculated for summer and winter as well as mixing power at 15 Ncum / minute per 1000 cum of tank volume and the higher duty installed. The summer sewage temperature shall be taken as 37 degrees C and that in winter at 14 degrees C. Provision shall be made in the design of diffuser density in plan such that if required, 40 % of the air should be available for discharge in the first 15 % of the tank volume. This flexibility shall be ensured.

The blowers shall be capable of developing the required total pressure at the rated capacity for continuous operation. The blowers shall be multistage Centrifugal blowers or Twin lobe type. There shall be maximum two blowers working for each compartment of aeration tank and at least 50% stand by blowers shall be standby. VFD drive shall be provided for all blowers of each compartment. Directly coupled design shall be preferred. For Multistage centrifugal blowers dampers regulation by motorized linkage assembly may also be provided.

The blowers shall be provided with suction air filter, silencer, dead weight pressure relief valve and pressure guage and the air delivered shall be clean, dry and oil free. The blower noise level and velocity of vibration shall be within 90 dB and less than 4.5mm/s at a distance of 1.86 m respectively. The blower shall be and driven by squirrel cage induction motor

✓ ***For Multistage Blowers***

For multistage Centrifugal blowers the bearings shall be antifriction type designed for L10 life of at least 1,00,000 working hours. The damper shall be provided at the inlet of each fan with suitable linkages for actuator operation. The casing shall be minimum 8 mm thick. The impeller shall be minimum 6mm

thick and dynamically balanced. All the accessories such as drain plug, inspection door, common base frame, coupling and shaft guards etc., sand blasting and suitable anti corrosive painting shall be provided for the casing and impeller and other steel components. The requirement of standby and use of variable speed motors will be same as for twin lobe type.

Material of construction

Casing	MS conforming to IS-2062
Impeller	Medium tensile steel
Shaft	EN-8
Parameter	
Numbers	To suit, maximum 2 per compartment
Standby	one common stand by.
Type	Multistage Centrifugal
Discharge pressure	To suit
Power transmission	Direct
Silencer	to be provided
Testing code	IS 1940, Gr. 6.3

Twin lobe Blowers

(Alternative to multistage centrifugal blowers)

Contractor shall include in their bid either multistage blowers or twin lobe blowers only).

The speed of the blowers shall be below 1200 rpm. The power rating of motor shall be at least 10% above the maximum power requirement by the blower. The kW of single blower shall not exceed 220 kW. The blowers shall be mounted at a level necessary to avoid back flow or siphoning of sewage into the blower. The accessories shall be complete with common base plate for blower and motor, suction and discharge connection, non return valve, safety valve, pulley and V- belt guard, eye bolts etc., the pulleys used shall be taper lock of Fenner make.

Material of construction

Casing	C I conforming to IS: 210 Gr FG 260
Rotor	Alloy steel
Shaft	Carbon steel C40/EN 24/19
Timing gear	Cast alloy steel
Pulley and gear side plates and cover	CI conforming to IS 210 Gr FG 260
Parameter	
Numbers	Maximum 2 per compartment
Standby	one common for both compartments
Type	Twin lobe
Discharge pressure	To suit
Power transmission	direct drive preferred
Cooling	Air cooled
Code	BS 1571

Tests

No	Tests	Specs
1	Hydrostatic tests	Twice the maximum working pressure
2	Performance test	As per BS : 1571
3	Strip test	Clearances with tolerance limit
4	Mechanical balancing	ISO 1940 Gr. 6.3 or better

5	Visual Inspection	Before painting

- **Diffused Aeration System**

This comprises piping to diffusers and the diffusers.

✓ ***Type of diffuser system***

A fine bubble diffused aeration system shall be applied to both the selector zone and aeration tank for oxygenation. The number of diffuser elements can be varied by the Contractor depending on the manufacturer selected , subject to the condition that sufficient design calculations are attached along with it and the manufacturer is a standard one having supplied the diffusers to various waste water treatment plants for at least two years.

✓ ***Diffuser Elements***

The diffuser elements shall be membrane type and resistant to such ingredients as hydrocarbons, oil and grease. This shall afford a high oxygen transfer rate coupled with a minimal pressure drop besides permitting simple erection onto the horizontal air manifold. They shall also permit easy retrieval above the liquid surface by lifting the air vertical header feeding the horizontal air manifold. They shall have minimal coupling / attachments to the air manifold and shall have self-cleaning properties while in action. Flat surfaces facing upwards as membrane surfaces shall not be accepted. The diffuser unit shall be of corrosion resistant material. The membrane diffusers shall permit connection to the air manifolds of circular or square cross section and the entire lot of diffusers shall be capable of discharging designed flow of air at an average flow (maximum of summer and winter requirement) with the nominal air flow per diffuser per element shall not exceed 12 Ncum/h/m length of diffuser when installed in the said aeration tanks.

The headers onto which the diffusers are fixed shall be of standard SS304 pipe sections of suitable inner bore and shape with custom fixtures of the diffuser elements as directed by the membrane manufacturers. Alternative pipe materials shall be acceptable provided the same are a mandatory part of the diffuser suppliers and have been in the supplier's line of supply as original equipment. The headers shall also be procured from the equipment manufacturers who are the suppliers of the membrane diffusers. These headers shall have enough counterweight or alternative arrangement to surmount any buoyancy lift from the floor during air charging. The connection between the headers and the air piping from the compressor shall preferably permit a "quarter-turn" fitment and "quarter-turn" dismantling. This segment shall be assembled and installed above the water level and in the horizontal travel of the air piping. The coupling shall have a minimum of two neoprene washers to ensure against chance leakage of air. Alternatively flanged fittings of SS 304 material shall also be permissible**.** Each header shall travel downward from the air piping by aligning itself onto the sidewall of the aeration tank and thereafter travel horizontally onto the tank floor. Suitable mechanical provision for lifting the headers easily above the water level for maintenance without the need for draining the tank shall be provided for each header. Isolating valves of polypropylene shall be provided upstream of the coupling to cut off the flow through the specified header for purposes of attending to the diffuser header and also diffusers.

✓ ***Air Supply Piping***

The air piping from the compressor to the header shall be of MS epoxy painted material and pressure rated for the sewage depth plus frictional losses etc.

These shall be fixed securely to the concrete surfaces in the horizontal plane and vertical plane so that they are not clamped horizontally onto vertical sides of the walls. The clamping shall be so designed as to permit "in-situ" screw driven fittings. Breaking open concrete surfaces shall not be permitted.

Two spare drop pipes with diffuser elements shall be supplied by the Contractor one for each compartment. This will be used to replace the choked diffusers drop pipe or on preventive basis on rotation. The choked one will be attended to and used as spare drop pipe.

- **Primary Clarifier Mechanism**

There shall be two-(2) primary clarifier mechanisms suitable for installation in a circular concrete tank having an inward slopping hopper floor with 1 vertical to 12 horizontal slopes. The mechanism shall be of the center drive type with adequate torque rating as said in section II and shall be supported on an RCC influent column with the flow entering the bottom of the influent column and flowing upward to the inlet openings near the water level. The equipment shall include center assembly with drive unit, feed well, center cage, sludge removal rake arms with sweeper blades and squeegees, two scum skimmers with respective scum boxes, weirs, baffles, walkway with handrails, anchor bolts and such other fittings, devices or appurtenances as necessary for a complete operating installation.

- ✓ ***Center assembly with drive unit***

The drive assembly for each clarifier shall consist of a drive motor, helical gear box, steel roller chain drive, Intermediate worm gear assembly, turntable type internal spur gear, visual torque indicator, overload alarm and cut-off actuating system. The drive motor shall 3 phase, 50 cycle, 415 volts supply with its variations in voltage and / or frequency. The power transmission between the first reducer and the intermediate worm gear assembly shall be through a chain and sprocket drive, which shall be enclosed in a fiberglass chain guard. The intermediate worm gear assembly shall consist of a case hardened and ground alloy steel worm (EN353/equivalent hardness 50-52 Rc) and cast iron worm wheel (IS: 210 grade FG260), all placed within a graded cast iron housing (IS: 210 grade FG260) complete with oil fill, level and drain fittings. The main pinion and pinion shaft shall be keyed to the worm gear and made as an integral unit from forged alloy steel (AISI 4142/Equivalent 43-44 Rc). The main internal spur gear assembly shall be of a turntable type construction and with an internal spur gear. The turntable base shall be made of cast Iron (IS: 210 grade FG200) and the main spur gear shall be of cast high tensile alloy steel (IS: 2644 –Gr2 240-250 BHN final hardness). The turntable will be mounted on top of the center column and will have positive leveling features. The spur gear shall be running on a built-up large diameter precision bearing assembly consisting of high chrome alloy steel bearing balls (AFBMA Gr 500, 62-65 Rc) and four replaceable hardened alloy steel inserts (AISI 4140/equivalent 36- 38 Rc final Hardness) pressed into the annular grooves in the gear and turntable base all running in an oil bath. The base will have a provision for a dust seal complete with oil fill, level and drain fittings. All gears and bearings shall run in an oil bath. Readily accessible lubricant fill and drainpipes with necessary fittings shall be provided. The drive worm shaft shall be free to move horizontally within the limits afforded by a calibrated compression spring at the thrust end. The worm shaft movement shall be transmitted to the drive control by a pin contacting the cam support and camshaft, thereby actuating the pointer. The pointer shall indicate the relative torque load on a 0 to 100% graduated scale. Four cams and limit switches shall be included. Cams shall be independently adjustable over the full torque

range. Two limit switches shall be shop-adjusted to sound an alarm and stop the drive motor at predetermined torque settings. Switches and cams shall be mounted in a weatherproof steel box having conduit terminal strips. The drive shall be designed for a adequate torque rating with the main gear and pinion set designed for a yield torque of at least four times the duty rated torque. The drive main bearing shall be designed for a B10 bearing life of minimum 20 years with continuous operation and full total rotating mechanism weight.

- ✓ ***Center Drive Platform***

  A center drive platform shall provide access to the center assembly and drive control. It shall consist of galvanized chequer type floor plate with necessary epoxy painted structural steel stiffeners and supports resting on the center assembly and provided with connections to the walkway. The platform shall be surrounded by handrails made out of anodized aluminum of 1000mm high.

- ✓ ***Feed Well***

  There shall be a rotating feed well surrounding the inlet RCC column. It shall be integrally attached to the scraper drive assembly and the scum scraper assembly for uniform movement. The diameter of the feed well shall be 22% to 25% of the diameter of the clarifier so as to limit the downward velocity below 1.5 m / sec as calculated on the full plan area of the feed well at peak flow. The immersed depth of the feed well shall be 55 % to 65 % of the side water depth of the clarifier. The material of the feed well and all fixtures either partly or wholly exposed to the atmosphere or fully submerged shall all be of SS 304. In any case, the thickness of sheet used for fabrication of the feed well shall not be less than 5 mm.

- ✓ ***Center Cage***

  The center cage shall be of steel box truss construction and shall be provided with connections for the sludge rake arms and feed well supports. It shall be bolted to the main gear, which shall rotate the cage with the attached rake arms, and feed well. The main gear attachment to the cage shall have provision for adjustment to ensure leveling of the cage. Structural members as well as non structural members shall all be spliced 30 cm on both sides of the wastewater interface with SS 316 members to prevent corrosion from the waterline that may propagate to the whole assembly.

- ✓ ***Walkway with handrails***

  The effective width of the central walkway within the bridge shall be minimum 1m wide. Handrails shall be provided for the full length of the width of the walkway. The walkway shall be supported by the drive platform at the center and the tank walls at its outer end and shall be designed to withstand all normal operating loads. It shall consist beams of welded steel construction, with the walkway of galvanized grating floor plate supported by the cross members. A toe plate of 150mm height made of 5mm thick mild steel epoxy painted shall be provided on both the running edges. The height of protective hand railing & piping shall be 1000 mm from walkway up to the top row of piping and the steel member supporting this piping shall not project for more than 10 cm above this level and shall be finished with beveled edges. The piping shall be in two rows of aluminum thick-walled and equally spaced vertically. The horizontal spacing of the steel members supporting these pipes shall not exceed 1.5m center to center. These shall be integrally welded to the steel tensile members of the bridge. All structural steel members and fasteners used in the construction of the bridge shall be hot dip galvanized.

- ✓ ***Sludge removal rake arms with sweeper blades and squeegees***

  The sludge rake mechanism shall be a full diameter installation of either the parabolic or radial alignment of the scraper in plan. In either case, the assembly shall be dynamically balanced in design and erection. The material shall be of steel truss construction with steel raking blades and adjustable neoprene squeegees. The blades shall be spaced to insure complete raking of the tank bottom twice per each revolution and pushing the sludge to the sludge pit at the center. The rake arms shall be attached to the cage with provision for adjusting their slope. The rake arm truss and blades shall be fabricated from rolled / formed steel sections having a minimum thickness of 6 mm and designed to meet the full torque capacity of the central drive. All the structural members shall be sands blasted and epoxy painted with a minimum thickness of 250 micron. The tip speed of the arms shall be not more than 3.5 m per minute.

- ✓ ***Overflow Weirs***

  The weirs shall be of masonry construction finished true to level with pilasters at about 50 cm centers.

- ✓ ***Skimmer and Scum box Assembly***

  There shall be 2 radial scum skimmers aligned along a diameter equipped with dedicated scum boxes. The scraper assembly shall consist of a vertical SS304 plate supported from one rake arm and extending from the feed well to a recessed adjustable pivoted scum scraper with neoprene wipers at the tank periphery. The material of construction of scum scraper shall be SS 304 or aluminum. The scum box shall be supported from the tank wall and connected to the scum sump through a 150 NB diameter scum pipe and shall be made of minimum 5 mm thick welded SS304 plate to serve as an integral section of the tanks scum baffle. The assembly shall have a scum trough, vertical sides and a sloping ramp. A flexible connector shall be provided for the scum outlet piping in the tank wall. The scum scraper shall maintain contact with the scum baffle as it travels around the tank periphery. Upon approaching the scum box ramp, it shall trip the scum in an enclosure consisting of the scum box ramp at the bottom and the baffle and scum scraper as three sides. The trapped scum shall be carried up the ramp and into the scum trough. The scum baffles shall be curved with minimum 3 mm thick SS 304 plates.

- ✓ ***Fasteners***

  All fasteners in contact with sewage shall be SS 304 and others of hot dipped galvanized steel.

- **Secondary Clarifier mechanism**

The mechanism shall be suitable for installation in a RCC circular tank.

The specifications shall be as stated below.

- ✓ ***Rotating bridge***

  A bridge with peripheral on-board drive with steel wheels traveling on the steel billets on the peripheral wall will be provided with a radial scrapper system with bottom scrapper blades suspended from the bridge. The rotating bridge structure shall incorporate a walkway having a minimum effective width of 1000 mm which shall be surfaced with G I chequer plates. The bridge will be designed to take its own dead weight together with a uniform load of 250 Kg/ sqm over the full span and width of the walkway bridge. The maximum

deflection of the bridge under the specified loading shall not exceed 1/360th of the span. The positive camber shall be kept initially to compensate for the maximum deflection of the bridge under dead weight and superimposed loads. The bridge shall be so braced to limit lateral deflection to less than 80 mm measured at mid span under the full load condition. The bridge shall have hand railing to both sides forming an enclosure at the center in between. The finished height of the railing shall be 1 m above the walkway. Toe guards shall be provided and secured around the bridge walkway. They shall not be less than 150 mm high and 5 mm thick.

- ✓ ***Bridge support and end carriage***

  The bridge structure shall be supported at the center clarifier by means of a cast iron bearing assembly of the slewing ring type and incorporating trunnion type mountings to accommodate the vertical undulations of the traction wheels at the peripheral wall of the tank. The central bearings assembly shall be adequately lubricated. Grease points shall be extended to a battery plate mounted at a convenient point above the walkway. Oil fill/drains points where applicable shall be extended to provide a convenient access for filling and draining the system. Catch drains shall be provided under all oil grease points to prevent spillage from reaching the water surface. The wheel carriage assembly shall be suitably proportioned to provide adequate stability to the rotating bridge structure whilst providing the suitable base for the motors, gear box, driving and idling wheels, shafts and bearing. The wheels shall be plain without flanges and polyurethane sleeved of thickness not less than 75mm to suit load of mechanism. They shall travel on steel plate of not less than 5 mm thick grouted and leveled on the periphery of the tank. The size and design of wheels and carriage shall be calculated to transmit optimum tractive effort relative to the proportions of the scrapper without wheel spin when the wheel path is subject to climatic conditions.

- ✓ ***Drive***

  The bridge drive shall comprise of either a motor with helical reduction gear, a chain and a sprocket or a geared motor. The assembly shall be rigidly mounted and shall be rated for continuous service. A deflector shall be fitted to the leading edge of the driving carriage. It shall be angled at 45 degrees and arranged to be adjustable to within 3 mm of the perimeter rail such that material coming in the way of free passage of the wheel shall be deflected.

- ✓ ***Lubrication***

  All lubrication points and all necessary provisions shall be made for routine maintenance and for prevention of oil and grease spillage.

- ✓ ***Blades and fixtures***

  Scrapers shall be suspended and arranged to give continuous and progressive scrapping on the entire floor of the clarifier. The swept area of the successive blades shall overlap. The configuration of blades shall be designed to carry sludge and deposited suspended solids from the periphery of the tank and deposit them efficiently in the sludge pocket. The Contractor shall design the number and length of the individual blades. The depth shall not be less than 300 mm and the thickness not less than 6 mm. Renewable fabric reinforced rubber wearing strips of cross section not less than 12 mm x 100 mm shall be fitted to each blade to provide a continuous contact surface which is adjustable for wear. Backing strips shall be fitted to give support to the fixing of the rubber wearing strips. The assembly shall be secured by means of SS

304 bolts. Appropriate washers shall be fitted beneath all bolt heads and nuts. The top connections shall permit the blades to follow slight undulations in the tank floor. The bottom connections shall allow the blades to maintain contact with the floor throughout its length, while accommodating slight variations in the radial plane on the tank floor.

- ✓ ***Feed Well***

  There shall be a rotating feed well surrounding the inlet RCC column. It shall be attached to the rotating bridge for uniform movement. The diameter of the feed well shall be 22% to 25% of the diameter of the clarifier to limit the downward velocity calculated on the full plan area of the feed well not exceeding 1.5 m / sec at peak flow. The immersed depth of the feed well shall be 55 % to 65 % of the side water depth of the clarifier. The material of the feed well and all fixtures either partly or wholly exposed to the atmosphere or fully submerged shall all be of SS 304. In any case, the thickness of the feed well shall not be less than 5 mm.

- ✓ ***Motors starters and control***

  The electrical supply to the bridge driving motor shall be taken through a muti-ring and slip-ring collector unit mounted in a fully protected and weather proof enclosure. The unit shall be fitted at the center of rotation of each bridge and shall be complete with all necessary support brackets and an anti rotation device. A suitable means of lubricating shall be provided. The slip ring assembly shall be mounted above the top level of the walk way. Sufficient rings shall be included to cover the motor supply and any ancillary circuits. The drive motor shall be squirrel cage type protected and shall be rated 25% above bkW duty. The motor shall be controlled from an outdoor panel installed in the central part of the bridge. The drive status indicating lamps shall be installed to the main control panel.

- **Return Sludge Pumps**

The return sludge pumps shall be submersible type or Archimedean screw pumps as per specifications said in clause 4 & 5 above respectively. They shall be installed in two numbers, one working and one standby. The pump shall be designed for the required lift.

- **Sludge Thickener**

There shall be one (1) sludge thickener mechanism suitable for installation in concrete tank having an inward sloping hopper floor with 1.75 vertical to 12 horizontal slope with suitable torque rating. The mechanism shall be of the center drive “picket fence” type and shall be supported by the center drive. The equipment shall include a fixed half circle bridge, center assembly with drive unit, feed well, center cage, picket fence rake arms, walkway with handrails, scum skimmer, scum box, weirs, baffles, anchor bolts, and such other fittings, devices, or appurtenances as are necessary for a complete operating installation.

- ✓ ***Fixed Bridge***

  This shall provide access to the center assembly and drive control from a fixed location of the thickener periphery. The clear passage width shall be 1 m. The structure shall be designed out of mild steel. This shall also be designed to take the working load of the feed pipe. The rise and tread of the steps to reach the walkway from the concrete tank wall top surface shall be 20 cm x 15 cm respectively.

- ✓ ***Centre assembly with drive unit***

  The drive assembly for the thickener shall consist of a drive motor, helical gear box, steel roller chain drive, intermediate worm gear assembly, turntable type internal spur gear, visual torque indicator, overload alarm and cut off actuating system. The drive motor shall be of the TEFC type suitable for operation in 3 phase, 50 cycle, 415 volts supply with its inherent variations in voltage and / or frequency as detailed in sub-section VI. The power transmission between the first reducer and the intermediate worm gear assembly shall be through a chain and sprocket drive, which shall be enclosed in a fiberglass chain guard. The intermediate worm gear assembly shall consist of a case hardened and ground alloy steel worm (EN353/equv hardness 50-52 Rc) and cast iron worm wheel (IS: 210 grade FG260), all placed within a graded cast iron housing (IS: 210 grade FG260) complete with oil fill, level and drain fittings. The main pinion and pinion shaft shall be keyed to the worm gear. It shall be made as an integral unit from forged alloy steel (AISI 4142/Equivalent 43-44 Rc). The main internal spur gear assembly shall be of a turntable type construction and with internal spur gear. The turntable base shall be made of cast iron (IS: 210 grade FG260) and the main spur gear shall be of cast high tensile alloy steel (IS: 2644 –Gr2 240-250 BHN final hardness). The turntable will be mounted on top of the center column and will have positive leveling features. The spur gear shall be running on a built-up large diameter precision bearing assembly consisting of high chrome alloy steel bearing balls (AFBMA Gr 500, 62-65 Rc) and four replaceable hardened alloy steel inserts (AISI 4140/equivalent 36- 38 Rc final Hardness) pressed into the annular grooves in the gear and turntable base all running in an oil bath. The base will have provision for a dust seal and complete with oil fill, level and drain fittings. All gears and bearings shall run in an oil bath. Readily accessible lubricant fill and drainpipes with necessary fittings shall be provided. The drive worm shaft shall be free to move horizontally within the limits afforded by a calibrated compression spring at the thrust end. The worm shaft movement shall be transmitted to the drive control by a pin contacting the cam support and camshaft, thereby actuating the pointer. The pointer shall indicate relative torque load on a 0 to 100% graduated scale. Four cams and limit switches shall be included. Cams shall be independently adjustable over the full torque range. Two limit switches shall be shop-adjusted to sound an alarm and stop the drive motor at predetermined torque settings. Switches and cams shall be mounted in a weatherproof steel box having conduit terminal strips. The drive shall be designed for a duty rated torque of with the main gear and pinion set designed for a yield torque of at least four times the duty rated torque. The drive main bearing shall be designed for a B10 bearing life of minimum 20 years with continuous operation with the full rotating mechanism weight.

- ✓ ***Centre Drive Platform***

  A center drive platform shall provide access to the center assembly and drive control. It shall consist of hot dip galvanized chequer type floor plate with necessary structural steel stiffeners and supports, resting on the center assembly, and be provided with connections to the walkway. The platform shall be surrounded by handrails 1000mm high and made out of aluminum.

- ✓ ***Feed Well***

  There shall be a rotating feed well surrounding the inlet RCC column. It shall be integrally attached to the scraper drive assembly and the scum scraper assembly for uniform movement. The diameter of the feed well shall be 22% to

25% of the diameter of the clarifier so as to limit the downward velocity calculated on the full plan area of the feed well not exceeding 1.5 m / sec. The immersed depth of the feed well shall be 55 % to 65 % of the side water depth of the clarifier. The material of the feed well and all fixtures either partly or wholly exposed to the atmosphere or fully submerged shall all be of SS 304. In any case, the thickness of the feed well shall not be less than 5 mm.

- ✓ ***Center Cage***

The center cage shall be of a steel box truss construction and shall be provided with connections for the sludge rake arms and feed well supports. It shall be bolted to the main gear, which shall rotate the cage with the attached rake arms, and feed well. The main gear attachment to the cage shall have provision for adjustment to ensure leveling of the cage. Structural members as well as non structural members shall all be spliced 30 cm on both sides of the wastewater interface with SS 316 members to prevent corrosion from the waterline which might propagate to the whole assembly.

- ✓ ***Walkway with handrails***

The width of the full diameter bridge shall include a provision for housing the drive mechanism. The effective width of the central walkway within the bridge shall be minimum 1m wide. Handrails shall be provided for the full width. The width of the walkway supported by the drive platform at the center and the tank walls at its outer end and shall be designed to safely withstand all normal operating loads. It shall consist of two (2) side wide flange beams of welded steel construction, with the walkway of hot dip galvanized grating floor plate supported by epoxy coated cross members. A toe plate of 150mm height made of 5mm thick steel shall be provided on both the running edges. The height of protective hand railing & piping shall be 1000 mm from walkway upto the top row of piping and the steel member supporting this piping shall not project for more than 10 cm above this level and shall be finished with beveled edges. The piping shall be in two rows of anodized aluminum equally spaced. The horizontal spacing of the steel members supporting these pipes shall not exceed 1.5m center to center. These shall be integrally welded to the steel tensile members of the bridge. All structural steel members and fasteners used in the construction of the bridge shall be hot dip galvanized

- ✓ ***Picket Fence***

The picket fence shall consist of vertical steel angles erected so as to break the viscous under layers of settled sludge and “comb” the sediments consistently to release the trapped water particles and thereby enable a dewatering of solids. The picket fence shall not be closer than 15 cm and it shall not be more apart than 45 cm. The height of the picket shall be for a minimum of 1 m above the top of the raker arm at the bottom floor. The height in no case shall be more than 1.5 m measured from the floor level of the thickener. Screeding shall be used in finishing the erection of the sludge thickener mechanism.

- ✓ ***Inlet Pipe***

The inlet pipe shall be a top feed arrangement with a velocity of not less than 0.6 m/s and with a velocity of not over 1.0 m/s when pumping the excess sludge to the thickener. This pipe at the delivery end shall be submerged inside the feed well distributing effluent equally in a horizontal plane at a velocity not to churn the contents.

✓ ***Overflow Weirs***

The weirs shall be of masonry construction finished true to level with pilasters at about 50 cm centers. They shall be similar to the one constructed for the existing north zone STP at Jaipur.

✓ ***Fasteners***

All fasteners in contact with effluent shall be SS 304 and others of hot dipped galvanized steel.

Sludge Dewatering Units

Sludge dewatering shall be done by mechanical sludge dewatering units such as Solid Bowl Centrifuge. Provision of Sludge Drying Beds shall be made for 25% of the digested sludge as a backup for sludge dewatering. The dewatering units shall include but not limited to the following equipment:

- Powder or liquid Polymer storage tanks/ Bach tanks with mixers
- Polymer metering pumps
- Polymer service tanks
- Supply line & flush line
- Sludge feeding pumps
- Dewatering unit
- Belt conveyor
- Cake hopper
- Flow meters for feeding Sludge, and for feeding chemical solution
- Control valves on sludge feeding line, and on Chemical feeding line
- Drain system

Dewatered cake shall be conveyed by a belt conveyor to cake hopper for carrying out for reuse.

The dewatering system should be so located that the dewatered sludge can be loaded into trolleys/ drums/ bins directly – preferably the dewatering unit shall be so located that the dewatered sludge falls into the containers/ bins without requirement of another material handling unit.

The dewatered sludge should be truck-able & be suitable for disposal by open body truck and should have a minimum solid concentration of 20% or more (measured as dry solids w/w basis).

The dewatering unit should have a 90% solid recovery.

The centrifuge centrate should not contain more than 1000 mg/l solids.

The centrifuge should be capable of being operated at lower solid feed concentration in case of maintenance.

Dewatering units shall be provided in a separate Sludge Dewatering Building. Feed pump station shall be provided at lower level/floor and dewatering units shall be provided at upper level/ floor. Solid Bowl Centrifuge

The centrifuge shall comprise a conical cylindrical bowl and scroll feed horizontally mounted in bearings on a frame. The centrifuge bowl and scroll support frame shall be mounted on a fabricated steel sub-frame.

The bowl and scroll shall be made from stainless steel SS316 material. The leading faces of the scroll shall be protected against abrasive wear by the application of a suitable hard-coated material.

The whole rotating assembly shall be enclosed by a carbon steel fabricated

casing incorporating a Centrate discharge hopper and outlet pipe, and a rectangular solids hopper which shall discharge the dewatered sludge into the disposal system.

The rotor shall consist of a solid bowl which is conical-cylindrical in shape and which rotates about a central shaft. An inner scroll shall be provided to convey separated sludge from the periphery of the cylindrical bowl to the beach at the conical end of the rotor.

The main scroll bearings shall be arranged for lubrication by an external lubrication system. Wherever practicable greasing nipples shall be arranged together as a battery. The complete rotating assembly shall be dynamically balanced and test certificates provided.

Sludge shall be fed into one end of the rotor through a centrally positioned feed tube and dispersed to the bowl through an inlet chamber.

The bowl shall be provided with an adjustable 360o peripheral weir at its cylindrical end to control the depth of the Centrate in the rotor.

The fixed outlet castings of the rotor shall be designed to collect the centrate and dewatered sludge from

the rotor. Baffles within the casing shall direct the separate phases to the relevant discharge points and prevent cross-contamination.

The centrifuge shall be mounted on heavy-duty vibration isolators, located between the machine and the supporting steelwork or foundations, to damp vibrations and prevent vibration transmission. Two axis vibration monitors shall be provided to stop the centrifuge automatically when excessive vibration is detected.

Flexible connections shall be provided on the sludge fed system and the Centrate system at the centrifuge. The dewatered sludge discharge system shall incorporate flexible chutes.

Variable Speed Drive

A variable speed drive shall be provided to accelerate the rotor to operational speed and maintain that speed during the centrifuge's duty period. The bowl drive shall be electric or hydraulic and shall be coupled to the drive shaft by a multiple 'V' notch belt drive.

Differential Scroll Drive

The scroll drive shall be provided with a separate drive mechanism to control its rotation in the same direction but at a different speed to the outer bowl. The differential speed shall be adjustable.

The drive shall be linked to the main bowl drive by an epicyclic gearbox. The differential speed of the scroll shall be automatically and manually adjustable so that the moisture content of the dewatered sludge can be controlled as required.

For safe operation, Contractor shall provide control panel showing proper Sequence of operation with interlocking.

Chutes and interconnecting piping shall be provided with flexible joint (minimum 10 mm flexible in all direction) to avoid vibration.

- **Pumps**

  - ✓ ***Sump Pump***

    The pumps shall run smooth without undue noise and vibration.

    The power rating of the pump motor shall not be less than the maximum power required from zero discharge to zero head.

    Pump should be vertical, centrifugal, single stage, non-clog type.

It should be suitable for handling sewage containing stringy materials.

Plate type strainer should be provided to prevent large size solids entering into pump

The pump shaft journal bearings shall preferably be grease lubricated. No external water will be made available for the lubrication of the bearings.

Delivery piping with gun metal non-return valve should be supplied.

Delivery pipe should be as per IS: 1239, medium class.

Pump should be operated automatically by providing float operated level switch

The base plate shall not be directly fixed to the floor. Channels should be grouted in the floor and the base plate should be attached to the channel.

❖ **Materials of Construction**

- Impeller : Stainless Steel
- Casing : Cast Iron
- Shaft : Stainless Steel
- Cover plate : Steel

✓ ***Horizontal Centrifugal Pumps***

❖ **Design Requirements**

The pump should be capable of developing the required total head at rated capacity. Pumps should be suitable for single as well as parallel efficient operation at any point in between the minimum and maximum system resistance indicated in the system resistance curves.

The total head capacity curve should be continuously rising towards the shut off. The pump should deliver at least 125% of its rated capacity at 75% of the specified total head.

The required NPSH at duty point should be at least 1.0 M less than the available NPSH.

Pumps shall run smooth without undue noise and vibration. The velocity of vibration should be within 4.5 mm/sec. The noise level should be limited to 85 dBA at a distance of 1.85 M.

Operating range - -system curve shall be submitted along with that of motor if the pump/s are subjected to VFD application with the data sheet tagged as VFD application

The power rating of the pump motor should be the larger of the following:

The maximum power required by the pump from zero discharge to zero head.

115% of the power required at the duty point. Considering the combined efficiency of pump and motor with zero negative tolerance.

The pump set should be suitable for starting with discharge valve open, as well as closed.

The combined efficiency of the pump shall not be less than 75%. The motor shall be premium efficiency motors in accordance with IE3 as defined in IEC60034-30. The highest efficient pump set shall be

considered for selection.

- **Features of Construction**

Pump should be suitable for applications in municipal sewage handling or sludge handling as per process requirement, with back pull out design. It shall have end suction and side discharge. It should be of self-venting type.

Pumps should be identical for particular application and suitable for parallel operation with equal load division. Components of identical pumps should be interchangeable.

Pump casing should be of robust construction Liquid passages should be finished smooth and designed so as to allow free passage of solids. The volute tongue should be straight across and filed to a smooth rounded edge. Casing should be provided with hardened renewable wearing ring.

Impeller should be suitable for application, enclosed type with smooth blunt edges and large water ways so as to allow free passage of large size solids. It should be free from sharp corners and projections likely to catch and hold rags and stringy materials. Impellers should be provided with hardened wearing ring. Hardness of the Impeller ring should be at least 50 BHN more than that of casing ring.

The first critical speed of the rotor should be 30% above the operating speed. Complete rotor should be statically and dynamically balanced.

Replaceable shaft sleeves should be provided to protect the shaft where it passes through stuffing boxes. Surface hardness of shaft sleeve should be minimum 350 BHN.

Pumps should be provided with anti-friction bearings. Bearings should be easily accessible for inspection and maintenance. Bearings should be grease lubricated.

Stuffing box should be of such design that they can be repacked without removing any part other than gland and lantern ring. Stuffing box drain with pipe connection should be provided at the lowest point so that no leakage accumulates in it.

Lantern ring should be of axially split type. Grease should be used for stuffing box sealing. Water will not be available for this purpose. Gland should be of split type.

Pump should be furnished complete with flexible coupling.

Coupling guard bolted to the base plate should be furnished.

Base plate for pump and motor should be common. Suitable holes should be provided for grouting. Foundation bolts should be complete with nuts and washers.

Tapping should be provided at suction and discharge nozzles for pressure gauge connection.

Hand holes should be provided in the casing to allow easy access to the impeller as well as to the casing throat. Casing drain connection with stainless steel collared plug should be provided.

❖ **Material of Construction**

a.	Casing	CI to IS:210 GR FG 260 with 1.5 to 2% Nickel.
b.	Impeller	Stainless steel CF 8M STA STM A35/Gr.CF8M
c.	Wearing rings	SS 316 STA STM A35/Gr.CF8M
d.	Shaft	SS to AISI 431 STA STM A276 Type 410
e.	Shaft sleeves	SS to AISI 410 STA STM A276 Type 410
f.	Packing	Asbestos yarn coated with MoS2 (Molybdenum Di-Sulphide)
g.	Packing	CI/MS fabricated.CI IS210 Gr F G260
h.	Base plate	CI/MS fabricated IS 2062
i.	Gland	Cast Iron CI IS 210 Gr F G260
j.	Coupling	CI

✓ ***Dewatering Pump***

Pump should be suitable for handling settled sewage containing grit and suspended particles.

The pump motor should be suitable for working with or without submergence in sewage. The motor rating should be more than the maximum power required by the pump.

The pump set should be portable with necessary hooks.

The pump should be suitable for dewatering from a pit 900mm x 900mm x 100mm deep.

The pump should be vertical, centrifugal, non-clog type.

The pump impeller should be mounted on the extended shaft of the motor.

The pump should be provided with mechanical seal.

The pump should be supplied with flexible hose pipe of 50mm, 50M length.

Suitable cable of 50 M length should be supplied with the pump.

Materials of Construction :

a)	Impeller	Stainless Steel
b)	Casing	Cast Iron
c)	Shaft	EN8 (as per IS: 970)

✓ ***Screw and Progressive Cavity Pumps***

The progressive cavity pumps shall be self-priming and designed to handle abrasive, shear sensitive and viscous materials, solids in suspension and liquid/solids mixtures.

Automatic Variable stroke frequency / stroke length arrangement shall be incorporated wherever remote application with PLC/SCADA is envisaged and process demands these changes through remote, Local Control Panel shall also be envisaged with each pump with auto/manual selector switch and knob for these variations done manually.

The sludge will be a mixture of grit in the sludge that will be abrasive. The pump design shall incorporate features that prevent ragging around pump connecting rod and rotor head and include a shaft sleeve to protect the wear in these highly abrasive environments. These conditions must be considered when selecting the pump. Pump should be screw type, slow speed maximum 200 rpm having following construction features:

Casing : CI IS 210-FG 260
Rotor : SS316 Hard Chromed plated
Base Frame : ISMC Fabricated Epoxy coated
Bearing Housing : CI IS 210-FG 260
Shaft : SS 316
Foundation bolt : HTS GALVANIZED STEEL
Stator : Hypalon/Equivalent linning
Coupling : Flexible pin bush type
Coupling guard : MS Fabricated

The pumps must be sourced from a supplier that is ISO 9001:2000 certified to ensure that the pump is manufactured to certified standards.

✓ ***Polyelectrolyte solution preparation and Dosing System***

Polyelectrolyte solution is needed to be prepared and dosed for aiding sludge thickening and dewatering. The polyelectrolyte will be dosed online at the centrifuge inlet. Minimum dosage of polyelectrolyte shall be worked out by the Contractor. There shall be two poly-dosing tanks each suitable for minimum 8 hrs. of operation. Each-tank shall be equipped with slow speed mixer (100 RPM) to prepare polyelectrolyte solution. The solution will be fed using positive displacement metering type dosing pumps. There shall be dedicated dosing pumps to each centrifuge with one common standby. The pumps shall be interlocked with centrifuge so that it can only be running in auto when centrifuge is on and should shut down when centrifuge stops. The dosing system shall be housed in centrifuge house itself.

The polymer dosing required shall be as per peak requirement with 2 working and 2 standby. Polymer dosing pumps hydraulically actuated diaphragm pumps simplex and duplex type with maximum injection pressure of 5 kg/csqm complete with PP head, PP / PVC fittings, strainer, inbuilt PRV along with 415 V / 50 C / S suitable motor at 1000 RPM are required. The system will also have storage bins, polymer batch tank and polymer batch tank mixers.

❖ **Dosing Pumps**

Scope

The dosing pumps shall be selected to achieve optimum dosing technology and control safety with safety relieve valve. The pump shall have a resistant plastic enclosure that can safely be used for the selected application and shall provide soft and low-pulsation dosing.

The pump shall incorporate sensitive sensors that monitor the dosing flow and the diaphragm and provide process stability. The pumps shall be designed to have separation of hydraulics and electronics, to protected process from equipment failure.

Diaphram Valve, Gasket	PTTE
Liquid End	Stainless Steen 316
Foundation Bolt	Mild Sleet Epoxy Paint
Wetted Part	SS 316
Base Frame	Carbon Steel, epoxy
Painted. Flanges	Carbon steel
Plunger	Carbon Steel
Accuracy	±3%
Voltage	415 ±10%
RPM	1440

Polyelectrolyte Dosing

Head	PP
Check Valves	PVC
Balls	Glass
Diaphragm	Teflon Faced Nitrile
Motor Details	Explosion Proof Motor

Sludge Sump Pump House and Sludge Dewatering

Sludge Sumps shall be provided to collect sludge from PST & FST. The pump house shall be constructed above the sludge sump. Sludge transfer pumps shall be provided to feed the mechanical dewatering devices. The pump shall be screw type suitable to handle sludge of 1 – 2% solid consistency.

- **Pipe Works**

✓ ***General***

The term pipe work shall include all necessary supports, saddles, slings, fixing bolts and foundation bolts required to support the pipes and associated equipment. The pipe work shall be laid out and designed to facilitate the erection, painting in situ and dismantling of any section for maintenance and to give a constant and uniform flow of working fluid with a minimum of head loss. Where steel pipe work is used, the number of flanges shall be kept to a minimum and the size of each length of pipe work shall be determined by the ease of handling, installation and general appearance of the completed pipe system. Positions of flanges shall take account of any concrete pipe supports or thrust blocks needed. Flexible joints shall be provided where needed to facilitate removal of equipment or to allow for differential settlement of the building. Wherever practical, flexible joints shall be provided with tie-bolts or other approved means to transfer thrust or tension axially along the pipe work.

Where steel and cast flanges are to be bolted together, the steel flange shall be machined over its full face after welding to its pipe is completed. Flanges shall be finished truly square with the pipe axis. Wherever possible, standard fittings shall be used in preference to special fittings. Pipe work layout within pumping stations shall be prepared to meet the requirement of the pump manufacturer. Valves, strainers and other devices mounted in the pipe work shall be supported independently of the pipes to which they connect. Flanges shall be drilled in accordance with the appropriate pressure rating. Where a pipe passes through a wall, a retaining wall, or is subject to end thrust, it shall incorporate a puddle flange. Puddle flanges shall be undrilled.

✓ ***Material of Pipes, Sizing & Design Basis***

Unless otherwise specified, the flow velocity in the suction branches of a pump shall not exceed 1.5m/s, delivery 1.8 m/s for horizontal pumps and in the discharge branch shall not exceed 2.1 m/s for submersible pumps when the pump is operating within its specified working range. There shall be no discernible noise due to hydraulic turbulence or cavitations within the pump or its associated pipe work and valves.

✓ ***Piping Sizing & Material***

The piping and valves will be sized on the following basis for sizing.

Service / Flow	Basis	MOC
Gravity Lines for Sewage, Water &	Velocity between 0.6 to 1.2 m/s & designed as	DI Class K 7 DWC HDPE pipes

Service / Flow	Basis	MOC
Waste Water	pipe line flowing full	SN80 HDPE pipes material Gr. 80 PN 6
Pressure for Sewage, Water & Waste Water	Velocity between 1.2 to 1.8 m/sec	Di Class K 7 / MS Cement Mortar lined / HDPE pipes material Gr. 100 PN 10
Sludge line		DI Suitable with pressure rating/ MS with cement mortar above 500mm dia
Air (Pressurized Lines) [for Aeration Tank, Grit Chamber, Gas Mixing System etc.,]	At velocities between 8 – 10 m/sec (desirable) with a maximum of 15 m/sec in small sections	GI/MSEP
Bio Gas	At velocities between 3.5 to 4.5 m/sec (desirable)	CI / DI
Service Water	Velocity between 1.4 to 2.0 m/sec	GI Class B
Chemical Feed Lines	Velocity between 0.6 to 1.5 m/sec	PVC/ PP/ HDPE/ SS

- ✓ ***Cast Iron Pipes***

  The cast iron pipes shall generally conform to IS:1537/IS:1536 and pipe fittings shall conform to IS: 1538. All pipes and fittings above the ground level and inside pumping station shall be flanged.

  The material for cast iron pipes and fittings shall be of grey cast iron conforming to IS: 210, Gr FG 200.

  The pipes shall be of uniform bore and straight in axis. Length of the straight double flanged pipes shall be within a tolerance of + 3 mm.

  The flanges of the straight pipes shall be square to the axis of the pipe. The face of the flanges shall be parallel. The bolt hole circle shall be concentric with the bore and bolt holes equally spaced. In straight pipes the bolt holes in one flange shall be located in line with those in the other flange.

  The faces of the flanges of the fittings shall be square to the directional axes. The holes shall be located symmetrically off the center line. The intersecting axes of the tees shall be perpendicular to each other.

  The bolt holes on flanged pipes and fittings shall be drilled with the help of drilling jig. The blank flanges are to be machined and drilled.

- ✓ ***Ductile Iron Pipes***

  The DI Pipes conform to IS 8329 /ISO 2531/BS EN 545 & Fitting conform to IS 9523/BS EN:545. These pipes can also be offered with standard thickness for smooth flow and corrosion resistance.

  All the pipes, valves, specials and other pipe appurtenances shall be designed to withstand the maximum pressures to which it may be subjected to during the operation.

  The pipes shall be such that they could be cut, drilled or machined.

  In case of flanged pipes, the flanges shall be at right angles to the axis of the

pipe and machined on face. The bolt holes shall be drilled as per stipulations given in the relevant BIS.

- ✓ ***DI Specials/Fittings***

  DI specials shall be manufactured as per IS: 9523 and shall be ISI marked.

  In case of flanged joints, the flanges shall be at right angles to the axis of the pipe machined on the face.

  The bolt hole circle shall be concentric with the bore and bolt holes shall be located off the centre lines as per IS: 9523. Fittings shall be tested as per IS: 9523

- ✓ ***Stainless Steel Pipes***

  All gas pipes, fittings and other related components inside the digester shall be of stainless steel SS-304.

- ✓ ***Steel Pipes***

  All steel pipes shall conform to IS:3589.ERW steel pipes (200mm to 2000mm) for gas, water and sewage and laying should conform to IS:5822.

Sluice Gates

The construction of sluice gates shall be in accordance with the specification and generally as per AWWA C 501 or IS 13349. The sluice gates shall be capable of performing the duties set in the specification without undue wear or deterioration. They shall be constructed so that maintenance is kept to a minimum. All parts of sluice gate, including mechanism components shall be designed for the heads specified with a minimum safety factor of five. All sluice gates shall be of the raising spindle type.

All sluice gates shall be manually operated. Motorized gates, if provided by the Contractor, the actuator specs be got approved from the Employer's Representative.

- ✓ ***Constructional features***

  The sluice gates shall be standard design of manufacturer's and of robust construction. The special features shall be as follows

  - ❖ **Frame**

    The frames shall be of ample section and cast in one piece. All surface forming joints and bearings shall be machined. The frame shall be of the flange back type and shall be machined on the rear face to bolt directly to the machined face of the wall thimble.

  - ❖ **Guide**

    The guide shall be bolted to the frame or cast integrally with it and shall be machined on all bearing and contact faces. The length of the guide shall be such that it should support the gate upon the horizontal line of stem nut pocket. Arrangements shall be such that it should support the gate upon the horizontal line of stem nut pocket. Arrangements shall be made to prevent lateral movement of bolted on guides. They shall be capable of taking the entire thrust produced by water pressure and wedging action. Wedges or wedge facings shall be attached to the guides at point where, in the closed position, they will make full contact with the wedging surface on the slides.

- **Seating Faces**

  The seating faces shall be of full width, solid section. They shall be secured firmly by means of counter sunk fixings in finished grooves in the frame and slide faces in such a way as to ensure that they will remain permanently in place as well as free from distortion and loosening during the life of the sluice gates.

- **Wedging devices**

  Sluice gates shall be equipped with adjustable side, top and bottom wedging devices required providing contact between the slide and frame facing when the gate is closed position. All faces shall be machined accurately to give maximum contact and wedging action. Wedges shall be fully adjustable with suitable adjusting screws and lock nuts and so designed that they will remain in the fixed position after adjustment.

- **Gate slides**

  The slide shall be with strengthening ribs where required and reinforced section to receive the seating faces. The slide shall have tongues on each side extending its full length and tongues shall be machined accurately on contact surfaces. Surfaces of the slide that in come in contact with the seat facing and wedges shall be machined accurately. The maximum allowable clearances between the slide and slide gate shall be 1.6 mm. An integrally cast stem nut pocket with reinforced ribs shall be provided above the central line of the slide.

- **Stem nut and Lift nut**

  A gate shall be provided with lower fixed stem nuts for connecting the stem to the slide and revolving lift nut located in the lifting mechanism in the head stock. They shall be of ample design to endure the thrust developed during gate operating under maximum gate operating condition loads in opening and closing direction. The stem nut and slide shall be constructed to prevent turning of the stem nut in the pocket in the slide. The stem be threaded and keyed or threaded and pinned to the stem.

- **Stem**

  The operating stem shall be designed for a tensile strength to withstand 90 kg effort on the crank and for a critical buckling compressive load assuming a 36 kg effort on the crank. The threads of the stem be machine cut or rolled and of the square or acme type. The number of threads per inch shall be such as to work most effectively with the lift mechanism used. The top of the stem be provided with a stop collar. Stem shall be provided with GI pipe cover shall be fixed to the head stock.

- **Stem coupling**

  The coupling shall be threaded and keyed or threaded and bolted and shall be of greater strength than the stem

- **Stem guide**

  Stem guides shall be cast, with bushings and mounted on cast brackets. Guides shall be adjustable in two directions and shall be so constructed that when properly spaced they shall hold the stem in alignment. The number of stem guides shall be such that the unsupported length of stem shall not exceed one hundred times its diameter.

- **Lifting Mechanism**

  Sluice gates shall be operated through a suitable lifting mechanism, which shall incorporate gearing if required. The lifting mechanism shall be suitable for operation by one man under all conditions. The lifting mechanism shall incorporate a strong locking device suitable for use with a padlock or padlock and chain. The manual operation shall be of the hand wheel crank operated type and shall have a lift nut threaded to fit the operating stem. The crank shall be removable. Ball or roller thrust bearings shall be provided above and below flange on the lift nut to take the load developed in opening and closing the gate with torque of 14 kg-m on the crank. Fittings shall be provided to lubricate gears and bearing. The design of the lift mechanism of the hand operated gates shall be such that the slide can be operated with torque is not more than 7 kg-m on the Contractor after the slide is unseated from wedges based on the operating head. The maximum crank radius shall be 380 mm.

- **Gears and bearings**

  All gears and bearings shall be enclosed in cast iron housing with labyrinth seals. The lifting mechanism shall be of cast iron pedestal, machined and drilled to receive the gear housing and suitable for bolting to the operating floor. The gates shall close with clockwise rotation of the crank. The direction of rotation to close the gates shall be indicated on the lift mechanism. A suitable means shall be provided for lubricating the stem threads directly adjacent to the lift nut. An inspection cover shall be provided to access the lift nut and gearing.

- **Fasteners**

  All anchor bolts, assembly bolts, screw, nuts etc., shall be of ample section to safely withstand the forces created by the operation of the gate.

- **Wall thimbles**

  The wall thimbles shall be made of cast iron and shall be supplied along with the gate. The wall thimbles shall provide a rigid mounting and designed to prevent warping of the gate frame during installation. The cross section of the thimble shall have the shape of the letter 'F'. The front, or mounting flange, shall be machined and shall be attached to the thimble with bolts and studs. The depth of the wall thimbles shall not be less than 300mm. To permit entrapped air to escape as the thimbles are being encased in the concrete, holes not less than 35 mm diameter at not more than 600 mm span, shall be cast or drilled in each entrapment zone formed by the reinforcing ribs or flange and water stop.

Material of Construction	
Frame, Guide, Thimble, stem	C I conforming to IS 210 Gr 260
Guide Bracket, wedges	
Door Sealing faces	Bronze conforming to IS 318 Gr LTB 2
Spindle	SS AISI 431
Flush bottom resilient seal	Natural or synthetic rubber conforming to IS: 1855
Anchor bolts	SS conforming to IS 6603
Hand wheel	Cast iron
Stem cover	Polycarbonate transparent tube
Parameters	

Type	Rectangular rising spindle
Size	As per requirement
Applicable code	IS 13349
Class	1
Maximum seating head	As per standard
Unseating head	As per standard
Maximum distances between gates centre line and operating platform	As per standard
Tests	Seat clearance check, moving tests, leakage tests and Hydrostatic tests as per IS 13349/ AWWA C 501 shall be conducted at Manufacturer's works in accordance with the Inspection category

- **Open channel Gates**

The manufacture of open channel gates shall be in accordance with the manufacturer's standard.

All open channel gates shall be of the raising spindle type.

All open channel gates shall be manually operated.

Open channel gates shall as per tested manufacturer's standard.

The material of construction shall be as follows.

Components	**Material**	**Specification**	**Grades**
Gate frame, shutter, Headstock, Flush bottom seal support bar, Stop nut.	Cast Iron	IS: 210 – 1993	FG: 200
Sealing faces/ Seat facings	Stainless Steel	ASTM A276	AISI: 304, 316, 410
Resilient rubber seal	Natural Rubber EPDM Rubber Neoprene Rubber		
Seal retainer bar	Stainless Steel	ASTM A276	AISI: 304, 316, 410
Stem / Spindle	Stainless Steel	ASTM A276	AISI: 304, 316, 410
Operating Nut/ Stem Nut	Leaded Tin Bronze	IS: 318 – 1981	LTB 1, LTB 2
Fasteners	Stainless Steel	ASTM A276	AISI: 304, 316, 410
Anchor Bolts	Stainless Steel	ASTM A276	AISI: 304, 316, 410
Yoke	Mild Steel	IS: 2062 – 1992	Grade A

- **Fire Extinguishers**

The Contractor shall provide 3 Kg CO2 fire extinguishers of suitable capacity and numbers for the treatment plant at the following locations after consultation with the Employer's Representative these shall be provided as adhoc at the start itself and replaced fully up to date before handing over of the work. However for

providing fire extinguishers in substation, PMCC/MCC and control rooms, please refer to sub-section VI

Laboratory	-	1
Blower room	-	2
Near Gas holder	-	3
Near Sludge digesters	-	5
Gas engine room	-	3

These shall be installed in a fashion such that their use is facilitated in case of fire emergency.

- **First Aid kits**

The first aid kit shall consists of all materials, medicines necessary for treatment of cuts, wounds, burns etc., These shall be provided in addition to requirement mentioned in sub-section VI as adhoc at the start itself and replaced fully up to date before handing over of the work

- Laboratory
- Rest room
- Security room
- Plant in charge room
- Gas engine room

- **Emergency Lamps**

The Contractor shall provide for lamps with autonomy of 5 hours continuous service. The units shall be DC 6V and shall be rechargeable from any 5A plugs. They shall be continuously chargeable without damage to the battery at the following locations

- Security room
- Centrifuge floor
- Rest room
- Laboratory
- Toilets
- Vehicle parking area
- PMCC and MCC rooms, Control room, substation room and all rooms with starter panel

- **Exhaust fans**

The fans shall be as per IS 2312 and the blades shall of mild steel dynamically balanced to avoid noise and vibration. The blade and its carriers shall be securely fastened to avoid loosening in operation and shall have a SS AISI guard as a grill inside and a 10 sq mm mesh screen to safeguard birds from getting sucked in. The duty of the fans shall be calculated to ensure 3 to 10 air changes per hour in the command area depending on requirement. These shall be provided at the following locations

- Laboratory
- Rooms located with starter panel
- MCC room
- PMCC room
- Security room

- Kitchenette in rest room and Pantry
- Toilets

Material of Construction

- Casing M S as per IS 2062
- Impeller Cast Aluminum
- Test As per IS 2312

Chain Pulley Blocks

The monorail and trolley and the chain pulley block shall be provided for lifting the blowers and submersible pumps. The trolley and chain pulley block shall be hand driven. The capacity of the trolley and the chain pulley block shall be for the maximum weight to be lifted during erection and maintenance of the equipment but should not be less than 1 tonne. The trolley shall be gearless. The traveling trolley shall run on the lower flange of the rolled steel joist. The trolley shall have two wheels on both sides of the joist web. The trolley wheels shall be single flanged with treads machined to match the flange of the beam. The wheels shall be of carbon steel casting conforming to IS 1030. The trolley shall have an arrangement for the fixing chain pulley block and sling. The trolley shall be moved by pushing the load. Suitable arrangement shall be provided on the joist to prevent over traveling. The chain pulley block shall have frame housing gears load sheave, brake unit, hand chain wheel and load chain wheel shall have hooks on both sides, one fixed with traveling and other for the load. The frame shall be of welded construction.

The gears shall be of spur type incorporating high grade hardened carbon steel pinion and heat treated carbon steel wheels. The width of the gear shall be adequately sized for long life. The driving pinion shall be integrated with the driving shaft. The hooks shall be manufactured from the die forged steel and shall conform to I S 1875. Both hooks shall have 360 degree rotation. The load hook (bottom hook) shall rotate on the ball bearing. The chain shall be electrically welded, accurately calibrated, pitched and polished. The load chain shall be manufactured from alloy steel conforming to IS 3109. The length of the load chain shall be sufficient for taking out the blower/pumps from their location. The hand chain wheel shall be provided with roller type guarding to prevent slipping the chain. The hand chain wheel shall hang to cleat of the hook. The braking shall be automatic. The screw and friction disc type and shall offer no resistance. The load should be sustained in any position of lift when effort for hoisting or lowering is removed. Each chain pulley block shall be supplied with one set of 1 tonne sling with galvanized D- shackles and clamps. The slings shall be about 3 m long. The monorail shall be 'I' section. The exposed mild steel surfaces shall be enamel painted. The fasteners shall be G I or Cadmium plated.

Manually Operated Traveling Crane

✓ ***Crane***

The crane bridge shall consist of a single bridge girder carrying two wheels at each end of the span. Steel used shall be tested quality steel conforming to IS 2062.

✓ ***Employer's Requirements***

The long travel bridge wheels shall be rim toughened, heat treated carbon steel or low alloy steel or C.I. and shall be double flanged type. The wheels shall have antifriction ball / roller bearings. The wheels shall be machined on their treads to match the runway rail section. The bridge shall have a geared

shaft and pulley connecting to opposite wheels of the span to achieve the long travel motion of the bridge, by means of a chain. The runway rails of adequate strength and rigidity, rail clamps and other accessories for mounting the rails and suitable end stops for the bridge shall be supplied by the Contractor.

✓ ***Trolley and Chain Pulley Block***

The chain pulley block shall be operated on the lower flange of the bridge girder.

The load chain shall be made of alloy steel as per IS:3109. It shall be heat treated to give ductility and toughness so that it will stretch before breaking. It shall be of welded construction with a factor of safety not less than 5.

The hand chains for the hoisting and traverse mechanism shall hang well clear of the hook and both the chains shall be on the same side. The hand chain wheel shall be made from pressed sheet steel and shall be provided with roller type guarding to prevent snagging and fouling of the chain.

All the gearing shall be totally encased. Proper lubricating arrangements shall be provided for bearings and pinions. Gears shall be cut from forged steel blanks. Pinions shall be of heat treated alloy steel. Gears shall be as per BS:436/IS:4460.

The trolley track wheels shall be rim toughened, heat treated carbon steel or low alloy steel or C.I. and shall be single flanged and shall have antifriction ball bearings. The wheels shall be machined on their treads to match the flanges of the track joints.

The travelling trolley frame shall be made of rolled steel conforming to IS:2062. The side plates of trolley frame shall extend beyond wheel flanges, thus providing bumper protection for the wheels. The two side plates shall be connected by means of an equalizing pin

Axles and shafts shall be made of carbon steel and shall be accurately machined and properly supported.

The lifting hooks shall be forged, heat treated alloy or carbon steel of rugged construction. They shall be of single hook type provided with a standard depress type safety latch. They shall swivel and operate on antifriction bearings with hardened races. Locks to prevent hooks from swiveling shall be provided. Hook shall be as per BS:2903/IS:3815

The brake for the lifting gear shall be automatic and always in action. It shall be of screw and friction disc type self-actuating load pressure brake. Brakes shall offer no resistance during hoisting.

✓ ***Data***

Description	Particulars
Capacity	As per design
Span	On the roof ceiling 17.5 m long and 6m wide
Lift	About 14.0 m

Laboratory Equipment

General requirement and specification of the laboratory equipment are delineated in instrumentation Sub-section.

Valves and Appurtenances

All sluice gates, isolation valves, air release valves, check valves shall be designed for the medium carried in the respective pipeline, according to the diameter and the design working pressure of the pipeline. Manual operation shall

always be provided. Electrical drives shall be provided as per requirement unless otherwise specified. However all valves on suction side of pumps and blowers shall be manual operated and all valves on delivery side of pumps and blowers shall be motorized.

The valves shall be installed between flanges. The dismantling shall be possible by the use of rigid or flexible dismantling pieces or flange adapters at one side. For this purpose, suitable flange adapters may be provided. All valves shall be installed in the pipe work in such a manner that they can easily be removed from the line for dismantling and maintenance.

The non-return valves on the pump delivery branches shall be spring loaded and have high speed non slam closing characteristics.

Valves used in lines conveying chemical solutions and gases shall be manufactured of material suitable for the purpose and to withstand the corrosive and aggressive action of the medium. However for sludge pumps double flange Knife gate valve can be accepted.

Valves used on sludge conveyance piping etc. shall be of straight through type and non-logging. Double flange knife edge gate valves may also be used on sludge line.

The pressure rating of valves must at least be equal to the maximum expected pressure at the point of installation.

The size of valves must not be less than the size of the respective main (suction, delivery) pipes. The material of construction of valve shall be as follows:

- ✓ ***Sluice Valves for Sewage Water Application***

  Sluice valves shall be generally conforming to IS: 14846:2000. Additionally they should meet the specific requirement given below. The valves shall be double flanged machined and drilled to IS-1538 Part IV & VI. The backside of the drill holes to be spot faced for proper seating of bolts & nuts.

  Reasonable clearance behind the rear face of the flange on body and bonnet to be kept to provide free access to use spanners for assembling and dismantling. No tap hole is acceptable. The pressure rating of the Valves on the Suction side / discharge side of the pump shall be as per design requirement. They should close with clockwise rotation of hand wheel. The direction of closing shall cast on hand wheel. Nominal size, PN Rating and Brand name should cast on the body. The valves shall be of Rising Spindle type. They shall be with Back seat Bushing arrangement for replacement of packing without leakage. The Valve of size 350 and above should be supplied with 2 nos. Single trust deep groove Ball bearing on both end of spindle collar to reduce operating torque and vertical thrust on spindle. The valves of sizes 450mm and above should be supplied with enclosed grease packed bevel/worm gear box of suitable rating to ensure that the valve shall be operated with effort not more than 7 KgM at the pinion shaft for manual valve only. The valves shall be provided with position indicator for indication from full open to full close. They shall be provided with cast iron cleaning door at the bottom of sluice valve body. The clearance between the wedge nut housing lugs on the wedge and the inside surface of the valve body shall be adequate to insert the wedge nut into the wedge lug recess either in the direction of water flow or in perpendicular direction when the wedge is in closed position. The Valves shall be provided with Air Release plug arrangement on the top of the bonnet. Sluice valves shall be electrically operated with manual override facility. All valves in the pump house and on discharge /header shall be actuator operating. The valves which are operated rarely i.e. not regularly shall

be manually operated.

❖ **General**

- Sluice valve shall be conforming to IS: 14846: 2000 and with ISI marking. Additionally they should meet the specific requirement given here under.
- Sluice valve must be from ISO-9001 certified company towards Quality Management System.
- The valves shall be double flanged machined and drilled to IS- 1538 Part 4 & 6. The back side of the drill holes to be spot faced for proper seating of bolts & nuts. Reasonable clearance behind the rear face of the flange on body and bonnet to be kept to provide free access to use spanners for assembling & dismantling. No tap hole is acceptable.
- The valves should close with clockwise rotation of hand wheel. The direction of closing shall be cast on hand wheel.
- Nominal size, PN rating & Brand name should cast on the body.

❖ **Design Requirement**

- The valve should be of PN 1.0 rating/based on working pressure in the pipeline.
- The valves shall be of Non-rising Spindle type.
- The valves shall be with back seat bushing arrangement for replacement of packing without leakage.
- The valve size 350 mm & above shall be provided with renewable Shoe & Channel arrangement to reduce the clearance between body and wedge lugs.
- The valve size 350 mm & above should be supplied with 2 nos. Single trust deep groove Ball bearing on both end of spindle collar to reduce operating torque and vertical trust on spindle.
- The valve size 450 mm & above should be supplied with enclosed grease packed bevel/worm gear box of suitable rating to ensure that the valve shall be operated with effort not more than 7 KgM at the pinion shaft.
- The valves shall be provided with position indicator for indication from full open to full close.
- The valves shall be provided with cast iron cleaning door at the bottom of Sluice valve body.
- The clearance between wedge nut housing lugs on the wedge and the inside surface of the valve body shall be adequate to insert the wedge nut into the wedge lug recess either in the direction of water flow or in perpendicular direction when the wedge is in closed position.
- The valve shall be provided with air release plug arrangement on the top of the bonnet.
- The valves should also be compatible with Actuator system.

❖ **Material of Construction**

1.	Body	: Cast Iron to IS: 210 Gr. FG200
2.	Wedge	: Cast Iron to IS: 210 Gr. FG200
3.	Spindle	: St. Steel to IS: 6603 04Cr18Ni10

4.	Seat Rings	: SS to CF8
5.	Spindle Nut	: High Tensile Brass to IS – 320 HT2
6.	Back Seat Bush	: SS to CF8
7.	Shoe & Channel Lining	: SS to CF8

❖ **Shop Testing Witnessing**

1.	Seat Leakage Test (2 Minutes)	: 10Kg/csqm
2.	Body Leakage Test (5 Minutes)	: 15Kg/csqm
3.	Back Seat Leakage Test (2 Minutes)	: 10Kg/csqm

✓ ***Check Valve***

- Checking valve shall be conforming to IS: 5312. Additionally they should meet the specific requirement given below.
- The valves shall be double flanged machined and drilled to IS- 1538 Part 4 & 6. The backside of the drill holes to be spot faced for proper seating of bolts & nuts. Reasonable clearance behind the rear face of the flange on body to be kept to provide free access to use spanners for assembling & dismantling. No tap hole is acceptable.
- The valve should be of PN 1.0 rating based on working pressure in the pipeline.
- Nominal size, PN rating, Brand name & Direction of Flow should cast on the body.
- The Valves shall be of Swing Check type.
- The Valve sizes 50 to 600 mm should be of Single door design & above 600 mm should be Multi door design.
- The Check Valves shall be with Non Slam Characteristics. Non Slam Characteristics to be achieved by combination of hydraulic passage and additional disposition of weight on doors.

❖ **Material of Construction**

a.	Body & Cover	: Cast Iron IS: 210 Gr. FG 260
b.	Door	: Cast Iron IS: 210 Gr. FG 200
c.	Hinge Pin	: St. Steel to AISI – 316
d.	Seat Rings	Gunmetal with 2% Nickel / IS: 318 Gr. LT B2
e.	Bearing Bush	Teflon
f.	Fastener	carbon steel
Shop Testing Witnessing		
1.	Seat Leakage Test (2 Minutes)	: 10Kg/csqm
2.	Body Leakage Test (5 Minutes)	: 15Kg/csqm

✓ ***Kinetic Air Valve***

❖ **General**

- Kinetic Air valves shall be conforming to IS: 14845: 2000. Additionally they should meet the specific requirement given here as under.
- Kinetic Air valves should be from ISO – 9001 certified company towards Quality Management System.
- The Valves shall be flanged end machined and drilled to IS – 1538 Part 4 & 6

- The valves should have an isolating Sluice Valve attached to it.
- Nominal size, PN rating, Brand name should cast on the body.

❖ **Design Requirement**

- The valve should be of PN 1.0 rating /based on working pressure in the pipeline.
- The Valves should double ball air valve consisting of large orifice (LP) & small orifice.
- The large orifice chamber should have built-in Kinetic features to avoid blocking of the large orifice during filling & emptying of pipeline. It should have a large timber ball covered with rubber to be seated on a large orifice rubber ring.
- The small orifice chamber should have a small timber ball covered with rubber to be seated on gunmetal orifice plug.

❖ **Material of Construction**

Body, Cover, Cowl : Grey Cast Iron. IS: 210 – 1993 Gr. – 260

Ball of small office : Seasoned timber ball covered with soft Vulcanite Ball of large orifice : Seasoned timber ball covered with soft Vulcanite Seat of large orifice : Neoprene Rubber

Nipple for small orifice : LTB. : IS 318 – 1980. LTB – 2./ AISI: 410

Isolating Gate valve : IS: 14846 (GM internals & AISI: 410 Spindle) Bolt & Nut : M.S

❖ **Shop Testing Witnessing**

Seat & Body Leakage Test (2 Minutes) : 10Kg/csqm

✓ ***Painting & Coating***

❖ **Pre – inspection**

1st Step Surface Preparation

Blast cleaning to near white – SA 2 ½ Gr.

2nd step Application of Primer Coating after blast cleaning

One coat of two component epoxy based primer

❖ **Post – inspection, if applicable**

3rd Step Application of Finish Coat

One coat of two component solvent free amine cured epoxy coating (Shade)

✓ ***Butterfly Valves***

Unless otherwise specified, valve body and disc shall be of close-grained gray cast iron. Valves shall be mounted with shafts horizontal. Valves shall be fitted with indicators to show the position of the disc, clearly marked with 'open' and 'closed' positions. Valves shall not contain any brasses containing more than 5% zinc. Gunmetal conforming to BS 1400 Grade LG2, aluminum bronze, or nickel components may be used for internal components. Resilient-seated valves shall have nitrile rubber seals.

For valves of 900mm and above, retaining rings shall be provided to enable the sealing ring to be replaced without the need to remove the valve body from the pipe work. Metal seated valves of 900mm and above, shall have seat

clearances adjustable to obtain as near a watertight condition as possible, without the need to remove the valve body from the pipe work.

Percentage Opening - Flow Curve shall be submitted along with data sheet mentioning area where such valves are subjected for any controlling of the fluid flow.

Component Material

- Body Cast Iron : IS:210 Gr FG260
- Inner lining Stainless steel : BS:970 Gr 304
- Plate /DLSC Stainless steel : IS 3444 1987
- Stem Stainless steel : IS 6603:1972
- Seat ring / Boss Stainless steel : IS 6603:1972
- Gland housing Cast Iron : IS:210 Gr FG260
- Gland packing Teflon Impregnated with asbestos+Rubber

✓ ***Pressure-Relief Valves (PRV)***

Pressure-relief valves shall be designed to prevent the pressure in the pipeline upstream of the valve rising above a preset level. The valve shall remain closed at lower pressures. The pressure at which the valve opens shall be adjustable. A pressure gauge shall be provided to indicate upstream pressure over the operating range of the valve. Safety valves shall comply with BS 6759: Part 1.

They shall be designed to open at the specified pressure and re-close and prevent further release of fluid after normal pressure has been restored. The pressure / temperature rating shall be in accordance with relevant standards. Flanged ends shall be Class 900, raised-face type complying with ANSI B16.25 or relevant standards.

Component Material

- Body Cast Iron : IS:210 Gr FG260
- Inner lining Stainless steel : BS:970 Gr 304
- Knife gate/ plate Stainless steel : BS:970 Gr 304
- Stem Stainless steel : BS:970 Gr 304
- Seat ring / Boss Stainless steel : BS:970 Gr 304
- Gland housing Cast Iron : IS:210 Gr FG260
- Gland packing Teflon Impregnated with asbestos+Rubber

✓ ***Ball Valves***

Ball valves shall conform where applicable to relevant standards. Multi-piece bodies shall be used where work on the ball and seats when installed may be needed. If valves need removal for servicing, one- piece bodies may be used. Seat materials shall be chosen for long life, with erosion and corrosion resistance. Ball supports shall be of the floating ball or trunnion type. If line pressure is too low to ensure a positive leak-free seal, built-in seat loading devices, or specially shaped seatings shall be used to ensure sealing.

Component Material

- Body Cast Iron : IS:210 Gr FG260
- Inner lining Stainless steel : BS:970 Gr 304
- Plate Stainless steel : BS:970 Gr 304

- Stem Stainless steel : BS:970 Gr 304
- Seat ring / Boss Stainless steel : BS:970 Gr 304
- Gland housing Cast Iron : IS:210 Gr FG260
- Gland packing Teflon Impregnated with asbestos+Rubber

✓ ***Knife Gate Valves***

The valve shall meet standards C105/A21.5-10, C520-10, C706-10, C707-10, C713-10 and D106-10 and testing requirements of MSS SP 81.

Outer body may preferably be provided with inner liner in corrosion resistant stainless steel which shall extend into the gland. The body shall be devoid of any wedge/ dead pockets to avoid setting of suspended particles and solids in the service fluid.

The gate / plate shall be precision buffed and the edge contoured to a knife edge. The gate shall move along / be guided by the seat ring to ensure that it scraps any deposit / scale enabling smooth uninterrupted movement.

Seat shall be so designed that there is no recess / relieve groove to harbour deposition that could build-up and swamp the valve. The design should also incorporate bosses that guide the gate and avoid deflection ensuring positive shut-off. The stem shall have double start threads cut in order to ensure smooth and speedy operation.

Gland packing shall offer minimal frictional resistance and precludes external lubrication. As positive sealing elements, the packing shall also include a resilient rubber ring. The knife edge and seat face in flow path shall be hard faced to a hardness of 400 to 450 BHN to counter erosion. In such cases, provision shall also be made to ensure the fluid contact with the seat ring is minimal.

Component Material

- Body – Cast Iron : IS:210 Gr FG260
- Knife gate/ plate – Stainless steel : BS:970 Gr 304
- Stem – Stainless steel : BS:970 Gr 304
- Seat ring / Boss – Stainless steel : BS:970 Gr 304
- Gland housing – Cast Iron : IS:210 Gr FG260
- Gland packing – Teflon Impregnated with asbestos + Rubber

✓ ***Cast Iron Flap Valves (Circular Flap Valves)***

The Flap Valves with circular aperture, single door and double flanges, shall be provided. The flap valves upto 600mm dia shall have sealing faces in angular section and secured to the frame and door by a force fit. For sizes above 700 to 2000mm dia the sealing faces are of rectangular section and are secured to the frame and door using countersunk taper headed screws in the same material as the sealing face. The flap valve shall be suitable for mounting on a vertical wall or flange for static seating heads up to 6 meters.

✓ ***Material of Specification***

❖ **Frame**

Constructed in BS EN 1561 min. 250 cast iron designed for wall, thimble or pipe mounting applications.

❖ **Door**

Constructed in BS EN 1561 min. 250 cast iron designed to withstand static

seating heads up to 6 meters.

- **Sealing Faces**

  Copper alloy sealing faces to BS EN 1982 : 1999 are supplied as the standard material for ranges up to 600mm dia and for the ranges 700 to 2000mm dia phosphor bronze to BS EN 12167 : 1998. Sealing faces are set to 0.1mm feeler gauge non-acceptance to provide an effective seal.

- **Hinge Links**

  Manufactured in Spheroidal Graphite cast iron

- **Fasteners**

  Standard fasteners are supplied in stainless steel to BS EN 10088 : 1995 grade 1.4401 (316).

- **Hinge Pins**

  Manufactured from stainless steel to BS EN 10088 : 1995 grade 1.4401 (316).

✓ ***Electrical Overhead Traveling (EOT) Crane***

The capacities of various EOT's shall be decided as per recommendations of IS: 875.

The crane shall be of single / double girder type designed from lowest sump level and up to under size of the bridge.

Suitable crane rails complete with fixing bolts, nuts, washers and anchor plates shall be supplied for each crane.

The bridge structure shall be formed by a single/double cross girder with the hoist units traveling along the lower flange of the bridge girder.

The end carriages shall be fabricated adequately stiffened throughout their length to produce a section with high torsional resistance designed to eliminate and tendency for the bridge to cross whip. The carriage wheel shall be adequate proportioned in relation to its span to give a widely distributed load on the crane rails.

Proper selection of reduction gears shall be done to run drive motors. Wherever required the motor enclosure shall afford protection to IP: 55 of IS: 4691 and have cooling facility to IC: 41 of IS: 6362. Each drive motor shall be fitted with an automatic electro-magnetic brake to stop the crane on interruption of the power supply, whether intentional or accidental power failure.

Suitable end stoppers/buffers shall be provided on the bridge girder and at each end of crane rails.

The crane and hoist shall conform to IS: 3177, IS: 3832 and IS: 3938, class 2, medium duty and meet specified operational requirements.

Power feed to the crane shall be form a shrouded conductor rail system and that to the hoist shall be through close looped flexible suspension system with carriers sliding along a wire across the full span of the crane.

Proper illumination of the area shall be done under the crane and on the crane.

All the crane and hoist functions and excluding the illumination lights shall be controlled from a single pendant push button station. The pendant unit shall be suspended from a special track spanning the bridge length using a non-metallic cord and not the control cables. The pendant shall operate on a low

voltage (typically 220 volts AC) source, incorporated with a key operated switch to operate switch to prevent unauthorized operation and indicators to indicate ail crane or hoist movements including start and stop.

EOT Operations and faults shall be interfaced with respective LCP about their operations.

Lifting speed	Low High	0.9 MPN 3 MPN
L.T. speed C.T. speed		10 – 15 MPN 10 MPN (Max.)

However illumination lights to be operated by separate switch which will not be mounted on pendant.

Other Common specification:

Brakes All brakes are electro-hydraulic thrusters/ECM brake

Operation Through pendent push button

Gear box Precise machine cut hardened material gear noiseless operation long life

Cable All cables are insulated ISI Marked Power supply All 415:440 4 phase 50 Hz. AC supply Control voltage 220/230 volts-50 Hz

The hoist shall comply Class II with the performance requirement IS 3177/80, IS: 3938/IS: 3832 Class 2.

The electric hoist shall be fitted with right and left handed spiral grooved cast iron drum with a rope hoist arrangement with spring loaded rope band and guards to ensure accurate rope guidance and location.

Hoist rope shall be extra flexible, improved plog plough steel rope with well lubricated hemp core and having 6 strands 37 wires per strand with an ultimate tensile strength of 160/180 kg/sq.mm. The braking load for the hoist rope shall be as per IS: 2266.

Electromagnetic brake shall be provided to hold suspended load instantly, securely and automatically in the event of the electric current being cut off whether intentionally, accidentally or due to power failure.

The lifting hooks shall be single ‘C’ type complying with the requirement of IS: 15560 made from grade C30/C20 carbon steel. The hook shall have a safety latch to prevent rope coming off the hook.

5.5.3.8 Electrical System General and Particular Specifications

(A) General

The scope of work includes design, equipment selection, manufacture, inspection at Contractor's or his Sub-Contractor's works, supply, installation (including storing, unloading and transferring the material / equipment to Contractor’s storage area, maintaining equipment / material in safe custody and assembling the elements of the equipment and installing at the place of work), testing and commissioning of the plant equipment/ electrical system on ‘turnkey’ basis. After successful commissioning and trial run of the plant, it should be handed over to the Employer or their representative. The Contractor shall submit their design calculations/ drawings based on ‘Design criteria for electrical equipment/ system’ for Employer or their representative’s review and approval. These specification covers, 33kV switchboard, LV switchboards, LV energy efficient motors, LV soft starters, LV capacitors, HV, and LV power cables and control cables, DC supply system and other allied equipment, etc. along with the specifications for workmanship, laying cables, lighting system, earthing systems, lightning

protection etc. for this project. It shall be the responsibility of the Contractor to design the electrical system based on the selection of the mechanical equipment.

The Contractor shall make his own estimate of sizes, ratings and quantities for 33kV system, equipment, all plant items and miscellaneous systems such as earthing, lightning protection, lighting for SPS, STP and Master Control Centre etc. as required for Amanishah Nallah. However, facility for upgrade/ expansion of all equipment to cater any future requirements of load shall have to be considered during design-engineering stage.

All equipment offered shall comply with the requirements specified in the latest editions of applicable Indian/ International Standards and shall also comply with the good engineering practices.

Contractor shall design the electrical system on the basis of 'Design Criteria' and to be submitted for Employer or their representative's approval. Contractor shall incorporate any changes/ suggestions in the drawings to suit site conditions and design criteria and standard engineering practice and resubmit for approval to Employer or their representative.

Electrical installation work shall be carried out through agency having valid electrical license of appropriate class from the concerned statutory bodies governing the area of work place. The Contractor shall fully comply with the relevant statutory rules and regulations.

All type (as applicable), routine and acceptance tests shall be conducted in the presence of Employer's representative on all the equipment as per latest applicable IS/IEC at no extra cost. Typical type test reports for other equipment shall be submitted by the Contractor for approval by Employer or their representative.

All commissioning tests shall be carried out in the presence of Employer or their representative and approval for the same shall be obtained before commissioning and installation. All test reports shall be properly maintained by the Contractor duly approved by the statutory bodies and shall be handed over to the Employer or their representative after completion of the job. All instrument and accessories required for testing and commissioning of the equipment specified herein shall be provided by the Contractor at no extra cost to the Employer or their representative.

Liaison with JVVNL/RVPLN and other Government organization/ statutory bodies for obtaining Power supply/ other clearance shall be Contractor's scope. After completion of installation work, the Contractor shall arrange for inspection and obtain approval from the concerned statutory bodies. Any fees that are to be paid to such statutory bodies for testing, inspection or calibration shall be paid by the Contractor. Any modification / revision in the equipment / installation of equipment as required by the statutory bodies shall be carried out by the Contractor. All such costs / fees for revisions / modifications shall be deemed to be included in the prices of supply, installation, testing and commissioning of equipment as quoted by the Contractor.

- **Power Supply Information**

The proposed power supplies are as follows:

33 kV AC System	Voltage variation +10 to -5% Freq. Variation +5 to -3%	Three Phase, 50 Hz, effectively earthed AC System SC. Rating of 750 MVA
415V AC System	Voltage variation +10 to -10% Freq. Variation +5 to -5%	Three Phase and neutral, 50 Hz, effectively earthed system, SC. rating of 20 MVA

240V AC System	Voltage variation+10% to 10% Freq. Variation + 5% to - 5%	Single phase and neutral, 50 Hz, effectively earthed system
110V DC Supply	Voltage variation +/- 15%	Unearthed two wire system

All equipment shall have rated withstand capacity based on above criteria.

- **Design Criteria for Electrical Equipment/ System**

The Design Criteria described below covers the electrical equipment/ system for the proposed for Amanishah Nallah.

- General Power Distribution Scheme
- Estimation of Load

The following assumptions have been be made to arrive at the estimated load of the different sites.

a) Load Factor

i)	Motor	:	0.9
ii)	Auxiliary load, valve motors, etc.	:	0.9
iii)	Lighting load	:	1.0

b) Diversity Factor

i)	Motor	:	1.0
ii)	Auxiliary load, valve motors, etc.	:	1.5
iii)	Lighting load	:	1.2

c) Power factor of Motors : As per Manufacturer's Catalogue

d) Efficiency of Motors : IE 3 as per IS 12615

(Energy efficient, high performance motors shall be provided for optimum utilization of energy).

e) Protections

The following protections are proposed for various switchboards, transformers, motors and other plant feeders.

1) 32 kV Switchboard
   - i) IDMT over current and earth fault protection for incomers
   - ii) IDMT and instantaneous over current and earth fault protection for outgoing transformer feeders

2) LV switchboard
   - i) Over current, short circuit and earth fault protection on ACBs/ MCCBs

3) Motors
   - i) Overload protection by thermal (bimetal) relays in all the three phases to trip with single phase preventer (SPP) and short circuit protection in all the three phases through motor protection circuit breakers/ MCCBs Alternatively, microprocessor based motor protection relay shall also be used.
   - ii) Thermal, locked rotor, short circuit, negative sequence, under voltage, over voltage and earth fault for each motor feeder of rating 90kW and above.

f) Metering

The following metering shall be provided.

1) 33 kV Switchboard

Multifunction meter (for incomer) containing -

i) Ammeter
ii) Voltmeter
iii) kW meter
iv) Frequency meter
v) Power factor meter
vi) Kilowatthour meter
vii) kVAr meter
viii) kVA meter

For outgoing feeder

i) Ammeter with selector switch

2) LV Incomers

i) Ammeters with selector switch
ii) Voltmeter with selector switch
iii) kW meter
iv) Power factor meter
vi) Kilowatt-hour meter
vii) Frequency meter

3) LV Outgoing Feeders

i) Ammeter with ammeter selector switch

Multifunction meter shall be equipped with interfacing capability for RS-485 port.

g) Indicating Lamps

The following indication shall be provided:

1) 33kV Incomer, Bus Coupler and Outgoing feeders

i) Circuit breaker ON, OFF and TRIP, spring charged, control supply healthy and trip circuit healthy (Mains ON (R,Y,B) indication for incomer only)

2) LV Incomers

i) Mains ON (red, yellow and blue)

3) Motor Feeders

i) Motor ON, OFF and Trip indication (Red, green and Amber)
ii) Motor ON, OFF and Trip indication (Red, green and Amber), control supply healthy and trip circuit healthy for breaker feeder.
iii) Multifunction meter

All electrical equipment will be rated for 50^0 C design ambient temperatures.

All power cables shall be sized based on continuous current capacity, permissible voltage drop and short circuit current rating. The voltage drop shall be limited to 2.5 % at rated equipment current rating.

The other rating factors for variation in ground temperature, variation in ambient air temperature, grouping of cables, depth of laying, etc. shall also be considered

for cable sizing.

The illumination levels proposed for various areas are as follows:

Area	Illumination level (Lux)
Pump House	250
Office/Conference Room	400
Switchboard Room	250
All other indoor areas	150
Outdoor plant area and Road	10 – 20

Component of luminaries shall be 'energy efficient low loss' type. CFL/LED type of luminaries shall be used for office/ all indoor areas except pump house area. HPSV or HPMV luminaries shall be used for pump house area and other outdoor areas. Decorative fixtures/ receptacles shall be used for office areas and industrial type fixtures/ receptacles shall be used for remaining areas. Street/ area lighting shall be of LED type and controlled by time switch/ photocell for automatic switching of luminaries. Emergency light shall be provided for safe evacuation of the people in case of fire or panic (blackout, total power failure, etc.) Emergency lighting shall be automatically switched ON when mains power supply fails.

The values of fault level for designing the electrical system shall be based on transformer capacity, its impedance and system fault level. Fault clearing time for sizing of earth conductor will be taken as one second.

The material of earthing conductor shall be hot dip Galvanized Steel. All connections between the earth conductors buried in earth/concrete and between earth conductor and earth leads shall be of welded type. While sizing the buried earth conductor, a corrosion allowance of at least 20% shall be taken. Plant earthing system shall be designed such that the overall earthing grid resistance is maximum one ohm.

Main earthing conductors outside and inside the building shall be planned in such a manner that various equipment is connected to earthing system by two connections in a reliable manner.

- **System Description**

  - ✓ ***Electrical System***

    Each STP with 33 kV power sub-station shall be constructed and power shall be feed to each SPS located near the STP's. The 33kV supply shall be made available by RVPNL/JVVNL but Contractor has to get verified the available system voltage from RVPNL/JVVNL prior to commencement of works.

    The 33 kV switchboard shall feed two nos. of 33/0.433 kV transformers with on -load tap changer (OLTC), which in turn to feed the 0.433 kV indoor switchboard. 100% redundant transformer shall be provided to feed the entire load of the STP& SPS. The 33kV indoor switchboard shall consist of two incomer VCBs (with line VTs), a bus coupler VCB and VTs on both the bus sections along with two nos of outgoing VCB feeders.

    A 415 V PCC shall receive power from two nos of 33KV/0.433 kV transformers and to feed the individual loads through different switchboards located at different locations and sufficient space for installation of these switchboards should be made available at site.

    LV capacitor banks with control panel consisting of automatic power factor correction (APFC) relay are to be proposed across each LV bus section of the LV switchboards.

    Necessary metering, protection and indication/ annunciation are to be

provided on all the switchboards.

✓ ***Units of Measurement***

Metric units of measurement (System International) shall be used in all Contract documentation. Angular measurement shall be in degrees with 90 degrees comprising one right angle.

✓ ***Reference Standards***

All equipment / systems supplied under this Contract shall conform to the latest editions of the International Electro-technical Commission (IEC) Standards or equivalent Indian Standards or other International Standards, provided they promise to confirm equal or superior performance. If standards other than IEC are referred, then the Contractor shall enclose English Version of the standard with the bid.

✓ ***Inspection and Testing at Manufacturer's Works and Dispatch***

The Contractor shall follow the approved QA/QC Plan for the Inspection and Testing of Equipment at Manufacturer's Works and Dispatch.

✓ ***Construction Power Supply***

Contractor shall make his own arrangements for construction power supply from JVVNL authorities. However, upon request of the Contractor, if Employer or their representative agrees to provide the construction power supply then it is the responsibility of the Contractor to connect his equipment at the point of supply and pay the requisite charges / fees to the Employer or their representative as per the prevalent rates of JVVNL.

All power and lighting circuits shall be constructed with due regard for personnel safety and shall comply with recognized codes of practice and local regulations. All circuits shall be fitted with earth leakage systems.

Power Transformers

✓ ***Standards***

Transformers and its accessories shall comply with the following International Standards, including those referred to therein.

IEC 60076, 60214, 60296 / IS 2026, IS 335 / BS 148, 171

The technical parameters of transformers shall be as below:

Description	**Unit**	**Particulars**
General		
Quantity required		2 nos at each STP or load centre
Installation (Indoor / Outdoor)		Outdoor
Ratings		
Rated power		
(*) Contractor shall submit their design calculation for rating of each equipment for Employer or their representative for approval.	kVA	
No load voltage Primary	kV	33
Secondary	kV	0.433
Number of phases		3
Rated frequency	Hz	50
Impedance voltage	%	As per IEC/BIS

Description	**Unit**	**Particulars**
Vector group		Dyn11
Winding material		Electric Grade Copper
Type of cooling		ONAN
System Voltage		
Nominal system voltage Primary	kV	33
Secondary	kV	0.415
Highest system voltage - Primary	kV	36
Secondary	kV	
Transformer Secondary Neutral Earthing		Effectively earthed
Insulation Withstand		
Rated lightning impulse withstand voltage	kV (peak)	170
- Secondary	kV rms)	3.5
Temperature Rise		
Reference design ambient	^{0}C	50
Temperature rise over design ambient temperature of 50 ^{0}C		
- Average winding temperature rise (by resistance measurement)	^{0}C	55
- Top oil temperature rise (by thermometer)	^{0}C	50
Tap Changing Gear		
Type of tap changer		OLTC
Tapping range	%	$\pm$ 10%
Tapping steps	%	1.5
Bushings		
Rated voltage – Primary	kV	36
– Secondary	kV	1.1
One minute power frequency withstand voltage (dry and wet) – Primary	kV (rms)	70
- Secondary (Line and Neutral)	kV (rms)	2.5
Rated lightning impulse withstand voltage	kV (peak)	170
Nominal creepage distance	mm/kV	31
Terminal Connections		
Primary line end		Cable box
Secondary line end		Cable box/Bus Duct
Secondary neutral end		One bushing each inside and outside cable box
Type of wheels		Plain – Bi-directional

(*) Values to be ascertained by the Contractor after Submitting design calculations subject to approval.

- ✓ ***Design Features***

Transformers will be located outdoor and shall also be rated for satisfactory

operation at 50^0C design ambient temperature.

- ✓ ***Accessories and Fittings***

Each main power transformer shall have the following fittings and accessories including but not limited to:

a) A conservator of sufficient volume with
   i. oil level gauge with potential free contacts for initiating alarm for low oil level
   ii. weather-proof dehydrating breathers for both compartments with activated alumina or silica gel as the dehydrating breather
   iii. shut off valves
   iv. filling plug and drain valves

   The conservator shall be designed to maintain an oil seal upto a temperature of 100^0 C.

b) Gas and oil actuated Buchholz relay with
   i. necessary shut off valves
   ii. test cock with pipe connections for sampling
   iii. potential free contacts for initiation of alarm in case of slow gas formation and trip in case of fast oil and gas surges

c) Dial type thermometer with
   i. maximum temperature indicator and its resetting device
   ii. potential free contacts for initiating alarm on high temperature and trip on very high temperature

d) Winding temperature indicator with
   i. necessary sensing, compensating and calibrating devices
   ii. potential free contacts for initiating alarm on high temperature and trip on very high temperature
   iii. WTI transmitter for remote indication on remote tap changing panel

f) Detachable type of radiators including but not limited to:
   i. Shut-off valves and blanking plates on transformer tank at each point of connection of inlet and outlet header
   ii. Top and bottom shut-off valves and blanking plate on each radiator
   iii. Lifting lugs
   iv. Top oil filling plug, 19 mm size
   v. Air release plug at top
   vi. Oil drain plug at bottom, 19 mm size
   vii. Earthing terminals

g) Pressure relief device for transformer tank

h) Weather - proof marshaling box mounted on transformer tank

i) Name plate, rating plate and Diagram plate

j) Valves and plugs as below:
   i. Drain valve
   ii. Filter valve
   iii. Oil sampling valves at top and bottom

iv. Valves between radiators and tank (in case of detachable radiators)
v. Air release plug
vi. Twin outlets (with plug) for applying vacuum with attachments.

k) Earthing pads of copper or non-corrodible material for transformer tank (2 places) and radiator banks
l) Inspection manholes as required

m) Lifting arrangement for
i. fully assembled transformer
ii. core and coil
iii. tank
n) Hauling eyes on each face of the transformer

o) Bi-directional flanged wheels
p) Anti-earthquake clamping devices
q) Jacking pads
r) Adequate number of air vents for relieving trapped air during oil filling and during maintenance.
s) Accessories for clamping the wheel to the foundation channel in order to withstand earthquake forces.

✓ ***Windings***

The windings shall be of electrical grade copper.

Materials used in insulation and assembly shall be insoluble, non-catalytic and chemically inactive in the hot transformer oil and shall not soften or otherwise be affected under operating conditions. Windings and insulation shall be so arranged that free circulation of oil is possible between coils, between windings, and between winding and core.

Leads from winding to the terminal board and bushings shall be rigidly supported to prevent injury from vibration. Guide tubes shall be used where practicable.

Windings shall be subjected to shrinking and seasoning processes so that no further shrinkage occurs during service. Adjustable devices shall be provided to take up possible shrinkage in service. High voltage end - windings shall be suitably braced to withstand short circuit stresses.

✓ ***Core***

The magnetic circuit shall be constructed from high grade, cold rolled, non-ageing, grain oriented silicon steel laminations. Each sheet shall have an insulating coating resistant to the action of hot oil. Each lamination shall be coated with insulation which is unaffected by the temperature attained by the transformer during service.

The insulation structure for the core to bolts and core to clamp plates shall be such as to withstand appropriate dielectric test. All steel sections used for supporting the core shall be thoroughly shot or sand blasted after cutting, drilling and welding. Core laminations shall be annealed and burrs removed after cutting. Cut edges shall be insulated. The framework and clamping arrangements of core and coil shall be securely earthed inside the tank by a copper strap connected to the tank. The core clamping structure shall be designed to minimize eddy current loss. The core shall be provided with lugs suitable for lifting the complete core and coil assembly. The framework and clamping arrangements shall be securely earthed.

The core and coil assembly shall be dried out and impregnated under vacuum.

- ✓ ***Tank***

The transformer tank shall be made from high-grade sheet steel, suitably reinforced by stiffeners made of structural steel sections. All seams, flanges, lifting lugs, braces, and other parts attached to the tank shall be welded. The interior of the tank shall be cleaned by shot blasting and painted with two coats of heat resistant, oil insoluble paint. Adequately sized manholes shall be provided for ease of inspection and maintenance. Steel bolts and nuts exposed to atmosphere, shall be galvanized.

Tank together with radiators, conservator, bushings and other fittings shall be designed to withstand without permanent distortion the following conditions:

a) Full vacuum of 760 mm of Hg for filling with oil under vacuum

b) Internal gas pressure of 0.35 kg/cm² with oil at operating level

Tank shall be provided with a pressure release device, which shall operate at a pressure below the test pressure for the tank and radiators. The device shall be provided with a device visible from ground to indicate operation. An equalizer pipe connecting the pressure relief device to the conservator shall be supplied. The device shall be provided with potential free contacts for alarm and tripping. Alternatively, a separate pressure relay shall be provided for this purpose.

The tank cover shall be bolted type and not welded, sealed type. The tank cover shall be removable and shall be suitably sloped so that it does not retain rainwater.

- ✓ ***Radiators***

Radiators shall be designed to withstand the vacuum pressure conditions specified for the tank. They shall be so designed as to completely drain oil into the soak pit and to prevent formation of gas pockets when the tank is being filled.

Transformers of rating above 1500 kVA shall be equipped with detachable or separately mounted radiator banks. Radiators for the main transformers shall be with bolted and gasket flange connections. Transformers of rating 1500 kVA and below shall be provided with fixed type radiators. Fins of the radiators shall not have sharp edges and shall be rounded in shape.

When transformers are provided with separately mounted radiators, flexible joints shall be provided on the main oil pipes connecting the transformer tank to the radiator banks, to reduce vibration and facilitate erection and dismantling. The interconnecting pipes shall be provided with drain plug and air release vents.

On Load tape changer

On Load tap changer shall be provided for auxiliary transformers. It shall comprise

a) Operating handle or wheel accessible from ground level

b) Tap position indicator

c) Padlocking arrangement with padlock.

- ✓ ***Marshalling Box***

The marshalling box shall be tank mounted, weather proof, vermin proof, dust proof, sheet steel (2 mm thick), enclosed and with hinged door having padlock. Door and gland plate shall be fitted with neoprene gaskets. Bottom shall be at

least 600 mm from grade level. Top surface shall be sloped. The degree of protection shall be IP65.

Contacts / terminals of electrical devices / relays, etc. mounted on the transformer shall be wired to the marshalling box. Interconnecting wires between the marshalling box and the accessories / devices shall be either PVC insulated wires in GI conduits or PVC insulated, armoured cables together with provision of double compression type, brass cable glands at the marshalling box. The above mentioned cables as well as terminating the cables shall be the Contractor's responsibility.

All contacts for alarm, trip and indication circuits shall each be electrically free, designed for the auxiliary DC supply of 110 V and brought out to separate terminals in the marshalling box. Terminals shall be rated for 10 A. Disconnecting / shorting type terminal block shall be used for CT circuits.

Provision for remote annunciation shall be provided with two changeover contacts for alarm condition and two changeover contacts for trip condition for each of the following conditions including but not limited to:

- Buchholz alarm
- Buchholz Trip
- Oil Temperature high
- Oil Temperature very high
- Oil level low
- Pressure relief device operated
- Winding temperature high
- Winding temperature very high
- Conservator oil level low

✓ ***Cable Terminations***

Cable boxes shall have sufficient space for segregating the cable cores and for adequate clearance in air between bare conductors at the terminals. Cable boxes shall be complete with necessary glands, lugs and armour grips.

Air filled cable boxes shall be of adequate dimensions and designed in such a manner that they can be opened for inspection without disturbing the gland plate or incoming cable. Disconnecting chamber shall be provided for disconnecting and moving away the main transformer, without removing the cables or the cable box. Provision shall be made for earthing the body of each cable box.

✓ ***Tests***

All tests required by the specification including repeated tests and inspection that may be necessary owing to the failure to meet any tests specified, shall be carried out at the Contractor's expense.

The following tests shall be carried out on the assembled transformer during inspection at the manufacturer’s works.

- Temperature rise test on one transformer
- Measurement of resistance of windings at principal and extreme taps
- Ratio at each tap, polarity and phase relationships
- Measurement of impedance voltage at principal and extreme taps
- Measurement of no load current and no load losses at rated frequency and at both the rated voltage and 110 % rated voltage

- Measurement of efficiency and regulation at ½, ¾ and full load
- Measurement of insulation resistance
- Induced over voltage withstand test
- Separate source voltage withstand test
- Magnetic balance test
- Test on OLTC

Type test certificates shall be provided for verification. Whenever two nos. or more identical transformers are being offered, type tests on one of them shall be carried out, including heat run test.

All auxiliaries and accessories such as temperature indicators, Buchholz and pressure relays shall be tested as per the applicable standards and test certificates shall be furnished to the Employer's Representative for approval.

✓ ***Rejection***

The Employer may reject the transformer if anyone of the following conditions arises during testing:

a) Any of the quantities / parameters of transformers subject to tolerances are outside the tolerances given in the applicable standards or such tolerance as guaranteed in the Contractor's bid.

b) Winding and / or top oil temperature rise exceeds the specified / guaranteed value; and

c) Transformer fails to withstand any of the dielectric tests.

Additional tests shall be conducted to locate the failure and after rectification, all tests shall be repeated to prove that the rebuilt transformer meets the specification in all respects, all at the Contractor's expense.

Employer reserves the right to have the transformer replaced or repaired by the Contractor within reasonable period to Employer's satisfaction at no extra cost to the Employer. The Contractor shall also bear the costs, including but not limited to, incurred by the Employer in re-inspection / re-testing such as travel and incidental expense, etc. The Contractor shall note that any delay in completion time due to such repair / replacement shall be subject to liquidated damages as specified in the Conditions of Contract.

HV Indoor Switchboard

HV switchboard shall comply with the following Standards, including those referred to therein.

IEC 60044, 60186, 60255, 60265, 60282, 60298, 60466, 60529, 60694, 60787, 62271 IEC/TR2 61211 and IS 9046, 9920, 9921, 13118, 3427, 4237, 2156, 2705, 3156, 10118, 722, 13118.

The technical parameters of HV switchboards shall be as below:

✓ ***HV switchboard***

Description	**Unit**	**Particulars**
General		
Type		Metal enclosed, compartmentalized, draw-out type
Rated voltage, no. of	kV / - /	33 kV, 3 Phase, 50Hz

Description	**Unit**	**Particulars**
phases and rated frequency	Hz	
System neutral earthing		Effectively Earthed
Rated Insulation Levels		
- Rated short duration power frequency withstand voltage	kV (rms)	70
- Rated lightning impulse withstand voltage	kV (peak)	170
Rated normal current of bus bars under design ambient temperature of 50^0C and material of busbar	A / -	(*), Copper - suitable for 100% load including future loads
Rated short-time withstand current and time	kA (rms) / sec	16 kA for 1 sec
Dynamic rating	kA (peak)	40
Constructional Requirements		
Minimum thickness of sheet steel in mm Cold rolled (Frame/Enclosure/ Covers)	mm	Frame – 2.5 Doors/Covers – 2.0
Degree of protection of enclosure		IP-5X
Color finish shade		
- Interior		Glossy White
- Exterior		Light Grey Semi Glossy
Cable connection		Bottom entry and exit
Circuit Breakers		
Type		Vacuum/ SF6
Rated current inside the cubicle under design ambient temperature at 50°C	A	(*) – (Breakers shall be rated for final ratings of motors in STP)
Rated operating sequence		O–3 Min–CO-3 Min-CO
Rated short time breaking current	kA (rms)	16
Rated short time making current	kA (peak)	40
Rated short-time withstand current and time	kA (rms) / sec	16 kA for 1 sec
Rated peak withstand current	kA (peak)	40
Min. no. of auxiliary contacts		6 NO + 6 NC after internal use by manufacturer
Type of operating mechanism		
- Normal		Spring charging for closing and tripping
- Emergency		Manual and Spring charged for closing and tripping
Auxiliary control voltage		

Description	**Unit**	**Particulars**
- Closing coil / Tripping coil	V	110V DC
- Spring charging motor	V	110V DC
- Space heater and lighting	V	230V AC
Earthing switch		Required
Current and Voltage Transformers		
Details of ratio, taps, burden, accuracy		As per Single Line Diagram (*)
Protective Relays		
Type		Numerical (Microprocessor based)
Auxiliary supply	V	110V DC
Details of protective relays		As per Single Line Diagram
Switch-Disconnector		
Rated current under design ambient temperature of 50°C	A	(*)
Rated making current	kA (peak)	40
Rated peak withstand capacity	kA (peak)	40
Rated short-time withstand current and time	kA (rms) / sec	16 kA for 1 sec
Insulation levels		
Rated lightning impulse withstand voltage		
- Across the isolating distance	kV (peak)	70
- Phase to phase, between phases and across open switching devices	kV (peak)	60
Rated short duration power frequency withstand voltage		
- Across the isolating distance	kV(rms)	23
- Phase to phase, between phases and across open switching devices	kV(rms)	20
Operating mechanism		
- Closing and opening		Spring charged
- Control voltage	V	110V DC
Earthing switch		Required
HV Fuses		
Application		Indoor
Type		HRC
Rated current	A	(*)
Rated voltage	kV	36
Rated breaking capacity	kA (rms)	16

(*) Value to be ascertained by the Contractor after submitting design calculations subject to approval.

✓ ***Circuit Breaker***

Circuit breakers shall preferably vacuum type. Circuit breaker along with its operating mechanism shall be mounted on a wheeled carriage moving on guides, designed to align correctly and allow easy movement. Plugs and sockets for power circuits shall be silver faced and shall be insulated with suitable insulating material shrouds. All corresponding components of circuit breaker cubicles of same rating shall be interchangeable with one another.

There shall be 'Service', 'Test' 'Fully withdrawn' positions for the breakers. In the 'Test' position the circuit breaker shall be capable of being tested for operation without energizing the power circuits, i.e. the control circuits shall remain undisturbed while the power contacts shall remain disconnected. Separate limit switches, each having a minimum of 2 'NO' + 2 'NC' contacts, shall be provided for both 'Service' and 'Test' positions of the circuit breakers for future SCADA.

Electrical tripping shall be performed by shunt trip coils. "Local / Remote" selector switch lockable in "Local" position shall be provided on the cubicle door. `Red' and `Green' indicating lamps shall be provided on cubicle door to indicate breaker close and open positions. Breaker "Service" and "Test" positions shall be indicated by separate indicating lamps on the cubicle door, in case mechanical indication of "Service" and "Test" positions are not available on the cubicle door.

Connection of the control / interlocking circuits between the fixed portion of the cubicle and the breaker carriage shall be preferably by means of plug socket arrangement.

✓ ***Operating Mechanism Control***

- Circuit breakers shall be operated by a motor spring charging type of mechanism. The mechanism shall be complete with motor, opening spring, closing spring and all accessories to make the mechanism a complete operating unit
- Operating mechanism shall normally be operated from the breaker cubicle itself.
- The tripping spring shall be charged by the closing action, to enable quick tripping. Closing of the circuit breaker shall automatically initiate recharging of the springs to enable the mechanism to be ready for the next closing stroke. Charging time for the springs shall not exceed 30 seconds. It shall be possible to manually charge the springs in an emergency. Transfer from motor to manual charging shall automatically disconnect the charging motor. All operating mechanisms shall be provided with "ON" - "OFF" mechanical indication. The charging mechanism shall be provided with mechanical indicators to show "charged" and "discharged" conditions of the spring. Failure of any spring, vibration or mechanical shock shall not cause tripping or closing of the circuit breaker.
- Only one closing operation of the circuit breaker shall result from each closing impulse (manual or electrical), even if the breaker trips while the control device (manual or electrical) is being held in the "close" position.
- The circuit breaker mechanism shall make one complete closing operation, once the push button (PB) or control switch has been operated and the first device in the control scheme has responded, even though the PB or control switch is released before the closing operation is complete, subject to the condition that there is no counter- impulse for tripping.

- Means shall be provided to manually open and close the breakers slowly, when the operating power is not available, for maintenance and adjustments. A local manual trip device shall also be provided on the operating mechanism.
- Circuit breaker control shall be on 110 V DC. Closing coils and other auxiliary devices shall operate satisfactorily at all voltages between 85-110 % of the control voltage. Trip coils shall operate satisfactorily between 70 - 110 % the rated control voltage.
- Provision for remote control shall be provided for future SCADA.

✓ ***Safety Interlocks and Features***

- Withdrawal or engagement of a circuit breaker / switch disconnector shall not be possible unless it is in the open position.
- Operation of a circuit breaker / switch disconnector shall not be possible unless it is in service position, withdrawn to test position or fully drawn out. It shall not be possible to close the circuit breaker electrically in the service position, without completing the auxiliary circuit between the fixed and moving portions.
- Circuit breaker / switch disconnector cubicles shall be provided with safety shutters operated automatically by the movement of the circuit breaker / switch disconnector carriage to cover the stationary isolated contacts when the breaker / switch disconnector is withdrawn. Padlocking facilities shall be provided for locking the shutters positively in the closed position. It shall, however, be possible to open the shutters intentionally against spring pressure for testing purposes.
- The circuit breaker / switch disconnector carriage shall be earthed before the circuit breaker / switch disconnector reaches the test position from fully withdrawn position. In case of breakers / switch disconnector with automatic disconnecting type of auxiliary disconnects, the carriage shall be earthed before the auxiliary disconnects are made and the carriage earthing shall break only after the auxiliary disconnects break.
- Caution nameplate, “Caution Live Terminals” shall be provided at all points where the terminals are likely to remain live and isolation is possible only at remote end, i.e. incomer to the switchboard. Suitable interlock shall be wired for the purpose.

✓ ***Current and Voltage Transformers***

CTs and VTs shall have polarity marks indelibly marked on each transformer and at the associated terminal block. Facility shall be provided for short-circuiting and earthing the CT secondary at the terminal blocks.

CT shall be able to withstand the thermal and mechanical stresses resulting from the maximum short circuit current. Core laminations shall be of high grade silicon steel.

VTs shall be of the single phase type and mounted on a draw out trolley. VTs shall be protected on their primary and secondary sides by current limiting fuses with interrupting ratings corresponding to breaker rating. It shall be possible to replace the secondary fuses safely when the switchboard is energized. Alternatively, MCB having auxiliary contact shall be provided. Primary side fuses shall be replaceable only in the de-energized position.

Secondary winding of voltage transformer (VT) shall be rated for a three phase line to line voltage of 110 V.

Identification labels giving type, ratio, output and serial numbers shall be provided for CTs and VTs.

✓ ***Relays***

Protection relays shall be Numerical (microprocessor based) type. Relays shall have interfacing facilities to communicate data to SCADA system.

All relays shall be enclosed in rectangular shaped, dustproof cases and shall be suitable for flush mounting.

All relays shall be accessible from the front for setting and resetting. Access to setting devices shall be possible only after the front covers of the relays are removed.

All protective relays shall be of the draw-out type and shall be provided with operation indicators visible from the front.

✓ ***Over Current / Earth Fault Protection***

- This relay shall be of the multi-characteristics type which has a flexible mode selection facility so that it is possible to select one mode for the over current elements and another for the earth fault element.
- Phase current range shall cover at least 50-300% of 'In' in steps of not more than 10% while the earth current range shall cover at least 5-100% of 'In' in steps of not more than 5%.
- The time setting range of the definite time mode shall not be less than 5 seconds in steps of 0.1 second each.
- The time multiplier setting for the inverse time-current characteristic modes shall have a range not less than 0.05- 1.6 in steps of 0.05.
- Over current and earth fault relays shall have separate timers and operation indicators.
- The high set element shall have a range of 2 - 15 times the nominal current in steps of 'In' and shall be of low transient overreach, with a tripping time of less than 25 ms and possible to be selected on "blocked" position. Reset time shall be not more than 50 ms for both elements.
- The relays that are installed on the transformer neutral side shall be of single phase version, but they shall have the same characteristics as the phase side relays.

✓ ***Restricted Earth Fault Protection***

- The restricted earth fault relay shall be operated from a completely separate core of line and neutral current transformers. The dedicated CTs shall be of class PS and have the same magnetization characteristics with a knee 'emf' value higher than the highest possible setting of the relay. Intermediate CTs for ratio correction are not acceptable. CT sizing shall be matched with the requirements of the relay.
- For this protection, 1-phase high impedance relay shall be provided and all the aspects regarding stability of the protection, dimensioning of current transformer, considering the peak short circuit current, etc. and all the auxiliary equipment such as non-linear VDR resistor for voltage limiting, filter for harmonics and DC component suppression and variable shunt resistor for sensitivity adjustment, if required, shall be provided. The total fault clearing time shall not exceed 20 m sec. at 3 x In.
- The stability of this protection against out-zone faults shall be confirmed. A calculation to show the proper selection of the relay up to the maximum

short circuit of the switchboard shall be submitted.

- ✓ ***Under Voltage Relays***
  - Suitable voltage operated relays for sensing loss of voltage shall be provided. The relay shall have a drop off to pick up ratio of the order 90%. The relays shall be fast operating type and shall be fitted with operation indication. The indication shall come on drop off or loss of voltage.
  - Additional potential free contacts for all the relay outputs i.e. trip as well as alarm signals shall be provided for connection to future SCADA.
- ✓ ***Motor Protection Relay***
  - It shall be designed to protect the motor against thermal overload, locked rotor, over current and earth fault protection, under voltage, over voltage, phase reversal and negative sequence.
  - Thermal setting range shall cover at least 50% to 200% of 'In' in steps of not more than 5 % of 'In'.
  - Phase current range shall cover at least 5-200% of 'In' in steps of not more than 1% while the earth current range shall cover at least 1-100% of 'In' in steps of not more than 5%.
- ✓ ***Auxiliary Relays and Timers***
  - Following auxiliary relays shall be provided on each breaker cubicle:
    i. Trip circuit supervision relay
    ii. Anti- pumping relay
  - Hand reset type lockout (tripping) relays and timers shall be provided as required in addition to the protection relays given in the single line diagram.
  - Auxiliary relays and timers shall be rated to operate satisfactorily between 70 % and 110 % of the rated voltage.
  - Voltage operated relays with sufficient contacts to initiate tripping, alarm, annunciation for various trip functions like Buchholz relay operation. Each relay shall have four (4) pairs of self-reset contacts except for Buchholz and "PRD" trip which shall have hand-reset contact. The relays shall have hand-reset operation indicators.
  - Voltage operated relays with sufficient contacts to initiate alarm and data logging for various alarm functions for transformers, etc. shall be provided. Each relay shall have four (4) normally open self reset contacts. The auxiliary relay for Buchholz alarm shall be slugged to have delay on drop off at 100 ms. The relays shall have hand reset operation indicator.
- ✓ ***Switch Disconnectors and Fuses***

  Switch disconnectors when switched, shall be of the load break, fault make, grouping operated type. For use on 3-phase systems, the switches shall be of the triple pole type with a link for neutral connection.

  Switch disconnectors shall be of the heavy duty, quick make and quick break type. It shall be electrically and manually operated. Their contacts shall be silver plated, and contact springs shall be of stainless steel. Their handles shall have provision for locking in both fully open and fully closed positions. Mechanical 'ON-OFF' indication shall be provided.

  For combination units of switch disconnector and fuses, the following interlocks shall be incorporated:

- The fuses should not be accessible unless the switch disconnector is in fully open condition.
- It should not be possible to close the switch disconnector when the fuse cover is open, but an authorized person may override the interlock and operate the switch disconnector. After such an operation, the cover shall be prevented from closing if the switch disconnector is left in the "ON" position.

All fuses shall be of the HRC cartridge type in accordance with IEC 60269 mounted on plug-in type of fuse bases. Fuses shall be provided with visible indicators to show that they have operated. Current vs. time characteristics of all types of fuses shall be furnished to the Employer or their representative.

Fuses and links functionally associated with the same circuit shall be mounted side by side.

An adequate number of spare fuse cartridges of each rating shall be supplied and fitted in clips inside the panel.

✓ ***Constructional Features of Switchboard***

Switchboard design shall comprise metal enclosed, fully compartmental and draw out execution having separate sections for each circuit. Compartments with doors for access to operating mechanism shall be so arranged as not to expose high Voltage circuits. Switchboard cubicle shall be provided with hinged door on the front with facility for locking door handle.

Switchboard shall be dust and vermin-proof and shall have a degree of protection of enclosure of IP 4X.

All removable covers shall be gasketed all around with neoprene or superior gaskets.

Instruments, relays and control devices shall be flush-mounted on hinged door of the metering compartment located in the front portion of cubicle. The metering compartment shall be properly shielded to prevent mal-operation of electronic equipment such as numerical / static relays due to electro-magnetic fields. Separate signal earth shall be provided for such devices, if necessary.

Each switchboard cubicle shall be fitted with a label on the front and rear of the cubicle. Each switchboard shall also be fitted with label indicating the switchboard designation, rating and duty. Each relay, instrument, switch, fuse and other devices shall be provided with separate label.

Sheet steel used for fabrication of switchboards, control cabinets, marshalling boxes, etc shall be cold rolled.

All panels, cabinets, kiosks and boards shall comprise rigid welded structural frames made of structural steel sections or of pressed and formed cold rolled sheet steel of thickness not less than 2 mm. The frames shall be enclosed by sheet steel of at least 2 mm thickness. Stiffeners shall be provided wherever necessary.

All doors, removable covers, gland plates, etc. shall be of at least 2 mm thickness and shall be gasketed all round the perimeter.

All doors shall be supported by strong hinges of the disappearing or internal type and braced in such a manner as to ensure freedom from sagging, bending and general distortion of panel or hinged parts.

All floor mounted panels / boards shall be provided with a channel base frame.

It shall be possible to extend the switchboard on both sides.

The fully draw-out modules shall have all the circuit components mounted on

withdrawable type steel chassis. All power and control connections shall be of the draw out type. It shall be possible to withdraw the chassis mounted circuit components without disconnecting any connections. All draw-out contacts shall be of silver plated copper.

In case of circuit breaker compartments, suitable barriers shall be provided between breaker and all control, protective and indication circuit equipment including instrument transformers such that no live parts are accessible. External cable connections shall be through separate cable compartments for power and control cables.

One metal sheet shall be provided between two adjacent vertical sections running to the full height of the switchboard except for the horizontal bus bar compartment. However, each shipping section shall have metal sheets at both ends.

After isolation of the power and control connections of a circuit, it shall be possible to carry out maintenance in a compartment safely, with the bus bars and adjacent circuits alive.

- ✓ ***Earthing***

A copper earthing bus shall be provided and extended throughout the length of the switchboard. It shall be bolted to the framework of each unit and brazed to each breaker earthing contact bar. It shall be located at the bottom of the board.

The earth bus shall have sufficient cross section to carry the momentary short circuit and short time fault current for at least 1 second or higher as specified, without exceeding maximum allowable temperature rise. The earth bus shall be properly supported to withstand stresses induced by the momentary short circuit current.

Suitable clamp type terminals at each end of the earth bus shall be provided to suit the size of the earthing conductors.

Bolted joints, slices, tap, etc. to the earth bus shall be made with at least two bolts.

Positive earthing of circuit breaker frame shall be maintained when it is in the connected position and in all other positions whilst the auxiliary circuits are not totally disconnected.

Hinged doors shall be earthed through flexible earthing braid of adequate cross section. All non-current carrying metal work of the switchboard shall be effectively bonded to the earth bus. Positive connection of the frames of all the equipment mounted in the switchboard to the earth busbar shall be maintained through insulated conductors of size equal to the earth bus bar or the load current carrying conductor, whichever is smaller.

All instrument and relay cases shall be connected to earth bus bar by means of 1100V grade, green colored, PVC insulated, stranded, tinned copper, 2.5 sq. mm conductor looped through each of the earth terminals.

- ✓ ***Circuit / Bus bar Earthing Facility***

It shall be possible to connect each circuit or set of 3 phase bus bars of the switchboard to earth through earthing switches.

Earthing switches / earthing devices shall be mechanically interlocked with the associated breakers / switch disconnector to prevent accidental earthing of live circuit or bus bars.

In case the earthing facility comprises earthing trucks to be inserted in place of

circuit breakers, separate earthing trucks shall be supplied for each type / size of breaker.

The earthing facilities proposed to be provided by the Contractor shall be clearly detailed in the Bid and shall be subject to Employer or their representative's approval.

Auxiliary contacts (min. 2 NO + 2 NC) shall be provided on each earth switch / earthing device and shall be wired to the terminal block for interlocking purpose.

- ✓ ***Annunciators***

Annunciators shall be of facia type with translucent plastic window for each alarm point. Annunciator facia plates shall be engraved in block lettering with respective alarm inscriptions. The inscriptions shall be clearly readable and visible when the respective facia light is lighted.

Each annunciation window shall be provided with two lamps to provide redundancy against lamp failure. Lamps shall be replaceable from the front. Lamps shall be of clustered LED type.

All facia annunciator points shall be suitable to accept external contacts of either 'NO' or 'NC' self or hand reset type for initiating the annunciation sequence. Annunciators shall be suitable for accepting fleeting faults of duration as less as 15 millisecond.

For static annunciator schemes, special precaution shall be taken by the Contractor to ensure that spurious alarm conditions do not appear due to influence of external magnetic fields on the annunciator wiring and switching disturbances from the neighboring circuits within the panels / desks.

A "Lamp Test" push button shall be provided for each individual panel's group of annunciators to limit the sudden drain on the battery.

Provision of testing facilities for flasher and audible alarm circuits of annunciators is desirable. The Contractor shall give the details of the offered scheme.

Annunciators shall have following features:

- Suitable for annunciating subsequent faults immediately after the sound cancel of the previous fault.
- During lamp test, if a fault occurs, the corresponding lamp circuit shall be automatically disconnected from the "lamp test" circuit and shall start flashing.
- Designed to prevent mal-operation of the scheme or sequence when the push buttons are pressed incorrectly or in the wrong order.
- "Alarm Supply Failure" Alarm scheme similar to the normal annunciation sequence, but shall operate on a different DC supply or on AC auxiliary supply.

- ✓ ***Instruments***

All electrical instruments and meters shall comply with IEC 60051, 61010 and IS 722, 1248.

All indicating and recording instruments shall be flush mounted in dust proof cases complying with IEC 60068 and dimensions to IEC 61554. All digital instruments shall have interface facilities to communicate data to SCADA system.

✓ ***Indicating Instruments***

- Electrical indicating instruments shall be 96 or 110 mm square with 2400 scale. Taut band type of instruments is preferred. Taut band moving coil instruments for use on AC systems shall incorporate built-in transducers.
- Instrument dials shall be white with black numbers and lettering. A red line shall be drawn on each scale to represent rated conditions.
- Normal maximum meter reading shall be of the order of 60 % normal full scale deflection. Ammeters for motor feeders shall have suppressed scale to show current from full load up to six times the full load current.
- Instruments shall have accuracy class of 1.0 or better. The design of the scales shall be such that it can read to a resolution corresponding to 50% of the accuracy class index.
- Ammeters and current coils of Watt meters and Voltmeters shall continuously withstand 120% of rated current and 10 times the rated current for 0.5 sec., without loss of accuracy. Voltmeters and potential coils of Watt meters and Varmeters shall withstand 120% of rated voltage continuously and twice the rated voltage for 0.5 sec. without loss of accuracy.
- Alternatively, instruments can be electronic / digital type with LCD display. These instruments should have high performance ratio and can be equipped with digital output (for alarms) or with interfacing facilities for communication and remote reading of parameters in SCADA.

✓ ***Metering instruments***

A multi function meter with suitable communication port to interface with SCADA. These instruments should have high performance ratio and can be equipped with output for alarms.

✓ ***Control and Selector Switches***

Control and instrument switches shall be rotary type, provided with escutcheon plates clearly marked to show operating position and suitable for semi-flush mounting with only the switch front plate and operating handle projecting out. The connections shall be from the back. The contact assembly at the back of the switch shall be enclosed in dust tight removable covers.

The control switches shall be 3 position, spring return to neutral type. They shall be provided with contacts to close in ‘normal after close’ and ‘normal after trip’ position. Each switch shall have external red and green indicating lamps, (except when discrepancy type switches are called for). In addition, a semaphore indicator shall be provided for earthing switch.

Contacts of the switches shall be spring assisted and contact faces shall be of silver / silver alloy. Springs shall not be used as current carrying parts. Contact rating and configurations of the switches shall be adequate for the functions desired.

Instrument selector switches shall be of the maintained (stay-put) type. Ammeter selector switches shall have make-before-break type contacts so as to prevent open circuiting of CT secondary when changing the position of the switch.

Lockable type switches, which can be locked in a particular position, shall be provided, if required.

Emergency stop buttons, if any, shall incorporate ‘stay-put’ features with independent reset facilities.

- ✓ ***Indicating Lamps / Pilot Lights***

  Indicating lamp shall be of the double contact, bayonet cap type rated for operation at either 230 V AC or at the specified DC system voltage as applicable. Lamps shall be provided with translucent lamp covers.

  Clustered LED type lamps shall be provided Lenses shall be glass or plastic in standard colors, red, green, blue, white and amber, in accordance with IEC 60073.

  Bulbs and lenses shall be interchangeable and easily replaceable from the front of the panel. Tools, if any, which are required for replacing the bulbs and lenses, shall also be included in the scope of supply.

  Miniature pilot lamps may be provided with plastic marking plate contained inside square (or rectangular) front lens to provide indication of legend or symbols engraved on the marking plate.

  The basis of colors shall be as follows:

Red	:	Flow of energy.
Green	:	No flow of energy.
White	:	Supervision of power available, relay coil healthy, etc.
Amber	:	Disagreement with original condition, 'abnormal' condition or 'Sequence–on' condition.

- ✓ ***Push Buttons***

  Push buttons shall be of momentary contact type with rear terminal connections. The color of the push button actuator shall be red for 'OPEN / STOP' and green for 'CLOSE / START' and for other applications shall be as per specified requirements. The push button knob shall be suitably shrouded to prevent inadvertent operation. The push buttons shall be provided with integral inscription plates engraved with their designation.

  All push buttons shall have independent, potential free, 2NO + 2NC contacts. The contact faces shall be of silver / silver alloy. The contacts shall be rated 10A and capable of breaking inductive load of 1A at 110V DC and 5A at 110V AC.

- ✓ ***Space Heaters***

  Adequately rated anti-condensation space heaters shall be provided for each switchboard / cubicle.

  Space heater shall be of the industrial strip continuous duty type, rated for operation on a 230 V, 1 phase, 50 Hz, AC system.

  Space heater shall be provided with a single pole MCB with overload and short circuit release, a neutral link and a thermostat to cut off the heaters at 35^0 C.

- ✓ ***Cubicle Lighting / Receptacle***

  Each cubicle shall be provided with interior lighting by means of 18 W fluorescent tube lighting fixture. An MCB shall be provided for the lighting circuit. The lighting fixture shall be suitable for operation from a 230 V, 1 ph, 50 Hz, AC supply.

  A 230 V, 1 phase, AC receptacle (socket) plug point shall be provided in the interior of each panel with an MCB.

- ✓ ***Power and Control Cable Terminations***

  Terminals for power connections shall be complete with adequate phase

segregating insulating barriers, shrouds and suitable crimping type of lugs for terminating the cables.

Double compression type glands with armour and bonding clamps for the termination of all solid dielectric multicore cables shall be provided. They shall be designed to secure the armour wires to provide electrical continuity between the armour and the threaded fixing component of the gland and to provide watertight seals between the cable outer sheath and gland and between the inner sheath and threaded fixing component. The gland shall preferably project above the gland plate to avoid entry of moisture.

Earthing connectors between cable armour and earth shall be routed outside the cable gland in an approved manner. Gland insulation shall be capable of withstanding test for appropriate higM Voltage for one minute.

Cable terminations for HV / MV cables shall be heat / cold shrinkable type. Adequately sized shrouds/bolts shall be provided at connections to completely cover the terminations.

Where core-balance type current transformers are provided on the feeder cables for earth fault protection, glands for cables shall be insulated from earth in an approved manner.

- ✓ ***Wiring for Control and Protective Circuits***

All low voltage wiring for control, protection and indication circuits shall be carried out with 1100 V grade, PVC insulated cable with stranded, tinned copper conductor of minimum 1.5 sq. mm size. The size of conductor for CT circuits shall be minimum 2.5 sq. mm.

All wiring shall be run on the sides of panels and shall be neatly bunched and cleated without affecting access to equipment mounted in the panel.

The wiring shall be bound and supported by clamping, roughing or lacing. Spiral wrapping will not be accepted. Wire ways shall not be more than 50% full. Adequate slack wire shall be provided to allow for one restriping and reconnection at the end of each wire. When screened cables or wires are necessary, an insulating sheath shall be included.

Wiring and supports shall be of fire resistant material.

Wiring shall only be jointed or teed at terminals. Terminals of the clamp type shall not have more than two wires connected.

- ✓ ***Terminations and Ferrules***

Engraved core identification ferrules, marked to correspond with the wiring diagram, shall be fitted to each wire and each core of multicore cables terminated on the panels.

Moisture and oil resisting insulating material shall be used. The ferrules shall be of the interlocking type and shall grip the insulation firmly without falling off when the wire is removed.

All wires forming part of a tripping circuit shall be distinctively marked.

Spare auxiliary contacts of electrical equipment shall be wired to terminal blocks.

- ✓ ***Control Wiring Terminal Blocks***

Terminal blocks shall be of 1000 V grade and stud type. Brass stud of at least 6 mm dia. with fine threads shall be used and securely locked within the mounting base to prevent turning. Each terminal shall comprise two threaded studs, with a link between them, washers, and matching nuts and locknuts for

each stud. Connections to the terminals shall be at the front.

Terminals shall be numbered for identification, grouped according to function. Engraved 'black on-white' labels shall be provided on the terminal blocks describing the function of the circuit.

Terminals for circuits with Voltage exceeding 110 V shall be shrouded. Terminal blocks at different voltages shall be segregated into groups and distinctively labeled.

Terminals used for connecting current transformer secondary leads shall be 'disconnecting and shorting' type with a facility for earthing the secondary.

Terminal blocks shall be arranged with 100 mm clearance, between any two sets.

Separate terminal stems shall be provided for internal and external wiring respectively.

All wiring shall be terminated on terminal blocks, using crimping type lugs or claw type of terminations.

- ✓ ***Electronic Equipment***

Electronic equipment shall be capable of withstanding randomly phased transient over voltages of either polarity on the power supply or interruptions of the power supply without damage or impairment to the equipment's subsequent performance. In the case of controls, no mal-operation shall occur.

Where manufacturers require that electronic equipment supplied under this Contract should not be subjected to insulation resistance tests ('Meggering'), suitable warning notices shall be provided and installed in appropriate locations. When specified by manufacturers, separate shield / signal earthing shall be provided.

It shall be possible to remove / replace cards from / to electronic equipment without damage and without interfering with the operation of the rest of the equipment or system. If necessary, consideration should be given to switching off the supplies locally to a card to prevent inadvertent interference to the equipment or system during removing / replacing a card.

Electronic equipment shall not use local internal batteries unless the approval of the Employer or their representative's Representative has been obtained. Where approval is given, batteries used inside equipment shall be of the totally sealed, leak proof type.

- ✓ ***Interference***

a) Self-Generated Interference

Equipment shall not generate any type of interference at a level, which could be detrimental to the performance of any other equipment / component or which could cause annoyance or discomfort to personnel.

The earthing and cabling arrangements shall be such that detrimental interference is not generated.

b) External Interference

In the presence of interference expected in substation environments, the design of the equipment shall be such that no damage occurs and performance is maintained to the requirements of the individual specifications.

c) Spark Quenching

Spark quenching devices shall be fitted wherever necessary to ensure

continued satisfactory operation of contacts and prevent mal-operation of electronic devices.

d) Noise and Vibration

The acoustical noise levels and / or vibration produced by the equipment in operation shall be as low as is reasonably practicable for the type of equipment concerned and shall be agreed with the Employer or their Representative.

✓ ***Setting-Up and Maintenance Facilities***

All equipment shall be provided with sufficient easily accessible test points to facilitate setting-up and fault location together with maintenance aids such as extension boards, jumper leads and special maintenance tools.

Pin or terminal numbering of all cards in all crates shall be consistently uniform throughout. Power supplies shall use the same pin positions on all cards in an equipment or system.

✓ ***Loose Equipment***

Special connecting leads, extension boards and any special item required for calibration or maintenance purposes, together with the mating half of all necessary connectors shall be supplied.

✓ ***Printed Circuit Boards***

Printed circuit boards shall be epoxy glass fabric boards to comply with IEC - 60321 suitable for use in hot humid climates. Printed circuit boards may be single-sided, double-sided or multi-layer.

Printed boards shall, in general, comply with IEC 60326. They shall not bow perceptibly when they are mounted in their shelves or racks. Means shall be provided to prevent boards being plugged into the wrong sockets and the plugging in / out action shall be arranged in a positive manner.

An approved protective coat shall be applied to the printed circuit side of the board to protect against tracking, tarnishing and general deterioration due to moisture and deposition of dust. The coating shall not have any adverse reaction with any other material or components used and shall be suitable for use under tropical conditions. When boards are repaired in the field it shall be possible to apply (or 'touch up') such a finish by simple convenient means.

✓ ***Component Identification***

- A component reference number shall be marked adjacent to each component. Where this is impossible, components shall be identifiable from the layout drawings provided.
- The following shall be marked in all instances:

i. Fuses

The rating and the circuit identification of each fuse shall be marked adjacent to the fuse base.

ii. Control, Protection and Indication Devices

The function of each control, protection and indication device shall be marked. The caption and its arrangement shall be subject to the approval of the Employer or their Representative.

iii. Preset Controls

The circuit reference and if possible, the function shall be marked adjacent to each preset control in a position where it will be clearly

visible while the adjustment is being made.

iv. Connectors

The diagram reference number shall be marked on or adjacent to each connector.

- Test points shall be individually marked with the diagram reference number.
- The polarity of any polarized devices (e.g. diodes) shall be marked.

✓ ***Test Terminal Blocks***

Test terminal blocks, if any, shall be provided for secondary injection and testing of relays. A suitable metering block shall be provided where specified for the connection of a portable precision instrument to be operated when required for specific plant testing purposes.

✓ ***Tests***

The following routine tests shall be carried out on the assembled switchboard / panel during inspection at the manufacturer's works in addition to other tests as per applicable standards.

- Primary injection tests to ensure correct ratios and polarity of current and voltage transformers and of the current operated protection relays and direct acting coils, over their full range of settings.
- Balance earth fault stability test by primary current injection. Care must be taken to reproduce accurately the burdens of interconnecting cables. A further test to ensure correct polarity must be made after assembly.
- Tests on auxiliary relays at normal operating voltages by operation of associated remote relays.
- Correct operation of sequencing and control circuits at normal operating voltages by operation of local control switches, and simulation of operation from remote control positions.
- Carry out functionality tests, check interfacing status contacts and instrumentation.
- Checking of Differential protection relay.
- One minute power-frequency voltage dry withstand tests on the main circuits
- One minute power-frequency voltage dry withstand tests on auxiliary circuits
- Insulation resistance tests

All circuit breakers shall be subject to the following tests:

- Routine tests including HV pressure test, millivolt drop tests and mechanical tests.
- To ensure the operation of the dc closing coil and satisfactory closing of the circuit breaker with the voltage of the coil down to 80% of its rated voltage, and that mal-operation does not occur with a voltage on the coil of 120% of its rated voltage.
- Interchangeability of withdraw able identically equipped circuit breakers, and checking of all mechanical and electrical interlocks.
- Type test figures for heat test runs performed on identical panel types shall be made available.

Motors

All motors shall comply with IEC 60034, 60072/ IS 325, 4691, 6362,4029,12065, 12075, including standards referred to therein.

✓ ***The technical parameters of main***

The technical parameters of motors shall be as below :

Description	Unit	Particulars
Type		Squirrel cage Induction motor (TEFC)
Rating	kW	(*)
Rated voltage	kV	0.415
Type of mounting		Vertical / Horizontal (As required)
Duty type		Continuous (S1)
Method of starting		By variable speed drive (For Blower/compressor /Return Sludge Pumps, Compressor, motors) Direct on line- for motors upto 3.7kW Star-Delta (Close transition type) – For motors above 3.7kW and upto 75kW Soft Starter – For motors above 75kW
Type of system earthing		Effectively earthed
Class of insulation		F
Design ambient temperature	°C	50
Limits of temperature rise of winding		
- Determination by resistance method	°C	70
- Determination by ETD method	°C	80
Location		Indoor
Degree of Protection		IP55
Cooling designation		IC411
External cable details		0.4 / 1 kV, 3C x (*) Aluminum, XLPE, armoured
Space heater for motor		Required for rating 30kW and above

(*) Value to be ascertained by the Contractor after submitting design calculations subject to approval.

The LV motors shall be of the totally enclosed fan cooled type, with degree of protection for enclosure of IP 55 and shall be suitable for continuous operation and direct-on-line starting, unless otherwise specified.

They shall be suitable in all respects for service in extreme climatic conditions. Main conductor and slot insulation shall be non-hygroscopic and in accordance with Class F of IEC 60085.

Motors shall be capable of operating continuously at rated output at any frequency between 49 and 51 Hz and at any voltage within + 10% of the

nominal value. Motors shall be designed to be operated for a period of not less than five minutes at a voltage of 20% below the nominal value and at normal frequency without injurious overheating.

The starting current at rated voltage when started direct-on-line shall not exceed 6 times the rated full load current. When started with soft starter it should be 2.5 to 3 times the rated full load current. The motor characteristics shall be coordinated with soft starter manufacturer.

All bearings shall be fitted with oil or grease lubricators. Vertical shaft motors shall have thrust bearings.

All terminals shall be of the stud type of adequate size for the particular duty, marked in accordance with an approved standard and enclosed in a weatherproof box.

All terminal boxes shall be fitted with an approved sealing chamber, conduit entry or adapter plate, as required, together with the necessary fittings to suit the type of cable specified.

The power rating of the motors shall be larger of the following:

- 115% of the power input to the pump at duty point at a speed corresponding to a frequency of 50 Hz.
- Motors shall be capable of starting and accelerating the load with the applicable method of starting, without exceeding permissible winding temperatures, when the supply voltage is 80% of the rated voltage.
- Motors shall be capable of satisfactory operation at a supply voltage of 80% of the rated voltage for 5 minutes, commencing from hot condition.
- The locked rotor withstand time under hot conditions at 110% rated voltage shall be more than the starting time at minimum permissible voltage by at least two seconds or 15% of the accelerating time, whichever is greater. The locked rotor current of motors shall not exceed 600% of full load current of motor, which is inclusive of 20% tolerance.
- Motors when started with the drive imposing its full starting torque under the specified supply voltage variations shall be capable of withstanding at least two successive starts from cold conditions and one start from hot condition without injurious heating of windings. The motors shall also be suitable for three equally spread starts per hour under the above referred supply conditions.
- In case of motors started by soft starters, the three phases shall be segregated by metal barriers within both line and neutral side terminal boxes. The two terminal boxes shall be on opposite sides.
- The earthing pad shall be of non-corrodible metal, welded / brazed at two locations on opposite sides. The pad size shall be 75x65x25 mm with two holes drilled at 40mm centers, tapped and provided with suitable bolts and washers for connecting the earthing strip.
- Motors shall have space heaters suitable for 230 V, single phase 50 Hz AC supply. These shall be placed in easily accessible positions in the lower part of motor frame. Provision shall be made to measure temperature of bearing by inserting hand held temperature measuring device.
- Motors shall have drain plugs so located that they will drain water, resulting from condensation or other causes from all pockets in the motor casing.
- Pockets shall be provided in the motor bearing housings for insertion of portable instrument probes for measuring bearing temperature. One portable hand held instrument per pumping station shall be provided for

measuring motor bearing temperature. The same instrument shall also be used to measure the pump bearing temperature.

- ✓ ***Insulation***

  Any joints in the motor insulation such as at coil connections or between slot and winding sections, shall have strength equivalent to that of slot sections of the coil. The insulation shall be given tropical and fungicidal treatment for successful operation of the motor in extreme climate. The motors shall be provided with class F insulation with temperature rise limited to that of class B insulation.

- ✓ ***Constructional Features***

  The motor construction shall be suitable for easy disassembly and re-assembly. The enclosure shall be sturdy and shall permit easy removal of any part of the motor for inspection and repair.

  Motors weighing more than 25 kg shall be provided with eyebolts, lugs or other means to facilitate safe lifting.

  The rotor bars shall not be insulated in the slot portion between the inner core laminations for squirrel cage motors.

- ✓ ***Terminal Box***

  Terminal boxes shall be of weather proof construction designed for outdoor service. To eliminate entry of dust and water, gaskets of neoprene or equivalent approved shall be provided at cover joints and between box and motor frame. It shall be suitable for bottom entry of cables. It shall be suitable of being turned through 3600 in steps of 900.

  The terminals shall be of stud type with necessary plain washers, spring washers and check nuts. They shall be designed for rated current carrying capacity and shall ensure ample phase to phase and phase to earth clearances. Suitable cable glands and lugs shall be supplied to match specified cables.

- ✓ ***Accessories***

  Two independent earthing points shall be provided on opposite sides of the motor for bolted connections. These earthing points shall be in addition to earthing stud provided in the terminal box.

- ✓ ***Tests***

  Motors shall be subject to routine tests which shall also include the following:

  - Insulation resistance
  - Measurement of winding resistance
  - High voltage test
  - no load / full load tests to determine efficiency, power-factor and slip
  - momentary overload test
  - test for noise levels of motor
  - test for vibration severity of motor
  - over speed test
  - locked rotor reading of voltage, current and power input at a reduced voltage.

  Type test certificates for test runs performed on identical motors (below 11 kW

rating) shall be made available. Whenever two nos. or more identical motors (above 11 kW rating) are being offered, type tests on one of them shall be carried out, including heat run test.

- ✓ ***Soft Starters for LV Motors***

  The soft starters shall comply with the requirements of IEC 60034, 60947 and IS 325 including those standards referred to therein.

- ✓ ***Constructional and Performance Features***

  Motor soft starters shall be switched or electronic type.

  Soft starter panel shall be indoor, metal clad with separate metal enclosed compartments for

  a) control, metering and current transformers for differential protection, if specified
  b) shorting (bypass) arrangement
  c) bus bars
  d) power cable terminations
  e) push buttons with indicating lamps.

  Soft starter shall achieve smooth starting by torque control for gradual acceleration of the drive thus preventing jerks and extending the life of equipment.

  Starting current shall be limited to 2.5 to 3 times the rated current of the motor. The soft starter manufacturer shall co-ordinate with motor manufacturer for this purpose.

  Separate removable gland plates shall be provided for power and control cables.

  Each cubicle shall be fitted with a label in the front and rear of the cubicle, indicating the panel designation, rating and duty. Each relay, instrument, switch, fuse and other devices shall be provided with separate labels.

  Necessary wiring diagram shall be provided considering starting interlock, trip circuit, starting and running mode signal.

  It shall be possible to manually start the motor locally from the starter panel or in Auto mode through PLC.

- ✓ ***Main Bus Bars***

  Bus bars shall be fully insulated by encapsulation in epoxy resin /shrinkable PVC Sleeve, with moulded caps protecting all joints. Bus bars shall be supported on insulators capable of withstanding dynamic stresses due to short circuit. Bus bars shall be of Aluminum conductor(Copper is not recommended in sewage corrosive atmosphere as it us oxidized.)

- ✓ ***Earthing***

  A copper earthing bus shall be provided at the bottom and extended throughout the length of the panel. It shall be bolted / welded to the framework. All non-current carrying metal work of the panel shall be effectively bonded to the earth bus. Hinged doors shall be earthed through flexible earthing braid.

- ✓ ***Panel Accessories and Wiring***

  Panel shall be supplied completely wired internally upto equipment and terminal blocks and ready for the external cable connections at the terminal blocks. Inter panel wiring between compartment of the same panel shall be

provided.

All auxiliary wiring shall be carried out with 1100 volts grade, single core, stranded copper conductor with PVC insulation. The sizes of wire shall be not less than 1.5 sq. mm.

Terminal blocks shall be of stud type, 10 A rated, complete with insulated barriers. Terminal blocks for CTs shall be provided with test links and isolating facilities.

All spare contacts and terminals of cubicle mounted equipment and devices shall be wired to terminal blocks.

Accuracy class for indicating instruments shall be 1.0 or better. Instruments shall be 110 mm square, 240^0 scale for flush mounting with only flanges projecting.

Push buttons shall be provided with inscription plates engraved with their functions. Indicating lamps shall be of clustered LED type.

Space heaters of adequate capacity shall be provided inside each panel. They shall be suitable for 230 V, 1 ph, 50 Hz supply. They shall be complete with MCB and thermostat.

Each panel shall be provided with 230 Volts, 1 phase, 50 Hz, 5 A, 3 pin receptacle with MCB located in a convenient position. An interior illuminating lamp together with the operating door switch and protective MCBs shall be provided.

The DC and AC auxiliary supply shall be distributed inside the panel with necessary isolating arrangements at the point of entry and with sub-circuit MCBs as required.

- **Capacitors and APFC Panel**

Capacitors shall comply with IEC 60871 and IS 5553, 13925 including those standards referred to therein.

The technical parameters of capacitors shall be as given below:

✓ ***LV Capacitors and Control Panel***

Description	**Unit**	**Particulars**
Capacitor Bank		
Application		Power factor improvement
Arrangement		Automatic Power Factor Correction (APFC)
Type of insulation		Polypropylene (APP) / Mixed Dielectric (MD)
Rated output	kVAR	(*)
Rated voltage	V	415
Rated frequency and no. of phases	Hz / -	50, 3 Phase
Capacitor bank connection		Delta
Type of mounting and location		Floor mounted and Indoor
Design ambient temperature	°C	50
Type of switching		Automatic
Control supply		110V DC
No. of steps for control	Nos.	Minimum 8

Description	Unit	Particulars
Degree of protection of enclosure		IP4X
Color finish shade		Light Grey Semi Glossy
Type of APFC relay		Microprocessor based automatic power-factor correction relay (maximum setting 0.99 lag)

(*) Value to be ascertained by the Contractor after submitting design calculations subject to approval.

APFC relay and a panel shall be provided for connection to LV switchboard bus, where specified.

- ✓ ***Design Criteria***

MV capacitors – Capacitor rating shall be such that capacitor current is less than 90% of the magnetizing current of the motor or for improvement of rated motor power factor to 0.98, whichever is lesser.

LV capacitors – Rated for improvement of power factor on LV side to 0.98

- ✓ ***General***

The capacitor bank 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. It shall be complete with the required capacitors along with the supporting post insulators, steel rack assembly, aluminum bus bars, copper connecting strips, foundation channels, fuses, fuse clips, etc. The steel rack assembly shall be hot dip galvanized.

The capacitor bank shall comprise of suitable number of single phase units in series parallel combination. However, the number of parallel units in each of the series racks shall be such that failure of one unit shall not create an over voltage on the units in parallel with it, which will result in the failure of the parallel units. The assembly of the banks shall be such that it provides sufficient ventilation for each unit.

Each capacitor case and the cubicle shall be earthed to a separate earth bus. Capacitors shall be of polypropylene type. Each unit shall satisfactorily operate at 135% of rated kVAR including factors of over voltage, harmonic currents and manufacturing tolerance. The units shall be capable of continuously withstanding satisfactorily any over voltage up to a maximum of 10 % above the rated voltage, excluding transients.

Each capacitor unit / bank shall be fitted with a directly connected, continuously rated, low loss discharge device, if required, to discharge the capacitors to reduce the voltage to 50 volts within one minute upon disconnection.

- ✓ ***Unit Protection***

Each capacitor unit shall be individually protected by a HRC fuse suitably rated for load current and interrupting capacity, so that only the faulty capacitor unit will be disconnected without causing the bank to be disconnected. An operated fuse shall give visual indication so that it may be detected during periodic inspection. The fuse breaking time shall co-ordinate with the pressure built up within the unit to avoid explosion. Mounting of the individual fuse should be internal to the capacitor case.

✓ ***Capacitor (APFC) Control Panel for LV Application***

APFC microprocessor based relay shall automatically switch ON / OFF the capacitor banks to attain the value of 'pf' close to the set value. 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. Harmonic filter (inbuilt with APFC panel) shall be provided to restrict Total Harmonic Distortion (THD) to 3% or less.

Capacitor and capacitor control shall be housed in a metal enclosed cubicle. Capacitor shall be housed in the lower compartment and capacitor control unit at the top compartment, the two compartments being segregated.

The cubicle shall be fabricated out of 2 mm thick cold rolled sheet steel and shall of a degree of protection of IP 4X (for Capacitor Panel IP 4X is applicable as cut out for fan for heat dissipation.). The panel shall be of indoor type and shall consist of:

- Isolating MCCB
- Contactors with overload element
- Relays responsive to current / voltage / kVAR / pf for automatic switching
- Sequencing devices, timers and auxiliary relays for automatic sequential switching of capacitor units in and out of circuit
- Auto-manual selector switch
- Microprocessor based Automatic Power Factor Correction (APFC) Relay
- Push button for opening and closing the power circuit
- Red and Green lamps for capacitors ON / OFF indication
- Protective relays to protect the healthy capacitor units when one unit fails in a series connection
- Space heater and cubicle lighting

✓ ***Tests and Test Reports***

Capacitors shall be subjected to routine tests as per IS: 13925. Test for capacitor losses shall also be carried out on one capacitor bank of each type ordered.

In addition to the above, the capacitor units shall be subjected to the following tests:

- Load test at 110% rated voltage at an ambient of 45 to 50 ^{o} C for a period of 8 hours or more.
- Leak proofness test-initially after impregnation and total sealing, each capacitor shall be heated up to 80^{o} C to 110 ^{o} C for a few minutes. After the load test each capacitor unit shall be carefully inspected for leakage.

Type tests shall be carried out as per IS: 13925 on capacitors above 1000V rating of identical design. Certificates of type tests carried out in the last three years for similar capacitor units shall be furnished.

HV and LV Cables

HV / LV Cables shall comply with the following International Standards, including those referred to therein.

IEC 60183, 60227, 60502, 60885 and IS 7098, 5831, 8130, 1554, 10810.

The technical parameters of cables shall be as given below:

Description	**Unit**	**Particulars**
HV XLPE Power Cables		
Rated voltage U / Uo (Um)	kV	18 / 30 (36)
Material of conductor		Aluminum (stranded)
Cross-sectional area		(*)
Type of insulation		XLPE
Inner sheath		Extruded
Outer sheath		Extruded
Conductor and insulation screening		Required
Material of armour		Galvanized Steel (Aluminum for single core cable)
LV Power, Control and Lighting Cables		
Rated voltage U / Uo (Um)	kV	0.6 / 1 (1.2)
Material of conductor		Aluminum for Power and Tinned Copper for Control cable (stranded)
Cross-sectional area		(*)
Type of insulation		XLPE for power and PVC for control cables
Inner sheath		Extruded
Outer sheath		Extruded
Material of armour		Galvanized Steel (Aluminum for single core cable)
Cable Protection		Compound of outer sheath of all HV/MV/LV cables shall contain suitable chemicals for preventing attack by rodents.

(*) Value to be ascertained by the Contractor after submitting design calculations subject to approval.

✓ ***Installation***

- In air or buried in ground
- Depth of laying in ground 1000 mm for directly buried HV cables and 750 mm for LV cables
- In conduit: space factor not more than 40 % (ratio of total cable area to internal conduit area)
- In trays: single layer with spacing of one diameter for HV and main LV cables and touching for small LV cables

Control cables shall be 2C, 4C, 7C, 12C and 19C type. Minimum size of conductor for control cables shall be 2.5 sq.mm. copper.

All power cables shall be sized based on continuous current capacity, maximum permissible voltage drop of 2.5% and rated short circuit current withstand. In addition, rating factors for variation in ground/air temperature, grouping of cables, depth of laying, number of racks, etc. shall be considered for cable sizing.

✓ ***Tests***

All HV, and LV cables shall be subject to routine tests in accordance with the

relevant Indian Standard Specifications.

Test certificates shall be provided against each drum and/or cable length.

The tests carried out on every cable length and / or drum at manufacturer's premises shall include following tests as applicable but not limited to:

- High Voltage dc insulation pressure test, between cores, each core to earth, metallic sheath or armour as applicable;
- insulation resistance test;
- core continuity and identification;
- conductor resistance test
- Elongation test
- Smoke density test
- HCl gas generation test
- Anti rodent test (Presence of lead)

LV Indoor Switchboard

LV indoor switchboard and its components shall comply with the following International Standards, including those referred to therein.

IEC 60269, 60947, 61459, 60529 and IS 4237, 8623, 1248, 722, 2705, 3156, 10118, 11353, 13947

The technical parameters of LV switchboard shall be as given below:

Description	**Unit**	**Particulars**
General		
Rated voltage, no. of phases and rated frequency	V / - / Hz	415V, 3, 50Hz
System neutral earthing		Effectively Earthed
Rated short duration power frequency withstand voltage		
- Power circuit	kV (rms)	3.5
- Control circuit	kV (rms)	1.5
Rated normal current of bus bars under design ambient temperature of 50°C and material of busbar	A / -	(*), Copper
Rated short-time withstand current and time	kA (rms) / sec	25 kA for 1 sec
Constructional Requirements		
Thickness of sheet steel in mm Cold rolled (Frame/Enclosure/Covers)	mm	Frame – 2.5 Doors/Covers – 2.0
Degree of protection of enclosure		IP-5X, Form-4 enclosure
Color finish shade		
- Interior		Glossy White
- Exterior		Light Grey
Cable connection		Bottom entry and exit
Circuit Breakers		
Type		Air

Description	**Unit**	**Particulars**
Rated current inside the cubicle under design ambient temperature at 50°C	A	(*)
Rated operating sequence		O–3 Min–CO-3 Min-CO
Rated short-time withstand current and time	kA (rms)/ sec	25(*)
Min. no. of auxiliary contacts		6 NO + 6 NC after internal use by manufacturer
Type of operating mechanism		
- Normal		Spring charging for closing and tripping
- Emergency		Manual and Spring charged for closing and tripping
Auxiliary control voltage		
- Closing coil / Tripping coil	V	110V DC
- Spring charging motor	V	110V DC
- Space heater and lighting	V	230V AC
Earthing switch		Required
Current and Voltage Transformers		
Details of ratio, taps, burden, accuracy		As per Single Line Diagram (*)
Protective Relays		
Type		Numerical (Microprocessor based)
Auxiliary supply	V	110V DC
Details of protective relays		As per Single Line Diagram
Moulded Case Circuit Breakers		
Type		Moulded Case (microprocessor based)
Rated current when installed within cubicle under design ambient temperature of 50^0C	A	As required (*)
Rated short-time withstand current	kA (rms)	25 kA
Miniature Circuit Breakers		
Type		Miniature
Rated current when installed within cubicle under design ambient temperature of 50^0C	A	(*)
Rated short-time withstand current	kA (rms)	10
Motor Starters and Contactors		
Type		Variable Frequency Drive/ Star-Delta / Direct-on line
Rated current	A	(*)
Rated voltage of coil	V	230V AC / 110V DC

Description	Unit	Particulars
Utilization category		AC-3

(*) Value to be ascertained by the Contractor after submitting design calculations subject to approval.

These cover the main switchboard and distribution boards. The distribution board shall be of floor / wall mounting and Draw out execution type. Entry for incoming and outgoing cables shall be from bottom. Bus bars shall be of aluminum. Degree of protection of the panel shall be IP 5X.

The board shall be provided with circuits as required, ammeter with ammeter selector switch and voltmeter with Voltmeter selector switch. Contractor shall furnish proposed single line diagram of the board along with the Bid.

Incoming and outgoing circuit shall be protected by suitably rated ACBs/MCCBs. The switchboard and its components shall be subjected to tests as per the applicable standards.

- ✓ ***Bus Bars***

The phase and neutral bus bars shall be of rating indicated in the corresponding single line diagram. Bus bars shall be of aluminum and shall be provided with minimum clearances as per standards.

All bus bars and bus taps shall be insulated with close fitting sleeve of hard, smooth, dust and dirt free, heat shrunk PVC insulation of high dielectric strength, to provide a permanent non-ageing and non-tracking protection, impervious to water, tropical conditions and fungi. The insulation shall be non-inflammable and self-extinguishing type and in fast colors to indicate phases. The dielectric strength and properties shall hold good for the temperature range of 0 to 95 degree centigrade. If the insulating sleeve is not colored, bus bars shall be color coded with colored PVC tape at suitable intervals.

Busbar joints, if any, shall be of the bolted type with minimum 4 bolts. Spring washers shall be provided to ensure good contact at the joints. Bus bars shall be thoroughly cleaned at the joints and suitable contact grease shall be applied just before making a joint.

Direct access to, or accidental contact with bus bars and primary connections shall not be possible. All apertures and slots shall be protected by baffles to prevent accidental shorting of bus bars due to insertion of maintenance tools.

Sequence of red, yellow and blue phases and neutral for four-pole equipment shall be left to right and top to bottom, for horizontal and vertical layouts respectively.

- ✓ ***Moulded Case Circuit Breaker (MCCB)***

MCCBs shall be of the air break, quick make, quick break and trip free type and shall be totally enclosed in a heat resistant, moulded, insulating material housing.

MCCBs shall have an ultimate short circuit capacity not less than the prospective short circuit current at the point of installation.

MCCBs shall have a service short circuit breaking capacity equal to the ultimate short-circuit capacity.

Each pole of MCCB shall be fitted with microprocessor based protection for over current, earth fault and short circuit (L-S-I-G). Such a protection system shall be fully self-contained, needing no separate power supply. The elements shall be adjustable. Adjustments shall be made simultaneously on all poles from a common facility. MCCB shall be suitable for remote On-Off-Trip

operation. Necessary spare auxiliary contacts (minimum 2NO+2NC) shall be provided for future use.

Motor protection circuit breaker (MPCB) shall be used for motor feeder instead of MCCBs.

- ✓ ***Miniature Circuit Breaker (MCB)***

Miniature circuit breakers shall be of the thermal and magnetic tripping type, and comply with IEC 60898 and IEC 60947-2.

MCB shall be hand operated, air break, quick make, quick break type.

Operating mechanisms shall be mechanically trip-free from the operating knob to prevent the contacts being held closed under overload or short-circuit conditions.

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. For motor feeders, MCB shall have type C characteristics.

The short circuit rating shall be not less than that of the system to which they are connected with a minimum of 10 kA.

- ✓ ***Contactors and Starters***

The power contactors used in the switchboard shall be of air break, single throw, triple pole, and electromagnetic type. Contactors shall be suitable for uninterrupted duty and rated for Class AC3 duty in accordance with IEC 60947-4.

Operating coils of all contactors shall be suitable for operation on 230 V, single phase, 50 Hz supply.

Contactors shall be provided with at least two pairs of NO and NC auxiliary contacts.

Contactors shall not drop out at voltages down to 70 % of coil rated voltage. All motor contactors and their associated apparatus must be designed to operate for a period of not less than 5 minutes at a voltage of 20% below the nominal value and at normal frequency without injurious overheating.

Contactors shall be provided with a three element, positive acting, ambient temperature compensated, time lagged, hand reset type thermal overload relay with adjustable settings. The hand reset button shall be flush with the front door of the control module, and shall be suitable for resetting the overload relay with the module door closed. Relays shall be either direct connected or CT operated. Overload relay and reset button shall be independent of the "Start" and "Stop" push buttons. All contactors shall all be provided with single phasing preventer (SPP).

Motor starters shall be complete with auxiliary relays, timers and necessary indications.

Starters shall be of the electrically held-in type with integral “start” and “stop” push buttons mounted externally on the door, with integral interlocked isolators. Where required, auxiliary switches shall be included for the operation of “red” and “green” indicating lights in remote instrument panels.

For details of other equipment/ accessories of LV switchboard (e.g. circuit breaker, current and voltage transformer, relay, constructional features of switchboard, earthing, annunciator, indicating and measuring instrument, control and selector switch, indicating lamp, push button, space heater, cubicle lighting/ receptacles, power and control cable termination, wiring, terminal

blocks, etc), refer specification of HV switchboard.

✓ ***Tests***

The following routine tests shall be carried out on the assembled switchboard / panel during inspection at the manufacturer's works in addition to other tests as per applicable standards.

- Primary injection tests to ensure correct ratios and polarity of current and voltage transformers and of the current operated protection relays and direct acting coils, over their full range of settings.
- Balance earth fault stability test by primary current injection. Care must be taken to reproduce accurately the burdens of interconnecting cables. A further test to ensure correct polarity must be made after assembly.
- Tests on auxiliary relays at normal operating voltages by operation of associated remote relays.
- Correct operation of sequencing and control circuits at normal operating voltages by operation of local control switches, and simulation of operation from remote control positions.
- Carry out functionality tests, check interfacing status contacts and instrumentation.
- Checking of Differential protection relay.
- One minute power-frequency voltage dry withstand tests on the main circuits
- One minute power-frequency voltage dry withstand tests on auxiliary circuits
- Insulation resistance tests

All circuit breakers shall be subject to the following tests:

- Routine tests including HV pressure test, millivolt drop tests and mechanical tests.
- To ensure the operation of the dc closing coil and satisfactory closing of the circuit breaker with the voltage of the coil down to 80% of its rated voltage, and that mal-operation does not occur with a voltage on the coil of 120% of its rated voltage.
- Interchangeability of withdrawable identically equipped circuit breakers, and checking of all mechanical and electrical interlocks.

Type test figures for heat test runs performed on identical panel types shall be made available.

DC Equipment

DC equipment shall comply with IEC 60896 including those standards referred to therein.

✓ ***Requirements***

Following items shall be covered in the Contract:

- One no. 110 V Nickel Cadmium type Battery (Minimum capacity of Battery – 200AH)
- Two nos. Float-cum-boost chargers for 110 V battery
- DC distribution board.

All connections between battery, battery chargers and DC distribution board shall be designed for effective segregation between positive and negative

leads.

- ✓ ***110 V Battery***

Battery offered shall be Nickel Cadmium (Ni-Cd) type. Nickel hydroxide and Cadmium hydroxide shall be used for positive and negative electrode respectively. Aqueous solution of Potassium hydroxide with small quantities of lithium hydroxide shall be used as electrolyte. It shall be used only for ion transfer and shall not chemically changed during charging/ discharging.

The containers shall be transparent and preferably be made of toughened glass or plastic and provided with acid level indicator.

The battery shall be rated on 5-hour basis and for the specified ambient temperature. The battery shall have maximum recharge time of 8 hours. The batteries shall be sized for a backup of 24 hours, in case of power failure. The ampere-hour capacity shall be selected to cater to all the emergency loads, operation of control gear, indication lamps, annunciation panels, emergency lighting, incoming breaker(s) spring charging currents, short time loads etc. A margin of about 25% shall be taken to cater to the contingencies.

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 external terminal connections. Bolts, heads and nuts, except seal nuts, shall be hexagonal and shall be lead covered. The junction between terminal posts and cover, and between cover and container shall be so sealed as to prevent any seepage of electrolyte.

Required quantity of electrolyte for first filling with 10% extra shall be supplied in non-returnable containers.

Each battery shall be complete with following accessories, as applicable, that include, but are not limited to:

- Battery racks
- Porcelain insulators, rubber pads, etc.
- Set of inter-cell, inter-tier and inter-bank connectors as required for the complete installation.
- Electrolyte for first filling + 10% extra.

Accessories for testing and maintenance

i.	One	-3, 0, +3 volts DC voltmeter with built-in discharging resistor and suitable leads for measuring cell voltage.
ii.	One	Filler hole thermometer fitted with plug and cap and having specific gravity correction scale.
iii.	Three	Pocket thermometers
iv	Two	Cell lifting straps
v	One set Each of	Terminals and cable boxes with glands for connecting cable as required. Spare connectors Spare vent plugs Spare nuts and bolts Suitable set of spanners

Each battery shall be mounted in a manner that permits easy accessibility to any cell. The racks shall be suitable for fixing on flat concrete floor. The

complete racks shall be suitable for bolting end to end.

It shall be the responsibility of the Contractor to provide batteries of adequate capacities to meet specified requirements pertaining to control, indication, annunciation, etc. and emergency lighting. For computing battery capacity, it shall be assumed that the battery is fully charged at the beginning of loading cycle and is discharged to a voltage of 1.2 volts per cell at the end of the loading cycle.

The battery shall have minimal difference (approx. 0.3 V per cell) between float and boost charging voltages.

- ✓ ***Battery Charger (110 V)***

The 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.

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.

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. Boost charging time for charging the battery to full capacity from fully discharged condition shall not exceed 8 hours.

In the float charging mode, the charger shall be designed for supplying:

- 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
- The float charging current of the battery.
- 25% margin over the above load

Battery charging equipment complete with all accessories shall be housed in a free standing sheet steel cubicle having degree of protection of IP 4X. Sheet steel used for construction shall be 1.6 or 2 mm thick. The units shall be wired using 1100 V grade, PVC insulated, stranded copper conductor cables.

Each battery charger shall be provided with accessories that include, but not limited to the following:

- Silicon controlled rectifiers connected in full wave bridge circuit with ripple control devices and transient suppression network.
- Double wound dry type transformer with taps
- Automatic voltage regulator unit with manual / auto control switch
- Coarse and fine control potentiometers for manual control
- Selector switch for mode of charging i.e. float charging / boost charging
- Off-load tap changing switch for changing the taps of the transformer
- DC voltmeter with fuses and a three position selector switch
- DC ammeter with shunt
- AC ammeter with selector switch for incoming AC power
- AC voltmeter with selector switch for incoming AC power
- MCB for incoming AC supply along with surge suppressers
- Switch-fuse / MCB on DC output side with kick fuses and alarm contacts
- Voltage dropping diodes in load circuit during boost charging mode
- DC under voltage relay and earth fault relay
- AC / DC switching relays for alarm and indication circuits including buzzer
- Cubicle space heater suitable for 230 V AC, 1 ph, 50 Hz supply, with MCB and thermostat
- 230 V AC compact fluorescent lamp fixture for internal lighting with MCB

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

The Contractor shall include in the bid, detailed AC and DC scheme for battery charger offered.

✓ ***110 V DC Distribution Board (DB)***

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 aluminum or copper.

Incomers, bus coupler and outgoing circuits shall be controlled by suitably rated double pole MCBs type suitable for DC application. Contractor shall furnish proposed single line diagram of the board along with the Bid.

Constructional features, pre-treatment, painting and other aspects shall comply with the specifications for LV switchboard.

Aluminum earth busbar of suitable size 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.

✓ ***Tests***

The batteries, chargers and distribution boards and their components shall be subjected to routine/ acceptance tests as per the applicable standards. For

battery, following tests are also to be carried out:

- Capacity test
- Test for voltage charging and discharging
- Ampere-hour and watt-hour efficiency test

Certificates of type tests carried out on similar equipment shall be furnished.

- **Variable Frequency Drives (VFD)**

✓ ***General***

AC induction motor shall be coupled with a frequency drive of rating commensurate with the rated motor for different process driven equipment like blower etc. VFD should be chosen in such a way the power consumption can be optimized. The Frequency drives shall be of Current Source Inverter Pulse Width Modulated (CSIPWM) with GTO/IGBT/IGCT/SGCT/DTC technologies or later version, which performs precise speed and torque control of standard squirrel cage motors with optimum efficiency. Each drive must have a soft starting feature and a bypass arrangement for DOL starting of motors. All frequency dives shall be suitable for data connectivity with PLC/SCADA system and shall have suitable communication port and protocol. The drives must be easily programmable. The drives shall be provided with surge protection, programmable lockable code. The Frequency drive shall have following characteristics:

- Accurate open loop torque control
- Torque step rise time typically less than 5 ms
- Speed control inaccuracy typically 0.1% to 0.5% of nominal speed
- 150% overload capacity for 60 second
- Total Harmonic distortion shall comply with the provisions of IEEE 519. Necessary metering, self-diagnostic arrangement (including display and alarm facilities) shall be provided for local/ remote monitoring.

✓ ***Technical Parameters***

Main connection		
Voltage	:	3 phase, 415 +/- 10 % permitted tolerance
Frequency	:	45 to 65 Hz, maximum rate of change 17%/s
Imbalance	:	Max. +/- 3% of nominal phase to phase input voltage
Fundamental Power factor	:	0.97 (at nominal load)
Motor connection		
Voltage	:	3 phase, from 0 to applied incoming supply voltage, 3-phase symmetrical
Output Frequency	:	0 to 250 Hz
Frequency Resolution	:	0.01 Hz
Continuous Current	:	1.0 * I2N(normal use)
Short Term Overload Capacity (1min./10min)	:	I2max = 1.1 * I2N
Field Weakening point	:	8 to 300 Hz
Acceleration Time	:	0 to 1800 sec
Deceleration Time	:	0 to 1800 sec

Efficiency	:	Min. 97% at nominal power level
Environment limits		
Ambient temperature	:	0 to 45 deg. Cent.
General Standard Control Connections or as per Process Requirement		
3 programmable differential analogue inputs (1 voltage signal, 2 current signals)		
7 programmable digital inputs		
2 programmables analogues outputs (current signal)		
3 programmable digital outputs (from C relays)		
Analogue and digital extension modules can be added as well as a wide range of field bus adapters.		
Protection		
Over current		
Short circuit at start-up		
Input phase loss		
Output phase loss		
Motor overload		
Earth fault		
Overvoltage		
Under voltage		
Over temperature		
Motor stall		
Application macros		
The features a selection of built-in, pre-programmed application macros for configuration of inputs, outputs, signal processing and other parameters. It shall have interfacing facilities to communicate data to SCADA system. These include:		
Factory setting for basic industrial applications		
Hand/auto control for local and remote operation		
Pid control for closed loop processes		
Torque control for process where torque control is required.		
Sequential control for processes where torque control is required.		
User macro 1 and 2 for user's own parameter setting		
Comprehensive testing and diagnostic function		

✓ ***Tests***

Each unit of Variable frequency drive shall be tested at the manufacturer's work. Test result must satisfy the efficiencies on various loads and at different frequency levels against their quoted values during bidding.

Lighting System Equipment

Lighting system shall comply with the following International Standards, including those referred to therein.

IEC 60083, 60598, 60669, 60884, 60906 and 60947

General Requirements

Lighting system equipment shall cover lighting panels, lighting fixtures, switches, receptacles with switches, for outdoor lighting - lighting masts, street lighting poles, etc.

Normal and emergency lighting for indoor and outdoor areas shall be provided.

Supply for emergency lighting shall be derived from 110 V DC distribution board to

be provided under this Contract. The Contractor shall provide emergency lighting in the vital installation including pump house, switchboard room, office building, administration areas, etc. 10% of the total normal lighting shall be emergency type.

Galvanized conduits shall be used for all exposed wiring and black enameled MS conduit shall be Employer's representative for all concealed wiring. Minimum size of conduit shall be 20 mm / 25mm for exposed / concealed conduits respectively. Wiring inside the pump house, switchboard room and other areas shall be concealed type.

Wires used for conduit wiring of lighting fixtures / ceiling fans and receptacles shall be 250/440V grade, PVC insulated, single core, stranded copper conductor wires of sizes not less than 2.5 sq. mm and 4 sq. mm respectively. Wires shall conform to IS standards. Three individual wires with proper color coding (P-N-E) shall be used for wiring and no joint in wires between conduit is allowed. 3 core x 2.5 sq. mm. copper cable shall be used for circuiting of peripheral lighting.

- ✓ ***Lighting Panels***

  Lighting panels shall be of wall mounting type and fabricated out of 1.6 mm. thick cold rolled sheet steel. Incomer circuit shall be controlled by a switch disconnector with a link in the neutral circuit. Outgoing circuits shall be controlled by single pole MCBs of minimum 10A rating and a link in the neutral circuit. TPN MCB shall be provided for street lighting/ area lighting purposes. Breaking capacity of MCBs shall not be less than 10 kA. Residual circuit breakers (RCCBs) shall be used on all lighting and receptacle circuits.

  It shall be possible to terminate incoming and outgoing circuits from top and bottom. Knock-out for cable / conduit entries for all the circuits shall be provided. Separate circuits shall be provided for control of lighting fixtures and receptacles. Each phase shall have at least one spare circuit.

  The panel shall be provided with 3 phase and neutral copper busbar adequately rated to cater to the requirement of all the outgoing circuits. Two earthing terminals shall be provided external to the panels for terminating the external earthing conductor.

  The panel shall be internally wired using color coded, stranded copper conductor, PVC insulated wires of 1100 V grade.

  The panels shall have hinged door, gasketed all round and provided with handle lock. Operation of incomer switch or MCBs shall be possible without opening the door.

  Detailed specification of lighting panel and its accessories (e.g. busbar, MCB, indicating instrument, indicating lamp, etc.) are described at MV and LV switchboard.

- ✓ ***Lighting Fixtures and its Accessories***

  Lighting fixtures for illumination of outdoor and indoor areas shall be supplied. Fixtures for outdoor installation shall be of weatherproof design with degree of protection of IP65. The fixtures shall be suitable for operation on a nominal supply of 240 V, single phase, 50 Hz, AC with a voltage variation of + 10 %.

  Fixtures shall be complete with internal wiring, lamp, capacitor, starter, holder, ballast, reflector, louvres / perspex, etc. as required for their satisfactory operation. Fixtures shall be energy efficient and ballast shall be electronic low loss type. All indoor lighting fixture for office and control room shall be decorative type and for remaining areas it shall be industrial type.

  Starter of the fluorescent/ HPSV/ MH light fixture shall be replaceable without

disturbing the reflector or lamps and without the use of any tool. The capacitor of the HPSV / lighting fixture shall have adequate value of capacitance to correct the power factor of its fixture to 0.98 lag.

Lamp holders for fluorescent tubes shall be of the spring loaded, low contact resistance, bi-pin rotor type, resistant to wear and suitable for operation at the specified temperature, without deterioration in insulation value, contact resistance or lamp holding quality. Fluorescent lamp shall be 'Tri-band phosphor' coated and color designation shall be 'Cool day-light' type (i.e. color temperature shall be more than 6000K) Contractor may use Compact Fluorescent Lamp (CFL) in place of fluorescent lamp in suitable application.

Lighting fixture reflectors shall generally be manufactured from steel or aluminum sheet of not less than 20 SWG thickness. Each fixture shall be complete with a four way terminal block for connection and looping of incoming and outgoing cables. Each terminal shall be able to accept two 2.5 msqm copper stranded conductors. Each lighting fixture shall be provided with an earthing terminal suitable for connecting 16 SWG copper stranded conductor. All metal or metal enclosed parts of the housing shall be bonded and connected to the earth terminal to ensure satisfactory earthing continuity throughout the fixture. All reflectors and louvers shall be finished to the same standard as the fixture housing.

The enamel finish shall have a minimum thickness of 2 mils for outside surface and 1.5 mils for inside surfaces. The finish shall be non-porous and free from blemishes, blisters, and fading.

Size of wire chosen shall be such as to limit the voltage drop to within 3 %. Minimum area of conductor shall be 1.5 sq mm stranded copper for lighting and 2.5 sq mm / 4 sq mm for 5A / 15A receptacle circuits respectively, and current density shall not exceed 2.5 A/sq mm. Generally, not more than 8 to 10 lighting points shall be wired in one circuit. For calculating connected loads of various circuits, a multiplying factor of 1.25 shall be assumed on the rated lamp wattage for sodium vapour and fluorescent lamp fixtures to take into account the losses in the ballast. A loading of 100 watts and 500 watts shall be assumed for each, single-phase 5 amps and 15 amps receptacles respectively. Wires belonging to different phases shall not be run in the same conduit. However, more than one circuit on the same phase can be run in the same conduit. For every phase wire, a separate neutral wire shall be run. Neutral wire for different phases shall not be looped.

The following types of fixtures shall be considered for various areas. The construction features are indicative. Equivalent or superior feature is acceptable.

General purpose flood lighting fixtures - Housing with integral control gear from die-cast aluminum alloy, vitreous enameled, and with electrochemically brightened anodized aluminum reflector, clear, heat resistant glass with rubber gasket secured to housing by a ring, cast iron base and MS cradle for turning in horizontal and vertical planes and lockable in desired position, suitable for 250/400 W HPSV/MH lamp. These fixtures shall be used for illumination of outdoor area for providing general illumination.

Gate post lights - Top canopy spun from aluminum sheet and vitreous enameled. Spigot shall be made of die-cast aluminum and vitreous enameled. Fixture shall be suitable for 70 W HPSV/MH lamp.

Fluorescent tube fixtures - Housing made from mild steel sheet and stove enameled white. Reflector assembly made from electrochemically brightened anodized aluminum sheets secured to housing with spring loaded triggers and

suitable for 2/3 nos. 36 watt triphosphorous coated tubes. These fixtures shall be used in switchboard room and other areas. Where false ceiling is provided, fixtures shall be suitable for recessed mounting. For non-false ceiling office areas, decorative type fixtures shall be used. Contractor may also use Compact Fluorescent Lamp (CFL) as an alternative.

Street lighting fixtures for Plant for the approach road shall be weather-proof, suitable for 150W LED lamp and shall be cut-off type. The degree of protection shall be IP67. Street lighting control (switching ON and OFF automatically) shall be done by photo-electric sensor or by timer.30% of total lighting shall be on Panels.

Lighting fixture used for pump house and other areas with high ceiling shall be medium/high bay type suitable for 150/250/400 W HPSV/MH lamps. These shall have housing with integral control gear of from die-cast aluminum alloy, electrochemically brightened anodized aluminum reflector, etc.

1200mm sweep ceiling fans shall be provided in areas such as offices, etc. as per design requirement. Adequate ventilation arrangements shall be made for enclosed areas where ceiling fans are not proposed to be installed or cannot be provided. Power supply for the ceiling fans shall be derived from lighting circuits. Ceiling fans shall be complete with all accessories. Regulators shall be electronic (triac) type.

The work shall comprise wiring in heavy gauge (minimum 16 SWG) GI conduits, fixed and supported at intervals of 300 mm on walls, ceiling etc.; installation of light control switches and receptacles housed in GS boxes; earthing with 16 SWG copper wire run along the conduit and clamped to it at every 300 mm; and termination of cables/wires at lighting panels, light control switches, receptacles, lighting fixtures etc., as required. The minimum size of conduit shall be 20 mm. Space factor (ratio of total wire area to internal conduit area) shall be 40 %. Concealed conducting shall be provided to all building / office areas. For pump house area, the Contractor shall adopt surface conducting also.

Receptacles and Switches – It shall be weather-proof for outdoor application. For Pump-house area and Switchgear room, industrial type receptacles with switch shall be provided. For Office areas, it shall be decorative type. 3 phase welding receptacles shall also be provided as per requirement.

Types of fixtures proposed by the Contractor for various areas shall be subject to Employer or their Representative approval.

The lighting poles for streetlights shall be of tubular / swaged type steel poles, circular in construction. The steel poles shall be coated with bituminous preservative paint on the inside as well as embedded outside surface. Exposed outside surface of the steel poles shall be painted with one coat of red lead oxide primer. After completion of installation, two coats of aluminum paint shall be applied. 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. 2 nos. studs shall be provided on the pole for earthing. The lighting poles shall have an end cap with brackets for mounting HPSV/MH lamps (of suitable wattage) in weatherproof fittings, cut-off type or semi- cut off type luminaries. The brackets shall be welded to the pole and shall ensure an suitable overhang depending on height of the pole.

Junction boxes with terminals shall be supplied for branching and terminating the lighting cables, weatherproof and suitable for usage in outdoor areas. The junction boxes shall be dust and vermin proof and shall be fabricated from 2

mm CRCA sheet steel and shall be complete with removable cover plate with gaskets, two earthing terminals each with nut, bolt and washer. The Contractor shall provide support arrangement (through 25 x 4 mm GI flat U clamp) for proper fixing of the junction box to the pole.

The boxes shall be hot dipped galvanized / painted with on shop coat of red oxide zinc chromate primer followed by a finishing coat of paint. Suitable rubber gaskets shall be provided on the doors of the junction boxes. The junction boxes shall have a locking facility, suitable to be opened by a common panel key for all the junction boxes. The boxes shall have provision for mounting on the poles. Suitable knockouts for the entry for cable / conduit entry shall be provided with terminal blocks, HRC fuses etc.

The terminal blocks shall be mounted securely on brackets welded to the back sheet of the box. The terminals shall be 1.1kV grade, one piece construction complete with barriers, galvanized nuts, bolts, washers and provided with identification strips of PVC. The terminals shall be made of copper alloy and shall be of box clamp type. Double compression brass glands shall be provided for entry / exit of the cables into the junction box.

- ✓ ***Receptacles with Switches***

Adequate number of receptacles of 6A, 16A and 32A rating with MCBs suitable for operation on 230 V AC, 1 phase, 50 Hz supply shall be provided as detailed below:

a) Decorative and industrial type shall be proposed in relevant areas.

b) Receptacles proposed for outdoor installation shall be of weatherproof design of degree of protection IP65.

c) Single phase receptacle shall be provided with a switch / MCB of the same current rating, housed in the same enclosure. Three phase receptacles shall be associated with a MCB of the same rating, housed in the same enclosure. The number, type, rating and location of receptacle shall be subject to approval of the Employer or their representative's Representative.

- ✓ ***Switches***

Decorative / industrial type switches of 6A / 16A rating shall be provided for all indoor areas. Switches shall be provided to control a group of lighting fixtures in various areas. Switches shall be housed in galvanized steel boxes.

- ✓ ***Water Coolers***

  - ❖ **General**

Water cooler shall conform to IS 1475/78 with latest amendment suitable for operation on 230 volts ±10%, 50 cycle's single phase AC supply. It shall be supplied with hermetically sealed type suction cooled compressor with overload protection conforming to IS 10167. It shall have cooling capacity of 40 liters per hour with storage capacity as 80 liters. The other technical parameters are as under:

  - ❖ **Specifications**

S. N.	Particulars	Parameter
1	Overall Dimensions of	
	Unit	
	Width	590 mm
	Depth	735 mm

S. N.	Particulars	Parameter
	Height	1555 mm
	Tank	
	Width	485 mm
	Depth	455 mm
	Height	485 mm
2	Details of Cabinet	
	Material of Construction	CRCA Sheet/Coated GI
	Thickness	1 mm
	Surface Treatment	Powder Coated
	Type of finish	Structural
	Dimensions of SS front panel below water outlets	410mm X 465 mm
3	Details of pedestal	
	Material of construction	Stainless steel
	SS conforming	AISI 304
	Thickness	2.65 mm
	Method of securing to the cabinet	SS bolts washer and nuts
5	Rated voltage of water cooler	230 ±10 % volts
6	Details of compressor	
	Capacity of compressor	900 Kcal per hour
	Max output of compressor motors	0.25 KW
	Rated	
	Current	3.1 (nominal) Amps
	Speed	2850 RPM
	Voltage	230±10 % volts
	Maximum full current of compressor	3.4 Amps
	Class of insulation	B
	Power consumption (max) during operation under capacity rating test condition	575 watts

❖ **Tests**

Lighting panels, fixtures, receptacles and other accessories shall be subjected to routine and acceptance tests as per the applicable standards.

Cabling System Installation

✓ ***General***

The scope shall cover, in addition to supply, complete installation of plant items and accessories as indicated in various parts of the specification. Requirements / guidelines / information / parameters / instructions, etc. specified in this section shall apply to all the sections.

Installation work pertaining to plant items and systems such as cabling, lighting, earthing and lightning protection systems, etc. shall comply with the applicable standards, safety codes, etc.

Installation shall be carried out strictly in accordance with the approved drawings. Changes, modifications, if any, required to suit site conditions, shall be carried out only with the prior approval of the Employer or their representative's Representative. All such changes shall be incorporated in the

"As built" drawings to be furnished by the Contractor.

All tools, brazing equipment, crane, scaffolding, rigging materials, ladders, consumables, hardware, etc. required for installation shall be provided by the Contractor.

It shall be the responsibility of the Contractor to engage Specialist Engineers from his Sub-Contractors / Manufacturers to supervise installation work for plant items such as switchboard, motors, etc. where felt essential. Such services shall be arranged by the Contractor at no extra cost to the Employer or their representative.

It shall be the responsibility of the Contractor to obtain approval / clearance, if any, from local statutory authorities, for conducting any work for completed installation.

The Contractor shall ensure that all plant under erection as well as the work area and the project site are kept clean to the satisfaction of the Employer or their representative. In case the Employer or their representative is not satisfied about the cleanliness, he will have the right to carry out the cleaning operations. Expenditure incurred by him in this regard will be to the Contractor's account. Packing cases and packing material, except for spares shall be cleared from sites.

In order to avoid hazards to personnel moving around the equipment, which is kept charged after installation before commissioning, such equipment shall be cordoned off by suitable barriers to prevent accidental injury.

Switchboard shall be installed on finished surfaces. Proper aligning, joining of various vertical shipping sections, busbar connections, inter panel wiring, etc. will be the responsibility of the Contractor.

The Contractor shall take utmost care in handling instruments, relays and other delicate mechanisms. Wherever the instruments and relays are supplied separately, they shall be installed only after the erection of switchboards is complete.

- ✓ ***Cabling System***

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 a fire.

Cables shall be laid directly buried in earth, on cable trays in built-up trenches, in conduits / pipes along walls / structures / foundations / ceilings, etc. The Contractor's scope of work includes unloading, excavation, laying, backfilling, fixing, bending and terminating the cables. The Contractor shall supply the necessary material and accessories required for installation and termination of the cables which shall include but not be limited to items such as glands, lugs, terminating accessories, hardware, consumables, saddles / spacers, GI conduits / pipes, cable identification tags, protective bricks, civil materials, etc.

- ✓ ***Buried Cables***

Cable installation in outdoor areas shall be carried out in directly burried cable trenches. Stabilized thermal backfilling shall be used for directly buried cables. Cabling from trenches up to junction box / equipment, etc. shall be carried out in GI conduit / pipes of class B. Provision of GI pipe sleeves in trench wall shall be the Contractor's responsibility. Where cables cross roads or water / sewage pipes, the Contractor shall provide rows of 150 mm diameter GI pipes in a concrete block for passage of cables. Contractor shall also lay spare pipes for future use. Alternatively, Contractor shall provide concrete cable duct for

road crossing. LV cables shall be buried at a depth of minimum 750 mm while HV and MV cables shall be buried at a depth of minimum 1000 mm. For road crossings, the pipe for the cables shall be buried at not less than one meter depth.

Directly buried cables shall be laid on a 75 mm thick riddled and compacted earth bed. The cables shall then be covered on top and at their side with riddled earth to a depth of about 150mm. This shall then be gently pulled down to a depth of about 100 mm above the top of uppermost cable to provide bedding for the protective concrete cable covers, which shall be placed centrally over the cables. The protective cable covers shall be 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 should be then backfilled with the excavated soil and well rammed in successive layers of not more than 300 mm thick, with the trenches being watered to improve consolidation, wherever necessary. To allow for subsidence, a crown of earth not less than 50 mm in the center and tapering towards the sides of the trench should be provided.

All cables to be routed along any particular route shall be laid at one time to avoid repeated excavation, etc. Each cable shall be tagged with numbers. The tag shall be of aluminum with the number punched on it and securely attached to the cable / conduits by not less than two turns of 20 SWG GI wire. Cable tags shall be of rectangular shape for power cables and of circular shape for control cables. Cables tags shall be provided on all cables at each end, on both sides of wall / floor crossings, on each duct / conduit entry, at each bend/ corner and at every thirty (30) meters in cables trench / tray racks on straight run.

Where groups of HV, LV and control cables are to be laid along the same route, suitable metallic barriers to segregate them physically shall be Employer or their representative. When power cables are laid in the proximity of communication cables, minimum horizontal and vertical separation of 300 mm shall be maintained. Power and communication cables shall, as far as possible, cross at right angles to each other.

- ✓ ***Cables in Trays***

Cables in trays shall be cleated individually or in a group using GI saddles. Interval for cleating shall not exceed 1500 mm.

In case of laying on cable trays / racks, power and control cables shall be laid in separate cable trays, the order of laying of various cables being as given below:

a) HV cables on top tiers

b) LV cables on subsequent tiers

c) Control, instrumentation and other service cables in bottom-most cable tier.

Ladder type GI cable trays and painted rack support shall be installed in cable trenches for power cables. Perforated trays shall be used for control and instrumentation cables. Embedded flats for fixing cable tray supports shall be provided in cable trenches to support the cable trays during civil works. Where such flats cannot be used, the fixing of cable trays shall be done using anchor fasteners. All cable trays shall be earthed at a regular interval.

The cable trays shall be complete with all necessary coupler plates, elbows, tees, bends, reducers, stiffeners and other accessories and hardware. Cable trays and accessories such as tees, elbows, reducer, etc. shall be fabricated

out of minimum 2 mm thick sheet of hot dip galvanized sheet except for trays of width 300 mm and lower for which 16 G GS sheet is acceptable. Bends, tees, etc. shall be suppliedor fabricated at site, as required. Cable tray supports such as angles, channels, etc. shall be of galvanized steel. Galvanizing thickness shall be not less than 85 micron.

- ✓ ***Cable Pulling***

The cables shall be laid in built-up trenches, directly buried in ground, or on cable trays, vertical raceways, clamped on structures / walls / ceiling, pulled through pipes and conduits, etc. The scope of cable installation shall include excavation and backfilling (in case of buried cable trench), laying, pulling of cables, proper dressing of cables on cable trays, racks, vertical raceways and supply and installation of cable tags, saddles, spacers and nylon chord for tying as required. The cost of supplying covers for cable route / joint markers, supply of sand and cover plates are included in the scope of the Contractor.

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 Employer or their representative'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 conduit / pipes and ducts.

After pulling the cable, the Contractor shall record cable identification with date pulled neatly with waterproof ink in linen tags / aluminum tag and shall securely attach such identification tags. Identification tags shall be attached to each end of each cable with non-corrosive wire. The wire must be non-ferrous material on single conductor power cable. Tags would further be required at 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.

Each cable shall be pulled into the particular conduit / pipe and shall be taken from the particular reel designated for the run. In hand holes, pull boxes or junction boxes having any dimension over 1000 mm, all conductors shall be cabled and / or racked in an approved manner. Care shall be taken to avoid sharp bending or kinking cables, damaging insulation or stressing cable beyond manufacturer's recommendations in pulling. Cable shall be protected at all times from mechanical injury and from absorption of moisture at unprotected ends. The bending radii for various types of cables shall not be less than 12/15 times the overall diameter of the cable for armoured cables and 15/20 times the overall diameter of the cable for unarmored cables.

Cables on cable racks and in conduits / pipes shall be formed to avoid bearing against edges of trays, racks, conduit / pipes or their supports upon entering or leaving racks or conduit / pipes.

Cables splices shall not be used except where permitted by the Employer or their representative's Representative. Splices shall be made by Contractor for each type of wire or cable in accordance with the instructions issued by cable manufacturers and the Employer or their representative'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.

At cable terminal points, where the conductor and cable insulation will be terminated, terminations shall be made in a neat, skillful and approved manner by specially trained staff. Terminations shall be made by the Contractor for each type of wire or cable in accordance with instructions issued by cable manufacturers and / or the Employer or their representative's Representative.

Control cable termination shall be made in accordance with wiring diagrams, using proper color codes for the various control circuit.

When control cables are to be fanned out and corded together with a 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 doubt about correctness of 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, 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 skillful manner. Jointing of cables shall be in accordance with relevant Standards and manufacturer's instructions. Materials and tools required for cable jointing work 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.

Where cables pass through floor or wall openings or other partitions, suitable bushes / pipe sleeves of GI shall be provided by the Contractor. The Contractor shall seal the cables at the bushes / pipe sleeves using fire resistant material.

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 under supervision of the Employer or their representative's Representative. Before joining is commenced, insulation resistance of both sections of cables to be jointed shall be checked by megger.

In case of motor cables, after installation and alignment of motors, the Contractor shall complete the conduit / pipe installation, including a section of flexible conduit / pipe between motor terminal box and trench / tray, if necessary. The Contractor shall install and connect the power, control and heater supply cables as per equipment manufacturer's drawings / instructions. The Contractor shall be responsible for correct phasing of the motor power connection and shall interchange connections at the motor terminal box, if necessary, after each motor is test run.

Connections to recording instruments float switches, level electrodes, limit switches, pressure switches, thermocouples, thermostats and other miscellaneous equipment shall be done as per manufacturer's drawings and instructions.

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 fault at a later date.

- ✓ ***Conduits / Pipes***

Where cable trench is not available, cables shall be laid in GI conduits / pipes routed along walls / columns / beams / steel structures or buried in concrete slabs, etc. to suit site conditions. GI conduits shall be Class C type. Supply and installation of GI conduits / pipes, their accessories such as bends, tees,

couplers, etc., saddles, spacers, junction / marshalling boxes and GI hardware required for installation shall be included in the Contractor's scope. Interval between supports shall not exceed 500mm. For multiple cables, maximum utilization factor (ratio of total wire area to internal conduit area) shall be 50% of the conduit area.

Non-metallic conduits / pipes shall be used for single core cables of a 3 phase circuits.

✓ ***Junction Boxes / Marshalling Boxes***

Junction boxes / marshalling boxes shall be hot-dip galvanized, weather proof with IP 55 degree of protection and shall be provided with cable glands for incoming and outgoing cables. The boxes shall be fabricated from 1.6 mm thick sheet steel and galvanized. The boxes shall be suitable for mounting on walls / columns / steel structures, etc. and shall be supplied with mounting accessories. The front covers of the boxes shall be removable and provided with gaskets. All the terminals shall be complete with insulated barriers, terminal studs, washers, nuts, etc. The boxes shall be effectively earthed.

✓ ***Fire Proof Sealing (FPS) System***

Fire proof sealing system shall be provided and shall consist of

a) Fire-stops / fire-seals for sealing of cable / cable tray and conduit / pipe penetrations, both horizontal and vertical, through brick or RCC walls / floors, to prevent the spread of fire from one area to other areas by fire-resistant barriers.

b) The FPS system shall also include all the necessary accessories and equipment required for supporting, holding in position, fixing and installation of the fire-stop.

c) The FPS system shall comply in all respects with the requirements of the codes and standards mentioned herein IEC-111 and IEC-112.

✓ ***Fire Stop / Seal***

The FPS system adopted for cables or cable trays penetrating through walls and floor openings, or cables passing through embedded conduits / pipes / pipe-sleeves, constitutes a `fire stop / seal', which is meant to prevent spreading of fire between areas separated by fire-resistant barriers.

✓ ***Performance Requirements***

- The material, design and construction of the fire stops shall be such as to provide a fire-rating of 120 minutes for a fire on any side and meet all requirements listed in this specification and the relevant codes and standards.
- The materials used in the fire stops shall be non-hygroscopic, compatible with the type of cables.
- The fire stops shall be suitable for retrofitting of cables through the penetration seal without disturbing the sealing of the cables already existing.

✓ ***Application of Fire Proof Sealing System***

Fire stops shall be provided for cable penetration openings listed below

- The passage of cables / cable trays pipe sleeves / embedded conduits through walls / floors.

- Vertical raceways, if any, which carry cables between successive floors, through openings provided in the RCC floor slab, shall be sealed by fire stops at each floor level.
- Cable entry through openings in floor slabs.

Contractor shall furnish the test certificates for the fire stops after award of Contract for Employer or their Representative review. If the certificates are not satisfactory, all the tests shall be conducted free of cost. The offered system i.e. fire stops and fire breaks shall be identical (or better) with the system which is successfully type tested for the specified rating i.e. the composition density of the material, thickness of coating in case of fire breaks and any other properties of the material / system offered shall be identical or better than the tested system and shall be subject to Employer or their representative approval.

✓ ***Performance Tests***

- The fire stops shall be subjected to the following type tests:
  i. Fire Rating Test
  ii. Hose Stream Test
- Type tests shall be conducted on different fire stop test specimens described above as per IEEE-634. The sizes of the fire stop test specimens shall be similar to the largest of the sizes being used in the plant.
- Preconditioning of fire stop test specimens

  Before conducting the Fire Rating and Hose Stream tests, each test specimen shall be preconditioned for thermal ageing, water immersion and vibration.
- Test on Fire Stops

  During the Fire Rating test, the transmission of heat through the cable penetration fire stop shall not raise the temperature on its unexposed surface above the self ignition temperature of the outer cable covering, the cable penetration fire stop material, or material in contact with the cable penetration fire stop, with a maximum temperature limit on the unexposed surface of 200^0C.

Earthing and Lightning Protection System

Earthing and lightning protection system shall comply with the following International Standards, including those referred to therein.

ANSI / IEEE Std. 80 and 142, IEC 61024 and IS 2309, 3043.

The scope includes measurement of electrical soil resistivity (during dry season) at site, supply of earthing conductors, earth electrode pits, lightning protection system and their installation including associated civil work as per the specifications and approved drawings, to the satisfaction of the Employer or their representative 's Representative. The scope of works shall also comprise designing the earthing and lightning protection systems as per the applicable standards and specific design basis listed below:

- Average value of soil resistivity as measured for different electrode spacing, at site. (from 2 to 100 Meter or more in steps of 5, 10 Meter. At least 20 nos. readings shall be taken over the plant area, each in two different directions)
- Permissible values of step and touch potentials based on weight of human being as 70 kg and Earth fault current of 40 kA for 1 seconds

- Gravel with surface resistivity of 3000 ohm-m
- Depth of burial of earth conductors of 600 mm below ground level
- Ground resistance with only electrodes of maximum 1 ohm.
- Ground resistance of earthing grid of maximum 1 ohm
- Corrosion allowance of at least 20 %
- Earthing conductor material shall be minimum 20 mm diameter and 3 m long GI Pipe.
- Earthing system design and calculations shall be subject to Employer or their representative's approval.
- Earthing and lightning protection system shall be provided to ensure equipment safety, personnel safety and to facilitate designed operation of protective devices during earth fault conditions in the associated system.
- The Contractor shall install bare earth conductors as required for the system and individual equipment earthing. All the work such as cutting, bending, supporting, drilling, brazing / soldering/welding, clamping, bolting and connections to structures, equipment frames, terminals or other devices shall be in the Contractor's scope. All hardware and consumables such as fixing cleats / clamps, anchor fasteners, lugs, bolts, nuts, washers, brazing electrodes, flux, bituminous compound, anti-corrosive paint, etc. as required for the complete work shall be included by the Contractor.
- Tap connections (earthing leads) of more than 500 mm long, from main earthing grid to equipment shall be embedded in the floor by the Contractor together with associated civil work such as chipping / chasing, concreting and surfacing, etc. The concrete cover over the conductor shall not be less than 50 mm.
- The scope of installation of earth conductors in outdoor areas, buried in ground shall include excavation in earth up to 600 mm depth and 400mm width, laying of conductor at 600 mm depth, brazing as required of main grid conductor joints as well as riser's up to 500 mm above ground at required locations and backfilling. Backfilling material to be placed over buried conductor shall be free from stones and other mixtures. Backfill shall be placed in layers of 150 mm, uniformly spread along the trench and compacted. If the excavated soil is found unsuitable for backfilling, the Contractor shall arrange for suitable material from outside. Earthing conductors in outdoor areas shall be laid 1500mm away from buildings. The scope of installation of earth conductors in outdoor areas buried in ground, shall include excavation of earth up to 600 mm depth, brazing / welding of main grid conductor, joints as well as risers of length 500 mm above ground at required locations and then backfilling.
- Wherever earthing conductor crosses underground service duct and pipes, it shall be laid 300 mm below them. If the distance is less than 300 mm, the earthing conductor shall be bonded to such service ducts / pipes.
- The scope of installation of electrodes shall include installation of electrodes in constructed earth pits, and connecting to main buried earth grids. The scope of work shall include excavation, construction of the earth pits including all materials required for treatment (salt, charcoal, chemicals, etc.), placing the electrode and connecting to main earth grid conductors.
- 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 preferably before the floors / columns / walls are cast. The

embedded conductors shall be connected to reinforcing rods wherever necessary.

- The scope of installation of earthing leads to the equipment and risers on steel structures / walls shall include laying the conductors, brazing / cleating at specified intervals, brazing to the main earth grids, risers, bolting at equipment terminals and coating brazed joints by bituminous paint.
- Earthing and lightning protection system conductors along their run on walls / columns, etc. shall be cleated at an interval of 750 mm.
- Main earthing conductor shall be buried below the trench at crossing points.
- Metallic frames of all electrical equipment shall be earthed by two separate and distinct leads and then connected with earthing system.
- Neutral of a transformer shall be earthed to two separate earth electrode pit by two separate earth leads.
- Crane rails shall be connected to the earthing system.
- An earthing mat shall be provided under the operating handle of the disconnector. Operating handle of the disconnector and the supporting structure shall be bonded together by a flexible connection and connected to earth grid.
- Metal pipes and cable conduits shall be effectively bonded and earthed by earthing clamps efficiently fastened to the conduit at both ends.
- Neutral connection shall never be used for equipment earthing.
- A separate earth electrode shall be provided for each lightning arrester and for each lightning conductor down comer.
- Cable sheaths and screen shall be bonded to the earthing system.
- Armour of multicore cables shall be bonded to earthing system at both ends, while that of single core cables shall be earthed at source end only. The size of conductor for bonding shall be appropriate with the system fault current.
- Conduits, fixtures, junction boxes, etc. shall be bonded to the earthing system by 16 SWG diameter copper wire looped from lighting panel earth bus onwards. Outdoor lighting poles, junction boxes, etc. shall be earthed by 12 SWG copper wires.
- Street light pole and junction box shall be earthed with 12 SWG tapped off from the 25x3 mm GI earthing conductor to be laid along the street lighting cable.
- All metallic parts such as transformer, fence, gate, etc. shall be properly earthed.
- Wherever earthing conductor passes through walls, galvanized steel pipe sleeves shall be provided for the passage of earthing conductor. The pipe ends shall be sealed by the Contractor, by suitable water-proof compound. Water stops shall be provided wherever earthing conductor enters the building from outside below ground level.
- All connections in the main earth conductors buried in earth / concrete shall be brazed type. Connections between main earthing conductor and earth leads shall also be of brazed type. Connection between earth leads and equipment shall be by two bolts.

- Installation of lightning conductors on the roof of buildings shall include laying, anchoring, fastening and cleating of horizontal conductors, grouting of vertical rods wherever necessary, laying, fastening / cleating / brazing of the down comers on the walls / columns of the building and connection to the test links to be provided above ground level.
- Lightning protection system down-conductors shall not be connected to the conductors of safety earthing system above ground level. The lightning protection system for the structures shall be installed by forming a grid of exposed continuous earth conductors and taking down-comers along the walls/supports of the structure and terminating the same at earth pits. A separate earth electrode shall be provided for each lightning arrester and for each lightning conductor down comer. The lightning protection system earth pits shall be inter-connected to form the safety earthing grid provided for the building / structure. The safety earthing grid shall be connected to the mains grid of the switch yard.
- The lightning protection air termination rods and / or horizontal air termination conductors shall be fixed in a firm manner. The necessary accessories such as cleats, clamps, brazing materials, bolts, nuts, shall be supplied by Contractor.
- Air termination systems shall be connected to earthing system by down conductors. There shall not be any sharp bends, turns and kinks in the down conductors.
- All joints in the down conductors shall be of brazed type. All metallic structure within 1 meter of down conductors shall be bonded to lightning protection system.
- Every down conductor shall be provided with a 'test link' mounted on wall / column at about 1000 mm above ground level housed in a 16 SWG GS enclosure. The test joint shall be directly connected to the earth electrode.
- The lightning protection system shall not be in direct contact with underground metallic service ducts, cables, cable conduits and metal enclosures of electrical equipment. However, all metal projections, railings, vents, tanks, etc. above the roof shall be bonded together to form a part of roof grid.
- Lightning protection system down conductors shall not be connected to other earthing conductors above ground level. In addition, no intermediate earthing connection shall be made to lightning arresters and transformer, whose earthing leads shall be directly connected to electrode pit.

✓ ***Earth Electrodes and Pit***

- Treated earth pits shall comprise of treatment material such as salt and charcoal or any other conductivity enhancing compound. Treatment material placed around the electrode shall be finely graded, free from stones and other harmful mixtures. Backfill shall be placed in 150 mm thick uniformly spread and compacted layers. If excavated soil is found unsuitable for backfilling, the Contractor shall arrange for a suitable soil from outside.
- Earth electrodes shall be fabricated from minimum 20 mm diameter, 3m long, copper rod or 40 mm diameter, 3m long GI pipe. The minimum spacing between adjacent electrodes shall be 6 m. Design and constructional details of electrode pit shall be subject to the Employer or their representative's Representative approval.

- Electrodes shall, as far as practicable, be embedded below permanent moisture level.
- Test pits with concrete covers shall be provided for periodic testing of earth resistance. Installation of 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 works such as excavation / drilling and connection to main earth grid. Earth electrode pit marker shall be provided.
- Treated earth pits shall be treated with suitable treatment material mentioned above, if average electrical resistivity of soil is more than 20 ohm meter.

Conductor size for connections to various equipments shall be as per the table as follows:

Equipment		**Conductor Size**
Motors	Up to 11 kW 11 kW up to 22 kW 22 kW up to 37.5 kW 37.5 kW to 90 kW 90 kW to 200 kW Above 200 kW	8 SWG GI wire 4 SWG GI wire 25 x 3 mm GI flat 25 x 6 mm GI flat 40 x 6 mm GI flat 50 x 10 mm GI flat
PCC		50 x 6 mm GI flat
PDB		50 x 6 mm GI flat
DG and other panel		50 x 6 mm GI flat
Local control station, street light pole and its junction box		8 SWG GI wire
All switchyard equipment		50 x 6 mm GI flat
Main earth grid		50 x 6 mm GI flat
Lighting Panel		25 x 3 mm GI flat
Indoor fixtures		14 SWG GI wire

All paint, scale etc. shall be removed before earthing connections are made.

Anchor bolts or fixing bolts shall not be used for earthing connections.

DG Set

Each load center shall be provided with a DG Set as a standby power backup for 100% load. DG sets up to 1000 KVA capacity are required to be supplied with acoustic enclosure as per CPCB norms.

DG Set with acoustic enclosure shall preferably be installed outside the building. However, DG set shall be as near to the substation as possible i.e. as near to Essential LT Panel as possible.

Associated AMF panel/ Electrical panel of the DG Set can be located inside the acoustic enclosure or outside the acoustic enclosure as per manufacturer standard. All other specifications shall be in line with CPWD specifications.

5.5.3.9 Instrumentation Specifications

(A) General

Employer wants to have latest technology with compatible automation system having fully automatic process control, ON LINE to monitor and control the plant from a single location. Typical control system architecture is enclosed with bid

which is to be strictly followed by Contractor/ Contractor while designing the control system and instrumentation. The plant data collected through online monitoring of sewage quality and desired plant monitoring parameters shall be made available via suitable means of data communications to third party integration..

The Contractor shall provide, install, test and commission all instruments (online and laboratory) and local panels required for proper operation of the works. Details of instruments associated with the actual waste water treatment processes are in some instance given in the relevant sections of the specification. The Contractors are advised to diligently go through the complete tender document and quote instruments accordingly. The Contractor shall include in their bid a list of instruments / devices showing compliance to agencies such as ISO, BIS, EPA, etc. as applicable.

The instrument proposed for each application shall be of reputed make with latest technology and that which in the opinion of the Contractor and the manufacturer is most appropriate subject to EMPLOYER approval. In addition to the above criteria, the instruments offered shall be of approved make of EMPLOYER and the selection of instruments shall minimize the quantity and multiplicity of spares required to facilitate ease of maintenance and servicing.

(B) Aim

Using the latest technology for ON LINE monitoring and control of various parameters EMPLOYER hopes to achieve following aim:

- Improvement in effluent quality
- Proper monitoring and correction
- Low manpower
- Generation of all faults and trends
- Correct display of input raw material and output treated effluent
- Long term historical storage of process data
- Analysis and graphical plots of historical data
- Prevention maintenance management
- Inventory control
- Maintain plant operation summaries
- Improve plant efficiency and increase the plant life
- Maintain records of pumping through flow meters

(C) Scope

This part covers the general requirements for the design, supply, installation, inspection and testing of the instrumentation and automation solution proposed for flow measurement, monitoring of waste water quality and control of plant and flow in the Amanishah Drain.

(D) Reference Standards

Unless otherwise approved, instrumentation shall comply with relevant quality standards test procedures and codes of practice collectively referred to as Reference Standards in accordance with the requirements detailed elsewhere in this specification. IEC 60381-1:1982 Analogue signals for process control systems.

(E) Statement of Compliance

The Contractor shall provide a list of the reference standards used and shall provide a compliance/non-compliance statement for all the online and lab instruments proposed.

All standards which the Contractor intends to use but which are not referenced herein shall be submitted to the Employer's Representative for consent before any design against that standard proceeds. Installation works shall comply with all relevant local Indian Regulations including the National Electrical Code

(F) Submissions by Contractor

General

The Contractor shall make submissions to the Employer's Representative of all design drawings and schedules relating to instrumentation and control equipment and systems provided under this Contract. These submissions shall include, where relevant, the following:

Functional Design Specification

The Contractor shall submit a complete functional design specification (FDS) for approval by the Employer's Representative. This document shall serve as the primary mechanism by which the Employer's Representative may confirm that the Contractor possesses an accurate understanding of the system and its control requirements. The Contractor is encouraged to obtain clarifications and to suggest refinements to the control descriptions contained in this Specification. The FDS shall comprise an overall description of the plant, its functioning and control, and a detailed description of each section of the control system covering modes of operation, manual overrides, set-point and parameter selection and adjustment. The detailed description shall include a step-by-step control description which defines the function of each piece of equipment and each control action and interlock, including details of the program in each programmable item. The format of the program details may be chosen by the Contractor, however it is suggested that this format be chosen to satisfy the requirements of the software design documentation, if applicable, as described elsewhere.

The FDS shall describe the 'fail-safe' features incorporated into the design for the event of failure of a plant item or system, or loss of an input signal affecting a control loop or process sequence.

The FDS shall describe control actions taken and monitoring functions which remain available during a power failure, and any automatic controls or sequencing which take place during system start-up and shut-down.

The FDS shall be presented in a clear and precise manner and shall include figures or drawings where appropriate. The Contractor shall submit and obtain approval of the FDS from the Employer's Representative before beginning the detailed control system design. The Contractor should take note of the importance of this obligation.

Drawings and Schedules

- Process and instrumentation diagram which shall comply with BS 1646 (all parts) and BS 1553-1:1977.
- General arrangement drawings of field-mounted instruments showing installation details.
- General arrangement drawings of instrument and control panels, fully-dimensioned in plan and elevation views, showing foundation and fixing

details, access doors, clearances, cable-entry positions, weight and lifting arrangement.

- Layout drawings of panel fascias showing instruments, controls and details of all labels.
- Layout drawings of panel interior showing equipment, terminal blocks and cable ways.
- Annunciator arrangement and engraving details.
- Internal circuit and wiring diagrams for instrument and control panels.
- Schematic control diagrams.
- Instrument loop diagrams.
- Instrument wiring and piping diagrams.
- Interconnection wiring diagrams.
- Cable block diagrams, drawings and schedules.
- Instrument system and panel power distribution diagrams.
- Programmable-device functional design specifications which shall include hardware details, logic flow charts, ladder diagrams and program listings.
- Schedules of inputs to and outputs from programmable controllers and telemetry outstations.
- Labelling schedules.
- Comprehensive testing schedules for all off-site, on-site, pre-commissioning and commissioning tests and take-over tests.
- All other drawings necessary for the provision of ducts, openings, trenches, fixing holes for panels and the like and for the complete understanding of the operation, maintenance and extension of the system including any required for the Purchaser to dismantle, repair, maintain, modify or extend the Plant during the O&M period.

Data and Calculations

- Manufacturer's catalogues and data sheets
- Calculations to support control system design
- Specification for protective coatings and painting
- Certificates
- Manufacturer's works tests
- Pre-installation checks
- Pressure-testing schedules
- Instrument loop test check sheets
- Installed instrument performance tests
- System tests
- Statutory certificates of compliance (such as hazardous area equipment)
- Operation and Maintenance Instructions
- Composite manual describing the functional and operation of each piece of equipment.
- Composite manual for testing and servicing every system and individual item.

Basic Features

Each instrumentation system shall be designed, manufactured and installed to

achieve the following basic requirements:

- Basic Requirements
- To maintain the highest standards of availability, reliability and accuracy and to give clear warnings of any deterioration in performance
- To suit the abilities of the staff who will:
- Use the systems
- Service the systems
- To measure, indicate, process, store and control the relevant parameters, as specified
- To give clear warnings of dangerous and other abnormal conditions and to initiate plant safety procedures, shutdowns and corrective measures as specified to assure the safety of 'operations and maintenance' personnel and that of the plant and to store and collate the data, as required
- To derive, present and utilize, as required, such additional data to facilitate:
- The most efficient operation of the plant
- The routine maintenance of the plant

(G) Design Requirements for Instrumentation and Control Systems (I&C)

The instrumentation, control and automation installations shall fully comply with design standards, regulations and the material and workmanship requirements of the Specification. The instrumentation control and automation systems shall comply with the relevant Indian Standards being practiced as per the industry norms. All consumable items and spare parts shall be readily available within India.

All equipment and materials incorporated in the system shall be selected, designed and rated to operate under the defined performance duties and specified site conditions and to maintain a high level of operational reliability. The instrumentation control and monitoring system equipment and materials shall have an operational life of not less than 15 years, unless otherwise consented to by the Employer's Representative.

Unless otherwise specified, all functions shall be transmitted electrically and all analogue signal-transmission systems shall be in accordance with IEC 60381-1:1982 or equivalent and shall use a signal of 4 -20mA dc. Where possible, measuring systems shall be designed so that any necessary power supply is taken from the appropriate instrument panel. Transmitting devices shall have integral indicators to monitor the output signal or connections suitable for use with a portable test meter, and shall be capable of meeting the performance requirements specified in the appropriate part of IEC 60770-1:1999 or equivalent. Equipment mounted in enclosures shall be suitable for continuous operation at the maximum internal temperature possible in service, due account being taken of internally-generated heat and heat dissipated by other plant. All components shall be rated adequately and circuits shall be designed so that change of component characteristics within the manufacturers' tolerances shall not affect the performance of plant. All equipment shall be designed to operate without forced (or fan) cooling.

All measuring instruments shall have zero and span adjustment. Instruments not mounted in panels shall be supplied complete with all brackets, stands, supporting steelwork and weatherproof enclosures (separate from the instrument cases) necessary for securing them in their working positions and affording complete protection at all times including periods of servicing, adjustment, calibration and

maintenance. The installation arrangements for meters measuring conductivity, pH, dissolved oxygen, chlorine residual and ionic concentration shall include a sample bench and other facilities for operating portable test meters. Each installation shall incorporate a valve and pipe work for obtaining a sample representative of the fluid at the position of the permanent meter, tundish and drain. If the measuring and sampling points are remote from each other, the test and sample facilities shall be provided at both points. Sample transport times shall be minimized by provision of a bypass and drain with control and isolating valves and a local flow meter to enable the correct sample flow to be adjusted. An automatic portable sampler shall be provided for collecting and transporting the samples from the sampling locations to the laboratory.

Instrument Design Criteria

The design criteria to be applied to instrumentation system shall be as follows:

- Instrumentation & Control (I&C) systems shall be selected, designed, manufactured, installed, tested and rated to operate under the defined performance duties and specified site conditions and to maintain a high level of operational reliability. Instruments mounted in field and on panels shall be suitable for continuous real time operation. All electronic components shall be adequately rated and circuits shall be designed so that change of component characteristics shall not affect the plant operation.
- All I&C equipment shall be new, of proven design, reputed make and have data logging facility. Unless otherwise specified, all instruments shall be tropicalized. The outdoor equipment shall be designed to withstand tropical rain and shall be suitable for the worst environmental operating conditions. Wherever necessary space heaters, heat dissipaters, dust and weather proof cabinets shall be provided. Instruments offered shall be complete with all the necessary mounting accessories & safety features.
- No custom made hybrid type IC's [Integrated Circuits] shall be used in any circuit in instrumentation and control equipment. Any hybrid circuits or sealed modules or devices which do not have alternative manufacturer shall be disclosed in the Bid by Contractor, so that such devices can be included as component spares in sufficient quantity in advance and shall be deemed to be included in the bid price.
- Instruments and loggers provided shall be able to carry out continuous real time monitoring and logging of selected water quality parameters.
- All instrumentation shall be suitable for continuous real time operation and be powered through the UPS.
- The output of the transmitting instruments shall be 4-20 mA / 0-10V DC linear having two wire system
- After a power failure, when power supply resumes, the instruments and associated equipment shall start working automatically.
- Unless otherwise specified, the normal working range of all indicating instruments shall be between 80% and 120% of the rated value.
- The field instruments i.e. the instruments mounted outside the control panel shall be mounted at a convenient height i.e.at eye level. above grade platform.
- Unless otherwise stated, field mounted electrical and electronic instruments shall be weatherproof to IP-65 or better.
- The instruments shall be designed to work at the ambient conditions of temperature, humidity, and contamination that may prevail at site. The instruments shall be given enough protection against corrosion. All wetted

parts of instrument sensors shall be non – corrosive and suitable for use within sewerage environment.

- The performance of all instruments shall be unaffected for the ±10% variation in supply voltage and ±5% variation in frequency simultaneously.
- Unless otherwise specified, double compression glands shall be used for glanding the cable in field instruments and instrument control panel.
- All digital outputs shall be volt free.
- All probe type analyzers should be IP68 rated.
- All displays shall be of the digital type with no moving parts and should utilize back lit liquid crystal diode LCD/ LED technology.
- Instrumentation shall utilize solid state electronic technology and avoid the use where practical of any moving parts.
- Minimum maintenance requirements. The instruments selected shall be rugged and not require any consumables / filling solutions. Systems should be able to work with minimum power requirements.
- Lockable enclosure shall be provided for all the field mounted instruments.
- All the instruments and cabinets shall have tag plates / name plates permanently attached to them.
- All instruments to be used or installed within a corrosive sewerage environment shall be Explosion Proof and Intrinsically Safe.
- Unless otherwise specified, all continuous online monitoring instruments shall be plug and play type.
- Instrumentation system shall be provided to monitor the following parameters
- Online Continuous Dissolved Oxygen Measuring System
- Ultrasonic Level Measurement
- Ultrasonic Differential Level Measurement
- Ultrasonic Open Channel Flow Measurement at Parshall Flume
- Pressure Transmitter
- Continuous Online Total Suspended Solids Analyzer
- Online Residual Chlorine Measuring System
- Indicative BOD Analyzer
- Electro-Magnetic Flow Meter

(H) Type of Instrumentation

Online Instruments

The online measurement would be done at various locations within the plant. The location wise instrumentation shall be followed as per the requirement of different process.

Ultrasonic Flowmeter – Open Channel

The open channel flow meter should employ ultrasonic principle to measure level and level to flow conversion should be inbuilt in the unit. Ultrasonic flow measuring system shall consist of flow sensor / transducer, flow computer and flow transmitter. The flow transmitter shall be coupled with an ultrasonic level sensor for emitting and receiving ultrasonic waves and signal conditioning & flow compounding unit. The unit shall be suitable for installation in corrosive environment and shall be unaffected by H2S laden atmosphere.

Flow transducers shall be rugged in construction and shall be suitable for continuous operation. Flow transducers shall have waterproof construction and shall be suitable for installation in underground/ above ground pipeline.

The design and application of ultrasonic level meter shall take into account the channel construction, the material size, shape, environment, process fluid or material, the presence of foam granules, size etc. To avoid the effects of disturbances in the velocity profile, a straight and uninterrupted run, upstream as well as downstream from the location of the flow sensor shall be provided in accordance with the requirements of the flow meter manufacturer.

The flow transmitter shall be suitable for field mounting and shall accept an input from the flow sensor. It shall process the input signal and provide isolated 4-20mA/0-10VDC output proportional to flow rate. The flow range shall be adjustable.

Flow measurement shall not be affected by physical properties of waste water viz., temperature, pressure, viscosity, density etc., within given limits. The system should have inbuilt temperature sensor for automatic compensation for changes in air temperature to ensure measurement accuracy. Contractor shall provide additional compensating electronic circuits if required. The installation shall avoid any degradation of performance from spurious reflections, absorption, sound velocity variations, sensor detection area, temperature fluctuation, specific gravity changes and condensation. For application where spurious reflections are unavoidable the control unit shall be provided with facilities for spurious reflection rejection. The structure required for supporting the level sensor, platform, railings etc. shall be in the Contractor's scope.

Measuring Principal	Ultrasonic
Application	H2S laden atmosphere and other poisonous gases, Corrosive Waste Water Environment
Safety	Explosion Proof or Intrinsically Safe
Range	2 Meters
Accuracy	± 0.5% of measured value or better Mounting
Sensor	Installation in open channel (above Parshall Flume)
Transmitter / Controller	Wall, Panel, Pole Protection Category
Sensor	IP-65
Transmitter / Controller	IP-66 (NEMA 4X)
Transmitter / Controller Type	Microprocessor Based
Diagnostic	Inbuilt
Display	LCD with LED backlighting
Power Supply	230 V AC ± 10%, 50 Hz
Analog Output	Isolated 4 – 20mA
Relay Contacts	Minimum of 3 SPDT contacts
Zero & Span	Field Adjustable
Operating Temperature	0 to 50°C
Temperature Compensation	Inbuilt temperature sensors for automatic compensation for changes in air temperature
Communication Protocol	Open Protocol like MODBUS, PROFIBUS, etc.
Sensor Cable	Integral to sensor
Cable Length	As per site requirement

Electromagnetic Flowmeter

Flow meters shall operate on the electromagnetic induction principle and shall consist of a measuring sensor and measuring transmitter complying with ISO 6817:1997. Measuring sensors shall have a full bore stainless steel metering tube and non-conductive, abrasion-resistant lining to suit the fluid being metered. The lining of material can be of polyurethane. No rubber lining will be allowed. The flow meter shall have flanged connection. Measuring sensors shall have factory-sealed power and signal cables. Unless otherwise specified, the cable lengths shall be sufficient to permit termination external to the chamber, either at a junction box or at the measuring transmitter. Remote flow indicator cum integrator shall be provided on the control panel.

Measuring sensors installed within a chamber shall be suitable for indefinite submersion under a head of water equal to the chamber depth or 3 meters whichever is the greater. Measuring sensors shall be installed on a steel cradle or concrete plinth with upstream and downstream straight pipe lengths not less than those recommended by the manufacturer. When fitted in lined non-metallic or internally-coated pipe work, measuring sensors shall have an earthing electrode or corrosion-resistant earthing rings. To ensure full electromagnetic compatibility the flow tube flanges and transmitter housing shall be connected earth.

Measuring sensors shall be bonded by tinned copper braid links at each end to the adjacent pipe work to ensure a good connection between the body and the metered liquid. Measuring sensors installed in a catholic protected pipeline shall have isolation and bonding in accordance with the recommendations of the manufacturer. The measuring transmitter shall provide a precise current input to the field winding of the measuring sensor and shall convert the resultant signal from the electrodes to analogue and pulse outputs in accordance with IEC 60381-1:1982. The signal processing facilities of the converter shall ensure that the output signals are unaffected by interfering voltages, stratified flow, changes in fluid electrical conductivity within the limit stated, non-homogeneity of the fluid and the presence of ferrous particles. The zero and output signals shall be unaffected by partly-fouled electrodes.

The following measuring transmitter features shall be provided as a minimum; additional requirements may be stated elsewhere in the Specification.

Measuring Transmitter Features

- Pulsed D.C. field excitation
- Scaled pulse output for integration counter drive
- Capability of bi-directional measurement with differing forward and reverse ranges and with local and remote indication of flow reversal
- Contact operation at a programmable measured value
- Integral display of flow and integrated quantity
- Galvanic isolation between each output circuit and between the electrode circuit and output circuit
- Output circuit isolation from earth within the instrument but suitable for earthing at any point in the external circuit
- Key entry for basic parameters
- Commissioning and re-scaling to require no special programming knowledge
- Adjustable low flow cut-off

Self-diagnosis

- Continuously adjustable velocity and flow range settings
- Terminals accommodated in a compartment separate from electronic components
- Outputs including: analogue - 4-20mA
- Pulse - two programmable outputs
- Alarms - two outputs programmable for high/low
- Flow, polarity, forward/reverse, instrument fault, liquid sensing fault condition including partially empty pipe

Measuring Principal	Electromagnetic
Type	Pulsed DC
Application	H_2S laden atmosphere and other poisonous gases, Corrosive Waste Water Environment
Safety	Explosion Proof or Intrinsically Safe
Metering Tube	SS 304
Sensor Housing	SS 304 fully welded
Connection / Junction Box	SS 304
Lining Material	PTFE/Polyurethane
Range	As per site requirement
Accuracy	± 0.5% of flow rate at maximum mean velocity of1.5 to 3.0 m/sec
Electrode Type	Flush or bullet nose as recommended by the Manufacturer
Earthing Ring/Electrode Material:	Type 316 stainless steel Protection Category
Sensor	IP-68
Transmitter / Controller	IP-65
Transmitter / Controller Type	Microprocessor Based
Display	Indicating and totalizing
Indicator	Digital 16-character display
Totalizer	Digital 16-character display
Mounting	Pipe, wall, panel
Diagnostic	Inbuilt
Power Supply	230 V AC ± 10%, 50 Hz
Analog Output	Isolated 4 – 20mA / 0-10VDC output based on the flow rate
Zero & Span	Field Adjustable
Turndown Ratio	Minimum of 10 to 1 when flow velocity at minimum flow is at least 0.3 metres per second
Zero Stability Feature	Required to eliminate the need to stop flow to check zero alignment
Pressure Loss	Very Low
Removable Electrodes	Required
Flange Material	Carbon steel, Epoxy Coated
Empty Pipe Detection	Inbuilt
Operating Temperature	0 to 50°C
Temperature Compensation	Inbuilt temperature sensors for automatic

	compensation for changes in air temperature
Communication Protocol	Open Protocol like MODBUS, PROFIBUS, etc.

- **Level Measuring System**

Ultrasonic Level Meters

Ultrasonic level measuring devices applied for liquid level measurement shall comprise of level sensor / transducer, level transmitter, digital level indicator / remote indicator, control unit and any other items required to complete the level measuring system.

The transducer shall be suitable for flange or bracket mounting as required. To reduce the effect of sewage turbulence in wet wells / tanks, averaging facility should be provided in the transmitter unit for providing steady readings.

The design and application of the ultrasonic level measuring system shall take into account the vessel / sump / wet well / channel construction, the material, size, shape, environment, process fluid or material, the presence of foam, granules, size etc.

In case of ultrasonic level sensor, the installation shall avoid any degradation of instrument performance due to spurious reflections, absorption, sound velocity variations, sensor detection area, temperature fluctuations, specific gravity changes and condensation. For applications where spurious reflections are unavoidable the control unit shall be provided with facilities for spurious reflection rejection. If turbulence exists, shielding, stilling tubes or other measures shall be provided to avoid effects on the measurement.

Measuring Principal	Ultrasonic
Application	H2S laden atmosphere and other poisonous gases, Corrosive Waste Water Environment
Safety	Explosion Proof or Intrinsically Safe
Range	As required at site
Accuracy	± 0.25% of measured value or better
Resolution	2mm or 0.2 percent of range, whichever is greater
Blanking Distance	As short as 0.3 meters
Beam Angle	12 degrees or less
Temperature compensation	Integral Mounting
Sensor	Flange or bracket
Transmitter / Controller	Wall, Panel, Pole Protection Category
Sensor	IP-68
Transmitter / Controller	IP-66 (NEMA 4X)
Transmitter / Controller Type	Microprocessor Based
Diagnostic	Inbuilt
Display	LCD with LED backlighting
Power Supply	230 V AC ± 10%, 50 Hz
Analog Output	Isolated 4 – 20mA
Relay Contacts	Minimum of 3 SPDT contacts
Zero & Span	Field Adjustable
Operating Temperature	0 to 50°C
Communication Protocol	Open Protocol like MODBUS, PROFIBUS, etc.

Sensor Cable	Integral to sensor
Cable Length	As per site requirement

Ultrasonic Differential Level Measurement

The ultrasonic type differential level measuring system shall consist of ultrasonic type level sensors on upstream and downstream of screens, differential level computer / transmitter and indicator. The flow computer / transmitter shall be microprocessor based and shall have facility for programming (i.e. adjustment of set points) while the sensor shall be capable of adjustable datum setting facilities.

The differential level control shall be done by two ultrasonic sensors, one before and one after the screen to sense the differential level through the screen and give a signal to the control to start the screens operation as soon as a preset differential level is reached. After receiving the level signal the control shall start and operate the screen as long as the preset level difference appears.

Measuring Principal	Ultrasonic
Application	H_2S laden atmosphere and other poisonous gases, Corrosive Waste Water Environment
Safety	Explosion Proof or Intrinsically Safe
Range	As required at site
Accuracy	± 0.25% of measured value or better
Resolution	2mm or 0.2 percent of range, whichever is greater
Blanking Distance	As short as 0.3 meters
Beam Angle	12 degrees or less
Temperature compensation	Inbuilt Mounting
Sensor	Flange or bracket
Transmitter / Controller	Wall, Panel, Pole Protection Category
Sensor	IP-68
Transmitter / Controller	IP-66 (NEMA 4X)
Transmitter / Controller Type	Microprocessor Based
Diagnostic	Inbuilt
Display	LCD with LED backlighting
Power Supply	230 V AC ± 10%, 50 Hz
Analog Output	Isolated 4 – 20mA
Relay Contacts	Minimum of 3 SPDT contacts
Zero & Span	Field Adjustable
Operating Temperature	0 to 50°C
Communication Protocol	Open Protocol like MODBUS, PROFIBUS, etc.
Sensor Cable	Integral to sensor
Cable Length	**As per site requirement**

- **Pressure Measuring System – Pressure Transmitter**

Pressure measuring system shall measure pressure and transmit signal proportional to pressure. The system shall consist of a combined pressure transducer and transmitter, digital panel indicator, connecting pipe work, diaphragm seal and valves. Pressure measuring system shall be rugged in construction and shall be capable for with standing surge pressures likely to occur in the monitored system. Pressure transmitters shall have over range protection up to 1.5 times the maximum line pressure and shall be capable of withstanding full line pressure on any side with the other side vented to atmosphere without damage or effect on the calibration. No plastic material shall be used in their

construction. Internal parts shall be of stainless steel, bronze or approved corrosion-resistant material. Where necessary, a special diaphragm shall be used to segregate the corrosive fluid media. In ammonia applications, the diaphragm shall be in stainless steel. In chlorine applications, the diaphragm shall be in silver or tantalum. In Sulphur dioxide applications, the diaphragm shall be in tantalum.

The zero and span of a pressure transmitter shall not change by more than ±0.1% of the span per °C change in ambient temperature. After application for 10 minutes of pressure at 130% of maximum pressure, the change in zero and span shall not exceed ±0.1% of the span. Pressure transmitters shall be protected to BS EN 60529:1992, IP 65 standard or higher. For transmitters installed in locations liable to flooding or underwater applications, they shall be to IP 68 standard and shall operate up to a maximum submergence of 20 meters of water.

Parts	Transmitter and communicator
Type	Electronic variable capacitance; two-wire transmitter
Application	H2S laden atmosphere and other poisonous gases, Corrosive Waste Water Environment
Safety	Explosion Proof or Intrinsically Safe
Range	As required at site
Accuracy	± 0.25% of span or better
Humidity	0 to 100% relative humidity
Damping	Fluid or electronic type with adjustment
Indicator	LCD with LED backlighting
Materials	Wetted parts including process flanges and drain / vent valves, Type 316 stainless steel otherwise specified
Wetted O-Rings	Glass filled TFE, graphite filled PTFE, or Viton, unless otherwise specified
Fill Fluid	Silicone
Output	4 – 20mA DC output proportional to the pressure range
Mounting	Pipe or wall as specified. Provide stainless steel brackets with stainless steel bolts
Housing	Modular with separate compartments for electronics and field wiring termination. Epoxy coated aluminum, unless otherwise specified
Power Supply	230 V AC ± 10%, 50 Hz
Operating Temperature	0 to 50°C
Communication Protocol .	Open Protocol like MODBUS, PROFIBUS, etc

- **Dissolved Oxygen Measuring System - DO Analyzer**

DO Analyzers shall be installed to continually record the dissolved oxygen level at every grid within each aeration basin. The primary sensing device used for the dissolved oxygen level measurement, shall be a sensing probe mounted within the aeration basin and connected to a controller for displaying and transmitting the results

Measuring Principal	Optical
Application	H_2S laden atmosphere and other poisonous gases, Corrosive Waste Water Environment
Safety	Explosion Proof or Intrinsically Safe
Range	0 to 20.0 ppm, 0 to 20.0 mg/L
Accuracy	± 0.5% or better

Repeatability	±0.5% of span
Sensitivity	±0.5% of span
Pressure Limit	4 - 6 bar
Temperature Indication	Inbuilt
Calibration Method	Air Calibration: One point, 100% water saturated air;
Sample Calibration	Comparison to standard instrument, or comparison to Winkler Titration method
Cleaning	Air Blast Unit. Probe should be able to function with cleaning unit attached to it Mounting
Sensor	Inside aeration basin at each grid
Transmitter / Controller	Wall, Panel, Pole Protection Category
Sensor	IP-68 for Sensor
Transmitter / Controller	IP-66 (NEMA 4X)
Transmitter / Controller Type	Microprocessor Based
Diagnostic	Inbuilt
Display	LCD with LED backlighting
Power Supply	230 V AC ± 10%, 50 Hz
Analog Output	Isolated 4 – 20mA
Relay Contacts	Minimum of 2 SPDT contacts
Operating Temperature	0 to 50°C
Communication Protocol	Open Protocol like MODBUS, PROFIBUS, etc.
Sensor Cable	Integral to sensor
Cable Length	As per site requirement

- **Total Suspended Solids Measuring System - TSS Analyzer**

Measuring Principal	Optical
Application	H2S laden atmosphere and other poisonous gases, Corrosive Waste Water Environment
Safety	Explosion Proof or Intrinsically Safe
Range	0 – 50 mg/l, 0 - 1000 mg/l, 0 – 5000 mg/l
Accuracy	<5% of reading or better
Pressure Limit	6 bar
Flow Rate	Maximum 3m per second
Temperature Indication	Inbuilt
Calibration Method	Single point or two point
Cleaning	Inbuilt Mounting
Sensor	Inside pipe / channel / tank
Transmitter / Controller	Wall, Panel, Pole Protection Category
Sensor	IP-68 for Sensor
Transmitter / Controller	IP-66 (NEMA 4X)
Transmitter / Controller Type	Microprocessor Based
Diagnostic	Inbuilt
Display	LCD with LED backlighting
Power Supply	230 V AC ± 10%, 50 Hz
Analog Output	Isolated 4 – 20mA
Relay Contacts	Minimum of 2 SPDT contacts
Operating Temperature	0 to 50°C
Communication Protocol	Open Protocol like MODBUS, PROFIBUS,

	etc.
Sensor Cable	Integral to sensor
Cable Length	As per site requirement

- **pH Measuring System – pH Analyzer**

Measuring Principal	Combination / Differential Electrode
Application	H_2S laden atmosphere and other poisonous gases, Corrosive Waste Water Environment
Safety	Explosion Proof or Intrinsically Safe
Range	0 - 12 pH
Accuracy	±0.02 pH or better
Repeatability	±0.05 pH
Sensitivity	±0.01 pH
Pressure Limit	4 - 6 bar
Flow Rate	Maximum 3m per second
Temperature Indication	Inbuilt
Temperature Compensation	Inbuilt automatic temperature compensation
Temperature Accuracy	±0.5 °C
Calibration Method	Two point automatic, one point automatic, two point manual, one point manual
Mounting	
Sensor	Inside pipe / channel / tank
Transmitter / Controller	Wall, Panel, Pole
Protection Category	
For Transmitter / Controller	IP-66 (NEMA 4X)
Transmitter / Controller Type	Microprocessor Based
Diagnostic	Inbuilt
Display	LCD with LED backlighting
Power Supply	230 V AC ± 10%, 50 Hz
Analog Output	Isolated 4 – 20mA
Relay Contacts	Minimum of 2 SPDT contacts
Operating Temperature	0 to 50°C
Communication Protocol	Open Protocol like MODBUS, PROFIBUS, etc
Sensor Cable	Integral to sensor
Cable Length	As per site requirement

- **Residual Chlorine Measuring System – Residual Chlorine Analyzer**

Measuring Principal	Amperometric or DPD Colorimetric
Application	H_2S laden atmosphere and other poisonous gases, Corrosive Waste Water Environment
Safety	Explosion Proof or Intrinsically Safe
Range	0 – 10 ppm
Accuracy	±3% of the reference test or better
Resolution	0.001 ppm
Repeatability	30 ppb or 3%, whichever is greater
pH	Automatic
Temperature Compensation	Inbuilt temperature sensor
Temperature Indication	Inbuilt

Pressure Limit	0.5 bar
Flow Rate	Maximum 50 L/hour
Calibration Method	1-point or 2-point calibration
Mounting	Wall, Panel Protection Category
Sensor	IP-65
Transmitter / Controller	IP-66 (NEMA 4X)
Transmitter / Controller Type	Microprocessor Based
Diagnostic	Inbuilt
Display	LCD with LED backlighting
Power Supply	230 V AC ± 10%, 50 Hz
Analog Output	Isolated 4 – 20mA
Relay Contacts	Minimum of 2 SPDT contacts
Operating Temperature	0 to 50°C
Communication Protocol	Open Protocol like MODBUS, PROFIBUS, etc.
Sensor Cable	Integral to sensor
Cable Length	As per site requirement

- **BOD Measurement – Indicative BOD Analyzer**

Measuring Principle	UV Absorption
Application	H_2S laden atmosphere and other poisonous gases, Corrosive Waste Water Environment
Safety	Explosion Proof or Intrinsically Safe
Range	0 – 50 mg/l, 0 - 500 mg/l
Accuracy	± 5% or better
Compensation	550 nm
Sample pH	4.5 to 9 pH
Pressure Limit	0.5 bar
Cleaning	Automatic
Mounting	
Sensor	Inside pipe / channel / tank
Transmitter / Controller	Wall, Panel, Pole
Protection Category	
Sensor	IP-68
Transmitter / Controller	IP-66 (NEMA 4X)
Transmitter / Controller Type	Microprocessor Based
Diagnostic	Inbuilt
Display	LCD with LED backlighting
Power Supply	230 V AC ± 10%, 50 Hz
Analog Output	Isolated 4 – 20mA
Relay Contacts	Minimum of 2 SPDT contacts
Operating Temperature	0 to 50°C
Communication Protocol	Open Protocol like MODBUS, PROFIBUS, etc.
Sensor Cable	Integral to sensor
Cable Length	As per site requirement

- **Laboratory – Laboratory Instruments and Sampling System**

There shall be one laboratory for the entire system. The laboratory shall be housed within the Central Control building and shall be equipped with instruments, equipment, chemicals and other infrastructure that is necessary to perform the routine analysis for the parameters as detailed in table below. The equipment

shall be supplied with all the accessories that are necessary to make the equipment functional for analyzing parameters and generating daily reports. In addition to these, Contractor shall also provide necessary chemicals, glassware and reagents required for sample testing in the laboratory along with calibration standards / solutions for calibrating the instruments.

The quality of the sewage entering, passing and leaving the treatment plant shall be monitored via online monitoring equipment as well as manual sampling systems and tested daily while developing appropriate correlation between on-line parameters and that measured in the laboratory.

Parameters

Sl. No.	Parameter
1.	Biochemical Oxygen Demand - (BOD_5 or BOD_3)
2.	pH
3.	Suspended Solids
4.	Temperature.
5.	Chemical Oxygen Demand – (COD)
6.	Ammonia
7.	Total Phosphorous
8.	Acidity/Alkalinity
9.	Total Kjeldahl Nitrogen (TKN)
10.	MLSS/MLVSS
11.	Dissolved Oxygen (DO)
12.	Sludge Volume Index (SVI)
13.	Total Hardness, Calcium Hardness
14.	Gas Analysis
15.	Calorific Value Monitoring
16.	Volatile Suspended Solids (VSS)
17.	Total Solids (TS)
18.	Specific Gravity (Sg)
19.	Moisture Content
20.	Total Coliform
21.	Fecal Coliform
22.	Total Dissolved Solids (TDS)
23.	Bacteria, Escherichia Coli

Three nos. portable samplers shall be provided to collect composite samples for monitoring from

- Inlet chamber for raw sewage
- At the outlet of treated effluent
- In the water way of Amanishah Drain

The laboratory shall have sufficient space to house equipment, storage space for chemicals and space for all the chemical and bacteriological routine analyses. The laboratory shall have sufficient length of working platforms and adequate no. of sinks. Area of laboratory shall be defined by Contractor as per the requirement but not less than specified in the bid document. At least the following equipment and all required laboratory chemicals / reagents given in below Table are to be provided by the Contractor within the scope of work and have to be replenished by him till the end of the O&M Period.

Lab Instruments

S N.	Description
1.	Comparator test set for residual chlorine or chloroscope
2.	Single / Multi parameter instrument for pH, Conductivity, DO, Ammonia and Phosphate
3.	Mains operated pH meter completed with one calomel electrode and glass electrode
4.	Turbidity meter - Bench Model
5.	Turbidity meter - Hand held (Portable)
6.	UV / VIS Spectrophotometer
7.	Water bath with 6 to 8 concentric holes and discs, electrically heated
8.	Hot plates – 25cm
9.	Ultrapure Water Plant
10.	Conductivity with TDS meter
11.	Refrigerator (280 litres capacity) double door / cooling cabinet for sample preservation
12.	Muffle furnace
13.	Electronic Burettes and Dispensers
14.	Magnetic stirrer
15.	Analytical balance (Electronic) with weight box – Resolution up to 4 decimal places
16.	Jar-Test apparatus – 6 Stirrers
17.	Centrifuge
18.	Flame photometer with gas cylinder
19.	Fume cupboard
20.	Field Test kit for cations and anions
21.	Depth Sampler
22.	Total Organic Carbon Analyser
23.	Sieve shaker with standard sieves and two pan balance weighing up to 200gm samples
24.	Hot Air Oven
25.	Autoclave
26.	Binocular microscope
27.	Automatic Portable Sampler
28.	Pipette Box (Stainless Steel)
20.	Wooden Racks/Aluminum Racks
30.	Wire Baskets
31.	Cotton/ Aluminum Foils
32.	Burners (Bunsen) With Pilot Lamp
33.	Suction Flask (1 Litre Cap)
34.	Suction Pump
35.	Sampling Bottles
36.	Measuring Cylinders (1000 Ml, 500 Ml, 200 Ml, 100 Ml, 50 Ml, 25 Ml)
37.	Vacuum pump
38.	Soxhlet extraction unit
39.	Kjeldhal digestion unit
40.	Weighing Balance (max 10kg)
41.	Laminar Air Flow chamber
42.	M. Endo Broth (dehydrated)

S N.	Description
43.	Lactose or Lauryl Tryptose broth
44.	Mac Conkey broth
45.	Brilliant Green Bile Lactose Broth
46.	Total Plate Count Agar
47.	Peptone / Triyptone Water
48.	BOD Analysis: Incubator, Reagents, etc.
49.	COD Analysis: COD Reactor – 15 Vials, Reagents, etc.
50.	Filtration assembly for suspended solids
51.	Incubator 44°C (Water/Air-Jacketed)

(I) Surge Protection Devices

Surge protection devices (SPDs) shall be suitable for withstanding the surge arising out of high energy static discharge / lighting strikes and protect the instrument to which it is connected against damage. SPDs shall provide protection through the use of quick acting semiconductors like Tranzorb, zener diodes, varistors and an automatic disconnect and reset circuit. SPDs shall be passive and shall require negligible power for operation. During the occurrence of a surge it shall clamp on the allowable voltage and pass the excess voltage to the ground. The SPD shall be self-resetting to minimize the down time of the measurement loop.

SPDs shall be provided to protect devices transmitting and receiving analogue and digital signals derived from field devices located outdoors.

The surge protection device shall be rated for surge rating of 10kA.

(J) Cabinets for Field Instruments

Wall mounted cabinets shall be provided for enclosing transducer unit and associated accessories which are mounted outside the main control panel. The cabinet shall be of die-cast aluminum; field provided not less than IP-65 protection and shall be lockable. The cabinet shall have facilities for earthing. A steel plate shall be provided inside the cabinet for mounting instrument and accessories.

(K) Panel Details

- **Cabinet / Enclosure for Instruments**

Enclosures shall be any form of board, cabinet, panel, desk, box or case used to protect, contain or group instrumentation, telemetry or control equipment. Cabinets shall be fabricated from cold rolled steel with powder coating sheet of minimum 2 mm thick and shall be suitable for wall mounting or pedestal mounting as required. A steel plate/pipe, as per the requirement, shall be provided in the cabinet for mounting the instrument and accessories. The cabinet shall be properly painted from inside and outside and shall have built in locking facility. The cabinet shall also be earthed properly. All equipment in or on enclosures shall be arranged logically and, as far as possible, symmetrically, with projections kept to a minimum. Each enclosure shall be designed on ergonomic principles and shall permit in-situ and safe access for any normal adjustment, maintenance and servicing. The tops of plant-mounted enclosures shall be sloped downwards from front to rear.

The minimum degree of protection shall be IP 54 for indoor locations and enclosures for use outside buildings or in places where splashing may occur shall have a minimum rating of protection to BS EN 60529:1992, IP 65 and have tops which project sufficiently to protect the vertical faces of the enclosure and any component mounted thereon from splashing, inclement weather and direct

sunlight. Also, when enclosures for use outside buildings are located where exposure to direct sunlight will give rise to high top-panel surface temperatures such that the internal temperature rises above the manufacturer's recommendation (normally 40°C), the enclosure shall include a sun shield fitted to the top of the enclosure and should have sufficient air ventilation for heat dissipation.

Fixing arrangements for surface-mounting enclosures shall be external to the enclosure and shall ensure that the rear face of the enclosure is not in contact with the surface to which it is fixed. Enclosures shall have hinged access doors, fitted with recessed lockable handles. Doors shall be of rigid construction and provided with close-fitting flexible seals in recesses to prevent the ingress of liquids, moisture, dust and vermin. Hinges shall be of the lift-off pattern and one hinge shall engage before the other for ease of fitting. Wherever necessary, removable access covers secured by quick-release fasteners shall be provided to ensure ease of maintenance for all installed apparatus. Mounting plates, brackets and racks shall be provided for all other internal equipment which shall be hinged or otherwise arranged with quick-release fasteners or captive screws to give quick and easy access to equipment, securing screws, terminals and wiring.

Enclosures for two or more devices with electrical circuits shall have gland plates and terminal blocks as specified elsewhere. Each enclosure shall be designed for the safe testing and servicing of equipment with the power on. Each part which may be live under any circumstances shall be so covered or shielded as to prevent inadvertent contact.

- **Panel Design and Construction**

Unless otherwise specified, all instrument panels, instrument cubicles, control panels, control consoles and desks, associated equipment and terminal racks, telemetry and electronic equipment racks and the like shall be free-standing, floor-mounted units and shall conform to the requirements of this part and will hereafter be referred to as panels. The design and dimensions of control consoles and desks shall be determined according to their intended function but shall be in accordance with the requirements of the Specification drawings. The height shall not exceed 1400mm above the finished floor level.

Unless otherwise specified or shown in the Specification drawings, the height of panels shall be not greater than 2130mm overall (excluding lifting devices) above finished floor level. Front-of-panel instruments and controls shall be mounted so that the height of their centers above the floor shall be generally between 1800mm and 900mm for indicators, 1400mm and 900mm for recorders and process controllers, 2000mm and 750mm for alarm facias and signal lamps and 1500mm and 750mm for manual controls. Controls, switches and push-buttons shall be positioned below or adjacent to any associated reading instrument. Panels for use in locations such as pumping stations and machinery rooms shall have anti-vibration mountings. The clearance between the extremities of apparatus mounted on the internal walls shall allow safe and unobstructed access to all terminals and to parts requiring maintenance. Panel layout drawings shall normally include a list of all instruments, accessories and components contained therein. If the drawings have insufficient space for the list, a separate schedule of instruments, accessories and components shall be provided and the panel drawing shall contain a cross reference to the contents list and an indication of the panel location of each item on the list.

- **Panels - Major**

Panels shall be constructed generally as specified in the preceding clause and as

shown in the Specification drawings. Panel material shall be prime-quality, cold-rolled and annealed mild steel or zinc-coated mild steel sheet, suitably braced and stiffened as necessary with flat bar or angle to form a rigid structure.

Panel fronts shall be flat and free from bow or ripple. Exterior corners and edges shall be rounded or welded and ground to give a smooth overall appearance. Flanged edges shall be straight and smooth. Materials shall be chosen with due regard to the panel size, number of cut-outs, instrument weight and position of centre of gravity and method of fabrication, with the following:

- minimum thicknesses except where otherwise shown in the Specification drawings
- instrument bearing surfaces, gland plates and pneumatic distribution plates: 3mm
- internal mounting plates: 3mm
- doors, covers and filler panels: 2mm

No design involving the use of externally-visible assembly or fixing bolts and screws nor any design resulting in dust or water-collecting crevices will be accepted. Stiffeners and supporting frameworks shall be provided where necessary inside panels. Framework shall be hinged or fixed, suitable for the installation of instruments, components and internal equipment for which it is provided and located to give easy access to adjacent equipment.

When a panel is constructed in sections, the sections shall be designed for ease of assembly during installation and, in any case, shall not exceed 2m in length. All necessary nuts, bolts, washers and the like shall be supplied and included in the same shipment as the relevant sections. Sections exceeding 1m in length shall be provided with double doors. Unless otherwise shown in the Specification drawings, each panel shall be mounted on a self-draining base frame fabricated from 150mm deep, steel channel section which shall be drilled or provided with clamps for bolting to the floor. The base frame shall be set back from the panel front face to give a toe space of not less than 25mm. The outside of the base frame shall be covered with an approved kicking strip.

Ceiling and other filler panels shall be fabricated from sheet steel and adequately stiffened. Each section shall have 50mm returned edges along all four sides and shall be braced to the main steelwork of the panel. A chequer-plate floor shall be provided inside and above the level of the base frame, having openings suitable for the bottom entry of cables when applicable. Sufficient removable undrilled gland plates, in sections convenient for handling, shall be fitted close to the appropriate terminal blocks and not less than 230mm above the panel floor or not less than 230mm below the panel top. The gland plates shall have removable side covers giving access to both sides of the gland plate and ensuring vermin-proof and dust-proof construction. Gland plates of a surface-mounted enclosure may form a part of the base or top. Panels containing pneumatic or other instruments using a fluid as the transmission medium shall have distribution plates with bulkhead unions for the termination of internal and external pipe work.

All doors shall open outwards and all doors in one panel assembly shall use the same lock and key combination. Panel design shall ensure adequate ventilation and air circulation without permitting the entry of vermin or dust. Panels installed in control rooms or other clean condition areas shall have louvres to allow air circulation. Temporary closures shall be provided to prevent the entry of dust and vermin during transit and installation. After commissioning has been completed, all entries except air-circulation louvres shall be sealed.

No equipment other than front-of-panel items shall be mounted on panel wall surfaces. If electrical and non-electrical instruments are mounted in the same panel, the panel shall be subdivided internally to separate the electrical and non-electrical sections. All connections shall be arranged to ensure that no accidental damage to cabling or electrical components can occur in the event of failure of any non-electrical component or connection. Provision shall be made for safe and easy handling during transit and installation. If lifting eyes are provided, they shall be reversible and panel tops shall be reinforced where necessary.

Where equipment is specified to be installed at a future date, space shall be allocated, and cutouts with removable masking plates, brackets, supports, wiring, terminals and piping and the like shall be provided. Panels shall be finish-coated at the place of manufacture before commencing the installation of apparatus and other fittings.

- **Panels - Minor**

Panels for installation on the Plant which contain relatively few items of equipment, or where so specified elsewhere, shall be classed as minor panels and shall be constructed generally as specified in the preceding clause and comply with this Clause. Panels shall be fabricated from sheet steel or other approved material less than 2.5mm thick suitably braced to form a robust and rigid structure. Exterior corners and edges shall be rounded to give a smooth overall appearance and assembly bolts, screws or rivets shall not be visible on the front face.

The design shall be such as to ensure adequate ventilation and air circulation where required, without permitting the entry of vermin. Openings for cables shall be made vermin-proof. Doors shall be hinged and shall be provided with close-fitting flexible seals in recesses to prevent the ingress of liquids, moisture, dust and vermin. Unless otherwise specified, panels shall be suitable for floor mounting and shall not exceed 2130mm in height. Where surface mounted panels are provided, the fixing shall prevent the ingress of moisture and the rear of the enclosure shall be not less than 10mm from the wall.

Lifting eyebolts shall be removed, issued to the Purchaser and subsequently replaced with bolts after installation. Panels shall be extensible, and symmetrically arranged as far as possible with projections kept to a minimum. Where two or more panels are fitted together, they shall form a flush-fronted continuous panel of uniform height. Front door and top cover dimensions shall match. Instruments, relays, and control devices shall be mounted at a height not more than 2000mm and not less than 300mm from floor level.

The arrangement of equipment within each enclosure shall be such as to permit easy access for installation and maintenance. No instruments, relays or other components shall be mounted on rear access doors or removable covers.

- **Panels - Composite**

In situations where space limitations preclude the use of separate instrumentation, control and automation (ICA) and switchgear panels and, at the sole discretion of the Employer's Representative, ICA equipment may be combined within a single enclosure subject to the following conditions:

- Enclosure
- The observance of all other clauses herein relating to enclosures, mounting boards and minor panels.
- The written assurance of each supplier of ICA equipment that the proximity of the switchgear will have no detrimental effect on the life or performance of any

ICA component

- The total segregation of ICA equipment and switchgear including the glanding and termination facilities.
- The absence of any voltage exceeding 250V ac or 50V dc from any compartment containing ICA equipment.
- The use of the full height of the panel (excluding the busbar chamber and cable space) for any ICA equipment compartment.

Panels - Glass Reinforced Plastic (GRP)

Any panel required to be installed outside buildings shall, unless otherwise approved by the Employer's Representative, be manufactured from double-skin, resin-bonded fiberglass, with a totally encapsulated infill of rigid weatherproof and 'boil proof' plywood to BS 1203:2001 between the two skins to provide a rigid and vandal-proof enclosure. The environmental rating shall be IP 65 or better.

For any application in a non-temperate climate or where so specified elsewhere, the roof section shall be sloping and have a totally-encapsulated infill of end-grain balsa instead of plywood. Box-section steel shall be encapsulated into door edges and door frames. Door locks, handles and hinges shall be of a high tensile strength, non-corroding alloy with stainless steel pins and through fixing bolts. Large plane surfaces shall have adequate reinforcing to ensure rigidity.

The doors shall be complete with latching handles and locks. All door catches and locks shall latch onto steel-reinforced surfaces. Threaded studs shall be incorporated into the design of the panel for the mounting of sub frames within the panel. Any panel drilled to provide fixings for internal equipment will not be accepted. Each cubicle shall be provided with a floor or deck with a removable gland plate for cable entry.

The laminate material shall have flame-retardant characteristics in compliance with BS 476 Class 2, and shall retain 'stability, integrity and insulation' for 30 minutes. Colour-impregnated gel coats backed by coloured resin shall be used to ensure maintenance free and 'colour-fast' finishes. The external finish colour shall be advised by the Employer's Representative and the internal finish colour shall be white. The fronts of externally-visible instruments and windows shall be of glass. An air-gap of 100mm shall be provided between the top surface of the panel and its protective canopy. All internal equipment shall be mounted on supports built into the fiberglass structure. Fixing bolts through the skin will not be accepted.

Panel Protection

Adequate facilities for isolation and protection by miniature circuit breaker or fuse for each instrumentation and control circuit and sub-circuit shall be provided and shall be so arranged that any interruption causes minimum disruption of plant, operates the appropriate alarm and cannot result in any unsafe operating condition. All fuses shall be of the cartridge pattern and main fuses shall be of the high rupturing capacity type. Fuse and solid-link carriers and bases shall be of plastic-moulded insulating material of an approved make. Ceramic materials will not be accepted. Live connections shall be efficiently shrouded and it shall be possible to change fuses with power on without danger of contact with live metal. The fuses shall be rated to give maximum protection to the equipment in circuit and the rating shall be permanently inscribed on the fuse label and on the fuse carrier.

Unless necessary for the protection of particular equipment, miniature circuit breakers used for individual circuits in a panel or control desk shall not trip on

over-voltage or under-voltage. Bases for solid links shall not be interchangeable with those for fuses. Fuses and links in the same circuit shall be mounted opposite each other in separate adjacent rows and shall not alternate in the same row. At least 10% and not less than two unallocated miniature circuit breakers or fuses and links shall be provided in each panel distribution board. Miniature circuit breakers and fuses of similar size and rating shall be of the same make and type. At least 10%, and not less than two, spare fuses and links of each rating shall be provided and fitted in clips inside the panel.

Each instrument requiring a power supply shall be individually wired and protected so that, in the event of a failure in one circuit, the remainder is unaffected. Power supply circuits shall be of sufficient rating that any protective device may operate without reducing the voltage at the terminals of any other component to an unacceptable level. Remote alarms shall be operated on failure of the electrical supply to a panel or to any internal sub-circuit. Clearly identifiable, switched socket outlets of 15A minimum rating to comply with IS 4615, supplied at the main cabinet operating voltages shall be fitted within the panel at the rate of one for each operating voltage per meter of panel length; for a panel whose length is less than one meter, one switched socket outlet for each main operating voltage shall be provided. Suitable socket outlets for portable tools and hand lamps shall be provided as specified elsewhere.

- **Panel Isolation**

Clearly-labelled isolating circuit breakers shall be provided for each incoming power supply. Switches shall be of the quick make-and-break type with spring-loaded contacts that close fully without requiring full operation of the handle. The handle and cover shall be interlocked so that the handle cannot be operated when the cover is open and the cover cannot be opened unless the switch is in the 'off' position. The 'on' and 'off' positions of each switch shall be indicated clearly.

Circuit breakers for panel power supplies shall be mounted near an access point and in positions where they may be operated easily from a standing position. Plug-in isolating links or devices of an approved type shall be provided in any circuit that may still be alive when the power supply isolators are in the 'off' position, as, for example, in circuits controlling equipment whose power supply is independent of the panel. Such links or devices shall be properly screened and, if not incorporated in or adjacent to their associated outgoing terminals, shall be labelled with suitable warning notices. Any item of panel equipment to which panel internal wiring is connected with a plug and socket instead of terminals shall be wired in flexible cable of adequate rating between the 'free' plug and a socket mounted adjacent to the device. The power supply connector shall be a socket.

- **Panel Terminal Blocks**

External wiring for panel power supplies shall be terminated on the appropriate isolator. Signal cables from strain gauges, analyzers, resistance thermometers, re-transmitting slide wires and thermocouples may be terminated at their appropriate instruments. A terminal block shall be provided as the interface between the corresponding conductors of each internal and external wire and each internal and external connection except those listed above. The terminal blocks shall be mounted vertically where possible and not nearer than 230mm to the floor or less than 230mm from an incoming cable gland.

Terminal block rows shall be spaced apart by not less than 150mm and arranged to permit convenient access to wires and terminals and to enable ferrule numbers to be read without difficulty. Other circuits shall be grouped on the terminal blocks according to the classification given in the clause for 'Panel internal wiring' which

shall be clearly marked along the corresponding section of each terminal board. Groups of different voltages on the same board shall be separated by insulated barriers.

All connections shall be made from the front of terminal blocks and no live metal shall be exposed at the back. All terminal blocks shall be of the type which clamps the wire securely and without damage between two plates by means of a captive screw and which permits removal of any terminal without disturbance to adjacent terminals. Pinch-screw type terminal blocks will not be accepted. Terminal mouldings shall be in melamine to ISO 2112:1990, polyamide or equivalent. Terminal rails shall be hot-dip galvanized. Current bars between the two connection points of each terminal block shall be of copper or brass with tin/lead alloy plating. All steel parts shall be zinc-plated and passivated with a yellow chromate layer.

Terminal blocks for input and output analogue signals and for circuits containing volt-free contacts internal or external to the cabinet shall be of the Klippon type SAKC or equivalent which permit the connection of a test millimeter or continuity meter without disconnecting any wiring. Terminal blocks for power supplies for equipment external to the panel shall permit the isolation of the item of external equipment without affecting the operation of any other circuit within or outside the panel.

No more than one core of external cables or one internal wire shall be connected to any terminal. If terminal blocks are used as common points for two or more circuits, individual terminals with the appropriate number of permanent cross-connections shall be provided. The lengths of exposed cable cores shall be sufficient to reach any terminal in the appropriate row or rows. The cores shall be formed into a neat loom and a separate loom shall be provided for each cable. Identification ferrules as specified in the clause for 'Panel wiring identification and termination' shall be fitted on each core of all external cables and on each internal wire. The size of the terminals shall be appropriate to the size and rating of the cable cores which will be connected to them but shall not be smaller than Klippon type SAK2.5 or equivalent unless otherwise agreed with the Employer's Representative.

Each row of terminal blocks shall contain at least 25% spare terminals over the number required for terminating all cores of external cables in that row. Unless otherwise specified or shown in the Specification drawings, each external cable shall contain at least 20% spare circuits, with a minimum of one spare circuit. Terminal blocks shall be numbered consecutively in a sequence different from that used for identifying wiring. The terminal numbers, voltage grouping and terminal board layout shall correspond precisely with wiring diagrams so that quick and accurate identification of wiring can be made. All the terminal boards shall be provided with covers of transparent insulating material that does not sustain combustion and shall be sectionalized where possible to give access to groups of terminals without uncovering all boards. Terminals which may be live when the panel is isolated from its main supplies shall be suitably labelled to minimize the risk of accidental contact.

- **Panel Internal Wiring**

Panel circuits shall be segregated into the following categories:-

Group 1: Power control and very-high-level signal wiring (above 50V)

- AC power supplies
- DC power supplies
- DC current signals above 50mA (such as CT circuits)

- AC voltage and control signals above 50V (such as PT circuits)

Group 2: High-level signal wiring (6V to 50V dc)

- Signals from conventional electronic transmitters and controllers (such as 4mA to 20mA)
- Circuits to alarm enunciators and other solid-state devices (excluding those in categories 2.1, 2.5, 3.1, 3.2 and 3.3)
- Digital signals
- Emergency shut-down and tripping circuits
- On / Off control circuits
- Intrinsically safe circuits
- Speech-frequency circuits

Group 3: Low-level signal wiring (5V dc and below)

- Signals from thermocouples
- Signals from resistance thermometers and re-transmitting slide-wires
- Signals from analytical equipment and strain gauges

For Group 3 wiring, internal connections to the instruments shall be made by one of the following methods:

The twisted, screened conductors of the external cable shall be led direct to their appropriate instruments via ducting systems installed for this purpose during construction of the panel.

The conductors of the external cables shall be terminated on terminals segregated from all other categories and the connections to the appropriate instruments shall be made using twisted pairs with individual screening installed for this purpose during construction of the panel.

Internal wiring for all circuits in Group 2 except those sharing a common connection shall be multi-stranded, twisted pair, 0.75mm² minimum copper conductors with HPDE or PVC insulated cable of adequate grade and rating in accordance with BS 6004:2000. Wiring for circuits in other Groups or sharing a common connection shall be run in stranded, 1.0mm² minimum copper conductors with 250V grade, PVC-insulated cable of adequate grade and rating. Wiring sheath colours shall be black for ac circuits, and grey for dc circuits (excluding thermocouple circuits) and blue for Group 2.6 circuits. Circuits supplied at 240V, between 240V and 110V dc shall also be physically segregated from each other and from other circuits. Access to wiring and components of circuits having voltages exceeding 240V shall not be possible unless and until the circuit has been isolated.

Separate ducts, trunking, cable looms, tray work and the like shall be provided within the panel for each category with at least 150mm between parallel paths of Group 1 and those of any other Group. Intrinsically-safe circuits and their terminals shall be segregated from other circuits and terminals. All wiring shall be neatly and securely fixed by insulated cleats, bunched and secured by approved plastic strapping or run in approved insulated wiring trunking or non-corrodible flexible tubing. Not more than 75% of the capacity of trunking, ducts, looming, or tubing shall be used. Insulated earth wiring shall be so arranged that access to any equipment or connection point or the removal of any item of equipment is unimpeded. Wiring for future equipment shall be secured and terminated on terminal blocks. Lacing for wiring looms shall be of rot-proof cord or plastic strips. Inter-section wiring in multi-section cabinets shall be via a terminal block in each

section.

- **Panel Wiring Identification And Termination**

  Identification ferrules shall be fitted at both ends of each wire. The numbers or letters used shall correspond with the appropriate wiring diagram. The ferrules shall be of plastic insulating material with permanent black characters on a colour-coded background for numbers and on a white background for letters, unaffected by oil or water. They shall be so arranged that they can be read logically from left to right when viewed normally. The system of wire identification shall be such that wires in the same circuit on opposite sides of a terminal shall have the same reference, and this system shall be continued through all external cabling. Terminal ferrules (spade, tongue, crimped connections) shall be provided on each conductor.

- **Panel Earthing**

  A continuous copper earth bar of not less than 25mm % 6mm cross section shall run the full length of each panel and shall be securely fixed and bonded electrically to the main frame. The cable gland-plates and the earth bar shall be provided with suitable brass terminals of not less than 6mm diameter for connecting the metal cladding or armouring of all incoming and outgoing cables to the station earthing system.

  A second continuous copper earth bar of not less than 25mm % 6mm cross section, electrically isolated from the steelwork of the panel and metal cladding and armouring of cables, shall be provided for earthing the signal earth connection of each instrumentation and control device and the screen(s) of each instrument cable not earthed elsewhere to the station instrumentation earth plate. The earth bar shall have sufficient brass terminals as specified above for each instrumentation and control device and the screen of every shielded cable plus 25% spare terminals. In multi-section panels, each earth bar shall be electrically bonded to the corresponding bars in the adjacent section(s). Instrumentation and instrument cable screen earthing shall comply with BS 6739: 1986, Section 10, unless otherwise stated in this clause.

- **Panel Heating**

  Each panel shall have one or more thermostatically-controlled tubular or ribbed panel heaters to prevent condensation and assist ventilation and which shall be adequate for ambient temperatures down to 5°C. The heater rating shall not exceed 0.2W/mm and the surface temperature of any part which could be contacted accidentally shall not exceed 60°C. Heaters shall be so situated that no deterioration can be caused to any equipment or wiring in the panel. The heating circuits shall be switched and fused independently of the instrumentation and control equipment and manually controlled by an enclosed switch mounted in an accessible position within the panel. Thermostats shall be mounted remote from the heaters and other sources of heat and shall be fully adjustable over a range of not less than 0°C to 50°C.

  Thermostats shall cut out each heater when the internal temperature of the panel exceeds a preset value; differential thermostats shall be used to maintain the panel internal temperature at a pre-set value above the external ambient temperature. If the permanent power supply is not available at the time of installation of the panel and condensation is detected, a temporary power supply shall be connected to the panel of sufficient rating to operate the heaters.

- **Panel Lighting**

  Each panel shall be adequately illuminated internally, as evenly and as free from dazzle as possible, by fixed fluorescent lighting controlled from totally-enclosed light switches and by totally-enclosed door-operated switches positioned so as not to interfere with access. There shall also be one installed inspection lamp per three meters of panel length or part thereof with adequate flexible connection cable to reach any point in the panel. The control switch for an inspection lamp shall form part of the lamp assembly. Lighting circuits shall be fused independently of any instrumentation and control circuit and designed to allow lamps to be replaced safely and shall be fed from a distribution board and circuit breaker connected on the live side of the main panel ac supply circuit breaker.

- **Panel Ventilation**

  Each panel shall be provided with ventilation fans as required to ensure that equipment within the panel is maintained within manufacturer's recommendations, with due regard to the environment in which the panel will be mounted. Fans shall be controlled by a suitably labeled enclosed switch mounted internally in an accessible position. Fans shall be mounted with their axes horizontal and shall be arranged to draw clean air into the panel. Air entries shall have filters which can be renewed from outside the panel and shall be designed to prevent the entry of rain, spray, injurious fluids, sand or dust.

- **Panel Piping and Tubing**

  Panels containing equipment using a supply of compressed air shall have a common air pressure-reducing station with duplicate pressure-reducing valves and filters. The pressure reducing station shall also include isolating valves upstream and downstream of each filter/reducing-valve set, pressure-relief valve, pressure indicator and low-pressure alarm unit for the low-pressure header and a pressure indicator for the high-pressure pipe work. The pressure-reducing station components shall be mounted in a clear space inside the panel, supported on a suitable framework between the lower horizontal row of instruments and the main low-pressure header.

  All piping, fittings and valves downstream of the pressure-reducing station shall be of brass, copper or plastic. PTFE tape shall not be used downstream of the main filters. The low-pressure header shall be brass and shall be near the panel floor with drain valves and tundishes piped to a drain. Branch air headers shall be of brass (15mm diameter minimum) and shall run vertically from the header to the instrument. The low pressure header and each branch shall have a 6mm minimum, non-ferrous shut-off valve for each instrument requiring an air supply and a compression coupling for each air-purge connection. At least 10% spare connections for possible future instruments shall be provided in each panel section. Any header dismantled before shipment shall have brass unions or flanges at each panel-section junction.

  Panel-mounted instruments shall be piped to bulkhead fittings on a gland plate during assembly at the manufacturer's works. Piping shall be colour-coded in accordance with Recommended Practice ISA−RP 7.2 issued by the Instrument Society of America and shall be segregated from wiring so that any leakage is harmless. Each panel-mounted pressure gauge shall have a stainless steel flush-mounted shut-off and fine-regulating valve mounted vertically below. A drip tray shall be provided below each row of gauges. Exhaust and de-pressurizing pipe work shall be routed out of the panel.

Panel Labels

Labels shall be provided for every panel to describe the duty or otherwise identify the panel and its sections and every instrument, component and item of equipment mounted internally and externally. Where applicable, front-of-panel labels shall be as shown in the Specification drawings. Wording shall be clear, concise and unambiguous and shall be subject to review by the Employer's Representative before manufacture. Each label shall be permanently secured to the surface near the item to which it refers. Externally-fitted labels shall be of perspex or other approved transparent plastic, with letters and numbers rear-engraved and filled with black. The rear surface of each perspex label shall be finished with a coat of paint of the same colour as the panel external finish. Instrument duty labels fitted externally shall be below the item to which they refer. Embossed tape or similar adhesive labels will not be approved.

Laminated materials or rear-engraved and filled plastic shall be used for internally-fitted labels, which shall be white with engraved black letters. Labels conforming to the requirements of the preceding paragraphs or other approved means shall be provided:

Labels

- To describe or identify circuits or circuit components
- To identify DC polarity
- To warn or remind about dangerous or potentially-dangerous circumstances
- Wherever elsewhere specified

Unless otherwise specified, all engraving shall be in plain block letters, 4mm high. The minimum practicable number of different sizes shall be used. Manufacturers' nameplates shall not be fitted on panel external surfaces.

Panel Finish

For control and instrument panels, desks and cubicles a hard, smooth, durable finish, free of blemishes, shall be provided. Before painting, all external welds and any rough areas shall be smoothed, and all surfaces shall be thoroughly cleaned and free from scale, contaminates, corrosion or grease. If rust-proof or Zintec steel has not been used in the construction, the panel shall be treated with a passivating agent such as phosphoric acid. All internal surfaces shall have a minimum of three coats of paint of which the first shall be an approved antirusting priming coat and the final coat shall be opaque gloss white enamel. All external surfaces shall have not less than five coats of paint of which the first shall be an approved etchpriming coat, and the second and third suitable undercoats, all of which shall be rubbed smooth when dry before application of the next coat. The undercoats shall be easily distinguished in shade or colour from the priming and finishing coats. The two final coats shall be of stove enamel paint, gloss or semi-matt finish, to a colour and finish to be advised by the Employer's Representative. Stoving shall be carried out in accordance with the recommendation of the paint manufacturer. The overall dry film thickness (DFT) shall be between 85 and 120 microns. Nuts, bolts, washers and other fixing devices which may have to be removed for transit or maintenance purposes shall be galvanized or otherwise finished to an approved standard. A 500ml tin of matching touch-up paint shall be provided and packed with each panel. The colour of glass reinforced plastic panels shall be to the approval of the Employer's Representative.

- **Electrical Indicators and Integrators**

  Indicators for use with analogue signal-transmission systems shall comply with BS 89:1990 or equivalent and have an accuracy class index of 1.0. Indicator movements shall be critically damped (dead-beat). Indicators for use on more than one circuit shall have rotary switches to select the circuit, with engraved plates to show the circuit selected. Indicators shall have circular scales or shall be of the vertical edgewise type and shall be designed to avoid parallax error. Scales shall be clearly marked in SI units and shall comply with BS 3693:1992 or equivalent. All instruments mounted on one panel or board, or in adjacent groupings, shall have similar styles of figures and letters. Dials shall be white with black scales and lettering not subject to fading.

  The material for scales shall be such that no peeling or discolouration will take place with age under any environmental conditions. Major scale marks and numerals shall be of the same size and thickness and shall be separated by not more than twenty-five minor marks. Pointers shall taper to the width of the scale marks. Integrators shall be of the multi-digit cyclometer type. Integrators operating in conjunction with an electromagnetic or ultrasonic flow meter shall use the pulse output from the flow transmitter. Any integrator operating from a device without a pulse output shall have an integral or separate current-to-pulse converter with sufficient adjustment of the pulse rate to avoid the use of any multiplying factor except in integer power of 10. Each integrator shall incorporate an adjustable limiter whereby any input below a pre-set value is inoperative. Unless otherwise specified, integrators shall have a minimum of eight digits with a decimal point where applicable.

- **Alarm System**

  Alarms shall be initiated by the opening or closing of volt-free contacts which shall remain unchanged throughout the periods in which the alarm conditions exit. Alarm circuits shall be capable of conversion from open-healthy to open-alarm or vice versa by a simple modification after installation requiring no additional parts or special equipment.

  Each alarm shall initiate the operation of both visual and audible devices. The sound intensity of each audible device shall be suitable for the maximum sound level of its environment.

  Audible devices in the same room or area shall have distinguishable sounds and adjustable sound levels.

- **Matrix Type Alarm Annunciators**

  The alarm annunciator shall be microprocessor based, modular, split type unit with alarm windows mounted on the front door and electronic modules inside the panel. The weather protection class for alarm annunciator shall be IP-54 of IS 13947, Part-I.

  Each alarm shall initiate a visible and audible indication of the specified condition. Unless otherwise specified, alarm indicators shall be grouped together in annunciator units each having at least 20% spare ways. Alarm indicator lamps (Cluster LED type) shall have transparent screens engraved with legends approved by the Project Implementation Unit of EMPLOYER (PIU). The legend area of each indication shall not exceed 40mm high and 75mm wide.

  When any alarm condition occurs, a condition device common to an alarm annunciator system shall sound and the appropriate indicator shall flash on an off. The flashing rate shall not be less than 2 Hz and shall not exceed 5 Hz. On pressing an accept pushbutton, the audible device shall be silenced and the

flashing light shall become steady. The alarm indicator shall remain illuminated until the alarm condition ceases and a reset pushbutton has been operated.

The operation or acceptance of one alarm shall not inhibit the operation of the audible device or the flashing of the appropriate alarm indicator if a further alarm condition occurs.

At unmanned locations alarms operated on two or more annunciators shall require acceptance at each annuciator.

Alarms shall be accepted automatically and the appropriate audible device silenced after an adjustable period of 1 to 5 minutes.

An integral 'test' pushbutton shall be provided to illuminate each lamp in the appropriate group and to operate the audible device but shall not cause a spurious alarm condition on any other annunciator.

Alarm circuitry shall be arranged so that spurious or transient alarm states persisting for less than 0.5 seconds do not initiate any action.

Alarm annunciator / indicator legends or labels shall be arranged with three lines of text as follows:

Top Line: Location; example: Sludge Blanket Level

- **Push-Buttons and Indicator Lights**

Push-buttons in control circuits shall have shrouds, guards or other suitable means for preventing inadvertent operation. Status-indicator lights shall be of the high-intensity LED type. Indicator lights shall be of a design which allows easy LED replacement from the front. Indicator lights shall be easily visible above the ambient light level when viewed from within an included angle of 120 degrees. LEDs shall be chosen to ensure clear discrimination between the energized and de-energized states and to ensure an average working life of not less than 3000 hours. A 'lamp-test' push-button shall be provided for each group of indicator lights. The colours of push-buttons and indicator lights on instrument panels shall be as follows:

Indicator Lights on Instrument Panels

Duty Push button	-	Signal lamp
Start or on (energize)	-	Green
Stop or off (de-energize)	-	Red
Open valve	-	Black*
Close valve	-	Black*
Accept	-	Black
Lamp test	-	Black
Reset	-	Black
Motor running (energized)	-	Red
Motor stopped (de-energized)	-	Green
Valve open	-	Red
Valve closed	-	Green
Urgent alarm	-	Red
Non-urgent alarm	-	Yellow
Plant healthy or ready for use	-	White

*Panel-mounted push-buttons for valve operation shall be coloured black, unless otherwise agreed with the Employer's Representative, with the duty clearly defined by legend on an associated label.

Analogue Signal Transmission

Unless otherwise specified, analogue signal-transmission systems shall be in accordance with BS EN 60546-1:1993 and shall use a signal of 4mA to 20mA DC. Transmitting devices shall have integral indicators to monitor the output signal or connections suitable for use with a portable test meter. Transmitters shall be capable of meeting the performance requirements laid down in the appropriate part of IEC 60770-1:1999.

Analogue Process Controllers

Analogue controllers shall use solid-state components and shall have outputs containing three terms with negligible interaction. The controller fascia shall have measured value, set value and output indication, manual set-value and output controls, auto/manual switch for control mode and remote-local transfer switch for set-value control. Manual control stations shall have measured-value and set-value indication, local/remote switch and control available lamp indicator. Each controller shall have the means to restrict its output signal to a predetermined, fully adjustable band so that the regulating device is not moved to unsafe positions. The adjustment of these safe operating limits shall be by means of accessible, clearly marked, internal components. A continuously adjustable proportional band of not less than 5 to 500% shall be provided. Integral and derivative action times shall be adjustable over ranges which shall not be narrower than 6 seconds to 25 minutes and 0-to 10 minutes respectively. If the integral or derivative action times' adjustments are in steps, the ratio of successive steps shall not exceed 2. The controls used to set the P, I and D values may be at the front of the instrument or mounted internally in an accessible position.

Each controller shall be designed so that in the event of failure, it shall be possible to plug a portable manual station into the controller case and to control the regulating device manually. Controller design shall ensure automatic procedure-less, bump less transfer whenever the instrument is switched from "auto" to "manual" or vice versa. Controller action shall be adjustable from direct to reverse and vice versa by the operation of an internal switch. Analogue process controllers shall be capable of meeting the performance requirements laid down in the appropriate part of BS EN 60546-1:1993.

(L) SCADA System

General

The purpose of this document is to briefly describe the proposed Automation system (SCADA System) for this Project components. The SCADA shall monitor complete parameters of Plant including Mechanical Equipment (Pumps, Motors, Valves, etc.) Process Instruments and Power Network. The System should be such that it has feature as per generic requirements to enable the system for seamless integration with other SCADA System.

The SCADA System shall collect data of various Process instruments, Mechanical Equipment, MFM and I/Os through Communication Network.

The System shall collect data through PLC under scope of supply. The field instruments (continuous monitoring online real time parameters) can transfer data to Control Centre/Master Control Centre directly through GPS/GPRS or any other means. Other equipment (pumps, motors, valves, etc.) data will report to remote PLC and PLC will report to Control centre through Fibre cable. The fibre cable will be laid across all location in Ring so that redundant communication can be achieved.

- **Basic Requirements for the Control System**

This section summarizes the basic requirements for the control system, including the system's components, its open communication capabilities, its combined DCS functionality, and its scalable architecture.

- **System Components**

The control system shall consist of a modular controller (including control, I/O, and communications functions), a peer to peer architecture, comprehensive process automation software (including configuration, documentation, Contractor interface, historian, and simulation software) and software modules that facilitate open systems connections.

The system shall include a full complement of modular supporting equipment (including mounting racks, power supplies, termination strips, equipment enclosures, prefabricated cables, furniture, etc.), all of which shall be designed to simplify construction and the overall engineering effort.

- **Open Communications**

The control system shall be open to enable easy integration with OPC (OLE for Process Control) [where OLE stands for Object Linking and Embedding (OLE)] server so as to collect the data from the remote housing station.

The control system shall include features traditionally associated with both a programmable logic controller (such as logic processing, modular rugged hardware, and remote I/O architectures) and a distributed control system (such as continuous and complex control, advanced Contractor interfaces, sophisticated redundancy). These capabilities must seamlessly reside in one control system, without the use of special gateways or interfaces.

- **Scope of Work**

The solution should meet the functionality as per requirements for connectivity of PLC, IP Camera etc. with Control Centre. The scope of supplies for the SCADA project shall be as detailed below.

✓ ***Scope of Supply***

- Supply of Control Centre Hardware and Software for SCADA System
- Networking Equipments (Router, Firewall etc.) for Control Centre.
- Interface / Integration of PLC Units with SCADA System.
- Integration of Field instruments Hardware with Control Centre.
- Testing, Erection & Commissioning of supplied system.
- Training as per detailed Offer.

✓ ***Hardware Details***

This chapter contains a detailed configuration description of Automation System.

The building sub-systems are:

- SCADA cum Communication Server
- User Interface subsystem like WS
- Video Projection System
- IP Camera
- Local Area Network subsystem like LAN switch, Router, Firewall

- 12 C Single Mode Fibre cable
- RTU/PLC,
- Peripheral subsystem
- Each subsystem is built from hardware common components. All subsystems and hardware components are described below:

✓ ***Subsystem Description***

This section lists and describes the subsystems (associated hardware components) at each location.

SCADA Cum Communication Server, Web Server, ISR Server

Qty	Hardware Component	Remarks
1	SCADA cum Communication Server	The interfaces for each server are connected to Ethernet networks to collect data from field.
1	WEB server	Interface with Internet to remote client
1	ISR server	Databases server with Oracle/SQL for Alarm and MIS Report

User Interface Subsystem

Qty	Hardware Component	Remarks
2	Workstation Console	The console is provided with 2 TFT Monitor The interface is connected to the Ethernet networks.
1	Remote access terminal	LAPTOP connected through a serial link and a modem.

Local Area Network Subsystem

Qty	Hardware Component	Remarks
1	LAN Switch	Ethernet switch 14 ports (10/100 Base TX)+2 Fibre Port
6	Remote Location LAN switch	Ethernet switch 14 ports (10/100 Base TX)+2 Fibre Port
1	Router	2 LAN+2 WAN, all are 10/100 with 2 V.35 Port
2	Firewall	4LAN+2 WAN, all Wan are 10/100Mbps and LAN are 10/100/1000 Mbps
Lot	12C Single Mode Fibre armored cable	For Connectivity

✓ ***Peripheral Subsystem***

Printers

Qty	**Hardware Component**	**Remarks**
1	Laser Printer(Colour)	Each laser printer is connected to Ethernet network.

UPS

Qty	Hardware Component	Remarks
1	10 KVA UPS for Control room Hardware	The UPS is designed for 10 KVA with two hours backup.
2	3 KVA UPS at all Remote location	The UPS is designed for 2 KVA with two hours backup.

IP Camera

Qty	Hardware Component	Remarks
1	IP Camera	Each Camera is connected to Ethernet network for Remote location surveillance

Video Projection System

Qty	Hardware Component	Remarks
1	Rear Projection one cube with controller	Each VPS is connected to Ethernet network.

- ✓ ***Hardware Components Description***

  This section describes the common hardware components.

- ✓ ***Communication cum SCADA Server, Web Server, ISR Server***

  Characteristics*

Intel® Xeon® Quad-Core Processor E5606 2.13 GHz, 8MB L3 Cache	1
Integrated Two Broadcom dual-port Gigabit Ethernet with TOE enabled	1
8GB Memory (4x2GB), 1333MHz, DDR3 RAM	1
2nd Intel® Xeon® Quad-Core Processor E5606 2.13 GHz, 8MB L3 Cache	1
300GB 15K RPM,6Gbps SAS 3.5 Hot Plug Hard Drive " With RAID5	3
DVD+/-RW ROM, SATA, Internal for Ms 2008 R2	1
High Output Power Supply, Redundant, 460W	1
Power Cord, GType, 230V (Nepal, Sri Lanka, India)	2
2U Cable Management Arm	1
2U Sliding Rail	1
Windows Server latest	1

***** The system (hardware, software, accessories, etc.) being provided during installation would be of latest configuration.

- ✓ ***Workstation Console Dual Monitor***

  Characteristics*

Motherboard	Intel® Xeon® Dual-Core Processor W3503 (2.40 GHz, 4 MB cache, 1066 MHz memory)
Video Card	ATI FirePro 2270 (512 MB)
RAM Memory	4GB (2x2GB) DDR3 SDRAM Memory, 1333MHz,ECC 1
HDD	500 GB SATA (7200 RPM) HDD
Input Power Supply	220 to 240 VAC (+/- 10%), 50 Hz (+/- 2 Hz)
Power Cord	Indian Style

CD Drive	16X DVD + /-RW Combo Drive
Keyboard	USB Entry Keyboard
Mouse	USB Optical Scroll Mouse (2 buttons) with Mouse Mat
LAN(Ethernet port)	Dual Broadcom RJ45 10/100/1000 BASE on board Ethernet NIC
I/O Cards	One serial RS-232 port, 4 USB port and one parallel port
Indicator & Switch	Power on/off x 1, HDD x 1. Power on/off x 1, System reset x 1

*****The system (hardware, software, accessories, etc.) being provided during installation would be of latest configuration.

- ✓ ***Remote Access Terminal***

Characteristics*

Laptop*

Processor	2nd generation Intel® Core™ i3-2350M processor (2.30 GHz, 1333, 3M cache)
Operating System	Genuine Windows® 7 Professional SP1 32bit (English) for India
Display	14.0" HD WLED Anti-Glare (1366x768)
Memory2	2GB2 DDR3 SDRAM at 1333MHz
Hard Drive	1 TB 5400RPM SATA Hard Drive
Video Card	Intel® HD Graphics/ Intel® HD Graphics 3000 (It depends on processor selected)

*****The system (hardware, software, accessories, etc.) being provided during installation would be of latest configuration.

- ✓ ***LAN Switch***

Characteristics*

Specification	Managed Industrial Ethernet switch
Ethernet Standards	IEEE 802.3 for 10BaseT IEEE 802.3u for 100BaseT(X) and 100BaseFX IEEE 802.3x for Flow Control
Design Standard	FCC Part 15, CISPR (EN55022) class A, Shock-IEC60068-2-27, Vibration-IEC60068-2-6, EN61000-4-2 (ESD), EN61000-4-3 (RS), EN61000-4-4 (EFT), EN61000-4-5 (Surge), EN61000-4-6 (CS), EN61000-4-8, EN61000-4-11 standards
Input Voltage	9.6-60 VDC
Operating Temperature:	0 to 60°C
Ambient Relative Humidity:	5% to 95% Non-condensing
Overload Current Protection	Present
Mounting	DIN Rail Mounting
No. of Ports	12 Nos. (10 CU + 2 FO)
Interface	
Ethernet ports	10 no. RJ45 Ports with 10/100BaseT(X) auto

	negotiation speed, Full/Half duplex mode, and auto MDI/MDI-X connection
Fiber Port	Two 10/ 100BaseFX port SC Type Single-Mode, 1310 nm Supports Ring, and Self Healing

***** The system (hardware, software, accessories, etc.) being provided during installation would be of latest configuration.

- ✓ ***Color Laser Printer***

Characteristics*

Print speed	Up to 12 & 8 ppm
Print quality	Up to 600x600 dpi with HP ImageREt 3600
(A4 Size, ready)	26/32 sec
Print speed footnote	Exact speed varies depending on the system configuration, software application, driver and document complexity.
Memory, standard	128 MB, expandable to 384 MB
Processor speed	600 MHz
Duty cycle (monthly, A4)	Up to 30000 pages
Connectivity, standard	Hi-Speed USB 2.0 port; built-in Fast Ethernet 10/100Base-TX
Print technology	In-line colour laser printing technology
Print languages	HP PCL 6, HP PCL 5c, HP Postscript level 3 emulation
Paper trays, standard	2
Paper handling input, standard	150-sheet input tray
Paper handling output, standard	150-sheet face-down output bin
Power	Input voltage 115 to 127 VAC (+/- 10%), 60 Hz (+/- 2 Hz), 12 A; 220 to 240 VAC (+/- 10%), 50 Hz (+/- 2 Hz), 6 A
Power consumption	445 watts maximum (active), 18 watts maximum (ready), 6.7 watts maximum (sleep), 0.48 watts maximum (off)
Media sizes supported	Tray 1: A4, A5, A6, B5 (JIS), 10 x 15 cm, 16K, envelopes (ISO DL, ISO C5, ISO B5), post cards (Standard #10, JIS Single, JIS Double); Tray 2 : A4, A5, A6, B5 (JIS), 10 x 15 cm, 16K, envelopes (ISO DL, ISO C5, ISO B5), post cards (JIS Single, JIS Double)
Media sizes, custom	Tray 1: 76 x 127 to 216 x 356 mm; Tray 2 : 100 x 148 to 216 x 356 mm
Media weight, supported	Tray 1: 60 to 176 g/m² (up to 220 g/m² with HP laser glossy photo papers); tray 2, tray 3: 60 to 163 g/m² (up to 176 g/m² with postcards, up to 220 g/m² with HP laser glossy photo papers)
Recommended operating	15 to 27° C
Operating humidity range	20 to 70% RH

***** The system (hardware, software, accessories, etc.) being provided during installation would be of latest configuration.

- ✓ ***UPS***

Characteristics*

Technology	Micro processor based IGBT, High Frequency Switching Sinusoidal multiple PWM
Rating	10 KVA
Input	230 V AC, +10%, -15%
Output	230 V AC
Battery	Sealed Maintenance Free Batteries, CSB / Panasonic / Global & Yuasa or eqvt
Backup Hours	120 Minutes

- ✓ ***Router***

Characteristics*

Memory	RISC @ 533 MHz
	Flash Memory:256M Bytes
	SDRAM: 256M Bytes
Interface	2 x 10/100/1000 Mbps Ethernet Port
	2 Serial Ports (V.35)
	2 X 10/100 Mbps WAN Interface
	1 Console port
	1 Auxiliary port
Performance	
Throughput	300 Kpps (64-byte packets)
Routing table size	30000 entries
Network Management	IMC - Intelligent Management Center; command-line interface; Web browser; SNMP Manager; Telnet; RMON1; FTP; IEEE 802.3 Ethernet MIB
Operating Temperature	0° to 40° C (32° to 104° F) (Relative Humidity: 5% to 90% non-condensing)
Non Operating Temperature	-40° to 70° C (Relative Humidity: 5% to 90% non-condensing)
Power	100-120/200-240 VAC

*****The system (hardware, software, accessories, etc.) being provided during installation would be of latest configuration.

- ✓ ***IP Camera***

Characteristics*

Camera	
Sensor	1/2.7” HD progressive scan CMOS
Lens	C/CS mount lens (lens not included)
Auto Iris Type	DC drive
Illumination (low light sensitivity)	
	• Color: 0.2 lux at F1.2
	• B/W: 0.05 lux at F1.2
Synchronization	Internal
White Balance	ATW/AWB (range: 3200 to 10000°K)
Dynamic Range	
	• Color: 100 dB

	• B/W: 110 dB
Auto Electronic Shutter	1/30 to 1/25000 sec.
Electronic Shutter	Auto
S/N Ratio	50 dB (Gamma, Aperture, AGC OFF; DNR ON)
ICR Control	Auto (light sensor control) or DI control
DNR	Built-in DNR
WDR	Level 1-8/Off
AGC control	2X, 4X, 8X, 16X, 32X, 64X
Flicker less Control	Indoor/Outdoor mode
Black Level Control	High/Medium/Low
Auto Exposure	Level ±5
Image Rotation	Flip, Mirror, and 180° rotation
Image Setting	Manual tuning with saturation, sharpness, and contrast
• Video	
Video Compression	H.264 (ISO/IEC 14496-10) or MJPEG
Video Outputs	Ethernet
Video Streams	Up to 3 video streams (2 x H.264 and 1 x MJPEG)
	• Stream 1: H.264, 1280 x 800 resolution (max.)
	• Stream 2: H.264, 720 x 480 resolution (max.)
	• Stream 3: MJPEG, 720 x 480 resolution (max.)
Note	Streams 2 and 3 must be at the same resolution
Video Resolution and FPS (frames per second)	Not less than 20 FPS in NTSC or PAL
• Network	
Protocols	TCP, UDP, HTTP, SMTP, FTP, Telnet, NTP, DNS, DHCP, UPnP, RTP, RTSP, ICMP, IGMPv3, QoS, SNMPv1/v2c/v3, DDNS, Modbus/TCP, 802.1X, SSH/SSL
Ethernet	1 10/100BaseT(X) Ethernet port, RJ45 connector
• Serial Interface	
RS-485	1 half-duplex RS-485
• GPIO	
Digital Input	1, max. 8 mA
	• High: +13 V to +30 V
	• Low: -30 V to +3 V
Relay Output	1, max. 24 VDC @ 1A
• LED Indicators	
STAT	Indicates if the system is booted properly or not
Network	10 Mbps or 100 Mbps
Power	Power on/off
• Local Storage	
SD Socket	Standard SD socket (SDHC)
• Power Requirements	
Input	
	• Redundant power inputs
	• 12/24 VDC, 24 VAC, or Power-over-Ethernet (IEEE 802.3af)
• Physical Characteristics	
Camera Body Housing	Metal, IP30 protection

Installation	Wall mounting, pole mounting, corner mounting
Note	External housing and mounting accessories may be required.
• Security	
Password	User level password protection
Filtering	By IP address
Authentication	802.1X
Encryption	HTTPS, SSH
• Alarms	
Intelligent Video	Camera tamper, virtual fence, alert zone, missing object, unattended object
Note	IVA functions are except for camera tamper.
Video Motion Detection	3 independently configurable motion areas
Scheduling	Daily repeat timing schedule
Imaging	JPEG snapshots for pre/trigger/post alarm images
Video Recording	Event recording and stored in the SD card
Email/FTP Messaging	Automatic transfer of stored images via email or FTP as event-triggered actions
Custom Alarms	HTTP event servers for setting customized alarm actions
Pre-alarm Buffer	24 MB video buffer for JPEG snapshot images
• Environmental Limits	
Operating Temperature	
	Standard Models: 0 to 60°C (32 to 140°F)
	Wide Temp. Models: -40 to 75°C (-40 to 167°F)
Storage Temperature	-40 to 85°C (-40 to 185°F)
Ambient Relative Humidity	5 to 95% (non-condensing)
• Standards and Certifications	
Safety	UL 60950-1
Hazardous Location	UL/cUL Class I Division 2 Groups A/B/C/D (Pending), ATEX Zone 2 Ex nCnAnL IIC T4 (Pending)
EMI	FCC Part 15, CISPR (EN 55022) class A
	EN 61000-4-2 (ESD), Level 3,
	EN 61000-4-3 (RS), Level 3,
	EN 61000-4-4 (EFT), Level 3,
	EN 61000-4-5 (Surge), Level 3,
	EN 61000-4-6 (CS), Level 3,
	EN 61000-4-8,
	EN 61000-4-11
Traffic Control	NEMA TS2
Rail Traffic	EN 50121-4
Shock	IEC 60068-2-27
Freefall	IEC 60068-2-32
Vibration	IEC 60068-2-6

*****The system (hardware, software, accessories, etc.) being provided during installation would be of latest configuration.

- ✓ ***Video Projection System***

Characteristics*

Resolution	SXGA+
Individual Cube Size	67" Diagonal
Image Size (mm)	1361 x 1021
Display Technology	DLP, single chip
Native Resolution	1400 x 1050 pixels
Aspect Ratio	4:03
Screen to screen gap	Rear access:
	Adjustable up to 0.2 mm
DMD	0.95" DMD 12 deg.
Light Source	LED - 1R1G1B - 12 sq mm each
Brightness	650 Lumens
Luminance (Nits or cd/sqm)	Based on screen used, lamp mode and screen size
Brightness Uniformity	Greater than 90%
Screen Type	Fresnel/ Lenticular/Black Bead/Cross Prism (XPS)
Full Viewing Angle	180 degrees
Colors	16.7 million
Color Temperature Range	3200K to 9300K
Color Temperature Range	3200K to 9300K
LED Life (typical)	> 60,000 Hours
Inputs	RGBHV on BNC, Dsub -15,
	DVI-DX2, Composite video, (NTSC/PAL/SECAM)
	Component video HDTV, RS232C
Outputs	Video/DVI
Control	RS-232/IR, RS 422/IP
Voltage	AC100-240V @ 50/60 Hz
Power Consumption	‹ 350 W
Operating Temperature	10-35°C
Operating Humidity	10%~90%
Storage	-20 to 60°C

*****The system (hardware, software, accessories, etc.) being provided during installation would be of latest configuration.

- ✓ ***12C Single Mode Fibre Cable***

Characteristics

Configuration	Multitube Double Sheath Armoured Cable
Nos. of Core	12
Maximum Tensile Loading	1361 x 1021
Installation	2700N
Long Term Installed	900N
Operating Temperature	-30°C to +60°C
Normal Dia	14.8 mm
Nominal weight	200 KG/KM
Mode	Single Mode
Single mode Fiber:	(G.652.B)

✓ ***Server Panel***

The equipment can be of any Standard make which can comply with the following standards:

Type	SERVER RACK 42U/600W/1000D
Specification	Captive Front Panel Hardware, Pkt of 20
	Castors (Plain)
	Server Rack, 19"/42U
	consisting of High quality extruded Aluminum vertical profiles 4 Nos. Top and Bottom steel end
	frames with bottom Panel having gland plate for cable entry, Top cover with FHU provision, Side
	Panels with latches and venting slots at bottom 1/3 area and 2 pairs of 19" Mounting Angles
	Dimension: 2150 x 600W x 1000D Powder Coated BLACK
	Front CRCA steel single door with Perforation
	Rear CRCA steel single door with Perforation
	Component Shelf, Universal, 19"W/575mmD, Load cc 50 kg.
	Top Mounting, Fan Housing Unit with 4 fans 230 V / 90CFM
	Rotary Keyboard Tray with slides
	Castors (with brake)
	Earth Continuity straps (kit)

✓ ***PLC***

The equipment should be of Reputable make which can comply with the followings standard:

❖ **Powerful Integrated Controller**

The controller shall consist of a family of intelligent integrated modules, with each performing a dedicated function. It shall have an integrated redundant interface for the I/O modules as well as redundant interface for the Human machine interface.

Additionally the controller should be able to able to communicate to its redundant pair directly preferably on a Passive backplane.

❖ **Modular Architecture**

The modular approach shall enable a very small system to be installed with expansion to a very large system without changing the basic hardware or disrupting the architecture. A minimum of the following module types must be available: control modules, I/O modules, communications modules, computer modules, and power supply modules.

❖ **Controller Packaging**

For installation flexibility and high reliability, controller hardware must be designed to withstand harsh conditions within industrial environments, such as heat, humidity, shock, vibration, and electrical surge and discharge.

❖ **Module Hardware**

Module hardware must meet the following requirements:

- The modules shall be identical in appearance.
- All the module shall be housed in a powder coated metal case rack to prevent physical damage from handling or dust.
- All control and I/O modules shall be rated for operation within the following ranges: 0-50 Deg C and 5-95% relative humidity, non-condensing.
- I/O and power modules shall have circuitry to protect the system from electrical surge and discharge.
- The modules shall comply with the latest relevant national/international standards.

❖ **Module Racks**

The modules shall be grouped together in racks to form the control system. The racks shall provide the communications mechanism to fully integrate the modules and facilitate intercommunications between racks. A rack should hold approximately ten individual modules, with each slot identical and able to accept any module. Modules should be connected to the backplane using high quality, gold-plated, industry-grade pin connectors.

It shall be possible to remove and reinsert the modules under power with no damage to the rack or modules and without removing any external wiring or cables. The rack and modules shall provide a physical keying mechanism to prevent incorrect module insertion during system operation.

To simplify installation and maintenance, the module racks and modules shall be designed for front access only. All user functions, including diagnostics, field wiring, cable connections, switches and status indications, shall be available from the front of the rack.

❖ **Power Supply**

Redundant Power supplies shall be available for card rack mounting to form as an integral part of the system. The module rack must provide two individual power supply buses that to be driven by two independent power sources for high availability placed in the rack in current sharing mode. Each module shall be capable of using power from any of the two buses.

❖ **Enclosures**

The racks shall be mounted in an industrial enclosure with a front & rear - access design, with all frequently accessed items (such as modules, connectors, status indicators, switches, and termination assemblies) located in the front of the enclosure. For maximum flexibility, the enclosures shall be modular, with the ability to be stacked, joined side to side, or joined back to back. To provide the degree of environmental security required, enclosures shall be available in sealed and vented versions. Enclosure shall be

i) for Indoor IP 44 and

ii) for Outdoor IP 65

❖ **Control Module**

A control module shall provide process control functions. The control module should be used with dedicated I/O modules to read and control field signals. The module shall also be capable of operation independent of

I/O modules, "supervising" operation of other control modules. In addition, the control module shall be capable of executing on a 5 millisecond resolution input-to-output when required by the application.

- **Hardware**

  The control module shall consist of a single-slot module with a dedicated microprocessor. Memory should be battery-backed RAM so that the module retains its configuration and state information to optionally and automatically restart after a power failure without requiring its database to be downloaded. The minimum memory required is 16MB.

  During a hot start, all variables can be selected as retain or non retentive.

- **Software**

  The control system must support a full complement of process control functions. It shall be possible to define these functions using a mix of function blocks, ladder logic diagrams, sequential function charts, and textual programming. Each of the four languages and their interaction within a configuration shall be based on the IEC 61131-3 standard. The languages shall be completely interchangeable and interactive, with a single control module's database capable of including any combination of the four languages.

- **Input / Output Devices**

  Input/output Modules shall be intelligent I/O modules. Each module should be able to communicate with the CPU in a dedicated fashion without requirement of any additional interfacing hardware so as to reduce the common cause of the Failure. Each module should have its own microprocessor to execute its input/output function, maintain Employer ship of its configured data, and perform module diagnostics.

  All process I/O shall be electrically isolated from both computer common and communications common. Isolation shall meet be min 1500 VAC requirements. Modules shall automatically determine their physical address and report this information to the controller. No range jumpers or user- configurable physical address jumpers should be necessary.

  All configurable data shall be set via software, with no hardware jumpers used. Configurable data should include Channel tag.

  All the I/O modules shall have max 8 channels for the Analog and 16 channels for the Digital modules. Special modules like Counter inputs shall monitor dry contact pulses with an input resolution of one HZ minimum.

- **Field Termination for I/O Modules**

  Each I/O module's field signals shall be wired into the system such that an I/O module can be removed at any time without disturbing the field wiring.

  The field wiring should be separate from the I/O module(s). The extension from the module(s) shall be accomplished via a marshalled I/O cable assembly. This assembly should be a multi-conductor cable that attaches to the module rack (and the back of the I/O module) on one end and a finished termination end.

  The marshalled termination assemblies shall be DIN rail-mounted PCB-based fixtures that include terminal blocks and two receptacles for accepting the interconnect cable plug. These receptacles must be female to eliminate the possibility of power from the terminal block being exposed on pins.

- ✓ ***System Communications***

  The communication networks in the system shall provide redundant, high-speed, secure controller information exchange via Ethernet TCP/IP. Communication between individual modules shall be via redundant, local, independent buses that allow complete integration of the family of modules.

- ✓ ***Module Communication Bus***

  All the communication to the I/Os in the DCS shall use a deterministic. This protocol must be compliant to IEC61158, and open. It shall be possible to connect a minimum of 100 nodes on a single network

  The bus must be redundant. Minimum data transmission rate is 10 Mbps.

  Communication on the expanded network shall be accomplished in a manner identical to that of local communication bus. The extension shall be transparent to the user, and no extra software configuration effort shall be required.

- ✓ ***Configuration Software***

  The configuration software shall be portable. It shall run on a personal computer of the most current technology under Windows.

  The software shall execute in the off-line mode when the computer is not attached to any controller hardware, allowing controller databases to be created, edited, and documented. When the computer is attached to the controller hardware via the networked or direct-connected PCs, the networked workstations, or by running in the industrial computer module, an on-line mode of operation shall be available to allow use of all off-line functions plus on-line troubleshooting tools. This software shall be able to be used to configure continuous, batch, and safety protection control strategy configurations from a single user console.

- ✓ ***IEC 61131-3***

  The configuration software shall allow controller databases to be created using the following standard languages defined by the specification IEC 61131-3: function blocks, ladder logic, sequential function charts, and structured text.

- ✓ ***Graphical Configuration and Documentation***

  Controller configuration should provide graphical configuration methods, with functions entered into a database using a point and click object-oriented routine. The resulting database should be its own documentation because of the graphical appearance. Furthermore, the graphical database must be transferable directly to the controller as it exists, including all graphical information, with no compile routine necessary before transferring the database to the controller. The graphically configured database shall be stored and executed in the controller, and the controller-resident database shall be viewable graphically on-line and uploadable to a PC or workstation without the need for storing the “source” database off-line.

  - ❖ **On-Line Tools**

    The configuration software shall provide on-line tools that assist in troubleshooting control schemes. These tools must include on-line display of variables, the ability to force values and states, support for on-line database changes, and on-line real-time trending.

    It should be possible to display variables’ values and the status of ladder logic and SFC elements while viewing an on-line controller database. The

ladder logic and SFC element states shall be indicated using colors.

The configuration software shall provide the ability to write values, states, and modes to independent variables and elements in the controller. It shall also provide the ability to force non-independent variables and elements to a predetermined value, state, or mode.

During troubleshooting, the user shall have the ability to stop the controller and single-step its execution. This will provide a way to clearly understand complex configuration schemes and highly interactive logic that might need to be examined.

❖ **Prebuilt Library of Functions**

The configuration software shall include a predefined library of control schemes. The library must include at least:

- Single PID loop with alarm
- Single PID loop with external set point and alarm
- Ratio control loop with alarm
- Cascade loop with alarm
- Primary control loop with alarm etc.

Separate, optional libraries should be available for specialized applications.

The configuration software shall also allow commonly used functions created by the user to be added to a library for future use.

❖ **On-Line Help**

On-line help screens in the configuration software shall be available to assist while creating a database. The help screens shall include descriptions of every configuration element (e.g. each function block and ladder logic element).

❖ **System Architecture**

A system architecture graphic depicting the hardware within the control system. This graphic should give status information for the modules in the system by using colors to indicate general health of the modules.

✓ ***Windows Based Contractor Software***

The industrial-grade PC-based Contractor interface software shall be able to run on a personal computer of the most current technology under Windows. The software shall provide all standard Contractor functions, including process monitoring, alarm management, real-time and historical trends, reports, plus provide process graphic displays, an integrated historian, Internet enabler, batch manager and control simulator.

✓ ***Reliability***

The system must be designed for maximum reliability and minimal downtime. This should be achieved through a fault-tolerant design with minimal common cause failures and state-of-the-art redundancy schemes.

✓ ***Controller***

The controller must have a fault-tolerant design, with redundancy in the same model

- **Standard Fault Tolerance**

  The module communication bus and each I/O communication bus must be redundant. If one side of a redundant bus should fail, communications should continue, uninterrupted, on the remaining side of the bus.

  The module rack shall provide two separate power supply modules, with each module capable of drawing power from any of the two.

- **Redundancy**

  Complete 1:1 redundancy needs to be quoted. The redundant control modules that share a single set of I/O, identical, standard hardware must be used for all redundancy schemes with option of duplication of control modules and I/O modules.

  It must be possible to replace a failed component on-line, without removing power. Process control shall continue to be executed in the non-failed unit.

  When a module is replaced, the new module must automatically initialize, receive the current database from the primary module, and pick up in synchronous execution as a secondary module in the redundant relationship. This should take place without user action for any of the steps.

✓ ***Contractor Interface***

Window based Contractor interfaces need to be supplied such that the failure of one component, card, or module does not cause the Contractor to lose any portion of the process window.

✓ ***System Architecture***

The system should be capable of Remote I/O modules architecture at various remote locations near to the major equipment sensors to reduce the commissioning. There will be two remote I/O module stations..

✓ ***Features Required in SCADA System***

The system will be based on latest version of **SCADA** system. The main SCADA system will be redundant. Based on application, servers are to be distributed with redundancy. For Cyber Security it is proposed that Security Solutions Shall be provided and separate DMZ zone be made so that outside intrusion can be minimized. Network monitoring system shall also be provided for monitoring of Network devices. SCADA system will have many extra features and the proposed system should support multiple PLC/ RTU Protocol like Modbus, Profibus, DNP (Serial/TCPIP), OPC etc.

Detailed Specification of SCADA System Components

✓ ***Data Acquisition***

The SCADA system shall perform data acquisition from PLC and field Equipments. PLC is to be located at each location of the plant. PLC communications with Control Centre shall utilize the Open protocol like Modbus, Profibus.

✓ ***Data Exchange***

The SCADA systems shall be able to exchange various types of data with the other application software using ActiveX Data Objects (ADO) or Dynamic Data Exchange (DDE).

✓ ***Data Processing***

❖ **Analog data**

- Analog data processing shall be performed according to the requirements listed below.
- Conversion to Engineering Units
- Reasonability Limits Checking
- Limit Monitoring

❖ **Digital/Status Input Data**

The following status input data types shall be accommodated as a minimum:

Two-state points: The following pairs of state names shall be provided:

(1) Open/Closed

(2) Tripped/Closed

(3) Alarm/Normal

(4) On/Off

(5) Auto/Manual

(6) Remote/Local

❖ **Calculated Data**

It shall be possible to define the calculations on real-time data and historical data, periodically and on request. The results shall be incorporated into the database as calculated data available for display & report generation.

The user shall be able to define calculated analog values using database points as the arguments and mathematical functions as the operations. Functions such as addition, subtraction, multiplication, division, maximum value, minimum value, average, count, square root, exponentiation, trigonometric functions, logarithms and other statistical functions shall be provided.

The SCADA system shall be capable of analysing the open/closed status of switching devices, such as Motor, PUMP etc. The configuration shall be updated whenever a switching device status change is detected.

✓ ***Quality Codes***

Quality codes indicate the presence of one or more factors that affect the validity of a data value. All quality codes that apply to a data value shall be maintained in the database for that data value. At least following quality codes shall be supported:

- Telemetry failure
- Delete from scan
- Limit violated
- Manually replaced
- Alarm inhibit
- Abnormal data

✓ ***Sequence-Of-Events Recording***

The Sequence-of-events (SOE) data is listing of status change events with

time stamp. SOE data shall be collected by the SCADA system from PLCs. The description of each event shall include the database description name, device state, the date, and the time (to the nearest millisecond) of each event.

- ✓ ***Supervisory Control***

  An authorized user of an SCADA system shall be able to control the operation of field devices connected to PLCs. A control action shall require a confirmation of selection prior to execution of control command.

  The user shall be able to select and operate any controllable switching device. Controllable switching devices will be of like, Pump, Motor.

- ✓ ***Information Storage and Retrieval***

  Information Storage and Retrieval (ISR) system shall collect and store analog data (telemetered and calculated) periodically at every 5 minute (configurable) and status data by exception. Associated quality codes shall be included. It shall be possible to perform calculations on the stored data, and the results of these calculations shall be collected and stored. Other information such as alarms, events, SOE and reports shall also be stored. The data shall be stored on hard disc with date tag on daily basis for easy retrieval. Subsequently, the data shall be retrieved for analysis, display, trending, and report generation.

- ✓ ***Extensive Use of Standard***

  The SCADA Software should be such that it uses an extensive use of standards, achieved by a corporate commitment to comply with all standards that are recognized on the SCADA market, and in particular:

  - Intel (or compatible) based hardware;
  - Operating system options of WNT 4.0, Windows 2000 or Windows 2003;
  - Uses Microsoft Foundation Class (MFC) Object Oriented Database;
  - Developed with Microsoft Developer's Studio;
  - Installed using Microsoft Install Shield utilities;
  - Component Based Architecture;
  - Interfaced using Active X controls (OCX);
  - TCP/IP for Local and Wide Area Networks (LAN & WAN) ;
  - Web-enabled Contractor Consoles;
  - Control Centre Application Programming Interface (CCAPI) Initiatives

- ✓ ***System Sizing & Extensibility***

  The hardware and software openness of **SCADA** allows the customer to smoothly upgrade the proposed system with great facilities. Common upgrading needs include (but not limited to) the following items:

  - Additional measurement points (analog and digital);
  - Additional protocol-compliant IEDs;
  - Additional protocol-compliant PLCs;
  - Additional Contractor consoles;
  - Additional printers;
  - Connection to other SCADA centres

- ✓ ***SCADA Interfaces***

  User interface and gateway services communicate with SCADA over the

following interfaces:

- **OLE Automation Control Interface** - OLE Automation provides the easiest programming interface to SCADA. OLE automation client services may be built using Visual Basic or C++. The service may direct SCADA to add, delete, or modify SCADA objects, may issue controls, and may retrieve measurement data. The OLE Automation interface may be distributed across CPUs, such that a service on one server uses SCADA running on another server;
- **Publisher/Subscriber Control Interface** - The publisher / subscriber interface allows for high performance data update and automatic refresh. This interface is based on TCP/IP sockets, and may run on the same server or between servers. This may be used directly from C++ or using custom OLE controls in Visual Basic;
- **Custom ITelemetry Sink Interface –** The custom ITelemetry Sink interface is used by gateway services for high performance data transfer. This interface works between two processes on the same server. This interface supports C++ programming.

✓ ***Graphical User Interface (Gui)***

The GUI shall operate within a window environment The system shall use displays which mimic the existing control panels so that the Contractors working in conventional control room environment are comfortable while working on the new system. Contractor shall develop control panel display generally similar to the one existing in conventional control room.

The GUI shall allow the personnel to monitor and control the equipment through the control panel displays and Tabular displays. The control panel displays shall be dynamically updated for measurands, device positions, annunciations. To have better visibility of control panels, it shall be possible to iconise each control panel separately. Contractor shall select that icon to zoom/view that panel display & carry out operations such as alarm annunciation accept/reset, device close/open operations etc.

✓ ***Trending***

Trend displays shall enable the user to select real-time and historical data for trending on graphical displays and for tabular displays. It shall be possible to take print of these trends.

✓ ***Alarms***

Alarms are conditions that require user notification when detected. Audio, visual alarm shall be generated for all such conditions. It shall be possible to accept & reset all trip & non-trip alarm annunciation appearing on control panel facia from control panel display itself. Alarm annunciation on control panel shall have following characteristics:

Condition	**Facia**	**Sound**
Alarm initiation by relay contact	Flashing Glow	On
Accept PB pressed	Steady Glow	Off
Reset	Off (if relay contact is reset) Steady Glow (if relay contact is not reset)	Off

Other alarm conditions shall be acknowledged from respective alarm list displays. Other alarm conditions shall include, but not be limited to the

following:

(a) Telemetered or calculated value limit violations

(b) Un-commanded changes of a power system device state

(c) Data source communication errors resulting in loss of data

(d) SCADA hardware and software element failures.

The standard products for advanced alarm management shall also be provided. Regardless of the alarm management technique used, all alarm messages shall be recorded with time & date tag on auxiliary memory for review and printing on demand by the user.

Displays shall highlight alarm condition using a combination of colour, intensity, inverse video and blinking. Alarm messages shall be a single line of text describing the alarm that has occurred with date & time of occurrence.

✓ ***Events***

Events are conditions or actions that shall be recorded by the SCADA system but do not require user action. Events shall be recorded in the form of an event message. The event message format shall be similar to the alarm message format. Events shall include but not limited to followings:

- Values returning to normal from a limit violation state
- Device status change on manual operation.

✓ ***Hardcopy Printing of Display***

A means shall be provided to produce a copy of a display. The display printout shall be initiated from user friendly push buttons/pull down menus. The options for printing mode shall include at least selection for orientation, background colour, page size, colour or black & white print and print preview. It shall also be possible to print selected portions of display and direct printing on any of the connected printer.

✓ ***Report Generation***

The user shall be able to schedule periodic reports generation, direct a report to a display, print a report, and archive a report. Hardcopy report formats shall be handed over to Contractor for generation of report formats in the system. It shall also be possible to define and generate the additional user configurable reports. The generation and printing of any report shall not effect normal scanning of data from PLC. The report scheduling display shall enable entry of the following parameters, with default values provided where appropriate:

(a) Report name

(b) Report destination (printer or archiving device)

(c) Time the system should produce the report.

✓ ***SCADA System Access Security***

A mechanism for defining and controlling user access to the SCADA system shall be provided.

✓ ***Alarm Summary Displays***

Displays that list or summarize all unacknowledged and acknowledged alarms shall be provided. The user shall be able to select between viewing alarms in chronological and reverse chronological order. The default shall be most recent alarms. The summary shall separate acknowledged and unacknowledged alarms. To facilitate identification of unacknowledged

messages the time field shall blink or entire row shall blink. It shall be possible to sort alarms by user defined text, date, time.

- ✓ ***Event Summary Displays***

  Event summary displays shall list the most recent events. The user shall be able to select between viewing events in chronological and reverse chronological order. The user shall be provided with a convenient and efficient means of selecting an event summary display. It shall be possible to sort events by user defined text, date, time.

- ✓ ***Operating Information Summaries***

  The operating information summaries defined below shall be provided. Summary items will be listed in reverse chronological order with the most recent item shown on the first page. The user shall have the ability to sort summary items by device.

- ✓ ***Abnormal Summary***

  The summary display shall list devices and values that are found to be abnormal, i.e., are not in their normal state. Telemetered, calculated, and manually entered status and data values shall be included.

- ✓ ***Out-of-Scan Summary***

  The out-of-scan summary display shall list device status and data values that are not currently being processed by the system.

- ✓ ***Alarm Inhibit Summary***

  This display shall list devices and data values for which the user has suspended alarm processing.

- ✓ ***Tag Summary***

  This display shall list and describe all active device tags.

- ✓ ***Help Displays***

  Help displays shall be provided to aid the user in interpreting displayed information and to guide the user through a data entry or control procedure.

- ✓ ***Alarm Beeper Services***

  The Alarm Beeper service audibly notifies the Contractor of recent alarms by playing a wave file. Wave files can be used to distinguish between Alarm priorities. All the Windows'.wav files or customized.wav files can be used

- ✓ ***Alarm Pager Services***

  The Alarm Pager service allows the user to configure the system to issue various pages in response to specified alarms.

- **Quality Assurance Plan**

To ensure total conformation of the application to the user requirement and to make sure that S/W package development is of high quality, proper quality control activities shall be performed and documented throughout the development. For this, the Contractor shall give a S/W quality assurance plan to establish system of controls and make the S/W development activity less intangible and more manageable throughout life cycle of S/W development viz. Review and acceptance of Requirement Analysis, Design, Development, Testing, Implementation, User training, Maintenance, etc.

The Vendor shall be ISO 9001:2000 certified and shall ensure that all the activities including documentation comply with the standards.

✓ ***Preventive Maintenance***

Time for regular preventive maintenance with a frequency of not less than once per quarter will be required during the Warranty period. This should include general checkup of various parameters, running diagnostics etc. to avoid any possible failure or deterioration in response time.

✓ ***Documentation***

The following documents shall be required for smooth functioning of the system:

DOCUMENT NAME
Installation Manual
System Administration and Maintenance Manual
User Manual
Technical Manual
Test Document(FAT &SAT)

✓ ***Training of Employer's Engineers***

The Contractor is required to provide in depth training to Employer's engineers (10 Nos.) for 1 month at his facilities on all aspects of the system being supplied. Training module shall be mutually discussed and finalized to cover Employer's personnel to operate, append, modify and troubleshoot the System effectively. All the documentation and write up material for trainees shall be provided by the Contractor.

The vendor should conduct this training at his premises, before testing of the package start. The Contractor should devise an exhaustive training program.

Testing / Inspection

✓ ***Test on Complete Control System***

On completion, the functioning of the complete system shall be tested to demonstrate its correct operation in accordance with the Specification.

For control system testing, the Contractor may provide temporary means to simulate operating conditions, but the system will not be finally accepted until correct operation has been demonstrated to the satisfaction of the Employer's Representative when all the pumps are operating.

The system shall be shown to operate correctly whatever the selection of duty and standby equipment may be.

Conditions to be tested shall include:

- Normal automatic operation.
- Normal manual operation
- Emergency manual operation

✓ ***Commissioning Tests***

Correct operation of controllers shall be verified by observing that the final control element moves in the proper direction to correct the process variable as compared to the set point.

All logic sequences shall be verified to operate in accordance with the specifications.

All defects and malfunctions disclosed by test shall be corrected immediately.

New parts and materials shall be used as required and approved and tests shall be repeated.

A report certifying completion of validation of each instrument system indicating calibration values, verification that the system performs as per requirements and any provisional settings made to devices shall be provided. A format for commissioning checklist to be provided for approval before performing the commissioning tests.

✓ ***Final Operational Testing and Acceptance***

Upon completion of instrument calibration and system validation, all systems shall be tested under process conditions.

The testing shall include, but not limited to all specified operational modes, taking process variables to their limits (simulated or process) to verify all alarms, failures, interlocks and operational interlocks between systems and/ or mechanical equipment.

Any defects or malfunctions shall be immediately corrected using approved methods and materials and the tests shall then be repeated.

Upon completion of final operational testing, a report shall be submitted, indicating that the total control system provided meets all the functional requirements specified herein. This report shall be made in the format approved by the Employer's Representative. The Employer's Representative shall certify this report and it shall constitute final acceptance of the control system.

Commissioning

After completion of installation works the Contractor shall arrange to carry out following checks/tests in the presence of Employer's Representative.

✓ ***Test on Control Panels and Switchboards***

- Mechanical Completion Test
- Check name plate details of every associated equipment according to specification
- Check for physical damage
- Check for tightness of all bolts, clamps and connecting terminals
- Check earthing
- Switch developments
- Each wire shall be traced by continuity tests and it should be made sure that the wiring is as per relevant drawings. All interconnections between panels/equipment shall be similarly checked.
- All the wires should be maggered to earth

✓ ***Commissioning Tests***

- Checks on relays, functioning of relays, simulation of fault for testing
- Checks on motors
- Setting of relays, other alarm, tripping devices and interlocks as per scheme
- Phase angle checks, measurement of magnitude and phase angle of current transformer secondary currents and potential transformer secondary voltage
- Functional checking of all power and control circuits e.g. closing, tripping,

control, interlock, supervision and arm circuits including proper functioning of the components equipment. If inter locks are provided with other equipment, it shall be thoroughly tested.

✓ ***Mechanical Completion Checks***

- Check name plate details according to specification
- Check for any physical damage
- Check internal wiring
- Megger all terminals to body
- Megger AC to DC terminals

✓ ***Commissioning Checks***

- Check operating characteristics over the entire range by secondary injection
- Check minimum pick up voltage
- Check operation of electrical / Mechanical targets
- Relay settings to be checked by injecting different values of current
- Setting of relays as per discrimination chart

Miscellaneous

Mechanical completion checks and commissioning tests on items not covered above, shall be carried out by the Contractor as per the instructions of Employer's Representative.

5.5.4 Inspection and Testing Requirements on Completion of STP

5.5.4.1 General

Following Tests shall be conducted prior to the commencement of these Tests, the Contractor shall submit for approval the following:

- Certificate/undertaking for having achieved Physical completion of Plant and facilities;
- As- Built Drawings; and
- Operation and Maintenance Manuals.

All the tests shall be conducted in the presence of Employer's Representative and shall not be commenced until the aforementioned documents are approved by the Employer's Representative.

5.5.4.2 Tests on Physical Completion of Plant and Facilities

(A) Dry Test

General

As a minimum requirement, the following dry tests shall be carried out:

- A general inspection to check for correct assembly, installation of all equipment etc., and quality of workmanship;
- A check on the presence of lubricant, cooling medium, etc;
- A general check to ensure that all covers, access ladders, water proofing, guard railings, etc are in place; and
- A check on damp-proofing, rust – proofing, vermin-proofing and particularly the sealing of apertures between building structures, chambers etc.

- **Civil and Building Works**

  As a minimum requirement the presence of foreign bodies in pipe work and structures shall be checked and rectified as necessary. All Building services including Lighting and Sanitary fixtures shall be checked.

- **Mechanical Works**

  As a minimum requirement, preliminary running checks shall be carried out on all the mechanical works as far as permitted by circumstances in order to ensure smooth operation of the equipment and machinery. The Mechanical lifting arrangement of diffusers from drop pipe shall be checked for all drop pipes to ensure their functionality. The noise levels and vibration etc of centrifuge, blower and gas engine if provided shall be assessed and corrective measures for meeting the criteria taken, as required.

- **Electrical Works**

  The following tests are to be carried out on all the equipment/ systems, as applicable.

  - Insulation resistance measurement of equipment, accessories, cabling, wiring etc.;
  - Dielectric tests of the oil of Transformer;
  - Phase sequence and polarity of Transformer;
  - Voltage and current ratios of Transformer;
  - Vector group of Transformer;
  - Resistance measurement of winding, contacts, of Transformer and motors;
  - Continuity tests of all equipment;
  - Calibration of indicators, meters, relays, etc.;
  - Control and interlock checks in PMCC, MCC etc.;
  - Settings of equipment and accessories;
  - Checking of accuracy and error;
  - Checking of operation characteristics, pick-up voltages and currents, etc. of all drives;
  - No load tests and trials on drives (electrical motors);
  - Operational and functional tests on equipment, accessories, control schemes, alarms, trip, indication circuits, etc.
  - Measurement of guaranteed or approved designs including lighting levels, earth resistance measurements etc.; and
  - Complete commissioning checks of the system.

- **Instrumentation & Control System**

  The following dry tests shall be carried out on the instrumentation and control system:

  - Continuity checks on all signal, control and power supply cables;
  - Checking of instrument loop integrity, functionality and calibration. A written report on each instrument in the format required by the Employer's Representative shall be provided certifying that the instruments have been calibrated to the published specified accuracy;
  - Checking functionality of the instrument control panels and consoles; and
  - PLC console/MMI and associated equipment.

5.5.4.3 Hydraulic Wet Test

(A) General

Hydraulic wet tests shall be carried out on completion of dry tests. Screened and degritted raw sewage shall be used for hydraulic performance of the Works. In order to demonstrate hydraulic wet test, the Contractor shall ensure that each part of the works is hydraulically loaded to its rated throughput for a period of at least twenty-four (24) hours. In order to remove doubt, the following tests inter alia shall be carried out:

- Pressure testing of all piped systems in accordance with the relevant standards;
- Filling of all structures and check for leaks and structural stability;
- Running of all rotating systems in order to check for:
- Correct functionality;
- Absence of leaks;
- Allowed temperature rise, smoothness of running and the absence of undue vibration, stress, and noise level; and
- Check drives running currents, power-factor, efficiency etc. under full load conditions of all equipment.
- Carry out calibration of instruments, especially flow meters and integrators for gas and raw sewage where appropriate;
- Carry out valving, diversions etc. to full hydraulic load (or where there is a requirement to withstand no load to overload) on each process element;
- Demonstrating correct functionality of electrical, control, and instrumentation systems.
- Assess leakage levels in piping, gates and valves etc.
- During these tests a check on the performance of Plant shall be made, as far as site facilities will allow, to compare its site performance with the factory test data and to identify any constraints on performance due to site conditions.

5.5.4.4 Diffused Aeration Oxygen Transfer Test

The Contractor shall carry out the oxygen transfer test in the aeration tank (or one compartment) using clear water for demonstration of the oxygen transfer rate guaranteed. Procedure as detailed in Annex “D” of volume 1 shall be followed.

5.5.4.5 Safety Audit

After satisfactory completion of the hydraulic wet tests and prior to the continuous introduction of raw sewage to the plant, a safety audit shall be carried out to ensure compliance with the necessary requirements of safety during operation of the Plant. The safety audit shall be documented. The Employer’s Representative shall approve the safety audit document.

5.5.4.6 Tests during Trial Run and Commissioning

(A) Process Wet Tests

On approval of safety audit the Contractor shall carry out process wet tests. Screened and degritted sewage shall be used as the primary feed stock for process wet tests. These tests shall be carried out to demonstrate the process performance of the works. In order to demonstrate this, the Contractor shall ensure that each part of the treatment system is loaded to its rated throughput for a continuous stable operating period of not less than 36 hours. The Contractor

shall arrange collection and disposal of screenings, wet grit and sludge also as generated from the plant area as directed by the Employer's Representative from this point of time onwards.

The following test inter-alia shall be carried out:

- Check for leaks in structures, chambers, pumps and pipe works.
- Running of all rotating systems in order to check for:
- Correct functionality
- Absence of leaks
- Allowed temperature rise.
- Smoothness of running and absence of undue vibration or stress.
- Check drive running currents where the clear sewage and sludge is pumped
- Carry out calibration of laboratory instruments.
- Demonstrate correct functionality of electrical, control and instrumentation systems
- On completion of the tests on the various parts of the works the Contractor shall proceed for commissioning and stabilising the plant.
- The Contractor may evaluate various indigenously available polyelectrolyte to ascertain the exact type and dosage requirement in the aim to keep the operational efficiency of Centrifuges high and operational cost low.
- During commissioning and stabilisation period Contactor shall collect raw sewage and treated sewage composite samples based on flow. The laboratory shall be utilized to analyse the Biochemical Oxygen Demand (BOD), Suspended solids (SS) and Chemical Oxygen Demand (COD) of both raw and treated sewage.
- The Contractor shall establish a graph for the relationship of COD and BOD in both raw sewage and treated sewage. This ratio may be utilized during PG test to arrive at the value of BOD on the basis of COD test results. However, results of laboratory BOD tests shall prevail. In the same way, relationship between BOD and suspended solids shall also be generated in the treated sewage samples.

5.5.4.7 Tests on Completion

(A) Performance Guarantee tests (PG tests)

Once the Contractor is satisfied with the stabilisation of critical units and energy efficiency of the system, it will inform the Employer's Representative in writing that it is ready to perform performance guarantee test (PG Test). The performance guarantee test will be conducted at a mutually agreed convenient date.

The performance test shall be conducted for a continuous period of 7 days (168 hours). All tests shall be conducted by the Employer's Representative in the presence of Employer and / or such referee appointed by it.

In the event, during commissioning stage, BOD values exceed the design values as stated in Employer's Requirements then it shall admit the BOD load per day (flow x BOD concentration) in the aeration tank, equal to stipulated influent BOD* Flow MLD, as applicable, by regulating the flow to either one stream or both the streams depending on the inflow of sewage. Contractor shall inform the Employer's Representative in writing about the flow it is proposing to load on the system and get the approval for the same. PG test conducted with flow regulation based on BOD load per day as per the design norm shall meet the functional

guarantees. However, the Employer reserves the right to ask the Contractor to load the plant to full capacity or in one steam if sufficient flow is not available. In this case the Employer will take over the plant based on the actual results obtained, which may or may not meet the all the functional guarantees.

Alternatively, the Employer reserves the right to conduct PG test within six months by issuing a "Conditional Taking-Over Certificate" from the date of issue of this certificate. In such an event, the 'Operation & maintenance period' shall be deemed to have commenced from the date of issue of "Conditional Taking over Certificate". The Employer's decision shall be final and binding on the Contactor in this regard.

The plant shall generally have two streams of half the capacity each and it will be operated at rated capacity for each stream of C MLD. In the event, at the time of trial run and commissioning the flow observed does not reach this figure, then during PG test the flow shall be maintained as follows.

If the observed flow is between ½ C and C MLD, then only one stream of C MLD shall be operated for PG test.

If the observed flow is more than C MLD, then both the streams of C MLD shall be operated for PG test

If the observed flow is below ½ C MLD, then "Conditional take over certificate" shall be issued by the Employer and PG test shall be conducted within six months thereafter.

However the Employer's decision shall be final in this.

In the event of any interruption in the PG Test for the reasons not attributable to the Employer, the Contractor shall redo the PG test for 168 hours again. The time gap between the interruption and restart shall not exceed 7 days. If the Contractor does not restart the test after interruption within the period stipulated above the Employer shall initiate action in accordance with Clause 9.2 Section 2.

During the tests the Contractor shall take samples to demonstrate that each part of the works and the works as a whole is performing in accordance with functional guarantees. In case, functional guarantees are not met during the Performance Guarantee Test, Performance Guarantee Test shall be considered as failed.

In case of failure of first Performance Guarantee Test, action shall be initiated in accordance with Clause 9.3 Section 2. In any case, the extension for clearing the PG Tests shall not be extended beyond 90 days after the Works has failed first Performance Guarantee Tests.

In case of failure of Performance Guarantee Test, in-respect of Effluent parameters (BOD, COD, SS, pH) the works shall be rejected and the Performance Security shall be forfeited by the Employer without referring to the Contractor, besides initiating action in accordance with Clause 9.4 of Section 2 (General Conditions).

All consumables needed for operation of the works such as chemicals, lubricants, polyelectrolyte etc and transportation of screening, wet grit, wet sludge off site, shall be provided by the Contractor. The Contractor shall provide all facilities and equipment not supplied under the contract and which are deemed necessary to carry out and monitor the Tests on Completion. Samples during PG tests shall be drawn for testing as below:

S No.	Location of Sampling/ Check point	Sample/ Reading	To be tested for
1	Distribution Chamber Up stream of Primary Clarifier	Liquid	BOD, COD, SS and pH
2	Grit Discharge Chute	Wet Grit	Organic content in grit (on Dry basis)
3	Distribution Chamber Up stream of Secondary Clarifier	Liquid	Dissolved Oxygen
4	Secondary Clarifiers Launder	Liquid	BOD, COD, SS and pH
5	Digester/ Gas Holder meter	Reading	Quantity of Gas*
6	Sludge Holding Tank	Digested Sludge	% Solids Concentration ans VSS fraction (on dry basis)
7	Discharge Chute of Centrifuge	Wet Cake	% Solids Concentration
8	Energy meter	Reading	Guaranteed process power consumption from JVVNL grid.

All Liquid samples including samples of Digested sludge shall be collected at the rate of 3300 ml every four hours in an iced container and stored in a bottle cooler such that a total of 19800 ml becomes available daily and this sample shall be used for testing. This composited sample shall be divided equally into three parts and one part shall be used for testing at the Plant laboratory, one part given to the Employer for testing at any place selected by him and one part given to the referral laboratory as nominated by Rajasthan State Pollution Control Board. The results of the third named laboratory shall overrule the results of the first and second laboratories in the event of a discrepancy between the results of two.

Wet grit samples shall be collected at the rate of about 250 gm at every four hours and sealed in an air tight poly bag from each grit separator in an iced container and stored in a bottle cooler such that a total of about 1500 gm per day per grit separator becomes available on final collection and this sample shall be used for testing. This composited sample shall be divided equally into three parts and one part shall be used for testing at the Plant laboratory, one part given to the Employer for testing at any place selected by him and one part given to the referral laboratory as nominated by Rajasthan State Pollution Control Board. The results of the third named laboratory shall overrule the results of the first and second laboratories in the event of a discrepancy between the results of two.

All the readings energy shall be recorded at every four hours in a separate register and every reading shall be signed as accepted then and there by the Employer's Representative, Contractor and PHED / referee and shall be used for compliance evaluation with respect to the corresponding guaranteed values in the contract.

During P G test period alone, one of the three centrifuges shall be operated by rotation continuously each operating for a period 24hours along with respective feed pump. The samples of wet cake shall be collected at the rate of about 250 gm at every four hours and sealed in an air tight poly bag in an iced container and stored in a bottle cooler such that a total of about 1500 gm becomes available daily and this sample shall be used for testing. This composited sample shall be divided equally into three parts and sealed in an air tight poly bag. One part shall

be used for testing at the Plant laboratory, one part given to the Employer for testing at any place selected by him and one part given to the referral laboratory as nominated by Rajasthan State Pollution Control Board. The results of the third named laboratory shall overrule the results of the first and second laboratories in the event of a discrepancy between the results of two.

5.5.4.8 Treated Sewage Quality Criteria For Passing The Tests On Completion

The treated water quality and other key deliverable standards shall be demonstrated by the Contract at

(A) At Each STP

The nominal design flow:

- 25% of nominal design flow*
- 10% above the nominal design flow*
- the pollutant concentration of all incoming pollutants as freight (i.e. kg/day in terms of flow received) in a range of 75% to 110% of the pollutant freight calculated at the design pollutant concentration and nominal design flow.

*On some occasions during the year like festivals, excessive rain, extreme weather conditions etc.

S. No.	Parameter	Value
1	pH	6.5 – 8.0
2	BOD @ 25^0 C	< 10.0 ppm
3	COD	< 50 ppm
4	TSS	< 10.0 ppm
5	Oil and grease	< 5 ppm
6	Total Nitrogen	< 10 ppm
7	Total Phosphorous	< 2 ppm
8	Coliform (MPN/100 ml)	10

(B) In the water way in Amanishah Drain:

- pH 6.5 to 8.5
- DO > 4.0 ppm
- Free Ammonia < 1.2 ppm

(C) Acceptance Criteria

Non-compliance to demonstrate the plant performance during the completion tests with respect to treated water quality and sludge quality for a continuous period of 72 hours, is not acceptable and the Contractor shall rectify the facility to demonstrate the performance. Not being able to demonstrate the plant performance as per the stipulated standards shall render the plant as “Not Acceptable” leading to a penalty of 10% and forfeiture of the performance securities.

Contractor to maintain guarantee parameters for treated effluent and water way quality during O & M period and during Retention Period. These quality parameters are subject to presumptions that actual pollutant (Pollutants like BOD, SS, Nitrogen etc. in kg/day) load will not exceed design pollutant load (kg/day) per day for every parameter. However, on some occasions during the year (i.e. festivals, excessive rain, extreme weather conditions), individual pollutant concentration (mg/l) can exceed up to 10% of design parameters, and total sewage flow can exceed up to 10% design flow.

The treated effluent parameters shall be demonstrated with 24 hour composite

samples with 95% compliance on monthly basis i.e. not more than 5% cumulative samples during the month can be off specifications.

The Maximum Allowed Concentration (MAC) on individual grab samples shall not be more than 2 times of the above specified 95 percentile value.

If any parameter of any grab sample exceeds the MAC values, the sample shall be considered as "Not compliant".

Guarantee for Fecal Coliform shall be based on 30 days geometric mean value.

For monitoring the compliance of power guaranteed and actual power consumed, the following procedure shall be adopted.

The process energy meter reading of JVVNL shall be recorded in the presence of Contractor on every first of the month. Contractor and Employer's Representative shall sign this monthly record.

The flow integrator reading will be recorded every day at 11 AM. Contractor and Employer's Representative shall sign this daily record.

The composite value of BOD measured shall also be recorded and signed.

Employer reserves the right to send part of the sample collected by the Contractor to outside laboratory of Employer's choice, periodically without any notice.

d. At the end of the every calendar month, the computation shall be done as follows.

The guaranteed energy corresponding to the actual flow recorded and actual BOD observed shall be summed up for the entire calendar month. If such summed up values for the calendar month exceed the corresponding JVVNL energy meter reading, then excess energy charges as said in Appendix to the Technical proposal shall be levied and recovered from the subsequent O & M bills due for payment.

5.5.5 Operation And Maintenance Manual And As-Built Drawings

The submission of the As–built drawings and the operation and maintenance manual for the system is the precondition for the final payment.

5.5.5.1 Operation And Maintenance Manual

The Contractor has to submit as operation and maintenance manual after the physical completion of the work. This manual will be submitted as draft at the date of physical completion and as final version one month after commissioning. It shall include all the experience made during the tests and the training given to the Contractors during the commissioning period. The Contractor shall prepare this manual in cooperation with his suppliers and subcontractors and after consultation with the Employer's Representative for detailed contents. It will at least contain the following items.

- General description of the plant and its functioning.
- Step- by step procures for all the plant functioning.
- Architectural, mechanical electrical, instrumentation, piping drawings, sections, details, charts.
- Nomenclature of all the equipment (mechanical, electrical, instrumentation, power and signal cables, electrical and sanitary fixtures)
- For each item of the equipment:
- Drawing charts (if required)
- Operational Instructions
- Calibration charts (if required)

- Fault identification and location guides and charts
- Repair instructions (if repair by operations if possible)
- Maintenance instructions including type and quantity of lubricants
- Spare parts list with addresses of suppliers and procedures for ordering.
- Preventive maintenance schedules for all the equipment, showing the type and frequency of maintenance of different items
- Type and quantity of the recommended consumables (lubricants, fuels etc.,)
- Emergency management for specimen emergency situation which might occur due to external or internal factors
- Logs for the Contractor of the system
- Operating hours
- Salient indicators of the operation
- Maintenance operations
- Fault and actions taken
- Other events

Address and telephone number to contact in case of operation problems shall be provided.

It is emphasized that a collection of standard literature of a general nature, unaccompanied by specific drawings and descriptive matter relating to the work as commissioned, shall not be acceptable.

The operation and maintenance manual shall be bound in one or several loose-leaf binders designed to prevent loss and damage of the contents. The binders shall be tilled, numbered, and have a table of contents of all information contained.

5.5.5.2 As – Built Drawing

The Contractor shall submit to the Employer's Representative within four months of actual completion, "Completion" Drawings as specified below. These Drawings shall be accurate and correct in all respects and shall be shown to and by the Employer's Representative.

Completion Drawings as specified below on shall be supplied by the Contractor two prints and one polyester film, along with a soft copy in CD. These drawings shall be developed in Auto CAD – 14 or more recent version. Drawings shall be of standards size described below.

- Site plan showing all features existing and as constructed under this contract with all external dimensions of clear spaces among those, diameter and materials of pipeline etc. complete.
- Architectural, civil and structural details of all components of the Plant, including plans at different levels, elevations from all sides as well as sections etc. complete with all dimensions including structural thickness, concrete grade, reinforcement details, finishing details, schedules of doors and windows, details of associated fittings and features complete.
- All piping, plumbing and electrical details with dimensions, diameters etc. complete. At specific cases isometric views of piping may be necessary.
- Dimensional details of all electrical, mechanical and instrumentation equipments including accessories along with arrangement inside the buildings or enclosures, connected piping and cabling, layout, etc. all complete.
- Dimensional details of all control and measuring devices lined weirs, V-

notches, probes, valves, gates, consoles, panels, switch boards, cable layout etc. for the complete Plant. Fine diagrams and circuit diagrams shall be used wherever applicable.

- L-Section for pipelines laid externally, showing pipe profile, ground profile, soil condition, bedding location of specials, valves, and other accessories complete.
- Dimension details of all site development works such as roads, drainage, cables, pipelines, landscaping, etc. complete with layout, cross sections, levels, etc. complete.
- All drawings shall be prepared in appropriate scale and with adequate notes, legends, titles, etc. for clarity.

5.5.5.3 Performance Certificate

The conditions for issuance of a Performance Certificate as detailed in Clause 12 of the Conditions of Contract shall inter-alia comprise of the following items:

- The completion of the one year's operation of the works to the satisfaction of the Employer's Representative;
- The submission of updated O & M Manuals have been made following one year of operational experience and approved by the Employer's Representative;
- All defects identified prior to Taking Over and defects identified during the one year's operation of the Works have been rectified;
- All Tests After Completion have been completed to the satisfaction of the Employer's Representative;
- First phase training(s) detailed in the Employer's requirements have been completed.

5.5.6 Automation & Control

5.5.6.1 Operation, Control Philosophy & Data Acquisition for Sewage Interception and Treatment for Amanishah Nallah

- Operation philosophy is basically divided into three:
- Control Philosophy for Sewage Lifting Station
- Control Philosophy of Sewage Treatment Plant
- Centralized Data Acquisition System (DAS)

5.5.7 Control Philosophy for Sewage Lifting Station

The system consists of interception pipelines along the Nallah. All sewage shall be intercepted and not allowed to be discharged in Nallah. The interception pipe lines are on both banks of the Nallah.

There are approx. 11 proposed Sewage Treatment Plants on the left and right bank of Nallah. Lifting stations are provided on either one bank or both banks depending on the sewage flow, source i.e., incoming drain channels to the interceptor pipelines.

There are totally 20 lifting stations proposed of which 1-18 are having flow downstream and the flow to the interception pipe is by gravity. From the Lifting Station, Sewage water is pumped to the nearest STP. The Lifting Stations in many STPs are on both sides of the canal / Nallah and pipes are expected to cross the Nallah for which suitable mechanism that may include a duct or a conduit in the Check Dam in the Nallah.

Last 2 pumping stations - 19 & 20 - are the last pumping stations at the end of the Nallah and the pipeline from these two stations to the upstream Lifting stations shall be pressurized.

5.5.7.1 Operation Philosophy and Logic for Lifting Stations

Lifting station pumps shall be selected as per CPHEEO guidelines and shall be minimum 2 working + 1 Standby. These pumps shall have three modes of operation:

Local: Pumps have to be switched ON / OFF by local Push button system.

Remote: In this mode of operation, Pumps have to be manually operated from Remote through PLC of nearest STP.

Automatic operation: The Pumps shall be kept in totally remote mode and based on the levels in the lifting stations which is designed for 30 mins. The PLC shall initiate pumping directly to the Equalization Tank. This operation shall be based on logic only.

In the event of emergency / contingency, a by-pass line shall be provided from the Lifting station to the next Lifting station. This shall be controlled by motor-operated / solenoid valves. This facility shall be provided for all lifting stations in such a way that sewage can be transferred automatically from lifting station 1 up to even the lifting station 18 through intermediate lifting stations in an automatic mode in consultation and communication with each STP. However, the reverse i.e. Sewage from lifting station 18 **CANNOT** be pumped to Lifting station 1.

Based on level switches and logic which is provided in the nearest STP, Redundant level switches and one Level Transmitter shall be provided for low level and high level in the lifting stations.

Emergency shutdown option shall be provided for local emergency stop only. Hence to conclude, these pumps can be started from the PLC in nearest STP.

In the PLC, signal from the level transmitter provided in the lifting station will indicate the height / depth of the liquid, whereas level switches shall control the switching ON / OFF of the pumps.

5.5.7.2 Operation and Control Philosophy of Sewage Treatment Plant

We have listed the list of equipment and defined the type of controls which is not dependant on any technology. All STPs shall have critical components controlled from the PLC. A semi-automatic mode of operation is only considered. The critical data and instrument readings will also be displayed in the PLC. Also, all critical data will be transferred to the DAS from each STP-PLC by Optical Fiber cable (OFC) or through Wireless protocol.

During detail engineering based on the location of the central control room, suitable signal boosters need to be provided to have a good healthy signal at the control room. This is irrespective of data transmission by either wireless mode or by OFC.

The proposed system is semi-automatic as given in the table below:

S. No.	Equipment	Control desired	Instrument triggering control	Local Control	PLC	PLC Display	PLC Control	DAS	Remarks
1	Raw Sewage t/f Pumps	ON/OFF & Level Indication	ON/OFF, level switch, level indication & level transmitter	Switching ON/OFF to be considered in manual mode and emergency OFF in AUTO mode	ON/OFF to be considered. Also ON/OFF based on level to be considered in AUTO mode	Level Pump ON/OFF/TRIP/ LOCAL/REMOTE	YES from PLC in remote mode	Display in DAS	Applicable irrespective of technology
2	Belt conveyor for Fine screen	Local	motor ON/OFF status	Yes	Control: NO	Yes	NO	NO	Local control envisaged, motor ON/OFF display in Local PLC
3	Level Transmitter (Ultrasonic - Open Channel)	NIL	Ultrasonic level indicator in Parshal Flume: ON/OFF status	No	Yes	Yes	NO	Yes	Ultrasonic flow meter shall display the flow into the STP
4	Blower for EQT	None	Pressure Switch (ON/OFF)	Yes (in Local mode)	Yes (in Remote mode)	Yes	Yes (ON/ OFF)	Yes	Irrespective of STP Technology, ON/OFF status shall be displayed.
5	EQT t/f Pumps	ON/OFF	ON/OFF, level switch, level indication & level transmitter	Emergency STOP shall be provided in case of Level is HIGH for EQT Pump	ON/OFF to be considered. Also ON/OFF based on level to be considered in AUTO mode	Level Pump ON/OFF/TRIP/ LOCAL/REMOTE	YES from PLC in remote mode	Display in DAS	Applicable irrespective of technology
6	Level control in Bio-reactor	ON/OFF & Level Indication	ON/OFF, level switch, level indication & level transmitter	Emergency STOP shall be provided in case of Level is HIGH	ON/OFF to be considered. Also ON/OFF based on level to be	Level Pump ON/OFF/TRIP/ LOCAL/REM	YES from PLC in remote mode	Display in DAS	Applicable irrespective of technology, control through

S. No.	Equipment	Control desired	Instrument triggering control	Local Control	PLC	PLC Display	PLC Control	DAS	Remarks
					considered in AUTO mode	OTE			ON/OFF motorized valve / Pneumatic valve.
7	Blower for Bio-Reactor	Control1: Blower ON/OFF Control2: with DO	ON/OFF, Pressure Switch. Operation: Manual/AUTO	Yes : ON/OFF (Working / Standby Selection)	Yes : ON/OFF (in Remote Mode)	Yes: ON/OFF/TRIP	YES	Display in DAS	Control is from DO meter as described below
8	DO for Bio-Reactor	DO Level not less than 2 mg/l	online DO analyzer / controller	NO (for analyzer)	YES: Display of DO level	Yes: ON/OFF/TRIP of blowers as mentioned above in total automatic remote mode	YES (only through PLC)	Display of DO	DO level shall trigger ON/OFF of blower motors / VFD to bio-reactor to maintain process set point of DO under all given condition. DO set point is made by human intervention in AUTO REMOTE Mode
9	RAS / WAS Pump	Manual / Automatic	Pressure Switch (ON/OFF)	Yes (ON/OFF of pumps)	YES: ON/OFF/Control	Yes: ON/OFF/TRIP	YES (Manual /Automatic)	Display (ON/OFF)	To maintain MLSS in bio-reactor as per suitable technology. Control of RAS/WAS pumps to

S. No.	Equipment	Control desired	Instrument triggering control	Local Control	PLC	PLC Display	PLC Control	DAS	Remarks
									maintain MLSS as per technology
10	Decanter Mechanism	Level	Timer in PLC	NIL	YES: DDE	Yes: ON/OFF	YES (Automatic)	Display (ON/OFF)	Applicable to SBR only
11	Secondary Clarifier	Level	Level Transmitter	NIL	NIL	Yes: Level Transmitter Display	None	Display (ON/OFF)	Not applicable for SBR
		TSS	TSS Analyzer	NIL	NIL	Yes: TSS Reading Display	None	Display (ON/OFF)	Not applicable for SBR
		Motor Rotation	MCC Feedback NO/NC from Relay	YES (ON/OFF)	YES (ON/OFF)	Yes: ON/OFF	YES (ON/OFF)	Display (ON/OFF)	Not applicable for SBR
	Disc Filter	None	None	YES (ON/OFF)	YES (ON/OFF)	Yes: ON/OFF	YES (ON/OFF)	Display (ON/OFF)	Equipment selection shall be Disc Filter / Secondary Clarifier during details Engineering. Not applicable for SBR
12	Sludge Pit	Level Transmitter	Indication in PLC	NIL	YES	None	Level Indication	Level indication	
		Pump	None	YES	YES	Yes: ON/OFF	Manual from PLC / LOCAL	Display (ON/OFF)	TRIP Signal can be initiated from LOW level of Level transmitter

S. No.	Equipment	Control desired	Instrument triggering control	Local Control	PLC	PLC Display	PLC Control	DAS	Remarks
		Blower	None	YES	YES	Yes: ON/OFF	Manual from PLC / LOCAL	Display (ON/OFF)	Status taken from MCC, No pressure switch
13	Centrifuge	None	None	YES	YES	Yes: ON/OFF	Manual from PLC / LOCAL	Display (ON/OFF)	Status taken from MCC
14	Chlorination System	Booster Pumps	Yes: FRC Analyzer	YES	YES	Yes: ON/OFF	Manual from PLC / LOCAL	Display (ON/OFF)	Status taken from MCC
		Control Valve	Yes: FRC Analyzer	NO	YES	Yes: ON/OFF	Manual from PLC / LOCAL	NONE	
		Free Residual Chlorine (FRC) Analyzer	None	NONE	NONE	Yes: FRC Reading	NIL	YES: FRC Reading	FRC Triggers booster pump ON/OFF and isolated control valve and saturation achieve
15	Treated Water Tank	Level Transmitter	Indication in PLC	NIL	YES	YES	Level Indication	Level indication	
		Control Valve	All below	YES	YES	YES	All Instrument Below	YES	
		pH Analyzer	None	NONE	YES	YES: pH	Yes: Signal to control Valves	Display: pH	Signal taken from pH Analyzer to PLC, through suitable Card
		DO Analyzer	None	NONE	YES	YES: DO	Yes: Signal to control	Display: DO	Signal taken from DO

S. No.	Equipment	Control desired	Instrument triggering control	Local Control	PLC	PLC Display	PLC Control	DAS	Remarks
							Valves		Analyzer to PLC, through suitable Card
		TSS Analyzer	None	NONE	YES	YES: TSS	Yes: Signal to control Valves	Display: TSS	Signal taken from TSS Analyzer to PLC, through suitable Card
		Ammonia Analyzer	None	NONE	YES	YES: Ammonia	Yes: Signal to control Valves	Display: Ammonia	Signal taken from Ammonia Analyzer to PLC, through suitable Card
		Indicative BOD/Nitrogen/Phosphorous Analyzer	None	NONE	YES	YES: BOD/N_2/P based on Electrode used	Yes: Signal to control Valves	Display: Based on electrode used	Signal taken from Multi-Parameter Analyzer (Parameter displayed shall be based on electrode used) to PLC, through suitable Card

5.5.7.3 Configuration of the control system

The Controls described above shall be performed by Programmable Logic Controller (PLC). The PLC shall have redundancy in hot standby automatic changeover mode. The control system shall consist of various power modules, analog input cards, analog output cards, and digital input cards, digital output cards or any other cards as desired. There shall be min 10% spare for I/Os / Slot on every card. There shall be a provision of placing 10% additional card of each type or 1 slot whichever is higher (applicable for each card). The PLC and accessories (cards) shall be of reputed makes like Honeywell, Emerson, Siemens, ABB, Allen Bradley, GE Fanuc etc. The PLC shall be tested and the logic, the PLCs and cards shall be offered for Factory Acceptance Test (FAT). Later on, Site Acceptance Test (SAT) shall be carried on at the STP control room. The PLC shall have suitable redundant ports to facilitate signal communications to transfer data to central control room. The PLC shall also have provision to display key parameters on a LED / LV screen which shall be mounted at the entrance of the STP. The selected PLC shall have Slave clock facility to integrate with the master clock which will be at the central control room. There shall be further slave cocks displaying the master time in at least 8 locations in each STP.

In the event there is any delay in central control room readiness / operation, then each STP's PLC shall define the master clock for that STP. The local PLC shall have redundant communication ports to transfer signals/ data through Fiber Optic or wireless protocol. The data highway shall be having facility to have signal boosting for large STPs and for data highway communication to central control room.

5.5.7.4 Control Philosophy for Central Control Room for Sewage Treatment Plants for Amanishah Nallah

The Amanishah Nallah / Canal has 11 STPs, the two interception pipelines – one on each bank of Nallah of approximately 47 Km long. The first Pumping station and STP are at 4.7 km (near Mazhar Dam), whereas the last STP is at 39 Km chainage. It is proposed that a central control station somewhere mid-way around 21Km -22Km chainage. It may be noted that the STP Nos. 6 & 7 are in these locations. Two options need to be explored in this case are:

Option 1: The central Control Room can be integral part of any one of these two STPs. It can be a separate building in the STP campus or can be an Annexure to the control room of that STP.

Option 2: A central control room for CCTV camera vigilance is also proposed as part of the administration of the main Amanishah Nallah water body. The tentative location of this is also between 21 Km & 22 Km. Hence, the STP centralized control room can be a part of this complex and can be a separate building or can be an annexed to that main control room.

This control room has only monitoring and communication facilities. No operation and control is envisaged from this Control Room. The controls shall remain in the 11 STP control rooms only (Local). The information from that control room shall be transmitted to the centralized control room by either OFC or wireless mode.

This control room shall also have a PLC and large display screens. The number of screens can be decided during detail engineering but shall not be less than 4. Local monitors (computer monitors) shall be provided displaying data from each STP.

To conclude, this station shall have 11 computer screens displaying data from each STP which can be interchangeable. Four very large display screens are also proposed which can display selected critical data of each STP. The data which shall be displayed from each STP are as follows:

- Lifting Station Level

- Lifting station Pump ON/OFF/STANDBY/TRIP status
- By-pass valve status
- Motor Status of Screen (Fine)
- Flow to Bio-reactor (Parshal Flume)
- Status of blowers in Equalization tank
- Status of EQT Pumps
- Level Status of Bio-Reactor
- Blower status in Bio-Reactor
- DO in Bio-Reactor
- Sludge Pump Status
- Decanter Mechanism Level status (if applicable)
- Level, TSS & Motor Status in Secondary Clarifier
- Disc Filter motor Status (if applicable)
- Level, Sludge pump & Blower status in Sludge pit
- Centrifuge Motor ON/OFF Status

Booster Pumps: ON/OFF/TRIP Status, Control Valve: ON/OFF Status, FRC Analyzer: FRC Status for Chlorination system Level Status, control valve status ON/OFF along with pH, DO, TSS, Ammonia, Indicative BOD, Nitrogen, Phosphorous value at Display for Final treated water Tank

Walkie-talkies / telecommunication system shall be available from central control station to communicate to each STP. Also, from the central control station the PLC shall have provision to send critical outputs / trends to any statutory body electronically. Suitable ports in the PLC shall be provided to facilitate communication either through OFC, wireless or through MODEM.

Note: It would be preferable to have PLCs of all STPs and central control room of the same make

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5.6 Peripheral Development and Other Miscellaneous Works

5.6.1 Road Works

5.6.1.1 CC Road for maintenance of Nallah

For O&M purpose cement concrete roads for providing accessibility of trucks and other cleaning equipments to the bottom and any other part of the Nallah are to be made, a3.5 m wide cement concrete road 15 cm thick grade M15 laid over 15 cm thick coarse aggregate of size 60-90 mm ,having a gradient of at least 1 in 10 can be provided for this purpose at an interval of 1.5km along the Nallah. It needs to be ensured that such maintenance vehicles can reach in every portion of the channel for cleaning and maintenance purpose. Wherever required, suitable arrangements of localized ramp from one portion to another portion within channel shall be provided.

It needs to be ensured that such maintenance vehicles can reach in every portion of the channel for cleaning and maintenance purpose. Wherever required, suitable arrangements of localized ramp from one portion to another portion within channel shall be provided.

5.6.1.2 Peripheral Bituminous Road

A flexible pavement road having bituminous top shall be constructed along the outer periphery of Nallah in both side, in approximate total 16 km. length about 8 km. in each side, wherever land will be available. Road will have a minimum 5.50 mtr wide carriage way with one side 3 mtr. wide foot path as approved design from Employer's Representative, where ever construction is possible and land is available.

The specifications of the Road Works shall include following:

a) P/L a top layer of earth of 15 cm. Compacted thickness rolling with 10/12 tonne power roller, watering etc. complete in conformity with the lines, grades & cross sections & camber super elevation (Lab C.B.R. in soaked condition shall not be less than 10) including clearing & grubbing the ground etc. complete (including stabilization if necessary.)

b) Granular Sub-Base with Coarse Graded Material: (Table:- 400- 2) Construction of granular sub-base by providing coarse graded material, spreading in uniform layers with motor grader on prepared surface, mixing by mix in place method with rotavator at OMC, and compacting with vibratory roller to achieve the desired density, complete as per clause 401. Spec. No. MORTH – 401. This need to be provided in three layers of 75 mm each as given below:

   - for grading- I Material
   - for grading- II Material
   - for grading-III Material

c) Water Bound Macadam (75 mm thickness): Providing, laying, spreading and compacting stone aggregates of specific sizes to water bound macadam specification including spreading in uniform thickness, hand packing, rolling with 3 wheeled steel/ vibratory roller 8-10 tonnes in stages to proper grade and camber, applying and brooming requisite type of screening/ binding Materials to fill up the interstices of coarse aggregate, watering and compacting to the required density. Spec.No. MORTH – 404.

d) Tack coat: Providing and applying tack coat on the prepared surface heating by fames in roller and spraying bitumen with spray set footed in bitumen boiler on B.T. surface @ 60/70 Bulk (Bitumen VG-30)@ ii) 5Kg/10 Sq.M., Spec.No. MORTH – 503.

e) Bituminous Concrete : Providing and laying bituminous concrete of 20 mm or more thickness with 40-60 TPH batch type hot mix plant producing an average output of 35 tonnes per hour using crushed aggregates of specified grading, premixed with bituminous binder @ 5 percent of mix and filler, transporting the hot mix to work site, laying with a hydrostatic paver finisher with sensor control to the required grade, level and alignment, rolling with smooth wheeled, vibratory and tandem rollers to achieve the desired compaction as per MORTH specification clause No. 509 complete in all respects. Spec.No. MORTH – 509

5.6.1.3 Traffic Signs, Markings & Other Road Appurtenances

Painting Lines, Dashes, Arrows etc on Roads in Two Coats on New Work: Painting lines, dashes, arrows etc on roads in two coats on new work with ready mixed road marking paint conforming to IS:164 on bituminous surface, including cleaning the surface of all dirt, dust and other foreign matter, demarcation at site and traffic control. Spec.No. MORTH - 803

5.6.1.4 Road Delineators

Supplying and installation of delineators (road way indicators, hazard markers, object markers) 80-100 cm high above ground level, painted black and white in 15 cm wide strips, fitted with 80 x 100 mm rectangular or 75 mm dia. circular reflectorised panels at the top, buried or pressed into the ground and conforming to I.R.C. 79 and the drawings

Providing and fixing cautionary / warning sign board of 90 cm size having shape of equilateral triangle with apex point up-wards. Prepared on 16 gauge M.S. sheet including painting with one coat of zinc cromate stoving primer and two coats each of white back ground, red border and backside gray stove enamelled, bonded with cut out of Retro reflective sheet Engineering grade, symbol/letters/ numerals/ border arrow, coated with non pealable crystal clear protective transparent coat retaining 100% reflection including one number of M.S. Angle iron post of size 50 x 50 x 5 mm of 3.65 m long inflated at bottom drilling on top in one piece without joint painted with white and black bands of 25 cm fixing board and post with 2 Nos. high strength G.I. bolts and nuts of size 10 mm dia. 20 mm long including all taxes, conveying, fixing in ground with cement concrete 1:4:8 block of 60 cm x 60 cm x 75 cm. size etc. complete. Spec. No.: I.R.C. : 67 – 1977 (90 cm).

Codes for Roads Construction

No	Name of IRC Code	Code No:
1	Recommended practice for the Design and Layout of Cycle Tracks	IRC: 11-1962
2	Lateral and Vertical Clearances at Underpasses for vehicular traffic.	IRC:54-1974
3	Space Standards for Roads in Urban Areas	IRC:39-1977
4	Guidelines on Regulation and control of Mixed traffic in Urban Areas	IRC:70-1977
5	Geometric Design Standards for Urban roads in Plains	IRC:86-1983
6	Guidelines for the Design of Interchanges in Urban Areas	IRC:92-1985
7	Guidelines on Accommodation of Underground Utility	IRC:98-2011

No	Name of IRC Code	Code No:
	Services Along and Across Roads in Urban Areas (Second Revision)	
8	Tentative Guidelines on the provision of Speed Breakers for Control of Vehicular Speeds on minor Roads	IRC:99-1988
9	Guidelines for Pedestrian Facilities	IRC:103-2012
10	Guidelines for capacity of Urban Roads in Plain Areas	IRC:106-1990
11	Tentative Recommendations on the Provision of Parking spaces for Urban Areas	IRC:SP 12- 1973
12	Code of Practice for Road Markings (with paints) (First Revision)	IRC:35-1997
13	Code of Practice for Road Signs (Third Revision)	IRC:67-2012
15	Vertical Curves for Highways	IRC:SP23-1983
16	Guidelines for the design of curves for Highways & Design Tables (First Revision)	IRC:38-1988
17	Guidelines on Design of At-Grade Intersections in Rural & Urban Areas	IRC:SP41-1994
19	Standards for vertical and horizontal clearances of Overhead electric power and telecommunication lines as related to roads.	IRC:32-1969
20	Tentative Guidelines for the Design of Flexible pavements	IRC:37-2012

Specific Design Standards/ Guide lines for different Road Elements

Road Elements	Design Standards used for	
	Name of Code	Description
Ground Improvement	HRB - SR No. 14, 1994	State of the Art report: High Embankment on soft ground, Part B - Ground Improvement.
Embankment Fill	HRB - SR No. 3, 1999	State of the Art Report: Compaction of earthworks and sub grades.
Pavement Design	IRC:37-2012	Tentative Guidelines for the Design of Flexible Pavements.
Road Markings	IRC:35 -1997	Code of Practice for Road Markings (with paints) (First Revision).
Road Signs	IRC:67 -2012	Guidelines for Pedestrian Facilities.
Landscaping	IRC:SP21-2009	Guidelines on Landscaping and Tree plantation.
Pedestrian Facilities	IRC:103-2012	Guidelines for Pedestrian Facilities.
Cycle Tracks	IRC:11-1962	Recommended Practice for the design and layout of Cycle tracks.
Traffic Lights	IRC:93-1985	Guidelines on Design and Installation of Road Traffic Signals.
Junction / Medians	IRC:SP41-1994	Guidelines on Design of At Intersections in Rural and Urban Areas.
Structures	IRC:112-2011	Code of Practice for Road Bridges.
Protection works	IRC:89-1998	Guidelines for Design and Construction of River Training works.
High Embankments	IRC:75-1979	Guidelines for the design of High Embankments.

Road Elements	Design Standards used for	
	Name of Code	Description
Erosion Control	IRC:56-2011	Recommended practice for Treatment of Embankment and Road side slopes for Erosion control. (First Revision)
Slope Stability	HRB: Sl.No:1 - 2000	State of the Art Report: Lime Stabilisation.

5.6.2 Other Development Works

5.6.2.1 Garden benches

Contractor shall Supply & fix the appropriate number of Garden Benches along the length of the Nallah in green tree avenue space all along the Nallah on both side except in Reaches before Mazar Dam (Reach 1 & Reach 2), Reach4, Reach 5, Reach 12 and Reach 13. The benches shall be placed at an average distance of 10 mtr from each other.

Benches shall be architecturally designed pink color karauli or Dholpur stone benches of standard sizes: 1.5 m long with back rest and standard height of 43-45 cm.

5.6.2.2 Utility Buildings

All buildings should be constructed with RCC work grade M15, Brick masonry walls in C.M 1:4,height at least 3.3 meters ,Plaster20 mm thick in C.M. 1:6, vitrified flooring tiles, solid flush type wooden doors 30 mm thick with veneers with approved steel fittings, best quality water supply, sanitary and electrical fittings, oil bound distemper painting etc.

- **Public Toilets**

  Public toilets consisting of 3 WC seats and 4 urinals, (separate arrangement for ladies and gents) for each block of size 300 sq ft. shall be constructed along the Nallah to take care of current need of slums or colonies who are using the Nallah for open defecation and can use these toilets after development of Nallah as a water front. The proponent has assessed that about 45 toilet block would be needed. Bidders are advised to have their own assessment

- **Security Cabins**

  security cabins at least 50 no along the length of Nallah each having a plinth area of 50 sq ft each, location to be decided in consultation with JDA

- **Operation &maintenance office building cum emergency response center**

  Operation &maintenance office building cum emergency response center having a plinth are of 1300 sqm. location to be decided in consultation with JDA, The building should have all facilities such as office furniture , office equipments such as computers, printers, telephone facility etc, the building should accommodate space for staff to be engaged for emergency response as the building should be used as emergency response center also ,detail specification attached

- **Public Awareness and Exhibition Centre**

  It is proposed to establish an Exhibition centre for the awareness of public to Know about the status of Amanishah Nallah 'before construction' and 'post

construction'. It is important to educate the people on the ill-effects of the Amanishah Nallah's current state and need for change. This is expected to help in public opinion and participation. It is proposed that Posters, Audio Visual Effects, Models, Prototypes etc., will be part of the exhibition centre. Site for this centre is to be finalised in consultation with JDA. The size of the building should be at least 1000 sqm.

- **Storage Yard**

  Storage yard of size 9200 sqm is to be provided with at least 50% area covered with tin shed and a plinth for storage of material during construction and O&M . location to be decided in consultation with JDA, specification attached

- **Field Quality Testing Labs**

  A suitable size temporary field quality control lab should be established. Preferably at the middle of Nallah length

5.6.2.3 Drinking Water Facilities

Architecturally designed public drinking water points with 5 outlets with provision for drinking water of CPCB standards. It shall have a minimum storage capacity of 1 KL / Day. All need to be with granite finish, proper draining arrangements and water supply provisions. Proper provisions for drainage for waste water shall be provided.

These facilities can be provided along with Toilet block with proper care to maintain hygiene factors.

CPVC Pipes and fittings are to be used as per following specifications

(A) CPVC Pipes & Fittings

CPVC pipes & fittings used in hot & cold potable water distribution system shall conform to requirement of IS 15778. The material from which the pipe is produced shall consist of chlorinated polyvinyl chlorides. The polymer from which the pipe compounds are to be manufactured shall have chlorine content not less than 66.5%. The pipes can be used for hot & cold water supply piping system with pipes as per CTs SDR -11 at a working pressure of 320 PSI at 23 deg C and 80 PSI at 82 deg.C, using solvent welded CPVC fittings i.e. Tees, Elbows, Couples, Unions, Reducers, Brushing etc. including transition fittings (connection between CPVC & Metal pipes / GI) i.e. Brass adapters (both Male & Female threaded and all conforming to ASTM D-2846 with only CPVC solvent cement conforming to ASTM F-493, with clamps / structural metal supports as required /directed at site including cutting chases & fitting the same with cement concrete / cement mortar as required, including painting of the exposed pipes with one coat of desired shade of enamel paint. All termination points for installation of faucets shall have brass termination fittings. Installation shall be to the satisfaction of manufacturer & Project Manager. For higher diameter Pipes from 65 mm to 150 mm dia shall be Schedule 40 for CWC & Schedule 80 for HWS / HWR shall be used. Whenever used for the hot water proper insulation of approved material shall be done on pipe. All pipes shall be laid confirming to latest CPWD standards.

(B) Laying and Jointing of CPVC pipes and Fittings

- **Cutting**

  Pipes shall be cut either with a wheel type plastic pipe cutting or hacksaw blade and care shall be taken to make a square cut which provides optimal bonding area within a joint.

- **De-burring / Bevelling**

  Burrs and fittings should be removed from the outside and inside of pipe with a pocket knife or file otherwise burrs and fittings may prevent proper contact between pipe and fittings during assembly. Chamfer or deburr pipe or both, approximately at 10-15°. Remove burrs from inside and outside diameters with a knife, file or abrasive paper

- **Fitting preparation**

  A clean dry rag/cloth should be used to wipe dirt and moisture from the fitting sockets and tubing end. The tubing should make contact with the socket wall 1/3 or 2/3 of the way into the fitting socket.

- **Solvent Cement Application**

  Only CPVC solvent cement confirming to ASTM-F493 should be used for joining pipe with fittings. An even coat of solvent cement should be applied on the pipe end and a thin coat inside the fitting socket, otherwise too much of cement solvent can cause clogged water ways.

- **Assembly**

  After applying the solvent cement on both pipe and fitting socket, pipe should be inserted into the fitting socket within 30 seconds, and rotating the pipe ¼ to ½ turn while inserting so as to ensure even distribution of solvent cement with the joint.

5.6.2.4 Parking + Vendor Space

(A) Parking

Minimum 1000 car park provisions on multiple locations adjacent to the outer peripheral road, with movement space as per traffic designed will be developed. The parking lots shall be developed with clear demarcation of parking spaces with signage's and markers with provision of handicap parking per 10 parking space with porous finish which also allows percolation of rain water into the ground. Sufficient parking provisions as per NBC public spaces guidelines shall be arranged near every intersection as per the final Master Plan developed.

(B) Vendor Space

20% of total parking area shall be provided as vendor space. Dedicated area as per architectural and master plan layout with kiosk shall be developed. Area to be marked in separate flooring or color as per approval and provided with extra dust bins & seating area, electricity and other necessary arrangements required for smooth functioning of the vendor.

5.6.2.5 Solid Waste Management

(A) Dust Bins

Appropriate arrangement for collection of solid waste which include provision for dust bins of appropriate size, organic waste converter with shade and efficient arrangement for it's disposal. Disposal of solid waste is to be made at a place indicated by JDA. Some display boards for IEC giving message to public not to dispose the garbage into the Nallah now as it has been rejuvenated. Bidders are advised to have their own assessment. Following specifications shall be followed

Placement of bins shall be such that:

- it is clearly accessed and serviced from all sides

- it should not block access to the other bin
- it should be close to high traffic area

Material

Use bins made of recycled materials, durable and easy to clean and maintain, should not corrode or rust from rain, sunlight. It shall include all fittings, paints, pedestal and any other arrangements required to make these functional.

The price shall include all fixing and support frame or pedestal if required as per detail design

(B) Organic Waste Converter

The Shed will consist of housing of OWC machine, collection and segregation area, 7 days storage of converted manure.

Organic Waste Converter Machine of 1 ton per day capacity, with pulveriser, watering arrangements, rack system, required number plastic waste bin system, pump along with arrangement for sprinkling water

Shredding arrangements for OWS machine and system with GI wire mesh on all four sides with arrangements for gate and electric point for OWC machine (4 locations), and flooring platform with plane concrete (1:4:8) and shading arrangements on top.

5.6.3 Landscaping & Plantation Works

For improvement of aesthetic view of project area; landscaping works shall be executed at two defined locations:

- Along the length of channel
- Additional landscape area of 65000 sq m in minimum two blocks.

5.6.3.1 Development of Green strip along the canal will include

- Supply & Planting of shady plants (Neem, Peepal, Gullar, Jamun, Imli or other specified) in defined pattern along the pathway or road as approved by Employer's Representative including the following activities :-
  a) Preparation of soil including cleaning & removing of unwanted shrubs removal of stones & garbage
  b) Supply of plant at site of two years of age & height more than 1.50 m
  c) Supply of dry manure (Farm yard manure organic)
  d) Supply of Insecticides
  e) Digging of pits size 60x60x60 cms including removal of stones, Manuring application of insecticides & watering at least 15 litre per plant after planting
  f) Half brick Circular tree guard in second class bricks, internal dia 1.25 meter and height 1.20 meter above ground and 0.20 meter below ground, bottom two courses laid dry and top three courses in cement mortar 1:6 (1 Cement : 6 Sand) and the intermediate courses being in dry honey comb masonry, as per design complete
  g) Watering to plants
  h) Maintenance of plants by the Contractor including pits, preparation of Thavala Hoeing weeding etc. & application of insecticides etc. & security. If the plant die during maintenance Contractor has to replace same height

plant at his own cost

- Supply & Planting of ornamental plants (Dates Palm, Kachnar, Amaltas, Gulmohar, Arjun, Kala Siris, Jacranda etc. or other specified) in defined pattern along the pathway or road as approved by Employer's Representative including the following activities:-

  a) Preparation of soil including cleaning & removing of unwanted shrubs removal of stones & garbage

  b) Supply of plant at site of two years of age & height more than 1.50 m.

  c) Supply of dry manure (Farm yard manure organic)

  d) Supply of Insecticides

  e) Digging of pits size 60x60x60 cms. including removal of stones, Manuring application of insecticides & watering at least 15 litre per plant after planting.

  f) Half brick Circular tree guard in second class bricks, internal dia 1.25 meter and height 1.20 meter above ground and 0.20 meter below ground, bottom two courses laid dry and top three courses in cement mortar 1:6 (1 Cement : 6 Sand) and the intermediate courses being in dry honey comb masonry, as per design complete.

  g) Watering to plants.

  h) Maintenance of plants by the Contractor including pits, preparation of Thavala Hoeing weeding etc. & application of insecticides etc. & security. If the plant die during maintenance Contractor has to replace same height plant at his own cost.

- Planting & Maintenance of shrubs

  a) Planting of shrubs in central verge

  b) Preparation of soil including cleaning & removing of unwanted shrubs removal of stones & garbage.

  c) Supply of plant at site like Bouganvillia & Kaner

  d) Supply of dry manure (Farm yard manure organic)

  e) Supply of Insecticides.

  f) Digging of pits size 60x60x60 cms. Including removal of stones, Manuring application of insecticides & watering at least 15 litre per plant after planting.

  g) Watering to plants.

  h) Maintenance of plants by the Contractor including pits, preparation of Thavala Hoeing weeding etc. & application of insecticides etc. & security. If the plant die during maintenance Contractor has to replace same height plant at his own cost.

- Landscape Irrigation

  Landscape irrigation along the Amanishah Nallah shall be done through the submersible pump sets placed at the small sump created at the check dam storage area (near to check dam u/s). One set of pump shall cover an approximate area of 500m length at one side. The same pump shall be used for supplying water to the fountains laid at the center of the canal bed. These

pumps shall also be used for landscape irrigations for the other areas e.g., public parks, open spaces as given in the next paragraph.

5.6.4 Development of Public Park

This includes specifications for Public Park and open spaces proposed to be developed under current project. In totality an area of 65000 sq m is proposed to be developed under name landscape and park. These can be distributed at 2 or 3 locations as per the final consent with Employer. All these parks shall be in compliance with the detail Master Plan and business plan proposed under this project and shall integrate well with the surrounding features and the water front. All the parks shall be designed by reputed architect/planner/landscape professional and shall have following features or additional features.

5.6.4.1 Park Barrier Wall

Random Rubble masonry 450 mm wide and 600 mm high above the ground 300 mm deep below the ground with all the joints pointed with 1:5 cement mortar, used for space barrier within the public open space in 1:6 cement mortar. Cost includes necessary excavation and backfilling of soil.

5.6.4.2 Stone Finishing

Stone finishing by wet cladding over the completed masonry or PCC surface (Dholpur Stone)

5.6.4.3 Tree plantation

- Planting of 10 Feet tall grown up tree in a 1 Cum pit and refilling with the same with necessary soil mix including soil, sand, and manure. Cost includes temporary tree guard for 1 year.
- Making earth mounds as per drawing and direction at site, with good earth (price to be taken separately) and fine dressing to get smooth shape.

5.6.4.4 Shrubs, Groundcovers and Creepers

Excavation of pits of size 0.45 m. dia. & 0.45 m. deep for shrubs, groundcovers & creepers at exact positions as marked on the drawing & backfilling of the same with prepared good earth & organic manure (supplied as above) mixed in the ratio 5:1:1 respectively, including filling and laying so as to achieve the specified levels for planting the shrubs at distances as specified and maintaining the same for a period of 6 months.

5.6.4.5 Lawn

Providing and laying of Jodhpur grass tiles over a prepared bed surface having sufficient admixtures for 200 mm thk. Cost including watering and maintenance of the lawn for 6 months till the grass forms a thick lawn free from weeds and fit for mowing including (Including weedicides, supply & making of sand if required)

5.6.4.6 Water Body

Architecturally designed water bodies are to be provided in the public parks of appropriate size and depth as per approved design, having ceramic tiles bed as per following specifications:

Glazed Ceramic Tiles: Providing and laying 6mm thk. Light coloured glazed ceramic tiles for water bodies as specified below conforming to I.S.15622-2006 for flooring of an approved, quality, make, size and pattern /design, for walls and flooring including cement mortar bedding of 25 mm thick in 1:4 proportion, neat cement float, cutting, levelling, jointing, filling the joints by neat cement slurry or approved colour grout, curing, finishing etc. complete as directed by Employer's

Representative.

5.6.4.7 Wooden Bridges

Wooden bridges over the small 4 m wide water channels within the public parks.

5.6.4.8 Stone benches

- 1.5 m long polished Stone benches with back rest and standard height of 43-45 cm
- 1.5 M Long RCC Benches without backrest and standard height of 43-45 cm

5.6.4.9 Kiosk

A decorated Kiosk of 5 x 5 m with 100% stone cladding with seating arrangement. The kiosk will be constructed with brick masonry work with stone cladding and ornamental details with cement mortar. Decorated exposed stone pillars to be used.

5.6.4.10 Topiary Works

- Topiary work with single plain colour of size approximately dia 5 m
- Topiary Work of triple colour Size approximately 3 m dia
- Topiary Work of triple colour Size approximately 2 m dia

5.6.4.11 Security Cabin

3M x 3M Security Cabin at the entrance of park. This need to be made up of ReF technology with entrance gate and windows and necessary interior done for easy operations of the security guard.

5.6.4.12 Kids Play

- A sand pit of area 200 Sqm and 300 mm deep to be created where kids play equipment's like Slide, Seesaw, Rope Climb, Swing, Trampoline, Wall climbing will be erected.
- preparation of ground surface with murrum soil mixed with necessary admixtures
- Fountain heads in water bodies, Public squares and plazas
- Lighting park –entire park area should be adequately lighted

5.6.4.13 External and Area Lighting

The intent of this section, is to define the requirements for the supply, installation, testing and commissioning of the external lighting system for common area places consisting of various lighting components, earthing & lightning protection system and cabling system and other miscellaneous lighting works for establishment of Amanishah Nallah. lighting system consisting of lighting, feeder pillers, power panels, led fixtures, switches, cabling and earthing etc. complete.

The work shall be carried out in best workmanship-like manner, in conformity with relevant National Electrical Code, National Building Code, other relevant Indian standards and CPWD specifications to achieve suitable lux level, approved drawings and the instructions, from time to time, of the Employer or his representative.

The scope of this section includes but is not limited to the following works.

- 120 WLED light Fixtures with Lighting Poles all along with road
- Bollard Lights in Public Parks
- Lights in Toilets

- Solar Lights as per MNRE guidelines
- 20 Mtr High mast with Light Fixtures at junctions
- Pathways
- Spares wherever required.

30% Road Lights shall be of solar type and the LED lights and Poles shall be as per following specifications:

Technical Specifications of 120W LED Light fixtures		
S. No	**Parameters**	**Value**
1	Input Voltage	100-270 V AC 50 Hz
2	LED Lamp Efficiency (lumens/watt)	110 (lumens/watt)
3	Uniformity	Ratio of minimum and average illumination should be minimum 50% ,Ratio of minimum and maximum should be minimum 33%
4	Usage hours	10- 12 hrs per day
5	Power Factor	> 0.95
6	Life expectancy	Above 50,000 hours with 70% Lumens
7	Rated Wattage	120 W +/- 10%
8	Lumens Flux	11220 lumens
9	Colour Temperature	5500- 7000K
10	LED	High Power LED 1 – 2 Watt
11	Working Humidity	10% to 90% RH
12	Working Temperature	0 to 60 degree Celsius
13	Ingress Protection	IP 66
14	Colour Rendering Index (CRI)	Ra > 75
15	Total harmonic distortion (THD)	< 15 % maximum
16	Average lighting/ beam Angle	LM 79, Photometric Report of Luminaire to be submitted.
17	Luminary casing	High pressure Die cast Aluminum Alloy housing & toughened glass
18	Pole entry	Should be suitable for mounting of 30 to 56 mm diameter of 9 M high Octagonal poles with locking bolts/ should provide with complete bracket with locking Bolt.
19	System Components	All printed circuit board must be MCCB
20	Control circuit	Compatible to LED
21	Lamp Starting Time	Should not be more than 10 seconds
22	Energy Consumption of the system	Not more than 1.18 times
23	Thermal Management of LED	Good thermal management system should be provided and LED must be mounting on Heat sink conductive aluminum with suitable large area surface by means of fins to dissipate the heat to ambient air
24	Electrical connector	Lead wire of required length for connection
25	System Power efficiency	More than 85%
26	Protection	Electrical Insulation Class-1
27	LED Drive current	500 mA (firm may give LED drive current of their product)

Technical Specifications of 120W LED Light fixtures		
S. No	**Parameters**	**Value**
28	Internal surge Protection against lighting or any other electrical surge	Up to 2 KV
29	Standard	1. The luminary should confirm to IEC 2. 6v598/IS10322 LM80 Report of LED 3. LM 79 Photo Metric Report of Luminaire Driver should confirm to EMC Standard IEC 61547, 610-3-2 4. Safety Standard IEC 61347-2-13
30	Driver Efficiency	More than 80%
31	Lumens per Watt of System	More than 80 Lumens per watt
32	Maintenance factor	0.8

(A) Specifications For Intelligent GPRS Based Street Light Feeder Pillar (Out Door Type)

- Street light feeder pillar shall be suitable for 415 V, 3 phase, 4 wire, 50 Hz supply and shall outdoor type with canopy and shall be free standing floor type.
- It should be robust in construction and capable of withstanding the vibration normally experienced due to vehicular traffic.
- The cubical will be required to be mounted on cement concrete plinths by the road side or in central verge.
- Street light feeder pillar shall be provided with incoming & outgoing MCCB / MCB of appropriate rating and in desired quantity depending on total no. of circuits in use. Outgoing shall have a least one spare circuit all the time. Major switchgears shall have potential free terminals for communication with RTU.
- Street light feeder pillar shall be made up of CRCA sheet steel and shall be dust and vermin proof providing a degree of protection of IP 55. The thickness of sheet steel enclosures shall be 2 mm minimum for load bearing and 1.6 mm for other members.
- Bus bars will be made up of aluminum, colour coded for easy identification and of appropriate size.
- Internal hinged doors shall be provided, where all the material & control equipment shall be flush mounted. The incomer switchgear shall have interlocking mechanism so as to prevent opening of the door when the switch is ON and to prevent closing of the switch when the door is not fully closed. However, a device for bypassing the door interlock shall be provided to enable the operation of the switch with the door open, when necessary, for examination / maintenance.
- External hinged door shall be provided with all round neoprene gasket with padlocking arrangement.
- All accessible live connection/metals shall be shrouded and it shall be possible to change individual fuses, switches, from the front of the boards/panels without any danger of contact with live parts.
- Adequate interior cabling space and suitable removable cable gland plate (min. 3 mm thickness) plates shall be provided for bottom entry of cables through glands. Necessary number of glands to suit the required cable sizes shall be provided. Cable glands shall be double compression type made of

chrome-plated brass.

- Every Street light feeder pillar will have LED type 'SUPPLY ON" indicating lamps. Indicating lamps shall be of the clustered LED type and low watt consumption. Lamps shall be provided with series resistors.
- Earth bus of 50x6 GI flat with zinc plated bolts and nuts shall be provided in the bottom of the panel.
- The Street light feeder pillar shall be provided with individual labels with equipment designation / rating. Also the boards shall be provided on the front with a label engraved with the designation of the Street light feeder pillar. Labels shall be made of non-rusting metal or 3 ply lamicoid or engraved PVC.
- Internal wiring of the panel shall be done using flexible copper cables of appropriate sizes. All the wires shall be numbered and ferrules shall be provided for easy identification.
- Proper clip-on stud type terminals of appropriate rating shall be provided for termination of incoming as well as outgoing cable inside the Street light feeder pillar.
- Each Street light feeder pillar shall have appropriate antenna, GSM modem, Feeder interface unit and major switchgears with potential free terminals for communication with Feeder interface unit.
- Inside the door of lighting panels a single line circuit diagram / description shall be fixed for ready reference.
- As required all sheet steel enclosures of panels will be chemically cleaned rinsed, phosphate & dried. After the treatment steel surfaces will be given two coats of primer & finished grey enamel paint or powder coating of shade 631 of IS - 5. Coating thickness shall be minimum 50 microns.
- Street light feeder pillar should be mounted on angle iron ISA50X50X6 (NS) 90 cm long legs out of which 45 cm duly grouted in cement concrete 1:2:4 (1 cement 2 send 4 stone aggregate)
- Feeder pillar of suitable size not less than 30 cm and up to 45 cm deep made out of M.S. sheet 2mm.Thick powder coated duly compartmentalized having 4 strip busbar of 200 amp capacity double door with locking arrangement for protection from rain, dust. Feeder Pillar duly fixed on MS angle iron frame work of size 50mmX50mmX6mm (NS) 90 cm long legs out of which 45 cm duly grouted in cement concrete 1:2:4 (1 cement 2 sand 4 stone aggregate 20mm) with the following equipment mounted inside the panel under:

A	Incomer MCCB	1
B	Outgoing MCCB	2
C	Power Contactor	1
D	Voltmeter 0-500 volts 96 sq.mm flush type with selector switch.	1
E	Ammeter 0-100 volts 96 sq mm flush type with selector switch.	1
F	LED Indication lamps (RYB)with HRC control fuse with fuse fitting	3
G	Astro timer Rex modular D-21 model (legrand or equivalent)	1
H	Push Button	4
I	Danger Plate	1
J	GPRS Based feeder inter face unit and power monitor unit complete with power supply system, battery for 48 hours power back up, relay for switching the contactor mounted in the feeder pillar, modem, MCB for isolation and protection of feeder interface unit, wiring, Auto/Manual by pass switch and fixing	

	arrangement as required to be installed inside the above Feeder Pillar complete specification mention above	

Specification for GPS/GPRS based Monitoring and Controlling System (Feeder Interface Unit)

(B) Street light Monitoring and Control System (Feeder Interface Unit)

The objective of the system is to operate and monitor the street lights, and to record and the report failure event to take corrective actions immediately.

The automation of the street light consists of a single integrated Feeder Panel Interface Unit and Central SCADA Server located in Master Control Centre. The all the feeder pillar with Feeder Interface Unit shall connect to the SCADA server through GPS/GPRS. The server is maintained and hosted by the DBO Contractor at its own cost,

(C) Operational features

a. The system should be capable of switching ON and OFF the lights connected to the feeder pillar from Master Control Centre or automatically throughout the year the basis of sunrise and sunset time.

b. The Feeder Interface Unit shall work on GPS/GPRS and should send the status of the feeder and the electrical parameters data collected from the inbuilt Energy Meter in housed inside the each Feeder Interface Unit.

c. The system should monitor the following parameters

- Voltage each phase
- Current each phase
- PF each phase
- Frequency of Supply
- KWH cumulative
- KW each phase
- KVA each phase

d. Further system should be able to indicates various faults

- Number of operational light
- Number of non-operational light
- Status of incoming supply (power failure)
- High / Voltage
- The feeder interface unit should be capable of sending SMS directly to the maintenance staff.

e. Event alarm logging facility can be customized for analysis of the fault duration and types of the faults.

f. The Application Software and Services shall provide tabular as well as graphical reports on following intervals:

- 15 minutes
- Hourly
- Daily

- Weekly
- Monthly
- Yearly

g. Security operation by password at the server or user login.

h. Tabular/Graphical Data Representation: view data in both tabular as well as Graphical format with selective or composite view of parameters & in different styles viz. bar & line.

i. Zooming: Graphic Reports should have functionality of zoom in & Zoom out.

j. Menu Guidance: Menu option shall be available for reviewing each data reports. The options should be enabling based on the availability of the data, for the selected Feeder Interface Unit / Meter / Sensor.

k. It shall be possible to modify / change the authorized mobile phone number of the zonal staff from the server.

l. Any deviation beyond predefined percentage should be reported as an exception to the zonal staff mobile phone by SMS and server by GPRS with the absolute value of the deviated parameter.

m. Calculation of the efficiency and distinctive as per given format should be provided by the SCADA.

n. The system should be generate an event massage, in case of loss of communication with power monitor (PM) and generate an alarm at SCADA.

o. If required, there should be flexibility to customize the SCADA software, taking into consideration the specific needs of the Employer.

p. The SCADA Software shall a login interface to the administrator to interact with user management module. Administrator shall be able to Add User / Delete User / Define roles of user / Edit User Information and their Roles.

q. The SCADA Software shall support the role based access of the information. The Application Software shall have features to define/ select information to be viewed based on User Role.

r. Feeder interface unit shall have power backup of minimum 4 hours in case of power failure and battery shall inside the box not visible outside.

s. In case of GPRS or GSM failure, the feeder interface unit shall store all the data for at least 15 days and send it to the server in FIFO order when GPRS resume.

t. The DATA sent by the feeder interface unit shall have real time stamping of the feeder interface unit.

u. The minimum interval for the update of the DATA shall be five minute.

(D) Feeder Interface Unit Hardware Requirement

The feeder interface unit should have the following specification:

- Shall be rugged and industrial grade rated for operation -20 to 55 degree.
- Shall capable of operating at 100 to 265 VAC.
- Shall have capability of selection of best phase out of three phases and give the output of best phase only with latching arrangement.
- Shall work on GPRS and also capability to send SMS.

- shall have minimum of 3 to 4 digital input and 3 to 4 digital outputs, and minimum one analog input.
- shall be capable of measuring the ambient temperature of the installed location.
- shall have a battery backup of at least 4 hours.
- shall be single unit with integrated modem, energy meter, power supply and I/O's.
- shall have LCD display and LED indication for health status.
- shall have a RTC, which shall be remotely configurable.
- shall have memory of at least 2.5 MB for DATA storage.
- shall be capable of sending and receiving SMS also.
- shall be capable of sending the DATA itself on any event at feeder pillar.
- shall be capable of updating the data to Server at a minimum of every 5 minute.
- shall have 2 communication port, having RS232 or RS485.
- The data stored or sent by feeder interface unit shall be time stamped.
- Each Feeder Interface Unit shall have unique connection channel for communication with the central server at central data centre.
- There shall be no requirement of polling of data of the Feeder Interface Unit by the Central Server.
- The Intelligent Field Devices shall publish their data to the server at Master Control Centre on their own at a frequency of 5 minutes and above as per configured by User.
- In case of interruption in the communication, the Feeder Interface Unit shall be capable of resuming the communication from the last point.
- The Feeder Interface Unit shall establish and maintain connection with the server at Master Control Centre using static IPs without any hardware requirement such as Modem etc. The Feeder Interface Unit must have inbuilt Energy Meter for Electrical Parameters Monitoring and shall be- be part of the feeder interface unit, the technical specification are as follows:

  a) Accuracy shall be class 1.0

  b) Parameter name and value display with seven segment LED or LCD.

  c) PT, CT of suitable burden.

  d) Measurement shall be true RMS.

  e) The Aux supply shall be 90 to 270 VAC with a burden of 4 VA max.

  f) Communication shall be RS 485 or RS 232.

  g) CT and PT ratio shall be programmable.

- The Feeder Interface Unit shall have inbuilt modem for GDS/GPRS based Communication for data transmission and command execution. In-built GPS/GPRS modem.
- The Server shall be able to request an Feeder Interface Unit time and to set time of an Feeder Interface Unit remotely.
- The Feeder Interface Unit shall capable of inherent local intelligence as following;

a) Self monitoring of the Battery Status and Battery Charging.

b) SMS Based Control through Mobile.

c) Perform regular operations of monitoring, scheduled On/Off and communication

d) Accept the commands from data centre when on battery backup.

e) Automatic time synchronization with server.

f) Default Data Updates to central server at duration of 15 Minutes.

g) On Demand Device Reading

h) Configurable Device Data Sampling Time (15-60 Minutes)

i) Automatic connection to Server over GPRS / 3G as Prime medium

j) Time stamping of data stored or sent by the Feeder Pillar Interface Unit.

- The Feeder Interface Unit shall have Power Supply module with following specifications:

  a) Operating voltage will be 140VAC – 315VAC Phase to Neutral, 240VAC-550VAC phase to phase.

  b) Power supply work with neutral with any one phase, without neutral using any two phases.

  c) Filter circuit with fuses to protect the system against Surge up to 6KV, against fire.

  d) Protection against faults like neutral missing/weak, phase to phase shorting.

  e) DC Supply output to user for sensor conditioning - 12V @1Aand24V@300mA.

  f) DC supply to main controller is isolated from field supply for better noise immunity.

  g) Power Supply status indications for Mains fail, Battery charging and low battery.

  h) In-built short circuit protection for each DC output using resettable fuses

  i) Power supply shall comply with EN-60950-1

  j) 4 - Fuses for all phases and neutral.

- The Feeder Interface Unit shall send Power Fail and Power Restoration alerts to server and an Intelligent Field Device shall operate on battery power mode during this condition. The Feeder Interface Unit enclosure shall have following;

  a) Ingress Protection with IP54 Compliant.

  b) LCD Display for Meter Parameters, GPRS status, GPRS Strength

  c) Keypad for user interaction

  d) Status Indication Buzzer

  e) A Weather Proof Metal Enclosure with provision for wall mounting suitable for outdoor installations.

  f) Provision for Proper Earthing

- The Feeder Interface Unit shall be properly marked with manufacturing details such as
  a) Type,
  b) Model Number,
  c) Name &Trade mark of the manufacturer with Serial Number etc.
- The Intelligent Field Device shall be properly marked with technical details such as
  a) Rated KVA/KW,
  b) Phase,
  c) Rated frequency,
  d) Rated voltage,
  e) Rated current.
- The Feeder Interface Unit shall have tamper proof enclosure with inbuilt tamper detection alarm.

(E) SCADA Software

The SCADA software shall have the following items with required specifications:

- The SCADA software shall work with any ordinary computer / laptop having windows operating system and internet connection for monitoring, control and status viewing.
- The SCADA shall be competent enough to perform mathematical, analytical and DATA logging for generating various reports.
- The SACADA should have enough flexibility to incorporate changes even at the time of commissioning or regular operation.
- The SCADA shall be capable of handling proposed nos of feeder interface unit at the same time.
- Data updation for each feeder interface unit shall be done at minimum five minute interval and maximum upto 60 minutes as per department requirements and shall be stored in the server with real time stamping and can be retrieved using function for analysis purpose. The facility for report generation as per Employer requirement in excel or word or other window format.
- The SCADA shall work on high speed broadband on static IP for GPRS.

(F) Server at Master Control Central

- The entire lighting system shall be hosted by the Contractor at Master Control Centre. The Server shall be based on system Architecture and scalability to incorporate all future needs. There shall be provision of Antivirus also.
- The server at MCC shall be modular and future scalable so that it can at a later date be integrated with third party without any further enhanced cost implication on the department at any stage.

(G) Accessories

The following accessories shall be required:

- MCB for isolation and protection of feeder interface unit
- Relay has to be used for switching the contactor mounted in the feeder pillar

the relay shall be 2 CO rated at 5 amps. Having facility of manual override,

Wiring shall be of industrial standards. Electrical Cables, Control Cables and Antennas or Communication Cables should be terminated inside the Intelligent Field Device Enclosure to avoid Tampering.

(H) Surveillance Cameras & System

Providing, installation and testing of day/night surveillance Cameras in Project Area at various locations as detail:

- **In STP and SPS Campus**

Providing, installation and testing of day/night surveillance CCTV cameras near the security guard room, digester and gas holder area as per CPHEEPO guidelines and other outdoor area. The cameras shall be placed in such a manner so as to cover the entire area required to be secured. The system will be used for monitoring at a predetermined place within the plant. The proposed surveillance system shall consist of camera and DVR (Digital Video Recorder). The DVR unit should direct recording of cameras in real time. The resolution of the picture should be high and have clarity in pictures. Multiple monitors should be used for effective monitoring. The Contractor should have the facility to choose any given camera for viewing on the other monitor. Each image should be recorded with a camera number, title, time, date and recording speed.

Camera water proof level of the cameras shall be as per IP66, minimum illumination 0.5 Lux/F1.2, 3.14 Megapixel – 2048(H) x 1536(V), Lens – IRIS and CS interface more than 2.0 Mpega, power supply AC/DC = 10 – 24V, power < 2.5 W, S/N ratio > 60dB, WDR 80dB, video format – 1080P50/60; 1080P25/30; 1080I50/60; 720P25/30; 720P50/60 and video output 1 channel SDI interface. The Contractor shall provide the data sheet to the Employer's Representative for approval.

- **In Complete Nallah Stretch**

Providing, installation and testing of day/night surveillance PTZ cameras approximate 188 nos. at appropriate locations in project area approved the Employer's representative. The locations may be at each entry gate, pathways, public toilets, in public parks, buildings etc. The cameras shall be placed in such a manner so as to cover the entire area required to be secured. The system will be used for monitoring at a predetermined place within the plant. The proposed surveillance system shall consist of camera and DVR (Digital Video Recorder). The DVR unit should direct recording of cameras in real time. The resolution of the picture should be high and have clarity in pictures. Multiple monitors should be used for effective monitoring. The Contractor should have the facility to choose any given camera for viewing on the other monitor. Each image should be recorded with a camera number, title, time, date and recording speed.

All cameras feed shall be directed to control room situated appropriately on or very near to Nallah and connected to relevant police station through appropriate connectivity as per the suggested system architecture (refer Drawing No. 41 of Section 9 of Volume-2). Detail specifications are as under:

- ✓ ***Outdoor PTZ camera***

Parameter/item	**Specifications**
Image sensor	1 / 2.8” CCD / CMOS Progressive Scan (2 MP)
Focal Length	4.3 to 129mm
Zoom	30x Optical & 10x Digital or better

Parameter/item	**Specifications**
Electronic Shutter	1 to 1 / 10,000 s
Min illumination/ light Sensitivity (Color)	0.02 lux (30 IRE, F 1.6)
Min illumination/ light Sensitivity (B/W)	0.001 lux (30 IRE, F 1.6)
Wide Dynamic Range	Should support WDR Pro
Backlight Compensation	ON/OFF
IRIS Control	DC or Automatic
Focus	Automatic / Manual
Automatic Gain Control	Automatic / Manual
Color, Brightness, Contrast functionality	Required
Frame Rate	25 FPS for 1920 x 1080
Alarm Triggers	Video Motion detection, Manual trigger, periodical trigger, system boot, recording notification
Video	
Day and Night functionality	Automatic, Color, Mono
Video Resolution	2 MP (1920 x 1080)
Video Streams	Individually configurable 02 video streams or better
Intelligent Video	Motion detection (triple window)
Electronic Image Stabilization	Required
PTZ Function	
PAN TILT Range	360° continuous pan & 220° tilt range
PAN TILT Speed	450°/Sec for pan & tilt. or better
On-board Storage	Should preferably support Onboard storage up to 64 GB
Presets	256 Preset Points
Tour & Pattern	Required
Privacy Mask	04 Zones
Compression	
MJPEG	Required
H.264	Required
Audio	
Audio support	Required
Audio Compression	G.711 or better
Two-way audio	Required
Input / Output	01 IN & 01 OUT
Network & Interface	
Interface	RJ-45 for 10/100 base-T Ethernet
I/O Port	04 IN, 02 OUT
Upgrade	Through web browser , online, firmware upgrade
Network Protocols support	TCP/IP, HTTP, ICMP, PPPoE, DDNS, DHCP, UDP,DNS, SMTP, RTP, RTSP, SNMP protocols
Alarm Event	Events / alerts send via FTP, HTTP, email, Pre-Post alarm video buffering.
Compliance	ONVIF

Parameter/item	Specifications
Security	
Password Protection	Required
HTTPS encryption	Required
IEEE 802.1X	Required
General	
Operational temperature°C	(-40°C to 50 °C)
Humidity	0 to more than 90% RH non-condensing
IP rating	IP66, NEMA 4X Rated Outdoor Housing
Power	PoE, AC24V/ DC12V, 100-230VAC
Certifications	CE, UL, EN, FCC
Compliance	ONVIF S Profile

- ✓ ***Poles for cameras (4m to 6m height above ground) with required civil works***

  - Carriage & erection of Conical/Octagonal – Hot dip galvanized pole coated weather of 4 to 6 m height, made of high tensile mettle, Hot dip galvanized with 8 gussets, earth point provision, anti-climbing restriction on the pole using thorn wires / taut wires, Cross arm support, equal thickness for the base plate of the pole and pillar, provision of anti-vibration mats, The pole shall be erected on a Reinforce concrete Foundation of minimum 1 Mt. J type foundation bolts will be 16mm and for an length of 1 meter foundation.
  - Below ground, RCC readymade muff shall be filled with cement concrete 1:2:4. The poles should be of industry grade, Conical/ Octagonal – Hot dip Galvanized pole color coated weather and should have lightening proof with appropriate earthing.

    (The maximum value of earth Resistance shall be 0.5 ohm)

- ✓ ***29 UIP 55 Outdoor Enclosure with needful Cooling for outdoor + indoor installation***

Features	Specifications Required
Dimensions (mm)	The Overall dimension of cabinet should not exceed 800W X 1300H X 600D.
Enclosure	Outdoor IP55 Enclosure. Condensate discharge plug to be provided inside the enclosure to prevent condensation.
Load carrying capacity (Kgs.)	1000
Plinth height (mm)	100
Doors and locking system	Front and rear 2 mm thick sheet steel door with PU Foamed Seal(Gasketing) with removable galvanized rectangular frame with holes on a 25 mm DIN pitch pattern with 3 point locking system.
	The hinges and retainers should be made of die cast, copper nickel chrome plated with SS hinge pins. The doors should be swapped to LH if required with door opening angle 130 deg to VDI.
	Top panel made of 1.5 mm thick sheet steel

Features	**Specifications Required**
	with PU foamed (Gasketing) boltable from inside.
Panel Sizes (mm.)	Bottom panel made of 1.5 mm thick sheet steel with PU foamed (Gasketing) with provision for fixing 4 nos of PG 29 glands.
	Side panels in double walled construction with air gap of mm between two walls with PU foamed (Gasketing) for IP 55minimum 20 protection
Regulatory Compliances	IP55 to EN60529/09.2000, ISO 9001, 14001, 18001 comply with EIA 310, DIN 41494 and IEC 297 standards.
Painting	The cabinet has to be nano ceramic coated, Electrophoretic (EC) dip coat priming to 20 Microns and then powder coated to RAL 7035 textured Pure Polyester (PP) to 80 to 120 Microns.
Rain Canopy Height (mm)	75
Universal sockets	One 19" mountable socket strip with 4 nos of 5/15A universal sockets
Angles	2 pairs of L type 19" angles to be provided at front and rear for mounting the equipment's on 23X73 (maxim) punched sections:
Earthing	Earthing to be done for the entire cabinet with 4 sq mm earthing cables.
Cantilever Shelf	One 1U cantilever shelf of 250 mm deep.
Cable Manager	2 Horizontal 1U cable managers with 5 nos of plastic cable loops
Limit Switches	2 Door Operated limit switch to be provided at front and rear door.
Hardware	Captive hardware (pack of 20): 1 pack.
For Front and rear door	4 Ergoform S handles with key insert and pad locking arrangement for front and rear door
Cable Entry	PG 29 glands to be provided at the bottom for cable entry
Cooling unit output	1400 Watts at L35L35
	1100 Watts at L35L50
Outdoor cooling unit	
Rated operating Voltage	230V/50/60 Hz
Dimensions of cooling unit	420W X 1050H X 330D
Rated current	5A
Startup current	18A
Power consumption	1000W
Refrigeration Factor	1.7
Refrigerant	R-134 a Gas
Weight	600 Gram
Permissible Operating pressure	24 bar
Temperature Range	+20^{o}c to +55^{o}c

Features	**Specifications Required**
Duty cycle	100%
Protection category to EN 60529/10.91	IP 55 Internal circuit
Type of Connection	Contractor to specify
Colour	Contractor to specify
Temperature Control	+20ºc to +55ºc, Factory set 35 c.
Internal Fan	Required
External Fan	Required
Expansion valve	Required
Copper Tubes	Required

- ✓ ***Network Switch with PoE, Industrial Grade***

Features	Specifications Required
Type	Managed Outdoor Industrial grade switch
Total Ports	Minimum 6 10/100 TX PoE + 2 1G SFP ports
	May require higher port density at some locations, depending upon site conditions. May require fibre ports at some locations, depending upon site conditions/ distances.
PoE Standard	IEEE 802.3af or better
Protocols	Support 802.1Q VLAN
	DHCP support
	SNMP Management
Access Control	Support port security
	Support 802.1x (Port based network access control).
	Support for MAC filtering.
PoE Power per port	Sufficient to operate the CCTV cameras connected
Rating	IP 30 , DIN Rail Mounting with industrial grade.
Operating Temperature	0-50 C or better

- ✓ ***CORE Switch***

The specifications given is the base specification for the core Switch

Features	**Specifications Required**
Ports	24 or 48 (as per requirements) 10/100/1000 Base-TX Ethernet ports and extra 2 nos of Base-SX/LX ports · All ports can auto-negotiate between 10Mbps/ 100Mbps/ 1000Mbps, half-duplex or full duplex and flow control for half-duplex ports.
Switch type	Layer 3
MAC	Support 8K MAC address.
Back plane	56 Gbps or more Switching fabric capacity
Forwarding rate	Packet Forwarding Rate should be 70.0 Mpps or better
Port Features	Must support Port Mirroring, Port Trunking and 802.3ad LACP Link Aggregation port trunks
Flow Control	Support IEEE 802.3x flow control for full-duplex

Features	Specifications Required
	mode ports.
Protocols	Support 802.1D, 802.1S, 802.1w, Rate limiting
	Support 802.1Q VLAN encapsulation, IGMP v1, v2 and v3 snooping
	802.1p Priority Queues, port mirroring, DiffServ
	Support based on 802.1p priority bits with at least 8 queues
	DHCP support & DHCP snooping/relay/optional 82/ server support
	Shaped Round Robin (SRR) or WRR scheduling support.
	Support for Strict priority queuing & Sflow
	Support for IPV6 ready features with dual stack
	Support upto 255 VLANs and upto 4K VLAN IDs3
Access Control	Support port security
	Support 802.1x (Port based network access control).
	Support for MAC filtering
	Should support TACACS+ and RADIUS authentication
VLAN	Support 802.1Q Tagged VLAN and port based VLANs and Private VLAN
	The switch must support dynamic VLAN Registration or equivalent
	Dynamic Trunking protocol or equivalent
Protocol and Traffic	Network Time Protocol or equivalent Simple Network Time Protocol support
	Switch should support traffic segmentation
	Traffic classification should be based on user-definable application types: TOS, DSCP, Port based, TCP/UDP port number
Management	Switch needs to have RS- 232 console port for management via a console terminal or PC
	Must have support SNMP v1,v2 and v3
	Should support 4 groups of RMON
	Should have accessibility using Telnet, SSH, Console access, easier
	software upgrade through network using TFTP etc. Configuration
	management through CLI, GUI based software utility and using web interface

- ✓ ***Video Management Software***

S.N.	Functions	Specifications
1	VMS Hardware	The VMS system shall utilize commercial-off-the- shelf(COTS) computer workstations, servers, networking devices and storage equipment. VMS shall already support IP cameras from at least fifty (50)major vendors. Contractors shall clearly list in their proposal the brands and models already

S.N.	Functions	Specifications
		integrated into VMS. The proposed VMS should be listed global IMS report for last 3 years.
2	Unattended Recording	Recording of all video transmitted to the VMS shall be continuous, uninterrupted and unattended.
3	Motion Detection	The VMS system shall offer the capability of video Motion detection recording, such that video is recorded when the NVRMS detects motion within a region of interest of the camera's view. Video prior to the detection of the motion shall also be stored with using the pre-alarm buffer feature of the camera.
4	System Health Monitoring	The VMS system shall manage the video it has been Configured to monitor. Loss of video signal shall be configured to annunciate on VMS client by an on screen visual indication alerting operators of video loss
5	Open Architecture	The VMS software shall have an open architecture supporting IP cameras and encoders from multiple manufacturers providing best-of breed solutions ranging from low-cost, entry-level features to high-resolution, megapixel features. The VMS system shall be a scalable client–server architecture built using well known operating systems. The Video Management System software shall include multicast and multi streaming support.
6	Audio Support	The VMS client software shall be able to view live Video and audio, recorded video and audio, and be able to configure the complete system all from a single application. The Audio shall be broadcasted through loudspeakers from control room to the cameras connected to external speakers. Operator shall be able to select particular camera speaker to enable the public addressing.
7	Uninterrupted Recording	The VMS shall continue to record video and audio at all times during the administration and configuration of any feature. The VMS shall allow for upto 120 cameras or other devices to be connected to each Recording Server and for an unlimited number of Recording Servers to be connected to a single master Recording Server across multiple sites. The system shall support any combination of master and slave servers to provide flexibility and scalability in the overall system configuration.

S.N.	Functions	Specifications
8	Fully featured Remote Client	The VMS client software shall have the same functionality when connected remotely as it does when it is run locally on the same computer as the server software
9	User Level based Feature access	The VMS client software shall add and remove Features based on the permissions of the user and the licensed functionality
10	Operating System Support	All of the following should be supported- 1) MicrosoftWindowsServer2003/2008/2012 2) MicrosoftWindows7(all versions)
11	Combination of OS supported by clients	The VMS software shall allow the user to have any Combination of VMS client applications running on any of the supported operating systems be able to connect to any of the VMS servers running on any Of the supported operating systems. For example, a VMS client running on MicrosoftWindows7 shall be able to simultaneously connect to four(4) different VMS servers all running on different operating systems,suchasWindowsServer2003, Windows
XP and Vista		
12	Monitor support per client	The VMS software shall have the capability to run multiple client applications simultaneously on one workstation with multiple monitors. Up to 4 monitors shall be configured on a single workstation with one (1) client application running on each monitor. Because decompressing video is CPU-intensive, the PC workstation shall have multiple core processors, with a recommendation of one core for each VMS client application
13	Web Client Support	The VMS shall also allow an authorized user to view video through a web client interface. The web client interface shall allow authorized users to view live video, view recorded video, control pan-tilt-zoom (PTZ)cameras and activate triggers. The web client Interface shall allow connections to multiple VMS Servers simultaneously. The web client interface shall operate without requiring installation of any software.
14	Browser Support	All of the following should be supported– 1)Internet Explorer 7 and later versions 2)Firefox 2 and later 3)Safari2 and later 4)The web client interface shall also connect with non-Java Script browsers and shall be compliant with HTML4.0(www.w3.org).

S.N.	Functions	Specifications
15	Recording Retrieval	The VMS server software shall record and retrieve video, audio and alarm data and provide it to the VMS clients upon request
16	Mobile client	The VMS software shall provide at no additional Charge a purpose-built mobile application capable Of viewing multiple simultaneous live video streams and playing a recorded video stream. Application shall be provided for both IOS and Android operating systems (including Kindle Fire).
17	Data safety	The VMS server shall not decode video for the Purpose of repacking it for transmission to clients
18	Metadata Support	The VMS server software shall record video based On metadata generated by an edge network device. The edge network devices shall generate the metadata and transmit it with the video stream to the VMS server software
19	Camera Licenses	The VMS shall license the total number of cameras on the system. This license shall be based on the Camera MAC ID and not Server network card Mac ID.
20	VMS server service	The VMS server software shall run as a service. The VMS shall not require any application to be running in order to operate
21	Map integration	The VMS shall allow the use of maps. The maps will be accessible to users with the appropriate permission levels and display video sources and their status.
22	Wide screen support	The VMS shall provide an option to view16:9wide Video display panels
23	Digital PTZ	The VMS software shall allow control of PTZ Cameras to authorized users and can be used to maneuver a PTZ camera. When used on a non-PTZ camera, it shall allow the user to digitally pan, tilt, and zoom on any video whether in live or recorded mode
24	Camera Grouping	The VMS software shall have a feature for viewing Logical groups of cameras. This shall allow efficient viewing of cameras in a logical order.
25	Preset Viewing	The VMS software shall have a feature to organize Your cameras into preset views. Views are preconfigured arrangements of the video panels so that they may be easily recalled later. A view can save the location of the video streams, audio streams, POS data, maps, and event views. These views shall be accessible in both live and recorded video modes
26	Video Play	The VMS client software shall be used to

S.N.	Functions	Specifications
	Back	search for And playback recorded video, audio and events from VMS servers. All recorded video shall be played back and displayed in a synchronized multi-camera layout. It shall be possible to playback simultaneously 64 cameras on the surveillance system, with a selection of advanced navigation tools, including an intuitive timeline browser.
27	Searching parameters	The VMS software shall support searching through recorded video based on time, date, video source, image region and have the results displayed as both a clickable timeline and a series of thumbnail images.
28	Audio play back	The VMS software shall allow search and playback Of audio in synchronization with video
29	Export	The VMS software shall provide the option of Exporting the file in the following formats: 1)Stand alone Exe(*.exe)– includes an executable player with the video and audio data 2)AVI File (*.avi)–a multi media container format 3) MKV File(*.mkv)–a format to play HD video files.
30	Recording Triggers	The VMS software shall have the ability to configure Each video inputs recording time on an hourly basis.
31		This shall allow the user to schedule when to record On motion, when to record an event and when to not record.
32	Email Trigger	The VMS software shall be able to send a Predefined email based on an event trigger. The VMS software shall also support SSL and TLS connections for transmissions of the mail
33	Map Function	The Video Management System shall incorporate Intuitive map functions allowing for multilayered map environment. The map functionality shall allow for the interactive control of the complete surveillance system, at-a-glance overview of system integrity, and seamless drag-and-drop integration with video wall module option. The activation of The VMD or Camera disconnected alarm shall display the alarm location with animated camera's icon shown in the location map, and the pre-defined alarm documents.
34	Alarm Management	The VMS shall support a central alarm management And monitoring function, providing an alarm/event queue where all incoming events are on display. The alarm

S.N.	Functions	Specifications
		queue shall provide, but not limited to, the following information: 1. Alarm date and time 2. Alarm status 3. Current alarm condition 4. Detector/input name/address 5. Alarm location 6. Message priority 7. Operator who is working on the alarm/event when it was acknowledged.
35	Integration	The VMS shall include support for seamless integration with Access control system and perimeter Intrusion system. The VMS shall provide a documented Software Development Kit(SDK)to allow integration with other application software
36	Redundancy	The Video Management System shall support high Availability of recording servers. A failover option would provide standby support for recording servers with automatic synchronization to ensure maximum uptime and minimum risk of lost data. MinimumrequiredisN:1 OR N:N Redundancy. In case of Network Failover, the video should be able to locally store on the Camera, once the network is re-established the stored video should be able to be synchronized with the central storage system.

- ✓ ***Central Command & Control Software***

Features	Specifications Required
Solution & Platform	The Command & Control solution should be implemented and complied to the industry open standards based Commercial-of-the-shelf (COTS) products.
	The solution or underline products should be enable components to run on all major operating systems, including Microsoft Windows, Unix & Linux
	Must have built-in fault tolerance, load balancing and high availability & must be certified by the OEM.
	Software (Application, Database and any other) must not be restricted by the license terms of the OEM from scaling out on unlimited number of cores and servers during future expansion.
	System must provide a comprehensive API (Application Program Interface) or SDK (Software Development's Kit) to allow interfacing and integration with existing systems.
	The city surveillance system shall allow seamless integration with all of the department's existing (e.g. Dial 100) and future initiatives (e.g. open source intelligence, situation management war

Features	Specifications Required
	room, etc.)
	The Safe City Architecture comprises of multiple state-of-the-art systems that will be integrated to create a world-class Safe City solution. This includes systems already being deployed such as Dial 100, and future systems such as open source intelligence, situation management war room and so on. The "Safe City Middleware" enables integration between all these systems using secure, open standards. The CCTV solution shall provide seamless integration with the Safe City Middleware.
	The application should adhere to the following emergency management & operations standards for interoperability, data representation & exchange, aggregation, virtualization and flexibility: Emergency Management Standards - such as the OASIS Emergency Data Exchange Language (EDXL) and Common Alerting Protocol (CAP), Universal Core (UCore) for Incident Capture Form at the command centre, IT Infrastructure Library (ITIL) standards for Standard Operations Plan & Resource Management, Geo Spatial Standards like GML & KML and Business Process Model and Notation (BPMN) for KPI Monitoring.
Industry Standards for the Command & Control Centre	The application should adhere to the following emergency management & operations standards for interoperability, data representation & exchange, aggregation, virtualization and flexibility: Emergency Management Standards - such as the OASIS Emergency Data Exchange Language (EDXL) and Common Alerting Protocol (CAP), Universal Core (UCore) for Incident Capture Form at the command centre, IT Infrastructure Library (ITIL) standards for Standard Operations Plan & Resource Management, Geo Spatial Standards like GML & KML and Business Process Model and Notation (BPMN) for KPI Monitoring. Web server to manage client requests. Client should provide web-based, one-stop portals to event information, overall status, and details. The user interface (UI) to present customized information in various preconfigured views in common formats. All information to be displayed through easy-to-use dashboards.
Command & Control Centre Components	Application server to provide a set of services for accessing and visualizing data. Should be able to import data from disparate external sources, such as databases and files. It should provide the contacts and instant messaging service to enable

Features	Specifications Required
	effective, real-time communication. It should provide business monitoring service to monitor incoming data records to generate key performance indicators. It should also provide the users to view key performance indicators, standard operating procedures, notifications, and reports, spatial-temporal data on a geospatial map, or view specific details that represent a city road, building or a area either on a location map, or in a list view. The application server should provide security services that ensure only authorized users and groups can access data.
	Data server should be able to store configuration and event databases.
	Analytics server should provide Real Time Dashboards, Business Intelligence, Predictive Analysis & Social Media Analytics tool along with business monitoring capability and have CPLEX based optimization tool. It should also have the integration broker service and externalized Rule Engines for multiple event correlation.
	The system must provide Incident Management Services to facilitate the management of response and recovery operations:
Incident Management	Should support comprehensive reporting on event status in real time manually or automatically by a sensor/CCTV.
Requirements	Should support for sudden critical events and linkage to standard operating procedures automatically without human intervention.
	Should support for multiple incidents with both segregated and/or overlapping management and response teams.
	Should support Geospatial rendering of event and incident information.
	Should support plotting of area of impact using polynomial lines to divide the area into multiple zones on the GIS maps.
	Should support incorporation of resource database for mobilizing the resources for response.
	Should provide facility to capture critical information such as location, name, status, time of the incident and be modifiable in real time by multiple authors with role associated permissions (read, write). Incidents should be captured in standard formats to facilitate incident correlation and reporting.
	The system must identify and track status of critical infrastructure / resources and provide a status overview of facilities and systems
	Should provide detailed reports and summary

Features	Specifications Required
	views to multiple users based on their roles.
	A Reference Section in the tool must be provided for posting, updating and disseminating plans, procedures, checklists and other related information.
	Provide User-defined forms as well as Standard Incident Command Forms for incident management.
	Should provide integrated dashboard with an easy to navigate user interface for managing profiles, groups, message templates, communications, tracking receipts and compliance
Integrated User Specific & Customizable Dashboard	Should provide tools to assemble personalized dashboard views of information pertinent to incidents, emergencies & operations of command center
	Should provide historical reports, event data & activity log. The reports can be exported to pdf or html formats.
	Should provide dashboard filtering capabilities that enable end-users to dynamically filter the data in their dashboard based upon criteria, such as region, dates, product, brands, etc and capability to drill down to the details
	Should provide integrated Mobile Application for Android, Windows and iOS for capturing real-time information from the field response team using Mobile-Standard Operating Procedure.
Integrated Mobile Application for Field Response Team	Field Responder should be able to acknowledge the incident and provide real time updates from the incident site.
	Should provide out of the box integration of the Incident Management application with the department's WhatsApp mobile application number.
Integration with Social Media & Open Source Intelligence for War Room	Should provide out of the box analytics capability to analyze WhatsApp messages during investigation.
	Should extract messages and display it in a operational dashboard.
	Should be able to correlate the extracted message from the social media with existing other events and then should be able to initiate an SOP.
	Should be able to identify the critical information and should be able to link it to an existing SOP or a new SOP should be started.
	Should provide notifications to multiple agencies and departments (on mobile) that a new intelligence has been gathered through open source/social media.

Features	Specifications Required
	The solution should create a tag cloud which will give an easy view on number of messages coming from open source/social media across different categories.
	Video Analytics Search functionality in the War Room should be able to do text based search through hundreds of hours of videos from hundreds of cameras spread across the city and multiple cities.
Integrated Video Surveillance for War Room	War Room software should provide post incident search of CCTV frames over last several days/weeks. These videos will be from various cameras installed across all the cities.
	Should have the ability to do single attribute and combined attribute search on a person's features (People search) or clothing, such as baldness, hat, glasses, sun glasses, hair color, skin tone and texture, and up to three colors combination search on torso area with 13-color palette.
	Should provide tricolor combinational search capability on upper and lower body areas with 13-color palette for clothing.
	Should provide enhanced analytics capability to search in crowded scenes and challenging environmental conditions, such as lighting, shadows, reflections, and clouds.
	Should provide enhanced ability to detect and search objects of interests (such as cars, buses, and trucks) with multiple colors (bigger selection and better colors).
	Should be able to leverage and integrate with existing & new CCTV cameras & video management systems, to provide an integrated video surveillance at the war room.
	Should be able to receive video alarms on the standard command center application user interface having severity, response level indicated in the notification.
	All CCTV Cameras should be accessible on the GIS map by using GIS Filters.
	Should provide Meta Data Search over the video analytics feed across all cameras or selected cameras simultaneously from the video analytics search interface.
	All alarms notifications that are notified on the Command Centre Application should automatically trigger the Standard Operating Procedures (SOP) for response.
	Should be able to provide the captured image, archive and live video feed from the VMS player for the alarm that is generated by the video analytics system.

Features	Specifications Required
	Should provide ICON based user interface on the GIS map to report non-functional device.
Device Status, Obstruction Detection and Availability Notification	Should also provide a single tabular view to list all devices along with their availability status in real time.
	Should provide User Interface to publish messages to multiple VMS at the same time.
	The system shall have the ability to create a case-specific matrix of camera feeds - to allow central command to create custom situational awareness maps.
	To be effective in the case of an incident, the CCTV infrastructure needs to be monitored and maintained for uptime. The solution shall provide a complete monitoring and maintenance system for the camera assets on ground. This ensures that cameras which are not functional, or disconnected - are proactively repaired and brought online.
	In addition, using video analytics, the cameras should be able to detect full or partial obscuration (for example, by placing a cloth or obstruction in front of the camera) or forced tampering (e.g. scene not changing, loopback).
	The system shall work with automated rules that allow detection and closure of such cases. To provide all these capabilities, the solution shall provide an asset lifecycle management (ALM) solution for camera assets on ground.
	Command & Control Center should be able to correlate two or more events coming from Dial 100 and CCTV Analytics system based on time, place, custom attribute and provide correlation notifications to the operators based on predefined business and operational rules in the configurable and customizable rule engine.
Event Correlation	Command & Control Center should provide for authoring and invoking un-limited number of configurable and customizable standard operating procedures through graphical, easy to use tooling interface.
Standard Operations Procedures (SOP)	Standard Operating Procedures should be established, approved sets of actions considered to be the best practices for responding to a situation or carrying out an operation.
	The users should be able to edit the SOP, including adding, editing, or deleting the activities.
	The users should be able to also add comments to or stop the SOP (prior to completion).
	There should be provision for automatically logging the actions, changes, and commentary

Features	Specifications Required
	for the SOP and its activities, so that an electronic record is available for after-action review.
	The SOP Tool should have capability to define the following activity types:
	Manual Activity - An activity that is done manually by the owner. and provide details in the description field.
	Automation Activity - An activity that initiates and tracks a particular work order and selects a predefined work order from the list.
	If-Then-Else Activity - A conditional activity that allows branching based on specific criteria. Either enter or select values for Then and Else.
	Notification Activity - An activity that displays a notification window that contains an email template for the activity owner to complete, and then sends an email notification.
	REST Service Activity - An activity that creates a REST service call.
	SOP Activity - An activity that launches another standard operating procedure.
	Command & Control Center should be able to facilitate measurement or criteria to assay the condition or performance of departmental processes & policies.
Key Performance Indicator	Green indicates that the status is acceptable, based on the parameters for that KPI, no action is required.
	Yellow indicates that caution or monitoring is required, action may be required.
	action is recommended.
	Gray indicates that there is insufficient data available to calculate the KPI status.
	Command & Control Center should provide easy to use user interfaces for operators such as Click to Action, Charting, Hover and Pop Ups, KPIs, Nestled KPIs, Event triggered KPIs, Event Filtering, Drill down capability, Event Capture and User Specific Setup
Reporting Requirements	Should provide tools for users to collaborate & communicate in real-time using instant messaging features.
Collaboration Tools	The solution should adhere to the below mentioned communication requirements.
Communication Requirements	Provide the ability to search/locate resources based on name, department, role, geography, skill etc for rapidly assembling a team, across department, divisions and agency boundaries, during emergency
	Provide the capability to Invite - Using information provided during the location of those

Features	Specifications Required
	individuals or roles, invite them to collaborate and to share valuable information.
	Use authentication information to authenticate individuals and/or assign roles.
Authentication	Provide the ability to see, in advance, whether a person(s) or application(s) is available to collaborate, share information and/or take an action.
Presence awareness	Provide ability to converse virtually through the exchange of text, audio, and/or video based information in real time with one or more individuals within the emergency management community.
Instant messaging	Should provide the capability for the events that are produced from CCTV systems and are forwarded to the Command & Control Center. Events could be a single system occurrence or complex events that are correlated from multiple systems. Events could be ad hoc, real-time, or predicted and could range in severity from informational to critical. At the Command & Control Centre, the event should be displayed on an operations dashboard and analyzed to determine a proper directive.
Events and Directives control	Directives issued by the Command & Control Center should depend on the severity of the monitored event. Directives will be designed and modified based on standard operating procedures, as well as state legislation. A directive could be issued automatically via rules, or it could be created by the operations team manually.
	The solution should provide the capability to manage the emergencies and in-turn reducing risks, salvaging resources to minimize damages and recovering the assets that can speed up recovery.
What-if Analysis Tool	To take proactive decisions that help minimize risks and damages, the solution should provide Analytical and Simulation systems as part of the Decision Support System. The solution should help simulate what if scenarios. It should help visualize assets/resources at risk due to the pending/ongoing incident, should render impacted region on a GIS/3D map. The solution should help build the list of assets, their properties, location and their interdependence through a easy to use Graphical User Interface. When in What if
	Analysis mode the solution should highlight not only the primary asset impacted but also highlight the linked assets which will be impacted. The

Features	Specifications Required
	user should be able to run the What-if Analysis mode for multiple types of emergency events such as Bomb Blast, Weather events, Accidents etc..
	Should provide Optimization software that should be the consolidation of the OPL integrated development environment and the CPLEX and CP Optimizer solution engines in a single component
Resource & Route Optimization	Should provide an optimization engine for solving problems expressed as mathematical programming models.
	Should provide a software library of constraint programming tools supporting constraint propagation, domain reduction, and highly optimized solution search.
	The system should provide the software component for the message broadcast and notification solution that allows authorized personal and/or business processes to send large number of messages to target audience (select-call or global or activation of pre-programmed list) using multiple communication methods including SMS, Voice (PSTN/Cellular), Email and Social Media.
Alert & Mass Notification Requirements	Provide a single web based dashboard to send notifications to target audiences using multiple communication methods including voice-based notification on PSTN/Cellular, SMS, Pager, Voice mail, E-mail and Social Media
	Provide function for creating the alert content and disseminating to end users. Provision of alerting external broadcasting organizations like Radio, TV, Cellular, etc., as a CAP compliant web-service.
	Provide Role based security model with Single-Sign-On to allow only authorized users to access and administer the alert and notification system.
Security & Access Control	Provide comprehensive protection of web content and applications on back-end application servers, by performing authentication, credential creation and authorization.
Internet Security	Comprehensive policy-based security administration to provide all users specific access based on user's responsibilities. Maintenance of authorization policy in a central repository for administration purposes.
Authorization	Support to enable assignment of permissions to groups, and administration of access control across multiple applications and resources. Secure, web-based administration tools to manage users, groups, permissions and policies

Features	Specifications Required
	remotely
User group	Policies using separate dimensions of authorization criteria like Traditional static Access Control Lists that describe the principals (users and groups) access to resource and the permissions each of these principals possess.
Provide multi-dimensional access control	SSO to Web-based applications that can span multiple sites or domains with a range of SSO options.
Flexible single sign-on (SSO)	Support LDAP authentication mechanism
Authentication	Should have ability to respond to real-time data with intelligent & automated decisions
Rule Engine & Optimization	Provides an environment for designing, developing, and deploying business rule applications and event applications.
	The ability to deal with change in operational systems is directly related to the decisions that operators are able to make
	Should have at-least two complementary decision management strategies: business rules and event rules.
	Should provide an Integrated development environment to develop the Object Model (OM) which defines the elements and relationships

- ✓ ***Video Analytic Software***

Features	Specifications Required
Integrated Video Analytics	It should provide an integrated video analytics System that provides functionalities like behavioral analytics, face detection, motion detection, trip wire, object removal, abandoned objects. The real-alerts generated by this video analytics system should automatically be listed in the Command & Control Center application's list of events & incidents.
	Should be an open extensible framework for event based surveillance
	Should provide Centralized monitoring of real-time alerts across geographic locations
	Should be Scalable &reliable system that Seamlessly integrates with existing ONVIF compliant CCTV
	Should provide Real-time event analysis engine that is capable of supporting a variety of video/image analysis technologies and should provide:
	Standard Plug-in Interfaces
	Extensible Meta-Data Interfaces
	Real-time Alert Interfaces
	Compound Alert Interfaces
	Real-time Actuation Interfaces

Features	Specifications Required
	Extensive forensic search enhancements to Support people search capabilities.
	Event detection and searching based on actual measurements such as object length, height, size and speed.
	Should have improved detection rate and reduced false positive rate for abandoned packages(and other alert detection)in typical city and mass transportation environments.
	Should provide consistent seasonal analytics accuracy performance.
	Should provide enhancements to optimize Detection rate and reduce false positives for critical and specialized video analytics for city counter terrorism operations and crime investigation such as abandoned object detection, and face detection, which enhances face recognition integration.
	Should provide enhanced analytics capability to handle crowded scenes and challenging environmental conditions, such as lighting, shadows, reflections, and clouds.
	Should provide enhanced ability to detect and Search objects of interests (such as cars, buses, and trucks) with multiple colors (bigger selection and better colors).
	Should provide Improvements to analytic installation, configuration, and tuning in order to reduce deployment time while enhancing alert accuracy.
	Should provide ability to run multiple Frameworks on a single physical server for improved scalability.
The Operator UI to be flexible and have following mandatory features	Should be customizable to meet the specific needs and operational processes of a given user environment, and to support unique requirements specific to forensic search and alert response.
	Should provide integration with Global Information System (GIS) functionality to allow for event displays on maps.
	Should enable new analytic functionality, such as people search and augmented color support.
	Should be able to deliver native federated Proxy capabilities where several Intelligent Video Analytics instances can be federated together into a seamless user experience.
	Should allow the system administrator to Enable all or a portion of the channels (cameras) for single sign-on, alert passing, forensic searching,
	and adjudication (alert dis- positioning)between instances to specific or all operators.

- ✓ ***Enterprise Management System***

Features	Specifications Required
General	Solution should provide fault & performance management of the entire Data Centre infrastructure and should monitor IP\SNMP enabled devices like Routers, Switches, Cameras, etc.
	Proposed Network Management shall supply Information like availability, utilization in order to measure central SLA's and help Administrator to calculate penalties.
	Following are key functionalities that are required which will help measuring SLA's as well as assist administrators to monitor network faults & performance degradations in order to reduce downtimes, increase availability and take proactive actions to remediate & restore network services.
Feature 1	The proposed solution must automatically discover manageable elements connected to the infrastructure and map the connectivity between them. Solution should provide centralized monitoring console displaying network topology map from central location to surveillance location.
Feature 2	Proposed solution should provide customizable reporting interface to create custom reports for collected data.
Feature 3	The system should be able to clearly identify configuration changes and of network problems and administrators should receive an alert in case of any change made on routers spread across surveillance project
Feature 4	Network monitoring system should provide predictive performance monitoring and should be able to auto-calculate resource utilization baselines for the entire managed systems and networks and allow user to set corresponding upper and lower threshold limits based on baseline data instead of setting up manual thresholds for monitored devices.
Feature 5	The system must support the ability to create reports that allow the surveillance administrators to search all IP traffic over a specified historical period, for a variety of conditions for critical router interfaces
Feature 6	The proposed system must be capable of providing the following detailed analysis across surveillance domain:
	Top utilized links (inbound and outbound) based on utilization of link
	Top protocols by volume based on utilization of

Features	Specifications Required
	link
	Top host by volume based on utilization of link.
	EMS should support hytroginious network environments
	NMS should update automatically update inventory layer2 map, port to port connectivity

- ✓ ***Server for Video Management Software***

Features	Specifications Required
Processor	Intel® 2 x 8C Xeon E5-2630 v3 or better
Memory	2 x 16GB DDR4 Register RDIMM (32GB), 2133MTs, Should have total 24 DIMM slots
OS Drive	3 X 2.5” 600 GB 6Gbps 10k rpms Hot Plug SAS Drive
Bays	8 Hot Plug 2.5" hard disk bay, Installable up to minimum 8 Drives from day one. Should also support SED and SSD Disks
Raid Controller	SAS RAID Controller supporting RAID 0,1, 5, 6 (from Day one) with 1 GB NV Cache memory with battery backup
USB 2.0 Ports:	2 * USB 3.0 ports
Ethernet Ports:	4 Nos. of 1 Gbps Ethernet Ports (without consuming the external PCIe slots). 1 * dedicated Management Port (Gigabit Ethernet)
Keyboard & Mouse:	Should be included
DVD/CD RW:	Front panel access required
Operating System	Windows 2008/2012 Std. / Enterprise Edition 64 bit
Operating Temperature:	10° – 35°C
Relative Humidity:	5 – 95% RH (non-condensing)
Power Supply & Cooling	Redundant Power supply and cooling in N:N
Warranty:	Should have minimum 3 Years of warranty

- ✓ ***Server for Command and Control Software***

Features	Specifications Required
CPU	4 x Intel Xeon Eight Core E5-2670 CPU @ 2.6 GHz or Higher, upgradable to 2 processor
No. of CPUs	2 Separate bare metal servers each having 32 Cores in Primary and 32 Cores in Secondary Node
Cache L3	20 MB of L3 Cache
Chipset	Intel C602J Chipset
Memory	64 GB Registered DDR-3 ECC Memory Upgradeable to 384 GB with RDIMM
Active Memory protection	Advanced ECC memory protection support, Memory mirroring
Drive Bays	Server should have Minimum of 16 x 2.5" Hard Disk Drive bays

Features	**Specifications Required**
Hard Disk Drives	Server should be configured with 3x600GB 10 KRPM
RAID Controller	RAID Controller with 512 MB Battery back cache. The RAID controller should support Raid 0, 1, 5, 10, 50. Raid controller should have an option to upgrade to Raid 6 and 60 as well. Raid controller should support on line Raid level migration, on line capacity expansion and data scrubbing as well.
Graphics Controller	Integrated Video Memory 16MB DDR-2 SDRAM
Ethernet Adapter	Quad-port with TCP/IP Offload Engine (TOE), Wake on LAN, Serial over LAN , PXE 2
I/O Expansions	Minimum Six Number of PCIe Slots
Power Supply	Dual Redundant Hot Swappable Power Supplies
Hot Swap/ Redundant Fans	Server should be configured with Hot Swap Fans
Warranty	3 Years Onsite Comprehensive Warranty
Storage	Storage - Min 650TB usable with RAID-6 (Upgradable upto 2 times of the usable storage capacity with RAID-6 on day-one by adding similar to existing type of hard-disks only)- 25% capacity to be configured with 900 GB 10k rpm drives and rest 75% on NL-SAS 7.2k rpm drives.
	Array should support , 10krpm of SAS-2 drives and 7.2k rpm of NL-SAS-2/SATA drives (maximum HDD capacity of 3/4 TB each)
	Memory - Min. 64GB upgradable to 128 GB or Higher per controller
	Front-end iscsi/SAS/FC/NAS(CISF/NFS)[All the required protocol should be enabled and made available for the system from day one] using special purpose storage controller
	for NAS protocols. All the above protocol would be required for CCTV project and should be enabled for full quoted capacity of the proposed box from day on
	4 X 10 Gbps iSCSI / NAS (CIFS/ NFS) [for connectivity to Layer-3 switches] / 8 X 6 Gbps SAS [for direct connectivity to NVR, if required] / 4X 8 Gbps FC (Note:1)
	Dual controllers operate in an active-active environment. Cache protection shall be provided for at-least 72 hours with battery-backup or via flash memory for permanent data protection
	There shall be sufficient LED indicators for any activity or fault in any hardware component on the storage including Hard Disk, Controller, Power Supply, Fan module etc
	Should have separate GbE port for remote management. GUI based Storage Management software shall also be provided with thin

Features	Specifications Required
	provisioning, auto tiering, analytics and snapshot software as mandatory features for the entire supplied capacity. Proposed Storage must have Automated serviceability features for "Phone Home" capability with automatic case creation, configurable alerts as required by VMC
Server Rack	Basic frame: Frame Of sturdy frame section construction, consisting of 16 x folded rolled hollow frame section punched in 25mm DIN pitch pattern. All profile edges are radiused. The corners are stiffened with welded zinc die- cast corner connectors, 2 nos. of stationery Tray to be supplied and installed in Server Room. Front Glazed and rear metal door
	Painting : Primary Dip Coat or equal to 20-30 Microns Power Coat or equal to 80-120 Microns, ISO 9001, EN ISO 14001 approvals required
	5A, 12 socket PDU and 6 Socket IEC 13 PDU per rack
	Heavy duty Castors (Set of 4) load baring capacity per castor is 350 kg
	Captive Hardware (Pack of 20)
	4 pcs 19" verticals, 125mm front space
	2 side panels
	7" Comfort handle for easy opening doors
	1 top cover with cable entry, passive airflow
	Vertical cable manager (ring type)
	Component Shelf
	4 pcs leveling feet, earthling set complete

- ✓ ***Client PC with Display for video live monitoring with Software for Operators***

Features	Specifications Required
Processor	Fourth Generation Intel Core™ i7 Processor
Chipset	Intel Z87 or higher
Motherboard	OEM
RAM	Minimum 4 GB Memory
Graphics card	Graphic s card with 1 GB video memory (non-shared)
HDD	320 GB SATA Hard drive @7200 rpm
Media Drive	NO CD / DVD Drive
Network interface	1000BaseT, Gigabit Ethernet
Audio	Line/Mic IN, Line-out/Spr Out (3.5 mm)
USB ports	Minimum 6 USB ports (out of that 2 in front)
Keyboard	104 keys minimum OEM keyboard
Mouse	2 button optic al scroll mouse (USB)
PTZ joystick controller	PTZ speed dome control for IP cameras
	Minimum 10 programmable buttons
	Multi-camera operations
Monitor	22" TFT LCD monitor, Minimum 1920 x1080 resolution, 5 ms or better response time, TCO 03

Features	Specifications Required
	(or higher) certified
	For command Control Centers : 3 LCD Monitors, For Viewing centers : 1 LCD Monitor
Operating System	64 bit pre- loaded OS Windows 7 OR Latest with recovery disc
Antivirus feature	Advanced antivirus, antispyware, desktop firewall, intrusion prevention (comprising of a single, deployable agent) which can be managed by a central server. (Support, updates, patches and errata for the entire contract/ project period)

- ✓ ***48" Video wall with controller for 24 x 7 Operation***

Features	Specifications Required
Configuration	12 Cube should be 48" diagonal size or more. DIAGONAL IN A 4 (C) X 3 (R) CONFIGURATION COMPLETE WITH COVERED BASE STAND
Chip Type	1-chip 0.95" Digital Micro Mirror Device
Resolution	Full HD (1920 x 1080)
Light Source Type	LED light source with separate LED array for each color (RGB) 3 x 6 segment
Brightness ANSI	Upto 1350 Lumens in eco mode
Brightness Uniformity	≥ 95 %
Dynamic Contrast ratio	2200:1 or more
Control	IP based control to be provided
Screen to Screen Gap	≤ 1 mm
Screen Support	Screen should have a Anti-Reflective Glass Backing to prevent bulging
Control BD Input terminal	Input: 2 x Digital DVI
	Output: 1 x Digital DVI
Cooling Inside Cube	By Means of a sealed heat pipe
Maintenance Access	Rear
Published White Balance	Not more than 0.003ΔuΔv center to corner/cube
Noise Level	Silent : Not more than 30dBa one meter from screen
Cube Size	Each cube should be minimum 48 " diagonal in size
MTBF & MTTR	Published MTBF of greater than60000hrs for all parts, and a MTTR of 15min via modular servicing
Power consumption	Not more than 155W in eco mode, 210 W in normal mode and 270 W in high brightness
Cube & Controller	Cube & Controller should be from the same manufacturer
Reputed Company	The OEM should be an established multinational in the field of video walls and should have installations around the world

Features	**Specifications Required**
Reference	The OEM should have at least one video wall installed in city surveillance project and successfully running for at least 1 year
Display controller	Controller to control Video Walls in a matrix of 4 (C) x 3(R) with outputs , video inputs and DVI inputs along with necessary software's
Processor	Single Quad Core Intel® Xeon 64-bit 2.4 GHz CPU or better
HDD	Min 12GB RAM
	Min 500 GB 3G SATA 7200 RPM Hard Disk
	Hard disk Capacity should be upgradable
Networking	* Dual-port Gigabit Ethernet Controller inbuilt
Accessories	DVD-R,DVD+RW,, Keyboard, mouse
OS	* Supports 64-bit Operating Systems Windows 7
Power Supply	(1 + 1) Redundant AC-DC high-efficiency power supply w/ PFC
	* AC Voltage 100 - 240V, 50-60Hz
Chassis	4U form factor
System Reliability	* Operating Temperature: 5° to 35°C (40° to 95°F)
	* Operating Relative Humidity: less than80% Non Condensing
	* Humidity: 8 – 85% non-condensing
	* Non-operating Relative Humidity: 8 to 90% (non-condensing)
Wall configuration	12 DVI-D Outputs
Resolution output support	1920x1080 per output minimum
Wall Management software	Included
Features	
Hardware Platform	Quiet operation
	Mounting
	Number of inputs and outputs
	Streaming inputs
Reliability and Serviceability	MTBF (Mean Time Between Failures)
	MTTR (Mean Time To Repair)
Video Input Capabilities	Inputs
	DCP compliant
	Real time encoding
KVM Capabilities	Dual USB interface for HID (KVM) control of DVI input sources
Audio Capabilities	Dual analog inputs, 1/8" mini-RCA
Output Capabilities	Twelve (12) Dual-link DVI outputs Support for
	□ Maximum output capability
	□ Multiple display walls support
	□ No of decodes per output node

- ✓ ***UPS(1 KVA with 2 Hours Back Up with SNMP Card)***

Output
i. Output Power Capacity 1000VA /800 Watts
ii. Nominal Output Voltage 230V
iii. Output Voltage Note Configurable for 220 : 230 or 240 nominal output voltage
iv. Efficiency at Full Load 88 %
v. Output Voltage Distortion Less than 3% for linear loads, less than 5 % for non linear loads
vi. Output Frequency (sync to mains) 50/60 Hz +/- 3 Hz user adjustable +/- 0.1
vii. Crest Factor 3 : 1
viii. Waveform Type Sine wave
ix. Output Connections : (4) IEC 320 C13
x. Bypass : Built In, Internal Bypass – Automatic
Input
xi. Nominal Input Voltage 230V
xii. Input Frequency 47-63 Hz (auto sensing)
xiii. Input Connections : IEC-320 C20
xiv. Input voltage range for main operations 160 -280 VAC (at full load), 100-280VAC (at half load)
Battery
xv. Battery Type Sealed Maintenance free
xvi. Back UP time : 2 Hours at full load - 2340VAH
xvii. Battery Make : Exide / Rocket / Panasonic
Communications & Management
xviii. Interface Port(s) Smart Slot , DB-9 RS-232
xix. SNMP : With SNMP card web based
Control panel
xx. LED Display with Load, Battery Bar Graphs and On Line : On Battery : Replace Battery : Overload and Bypass Indicators
xxi. Audible Alarm when on battery : distinctive low battery alarm : overload continuous tone alarm
Environmental
xxii. Operating Environment 0 - 40 °C
xxiii. Operating Relative Humidity 0-95 %
Conformance
xxiv. Regulatory Approvals EN 60950, EN/IEC 60950-1, EN/IEC 62040-1, EN/IEC 62040-2
xxv. RoHS Compliance Required

- ✓ ***UPS(2 KVA with 2 Hours Back Up with SNMP Card)***

Output
i. Output Power Capacity 2000VA /1600 Watts
ii. Nominal Output Voltage 230V
iii. Output Voltage Note Configurable for 220 : 230 or 240 nominal output voltage
iv. Efficiency at Full Load 88 %
v. Output Voltage Distortion Less than 3% for linear loads, less than 5 % for non linear loads

vi. Output Frequency (sync to mains) 50/60 Hz +/- 3 Hz user adjustable +/- 0.1
vii. Crest Factor 3 : 1
viii. Waveform Type Sine wave
ix. Output Connections : (1) Hard Wire 3-wire (H N + G) (2) IEC 320 C13
x. Bypass : Built In, Internal Bypass – Automatic
Input
xi. Nominal Input Voltage 230V
xii. Input Frequency 40-70 Hz (auto sensing)
xiii. Input Connections : Hard Wire 3 wire (1PH+N+G)
xiv. Input voltage range for main operations 160 -280 VAC (at full load), 100-280VAC (at half load)
xv. Input Protection : Thermal Circuit Breker
Battery
xvi. Compatible with both SMF & Tubular Batteries
xvii. Back UP time : 2 Hours at full load - 4680VAH
xviii. Battery Make : Exide / Rocket / Panasonic
Communications & Management
xix. Serial Connectivity : Management of the UPS Via a serial port
xx. SNMP : With SNMP card web based
xxi. RJ45 to USB port for Software Interface
Control panel
xxii. LED/LCD Display with Load, Battery Bar Graphs and On Line : On Battery : Replace Battery : Overload and Bypass Indicators
xxiii. Audible Alarm when on battery : distinctive low battery alarm : overload continuous tone alarm
xxiv. Mounting & Redundancy
xxv. Should be rack mountable
Environmental
xxvi. Operating Environment 0 - 40 °C
xxvii. Operating Relative Humidity 0-95 %
Conformance
xxviii. RoHS Compliance Required

- ✓ ***UPS 80 KVA with 30 min battery backup on full load with SNMP.***

Features	**Specifications Required**
Capacity	80 KVA / 72KW
Battery Backup	30 minutes
General	
Inverter Technology	Pulse Width Modulation (PWM) using IGBTs, double conversion
Switching frequency	20 KHz or higher
Total Harmonic Distortion (THD)	less than 3% for 100% linear load
Voltage	less than 5% for 100% non-linear load
Noise level	70 db
Operating Temperature	0° - 40° C
Output Wave Form	Pure sine wave
Cooling	Air Cooled
Input	
Voltage Range	250 V AC to 470 V AC , Three Phase

Features	**Specifications Required**
Frequency range	50 Hz/60 Hz +/- 10%
D/G set comp ability	Required
Input Power Factor	greater than.99
Output	
Voltage	380 V/400 V/415 V, three-phase + neutral, Three Phase
Regulation	Less than + 1% in the following conditions
	1. No load to full load/Full load to no load
	2. 0.6 lag to Unity PF
	3. During Entire Backup time.
	4. Complete Input Voltage Range
Frequency	50 or 60 Hz +/- 0.1%
Efficiency	
Overall	Efficiency 93.5 % or better on rated full load of 0.9 PF & 415V, 50Hz AC output
Inverter Efficiency	94% or better on rated full load of 0.8 PF & 415V, 50Hz AC output
Overload Capacity	125% for 10 minutes; 150% for 60 seconds
Load Power Factor	0.9
Protection	IP 20

- ✓ ***Passive Items Cable & others***

The OEM should be ISO 9001:2000 & QS: 9000 Certified. In the changing needs of the global resources if the company has environmental management systems in place like ISO 14001 accreditation the same shall be added advantage.	
UTP components should be UL complied and should have independent lab verification like ETL certificates (wherever applicable)	
UTP CABLING COMPONENTS Category 6 Unshielded Twisted Pair 4 pair 100W cable shall be compliant with ANSI/TIA/EIA-568-B.2-1 Additional Transmission Performance Specifications for 4-pair 100W Category 6Cabling.	
Category 6 UTP cables shall extend between the work area location and its associated telecommunications closet and consist of 4 pair, 23 AWG, UTP Non Plenum cable jacket.	
The 4 pair Unshielded Twisted Pair cable shall be ULÒ Listed	
All Category 6 cables shall meet or exceed the following characteristics:	
Construction: 4 twisted pairs separated by internal X shaped, 4 channel, polymer spine / full separator. Half shall not be accepted.	
Conductor Solid Copper	
Conductor Diameter 0.56±0.005mm (23 AWG)	
Insulator Polyolefin	
Jacket FR PVC	
Outer Diameter 6.0±0.4mm	
Max. Temperature 75°C	
FACE PLATE	Single Gang square plate, 86mmx86mm
Write on labels in transparent plastic window – supplied with plate	

Screw hole covers – to be supplied with plate	
Plug in Icons – Icon tree – to be supplied with plate	
Should be able to support variety of jacks – UTP, STP, Fibre, Coax etc.	
INFORMATION OUTLET	Category 6, TIA568B.2-1 – 250MHz
All information outlets for 100 W, 22-24 AWG copper cable shall: Use insulation displacement connectors (IDC)	
Allow for a minimum of 200 re-terminations without signal degradation below standards compliance limits.	
Be constructed of high impact, flame-retardant thermoplastic with color and icon options for better visual identification.	
With spring loaded shutter	
With Terminator cap	
IDC posts should be pointed	
568A/B configuration	
Information outlet (RJ45 jack) should be covered under ETL Verification program for compliance with TIA568B.2-1, ETL certificate to be submitted with offer	
Mechanical : Jack Connector Plastic Housing: Polycarbonate, UL94V-0 rated or equivalent	
Operating Life: Minimum 750 insertion cycles	
Contact Material: Copper alloy	
Contact Plating: 50 µinches gold over 100 µ inches nickel	
Plastic Housing: Polycarbonate, UL94V-0 rated or equivalent	
Operating Life: Minimum 200 Re-terminations	
IDC Contact Plating: Tin Plate (tin/lead)	
24 PORT JACK PANEL Be made of powder coated steel, in 24 port configurations.	
Allow for a minimum of 200 re-terminations without signal degradation below standards compliance limit.	
Have port identification numbers on the front of the panel.	
Should have self adhesive, clear label holders (transparent plastic window type) and white designation labels with the panel, with optional color labels / icons.	
Should be upgradeable as Intelligent Patch Panel without changing the existing Patch Panel hardware and by simple retro fitting of intelligent sensors as and when required.	
Each port / jack on the panel should be individually removable on field from the panel.	
Should have integrated rear cable management shelf.	
Should be covered by ETL verification program for compliance with TIA 568B.2-1.	
Shutter on the jack panel port is mandatory	
MOUNTING CORDS Category 6 Equipment cords	
The work area equipment cords shall, at a minimum comply with proposed ANSI/TIA/EIA-568-B.2-1 Commercial Building Cabling Standards Transmission Performance Specifications for 4 pair 100W Category 6 Cabling.	
Category 6 modular equipment cords: Shall be round, and consist of eight insulated 24 AWG, stranded copper conductors, arranged in four color-coded twisted-pairs within a flame-retardant jacket.	
Equipped with modular 8-position modular plugs on both ends, wired	

straight through with standards compliant wiring.	
Should have 50 micro inches of gold plating over nickel contacts.	
Modular cords should include a molded strain relief boot.	
Should be covered by ETL verification program for compliance with TIA 568B.2-1. Certificate to be submitted with bid.	
Mechanical – Cable Conductor size: 24 AWG stranded bare copper	
Max O.D.: 5.6mm (.22")	
Jacket: PVC LSZH	
Temperature range: -20oC to +60oC	
Mechanical Characteristics – Plug Operating life: Minimum 750 insertion cycles	
Contact material: Copper alloy	
Contact plating: 50µ" Gold/100µ"Nickel	
Plug dimensions & tolerances compliant with FCC Part 68 and IEC 60603-7	
Approvals: UL, CSA	
Electrical Characteristics – Plug Max voltage: 150 VAC (max)	
Max current: 1.5A @ 25oC	
Operating temperature: -40oC to 85oC	
FIBRE CABLING COMPONENTS:	
Optical Fibre Cable Single mode (SM) Fibre The fibre type is a Matched Cladding Single Mode Fibre dual coated with acryl ate coating.	
The fibre is optimized for operation at 1310 nm and at 1550 nm.	
Should fulfill the requirements of:	
• IEC 793-2: 1992, Category B 1.1	
• EN 188101	
• ITU-T Recommendation G.652	
Testing methods are in accordance with the following standards:	
• ITU-T G.650	
• IEC 793-1	
• EN 188 000	
Nominal mode field diameter	9.0 µm
Mode field diameter tolerance	±10%
Cladding diameter	125 µm
Mode field concentricity error	Max.:0. 8 µm
Cladding non-circularity	Max. 2 %
Diameter of outer coating layer	245 µm (without coloring layer)
Tolerance of coating layer diameter	±10 µm
Coating concentricity error	Max. 12 µm
OPTICAL PROPERTIES	Attenuation (of cable with fibres):
At 1310 nm	less than or equal to 0.40 dB/km
In the range 1285-1330 nm	less than or equal to 0.43 dB/km
At 1550 nm	less than or equal to 0.25 dB/km
Cut-off wavelength	
High limit	1330 nm

Low limit	1180 nm
Cut-off wavelength	
High limit	1260 nm
Loss increase at 1550 nm for 100 turns of fibre loosely wound with a 37.5 mm radius: Max.	0.1 dB
Loss due to hydrogen:	
Maximum induced permanent loss after 1000 h at 1 bar H2 at 70 °C and out gassing for 72 h at 70°C (valid both at 1310 nm and at 1550 nm)	0.2 dB/km
Dispersion:	
Zero dispersion wavelength	1310 nm
Tolerance of zero dispersion Wavelength	-10/+12 nm
Zero-dispersion slope: Max.	0.092 ps/(nm²)
Chromatic dispersion coefficient: In 1285 nm - 1330 nm interval: Max.	3.5ps/km , nm
In 1270 nm - 1340 nm interval Max.	6 ps/km , nm
At 1550 nm Max.	18 ps/km , nm
Polarisation Mode Dispersion (PMD): Max.	0.5 ps/km
In homogeneity of OTDR trace for any two 1000 meter fibre lengths Max.	0.1 dB/km
Proof test level	1%
FIBRE PATCH PANELS – RACK / WALL MOUNT	Have sufficient slots accommodate duplex SC adapters individually.
Should have fibre management provision inside	
Have earthing lugs and other accessories.	
Panel cover should be slide out for easy maintenance	
Provide self-adhesive, clear label holders (transparent plastic window type) and white designation labels with the panel, for front panel labeling.	
Should be upgradeable as Intelligent Patch Panel without changing the existing Patch Panel hardware by simple retro fitting of intelligent sensors as and when required.	
SC DUPLEX ADAPTORS All SC adaptors should be duplex type with shutter for protection. Adapters should be snap mount for easy insertion and removal.	
Optical Fibre Optic Pigtails Connector Type:- SC/LC-Style, Pre-terminated Pigtails offer premium factory-controlled optical performance on a variety of connectors that enable fast, economical installation. Pre-terminated leads are ideal for mission-critical backbone applications such as Data center tie cables and low optical loss backbone riser cables	
Operating Temperature: -10°C to 60°C	
Durability & color :	
Material : LSZH	
MM connectors:- 500 cycles, Beige	
SM connectors:- 220 cycles, Blue	
Ferrules:- Pre-radiused Ceramic Ferrules	
Attenuation:- Not more than 0.75 dB per mated pair	

Optical Fibre Equipment Cords (minimum 3 meter) All optical fibre patch leads shall comprise of Single mode 9/125µm fibre with SC, fibre connectors terminated at each end. The optical fibre patch leads shall comply with the following specifications:
Connector: Zirconia ceramic ferrule
Pre-radiuses and pre-polished ferrule
Epoxy type fibre encapsulation
Color-coded connector boots fitted to connectors on duplex patch leads
Dust caps shall be fitted on each connector at the assembly
Cable: 9/125, SM Material : PVC LSZH
Strength member: aramid yarn
900µm tight buffer diameter

5.6.5 Other Miscellaneous Works

5.6.5.1 Weather Station (One)

Procurement, fixing and commissioning of a weather station at an appropriate place within the O&M office building as per the design and technical solution. The price shall include all supporting equipment, consumables required for the functioning of the station and all electrical connections.

The weather station shall include but not limited to followings:

(A) Open Pan Evaporimeter

Pan Evaporimeter is should follow IS:5973 :1970. The Pan shall be manufactured from painted Copper sheet and tested for water leak proofing. The stilling well and thermometer clamps shall be manufactured from Brass. It should be supported on wooden platform and covered with wire mesh for preventing Birds & Leaves; Measuring Cylinder should be manufactured from transparent Acrylic.

S. No.	Specifications		Details
1	Pan		
	□	Size	1.22 x 0.255 m (diameter x height)
	□	Accuracy of reading	0.1 mm
	□	Pan Evaporimeter	Copper sheet of thickness 1.0+-0.1mm point gauge and still well made of brass
2	Measuring Cylinder		
	□	Material	Clean cast seamless acrylic plastic
	□	Bottom Plate	acrylic plastic sheet
	□	Thermometer Clamp	Brass
	□	Platform	Wooden
	□	Inner diameter	122 mm

(B) Thermo Hydrograph

For measuring and recording atmospheric temperature and humidity as a function of time on recording chart.

The Thermo-hygrograph is designed for measuring and recording atmospheric temperature and humidity as a function of time on recording chart. The Drum rotates by Daily Quartz Electronic Clock. The temperature is measured using bi-metallic strip & humidity is measured by humidity effect on hair length. This instrument is used for meteorological research.

Parameter	Temperature	Humidity
Sensing Element	Bi-metallic Assembly	Human Hair Bundle

Range	-20 to 600 C	0 to 100% RH
Accuracy	+-10 C	+-2% (Above 20%)
Recording Resolution	0.50 C	1%
Housing Material	FRP/ Aluminum/ Metal	
Recording Mechanism	Drum driven by Quartz Clock	

(C) Sun Shine Recorder

This Sun-Shine Recorder shall be as per IS:7243:1974. The scale of degree of latitude from -5 to 45 degree. The instrument should be mounted on heavy base. The sphere support with the glass sphere and bowl should have arrangement that it can be tilted, adjusted and clamped at the angle to suit the latitude of the station. The focused Sun's rays bun a trace on the card to indicate the period of bright sunshine during the day.

The glass sphere should have a focal length of 74.9 mm and having deviation of +/-0.25 mm. the base of the instrument should be of good quality marble stone.

The card used in the instrument should be made from the pasteboard and has a thickness in between 0.43mm and 0.48mm The three card used in the instrument should have Straight, Curved and Short Log. The upper surface of the card should be colour to a standard shade of the blue/ dark grey colour. The instrument shall be supplied with one year cards.

(D) Self-Recoding Rain gauge station with Anemometer

Self-Recording Rain Gauges shall be as per IS:5225 :1969 and manufactured from non-corrosive fibre glass reinforced plastic container. Recording raingauges shall obtain a continuous record of daily or weekly rainfall. It consists of a funnel-shaped collector at the top of the gauge and a float syphon chamber and recording mechanism just below it. The rain water collected by the collector is led into the float chamber. The float is having a central stud on which a pen assembly is fixed. The pen is moving over a daily chart wound over a clock drum. After every 10 mm of rainfall syphoning should occurs and recording of rain starts afresh.

Specifications:

Specifications	**Dimensions**
Internal diameter of gunmetal	203.4mm
collecting ring:	
Collection Area	325 csqm (10 mm)
Diameter of clock room	93.3 mm
Rainfall capacity	Unlimited
Standard Set:	

Collector & Base with foundation bolt Recording mechanism with daily clock drum 100 recording charts & 15cc ink bottle

(E) Cup type Water Current Meter

The Cup type Water Current Meter should be as per IS specification:

- This Digital Water Current Meter to measure Velocity of water flow directly in m/s with stainless steel spindle carrying the cup wheel freely rotates in the bearing assembly.
- The rotation of the Water Current Meter sensed by sensor & gives pulsed output signal. The Digital Datalogger Unit should consist of latest technology Microprocessor & 20 x 4 alphanumeric LCD which displays water flow velocity directly in m/s along with date & time.

- The resulting signal from Current Meter should be processed by microprocessor assures maximum possible accuracy and should provide special functions like storing velocity at different position across channel, different depth (15 to 200 cm) along with Date-Time stamp, stored in its internal non-volatile memory upto last 500 data.
- When required the stored data shall be uploaded to supplied memory module & then from Memory module to PC using RS 232 cable. Compatible with PC user friendly Microsoft Windows based software for downloading data from Memory module in spreadsheet / ASCII format for further analysis.
- The Datalogger should be programmed according to the velocity formula supplied with Current meter when calibrated.

(F) Digital Display Unit

- Sensor Input : Contact Pulses / TTL Pulse
- Display : 20 x 4 character alphanumeric LCD display
- User Input : User friendly pushbutton switches (easy menu navigation)
- Memory : up to 500 readings with date-time, Position, Depth Non-volatile memory chip
- Settings : Velocity formula can be programmed as per current meter
- Operating Temperature : 0 to 60 c
- Operating Humidity: max. 80% RH
- Date-time function : battery backed digital
- RTC chip RTC Backup Battery : 3 V Lithium Coin cell (CR 2032)
- Battery : 12V SMF battery
- Digital Water Level Recorder (Data Logger with memory module)
- These are fixed type and will be fixed at 12 locations
- The Digital Water Level Recorder (DWLR) is to be used to measure water level in canal. It should consists of mainly Float, pulley, Encoder, Datalogger with alphanumeric display, Real Time clock & inbuilt non-volatile memory with battery backup.
- The rise and fall of the float with changing water levels turns the pulley & encoder which converts the position into digital format & sends to RISC microcontroller base datalogger. It should store the current reading at predefined data logging interval (1 min. to 12 hour) along with current time stamping in internal memory continuously.
- Using memory module, the data should be retrieval from datalogger & transferred to PC using supplied cable & communication software for further data analysis.
- Sensor: Float-Pulley type & Incremental Encoder.
- Range: 0 - 10.0 m (As per request)
- Resolution : 0.01% of Full scale range
- Display : 20 x 4 Alphanumeric LCD display
- Clock : Internal RTC clock with battery backup
- Logging Interval : User selectable (1,5,10,15,30,60,120 minutes)
- Internal Memory : 128 KB Internal fixed
- Memory Interface : RS 232 port

- Battery : 12V SMF rechargeable battery
- Enclosure : Weatherproof Enclosure

(G) Wind Datalogger

Portable Digital Anemometer and Wind Vane to measure wind speed and wind flow direction directly in velocity m/s & direction in degree north and log into memory modules for later retrieve.

Allow friction rotating vane and highly precision parts to measure the velocity in "m/s" and direction. The resulting signals should be processed by microprocessor to assures maximum possible accuracy and provide special functions and features using RTC chip & memory modules having small package which can hold data without any attention.

The unit should also contain RS232 port for direct logging of Data to Computer or store data in Memory Module.

The software to view the logger data for the period of logging (1 month or year) & analyze it through EXCEL.

	WINDVANE	ANEMOMETER
Sensor :	Wire-wound	Low friction
	potentiometer	rotating Cup Type
Resolution :	better than 5 Degree	0.01 m/s

Technical Specifications

Range :	0 – 355	0.2 m/s to 40 m/s
Threshold :	0.3 m/s	0.2 m/s

(H) Data Logger

- Sensor : Wire-wound potentiometer
- Resolution : better than 5 Degree 0.01 m/s O
- Range : 0 - 355 0.2 m/s to 40 m/s Threshold : 0.3 m/s 0.2 m/s
- Display : 20 x 4 Alphanumeric LCD Display
- Display Unit: "m/s" ("kmph") & Degree North Wind Direction
- Interface: RS232 Serial Port Connection
- Memory Capacity: 128 KB Non-volatile
- Memory Logging Interval: User Selectable (upto 60 minutes)
- Operating Condition: 0 to 70 C Temp and max. 80% RH
- Date-time function: battery backed digital RTC chip
- Power Supply: 230 V AC Mains and 12 V Battery
- Backup Battery: 3 V Lithium Coin cell (CR 2032)

(I) Amphibious Tools carrier /Dredger/ Aeration

For regular maintenance and removal of vegetation/hyacinth/weed etc., from running channel, an amphibious equipment has to be supplied with following specifications:

Motor	turbo diesel 45 hp / 3000 rpm.
Electric system	12 volt, 60-A generator, 45 AH battery
Engine	Turbo charged diesel engine
Fuel consumption	Min: 3.8 litre/hr. Med: 4.2 litre/hr. Max: 6.8 litre/hr.
Dimensions	Length: 5 m, Width: 2 m, Height: 2 m
Cooling system	prevents dirt in radiator cells

Hydraulic system	Hydraulic tank with cyclone technology 19 litres, volume of hydraulic system 36 litres. Load-sensitive hydraulic pump, torque 115 Nm.			
Control system	Automatic cut-out if the level in the hydraulic tank is too low.			
Left joystick	For driving the machine.			
Right joystick	Lifting, tilting, weight distribution.			
Driving speed	0-6 km/hr (rubber paddle). Hydraulic propeller: 7-8 km/hr.			
Material	Light weight material, non corrosive			
Operating Tools Technical Information				
Tool	Working width(Mts)	Working depth (Mts)	Capacity (max)	Remarks
Dorocutter	2.2-3-4	1.0(3090), 1.4(3091)		The tools are used for removing various water weeds, reeds and hyacinths.
ESM1700	1.7	0.3		
" 2100	2.0	0.5		
" 2200	2.0	0.8		
Reed rake, standard	2.0-3.5	0.4		The rakes are equipment's for Collecting and disposing the harvested Water weeds and hyacinths. Usage based on type of water weeds

- Water level u/s of Majar dam. We may like to control gate operation remotely.
- Water level u/s and d/s of the screens proposed on the open channels/drains Joining Amanishah Nallah for monitoring and control of the screen operations.
- Water level at outfall structures /sedimentation basin / overflow weir/ screens at outfall structure
- Water level at the check dam structures all along the Nallah where minimum depth of flow is prescribed for monitoring of performance parameter.
- Water quality measuring probes and transmitters for measurement of water quality in the water front at selected places, especially d/s of joining point of major drains.
- Water depth and water quality measurement for the water bodies proposed to be created under area development at 4/5 locations in the upstream reaches of the Nallah.

5.6.5.2 Railings

Railings are to be provided at three places as under:

- At the top of Nallah section above masonry parapet from km 5.1 to 34.8—here the railing should made of MS bars at least 16 mm dia. closely spaced vertically with a grill shape having a height of at least 1.5 m with a MS gate 4 m wide spaced at around 1 km interval. Complete railing should be painted. Design to be got approved from Employer's Representative.
- At the berm with in Nallah section from km 5.1 to 34.8 —here the railing

should be made of pink color Jodhpur stone both vertical pillars and horizontal stone patties should be of Jodhpur stone, the pillars should be square in shape having a side of at least 100 mm ,should be spaced at 3 meter interval. Design to be got approved from Employer's Representative.

- At the check dams--- here the railing should be made of steel wire rope at least 25 mm dia. tied to MS pipes at least 50 mm dia placed at an interval of 3 meters on both the sides of check dam width. Complete railing should be painted. Design to be got approved from Employer's Representative.

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5.7 Operation and Maintenance

5.7.1 O&M Specifications for Nallah Works

5.7.1.1 General Obligation for O & M Period

- Contractor shall maintain the well equipped site office; constructed under work contract at his own cost and will keep the sufficient staff, tool and tackle required for the complete O&M. The Contractor may require to increase the staff strength adequately if in view of the exigency and volume of work.
- Contractor shall maintain the complete 24 hours security of the whole project area by deploying the adequate strength of security guards and maintaining the proper illumination in night hours.
- Contractor shall prepare and submit a schedule for entry and closing hours for project area and he will ensure strict compliance of this approved schedule.
- Every workman is to be covered under PF from the date of employment. The Contractor will deposit the subscription of EPF along with his own contribution in his own PF Account. The Contractor is required to comply with the provisions of ESI Act, 1948 for all workers from the date of employment.
- The Contractor has to pay minimum wages to his workers as fixed by the Govt. from time to time.
- The Contractor shall issue photo gate passes to their employees/workers. In case the Contractor or its employee is found mis-using the identity card/ gate pass issued by Employer's Representative, the Contractor will be wholly responsible for its consequences.
- Compensation for any injury/death to Contractor's worker(s) while on duty, shall be payable by Contractor and Employer's Representative will not have any liability on this account. An amount as applicable from time to time shall be paid by the Contractor immediately to the dependents of his worker(s) in case of death while on duty.
- The Contractor or his qualified supervisor must be available at site on all the working days irrespective of quantum of job. In case he has to leave the place of site, he must take permission from the Employer's Representative.

5.7.1.2 Operational Obligations

- Contractor will require working for O & M of all project components in all the weather conditions and no extra rate will be considered on this account. He may have to carry out jobs to work round the clock as per the Employer's requirement under the direction of Employer's Representative. No extra claims/overtime will be paid on this account.
- Contractor shall maintain the 24 hours security to the whole project area by deploying the adequate strength of security guards and other arrangements .
- To ensure the quality standards of water in project area, Contractor shall ensure the check and control on any domestic, industrial or other type of waste discharge into Nallah during the complete O&M period.
- The cost of all consumables, water and communication system shall be borne by Contractor whereas regular electricity bills will be paid by the Employer as per condition referred in Particular Conditions of Contract, Part B Clause 13.8 and 14.
- Contractor shall maintain the all components of project in their efficient and proper working conditions in all required manner. He has to ensure that

system is properly working for the intent purpose. The major components are, but not limit to, as:

- ❖ Instrumentation including weather station equipments, water flow measurement equipment, O&M equipments such as dredgers etc.
- ❖ Surveillance equipment
- ❖ Street light system
- ❖ Electrical systems
- ❖ Utility buildings
- ❖ Vendors space and parking space
- ❖ Green area, Park and Plantation in project area

- Contractor shall appoint the adequate manpower staff for each utility and public building and to ensure the efficient working of all units such as, but not limit to:
  - ❖ Exhibition hall
  - ❖ Public Toilets
  - ❖ Park

5.7.1.3 Routine Inspection, Maintenance & Repair works:

The Amanishah Nallah which is being rejuvenated under the project shall have following types of civil works and other facilities. These will require efficient operation, routine inspection and maintenance so that complete system remains fully functional and the project benefits are continuously extended to public forever, the activities are classified as:

S.N.	Particular	Critical	Non critical	Mandatory Daily
1.	Gabion structures in upstream of Mazar dam up to km 5.1	✓		
2.	Civil works including regulating gate at Mazar dam	✓		
3.	C.C. lined base section from km 5.1 to 34.8 including fall and check dam structures	✓		
4.	Grass turfing in alternate panels of 10 m from km 5.1 to 34.8		✓	
5.	Stone steps in alternate panels of 10 m from km 5.1 to 34.8		✓	
6.	Pedestrian path way made of Jodhpur stone tiles on berm with in Nallah section from km 5.1 to 34.8		✓	
7.	Masonary parapet covered with Jodhpur stones all along the length of Nallah		✓	
8.	Flared walls at the junctions of lining and existing structures	✓		
9.	Ground water recharge structures		✓	
10.	Railings provided at different places		✓	

S.N.	Particular	Critical	Non critical	Mandatory Daily
11.	Instrumentation including weather station equipments, water flow measurement equipment, O&M equipments such as dredgers etc.	✓		
12.	Surveillance system	✓		
13.	Street light system			✓
14.	Electrical system	✓		
15.	Utility buildings			✓
16.	Vendors space and parking space		✓	
17.	Plantation along Nallah			✓
18.	Landscaping work done at various places			✓
19.	Solid Waste Management System			✓
20.	Drinking water facilities provided at various locations			✓

Addition to the above mentioned inspection schedule, Contractor shall have to conduct these inspection activities as and when required by Employer's Representative.

Some of the routing Operational & Maintenance works will be as detail below, but not limit to:

- Contractor shall maintain the minimum water depth and continuous flow in every reach of Nallah for which he will require to:
  - ❖ Desilting of Nallah bed on regular basis, to not allowing the deposit of silt more than 10 centimetre depth in any reach
  - ❖ Control/removal of hycinth in each Nallah Reach
- Contractor shall have routine inspection of the Nallah portion in case of any defect found in the bed/structure, he shall repair the defect within the minimum time period as allowed by the Employer's Representative;
- In case of any damage found to any of the component listed above it should be repaired in minimum possible time fixed by the Employer's Representative for each type of activity;
- The gate at Mazar dam should be tested for it's functionality before onset of monsoon and oiling and greasing required is done;
- Immediately after flood season if any damage to lining or any other component found it should be rectified;
- If flood water gets accumulated at any point along the Nallah it should be dewatered immediately;
- Regular recording of all weather station equipments should be done and report be sent to Employer's Representative on daily basis, the equipments be kept functional;
- Similarly regular recording of water flow measurements be done on daily basis;
- Regular recording of energy consumption meters be done and reported on monthly basis;
- All street lights be maintained efficiently, any fused lights be replaced within 48 hours;

- Watering to plantation should be done on daily basis so that survival rate of plants is 90%, the damaged plants should be immediately replaced;
- Landscaping area be kept cleaned, properly guarded, adequately kept lit and the plantation and lawns etc. be watered daily and maintained properly;
- Security guards are provided in adequate number at each desired place, their daily attendance be provided to Employer's Representative, guards for leave vacancy should also be provided;
- All toilets be cleaned two times a day;
- The Contractor should ensure that solid waste is disposed off daily to a place instructed by the Employer's Representative, he should also ensure that the Nallah area is no more being used as a space for open defecation;
- The Exhibition hall should be provided with desired types of Exhibits and it kept opened daily for fixed tome and kept cleaned;
- Surveillance equipment is kept functional all the time and it's regular recording be ensured;
- Drinking water facilities provided at various places be kept functional and potable water should be supplied on 24x7 basis, the surroundings be kept dry and clean;
- Vendors space and parking space be kept cleaned and the tiles should be kept maintained;
- Any other relevant action related to maintenance is required shall have to be done promptly.

Note:

(i) Activities identified as mandatory daily must be attended within 24 hours

(ii) Activities marked as Critical must be attended within 3 (three) days

(iii) Activities marked as Non Critical must be attended within 7 (Seven) days

(iv) In case the Contractor fails to comply any of the above requirements within prescribed time limit, the Employer's Representative shall be at liberty to get it done at risk and cost of the Contractor and the actual expenditure plus 25% supervision charges shall be recovered from any payment of Contractor's due payment

5.7.1.4 Record Keeping & Monitoring

- Maintain a periodical reporting system to provide access operating data including all such information which is necessary to confirm that the Contractor is in compliance with its obligations under the terms and conditions of this Contract;
- The Contractor shall prepare daily and monthly reports (in Employer format) of plant and machineries and project performance and submit to the Employer's Representative and will assist the department in preparing the necessary documents for their purpose and record as per proforma given from time to time.
- Monitoring of all spaces along the banks of the Amanishah Nallah shall be done under surveillance system and all the online data shall be recorded for at least one month.

5.7.2 Operation and Maintenance of STPs

5.7.2.1 General Requirements

The Contractor shall ensure the Operation and Maintenance of the STPs, Sewerage Network, Pumping Stations and other allied works in compliance to the guidelines contained in the Manual on "Sewerage & Sewage Treatment", latest edition as published by the Central Public Health Environmental Engineering Organization (CPHEEO), Ministry of Urban Development, Government of India, New Delhi and the prescription laid down hereunder.

The Contractor shall operate and maintain the entire Sewage Treatment Plants (STP) provided in the Project by him, all the Sewage Pumping Systems (SPS) established, all sewerage lines laid by him, all tapping points for sewage established by him, Electric Supply System, including all ancillary works that are carried out in the Project. The cost of such maintenance will be included within its contract price for a total operation and maintenance for a period of 3650 days from the date of taking over of the plant by the Employer after completion. The operation and maintenance period shall include the Retention Period and shall commence from the date of taking over by the Employer. All necessary repairs, maintenance, overhaul, replacements etc., shall be made during the O & M to maintain the Plant at the status of formal handing over after the Performance tests on completion of works. At the end of O & M period the plant shall be handed over to the Employer in fully functional and new condition except normal wear and tear.

The price for O & M bill shall include supply of all tools, tackles, spares, lubricants, laboratory chemical, glassware and polyelectrolyte including all incidentals. **The power supply shall be made by the Contractor. The power bills shall be refunded by the Employer as per actual after check for the power guarantee compliance.** The power consumed shall be within the guaranteed figures as indicated by the Contractor in the schedule submitted by him in the tender. **Power consumption exceeding this is subject to penalty as said in the above section**. The scope shall include but not limited to the following items.

5.7.2.2 General Scope

- To Operate and maintain the sewage treatment plant, all instruments and mechanical, electrical equipment in accordance with the aim and purpose of treatment. The plant &equipment covered under the above contract will be totally attended to, by the Contractor including any "Troubleshooting" to ensure smooth and trouble free operation.
- The Contractor shall monitor the performance of the sewage treatment plant; conduct the analysis of the inlet sewage and water quality after treatment. Contractor shall initiate and take adequate actions to ensure smooth and satisfactory performance / running of the plants on a 24 hours / round the clock basis.
- The Contractor shall prepare and implement an effective plant maintenance programme in consultation with the Employer. It is an absolutely Contractor's responsibility to look after all sorts of maintenance whether preventive, Minor, Major, or break-down
- The Contractor shall determine operating parameters, select settling (Chemical doses etc.) and generally optimize the process, and working of the treatment plant. Excessive chemical dozing i.e. dose more than normal should be avoided otherwise penalty shall be levied and recovered from the Contractor.
- The Contractor should plan & procure all spares, Polyelectrolyte and all

consumables including chemicals, grease, lubricating oil, cleaning agents, laboratory reagents etc. Further the Contractor shall plan about the requirement well in advance (At least 4 months) and procure the material from the market.

- The Contractor shall be responsible for keeping up-to-date record of documents including History Card for equipment and maintaining every day log book relating to various analysis performed.
- The Contractor shall maintain and update logbook, in which details of operational parameters are recorded in every shift and at regular interval say hourly or as decided mutually.
- The Contractor shall prepare and submit a daily report of plant performance and will assist the Employer in preparing the necessary documents for their purpose and records.
- The Contractor shall be responsible to carry out day to day periodic maintenance, necessary to ensure to smooth and efficient performance / running of all equipment / instruments comprising the sewage treatment plant and maintaining the record of the same.
- The Contractor shall have to issue identity cards with photographs to all the staff employed for Operation and Maintenance. The list of the same shall be submitted to the Employer mentioning qualification & experience.
- The Contractor shall also be responsible to carry out day to day Maintenance of the rising main inside the STP premises.
- The Contractor shall employ minimum staff for operation and maintenance of the Plant as per the list mentioned in the detailed scope of work.
- The above staff shall be distributed in three shifts as per mutual agreement between Contractor and Employer As per agreement the number of staff in each shift should always remain present otherwise penalty towards absence of any staff shall be recovered from the Contractor as per Volume-I GCC. The Contractor shall make the arrangement of reliever for weekly off/holiday etc. Absence on any ground like weekly off or holiday shall not be considered. The presence of staff in each shift should be marked in muster to be maintained at office of shift in charge at Sewage Treatment Plant that shall be considered as final. The Contractor's staff must mark their presence in this muster. The Contractor may maintain a separate register for his own purpose.
- The staff of Contractor shall always remain in contact with the Junior Engineer, Assistance Engineer/Electrical Supervisor, in charge of the Plant deployed by the Employer and follow their instruction.
- Unsatisfactory and inefficient running of the plant and unnecessary and excessive usage of spare, consumable, etc. supported by the reasons which are under control of Contractor shall be highly objected. In such cases Employer's decision will be final and binding to the Contractor.
- It is required that at least once in every one month a technical expert other than the Monthly Staff of the Contractor shall visit the plant and will suggest if required, to improve the efficiency and working of the plant etc. No separate payment will be made for such visits. The visit must be recorded and outcome of the visit/minutes of the meeting should be got signed by Employer authorities without which the visit shall not be considered.
- Contractor shall comply with all safety rules and regulations as followed by the Employer.
- The Employer will not be responsible for any accident /injury to the staff of the

Contractor. Further the Employer will not provide any insurance or medical facility to the staff of Contractor. The responsibility lies with the Contractor.

- All Central/State Government / Semi-Government / Local Body's Rules and Regulations pertaining to this contract shall be followed and observed by the Contractor without any extra cost to the Employer.
- No accommodation / guesthouse / transportation facility will be provided by the Employer to the Contractor. Operation & maintenance staff will not be allowed any accommodation facility inside the plant premises.
- The duration of the O&M shall be 120 months from the date of successful commissioning of the STPs. The same can be extended for the further period if the Employer so desires. The Contractor should employ all the staff within two days of successful commissioning. The Contractor shall provide the necessary tools and tackles required for day-to-day maintenance.
- The scope of work also includes cleaning of complete plant area including floor, toilet block railing, door, windows, light fixtures and ceiling etc. The entire premises of the plant area shall also be cleaned and maintain by the Contractor regularly.
- This work is inclusive of but not limited to operation, maintenance, housekeeping, cleaning, removing sludge by its own carrier arrangement & disposes it off as per Employer's instructions. Preparing data recording, correspondence work to Employer and Government Departments, etc. All this work should be done as per standard practices and by following labour, factory, electrical, RSPCB, and all other latest updated regulations, Indian standards etc. as applied of Local, State and Central Government of India.
- The Contractor shall not employ persons who are, pronounced guilty or charged with indiscipline.
- Right is reserved by Employer of suspension, dismission, termination of any officer / staff employed by Contractor. He shall have taken prior permission to employ or to terminate his personals.
- No watch and ward, safety insurance, security, storage, housing accommodation etc. will be provided by Employer. This will be responsibility of Contractor.
- Consumable items like rubber bush, graphite packing, rubber sheet, nut-bolts, material required for cleaning and housekeeping etc. are to be brought by the Contractor.
- Monitoring should be done as per guideline given by Employer's representative. Contractor has to maintain all the parameter of effluent within stipulated limit or he will be penalized for not maintaining the parameters given by RSPCB and Employer. All expenditure incurred for the same like, suite fee, court fee, case fee, or the penalty as decided by Employer's Representative and penalty charged by RSPCB will be charged to Contractor and deducted from his bills, SD etc.
- Contractor shall have to test the effluent / influent at his own cost at the plant lab on daily basis. The same be verified by and checked by Employer whenever required. The Contractor shall also have to test the effluent / influent at RSPCB lab for different parameter on weekly basis at his own cost.
- No equipment shall remain ideal or un-attended or damaged for the period of 3 days..
- The payment of O & M charges will be made as per the tender conditions. The other terms and condition described in these complete tender documents,

wherever applicable shall remain unchanged. In case of any discrepancy the decision of Employer's Representative will remain final & binding on the Contractor.

- During Operation & Maintenance period, Contractor has to supply all the spares, at his cost during preventive, major-minor breakdown, replacement and maintenance work. No extra payment will be made for such maintenance on any ground. The payment for the same will be made strictly as per tender document irrespective of the number of break down / minor, major repairs replacements. During the O & M Contractor shall have to enter annual maintenance agreement with Manufacturers of all major Mechanical Equipments like Centrifuge, Air Blowers, Screens, Decanters etc.
- Contractor shall have to maintain required Power Factor as per STATE EB rules and regulations. Incase penalty is levied by STATE EB for not maintaining the Power Factor the same will be recovered from the. Contractor
- Maintenance of Garden, Lawns, Plants, Bushes, Plantation of new Plants, Lawns etc. and feeding, gardening, cleaning etc. is in the scope of the Contractor. No separate payment will be made for the same.
- The Contractor during his O&M period will have to follow all the guidelines set by RSPCB for Operation & Maintenance of STP.
- Operation and maintenance of all General facilities and utility services including all other components of work done under this contract.
- Operation and maintenance of PLC based automation system and all instruments installed in the STPs including all repairs, replacements towards the entire instrumentation works during the O & M period shall be in the scope of Contractor.
- Any other services required for smooth running of the scheme.
- The Contractor shall also dispose off the sludge, screenings, grit and any other material, as per specifications and to the satisfaction of the Employer's Representative. It is to be noted that all costs during the O&M period, excluding the cost of power and chlorine are to be borne by the Contractor. The Contractor is to ensure that the following guarantees are maintained during the operation & maintenance period:

  a. for quality of treated effluent

  b. for consumption of chemicals

  c. for automation

- The Contractor shall provide on job training to the Employer's staff as per specifications.
- At the end of every 2(1/2) year of operation & maintenance period, an assessment of the condition of the plant has to be done by the Employer through third party inspection at Employer’s cost and based on that assessment the Contractor shall, at no extra cost to the Employer, repair and re-condition all the mechanical equipment in the concluding year of the O&M contract to a condition so that they are in running condition with regular preventive and recommended maintenance as per manufacturer's recommendations or as per CPHEEO manual.
- Variability of through output: If the quantity of treated sewage from the Facility can be increased in the existing system without impacting the annual fixed costs to the Contractor, the Contractor shall comply with such requirements. For a sustained requirement of higher throughout from the Facility, the

Contractor may be required to frame and submit a proposal that shall be implemented if mutually acceptable.

5.7.2.3 Down time

Any STP shall never be operated at less than 50% of its design capacity due to maintenance and repair reasons. The period of such exceptional operation shall not exceed two consecutive days and shall not be more than three days a week. The maximum downtime of the whole Plant shall not exceed 8 hours. The periods for repairs and maintenance have to be communicated to the Employer's Representative at least one month in advance. For machinery and equipment which requires maintenance to be carried out by manufacturer/ manufacturer's authorized representative, the down time shall not exceed 30 days. Employer reserves the right to impose penalty, should there be any default by Contractor on this account. The penalty amount will be deducted in the next O & M bill if adequate resins are not furnished by the Contractor for delay.

5.7.2.4 Operation of the Plant as per O&M Manual:

- The Contractor shall prepare a detailed program (referred to as O&M Manual) covering the operation and maintenance of the Sewerage Network as a whole. This program shall include the work and activities described in this Chapter, as relevant to the specific items and technology.
- The Contractor shall provide 6 copies of draft O&M Manual to the Employer, at the time of the commissioning of the project and on approval of draft, 10 copies of operation &maintenance manual shall be supplied by the Contractor.
- The O&M Manual shall include the daily, weekly, monthly, quarterly, half yearly and
- annual checks and remedies if necessary to be performed for effective operation of the plant, elaborate detail, all operating and maintenance procedures and policies which are required, advisable and / or necessary for the Facility to achieve full compliance with the operational guarantees and to achieve maintenance and repair standard for the Facility which will ensure compliance with the maintenance specifications. The O&M manual shall include interalia full explanation of all plant procedures and processes.
- Without limiting the generality of the foregoing the O&M Manual shall include descriptions, procedures; schedule of maintenance, and shall comply with the requirements, set forth in the provisions of the Bid Documents.
- The draft of the O&M Manual shall be subject to the review and approval of Employer, which shall have the right to make any changes and revisions to the O&M Manual as it may deem appropriate. The Contractor shall revise such draft O&M Manual prior to the commencement of the O&M period.
- At the end of the construction period, the Contractor shall revise the draft O&M Manual to reflect any updates, changes or revisions it deems appropriate, inter-alia based on
- its experience and as necessary to reflect any modifications or adjustments to the plant. Without limiting the above, the Contractor shall annually fully review, revise, update and modify the draft O&M Manual as may be necessary or appropriate. Any revision to the draft O&M Manual shall be subject to the review and approval of Employer.
- Employer shall have the right to require revisions to the draft O&M Manual as it may deem appropriate. The Contractor shall prepare and submit to Employer, for its review and approval, 30 days prior to the proposed date of

commencement of O&M, a revised draft O&M Manual which reflects all changes, revisions and modifications. The Contractor shall prepare the O&M Manual, as approved by the Employer, prior to the start of O&M.

- During the term of this Agreement, the Contractor shall promptly notify Employer of any revisions, additions or modifications which he, in his professional opinion, believes should be made to the O&M Manual, whether as a result of additional experience in operating and maintaining the Facility, changes in influent quality or volume, changes or modifications to any equipment part, component or structure incorporated in the Facility.
- Such notification shall set forth the reason for the proposed revision. Any proposed revision shall be subject to the approval of the Employer. In addition, during the term of this Agreement, Employer shall have the right to require relevant changes, revisions, or additions to the O&M Manual as it, shall deem appropriate to ensure full compliance with the O&M Standards.
- The Contractor shall submit 10 copies of the final O & M manual along with a soft copy in Microsoft Word Format.

(A) Maintenance schedules

- The Contractor shall prepare and follow a Maintenance plan, detailing the maintenance activities scheduled for each of the component of the Sewerage Network on a periodic approved by Employer's Representative and / or the Employer.
- Every part of the works and all the materials to be used therein shall be subjected to such tests from time to time during the execution of the work as the Employer may direct and the whole of such tests shall in all cases be made at the Contractor’s sole expense.
- The work shall be carried on and completed under the exclusive control direction and supervision and to the satisfaction of the Employer. The Employer shall likewise have full power to reject or condemn any work or material that he may deem unsuitable. In case of any work or material being rejected by the Employer's Representative, the Contractor shall immediately remove and replace the same to the satisfaction of the Employer or the Employer shall have full powers to get the same removed and replaced and deduct the expenditure incurred in the process from any amount due or that may become due to the Contractor.
- The Contractor shall use only the original and genuine spares of the original equipment as per recommendations given in the maintenance booklet of the manufactures/as per directions of the Employer. Adequate stock of such spares is to be maintained by the Contractor. Test certificate of manufacturer is required for bearings along with supplies. Test certificate of all major equipment will be submitted from the manufacturer.
- If any material brought to the site of works, be in the judgment of the Employer's Representative, found inferior or improper & not as per described standards, the said materials or workmanship shall where required by the Employer shall be removed or amended by the Contractor forthwith or within such period for every breach by the Contractor in this clause.
- All the steel structures and machines, if installed in open areas, should be painted after every monsoon period after cleaning the surface as per the instructions of the Employer's Representative. Entire plant including all civil structures, mechanical equipment, HT panel and Transformers etc. shall be repainted after every 2(1/2) years as per original painting specifications.

- All leakages should be attended and all network blockages shall be removed within three days of them being identified and reported. All the valves/gates which are not used regularly should be operated at least once a week and make sure that they are properly lubricated /greased.
- All safety valves should be checked daily and ensure that they are working properly. In case of any fault the same should be attended immediately without any wait. The maintenance of the plant shall be as per maintenance manuals of the manufacturer for all equipment. Contractor shall keep all the safety devices in working order.
- The Contractor should make sure that no unwanted material should float/grow in and around different units. In case it is found the same shall be removed /cleaned immediately. He shall also be responsible for cleaning/sweeping the plant buildings inside and outside, roads, foot path etc.
- Launders/Weirs etc. of reactors etc. to be maintained clean round the clock. During preventive/ breakdown maintenance, the Contractor has to visit the unit/units as and when needed. The pumping units or other machineries required if any shall have to be arranged by the Contractor at his own costs for completing the work. In case of battery operated auto system panels and also system alarm etc., batteries are required to be maintained and replaced as and when needed by the Contractor.
- The Contractor shall maintain the Supervision, Control and Data Acquisition System (SCADA) in working condition for the 10 years of O & M period. The Contractor shall not remove/ shift any equipment/ machinery even temporarily without written permission of the Employer or authorized representative. Though the Contractor has to operate and maintain all the equipment/machineries, lighting (plant area, boundary walls, gate lightening etc.) but the machine of the equipment under warranty should not be dismantled without prior permission of the Employer. The list of such equipment (Under warranty), if any, will be given by the Contractor.
- Consumables such as Manhole covers, POL (petrol/Diesel Oil & Lubricants) etc. has to be arranged by the Contractor as and when needed as per manufactures recommendations for periodical maintenance of entire Network. The Employer shall not provide such items.
- The Contractor shall carry out biannual cleaning of network before and after the monsoon season including cleaning of all manhole chambers and collection network.
- In case of major repair due to normal wear and tear/break down, the Contractor should bring the same to the notice of the Employer immediately and necessary measures for its repair should be taken simultaneously. Breakdown, all repairs of any kind are to be attended by the Contractor. Any unit/equipment being irreparable in the opinion of the Employer will be replaced by the Contractor at no cost to Employer. However, if there is any unexpected population growth / high flows are observed due to urban growth, which warrants replacement of sewer with higher diameters, such cases will be brought to the attention of the Employer. Upon Employer's approval, at Employer's cost, the same shall be executed and commissioned by the Contractor. In these cases no supervision or design and estimation charges will be paid by the Employer.
- The Contractor shall give his telephone no., contact addresses, etc. to the Employer as well as shift duty shift to contact him during emergency/odd hours etc.

- The Contractor shall be responsible to carry day to day as well as periodic maintenance, necessary to ensure smooth and efficient performance/running of all equipment instruments installed at the Sewage Pumping Stations. He shall be responsible for maintenance/replacement of street light poles and light etc. also. All the plant, building, land, etc. shall remain the property of Employer.

5.7.2.5 Operation

(A) Operational services

- The Contractor shall operate the complete sewage treatment Plant and associated services on a continuous 24-hour basis.
- The Contractor shall operate and utilize the control and monitoring systems provided. If found necessary, he shall make adjustments (within the operation range) of the control system and equipment, so that the Plant operation matches the treatment process requirements.
- If it is determined that the facility is not capable of meeting the design parameters for any reason beyond the Contractor's control and not attributable to him, the Contractor shall determine the specific cause of failure/ abnormality in the Plant functioning and report to the Employer's Representative and seek his directives on the necessary corrective action to be taken/adopted.
- The Contractor shall be required to furnish the details of electricity consumption in the format prescribed by the Employer's Representative.
- All consumables, Polyelectrolyte, and spare required operating and maintaining the Contractor shall provide the Plant in good condition. The grit, Screenings, Wet sludge and other garbage generated in the plant shall be removed from the site on daily basis. No accumulation of such residues shall be permitted within the Plant campus without express application by Contractor giving adequate reasons as well as permission of Employer's Representative. The Contractor shall such residues in conformity to Environmental regulations/ rules in force. The Employer's Representative may, if required, decide the mode and timing of disposal of such residues in consultation with concerned Environmental and Civic Authorities. Such directions shall be followed by the Contractor promptly, both in letter and spirit, without any reservations and without any increase in O&M /other costs. The loading, unloading and transportation cost of these shall be borne by the Contractor and shall be included in the price quoted by the Contractor for O&M.
- The Contractor at his own expense shall provide all tools, cleaning, and housekeeping equipment, security and safety equipment

(B) Laboratory services

The Contractor shall perform all tests, sampling and analyses regularly as approved by the Employer's requirement and as per the O & M standards

The Contractor shall submit in his offer a complete list of laboratory equipment and materials in accordance with the analysis program required, if in addition to the mandatory list of laboratory equipment said in Annexure 8

(C) Manpower

- The minimum personnel required for O & M is as given below. However, the Contractor shall mention the personnel required for O&M in his bid. The work shall be carried out on a 24 hour basis without intermission and the staff

deployed by the Contractor shall be in accordance with this contract.

S. N.	Key Staff	Nos. Required	Minimum Qualifications
1	Manager	1	Degree / Diploma in Civil Engineering / Mechanical Engineering / Electrical Engineering with minimum 10 years' experience in Operating & Maintaining a STP and Sewerage Network
2	Foreman	6	Degree / Diploma in Civil Engineering / Mechanical Engineering / Electrical Engineering with minimum 5 years' experience or ITI 'C'
3	Pump Operators	14	Certification with minimum 10 years experience in Operating & Maintaining a Sewerage System
4	Electrician	1	ITI 'C' certification with minimum 3 years' experience in Operating Sewerage System
6	Plumbers/ Fitters	5	(ITI 'C' certification with minimum 5 years' experience in Operating /Maintaining any Sewerage System
5	Sewer cleaning works and other support staff	20	- Experience in laying / maintaining and operating Sewerage System for a minimum of 1 year.
6	Security and Housekeeping	7	-

- The Contractor shall give or provide all necessary superintendence during the O&M and as long thereafter as the Employer may consider necessary. Such superintendence shall be given by a competent person having adequate knowledge of the operation and Maintenance to be carried out (including the methods and techniques required), the hazards likely to be encountered and methods of preventing accident) as may be required for the satisfactory working of the entire plant.
- No labor below the age to 18 years shall be employed on the work. List of staff is to be given by the agency to the Employer and advance intimation to be given before deputing/removing any staff from site during the period of contract. Not more than one of the Contractor's key staff shall be absent from the project site at any given time. In case it is necessary for more than one of the key personnel to be absent at a given time, the Contractor shall provide replacement of equivalent or better qualifications. The CVs of such key staff replacements shall be got approved from Employer in advance.
- Employer shall be authorized to direct the contracting agency to remove any or all staff employed on O&M of the sewerage network if in his opinion continued presence of such staff is detrimental to safety or proper O&M of the sewerage network. The Contractor shall comply with such directions & post suitable substitute(s) thereof. Whenever the Engineer has to inform the Contractor in writing that any person on the work is in his opinion unsatisfactory or/incompetent or unfaithful or dishonest, untruthful or disorderly or to be otherwise unsuitable/such person shall be discharged by the Contractor from the work and shall not be employed again on it.

5.7.2.6 Safety

The Contractor shall take all safety precautions under various Acts/Rules under central/State Govt. from time to time and he shall be responsible for safety of its staff and the consequences thereof. The Contractor shall deploy round the clock security personnel

at entrance of plant's premises and in the compound for the safety of the plant and premises for the safety of the plant, equipment and personnel during this period.

(A) Responsibility for damages

- The care of the whole of the permanent works shall remain with the Contractor who shall be responsible for all accidents or damages from whatever cause arising and chargeable for anything that may be stolen, removed destroyed or damaged to whomsoever belonging and also for making good all defects and damages to the said works or to any property adjoining or any cause whatever, whether such damage or defects were occasioned by the negligence of the Contractor or not or may be or might have been discovered during the progress to be known after the completion whereof or whether payment may wholly or partially have been made or the works approved as supposed to have been properly done and no certificate of approval of any works by any officers or members of the Board shall affect or prejudice the right of the RSPCB against the Contractor or be considered or held as at all conclusive as to the sufficiency of any work materials.
- Adequate safety precautions against fire, flooding, lightening, electrical shocks, accident due to moving/non-moving heavy/light equipments shall be strictly observed by the Contractor at his own cost. Suitable safety measures like gumboots, gloves, safety belts, ladders, safety lamps, gas masks, Oxygen apparatus, insulated tools, alarms etc. shall be provided by the Contractor. Necessary medical first aid kit shall be made available all the time. In absence of observance of above safety precautions, the Contractor shall be responsible for any unforeseen loss of the equipments or persons dealing with it. Special care shall be taken by the Contractor while carrying out the work in sewage gas zone. Any incidence of human life or accident will be totally Contractor's responsibility.
- The Contractor shall ensure that the staff employed takes all necessary precautions while carrying out the work either in shift duties or any general shift as per Indian Electricity Rules/Factory Act/CPHEEO Manual, or manufacturer's special instruction for safety / gas handling. The staff should use Gas masks, Oxygen apparatus, Gum Boots, Safety Belts and Safety Lamps, etc. while carrying out the work in Bar Screens, sumps etc.
- The Contractor shall make arrangement for all necessary safety equipments for persons working at STP as per Factory Act/Safety Rules. In the event of any accident on or off site, in which the Contractor or his personnel are involved, in which an injury occurs to any person whether directly concerned with the project or a third party, the Contractor shall inform Employer within 24 hrs. of the occurrence of the event. The plant will be open to local/state/central agencies for verification of safety/emission/ acts compliance.
- During night hours, the main gate should be locked. However, shift duty staff should be alert and open the gate during surprise checking of Employer staff or any other Government Authorities or his nominee without any wait. Only bona-fide persons be allowed in the plant premises being a prohibited area. Smoking and drinking are prohibited in the plant. The staff engaged shall wear

common uniform with name plate indicating name and designation during duty hours.

5.7.2.7 Reporting

- The Contractor shall prepare consolidated daily reports, weekly and monthly reports on Plant operation and maintenance and submit to the Employer's Representative. The daily reports are to be submitted within first working hour of the next day. The monthly reports shall be submitted on the first day of the next month and within two working hours.
- Overall reporting formats shall be approved by Employer's Representative and may have to be modified from time to time as required and approved by Employer's Representative. Contractor may have to prepare and submit additional reports on particular matters and incidents as and when required by the Employer's Representative for each significant occurrence.

5.7.2.8 Maintenance

(A) Maintenance of Installed Plant

- The Contractor shall ensure the continuity of the Plant operations and the breakdown or the deterioration in performance of the Plant under normal operating conditions of any items of the Plant and equipment and component parts thereof shall be minimized.
- The classes of maintenance provided shall comprise full Operational maintenance and standby Maintenance.
- Full operational maintenance comprises the planned and regular maintenance carried out by the Contractor on a day-to-day basis, including cleaning, lubricating, minor adjustment, together with the preventive and corrective maintenance plan for those items of the Plant and equipment within the treatment works which have been commissioned and made operational.
- Standby maintenance comprises the planned and regular maintenance carried out by the Contractor including cleaning, lubricating, periodic, and minor adjustment of all items of Plant and equipment within the treatment works which have been installed but have not yet been made operational.
- The Contractor shall carry out the maintenance of the Plant installations in accordance with the requirements of the O & M Manual and to the approved maintenance plan. The Contractor shall strictly adhere to the manufacturers' recommendations with respect to equipment maintenance, and only use types and grades of lubricants to be used. The frequency of lubrication, adjustments to be made regularly, and recommended spare parts by the equipment/machine/instrument manufacturer/supplier shall be carried out and appropriate inventory shall be held in store.

(B) Building and Site Maintenance

The Contractor shall be responsible for:

- The full maintenance of building and all electrical, ventilation, plumbing and drainage installation in the building.
- Building and housekeeping maintenance.
- Full maintenance of the site water and wastewater services, cabling and earthing systems, and the site road lighting system.
- Site maintenance including the upkeep of landscaped areas/ tree Plantation etc.,

- The telephone installations in all buildings.
- The building services and housekeeping maintenance shall be undertaken on all buildings and services installations.
- Routine housekeeping maintenance shall be carried out in accordance with procedures specified in the Operation and Maintenance Manual which shall be approved by the Employer's Representative.

(C) Preventive Maintenance

- The Contractor shall plan the day-to-day and the preventive maintenance. This planning must include for each equipment the estimated necessary hours in preventive maintenance and break down maintenance. It shall also include the qualification of the foreseen maintenance personnel.
- The Contractor shall provide the yearly requirement of spare parts and consumable needed for the maintenance of each piece of equipment for the day-to-day maintenance, preventive maintenance, and foreseen break down maintenance/ overhaul, if any.

5.7.2.9 Training

(A) General

The Contractor shall be responsible for instruction and training of all his personnel in all aspects of Plant operation and maintenance till the end of the operation and maintenance period. The Contractor shall also be responsible for training personnel designed by the Employer who will operate the Plant at the expiry of the contract.

The Contractor shall make available for this purpose competent staff and as well as propose schedule information that may be necessary for effective execution of the training programme.

The training shall be organized in two (2) stages as follows:

- Basic technical training education to be carried out during the final stages of the erection period of the contract through literature, manuals, handouts demonstration at site, etc.
- Intensive on-the- job training during commissioning and maintenance period.
- By the end of this training period these personnel should be able to carry out their respective duties efficiently under the supervision of Employer's Representatives and supervisory staff of the Employer.
- The Contractor shall provide at his cost all local transportation, literature, computers, CDs and other related hardware and stationery to be used by trainers and trainees during the training period.
- Towards end of O & M contract period, training shall be conducted once again to Employer's personnel or their authorized personnel. This training shall be for a duration of 30 working days.

5.7.2.10 Operation and Maintenance Records & Reporting

(A) Reporting and Record Keeping:

- Maintain a periodical reporting system to provide access and retrieval of Sewage Treatment Plant operating data including all such information which is necessary to verify costs and expenses incurred and otherwise to confirm that the Contractor is in compliance with its obligations under the terms and conditions of this Contract;

- The Contractor shall prepare daily and monthly reports (in Employer format) of pumping/treatment and project performance and submit to the Employer's Representative and will assist the department in preparing the necessary documents for their purpose and record as per proforma given from time to time. The reports shall contain, inter-alia, the following:
    a. Raw Sewage quantity and quality and effluent quality as per the on-line monitoring programme and other tests and print outs of online monitoring shall be submitted to Employer's Representative.
    b. A description of the maintenance work carried out in the reporting period.
    c. A report on major failures, if any, their causes and remedial actions taken.
    d. Sludge quality and quantity (daily basis) in the reporting period.
    e. Power and chemicals consumed in the reporting period.
- An inventory of the chemicals and spare parts available at the end of the reporting period.
- O&M staff deployed by the Contractor during the reporting period. Any major repair works, if any.
- Contractor shall maintain separate register/computerized records at all sites of following information:
    a. Pumping register
    b. Quantity of sewage treatment and performance register D
    c. Working hours register
    d. Electric break down register
    e. Maintenance register
    f. Staff attendance register
    g. Equipment breakdown, repair record and extent of repair
    h. Chlorination equipment and chlorine toner operating and using register
- The Contractor shall maintain a record for the entire Term of the following:
    a. status or progress report of the operation and maintenance of each of the Sewage Treatment Plant components;
    b. record of all consumables, tools, equipment's manhole covers, etc. used / replaced towards operations and maintenance of the STP;
    c. report certifying that the quality and quantity of the Residual Treated Water at the Discharge Point;
    d. Report certifying the reuse (quantity and quality) of treated effluent.
    e. daily readings of the meters at the Receipt Point;
    f. daily readings of the meters at the Discharge Point;
    g. methods of disposal used for Residual Matter; and
    h. Nature and scope of any ancillary activities being carried out in accordance with the terms and conditions of this Contract.
    i. Provide reports on accidents in respect of the Sewage Treatment Plant, if any

j. Daily readings of the meters at the inlet of the STP;

k. Nature and scope of any ancillary activities being carried out in accordance with the terms and conditions of this Contract; and

l. Provide reports on accidents in respect of the Sewage Treatment Plant, if any.

- The Contractor shall provide an accurate, complete and up-to-date record, report or document in relation to any aspect of modernization, expansion, operation, maintenance and management of the Sewage Treatment Plant to Employer as and when a request is made as soon as reasonably practicable and in any event within any time limit prescribed by Employer for the production of such record, report or other document.
- Provide a copy to Employer of its annual audited accounts of expenditure by the Contractor in the implementation of the Project as at the end of and for that accounting period.
- Report to Employer regarding any litigation or material claims, disputes or actions, threatened or filed, concerning the Sewage Treatment Plant or the obligations to be performed by the Contractor under this Contract;
- Report to Employer any refusal or threatened refusal to grant, renew or extend or any action pending or threatened that might affect the granting, renewal or extension of any Applicable Approval;
- Report to Employer any material information concerning new or significant aspects of the operations, maintenance and management of the Sewage Treatment Plant, any material complaint about the Sewage Treatment Plant from any person or any other information received by the Contractor which is material to the Operation and Maintenance of the Sewage Treatment Plant
- Hourly record of Flow as measured / recorded through the Notch / Weir / Flow meter:

Date/ Time	Head Over the Notch / Weir / Meter	Rate of Flow	Average Rate of Flow in Past Hour	Flow Quantity

5.7.2.11 Fulfillment of the Operational Guarantees

The Contractor shall be responsible for ensuring that the entire system operates and fulfills the guarantees stipulated in the document during the operation and maintenance period. The guarantees to be fulfilled for satisfaction of this clause will be related to:

- the quality standards of the effluent, sludge and the nuisance generated by any of the STP
- the quality of the dry weather flow in the water way of the Drain
- the power consumption in the STP
- the Power consumption in the SPS

5.7.2.12 Quality standards of the effluent, sludge and the nuisance generated by any of the STP

The inlet, outlet and treated water in Amanishah nallah flows parameters stipulated shall be checked daily at least 4 times and recorded (timings 9: am,

3:00 pm, 9:00 & 3:00 am). The parameters will be observed every hour on two days (1st & 15th of every month) and a weighted average of the values calculated.

If some parameter are found to be exceeded, the operator should ensure that it is corrected within 24 hrs and rechecked. There will be no penalty as long as such occurrence are not more than once a month for each plant.

In case the problem continues for more than 48 hrs., the Contractor shall be imposed a penalty @ of 2% of the monthly payment (all STP operation cost excluding electricity) for each day the plant fails to perform to the standard.

5.7.2.13 Quality Monitoring

Variations allowed in treated effluent quality during O & M period of 10 yrs and during Retention Period, and penalty for not maintaining the standards:

5.7.2.14 Liquidated Damages for failure in performance

During Retention Period of 12 months and O&M period of 10 yrs, The Employer will impose following penalties/liquidated damages for not maintaining the guaranteed parameters, as described below:

(Note: The O&M Cost for this purpose will not include the Power Charges)

(A) Liquidated Damages for non-compliance of treated effluent standards

Event Triggering the recovery of Liquidity Damages	Liquidated Damages	Frequency
Non-conformance with MAC for BOD Standard	Rs. 2000/-	For every event of non-conformance*
Non-conformance with MAC for TSS Standard	Rs. 2000/-	For every event of non-conformance*
Non-conformance with MAC for Total Nitrogen	Rs. 2000/-	For every event of non-conformance*
Non-conformance with MAC for Ammonia Nitrogen	Rs. 2000/-	For every event of non-conformance*
Non-conformance with MAC for Fecal Coliform Standard	Rs. 2000/-	For every event of non-conformance**
Non-conformance with MAC for DO in Water Way Amanishah Drain for low DO in the Water Way	Rs. 2000/-	For every event of non-conformance**

* An event is defined as online reporting duration, not exceeding 3 minutes i.e. a maximum of total 30 minutes a day i.e. 98% system reliability.

** An event is defined as daily composite sample, not exceeding one non-conforming sample in 30 days i.e. 97% system reliability.

The cumulative of above liquidated damages shall not exceed the monthly O&M cost (Maximum Liquidated Damages).

(B) Breakdown of Equipment:

In case of breakdown of equipment for more than the stipulated time period as below, on discretion of Employer's Representative, the Contractor shall be penalized as mentioned below:

Equipment	Breakdown Time Period	Liquidated Damages Imposed
Critical Equipment/ Instrumentation	beyond 72	3% of

Equipment	**Breakdown Time Period**	**Liquidated Damages Imposed**
(Critical equipment shall mean those ensure the plants performance and it shall include all flow and treated water quality measuring instruments and systems including submersible mixers , blowers, sludge and MLSS recirculation pumps, disinfection (chlorination system), filters panels etc.)electrical systems such as critical electrical system such transformers, electrical	hours i.e. 72 hours	Monthly O&M Cost per day of default beyond permitted breakdown time period
Semi-Critical Equipment Semi Critical equipment shall mean those necessary to ensure the plants performance and they shall include all screens, grit removal systems, primary clarifiers, bio reactors (aeration system), secondary clarifiers, sludge thickening, and digestion systems etc.	beyond 7 days	2% of Monthly O&M Cost per day of default beyond permitted breakdown time period
Non Critical Equipment Non Critical equipment shall mean those equipment at the plant are but are not critical in for delivering the plants performance, such as area lighting, air conditioners, Instruments not critical towards operation of the plant.	beyond 10 days	1% of Monthly O&M Cost per day of default beyond permitted breakdown time period

The cumulative of above liquidated damages shall not exceed the monthly O&M cost (Maximum Liquidated Damages).

However, if pollutants load (kg/day) exceeds the design pollutant load per day basis, or total flow exceeds (total of STP capacity provided on 24 hr basis), no penalty shall be applicable.

During trial run and commissioning, no penalties will be applied and Contractor shall rectify the plant to ensure successful commissioning.

Note: *In case the non-conformance, on a continuous basis, due to Condition A and Condition B becomes equal to or more than 50% of the monthly O&M value for a period more than 3 months in a year i.e. 90 days in a year, then the Employer reserves the right to terminate the Contractor after en- cashing all the Security Deposits, retention Money and Performance Guarantees.*

5.7.2.15 Grid Power Failure:

In any case if the grid power failure is more than 8 hrs in a single occasion in a day or cumulative grid power failure is more than 8 hrs in a day.

No treatment standards will be compulsory. However, Contractors are encouraged to maintain standards as far as possible. No penalties will be imposed on Contractor. Above relaxation shall be applicable only for a period of 24 hours after resuming regular grid power.

5.7.2.16 Use of Electrical Energy:

Contractor shall give complete details of total power consumption, Power consumption in each STP and SPS and the acceptable power consumption as per

the agreement for the same along with the power cost refund claim. The refund for the power shall be made only after deducting the cost of 2 times the u nit consumed in excess of the guaranteed consumption.

During Operation and Maintenance, damages payable by Contractor to Employer on excess consumption of net electrical energy shall be equal to the actual cost of the excess energy used for Operation and Maintenance of the Works for STP and SPS under the Contract, based on the guaranteed consumption provided by the Contractor and the current rates charged to the Employer for electricity consumed.

The guarantees for power consumption would come into effect after the Completion Test.

5.7.2.17 Residual Handling & Disposal

The Plant Residuals shall conform to the following specifications:

(A) Screenings

The screening shall comprise of all particles of an effective size in excess of 5 mm and be free of dripping water when disposed from the plant.

(B) Grit

The grit removed shall contain less than 3% organic matter on dry basis of an average particle size between of more than 100 microns but less than 1000 microns and be free of dripping water

(C) Excess Bio Solids (Sludge)

The sludge shall comply with the standards and the cakes can be disposed by the Contractor as he wishes to the land fill site or may be sold by him, the value recovered will be his property. However it should be periodically removed from the plant site to avoid any foul atmosphere.

Screenings & Grit: Disposal to the Sanitary Land fill (the tipping charges shall be borne by the Contractor.

5.7.2.18 Operation and Maintenance Manual

- The Contractor shall prepare a detailed program (referred to as O&M Manual) covering the operation and maintenance of the treatment plants as a whole. This program shall include the work and activities described in this Chapter, as relevant to the specific items and technology.
- The Contractor shall provide 6 copies of draft O&M Manual to the Employer, at the time of the commissioning of the Project and on approval of draft, 10 copies of operation &maintenance manual shall be supplied by the Contractor.
- The O&M Manual shall include the daily, weekly, monthly, quarterly, half yearly and annual checks and remedies if necessary to be performed for effective operation of the plant, elaborate detail, all operating and maintenance procedures and policies which are required, advisable and / or necessary for the Facility to achieve full compliance with the operational guarantees and to achieve maintenance and repair standard for the Facility which will ensure compliance with the maintenance specifications. The O&M manual shall include interalia full explanation of all plant procedures and processes.
- Without limiting the generality of the foregoing the O&M Manual shall include descriptions, procedures and shall comply with the requirements, set forth in the provisions of the Bid Documents.
- The draft of the O&M Manual shall be subject to the review and approval of

Employer, which shall have the right to make any changes and revisions to the O&M Manual as it may deem appropriate. The Contractor shall revise such draft O&M Manual prior to the commencement of the O&M period. At the end of the construction period, the Contractor shall revise the draft O&M Manual to reflect any updates, changes or revisions it deems appropriate, inter-alia based on its experience and as necessary to reflect any modifications or adjustments to the plant. Without limiting the above, the Contractor shall annually fully review, revise, update and modify the draft O&M Manual as may be necessary or appropriate. Any revision to the draft O&M Manual shall be subject to the review and approval of Employer.

- Employer shall have the right to require revisions to the draft O&M Manual as it may deem appropriate. The Contractor shall prepare and submit to Employer, for its review and approval, 30 days prior to the proposed date of commencement of O&M, a revised draft O&M Manual which reflects all changes, revisions and modifications. The Contractor shall prepare the O&M Manual, as approved by the Employer, prior to the start of O&M.
- During the term of this Agreement, the Contractor shall promptly notify Employer of any revisions, additions or modifications which he, in his professional opinion, believes should be made to the O&M Manual, whether as a result of additional experience in operating and maintaining the Facility, changes in influent quality or volume, changes or modifications to any equipment part, component or structure incorporated in the Facility.
- Such notification shall set forth the reason for the proposed revision. Any proposed revision shall be subject to the approval of the Employer. In addition, during the term of this Agreement, Employer shall have the right to require relevant changes, revisions, or additions to the O&M Manual as it, shall deem appropriate to ensure full compliance with the O&M Standards.
- The Contractor shall submit 10 copies of the final O & M manual along with a soft copy in Microsoft Word Format.

5.7.2.19 Technical Audit

- The Employer has the right to conduct a technical audit of the Facility and to perform any analysis or inspection he deems necessary. The Contractor shall at his cost provide all assistance the Employer required to complete these inspections. Such audits may cover all or any of the obligations of the Contractor, including without limitation,
- Verification of the system capacity and save for normal wear and tear during the O&M Period
- Verification of the performance standards and useful life of the individual assets of the Facility, save for normal wear and tear during the O&M Period
- Verification of the capacity of the Facility to meet Output Standards during the residual life of the Facility and save for normal deterioration expected during such residual life
- Sampling, testing and verification of the Output Standards for treated sewage, sewage losses

5.7.2.20 Facility Visits

At any time or at the end of each twelve month period, or at the initiative of the RSPCB, a visit shall be organized so that both parties can check the condition of the installations at the facility.

A report shall be drawn up to record the opinions of the both parties. The RSPCB reserves the right to call the equipment manufacturers or specialized technicians for these visits. All expenses are to be borne by the Contractor for the purpose.

5.7.2.21 Maintenance Schedules

- The Contractor shall prepare and follow a Maintenance plan, detailing the maintenance activities scheduled for each of the component of the STP on a periodic approved by Design-Build-Operations Engineer and / or the Employer.
- Every part of the works and all the materials to be used therein shall be subjected to such tests from time to time during the execution of the work as the Employer may direct and the whole of such tests shall in all cases be made at the Contractor's sole expense.
- The work shall be carried on and completed under the exclusive control direction and supervision and to the satisfaction of the Employer. The Employer shall likewise have full power to reject or condemn any work or material that he may deem unsuitable. In case of any work or material being rejected by the Employer's Representative, the Contractor shall immediately remove and replace the same to the satisfaction of the Employer or the Employer shall have full powers to get the same removed and replaced and deduct the expenditure incurred in the process from any amount due or that may become due to the Contractor.
- The Contractor shall use only the original and genuine spares of the original equipment as per recommendations given in the maintenance booklet of the manufactures/as per directions of the Employer. Adequate stock of such spares is to be maintained by the Contractor. Test certificate of manufacturer is required for bearings along with supplies. Test certificate of all major equipment will be submitted from the manufacturer.
- The Contractor shall also be responsible to maintain cleanliness in around the plant including machineries, disposal of floating removed from the Bar Screens/reactors, etc. Grit and other unwanted material.
- If any material brought to the site of works, be in the judgment of the Employer's Representative, found inferior or improper & not as per described standards, the said materials or workmanship shall where required by the Employer shall be removed or amended by the Contractor forthwith or within such period for every breach by the Contractor in this clause.
- All leakages should be attended promptly to avoid any nuisance etc. Chokages should be removed at once. All the valves/gates which are not used regularly should be operated at least once a week and make sure that they are properly lubricated /greased.
- All safety valves should be checked daily and ensure that they are working properly. In case of any fault the same should be attended immediately without any wait. The maintenance of the plant shall be as per maintenance manuals of the manufacturer for all equipment. Contractor shall keep all the safety devices in working order.
- All the steel structures and machines installed in open areas should be painted after every monsoon period after cleaning the surface as per the instructions of the Employer's Representative. Entire plant including all civil structures, mechanical equipment, HT panel and Transformers etc. shall be repainted after every 2(1/2) years as per original painting specifications.
- All safety valves should be checked daily and ensure that they are working

properly. In case of any fault the same should be attended immediately without any wait. The maintenance of the plant shall be as per maintenance manuals of the manufacturer for all equipment. Contractor shall keep all the safety devices in working order.

- The Contractor should make sure that no unwanted material should float/grow in and around different units. In case it is found the same shall be removed /cleaned immediately. He shall also be responsible for cleaning/sweeping the plant buildings inside and outside, roads, foot path etc.
- Launders/Weirs etc. of reactors etc. to be maintained clean round the clock. During preventive/ breakdown maintenance, the Contractor has to visit the unit/units as and when needed. The pumping units or other machineries required if any shall have to be arranged by the Contractor at his own costs for completing the work. In case of battery operated auto system panels and also system alarm etc., batteries are required to be maintained and replaced as and when needed by the Contractor.
- Consumables such as POL (petrol/Diesel Oil & Lubricants) etc. has to be arranged by the Contractor as and when needed as per manufactures recommendations for periodical maintenance of entire Network. The Employer shall not provide such items.
- In case of major repair due to normal wear and tear/break down, the Contractor should bring the same to the notice of the Employer immediately and necessary measures for its repair should be taken simultaneously. Breakdown, all repairs of any kind are to be attended by the Contractor. Any unit/equipment being irreparable in the opinion of the Employer will be replaced by the Contractor at no cost to Employer.
- The Contractor shall give his telephone no., contact addresses, etc. to the Employer as well as shift duty shift to contact him during emergency/odd hours etc.
- The Contractor shall be responsible to carry day to day as well as periodic maintenance, necessary to ensure smooth and efficient performance/running of all equipment instruments installed at the STP. He shall be responsible for maintenance/replacement of street light poles and light etc. also. All the plant, building land, Sewage treated/untreated/sludge, etc. shall remain the property of Employer.
- Oil & Grease Schedule: Routine & preventive maintenance of electrical /Mechanical/ hydraulic/ machines & equipments is to be carried out as per the operation & maintenance manual. Minimum oil & grease requirement for one year Operation & maintenance of the Plant to be procured by the Contractor well in advance

(A) Routine, Preventive, Minor & Major maintenance of all Civil, Electrical, Mechanical, hydraulic machines & Equipment of the plant

- The Contractor should prepare schedule of daily maintenance & preventive maintenance of all the equipment & machineries operated & run by him in the premises of the plant. The schedule should be as per the guidelines mentioned in the tender & as per the O& M manual. The scope covers Routine, Preventive, Minor & Major maintenance of all major minor equipment and machines in the Plant like Submersible pumps, Coarse &Fine screens Grit Removal Mechanism, Channel gates, Decanters, Sludge pumps, Centrifuge feed pumps, Centrifuges, All dosing systems including Chlorine Dosing equipment, etc.

- The scope also covers Routine, Preventive, Minor & Major maintenance of all the instrumentation system installed like PLC, Actuators, Flow meters level indicators etc. The Contractor should also carry out Routine, Preventive, Minor & Major maintenance of all major minor electrical equipment like Electrical Panels, Switch Gears, Power Cables, Control cables, Changeover switches DG set etc. so as to ensure uninterrupted round the clock operation of the Plant.
- The Contractor should maintain all civil structures including Administrative building, Store room, Storm Drains, fencing etc. in a neat manner. He should maintain all civil structures of the plant sturdy to complete the natural/Designed lifetime.
- The Contractor should carry out the safety audit of the plant & necessary certificate from the competent authorities. This item includes all types of Routine, Preventive, Minor & Major maintenance of all Civil, Electrical, Mechanical, hydraulic machines & equipment of the plant covering supply erection test &trial run of the part/machine to be repaired/ replaced with material &labor expenses, necessary hardware's, sundry materials, lubricant oils, power oils, grease other materials plus machining charges etc.
- The Contractor should procure all the spares required for all types of maintenances in advance. The part/equipment/machine to be repaired /replaced should be as per the Employer approved list & as per the O& M manual or as per the existing manufacturer's brand.
- The Contractor, after first notifying the UPCB shall be responsible for fulfilling all requirements associated with any release of any substance into the environment (form the facility or the site) as required by Applicable law or by any Legal Entitlement including but not limit to the notification or reporting of releases /
- Hazardous substances or Hazardous Waste. The Contractor shall prepare a memorandum evidence such notification or reporting and provide copies thereof to the Employer, along with any documents provided to the relevant regulatory agency regarding such release.
- The Contractor shall process and obtain the clearance of all such agencies as required for the purpose, including all clearances during O&M period. He shall be fully responsible to comply with all requirements of Laws including hazardous substances, emission standards for air, discharge standards for effluent oil, sub-soil pollution. The contracting agency shall not release any hazardous/toxic materials inside the premises.

5.7.2.22 Site Order Book

Site order Book shall be kept by the Employer's Representative at the plant site. Orders entered in this Book by the Employer's Representative or his authorized representative shall be held to have been formally communicated to the Contractor. The Employer's Representative or his authorized representative shall sign each order as it is entered and will hand over the duplicate to the Contractor or his agent, who shall sign the original in acknowledgment of having received the order

5.7.3 Operation and Maintenance of Sewerage Network and SPS

Operate the Sewerage System, for a period of 10 years from the date of commissioning as specified below:

- The Contractor shall operate and maintain the Sewage Pumping Station

(SPS), Lift Stations and Sewer networks under the Contract complete including the road works (liability of restored portions of roads is limited to 3 years only, however the Contractor shall not be held responsible for road restoration required on account of damage done by other agencies/ utilities), landscaping, civil/structural, mechanical components, instrumentation system, Electrical System, all utility and ancillary buildings, SPS premises area, lift station, for the period of Ten (10) years from the date of successful completion of "Tests after Completion of the Works".

- The Contractor shall make his own arrangements at his own cost for staff required for operation and maintenance of networks and other assets, lubricants, diesel, spares, tools and tackles, sewer cleaning vehicles and other equipment maintenance of all types such as routine, breakdown, periodic and repair maintenance, replacement of damaged/ unserviceable sewers, maintenance of house service connections after building lanes, screenings collection; desilted material collection, transportation and disposal; co-ordination with Bihar State Pollution Control Board (BPCB), Bihar Power Corporation Ltd. (BPCL) authorities and any other activity required for the operation and maintenance of the constructed Works in full compliance with all applicable rules, regulations, laws, codes, effluent quality requirements and any other limitations. The Contractor shall also maintain a Customer grievance redressal centre and ensure that O&M services meet the standards of services/ service levels maintained as follows:

Charter of Services

SN	Nature of complaints	Time for rectification(in days)	
		Minimum	Maximum
1	Sewerage overflow on the road	1	7
2	Choking at household premises	1	7
3	Replacement of missing manhole cover	1	7

- The Contractor ensures that there is a steady and uninterrupted flow of waste water/sewage to STPs.
- Identify and inform the Employer about the illegal connections on the Sewerage Network within seven days of its being detected.
- The Contractor shall submit a weekly report to the Employer detailing the Operation and Maintenance indicating the labour hours expended, Electrical Power Consumed and other Consumables consumed and also problems faced and rectified.
- The Contractor shall submit detailed schedule/manual of all O&M activities with references of equipment manufacturers' maintenance schedules/manuals to the Employer for review and approval.
- The Contractor shall submit Guidelines and Instructions manual for the maintenance staff of all levels for all the tools, plants and equipment and Operating Sewerage Network to maintain the service levels within the standards prescribed within the contract;
- The Contractor shall carry out all O&M activities as per the approved Operation and Maintenance Manuals.
- During the Operation and Maintenance period, the Contractor shall ensure that the sewage detention time in wet well not exceeds 30 min. and there is no backflow of sewage. The Contractor is responsible for maintaining back up power arrangements at his cost to ensure that the O&M services are not

affected due to failure of power supply from the Public Utility Company.

- The Contractor's responsibility shall also include the safety and security of the Works during the course of Operation and Maintenance.
- During Operation and Maintenance period, the Contractor shall appoint an Contractor and Electrical/Mechanical Technician. In addition, the Contractor shall appoint suitable number of Contractors, drivers, cleaners, fitters, electricians, helpers, gardeners, office peons, security guards, laborers as required for the operation and maintenance of complete proposed sewerage system for three shifts and adequate other staff / supporting personnel during general Shift. Security of man-power, built structures, equipment and other system components.

5.7.3.1 Undertaking capacity building measures

Conduct a training and handholding assistance programme for six months in aspects of Operation and Maintenance of the Project Facilities for maximum fifteen employees of the ULB.

5.7.3.2 Reporting and Record Keeping

- Maintain a periodical reporting system to provide access and retrieval of Project Facilities operating data including all such information which is necessary to verify costs and expenses incurred and otherwise to confirm that the Contractor is in compliance with its obligations under the terms and conditions of this Contract;
- The Contractor shall maintain a record for the entire Term of the following:
  a. status or progress report of the operation and maintenance of each of the Project Facilities;
  b. record of all consumables, tools, equipment's manhole covers, etc. used / replaced towards operations and maintenance of the Sewerage Network;
  c. Daily readings of the meters at the Sewage pumping stations;
  d. identification and reporting of illegal connections on the sewerage network;
  e. Nature and scope of any ancillary activities being carried out in accordance with the terms and conditions of this Contract; and
  f. Provide reports on accidents in respect of the Project Facilities, if any.
- The Contractor shall provide an accurate, complete and up-to-date record, report or document in relation to any aspect of modernization, expansion, operation, maintenance and management of the Project Facilities to Employer as and when a request is made as soon as reasonably practicable and in any event within any time limit prescribed by Employer for the production of such record, report or other document.
- Provide a copy to Employer of its annual audited accounts of expenditure by the Contractor in the implementation of the Project as at the end of and for that accounting period.
- Report to Employer regarding any litigation or material claims, disputes or actions, threatened or filed, concerning the Project Facilities or the obligations to be performed by the Contractor under this Contract;
- Report to Employer any refusal or threatened refusal to grant, renew or extend or any action pending or threatened that might affect the granting, renewal or extension of any Applicable Approval;

- Report to Employer any material information concerning new or significant aspects of the operations, maintenance and management of the Project Facilities, any material complaint about the Project Facilities from any person or any other information received by the Contractor which is material to the Operation and Maintenance of the Project Facilities

5.7.3.3 Transition Plan

- At least two years prior to the End Date, the Contractor shall develop a plan to hand-over the STP, Sewerage Network and all appurtenant structures and allied works to the Subsequent Contractor at the end of the term of the Contract (the "Transition Plan").
- The Transition Plan shall include,
  a. plans to transfer the STP and Sewerage Network to the Subsequent Contractor;
  b. transition plans with respect to the Contractor's Personnel including a plan for transition of the Contractor's Personnel to a Subsequent Contractor;
  c. a proposed process for the transfer of all Contract Records to the Employer;
  d. plans to transfer operations and maintenance functions to the Subsequent Contractor; and
  e. a program to train staff of the Employer in all aspects of the operation and maintenance of the New Facility.

5.7.3.4 Taking Over

- The STP, Sewerage Network and all appurtenant structures and allied works will be taken over by Employer on satisfactory completion of the Operation & Maintenance of the plant provided that
  a. The plant /equipment are in good, smooth running condition.
  b. The result of the treated wastewater quality for last three months of operation of the plant is within the limits specified.
  c. In case of major repairs /replacement of equipment, the performance guarantee is extended by six months from the date of putting back into satisfactory operation of such unit/equipment, in case such putting back is at the end of completion of operation & maintenance period.
  d. All records of operation & maintenance are handed over to Employer in proper condition.
  e. The Third Party Inspection of the STP, Sewerage Network and all appurtenant structures and allied works viz: Civil units, Mechanical units/equipment, Electrical units/equipment, instruments, & all other Major & minor units/machines has to be carried out & the defects unsatisfactory working performances of the equipment/ machines are to be corrected by the Contractor at his own cost. The necessary Third Party inspection Charges shall be borne by the Employer.
  f. The Contractor should repaint the STP, SPSs and all appurtenant structures and allied works including all civil structures, mechanical, electrical equipment/ units /structures as per the tender specifications

In case taking over is delayed on account of Contractor's failure to meet the requirement specified in sub clause (a) above, the operation & maintenance

period will be extended further till it meets the requirement without any additional cost to Employer.

Note:

1. Detailed Scope of Work has mentioned in above part of this Section, but not limit to, any additional work required to complete the whole Project, has to be done by the Contractor without any additional payment for it.
2. Contractor has to implement the work with the latest available technology, process, equipments with efficient methodology duly approved by Employer's Representative.

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Annexure 1: Runoff Coefficient Calculation for Amanishah Nallah sub Catchments

Reach No	Nodes	Mileage (KM)	Net Area (KM2)	Percentage Factor		Average Runoff Coefficient
				Permeable	Impermeable	
1.	Nahargarh Hill – Bhuteshwar Mahadev	2.8	14.7	90%	10%	0.25
2.	Bhuteshwar Mahadev – Mazar Dam	5.1	8.8	80%	20%	0.30
3.	Mazar Dam – Sikar Road Crossing NH-11	7.65	10.7	60%	40%	0.40
4.	Sikar Road Crossing to Jaipur Jhotwara Railway Line	9.6	6.8	50%	50%	0.45
5.	Jaipur – Jhotwara Railway line – NBC (Jaipur Khatipura Road)	11.35	17.6	40%	60%	0.50
6.	NBC – Jaipur Ajmer Road NH-8	13.95	12.7	40%	60%	0.50
7.	Ajmer road – near Neerja Modi School crossing	17.65	44.7	30%	70%	0.55
8.	Neerja Modi School crossing – Jaipur airport Sanganer Airport crossing	25.3	22.4	50%	50%	0.45
9.	Sanganer Bridge – Gular Dam	26.55	5.8	70%	30%	0.35
10.	Gular Dam – Confluence of Jawahar nagar	32.75	33.8	70%	30%	0.35
11.	Confluence of Jawahar Nagar- Ramchandrapur Dam	34.8	14.7	70%	30%	0.35
12.	Ramchandrapura Dam – Goner Road Crossing	41.3	12.7	70%	30%	0.35
13.	Goner Road Crossing to end	47.5	27.6	70%	30%	0.35

Annexure 2: Peak Discharge estimated by Rational Formula for 25/50/100 Years Return Period

Reach No	Nodes	Mileage (KM)	Net Area (KM2)	Discharge (Cumec)		
				Q25	Q50	Q100
1.	Nahargarh hill – Bhuteswar Mahadev	2.8	14.7	150.76	175.11	199.27
2.	Bhuteshwar Mahadev – Mazar Dam	5.1	8.8	189.02	219.55	249.85
3.	Mazar Dam – Sikar road crossing NH -11	7.65	10.7	82.17	90.86	99.49
4.	Sikar road crossing to Jaipur Jhotwara Railway line	9.6	6.8	114.69	120.70	126.66
5.	Jaipur – Jhotwara Railway line – NBC (Jaipur Khatipura Road)	11.35	17.6	228.00	252.31	276.43
6.	NBC – Jaipur Ajmer Road NH -8	13.95	12.7	281.02	313.89	346.51
7.	Ajmer Road – near Neerja Modi School crossing	17.65	44.7	503.02	571.75	639.96
8.	Neerja Modi School crossing – Jaipur Airport – Sanganer Airport crossing	25.3	22.4	554.52	633.12	711.38
9.	Sanganer Bridge Gular Dam	26.55	5.8	554.28	632.83	711.05
10.	Gular Dam confluence of Jhotwara Nagar	32.75	33.8	568.75	649.6	730.28
11.	Confluence of Jawahar Nagar Ramchandrapur Dam	34.8	14.7	596.05	681.49	766.59
12.	Ramchandrapura Dam – Goner Road crossing	41.3	12.1	563.74	643.86	723.62*
13.	Goner Road crossing to end	47.5	27.6	568.48	649.38	729.93*

Annexure 3: Flood Discharge Computed By SUHG Method

Reach	Catchment	Reach individual Distance (Km)	Incremental Mileage (Km)	U/S RL	D/S RL	Net Catchment Area (Sq. Km)	Incremental Catchment Area (Sq. Km)	Cumulative Flood (Cumec)
1.	Origin to Mazar Dam	5.1	5.1	494.99	445.33	22.5	22.5	365
2.	Mazar Dam – Sikar Road Crossing NH – 11	2.55	7.65	445.33	438.25	10.7	32.2	435
3.	Sikar road crossing to Jaipur Jhotwara Railway Line	1.95	9.6	438.25	425.66	6.8	40	487
4.	Jaipur –Jhotwara Railway line – NBC (Jaipur Khatipura Road)	1.75	11.35	425.66	414.41	17.6	57.6	677
5.	NBC – Jaipur Ajmer Road NH – 8	2.6	13.95	414.41	408.47	12.7	70.3	779
6.	Ajmer Road – near Neerja Modi School crossing	3.7	17.65	408.47	396.01	44.7	115	1123
7.	Neerja Modi School crossing – Jaipur Airport – Sanganer Airport crossing	7.65	25.3	396.01	374.74	22.4	137.4	1217
8.	Sanganer Bridge – Gular Dam	1.25	26.55	374.74	372.58	5.8	143.2	1269
9.	Gular Dam – Confluence of Jawahar Nagar	6.2	32.75	372.58	360.69	33.8	177	1445
10.	Confluence of Jawahar Nagar – Ramchandrapura Dam	2.05	34.8	360.69	351.54	14.7	191.7	1506
11.	Ramchandrapura Dam – Goner Road crossing	6.5	41.3	351.54	336.36	12.7	204.4	1515
12.	Goner Road crossing to end	6.2	47.5	363.36	324.23	27.6	232	1674

Annexure 4: Design of Canal Section for Amanishah Nallah

DESIGN OF CANAL SECTION FOR AMANISHAH NALLA

Base Section Peak flood of 100 year return period by Rational Method Freeboar 0m Critical velocity ration 1.1

S. No	Design Period	Chainage From	Chainage to	Length	IL at start	IL at end	Bed Width	Flow Depth	Top Width	Side Slope	Wetted Sides	Watted Perimeter	X-Sect Area	Hydraulic radius	Hydraulic Slope	Roughness Coefficient	Velocity	Calculated Discharge	Design Discharge	Check
		m	m	m	m	m	m	m	m		m	m	sqm			(concrete)	m/s	cum/s	cum/s	
				L	H1	H2	B	D	T	z	c	P	A	R(A/P)	S	n	V	Qc	Qd	
Chainage 0 to 2800					Jahargarh Hill – Bhuteswar Mahade															
1	T=100 Y	0	2800	2800	494.99	453.07	65	2.26	74.04	2	5.1	75.1	157.1	2.09	0.002	0.05	1.46	229.9	199	OK
Chainage		2800	to	5100	Bhuteshwar Mahadev - Mazar Dam															
2	T=100 Y	2800	5100	2300	494.99	445.33	75	2.3	84.2	2	5.1	85.3	183.1	2.15	0.002	0.05	149	272.5	250	OK
Chainage		5100	to	7650	Mazar Dam Sikar road crossing NH - 11									Reduction for starting Point		m				
3	T=100 Y	5100	7650	2550	445.33	438.25	18	1.8	23.4	1.5	3.2	24.5	37.26	1.52	0.002	0.015	3.94	146.9	99	OK
Chainage		7650	to	7600	Sikar road crossing to Jaipur Jhotwara Railway Line									Reduction for starting Point		m				
4	T=100 Y	7650	9600	1950	438.25	425.66	18	1.76	23.28	1.5	3.2	24.3	36.33	1.49	0.0035	0.015	5.15	187.1	127	OK
Chainage		9600	to	11350	Jaipur - Jhotwara Railway Line - NBC (Jaipur Khatipura Road)									Reduction for starting Point		m				
5	T=100 Y	9600	11350	1750	438.25	414.41	18	2.8	26.4	1.5	5	28.1	62.16	2.21	0.0016	0.015	4.53	281.4	276	OK
Chainage		11350	to	13950	N.B.C. - Jaipur Ajmer Road NH 8									Reduction for starting Point		m				
6	T=100 Y	11350	13950	2600	438.25	408.47	20	2.99	28.97	1.5	5.4	30.8	73.21	2.38	0.0016	0.015	4.75	347.9	347	OK
Chainage		13950	to	17650	Ajmer Road - near Neerja Modi School crossing									Reduction for starting Point		m				
7	T=100 Y	13950	17650	3700	438.25	396.01	38	2.99	46.97	1.5	5.4	48.8	127	2.6	0.0016	0.015	5.05	641.2	640	OK
Chainage		17650	to	25300	Neerja Modi School crossing - Jaipur Airport - Sanganer Airport									Reduction for starting Point		m				
8	T=100 Y	17650	25300	7650	438.25	374.74	43	3.1	52.3	1.5	5.6	54.2	147.7	2.73	0.0015	0.015	5.04	744.4	711	OK
Chainage		25300	to	26550	Sanganer Bridge - Gular Dam									Reduction for starting Point		m				
9	T=100 Y	25300	26550	1250	438.25	372.58	43	3.1	52.3	1.5	5.6	54.2	147.7	2.73	0.0015	0.015	5.04	744.4	711	OK
Chainage		26550	to	32750	Gular Dam - Confluence of Jawahar Nagar									Reduction for starting Point		m				
10	T=100 Y	26550	32750	6200	373.58	361.69	44	3.1	53.3	1.5	5.6	55.2	150.8	2.73	0.0015	0.015	5.05	761.2	730	OK
Chainage		32750	to	34800	Confluence of Lawahar Nagar Ramchandrapura Dam									Reduction for starting Point		m				
11	T=100 Y	32750	34800	2050	373.58	351.54	45	3.1	54.3	1.5	5.6	56.2	153.9	2.74	0.0015	0.015	5.06	778.1	767	OK
Chainage		34800	to	41300	Ramchandrapura Dam - Goner Road crossing									Reduction for starting Point		m				
12	T=100 Y	34800	41300	6500	351.54	336.36	102	3.1	114.4	2	6.9	115.9	335.4	2.89	0.0008	0.025	2.3	770.8	767	OK
Chainage		41300	to	47500	Goner Road crossing to end of Nallah									Reduction for starting Point		m				
13	T=100 Y	41300	47500	6200	351.54	324.7	102	3.1	114.4	2	6.9	115.9	335.4	2.89	0.0008	0.025	2.3	770.8	767	OK

Annexure 5: Design of Canal Section for Amanishah Nallah

DESIGN OF CANAL SECTION FOR AMANISHAH NALLA																21	1.5			
Top Section - for checking only												addition: 12m				critical velocity ratio	3			
Chainage 0 to 2800				Nahargarh Hill – Bhuteswar Ma																
S. No	Design Period	Chainage From	Chainage to	Length	IL at start	IL at end	Bed Width	Flow Depth	Top Width	Side Slope	Wetted Sides	Watted Perimeter	X-Sect Area	Hydraulic radius	Hydraulic Slope	Roughness Coefficient	Velocity	Calculated Discharge	Design Discharge	Check
		m	m	m	m	m	m	m	m		m	m	sqm			(concrete)	m/s	cum/s	cum/s	
				L	H1	H2	B	D	T	z	c	P	A	R(A/P)	S	n	V	Qc	Qd	
Chainage		5100	to	7650	Mazar Dam Sikar road crossing NH - 11															
3	T=100 Yr	5100	7650	2550	445.33	438.25	31.4	2.1	44	3	6.6	48.7	87.57	1.8	0.002	0.02	3.31	406.2	435	OK
Chainage		7650	to	9600	Sikar road crossing to Jaipur Jhotwara Railway Line															
4	T=100 Yr	7650	9600	1950	438.25	425.66	31.3	1.85	42.38	3	5.9	47	75.54	1.61	0.0035	0.02	4.06	461.1	487	OK
Chainage		9600	to	11350	Jaipur - Jhotwara Railway Line - NBC (Jaipur Khatipura Road)															
5	T=100 Yr	9600	11350	1750	438.25	414.41	34.4	2.6	50	3	8.2	54.8	120.1	2.19	0.0016	0.02	3.37	647.9	677	OK
Chainage		11350	to	13950	N.B.C. - Jaipur Ajmer Road NH 8															
6	T=100 Yr	11350	13950	2600	438.25	408.47	37	2.61	52.63	3	8.3	57.5	127.4	2.22	0.0016	0.02	3.4	741.8	779	OK
Chainage		13950	to	17650	Ajmer Road - near Neerja Modi School crossing															
7	T=100 Yr	13950	17650	3700	438.25	396.01	54	2.3	68.77	3	7.3	73.5	151.5	2.06	0.0016	0.02	3.024	1100	1123	OK
Chainage		17650	to	25300	Neerja Modi School crossing - Jaipur Airport - Sanganer Airport															
8	T=100 Yr	17650	25300	7650	438.25	374.74	60.3	2.2	72.5	3	7	78.2	156	1.99	0.0015	0.02	3.07	1194.3	1217	OK
Chainage		25300	to	26550	Sanganer Bridge - Gular Dam															
9	T=100 Yr	25300	26550	1250	438.25	372.58	60.3	2.35	74.4	3	7.4	79.2	16.7	2.12	0.0015	0.02	3.19	1247.9	1369	OK
Chainage		26550	to	32750	Gular Dam - Confluence of Jawahar Nagar															
10	T=100 Yr	26550	32750	6200	373.58	361.69	61.3	2.7	77.5	3	8.5	82.4	198.2	2.41	0.0015	0.02	3.48	1410	1445	OK
Chainage		32750	to	34800	Confluence of Lawahar Nagar Ramchandrapura Dam															
11	T=100 Yr	32750	34800	2050	373.58	351.54	62.3	2.8	79.1	3	8.9	84	209.2	2.49	0.0015	0.02	3.56	1479.4	1506	OK
Chainage		34800	to	41300	Ramchandrapura Dam - Goner Road crossing															
12	T=100 Yr	34800	41300	6500	351.54	336.36	122	2.35	136.5	3	7.4	141.3	313.6	2.22	0.008	0.02	2.41	1502	1515	OK
Chainage		41300	to	47500	Goner Road crossing to end of Nallah															
13	T=100 Yr	41300	47500	6200	351.54	324.7	122	2.65	138.3	3	8.4	143.2	356	2.46	0.008	0.02	2.6	1666	1674	OK

Annexure 6: Reach-wise Fall Structures proposed in Amanishah Nallah

Reach No.	Nodes	Chainage (in m)		No of Falls
		From	To	N
1	Nahargarh hill -Bhuteswar Mahadev	0	2800	0
2	Bhuteshwar Mahadev – Mazar Dam	2800	5100	0
3	Mazar Dam-Sikar road crossing NH-11	5100	7650	4
4	Sikar road crossing to Jaipur Jhotwara Railway line	7650	9600	12
5	Jaipur- Jhotwara Railway line – N.B.C (Jaipur Khatipura Road)	9600	11350	17
6	N.B.C – Jaipur Ajmer Road NH-8	11350	13950	4
7	Ajmer road – near Neerja Modi school crossing	13950	17650	13
8	Neerja Modi school crossing – Jaipur airport-Sanganer Airport crossing	17650	25300	20
9	Sanganer Bridge - Gular Dam	25300	26550	1
10	Gular Dam - Confluence of Jawahar nagar	26550	32750	3
11	Confluence of Jawahar nagar - Ramchandrapura Dam	32750	34800	14
12	Ramchandrapura Dam-Goner Road crossing	34800	41300	20
13	Goner Road crossing to end	41300	47500	14

Annexure 7: Reach-wise Check Dam Structures proposed in Amanishah Nallah

Reach No	Nodes	Chainage (in m)		Check Dams
		From	To	N
1	Nahargarh hill -Bhuteswar Mahadev*	0	2800	9
2	Bhuteshwar Mahadev – Mazar Dam*	2800	5100	8
3	Mazar Dam-Sikar road crossing NH-11	5100	7650	4
4	Sikar road crossing to Jaipur Jhotwara Railway line	7650	9600	10
5	Jaipur- Jhotwara Rlyline – N.B.C (Jaipur Khatipura Road)	9600	11350	4
6	N.B.C – Jaipur Ajmer Road NH-8	11350	13950	6
7	Ajmer road – near Neerja Modi school crossing	13950	17650	8
8	Neerja Modi school crossing – Jaipur airport-Sanganer Airport crossing	17650	25300	16
9	Sanganer Bridge - Gular Dam	25300	26550	3
10	Gular Dam - Confluence of Jawahar nagar	26550	32750	13
11	Confluence of Jawahar nagar - Ramchandrapura Dam	32750	34800	4
12	Ramchandrapura Dam-Goner Road crossing	34800	41300	
13	Goner Road crossing to end	41300	47500	

Annexure 8: List of Quality Control Equipment to be Provided in Field Laboratory (Minimum Requirement)

1. Field density apparatus core cutter with dolly and steel rammer.	3 sets
2. Modified heavy proctor density apparatus full unit.	1 set.
3. Rapid Moisture meter	3 sets
4. Sample Extruder.	1 set
5. Steel Straight edge – 300mm long.	3 nos.
6. Flakiness gauge	3 nos.
7. Mixing tools such as mixing pan, spoon, trowel, spatula etc.	3 sets
8. Air tight container, small size for M.C. determination	40 nos.
9. Oven, thermostatically controlled to maintain a temperature 105 – 1100C	1 no.
10. Steel tape 3mtr.	1 no.
11. Palette knife with blade 20cm long & 3cm wide.	1 set
12. Porcelain evaporating dish-15cm dia.	4 nos.
13. Stainless steel spatula 25 cm long	4 nos.
14. Aluminum dish with lid-5cm dia	4 nos.
15. Enamel plate - 45cm x 45cm size	1 no.
16. Enamel plate 20cm x 15cm size	1 no.
17. Glass plate 100 mm thick , 45cm x 45cm size	2 nos
18. round glass -5mm thick, 20cm x 15cm size	2 nos.
19. Brass rod of 3cm dia & 10cm long	1 no.
20. Wash bottle- 1 lit capacity, 500ml capacity.	2 nos.
21. Frying pan	1 no.
22. Stove	1 no.
23. Grafting tool or spade & pick axe	3 nos. each
24. Shallow tray 650 cm^2	3 nos.

25. Quartering Trowel 2	nos.
26. (a) Steel tamping rod having 16mm dia. & 600 mm long with bullet end (b) Steel tamping rod - 10mm dia 230mm long with bullet end.	3 nos. 1 no.
27. Slump test apparatus	3 nos.
28. Cube mould 150x150 x150 (six nos)	54 nos.
29. Pycnometer bottle	1 no.
30. Curing tank 1.6m x 0.8 m xo.4 m	1 no.
31. (a) I.S Test Sieve with base and top lid (square hole perforated plate) 80mm, 63mm, 40mm,31.5mm,25mm,20mm,16mm,12.5mm,10mm,6.3mm, 4.75mm and pan. (b) I.S Test Sieves (fine mesh wire) 4.75mm, 2.36mm, 1.70mm, 1.18mm,600 micron, 300 micron, 150 micron, 75 micron and pan. (c) Test sieve with base & top lid - 37.5mm, 20mm, 19mm, 10mm,9.5mm, 4.75mm, 2mm, 1.18mm, 600 micron, 425 micron, 300 micron, 150 micron, 20 micron, 10 micron, 3 micron, 2 micron.	3 sets. 3 sets. 1 set.
32. Hand operated sieve shaker for above sieves 1 no.	
33.(a) Electronic Balance-10 Kg Capacity with 1.0gm least count. (b) Electronic Balance 3Kg with 0.5gm least count (c) Electronic Balance-2 Kg Capacity with 0.1gm least count.	1 no. 1 no. 1 no.
34. Consumables (As per actual requirement from time to time) a) Sieve brush b) Wire brush c) Sodium carbonate d) Sodium hexametaphosphate e) Kerosene f) Mercury g) Cotton waste h) Distilled water i) Carbide for rapid moisture meter j) Dry Soft obstruent cloth of size 75cm x 45cm k) Engine Oil	

Annexure 9: Field Test to be Conducted Regularly

- Soil moisture before compaction
- Soil density by Modified proctors test
- Gradation and fineness modulas of sand
- Gradation of aggregate
- Crushing strength of aggregate
- Initial and final setting time of cement
- Slump of concrete
- Slump of mortar
- Compressive strength of concrete for 7 days and 28 days

Annexure 10: Location wise Inflow Measurement Sheet (As prepared by Project Proponents)

S.No	Chainage	Exact Location	Location	Inflow measurement By Tata	Remark	Section Proposed
1	1.25-1.5	1.25	Near National Test House	0.507		Earthen Section
2	5-5.25	5	Near Mazar Dam	4.081	Shree Ram Tila Kutchi Basti	
Mazar Dam						
3	5.5-5.75	5.75	Sastri Nagar	0.368	Near Police Quaters	CC Lining Section
4	7.25-7.5	7.55	Neharu Nagar	11.724		
5	9.75-10	9.75	Milatry Area	0.648	Behind Power Sub Station	
6	9.75-10	10	Milatry Area	0.972		
7	9.75-10		Milatry Area	0	Industrial waste	
8	10.25-10.75	10.3	Durga Vistar	0.675		
9	10.25-10.75	10.75	Durga Vistar	1.089		
10	11.25-11.5	11.3	Hasan Pura Puliya	0.196		
11	12.00-12.25	12.1	Ganpativihar colony	0.752		
12	12.50-12.5	12.3	Shiv colony	0.118		
13	12.50-12.5	12.4	Krishna Puri Colony	0.13		
14	12.50-12.5	12.5	Krishna Puri Colony	0.13		
15	12.5-12.75	12.65	Govindpura Colony	0.209		
16	12.75-13.25	12.67	Jamuna Nagar Vistar	0.196		
17	12.75-13.25	12.68	Jamuna Nagar Vistar	0.263	House Hold Line	
18	12.75-13.25	12.7	Jamuna Nagar Vistar	0.185	House Hold Line	
19	12.75-13.25	12.75	Jamuna Nagar Vistar	0.05	House Hold Line	
20	12.75-13.25	12.82	Jamuna Nagar Vistar	0.06	House Hold Line	
21	12.75-13.25		Nava Durga Colony	0.103	House Hold Line	
22	12.5-12.75		Kabir Colony	0.085	House Hold Line	
23	12.5-12.75	12.84	Kabir Colony	0.042	House Hold Line	
24	12.5-12.75	12.9	Kabir Colony	0.091	House Hold Line	
25	12.5-12.75	13	Kabir Colony	0.569		
26	12.5-12.75	13.2	Kabir Colony	0.637		
27	13.5-13.75		Military Water area entering	5.499		
28	13.5-13.75		Hari Nagar	0.427		
29	13.5-13.75	13.51	Jamuna Nagar	5.34		

S.No	Chainage	Exact Location	Location	Inflow measurement By Tata	Remark	Section Proposed
30	13.5-13.75		Hari Nagar	0.21		
31	13.25-13.50	13.75	Hari Nagar	0.229		
32	13.75-14.00	13.85	Before Susilpura Puliya	0.405		
33	13.75-14.00	14.6	Before Susilpura Puliya	0.666		
34	14.5-14.75	15	Modi Nagar	0.656		
35	15.00-15.25		Modi Nagar	0.105		
36	15.55-15.75	15.6	Devi Nagar	0.076		
37	15.55-15.75	15.63	Devi Nagar	0.222		
38	15.55-15.75	15.68	Devi Nagar	0.029		
39	15.75-16	15.8	Devi Nagar	0.165		
40	16-16.25	16.1	Khateva Nagar	0.591		
41	16-16.25	16.2	Basant Nagar	0.301		CC Lining Section
42	16.25-16.5	16.4	Mahendra Nagar	0.211		
43	16.25-16.5	16.45	Mahendra Nagar	0.249		
44	16.25-16.5	16.5	Atish Market	12.926		
45	17-17.250	17.05	Shanti Nagar colony	0.105		
46	17-17.250	17.1	Shanti Nagar colony	0.18		
47	17-17.250	17.2	Shanti Nagar colony	0.171		
48	17-17.250	17.25	Shanti Nagar colony	0.216		
49	17.5-17.750	17.5	Gujar ki Thadi	0.254		
50	17.5-17.750	17.8	Technology Point	0	Dry Nallah	
51	17.5-18.0	17.95	Nehru School	0	Dry Nallah	
52	18.0-18.250	18.25	Gandha Nallah	33.567		
53	18.250-18.750	18.75	Ridhi Shidhi	0.255		
54	18.750-19.00	18.8	Triveni Nagar	0.105		
55	18.750-19.00	19.27	Ayodhya Nagar	0.13		
56	19.250-19.50	19.4	Kiran Vihar Vistar	0.251		
57	19.250-19.50	19.6	Kiran Vihar Vistar	0.105		
58	19.250-19.50	1975	Kiran Vihar Vistar	0.105		
59	19.250-19.50	19.8	Kiran Vihar Vistar	0.105		
60	20.0-20.50	20.3	Jaganathpura Gandha Nala	30.36	Birla Farm	
61	20.75-21	20.8	Jaganathpura	0.105		

S.No	Chainage	Exact Location	Location	Inflow measurement By Tata	Remark	Section Proposed
62	21.25-21.5	21.3	Jaganathpura	0.245		
63	21.20-21.50	21.4	Maharani Farm Bridge	1.658		
64	21.25-21.5	20.45	Maharani Farm Bridge	0.1		
65	21.25-21.5	21.5	Maharani Farm Bridge	0.15		
66	21.25-21.75	21.7	Near Shamshan ghat	14.609		
67	23.00-23.250	23.1	Before railway bridge	0	Dry Nallah	
68	23.250-23.500	23.3	After railway bridge	0	Dry Nallah	
69	23.250-23.500	23.75	After railway bridge	0.506	Cloth Factory	
70	23.750-24	24.25	Gem vihar colony	0.97		
71	24-24.500	24.35	Gem vihar colony	0.819	Cloth Factory Water	
72	24-24.500		Gem vihar colony	0.432	Ganesh Colony	
73	25-25.2	25.1	Beside Sangsetu	0.312	Ganesh Colony	
74	25-25.25	25.25	Beside Sangsetu	0	Garbage	
75	27-27.5	27.25	After Gular Dam	0.37	Water Factory	
76	27.75-28.00	27.75	Shree Ram colony	5.521	Pipe Below House	
77	27.75-28.00	27.8	Shree Ram colony	0.1		
78	27.75-28.00	27.8	Shree Ram colony	0.1		
79	28.75-29.5	29.1	Maheshwari college	0.13	Sewage line	
80	34.8					Stone Pitching Section
81	40.70-41	39.1	Vidhani Colony	8.714		
				152.937		

SECTION-9: DRAWINGS

(Attached Separately in Volume-2)

Drawings

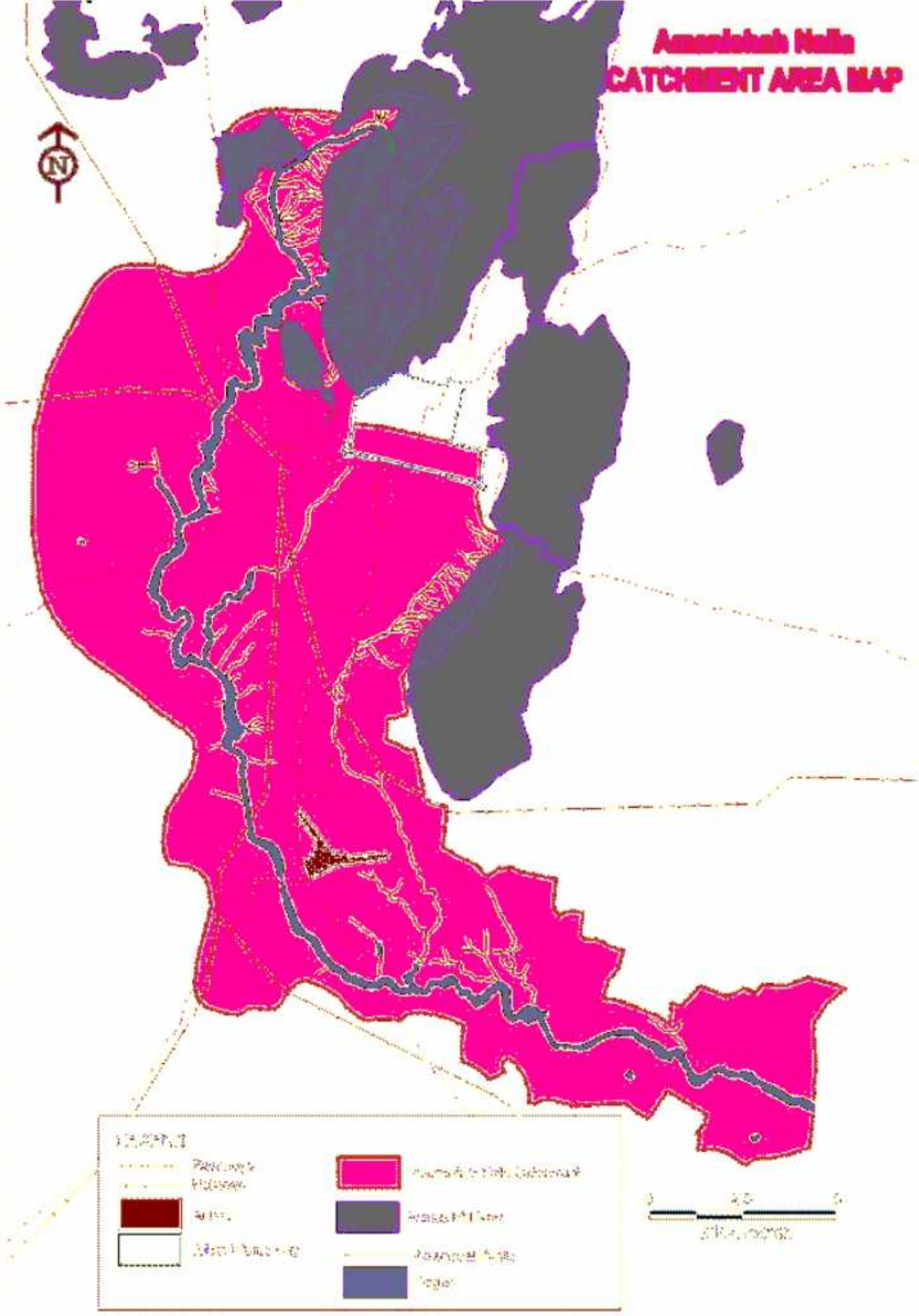
CONTENTS FOR DRAWINGS

Dwg. No.	Description
UDH/JDA/AMAN/CAP/01	CATCHMENT AREA PLAN AMANISHAH NALLAH
UDH/JDA/AMAN/TSN/02	AMANISHAH NALLAH IN JAIPUR CITY WITH TRUNK SEWER NET WORKS
UDH/JDA/AMAN/TSS.EX/03	TOTAL STATION SURVEY MAP OF EXISTING LAND AMANISHAH NALLAH PROJECT IN JAIPUR (CH 0.0 TO 47.5KM)
UDH/JDA/AMAN/PRO. LP/04	PROPOSED LAYOUT PLAN OF AMANISHAH NALLAH WITH STP LOCATIONS (0.00 TO 47.5 KM.)
UDH/JDA/AMAN/TCS/05	PROPOSED TYPICAL CROSS SECTION OF CHANNEL WITH ALL COMPONENTS
UDH/JDA/AMAN/TCS/06	PROPOSED TYPICAL CROSS SECTIONAL DETAILS OF LINED CHANNEL
UDH/JDA/AMAN/TCDS/07	TYPICAL DETAILS OF CHECK DAM STRUCTURE
UDH/JDA/AMAN/CSBC/08	CROSS SECTION OF BRIDGES AND CULVERTS (00.00 TO 05.85 KM.)
UDH/JDA/AMAN/CSBC/09	CROSS SECTION OF BRIDGES AND CULVERTS (05.85 TO 12.355 KM.)
UDH/JDA/AMAN/CSBC/10	CROSS SECTION OF BRIDGES AND CULVERTS (12.355 TO 15.520 KM.)
UDH/JDA/AMAN/CSBC/11	CROSS SECTION OF BRIDGES AND CULVERTS (15.520 TO 22.540 KM.)
UDH/JDA/AMAN/CSBC/12	CROSS SECTION OF BRIDGES AND CULVERTS (22.540 TO 27.750 KM.)
UDH/JDA/AMAN/CSBC/13	CROSS SECTION OF BRIDGES AND CULVERTS (27.750 TO 35.460 KM.)
UDH/JDA/AMAN/CSBC/14	CROSS SECTION OF BRIDGES AND CULVERTS (35.460 TO 47.5 KM.)
UDH/JDA/AMAN/P&LS/15	PLAN AND L SECTION OF AMANISHAH NALLAH CHAINAGE : 5100 TO 7650
UDH/JDA/AMAN/P&LS/16	PLAN AND L SECTION OF AMANISHAH NALLAH CHAINAGE : 7650 TO 9600
UDH/JDA/AMAN/P&LS/17	PLAN AND L SECTION OF AMANISHAH NALLAH CHAINAGE : 9600 TO 11350
UDH/JDA/AMAN/P&LS/18	PLAN AND L SECTION OF AMANISHAH NALLAH CHAINAGE : 11350 TO 13950
UDH/JDA/AMAN/P&LS/19	PLAN AND L SECTION OF AMANISHAH NALLAH CHAINAGE : 13950 TO 15800
UDH/JDA/AMAN/P&LS/20	PLAN AND L SECTION OF AMANISHAH NALLAH CHAINAGE : 15800 TO 17650
UDH/JDA/AMAN/P&LS/21	PLAN AND L SECTION OF AMANISHAH NALLAH CHAINAGE : 17650 TO 19650
UDH/JDA/AMAN/P&LS/22	PLAN AND L SECTION OF AMANISHAH NALLAH CHAINAGE : 19650 TO 21650
UDH/JDA/AMAN/P&LS/23	PLAN AND L SECTION OF AMANISHAH NALLAH CHAINAGE : 21650 TO 23650

UDH/JDA/AMAN/P&LS/24	PLAN AND L SECTION OF AMANISHAH NALLAH CHAINAGE : 23650 TO 25300
UDH/JDA/AMAN/P&LS/25	PLAN AND L SECTION OF AMANISHAH NALLAH CHAINAGE : 25300 TO 26550
UDH/JDA/AMAN/P&LS/26	PLAN AND L SECTION OF AMANISHAH NALLAH CHAINAGE : 30550 TO 32750
UDH/JDA/AMAN/P&LS/27	PLAN AND L SECTION OF AMANISHAH NALLAH CHAINAGE : 26550 TO 28550
UDH/JDA/AMAN/P&LS/28	PLAN AND L SECTION OF AMANISHAH NALLAH CHAINAGE : 28550 TO 30550
UDH/JDA/AMAN/P&LS/29	PLAN AND L SECTION OF AMANISHAH NALLAH CHAINAGE : 32750 TO 34800
UDH/JDA/AMAN/P&LS/30	PLAN AND L SECTION OF AMANISHAH NALLAH CHAINAGE : 32750 TO 34800
UDH/JDA/AMAN/P&LS/31	PLAN AND L SECTION OF AMANISHAH NALLAH CHAINAGE : 32750 TO 34800
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UDH/JDA/AMAN/P&LS/33	PLAN AND L SECTION OF AMANISHAH NALLAH CHAINAGE : 41300 TO 43000
UDH/JDA/AMAN/P&LS/34	PLAN AND L SECTION OF AMANISHAH NALLAH CHAINAGE : 43000 TO 45000
UDH/JDA/AMAN/P&LS/35	PLAN AND L SECTION OF AMANISHAH NALLAH CHAINAGE : 45000 TO 47550
UDH/JDA/AMAN/CS/36	CROSS SECTIONS (FROM CHAINAGE: 5100 TO 18000)
UDH/JDA/AMAN/CS/37	CROSS SECTIONS (FROM CHAINAGE: 19000 TO 30000)
UDH/JDA/AMAN/CS/38	CROSS SECTIONS (FROM CHAINAGE:31000 TO 39000)
UDH/JDA/AMAN/CS/39	CROSS SECTIONS (FROM CHAINAGE:40000 TO 47500)
UDH/JDA/AMAN/MANHOLE/40	SEWERAGE MANHOLE TYPE-A
UDH/JDA/AMAN/MANHOLE/41	SEWERAGE MANHOLE TYPE-B
UDH/JDA/AMAN/MANHOLE/42	SEWERAGE MANHOLE TYPE-C
UDH/JDA/AMAN/SSA/43	SUGGESTIVE SYSTEM ARCHITECTURE

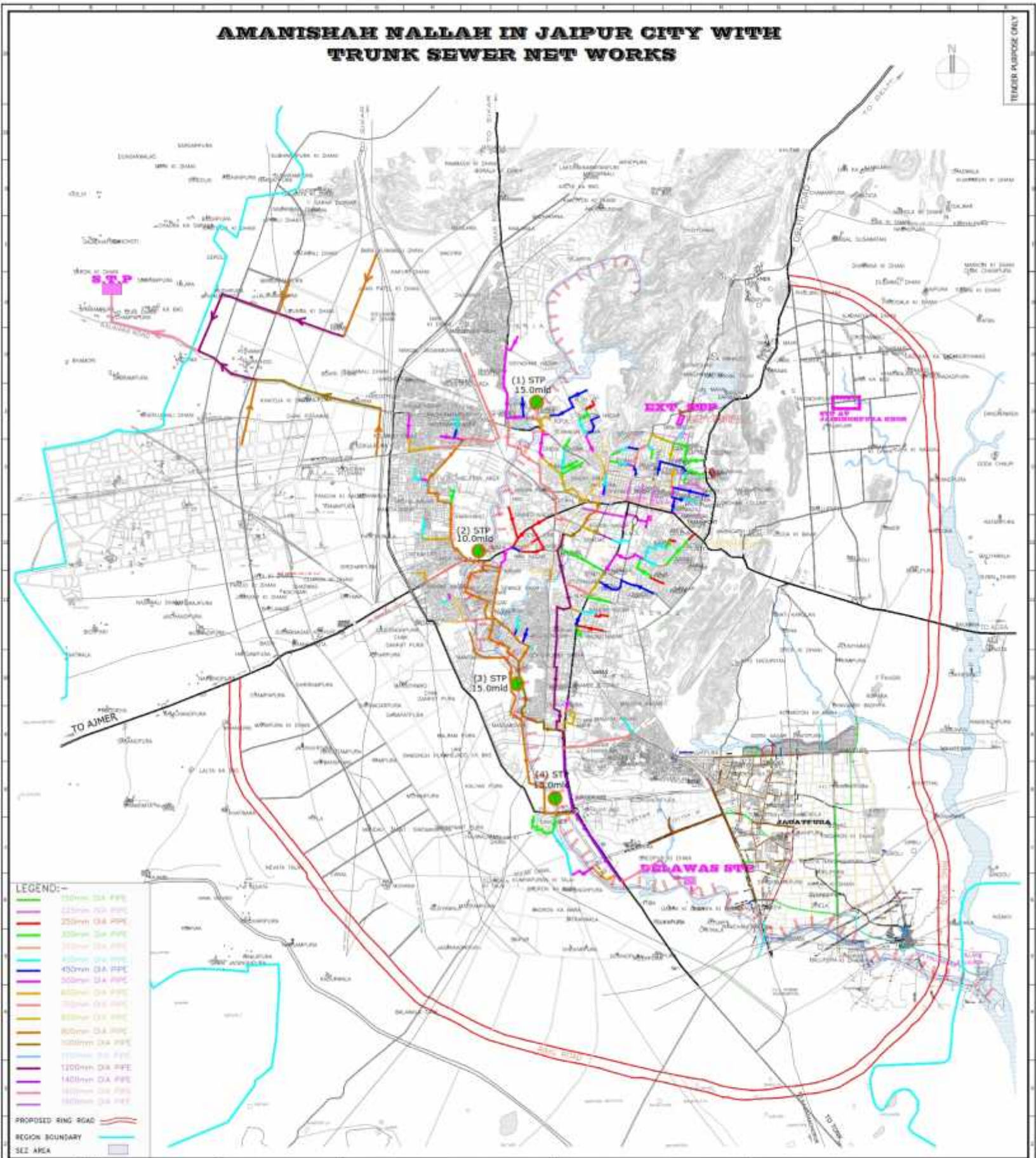
Amanabrah Nalla
CATCHMENT AREA MAP

TENDER PURPOSE ON
(Prepared by Project Propo



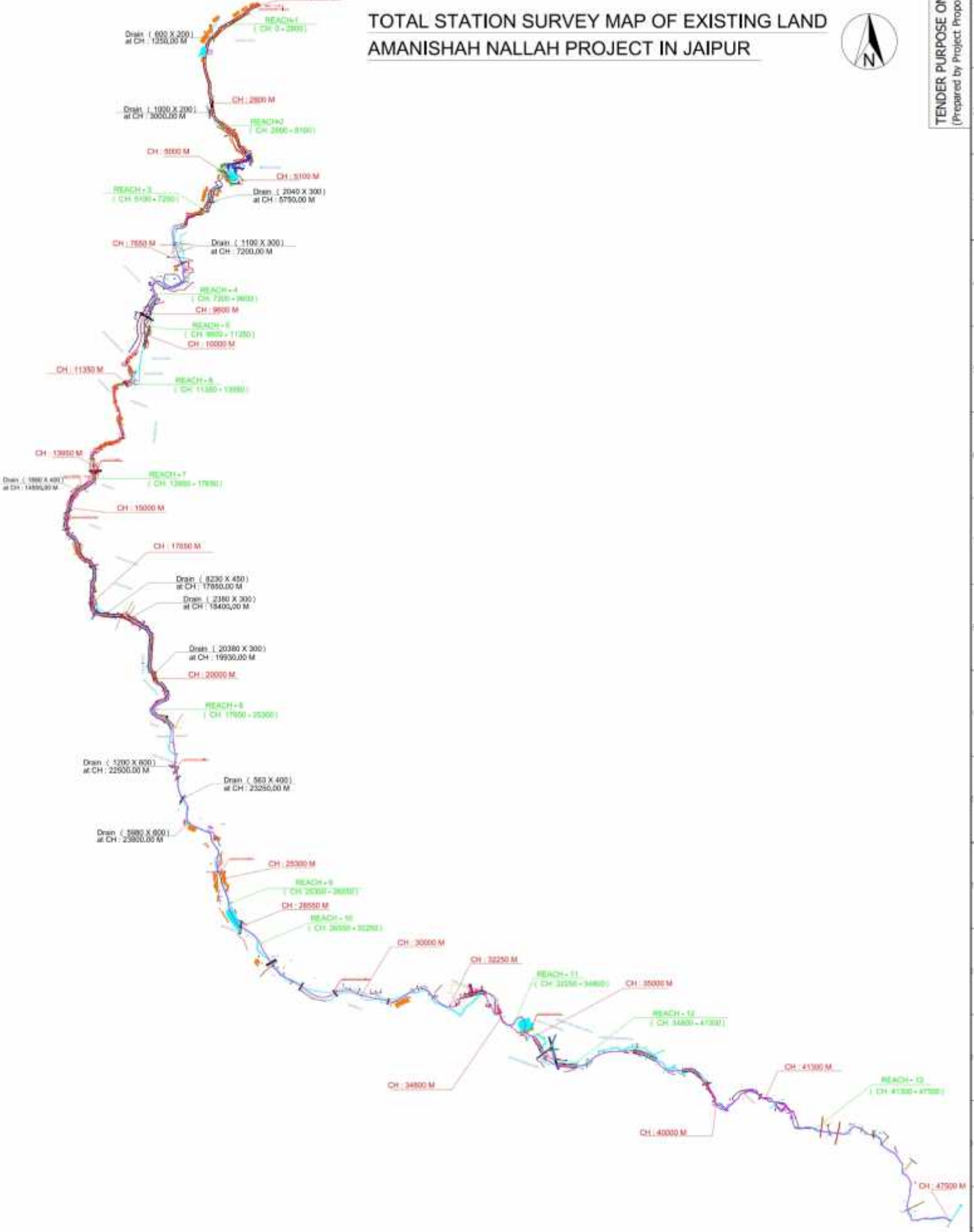
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				URBAN DEVELOPMENT & HOUSING (UDH)

AMANISHAH NALLAH IN JAIPUR CITY WITH TRUNK SEWER NET WORKS



REVISIONS	DATE:	DRAWING TITLE:	PROJECT TITLE:	EMPLOYER:
	SCALE:	AMANISHAH NALLAH IN JAIPUR CITY WITH TRUNK SEWER NET WORKS	REJUVENATION OF AMANISHAH NALLAH INCLUDING AREA DEVELOPMENT PROJECT	URBAN DEVELOPMENT & HOUSING (UDH) GoR THROUGH JAIPUR DEVELOPMENT AUTHORITY (JDA)
	DWG NO: UDH/JDA/AMNA/TSN/01			
	REVISION:			

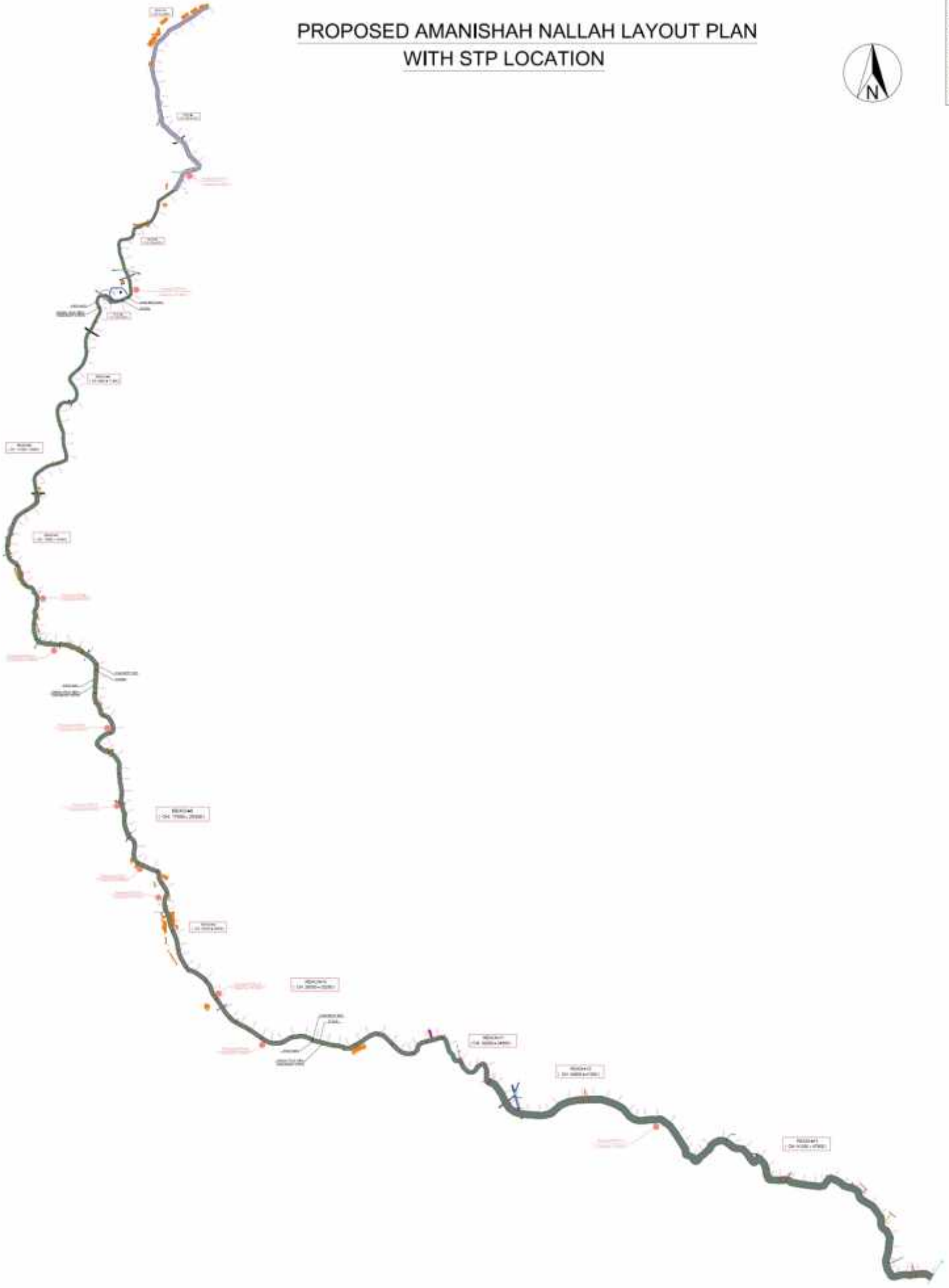
TOTAL STATION SURVEY MAP OF EXISTING LAND
AMANISHAH NALLAH PROJECT IN JAIPUR



TENDER PURPOSE ON
(Prepared by Project Propo

REVISIONS | DATE | DRAWING TITLE: | PROJECT TITLE: | EMPLOYER:

PROPOSED AMANISHAH NALLAH LAYOUT PLAN
WITH STP LOCATION

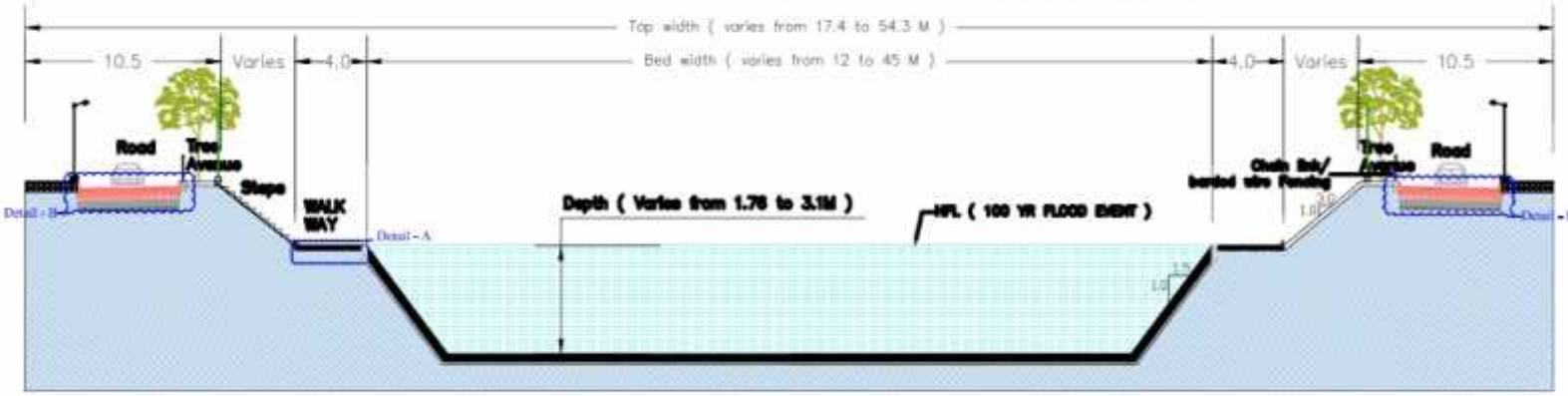


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Prepared by Project Proponent

REVISIONS	DATE	DRAWING TITLE	PROJECT TITLE	EMPLOYER

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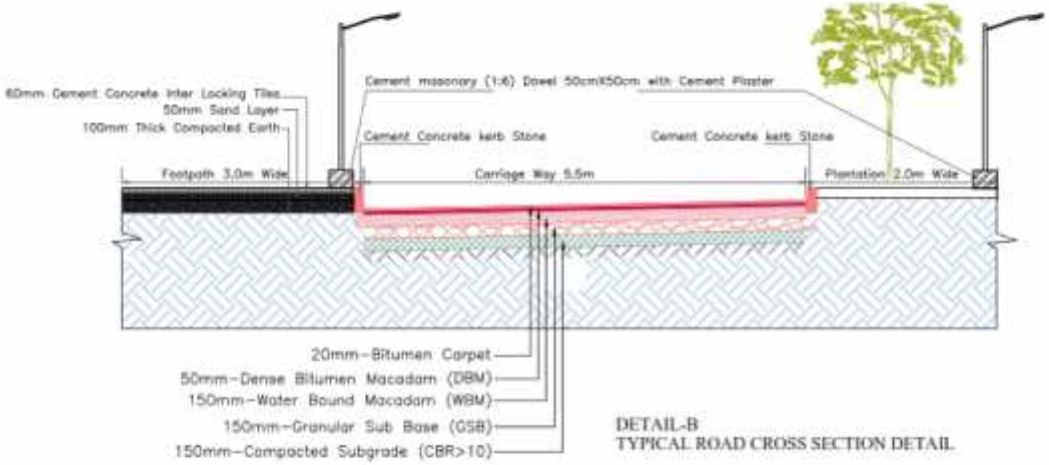
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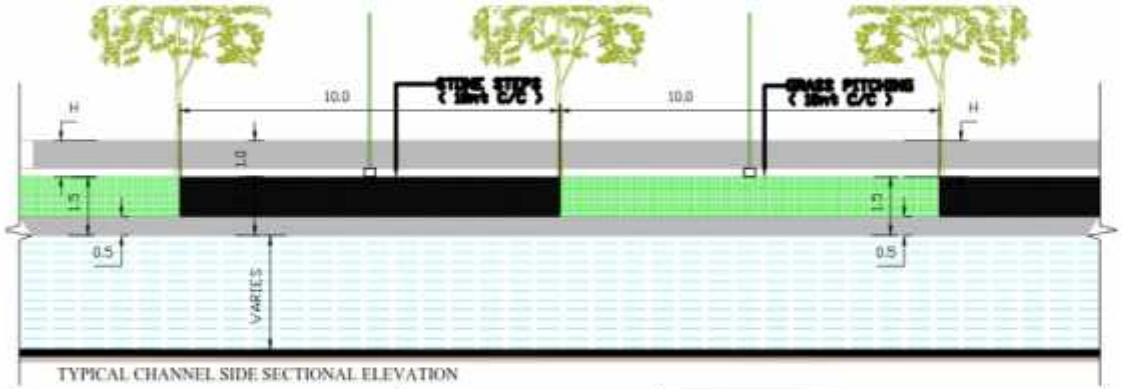
CHANNEL SECTION (CHAINAGE - 5.1-34.8 km)



DETAIL-A
TYPICAL WALK WAY DETAILS



DETAIL-B
TYPICAL ROAD CROSS SECTION DETAIL



TYPICAL CHANNEL SIDE SECTIONAL ELEVATION



DETAILS OF STEPS TO BE PROVIDED IN UPPER SECTION

DETAIL-C

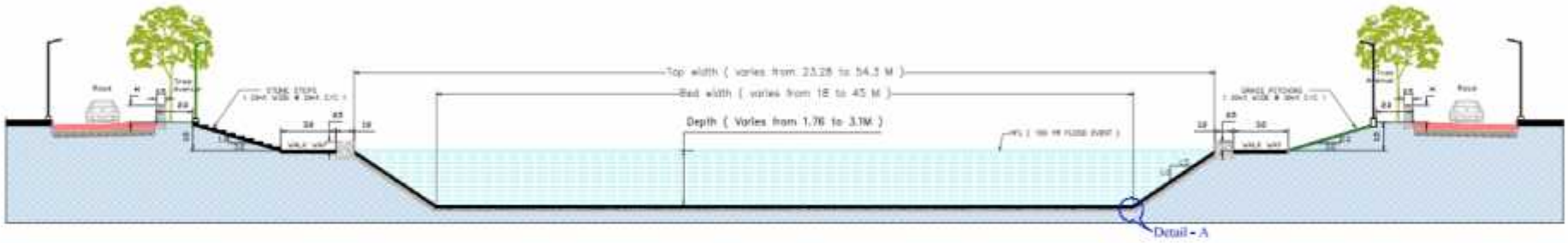
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	DWG NO: UDH/JDA/AMAN/TCS/05			
	REVISION:			

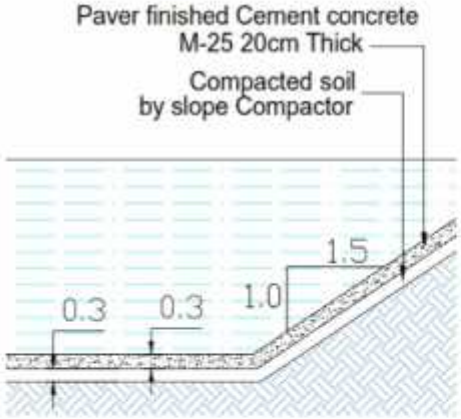
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TYPICAL CHANNEL CROSS SECTION



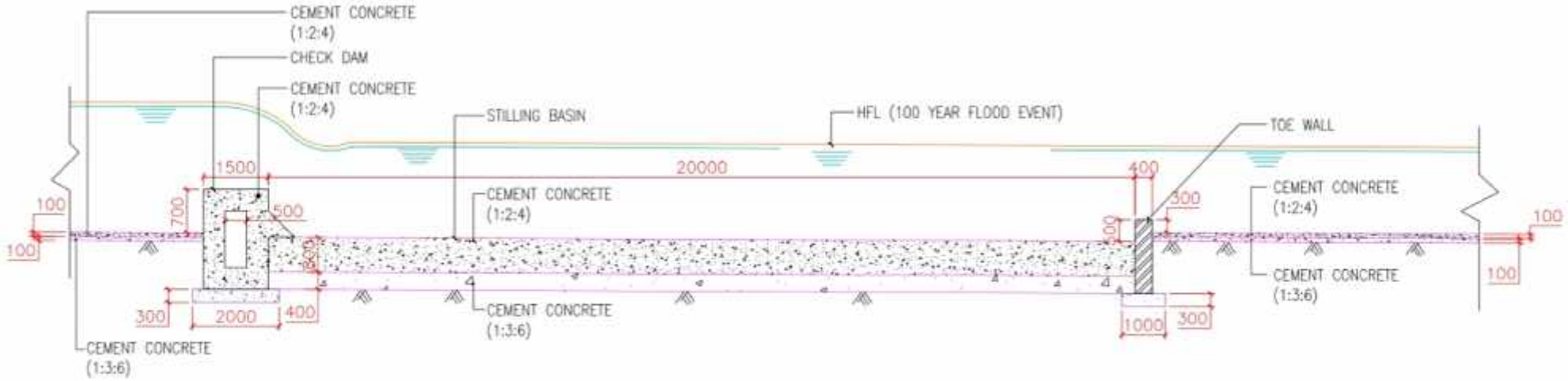
DETAIL-A
TYPICAL CHANNEL LINING DETAILS

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REVISIONS	DATE:	DRAWING TITLE:	PROJECT TITLE:	EMPLOYER:
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	DWG NO: UDH/JDA/AMAN/TCS/06			
	REVISION:			

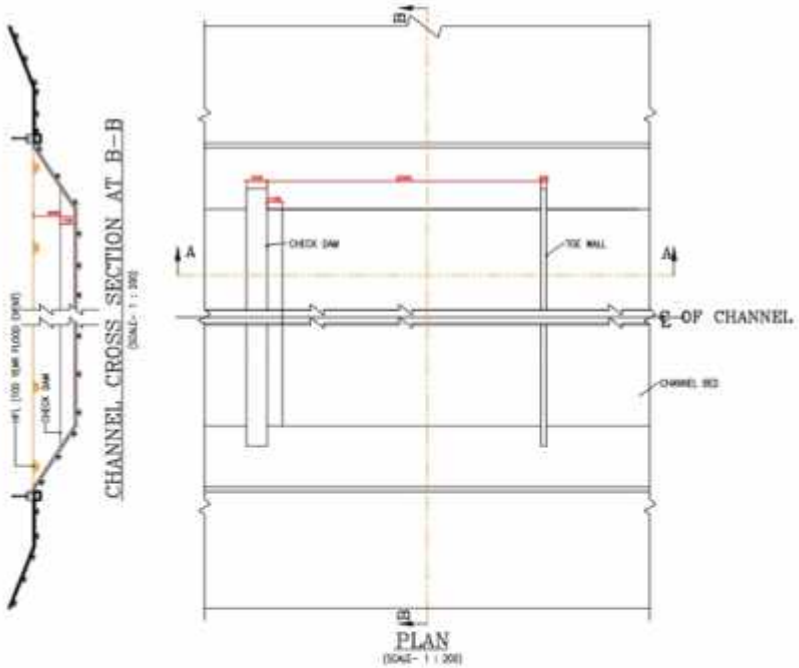
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Prepared by Project Proponent



SECTIONAL DETAILS ALONG A–A

(SCALE – 1:50)



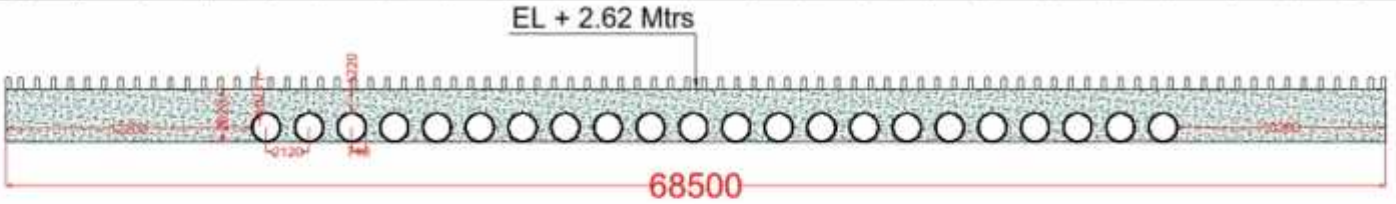
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NO.	DATE	DESCRIPTION	SIGN

DATE: _____
SCALE: _____
DWG NO: UDH/JDA/AMAN/CDS/07
REVISION: _____

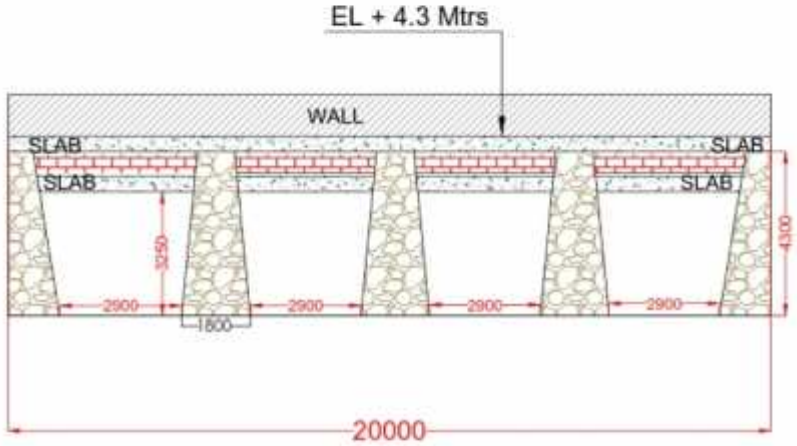
DRAWING TITLE:
TYPICAL DETAILS OF
CHECK DAM STRUCTURE

PROJECT TITLE:
REJUVENATION OF AMANISHAH NALLAH
INCLUDING AREA DEVELOPMENT PROJECT

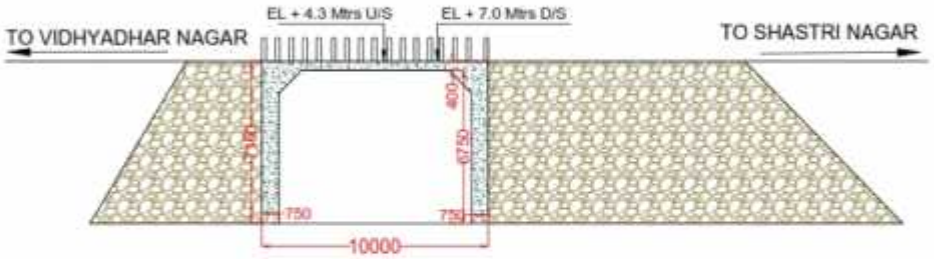
EMPLOYER:
URBAN DEVELOPMENT & HOUSING (UDH)
GoR
THROUGH JAIPUR DEVELOPMENT AUTHORITY (JDA)



PIPE CULVERT (CHAINAGE=2850 MTR)



BRIDGE (CHAINAGE=3625 MTR)



MAJAR DAM ROAD BRIDGE (CHAINAGE=5085 MTR)

TENDER PURPOSE ONLY
Prepared by Project Proponent)

REVISIONS			
NO.	DATE	DESCRIPTION	SIGN

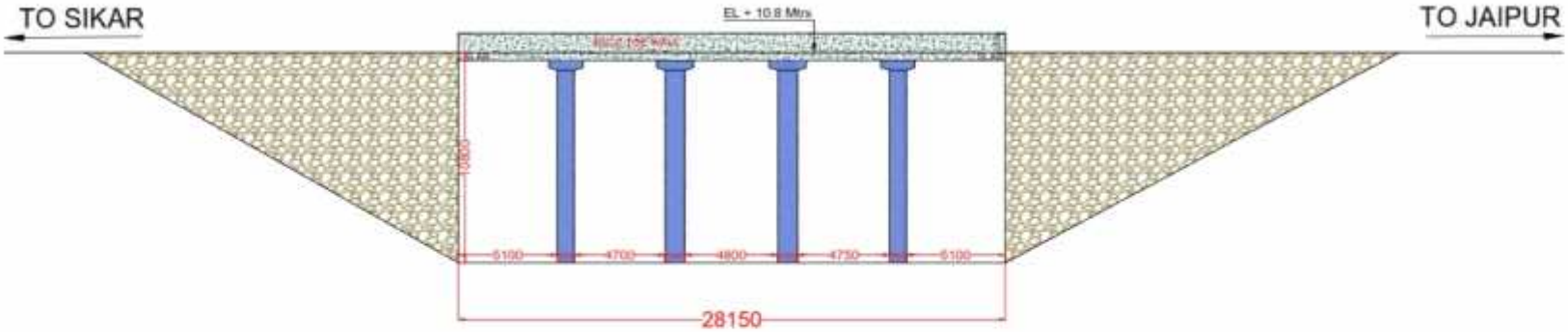
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REVISION:

DRAWING TITLE:
CROSS SECTION OF BRIDGES AND CULVERTS
00.00 TO 05.85 KM.

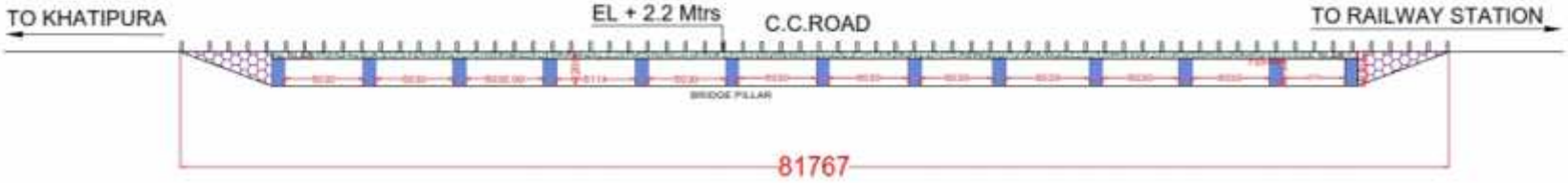
PROJECT TITLE:
REJUVENATION OF AMANISHAH NALLAH
INCLUDING AREA DEVELOPMENT PROJECT

EMPLOYER:
URBAN DEVELOPMENT & HOUSING (UDH)
GoR
THROUGH JAIPUR DEVELOPMENT AUTHORITY (JDA)

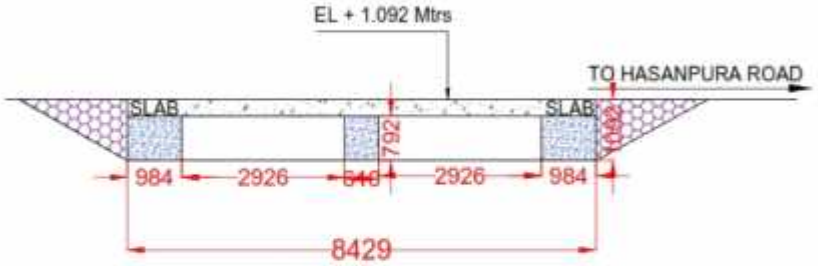
TENDER PURPOSE ONLY
Prepared by Project Proponent



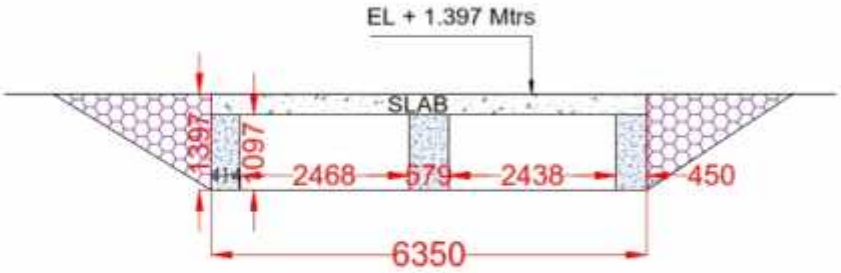
SIKAR BRIDGE (CHAINAGE=7665.00 MTR)



KHATIPURA BRIDGE (CHAINAGE=11400.00 MTR)



HASANPURA ROAD BRIDGE (CHAINAGE=11670.00 MTR)



CULVERT (CHAINAGE=12355.00 MTR)

REVISIONS			
NO.	DATE	DESCRIPTION	SIGN

DATE:
SCALE:
DWG NO: UDH/JDA/AMAN/ESBC/09
REVISION:

DRAWING TITLE:
CROSS SECTION OF BRIDGES AND CULVERTS
05.85 TO 12.355 KM.

PROJECT TITLE:
REJUVENATION OF AMANISHAH NALLAH
INCLUDING AREA DEVELOPMENT PROJECT

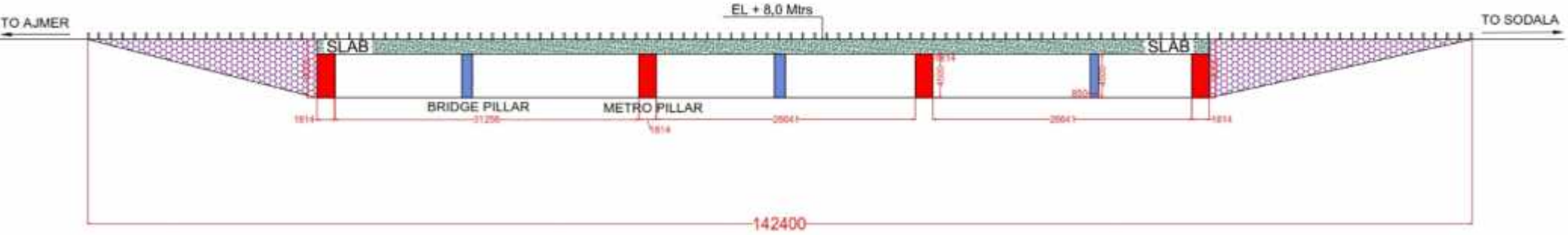
EMPLOYER:
URBAN DEVELOPMENT & HOUSING (UDH)
GoR
THROUGH JAIPUR DEVELOPMENT AUTHORITY (JDA)



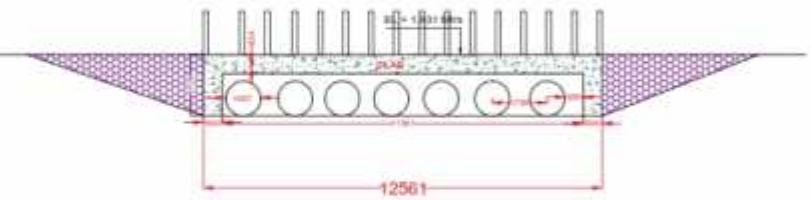
CULVERT (CHAINAGE=13250.00 MTR)



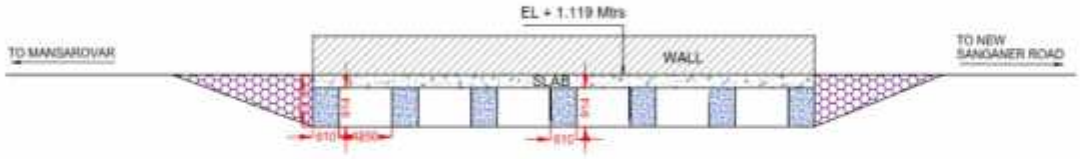
CULVERT (CHAINAGE=13385.00 MTR)



SUSHILPURA BRIDGE (CHAINAGE=13990.00 MTR)



PIPE CULVERT (CHAINAGE=15130.00 MTR)



BRIDGE CULVERT (CHAINAGE=15520.00 MTR)

TENDER PURPOSE ONLY
Prepared by Project Proponent)

REVISIONS	DATE:	DRAWING TITLE:	PROJECT TITLE:	EMPLOYER:
	SCALE:	CROSS SECTION OF BRIDGES AND CULVERTS 12.355 TO 15.520 KM.	REJUVENATION OF AMANISHAH NALLAH INCLUDING AREA DEVELOPMENT PROJECT	URBAN DEVELOPMENT & HOUSING (UDH) GoR THROUGH JAIPUR DEVELOPMENT AUTHORITY (JDA)
	DWG NO: UDH/JDA/AMANI/SBC/10			
	REVISION:			

TENDER PURPOSE ONLY
Prepared by Project Proponent)



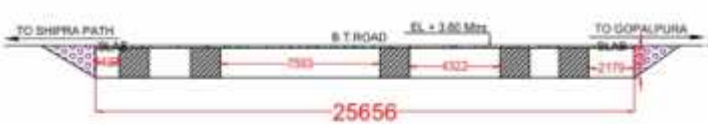
GUJAR KI THADI BRIDGE (CHAINAGE=16560.00 MTR)



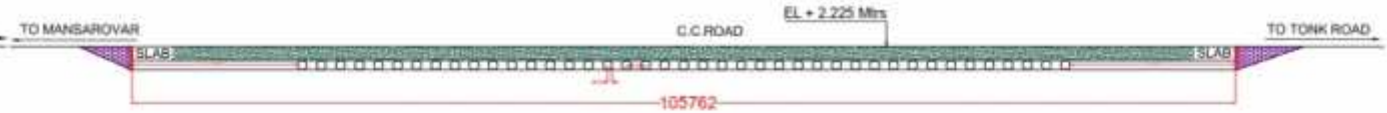
PIPE CULVERT (CHAINAGE=17650.00 MTR)



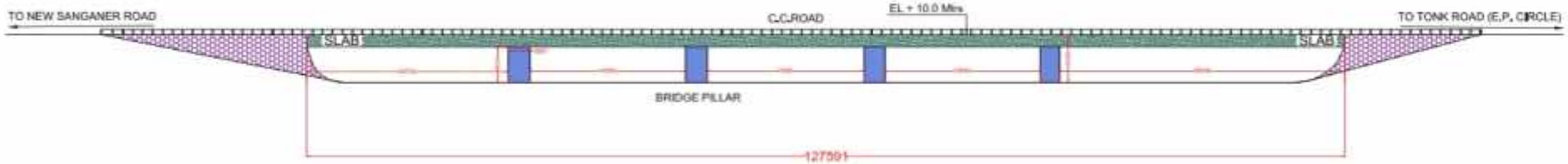
PIPE CULVERT (CHAINAGE= 17650.00 MTR)



RIDDI SIDDI BRIDGE (CHAINAGE= 18700.00 MTR)



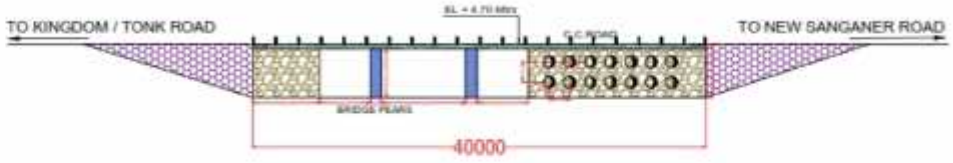
MAHARANI FARM PIPE CULVERT (CHAINAGE= 21415.00 MTR)



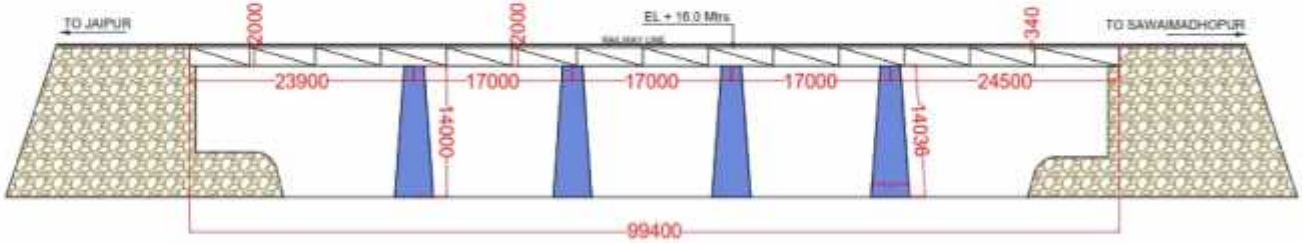
B-2 BYE-PASS BRIDGE (CHAINAGE=22540.00 MTR)

REVISIONS	DATE:	DRAWING TITLE:	PROJECT TITLE:	EMPLOYER:
NO. | DATE | DESCRIPTION | SIGN	SCALE:	CROSS SECTION OF BRIDGES AND CULVERTS 15.520 TO 22.540 KM.	REJUVENATION OF AMANISHAH NALLAH INCLUDING AREA DEVELOPMENT PROJECT	URBAN DEVELOPMENT & HOUSING (UDH) GoR THROUGH JAIPUR DEVELOPMENT AUTHORITY (JDA)
	DWG NO: UDH/JDA/AMAN/CSBC/11			
	REVISION:			

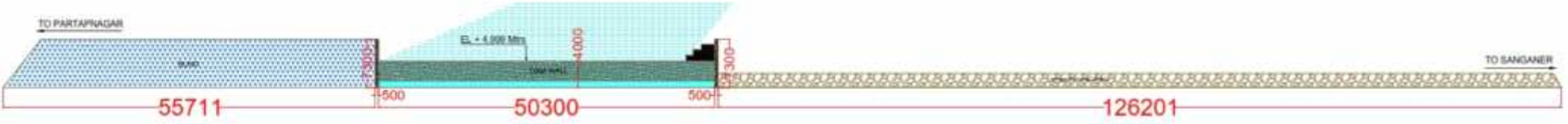
TENDER PURPOSE ONLY
Prepared by Project Proponent



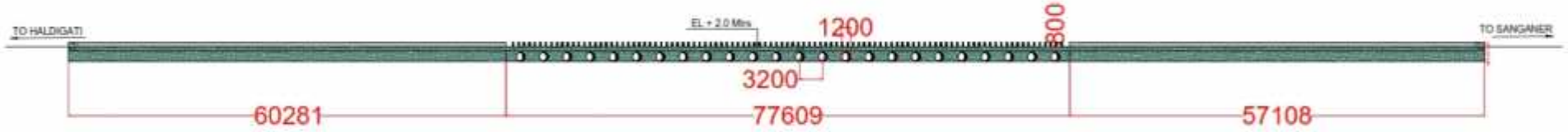
PIPE CULVERT (CHAINAGE=22750.00 MTR)



RAILWAY BRIDGE (CHAINAGE=23250.00 MTR)



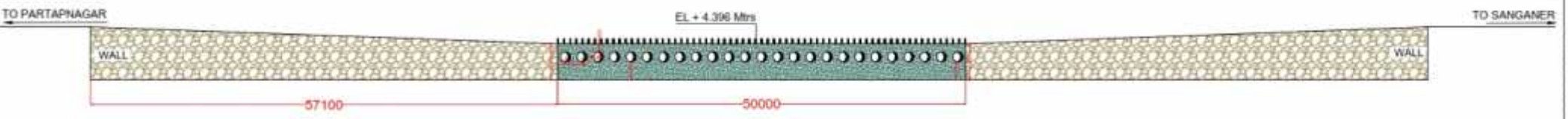
GULLAR DAM (CHAINAGE= 26655.00 MTR)



SIKARPURA BRIDGE (CHAINAGE=27750.00 MTR)

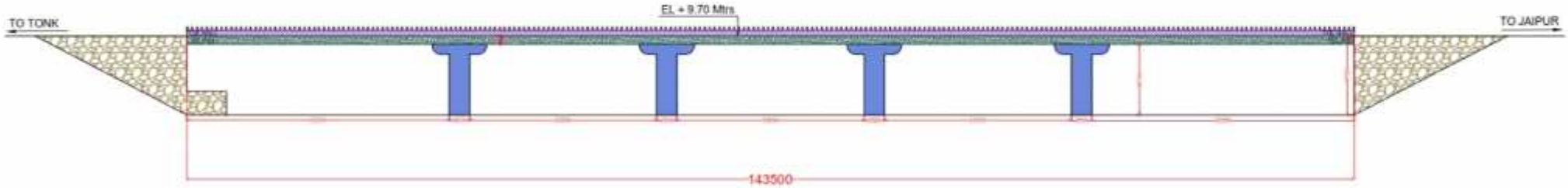
REVISIONS			
	DATE:	DRAWING TITLE: CROSS SECTION OF BRIDGES AND CULVERTS 22.540 TO 27.750 KM.	PROJECT TITLE: REJUVENATION OF AMANISHAH NALLAH INCLUDING AREA DEVELOPMENT PROJECT
	SCALE:		
	DWG NO: UDH/TDA/AMAN/PCSBC/12		
	REVISION:		

EMPLOYER:
URBAN DEVELOPMENT & HOUSING (UDH)
GoR
THROUGH JAIPUR DEVELOPMENT AUTHORITY (JDA)

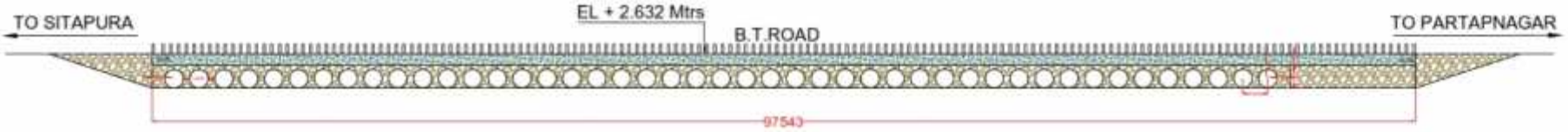


TENDER PURPOSE ONLY
(Prepared by Project Proponent)

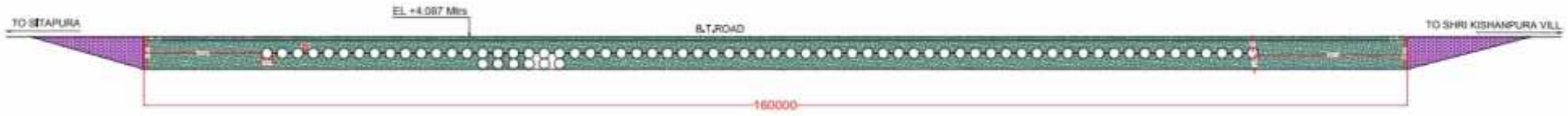
BRIDGE (CHAINAGE=28580.00 MTR)



TONK ROAD (BAMBALA) BRIDGE (CHAINAGE=29420.00 MTR)

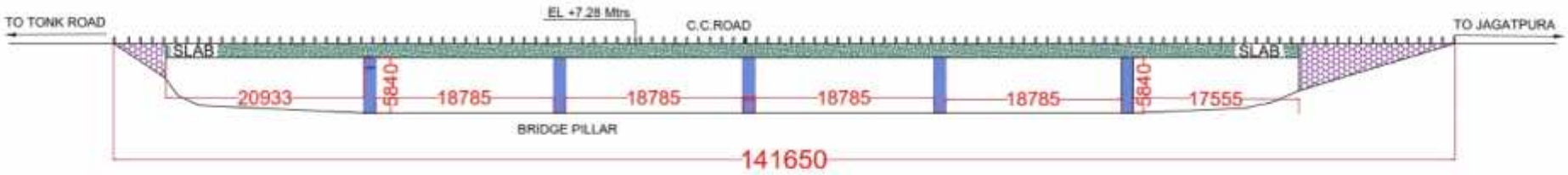


PIPE CULVERT (CHAINAGE=30640.00 MTR)

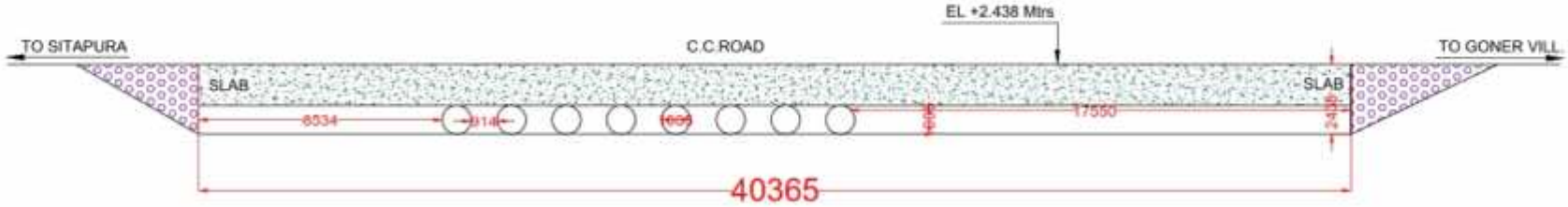


PIPE CULVERT (CHAINAGE= 35460.00 MTR)

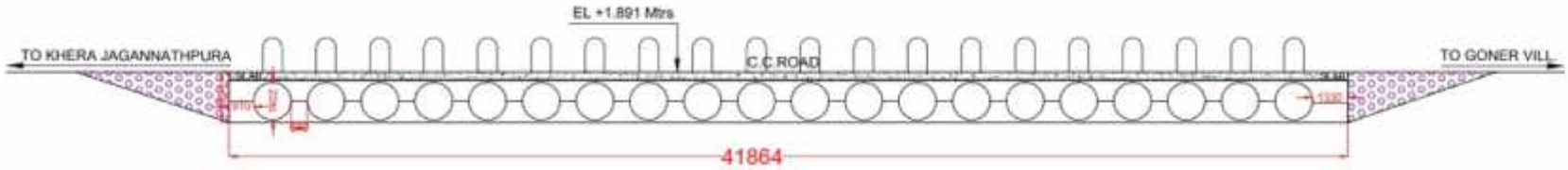
REVISIONS	DATE:	DRAWING TITLE:	PROJECT TITLE:	EMPLOYER:
	SCALE:	CROSS SECTION OF BRIDGES AND CULVERTS 27.750 TO 35.460 KM.	REJUVENATION OF AMANISHAH NALLAH INCLUDING AREA DEVELOPMENT PROJECT	URBAN DEVELOPMENT & HOUSING (UDH) GoR THROUGH JAIPUR DEVELOPMENT AUTHORITY (JDA)
	DWG NO: UDH/JDA/AMAN/CSBC/13			
	REVISION:			



MUMBAI HOSPITAL ROAD BRIDGE (CHAINAGE=35875.00 MTR)



PIPE CULVERT (CHAINAGE= 39530.00 MTR)



PIPE CULVERT (CHAINAGE= 41260.00 MTR)



PIPE CULVERT (CHAINAGE= 44405.00 MTR)

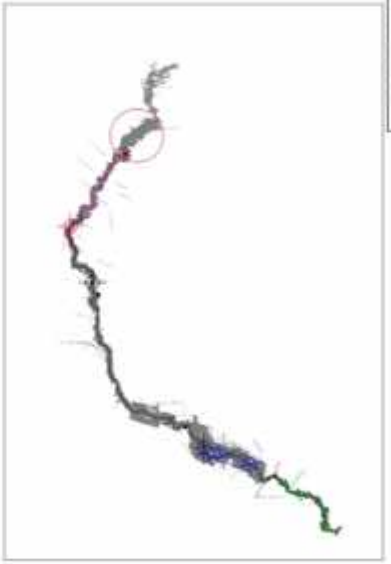
REVISIONS			
	DATE:	DRAWING TITLE: CROSS SECTION OF BRIDGES AND CULVERTS 35.460 TO 47.5 KM.	PROJECT TITLE: REJUVENATION OF AMANISHAH NALLAH INCLUDING AREA DEVELOPMENT PROJECT
	SCALE:		
	DWG NO: UDH/JDA/AMAN/CSBC/14		
	REVISION:		

EMPLOYER: URBAN DEVELOPMENT & HOUSING (UDH) GoR THROUGH JAIPUR DEVELOPMENT AUTHORITY (JDA)

TENDER PURPOSE ONLY (Prepared by Project Proponent)

TENDER PURPOSE ONLY
Prepared by Project Proponent)

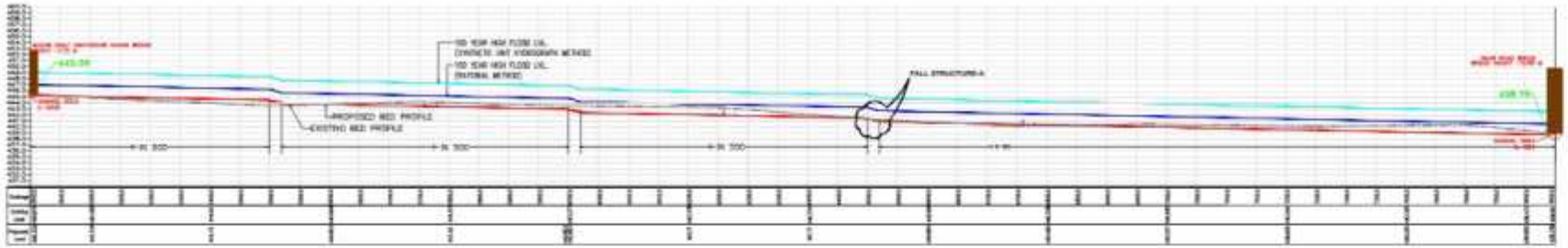




PLAN
(CHAINAGE : 5100 TO 7650)

LEGEND : PLAN

- Nallah Center Line
- Concrete Section Bottom
- Concrete Section Top
- COMPOSITE SECTION BOTTOM
- COMPOSITE SECTION TOP



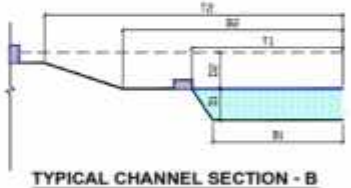
LONGITUDINAL PROFILE
H : V = 1:10

LEGEND : PROFILE

- Existing Bed Profile
- Proposed Bed Profile
- 100 Year High Flood Line (Rational Method)
- 100 Year High Flood Line (SUG Method)



TYPICAL FALL DETAILS



TYPICAL CHANNEL SECTION - B

NOTE :
All dimensions are in meters unless otherwise indicated.

REVISIONS			
NO.	DATE	DESCRIPTION	SIGN

DATE:
SCALE:
DWG NO: JDH/JDA/MNNP/SLS/17
REVISION:

DRAWING TITLE:
PLAN AND L SECTION OF AMANISHAH NALLAH
CHAINAGE : 5100 TO 7650

PROJECT TITLE:
REJUVENATION OF AMANISHAH NALLAH
INCLUDING AREA DEVELOPMENT PROJECT

EMPLOYER:
URBAN DEVELOPMENT & HOUSING (UDH)
GoR
THROUGH JAIPUR DEVELOPMENT AUTHORITY (JDA)

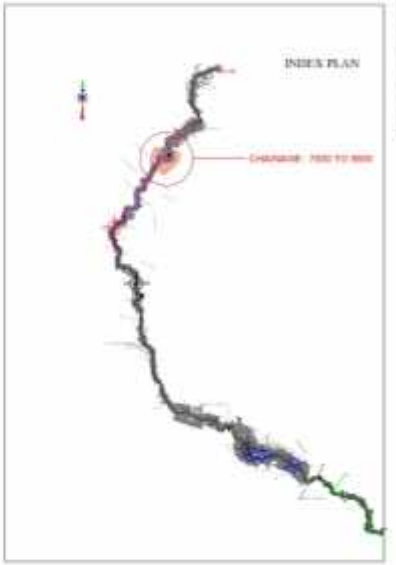
REACH NO.- 4

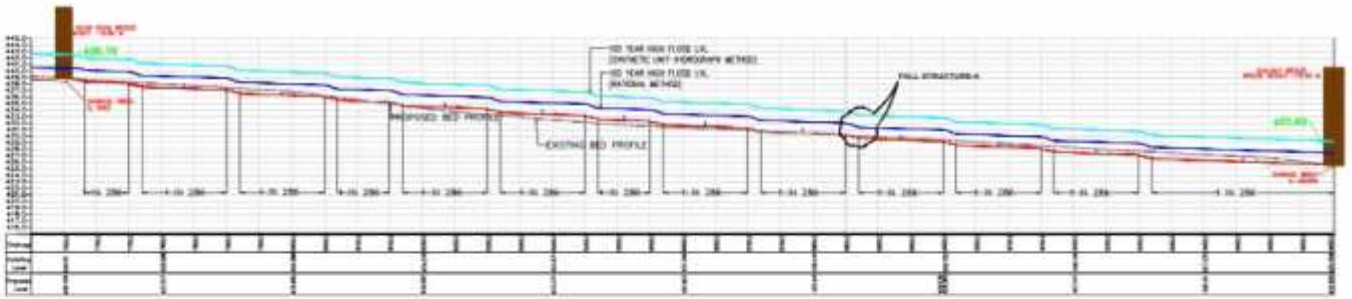


PLAN
(CHAINAGE : 7650 TO 9600)

LEGEND : PLAN

- Nallah Center Line
- Concrete Section Bottom
- Concrete Section Top
- COMPOSITE SECTION BOTTOM
- COMPOSITE SECTION TOP





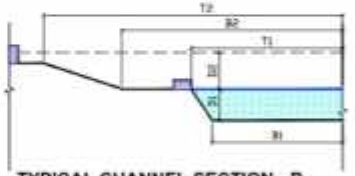
LONGITUDINAL PROFILE
H : V = 1:10

LEGEND : PROFILE

- Existing Bed Profile
- Proposed Bed Profile
- 100 Year High Flood Line (Rational Method)
- 100 Year High Flood Live (SUG Method)



TYPICAL FALL DETAILS



TYPICAL CHANNEL SECTION - B

NOTE :
All dimensions are in metres unless otherwise indicated.

TENDER PURPOSE ONLY
Prepared by Project Proponent

REVISIONS			
NO.	DATE	DESCRIPTION	SIGN

DATE:
SCALE:
DWG NO: UDH/JDA/AMANI/PSLC/10
REVISION:

DRAWING TITLE:
PLAN AND L SECTION OF AMANISHAH NALLAH
CHAINAGE : 7650 TO 9600

PROJECT TITLE:
REJUVENATION OF AMANISHAH NALLAH
INCLUDING AREA DEVELOPMENT PROJECT

EMPLOYER:
URBAN DEVELOPMENT & HOUSING (UDH)
GoR
THROUGH JAIPUR DEVELOPMENT AUTHORITY (JDA)

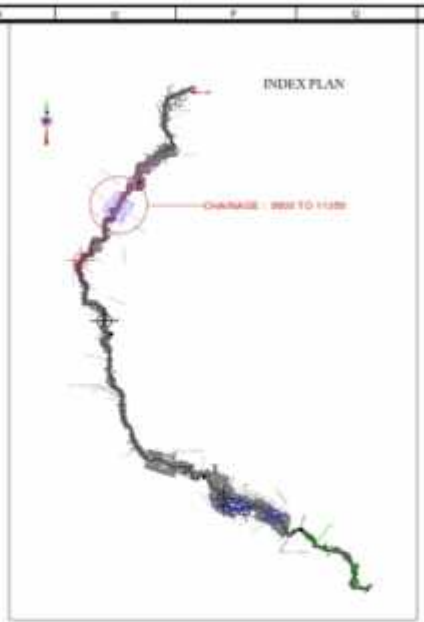
REACH NO.-5



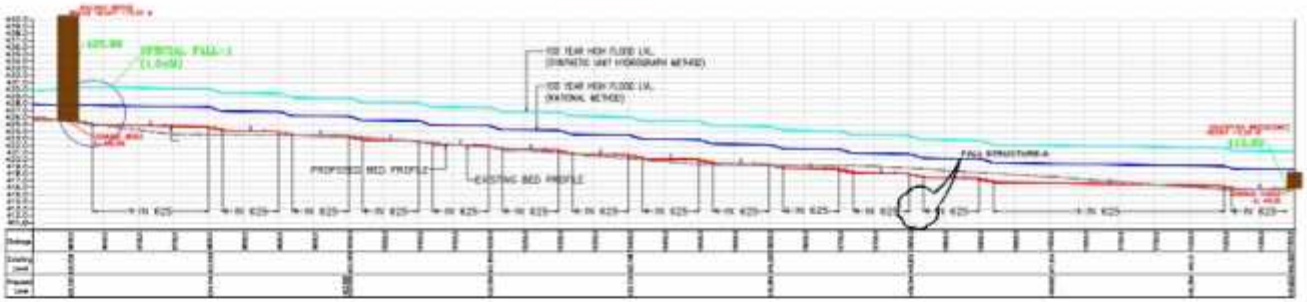
PLAN
(CHAINAGE : 9600 TO 11350)

LEGEND : PLAN

- Nallah Center Line
- Concrete Section Bottom
- Concrete Section Top
- COMPOSITE SECTION BOTTOM
- COMPOSITE SECTION TOP



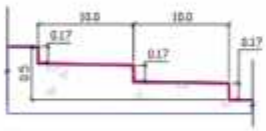
TENDER PURPOSE ONLY
Prepared by Project Proponent)



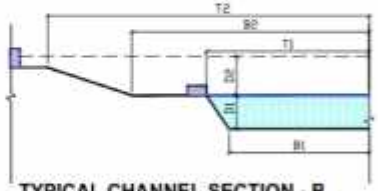
LONGITUDINAL PROFILE
H : V = 1:10

LEGEND : PROFILE

- Existing Bed Profile
- Proposed Bed Profile
- 100 Year High Flood Line (Rational Method)
- 100 Year High Flood Line (SUG Method)



TYPICAL FALL DETAILS



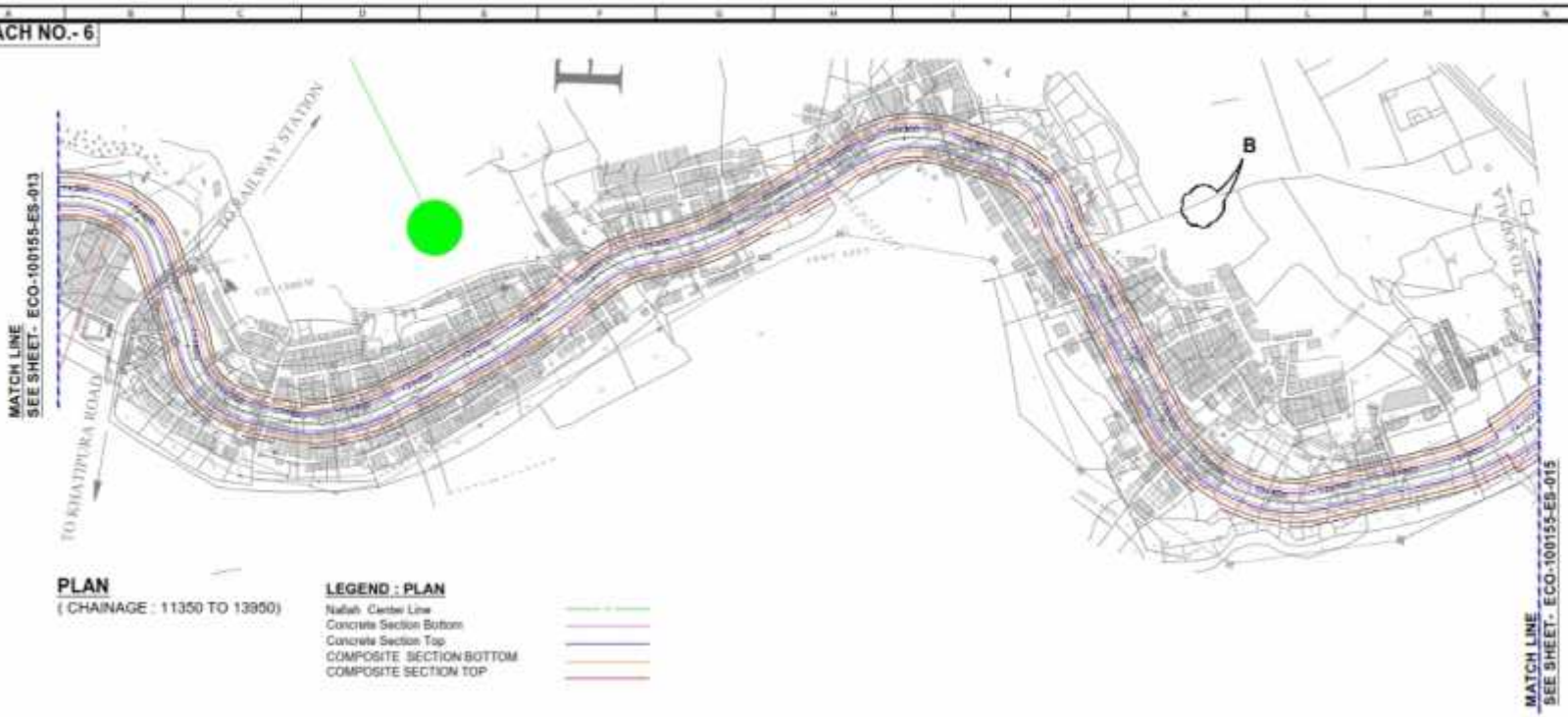
TYPICAL CHANNEL SECTION - B

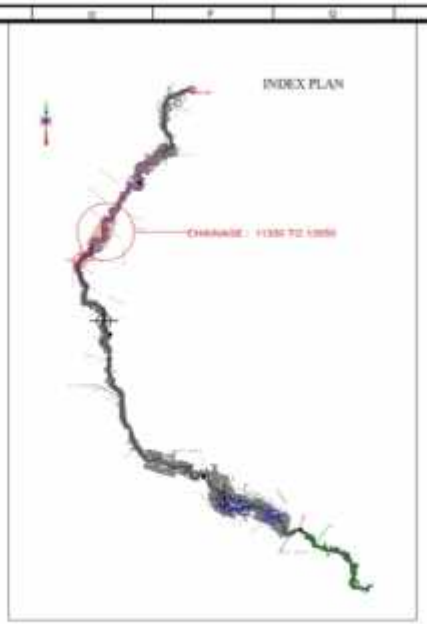
NOTE :
All dimensions are in meters unle otherwise indicated.

REVISIONS			
	DATE:	DRAWING TITLE: PLAN AND L SECTION OF AMANISHAH NALLAH CHAINAGE : 9600 TO 11350	PROJECT TITLE: REJUVENATION OF AMANISHAH NALLAH INCLUDING AREA DEVELOPMENT PROJECT
	SCALE:		
	DWG NO: UDH/JDA/AMAN/RALS/17		
	REVISION:		

EMPLOYER:
URBAN DEVELOPMENT & HOUSING (UDH)
GoR
THROUGH JAIPUR DEVELOPMENT AUTHORITY (JDA)

EACH NO.- 6

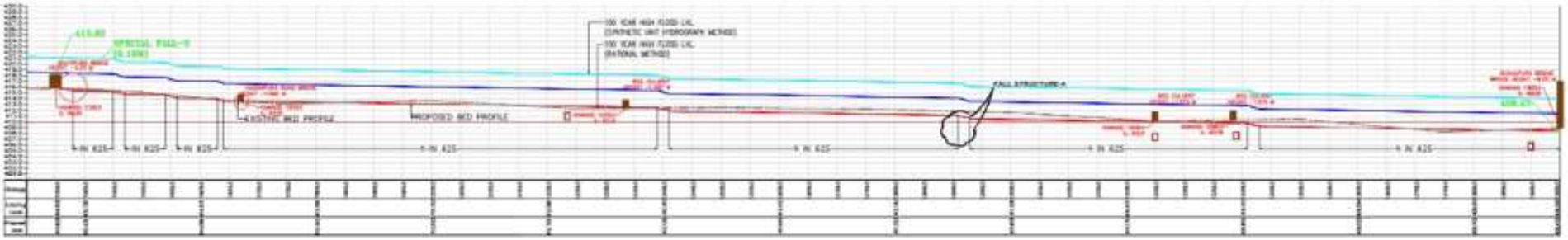




TENDER PURPOSE ONLY
Prepared by Project Proponent)

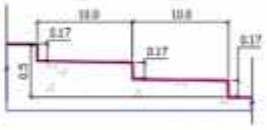
PLAN
(CHAINAGE : 11350 TO 13950)

LEGEND : PLAN
- Nallah Center Line
- Concrete Section Bottom
- Concrete Section Top
- COMPOSITE SECTION BOTTOM
- COMPOSITE SECTION TOP

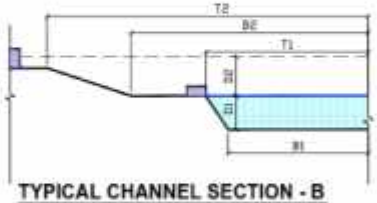


LONGITUDINAL PROFILE
H : V = 1:10

LEGEND : PROFILE
- Existing Bed Profile
- Proposed Bed Profile
- 100 Year High Flood Line (Rational Method)
- 100 Year High Flood Line (SUG Method)



TYPICAL FALL DETAILS



TYPICAL CHANNEL SECTION - B

NOTE :
All dimensions are in meters unle otherwise indicated.

REVISIONS			
NO.	DATE	DESCRIPTION	SIGN

DATE:
SCALE:
DWG NO: UDH/JDA/AMAN/P&L/018
REVISION:

DRAWING TITLE:
PLAN AND L SECTION OF AMANISHAH NALLAH
CHAINAGE : 11350 TO 13950

PROJECT TITLE:
REJUVENATION OF AMANISHAH NALLAH
INCLUDING AREA DEVELOPMENT PROJECT

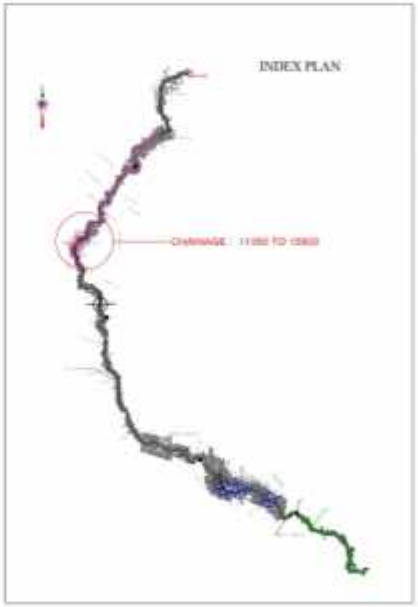
EMPLOYER:
URBAN DEVELOPMENT & HOUSING (UDH)
GoR
THROUGH JAIPUR DEVELOPMENT AUTHORITY (JDA)



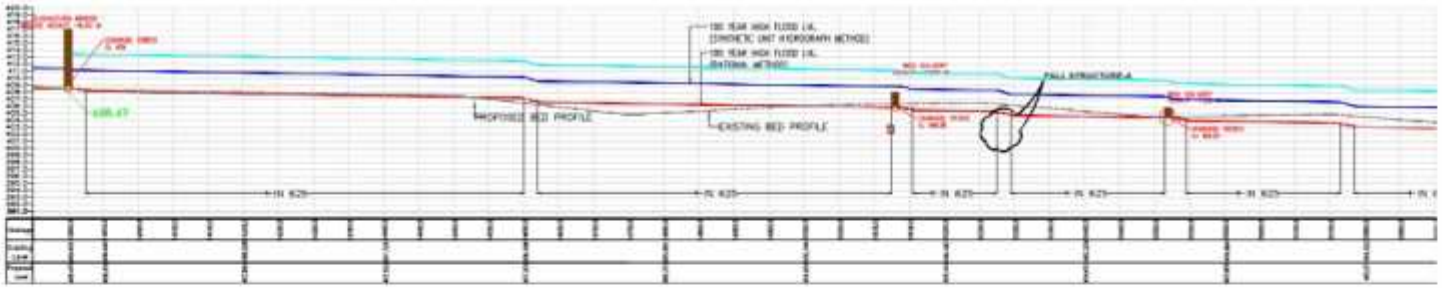
PLAN
(CHAINAGE : 13950 TO 15800)

LEGEND : PLAN

- Nallah Center Line
- Concrete Section Bottom
- Concrete Section Top
- COMPOSITE SECTION BOTTOM
- COMPOSITE SECTION TOP



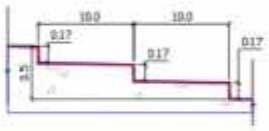
TENDER PURPOSE ONLY
Prepared by Project Proponent



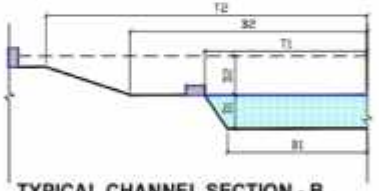
LONGITUDINAL PROFILE
H : V = 1:10

LEGEND : PROFILE

- Existing Bed Profile
- Proposed Bed Profile
- 100 Year High Flood Line (Rational Method)
- 100 Year High Flood Line (SUG Method)



TYPICAL FALL DETAILS



TYPICAL CHANNEL SECTION - B

NOTE :
All dimensions are in meters unle otherwise indicated.

REVISIONS			
	DATE:	DRAWING TITLE:	PROJECT TITLE:
	SCALE:	PLAN AND L SECTION OF AMANISHAH NALLAH CHAINAGE : 13950 TO 15800	REJUVENATION OF AMANISHAH NALLAH INCLUDING AREA DEVELOPMENT PROJECT
	DWG NO: UDH/JDA/AMANI/PBLS/19		
	REVISION:		

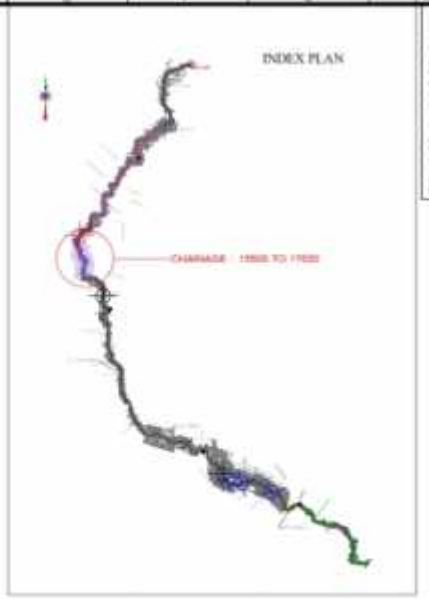
EMPLOYER:
URBAN DEVELOPMENT & HOUSING (UDH)
GoR
THROUGH JAIPUR DEVELOPMENT AUTHORITY (JDA)



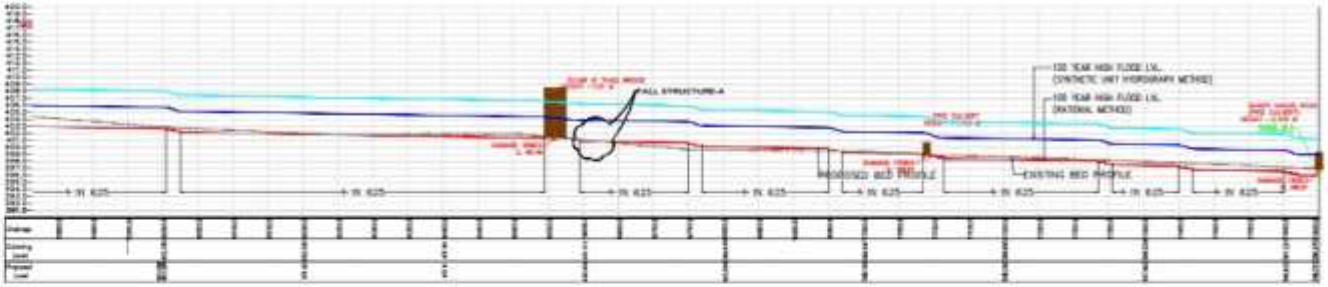
PLAN
(CHAINAGE : 15800 TO 17650)

LEGEND : PLAN

- Nallah Center Line
- Concrete Section Bottom
- Concrete Section Top
- COMPOSITE SECTION BOTTOM
- COMPOSITE SECTION TOP



TENDER PURPOSE ONLY
Prepared by Project Proponent)



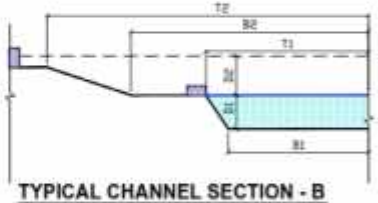
LONGITUDINAL PROFILE
H : V = 1:10

LEGEND : PROFILE

- Existing Bed Profile
- Proposed Bed Profile
- 100 Year High Flood Line (Rational Method)
- 100 Year High Flood Line (SUG Method)



TYPICAL FALL DETAILS



TYPICAL CHANNEL SECTION - B

NOTE :
All dimensions are in meters unle otherwise indicated.

REVISIONS			

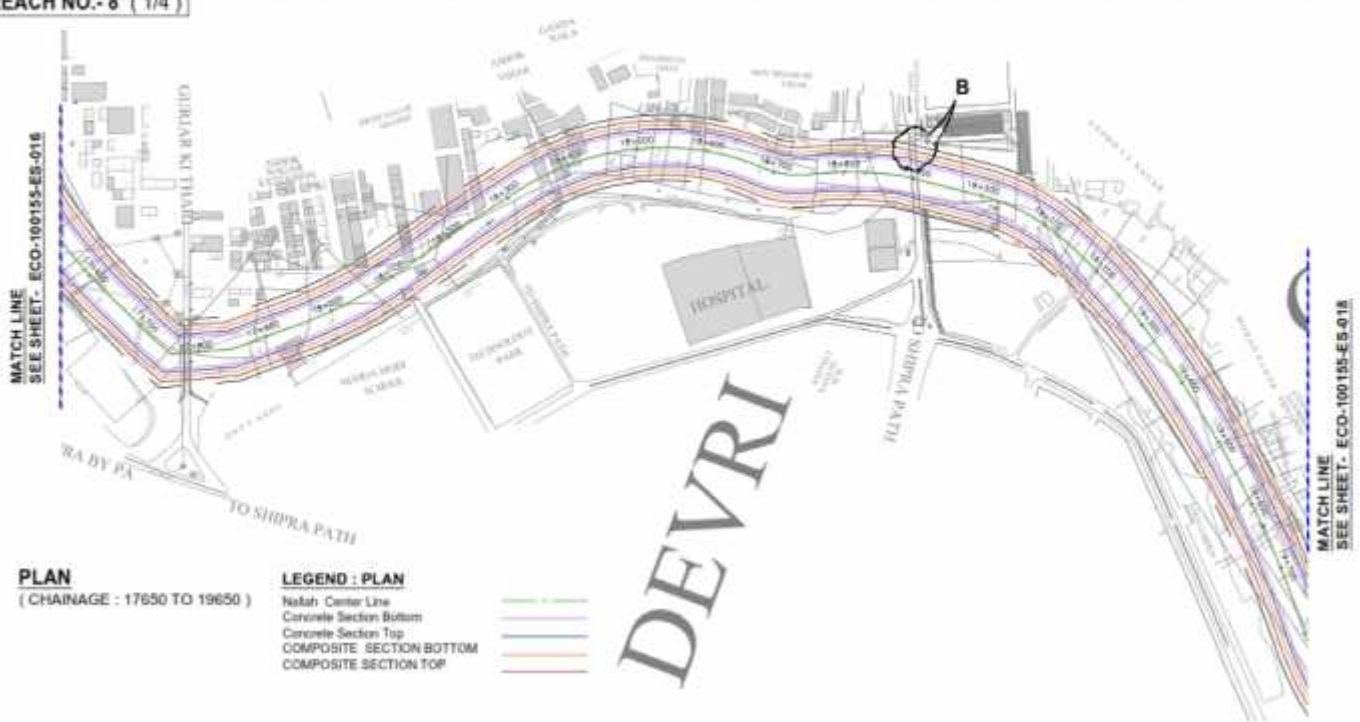
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SCALE:
DWG NO: UDH/JDA/AMANI/R&LS/20
REVISION:

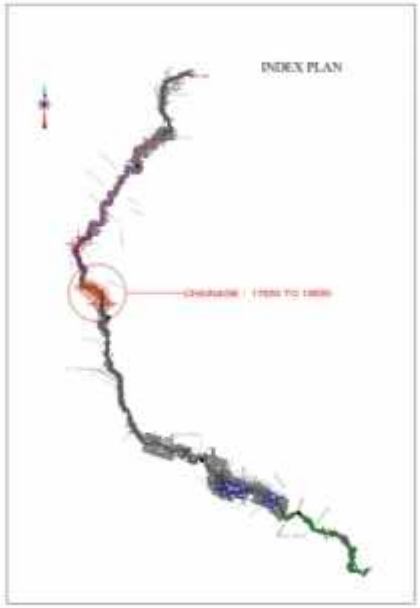
DRAWING TITLE:
PLAN AND L SECTION OF AMANISHAH NALLAH
CHAINAGE : 15800 TO 17650

PROJECT TITLE:
REJUVENATION OF AMANISHAH NALLAH
INCLUDING AREA DEVELOPMENT PROJECT

EMPLOYER:
URBAN DEVELOPMENT & HOUSING (UDH)
GoR
THROUGH JAIPUR DEVELOPMENT AUTHORITY (JDA)

EACH NO.- 8 (1/4)



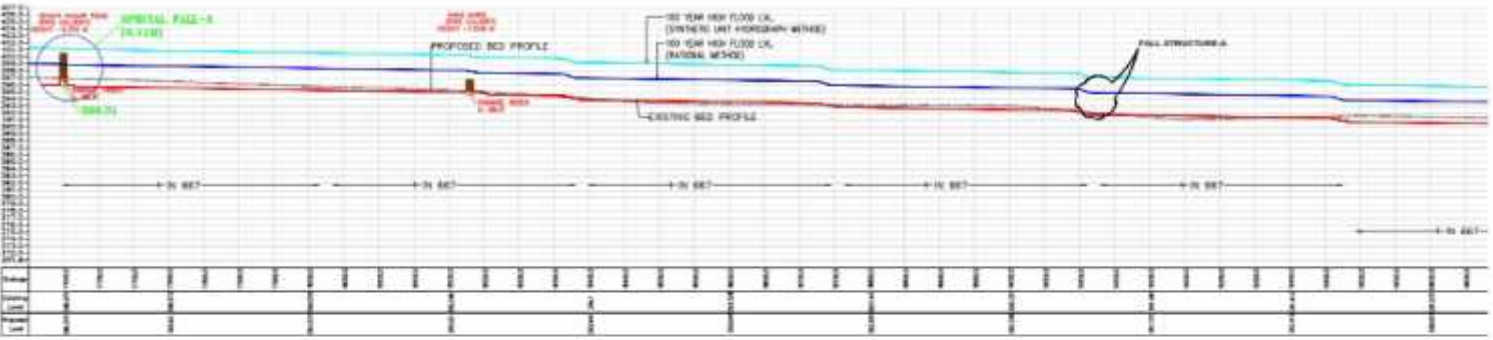


TENDER PURPOSE ONLY
Prepared by Project Proponent

PLAN
(CHAINAGE : 17650 TO 19650)

LEGEND : PLAN

- Nallah Center Line
- Concrete Section Bottom
- Concrete Section Top
- COMPOSITE SECTION BOTTOM
- COMPOSITE SECTION TOP

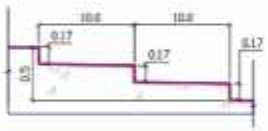


LONGITUDINAL PROFILE
H : V = 1:10

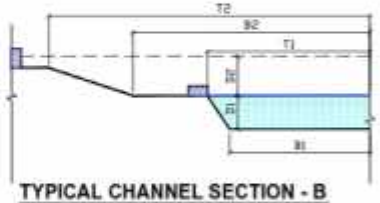
LEGEND : PROFILE

- Existing Bed Profile
- Proposed Bed Profile
- 100 Year High Flood Line (Rational Method)
- 100 Year High Flood Line (SUG Method)

NOTE :
All dimensions are in meters unle otherwise indicated.



TYPICAL FALL DETAILS

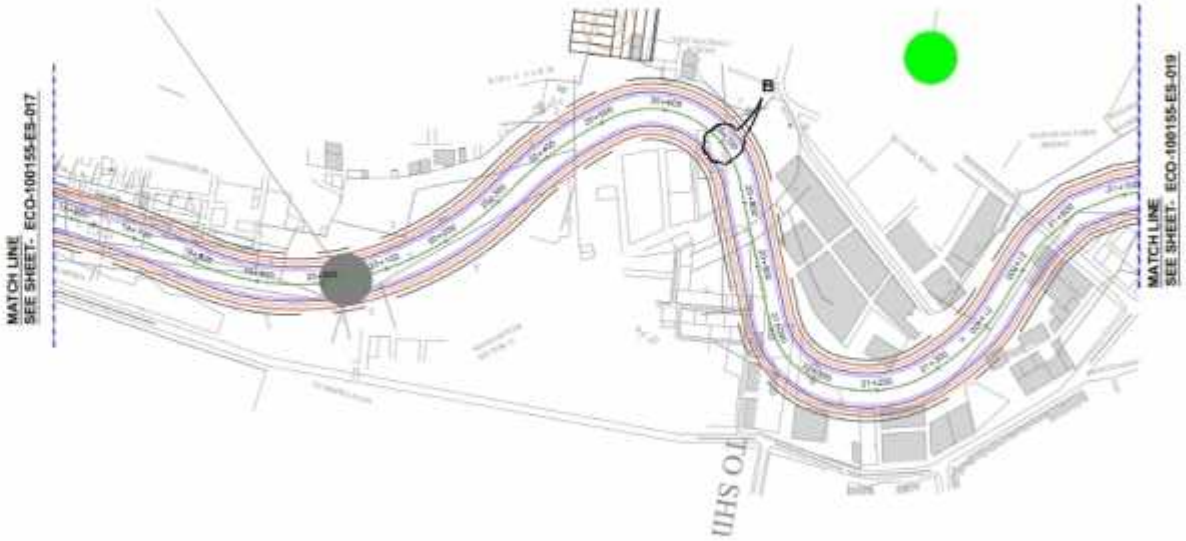


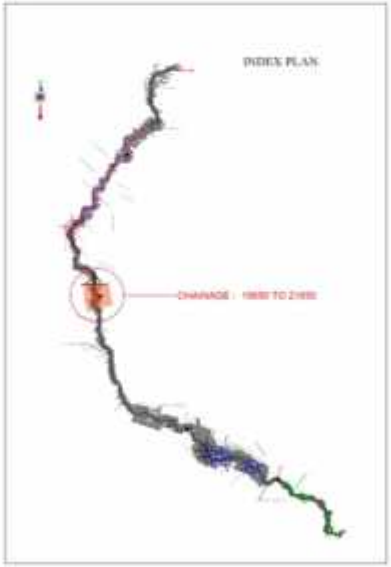
TYPICAL CHANNEL SECTION - B

REVISIONS	DATE:	DRAWING TITLE:	PROJECT TITLE:	EMPLOYER:
	SCALE:	PLAN AND L SECTION OF AMANISHAH NALLAH CHAINAGE : 17650 TO 19650	REJUVENATION OF AMANISHAH NALLAH INCLUDING AREA DEVELOPMENT PROJECT	URBAN DEVELOPMENT & HOUSING (UDH) GoR THROUGH JAIPUR DEVELOPMENT AUTHORITY (JDA)
	DWG NO: UDH/JDA/AMANI/PALS/21			
	REVISION:			

TENDER PURPOSE ONLY
Prepared by Project Proponent)

REACH NO.- 8 (2/4)

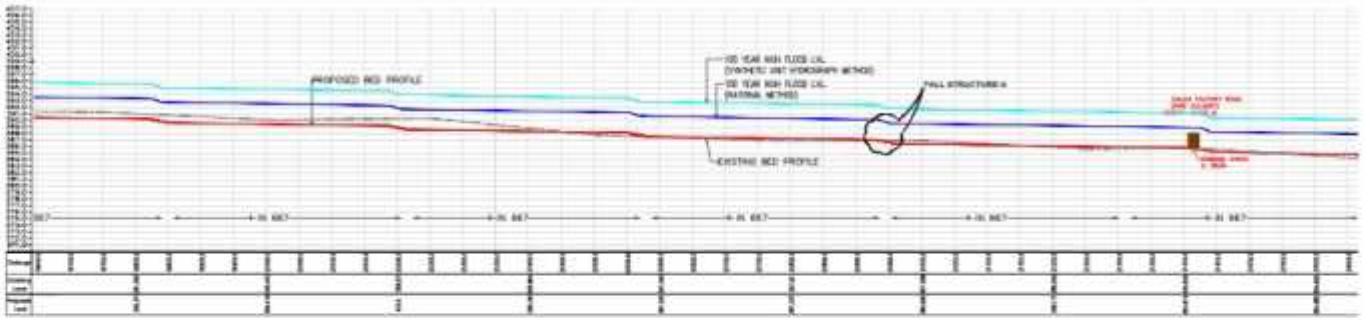




PLAN
(CHAINAGE : 19650 TO 21650)

LEGEND : PLAN

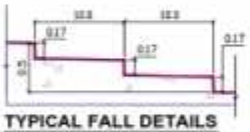
- Nallah Center Line
- Concrete Section Bottom
- Concrete Section Top
- COMPOSITE SECTION BOTTOM
- COMPOSITE SECTION TOP



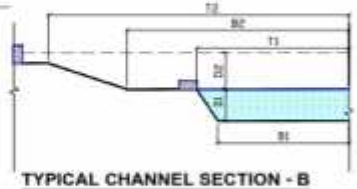
LONGITUDINAL PROFILE
H : V = 1:10

LEGEND : PROFILE

- Existing Bed Profile
- Proposed Bed Profile
- 100 Year High Flood Line (Rational Method)
- 100 Year High Flood Line (SUG Method)



TYPICAL FALL DETAILS



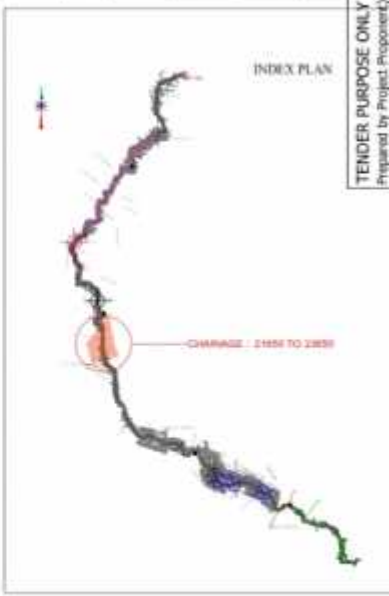
TYPICAL CHANNEL SECTION - B

NOTE :
All dimensions are in meters unle otherwise indicated.

REVISIONS	DATE:	DRAWING TITLE:	PROJECT TITLE:	EMPLOYER:
	SCALE:	PLAN AND L SECTION OF AMANISHAH NALLAH CHAINAGE : 19650 TO 21650	REJUVENATION OF AMANISHAH NALLAH INCLUDING AREA DEVELOPMENT PROJECT	URBAN DEVELOPMENT & HOUSING (UDH) GoR THROUGH JAIPUR DEVELOPMENT AUTHORITY (JDA)
	DWG NO:			
	REVISION:			

REACH NO.- 8 (3/4)

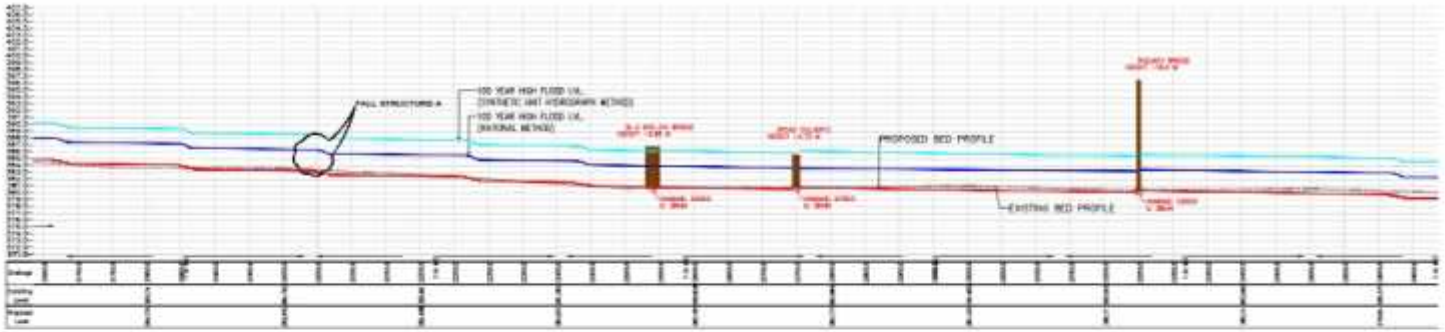




TENDER PURPOSE ONLY
Prepared by Project Proponent

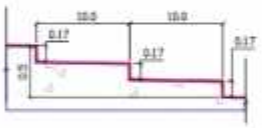
PLAN
(CHAINAGE : 21650 TO 23650)

LEGEND : PLAN
- Nallah Center Line
- Concrete Section Bottom
- Concrete Section Top
- COMPOSITE SECTION BOTTOM
- COMPOSITE SECTION TOP

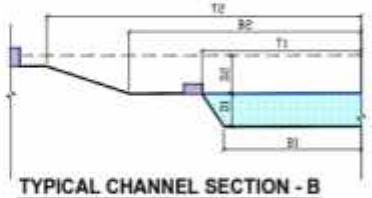


LONGITUDINAL PROFILE
H : V = 1:10

LEGEND : PROFILE
- Existing Bed Profile
- Proposed Bed Profile
- 100 Year High Flood Line (Rational Method)
- 100 Year High Flood Line (SUG Method)



TYPICAL FALL DETAILS



TYPICAL CHANNEL SECTION - B

NOTE :
All dimensions are in meters unle otherwise indicated.

REVISIONS			

DATE:
SCALE:
DWG NO: UDH/JDA/AMAN/P&LS/23
REVISION:

DRAWING TITLE:
PLAN AND L SECTION OF AMANISHAH NALLAH
CHAINAGE : 21650 TO 23650

PROJECT TITLE:
REJUVENATION OF AMANISHAH NALLAH
INCLUDING AREA DEVELOPMENT PROJECT

EMPLOYER:
URBAN DEVELOPMENT & HOUSING (UDH)
GoR
THROUGH JAIPUR DEVELOPMENT AUTHORITY (JDA)

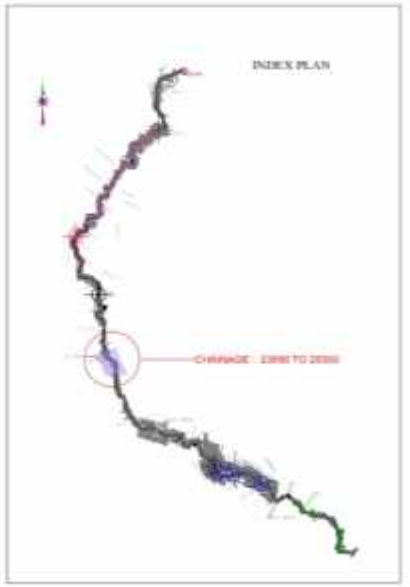
REACH NO.- 8 (4/4)

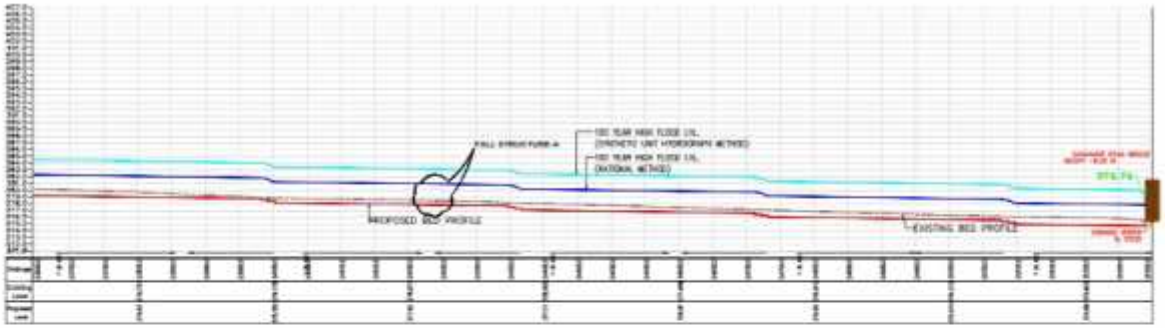
TENDER PURPOSE ONLY
Prepared by Project Proponent)



PLAN
(CHAINAGE : 23650 TO 25300)

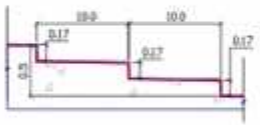
LEGEND : PLAN
- Nallah Center Line
- Concrete Section Bottom
- Concrete Section Top
- COMPOSITE SECTION BOTTOM
- COMPOSITE SECTION TOP



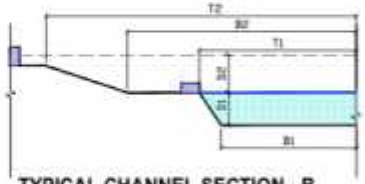


LONGITUDINAL PROFILE
H : V = 1:10

LEGEND : PROFILE
- Existing Bed Profile
- Proposed Bed Profile
- 100 Year High Flood Line (Rational Method)
- 100 Year High Flood Line (SUG Method)



TYPICAL FALL DETAILS



TYPICAL CHANNEL SECTION - B

NOTE :
All dimensions are in meters unle otherwise indicated.

REVISIONS			
NO.	DATE	DESCRIPTION	SIGN

DATE:
SCALE:
DWG NO: UDH/DDA/AMAN/PBLS/24
REVISION:

DRAWING TITLE:
PLAN AND L SECTION OF AMANISHAH NALLAH
CHAINAGE : 23650 TO 25300

PROJECT TITLE:
REJUVENATION OF AMANISHAH NALLAH
INCLUDING AREA DEVELOPMENT PROJECT

EMPLOYER:
URBAN DEVELOPMENT & HOUSING (UDH)
GoR
THROUGH JAIPUR DEVELOPMENT AUTHORITY (JDA)

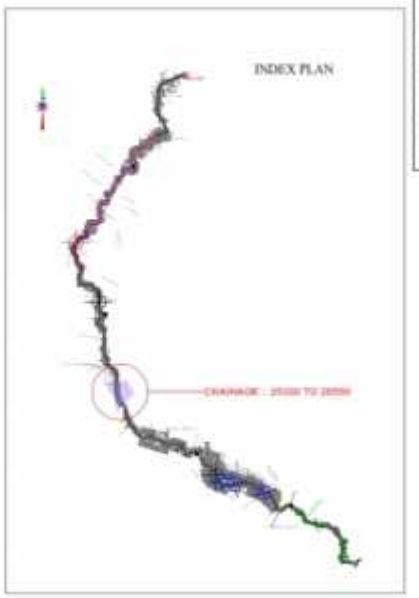
REACH NO.- 9



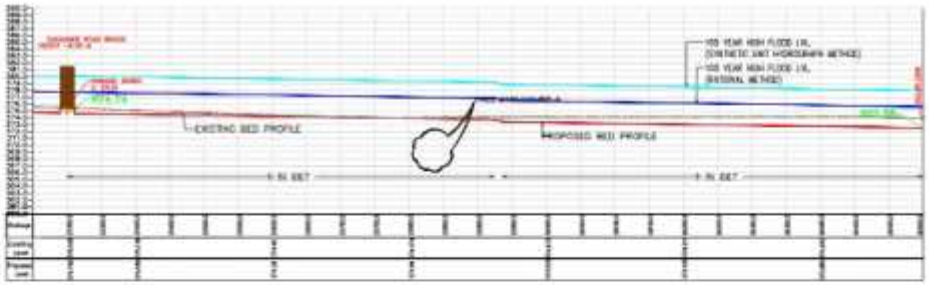
PLAN
(CHAINAGE : 25300 TO 26550)

LEGEND : PLAN

- Nallah Center Line
- Concrete Section Bottom
- Concrete Section Top
- COMPOSITE SECTION BOTTOM
- COMPOSITE SECTION TOP



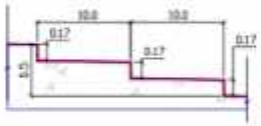
TENDER PURPOSE ONLY
Prepared by Project Proponent



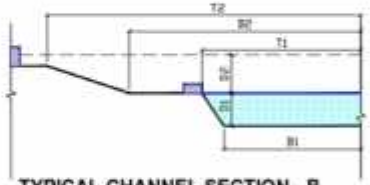
LONGITUDINAL PROFILE
H : V = 1:10

LEGEND : PROFILE

- Existing Bed Profile
- Proposed Bed Profile
- 100 Year High Flood Line (Rational Method)
- 100 Year High Flood Line (SUG Method)



TYPICAL FALL DETAILS



TYPICAL CHANNEL SECTION - B

NOTE :
All dimensions are in meters unle otherwise indicated.

REVISIONS			
NO.	DATE	DESCRIPTION	SIGN

DATE:
SCALE:
DWG NO: UDH/JDA/MAN/PNLS/25
REVISION:

DRAWING TITLE:
PLAN AND L SECTION OF AMANISHAH NALLAH
CHAINAGE : 25300 TO 26550

PROJECT TITLE:
REJUVENATION OF AMANISHAH NALLAH
INCLUDING AREA DEVELOPMENT PROJECT

EMPLOYER:
URBAN DEVELOPMENT & HOUSING (UDH)
GoR
THROUGH JAIPUR DEVELOPMENT AUTHORITY (JDA)

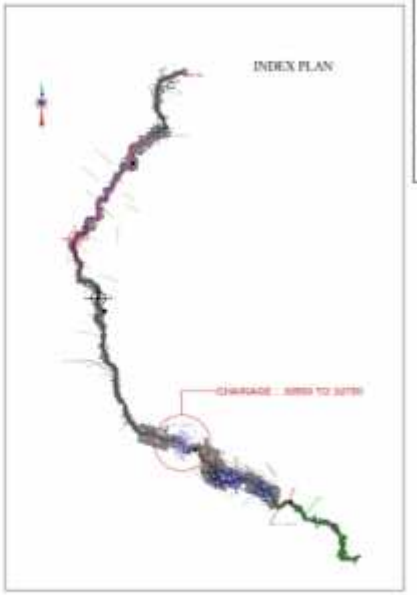
REACH NO.- 10 (3/3)



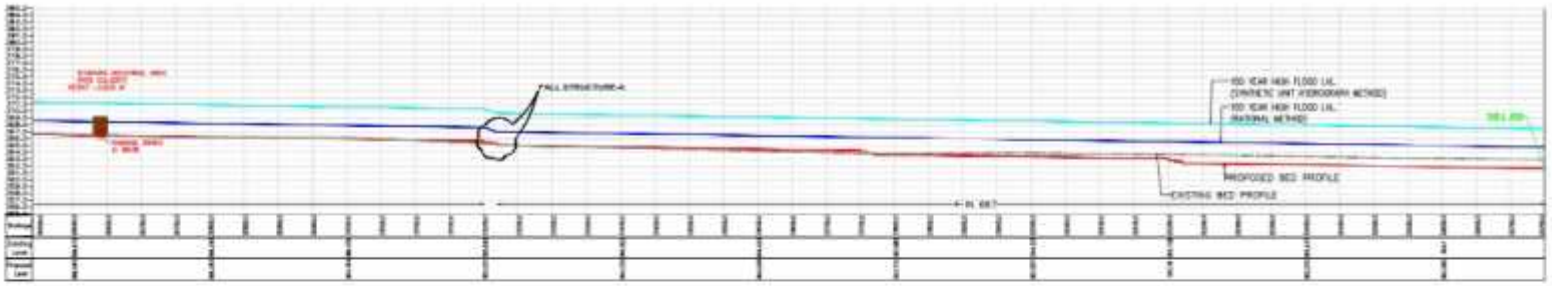
PLAN
(CHAINAGE : 30550 TO 32750)

LEGEND : PLAN

- Nallah Center Line
- Concrete Section Bottom
- Concrete Section Top
- COMPOSITE SECTION BOTTOM
- COMPOSITE SECTION TOP



TENDER PURPOSE ONLY
Prepared by Project Proponent)



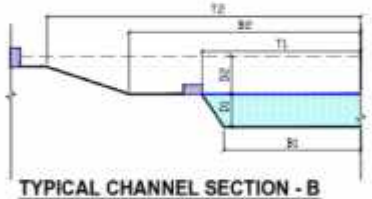
LONGITUDINAL PROFILE
H : V = 1:10

LEGEND : PROFILE

- Existing Bed Profile
- Proposed Bed Profile
- 100 Year High Flood Line (Rational Method)
- 100 Year High Flood Line (SUG Method)



TYPICAL FALL DETAILS



TYPICAL CHANNEL SECTION - B

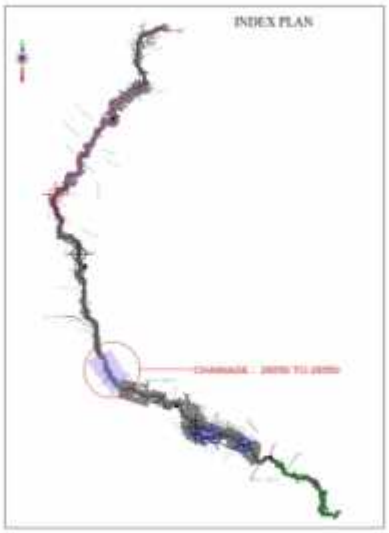
NOTE :
All dimensions are in meters unle otherwise indicated

REVISIONS	DATE:	DRAWING TITLE:	PROJECT TITLE:	EMPLOYER:
	SCALE:	PLAN AND L SECTION OF AMANISHAH NALLAH CHAINAGE : 30550 TO 32750	REJUVENATION OF AMANISHAH NALLAH INCLUDING AREA DEVELOPMENT PROJECT	URBAN DEVELOPMENT & HOUSING (UDH) GoR THROUGH JAIPUR DEVELOPMENT AUTHORITY (JDA)
	DWG NO: UDH/DA/MMNP/ES/26			
	REVISION:			

REACH NO.- 10 (1/3)

TENDER PURPOSE ONLY
Prepared by Project Proponent)

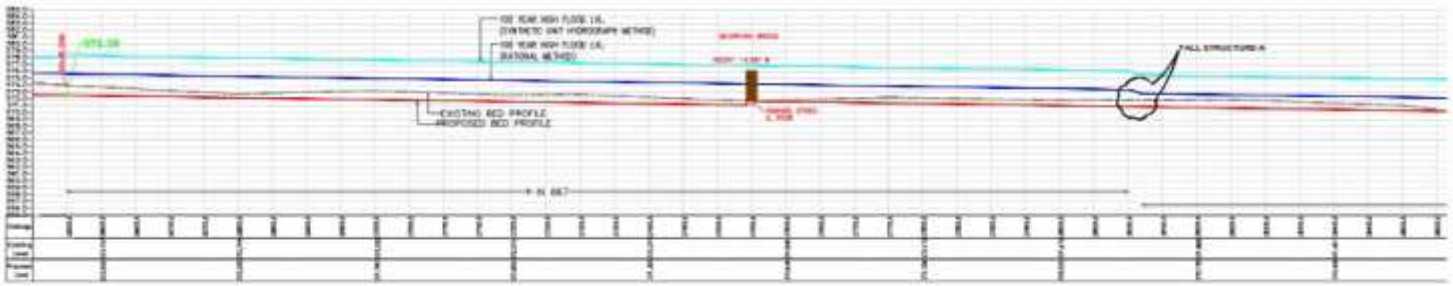




PLAN
(CHAINAGE : 26550 TO 28550)

LEGEND : PLAN

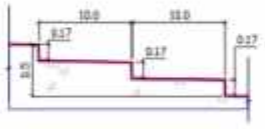
- Nallah Center Line
- Concrete Section Bottom
- Concrete Section Top
- COMPOSITE SECTION BOTTOM
- COMPOSITE SECTION TOP



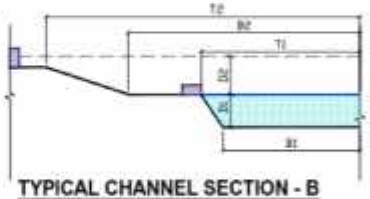
LONGITUDINAL PROFILE
H : V = 1:10

LEGEND : PROFILE

- Existing Bed Profile
- Proposed Bed Profile
- 100 Year High Flood Line (Rational Method)
- 100 Year High Flood Line (SUG Method)



TYPICAL FALL DETAILS



TYPICAL CHANNEL SECTION - B

NOTE :
All dimensions are in meters unle otherwise indicated.

REVISIONS			
NO.	DATE	DESCRIPTION	SIGN

DATE:
SCALE:
DWG NO: UDH/JDA/WMR/PNLS/27
REVISION:

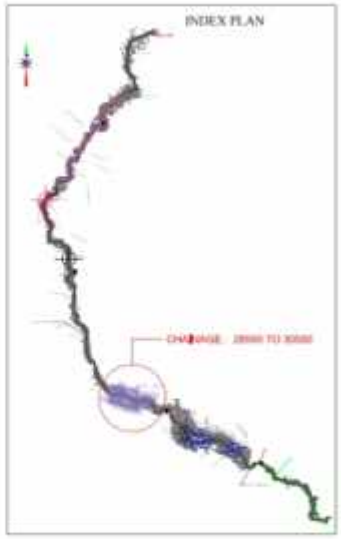
DRAWING TITLE:
PLAN AND L SECTION OF AMANISHAH NALLAH
CHAINAGE : 26550 TO 28550

PROJECT TITLE:
REJUVENATION OF AMANISHAH NALLAH
INCLUDING AREA DEVELOPMENT PROJECT

EMPLOYER:
URBAN DEVELOPMENT & HOUSING (UDH)
GoR
THROUGH JAIPUR DEVELOPMENT AUTHORITY (JDA)

REACH NO.- 10 (2/3)



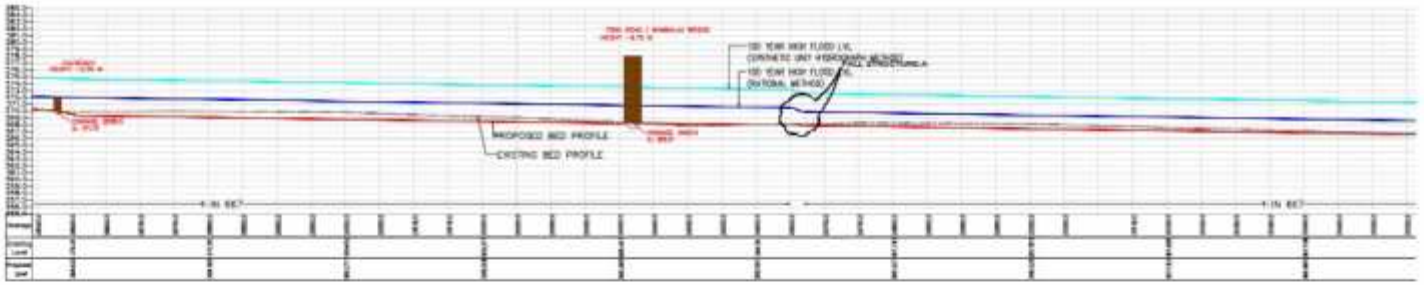


TENDER PURPOSE ONLY
Prepared by Project Proponent)

PLAN
(CHAINAGE : 28550 TO 30550)

LEGEND : PLAN

- Nallah Center Line
- Concrete Section Bottom
- Concrete Section Top
- COMPOSITE SECTION BOTTOM
- COMPOSITE SECTION TOP



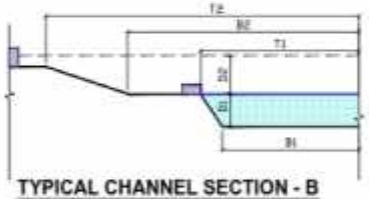
LONGITUDINAL PROFILE
H : V = 1:10

LEGEND : PROFILE

- Existing Bed Profile
- Proposed Bed Profile
- 100 Year High Flood Line (Rational Method)
- 100 Year High Flood Line (SUG Method)



TYPICAL FALL DETAILS



TYPICAL CHANNEL SECTION - B

NOTE :
All dimensions are in meters unle otherwise indicated.

REVISIONS			
NO.	DATE	DESCRIPTION	SIGN

DATE:
SCALE:
DWG NO: UDH/JDA/WMR/PNLS/28
REVISION:

DRAWING TITLE:
PLAN AND L SECTION OF AMANISHAH NALLAH
CHAINAGE : 28550 TO 30550

PROJECT TITLE:
REJUVENATION OF AMANISHAH NALLAH
INCLUDING AREA DEVELOPMENT PROJECT

EMPLOYER:
URBAN DEVELOPMENT & HOUSING (UDH)
GoR
THROUGH JAIPUR DEVELOPMENT AUTHORITY (JDA)

REACH NO.- 11

TENDER PURPOSE ONLY
Prepared by Project Proponent)

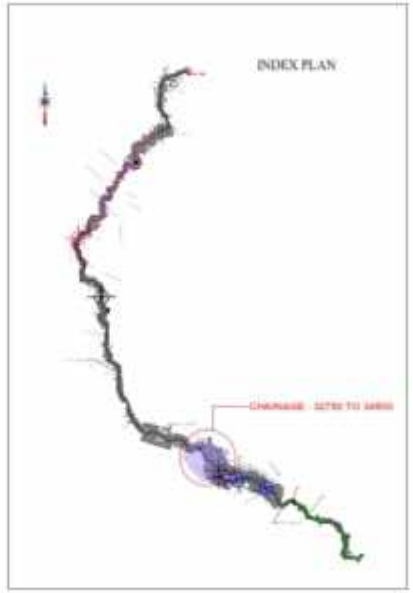


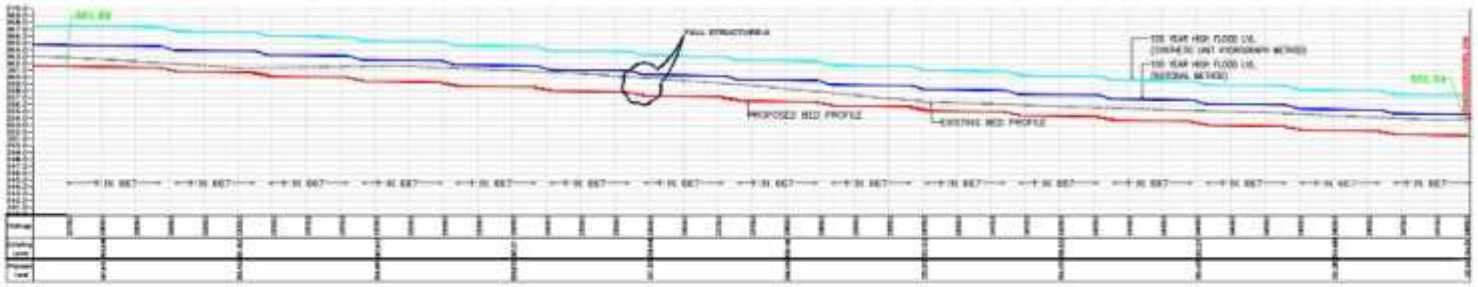
MATCH LINE
SEE SHEET- ECO-100155-ES-025

PLAN
(CHAINAGE : 32750 TO 34800)

LEGEND : PLAN

- Nallah Center Line
- Concrete Section Bottom
- Concrete Section Top
- COMPOSITE SECTION BOTTOM
- COMPOSITE SECTION TOP

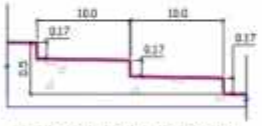




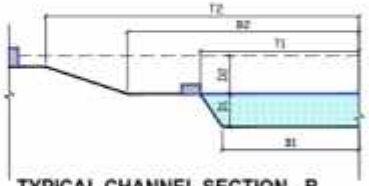
LONGITUDINAL PROFILE
H : V = 1:10

LEGEND : PROFILE

- Existing Bed Profile
- Proposed Bed Profile
- 100 Year High Flood Line (Rational Method)
- 100 Year High Flood Line (SUG Method)



TYPICAL FALL DETAILS



TYPICAL CHANNEL SECTION - B

NOTE :
All dimensions are in meters unle otherwise indicated.

REVISIONS			
NO.	DATE	DESCRIPTION	SIGN

DATE:
SCALE:
DWG NO: UDH/JDA/WMR/PNAL/29
REVISION:

DRAWING TITLE:
PLAN AND L SECTION OF AMANISHAH NALLAH
CHAINAGE : 32750 TO 34800

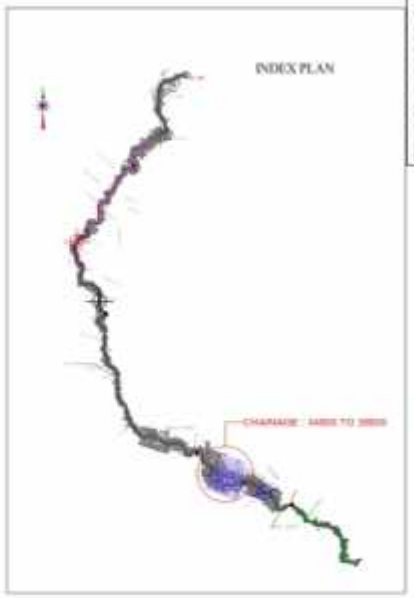
PROJECT TITLE:
REJUVENATION OF AMANISHAH NALLAH
INCLUDING AREA DEVELOPMENT PROJECT

EMPLOYER:
URBAN DEVELOPMENT & HOUSING (UDH)
GoR
THROUGH JAIPUR DEVELOPMENT AUTHORITY (JDA)

REACH NO.- 12 (1/3)

TENDER PURPOSE ONLY
Prepared by Project Proponent)





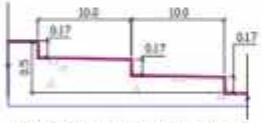
PLAN
(CHAINAGE : 34800 TO 36800)

LEGEND : PLAN
- Nallah Center Line
- Concrete Section Bottom
- Concrete Section Top
- COMPOSITE SECTION BOTTOM
- COMPOSITE SECTION TOP

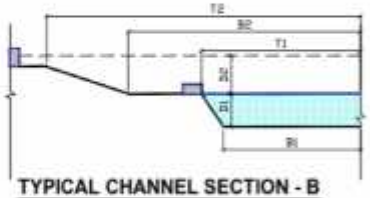


LONGITUDINAL PROFILE
H : V = 1:10

LEGEND : PROFILE
- Existing Bed Profile
- Proposed Bed Profile
- 100 Year High Flood Line (Rational Method)
- 100 Year High Flood Line (SUG Method)



TYPICAL FALL DETAILS



TYPICAL CHANNEL SECTION - B

NOTE :
All dimensions are in meters unle otherwise indicated.

REVISIONS				
NO.	DATE	DESCRIPTION	DATE	

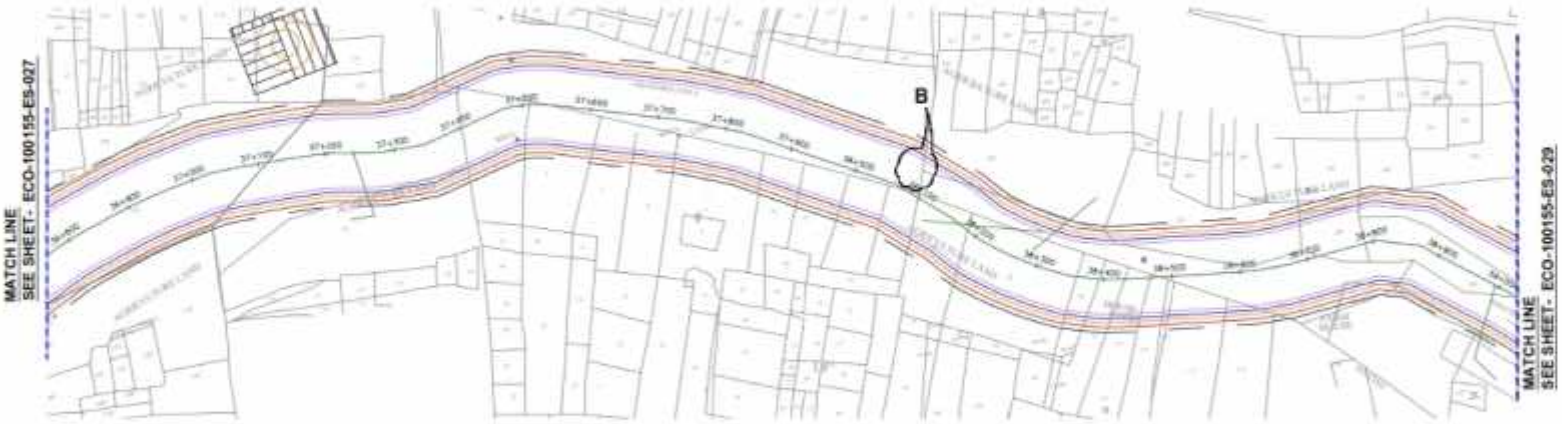
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SCALE:
DWG NO: UDH/JDA/WMR/PNLS/20
REVISION:

DRAWING TITLE:
PLAN AND L SECTION OF AMANISHAH NALLAH
CHAINAGE : 32750 TO 34800

PROJECT TITLE:
REJUVENATION OF AMANISHAH NALLAH
INCLUDING AREA DEVELOPMENT PROJECT

EMPLOYER:
URBAN DEVELOPMENT & HOUSING (UDH)
GoR
THROUGH JAIPUR DEVELOPMENT AUTHORITY (JDA)

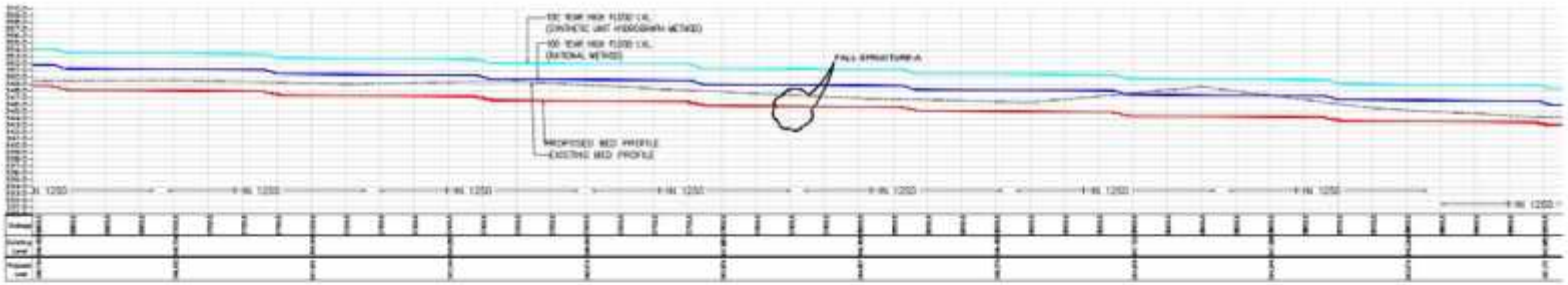
REACH NO.- 12 (2/3)



PLAN
(CHAINAGE : 36800 TO 39000)

LEGEND : PLAN

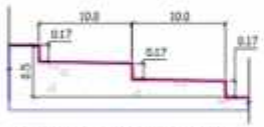
- Nallah Center Line
- Concrete Section Bottom
- Concrete Section Top
- COMPOSITE SECTION BOTTOM
- COMPOSITE SECTION TOP



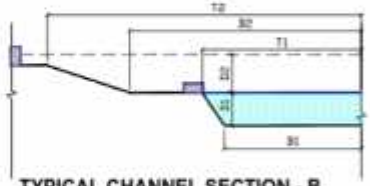
LONGITUDINAL PROFILE
H : V = 1:10

LEGEND : PROFILE

- Existing Bed Profile
- Proposed Bed Profile
- 100 Year High Flood Line (Rational Method)
- 100 Year High Flood Line (SUG Method)

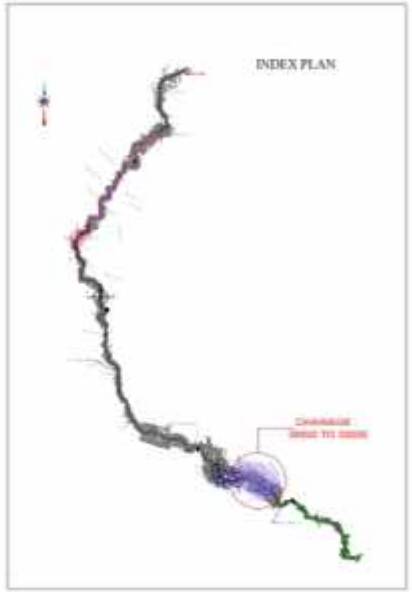


TYPICAL FALL DETAILS



TYPICAL CHANNEL SECTION - B

NOTE :
All dimensions are in meters unle otherwise indicated.



TENDER PURPOSE ONLY
Prepared by Project Proponent)

REVISIONS			
NO.	DATE	DESCRIPTION	SIGN

DATE:
SCALE:
DWG NO: UDH/JDA/MWR/PNL/01
REVISION:

DRAWING TITLE:
PLAN AND L SECTION OF AMANISHAH NALLAH
CHAINAGE : 32750 TO 34800

PROJECT TITLE:
REJUVENATION OF AMANISHAH NALLAH
INCLUDING AREA DEVELOPMENT PROJECT

EMPLOYER:
URBAN DEVELOPMENT & HOUSING (UDH)
GoR
THROUGH JAIPUR DEVELOPMENT AUTHORITY (JDA)

REACH NO.- 12 (3/3)

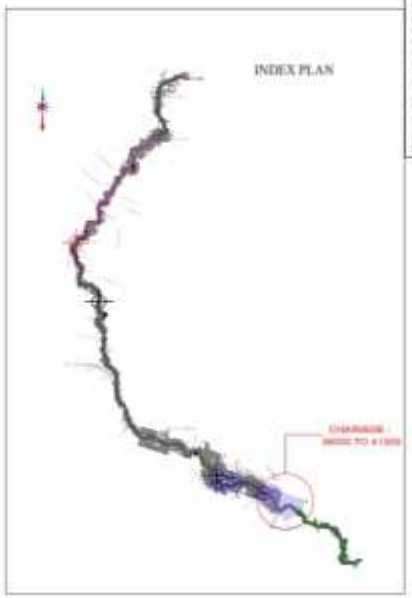
TENDER PURPOSE ONLY
(Prepared by Project Proponent)

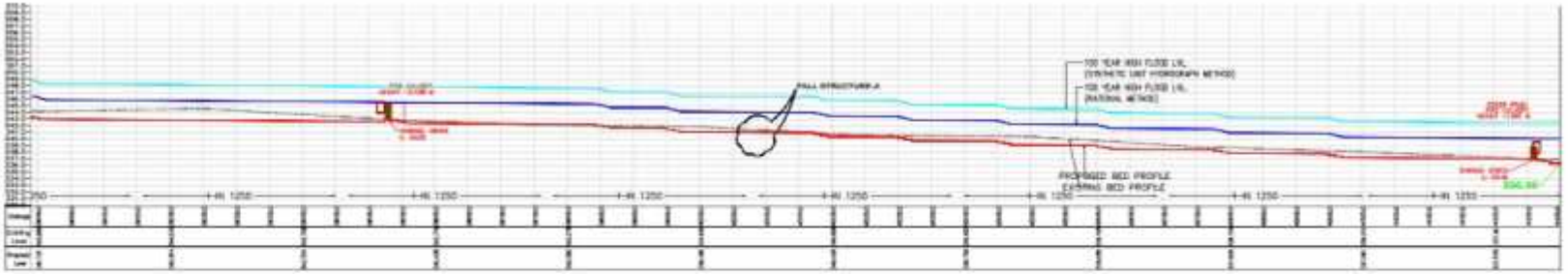


PLAN
(CHAINAGE : 39000 TO 41300)

LEGEND : PLAN

- Nallah Center Line
- Concrete Section Bottom
- Concrete Section Top
- COMPOSITE SECTION BOTTOM
- COMPOSITE SECTION TOP

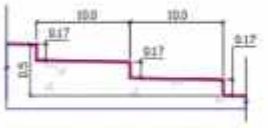




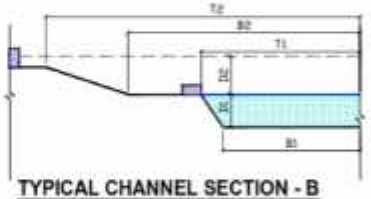
LONGITUDINAL PROFILE
H : V = 1:10

LEGEND : PROFILE

- Existing Bed Profile
- Proposed Bed Profile
- 100 Year High Flood Line (Rational Method)
- 100 Year High Flood Line (SUG Method)



TYPICAL FALL DETAILS



TYPICAL CHANNEL SECTION - B

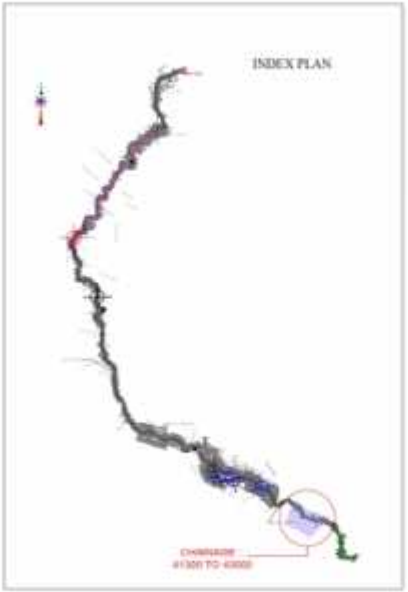
NOTE :
All dimensions are in meters unle otherwise indicated.

REVISIONS	DATE:	DRAWING TITLE:	PROJECT TITLE:	EMPLOYER:
	SCALE:	PLAN AND L SECTION OF AMANISHAH NALLAH CHAINAGE : 39000 TO 41300	REJUVENATION OF AMANISHAH NALLAH INCLUDING AREA DEVELOPMENT PROJECT	URBAN DEVELOPMENT & HOUSING (UDH) GoR THROUGH JAIPUR DEVELOPMENT AUTHORITY (JDA)
	DWG NO: UDH/JDA/WMR/PNLS/32			
	REVISION:			

REACH NO.- 13 (1/3)

TENDER PURPOSE ONLY
Prepared by Project Proponent)

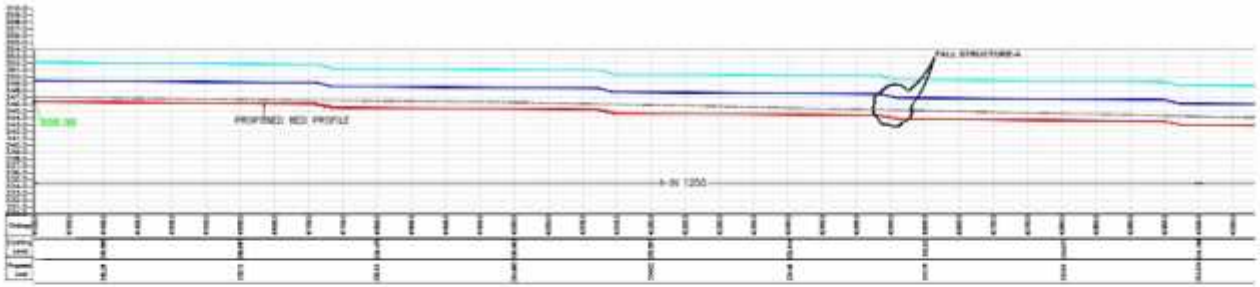




PLAN
(CHAINAGE : 41300 TO 43000)

LEGEND : PLAN

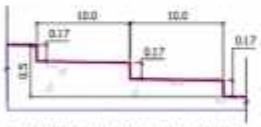
- Nallah Center Line
- Concrete Section Bottom
- Concrete Section Top
- COMPOSITE SECTION BOTTOM
- COMPOSITE SECTION TOP



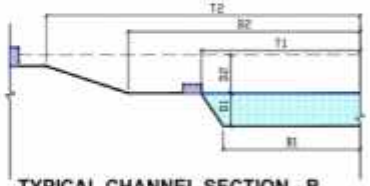
LONGITUDINAL PROFILE
H : V = 1:10

LEGEND : PROFILE

- Existing Bed Profile
- Proposed Bed Profile
- 100 Year High Flood Line (Rational Method)
- 100 Year High Flood Line (SUG Method)



TYPICAL FALL DETAILS



TYPICAL CHANNEL SECTION - B

NOTE :
All dimensions are in meters unle otherwise indicated.

REVISIONS			
NO.	DATE	DESCRIPTION	SIGN

DATE:
SCALE:
DWG NO: UDH/JDA/WMR/PNLS/01
REVISION:

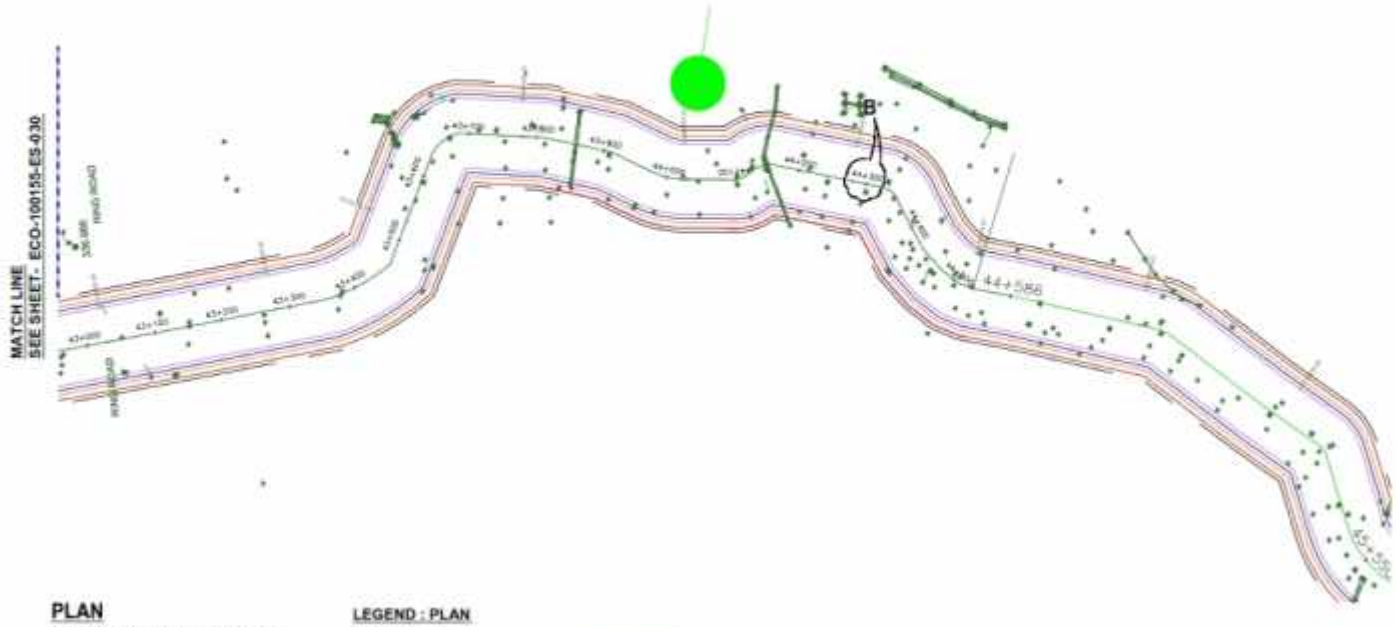
DRAWING TITLE:
PLAN AND L SECTION OF AMANISHAH NALLAH
CHAINAGE : 41300 TO 43000

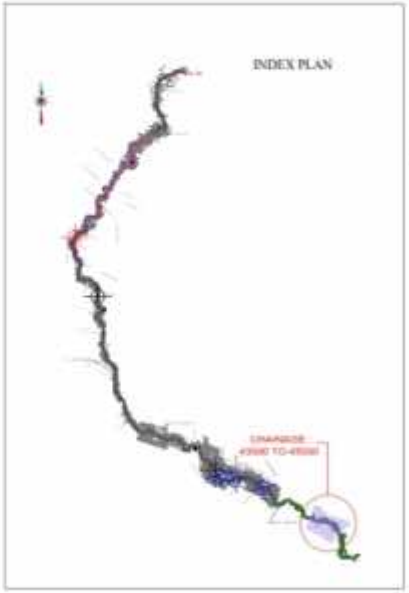
PROJECT TITLE:
REJUVENATION OF AMANISHAH NALLAH
INCLUDING AREA DEVELOPMENT PROJECT

EMPLOYER:
URBAN DEVELOPMENT & HOUSING (UDH)
GoR
THROUGH JAIPUR DEVELOPMENT AUTHORITY (JDA)

REACH NO.- 13 (2/3)

TENDER PURPOSE ONLY
Prepared by Project Proponent)

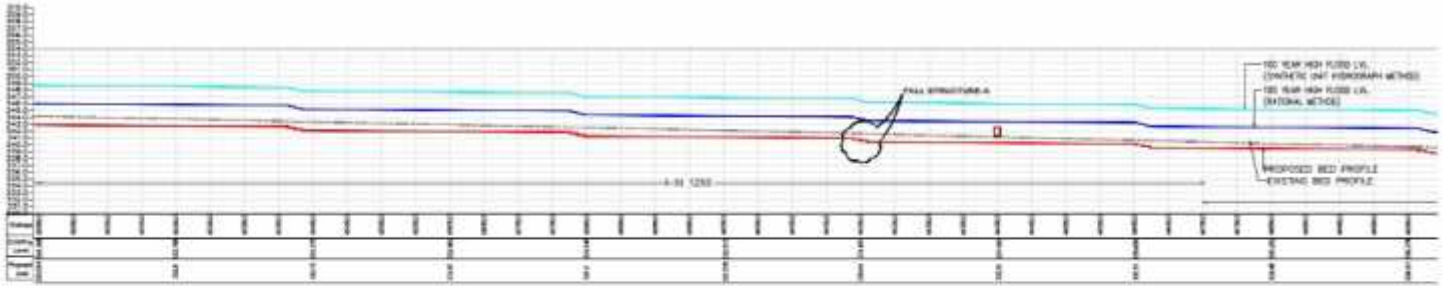




PLAN
(CHAINAGE : 43000 TO 45000)

LEGEND : PLAN

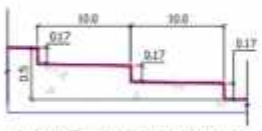
- Nallah Center Line
- Concrete Section Bottom
- Concrete Section Top
- COMPOSITE SECTION BOTTOM
- COMPOSITE SECTION TOP



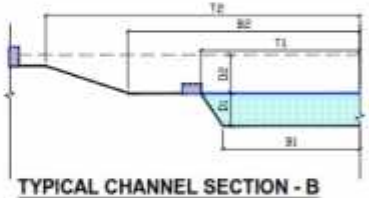
LONGITUDINAL PROFILE
H : V = 1:10

LEGEND : PROFILE

- Existing Bed Profile
- Proposed Bed Profile
- 100 Year High Flood Line (Rational Method)
- 100 Year High Flood Line (SUG Method)



TYPICAL FALL DETAILS



TYPICAL CHANNEL SECTION - B

NOTE :
All dimensions are in meters unle otherwise indicated.

REVISIONS			
NO.	DATE	DESCRIPTION	SIGN

DATE:
SCALE:
DWG NO: UDH/JDA/WMR/PNLS/24
REVISION:

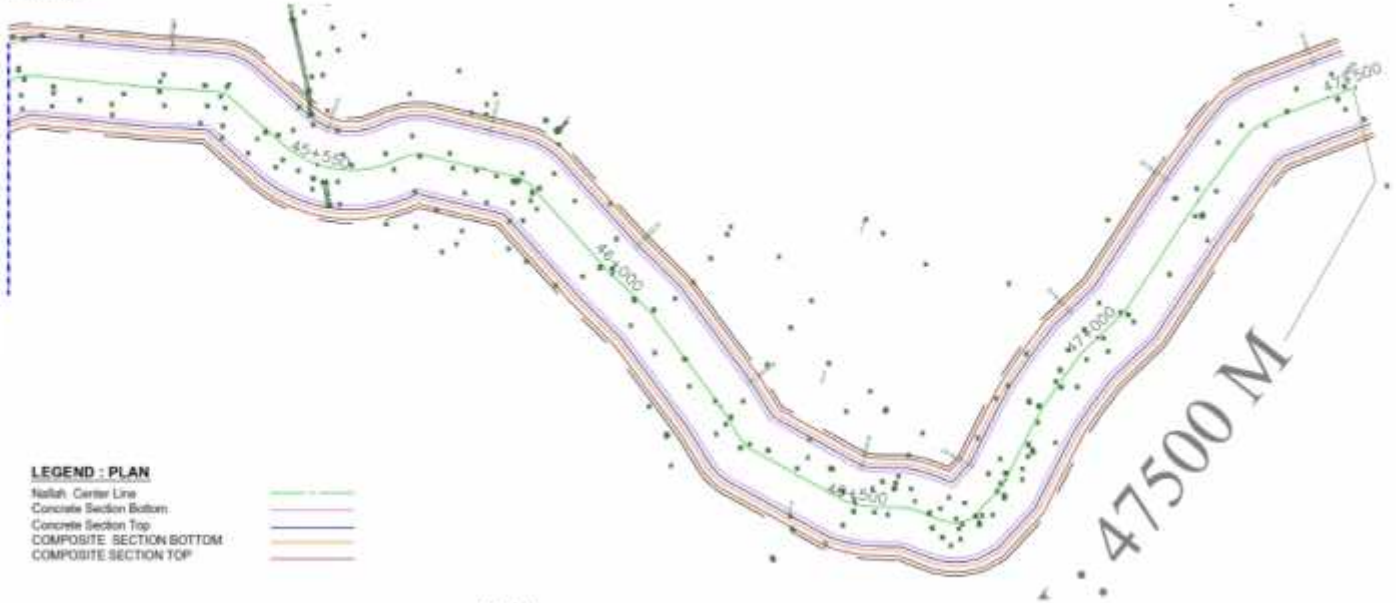
DRAWING TITLE:
PLAN AND L SECTION OF AMANISHAH NALLAH
CHAINAGE : 43000 TO 45000

PROJECT TITLE:
REJUVENATION OF AMANISHAH NALLAH
INCLUDING AREA DEVELOPMENT PROJECT

EMPLOYER:
URBAN DEVELOPMENT & HOUSING (UDH)
GoR
THROUGH JAIPUR DEVELOPMENT AUTHORITY (JDA)

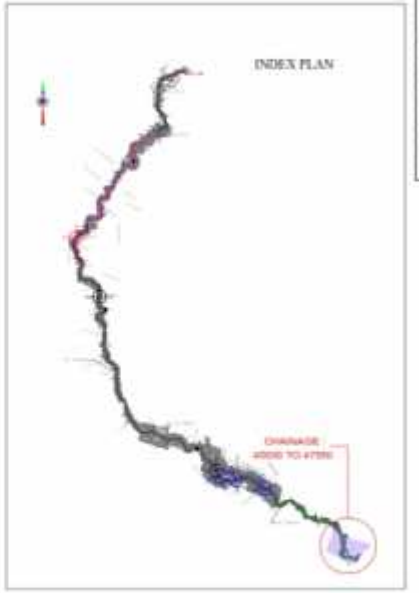
REACH NO.- 13 (3/3)

MATCH LINE
SEE SHEET:- ECO-100155-ES-031

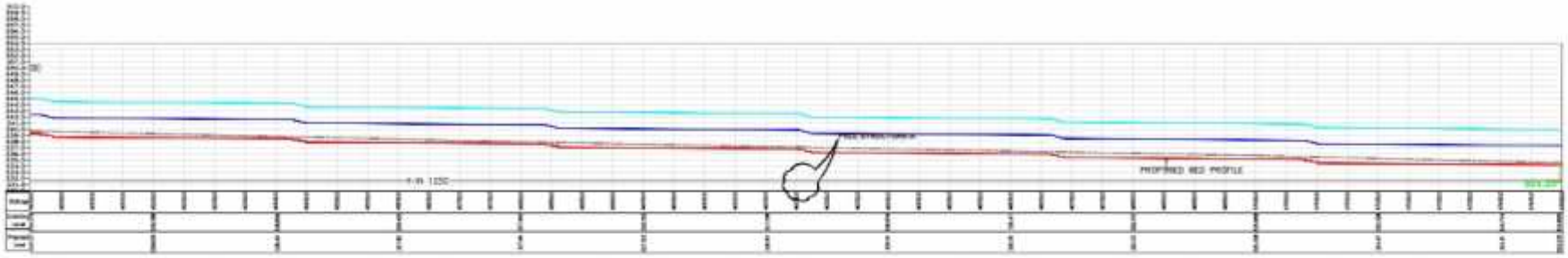


LEGEND : PLAN
- Nallah Center Line
- Concrete Section Bottom
- Concrete Section Top
- COMPOSITE SECTION BOTTOM
- COMPOSITE SECTION TOP

PLAN
(CHAINAGE : 45000 TO 47550)

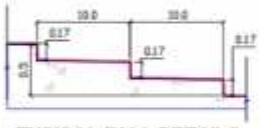


TENDER PURPOSE ONLY
Prepared by Project Proponent)

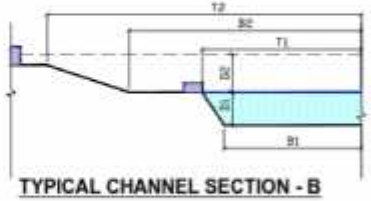


LONGITUDINAL PROFILE
H : V = 1:10

LEGEND : PROFILE
- Existing Bed Profile
- Proposed Bed Profile
- 100 Year High Flood Line (Rational Method)
- 100 Year High Flood Line (SUG Method)



TYPICAL FALL DETAILS



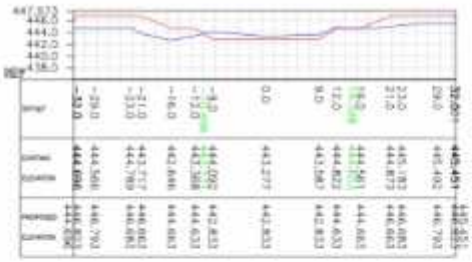
TYPICAL CHANNEL SECTION - B

NOTE :
All dimensions are in meters unle otherwise indicated.

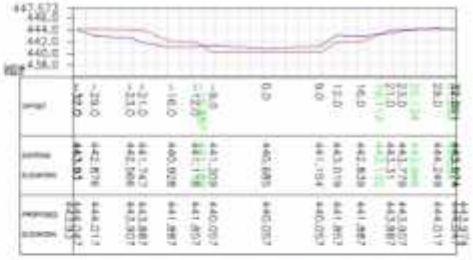
REVISIONS	DATE:	DRAWING TITLE:	PROJECT TITLE:	EMPLOYER:
	SCALE:	PLAN AND L SECTION OF AMANISHAH NALLAH CHAINAGE : 45000 TO 47550	REJUVENATION OF AMANISHAH NALLAH INCLUDING AREA DEVELOPMENT PROJECT	URBAN DEVELOPMENT & HOUSING (UDH) GoR THROUGH JAIPUR DEVELOPMENT AUTHORITY (JDA)
	DWG NO: UDH/JDA/WMR/PNALS/31			
	REVISION:			



Ch: 5100



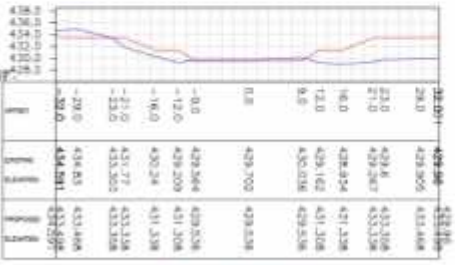
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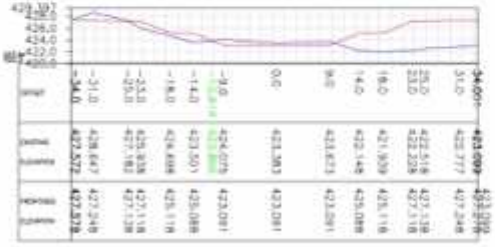
Ch: 7000



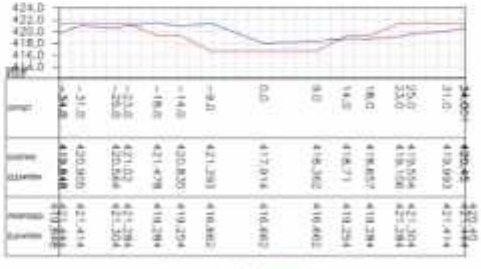
Ch: 8000



Ch: 9000



Ch: 10000



Ch: 11000



Ch: 12000



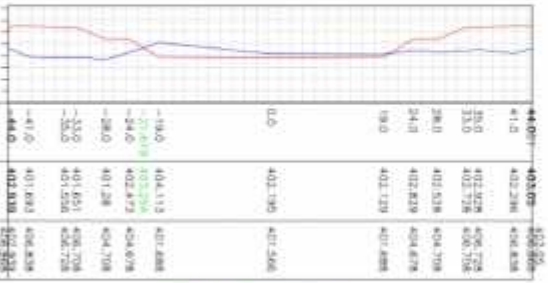
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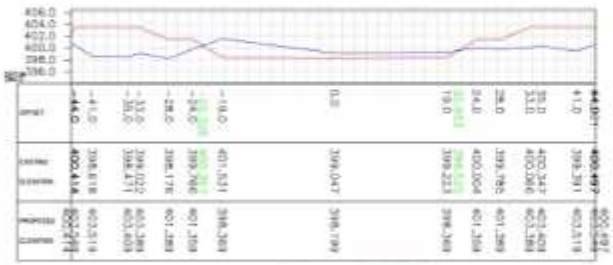
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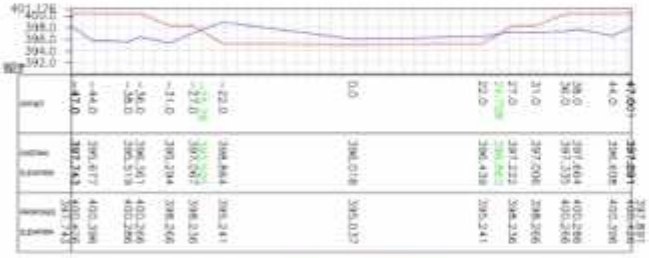
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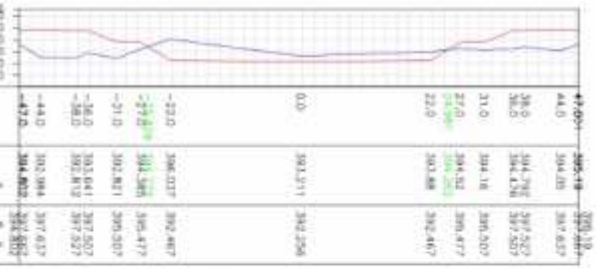


Ch: 17000

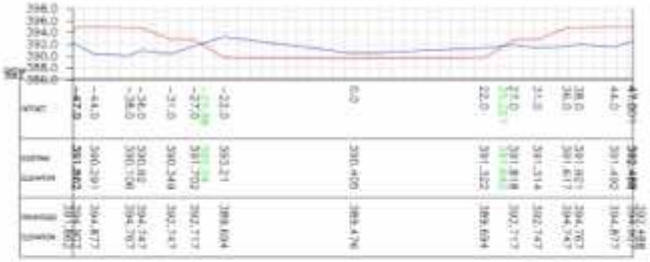


Ch: 18000

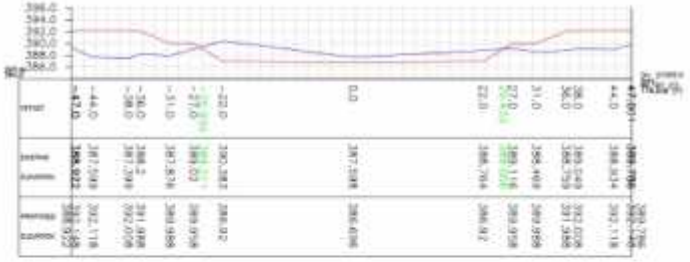
REVISIONS	DATE:	DRAWING TITLE:	PROJECT TITLE:	EMPLOYER:
	SCALE:	CROSS SECTIONS FROM CHAINAGE: 5100 TO 18000	REJUVENATION OF AMANISHAH NALLAH INCLUDING AREA DEVELOPMENT PROJECT	URBAN DEVELOPMENT & HOUSING (UDH) GoR THROUGH JAIPUR DEVELOPMENT AUTHORITY (J
	DWG NO: UDH/JDA/AMAN/CS/36			
	REVISION:			



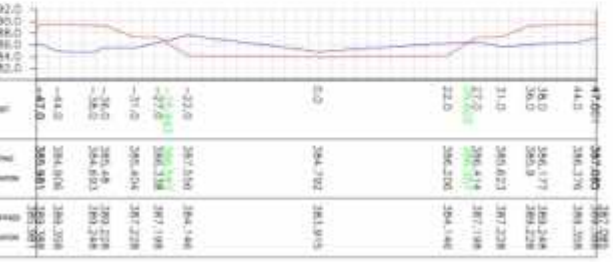
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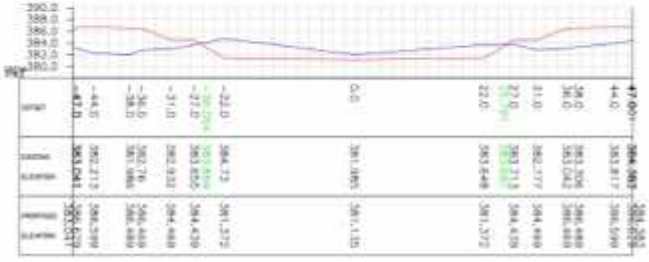
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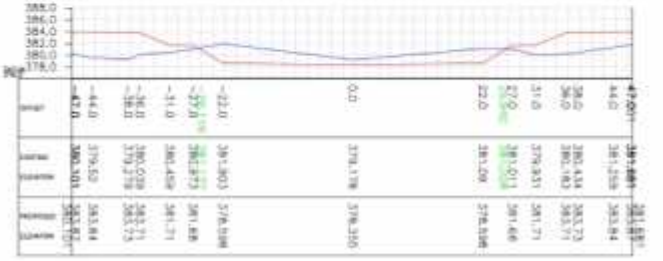
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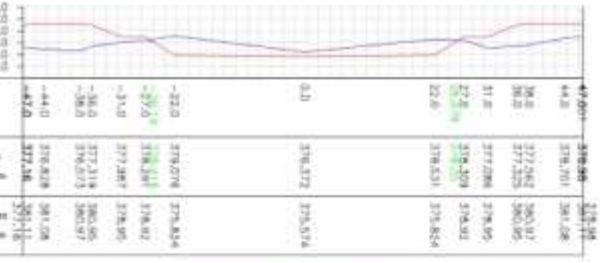
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Ch: 23000



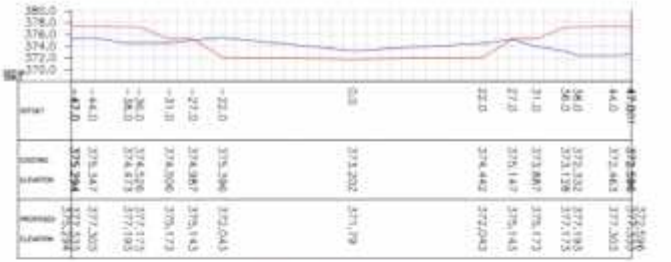
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Ch: 25000



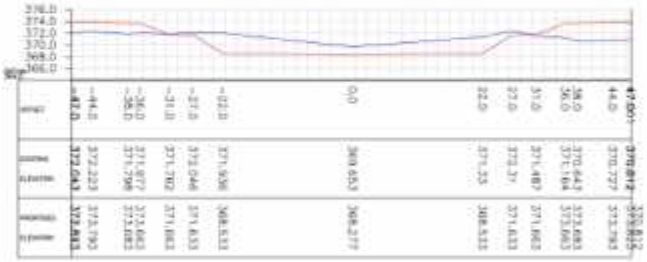
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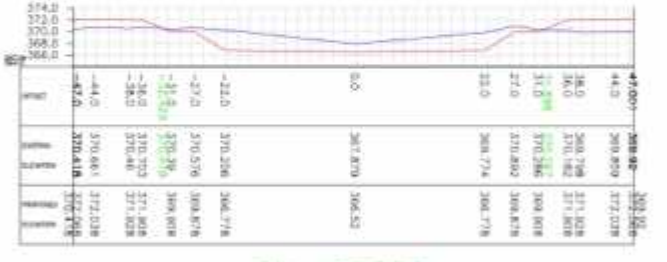
Ch: 27000



Ch: 28000



Ch: 29000



Ch: 30000

REVISIONS		

DATE:

SCALE:

DWG NO: UDH/JDA/AMAN/CS/37

REVISION:

DRAWING TITLE:

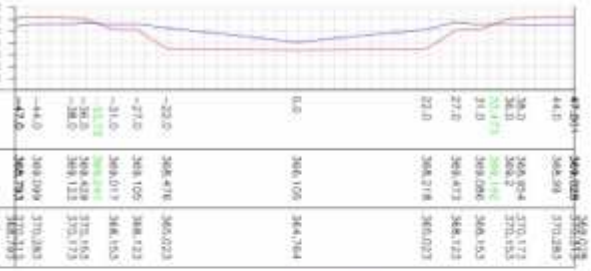
CROSS SECTIONS
FROM CHAINAGE: 19000 TO 30000

PROJECT TITLE:

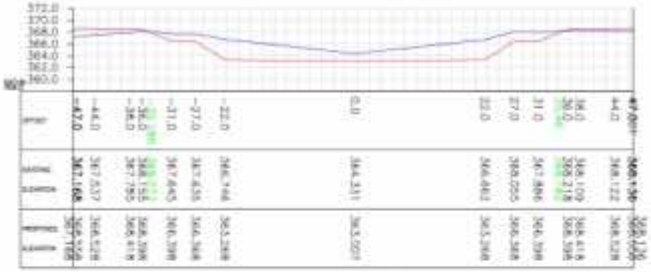
REJUVENATION OF AMANISHAH NALLAH
INCLUDING AREA DEVELOPMENT PROJECT

EMPLOYER:

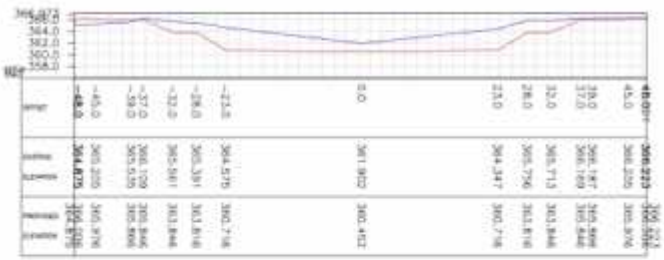
URBAN DEVELOPMENT & HOUSING (UDH)
GoR
THROUGH JAIPUR DEVELOPMENT AUTHORITY (J



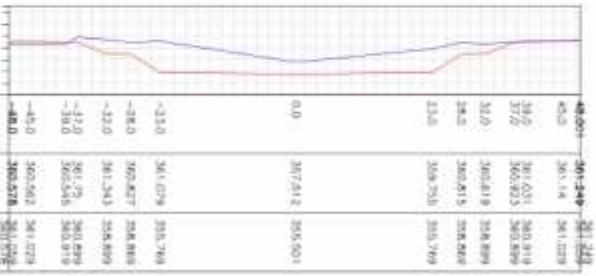
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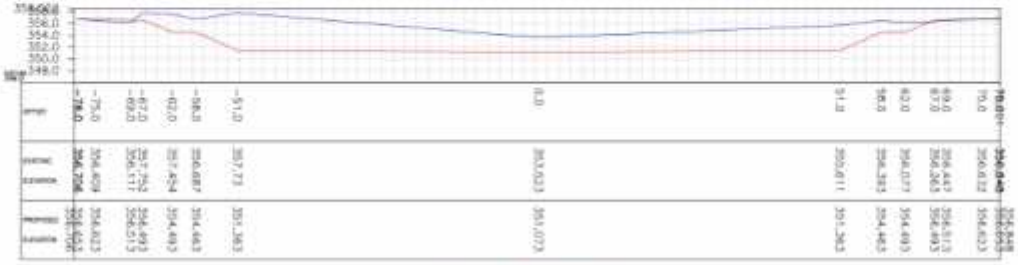
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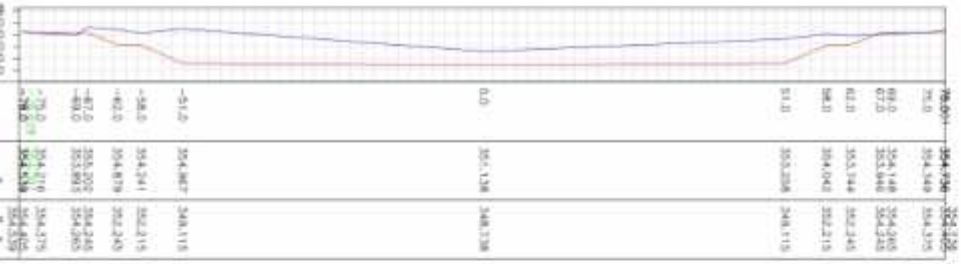
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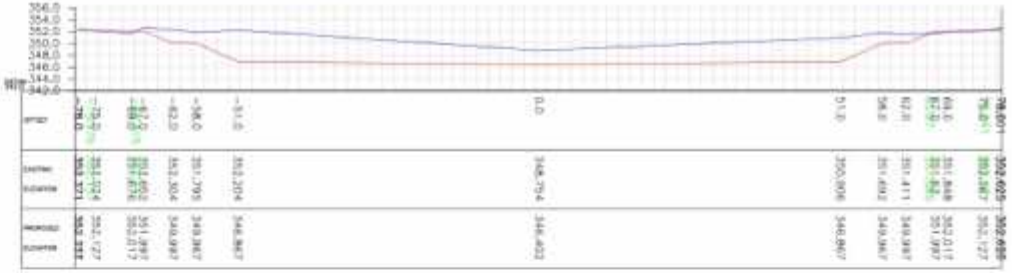
Ch: 34000



Ch: 35000



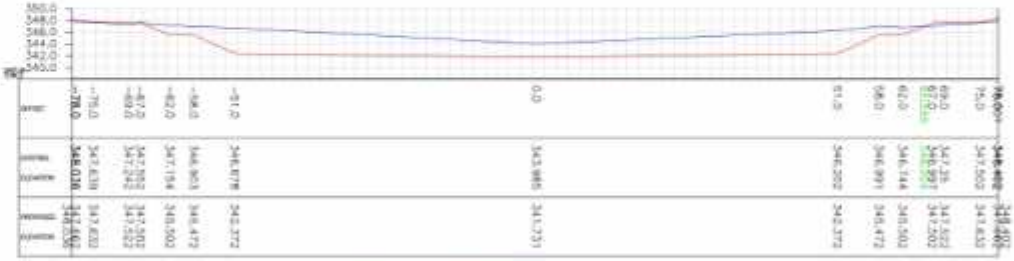
Ch: 36000



Ch: 37000



Ch: 38000



Ch: 39000

REVISIONS		

DATE:

SCALE:

DWG NO: UDH/JDA/AMANI/CS/38

REVISION:

DRAWING TITLE:

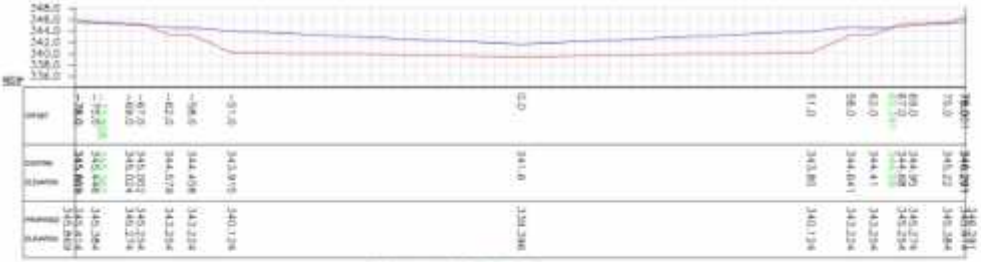
CROSS SECTIONS
FROM CHAINAGE:31000 TO 39000

PROJECT TITLE:

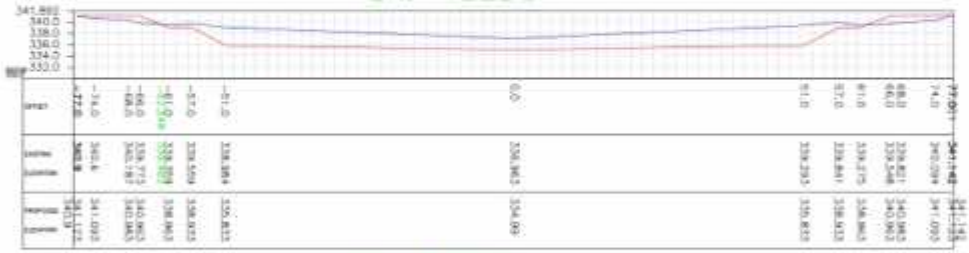
REJUVENATION OF AMANISHAH NALLAH
INCLUDING AREA DEVELOPMENT PROJECT

EMPLOYER:

URBAN DEVELOPMENT & HOUSING (UDH)
GoR
THROUGH JAIPUR DEVELOPMENT AUTHORITY (J



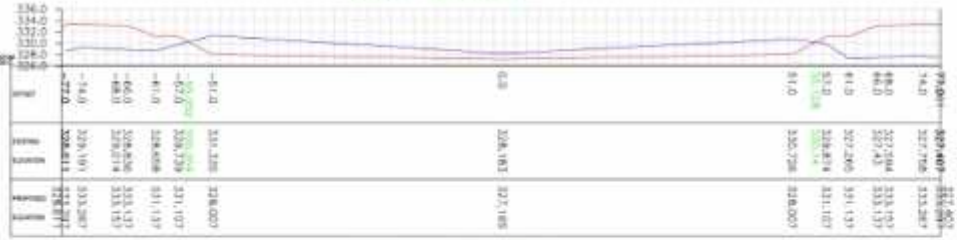
Ch: 40000



Ch: 42000



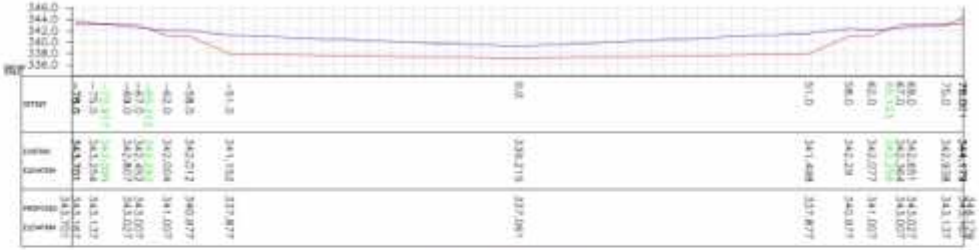
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Ch: 46000



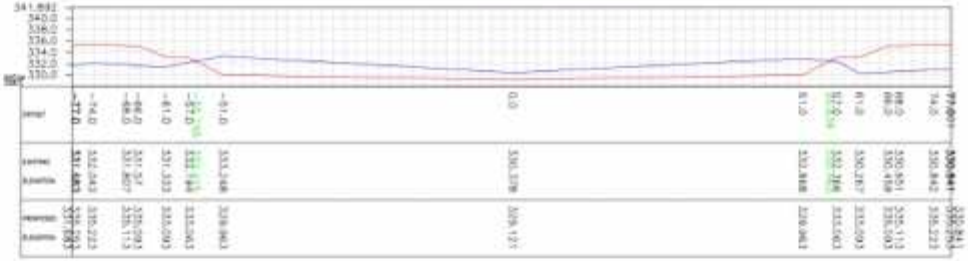
Ch: 47500



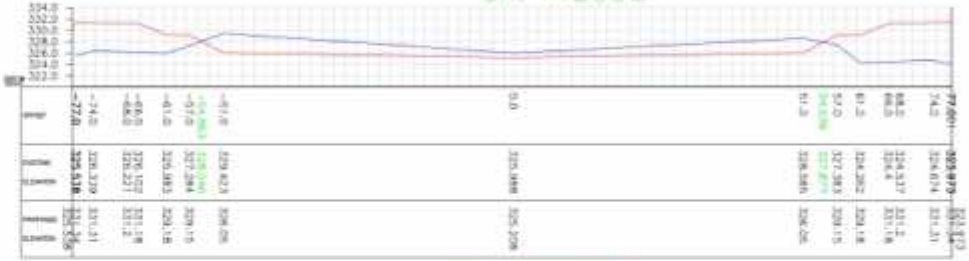
Ch: 41000



Ch: 43000



Ch: 45000



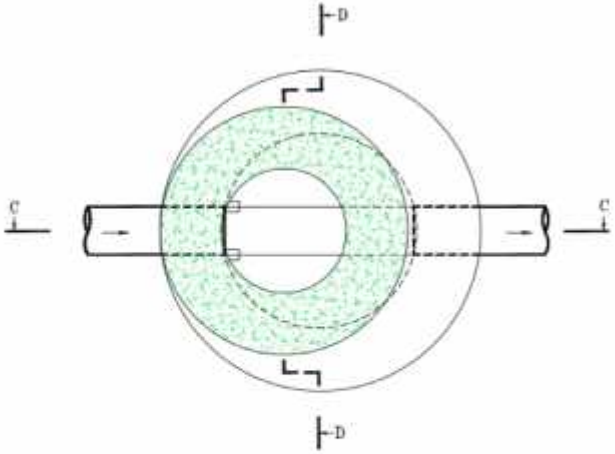
Ch: 47000

REVISIONS	DATE:	DRAWING TITLE:	PROJECT TITLE:
	SCALE:	CROSS SECTIONS FROM CHAINAGE:40000 TO 47500	REJUVENATION OF AMANISHAH NALLAH INCLUDING AREA DEVELOPMENT PROJECT
	DWG NO: UDH/JDA/AMAN/CS/39		
	REVISION:		

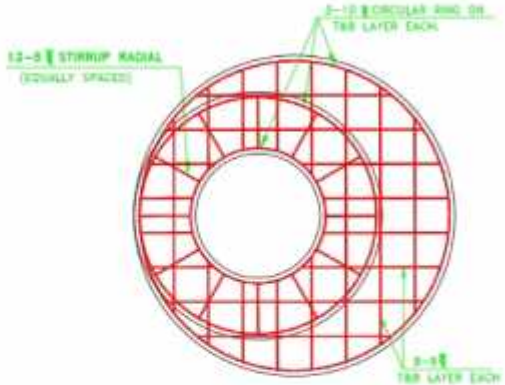
EMPLOYER:

URBAN DEVELOPMENT & HOUSING (UDH)
GoR
THROUGH JAIPUR DEVELOPMENT AUTHORITY (J

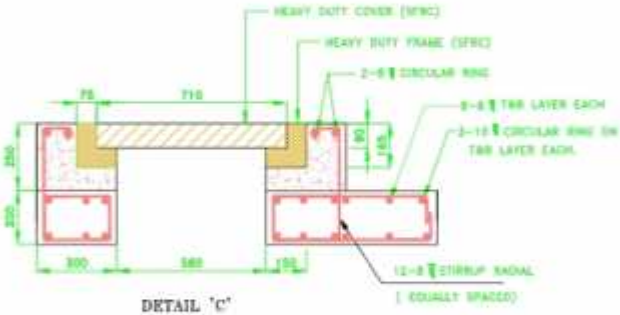
TENDER PURPOSE ONLY
Prepared by Project Proponent)



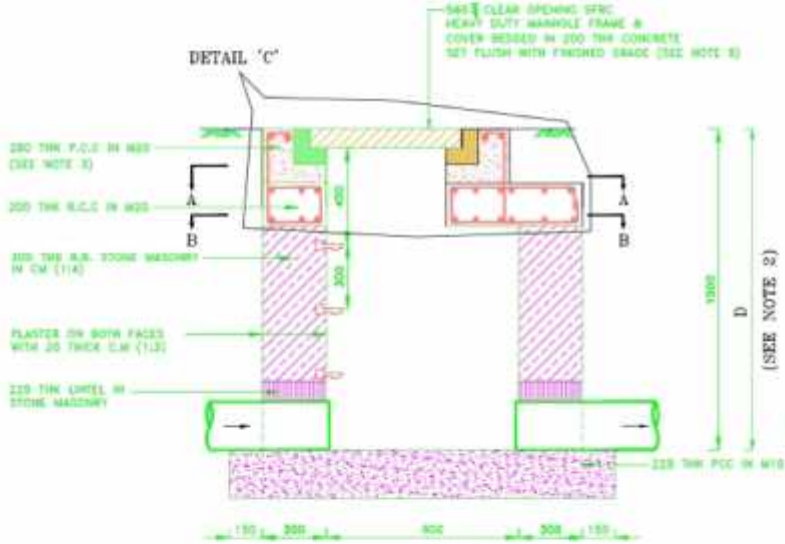
SECTION 'AA'



SECTION 'BB'

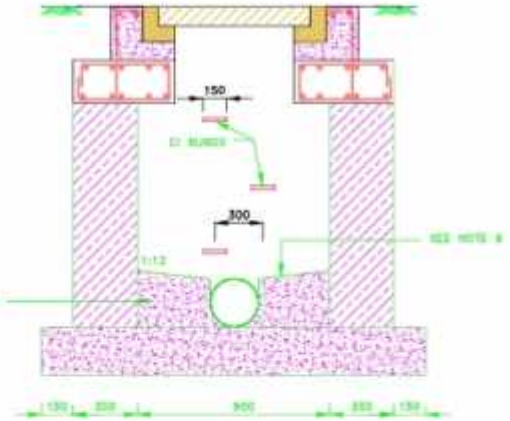


DETAIL 'C'
SCALE 1:20



SECTION 'CC'
UPTO 500ø SEWER
D ≤ 1500

TYPE 'A'



SECTION 'DD'

Notes:
1. ALL DIMENSIONS ARE IN MM.
2. 'D' IS THE DEPTH FROM GROUND LEVEL TO LOWEST SEWER INVERT LEVEL IN MANHOLE.
3. 230 THICKNESS OF CONCRETE CAN BE VARIED TO FLUSH MANHOLE COVER AND FRAME WITH ROAD SURFACE.
4. C.I STOP AS PER I.S. 5456. FOOT REST SHALL BE PAINTED WITH COAL TAR.
5. SFRC MANHOLE FRAME & COVER OF HEAVY DUTY AS PER I.S.12592 (PART 1 & 2).
6. THE BENCHING AT THE SIDE OF THE CHANNEL SHALL BE AT LEAST 50mm ABOVE THE CROWN OF THE PIPE AND THEN RISE WITH A SLOPE OF 1 IN 12 TOWARDS THE SIDE OF THE MANHOLE.

REVISIONS			
NO.	DATE	DESCRIPTION	SIGN

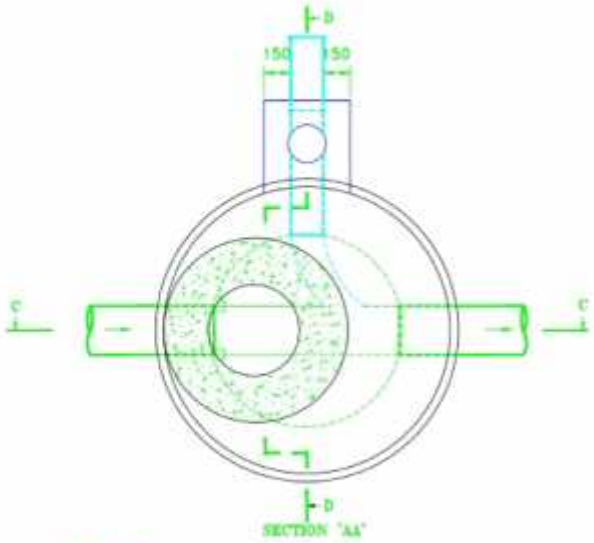
DATE:
SCALE:
DWG NO: UDH/JDA/AMAN/MANHOLE/40
REVISION:

DRAWING TITLE:
MANHOLE TYPE-A

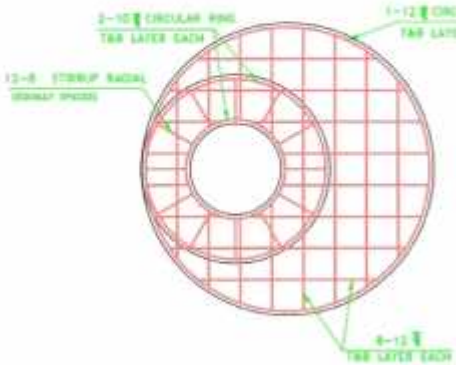
PROJECT TITLE:
REJUVENATION OF AMANISHAH NALLAH
INCLUDING AREA DEVELOPMENT PROJECT

EMPLOYER:
URBAN DEVELOPMENT & HOUSING (UDH)
GoR
THROUGH JAIPUR DEVELOPMENT AUTHORITY (JDA)

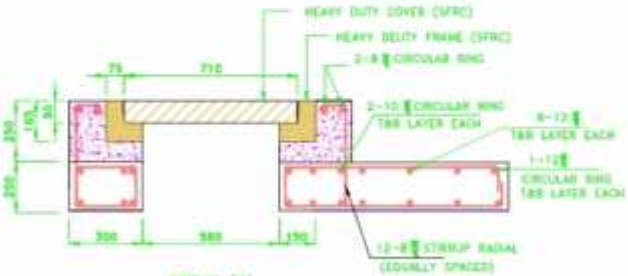
TENDER PURPOSE ONLY
Prepared by Project Proponent



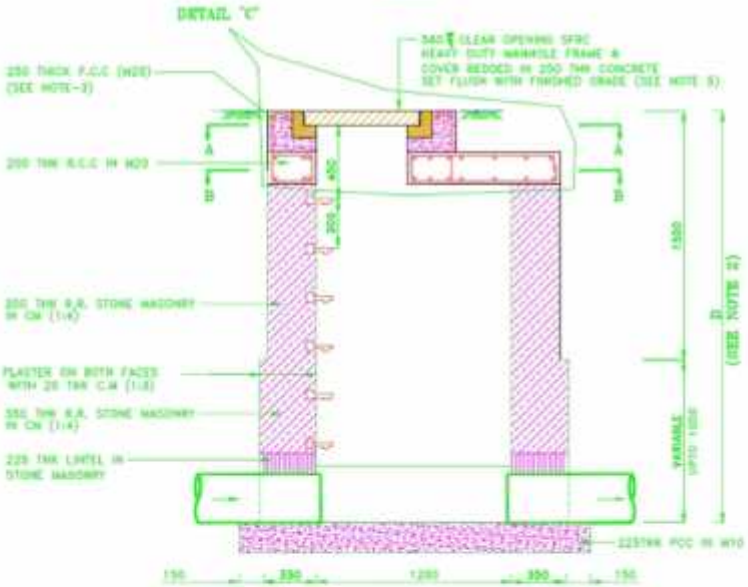
SECTION 'AA'



SECTION 'BB'

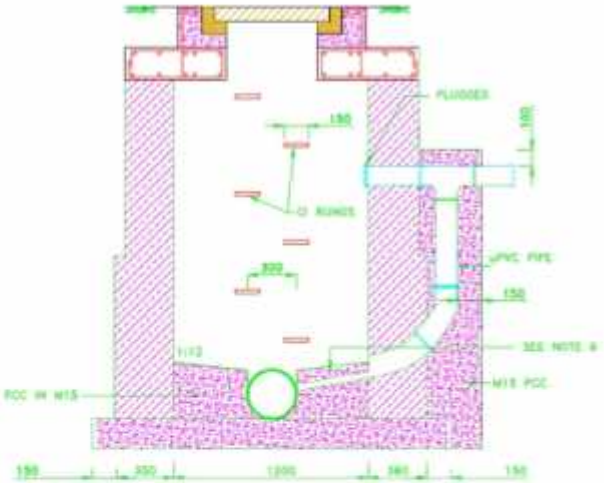


DETAIL 'C'
SCALE 1:20



SECTION 'CC'
UPTO 600ϕ SEWER
1500 < D ≤ 2500

TYPE 'B'

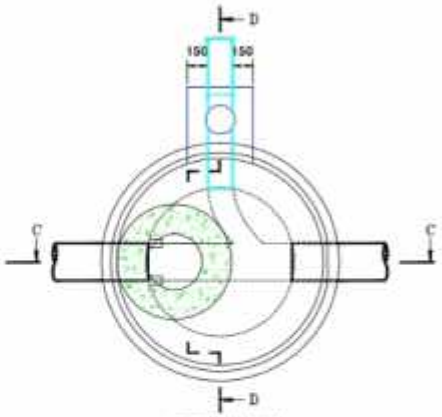


SECTION 'DD'
TYPICAL DROP ARRANGEMENT

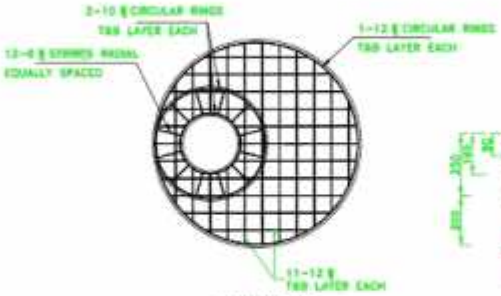
NOTES:
1. DIMENSIONS ARE IN MM.
2. "D" IS THE INTERNAL DIAMETER (SIZE) OF SEWER (SEWER HEIGHT (SIZE) IN RECTANGULAR SEWER).
3. THE THICKNESS OF CONCRETE MAY BE REDUCED TO SUCH REASONABLE LIMITS AS MAY BE DECIDED BY THE ENGINEER.
4. ALL EDGES OF RCC OR PCC SHALL BE CHAMFERED WITH 20mm SIDE.
5. COVER MANHOLE FRAME & COVER OF HEAVY DUTY AS PER IS:1726 (LATEST REVISION) CLASS D.
6. THE DIMENSIONS OF THE PIPES OF THE CHAMBERS SHALL BE AS GIVEN ABOVE FOR SEWER OF THE SIZES AND THOSE NOT GIVEN SHALL BE DECIDED BY THE ENGINEER.

REVISIONS				DATE:	DRAWING TITLE:	PROJECT TITLE:	EMPLOYER:
NO.	DATE	DESCRIPTION	DATE	SCALE:	MANHOLE TYPE-B	REJUVENATION OF AMANISHAH NALLAH INCLUDING AREA DEVELOPMENT PROJECT	URBAN DEVELOPMENT & HOUSING (UDH) GoR THROUGH JAIPUR DEVELOPMENT AUTHORITY (JDA)
				DWG NO: UDH/JDA/AMAN/MANHOLE/10			
				REVISION:			

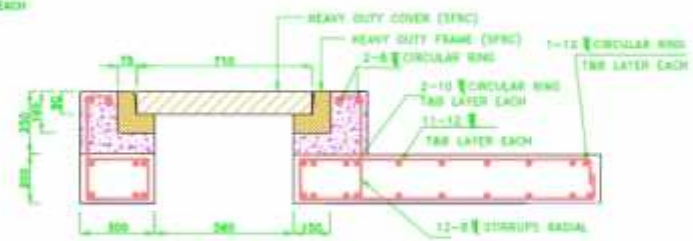
TENDER PURPOSE ONLY
Prepared by Project Proponent



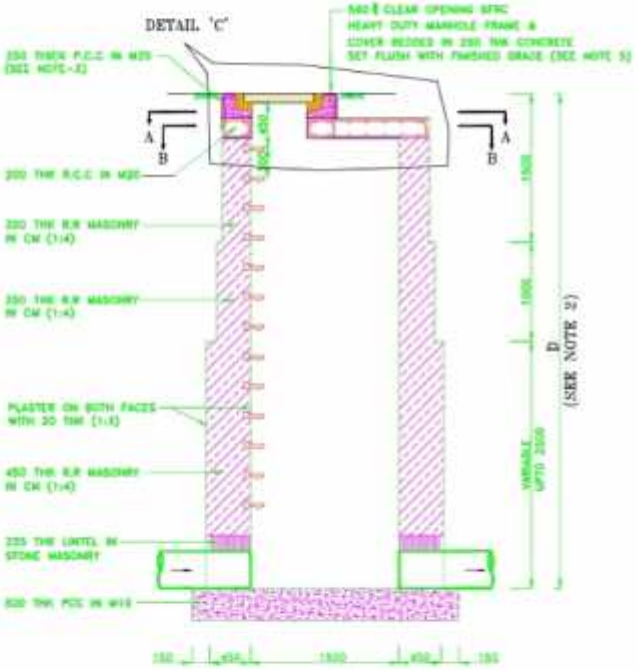
SECTION 'AA'



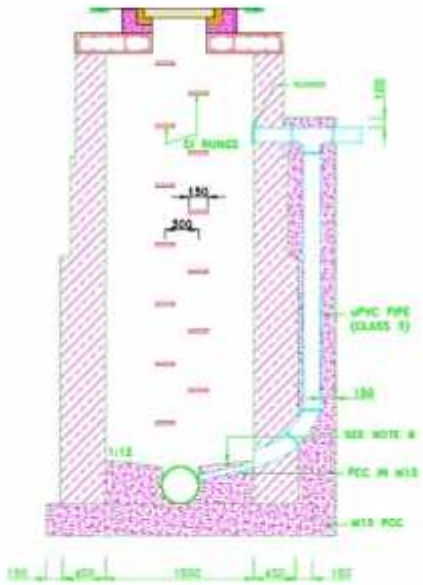
SECTION 'BB'



DETAIL 'C'
SCALE 1:20



SECTION 'CC'
UPTO 600ϕ SEWER
2500 < D ≤ 5000



SECTION 'DD'
TYPICAL DROP ARRANGEMENT

TYPE 'C'

Notes:
1. ALL DIMENSIONS ARE IN MM.
2. 'D' IS THE DEPTH FROM GROUND LEVEL TO LOWEST SEWER INVERT LEVEL IN MANHOLE.
3. 230 THICKNESS OF CONCRETE CAN BE VARIED TO FLUSH MANHOLE COVER AND FRAME WITH ROAD SURFACE
4. CI STEP AS PER I.S. 5455. FOOT REST SHALL BE PAINTED WITH COAL TAR.
5. SFRC MANHOLE FRAME & COVER OF HEAVY DUTY AS PER I.S:12592 (PART 1 & 2).
6. THE BENCHING AT THE SIDE OF THE CHANNEL SHALL BE AT LEAST 50mm ABOVE THE CROWN OF THE PIPE AND THEN RISE WITH A SLOPE OF 1 IN 12 TOWARDS THE SIDE OF THE MANHOLE.

REVISIONS			
NO.	DATE	DESCRIPTION	SIGN

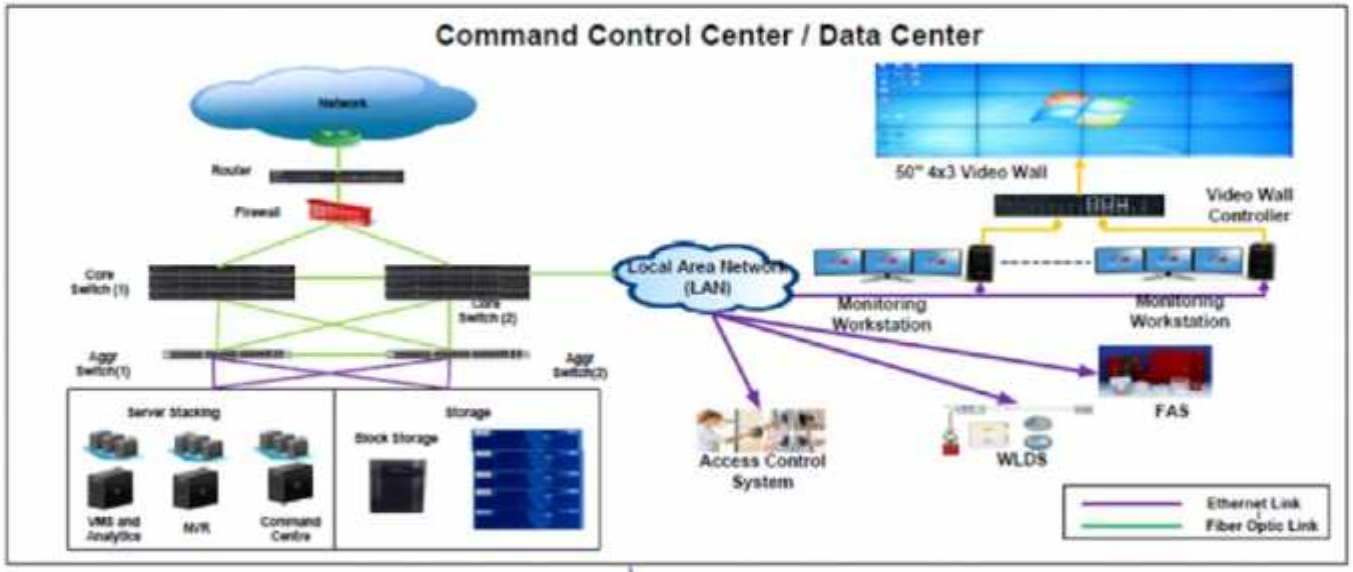
DATE:
SCALE:
DWG NO: UDH/JDA/AMAN/MANHOLE/42
REVISION:

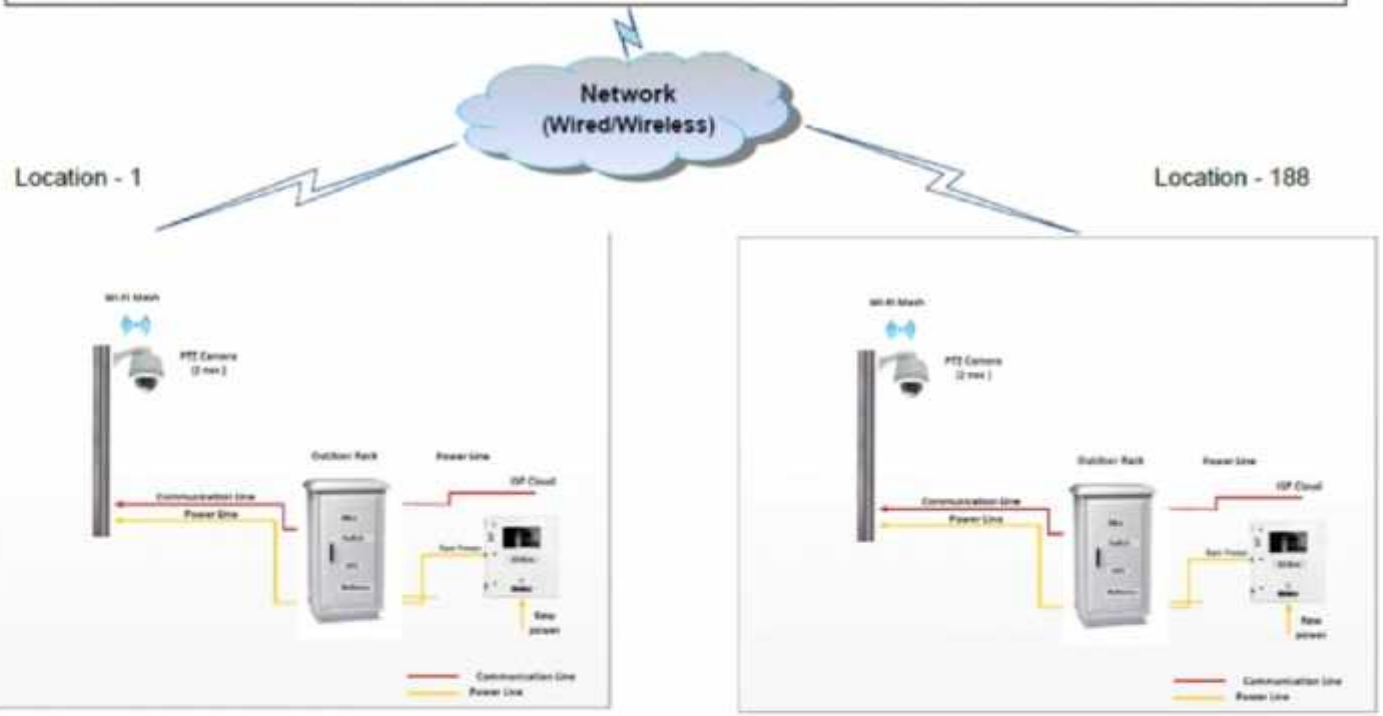
DRAWING TITLE:
MANHOLE TYPE-C

PROJECT TITLE:
REJUVENATION OF AMANISHAH NALLAH
INCLUDING AREA DEVELOPMENT PROJECT

EMPLOYER:
URBAN DEVELOPMENT & HOUSING (UDH)
GoR
THROUGH JAIPUR DEVELOPMENT AUTHORITY (JDA)

TENDER PURPOSE ONLY
Prepared by Project Proponent





REVISIONS			

DATE:
SCALE:
DWG NO: UDH/JDA/AMAN/SSA/43
REVISION:

DRAWING TITLE:
SUGGESTIVE SYSTEM ARCHITECTURE

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REJUVENATION OF AMANISHAH NALLAH INCLUDING AREA DEVELOPMENT PROJECT

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GoR
THROUGH JAIPUR DEVELOPMENT AUTHORITY (JDA)

SECTION-10: DPR OF PROJECT PROPONENT

(Attached Separately in Volume-2)

TATA PROJECTS
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TATA

Section-10: DPR of Project Proponent



Detailed Project Report

Amanishah Nallah

19th October 2015

"Rejuvenation of Amanishah Nallah including Area Development
under mandate dated 03.March.2015 issued by Jaipur Development Authority"

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LIST OF ABBREVATIONS

AMS	Annual Maximum Series
AN	Amanishah Nallah
BC	Bituminous Concrete
BoQ	Bill of Quantities
BT	Bitumen
CBR	California Bearing Ratio
CI	Cast Iron
CPHEEO	Central Public Health & Environmental Engineering Organisation
DBM	Dense Bituminous Macadam
DEM	Digital Elevation Model
DI	Ductile Iron
EOI	Expression of Interest
FRC	Fabricated Reinforced Concrete
HRB	Highway Research Board
IMD	Indian Meteorological Department
IRC	Indian Road Congress
JDA	Jaipur Development Authority/ Project Authority
MPC	Multipurpose Corridor
MSA	Million Standard Axles
MSL	Mean Sea Level
OF	Outfall
OMC	Optimum Moisture Content
PDS	Partial Duration Series
RCC	Reinforced Concrete Cement
ROW	Right of Way
SFRC	Steel Fabricated Reinforced Concrete
TA	Transactional Advisor (PDCOR)
TCS	Typical Cross Section
TPL	Tata Projects Limited
UCR	Un-coursed Rubble Masonry
WBM	Water Bound Macadam
WMM	Wet Mix Macadam
TPL	Tata Projects Limited

CHAPTER 1: EXECUTIVE SUMMARY

1.1 BACKGROUND

Tata Group attended a conference on Urban Transformation organized by Govt. of Rajasthan on 30.Sep.2014. The group was provided an opportunity to identify potentially transforming urban infrastructure projects in any two cities of the Rajasthan State and submit a formal response in 45 Days. The group identified the city of Jaipur for carrying out this Urban Transformation and a formal Expression of Interest (EOI) was submitted to Jaipur Development Authority (JDA).

A Cross Functional Team from Tata Projects was formed for Project assessment. Based on preliminary Project field surveys and other studies, the following project was identified as being critical for development of the city of Jaipur:

- **Rejuvenation of Amanishah Nallah including Area Development**

Government of Rajasthan (GoR) had examined Tata Group's EOI and accorded its mandate to Tata Group for submitting a DPR (Detailed Project Report) to JDA (Jaipur Development Authority). Tata Projects Ltd. (TPL) has been identified to take responsibility of the project development in these JDA projects.

About Tata Projects Limited

Established in 1979, Tata Projects is the EPC (Engineering, Procurement and Construction) company of Tata Group.

Tata Projects has focused its Strategic Business Units operating in core sectors such as:

a) **Urban Infrastructure** - Buildings (Commercial & Residential), Transport (Metros), Airports & Ports, Hydro Power.

b) **Industrial Infrastructure** - Construction Services primarily in Water & Wastewater; Power Generation, Metals & Minerals, Oil Gas & Hydrocarbons, Transmission & Distribution, Roads and Railways.

c) **Utility Services** – Potable Water Treatment Units

d) **Quality Services**– Third Party Inspection, Certification, Testing and Skill training.

Tata Projects is a pioneer in meeting the special and specific needs of these vital sectors with comprehensive solutions,state-of-art technologies, using innovative project execution methodologies, for delivering Projects on time, and with the highest quality standards.

1.2 THE ASSIGNMENT

For development of Amanishah Nallah project under Swiss Challenge Guidelines, Tata Projects identified Shanghai Urban Construction Group (SUCG), China as a prospective suitable partner (after an extensive global search) based on their experience in design and execution of projects similar in size and in similar climatic conditions. TPL and SUCG then took assistance from ECOFIRST (Subsidiary of Tata Consulting Engineers) and Shanghai Urban Construction Design and Research Institute (SUCDRI) (SUCG design arm) for all design aspects, and engineering to prepare the DPR.

TPL conducted preliminary field surveys supported by JDA with for field visits, historical data, past reports, drawings, maps and other details. A Vision presentation was made to Honourable Chief Minister of Rajasthan on 19 Dec. 2014. Subsequently an Expression of Interest (EOI) to develop the project was submitted on 23rd January 2015 to the Department of Urban Development and Housing (UDH), GoR. Following the EOI, JDA issued mandate on 03rd March 2015 under SWISS Challenge Method (SWM) for “Rejuvenation of Amanishah Nallah including Area Development.” A status presentation has been made to Hon’ble Chief Minister on 16th Jul. 2015, when CM reviewed the work done by TPL as well as further process steps leading to award and execution of the Project.

1.2.1 SCOPE OF WORKS

The scope of works considered for the DPR and SWISS proposal is as per the mandate issued and is detailed below:

1. **Course correction /Strengthening**
   a. Structure and align the existing Nallah with clear base/bed width, top width, sloping sides, center alignment, embankments, etc.
   b. 100 year flood discharge in the catchment area: the bed and the sides shall be able to withstand velocities and discharge of 100 year flood.
   c. To take care of energy dissipation arrangements all along the length of the Nallah including high energy of a 100 year flood event.
   d. Provide perennial flow of water in Nallah
   e. Provide appropriate connection and movement options from one side of the Nallah to other side
   f. Provide appropriate arrangements for crossing of utility pipes and cables between two ends.
   g. Arrest sediments and other waste material from the incoming streams to protect main water front stream.
   h. Upstream catchment improvement: to improve the rain water inflow into the Amanishah Nallah.

2. **Sewerage interception and treatment:**
   a. to intercept all the raw municipal waste water currently discharged into the Amanishah Nallah
   b. To treat the municipal waste water to relevant discharge norms either in a centralized manner or a decentralized way.
   c. To treat the municipal waste water in least area possible so as to keep valuable land free for other purposes.
   d. Treatment shall:
      i. Ensure no foul odour emission.

ii. Be high on sustainability quotient
iii. Be low on maintenance cost
iv. Be low on carbon footprint
v. Be robust to take care of seasonal variations of inflow.

e. Design shall be such as to merge with surrounding landscape.

f. To provide Uninterrupted power distribution from the nearest 33 kV distribution station via underground cabling or overhead line after ensuring 33 kV power spare outgoing feeder is available at the substation. This 33 KV power is stepped down to feed the LT loads in each STP. Similarly availability of power is to be ensured from the nearest 11kV / LT source to feed the Lighting loads.

g. The Water and Power charges (for running all the STP auxiliaries, lighting, street lighting) on commercial basis shall be assumed to be in the scope of the bidder.

3. Improving Water Quality Standard in the stream

a. Municipal Waste water shall be treated to the extent that it can be put into the proposed water front without any adverse impacts on health, hygiene, environment, aesthetic and smell of the area

4. Improving Water Availability in the stream

a. Shall provide a perennial water depth about 0.25 mtrs or 0.3 mtrs by construction of check-dams and reservoirs at various locations

5. Land Area Development planning along the Nallah

a. To provide a robust business plan along with Master Plan of the proposed reclaimed government land in and around the Amanishah Nallah, including landscape plan for the same.

b. As a part of the present development, at least two land parcels of not smaller than 25,000 sq, m each are to be developed which can be

merged/connected with the current water front development project loped and fits into the proposed Master Plan of the area.

c. To provide a clear walking avenue of at least 3 m wide for movement and 1 m wide for sitting.

d. To provide mass sitting/functional space for mass gathering on both side of the water front.

e. To provide safe area by providing railing/parapet along the water front and for all structures crossing the water front.

f. To provide at least 2 m wide tree plantation landscape bank

g. The whole water front shall be well lit all along the Nallah length as per the standards of lux level in public areas

h. Ornamental bollard light shall be used on the edge of the water front.

i. To provide arrangements for surveillance for 24X7 with CCTV camera of appropriate resolutions, at appropriate locations covering all proposed area along the length of the Nallah with all necessary power back system and cablings.

j. All CCTV feed shall be directed to control room situated appropriately on or very near to Nallah and connected to relevant police station through appropriate connectivity.

k. At least one month feed storage capacity shall be provided for the CCTV feed.

l. Appropriate software and connectivity system with integrated solutions shall be provided for surveillance and security aspects.

m. All along the Nallah a parallel road (wherever possible) shall be constructed for public use (minimum width of 5.5 m) along with pedestrian footpath of 3 m.

n. All proposed road and food path, common area; public areas shall have LED street lights for appropriate lux level of public area uses.

o. At least 50% of the street lights shall be powered by solar power of sufficient capacity.

p. Shall provide following buildings as part of the development

   i. Emergency Response Centre

ii. Security Gate
iii. Security Room
iv. Office space for maintenance and operation staff
v. Storage yards for equipment
vi. Exhibition Centre

q. All intersections points of approaching roads to Amanishah Nallah need to be developed for traffic management and as center point of activities.
r. Sufficient arrangements for vendors and other necessary commercial centres along the Nallah in public spaces shall be done to take care of the visitor's routine requirements.
s. Sufficient number of public toilets and toilets shall be made available. Sufficient arrangement for toilets shall be done to take care of current needs of the slums or other colonies who are currently using Amanishah Nallah for open defecation and can use these toilets after development of Amanishah Nallah water front.
t. The Water (construction and others) and Power charges (for street lighting) on commercial basis shall be assumed to be in the scope of the bidder.

6. Operations and Maintenance for 10 Years:
   a. Operations and Maintenance of the Sewage Interception Network, Pumping Systems and Sewage Treatment Plants.
   b. Operation and Maintenance of landscaping along the Nallah.
   c. Operation and Maintenance of utility provisions along the Nallah.
   d. Collection of solid waste from the Surface of the Nallah and its banks and disposal to the Govt. designated sites.
   e. Use of Maintenance equipment like amphibian carriers, dredgers etc. for hyacinth and sediment clearance.
   f. Measurements and monitoring which includes measurement of water quality and energy consumption segments, hydro-meteorological parameters measurement instruments and for collecting other weather details like solar radiation level, wind velocity, direction, temperature, humidity etc.

1.3 FIELD SURVEYS & DATA COLLECTION

Detailed survey of Amanishah Nallah has been carried out from 0 chainage (about 5 KM upstream of Mazar Dam) to 47.5 KM chainage. Topo survey plan has been provided and attached as drawing .no. W-JDA-AN-DRG-001 in the DPR.

Amanishah Nallah originates from the western slopes of Amer hills. It flows through the west side of Jaipur city from North to south. It collects storm water from Nahri ka Nallah, Ambabari, major portion of walled city and newly developed areas of Jaipur through Ganda Nallah, Sanganer Town and Pratap Nagar area. The Ganda Nallah and Jawahar Nallah are major tributaries of Amanishah Nallah. The Nallah on its way collects municipal wastewater, sewage, storm water and industrial waste from surrounding areas. The bed slope of Nallah is very steep which results in soil erosion. Total difference in elevation from 0 to 47.5 km is 134 m. There are lot of encroachments on Nallah banks from chainage 11 KM to 21 KM and these encroachments have reduced the cross section of Nallah and also obstructed the flow of water.

Treated sewage from two sewage treatment plants at Delawas and Swarna Jayanthi Park (Mazar dam) is released in to Amanishah Nallah. Some of the populous habitats located along and near the Nallah directly discharge sewage into the Nallah. At certain locations, the sewage gets injected into the soil and therefore does not reach the Nallah.

The Pink city of Jaipur like most other in India lacks solid waste management system and significant portion of such waste is dumped into the Nallah.

Untreated waste from industries especially textile mills, printing units near Sanganer and other industries causing pollution and contamination of Ground water also find their way into the Nallah.

The anthropogenic pressure in the catchment has resulted in degradation in bio-diversity and consequent erosion and increased silt flow in the erstwhile river bed.

Objectives of survey:

The primary objectives of survey are noted below:

- Determine the latest longitudinal section of Nallah
- Determine Cross sections of Nallah at regular intervals
- Locating various other Nallah's and sewer lines (from colonies) joining Amanishah Nallah
- Identification of various encroachments
- Identification of areas available for landscaping
- Identifying suitable locations for providing drop structures
- Identifying water reservoirs etc.

1.3.1 **SURVEY METHODOLOGY:**

For survey of Amanishah Nallah, 6 teams with Total Station equipment were deployed. Longitudinal sections with levels at around 250 m interval were plotted and sections at every 1 Km were prepared. There are about 30 existing bridges, culverts, and causeways at various locations of Nallah for which details have been collected.





1.3.2 SURVEY OBSERVATIONS:

- Total length of Nallah from starting point to its confluence with Dhund river is 47.5 Km.
- Difference in elevation from Zero chainage to 47.5 Km chainage is 134 m which gives a slope of 1 in 354.48 m which is quite an unstable slope.
- This steep slope needs to be stabilized by means of providing pucca drop structures at various suitable locations.
- In chainage 11 Km to 21 Km, Nallah is required to be widened so as to pass the designed discharge. This would involve removable of some pucca properties also.
- At some places, Sewerage lines from colonies are directly discharging into the Nallah.
- There are more than 75 locations wherefrom sewerage of nearby colonies and storm water during rainy season enters into the Nallah.
- There are more than 12 bigger drains wherefrom sewerage and storm water enters into the Nallah.
- There are more than 50 internal colony roads terminating at or near Nallah

1.4 DESIGN CONSIDERATIONS

The complete development project has been planned on fundamental sustainability principles with a consideration to develop a robust ecosystem which can withstand general public use. While planning, the theme of sustainability has been integrated with the current National focus of “Swacch Bharat”, “Swasthya Bharat” and “Surakshit Bharat” which is a directive of Honourable Prime Minister Shir. Narendra Modiji.

Important considerations in the design are given below:

- Field Investigation: Fully utilize the available data. Attention to the important problems which may influence the realization of comprehensive rehabilitation target with flood prevention, sewerage and its inception, interception and treatment, area beautification and other associate works with feasible plans.
- Watershed Management: Systematic plan for water engineering within the catchment area.
- Multi-functional Positioning: Combine flood prevention, pollution treatment and ecology landscape with catchment improvement.
- Design for 100 year flood discharge: Peak flood discharge has been calculated using Rational Method for all the 13 reaches of the Nallah. Maximum discharge in the end reach has been worked out as 766.56 cum/sec. In addition to this, a check under extreme flood discharge calculations by Synthetic Unit Hydrograph (SUH) method has been done. Highest discharge value for 100 year return period arrived at by this method is 1674 cumec. Though the probability of such event is extremely remote care has been taken to ensure that even such extreme flood events will be limited within the proposed freeboard area of the channel and necessary protection measures have been adopted for the base as well as freeboard sections.

  In addition an additional provision of suitable gated spilling structure at Mazar dam has been proposed which increases the discharge capacity of the dam from 28 cusecs to 45 cusec in the event of extreme 100 year return year flood event (as calculated by SUH).
- Cement concrete lining of 20 cm thick M 25 grade laid by Paver machine is proposed from Chainage 5100 to 34800 and Stone Pitching lining, 23 cm thick from Chainage 34800 to 47500.
- The Peak Flood discharge computed as per SUHG method: The peak flood at the tail reaches works out to be 1674 cumecs out of which 767 cumecs is proposed to be passed through Box Section where concrete lining is

proposed and remaining 907 cumecs is proposed to be passed from upper Free Board section comprising of Grass Turfing / Stone Steps

- Sewage Treatment and Control: Comprehensive measures to avoid direct discharge of raw sewage and raw industrial effluents are considered here. Since the recharge of the Nallah depends on sewage and its treatment, it is proposed to set up STP's to treat the raw sewage entering the Nallah and discharging the treated sewage into the Nallah after its alignment and rehabilitation to ensure perennial flow. It will be required to prevent raw industrial effluent from being openly discharged into natural streams. Hence it is proposed to have the Authorities ensure strict compliance of treatment of all/any industrial effluent (to achieve surface disposal norms) by the local industry (hence not a scope of this project). Industrial effluent treated to relevant surface disposal standards may be taken for charging the channel after relevant tests and compliances by the concerned authorities.

  For treatment of raw sewage entering the channel, Sewage treatment plants with primary and secondary treatment would be set up at various locations depending on land availability (land for construction of such STP's would be allocated from the land parcels available with JDA/GoR) and on merits of using gravity flow vis-à-vis pumping. Total STP capacity would be equal to the quantity of untreated sewage being presently discharged into the open Nallah plus the projected population growth as well as the consideration for storm water discharge.
- Bank Protection: Attention to bank protection from the viewpoint of ecology, selection of river section structures, landscape and a harmonious relationship between mankind and nature. Slopes above the base lining of Nallah are covered with grass turf / stone pitching.
  - At the top of Nallah banks, provision has been kept for planting approximately 12000 numbers of trees. Shrubs and ornamental plants are provided in the Tree lined-avenue with adequate lighting.
- Alternate panels of 10m width comprise of Grass Turfing / Stone Steps are proposed to be provided in the upper box section of the Nallah all along its length.

- Upstream Dam Ecology: To increase the inflow of water in Mazar dam, a channel is proposed to be excavated from the other catchment zone (west of Athunia Kund area) which is currently not feeding into the Amanishah Nallah, so as to direct additional seasonal rain water and increase the flow. Additionally proposed provision of suitable gated spilling structure will not only help to moderate the extreme flood events of upstream of Mazar dam but will also help to release some water during non-rainy days if sufficient water is available in Mazar dam.
- Development Plan: It is conceived to have a service road of 5.5 m width provided on both sides of Nallah where government lands are available. In total 16 Km of road construction has been proposed in current proposal. Wherever it is not possible to take up road, it is proposed that all road intersections of internal roads with Nallah shall also be developed so as to provide parking space and space for hawkers. Proposed Nallah development and STP work shall be taken up starting from Mazar dam onwards and suitable phasing as per site conditions will be planned. However suitable catchment improvement measures have been proposed in reaches upstream of Mazar dam.

1.5 TIMELINES

Table 1-1 Project Schedule

#	Activity	Who	Timeframe	Remarks
1	Submission of Final DPR under SWISS Challenge Guidelines	Tata Team	October 2015	6 draft DPR's have been submitted till 1st Sept 2015
2	Tendering and Award Process	JDA/TA	25th October to 30th November 2015	This would be in line with the agreement between GoR, TA, Proponent and allied government services
3	Letter of Intent	Govt. of	First week	Zero date for Project

#	Activity	Who	Timeframe	Remarks
		Rajasthan	of December 2015	
4	Engineering	Successful Bidder	Jan 2016	
5	Construction Phase		May 2018	30 Months from LOI
6	Target completion of Project and start of Operations and Maintenance scope		June2018	10 years O&M

1.6 AREA DEVELOPMENT

Development and Commercialization - Government Lands / Other Lands

Development of Amanishah Nallah will result in cleaner, clearer, odourless flowing water which will be suitable for survival of aqua life and in creation of river front with better aesthetic surroundings. Further, it would also result in reclamation of Government land of approximately 8.5 Lakh sq. m that can be valued cumulatively at more than Rs. 1700 crores. The project implementation will greatly improve the aesthetics of the surrounding land parcels all along the Nallah. These newly unlocked land parcels will facilitate holistic development of various facilities and public conveniences through multiple uses.

Water

170 MLD of untreated municipal wastewater is likely to be available for treatment and discharge into the Nallah after implementation of this project. After discharge of this water into the Nallah for maintaining a flowing water body, part of this water can be utilised for agriculture, commercial and residential construction, industrial purposes and for various other purposes (after suitable further treatment if required). The recharged water flowing through the Nallah length if tapped for direct reuse or reuse after tertiary treatment would serve as revenue generator. A conservative estimate of income out of such a sale of water would be around Rs. 13 crores at Rs. 10 per 1000 Litres.

Master Plan

Current project and development proposal does not include / scope details of any/or all Land Use. Master planning exercise would be taken up further to the execution of this Project. Depending on the development and final size, location and character of these land parcels (Execution would be done based on detailed engineering by the successful bidder), which would include participatory approach by the people at

large. A program will be adopted to develop the released spaces. The proposed Master Planning exercise will include following steps:

- Market survey
- Locational assessment
- Need assessment
- Product mix
- Business Plan and strategies for development
- Master Plan
- Landscape plan

1.7 ECONOMIC BENEFIT ASSESSMENT (EBA)

There are several intangible benefits of this project such as – cleaner water, air, and land mass. This would result in, appreciation in land value, improvement in health of the citizens, higher ground water availability, better ground water quality, employment generation, creation of business opportunities etc.

The economic value/gain corresponding to the above benefits has been calculated. Per sq. m rate of reclaimed land is uniformly considered @ Rs. 20000/-. For other adjoining lands (Government land) which are not directly connected with channelization of Nallah, average appreciation in land price @ Rs. 4000 per sq. m has been considered.

Most of the land parcels that would be reclaimed as well as those parcels that would be appreciated due to rejuvenation belong to JDA and other beneficiary departments such as RIICO, RHB, PHED and Irrigation.

- The total land to be reclaimed - 8.56 Lakh sqm
- The total land that would be appreciated - 5.3 Lakh sqm
- The value of reclaimed land - Rs. 1712 cr.
- The value of appreciated land - Rs. 212 cr.

The various options of revenues and expenses related to this project are as below:

Option 1: Land reclaimed from all departments is transferred to JDA and the amount realized through sale by JDA is utilized as capital for construction.

Option 2: JDA would sell its reclaimed land and other departments would contribute equivalent amount of the notional appreciated value of lands in their possession. In this case, the other departments would retain their reclaimed lands. This sum total would be form the capital to be utilized for construction.

1.8 SLEC (STATE LEVEL EMPOWEERED COMMITTEE) MEETING DATED 21.SEPTEMBER.2015

SLEC Meeting was held on Sep 21st 2015 under the chairmanship of Chief Secretary GoR in which TPL made a presentation on DPR before the committee. The Meeting concluded with a principal approval of the Project and suggested the following points to be discussed and resolved with TA:

1. To check the suitability of proposed section for maximum flood discharge calculated by Synthetic Unit Hydrograph (SUH) method.
2. Provision of Ground Water recharge
3. Total Sewage Treatment Plant capacity
4. Provision for addition / deletion of key BoQ Items

1.9 SUMMARY OF RESOLUTIONS BASED ON DISCUSSIONS WITH TRANSACTION ADVISOR

Subsequent to appointment of PDCOR as Transaction Advisor (TA), extensive technical discussions spread in several sessions were held between the team of Proponent & TA. During the course of discussions and meetings - various

documents, data, analysis, calculations, etc. were submitted to TA. Following is the summary of all the points raised and resolved. Subsequently, the agreed changes in scope and specifications including price impact have been incorporated in various sections of this DPR. The main points of the discussions are brifly summarised hereunder:

1. 100 year Flood discharge.

TA proposed a check for design for 100 year flood return period using SUH Synthetic Unit Hydrograph (SUH) method. Accordingly the same was carried out as additional check for flood carrying capacity. The discharge of 767 cumec considering Rational Method (RM) hence increased to 1695 cumec. The entire 1695 cumec discharge would still be within the channel boundaries.

Hence it was agreed to allow 767 cumec in base section and balance would be accommodated in the freeboard. As the velocities in the concrete lining reach is varying from 3.5 m/s to 5.15 m/s, reduction velocity is not possible because of constraints of land. Hence to accommodate higher velocities, the top lining for base section was changed from M 15 to M 25. To accommodate higher velocities, alternate panels each of 10 m width (i) RR stone work steps and (ii) grassing have been incorporated in the free board slopes when it would carry the 100 year flood discharge. It is also proposed to increase the height of parapet wall on top of the embankment to vary from 1 m to 1.5 m in different reaches.

2. Impact of 100 year flood discharge on Mazar dam.

Mazar Dam upstream to Amanishah Nallah has storage capacity of 8.1 mcum. In the worst case scenario on a 100 year flood discharge event, using SUH method, consideration was required to be given that the Dam would be full. In such a case, it was agreed to increase the discharge capacity of the Dam which is currently at 28 cusecs to 45 cusecs by providing a gated structure and lowering down the crest.

3. Ground Water Recharge.

The main bed of Nallah has presently only sewage and effluent flowing during the non-monsoon season (in less than 5 m wide stream during dry season). Pollutants in sewage and effluent have increasingly blocked the porosity of the soil in Nallah thereby reducing ground seepage. However since the existing natural surface will be lined, it was required and agreed to provide alternative measures of ground water recharge.

Area Method: The area currently available for natural ground water recharge is 30000 m x 4 m (avg) = 1.2 lac sq.m. Hence it is agreed and proposed to provide alternatively 1.5 lac sq.m of unlined surface where recharges can naturally be effected. This would be achieved in 3 parts:

1. Two parcels of 25000 sq m each to be developed as landscaped parks.
2. 1.6 lac sq.m of 2 m wide green strip running along both banks all along 42 km length.
3. 82 outfall areas would be developed as holding ponds, combining to 2 lac sq. m.

All 3 zones would have the beds designed to help maximum ground water percolation / seepage.

Volume Method: Present recharge quantity calculated is 15 MLD (raw sewage and effluent). It is proposed and agreed to provide 15 MLD for recharge from treated wastewater.

4. STP Capacity

Proponent had calculated the overall STP requirement to be 193 MLD (excluding Delawas). After review by TA, it was agreed to provide total treatment capacity of 170 MLD (excluding Delawas expansion). Different STP capacity plants shall be provided along the nallah, at available land of JDA based on the incoming sewer lines.

5. Variation in Quantities

Consideration is given to fact that a few key items which are (1) STP (2) Road (3) Street Light and (4) Tree (5) Landscaping - which are quantified today may see a revision due to detailing due to the size and spread of the project.

In addition to the above, in case the client needs any new items to be executed which are beyond the present scope of works, the same will have to be executed by the contractor at the rates arrived at through mutual consent.

6. Change in Existing structures across the Nallah considering 100 year flood discharge:

TA had requested revaluation of the existing old cross drainage and hydraulic structures including Dams (such as Gular, Ramachandrapura etc.) along the 47.5 KM length of the Nallah. These are existing old structures which have been designed and constructed through varied times by various government agencies. It is envisaged that to strengthen them for an extreme event would be complex and ultimately require changes and building new structures. Hence, this scope is excluded from the DPR and that authorities would take up such works separately, if required and needed.

7. Additional Sewer Lines:

TA proposed that complete sewer lines to be laid along the drains and other areas to ensure passage of sewage through closed conduit in dense areas and also to collect sewer directly from existing sewer lines which are falling in drains or passing through city area. Proponent in its project plan has taken sufficient measures to intercept and collect incoming sewage to Amanishah Nallah from drains and nearby surrounding areas within 500 m distance from Amanishah Nallah. Provision of Intercepting pipe running all along the Nallah length on both sides has been kept to take care of incoming sewage. Hence the network requirement beyond this area around Amanishah Nallah is beyond the scope of the DPR and to be taken up by the relevant authority as a separate project.

8.Inclusion of recommendations made by NEERI

It was suggested that the recommendations of NEERI report should be included in the scope of work. And it is agreed to incorporate recommendations of NEERI. Any modification in design or addition of scope which is not included in this DPR shall be included in the works at SOR provided by the bidder on mutual consent.

1.10 SLEC (STATE LEVEL EMPOWEERED COMMITTEE) MEETING DATED 14.OCTOBER.2015

Second meeting of SLEC was held on 14th October 2015 under the chairmanship of Chief Secretary GoR in which TPL made a presentation before committee on revised DPR base in the discussions with PDCOR. Following decisions were taken

1) Operations and Maintenance period to be taken as 10 years in place of 5 years
2) Unite price for taking care of additional quantities of key items is not required, as the unit price is already available in Chapter 10 of DPR\
3) O&M cost be given based on NPV with a discounting factor of 10%

These decision have been complied with, in the present final DPR

1.11 PUBLIC OPINION THROUGH EXHIBITION CENTRE

It is proposed to establish an Exhibition centre for the awareness of public to Know about the status of Amanishah Nallah ‘before construction’ and ‘post construction’. It is felt important to educate the people on the ill-effects of the Amanishah Nallah’s current state and benefits of change. This is expected to help in public opinion and participation. Various aids such as Posters, Audio Visual Effects, Models, Prototypes etc., are proposed to be used as part of the exhibition centre. Site for this centre is being finalised in consultation with JDA.

CHAPTER 2: PROJECT PROFILE

Tourism has been one of the biggest revenue generators for the State of Rajasthan since long. Owing to its rich and varied topography, vibrant culture and captivating festivities, the State of Rajasthan offers immense tourism delights to the visitors in the State. Visitors, starting from neighbouring states to the far flung countries throng the state at different times especially during the cooler periods starting from November to February. Jaipur is the capital, largest city of the State and is a major tourist destination.

The Walled city of Jaipur and other suburban developments are being developed by keeping aesthetics of the city in mind. While the tourist attractions such as HawaMahal, Jal Mahal, City Palace, Amer Fort, Jantar Mantar, Nahargarh Fort, Jaigarh Fort, Sanganeri Gate and the Jaipur Zoo are greatly popular - the open drains, undeveloped areas, slums, inferior infrastructure spoils the aesthetics of the city.

A major environmental issue in almost all the major cities in India is Open drains / Nallahs and Jaipur is no exception. Amanishah Nallah is one of the major open drains in Jaipur and occupies major land and is causing environmental hazard.

Major problems faced by the City Administration owing to Amanishah Nallah are:

- Complex effluents and sewerage causing health hazard to nearby habitations
- Loss of valuable land
- Threat of flooding due to encroachments
- Farmers use the wastewater in Nallah for Vegetation leading to toxic vegetation
- Unappealing aesthetics where Nallah passes
- Diminishing value of the properties along Nallah

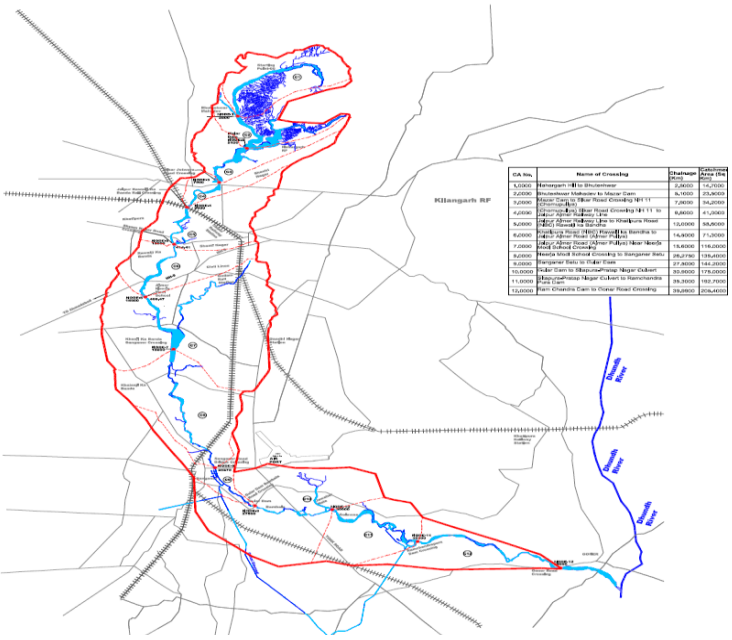
Dravyavati River was the active river of Jaipur which, over time and decades turned into a Nallah (Amanishah Nallah) due to rapid urbanization and select industrialization around the river. This rejuvenation project is based on the concept of watershed rehabilitation, flood prevention, pollution treatment and ecology landscape. Through comprehensive measures, the aim would be to gradually recover the green views on both sides of the river and building up its aquatic

ecosystem. This will help in restoring Jaipur's historic river as the resting corridor for the public facilitating a "harmonious relationship between the citizens of Jaipur and nature". The Amanishah Nallah which originates from the western slopes of Nahargarh hills flows thought the western side of Jaipur city from north to south. While flowing, it collects storm and waste water from Naharika Nallah and Ambabari. Some portions of the walled city and newly developed areas of Jaipur discharge storm and waste water through Ganda Nallah and Sanganer town into the Amanishah Nallah. Further, it collects storm and waste water from Jawahar Nallah after flowing for about 35 km and ultimately discharges into Dhund River.

Jaipur receives over 650 millimetres (26 inches) of rainfall annually but most rains occur in the monsoon months between June and September and during the monsoon there are frequent, heavy rains and thunderstorms, but flooding is not common. Temperatures remain relatively high throughout the year. The rainwater in the areas adjoining to Amanishah Nallah also flows in the Nallah.

The Nallah as it exists today is in irregular shape. This has prompted people to settle along the Nallah in an irregular manner and even waterways have been encroached. Due to this, during every rainy season administration has to arrange for shifting of population from such Kachhi Basti's. The developed areas of city also face acute problem of blocking of roads due to accumulation of water during rainy season.

CATCHMENT AREA OF AMANISHA KA NALLAH



To this effect there is a court directive to clear and make available minimum 150 ft. to 210 ft. right of way for the Amanishah Nallah and reference central line to be marked.

To solve the problems of encroachments, flooding and environmental hazard and enhance the opportunities to develop social and commercial infrastructure, it is proposed to develop the Amanishah Nallah, reclaim valuable land parcels along Nallah and build waste water treatment systems.

The development of Amanishah Nallah is aimed to meet the following objectives:

- To develop the Amanishah Nallah as a center of attraction and an important natural asset for the city of Jaipur.
- To stop any raw sewage or effluent entering the natural available stream.
- To treat raw sewage flowing into through the city.
- To use the treated sewage to rejuvenate the flow into the existing Nallah.
- To ensure perennial water flow in the Nallah.
- To restore to some extent water recharging capabilities of erstwhile Dravyavati river.
- To ensure a better flood Management and flood risk reduction for the nearby commercial and habitable areas.
- To develop land parcels within or adjoining areas of the Nallah for public use. To make newly developed area a safe and secure place to be used for by common public without any reservations. Development of Land Parcels for social and commercial infrastructure.

As a part of the development following major works have been proposed

1) Course Correction/ Strengthening of Amanishah Nallah

River rehabilitation includes ground preparations, lining, embankment works, protection & prevention, and development of other peripheral structures, landscaping, etc..

2) Sewerage Interception, treatment and disposal

Improve quality of water to be made available in the stream by treating

municipal wastewater for discharge into the Nallah.

Engineering includes intercepting sewage from current drains, intercepting sewage from existing sewer lines if any which are lying within 0.5 KM of the center of the Nallah, providing limited collection main (along the banks of the Nallah only) and putting up the treatment plant as detailed in later sections.

3) Value Creation and Monetization

A comprehensive Business Plan along with land use plan and detailed Master Plan of the precious land areas reclaimed from Nallah sections and other existing land parcels in and around Nallah. Primary objective of this exercise will be to propose the government after detailed market study and need assessment of the area that how Nallah improvement work will bring in significant value for the city in direct monetary terms and other intrinsic benefits. This plan will act as road map for the JDA to use newly developed assets as per the market needs and value creation done through Nallah.

CHAPTER 3: ESTABLISHING NEED OF PROJECT

Amanishah Nallah originates north of Mahalbag, in the Amer Forest Nature Reserve. It flows through the central parts of Jaipur city, and drains into Dhund River, 250 m to the east of Ralawata. The river is about 47 Km long. The watershed areas of Amanishah Nallah are Naharika Nallah, Ambabari and Ganda Nallah (which crosses part of old towns and new development zones, Sanganer and downstream areas which are still in development at present).

Presently Amanishah Nallah mainly undertakes drainages of rains from the catchment areas that include banks and other branches, wastewater drainage and agricultural irrigation along the river. The Nallah being dry in most of the seasons, heavy encroachments have created a danger of floods during Monsoons. The pollutants in the Amanishah Nallah are also rising causing health hazard and destroying the ecological system.

Amanishah Nallah rejuvenation project shall resolve the following key issues according to the present situation of the river and urban planning:

(1) Flood problem:

Amanishah Nallah is the main drainage channel in the city of Jaipur, which suffers from:



- Serious water and soil erosion on the hills in upstream area,
- Illegal construction of buildings alongside the river occupying large swathes of river bed,
- Growing of vegetables and commercial crop on the riverbed with polluted water.

- Unchecked use of the Banks and the Bed of the water channel as garbage dumps.

The above issues severely restrict the drainage capacity of river channel, making the area susceptible to floods, and thus threatening the safety of life and assets. Further, rapid urbanization increases hardened ground and reduces agricultural land which damages natural drainage mode. Moreover, in the rapid process of urbanization, the construction of drainage system in Jaipur didn't catch enough importance. The buffer zones for floods are filled now adding to the risks of floods. It has become necessary to construct flood prevention system in accordance with design standards by undertaking river rehabilitation.

(2) Water pollution:

Presently, the areas adjoining Amanishah Nallah lack a sound wastewater management network. The human and industrial wastewater flows into Amanishah Nallah. This wastewater is generated by the human habitation alongside the river, including hotels/commercial establishments. Also, there are about 900 small-scale dyeing and printing enterprises which drain their wastewater in the channel. Industrialization process in the city and the surroundings impact and deteriorate the water seriously. Amanishah Nallah carries dirty stinking water, which fosters the growth of mosquitoes which is severe health and sanitary risks for the locals. In addition, the direct polluted water used for irrigation or infiltration of polluted water into the ground increases water pollution risks, leading to a potential health risk to agricultural products.



(3) Water resource:

Jaipur is facing serious water resource shortage. Being in semi-arid climate zone, Jaipur experiences an average annual rainfall of 650 mm, with 90% rainfalls during Jun.-Sep. The rains fail to supplement the ground water sufficiently. At the same time, water deterioration, shortage of water management infrastructure and rapid increase in population, aggravate this phenomenon. Therefore, we have to consider effective rainwater preservation/conservation measures to address the problem of water shortage.

Further, the polluted water of the Nallah is being used for agriculture and thereby leading to health hazards with the production of toxic-infected food grains/vegetables.



(4) Ecology:

Limited green spaces, disorderly constructions, encroachments and unauthorized industrialization along the Nallah have damaged the ecology.





The water and soil erosion in the upstream is serious.

Drainage of polluted water with domestic and industrial garbage is being dumped in Nallah. All of this has adversely affected the ecology along Amanishah Nallah which is does not complement the development plans of Jaipur.

(5) Value Creation and Economic Boost

Water is lifeline for any city's economic growth and development. Development of Amanishah Nallah will for sure add a significant factor to accelerate the business activities around some of the most valuable pockets of the Jaipur. While in current state Amanishah Nallah and its surrounding land have diminishing value due to adverse conditions. It is expected that this project will give a significant fillip to the business activities around Nallah, starting with sky rocketing of the price of land holdings around Nallah. It is expected that this value enhancement will be multiple time of the proposed cost of the Nallah development work.

CHAPTER 4: ENVIRONMENT ASSESSMENT

The purpose of Environmental Assessment is to document screening of the environmental consequences of the project in accordance with the statutory requirements of the country as well as the global standards, to identify potential adverse and beneficial environmental impacts, and to document the mitigation measures that would be incorporated in the project to eliminate or minimise the adverse impacts.

Initial site assessment and survey established that there are no significant environmental issues in the Amanishah Nallah project area due to proposed infrastructure development.

4.1 POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK

India has well defined institutional and legislative framework. The legislation covers all components of environment viz air, water, noise, soil, terrestrial and aquatic flora and fauna, natural resources, and sensitive habitats. The environmental legislations in India are framed to protect the valued environmental components and comply with its commitment to international community under various conventions and protocols as well. This assessment is about the applicability of above laws and regulations, and safeguards.

4.2 BYE LAWS, REGULATIONS AND ITS IMPLEMENTATION

Country's Legal Framework and Regulatory Requirements for the Project

The legal framework of the country consists of several acts, notifications, rules, and regulations to protect environment and wildlife. Review of Indian legal system has been carried out to identify its applicability to the project.

The following rules, notifications and standards under the Environment (Protection) Act, 1986 are particularly relevant in this case:

- Environment (Protection) Rules, 1986 and its amendments
- EIA Notification, 1994 and its amendments
- The Forest (Conservation) Act 1980 (Amended 1988) and Rules 1981 (Amended 2003)
- The Wildlife (Protection) Act, 1972 (Amended 1993)
- The Water (Prevention and Control of Pollution) Act 1972 (Amended 1988) and Rules 1974
- The Air (Prevention and Control of Pollution) Act, 1981(Amended 1987) and Rules 1982
- The Noise Pollution (Regulation and Control) Rules, 2000 (Amended 2002) and
- Hazardous Waste (Management, Handling and Trans-boundary Movement) Rules 2008 (Amended 2009)
- Ancient and Historical Monuments and Archaeological Sites and Remains (Declaration of National Importance) Act, 1951 (No. LXXI of 1951)

4.2.1 **ENVIRONMENTAL CLEARANCE**

The Proposed Project envisages improvement of the environment by way of intercepting the sewerage entering in to water body, treating it to disposable standards and reusing it for landscape irrigation. Thus the project is adding to the quality of environment & ecology and preventing the groundwater contamination.

It is expected the that the development will improve overall air and ground water quality in the impact zone leading to improvement in quality of life of citizen of Jaipur.

It is expected any environmental clearance required for the project will be obtained by Jaipur Development Authority and will be supported by the Project Proponent.

4.2.2 **FOREST CLEARANCE**

As per Indian “Forests Conservation Act (1980), every project requiring diversion of forest land for non-forestry purposes requires forest clearance from MoEF.

Although Amanishah Nallah originates inside the Nahargarh forest area, the proposed project does not include any Pucca (Cemented) intervention other than velocity reduction and soil erosion activities in it. The proposed small scale interventions are based on watershed approach and are intended to be implemented with the help of Forest department. Hence no forest clearance would be is required for this project. However JDA needs to confirm the same.

4.2.3 PROTECTION OF ANCIENT, HISTORICAL MONUMENTS / SITES

The Government of India has a long history of protecting its antiquities, ancient monuments and sites which started during the cultural renaissance of early nineteenth century.

The State Legislature of Rajasthan passed a noteworthy act to protect ancient monuments; these are the Rajasthan Monuments, Archaeological Sites and Antiquities (Act, 1961) and its rules on 1968. The Act empowered the State to acquire rights or enter into agreement to protect and maintain monuments and areas. Amanishah Nallah project does not fall near to any visible ancient and historical monuments and archeologically sites, hence no clearance would be required. However JDA needs to confirm the same.

4.2.4 GROUND WATER EXTRACTION

The CGWB under the Ministry of Water Resources is responsible for providing scientific inputs for management, exploration, monitoring, assessment, augmentation and regulation of ground water resources of the country. The Board regularly publishes State and District hydro-geological reports, ground water year books and Atlases, ground water user maps and guides/manuals/pamphlets for proper ground water management. Central Ground Water Authority (CGWA) was constituted under sub-section (3) of Section 3 of the Environment (Protection) Act, 1986 for the purposes of regulation and control of ground water development and management in the country. The Authority is engaged in various activities related to regulation of ground water development to ensure its long-term sustainability.

As per the power granted under Environmental Protection Act, 1986, permission from Central Ground Water Authority is required for extracting ground water for construction purposes, from areas notified as critical or semi- critical from ground water potential prospective. Large area of Rajasthan and Jaipur are notified as critical areas. Permission of drilling tube wells is being granted only to the Govt. agencies responsible for drinking water supply..

Permission for temporary bore-wells will have to be obtained for use under current project for which JDA's assistance is required.

4.2.4.1 WATER BODIES:

Amanishah Nallah itself is the main water body of Jaipur. Any positive intervention in de-polluting the Nallah is always going to add to the environment improvement thus benefitting the people of Jaipur in large. Historical dams do exist on Amanishah Nallah catchment, but in this project no adverse impacts are envisaged. On the other hand, the catchment characteristics in upper reaches are going to be improved in long term by the interventions planned. Hence the existing water bodies created by these dams are going to be benefited multi-fold which will improve the ground water quality and quantity in the downstream and surrounding areas.

CHAPTER 5: POLICY SUPPORT AND ACTIVITIES

Amanishah Nallah project has been focal point of discussion in Jaipur and many efforts are made by State Govt. of Rajasthan under the directives of Hon'ble High Court. Following is the gist of High court orders and efforts made by the Govt. of Rajasthan to resolve the issues pertaining to floods and pollution caused due to current state of Amanishah Nallah

1) Under DB Civil writ petition (PIL) No.9497/2007 PN Maindola Vs. State of Rajasthan and Others
   a. It is mentioned that many persons have made encroachment in Amanishah Nallah obstructing its free flow of water. In the year 1981, substantial damage was caused to the properties and lives on account of such obstructions by way of encroachments.
   b. Hon'ble High Court vide its order dated 16.Nov.2009 directed that present width of Amanishah Nallah should be maintained minimum 150 ft. to approximately 210 ft. and if any encroachment is made to maintain this aforesaid width, the same would be removed as to maintain the free flow of water.
2) Under DB Civil writ petition (PIL) No.9497/2007 PN Maindola Vs. State of Rajasthan and Others
   a. On date 26.02.2015 citizens of Jaipur had shown a serious concern for protection of environment of the heritage city of Jaipur.
   b. In the last few decades Dravyavati river (Amanishah Nallah) has reduced to Nallah emanating foul smell, in which untreated sewer water of urban areas of Jaipur, and the untreated industrial waste of textile industries from Sanganer is discharged, unabated.
   c. The lower part of the river on its both sides is being used for cultivating the vegetables by pumping out dirty water used for irrigation, causing toxic effect in the vegetables sold in the city.

3) In view of above, Hon'ble high court has directed JDA to engage the services of NEERI to carry out a scientific study for restoration of Dravyavati river, for an overall improvement of the environment of the city of Jaipur.

4) Activities already performed by other agencies

   a) A report by Consulting Engineering Services on flood protection in year 1984 - 85
   b) A report by Span Consultant in the year 2007
   c) A report by MNIT in the year 2010
   d) And a few studies made by Chokhavatia Associates and WAPCOS

In the above context, JDA has directed Proponent to prepare DPR and proposal for Rejuvenation of Amanishah Nallah including Area Development.

Further, support from Government of Rajasthan is required in formulation of policy framework to address following aspects:

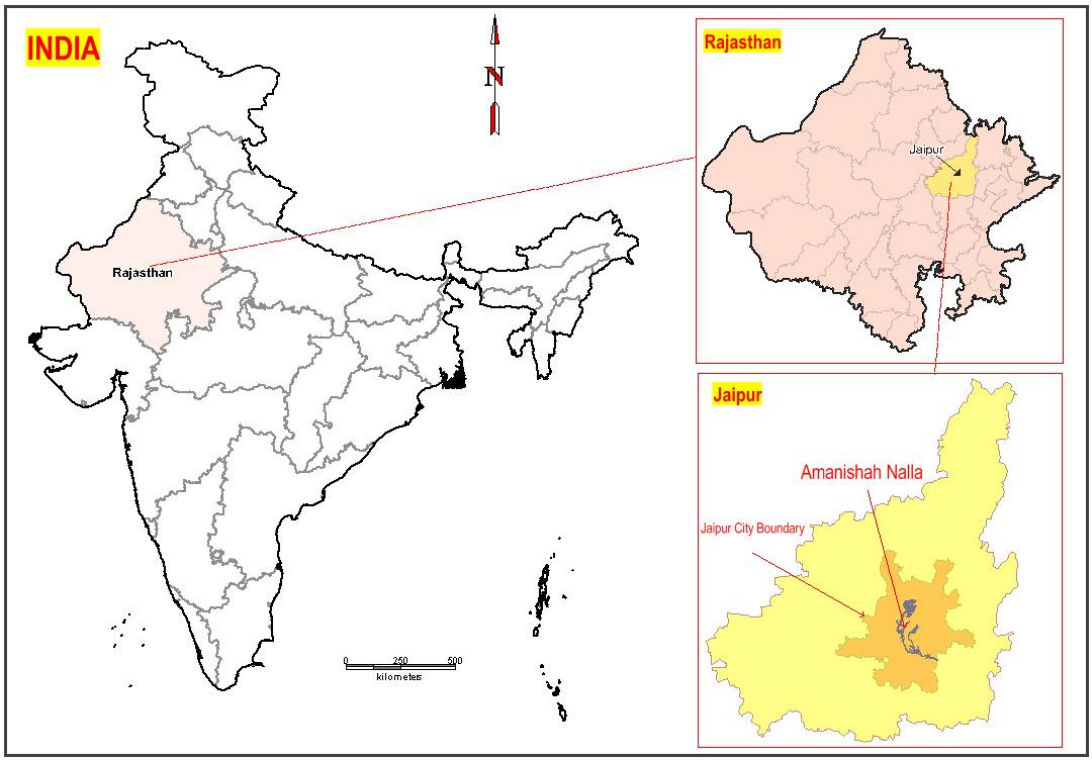
a. Identification of center line of Amanishah Nallah and marking on ground
b. Handing over of the encroachment and encumbrance free land for development to TPL
c. Providing data available with various government depart, which will be required for detailed design purpose and to develop Master Plan for the reclaimed land.
d. All necessary statutory approvals and clearances required from various departments state and central authorities as per applicability

CHAPTER 6: LAND AND SITE ANALYSIS

Jaipur, the capital of Indian state of Rajasthan is located at the GIS coordinates of Latitude N 26°54' & Longitude E 75°49', lies in the north-eastern part of Rajasthan.Its municipal boundary extends from N 260 46' to N 270 01' latitude and E 750 37' to E 760 57' longitude. The average level of the city is 430 meters above mean sea level.

The city is surrounded by the Nahargarh hills in the north and Jhalana in the east, which is a part of Aravalli hills - ranges. To the south and the west of the city are also prevailing hillocks but they are isolated and discontinuous in formation. The southern end of the city is open to plain and stretches far and wide towards Sanganer and beyond.

Jaipur has a convenient external transport, with developed highway, railway, and aviation. The city lies on Delhi-Ahmadabad rail route of Western Railway. The N.H-8 and N.H-11 intersect at Jaipur and N.H-12 leading to Jabalpur starts from Jaipur. Jaipur lies at a distance of about 260 Km from Delhi, 135 Km from Ajmer, 225 Km from Agra and 245 Km from Kota.



6.1 NATURE AND EXTENT OF THE CITY:

Jaipur is one of the fastest growing city in the country. Built in 1727, the city is known as “the Pink City of India”. It is the capital and cultural and educational center of Rajasthan, famous for the gems, handicrafts and printing and its heritage culture. The potential sectors that can provide impetus in development of economy of Jaipur are industrial & business development and tourism development.

The Jaipur Municipal Corporation (JMC) includes the walled city and the adjoining outer area. The total area under JMC jurisdiction is 465 sq.km. The present population of the Jaipur (2013) is 3127977 Souls, and the forecast of 4586800 Souls by 2026.

According to the Jaipur master plan "Master Development Plan 2025", the overall objective of urban construction is to build Jaipur into an international metropolis and the world-class city.

6.1.1 **EXISTING SITE CONDITION:**

6.1.1.1 DRAINAGE

Jaipur city is naturally drained by the Amanishah Nallah (originally known as “Dravyawati River” and Dhund River. Both form a fork like drainage pattern in the confluence zone just outside the (U1 boundary) in southeast part of the city.

Amanishah Nallah, a life line of the city starts from the foothills of Nahargarh and flows through the Jaipur City from north to south direction and merges in to Dhund River.

Many small drainage systems (now Nallah) mainly Nahri ka naka Nallah, Ganda Nallah, and Jawahar Nallah which drains most of the Jaipur City’s runoff water into the Amanishah Nallah.

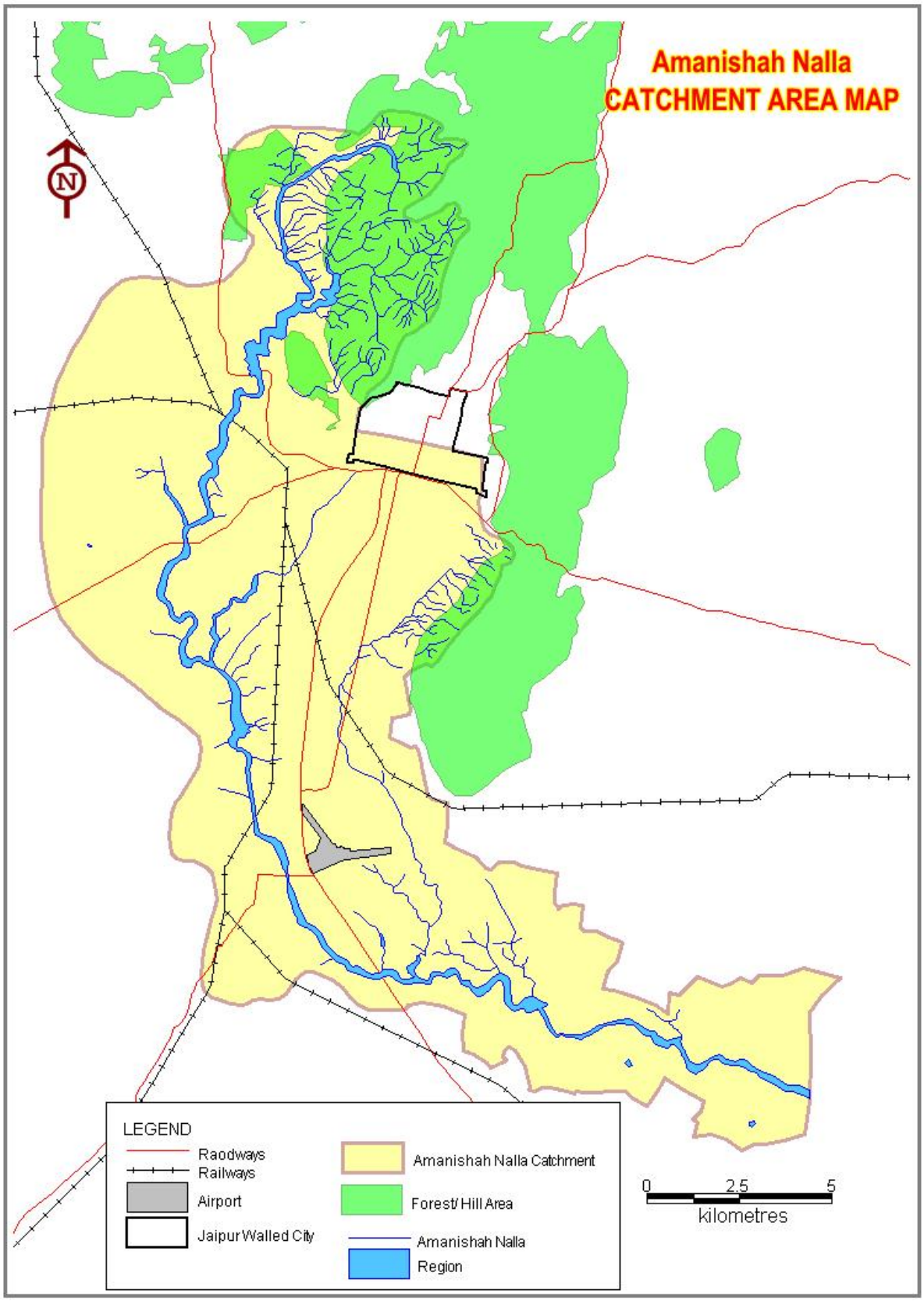


Figure 6-1Amanishahh Nallah Catchment Area Map

Length: Total Length of Amanishah Nallah is about 47.5 km (from origination point to submergence in Dhund River)

Slope: Amanishah Nallah originates from an elevation of 580m at Jaigarh / Nahargarh Hills and joins Dhund River at ground elevation of 324 m. The slope near the origination is quite steep and then becomes gentle slope in middle and lower part of its flow path.

Width: As per the JDA minimum 150' to 210' is available, however the actual figures vary from location to location along the flow path.

Catchment Area: The overall catchment area of 47.5 km long Amanishah Nallah is calculated as about 233 sqkm.

Existing Structures: Some dams which were originally constructed in the past for controlling the flood and recharge objectives are still existing in good conditions. These includes Mazar Dam, Hydraulic structure at Sikar road, Goolar Dam and Shri Ramchandrapura Dam. Apart from them many cross drainage structures, culverts and bridges exist for the movement of public traffic by road and railway.

6.1.1.2 LAND USE NEAR AREA ADJOINING AMANISHAH NALLAH:

In total flow path, the initial 5 km of length is under the ravine with steep slope. After about 20 km, the Nallah flows through the habituated residential areas of deferent densities. The width of drain varies considerably and at many places the width is less than 150 ft. Most of the encroachments and flooding issues are experienced in this area.

After this it is passing through the 5 km in length of Sanganer Industrial area. Here majority of discharge that gets entry in the Nallah is Industrial effluent.

Rest 17.5 k of drainage is passing through the mix density development/ village area before merging into the Dhund River

6.1.1.3 PROBLEMS IN AMANISHAH NALLAH

There are plenty of road culverts of smaller sized pipe diameters across the Amanishah Nallah. These pipe culverts have been constructed on the available Nallah width at the site. The carrying capacities of such structures are not at all sufficient to safely discharge the upstream peak flood discharge.

In some of the areas, the width of the Nallah has considerably got reduced due to encroachments by unauthorized construction, making it insufficient to carry the high flood discharge during the peak rainfall event.

Large volume of wastewater from the city is being discharged into the Amanishah Nallah without treatment. Further, printing and dyeing wastewater is being directly discharged in Sanganer area into the Amanishah Nallah. This has not only polluted the ground water but also degraded the environment in adjoining areas along its flow path area.

It was observed during the field survey that significant amount of dry weather flow is being utilised at various location for irrigating illegal agricultural field growing vegetables and other crops by fetching the water through the pump sets installed at Amanishah Nallah bed.

6.1.1.4 SEWERAGE SYSTEM IN AMANISHAH NALLAH CATCHMENT AREA:

As per the information received, there are five operational sewerage treatment plants in Jaipur city as given in the following table:

Table 6-1 Existing Sewerage Plants around Amanishah Nallah

Capacity, Location, and Process	Operational Status
2 units of 62.50 MLD STP at Delawas with Conventional Activated Sludge Process	Both Sewerage treatment plants are in operation at full capacity. Gas produced from Unit-I is used for power generation. Gases produced from Unit-II are to be sold to

	generate revenue. The treated water discharged in the Nallah is used by farmers for agriculture.
1 MLD STP at Swarna Jayanti Park on MBBR	This plant is operational. The plant is located within Nallah bed and may require relocation of the same.
30 MLD STP at Ralawata on ASP	This plant is operational; however, the full capacity utilisation has not reached.

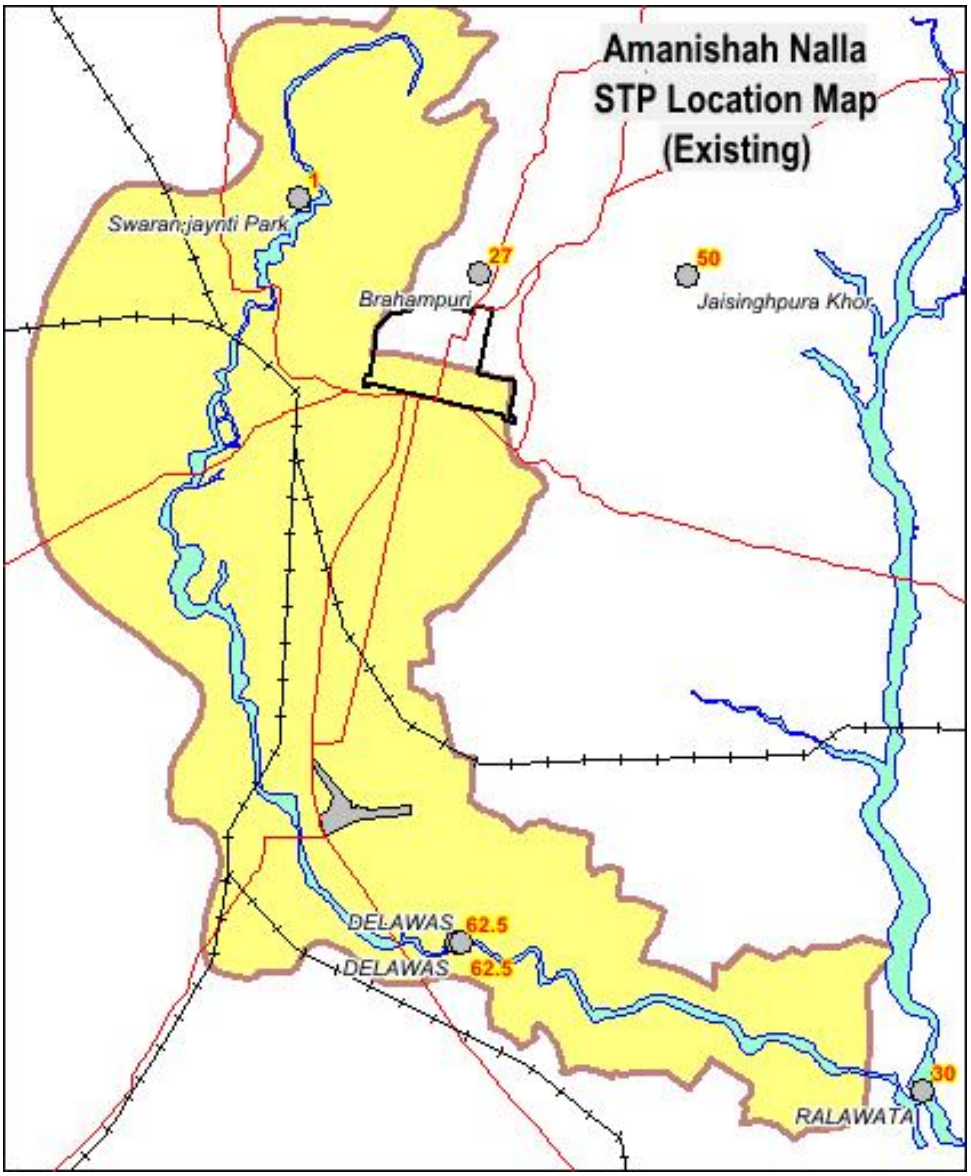


Figure 6-2 Location of Existing Sewerage Plants (STP)

6.1.2 SEWERAGE NETWORK

In the Adjoining Areas of the Amanishah Nallah there is no organized Sewerage System across major stretch. There are many colonies with sewerage lines but without proper arrangement of sewage discharge into the Nallah. At the same time, there are colonies without having sewerage lines but discharging sewage into the Nallah through drains directly.

6.1.3 GIS MAPPING & 3D ANALYSIS

Watershed delineation or catchment delineation is one of the most important activities in 3D terrain analysis and drainage planning. Digital Elevation Models (DEMs) provide 3D terrain representation from which watersheds can be derived automatically. These DEMs are used in Amanishah Nallah project to identify drainage features such as ridges, valley bottoms, surface drainage patterns, and to quantify Catchment and Sub catchment and existing drainage properties.

The project studies have been carried out on the basis of contour data received from satellite imagery from JDA for previous RUIDP project. Level Survey data obained from the Engineering Survey carried out at site has been verified, corelated and integrated in the master level data file used as input for generating the 3D model by the GIS software.

According to slope analysis based on the developed model the slope (of major drain) in upper reaches is about 1.2% (1:83) which reduces in middle reaches to 0.28% (1:350) and further decreases in lower reaches to 0.22% (1:450) and then joins the Dhund river.

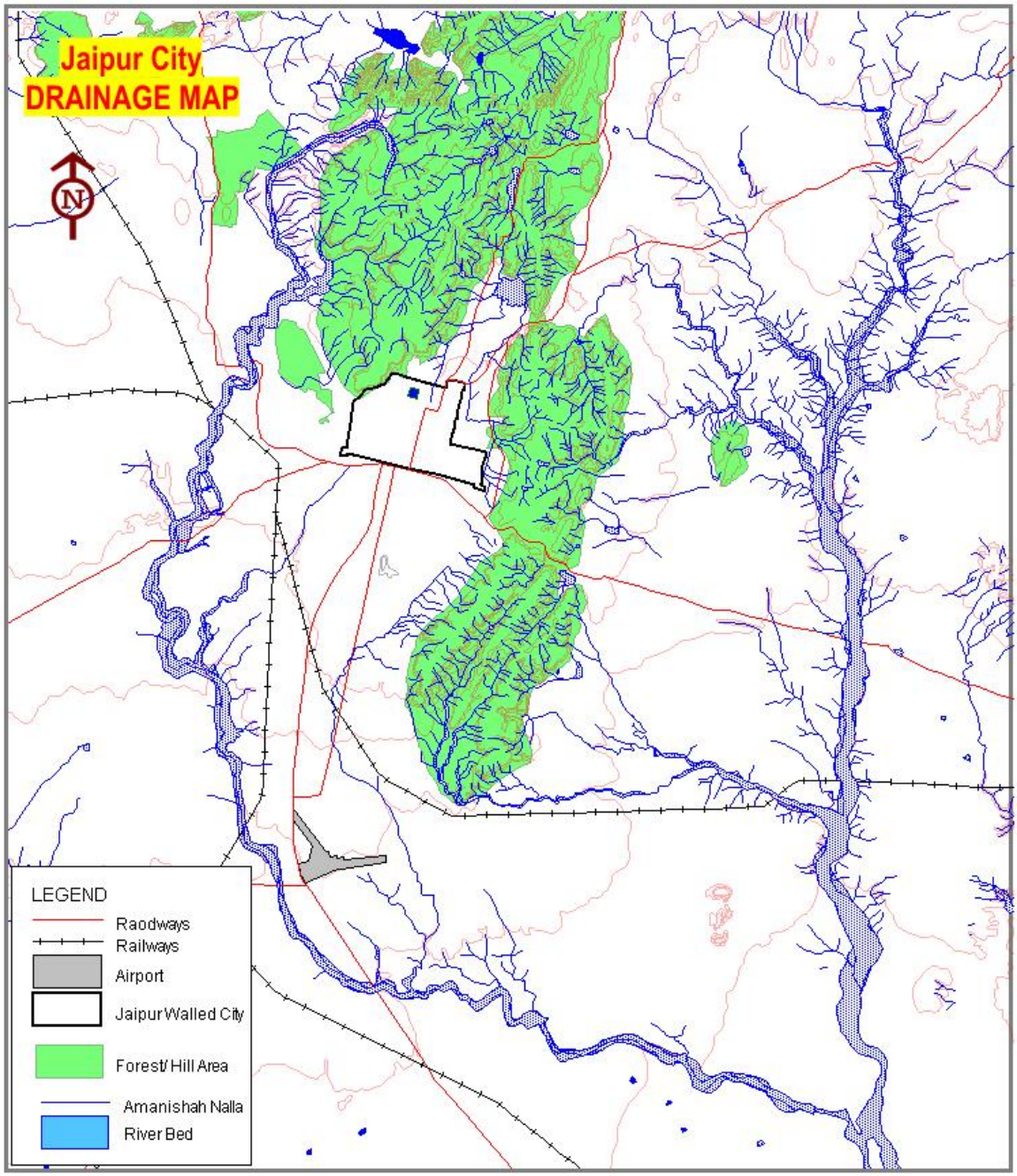


Figure 6-3 Existing Drainage Map of Jaipur City

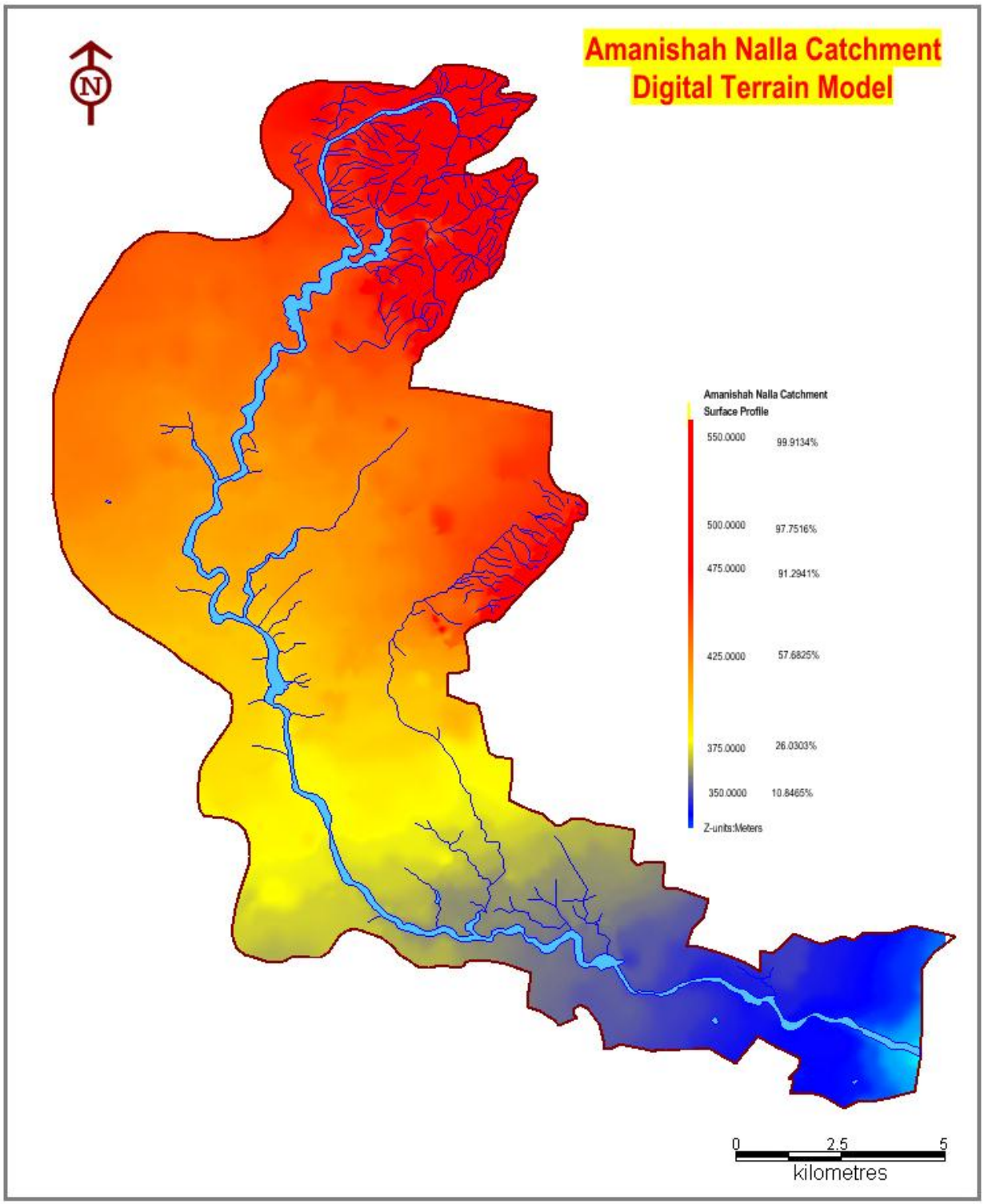

Amanishah Nalla Catchment
Digital Terrain Model
N
Amanishah Nalla Catchment
Surface Profile
550.0000
99.9134%
500.0000
97.7516%
475.0000
91.2941%
425.0000
57.6825%
375.0000
26.0303%
350.0000
10.8465%
Z-units:Meters
0
2.5
5
kilometres

Figure 6-4 Digital Terrain Model: Surface Profile

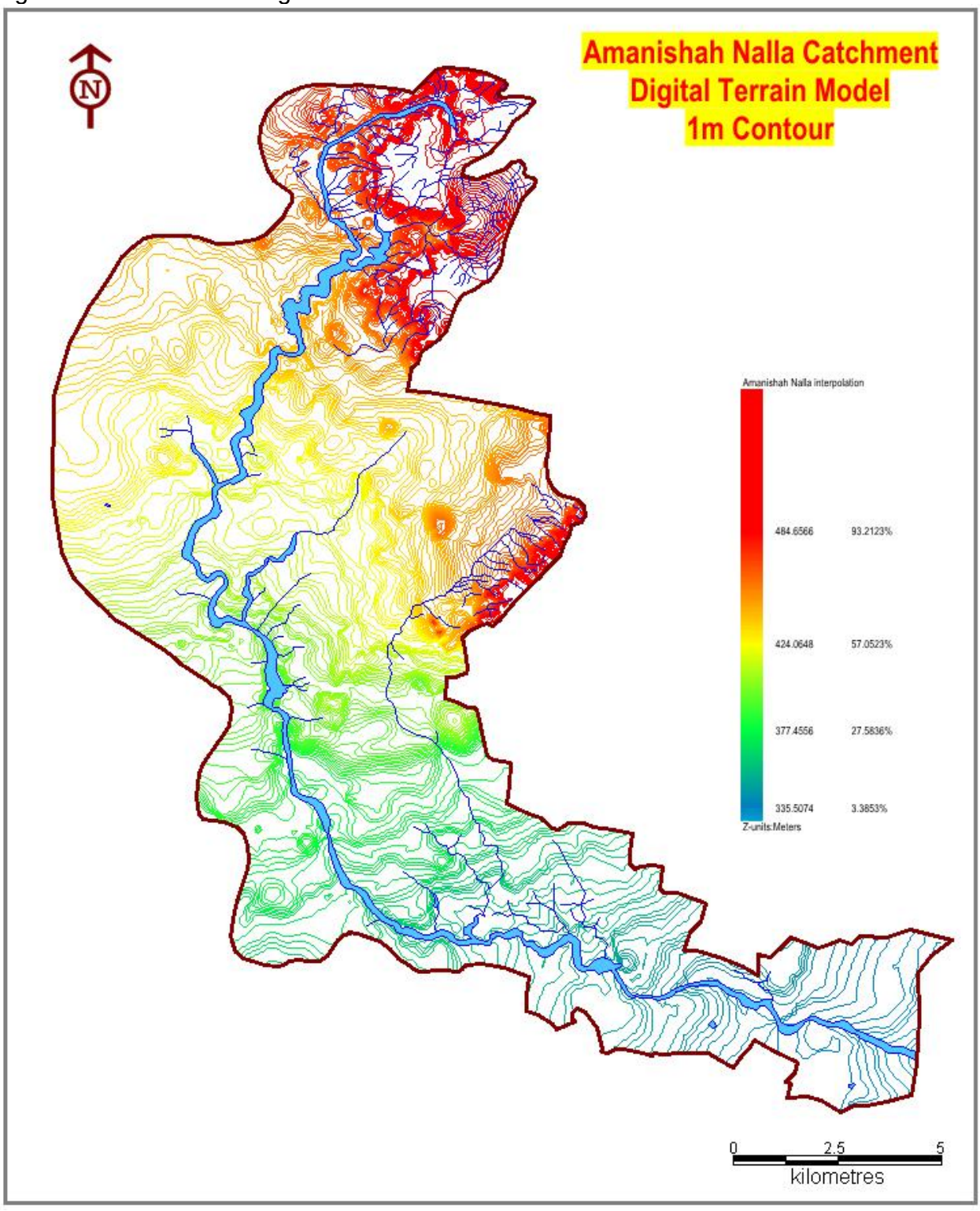


Figure 6-5 Digital Terrain Model: Contour profile @ 1m interval

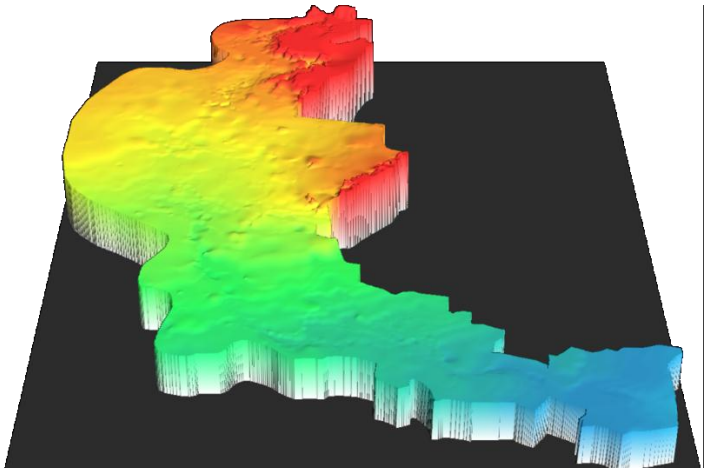


Figure 6-6 Digital Terrain Model: 3 D Profile

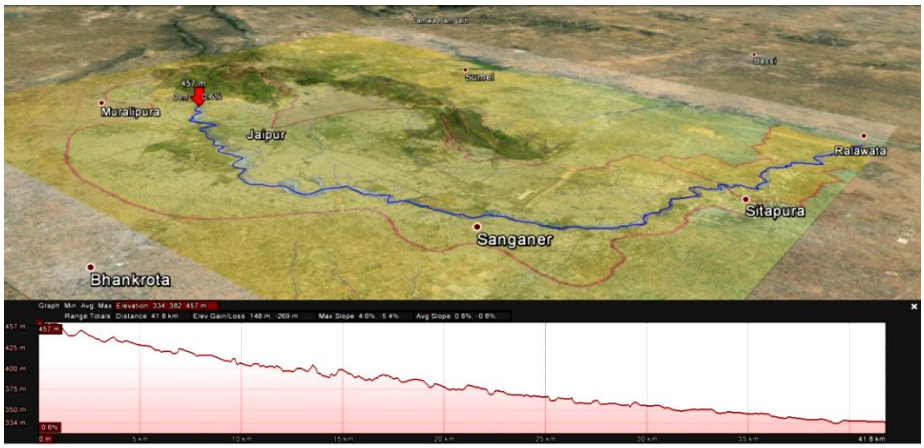


Figure 6-7 Satellite Imagery – 3D profile

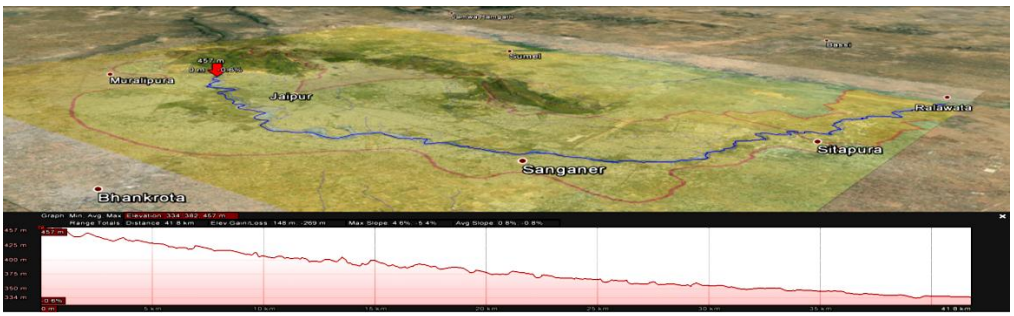


Figure 6-8Digital Terrain Model: 3 D Profile

CHAPTER 7: PROPOSED MASTER PLAN AND DESIGN BASIS

7.1 INTRODUCTION

Objective of the proposed Amanishah Nallah project is to strengthen and improve the natural drainage system, to improve ecological and environmental conditions within and around the Amanishah Nallah, protection against flood and to develop a Amanishah Nallah as a water front to make it a central attraction for the city of Jaipur. It has been explained in project brief presented in the earlier chapters of need establishment.

The geographical extent of the project covers the catchment area of Amanishah Nallah extending from its place of origination - Nahargarh hill in the upstream region upto the confluence point with Dhund River in the downstream region, with a main drain flow length of about 47.5 km covering the watershed area of 233 km^2.

7.2 PROJECT COMPONENTS

To meet the overall objectives the Amanishah Nallah, project has been divided into following sub-projects:

(1) Course Correction/ Strengthening of Amanishah Nallah

It includes main channel section and protection embankments, strategic falls to control the velocities, small check dams to retain water throughout the year as an effort to develop the water front.

(2) Sewerage Interception, Treatment, Reuse and Disposal

It includes interception of municipal wastewater which is freely flowing into the Amanishah Nallah, its treatment and discharge into the Amanishah Nallah to make it a water front throughout the year and use of a portion for nearby landscape and other requirements.

(3) Value Creation and Monetization

It includes development of a comprehensive business plan, strategy along with detailed master plan including landscape plan for the reclaimed and other existing land in and around Amanishah Nallah.

(4) Peripheral Works

This includes essential and miscellaneous works which are important for the functionality of the overall system created by the Amanishah Nallah Project.

Following sections will describe in detail the design basis of the solution proposed for all the above four sub projects and the solution itself proposed to be built.

7.3 COURSE CORRECTION/ STRENGTHENING OF AMANISHAH NALLAH

Course correction exercise starts with determination of the design flood for the course. Design flood is required to determine the size of the water-related structures in confirmation of the specified standard of flood control safety. The determination of design flood has significant impact on cost and safety of the project. Too high value will lead to the wasteful increase of expenditure, and low value will make structures unsafe. Therefore efforts have been made to optimize the flood assessment. Design flood estimation is divided into 3 steps:

- Catchment delineation
- Extreme value analysis for rainfall data
- Design flood estimation

Catchment delineation

Based on the digital terrain model prepared for the Amanishah Corridor and surrounding impact area as explained in previous chapter under section 6.1.2 of GIS Mapping and 3D analysis using Google Professional Satellite Data, Survey Data and the GT sheets of the area catchment delineation exercise has been done. Total length of the Amanishah Nallah drain flow path as per the field engineering survey has been calculated as 47.5 km based on the physiographical and hydrological characteristic of the contributing tributaries and physical features of the Nallah; the

entire Amanishah Nallah has been divided in to 13 sub-catchments or reaches based on presence of existing structures which act as limiting factor for finalization of levels upstream and downstream of the sections. These sections or reaches are as given in the following table:

Table 7-1: Design Reaches of Amanishah Nallah

Reach No	Details	Mileage (KM)	Catchment Area (KM^2)
1	Nahargarh hill - Bhuteshwar Mahadev	2.80	14.7
2	Bhuteshwar Mahadev – Mazar Dam	5.10	8.8
3	Mazar Dam-Sikar road crossing NH-11	7.65	10.7
4	Sikar road crossing to Jaipur Jhotwara Railway line	9.60	6.8
5	Jaipur- Jhotwara Rail way line – N.B.C (Jaipur Khatipura Road)	11.35	17.6
6	N.B.C – Jaipur Ajmer Road NH-8	13.95	12.7
7	Ajmer road – near Neerja Modi school crossing	17.65	44.7
8	Neerja Modi school crossing – Jaipur airport-Sanganer Airport crossing	25.30	22.4
9	Sanganer Bridge - Gullar Dam	26.55	5.8
10	Gullar Dam - Confluence of Jawahar nagar	32.75	33.8
11	Confluence of Jawahar nagar - Ramchandrapura Dam	34.80	14.7
12	Ramchandrapura Dam-Goner Road crossing	41.30	12.7
13	Goner Road crossing to end	47.50	27.6

A rain drop flow path analysis has been done to arrive at final catchment area of each section. All hydraulic and structural designs have been done in all these reaches individually and accordingly different sections have been proposed.

7.3.1 HYDROLOGICAL ANALYSIS

Hydrological analysis of Amanishah Nallah drain was done to determine the design flood discharge for 13 selected reaches.

7.3.1.1 BASIC ASSUMPTIONS AND CONSTRAINTS

- The catchment area and sub catchment areas of the Amanishah Nallah have been demarcated based on Google professional contour data, existing GT sheets, available data and information collected from the JDA.
- Runoff coefficient of any catchment area is primarily dependent on the land-use pattern in that catchment. To arrive at the runoff coefficient for each of the Amanishah Nallah sub-catchments preliminary analysis for permeable and impermeable area using satellite imageries and subsequent on-site visual inspection was carried out. Based on the findings of the exercise most suitable value for runoff coefficient was calculated.
- Design Rainfall Intensity for various return periods have been estimated using the 24 hour rainfall data series obtained for 33 years duration (1981-2013).
- No detail hydro-geological investigations and/or soil bearing ratio tests have been carried out in the Nallah bed to assess the geological conditions. However existing reports of the surrounding area and understanding of general geology of the Jaipur has been used to conclude the conceptual design solutions.
- Existing GT sheets and Google earth data have been interpreted, supported by field survey of the Nallah for estimation purpose. However, a detailed survey will be carried out before commencement of the detailed design of the project.
- A 100 year return period flood has been selected as the design flood to determine the discharge to be passed through Amanishah Nallah as per the recommended code provisions and CWC guidelines. However an analysis for 25 year and 50 year return period has also been done to assess and estimate the impact on flooding, safety and cost of the project. It has been observed and concluded that there is no significant difference in water level for the

proposed sections for 25 year and 100 year return period flood events. And therefore the proposed section has not only been designed for 100 year return period flood events but also the same has been found to be an optimized section as well.

- As the development has been proposed as water front development, it is important that a perennial source of water supply shall be maintained for the Nallah. As of now, city Jaipur gets rains during monsoon season only (July & August) and therefore no fresh water sources are available for the Nallah.
- To make Nallah perennial, it is proposed to supply treated waste water into the Nallah to maintain it as water front feel throughout the year.
- Net effective treated water required for the Amanishah water front will take care of evaporation and seepage losses from the Nallah.It has been calculated that ~10-12 MLD of water will be used to meet various losses in the Nallah. In addition, to create reasonable flow conditions in Nallah 40-80 MLD flow of water will be required (varies in different reaches).
- It has been calculated that sufficient waste water is currently diverted to Amanishah Nallah and the same can be treated and supplied to Amanishah Nallah to maintain it as a perennial water front.
- Out of the proposed development it has been estimated that around 78 Ha land will be reclaimed from the current inundation situation. As most of the channel has been designed in cutting with some excess material available, it is proposed that any such excess will be used for filling of such areas as per the priority agreed with the agency. It is expected that 30-35 lakh m3 filling can be done in these areas (with an average of 2 m fill). In addition to above filling will be required for embankments of outfall structures (82). There will be approximately 3 lakh m3 filling will be required for the same. In addition rest of the excess excavated quantity will be available for selling to the nearby private parties who will require the same for filling of their land.

7.3.1.2 DATA ANALYSIS:

7.3.1.2.1 Catchment Area:

The GT sheets of scale 1:50,000 have a contour interval of 20 m. the topo-sheets of 1:2,50,000 have a contour interval of 100 m. All these sheets are based on survey done in 1970. These levels are good for a regional slope analysis but not for designing of any drainage system as land-use and land profile in the Amanishah Nallah area has changed significantly over a period time.

Further most of the natural drainages or streams have been either blocked or diverted due to manmade structures in the past 25 - 30 years of development. Hence it is quite difficult to identify the ridge line forming the catchment areas and thier sub-catchments for Amanishah Nallah.

Keeping all these constraints in consideration a best possible demarcation of Amanishah Nallah catchment area has been done using Satellite Data, Field Survey data and available data from JDA and presented in the figure no.7.1

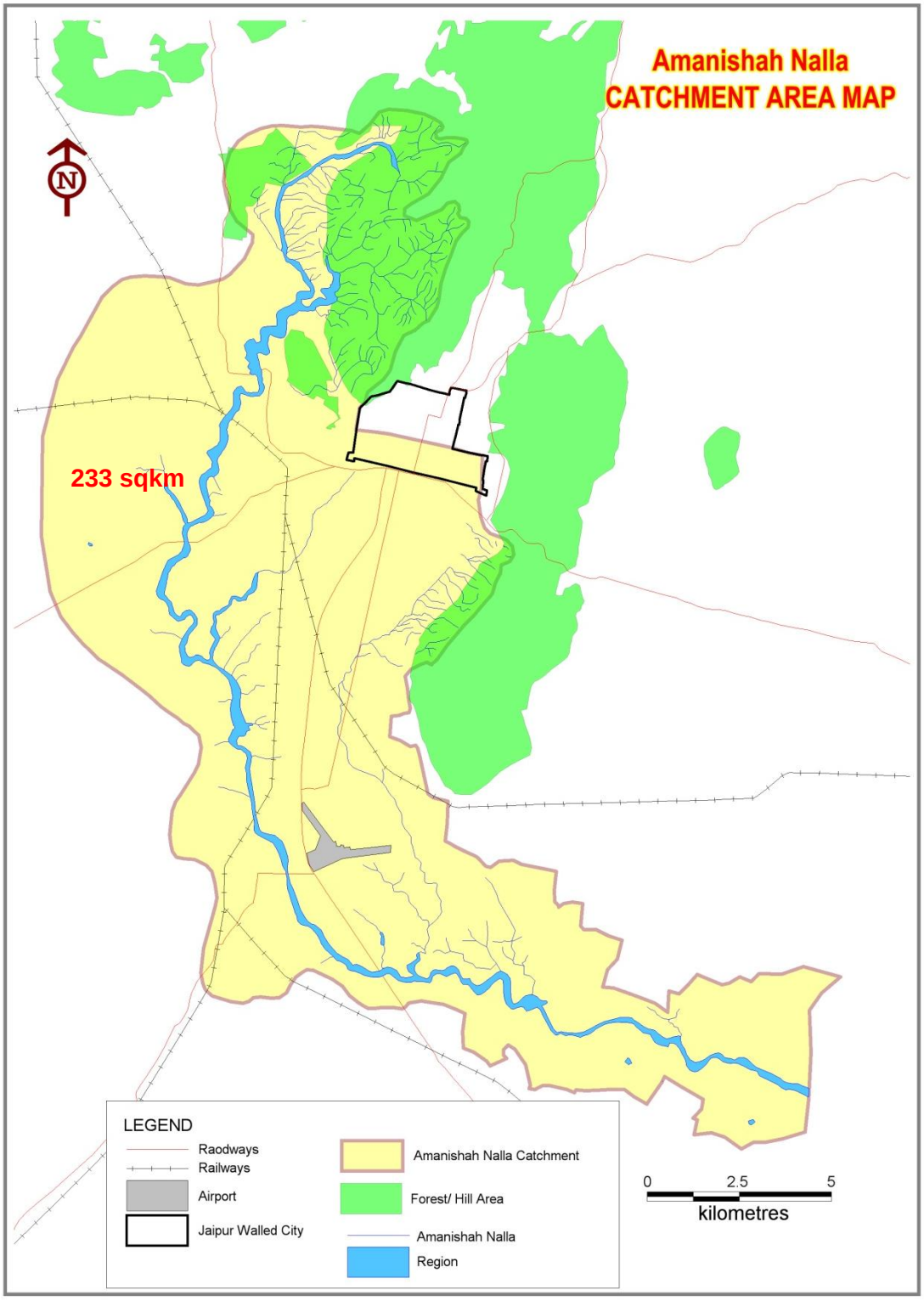


Figure 7-1 Catchment Area Map of Amanishah Nallah

The Catchment area of Amanishah Nallah has been divided into 13 sub-catchments based on the physiographical conditions e.g. crossings of roads, railway lines, existing Nallah and its tributaries etc.

Geographical areas of each sub-catchment have been calculated using GIS mapping and presented chainage wise in the following table:

Table 7-2: Amanishah Nallah Sub-Catchment Areas

No.	Name of Crossing	Chainage (Km)	Cumulative Catchment Area (Sq Km)
1	Nahargarh Hill to Bhuteshwar	2.800	14.70
2	Bhuteshwar Mahadev to Mazar Dam	5.100	23.50
3	Mazar Dam to Sikar Road Crossing NH 11 (Chomupuliya)	7.900	34.20
4	(Chomupuliya) Sikar Road Crossing NH 11 to Jaipur Ajmer Railway Line	9.600	41.00
5	Jaipur Ajmer Railway Line to Khatipura Road (NBC) Rawalji ka Bandha	12.000	58.60
6	Khatipura Road (NBC) Rawalji ka Bandha to Jaipur Ajmer Road (Ajmer Puliya)	14.500	71.30
7	Jaipur Ajmer Road (Ajmer Puliya) Near Neerja Modi School Crossing	18.600	116.00
8	Neerja Modi School Crossing to Sanganer Setu	26.275	138.40
9	Sanganer Setu to Gular Dam	27.500	144.20
10	Gular Dam to Sitapura-Pratap Nagar Culvert	30.900	178.00
11	Sitapura-Pratap Nagar Culvert to Ramchandra Pura Dam	35.300	192.70
12	Ram Chandra Dam to Gonar Road Crossing	39.990	205.40
13	Goner Road crossing to end	47.500	233

7.3.1.2.2 Extreme value analysis for rainfall data

The daily rainfall data of 33 years of Sanganer and Jaipur rainfall recording stations/ observatories have been collected and analysed.

The 24 hour (daily) maximum rainfall data year-wise for both the stations has been tabulated and presented in the following table:

Table 7-3: 24 hour (Daily) Maximum Rainfall Data of Sanganer and Jaipur

Year	Sanganer		Jaipur	
	Daily maximum (cm)	Date of Occurrence	Daily maximum (cm)	Date of Occurrence
1981	38.80	19-Jul	32.80	19-Jul
1982	4.20	03-Aug	8.20	03-Aug
1983	14.00	27-Jul	15.50	27-Jul
1984	5.18	02-Sep	2.30	16-Aug
1985	7.24	08-Aug	8.70	15-Aug
1986	7.66	27-Jul	12.90	27-Jul
1987	3.50	15-Aug	5.60	17-Jul
1988	10.80	27-Aug	4.40	13-Aug
1989	19.80	27-Aug	6.04	27-Aug
1990	16.56	04-Jul	7.90	N.A
1991	8.30	23-Aug	6.30	23-Aug
1992	15.00	25-Jul	18.80	25-Jul
1993	6.68	07-Aug	8.20	11-Jul
1994	7.00	03-Sep	7.50	21-Jul
1995	8.20	05-Aug	13.20	26-Aug
1996	9.20	21-Jul	7.50	03-Sep
1997	7.50	26-Aug	5.50	26-Aug
1998	8.40	05-Jul	13.74	05-Jul
1999	6.20	31-Jul	10.40	31-Jul
2000	12.50	14-Jul	5.30	18-Jul
2001	15.90	23-Jul	8.22	03-Jul
2002	7.00	31-Dec	6.00	04-Aug
2003	7.00	25-Jun	4.40	14-Jul

2004	8.80	18-Aug	11.30	13-Aug
2005	6.90	27-Jun	7.90	14-Jul
2006	5.1	3-June	6.4	21-July
2007	6.7	23-Aug	7.4	30-Aug
2008	9.6	10-July	3.8	28-Aug
2009	4.2	22-July	7.5	16 July
2010	8.8	1-Aug	6.3	19-Aug
2011	5	25 July	7.9	24-Juy
2012	17	22 Auf	30	22 Au
2013	6.7	8-Aug	9.1	8-Aug

The Highest daily rainfall observed in 1981 flood was 38.8cm and 32.8cm on the same date of 19th July at Sanganer and Jaipur observatory respectively.

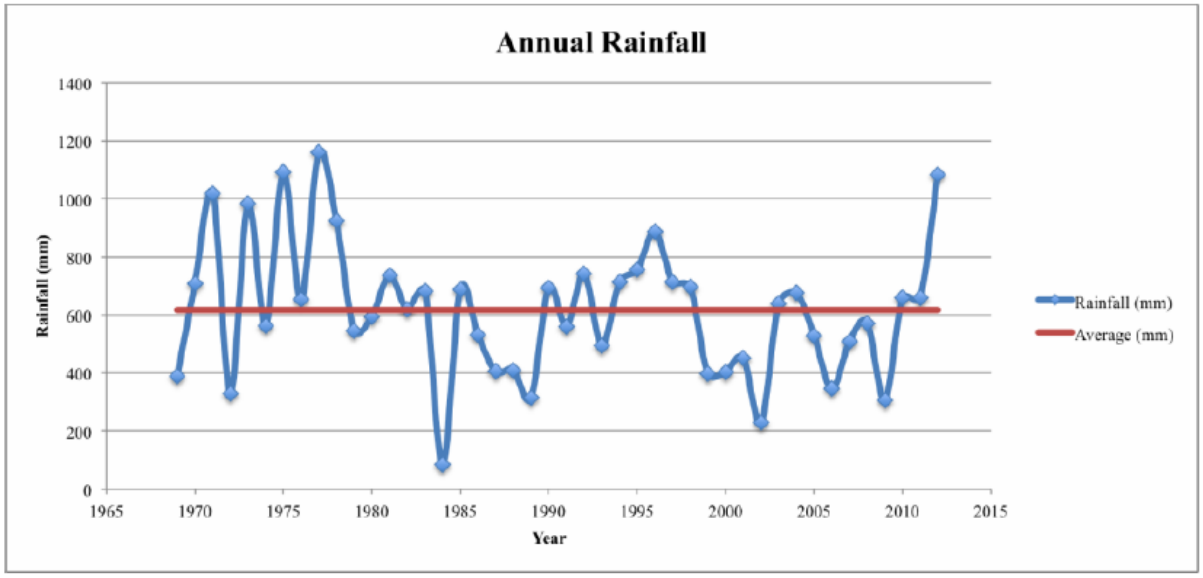


Figure 7-2 Jaipur Annual Average Rainfall (1981-2013)

7.3.1.2.3 Runoff Coefficient:

Assumptions:

- Runoff factor values given in IRC-SP-13 are referred however since the project is of Jaipur city values given in IRC SP-50 on Urban Drainage were also considered.
- To calculate the runoff coefficient following values of the runoff factor have been adopted:

  - Permeable strata (Open area - Sandy Soil) : 0.20
  - Impermeable strata (built-up, roads, paved area) : 0.70

Based on the preliminary analysis the runoff factors for each of the sub-catchment areas have been worked out and presented in the following table:

Table 7-4: Runoff Coefficient Calculation for Amanishah Nallah sub catchments

Reach No	Nodes	Mileage (KM)	Net Area (KM^2)	Percentage Factor		Average Runoff Coefficient
				Permeable	Impermeable	
1	Nahargarh hill - Bhuteswar Mahadev	2.8	14.7	90%	10%	0.25
2	Bhuteshwar Mahadev – Mazar Dam	5.1	8.8	80%	20%	0.30
3	Mazar Dam- Sikar road crossing NH-11	7.65	10.7	60%	40%	0.40
4	Sikar road crossing to Jaipur Jhatwara Railway line	9.6	6.8	50%	50%	0.45
5	Jaipur- Jhotwara Rlyline – N.B.C (Jaipur Khatipura Road)	11.35	17.6	40%	60%	0.50
6	N.B.C – Jaipur Ajmer Road NH-	13.95	12.7	40%	60%	0.50

	8					
7	Ajmer road – near Neerja Modi school crossing	17.65	44.7	30%	70%	0.55
8	Neerja Modi school crossing – Jaipur airport-Sanganer Airport crossing	25.3	22.4	50%	50%	0.45
9	Sanganer Bridge - Gular Dam	26.55	5.8	70%	30%	0.35
10	Gular Dam - Confluence of Jawahar nagar	32.75	33.8	70%	30%	0.35
11	Confluence of Jawahar nagar - Ramchandrapura Dam	34.8	14.7	70%	30%	0.35
12	Ramchandrapura Dam-Goner Road crossing	41.3	12.7	70%	30%	0.35
13	Goner Road crossing to end	47.5	27.6	70%	30%	0.35

7.3.1.2.4 Flood Frequency Analysis

To estimate the extreme flood events from the limited data series larger extrapolations for return period (T) is required necessitating the use of theoretical probability distributions. Using these, flood magnitude for a specific return period is estimated.

Following two commonly used frequency distribution functions for prediction of extreme flood values are used with the available date for Amanishah Nallah:

a) Gumbel's Method
b) Least Square Method

In the absence of discharge data the storm rainfall values which are available have been used in carrying out frequency analysis to obtain the 25, 50 and 100 Year return period storm rainfall by Gumbel Method and Method of least squares. The summary of the results are presented in the following table:

Table 7-5: Summary of Rainfall Intensity computed from Flood Frequency Analysis

Return Period in years	Method			
	Gumbel		Least Square	
	Jaipur	Sanganer	Jaipur	Sanganer
25	24.64	28.04	23.26	25.77
50	28.62	32.66	26.78	29.79
100	**32.57**	**37.26**	30.36	**33.79**

It can be seen that for all the three return Periods Sanganer shows the highest storm rainfall intensity.

7.3.1.2.5 Selection of Design Rainfall Intensity:

Following approach has been followed in arriving at the value of Design Rainfall Intensity:

- This highest daily rainfall value as recorded by IMD is much closure to the 100 year return period daily rainfall computed by analyzing daily rainfall data of Jaipur and Sanganer using Gumbel's method (37.26cm) and least square method (33.79 cm).
- For all calculation purposes the Peak daily rainfall values estimated by Gumbel's method is adopted for both Jaipur and Sanganer stations.
- Rainfall data of two rain gauge stations i.e., Jaipur and Sanganer station are available. In the flow length of 47.5 km of Amanishah Nallah both the stations have their range of applicability. Hence to optimize the applicability Rainfall data of Jaipur station has been used upto chainage 17650 (Catchment area 1 to catchment area-7) and Sanganer Station from chainage 17650 to 47500 (catchment 8 to 13).
- Values of Rainfall Intensities as presented in the Table no.7-5 as calculated by Gumbel's method i.e., **32.57 and 37.26 mm/h** for Jaipur and Sanganer station have been adopted respectively.

7.3.1.3 ESTIMATION OF PEAK FLOOD DISCHARGE

7.3.1.3.1 Selection of Method for Estimation

Based on the discussion with JDA and subsequent analysis of the studies already carried out on Amanishah Nallah the design discharge for 25/ 50/ 100 year return period and for the highest recorded have been calculated by most applicable method and reviewed for its practical applicability in the project context.

Peak flood discharges are generally computed by using following widely used methods:

a) Method 1: Rational Formula

b) Method 2: Synthetic Unit Hydrograph (SUH) Method using equations developed by CWC for Chambal Sub Basin

A close review of both methods has been done to arrive at a safe value of peak discharge for the design purposes of the Amanishah Nallah and to arrive at an optimum solution. Following are the observations for the same:

- It is observed that 1 hour peak areal rainfall for 100 year return period are in the range of 11 cm to 13 cm by using Synthetic Unit hydrograph method. At the same time observed value of hourly results of the rain fall even of 1981 assumed to be of 100 year return period frequency is only 6.6 cm. Therefore it can very well be concluded by giving credence to actual observed values that Method 2 is less applicable in present scenario for estimation of peak flood discharge.

- It is further observed that the Method 2 uses the equations developed for Chambal River sub-basin as given in “Flood Estimation Report for Chambal Sub-zone -1(b)” Published in Dec 1988 by CWC. Although the Amanishah Nallah is falling inside the Chambal River Sub-basin, still the character of its catchment is quite different from the parent catchment. The Amanishah Nallah primarily (now) receives the storm water from the urban development areas and the characteristics of which are quite different from parent sub-basin characteristics.

- It is also observed that variability of catchment characteristics due to significant urbanisation in the catchment area is very high and therefore method 2 is less applicable. As the runoff from a catchment is quite dependent on the land-use

pattern existing in that catchment area, the runoff generation factor for each of the sub-catchments will be quite different. Hence Rational Formula has more control in modifying the catchment factor to match the land-use characteristics.

Considering the above facts, **Rational Formula** for calculation of Flood Peak Discharge has been adopted.

However, further calculations by using SUH has been done to determine the extreme flood event for 100 year return period. While the core channel section with concrete lining has been designed with peak flood discharge obtained by Rational Method, additional free board and width has been provided to accommodate the high flood levels obtained by extreme high flood event of 100 year return period by using SUH method. It has been ensured that any such flood levels obtained by extreme high flood event of 100 year return period by using SUH method are contained within overall proposed channel cross sections.

It is expected that at some point of time (one in 100 years) there is possibility that water levels may rise to level that it will encroach free board area for a limited period during high flood level only. Though it is expected that even in such a scenario, no significant damages will be done to the embankment but the possibility of same cannot be denied and accordingly emergency response plan will be kept ready for one of such event.

7.3.1.3.2 Estimation of Peak Discharge by Rational Formula

The Rational Method expresses a relationship between rainfall intensity and catchment area as independent variables and the peak flood discharge resulting from the rainfall as the dependent variable.

Assumptions:

Following assumptions have been considered while using the Rational Formula:

- The rainfall is uniformly distributed on the entire drainage area upto the section where design discharge is to be calculated and is constant over the time.
- The predicted peak discharge has the same probability of occurrence (return period) as the used rainfall intensity.

- Peak runoff rate can be represented by the rainfall intensity averaged over the same time period as the drainage area's time of concentration (t_c)
- The runoff coefficient of different areas remains constant during the storm event.
- Formula given in IRC-13 has been used to arrive at the critical rainfall intensities using the Rational formula.
- 24 hours Rainfall Intensity of 100 year return period of 32.57**cm/day**of Jaipur station has been used upto chainage 17650 (Catchment area 1 to catchment area-7) and **37.26 cm/day** Sanganer Station from chainage 17650 to 47500 (catchment 8 to 13).
- Corrections in runoff to account for outflow capacity from the existing hydraulic structures have been adopted.
  - Inflow of the Mazar dam is large, but it has retention capacity also, the discharge capacity of Mazar dam is 28.373 cum/s. Inflow and outflow calculations were taken into account by Water Resources department while constructing the dam.Hence in the d/s of Mazar irrespective of higher inflow the outflow value of discharge at 28.373 cum/s has been considered with the assumption that Mazar dam stands.
  - Similarly for Hydraulic structure at Sikar road the outflow discharge capacity of the structure i.e. 77.5 cum/s has been adopted in runoff calculations in subsequent catchments.

Rational Formula:

Discharge by Rational Formula is calculated by following equation:

$Q = 0.028 \times C \times A \times I_c$

Where, Q = Maximum runoff in cum/sec.

C = Coefficient of runoff for the Catchment characteristics.

A = Area of Catchment in hectares.

I_c = Critical Intensity of rainfall in cm per hour.

Which is calculated by:

Ic = I x (T+1)/(t_c+1)

Where, I is the highest rainfall in T (= 24 hours in the present case) hours

And **t_c: = (0.87xL^3 /H)$^{0.385}$**

Where, L = the distance from the critical point to the point at which the discharge is to be estimated

H = the fall in the level from the critical point to the point at which the discharge is to be estimated.

7.3.1.3.3 Discharge Calculations:

The discharge values considering the design peak rainfall for 25, 50 and 100 years of return period have been calculated based on the Rational Formula and summary of design discharge at different nodal point of 13 reaches are presented in the following table:

Table 7-6: Peak Discharge estimated by Rational Formula for 25/ 50/ 100 Years Return Period

Reach No	Nodes	Mileage (KM)	Net Area (KM^2)	Discharge (Cumec)		
				Q25	Q50	Q100
1	Nahargarh hill - Bhuteswar Mahadev	2.8	14.7	150.76	175.11	199.27
2	Bhuteshwar Mahadev – Mazar Dam	5.1	8.8	189.02	219.55	249.85
3	Mazar Dam-Sikar road crossing NH-11	7.65	10.7	82.17	90.86	99.49
4	Sikar road crossing to Jaipur Jhatwara Railway line	9.6	6.8	114.69	120.70	126.66
5	Jaipur- Jhotwara Rlyline – N.B.C (Jaipur Khatipura Road)	11.35	17.6	228.00	252.31	276.43
6	N.B.C – Jaipur Ajmer Road NH-8	13.95	12.7	281.02	313.89	346.51
7	Ajmer road – near Neerja Modi school crossing	17.65	44.7	503.02	571.75	639.96
8	Neerja Modi school crossing – Jaipur airport-Sanganer Airport crossing	25.3	22.4	554.52	633.12	711.38
9	Sanganer Bridge - Gular Dam	26.55	5.8	554.28	632.83	711.05
10	Gular Dam - Confluence of Jawahar nagar	32.75	33.8	568.75	649.69	730.28
11	Confluence of Jawahar nagar - Ramchandrapura Dam	34.8	14.7	596.05	681.49	766.56
12	Ramchandrapura Dam-Goner Road crossing	41.3	12.7	563.74	643.86	723.62*
13	Goner Road crossing to end	47.5	27.6	568.48	649.38	729.93*

As the discharge values of Reach-11 is more than the discharge values estimated for reach no- 12 & 13, the discharge value of Reach-11 has been considered for the designing of the subsequent structures.

7.3.1.3.4 Estimation of Peak Discharge by Rational Formula

A Procedure adopted for estimation of design flood is given below.

The catchment area of the section at which the design flood has to be estimated has been calculated. The length of the Nalla is measured (L) up to the point of crossing. The equivalent slope (S) has been computed.

Synthetic (1 h) unitgraph parameters have been calculated using A, L, & S. and the following equations have been used for arriving at the parameters..

(i) $t_p = 0.339 \times (L/\sqrt{S})^{0.826}$

(ii) $q_p = 1.251 (t_p)^{-0.610}$

(iii) $W_{50} = 2.215 (q_p)^{-1.034}$

(iv) $W_{75} = 1.191 (q_p)^{-1.057}$

(v) $W_{R50} = 0.834 (q_p)^{-1.077}$

(vi) $W_{R75} = 0.502 (q_p)^{-1.065}$

(vii) $T_B = 6.662 (t_p)^{0.613}$

(viii) $t_m = t_p + t_r/2$

(ix) $Qp = q_p x A$

Using the above equations, the parameters of unit graph have been calculated and the unit hydrograph has been plotted.

Design storm duration has been estimated using the formula $T_D=1.1 \times (t_p)$

Rainfall distribution and determination of effective rainfall has been done as per the process explained and tables provided in the guiding manual of CWC for Chanbal Basin 1b.

Base flow has been estimated using the equation $q_p = 0.207 / (A)^{0.290}$ Cumec/Sq, m.

For the estimation of the peak discharges the effective rainfall units and the ordinates from the unit graph have been used and the Base flow is added to get the design flood.

The calculated extreme discharges of 100 year return period using SUH method are as follows:

Reach	Catchment	Reach individual Distance (Km)	Incremental Mileage (Km)	U/S RL	D/S RL	Net Catchment Area (Sq. Km)	Incremental Catchment Area (Sq. Km)	Cummulative Flood (Cumec)
1&2	Origin to Mazar Dam	5.1	5.1	494.99	445.33	22.5	22.5	365
3	Mazar Dam-Sikar road crossing NH-11	2.55	7.65	445.33	438.25	10.7	33.2	435
4	Sikar road crossing to Jaipur Jhotwara Railway line	1.95	9.6	438.25	425.66	6.8	40	487
5	Jaipur- Jhotwara Rlyline – N.B.C (Jaipur Khatipura Road)	1.75	11.35	425.66	414.41	17.6	57.6	677
6	N.B.C – Jaipur Ajmer Road NH-8	2.6	13.95	414.41	408.47	12.7	70.3	779
7	Ajmer road – near Neerja Modi school crossing	3.7	17.65	408.47	396.01	44.7	115	1123
8	Neerja Modi school crossing – Jaipur airport-Sanganer Airport crossing	7.65	25.3	396.01	374.74	22.4	137.4	1217
9	Sanganer Bridge - Gular Dam	1.25	26.55	374.74	372.58	5.8	143.2	1269
10	Gular Dam - Confluence of Jawahar nagar	6.2	32.75	372.58	360.69	33.8	177	1445
11	Confluence of Jawahar nagar - Ramchandrapura Dam	2.05	34.8	360.69	351.54	14.7	191.7	1506
12	Ramchandrapura Dam-Goner Road crossing	6.5	41.3	351.54	336.36	12.7	204.4	1515
13	Goner Road crossing to end	6.2	47.5	336.36	324.23	27.6	232	1674

7.3.2 HYDRAULIC DESIGN OF AMANISHAH NALLAH

7.3.2.1 DESIGN CONSIDERATION

The design of any hydraulic structure is significantly dependent on the value of flood discharge adopted in its design. Higher value of design discharge will always result in over –sizing of the structure and increased cost of not only that structure but also the other allied sub structure of the system. On the other hand the under estimated value of flood discharge will increase the risk factor and may result in huge damage of life and property.

At the same time absolute flood protection is unrealistic, a rational design of hydraulic structures must take into account the risk of flooding, consequent damages and cost of the structure.

Hence it becomes utmost important to adopt appropriate value of flood discharge after accounting the all the economic and hydrological factors of the Amanishah Nallah and then design the best optimized structure considering local material.

In designing of various components of the Amanishah Nallah which includes the channel section, check dams, falls, embankments and protection walls etc. a basic approach to ensure - economy, safety, durability and functionality has been followed in selecting various items and materials (available locally).

7.3.2.2 HYDRAULIC DESIGN BASIS

- The design of Amanishah Nallah is carried out based on the hydrology of the catchment area and hydraulics of the existing channel.
- Existing slopes in the channel are obtained from the cross sectional and longitudinal sections prepared from the primary engineering survey data.
- Catchment and sub catchment areas of Amanishah Nallah have been calculated using GIS mapping with the source data of topo sheets and data obtained from JDA.
- Considering the physiographic characteristics Amanishah Nallah flow path has been divided into 13 sections (Reach).
- Channel cross sections have been designed using Manning formula with trial and error approach.

- The most optimized cross sections have been adopted, taking into account the condition that land required for width of the channel section is a constraint.
- Cement concrete lining has been proposed for which the rugosity value (n) of 0.015 is adopted in velocity calculations assuming **in situ concreting with Paver machine**.
- For natural unlined sections in upper reach, the 'n' value of 0.05 has been adopted while in the downstream last reach the 'n' value of 0.025 considering the rough stone paved surface.
- Adequate number of falls has been proposed to control the velocities due to high slopes along the Nallah
- An optimized section has been design for the calculated discharge by optimizing the cross section (width and depth), allowing permissible velocities as per the material proposed, keeping the flow as sub critical (controlling Froude numbers) to avoid hydraulic jumps and other hydraulic phenomenon, controlling the slopes
- Slope protection measures have been provided.
- The existing water retaining structures have been preserved and are likely to be utilized for flood modulations. .
- The runoff from catchment contributing upto the specific node has been calculated using Rationale Method and corrections to account for outflow capacity from the existing hydraulic structures have been adopted.
- The channel is designed for each reach considering incoming tributaries and bed level of existing cross drainage structures.
- It has been proposed to keep different channel section lining for different area which depends on available width of the cross section and subsequent permissible velocities after maximum possible slope corrections. Accordingly concrete lining, stone pitching and natural sections have been adopted.
- In early reaches, where there are no constraints on land width available, larger cross sections with natural sections have been proposed. In addition to maintaining the existing ecological character of the region, it will also help in recharging of groundwater which can help the ground water table further downstream.

- The existing water storing area near control structures Mazar Dam will be utilized for recharging purpose.
- A provision of increasing the spillway capacity of the Mazar dam by gated structure has been proposed for modulating the extreme flood event of 100 year return period calculated by Method 2 (SUH).

7.3.2.3 FLOOD MANAGEMENT AT MAZAR DAM

The Technical note prepared for Mazar Dam indicated that Dam is having total flood absorption capacity of 287 MCFT as presented in the following table:

No.	Storage	Capacity in MCFT	Capacity in MCM	Levels m	Height m
	Bed			**443.0**	0
1	Up to Crest level	137	3.88	451.0	8
2	Above Crest level	150	4.25	454.5	11.5
	Total	**287**	**8.12**		

From the table it is clear that Mazar dam can store water upto its crest level of quantity 137 MCFT (3.88 MCM) and any flow above it will be discharge from the spillway section provided at the dam.

The Mazar dam is having flood control mechanism of crest height of 8m height and 10m wide below the bridge at the RHS part of the dam. The documented discharge capacity of the Mazar dam is 28.3 cumec.

The peak rainfall runoff calculated as (7.7 MCM)for the catchment area of Amanishah Nallah upto the Mazar dam is more than the dead storage capacity (3.88 MCM).

Flood Peak Management:

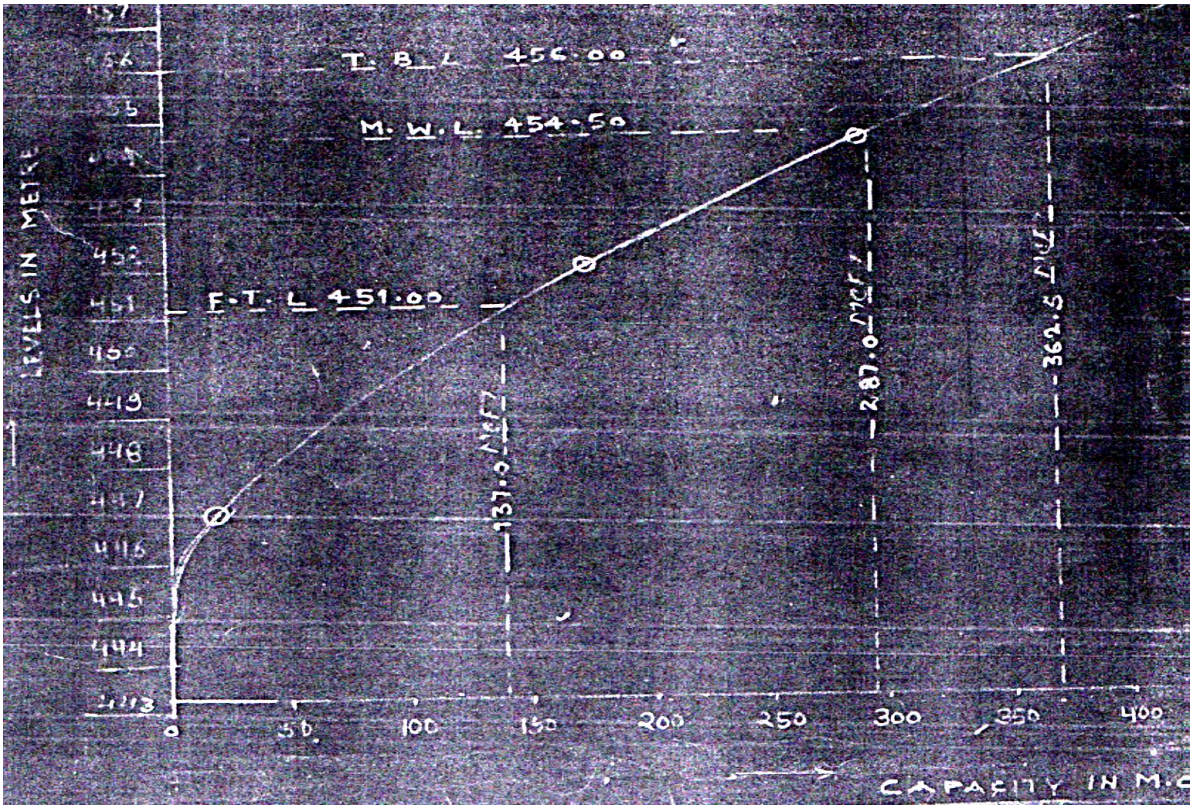
Case-1: Mazar dam empty at the time of peak flood event

- Mazar dam can absorb 8.1 MCM in case of emptied storage at the time of peak event.

Case-2: Mazar dam filled upto dead storage at the time of peak flood event

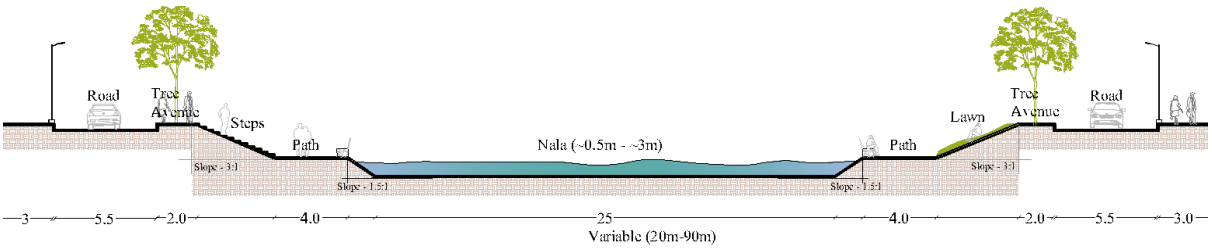
- In the case of Peak flood Event the discharge capacity of the dam will be 28 Cumec as compare to much higher flood runoff.
- To increase the flood absorption capacity the dead storage need to be emptied to match the case-1 condition.
- A provision of lowering the crest level by a gated structure by min 2 m need to be created so that it can be emptied in advance.
- It is considered that the IMD will telecast the critical heavy rainfall event in advance and a 24hour time would be available to empty the storage volume of 137 MCFT i.e., 3.88 MCM
- Hence a Gated spillway need to be created with discharge capacity of 3.88 MCM in 24 hour i.e., 44.90 cumec or say **45.0 cumec.**

Reference Document:



7.3.2.4 KEY FEATURES OF CHANNEL SECTION

An optimized channel section has been proposed to meet all the hydraulic as well as the river front landscape feature requirements for the Amanishah Nallah as



presented here.

Figure7-3 Typical Channel Section (RoW) of Amanishah Nallah

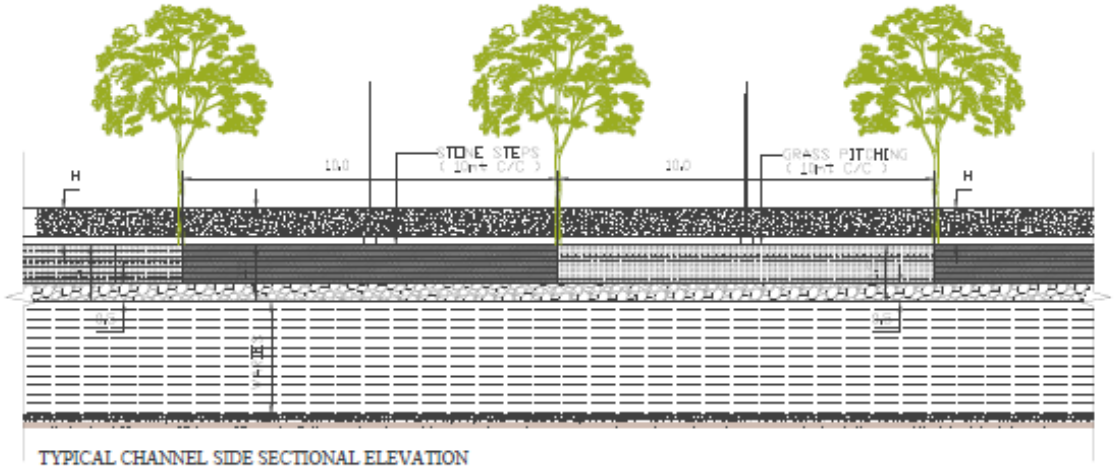


Figure7-4 Typical Channel Section Elevation of Amanishah Nallah

Various components of the sections are described as follows:

- As there is no significant variation in peak runoff values for 25 year and 100 year return period, hence the single trapezoidal section has been designed for 100 year of flood discharge.
- The main channel will be in trapezoidal section with side slope in the ratio of 1.5 H: 1V.
- The sections will be designed in such a way that it doesn't increase the depth of flow beyond 3.1 m in main channel section. This constraint will vary the bottom

width of the channel from 18 m to 102 m depending upon the inflow discharge at that section.

- After the main section a provision of Foot path as a pedestrian walk-way of 3 m wide has been provisioned on both sides of the section along with a sitting place of 1 m wide and 0.5 m high and further 0.5 m deep foundation. (Total width of this portion will be 4 m).
- Further to it the compacted earthen embankment with grass or steps has been proposed both sides. The height of the embankment will vary from place to place depending upon the nearby ground level. The side slope will be in the ratio of 3H: 1V. This section will not receive any impact during peak flow discharge. This space can be utilized for sitting as river front feature looking towards the main flow section.This section has been provided with alternate 10 m wide panels of (a) grass turf and (b) masonry steps with concrete bed on both sides of the Nallah.
- On top of the embankment tree plantation has been provisioned in 2 m strip as green belt all along the Amanishah Nallah and provide the stability to the embankment.
- Immediately on the end of green strip, boundary wall of 0.5 m thick stone masonry has been proposed with 1 m or 1.5 heights at various distances. (From Ch 5.1 KM to 26.55 KM 1 m high and from 26.55 onwards to 47.5 Km it is 1.5 m high.
- A service road of 5.5 m wide has been proposed after the green strip for the movement of vehicles along the Amanishah Nallah wherever Government land exists. A length of 16KM has been proposed to be constructed under current proposal.
- Existing slope of channel section is varying in different reaches identified in the Amanishah Nallah flow path. To keep the velocity in control, optimum slopes have been provided. This constraint has necessitated providing a fall structure in the flow path for dissipation of kinetic energy of the flooding water.
- In order to make a water front and for aesthetic considerations small check dams of 0.7 / 1.0 m height and 1.5 m of top width are introduced at suitable

locations in the Nallah bed. Considering the nature of public space, and likely popularity of the proposed water front as a family destinations water depth and in turn check dam height have been decided. It is expected that small children will play around and lot of casual public activities will happen around the proposed water front. Therefore the depth of water has been kept as the most optimum to keep the water front feel and safety both. These check dams are proposed to be constructed as hollow sections to pass the possible utility services across the Nallah in future. The Check Dam will serve following major purposes:

- To establish a feel of continuous water body.
- To serve as a conduit for future utility services
- To minimize the impact of the flow over the fall.
- To act as a path way for crossing the Amanishah Nallah during non-rainy period by pedestrians and bicycle riders.

7.3.2.5 DESIGN OF CHANNEL SECTION

Lined Channel Section has been designed using the principle of trial and error method. Manning's equation (Gravity flow equation) has been followed in determining the velocity of flow through designed section:

$$V = (1/n).R^{2/3}.S^{1/2}$$

Where, R = Hydraulic mean depth,

S = Hydraulic Slope

And 'n' = Manning (Roughness) coefficient

7.3.2.5.1 Lined Channel Section:

Following design parameters have been adopted:

- Manning Roughness coefficient 'n' = 0.015 (for Concrete surface)
- Hydraulic Slope 'S' = varying from 0.12 % to 0.35%

7.3.2.5.2 Unlined Channel Section

Following design parameters have been adopted in design:

- Manning Roughness coefficient 'n' = 0.05 (for Grass channel) in Reach-1&2
- Hydraulic Slope 'S' = 0.2 % or 1: 500

7.3.2.5.3 Random Rubble Pitched Section

Following design parameters have been adopted in design:

- Manning Roughness coefficient 'n' = 0.025
- Hydraulic Slope 'S' = 0.13 % or 1: 770

7.3.2.6 DESIGN OF FALL

Starting from origin to end point at 47.5 KM, Nallah has an overall drop of around 170 m, giving an average slope of 0.36%, which is considered high for such flow regime. This slope keeps on changing over different reaches selected for the design. This steep slope induces higher velocities flow during peak flood discharge. To keep the velocity of flow in desired range, either the sectional area needs to be increased or the slope needs to be reduced. Since sectional area has its own constraints of land availability, the only option remains is reduction in the slope of the bed. Thus the falls become unavoidable in order to maintain the velocity in range.

Design Basis:

- A very innovative approach to resolve the fall and subsequent downstream protection has been done by keeping the falls in continuous stepped form. A fall of 0.5 m maximum has been designed to protect the downstream.
- Falls are provisioned in reach - 3 to reach - 13 (Chainage 5100 to 47500).
- As provisions of checkdam will create storage of water which will act as a stilling basin to the fall structure, hence no bed protection works at d/s will be required.
- Aeration System has been provided to improve the dissolved Oxygen levels in the water so that quality of Water is sufficient to achieve sustainability for aquatic and marine life.
- While placing falls on the bed of the proposed channel, care has been taken to place appropriate size fall at the intersection of two reaches where, as per hydraulic calculations water depth is increasing in downstream reach. The size of

fall has been kept as the difference of water levels.

As per the designed slope for the main channel section, the numbers of Fall Structures calculated are tabulated in the following table:

Table 7-7: Reach-wise Fall Structures proposed in Amanishah Nallah

Reach No.	Nodes	Chainage (in m)		No of Falls
		From	To	N
1	Nahargarh hill -Bhuteswar Mahadev	0	2800	0
2	Bhuteshwar Mahadev – Mazar Dam	2800	5100	0
3	Mazar Dam-Sikar road crossing NH-11	5100	7650	4
4	Sikar road crossing to Jaipur Jhatwara Railway line	7650	9600	12
5	Jaipur- Jhotwara Rlyline – N.B.C (Jaipur Khatipura Road)	9600	11350	17
6	N.B.C – Jaipur Ajmer Road NH-8	11350	13950	4
7	Ajmer road – near Neerja Modi school crossing	13950	17650	13
8	Neerja Modi school crossing – Jaipur airport-Sanganer Airport crossing	17650	25300	20
9	Sanganer Bridge - Gular Dam	25300	26550	1
10	Gular Dam - Confluence of Jawahar nagar	26550	32750	3
11	Confluence of Jawahar nagar - Ramchandrapura Dam	32750	34800	14
12	Ramchandrapura Dam-Goner Road crossing	34800	41300	20
13	Goner Road crossing to end	41300	47500	14

7.3.2.7 DESIGN OF STORAGE STRUCTURE (CHECK DAM AND GABION)

7.3.2.7.1 Unlined Channel

- In Unlined channel section of the upper two reaches i.e. 0 - 5100 chainage, Gabion Structures are proposed to check the velocity as well as the soil erosion at a designed interval.
- The height of the check dams have been kept at 0.3 m with Gabion structures. In all 17 such small structures have been proposed in initial two reaches before Mazar dam.

7.3.2.7.2 Lined Channel

- Check Dams provisioned in the Lined channel sections i.e. reach - 3 to reach -11 (Chainage 5100 to 34800).
- The height and top width of the check dams are kept as 0.7 m and 1.5 m respectively. Apart from these at four places check dams of 1 m height have also been considered.
- As an innovative thought process, check dams of 0.7 m height are provided at the d/s of the fall at appropriate location in such a way that water storage is created by the stored water in between the two structures. This stored water will act as a stilling basin for water flowing through the fall thus d/s bed protection works are avoided
- All the check dams are expected to have provisions for limited release of water from the section, so that in case of any such requirements, particular sections can be drained out fully and can be cleaned.
- All these check dams top surface will be finished in appropriate manner.
- All the check dams will have railings on both sides with ropes which can be removed temporarily during monsoon seasons.
- Check dams will have restricted entry during monsoon season by extending the railings of the walkways.
- Ramp/steps will be provided within walkways to access the check dams by pedestrians interested in cross over.

As per the design, the numbers of Check Dam Structures calculated are tabulated in the following table:

Table 7-8: Reach-wise Check Dam Structures proposed in Amanishah Nallah

Reach No	Nodes	Chainage (in m)		Check Dams
		From	To	N
1	Nahargarh hill -Bhuteswar Mahadev*	0	2800	9
2	Bhuteshwar Mahadev – Mazar Dam*	2800	5100	8
3	Mazar Dam-Sikar road crossing NH-11	5100	7650	4
4	Sikar road crossing to Jaipur Jhatwara Railway line	7650	9600	10
5	Jaipur- Jhotwara Rlyline – N.B.C	9600	11350	4

Reach No	Nodes	Chainage (in m)		Check Dams
		From	To	N
	(Jaipur Khatipura Road)			
6	N.B.C – Jaipur Ajmer Road NH-8	11350	13950	6
7	Ajmer road – near Neerja Modi school crossing	13950	17650	8
8	Neerja Modi school crossing – Jaipur airport-Sanganer Airport crossing	17650	25300	16
9	Sanganer Bridge - Gular Dam	25300	26550	3
10	Gular Dam - Confluence of Jawahar nagar	26550	32750	13
11	Confluence of Jawahar nagar - Ramchandrapura Dam	32750	34800	4
12	Ramchandrapura Dam-Goner Road crossing	34800	41300	
13	Goner Road crossing to end	41300	47500	

* Gabion Structures

These check dams will be appropriately placed between the reaches as defined in the table above at the time of detail designs and Master Planning exercise to merge with the requirements of the proposed master plan around Amanishah Nallah.

7.3.3 HYDRAULIC DESIGN VALUES OF AMANISHAH NALLAH

As per the design basis explained above following hydraulic design values have been obtained for various reaches of Amanishah Nallah in following table.

Table 7-9: Design Properties of the Proposed Nallah Reaches: SIDE SLOPES: Z1 = 1.5, Z2= 3

SN	Section	Chainage		Length	Proposed Section			Required Width
		From	To	m	B (Bottom Width)	D (Depth)	T (Top Width of water surface)	
1	Nahargarh hill - Bhuteswar Mahadev				65	2.26	74.04	
2	Bhuteshwar Mahadev – Mazar Dam	2800	5100	2300	75	2.3	84.2	
3	Mazar Dam-Sikar road crossing NH-11	5100	7650	2550	18	1.8	23.4	44.4
4	Sikar road crossing to Jaipur Jhotwara Railway line	7650	9600	1950	18	1.76	23.28	44.28
5	Jaipur- Jhotwara Rlyline – N.B.C (Jaipur Khatipura Road)	9600	11350	1750	18	2.8	26.4	47.4
6	N.B.C – Jaipur Ajmer Road NH-8	11350	13950	2600	20	2.99	28.97	49.97
7	Ajmer road – near Neerja Modi school crossing	13950	17650	3700	38	2.99	46.97	67.97
8	Neerja Modi school crossing – Jaipur airport-Sanganer Airport crossing	17650	25300	7650	43	3.1	52.3	73.3
9	Sanganer Bridge -	25300	26550	1250	43	3.1	52.3	73.3

SN	Section	Chainage		Length	Proposed Section			Required Width
		From	To	m	B (Bottom Width)	D (Depth)	T (Top Width of water surface)	
	Gular Dam							
10	Gular Dam - Confluence of Jawahar nagar	26550	32750	6200	44	3.1	53.3	74.3
11	Confluence of Jawahar nagar - Ramchandrapura Dam	32750	34800	2050	45	3.1	54.3	75.3
12	Ramchandrapura Dam-Goner Road crossing	34800	41300	6500	102	3.1	114.4	135.4
13	Goner Road crossing to end	41300	47500	6200	102	2.67	112.68	133.68

Detailed design calculations have been done using Manning's formula as explained in section above for determining the channel dimensions and corresponding velocities. Careful attention has been given while selecting roughness coefficient to take into account not only material of the wetted perimeter but also depth of the flow.
Keeping the court directive of maintaining the minimum width 150 ft / 210 ft the land should be made available.
The section has been calculated in terms of base width (B) of the lined trapezoidal channel and top width (T) of water surface which has been calculated based on side slope (Z1) for the lined channel portion and depth of flow in that reach. Velocity has been determined by iteration method by changing water depth for the constant section, slope and roughness coefficient. Calculations for 100 year return flood calculated by Rational Method and by SUH are in given below table for reference purpose:

DESIGN OF CANAL SECTION FOR AMANISHAH NALLA

Base Section- Peak flood of 100 year return bperiod by Rational Method Freeboar 0 m critical velocity ratio 1.1

Chainage 0 to 2800 Nahargarh hill -Bhuteswar Mahadev

S.No.	Design Period	Chainage From	Chainage To	Length	IL at start	IL at end	Bed Width	Flow Depth	Top Width	Side Slope	Wetted sides	Wetted Perimeter	X-sect Area	Hydraulic radius	Hydraulic slope	Roughness coefficient	Velocity	Calculated Discharge	Design Discharge	Check
		m	m	m	m	m	m	m	m		m	m	sqm			(concrete)	m/s	cum/s	cum/s	
				L	H1	H2	B	D	T	z	c	p	A	R (A/P)	S	n	V	Qc	Qd	
1	T=100 Yr	0	2800	2800	494.99	453.07	65	2.26	74.04	2.00	5.1	75.1	157.1	2.09	0.002	0.05	1.46	229.9	199	OK
	Chainage	2800	to	5100	Bhuteshwar Mahadev – Mazar Dam															
2	T=100 Yr	2800	5100	2300	494.99	445.33	75	2.3	84.2	2.00	5.1	85.3	183.1	2.15	0.002	0.05	1.49	272.5	250	OK
	Chainage	5100	to	7650	Mazar Dam-Sikar road crossing NH-11							Reduction for starting point					m			
3	T=100 Yr	5100	7650	2550	445.33	438.25	18	1.8	23.4	1.50	3.2	24.5	37.26	1.52	0.002	0.015	3.94	146.9	99	OK
	Chainage	7650	to	9600	Sikar road crossing to Jaipur Jhotwara Railway line							Reduction for starting point					m			
4	T=100 Yr	7650	9600	1950	438.25	425.66	18	1.76	23.28	1.50	3.2	24.3	36.33	1.49	0.0035	0.015	5.15	187.1	127	OK
	Chainage	9600	to	11350	Jaipur- Jhotwara Rlyline – N.B.C (Jaipur Khatipura Road)							Reduction for starting point					m			
5	T=100 Yr	9600	11350	1750	438.25	414.41	18	2.8	26.4	1.50	5.0	28.1	62.16	2.21	0.0016	0.015	4.53	281.4	276	OK
	Chainage	11350	to	13950	N.B.C – Jaipur Ajmer Road NH-8							Reduction for starting point					m			
6	T=100 Yr	11350	13950	2600	438.25	408.47	20	2.99	28.97	1.50	5.4	30.8	73.21	2.38	0.0016	0.015	4.75	347.9	347	OK
	Chainage	13950	to	17650	Ajmer road – near Neerja Modi school crossing							Reduction for starting point					m			
7	T=100 Yr	13950	17650	3700	438.25	396.01	38	2.99	46.97	1.50	5.4	48.8	127	2.60	0.0016	0.015	5.05	641.2	640	OK
	Chainage	17650	to	25300	Neerja Modi school crossing – Jaipur airport-Sanganer Airport							Reduction for starting point					m			
8	T=100 Yr	17650	25300	7650	438.25	374.74	43	3.1	52.3	1.50	5.6	54.2	147.7	2.73	0.0015	0.015	5.04	744.4	711	OK
	Chainage	25300	to	26550	Sanganer Bridge - Gular Dam							Reduction for starting point				0	m			
9	T=100 Yr	25300	26550	1250	438.25	372.58	43	3.1	52.3	1.50	5.6	54.2	147.7	2.73	0.0015	0.015	5.04	744.4	711	OK
	Chainage	26550	to	32750	Gular Dam - Confluence of Jawahar nagar							Reduction for starting point					m			
10	T=100 Yr	26550	32750	6200	373.58	361.69	44	3.1	53.3	1.50	5.6	55.2	150.8	2.73	0.0015	0.015	5.05	761.2	730	OK
	Chainage	32750	to	34800	Confluence of Jawahar nagar - Ramchandrapura Dam							Reduction for starting point					m			
11	T=100 Yr	32750	34800	2050	373.58	351.54	45	3.1	54.3	1.50	5.6	56.2	153.9	2.74	0.0015	0.015	5.06	778.1	767	OK
	Chainage	34800	to	41300	Ramchandrapura Dam-Goner Road crossing							Reduction for starting point					m			
12	T=100 Yr	34800	41300	6500	351.54	336.36	102	3.1	114.4	2.00	6.9	115.9	335.4	2.89	0.0008	0.025	2.30	770.8	767	OK
	Chainage	41300	to	47500	Goner Road crossing to end of Nallah							Reduction for starting point					m			
13	T=100 Yr	41300	47500	6200	351.54	324.70	102	3.1	114.4	2.00	6.9	115.9	335.4	2.89	0.0008	0.025	2.30	770.8	767	OK

DESIGN OF CANAL SECTION FOR AMANISHAH NALLA

Z1 1.5

Top Section- for checking only

addition: 12 m critical velocity ratio 1.1 Z2 3

Chainage 0 to 2800 Nahargarh hill -Bhuteswar Mahadev

S.No.	Dezign Period	Chainage From	Chainage To	Length	IL at start	IL at end	Bed Width	Flow Depth	Top Width	Side Slope	Wetted sides	Wetted Perimeter	X-sect Area	Hydraulic radius	Hydraulic slope	Roughness coefficient	Velocity	Calculated Discharge	Design Discharge	Check
		m	m	m	m	m	m	m	m		m	m	sqm			(concrete)	m/s	cum/s	cum/s	
				L	H1	H2	B	D	T	z	c	p	A	R (A/P)	S	n	V	Qc	Qd	
	Chainage	5100	to	7650	Mazar Dam-Sikar road crossing NH-11															
3	T=100 Yr	5100	7650	2550	445.33	438.25	35.4	2.1	48	3.00	6.6	48.7	87.57	1.80	0.002	0.02	3.31	436.6	435	OK
	Chainage	7650	to	9600	Sikar road crossing to Jaipur Jhotwara Railway line															
4	T=100 Yr	7650	9600	1950	438.25	425.66	35.28	1.85	46.38	3.00	5.9	47.0	75.54	1.61	0.0035	0.02	4.06	493.7	487	OK
	Chainage	9600	to	11350	Jaipur- Jhotwara Rlyline – N.B.C (Jaipur Khatipura Road)															
5	T=100 Yr	9600	11350	1750	438.25	414.41	38.4	2.6	54	3.00	8.2	54.8	120.1	2.19	0.0016	0.02	3.37	686.6	677	OK
	Chainage	11350	to	13950	N.B.C – Jaipur Ajmer Road NH-8															
6	T=100 Yr	11350	13950	2600	438.25	408.47	40.97	2.61	56.63	3.00	8.3	57.5	127.4	2.22	0.0016	0.02	3.40	780.8	779	OK
	Chainage	13950	to	17650	Ajmer road – near Neerja Modi school crossing															
7	T=100 Yr	13950	17650	3700	438.25	396.01	58.97	2.3	72.77	3.00	7.3	73.5	151.5	2.06	0.0016	0.02	3.24	1131.9	1123	OK
	Chainage	17650	to	25300	Neerja Modi school crossing – Jaipur airport-Sanganer Airport crossing															
8	T=100 Yr	17650	25300	7650	438.25	374.74	64.3	2.2	77.5	3.00	7.0	78.2	156	1.99	0.0015	0.02	3.07	1222.9	1217	OK
	Chainage	25300	to	26550	Sanganer Bridge - Gular Dam															
9	T=100 Yr	25300	26550	1250	438.25	372.58	64.3	2.35	78.4	3.00	7.4	79.2	167.7	2.12	0.0015	0.02	3.19	1279.9	1269	OK
	Chainage	26550	to	32750	Gular Dam - Confluence of Jawahar nagar															
10	T=100 Yr	26550	32750	6200	373.58	361.69	65.3	2.7	81.5	3.00	8.5	82.4	198.2	2.41	0.0015	0.02	3.48	1450.3	1445	OK
	Chainage	32750	to	34800	Confluence of Jawahar nagar - Ramchandrapura Dam															
11	T=100 Yr	32750	34800	2050	373.58	351.54	66.3	2.8	83.1	3.00	8.9	84.0	209.2	2.49	0.0015	0.02	3.56	1522.2	1506	OK
	Chainage	34800	to	41300	Ramchandrapura Dam-Goner Road crossing															
12	T=100 Yr	34800	41300	6500	351.54	336.36	126.4	2.35	140.5	3.00	7.4	141.3	313.6	2.22	0.0008	0.02	2.41	1525.6	1515	OK
	Chainage	41300	to	47500	Goner Road crossing to end of Nallah															
13	T=100 Yr	41300	47500	6200	351.54	324.70	126.4	2.65	142.3	3.00	8.4	143.2	356	2.49	0.0008	0.02	2.60	1695.0	1674	OK

The above calculations are for checking the extreme flows caused by discharge calculations done by Synthetic Unit Hydrograph for 100 year return period flood

It is expected that this extreme flood event of 100 year return period may enter into the provided free board area of 1.5 m embankment +1-1.5 m of wall, in total giving cushion of 2.5 to 3 m.

It is expected that the velocities in the vicinities of the bank will be much lower as per horizontal disctribution of the velocities in a stream

Alternate stone steps with concrete base @10 m c/c along with grass turf @10 m c/c have been provided in the freeboard portaion of the embankment, which will be able to hold the reduced velocities at banks

There may be some nominal damages to grass turf during extreme flood event of 100 year return period of extreme value calculated by SUH, and the same can be repaired at nominal cost during maintenace

No effect of huge capacities of Mazar dam which is more that the design flood by SUH method have been taken in above caculations

It is expected that Mazar dam will absorb most of the flood from cathcment upstrem of Mazar dam andprovide further safety to velocities and capacities over and aboce shown in designs above

Reach wise excavation and filling quantities: Please note – No earth required from outside

Reach No	KMs	Bed Width	Excavation		Filling		Excess Filling Qty	Excess Cutting qty	filling Qty to be Transported From
			Qty in Cum	%	Qty in Cum	%			
1	0	65							
2	2300	75							
3	2550	18	549,385	6.78	244,107	3.87	305,278		
4	1950	18	33,149	0.41	285,401	4.53		-252,252	From Reach no 1: 252,252 Cum
5	1750	18	69,680	0.86	168,301	2.67		-98,620	From Reach no 1: 53,026 Cum From Reach no 9: 45,594 Cum
6	2600	20	102,459	1.26	456,381	7.24		-353,922	From reach no 9: 353,922
7	3700	38	148,097	1.83	891,732	14.15		-743,635	From Reach no 9: 1,094 Cum From Reach no 11: 594,061 Cum From Reach no12: 148,480 Cum
8	7650	43	558,532	6.89	1,142,039	18.12		-583,507	From Reach no 12: 583,507 Cum
9	1250	43	693,161	8.56	292,551	4.64	400,610		
10	6200	44	841,184	10.38	987,174	15.66		-145,990	From Reach no 12: 145,990 Cum
11	2050	45	925,126	11.42	331,064	5.25	594,061		
12	6500	102	2,629,788	32.46	454,328	7.21	2,175,460		
13	6200	102	1,550,808	19.14	1,048,841	16.64	501,967		

Total	44700	48.54	8,101,370	100	6,301,920	100	3,977,377	-2,177,927	Disposal Qty: 1,799,450

Surplus earth to be used in reclaimed land all along the bank

7.4 SEWERAGE INTERCEPTION, TREATMENT, DISPOSAL/USE/REUSE

7.4.1 CURRENT STATUS

7.4.1.1 SEWERAGE QUANTITY & SOURCE LOCATION

In the absence of any reliable data of sewage or any other effluent discharged into the Amanishah Nallah, a comprehensive (through preliminary since time-bound) field survey was done to identify the source, its locations and quantity for all the potential reaches.

As per the outcome of this survey the total quantity of sewerage entering in to Amanishah Nallah at various point locations was calculated as 193 MLD. Upon submission of the details to the TA, it was imposed that the actual requirement would be 170 MLD. As per the decision of Honourable High Court of Rajasthan, treatment of industrial effluents emanating from textile / dyeing from industrial area of Sanganer town and others, shall be established by the respective Textile association and monitored by the relevant authorities of GoR. Therefore treatment of industrial wastewater has not been envisaged to be a part of this project.

7.4.1.2 EXISTING SEWERAGE TREATMENT PLANTS (STP)

Based on the information collected from relevant authorities, the existing sewage treatment plants in the vicinity of Amanishah Nallah are as below:

- 2 units of 62.50 MLD STP at Delawas- (ASP)
- 1 MLD STP at Swaran Jaynti Park. (MBBR)
- 30 MLD STP at Ralawata (ASP)

It is required to ensure perennial flow into the rejuvenated Amanishah Nallah. Hence, most or major part of the untreated sewage is to be treated and most and major part of the same is to be discharged into the rejuvenated Nallah. The technological aspects treatment requirements are detailed below.

7.4.2 STP TECHNOLOGY

Introduction and Purpose

The Amanishah Nallah project in Jaipur is an integrated approach to the Rejuvenation and betterment of the river which has now become a Nallah because of the exponential growth of the city. The Nallah has a catchment area in the Mazar dam area and travels 47 kilometers in the city. The Nallah has many sources of water wastewater flowing into the Nallah. Majority of it is domestic sewage or municipal wastewater. In this project it is proposed to intercept all the sewage currently going to the Amanishah Nallah, treat it to the acceptable standards and norms for discharge into open surface channel and create a seamless water body with the purpose bringing life into an erstwhile water body neglected by the onslaught of rapid urbanization. This chapter covers the details of Sewage Treatment Plant, which is being proposed based on the flows arrived by various survey. STPs of various capacities and are planned to be located on both the banks of the Amanishah Nallah, details of the same are provided further on.

Referral Documents

There are many books referred to in this document, a few are listed below:

- CPHEEO Manual – Latest edition
- Waste water engineering reference manual Latest Manual by Metcalfe and Eddy by McGraw hill
- Water and waste water handbook of Degremont.
- Manual on Sewerage and Sewage Treatment, MoUD, CHPEEO and Jica – November 2013.

Assumptions and Guarantees

It has been assumed that the Sewage analysis and characteristics are in line with Indian conditions and as described and recommended in the class D standards of CPHEEO manual and the correction and deration factors mentioned there with. It is also assumed that no raw industrial effluent will enter the proposed Sewage treatment and also not enter the Nallah. The schemes being proposed herewith will not be able to treat sewage if it is mixed / poisoned by Effluent which has color/heavy metals/other toxicity.

The design raw Sewage parameters assumed for the design of sewage treatments plants is as below:

No.	Parameter	Value / Concentration
1	pH	6.5 to 8.0
2	BOD @ 25 deg.C	200 – 250 ppm *
3	COD	350 – 500
4	TSS	300- 400 ppm
5	Oil and grease	10 – 20 ppm
6	Total nitrogen	40 – 50 ppm
7	Total Phosphorous	6-8 ppm
8	Coliform (MPN/100ml)	10 ^9 to 10 ^ 10

Though above is the design basis, the process and the technology shall be selected assuming that the BOD and TSS will be higher considering the fact that Jaipur has an acute water shortage, and concentrations could be higher.

The designs / process here with considered can also handle 20 % higher TSS and also a BOD as high as 370 ppm on an intermittent basis as a shock BOD loading – subject to such flows being for about an hour in a day and an hour in the late night.

The Treated Sewage which will be discharged into the Nallah to create a water body shall have the following characteristics.

No.	Parameter	Values / Concentration
1	pH	6.5 to 8.0
2	BOD @ 25 deg.C	< 10 ppm
3	COD	< 50 ppm
4	TSS	< 20 ppm
5	Oil and grease	<5 ppm
6	Total Nitrogen (TN)	< 10 ppm
7	Total Phosphorous (TP)	<2 ppm
8	Coliform (MPN/100ml)	10 ML/100ML

A. Unit Operations in a Sewage Treatment Plant

Typically Sewage Treatment Plant (STP) includes the following Components

1. **Primary Treatment**: This consists of screening chamber and grit chamber. Screen Chamber removes inorganic material like paper, pouch, other floating particles etc. Grit chamber removes particles of sand, ash, clinkers, egg shells, bone chips and inert materials etc. In some cases, this also includes a primary clarifier for settling the bulk as suspended solids, thereby reducing the load on the subsequent stages.
2. **Aeration& Secondary treatment**: This consists of biological process in which the biological contaminants are removed by the biomass in the system. Further the suspended solids in the treated wastewater are removed to get clear water. The main components are biological aeration units, secondary clarifiers or decantation or filtration systems.
3. **Disinfection**: It consists of chlorination or UV treatment or other units for disinfection purpose.
4. **Sludge Disposal Unit**: It consists of sludge thickener followed by centrifuge/belt press to dewater the sludge. The sludge generated out of treatment of 170 MLD of sewage water shall be disposed through landfill. Use of this sludge by converting it into manure within the land area being developed is being considered.

B. Criteria for selection of the technology.

Rapid urban development poses fresh challenges for the Town Planner. Sanitation and safe disposal of wastewater has now become a burning issue. As the towns and cities grow and the population increases, treatment and disposal of sewage has become a major concern area.

The ideal technology in such urban settings should have the following characteristics.

1. Minimum Land utilization.
2. Minimum operating cost – power consumption.
3. Plant to be aesthetically appealing and blend with the environment
4. Capable to handle fluctuations in quality as well as quantity of wastewater.
5. Aim for Zero-Foul-Odour-Emissions
6. Aim for minimum sludge generation (Disposal in urban pockets is a major headache)
7. The quality of water should allow discharge into water bodies.

Till the end of the last century, most of the of STPs in India employ any one of the three technologies, namely, **Primary settling followed by Activated Sludge Process (PST+ASP)**, **Up flow Anaerobic Sludge Blanket + Polishing Pond (UASB+PP)** and series of **Waste Stabilization Pond (WSP)**. The first technology has been found capable of providing final effluent having BOD<20 mg/L and TSS< 30 mg/L and 90% of the plants in India are set up using this technology. This standard of effluent discharge has already been made stringent in the latest CPHEEO manual which now requires stricter limits for Nitrogen and Phosphorus removal.

To meet these new standards new technologies such as **MBBR, SBR, Modified or Advanced APS's, FBAS** and **MBR** are now being employed. All of them offer one or more advantages over the conventional processes, which are described in the following sections.The following parameters have been used to assess the suitable technology for the case for each STP under each location.

C. Treatment Technologies

There are several conventional and new progressive technologies available for sewage treatment. A list of available technologies is given below:-

1. Waste Water Stabilization Ponds / Aerated Lagoons / Oxidation Ponds
2. Up Flow Anaerobic Sludge Blanket (UASB)
3. Activated Sludge Process/ Extended Aeration (ASP)/Improved Oxidation Ditch
4. Sequential Batch Reactor/ Cyclic Activated Sludge Process(SBR/ CASP)
5. Modified or Advanced Activated Sludge Process /Fixed Bed Activated Sludge Process(MA-ASP's/ FBAS)
6. Moving Bed Bio-Reactor (MBBR) / Integrated Fixed-Film Activated Sludge
7. Membrane Bioreactor (MBR) Technology

7.4.3 DESCRIPTION OF FEW TECHNOLOGIES IN SEWAGE TREATMENT

1. **Waste Water Stabilization Ponds**: There are three types of ponds, (1) anaerobic, (2) facultative and (3) aerobic, each with different treatment and design characteristics.

   Disadvantages: Requires huge size of land, may be prone to odours.

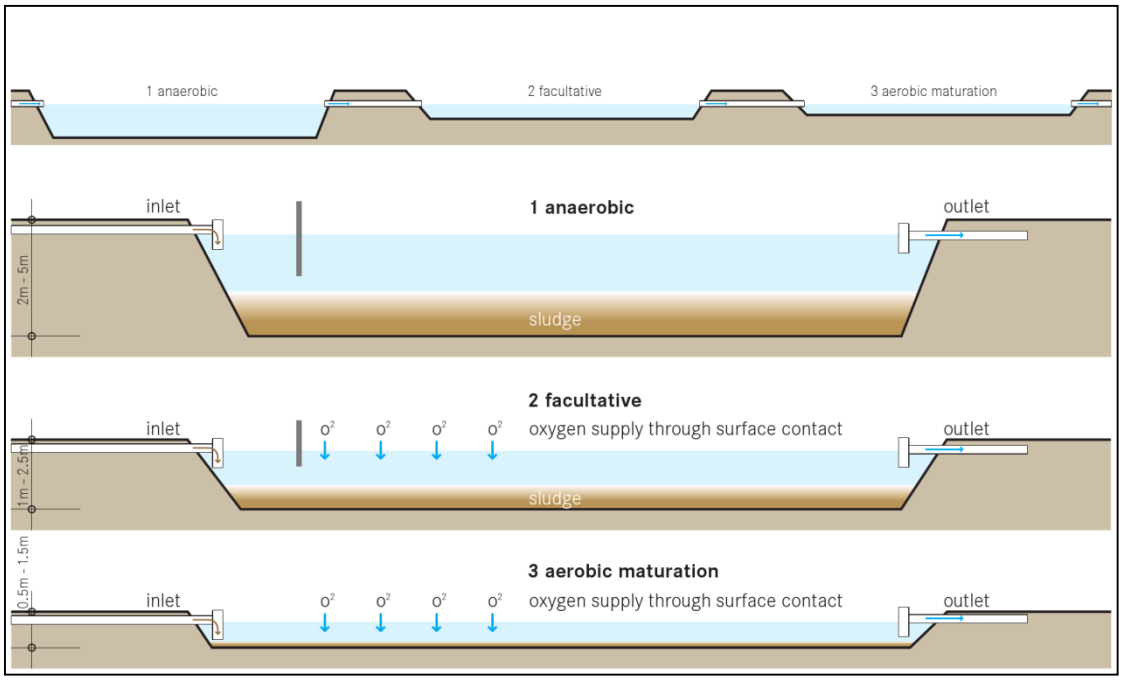


Figure 2: Wastewater Stabilization pond(source: www.grassrootswiki.org)

2. **Aerated Lagoons (Oxidation Pond / Ditches):** The mechanical aerators are provided to stabilize the organic matter and its decomposition into CO_2 and H_2O.This technology is one step advance technology to stabilization pond as it provides mechanical aeration to the waste water. This is also mostly obsolete technology for urban area, where availability of land is limited, and it creates odour nuisance in surroundings with very poor quality of treated water.

   Disadvantage: Requires relatively large size of land (although less than Stabilization ponds). May create odour, creates nuisance value for surrounding, reduces real estate value in urban locations due to large visible ponds of dirty water and does not give re-usable quality of water.

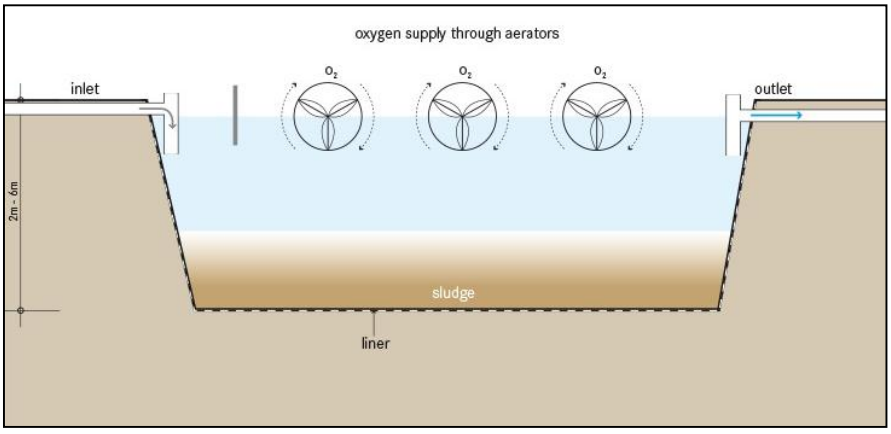


Figure 3: Aerate lagoons (www.gopixpic.com)

3. **Up- flow Anaerobic Sludge Blanket Reactor (UASBR):** This is an anaerobic waste water treatment technology. Sewage after screening and grit removal is directly fed into UASB reactors. The reactor maintains a high concentration of anaerobic biomass through formation of microbial aggregates. Untreated sewage inside the reactor flows upward through a layer of sludge while getting treated for organic content of sewage and converts them into methane gas. At top of the reactor, phase separation between gas-solid-liquid takes place and treated water is taken out form the reactor.

   Disadvantage: Anaerobic process has very slow growth rates of microorganism and hence these systems have poor treatment efficiencies of only 50-70%. In order to achieve disposal outlet quality of treated sewage, second stage aerobic biological units are required. This technology is also land intensive.

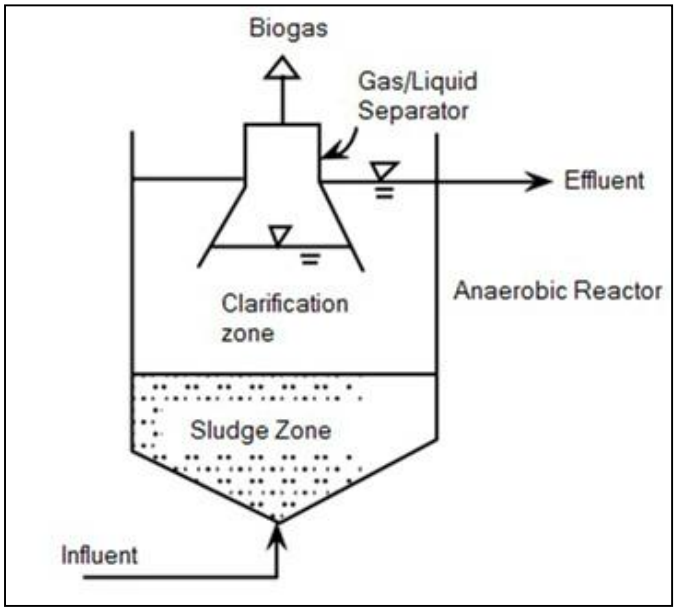


Figure 4: Up- flow Anaerobic Sludge Blanket Reactor (UASBR) (Sawant., A., 2013)

4. **Activated Sludge Process**: It is an aerobic biological treatment process, one of the widely used sewage treatment process worldwide. Due to aerobic process in ASP, it has less odour &vector nuisance in compare to anaerobic type process. The conventional activated sludge processes are of three types, a) Conventional System, b) Complete Mixed, and c) Extended Aeration.

   Disadvantage: This treatment requires a slightly larger area than the complete mix activated sludge; Aeration energy used is high and relatively required large aeration tanks, adaptable mostly to very small plants. This technology is in practice widely in all recently established STPs of Municipal Corporations; even after spending capital cost, manpower and energy for sewage treatment, recycled water is not usable for reuse, and hence treated water is discharged.

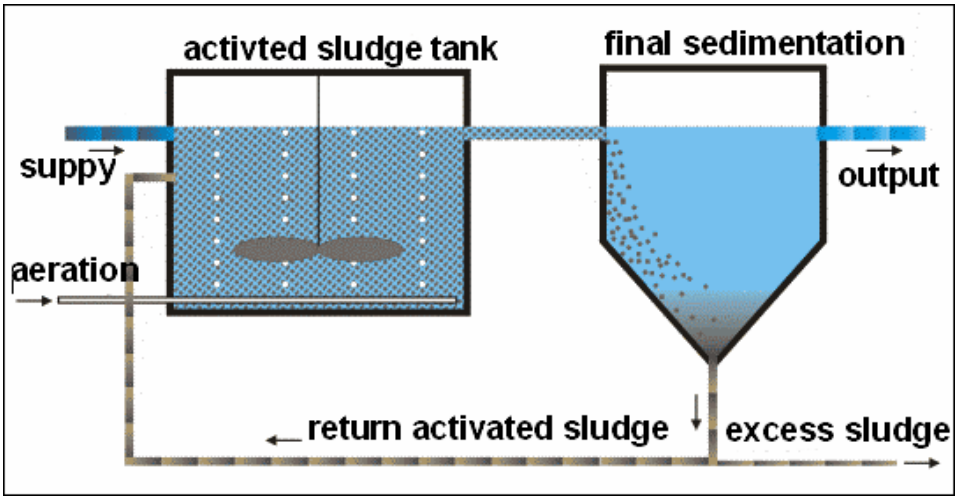


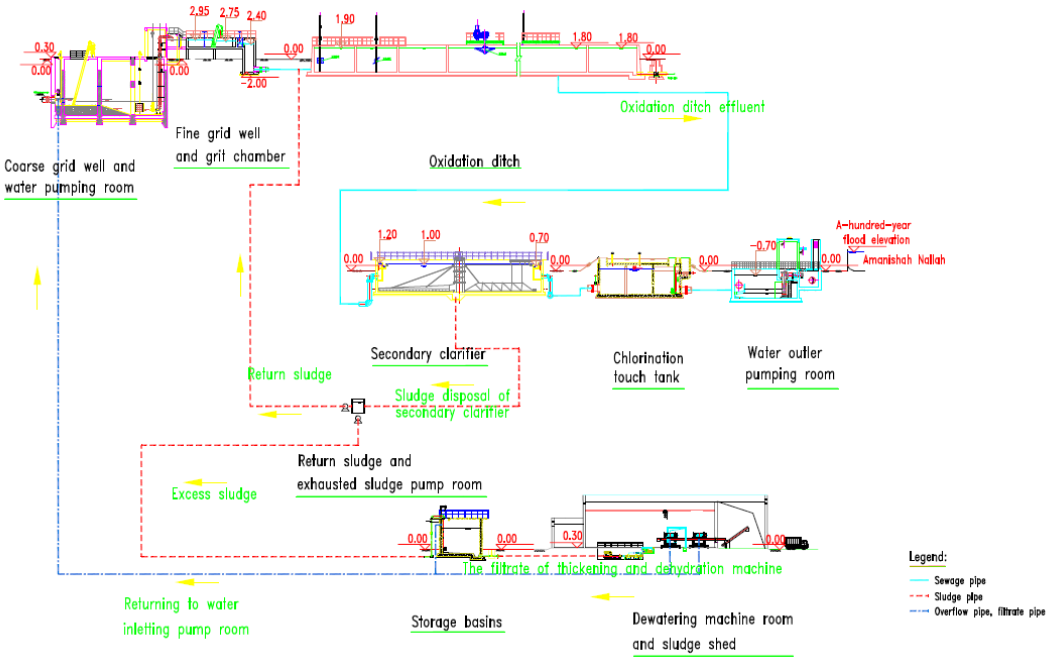
Figure 5: Activated Sludge Process (Bengtson., H, 2013

Improved Oxidation Ditch (IOD)

Sewage conduit outside the factory enters into facilities of the sewage treatment plant. Facilities include coarse grid, inlet water pump station, fine grille, vortex grit chamber and other processing structures. In the coarse grid well, massive particles and floater in the sewage were intercepted, and sewage was elevated to fine screen and vortex grit chamber wells with metering valves through the water pump in the inlet pump room. Fine screen is used to remove the particles whose size is greater than 6 mm in the sewage and fibrous floats, vortex grit chamber is to remove the sand particle whose size is greater than 0.2 mm, so as to protect the equipment in subsequent processing structures; Metering valve well is used to accurately measure water inflow of sewage plant.

Sewage after pre-treatment, enters into core structure of biological treatment - improved oxidation ditch. This structure is composed of anaerobic tank, anoxic pool and oxidation ditch, sewage experiences the process of aerobic, anoxic and aerobic in turn, and completes the de-phosphorization and de-nitrification and removes the organic matter. Outlet water of oxidation ditch enters into the secondary sedimentation tank, and after mud-water separation, enters into disinfection pool. the tail water after disinfection is discharged.

Part of the sludge from secondary sedimentation tank flow back to anaerobic tank in front of the oxidation ditch, the rest flow into the sludge treatment system. Oxygen facility of oxidation ditch adopts surface aerator.



5. **Sequential Batch Reactor/ Cyclic activated Sludge Process**: This is an improved and scientific version of activated sludge process which gives good treated water quality in sewage treatment plants, requires comparatively less area, than ASP. Batch Reactor (SBR) is a fill and draw activated treatment system. This process is capable of handling all type of Municipal sewage commonly treated by conventional activated sludge plants. A basic cycle of SBR comprises: (1) Fill-Aeration, (2) Settlement, and (3) decanting. These phases in a sequence constitute a cycle, which is then repeated.

   Disadvantage: The entire process has to be controlled by PLC and needs highly trained operators. Changes in influent quantity and quality require constant monitoring and control of cycle times. Handling of peak flows is problematic as it can impact treated water quality.

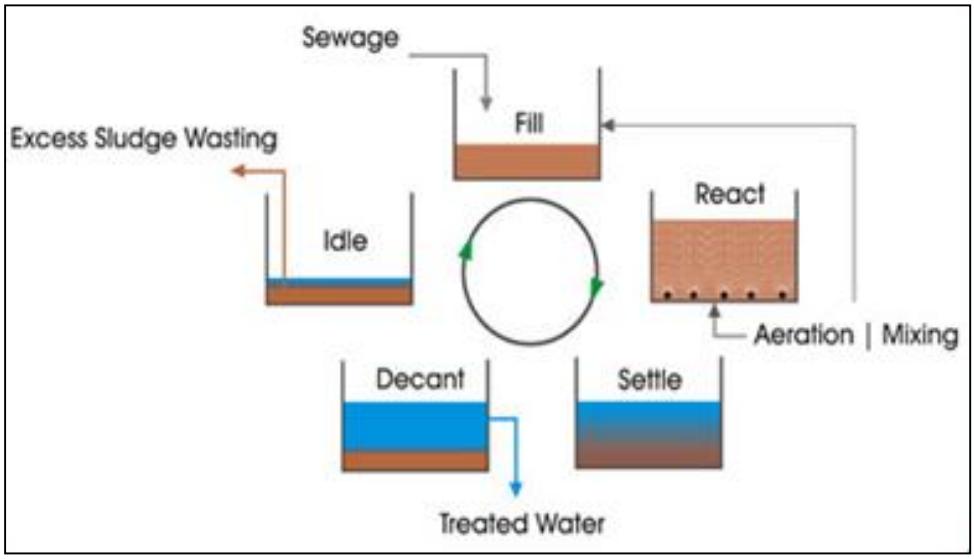


Figure 6: Sequential Batch Reactor (Source: Dohare and Bochare, 2014)

6. **Modified Activated Sludge Process/Fixed Bed Bio-film Activated Sludge Process (MA-ASP's/FBA'S)**: This technology uses the forces of nature to enhance the performance of a conventional activated sludge process, resulting in excellent treated water quality in sewage treatment plants, requiring less area, less energy and with the appearance of a botanical garden. Unlike other technologies there is no foul odour from the process. No other technology offers such type of advantages. This is a continuous treatment process capable of handling all types of municipal wastewaters. This technology is widely suited for urban areas. It is highly resilient to varying influents quantity and quality heads.

   Disadvantage: In cold climate, the plant has to be covered by a greenhouse to maintain the plant.

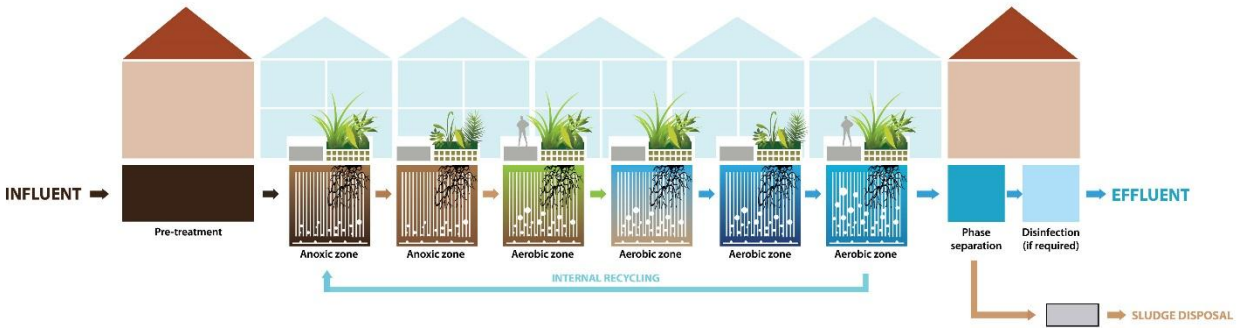


Figure 7: FBAS Technology (source: www.organicawater.com)

7. **Moving Bed Bio-Reactor (MBBR):** MBBR technology employs thousands of polyethylene biofilm carriers operating in mixed motion within an aerated wastewater treatment basin. Each individual biocarrier increases productivity through providing protected surface area to support the growth of heterotrophic and autotrophic bacteria within its cells. It is this high-density population of bacteria that achieves high-rate biodegradation within the system, while also offering process reliability and ease of operation. Technology is Cost efficient, Minimize process complexity and operator attention, Fast recovery from process upsets, Flexible Technology, Durable & Stable, Simply to extend, environmentally friendly.

   Disadvantage: The Plastic biofilm carriers may need to be replaced after a few years. Also, the energy requirement is higher compared to conventional ASP. This technology requires energy to keep the media floating in water.

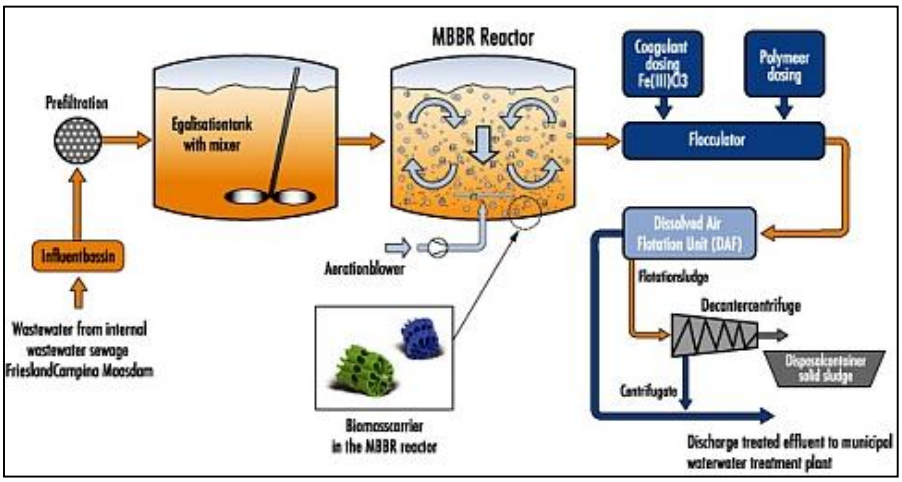


Figure 8: MBBR Technology

8. **Membrane Bioreactor (MBR) Technology:** The technology of membrane separation of activated sludge, commonly referred to as “membrane bioreactor” (MBR), is the combination of activated sludge treatment together with a separation of the biological sludge by micro- or ultra-filtration membranes with pore size of typically 10 nm to 0.5µm to produce the particle-free effluent. The latter step replaces the final clarifiers used in conventional activated sludge treatment which achieve solid separation by gravity only. The physical barrier imposed by the membrane system provides complete disinfection of the treated effluent.

Disadvantage: MBR technology is usually related to a higher total life cost, due to the high energy cost. In addition, the risk related to the fouling and the replacement costs of the membrane remains an important limiting factor to its broad application.

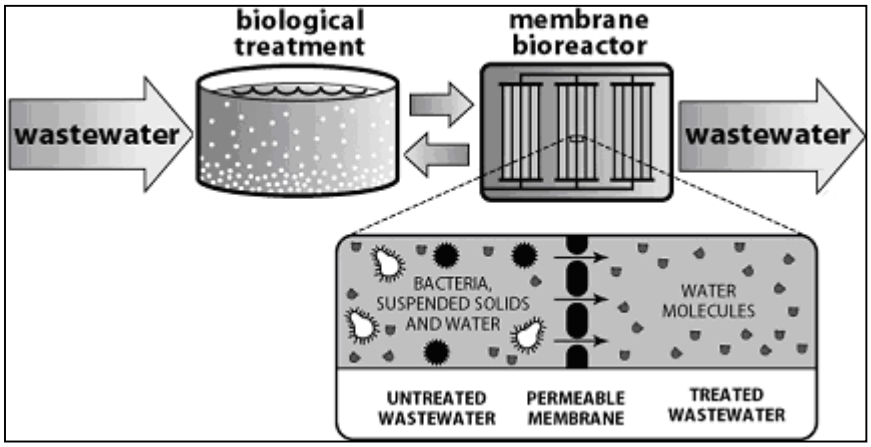


Figure 9: MBR Technology

D. Conclusion on the STP Technology selection

Considering the criteria of selection and the review of all the process and based on the discussions held at JDA office on 12th August 2015. It is concluded that the following three technologies are techno-economically more suitable for the Amanishah Nallah project at Jaipur:

a. Sequential Batch Reactor - SBR
b. Moving Bed Bio Reactor - MBBR
c. Modified or Advanced Activated Sludge Process – MA-ASP/FBA's

Comparison Table within Shortlisted Technologies

No.	Parameter	SBR	MBBR	FBAS
1	Capital cost	10-15% higher than ASP	5-10% higher than ASP	10-15% higher than ASP
2	Land requirement	10-20% less than ASP	20-30% less than ASP	50-60% less than ASP
3	Equipment replacement / repair	>15 years	>10 years	>15 years
4	Power Consumption	5-10% lower than ASP	10-15% higher than ASP	30-40% lower than ASP
5	Complexity of operation	Complex	Simple	Simple
6	Reliability	Proven	Proven	Proven Overseas
7	Sludge Production	Similar to ASP	5-10% lower than ASP	10-20% lower than ASP
8	Maintenance cost	Medium	Medium	Medium
9	Aesthetics	Average	Average	Good
10	Odour Management	Average	Average	Good

Application of the above technologies will depend on various factors like:

Availability of land parcels at the sewage discharge points or in adjoining areas.

Requirement to ensure there would be no sight or smell issues in densely populated areas where some of the STP's would be required to be located.

Area requirement depending on the location fixed.

Power consumption

7.4.3 POPULATION, DENSITY AND SEWAGE DISCHARGE ESTIMATION IN CATCHMENT AREA OF AMANISHAH NALLAH, JAIPUR

1. Jaipur is a fast growing city and ranks amongst the top ten in the country. Being the State Capital and a major tourist attraction, its population dynamics has two aspects as under:

a) The city attracts permanent settlers from across the State, with better opportunities for job, education and health-care.

b) The city has a floating population of upto 10 percent (reference Jaipur Nagar Nigam web-site). This would primarily comprise of tourists and other visitors from both, within and outside the state for job, education and health-care.

2. Keeping in view the population dynamics as stated above, the population and population density estimation is worked out as under:

a) **Population**:

i. The population of Jaipur City, as per the Census 2011 was 30,46,163.

ii. The population of Jaipur City, as per the Census 2001 was 23,22,575.

iii. The Annual Growth Rate between 2001 and 2011 was 2.8% and the Decadal Growth Rate was 32 percent.

iv. As per MDP-2025 (Vol-1, Page 223, Para 4.4.1) the population of Jaipur city was projected as 36 lacs for the year 2011, with a Decadal Growth Rate of 55 percent. The population in the year 2025 was projected as 64.9 lacs. This appears to be an over estimation and is hence not being used for calculation purposes.

v. For the purpose of estimating the current population of Jaipur city (2015) and that projected for the year 2025, it is recommended that an Annual Growth Rate of 2.7 percent be considered. This is in line with the growth rate trend for the decade 2011-21, as per MDP 2025, Vol 2, Para 2.2. As per this trend the decadal growth rate is likely to further reduce marginally over the coming years.

vi. Based on actual population of the year 2011 and the Annual Growth Rate of 2.7%, the estimate of projected population of Jaipur city for the years 2015 (current), 2021 and 2025 (10 years from now), will be as under:

No.	Year	Annual Growth Rate (%)	Population (in Lacs)	* Floating Population (@ 10%)	Total Population
1.	2011	-	30.46	3	33.46
2.	2011 - 15	2.7	34	3.4	37.4
3.	2016 - 21	2.7	40	4	44
4.	2022 - 25	2.7	45	4.5	49.5
5.	2026 - 35	2.3	56.5	5.6	62.1
6.	2036 - 45	2.0	69	6.9	75.9

*** Note**: Floating Population at 10% has been considered based on Jaipur Municipal Corporation estimates (reference corporation website: http://oswal.selfip.com/jaipurweb/UI/Static/staticpage.aspx?pageid=9)

b) **Population Density**: The current population density is being estimated, based on the population estimate and the Developed area of the city, as given in the MDP 2025. Details are as under:

i. Current Population (2015) – 37.4 L (including Floating Population)

ii. Developed Area as per MDP-2025 in the year 2009 (MDP-2025 Vol 1, Page 276 &277, Para 4.14) – 280 Sq Km.

iii. Current Developed Area, estimated from Google Imagery (19 June 2015) – 290 Sq Km.

iv. Density = Population / Developed Area
= 3740000 / 290 = **12897 Persons / Sq Km**

3. **Sewage Discharge estimation in Amanishah Nallah**. Sewage discharge estimation is worked out based on the population in its catchment area, as under:
   a) Total Catchment Area of Amanishah Nallah – 233 Sq Km.
   b) Catchment Areas to be excluded:
      i. Catchment Area in Hills, upto Mazar Dam – 23.5 Sq Km.
      ii. Catchment Area from 'Goner' down-stream – 27.6 Sq Km
   c) Net Catchment Area – 184 Sq Km.
   d) Population Density – 12897 Persons / Sq Km.
   e) Total Population contributing sewage discharge in Amanishah Nallah – 12897x184 = 2373048 = Say 24 lacs.
   f) Per capita water supply has been considered as 135 ltrs. Per day and it is assumed that 85% is discharged as sewage.
   g) **Sewage generated by 24 lac pop. = 2400000 x 135 x 0.85 = 275.4 MLD**.
   h) **Sewage Discharge as per Field observations**. Sewage discharge in Amanishah Nallah has also been estimated based on field observations and measurements, as 170 MLD. In addition to this, Delawas is treating 125 MLD. **This total comes to 295 MLD**.
4. **Conclusion**: The following can be concluded from the above:
   a) Untreated sewage discharge into Amanishah Nallah is about 170 MLD, besides the 125 MLD being treated at Delawas STP.
   b) Population growth for next 10 years, i.e., upto 2025 comes out to be 32%. However, Amanishah Nallah catchment area being mainly city area, which is already densely populated with little scope for further population growth, it is envisaged that growth would take place in outer urbanisable areas like Sanganer, Sitapura etc. Hence, growth factor is not considered in estimate of sewage treatment in Amanishah Nallah catchment for design purposes.

Note: The above method for calculation of sewage discharge into Amanishah Nallah is based on data, observations and certain assumptions. The outcome is a broad picture. There can be many other ways to arrive at more accurate estimations and the best method may be considered.

7.4.4 **PROPOSED SOLUTION**

To achieve the prime objective of the Amanishah Nallah project to make it a clean water flowing river, the inflow of untreated waste water needs to be stopped.

The scope of Sewage Treatment project shall include:

1. **Collection** of Sewerage from the existing flow channels before the Amanishah Nallah and by tapping and conveying it (either pumping or gravity flow) to Collection Tank at the STP.
2. **Treatment** of collected sewage upto the desired quality parameters for discharge.
3. **Discharge** of treated water into the main Amanishah Nallah to meet the desired storage and flow requirements and use of some part of this treated water for Landscape Gardening, or Ground Water Recharge.

The entire system and its sub-systems have been explained in the following table

Table 7-10: Waste Water Treatment Sub-system for Amanishah Nallah project

Sub System	Components	Objective	Location
Screening	Vertical Bar Screens	To remove floating materials from the flowing liquid	About a KM u/s to outlet point of the respective drain
Lifting/ Conveyance system	- UG tank, - Pumping arrangement - Piped Network	Transferring the sewerage from stream to the collection tank	Along the Storm drain upto the STP collection tank
STP	- Collection Tank - STP Equipment - Treated water Tank	Treatment of Waste Water collected upto the desired standards	STP locations
Reuse System	- Pumping arrangement - Piped Network	Supply of treated waste water for the landscape irrigation requirements	At STP and nearby reuse location/ garden/ park
Disposal System	- Pumping arrangement - Piped/ Channel Network	Designed disposal of excess treated waste water into Amanishah Nallah through proper outfall structures	At STP and nearby disposal/ outlet location

Although the waste water inflow occurs from more than 82 different locations, considering the ground reality, some of the locations have been combined to arrive at the final capacity of the STP.

Following table give the details of proposed locations chainagewise and the sizes for the STP:

Table 7-11: Proposed Location and Sizing of STP

No	STP bank	Chainage km	Distance between STP's km	Capacity MLD	Technology proposed	Approximate Space required m2	land available m2
1	left	**4.7**		**5**	SBR	3150	20000
2	left	**7.9**	3.2	**10**	SBR	5742	60000
3	right	**14**	6.1	**5**	SBR	3150	4000
4	left	**16.7**	8.8	**15**	MBBR/SBR	9360	16000
5	right	**18**	1.3	**10**	SBR	5742	5900
6	right	**20.5**	2.5	**40**	MA-ASP	22800	26000
7	right	**22.5**	2	**36**	MA-ASP	22149	20000
8	right	**24**	1.5	**15**	SBR	9840	12000
9	left	**27.3**	3.3	**15**	MBBR/SBR	8800	60000
10	right	**28.8**	1.5	**7**	SBR	3744	71000
11	right	**39**	10.2	**12**	SBR	6400	27600
				170 MLD			

No	**In between the Locations**	**No of Inflow Channels**		**Estimated Inflow**
		Left	Right	MLD
1	Up stream of Mazar Dam	0	2	0.938
2	Mazar Dam to Sikar Road	3	0	16.246
3	Sikar Road to Ajmeer Road	18	9	19.98
4	Ajmeer Road to Gujar ki thadi up to gopal pura bye pass	5	6	15.57
5	Gujar ki thadi (from gopalpura bye pass) to B-2 bye pass	21	2	81.91
6	B-2 Bye pass to Sanganer	0	6	3.03
7	Sanganer to Bambala	0	8	6.16
8	Bambala to Goner Road			
9	Goner Road to End of Nallah		1	8.71
	No of inflows	47	34	
	Total no of Inflows	**81**		**152.56**
	Other miscellaneous adjustments			**170 MLD**

7.4.5 INTERCEPTION DESIGN AND PHILOSOPHY

The Amanishah Nallah is 47.5 Kms long and sewage enters the Nallah from both sides at numerous places. There are many colonies with sewerage lines but without proper arrangement of sewage into the Nallah. At the same time, there are colonies without having sewerage lines but discharging sewage into the Nallah through drains directly. It is an herculean task to intercept hundreds of such incoming sewage lines / drains and collecting and taking effluent to STPs. At 82 Locations, it is required to extend the colony sewerage network over an average distance of 500 mtrs (using 250 mm RCC NP3 Hume Pipe) upto the Nallah so that the sewage can be channelized to common carrier pipeline. An interception pipeline is envisaged (700 mm dia NP3 RCC Hume Pipe) along the Nallah on either side. The sewage is proposed to be collected into the Interception chamber and on accumulation is lifted wherever needed, in a lifting station. The lifting station can be within STP or elsewhere in proximity depending on the land available.

The proposed plan for establishing various STPs is as below:

STP No	STP Capacity	Bank Side	Chainage	Source of water		
	MLD		Chainage KM	Interception Pipeline	Primary Lifting Station	Secondary Lifting Station
1	**5**	left	**4.7**	Yes	LS 2	LS 1
2	**10**	left	**7.9**	Yes	LS 3	-
3	**5**	right	**14**	Yes	LS 5	LS 4
4	**15**	left	**16.7**	Yes	LS 7	LS 6
5	**10**	right	**18**	Yes	LS 9	LS 8
6	**40**	right	**20.5**	Yes	LS 11	LS 10
7	**36**	right	**22.5**	Yes	LS 12	-
8	**15**	right	**24**	Yes	LS 13	-
9	**15**	left	**27.3**	Yes	LS 14	-
10	**7**	right	**28.8**	Yes	LS 15	-
11	**12**	right	**39**	Yes	LS 17	LS 16, LS 18 & LS 19

All the flows are by gravity to lifting stations and then pumped from there to the STPs as shown in the table and drawing. The above Table is only indicative and capacities of individual STPs may change subject to requirement and land availability.

Sewage collected beyond the last STP in the chainage will be pumped upstream into the last STP.

7.4.6 **PROPOSED REUSE SYSTEM**

7.4.6.1 QUANTITY OF TREATED WASTE WATER:

In total, 170 MLD of sewage water is going to be treated by proposed STPs of different capacities in Amanishah Nallah project. The total treated waste water quantity can be estimated as 160 MLD after incorporating the losses in treatment process.

7.4.6.2 REUSE OF TREATED WASTE WATER:

The treated waste water from STP will be primarily used to Recharging the Amanishah Nallah. The surplus water will first fill the storage spaces created within the Nallah bed and begin flowing following the gravity creating a water flowing in the Amanishah Nallah. Some water would be used for:

a) Requirements for Landscape proposed to be developed along the Amanishah Nallah ROW.
b) Green Landscape proposed to be developed at certain open spaces identified along the Amanishah Nallah.

   According to analysis the maximum water which can be consumed by Landscape along the ROW would be @ 8 liter per sqm and Land area development at identified open space will be in the order of 7-8 MLD.

Thus the surplus amount of treated waste water will make about 300 to 500 mm of depth of flow even during non-monsoon season after the full commissioning of the project.

7.4.7 EFFLUENT INTERCEPTION

The Saganer Industrial area located textile industries are currently discharging effluents into the Nallah. There is a court directive that the textile industry association shall install necessary CETPs and discharge only treated water into the Nallah. However in times such CETPS do not function for any reasons, it is proposed to divert these effluents to farthest point in the Nallah through a pipeline of 800 mm dia corrugated HDPE pipe.

7.4.8 METHODOLOGY TO REDUCE INFLOW IN EXISTING SEWERAGE TREATMENT PLANT AT DELAWAS

Present capacity of Delawas STP is 125 MLD. It is observed that many areas which are outside the Amanishah Nallah catchment have also been connected to the Delawas STP. This has resulted to about 165 - 175 MLD influent is reaching Delawas plant out of which Delawas is able to treat only 125 MLD as per its rated design capacity while balance 40 - 50 MLD influent is being bypassed untreated directly into Amanishah Nallah.

In the present project, it is envisaged that certain quantity of sewage would be intercepted before it reaches Delawas and routed to treatment facilities being proposed here. It is proposed that existing sewer lines shall be tapped at suitable location nearby Amanishah Nallah, so that load sufficient inflow is made available for proposed STPs.

7.4.9 POWER SUPPLY FOR PROPOSED SEWERAGE TREATMENT PLANTS

33 KV dedicated Power supply arrangement for 11 STPs from existing substations has been envisaged based on the following assumptions:

- The nearest Upstream 33 kV substation is about 5 km away for 5 nos S/s, while 3 km distance has been considered for another 6 nos S/s. Cabling to be

laid for the interconnection from Substation to the STP location for first 5 nos S/s, while Distribution line has been considered for balance 6 nos. S/s.

- RoW for transmission line and cable route shall be provided by JDA.
- There is no modification in existing substation envisaged except adding one new 33 KV panel as an extension panel to the existing Switchboard.
- Existing substation transformer capacity enhancement is not envisaged.
- Presumed fault level of 33 KV is considered as 26.3 KA
- No civil works envisaged for new panel addition in existing substation
- Transformer capacity presumed as 750 KVA (33 KV/415 Volts) for each STP

- Table 1: Referral codes are as below:

Agitators	IS 9522
C-PVC Piping	IS / ASTM / DIN as per manufacturer
HDPE Piping	IS / ASTM / DIN as per manufacturer
FRP / GRP Tanks	IS 14399
Activated Carbon	IS 8366 & 8755
Sewage Screens	IS 6280
Grit Removal Device	IS 6279
Sewerage pumping station & pumping main	IS 4111
Sewage application pumps	IS 5600
Biological Treatment	IS 8413
Buried Pipes	IS 1536
Sludge De-watering Equipment	IS 10037

Dosing Devices	IS 9222
Settling Tank Clarifier Equipment	IS 10261
Chlorinator Equipment	IS 10553
Clarifier Structures	IS 7215, IS 10313
Butterfly Valves	AWWA C-504 / BS 5155
Diaphragm Valve	BS 5156
Non return Valve	IS 5312
Gate / Globe / NRV valve	BS 5352 / BS 1634
Structural Steel	MS Plate as per IS 2062 Gr B Angle as per ISAChannel as per ISMCBeams as per ISMB
Statutory requirements for STP	CPHEEO (Manual on Sewerage & Sewage Treatment) & CPCB (Central Pollution Control Board)

7.5 COMMON SPACES AND MASTER PLAN FOR VALUE REALIZATION

The Nallah passes through different land-uses varying from natural hilly and unoccupied terrain of Nahargarh and immediate downstream (chainage 0 to 5100 m) to residential zones, slums, large open areas, industrial zones and agricultural zones. Some historical references are also available which call this early reach of Amanishah Nallah as river Dravyavati.

The Amanishah Nallah is currently inaccessible and serves only as a channel for waste water flow.

The proposal aims to provide a planned and accessible waterfront environment along the Amanishah Nallah. The proposal provides for the development of public parks and open spaces along the river. These spaces are meant to be used by the citizens - helping them reconnect to the waterbody.

In addition to its importance as a structure for flood control, drainage and a means of strengthening of ground water table, it has tremendous potential to not only improve the visual character of the area it flows through but also be used as effective means to support different functions around the River and bring positive changes in ecological and social fabric of the impact area.

Therefore, it is extremely important to take all necessary measures to bring a positive change in river, making it not only an attraction place for the city but also accommodate the sociological fabric around the river. The concept solution for the river has been development around the theme of bringing environmental restoration and social inclusion using landscape design measures. A “Healthy” and “Swatch” Jaipur has been visualized in developing proposed landscape theme. The proposal provides for the development of public parks and open spaces along the river. These spaces are meant to be used by the citizens - helping them reconnect to the water body.

The design process began by researching key factors that impacted this particular project. The team analyzed regional and local water management studies, landscape

and hydrology regulations, reviewed campaign efforts already in place and studied relevant solutions implemented in other communities both locally and internationally that deal with such water systems as part of their infrastructure. This study also included the various land use patterns along the existing river and tentatively identified the zones of various uses. Following a site visit, the completion of a site analysis study and a face-to-face team workshop, the team collaborated virtually to produce the solutions.

Based on this, the proposed development plan not only includes physical upgrades to the look of the open drainage, but also includes suggestions for a sustainable life cycle management of the development with plan to for community with a volunteerism component.

7.5.1 LANDSCAPING DESIGN CONCEPT

It is proposed that the river should be opened up to public activities and should be integrated well with surrounding habitation. A strong connect between routine lifestyle of common man in Jaipur has been planned around it. It is also expected that by developing land along the river, chances of encroachment shall be reduced significantly. Public open spaces will allow the citizens to access the river, this in turn will lead to a sense of place and they will get involved in keeping the area clean to help in maintaining the river as a clean water-body.



Canal corridor and urban park space © Cadence Located in Metairie, Louisiana, New Orleans. The canal runs through both residentialand commercial zones, surrounded by two lanes of traffic on either side andincludes vehicular bridges that traverse over the canal. The challenge was to make for amore visual appealing landscape, while maintaining flood protection and canal functionality,ensuring financially feasibility andabiding by regulatory parameters.

7.5.2 PUBLIC OPEN SPACE / PARKS:

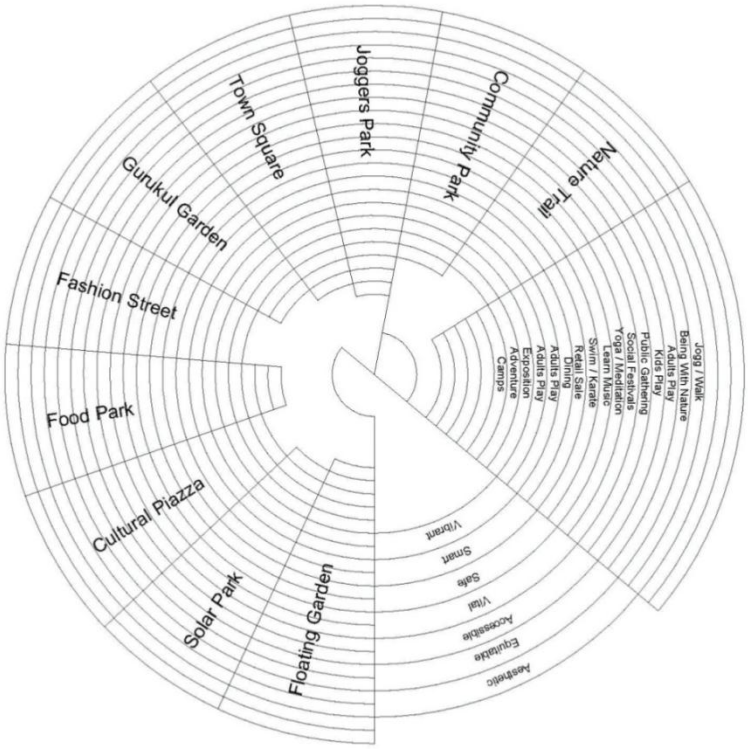


Figure 7-5 Program for Public Spaces

Different activities are planned along the riverfront in order to interest citizens of different age groups. This will help keep the riverfront vibrant and lively. The different activities that can be included along the riverfront development are:

Each public space which has been developed with emphasis on a particular theme can accommodate different functions as explained in matrix below. Accordingly provisions have been taken and policies will be decided.

Table 7-12 Activities in Public Spaces

Synod	Activities	Community Park	Town Square	Joggers Park	Fashion Street	Food Park / Eat Street	Cultural Piazza	Solar Park	Gurukul Gardens	Nature Trail	Floating Garden	Puppies Park
1	Walk / Jogging											
2	Relax / People watching											
3	Adult play											
4	Kids Play											
5	Public gathering											
6	Social / Community festivals											
7	Yoga / Meditations											
8	Music class											
9	Swimming / Karate											
10	Retail											
11	Restaurants											
12	Social Events											
13	Expositions / Displays											
14	Adventure / Fun activities											
15	Pet walk											
16	Camps											

7.5.3 LAND AVAILABILITY

Though the complete river work will be developed as landscape entity and a complete linear landscape as part of the bund section along the river has been planned. This linear structural element of river has been planned to be developed as effective landscape and utilizable area in addition to serving the purpose of flood protection and bonding to the river.

In addition to continuous section as part of the river cross section, identification of additional land for landscape development within or outside but adjoining to the river is a tedious exercise. Based on field survey of the Amanishah Nallah and its surrounding areas and visual inspection, only linear and large land parcels have been identified for further development for value realisation. The land parcels are identified at regular distances along the length of the river to allow accessibility to citizens from different areas of the city. The tentative and indicative concept program for each land parcel has been identified considering the neighbouring land-use, road, rail and metro network. Following process was adopted for this conceptual indicative planning:

- At the start of this stage the team has collected the basic information regarding Client's and site's requirements.
- Land along the Amanishah Nallah is being identified.
- A few identified Nodes are tittled as A, B, C, D, E, F - from North to South. A is located at Mazar Dam and F is located to the South of the Airport.
- For these Nodes, indicative Land Use and indicative layouts are prepared.
- These Nodes offer greater opportunity for a better development along the Nallah not only for its aesthetical appearance but also for the long-term maintenance of the Nallah and allied facilities proposed along the banks of it.

- A broad range of uses are proposed which will need to be further validated through the Market Research and other stages Identified below;

- Currently, the proposed uses include integrated township near Metro Station (C1), IT/ITS Park at RICCO land (D), Affordable Housing near Mazar Dam (B), a Botanical Garden and Recreational Park to the North of Mazar Dam (A), Integrated water front development including affordable housing, school, health care facilities, open market housing, convention center and indoor sports to the South of the Airport (E) and a large recreational golf club with Five* Hotel (F).

- The facilities identified at each Node reflect the improvement to Health, Environment, Affordability, Right to Education and Health and improvement to the quality of life.

While developing this concept, preference to visual and landscape continuity along with potential for value realisation has been given, wherever some conflict has come. It helped us to strongly connect the various land parcels to the surrounding area and to the proposed development. The proposed master plan has been woven around Nallah to seamlessly connect it with Nallah sections which are serving additional landscape entities.

7.6 ADDITIONAL FACILITIES

In addition to public open spaces along the river, it is important to provide arrangements for the activities such as sewerage discharge, solid waste disposal, prevent open defecation that will lead to pollution and unhygienic conditions along the river. The following facilities are recommended:

1. Public toilets accessible from outside the parks for slum dwellers
2. Solid waste collection segregation and treatment plant near the parks

7.6.1 **ADDITIONAL OPEN SPACES ALONG RIVER**

Pedestrian paths have been created along the river with sit-out spaces and safety railings. The pathways and public parks have been designed to be above the prescribed flood lines. The cross-section has been developed considering both wet and dry season in Jaipur.

It is proposed that the slope between walkway and Tree Avenue will have grass steps and grass slopes at regular intervals. While the grass slopes will be general relaxation space in a winter month, grass steps will be used for watching the activities around.

The vegetation planted along the river can help with slope retention. Native species will be planted to minimise use of water for irrigation. Walkways have been provided along wider linear strips of land.

A service road (at limited places) has been proposed for maintenance purpose and Walking / Cycling track on both side of the river. It will help citizens to access various locations along the river and will also help to service the river during maintenance period.

Each public space can accommodate different functions such as:

1. **Town Square:** This is to be located in commercial areas. It is a medium-large scale public space. The town square can be a location to commemorate leaders/heroes of the city. It is a suitable location for a memorial. Social events, public gatherings and expositions can be carried out here. It can help support surrounding commercial and retail activities.
2. **Cultural Piazza:** This can be located in a commercial or an institutional area. An ideal location can also be close to a heritage/cultural landmark. The cultural piazza is developed as a tourist hot-spot. Large public gatherings and festivals (Jaipur Literature Festival etc) can be conducted here. There are provisions for

amphitheatres, platforms and seating area to accommodate large crowds. Areas can also be allocated for permanent/temporary exhibitions. The cultural piazza can support large groups of people (5,000-10,000).

3. **Commercial Park:** This is a large-scale public space developed in a commercial area or tourist location. The commercial park is a space for citizens to gather at for recreational activities such as shopping, workshops, exhibitions, relaxing. Riverfront cafes and restaurants can be developed here. It can be a place for social gatherings.

4. **Fashion Street:** This can be located in residential or commercial areas. It can be developed as mainly a retail area with shops, cafes and restaurants. It can be a lively hang-out area for students and professionals. These can be developed in small linear land parcels. The indoor areas can be allocated in nearby buildings with open air seating and walking areas developed along the river.

5. **Eco Park:** This can be located near institutional buildings. It can be a small-scale to medium scale. The eco-park is primarily an educational park to showcase green technologies and way-of-life such as solar energy, water management, waste management, urban farming etc. Exhibition and workshop spaces can be provided for educational activities. Space can also be provided for exercising to ensure that citizens use the park regularly.

6. **Jogger Park:** This is to be located in primarily residential areas. It is a small scale park with easy access for residents from 1-2 areas. The jogger's park includes play areas for children, exercise areas for adults. It can also include a dog park and a walking area for pets.

7. **Community Park:** This is to be located in a primarily residential area. It is a medium scale park. The community park is a place for residents to interact, relax and exercise. The community park can be located in areas that are easily accessible to residents from multiple localities. Children's play areas as well as sport fields can be provided her. Areas can be developed to carry out health and recreational workshops (yoga, music etc) and conduct overnight camps.

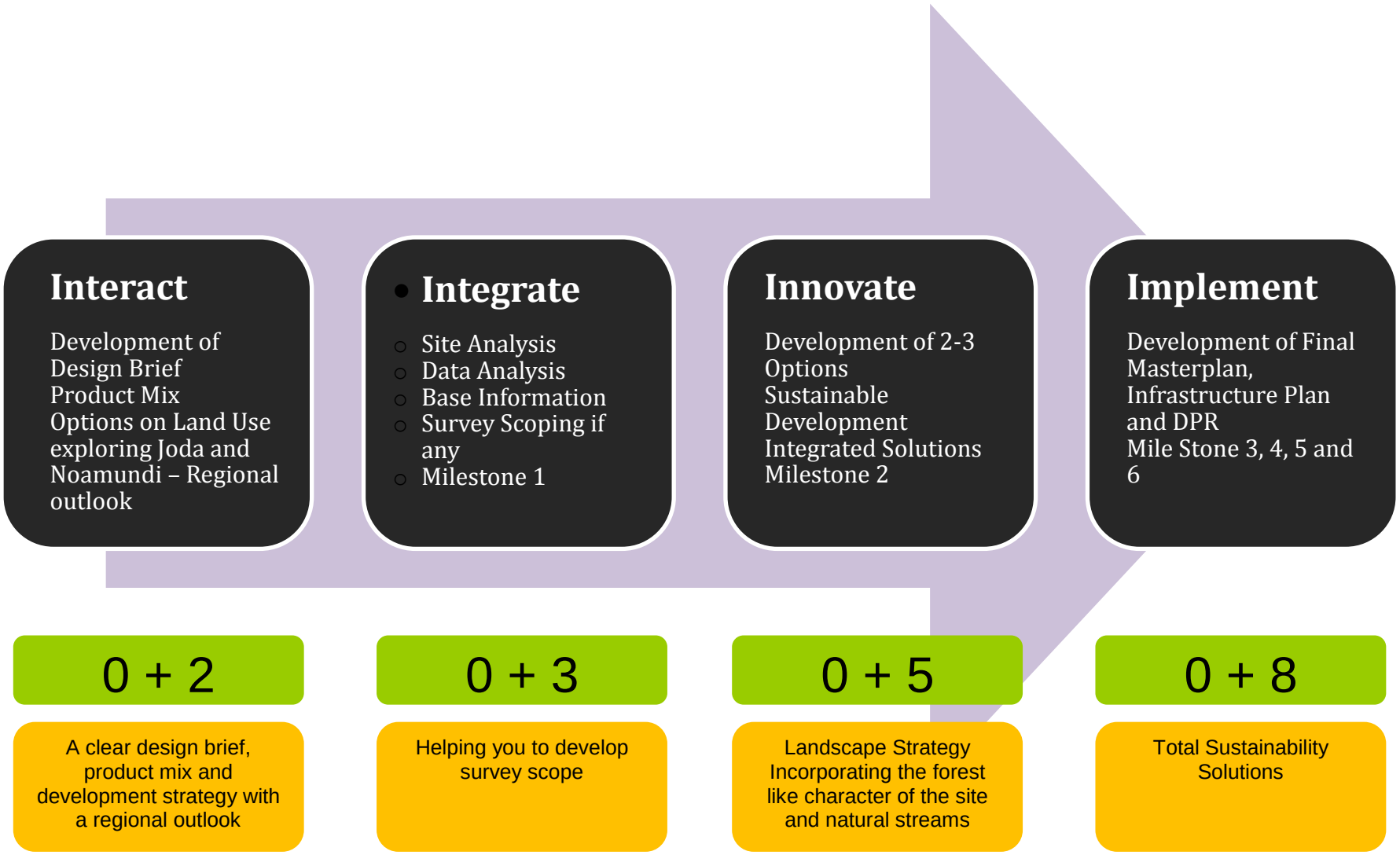
8. **Nature Trail:** This can be located along narrow-linear land parcels available along the river. The nature trail can be developed as a location to educate the public about the unique of riverfront bio-diversity. The preserved river-front will provide a habitat for local birds, animals, plants and fish. Educating the public will help create awareness for preserving the riverfront along the complete length of Nallah.

9. **Floating Garden:** This can be a landmark project. The floating garden can be a medium scale public space. Water activities such as boating can be offered here.

The appropriate program can be chosen depending on final size, location and character of the land parcels. People's participatory approach can be adopted to develop the program for the public spaces. The program of two or more public spaces can be combined in the same land parcel depending on land availability and location. Current development proposal does not contain this program as it is expected that this must be integrated with business plan and master planning exercise taken up under current proposal. The proposed Master Planning exercise will be preceded by a detailed market survey and assessment exercise and will include following steps:

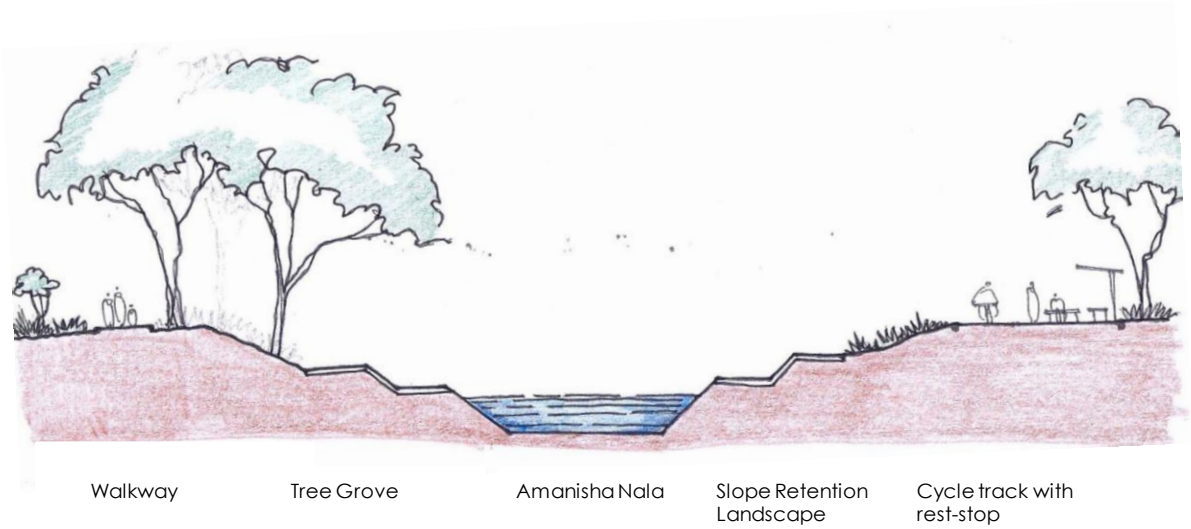
- Market survey
- Locational assessment
- Need assessment
- Product mix
- Business Plan and strategies for development
- Master Plan
- Landscape plan

Following aapproach and methodology will be used to deliver the master plan.


Interact
Development of Design Brief
Product Mix
Options on Land Use exploring Joda and Noamundi – Regional outlook
Integrate
Site Analysis
Data Analysis
Base Information
Survey Scoping if any
Milestone 1
Innovate
Development of 2-3 Options
Sustainable Development
Integrated Solutions
Milestone 2
Implement
Development of Final Masterplan, Infrastructure Plan and DPR
Mile Stone 3, 4, 5 and 6
0 + 2
A clear design brief, product mix and development strategy with a regional outlook
0 + 3
Helping you to develop survey scope
0 + 5
Landscape Strategy Incorporating the forest like character of the site and natural streams
0 + 8
Total Sustainability Solutions

Some of the indicative sections conceptualized are as given below:

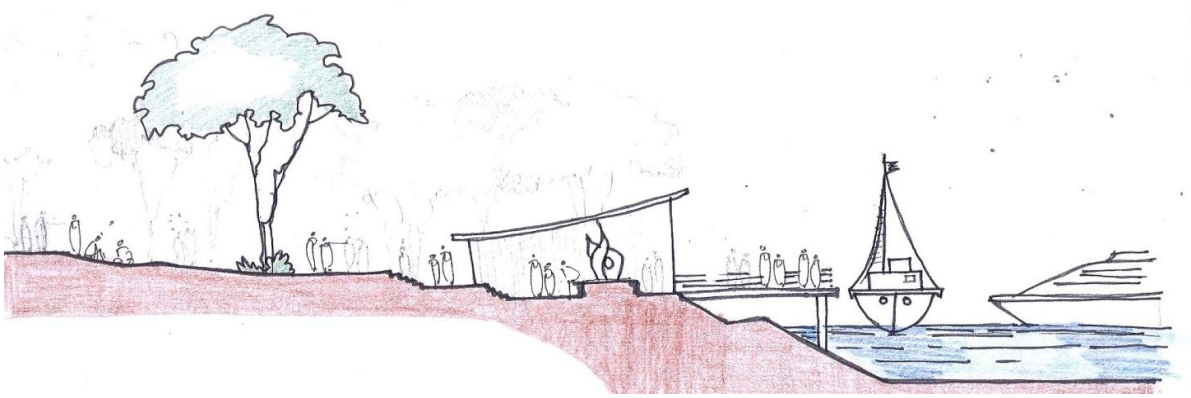
7.6.2 NATURAL EXTENSIONS OF FEEDERS



These sections may occur where landscape parcels are available on both side of the river at same chainage. In addition such sections are being planned in later reached of the river where not much development has been planned.

7.6.3 COMMERCIAL ACTIVITY

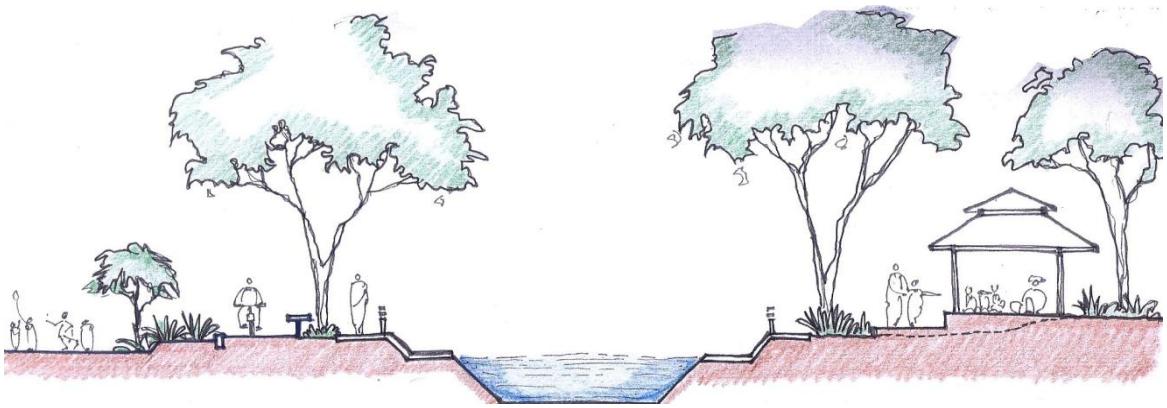
This space designed in areas accessible to residents, tourists from multiple locations. It serves as a space for recreational and cultural activities. Spaces are provided for art exhibitions, cafes, shopping and water sports. Attractions such as musical water fountains, water sports can be promoted here.



Picnic Ground Lawn on Slope | Pedestrian Plaza | Open Cafe & Public Plaza | Mini Jetty | Water Sports/ Playboats on Nalla

7.6.4 NATURE TRAIL

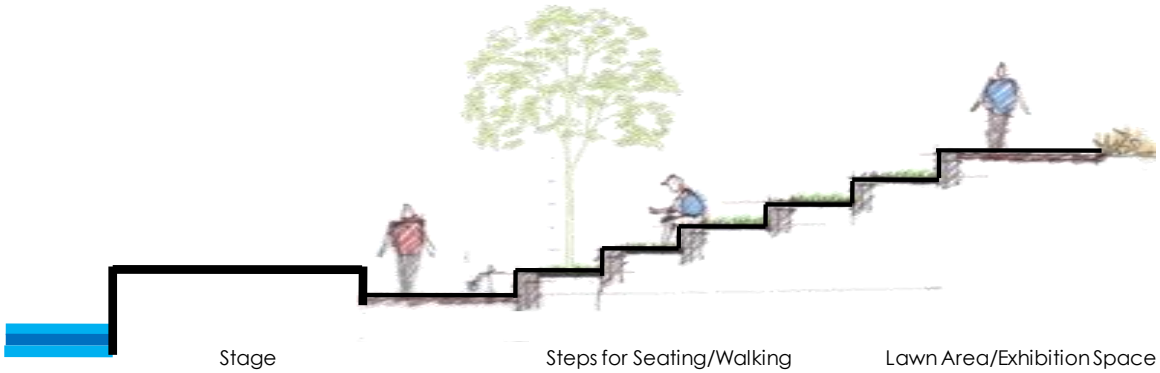
Nature trails has been planned to be provided along the river where only narrow strips of public land is available. The nature trails can help promote bio-diversity by providing information on flora and fauna, geology, cultural history, birds etc.



Pathway | Bicylce Track and Walkway | Amanisha Nalla | Tree Avenue | Workshops/ Meditation Area

7.6.4.1 TYPE D: CULTURAL PIAZZA

This space is developed near commercial areas. It provides a space for large public gatherings such as festivals and parades. Annual events such as the Jaipur Literature festival can be conducted here.



Stage Steps for Seating/Walking Lawn Area/Exhibition Space



7.6.5 OTHER FEATURES IN THE DEVELOPMENT

As mentioned earlier that it has been planned to develop complete Amanishah Nallah as a place of attaction for the city and in way similar to any riverfront developments. In addition to adjoining parks and open parcels, the Nallah cross section it has been planned with various features which are described below:

1. **Walkway:** A dedicated walkway and activity area along the length of Nallah
2. **Sit Out:** A sit out space along the banks of the water front
3. **Grass Beds:** Stepped or grassed sit out/ relaxation space along the upper bank of the Nallah
4. **Tree Avenue:** A plantation corridor along the Nallah to protect activity area from general traffic on service roads.
5. **Jetty Area:** Intermitted jetty areas where local small boats can be operated to cross the Nallah as fun activity. The jetty area with extra water depth will act as energy dissipater basins and silt collector basin for the Nallah
6. **Pedestrian and Cycle crossings:** All the check dams have been planned to be used as walkways with facility to pedestrian and cycle users to cross the Nallah at multiple points.
7. **Railings:** along the walk ways and on check dams
8. **Natural Trails:** Some portion of the Nallah have been planned to be developed as natural area with natural tracking trails to enjoy it as forest land.
9. **Water Fountains:** It has been planned to use water fountains within the water carriage part of the Nallah, which will serve additional purpose of oxidation and cleaning for the treated waste water which is planned to be released in the Nallah
10. **Event Decks:** It has been planned to use Nallah for possible international and national concerts as special venue by creating decks and sit out area as amphitheater along the Nallah.

Landscape Designs:

As a part of current exercise ~85.62 Ha of land will be available for further development in and around current proposed project area. A detailed Master Plan for the same has been proposed to be developed within initial 6 months of the project initiations and after getting final confirmation from the JDA for land holdings. An integrated landscape planning will be part of the Master Planning process and it is proposed that as a part of current project and partial implementation of Master Plan, it is proposed to develop 65,000 sq m of landscape integrating it Amanishah Nallah water front development and the Master Plan proposed.

Reference Images: Riverfront Development Projects

There cannot be a one to one match of the two cases, however various elements of the proposed development can be linked with works laready executed internationally and in India.

Melaka Historical city, Malaysia:



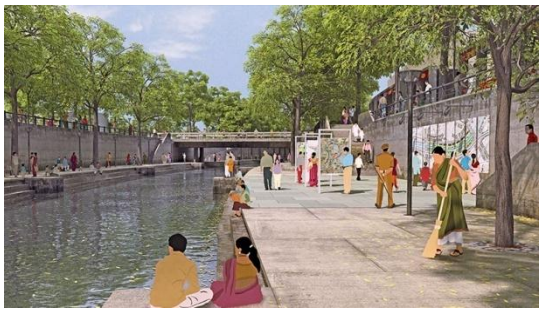


Delft Netherlands:





Himatnagar Canalfront Development, Himatnagar Gujarat







Photos: http://www.hcp.co.in/

Sabarmati Riverfront Development, Ahmedabad, Gujarat







7.7 OTHER WORKS

Other than three major categories of works explained in previous sections, it is proposed to provide additional value addition to the Project to make it functional and successful comprehensive unique proposition to meet our vision for the development. Following are the value addition components to the project:

1. Safety and Security
2. Transport connectivity (limited)
3. Health and hygiene solutions to keep it part of “Swatch Bharat” mission
4. Special intersection improvement plan with parkings
5. Facilitation for small street vendor segment
6. Monitoring and Measurements
7. Emergency Response Center
8. Catchment improvement programs
9. Electromechanical Equipment
10. A comprehensive business plan with detailed Master Plan to monetize the

value created through proposed work

7.7.1 SAFETY AND SECURITY

The proposed development integrate the nearby areas with Nalla cross section as a part of landscape concept and has been conceptualized it as a vibrant public use space post development. It is expected to act as center of attractions for people from all walks of life including but not limited to women, senior citizens, children and common public. Therefore a sense of safety has to be provided to keep it “Safe for Women” for all the time. Therefore a comprehensive solution for surveillance has been proposed as a part of value addition for the project. It has been proposed to keep the whole development a well lit place all the time which gives a significant sense of safety. In addition an elaborate surveillance system has been proposed for the entire length of the Nalla.

7.7.1.1 LIGHTING

It has been proposed to install street lights along the Nallah to keep at sufficient illumination level as per the National Building Code 2013, IS 3646_1- Interior illumination and IS 3646_2- Schedule for values of illumination & glare index.

It has been proposed to provide 50% of the lights powered with solar power with all necessary arrangements. It is expected that irrespective of electricity scenario, at least 50% of these lights will be lit at any point of requirement.

7.7.1.2 SAFETY & SECURITY MANAGEMENT SYSTEM: AN OVERVIEW

The Safety and Security Management System shall be multi-tasking, multi-users, and multiple divisions based on a distributed TCP/IP network monitored and controlled centrally. A typical Security & Safety System and its sub-systems with equipment proposed for the Amanishah Nalla project is presented in the following diagram:

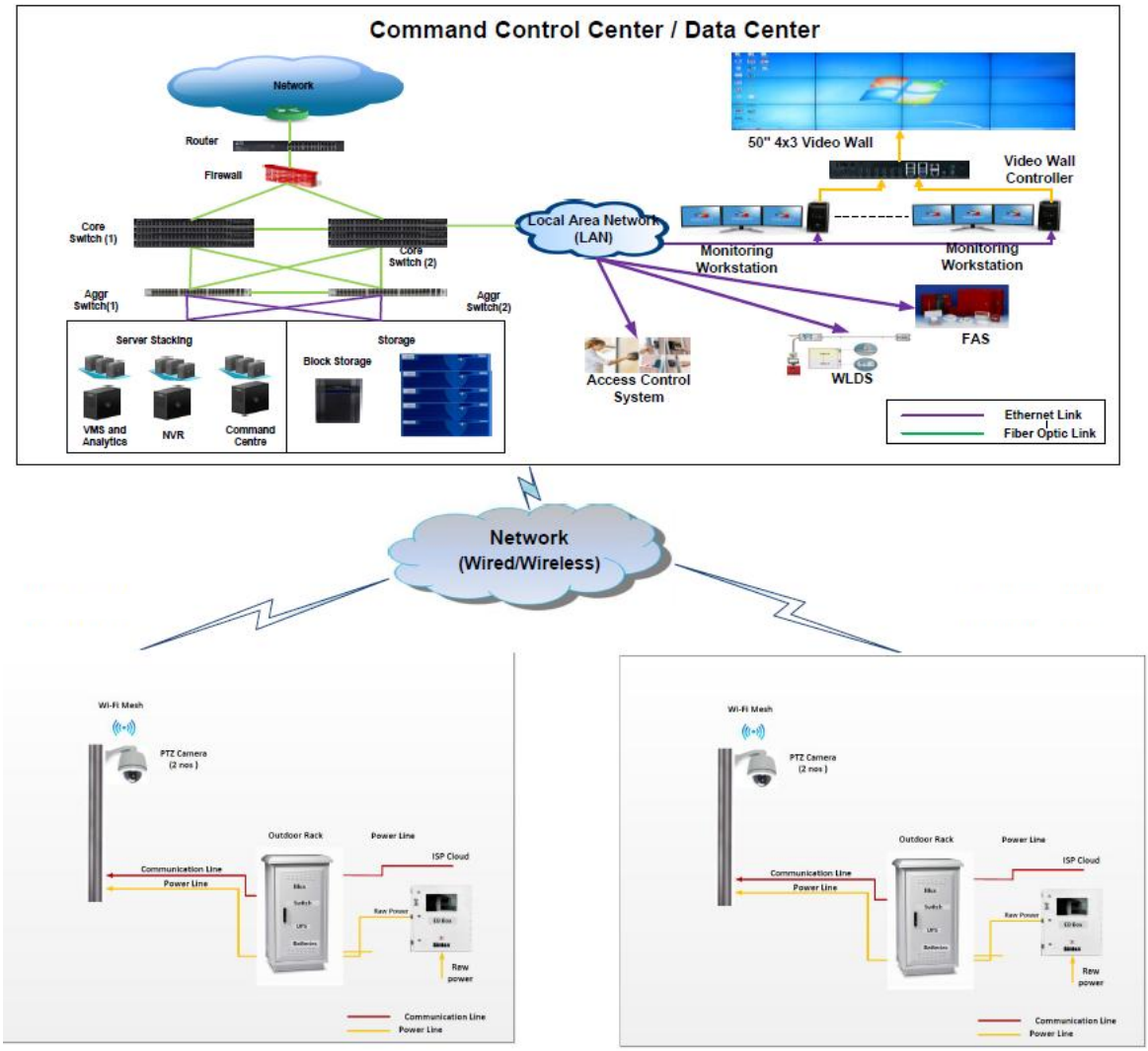


Figure no. 9.3: River Surveillance Network Diagram

7.7.1.3 CCTV SYSTEM

- The monitoring of all spaces along the banks of the Amanishah Nallah will be done through a series of poll mounted CCTV surveillance system operated from a central location to monitor and identify unauthorized movements, activities & record the same.
- PTZ cameras have been proposed to be along the length of the Nallah as per the specifications attached. PTZ cameras can be provided on high mast poles at regular intervals. Cameras can also be provided at strategic utility locations e.g. master receiving station, ESR/ WTP, STP and ETP etc.

- It is proposed to have a central control room inside the admin building at (Security Room). Location would be finalized at the time of detailed designs. All components of the system will be designed for operation in service conditions typical of the facility environment allowing the user to record, playback and view live images simultaneously. The design and construction of the system will ensure high reliability and availability.
- For monitoring and control of the system, there will be appropriate no. of colored monitors (TFT) with facility of maximum possible nos. of cameras can be configured in each monitor. UPS for Emergency power back-up will be provided. Refer figure no. 9.8 for various system components of a typical CCTV system.
- The CCTV system will be interfaced on an open platform through Ethernet and will be utilized for monitoring operation from the central control room (Ref. Figure 9.9 for configuration diagrams). The software requirements for the support and configuration of the entire system will be in line with the system requirements and shall be taken up during detail engineering.



Figure no. 9.8: CCTV System components

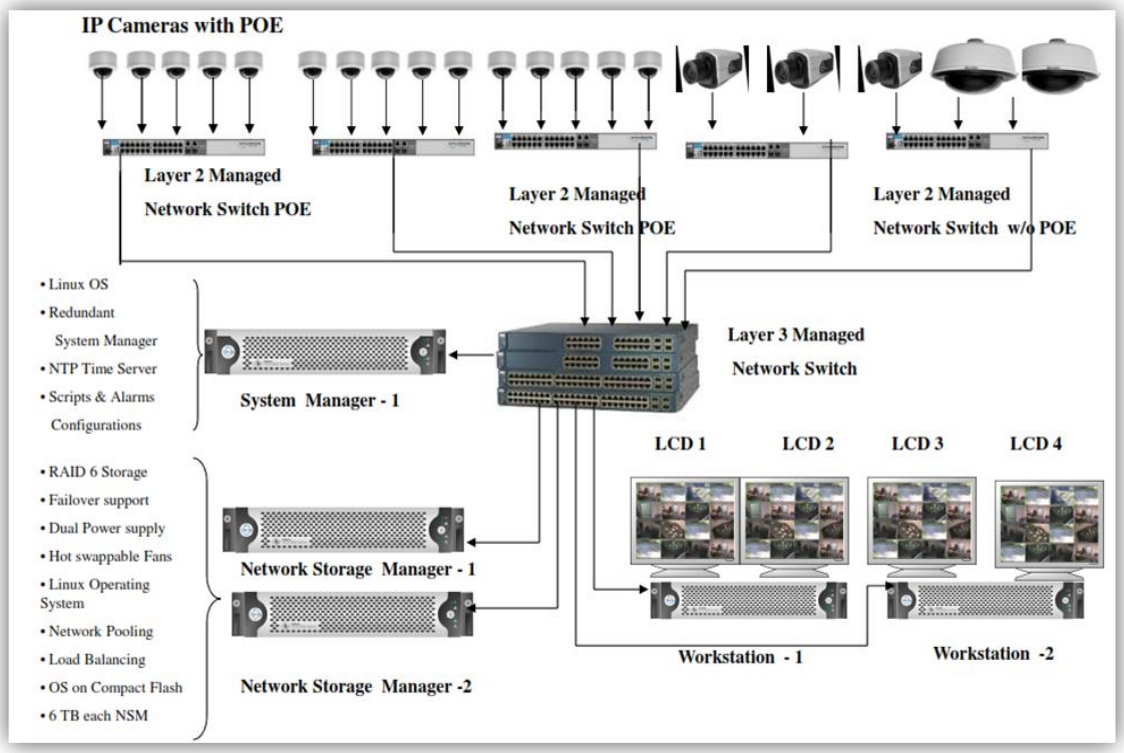


Figure No. 9.9: Central Control room Configuration Diagram

7.7.2 TRANSPORT CONNECTIVITY

7.7.2.1 SERVICE ROAD ALONG AMANISHAH NALLAH:

It is expected that with new development there will be significant changes in the traffic pattern of area around Amanishah Nallah. Moreover to encourage and also to service the Nallah for maintenance purposes, a proper service road will have to be planned along the length of the Nallah. Although for concept development a road width of 5.5 m has been proposed, wherever width is available, on both sides of the Nallah with an addition of 3 meter mountable side footpath which can at times be used for pedestrian traffic and general support activities. However after looking into actual land availability and General views of the development authority, this proposed section has been reduced to around 16 KM length portion only. Whenever in future the requirement for complete service road will be needed, the same can be implemented as per concept developed.

7.7.2.2 BRIDGES ACROSS THE AMANISHAH NALLAH:

There are more than 25 connections of different nature which exist on Amanishah Nallah. These structures vary from small height pipe culverts to proper bridges for road and railways. It is observed that most of the structures overflow during the peak flood events in monsoon season.

Since with Amanishah Nallah project the channel section is going to be improved for carrying capacity of 100 year of flood event these structures will need to be upgraded to match designed channel section.

Hence it is recommended that these structures should be upgraded by JDA during the implementation of Amanishah Nallah channel section so that the optimum results are achieved.

It is assumed that the construction of these structures will be carried out by JDA as per the designs of the city Master Plan, hence the cost of the same is not budgeted in this report.

7.7.3 "SWATCH BHARAT" TAKING CARE OF HEALTH & HYGIENE

7.7.3.1 TOILET BLOCK

It has been observed that due to various reasons of the past, Nallah and surrounding open spaces are being used for open defecation and general urinal purposes. This makes a serious challenge for the new development from health and hygiene perspective. While the new development can be built as one time effort a change management and change behavioural will have to be engineered for the current project affected people (PAP)/stakeholders along the Nallah.

Therefore as a process for **Social Inclusion** and to make it more successful, it has been proposed to build enough number of toilet blocks along the Nallah and the landscape areas. Total numbers of such blocks have been assessed with following assumptions:

- Facilities required for the visitors of the Nallah landscape
- Facilities required for the Project Affected People (PAP) of the surrounding habitation

The toilet block consisting of 5 Toilets (about 20 sqm) will be constructed following the applicable Health and Sanitation Guidelines. Also efforts for stake holder engagement will be done to educate and capacitate the people living in those areas to use and maintain the created facilities. In all 35 such blocks have been proposed under this proposal.

7.7.3.2 SOLID WASTE MANAGEMENT

Currently Amanishah Nallah has become a dumping yard for solid waste and nearly in all length of the Nallah, floating and dumped solid waste can be observed. With increasing activities along the Nallah and surrounding landscape attraction points, more solid waste will be generated. It is expected that general dumping of the city solid waste will automatically be stopped once this development is completed. However considering the scale of this project and the density, improved waste management will have a significant impact in terms of sustainability.



Composition of Solid Waste

Solid waste going to be generated from development can be divided into two broad categories:

- Organic
- Inorganic

Awareness Generation & Education for SWM

The success of any solid waste management plan for a community largely depends on the active participation & involvement of the inhabitants. Hence there is a need to educate the residents on various aspects of solid waste management and motivated them to participate actively.

The activities which should be carried out to achieve this are as follows:

- Raise awareness by distributing specially designed leaflets highlighting the need for sanitation, its importance, and the roles and responsibilities of citizens.
- Posters and signboards mentioning the hazards resulting from waste, dos and don'ts
- Occasional training workshops or documentary film shows.

Storage & Primary Segregation at Source

Storage of waste at source is the first essential step of Solid Waste Management. The waste should normally be stored at the source of waste generation temporarily till collected for its disposal. Segregation at source refers to the practice of setting aside post-consumer materials and household goods so that they do not enter mixed waste streams.

The following primary sorting practices must be followed:

- Biodegradable waste or organic waste such as kitchen waste should not be allowed to mix with recyclable inorganic waste.
- Hazardous waste such as battery, bulbs, fluorescent tubes, should not be mixed with organic & recyclable waste and disposed off separately.
- 3-coloured waste separation scheme shall be adopted for collecting the solid waste at public places created in the Nallah
- Bins of various capacities (10, 100, 250, 500, 1000, 1500 litres) shall be provided as per the requirements.

- Yellow lidded containers for organic waste
- Green lidded containers for recyclable inorganic waste
- Red lidded containers for hazardous wastes

- Stickers must be pasted onto each lid to help remind residents and advise visitors, of the correct items for each container.



Figure 7-6: Color coding scheme for waste collection containers

7.7.4 SPECIAL INTERSECTION IMPROVEMENT PROGRAMS AND PARKINGS

It has been identified that there are more than 50 small local roads which are terminating near Nallah. All these roads will be important points of confluence and it is expected that public will approach Nallah for recreational reasons through these roads. It has been proposed to develop a node at the termination of this road with 300 sq m of area. This area is proposed to be paved as per the landscape theme and will be used for parking of vehicles and will give small street entrepreneurs, opportunities to establish their livelihood. These nodes are expected to become lively joints along Nallah.

7.7.5 FACILITATION FOR SMALL STREET VENDOR SEGMENT

In order to make such development more user friendly and popular, it is important that these places should be facilitated with attractions and needs of the common man. Public approaching here will create the necessary foot fall for a conducive business environment for small scale street vendors, giving him opportunity to earn and run his family. Therefore both serve to each other as lifeline element.

Specific spaces for such activities have been planned as part of the development so as to facilitate bare necessities, entertainment and food.

7.7.6 MONITORING AND MEASUREMENTS

As of now no actual measurements of Nallah take place. However, to strengthen future designs and improvement programs, it is must that we have a continuous monitoring and measurement plan in place with necessary installation right from the beginning of the project. This will include following:

- Measurement of energy consumptions per categories
- Measurement of water consumptions per categories
- Measurement of river/flood levels
- Measurements of hydro-meteorological data (air, solar, precipitation)

Following instruments have been proposed for this:

7.7.6.1 RESOURCE CONSUMPTION:

- Water meter for each landscape parcel
- Water meter for each building block
- Energy meter for each building block
- Energy meter for all STPs
- Energy metering for all landscape blocks

7.7.6.2 WEATHER STATION:

- Open Pan Evaporimeter
- Thermo Hydrograph for measuring and recording atmospheric temperature and humidity as a function of time on recording chart.
- Sun Shine Recorder
- Self-Recoding Rain gauge station with Anemometer

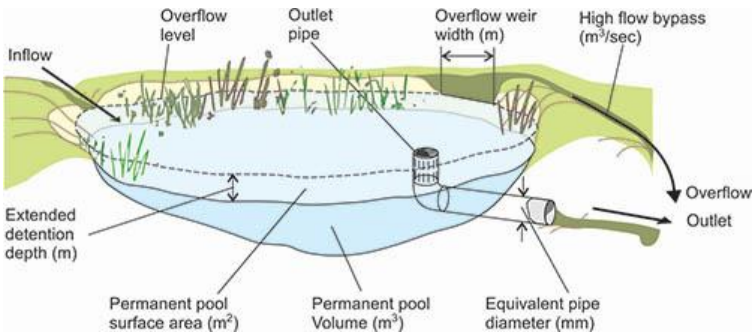
7.7.7 EMERGENCY RESPONSE CENTER

With waterfront development of 47 km, an important responsibility making it safe is also important. While all safety provisions can be taken, by equipment and policy regulations, there may be certain period during flooding and non flooding seasons when emergencies may arrive. An emergency response center equipped with necessary primary health, safety and rescue equipment has been planned as part of this project. This center will be kept at suitable distance to minimize the response time as per prescribed standards.

7.7.8 CATCHMENT IMPROVEMENT PROGRAMS

Drainage Works of incoming Drains

There are a few major outlets along with many smaller outlets which discharge storm water of the nearby colonies during the rainy season in Amanishah Nallah. These drains are not all cemented or a proper networked, hence in all likelihood will bring huge amount of silt and other floating materials during the rainy season. This will have a potential risk of failure or high expenditure in keeping the development clean after every monsoon. Therefore it has been proposed to construct outfall structures to capture wastes along with some additional catchment improvement programs.



All major and minor drains will be treated or strengthened by:

- Construction of proper designed section
- Providing of screen to trap the floating material at outfall locations
- Construction of sedimentation Basin to trap the silt
- Construction of designed outlet to prevent any adverse impact in Amanishah Nallah section.

Rainwater Harvesting / Ground Water Recharge

Water table of Jaipur city is depleting at the alarming rate and as per the latest Ground Water Department report all the zones are now falling in the Dark Zone. Amanishah Nallah is the main Natural Recharge System for the Jaipur city since historical time. However it has been observed that over the period and in current situation natural storm flow in Amanishah has reduced. All throughout the year a small stream (2-5 m wide) which disappears at certain sections is maintained by untreated sewage. This resulted in limited recharge of polluted water as over the period recharge capacity has reduced significantly due to muck and fine particles clogging the pores. With such recharge, nitrates levels in surrounding bore wells have been reported.

Present status:

The main bed of Nallah has only sewage and effluent flowing during the non-monsoon season. Hence all the recharge happening presently, is this polluted water seeping inside. Also pollutants over the years would have clogged the entire flow path to allow actual recharge to happen over period of time.

Current recharge area which will be lined during rejuvenation of Amanishah Nallah is 30000m x 4m (avg) = 1.2 lac sq.meters.

Volume recharge through this area is : 120000 X .001= 1200 m3/hr= 27 MLD

Proposal:

It is proposed to provide 2 lac sq. meters area to compensate for the blockage of current seepage area.

It is also proposed to improve the overall recharge potential of the area. For this following measures have been adopted:

1. All the catchment upstream of Mazar dam will be improved for increase opportunities of recharge by providing gabion structures and check dams in forest area
2. Provision of 82 in-fall structures of total capacity of more than 2 lac cubic meters would be made. These are natural ponds to regulate inflow of surface run-off water into Amanishah Nallah. These would be based on end points of all 82 natural streams entering Amanishah Nallah. It is proposed to enhance the area at these end-points and use them as catchments for rain water harvesting and ground water re-charge. During non-monsoon season, the same in-fall structures will be used for a capacity limited to less than 10% of their total capacity to encourage ground water recharge.
3. Under this project 2 landscape areas of 25,000 sq m each will be designed with maximum potential for recharge by storm runoff.
4. There is additional area of 1.6 lakh sq m of 2 m wide green strip on both the banks which is also potential area for recharge use.
5. A master plan for the surrounding parcels of land (measuring 80 ha) will be provided with water centric approach to maximize rain water harvesting opportunities.

During non-monsoon seasons it is proposed to divert part of the treated waste water (minimum 15 MLD as compensatory volume) for recharge through proposed outfall structures. It is expected that with huge capacities available for recharging, any additional extra volume can be diverted to the outfall structures for recharging which will help to improve general ground water scenario of the city.

7.7.9 ELECTROMECHANICAL EQUIPMENT

Electrical Equipment and Lighting:

In addition to various electrical equipment mentioned in independent section, elaborate arrangements have been done to keep this area well lit per the National Building Code 2013 standards for public areas. This has been described under section for safety and security above.

Mechanical Equipment

In spite of all efforts, due to ground realties like uncertain interception of storm through open Nallah and drains, existence of combined sewer and storm drains, creation of water body using treated waste water etc., there are possibilities that Nallah will have biological growth, unwanted sediment load and intermitted presence of solid waste. In such situations it is very important to restore the Nallah at original expected level of visual appearance. Therefore, a few Nallah cleaning instruments will be required during operation and maintenance of the Nallah, as under:

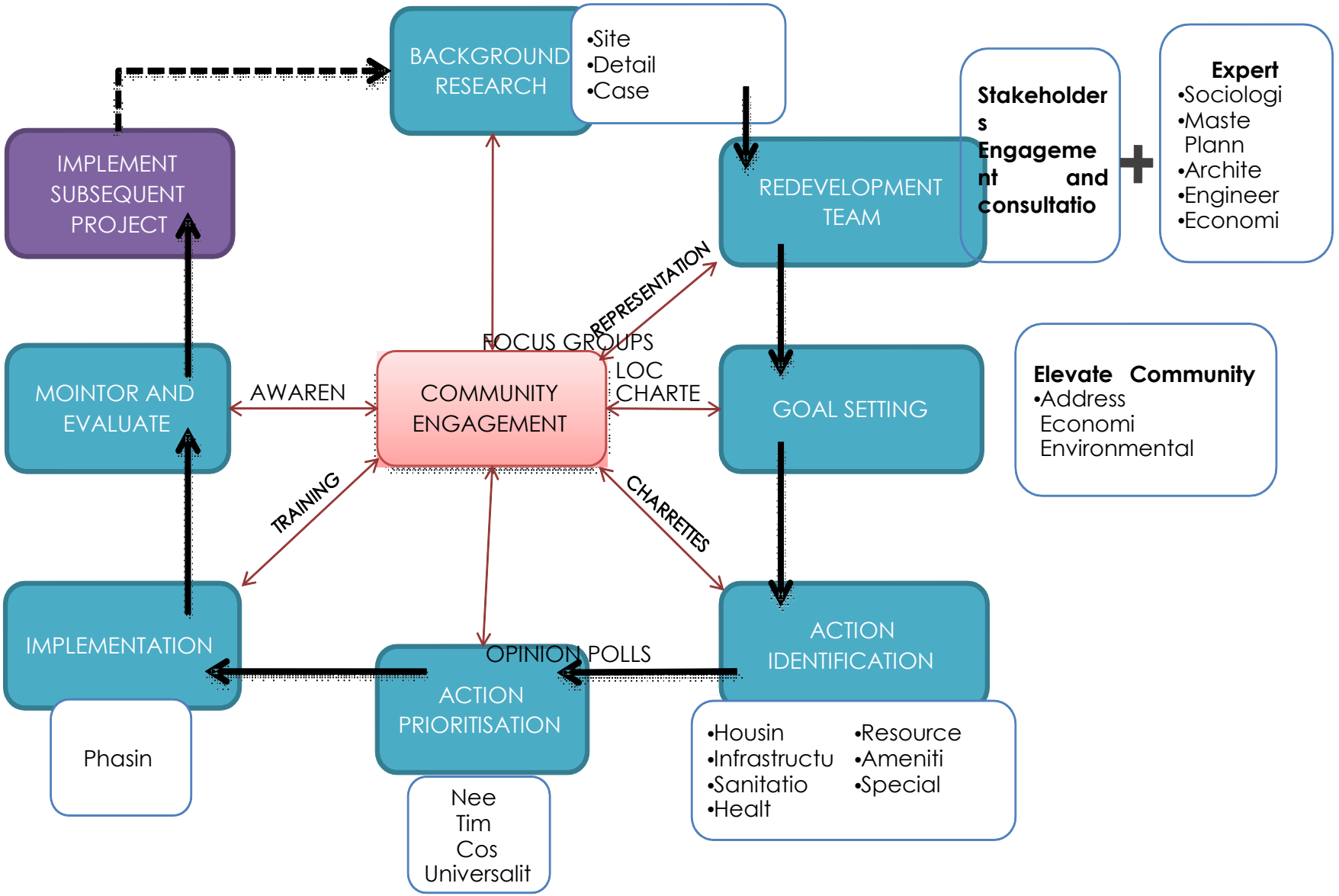
- Amphibious Tool Carriers
- Dredger
- Weed harvester etc.

The provision for such instruments has been made in current development proposal.

- A comprehensive business plan with detailed Master Plan to monetize the value created through proposed work

7.7.10 BUSINESS PLAN AND MASTER PLAN

As explained earlier, it is important not only to develop the complete Amanishah Nallah but make a place of attraction and value creation perpetually. Therefore it is extremely important from city development and economic development perspective to have a comprehensive blue print of development of the area along the Nallah. Present development of the Nallah has been conceptualized and proposed with a bigger concept of converting it into an attraction point and development stimulator for the city, Therefore a comprehensive master plan along with complete blue print of the business will be prepared as a forward integration of the Nallah development. This business plan can be used to monetize the value out of development of the Amanishah Nallah. Following inclusive approach for this work will be taken at the time of execution:


BACKGROUND RESEARCH
•Site
•Detail
•Case
IMPLEMENT SUBSEQUENT PROJECT
REDEVELOPMENT TEAM
Stakeholders Engagement and consultatio
Expert
•Sociologi
•Maste Plann
•Archite
•Engineer
•Economi
REPRESENTATION
FOCUS GROUPS
LOC CHARTE
MOINTOR AND EVALUATE
AWAREN
COMMUNITY ENGAGEMENT
GOAL SETTING
Elevate Community
•Address
Economi
Environmental
TRAINING
CHARRETTES
IMPLEMENTATION
OPINION POLLS
ACTION PRIORITISATION
ACTION IDENTIFICATION
Phasin
Nee
Tim
Cos
Universalit
•Housin
•Infrastructu
•Sanitatio
•Healt
•Resource
•Ameniti
•Special

Following exercise will be done in this:

- Market survey
- Location assessment
- Need assessment
- Product mix
- Business Plan and strategies for development
- Master Plan
- Landscape plan

7.7.11 OTHER BUILDINGS

1. Emergency Response Center
2. Security Gate
3. Security Room
4. Office space for maintenance and operation staff
5. Storage yards for equipment

7.7.12 PUBLIC AWARENESS AND EXHIBITION CENTRE

It is proposed to establish an Exhibition centre for the awareness of public to Know about the status of Amanishah Nallah 'before construction' and 'post construction'. It is important to educate the people on the ill-effects of the Amanishah Nallah's current state and need for change. This is expected to help in public opinion and participation. It is proposed that Posters, Audio Visual Effects, Models, Prototypes etc., will be part of the exhibition centre. Site for this centre is being finalised in consultation with JDA.

CHAPTER 8: TECHNICAL SPECIFICATIONS

Following technical specifications will be used for various components of the proposed work. These technical specifications have been grouped in four major categories:

1. Course Correction/ Strengthening of Amanishah Nallah
2. Sewer Interception, Treatment, Discharge & Use
3. Public Parks and Open Spaces
4. Other Value Added Items

8.1 SPECIFICATIONS FOR COURSE CORRECTION / STRENGTHENING OF AMANISHAH NALLAH

8.1.1 SITE CLEARANCE

SCOPE

This specification covers the general requirements for site clearance requirements covering:

a) Cutting & clearance of jungle, bushes, shrubs Ankra/Ipomoea, Julicflora typna etc. on canal and bunds in dry/moist/slushy conditions including disposal as per instructions of the Engineer-in-charge. The wood cut will be property of employer.
b) Cutting and uprooting of trees including removing of roots and filling of hole, cutting/up rooted would be property of the department:
   i. 7.5 cm to 15 cms girth
   ii. Over 15 cms to 30 cms. girth
   iii. Over30 cms to 45 cms. girth
   iv. Over 45 cms to 60 cms. girth
   v. Over 60 cms. girth

c) Uprooting " Water Hyacinth" (Jal Kumbhi) or similar aquatic plants in water including re-handling and disposal within lead of 250 m from dam/canal : In dam (when boat is to be used)

d) Weed clearance in canal and branches including disposal beyond canal banks and its burning:

   i. In dry bed

   ii. In pool of water

e) Removal of slit/soil/earth, sand, pebbles, 'Malba', debris, rubbish, stone pebbles & obstruction deposited in canal bed up to design line grade and sections having design due to erosion/scour/slips in canal banks/silting with or without bushes and weeds etc. in dry or moist condition from canal bed including dewatering, loading unloading and disposal at suitable place as directed by Engineer in charge with initial lead of 50m. and lift upto 1.5 m with proper dressing on canal bed complete in all respect

APPLICABLE CODES

The more important Codes, Standards and Publications applicable to this section are listed hereinafter:

8.1.2 EARTH WORKS

SCOPE

This specification covers the general requirements of earthwork in excavation in different materials for canal bed, embankment filling and footing/ foundation requirements of different structure's including compaction (wherever necessary), conveyance and disposal of surplus soils or stacking them properly as shown on the drawings and as directed by the ENGINEER-IN-CHARGE and all operations covered within the intent and purpose of this specification.

Earth Work in embankment shall include the following specifications:

a) Earth work in rough (borrow area) excavation for embankments in hard soil, murrum or highly weathered strata dry or moist, including laying in

20 cm layers (before compaction) and breaking of clods, sorting of grass, pebbles etc. and dressing when compacted by pneumatic tyred roller or any other suitable roller to obtain dry density of at least 95% of Standard Proctor's density after adding water at OMC with initial lift of 1.5m including loading and un-loading wherever required complete in all respect.

b) Lead shall vary from initial lead of 250m to 15km movement in different stages

c) Compaction of earth or highly weathered strata by mechanical equipment such as pneumatic tyred roller/vibro compactor or any other suitable compactor required as per site condition to obtain dry density of at least 95% of Standard Proctor's density.

d) Lip cutting and final dressing as per designed section including re-handling and disposal of excavated earth on embankments etc. with cost of dewatering wherever required, and complete in all respect

e) Watering of earth including cost of carriage of water with all possible leakages and wastages

f) Dressing of uneven embankment in required profile

g) Turfing by transplantation of grass on slopes of bunds etc. in rows 15 cm center to center in each direction including Ploughing, levelling, breaking of clods, and removal of stones etc. if required including maintenance for 30 days or more till the grass develops fully with all leads and lifts complete.

h) Protection Works: R. R. stone pitching, hammer dressed with packing of voids from small stones including all lead & lifts, in required profile of 23 cm thickness (± 5 % thickness tolerance)

Since the existing section of the nallah is quite irregular in shape, lot of earthwork is required to bring it in desired shape as per design section. For this purpose following steps must be followed

- First of all entire vegetation including all kinds of shrubs, bushes, trees of any girth size grown all along the inner perimeter of nallah and outside up to proposed nallah beautification boundary is to be removed up to it's root zone and thrown out of section and disposed of at approved place.
- All the valuable trees cut shall be the property of JDA
- The running sewage should be diverted by making a side drain along one of the side , so that remaining portion is dry and becomes workable
- Cutting of excess earth available in the section then desired as per design should be done by a suitable excavating machine and the excess earth removed should be laid on side if sides requires filling ,otherwise it should be loaded in dumpers for transportation to site where filling is required.
- The earth dumped on filling sites should be spread in layers by machines say by dozers so as to make a uniform layer of 20cm thickness
- Watering by sprinkling be done on spread earth so as to raise the moisture level in the layer up to OMC level, which is predetermined in laboratory in accordance with the procedure laid down in IS 2720 PART 7, the moisture content is tested regularly for each layer in accordance with procedure laid down in IS 2720 part II, if found satisfactory then only start of compaction should be permitted.
- After attaining OMC level moisture content, compaction by pneumatic tyred rollers should be started, the compaction is done covering a certain strip and should be continued till entire width is covered, the number of passés over a certain strip should be decided by trial till the desired density as per IS 3873 (95% for cohesive soils) is achieved. The proctors MDD for the soil is predetermined in laboratory by standard proctors test conducted as per IS 2720 PART 7.

- For every layer density is tested as per procedure laid down in IS 2720 part 38 and next layer is permitted only when density in lower layer is achieved, the process is continued till top level is achieved.
- The tyre of the roller is not able to compact the edges, as such the edges remains uncompacted, hence the uncompacted zone need to be removed and removed earth is placed back on embankment in middle portion where it is compacted, this is known as lip cutting , it is required to be done all along side slopes where lining is to be done
- When the compaction by pneumatic tyre roller is over and lip cutting is done, side slopes are again compacted to by slope compactor to ensure proper compaction of earth on the slopes
- After the compaction by slope compactors is done the entire side slope is dressed to remove any undulations and projection so as to achieve a smooth surface which can receive lining in uniform thickness.

APPLICABLE CODES

The important Codes, Standards and Publications applicable to Earth Work section are listed as below:

Table -0-1 Applicable Codes for Earth Work

IS 1200 (Part 1) (Part 27)	Method of measurement of building and civil engineering works. Part 1 Earthwork Part 27 Earthwork done by mechanical appliances.
IS 3764	Excavation work-code of safety.
IS 2720	Methods of test for soils:
(Part 1)	Part 1 Preparation of dry soil samples for various tests.
(Part 2)	Part 2 Determination of water content.
(Part 3)	Part 4 Grain size analysis.
(Part 5)	Part 5 Determination of liquid and plastic limit.
Part (9)	Part 9 Determination of dry density - moisture content relation by constant weight of soil method.
(Part 33)	Part 33 Determination of the density in place by the ring and water

	replacement method.
(Part 38)	Part 38 Compaction control test

8.1.3 CONCRETE AND ALLIED WORKS

SCOPE

This Specification covers the general requirements for ready mixed concrete and for concrete using on-site production facilities including requirements in regard to the quality, handling, storage of ingredients, proportioning by weigh, batchmixing, transporting by transit mixer or any other superior method, placing by paver, curing by continuous pipe nozzle for water spray , protecting, repairing, finishing and testing of concrete; formwork; requirements in regard to the quality, storage, bending and fixing of reinforcement; grouting for completed works. Concrete mix design shall be done before start of the work and same shall be approved by the engineer in charge of the site. Lining shall be laid in a panel fo 3X3 m size in both direction with all joints sealed with bitumen.

It shall be clearly understood that the specifications given herein are brief and do not cover micro- details. However, all works shall have to be carried out in accordance with the relevant standards and codes of practices or in absence in accordance with the best accepted current Engineering practices or as directed by ENGINEER-IN-CHARGE from time to time. The decision of ENGINEER-IN-CHARGE as regards the specification to be adopted and their interpretation and the mode of execution of work shall be final and binding on CONTRACTOR and no claim whatsoever will be entertained on this account.

Material

1. Cement : Ordinary Portland cement 43 grade confirming to IS 8112 is to be used. Cement is to be stored in godowns as per procedure laid down in Is-

4082. Portland pozzolana cement can also be used except for lining works with the approval of engineer in charge . The PPC should confirm to IS 1489

2. Coarse aggregate : Crusher broken aggregate well graded with maximum size of agg. as 20 mm made of hard and dense stone brought from approved quarry confirming to IS 383 is to be used
3. Fine aggregate: Natural river sand brought from approved quarry well graded confirming to IS 383 is to be used
4. Water: Fresh and clean water confirming to IS-456 is to be used

All construction material should be stored at site as per procedure laid down in IS 4082

Testing of material

Only tested and approved material should be used

1 cement –Both physical and chemical test should be conducted as procedure laid down in IS 4031,at least following test be conducted

(i) Initial setting time
(ii) Final setting time
(iii) Consistency
(iv) Compressive strength

2 Aggregate- should be tested as procedure laid down in IS 2386

At least following tests be conducted

(i) Crushing value
(ii) Compressive strength
(iii) Water absorption
(iv) Durability
(v) Abrasion value

3 Sand : At least following test be conducted as per procedure laid down in Is 2386

(i) Particle size gradation
(ii) Fineness modulus
(iii) Clay and silt content
(iv) Organic impurities

Mix design

Mix design for various grades of conc. by weigh batching is to be got done from a reputed laboratory, as per procedure laid down in IS-10262. All the ingredients should be brought from approved source. Only design mix should be used. Mix design for 7 days, 28days strength should be done

Batching

1 All ingredients of concrete are to be batched by automatic weigh batching plant as per mix design, the batching plant should confirm to IS 4925

Mixing

Mixing of ingredients is to be done in desired proportion coming out from batching plant as per mix design by mechanical mixers. The mixing plant should confirm to IS 4925 mixing be done as per procedure laid down in IS 456

Workability

The conc mix should remain workable till it is finally placed at desired site. The workability should be as per IS 456

Admixures

To maintain/improve the workability without increasing water cement ratio any suitable admixture such as plasticizer or any other material confirming to IS 9103 with the approval of engineer in charge should be used

Transportation of mix to placement site

Transportation of conc.mix coming out of mixing plant to placement site should be done by transit mixers for slope lining and all RCC works, having specifications as per IS 5892 with in prescribed time limit.

Testing of mixed concrete

The mixed concrete coming out of batching plant should be tested , at least following test be conducted at site

(i) Compressive strength by casting cubes of concrete as procedure laid down in IS 516

(ii) Slump test for assessing workability

Placing of concrete

(a) Preparation of subgrade: Concrete for lining purpose should be place on hard and compacted surface only. The compaction should be done to as per IS 3873. . The excess earth on edges of compacted surface should be removed by LIP cutting, If required the slope should again compacted by slope compactors. The rendering of surface should then be done to remove all uneven projection and the surface be made smooth

(b) Placing : concrete should be placed on the slope where lining is to be done with the help of a concrete paver machines for the desired slope and thickness and simultaneously it should be compacted with the help of attachment with the paver(cylindrical roller) so as to give a even thickness of desired thickness and must be finished to give a smooth surface. The placing should be done in panels of suitable size. The joint must be filled with bitumen-sand mixer

(c) Curing : curing of laid concrete should be done for a period prescribed in IS 456 by continuous trickling of water through a perforated pipe laid along the lining slope at top or by any suitable method approved by Engineer In Charge..

APPLICABLE CODES

The following specifications, standards and codes, including all official amendments/revisions and other specifications & codes referred to therein, should

be considered a part of this specification. In all cases the latest issue/ edition/ revision shall apply. In case of discrepancy between this specification and those referred to herein below or other specifications forming a part of this bid document, this specification shall govern.

Table -0-2 Codes for Concrete

a)	IS: 455	Specification for Portland slag cement.
b)	IS: 1489	Specifications for Portland - Pozzolana cement (Part 1&2).
d)	IS: 8112	Specification for 43 grade ordinary Portland cement
e)	IS: 12269	Specification for 53 grade ordinary Portland cement.
f)	IS: 383	Specification for coarse and fine aggregates from natural sources for concrete.
g)	IS: 432	Specification for mild steel and medium (tensile steel bars and hard-drawn steel) wires for concrete reinforcement. (Part 1 and 2)
h)	IS: 1786	Specification for high strength deformed steel bars and wires for concrete reinforcement.
i)	IS: 1566	Specification for hard-drawn steel wire fabric for concrete reinforcement.
j)	IS: 9103	Specification for admixtures for concrete.
k)	IS: 2645	Specification for integral cement water- proofing compounds
l)	IS: 4990	Specification for plywood for concrete shuttering work.

Material Testing

Table -0-3 Codes for Material Testing

a)	IS: 4031	Methods of physical tests for hydraulic cement (Parts 1 to 15)
b)	IS: 4032	Method chemical analysis of hydraulic cement.
c)	IS: 650	Specification for standard sand for testing of cement.
d)	IS: 2430	Methods for sampling of aggregates for concrete.
e)	IS: 2386	Methods of test for aggregates for concrete (Parts 1 to 8)

f)	IS: 3025	Methods of sampling and test (physical and chemical) for water used in industry.
g)	IS: 6925	Methods of test for determination of water soluble chlorides in concrete admixtures.

Material Storage

a)	IS: 4082	Recommendations on stacking and storing of construction materials at site.

Concrete Mix Design

Table -0-4 Concrete Mix Design

a)	IS: 10262	Recommended guidelines for concrete mix design.
b)	SP:23	Handbook on Concrete Mixes

Concrete Testing

a)	IS:1199	Method of sampling and analysis of concrete.
b)	IS:516	Method of test for strength of concrete.
c)	IS: 9013	Method of making, curing and determining compressive strength of accelerated cured concrete test specimens.
d)	IS: 8142	Method of test for determining setting time of concrete by penetration resistance.
e)	IS:2770	Methods of testing bond in reinforced concrete.

Equipment

Table -0-5 Codes for Equipment

IS:1791	Specification for batch type concrete mixers.
IS:2438	Specification for roller pan mixer.
IS:4925	Specification for concrete batching and mixing plant.
IS:5892	Specification for concrete transit mixer and agitator.

IS:7242	Specification for concrete spreaders.
IS:2505	General Requirements for concrete vibrators: Immersion type.
IS:2506	General Requirements for screed board concrete vibrators.
IS:2514	Specification for concrete vibrating tables.
IS:3366	Specification for pan vibrators.
IS:4656	Specification for form vibrators for concrete.
IS:11993	Code of practice for use of screed board concrete vibrators.
IS:7251	Specification for concrete finishers.
IS:2722	Specification for portable swing weigh batchers for concrete (single and double bucket type)
IS:2750	Specifications for steel scaffoldings.

Codes of Practice

Table -0-6 Codes of Practice

IS:456	Code of practice for plain and reinforced concrete.
IS:457	Code of practice for general construction of plain and reinforced concrete for dams and other massive structures.
IS:3370	Code of practice for concrete structures for storage of liquids (Parts 1 to 4)
IS:3935	Code of practice for composite construction.
IS:2204	Code of practice for construction of reinforced concrete shell roof.
IS:2210	Criteria for the design of reinforced concrete shell structures and folded plates.
IS:2502	Code of practice for bending and fixing of bars for concrete reinforcement.
IS:5525	Recommendation for detailing of reinforcement in reinforced concrete works.
IS:2751	Code of practice for welding of mild steel plain and deformed bars used for reinforced concrete construction.

IS:9417	Specification for welding cold worked bars for reinforced concrete construction.
IS:3558	Code of practice for use of immersion vibrators for consolidating concrete.
IS:3414	Code of practice for design and installation of joints in buildings.
IS:4326	Code of practice for earthquake resistant design and construction of buildings.
IS:4014	Code of practice for steel tubular scaffolding. (Parts 1 & 2)
IS:2571	Code of practice for laying in situ cement concrete flooring
IS:7861	Part1 - Recommended practice for hot weather concreting Part2 – Recommended practice for cold weather concreting
IS:3370	Code of practice for concrete structures for the storage of liquid (Part I to IV)

Construction Safety

Table -0-7 Codes for Construction Safety

IS:3696	Safety code for scaffolds and ladders.(Parts 1 & 2)
IS:7969	Safety code for handling and storage of building materials.
IS:8989	Safety code for erection of concrete framed structures.

Measurement

IS:1200 Part (1 to 12)	Method of measurement of building and Engineering works (Part 2 and 5)

8.1.4 GENERAL CIVIL WORKS

Applicable Codes and Specifications

The following codes and standards are included in this section.

Table 0-8 Code for Brickworks and Other Civil Works

IS: 110	Ready mixed paint, brushing, grey filler, for enamels for use over primers
IS: 269	Specification for 33 grade ordinary Portland cement

IS: 280	Specification for mild steel wire for general engineering purposes
IS: 383	Specification for coarse and fine aggregates from natural sources for concrete
IS: 412	Expanded metal steel sheets for general purposes
IS: 712	Specification for building limes
IS: 730	Specification for hook bolts for corrugated sheet roofing
IS: 733	Wrought aluminium and aluminium alloys, bars, rods and sections
IS: 1124	Method of test for determination of water absorption, apparent specific gravity and porosity of natural building stones
IS: 1322	Bitumen felts for water proofing and damp proofing
IS: 1398	Specification for packing paper, waterproof, bitumen laminated
IS: 1542	Specification for sand for plaster
IS: 1580	Specification for bituminous compounds for water-proofing and caulking purposes
IS: 1597	Code of practice for construction of stone masonry : Part 1 Rubble stone masonry
IS: 1659	Specification for block boards
IS:1661	Code of practice for application of cement and cement-lime plaster finishes
IS:1834	Specification for hot applied sealing compound for joint in concrete
IS:1838	Specification for preformed fillers for expansion joint in concrete pavements and structures (non-extruding and resilient type) : Part 1 Bitumen impregnated fibre
IS:2074	Ready mixed paint, air drying, red oxide- zinc chrome, priming
IS:2116	Specification for sand for masonry mortars
IS:2185	Specification for concrete masonry units (Parts 1,2 & 3)
IS:2250	Code of practice for preparation and use of masonry mortars
IS:2339	Aluminium paint for general purposes, in dual container
IS:2394	Code of practice for application of lime plaster finish
IS:2395	Code of practice for painting concrete, masonry and plaster surfaces (Parts 1 & 2)

IS:2571	Code of practice for laying in-situ cement concrete flooring
IS:2572	Code of practice for construction of hollow concrete block masonry
IS:2645	Specification of integral cement waterproofing compounds
IS:2690	Specification for burnt clay flat terracing tiles : Part 1 Machine made
IS:2691	Specification for burnt clay facing bricks
IS:2750	Specification for steel scaffoldings
IS:2835	Flat transparent sheet glass
IS:3036	Code of practice for laying lime concrete for a water-proofed roof finish
IS:3068	Specification for broken brick (burnt clay) coarse aggregates for use in lime concrete
IS:3384	Specification for bitumen primer for use in water-proofing and damp-proofing
IS:3495	Method of test for burnt clay building bricks: Part 1 to 4
IS:3696	Safety code of scaffolds and ladders (Parts 1 & 2)
IS:3935	Code of practice for composite construction
IS:4443	Code of practice for use of resin type chemical resistant mortars
IS:4631	Code of practice for laying epoxy resin floor toppings
IS:4832	Specification for chemical resistant mortars (Part II)
IS:4860	Specification for acid resistant bricks
IS:4948	Specification for welded steel wire fabric for general use
IS:5410	Cement paint, colour as required
IS:6041	Code of practice construction of autoclaved cellular concrete block masonry
IS:6042	Code of practice for construction of light weight concrete block masonry
IS:8042	Specification for White Portland Cement
IS:9862	Specification for ready mixed paint, brushing, bituminous, black, lead-free, acid, alkali, water and chlorine resisting
IS:10005	SI units and recommendations for the use of their multiples and of certain other units.
BS : 476	Methods for determination of the fire resistance of elements of

(Part–20)	construction (General Principles)
BS : 476 (Part–21)	Methods for determination of the fire resistance of load bearing elements of construction
BS : 476 (Part–22)	Methods for determination of the fire resistance of non-load bearing elements of construction
Part – IV	National Building code of India, 2005

Pitching

a) Providing and laying Pitching of 230 mm thick including boulder apron laid dry in front of toe of embankment complete as per drawing and Technical specifications. Spec. No.: MORT & H – 2504

b) Specifications of stones to be used confirming to IS 4515, brief specifications as under

- The stones used should be sound hard and durable, should be able to withstand weathering and water action,
- Stones should be round, subangular with large base, natural river stone or blasted rock pieces.
- The size should be almost uniform in all sides, thickness of lining is to be kept 23 cm.

Laying of stones

Laying of stones is to be done as per procedure laid down in IS 4515 , brief of which is given below

Before laying of stones, the subgrade should be prepared ,the specifications of subgrade should be same as that for concrete lining. Subgrade of the nallah should be divided into compartments by stone masonry or concrete ribs. The compartments should have dimensions of not more than 15 mt along the length of the canal. The spacing of ribs cross in the section of the canal

should be so chosen as to divide the canal bed and slope symmetrically about the centre line and in such a manner that ribs are provided at the junction of the slope and bed and at the upper extremity of the slope. The ribs along the slope of the bank should be continuous. The stone should be hand placed and hammer dressed to remove all projections. The voids must be filled with smaller chips of stone.

Railing

a) Ms Railing 1 m high as per the arch design. (10 Kg running meter)

b) Railing with ropes on both side of check dams

Fencing Works:

a) Supplying and fixing of chain link fencing with angle iron posts 50x50x6mm placed at every 3 m. apart 30cm in ground embedded in cement concrete 1:3:6 (30x30x45cm) corner and every tenth post to be strutted with (50 x 50 x 6cm) angle iron provided and fixed and fitted with posts including earth work in excavation etc. complete with chain link size.

    i. 75mm x 15mm x 3.15mm
    ii. MS Gate of 3 m wide and 2 m high architectural design @25 kg/sqm wt

Pedestrian Pathway

It includes:

a) Compacting the sub grade / gravel / design size metal including necessary, labour, materials and artificial watering complete by power roller:

    i. 200 mm loose layer
    ii. 200 mm loose layer hard murrum

b) Placement and fixing of Finishing stone slabs on walking area

c) Fixing of finishing stone using 1:6 cement mortar for sitting arrangement

8.1.5 DEVELOPMENT OF GREEN STRIP AT TOP OF EMBANKMENT:

The development of Green strip along the canal will include:

a) Supply & Planting of shady plants (Neem, Peepal, Gullar, Jamun, Imli or other specified) along road side including the following activities :-

i. Preparation of soil including cleaning & removing of unwanted shrubs removal of stones & garbage.
ii. Supply of plant at site of two years of age & height more than 1.50 m.
iii. Supply of dry manure (Farm yard manure organic)
iv. Supply of Insecticides.
v. Digging of pits size 60x60x60 cms. Including removal of stones, Manuring application of insecticides & watering at least 15 liter per plant after planting.
vi. Half brick Circular tree guard in second class bricks, internal dia 1.25 meter and height 1.20 meter above ground and 0.20 meter below ground, bottom two courses laid dry and top three courses in cement mortar 1:6 (1 Cement : 6 Sand) and the intermediate courses being in dry honey comb masonry, as per design complete.
vii. Watering to plants.
viii. Maintenance of plants by the contractor including pits, preparation of Thavala Hoeing weeding etc. & application of insecticides etc. & security. If the plant die during maintenance contractor has to replace same height plant at his own cost.

b) Supply & Planting of ornamental plants (Kachnar, Amaltas, Gulmohar, Arjun, Kala Siris, Jacranda etc. or other specified) along road side including the following activities :-

i. Preparation of soil including cleaning & removing of unwanted shrubs removal of stones & garbage.
ii. Supply of plant at site of two years of age & height more than 1.50 m.
iii. Supply of dry manure (Farm yard manure organic)
iv. Supply of Insecticides.

v. Digging of pits size 60x60x60 cms. Including removal of stones, Manuring application of insecticides & watering at least 15 liter per plant after planting.

vi. Half brick Circular tree guard in second class bricks, internal dia 1.25 meter and height 1.20 meter above ground and 0.20 meter below ground, bottom two courses laid dry and top three courses in cement mortar 1:6 (1 Cement : 6 Sand) and the intermediate courses being in dry honey comb masonry, as per design complete.

vii. Watering to plants.

viii. Maintenance of plants by the contractor including pits, preparation of Thavala Hoeing weeding etc. & application of insecticides etc. & security. If the plant die during maintenance contractor has to replace same height plant at his own cost.

c) Planting & Maintenance of shrubs.

i. Planting of shrubs in central verge

ii. Preparation of soil including cleaning & removing of unwanted shrubs removal of stones & garbage.

iii. Supply of plant at site like Bouganvillia & Kaner

iv. Supply of dry manure (Farm yard manure organic)

v. Supply of Insecticides.

vi. Digging of pits size 60x60x60 cms. Including removal of stones, Manuring application of insecticides & watering at least 15 liter per plant after planting.

vii. Watering to plants.

viii. Maintenance of plants by the contractor including pits, preparation of Thavala Hoeing weeding etc. & application of insecticides etc. & security. If the plant die during maintenance contractor has to replace same height plant at his own cost.

8.1.6 **ROAD WORKS:**

Construction of Services/ Access Road (wherever proposed)

The specifications of the Road Works shall include following:

a) P/L a top layer of earth of 15 cm. Compacted thickness rolling with 10/12 tonne power roller, watering etc. complete in conformity with the lines, grades & cross sections & camber super elevation (Lab C.B.R. in soaked condition shall not be less than 10) including clearing & grubbing the ground etc. complete (including stabilization if necessary.)

b) Granular Sub-Base with Coarse Graded Material:

(Table:- 400- 2) Construction of granular sub-base by providing coarse graded material, spreading in uniform layers with motor grader on prepared surface, mixing by mix in place method with rotavator at OMC, and compacting with vibratory roller to achieve the desired density, complete as per clause 401. Spec.No. MORTH – 401. This need to provided in three layers of 75 mm each as given below:

i) for grading- I Material
ii) for grading- II Material
iii) for grading-III Material

c) Water Bound Macadam (75 mm thickness):

Providing, laying, spreading and compacting stone aggregates of specific sizes to water bound macadam specification including spreading in uniform thickness, hand packing, rolling with 3 wheeled steel/ vibratory roller 8-10 tonnes in stages to proper grade and camber, applying and brooming requisite type of screening/ binding Materials to fill up the interstices of coarse aggregate, watering and compacting to the required density. Spec.No. MORTH – 404.

d) Tack coat

Providing and applying tack coat on the prepared surface heating by fames in roller and spraying bitumen with spray set footed in bitumen boiler on B.T.

surface @ 60/70 Bulk (Bitumen VG-30)@ ii) 5Kg/10 Sq.M., Spec.No. MORTH – 503.

e) Bituminous Concrete:

Providing and laying bituminous concrete with 40-60 TPH batch type hot mix plant producing an average output of 35 tonnes per hour using crushed aggregates of specified grading, premixed with bituminous binder @ 5 percent of mix and filler, transporting the hot mix to work site, laying with a hydrostatic paver finisher with sensor control to the required grade, level and alignment, rolling with smooth wheeled, vibratory and tandem rollers to achieve the desired compaction as per MORTH specification clause No. 509 complete in all respects. Spec.No. MORTH – 509

Table 0-9 Codes for Roads Construction

No	Name of IRC Code	Code No:
1	Recommended practice for the Design and Layout of Cycle Tracks	IRC: 11-1962
2	Lateral and Vertical Clearances at Underpasses for vehicular traffic.	IRC:54-1974
3	Space Standards for Roads in Urban Areas	IRC:39-1977
4	Guidelines on Regulation and control of Mixed traffic in Urban Areas	IRC:70-1977
5	Geometric Design Standards for Urban roads in Plains	IRC:86-1983
6	Guidelines for the Design of Interchanges in Urban Areas	IRC:92-1985
7	Guidelines on Accommodation of Underground Utility Services Along and Across Roads in Urban Areas (Second	IRC:98-2011
8	Tentative Guidelines on the provision of Speed Breakers for Control of Vehicular Speeds on minor Roads	IRC:99-1988
9	Guidelines for Pedestrian Facilities	IRC:103-2012
10	Guidelines for capacity of Urban Roads in Plain Areas	IRC:106-1990
11	Tentative Recommendations on the Provision of Parking spaces for Urban Areas	IRC:SP 12- 1973
12	Code of Practice for Road Markings (with paints) (First Revision)	IRC:35-1997

13	Code of Practice for Road Signs (Third Revision)	IRC:67-2012
15	Vertical Curves for Highways	IRC:SP23-1983
16	Guidelines for the design of curves for Highways & Design Tables (First Revision)	IRC:38-1988
17	Guidelines on Design of At-Grade Intersections in Rural & Urban Areas	IRC:SP41-1994
18	Guidelines on Urban Drainage	IRC:SP50-1999
19	Standards for vertical and horizontal clearances of Overhead electric power and telecommunication lines as	IRC:32-1969
20	Tentative Guidelines for the Design of Flexible pavements	IRC:37-2012

Table 0-10 Specific Design Standards/ Guide lines for different Road Elements

Road Elements	Design Standards used for	
	Name of Code	Description
Ground Improvement	HRB - SR No. 14, 1994	State of the Art report: High Embankment on soft ground, Part B - Ground Improvement.
Embankment Fill	HRB - SR No. 3, 1999	State of the Art Report: Compaction of earthworks and sub grades.
Pavement Design	IRC:37-2012	Tentative Guidelines for the Design of Flexible Pavements.
Road Markings	IRC:35 -1997	Code of Practice for Road Markings (with paints) (First Revision).
Road Signs	IRC:67 -2012	Guidelines for Pedestrian Facilities.
Landscaping	IRC:SP21-2009	Guidelines on Landscaping and Tree plantation.
Pedestrian Facilities	IRC:103-2012	Guidelines for Pedestrian Facilities.
Cycle Tracks	IRC:11-1962	Recommended Practice for the design and layout of Cycle tracks.
Traffic Lights	IRC:93-1985	Guidelines on Design and Installation of Road Traffic Signals.
Junction / Medians	IRC:SP41-1994	Guidelines on Design of At Intersections in Rural and Urban Areas.
Structures	IRC:112-2011	Code of Practice for Road Bridges.
Protection works	IRC:89-1998	Guidelines for Design and Construction of River Training works.

High Embankments	IRC:75-1979	Guidelines for the design of High Embankments.
Erosion Control	IRC:56-2011	Recommended practice for Treatment of Embankment and Road side slopes for Erosion control. (First Revision)
Slope Stability	HRB: Sl.No:1 - 2000	State of the Art Report: Lime Stabilisation.

8.2 SPECIFICATIONS FOR WORKS - SEWERAGE NETWORK

8.2.1 PIPES (HDPE PE 100-PN6)

SCOPE

This specification covers the requirements for manufacture, supplying, lowering, laying, jointing, testing and commissioning of High Density Polyethylene pipes (HDPE) and fittings used for the conveyance of sewerage. The detailed scope is available in Section 1.5 of this document

APPLICABLE CODES

The manufacturing, testing, supplying, jointing and testing at work site of HDPE pipes and fittings shall comply with all currently applicable statutes, regulations, standards and codes. In particular, the following standards unless otherwise specified herein, shall be referred. In all cases, the latest revision of the codes shall be referred to. If requirements of this specification conflict with the requirements of the codes and standards, this specification shall govern.

Table 0-11 Codes for HDPE pipes for Sewerage

Code No.	Title / Specification
IS: 14333	Specification for High Density Polyethylene pipes (HDPE) and fittings for the use for Sewerage
IS: 7634 Part 2	Code of practice for Laying and Jointing of High Density Polyethylene pipes (HDPE) piping system
IS: 2530	Method of test for polyethylene moulding materials and polyethylene compounds
IS: 7328	High Density Polyethylene material for moulding and extrusion
IS: 4905	Method for random sampling

Other codes as approved by Engineer but not specifically mentioned here pertaining to the use of HDPE Pipes form part of these specifications.

GENERAL
Design:

Design of HDPE pipes including material details and the maximum allowable hydrostatic design stress taking into consideration, the temperature and design life of pipes shall be in accordance with the relevant clauses of IS:14333

Grade of Material:

The High Density Polyethylene Pipes (HDPE)

Material Grade, Minimum Required Strength and Maximum Allowable Hydrostatic Design Stress shall conform to the relevant clause of IS – 14333.

Color:

The color of the pipe shall be black.

8.2.2 **PIPELINE APPURTENENCES**

Manholes

Location:

Manholes shall be constructed at places as directed by ENGINEER-IN-CHARGE.

General Requirements of Manholes

The manhole spacing in general shall be 30m or less, which will be specified in the construction drawings and at every junction, change in direction or change in diameter of pipe.

The Manhole dimensions and other details shall be as per requirements.

The location of manholes shall be as per drawing or layout given by the ENGINEER-IN-CHARGE.

The entire height of the manhole shall be tested for water tightness by closing both the incoming and outgoing ends of the sewer and filling the manhole with water and drop in water level not more than 50mm per 24 hours shall be permitted. The

CONTRACTOR at his own cost shall arrange the required water for testing and other requirements.

Safety Measures will be taken appropriately as per IS 4111

8.2.3 REINFORCED CEMENT CONCRETE (RCC) PIPES

Applicable Codes & Standards

The manufacturing, testing, supplying, jointing and testing at work sites of RCC pipes shall comply with all currently applicable statutes, regulations, standards and codes. In particular, the following standards, unless otherwise specified herein, shall be referred. In all cases, the latest revision of the Codes shall be referred to. If requirements of this Specification conflict with the requirements of the Codes and standards, this Specification shall govern.

Materials

Table -0-12 Material RCC pipes

IS: 458	Specification for Concrete Pipes (with and without Reinforcement).
IS: 3597	Method of Tests for Concrete Pipes.
IS: 5382	Specification for Rubber Sealing Rings for Gas Mains, Water Mains and Sewers.
IS: 432 Part I & II	Specification for mild steel and medium (tensile steel bars and hard drawn steel) wires for concrete reinforcement.
IS: 516	Method for test for strength of concrete.

Code of practice

IS: 456	Code of Practice for Plain and Reinforced Concrete.
IS: 783	Code of Practice for Laying of Concrete Pipes.

8.2.4 SPECIFICATIONS FOR STP

The Treated Sewage which will be discharged into the Nallah to create a water body shall have the following output characteristics:

No	Parameter	Values / concentration
1	pH	6. to 8.0
2	BOD @ 20deg cent	< 10 ppm
3	COD	< 50 ppm
4	TSS	< 20 ppm
5	Oil and grease	< 5 ppm
6	Total nitrogen	< 10 ppm as nitrates
7	Total Phosphorous	< 2 ppm
8	Coliform (MPN/100ml)	< 10 ML/100ML

Referral codes are as below

Table 1: This specification requires a reference to the following standard specifications

Agitators	IS 9522
C-PVC Piping	IS / ASTM / DIN as per manufacturer
HDPE Piping	IS / ASTM / DIN as per manufacturer
FRP / GRP Tanks	IS 14399
Activated Carbon	IS 8366 & 8755
Sewage Screens	IS 6280
Grit Removal Device	IS 6279
Sewerage pumping station & pumping main	IS 4111
Sewage application pumps	IS 5600
Biological Treatment	IS 8413
Buried Pipes	IS 1536
Sludge De-watering Equipment	IS 10037
Dosing Devices	IS 9222
Settling Tank Clarifier Equipment	IS 10261
Chlorinator Equipment	IS 10553
Clarifier Structures	IS 7215, IS 10313
Butterfly Valves	AWWA C-504 / BS 5155
Diaphragm Valve	BS 5156
Non return Valve	IS 5312
Gate / Globe / NRV valve	BS 5352 / BS 1634
Structural Steel	MS Plate as per IS 2062 Gr B Angle as per ISA Channel as per ISMC Beams as per ISMB
Statutory requirements for STP	CPHEEO (Manual on Sewerage & Sewage Treatment) & CPCB (Central Pollution Control Board)

8.3 SPECIFICATIONS FOR PUBLIC PARKS AND OPEN SPACES

Earthwork:

Excavation in all soils by mechanical means (Hydraulic excavator) in foundations, trenches, etc. upto 3m depth including dressing of sides and ramming of bottoms as directed. Rate shall be inclusive of shoring, strutting, removal of slurry, dewatering, including stacking of good excavated earth and rock anywhere within site premises and backfilling in layers as approved by Engineer-in-Charge, including all leads and lifts complete.

Compaction of Earth work in layers of 300mm thick as directed by engineer in charge

1. Reclamation of wet area with excavated soil within the premices and soil stabilization including grading and compaction as directed by engineer in charge. Rate shall be inclusive of shoring, strutting, removal of slurry, dewatering, including stacking of good excavated rock anywhere within site premises and place them in position as per landscape design or as approved by Engineer-in-Charge, including all leads and lifts complete.
2. Soil filling for raised tree plantation corridor

Masonry

3. Providing and constructing brick masonry for loadbearing walls of 230mm or thicker in PPC mortar 1:6 with all joints fully filled and finished flush with curing and protection, including labour, materials, transportation, loading, unloading & stocking, scaffolding, at all levels & heights, lead and lifts, all shapes, sizes, thickness etc. complete as per drawings, specifications and as directed by Engineer-in-Charge.
4. Providing and constructing brick masonry for loadbearing walls of 230mm or thicker in PPC mortar 1:6 for an height of 450 mm with all joints fully filled and finished flush with curing and protection, including labour, materials, transportation, loading, unloading & stocking, scaffolding, at all levels & heights, lead and lifts, all shapes, sizes, thickness etc. complete as per drawings, specifications and as directed by Engineer-in-Charge.

5. Providing and laying a top layer for subgrade of 150mm with material as mention in Clause 2 of HVFAC Road Construction Methodology . Size of the coarse material shall not exceed 50mm and CBR shall not be less than 7.compacted thickness rolling with 10/12 tonne vibratory roller to 97% Standard Proctor Density, watering etc. complete in conformity with the lines, grades & cross sections & camber super elevation including stabilisation if necessary.
6. Providing and laying of granular sub-base of 150mm with material as per Grading-1 in table mentioned in HVFAC Road Construction methodology, spreading in uniform layers with motor grader, mixing by mix in place method using Mechanical Mixer desired moisture content. Compacting using vibratory roller of 80-100kN static weight to required dry density, all labour, tools, equipment and incidentals to complete the work
7. Providing and laying rough cut 600mm X 600mm X 30 mm thk stone paver blocks.

Surface Finish

8. Stabilization and compaction of soil mixed with good quality murrum in layers of 300 mm. Compacted thickness rolling with 10/12 tonne vibratory roller to 96% Standard Proctor Density, watering etc. completes in conformity with the lines, grades & cross sections & camber super elevation including stabilisation if necessary.

Stabilization and compaction of soil mixed with good quality murrum in layers of 300 mm. Compacted thickness rolling with 10/12 ton vibratory roller to 94% Standard Proctor Density, watering etc. completes in conformity with the lines, grades & cross sections & camber super elevation including stabilization if necessary.

Kerb wall

9. **Provide** precast T shaped RCC M 20, 75 mm thk kerb of height 300 mm for laying around the pedestrian pathway. Cost includes necessary excavation for laying the kerb stone and back filling of soil.
10. **Provide** precast T shaped RCC M 20, 100 mm thk kerb of height 450 mm for laying around the pedestrian pathway. Cost includes necessary excavation for laying the kerb stone and back filling of soil.

Concrete Works

11. Providing and laying in position plain cement concrete grade M10 using OPC with fly ash including compaction, curing, finishing etc. The rate shall include top surface of the concrete to be finished smooth wherever required, providing slopes, gradients, preparation of ground surface for laying concrete, trimming, ramming, removal of slurry, cost of materials, labour, loading and unloading, transportation, scaffolding and all other incidental charges etc., with all leads and lifts and at all levels complete and as directed by the Engineer-in-Charge. Cost includes necessary shuttering but only on the side not exceeding 300 mm height.
12. Providing and laying in position plain cement concrete grade M15 using OPC with fly ash including compaction, curing, finishing etc. The rate shall include top surface of the concrete to be finished smooth wherever required, providing slopes, gradients, preparation of ground surface for laying concrete, trimming, ramming, removal of slurry, cost of materials, labour, loading and unloading, transportation, scaffolding and all other incidental charges etc., with all leads and lifts and at all levels complete and as directed by the Engineer-in-Charge. Cost includes necessary shuttering but only on the side not exceeding 300 mm height.
13. Providing and laying in position design mix self-compacting concrete (SCC) grade M25 using OPC with fly ash including the cost of admixtures in recommended proportions as per IS 9103 to improve workability without impairing strength and durability with proper compaction, curing, vibrating, consolidating, finishing, providing recesses, grooves, chamfers, rounding of corners as required in detailed drawings, cost of materials, labour, loading and unloading, transportation, scaffolding and all other incidental charges etc., with all leads and lifts and at all levels, complete and as directed by the Engineer-in-Charge. Min cements content as per IS 456. (90 KG / CuM of Concrete is assumed)

Steps

14. Creating steps of width 3m wide with 300 mm tread and 150 mm risers over the already graded site with random rubble stone and PCC (1:3:6) as base and proper step with masonry works and cladding the same with polished stone (Jodhpur pink

stone (SS))

RR Masonry

15. Random Rubble masonry 450 mm wide and 600 mm high above the ground 300 mm deep below the ground with all the joints pointed with 1:5 cement mortar, used for space barrier within the public open space in 1:6 cement mortar. Cost includes necessary excavation and backfilling of soil.

Stone Finishing

16. Stone finishing by wet cladding over the completed masonry or PCC surface (Jodhpur Stone)

Tree plantation

17. Planting of 10 Feet tall grown up tree in a 1 Cum pit and refilling with the same with necessary soil mix including soil, sand, and manure. Cost includes temporary tree guard for 1 year.

18. Making earth mounds as per drawing and direction at site, with good earth (price to be taken separately) and fine dressing to get smooth shape.

Shrubs, Groundcovers and Creepers :

19. Excavation of pits of size 0.45 m. dia. & 0.45 m. deep for shrubs, groundcovers & creepers at exact positions as marked on the drawing & backfilling of the same with prepared good earth & organic manure (supplied as above) mixed in the ratio 5:1:1 respectively, including filling and laying so as to achieve the specified levels for planting the shrubs at distances as specified and maintaining the same for a period of 6 months.

Glazed ceramic tiles

20. Providing and laying 6mm thk. Light coloured glazed ceramic tiles for water bodies as specified below conforming to I.S.15622-2006 for flooring of an approved, quality, make, size and pattern /design, for walls and flooring including cement mortar bedding of 25 mm thick in 1:4 proportion, neat cement float, cutting, levelling, jointing, filling the joints by neat cement slurry or approved colour grout, curing, finishing etc. complete as directed by Engineer In Charge.

Lawn

21. Providing and laying of Jodhpur grass tiles over a **prepared** bed surface having sufficient admixtures for 200 mm thk. Cost including watering and maintenance of the lawn for 6 months till the grass forms a thick lawn free from weeds and fit for mowing including (Including weedicides, supply & making of sand if required)

Water Body

22. Excavation of soil for a depth of 2 m and **preparation** of M 10 cement slurry bed for a thickness 200 mm at the bottom layer and random rubble stone pitching for the sloping side walls with all the joints neatly pointed with 1: 5 cement mortar. An RCC plinth beam of size 300 X 300 mm to constructed at the periphery of the pond at ground level with MS railing of 1 m height to fixed over the plinth beam. Cost includes complete finishing and plastering of RCC plinth area with provisions for storm water inlet and outlet.

23. **Excavation** of soil for 3 m wide and 1 me deep and finishing the bottom layer with M 10 cement slurry concrete for a thickness of 150mm and Random rubble stone pitching on both sloping sides with a RCC plinth beam of size 200 mm X 200mm on both periphery of the water channel. The RCC plinth beam to be finished with glazed mosaic tiles.

Wooden Bridges

24. Wooden bridges over the small 4 m wide water channels within the public parks.

Stone benches

25. 1.5 m long polished Stone benches with back rest

26. 1.5 M Long RCC Benches without backrest

Kiosk

27. A decorated Kiosk of 5 x 5 m with 100% stone cladding with seating arrangement. The kiosk will be constructed with brick masonry work with stone cladding and ornamental details with cement mortar. Decorated exposed stone pillars to be used.

Topiary Works

28. Topiary work with single plain colour of size approximately dia 5 m

29. Topiary Work of triple colour Size approximately 3 m dia

30. Topiary Work of triple colour Size approximately 2 m dia

Security Cabin

31. 3M x 3M Security Cabin at the entrance of park

Kids Play

32. A sand pit of area 200 Sqm and 300 mm deep to be created where kids play equipment's like Slide, Seesaw, Rope Climb, Swing, Trampoline, Wall climbing will be erected.

33. preparation of ground surface with murrum soil mixed with necessary admixtures

Lighting

34. providing and fixing and commissioning of 25 watts lights of Crompton or equivalent brand with glass diffuser Bollard poles of height 1 m. Cost include the poles, wiring cost for maximum distance of 5 m / fixture, light fixture and fittings.

35. Providing, fixing and commissioning of Solar Street light including the T% or CFL light fixture 80 watts Philips or equivalent brand and fitting, solar panels, battery for 12 hrs. back up and pole of ht 7m and Civil structure for foundation of the pole including wiring cost. Cost include maintenance of the system for 2 yrs.

Drinking water

36. Public drinking water point with 5 outlets treated with RO technology with a storage capacity of 1 KL / Day
37. Irrigation system including pumps, piping and control valves system for an area of 250 Sqm.

Railing

38. Ms railing 1 m height as per the arch design. 10 Kg / RM

Buildings

39. Class B Buildings for visitors/ shops / small information office, counters. Cost includes CIVIL, Architetural finishes, MEP services with fixtures and fittings.
40. Utility building structures for STP, Pump Room, and UG Tank.

Toilets

41. Toilet block consist of 6 WC seats and 4 urinal. Each block of size of 300 Sft
42. Fountain heads in water bodies, Public squares and plazas
43. Entrance Gate for Parks

8.4 SPECIFICATIONS FOR MASTER PLANNING

Interact (0+1 Month)

- As suggested by the title, this stage will be full of interaction between the Consultant and the Client teams.

- At the start of the project the team will host an inception workshop to;
    - Refine the Approach and Methodology;
    - Agree the dates for Deliverables;
    - Highlight any Data Gaps;
    - Discuss and agree the VISION for the Nala Masterplan;
    - The team will define some of requirements for surveys at this stage.

- After the Inception Workshop the team will closely work with the client in developing a robust design brief for the Amanishah Nala masterplan and Evaluate suitable locations along the fringes of the Nala for Market Analysis. The team will focus on;
    - Land Use Mix required at each location.
    - The team will agree a broad framework of development based on the detailed market research for a) reclaimable land from AN and b) sites adjoining to the AN area.
    - The team will also derive the product mix for each of the nodes identified for both a) and b);
    - The team will look at the site constraints and opportunities and help in identifying the short, medium and long term objectives for the identified sites (Nodes) for a) and b);
    - The team will explore the framework of masterplan, land allocations and a detailed design brief for each of the Nodes.

- Site Visits and Regional Analysis will be integral to this stage, however the analysis will be at a strategic level and would consider the impact zone of 5km radius from the site boundary for;
    - water
    - waste
    - power
    - telecom
    - transport and access

- At the end of this stage the team will submit a report on;

    - Detailed Market Analysis
    - Masterplan Vision

Integrate (0+3 months)

- At this stage the team will work on consolidation of progressive requirement and available areas for development of infrastructure and submit the base information for approval to JDA. The team will focus on the following key tasks at this stage;

    - Collection of infrastructure related data at AN.
    - Analysis and preparation of requirements based on the available infrastructure related data.
    - Where required the team will suggest for further investigation i.e. soil investigation report, hydrological data etc.
    - Consolidation of progressive requirements based on the discussions done at Stage 1.
    - Summary presentation of progressive requirement and available options for the selected location for development of township and related infrastructure.

Innovate (0+5 months)

- The team will understand further the social and cultural aspects related to the site and its vicinity.

- The team will then prepare Concepts and Strategies for the proposed development. The master plan and concept note will be based on the following:

    - Local building regulations and bye laws of town planning/municipality of National Building Code
    - Optimum area utilization
    - Mine expansion strategy
    - Manpower requirements
    - Men and material movement
    - Topographical and Geotechnical aspects
    - Site drainage
    - Site accessibility
    - Power & water distribution network to optimize consumption of natural resources.

- At this stage the team will develop high level Masterplan Concept report for 2-3 options for the proposed solution at selected location. This will include;

    - Preparation of initial layout and facilities for the selected area.
    - Consolidation of available options for development of infrastructure and submit the base information for approval.
    - The team will host a meeting with Client to present the options to the client and once the options are approved the team will generate a report and share with the Client.
    - The team will prepare a broad level business plan for entire for both a) and b) before proceeding for the further stages.

Implement (0+8 months)

- At this stage the consultant will undertake the preparation of a detailed Master plan for Pilot Project (Ideally Section E and F of Amanishah Ka Nala as defined by JDA) on the approved concept plan, which will include but will not be limited to the following:

- Preparation of a layout master plan indicating proposed overall land use and provide details of:

- Area required for each land use type (Residential, commercial, Institutional, recreation/open space, relocated units etc.) as a percentage of total area
- Road network, transportation and vehicular access
- Utility and infrastructure provision – in terms of land parcels
- Social and community facilities
- Urban Design framework, Streetscape and Building massing Plan

- Assessment of infrastructure requirement and trunk infrastructure lay out of the following:

  - Water supply
  - Sewerage
  - Power supply
  - Telecom
  - Solid waste management
  - Preparation of development control guidelines and regulation for Township as well as for the plot level.
  - The master plan, will be discussed with the Client, and upon approval by the client, consultant will proceed for Landscape Master Plan. The consultant will prepare landscape and horticulture plan for the identified land along the Nala, along with detailed drawings/specifications and BOQ.

- The Consultant will prepare Phasing Plan for the Nala, to indicate for various project components, physical and social infrastructure etc. the year of development, which will be in concurrence to the phasing plan already prepared for JDA

CHAPTER 9: DELIVERABLES

Deliverables of the project are as listed below:

1. Construction of Amanishah Water Front, extent of which has been described in earlier chapters in the document into a defined concrete channel with following details:
    a. shall carry 100 year flood discharge of the catchment area
    b. shall have a perennial water depth upto 1 m maximum of water depth
    c. shall be around the limits of the boundaries mandated by Hon'ble High Court of Rajasthan
    d. The bed and the sides shall be able to withstand velocities and discharge of 100 year flood event for erosion in all cases.
    e. Shall free up valuable land parcels in and around present Amanishah flood plane area
    f. Shall have appropriate connection and movement options for at least cycles and walking between two ends such that no one should move than 500 m distance at a time.
    g. Shall have appropriate arrangements for crossing of utilities pipes and cables between two ends.
    h. Shall have sufficient energy dissipation arrangements all along the length of the Nallah to take care of high energy of 100 year flood event.
    i. Shall have appropriate measures to protect the Nallah bed and sides for high flow conditions during 100 year flood events
    j. Shall have sufficient measures for aeration during non rainy seasons to aerate the water in the water body to take care of accidental inflow or BOD's of the treated waste water proposed to be discharged into the Nallah during the year.
    k. Shall have appropriate arrangements to arrest sediments and other waste material from the incoming streams to protect main water front stream.

l. Upstream catchment improvement shall be carried out to improve the rain water inflow into the Amanishah Nallah and increasing the rain water recharging of the area.
m. Necessary civil works to bring additional rainwater streams into the upper reaches of the Nallah shall be carried out wherever required and possible.
n. Necessary arrangements for accessibility of trucks and other cleaning vehicles to the bottom and any other part of the Amanishah Nallh shall be done as part of this development.

2. A water front for the proposed defined Amanishah Nallah with following features:
   a. Shall have a clear public space of at least 3 m wide movement and 1 m wide sitting space
   b. Shall have mass sitting/functional space for mass gathering on both side of the water front
   c. Shall be safe protected by railings along the water front and for all structures for crossing of the water front.
   d. Shall have at least 2 m wide tree plantation landscape bank
   e. Shall have access control all along the length of the Nallah
   f. Shall use high aesthetic quality material as per the culture of the region and suitable for public gathering, cleanliness, abrasive strength and matches with the city culture.
   g. The whole water front shall be well lit all along the Nallah length as per the standards of lux level in public areas
   h. Ornamental bollard light shall be used on the edge of the water front.
   i. Shall have arrangements for surveillance for 24X7 with CCTV camera of appropriate resolutions , covering all proposed area along the length of the Nallah with all necessary power back system and cablings.
   j. All CCTV feed shall be directed to control room situated appropriately on or very near to Nallah and connected to relevant police station through appropriate connectivity.
   k. At least one month feed storage capacity shall be provided for the CCTV feed.

l. Appropriate software and connectivity system with integrated solutions shall be provided for surveillance and security aspects.
m. Shall have appropriate connection and movement options for at least cycles and walking between two ends such that no one should move than 500 m distance at a time.
n. Shall have appropriate arrangements for crossing of utilities pipes and cables between two ends.
o. Appropriate arrangements for collection of solid waster and its disposal shall be made
p. The development shall be compliant to the accessibility guidelines for the disabled.
q. All along the Nallah a parallel road (wherever possible) shall be constructed for public use (minimum width of 5.5 m) along with pedestrian footpath of 3 m.
r. All proposed road and food path, common area, public areas shall have LED street lights for appropriate lux level of public area uses.
s. At least 50% of the street lights shall be powered by solar power of sufficient capacity.
t. All buildings shall be designed as green buildings with due certification of highest category.

3. Municipal Wastewater treatment arrangements as per following details:
   a. Shall be sufficient to take care of all untreated municipal wastewater currently discharged into the Amanishah Nallah.
   b. Shall be able to treat municipal wastewater which can be put to use into the proposed water front without any adverse impacts on health, hygiene, environment, aesthetic and smell of the area
   c. The system shall be designed to intercept and collect the current municipal wastewater streams of the area which are discharging into the Amanishah Nallah.
   d. The treatment plan shall cover least possible area so as to keep valuable land free for other purposes.

e. The treatment plant shall be high on sustainability quotient with low maintenance cost and low on carbon footprint
f. The treatment plan shall be designed such that it shall merge with surrounding landscape.
g. The treatment plant shall be free of any bad odour of sewage and keep its surroundings free from any such smell.
h. The treatment plant shall be robust and shall be able to take care of seasonal variations of the inflow

4. Accessory and enabling works
   a. Shall provide a robust business plan along with Master Plan of the proposed reclaimed government land in and around the Amanishah Nala, including landscape plan for the same.
   b. As a part of the present development, at least two land parcels of not smaller than 25,000 sq m each are to be developed which can be merged/connected with the current water front development project loped and fits into the proposed Master Plan of the area.
   c. Shall provide following buildings as part of the development
      i. Emergency Response Center
      ii. Security Gate
      iii. Security Room
      iv. Office space for maintenance and operation staff
      v. Storage yards for equipment
   d. Appropriate maintenance equipment like dredger for hycynth and sediment clearance Amphibious Tool Carriers, Dredger, Weed harvester etc.
   e. Arrangements for proper measurements and monitoring are required to be done which should include measurement of all water and energy consumption segments, hydro-meteorological parameters measurement instruments and for collecting other weather details like solar radiation level, wind velocity, direction, temperature, humidity etc.
   f. All intersections points of approaching roads to Amanishah Nallah need to be developed for traffic management and as center point of activities.

g. Necessary arrangements for vendors and parking at intersection points shall be done.

h. Sufficient arrangements for vendors and other necessary commercial centres along the Nallah in public spaces shall be done to take care of the visitors' routine requirements.

i. Sufficient number of public toilets and toilets shall be done.

j. Sufficient arrangement for toilets shall be done to take care of current needs of the slums or other colonies who are currently using Amanishah Nallah for open defecation and can use these toilets after development of Amanishah Nallah water front.

CHAPTER 10: PROJECT COST ESTIMATE

The Budgetary cost estimates for the project are mentioned below.

Quantity Abstract for Amanishah Nallah Project					
Sl no	**Description**	**Unit**	**Quantities**	**Unit Cost**	**Value**
	SITE CLEARANCE				
1	Cutting & Clearance of Jungle	Sqm	1587456	19	30,161,664
2	Uprooting of trees	Each	2001	1200	2,401,200
3	Removal of Debris in Nallah	Sqm	3017625	48	144,846,000
4	Silt Clearance Under Water & Mud	Cum	301763	12	3,621,156
	TOTAL				181,030,020
	Landscaping				
5	Trees/ Hrubs	Each	12126	928	11,252,928
6	Planting Of Shrubs	RM	47320	385	18,218,200
7	Lawn	SQm	299278	220	65,841,160
8	Developement & Landscaping	SQm	65000	2400	156,000,000
	TOTAL				251,312,288
	EARTHWORK IN EMBANKMENT				
9	Earthwork excavation	Cum	8101370	91	737,224,670
10	Re-handling of earth from a distance of 10KM and compaction	Cum	1799450	100	179,945,000
11	Dewatering in Nalla / Dams	LS	1	400000000	400,000,000
12	Spreading and Compaction of Nallah Works and Reclaimed Land	Cum	6301920	42	264,680,640
13	Lead upto 5 Kms	Cum	252252	72	18,162,144
14	Lead upto 20 Kms	Cum	3725124	140	521,517,360
15	Lip cutting & Dressing	Sqm	650988	24	15,623,712
16	RR Stone Pitching 230 mm thick	Cum	436404	2023	882,845,292
17	Diversion of Nallah	Kms	61	2000000	122,000,000
18	Out fall structure for Storm water Drainage	Nos	79	3631618	286,897,822
19	Outfall Structure for ganda Nalla Including Sump Well	Nos	1	83750000	83,750,000
	TOTAL				3,512,646,640
	CANAL LINING AT BED AND SLOPES				
20	Preparation of surfaces	sqm	1470100	20	29,402,000
21	Providing & laying 100 mm thick	sqm			

	M-10				
22	Providing & laying 200 mm thick M-25	Sqm	1470100	1200	1,764,120,000
23	Charges for water spray by nozzle	Sqm	1470100	7	10,290,700
24	Groove Cutting With Bitumen Sealant	RMT	284276	98	27,859,048
	TOTAL				1,831,671,748
	FALL STRUCTURES /CHECK DAM				
25	Excavation	Cum	7890	112	883,680
26	RR Masonry in Cm 1:3	Cum	5672	3387	19,211,064
27	CC 1:4:8	cUM	4521	4617	20,873,457
28	Chain Link Fencing & MS Gates	Sqm	84500	817	69,036,500
29	MS Gates	Nos	55	63908	3,514,940
30	M - 15 Grade Concrete	Cum	93675	5348	500,973,900
31	Reinforcement	MT	271	60331	16,349,701
	TOTAL				630,843,242
	PEDESTRAIN PATHWAYS				
32	Compacting the subgrade	Sqm	330720	18	5,952,960
33	Placing & Fixing the Karuli Stones	Sqm	299260	1200	359,112,000
					365,064,960
	ROAD				
34	Granular sub Base	Cum	27456	1450	39,811,200
35	Tack coat	Sqm	91520	84	7,687,680
36	Bituminious concrete	Cum	1830	11460	20,971,800
37	Painting Line Road marking	sqm	45760	300	13,728,000
					82,198,680
	MASONRY WORK & PITCHING				
38	Earthwork excavation	Cum	55120	111	6,118,320
39	RR Stone masonry in CM 1:6	Cum	137279	3387	464,963,973
40	Plastering 1: 4 , 25 mm thick	Sqm	190550	255	48,590,250
41	Railing	RMT	38064	1380	52,528,320
42	Coping (1:2:4) 50 mm thick	Sqm	55120	231	12,732,720
43	Masonry work with Jodhpur Pink Stone	SQm	193050	1097	211,775,850
44	PCC 1:4:8	Cum	23541	4617	108,688,797
45	R.R Stone .Masonry with CM 1 : 6 for sitting area	Cum	71280	3387	241,425,360
					1,146,823,590
	MISCELLANEOUS				

46	GI PIPING	Rmt	5200	422	2,194,400
47	Garden benches	Nos	1352	15000	20,280,000
48	Toilet Blocks	Nos	45	1020000	45,900,000
49	Drinking Water facilities	Nos	68	10200	693,600
50	CC Road for maintenance of Nallah	Cum	4655	1518	7,066,290
51	Security cabin	SQm	260	18000	4,680,000
52	Parking + Vendor Space	SQm	19500	1800	35,100,000
53	Office Space	Sqm	1300	18000	23,400,000
54	Storage yard	Sqm	9230	10800	99,684,000
55	Dust Bins	Nos	1014	3600	3,650,400
56	Organic Waste Convertor With Shed	Nos	4	5477250	21,909,000
57	Sediment Basin	Cum	88898	600	53,338,800
58	Penstock Pipe	M	61	3540	215,940
59	Weir Arrangement	Cum	306	11493	3,516,858
60	Atmospheric temperature	Nos	1	16750000	16,750,000
61	Amphibious Tools carrier /Wedges/ Aeration	Nos	2	46900000	93,800,000
62	Area Improvement works for reach 1 ---- 5 Kms	LS	1	201000000	201,000,000
63	Uprooting of Water Hyacinth	LS	1	16750000	16,750,000
64	Development of junctions	Nos	50	837500	41,875,000
65	Detailed Master Plan	LS	1	25125000	25,125,000
					716,929,288
	OTHER MAJOR ITEMS				
66	Manhole chambers & covers	Nos	5030	25242	126,967,260
67	Demolition of Existing Structures	Cum	57750	2200	127,050,000
68	Collection Sumps	Nos	100	125625	12,562,500
					266,579,760
	PIPING				
69	700 mm dia NP3 RCC Hume Pipe	m	79400	5700	452,580,000
70	250 mm dia NP3 RCC Hume Pipe	m	71500	2200	157,300,000
71	150 mm dia NP3 RCC Hume Pipe	m	13	1223	15,899
72	Water diversion main pipe: Pipe-buried project				-
73	800 mm dia Corrugated HDPE Pipe	m	14000	21308	298,312,000
					908,207,899
	STP				
74	170 MLD STP	Nos	1	3587000000	3,587,000,000

	STP's TOTAL				3,587,000,000
	Electrical				
75	Submersible pumps	LS	91	36199992	36,199,992
76	Solar Street LED Lighting system along with associated Poles	LS	1733	217008464	217,008,464
77	Street LED Lighting system along with associated Poles	LS	1733	133171968	133,171,968
78	Feeder Pillars along with associated cables and accessories	LS	24	9681718	9,681,718
79	Bollard light fixtures	LS	5200	98809724	98,809,724
80	Cables and accessories	LS	1	27136196	27,136,196
81	Earthing & Miscellaneous electrical works	LS	1	20485123	20,485,123
82	CCTV Cameras along with control systems	LS	226	207443620	207,443,620
83	Provision of dedicated Power supply from 33kV to STPs (11 nos.)				
83.1	By Tr Line option - 5 KMs distance	LS	6	28583228	171,499,370
83.2	By HT cable option - 3 KMs distance	LS	5	32982625	164,913,125
83.3	For providing electrical supply for street lighting through underground cable	LS	1	63000000	63,000,000
	Electrical TOTAL				1,149,349,300
84	Additional Items				
84.1	Providing gated spillway structure at Mazar dam	LS	1	10000000	10,000,000
84.2	Provision for restoration of existing capital structures	LS	1	150000000	150,000,000
	Additional Items Total				160,000,000
	TOTAL				14,789,657,415
85	OPERATION & MAINTENANCE				
	Operation & Maintenance for 10 Years	LS	1	4580489479	4,580,489,479
	Power supply for Operation & Maintenance for 10 Years	LS	1	3203612611	3,203,612,611
	O&M TOTAL 10 Years				7,784,102,090
COST ABSTRACT for AMANISHAH KA NALLAH					
1	PROJECT COST				22,573,759,505
2	SERVICE TAX, LABOUR CESS AND OTHER STATUTORY TAXES				1,122,141,585
3	PROVISION FOR UNFORSEEN ITEMS (@ 2 % of Project Cost)				451,475,190
	TOTAL PROJECT COST				**24,147,376,280**

COST ABSTRACT for AMANISHAH KA NALLAH With NPV of O&M Costs		
A	**Project Capital Cost**	14,789,657,415
	SERVICE TAX, LABOUR CESS AND OTHER STATUTORY TAXES	735,193,870
	PROVISION FOR UNFORSEEN ITEMS (@ 2 % of Project Cost)	295,793,148
	TOTAL PROJECT CAPITAL COST	**15,820,644,433**
B	***Net Present Value(NPV) of Operations and Maintenance cost**	4,436,217,406
	NPV of SERVICE TAX, LABOUR CESS AND OTHER STATUTORY TAXES	220,524,367
	NPV of PROVISION FOR UNFORSEEN ITEMS (@ 2 % of O&M Costs)	88,724,348
	***Total Net Present Value of Operations and Maintenance cost**	**4,745,466,121**
C	***Total Project Cost with NPV of O&M Costs**	**20,566,110,554**

*The O&M cost during the O&M term will be Rs. 778 Crores (Excluding taxes and provision for unforeseen items). O&M cost is worked out based on NPV considering a discount rate of 10% with base year as 2018. The year on year O&M costs and NPV of the same during the O&M term of 10 years is provided in Annexure 2 of Chapter 11 of this DPR.

CHAPTER 11: ECONOMIC BENEFIT ASSESSMENT (EBA)

11.1 INTRODUCTION

1. Amanishah Nallah, once restored to its pristine form through its rejuvenation, will not only help restore the physical health of the city residents, will also help in a healthy economic development along its banks. The benefits will be two fold as under:
   a) First, the rejuvenation works will result in reclamation of valuable land which is, otherwise, lying fallow or being misused currently. Such reclaimed land can be put to socially and economically better use through its planned development based on the philosophy of Utalitarianism, i.e., maximum benefit to the denizens of the city.
   b) Second, the land parcels, though not physically connected to the Nallah, but being under its profound influence, will experience a sharp enhancement in value. Development of the Nallah will directly impact the physical, economic and social health of the entire city in general and a two kilometer wide corridor, with the river in the middle, in particular. This corridor will evolve with a one kilometer wide belt on either bank of the water body being directly affected positively by its development. With a cleaner environment and a planned development along the river, the economic value of land parcels in this area of influence of the river, will get an immense boost. The value enhancement of such parcels can be leveraged by the State to ensure a favorable return on investment on the project which can be further invested into causes of social benefit, like Affordable Housing.
2. Amanishah Nallah, along with its corridor of influence, once developed, will cause the city to gravitate towards itself, with a welcoming environment of health parks, clean residential areas for all sections of the society, active institutional areas and bustling commercial zones. This potential of the River needs to be unlocked and tapped.

3. A major advantage of tapping of the potential of the River will be in terms of meeting the cost of implementing this project. Towards this, an exercise was carried out to ascertain the economic potential of the River corridor.

11.2 ECONOMIC ASSESSMENT EXERCISE

4. The scope of the exercise is as under:
   a) Identify undeveloped land parcels owned by the State Govt. and its agencies, in and along the Nallah bed, which can be reclaimed through Nallah works and assess their economic value.
   b) Identify undeveloped land parcels owned by the State Govt. and its agencies, in vicinity of the Nallah, upto a radial distance of 500 meters from the Nallah banks, which will stand to benefit in terms of enhanced economic value, through Nallah works.

5 It may be noted that the scope of the exercise as spelt out at Para 1. b) above, limits the land parcel value assessment upto a distance of 500 meters from either bank of the Nallah. This is in view of the fact that, while the value enhancement of land parcels in the immediate vicinity of the Nallah will be tangible in terms of the increase in their land cost, the land parcels further away, but within one kilometer distance from the Nallah will enjoy indirect economic and social benefits which may become quantifiable at a later stage, once the development has taken effect.

6 **Methodology**: For the purpose of this EBA, the Amanishah Nallah, which flows along a 47 Km long course, has been divided into six reaches, as under:
   a) Reach A: Mazar dam to Sikar Road Bridge.
   b) Reach B: Sikar Road Bridge to Sushilpura Pulia (Ajmer Road).
   c) Reach C: Sushilpura Pulia (Ajmer Road) to B2 Bypass Road Bridge (Near Shipra Path and Manasarovar).
   d) Reach D: B2 By-pass Road Bridge to Sanga Setu.
   e) Reach E: Sanga Setu to Bambala Bridge.
   f) Reach F: Downstream from Bambala Bridge to Goner.

7 The above reaches correspond to the administrative zones of JDA. Also, each 'reach', by the virtue of its location, offers distinct economic and social development scope.

8 **Govt. Owned Land Parcel Identification Process**: Land identification was undertaken in a three step process, as under:

a. **Step 1**: Identification of open (undeveloped) land parcels, in and along the Nallah alignment, from Mazar Dam to Goner Village, from Google Maps. The satellite imagery was of April 2015 and hence, reasonably recent.

b. **Step 2**: Verify the ownership of the parcels identified in Step 1, using the land record data shared by the Engineering Division of JDA and by making use of the on-line data of govt. revenue records (Apna Khata). Noted the parcels owned by the State Govt. and its agencies.

c. **Step 3**: Physical verification of govt. land identified in Step 2, by site visits. During the site visits, information was also collected from locals, wherever available for confirmation.

9 **Land Evaluation Basis**: The two different categories of land parcels, viz., Reclaimed land and land parcels which solely benefited from value appreciation consequent upon the Nallah works, were assessed on the following basis:

a. **Evaluation of Reclaimed land**: To arrive at the value of each parcel, the cost of the Land parcels (government land) has been taken on a conservative basis, approximately close to the 'reserve price'. The rate of reclaimed land in all the reaches, irrespective of their locational characteristics, has been uniformly considered at Rs. 20,000/- per sq. mtr.

b. **Value Appreciation of other Parcels**: For other adjoining land parcels (government) which are not directly connected with channelization of Nallah, the average appreciation of 20% over a fixed price of Rs.

20,000/- per sq. mtr., has been considered. This translates into an amount of Rs. 4,000/- per sq. mtr. as the appreciated value.

10 In the same way, land prices of private land owners is also expected to appreciate but the same has not been accounted.

11.3 FINDINGS AND ANALYSIS:

11 The exercise resulted in the identification of a number of land parcels owned by various government agencies. The details are as under:

a) Apart from JDA, the other govt. agencies who own the identified land parcels are RHB, RIICO, PHED and Irrigation Dept. Details of lands, Khasrawise, of all parcels to be reclaimed or which benefit from value appreciation, are furnished in **Annexure-1**.

b) The total land which will be reclaimed through Nallah works is approximately 85.6 Ha., with an approximate value of Rs. 1712 Cr.

c) The total land that will benefit from value appreciation due to Nallah works is approximately 53 Ha., with an approximate value of Rs. 212 Cr.

d) Most of the land reclamation will happen in reaches A, B, E and F. Largest beneficiary of land reclamation will be JDA, followed by RIICO.

e) Most of the value enhancement of land parcels will happen in reaches C and D. Largest beneficiary of land value enhancement will be RIICO, followed by RHB and JDA.

12 Agency-wise details of benefits that will accrue to each, on execution of this project, are as under:

No.	Agency	Land Reclamation			Land Value Enhancement			Total
		Area (Ha.)	Average Reserve Price (Rs. / Sqm)	Value of Land Reclaimed (Rs. In Cr.)	Area (Ha.)	20% of Rs. 20000	Value (Rs. In Cr.)	
1	JDA	65.35*	20000	1307.1	9.16	4000	36.64	1343.74
2	RHB	4.25	20000	85	14.73	4000	58.92	143.92
3	RIICO	10.78	20000	215.6	29.2	4000	116.8	332.4
4	PHED	4.74*	20000	94.8	0	4000	0	94.8
5	Irrigation	0.5	20000	10	0	4000	0	10
	Total	**85.62**		**1712.5**	**53.09**		**212.36**	**1924.86**

*** Net of area deducted for Services (STP, Landscaping & Public Parks and Amenities)**

13. A brief, Reach wise, analysis is as under:

a) **Reach A**: This reach is along a 3 Km stretch of the Nallah and has only one suitable open parcel of land owned by JDA of which 3.2 Ha. can be reclaimed through Nallah works. Located towards the northern end of the city this parcel is hedged between a Private colony, Vidyadhar Nagar and Forest dept. land and currently has only one access from the Private Colony (refer Fig. 10 - 1). This parcel is proposed for Affordable Housing.

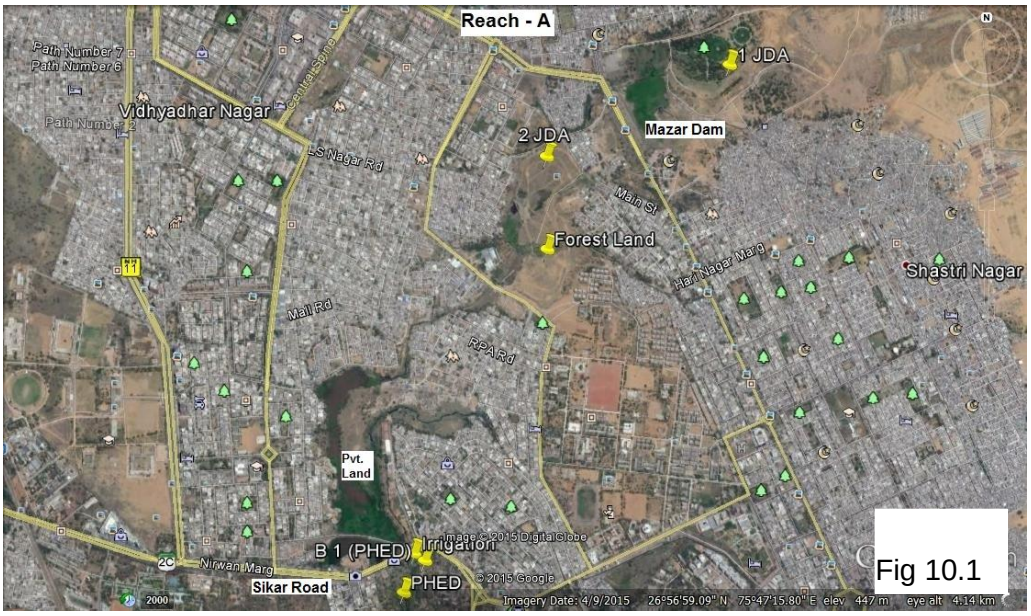


Fig 10.1

b) **Reach B**: This reach is along a six kilometer stretch of the Nallah, North West of the city (Fig – 10-2). Only one suitable land parcel of PHED is available in this reach, at its beginning. The Nallah mostly flows through military area or through densely populated private colonies. Sikar road being in vicinity, connectivity is good.

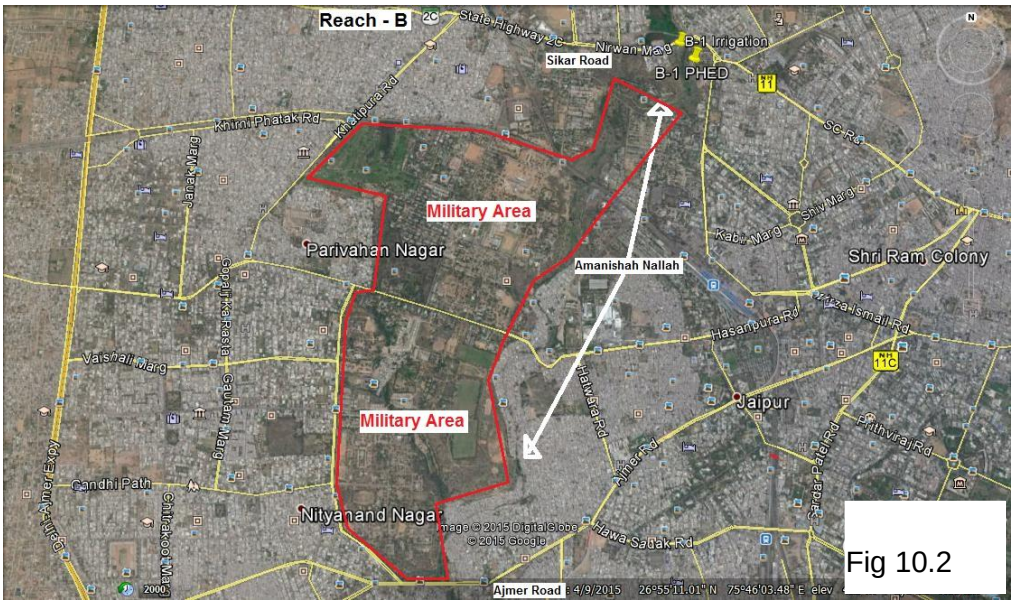


Fig 10.2

c) **Reach C**: Stretching from Ajmer Road (Sushilpura Pulia) to B-2 Bypass, this stretch passes through prime city area (Fig. 10-3). In this stretch, govt. land availability in and adjacent to the Nallah is very limited with only one parcel hugging the Nallah. Most of the govt. land parcels, though, benefit from value appreciation. All the parcels are located downstream from Gopalpura Bypass Bridge and are sandwiched between the Nallah to the East and Shipra Path to the West.

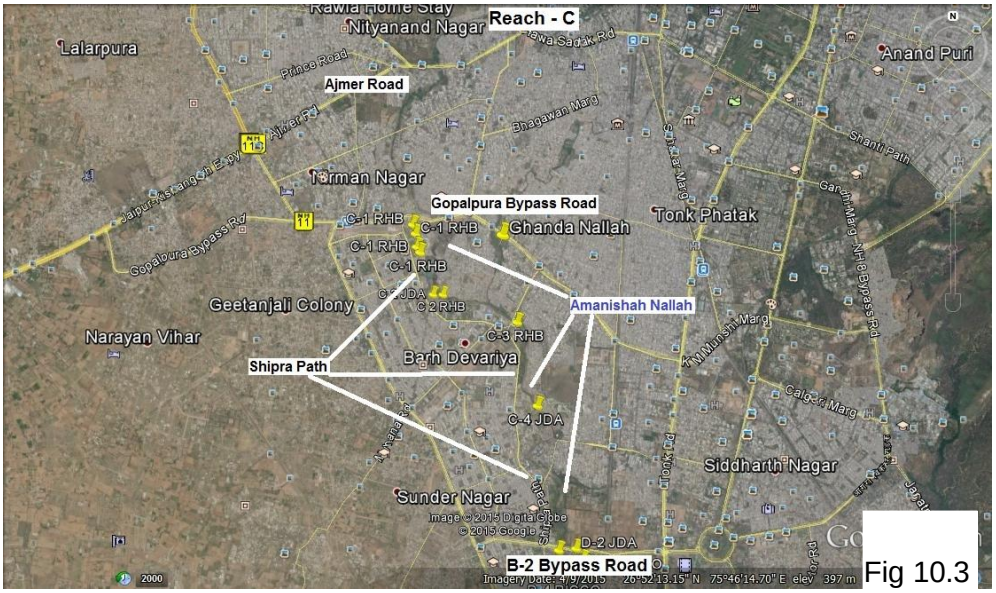


Fig 10.3

d) **Reach D**: From B-2 Bypass to Sanga Setu, this reach is approximately three Km in length and passes through well connected areas of the city (Fig. 10-4). This reach too is similar to Reach C, in that, most of the land parcels benefit from value appreciation. There is a large chunk of RIICO land, hugging the Nallah in mid reach. Most of the land parcels in this reach belong to RIICO and RHB.

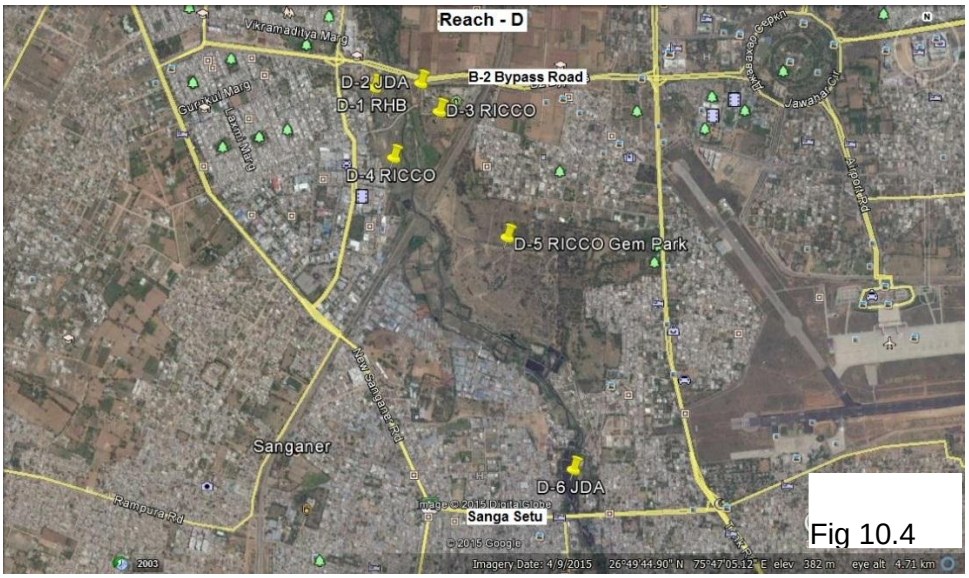


Fig 10.4

e) **Reach E**: This reach is due South from the city-center and stretches over 4 Km., from Sanga Setu to Bambala Bridge (Fig. 10-5). This reach will benefit from large parcels of reclaimed and is recommended for Mixed Use.

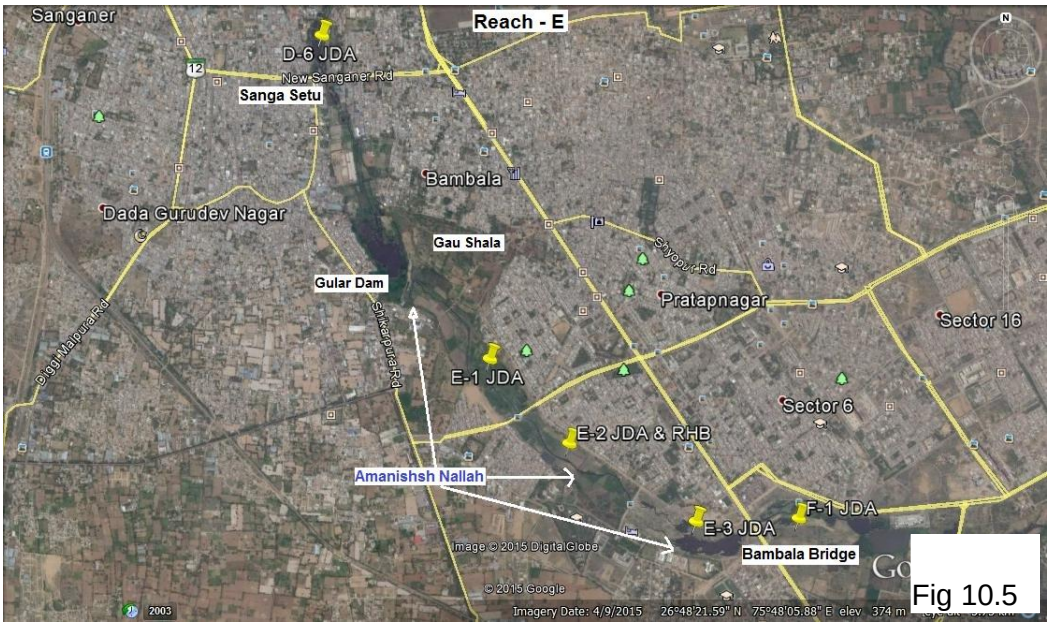


Fig 10.5

f) **Reach F**: South and South-East of the City, this reach stretches upto the Nallah's confluence with Dhund River (Fig 10-6). The Nallah, in this reach primarily traverses through Sitapura and Ramchandrapura industrial and institutional belt. Vast stretches of JDA land parcels will benefit from

reclamation in this stretch with some RIICO and RHB parcels benefitting from value appreciation too. Large-scale planned development will be made possible due to the Nallah works.



Fig 10.6

D Project Financing

14. The economic gain to the govt. consequent upon the execution of this project itself, is estimated to be of an order that will completely cover the total cost of the project. The total cost of the project is estimated at Rs. 1928 Cr. (approx.) and the revenue which will get generated through land reclamation and land value appreciation, even by a very conservative assessment as covered at Para 9, will cover a large part of project cost.

15 Based on the two categories of the land parcel benefits that accrue to the various govt. agencies, two options emerge for land utilization and revenue generation, as under:

a) Option 1: Land reclaimed from all departments is transferred to JDA and the amount realized through sale by JDA is utilized as capital for the project.
b) Option 2: JDA would sell its reclaimed land and other departments would contribute equivalent amount of the notional appreciated

value of lands in their possession. In this case, the other departments would retain their reclaimed lands. This sum total would form the capital to be utilized for construction.

16. Due to the administrative complexities involved in inter govt. agency transfer of land, as required in Option 1, Option 2 has been adopted for the Revenue-Expenditure model. This model too will generate a revenue of over Rs. 1500 Cr., thus covering a major portion of the project cost. Project completion period is estimated at 4 years, commencing from the award of work. Phasing of the expenditure has been made and details are furnished at **Annexure-2**.

	Detail of Govt. Land Parcels Identified Along Amanishah Nallah											
Nala Reach / JDA Zone	Parcel No.	Village	Khasra No.	Ownership	Area as per Revenue Records (Apna Khata)		Area as Measured from Google Earth	Length of Nala in Parcel	Area Required for Nala Works (Sq Mtrs.)	Area Available (Sq Mtr)	Recommended Use	Remarks
					Hec.	Bigha-Biswa	Total Area (Sq Mtrs)					
Reach A / Zone 2	A-1	Kishanbag	19/128	JDA		2-10	15000	Nil	Nil	15000	STP - 1 Ha.	Next to Sanjay Nagar Kacchi Basti
Mazar Dam to Sikar Road Bridge			22/129	JDA		2-10						
	A-2	Kishanbag	50	JDA		24-12	40300	210	8400	31900	Affordable Housing	East of Sector-4, Vidydhar Nagar.
									Total Area Available	46900		
Reach B / Zone 7	B 1	Bassi Sitarampura	43	Irrigation Dept.		2-19	85000	500	20000	65000	Group Housing - 3.5 Hec	Immediately downstream of Sikar Road
Sikar Road Bridge to Sushilpura Pulia (Ajmer Road)			167	PHED		15-12					STP in 1 Hec.	
			166	PHED		10-02					Landscaping in 1 Hec.	
			169	PHED		0-10					Convention Centre - 1 Hec.	
			176	PHED		6-16						
			177	PHED		2-15						
			179	PHED		3-01						
			180	PHED		0-09						
				Total		42-04						
									Total Area Available	65000		
Reach C / Zone 5	C 1	Sukhialpura	63	RHB	2.5		52000	Nil	Nil	52000	Commercial including Mall and Cinemahall - 2 Hec.	Near Gopalpura Bypass road and Shipra Path Junction.
Sushilpura Pulia to B-2 Bypass Road Bridge			110/122	RHB	1						Group Housing - 3.2 Hec.	
			110 (Approx)	RHB	2							
				Total	5.5							

	C 2	Sukhlalpura	40% of 94	JDA	0.20 (40% of 0.55)		1050	Nil	Nil	1050	Commercial (5 Star Hotel)	Shanti Nagar Road Shipra Path Road Junctio. Only 50% of Khasra area available
			96	RHB	0.92		6000	Nil	Nil	6000	Group Housing	
	C 3	Devari	15% of 440	RHB	1.1 (15% of 7.9)		9375	Nil	Nil	9375	Public Swimming Pool Complex	Near Shipra Path - Riddhi Siddhi Bridge Road Junction.
	C 4	Devari	544	JDA	2.6		26100	Nil	Nil	26100	STP - 2.6 Hec.	East of Mansarovar Sector 9
									Total Area Available	94525		
Reach D / Zone 4	D-1	Jhalana Chod	Approx. 25% of 270	RHB	2.05 (25% of 8.21)		19950	Nil	Nil	19950	1.5 Hec. Commercial, Facing B-2 Bypass; 0.5 Hec. Group Housing	Next to Aggarwal Farm, South of B-2 Bypass Bridge
B-2 Bypass Road Bridge to Sanga Setu	D-2	Jhalana Chod	251	JDA	0.5		4500	Nil	Nil	4500	Commercial - Hotel	Next to Fun Kingdom, B-2 Bypass Road
	D-3	Jhalana Chod	Approx 50% of 207	RICCO	0.25		20000	Nil	Nil	20000	Affordable Housing. Poor connectivity.	Next to Fun Kingdom, B-2 Bypass Road
			Approx. 40% of 208	RICCO	0.2							
			209	RICCO	0.26							
			210	RICCO	0.17							
			212	RICCO	0.26							
			213	RICCO	0.17							
			214	RICCO	0.36							
			215	RICCO	0.12							
			216	RICCO	0.05							
			317	RICCO	0.73							
				Total	2.57							
	D-4	Jhalna Chod	15% of 304	RICCO	1.09		21000	Nil	Nil	21000	Institutional Use	Near RICCO Indl. Area, Mansarover Sector 2.
			268	JDA	0.33							
			305	JDA	0.71							
			306	JDA	0.09							
			307	JDA	0.65							
				Total	2.87							
	D-5	Jhalana Chod	350	RICCO	0.73		380000	1200	84000	296000	Premium Housing Township & Commercial	West of Sitabadi and South of Surya Nagar.

			352	RICCO	1.8							RICCO Gem Stone Park.
			353	RICCO	0.15							
			354	RICCO	0.2							
			355	RICCO	2							
			357	RICCO	0.81							
			358	RICCO	0.14							
			359	RICCO	0.8							
			366	RICCO	0.71							
			367	RICCO	0.12							
			368	RICCO	0.12							
			369	RICCO	0.48							
			370	RICCO	0.12							
			371	RICCO	1							
			360	JDA	0.25							
			365	JDA	0.48							
		Dhoi Ka Bad	1	RICCO	0.43							
			2	RICCO	0.34							
			3	RICCO	0.12							
			5	RICCO	0.21							
			7	RICCO	1.2							
			9	RICCO	0.13							
			10	RICCO	0.6							
			12	RICCO	1.81							
			27	RICCO	2.1							
			29	RICCO	1.24							
			30	RICCO	0.7							
			31	RICCO	0.11							
			33	RICCO	0.12							
			35	RICCO	0.86							
			37	RICCO	0.94							
			38	RICCO	0.12							
			39	RICCO	0.7							
			41	RICCO	0.5							
			42	RICCO	0.94							
			44	RICCO	0.89							
			44/103	RICCO	0.11							
			45	RICCO	1.99							
			45/102	RICCO	0.13							
			46	RICCO	1.07							
			48	RICCO	1.46							
			49/106	RICCO	0.7							
			59	RICCO	0.91							
			78	RICCO	0.52							
			79	RICCO	0.24							
			80	RICCO	0.16							
			82	RICCO	0.62							

			83	RICCO	0.26							
			84	RICCO	0.27							
			86	RICCO	1.45							
			57	JDA	0.24							
			58	JDA	0.13							
			60	JDA	0.31							
			61	JDA	0.15							
			62	JDA	0.44							
			63	JDA	0.23							
			64	JDA	0.53							
			65	JDA	0.31							
			66	JDA	0.38							
			67	JDA	0.06							
			71	JDA	0.3							
			72	JDA	0.38							
			73	JDA	0.24							
			74	JDA	0.19							
			75	JDA	0.15							
			76	JDA	0.05							
			77	JDA	0.2							
			91	JDA	0.11							
			92	JDA	1							
			93	JDA	0.14							
			94	JDA	0.03							
			95	JDA	0.07							
			96	JDA	0.05							
				Total	39.55							
	D-6	Sanganer	50% of 3612	JDA	1		11550	Nil	Nil	11550	STP	Upstream of Sanga Setu.
			3644	JDA	0.26							Area currently water logged due to ponding.
				Total	1.26							
									Total Area Available	373000		
Reach E / Zone 8	E-1	Bhambala	655	JDA	1.56		90000	365	29200	60800	STP - 1 Hec.	Between Gaushala and Shikarpura Road Bridge
Sanga Setu to Bambala Bridge (Tonk Road)			656	JDA	4.22						Affordable Housing - 1 Hec.	
			657	JDA	0.55						Landscaping - 1 Hec.	
			658	JDA	0.21						Group Housing - 3 Hec.	
			659/1133	JDA	0.45							
			20% of 654	RHB	1 (20% of 4.96)							
				Total	7.99							
	E-2	Bhambala	80% of 654	RHB	3.96		140000	840	67200	72800	City Convention Centre - 1 Hec.	Downstream of Shikarpura Road Bridge
			653	RHB	1.26						Theme Park - 1 Hec.	
			667	JDA	0.4						Group Housing - 3 Hec.	
			697/1129	RHB	1.35						Indoor Sports Complex - 1 Hec.	
			761	JDA	3.71						Institutional Area (School / Vocational) - 1 Hec.	
			760	JDA	3.6						Pvt. Medical Centre - 1 Hec.	
				Total	14.28							
	E-3	Bhambala	759	JDA	3.76		136800	815	65200	71600	STP - 0.9 Hec.	Immediately upstream of Bambala Bridge
			758	JDA	3.11						Landscape - 1 Hec.	
			757	JDA	2.66						Commercial (5 Star Hotel - 1Hec.	
		Shyopur	1118	JDA	1.55						Commercial (Mall - 1 Hec.	
			1119	JDA	6.6						City Club (Social) - 1 Hec.	
				Total	17.68						Group Housing - 3 Hec.	
									Total Area Available	205200		
Reach F / Zone 9	F-1	Sheopur	1518	JDA	4.8		86100	410	32800	53300		Immediately downstream of Bambala Bridge
Bambala Bridge to Goner			1520	RHB	0.85							
			Not Known	JDA	3 (Approx)							Down stream of Khasra No. 1518
				Total	8.65							
	F-2	Dahlawas	345	JDA	1.78		60000	Nil	Nil	60000		Near Narayana Hrudayalaya
			347	JDA	0.49							
			348	JDA	0.14							
			349	JDA	0.11							
			350	JDA	0.06							
			351	JDA	1.64							
			352	JDA	1.06							
				Total	5.28							

F-3	Dahlawas	354	JDA	14.09		210000	1500	120000	90000		Nala bed in the area of Dehlawas STP
		414	JDA	5.92							
		417	JDA	0.31							
			Total	20.32							
F-4	Dahlawas	655	RHB	0.32		60000	Nil	Nil	60000		Immediately East of Dehlawas STP
		656	RHB	0.18							
		657	RHB	0.56							
		658	RHB	0.33							
		635	RHB	0.34							
		634	RHB	0.18							
		633	RHB	0.17							
		624	RHB	0.16							
		623	RHB	0.14							
		625	RHB	0.13							
		626	RHB	0.1							
		627	RHB	0.24							
		628	RHB	0.22							
		629	RHB	0.22							
		630	RHB	0.3							
		631	RHB	0.11							
		632	RHB	0.13							
		636	RHB	0.04							
		637	RHB	0.11							
		638	RHB	0.01							
		639	RHB	0.06							
		643	RHB	0.14							
		644	RHB	0.16							
		645	RHB	0.07							
		646	RHB	0.06							
		647	RHB	0.13							
		649	RHB	0.14							
		651	RHB	0.13							
		654	RHB	0.27							
		653	RHB	0.2							
			Total	5.35							
F-5	Dahlawas	669	JDA	4.73		182000	1400	112000	70000		Upstream of Ramchandrapura Dam
		668	JDA	1.57							
		612	JDA	8.02							
			Total	14.32							
F-6	Ramachandrapura	249	JDA	10.22		300000	1600	224000	76000		Downstream of Ramchandrapura Dam
		267	JDA	6.62							
		268	JDA	7.9							
		269 (70% of 9.54)	JDA	6							
		272	JDA	1.76							
		273	JDA	2.99							
			Total	35.49							
F-7	Jhirota	737	JDA	5.79		209000	1050	147000	62000		Near Poornima University
		740	JDA	0.41							
		741	JDA	8.35							
	Jalsinghpura	326 (60% of 5.85)	JDA	4.5							
		327	JDA	4.67							
	Vidhani	119	JDA	4.01							
			Total	27.73							
F-8	Salagrampura	179 (45% of 10.08)	JDA	4.5		205000	920	128800	76200		Near Vimalpura
	Goner	445	JDA	3.66							
		487	JDA	2.76							
	Vimalpura	67	RIICO	0.83							
		68	RIICO	0.91							
		69	RIICO	0.71							
		94	RIICO	1.46							
		95	RIICO	3.27							
		96	RIICO	0.56							
		97	RIICO	1.02							
		112	RIICO	1.11							
		113	RIICO	0.87							
		114	RIICO	0.14							
		115	RIICO	2.03							
		116	RIICO	1.53							
			Total	25.36							
								Total Area Available	547500		

Total for all Reaches	133.21 Ha.

Annexure 2

Year Wise Expenditure & Revenue

	2015-16	2016-17	2017-18	2018-19	Yr.1	Yr.2	Yr.3	Yr.4	Yr.5	Yr.6	Yr.7	Yr.8	Yr.9	Yr.10	Total
Expenditure															
Capital	*242	334	943	63											**1,582**
O&M					52	57	63	69	76	84	93	102	112	124	**833**
Total	242	334	943	63	52	57	63	69	76	84	93	102	112	124	**2,415**
***O&M NPV	-	-	-	-	47	47	47	47	47	48	48	48	48	48	**475**
**Revenue			244	781	270	56	56	56	56						**1,519**

***The O&M cost during the O&M term will be Rs. 833 Crores (Including taxes and provision for unforeseen items). O&M cost is worked out based on NPV considering a discount rate of 10% with base year as 2018. The year on year O&M costs and NPV of the same during the O&M term of 10 years is provided in the table above.

**Note: In revenue calculation, cost of land reclaimed of JDA and value enhancement of land adjoining Nallah, for all agencies including JDA has been considered

* Amount shown for the year 2015-16 includes advance payment also.

CHAPTER 12: PROJECT STRUCTURE

The Tata Team consisting of Tata Projects along with its partner M/s SUCG and Tata Group partner Companies, namely – Ecofirst Service Limited (collectively referred as Tata Team) have completed the pre-feasibility and feasibility studies leading to the final DPR for the Rejuvenation of Amanishah Nallah project. The broad division of overall responsibilities is mentioned below

1) Pre-Feasibility: Tata Team
2) Feasibility Studies leading to DPR: Tata Team
3) DPR: Tata Team
4) Basic Design and Engineering: Tata Team
5) Detailed Design and Engineering: Successful Bidder
6) Procurement, Project & Construction Management: Successful Bidder
7) Operations and Maintenance: Successful Bidder

A Mega project of the size and complexity as in Amanishah Nallah needs critical planning and phasing for timely completion. The Successful Bidder team will phase the project in Sections/Zones of the Amanishah Nallah and assign priorities to the critical Zones/sections.

The Contractor needs to select dedicated members of the project team based on applicable experience. This “task force” approach will include placing full responsibility for Engineering, Procurement, Construction, start-up and project controls under the direction of Project Manager.

- The Project Manager is direct link to the project team. His principal mission is to integrate and focus all EPC activities to ensure meeting overall quality, schedule, cost, and safety commitments to Project Authority. His mission includes overall project management and close liaison with site construction and start-up staffs, engineering and procurement, proper approvals and timely flow of all information, material and equipment. The Project Manager coordinates all engineering and procurement activities to

ensure that these activities are compatible with construction and start-up requirements. He assures development of safety and quality progress, secures necessary support services and directs planning and scheduling efforts.

- The Head - Project Engineering coordinates all engineering activities and procurement to ensure that these activities are compatible with project construction and start-up requirements. His principal mission is to integrate and focus all works activities to ensure meeting requisite quality, schedule, cost, and safety commitments to Project Authority. The Engineering Manager assures appropriate review and approval of all engineering documents and issues monthly progress reports. He is responsible for control and development of engineering and design documents to support the overall project schedule.
- The Planning Manager is responsible for planning, developing, maintaining, and documenting the Project Schedule as well as estimating, cost-control and project reporting.
- The Engineering / Design Manager is responsible for all engineering and design work, which includes mainly preparation of specifications, tender documents, preparation of construction drawings, equipment inspections etc.
- The Procurement Manager coordinates development of project purchasing and subcontracting procedures; develops qualified bidder lists; serves as principal commercial point of contact with all suppliers and subcontractors; guides and counsels project personnel in dealings with suppliers and subcontractors; reviews all procurement documents prepared by other project personnel to ensure that they conform to project requirements; and acts as liaison between project engineering, inspection and expediting to develop and administer project requirements for surveillance of suppliers. He is also responsible for coordinating meetings with the suppliers and subcontractors to discuss technical compliance schedule compliance and transportation requirements.

- The Resident Construction Manager (RCM) is responsible for all site activities. He directs the activities of all groups which receive, store, install, erect, construct, inspect, checkout, commission, start-up and test all structures, systems, and equipment within the scope of the Project. He will be the JDA's primary site contact for the project.

  The RCM is responsible for developing project specific construction procedures, directing craft workforce, coordinating all subcontractor activities and safely completing all civil works, structures, equipment, and systems in accordance with project quality, schedule and cost objectives. The Site Manager reports to the Resident Project Manager.
- The Commissioning Manager is responsible for developing specific start-up procedures, coordinating with the RCM for the completion and turnover of systems, directing the commissioning and start-up of systems and equipment, directing the start-up, initial operation and performance testing of the units.
- The Quality Manager – Section 1.8 below.

12.1 PROJECT TEAM

Contractor will assign experienced and capable team leaders to the Project, many of whom worked together on other successful mega construction projects. The personnel listed below are representative of the professionalism that will be assigned to the Project upon award of contract.

- Project Direct
- Project Manager
- Project Engineers
- Resident Construction Manager
- Engineering Manager
- Procurement Manager
- Site Manager

- Commissioning Manager
- Planning Manager Project

Contractor will select these leaders, having history of meeting project objectives and exceeding key performance areas on many mega projects similar to the size and complexity.

PROJECT KICK-OFF MEETING

The execution of each project begins with one or more kick-off meetings. A meeting is an essential part of every project. Its purpose is to bring all key personnel together, provide background information on the project, and provide details of the execution plan. Kick-off meetings provide the opportunity for Project Authority and Contractor's team to ensure each party has a common understanding and ownership of the project goals and objectives. Kick-off also includes a mutually agreed-on mission, clearly understood roles and responsibilities and defined actions that will achieve Project goals.

Kick-off meetings will ensure that all project participants and team members stay focused on the project goals for quality, schedule, cost and safety. These meetings start with an initial meeting after contract award and are repeated as necessary when new participants become involved, or when a major phase or milestone of the project is about to occur. Appropriate participation in the kick-off meetings will be determined jointly by Contractors Project Manager and Project Authorities Project Manager.

The kick-off meeting shall address the actions to prepare following documents which will become part of inception report:

- Introduction
- Roles and Responsibilities
- Scope definition – Services and facilities provided by Contractor, coordinated with estimated, schedules, forecasts and reporting
- Particular requirements of the contract

- Project mission, vision, objectives, key result areas, etc.
- Project organization for accomplishing mission, vision, objectives, key results and their associated measurement systems
- Task force location and moving plans
- Project schedule
- Project cost
- Interfaces
- Engineering execution plan
- Procurement execution plan
- Construction execution plan
- Plans for further meetings, including weekly task force meetings
- Plans for release of each project team to proceed with the work
- Needs for confidentiality/security
- Periodic management visits
- Names, addresses and format for formal correspondence and invoicing
- Establish approval procedures

A written detailed project execution plan will be developed based on agreements with JDA that integrates the phases and elements of the project. The project execution plan is a brief formal document prepared early in the project jointly by Contractor and Project Authority. It states in broad terms how the scope of work and job requirements will be met. Its purpose is to state in a written format the strategic and, to some extent, the tactical plans for executing each phase and major division of the project. The project execution plan is goal oriented and is one of the primary documents in the projects quality plan.

PLANNING MANAGER

Project Planning includes planning, scheduling, estimating, cost control, performance monitoring and reporting. This area is managed by the Planning Manager Projects who is responsible for documenting the

integrated project plan and monitoring performance against plan to ensure the project meets its schedule and cost objectives are met.

For the Project, the Planning Manager will take the lead in developing an integrated schedule which will include the way work is divided into packages. For each package, engineering, procurement, construction and start-up activities will be identified and the activities interrelationships will be documented in the CPM schedule using Primavera scheduling software. As work progresses, performance is monitored and reported monthly.

Planning and Schedule

Primavera software used for planning and scheduling is capable of scheduling, resource management and cost control. Primavera' s CPM scheduling system has the capability to "freeze" a project at a point in time and perform calculations of early and late date and float, resource loading and levelling and tracking of resources, both budgeted and expanded.

Our planning and scheduling systems are designed to assist project management in developing integrated engineering, procurement, construction and start-up plans and to implement these plans through detailed scheduling. Work Breakdown Structure (WBS) and network analysis techniques are used as tools to coordinate, assemble and document information resulting in efficient utilization of workforce, equipment and capital.

A multi-level system of schedule documents is used to effectively integrate all levels of project management and supervision and to maintain cost-effective work plans. Most schedules for management are released in monthly Project Status Reports. Schedules for contractors are released in bid packages, post-bid meetings and the status meetings. The following presents a brief description of each level of schedule that may be used and its relationship to the overall project planning and scheduling process.

Project Master Schedule

A Project Master Schedule (PMS) will control milestones for the total project. The PMS is the first of three or more tiers of schedules.

Project Master CPM Schedule

At the second level is the Project Master CPM. This establishes a plan for project sequencing and a method for monitoring progress. The CPM provides a mechanism to determine the impact caused by actual or potential delays resulting from changes in the design packages or in deliveries of material or equipment. This precedence networking process allows project management to evaluate alternatives to the plan and to adjust resources to recover objectives as changes occur. One effective way we use the CPM is to convert the network into a time-scaled activity diagram.

Intermediate Range Bar Chart

The CPM network is expanded into intermediate range schedule through input from superintendents and subcontractors. This schedule supports the milestone objectives of the Project Schedule. The intermediate range schedule is used to expedite the delivery of drawings and materials and to coordinate activities between subcontractors.

Weekly Work Schedule

Preparation of weekly work schedules for all construction and start-up tasks. Subcontractors are required to provide similar weekly work schedules which are coordinated with Contractor team's tasks. Each schedule is analysed against the Project Master CPM Schedule to verify compliance with project milestones, coordination of subcontractors,

workforce levels and to establish benchmarks for contractor evaluation and progress.

Work Packages

Contractor to break the project into work packages that are logically tailored to fit the construction sequence and schedule and where appropriate, are subcontract bid packages. Close coordination of engineering and construction will ensure the design program drawings and specifications are well integrated with the construction plan and “on track”. Detailed work schedules will target an earlier completion for each work package than is shown in the project plan.

Project Status Report

A project status report will be developed monthly starting with the award of contract. The report will include a status of the project as compared with the original project plan. Planned versus actual work performance will be reviewed for engineering, procurement, construction and start-up/testing. Site progress Digital photographs will be included in the report. The report will be transmitted to JDA electronically or by updating a secure project web page that can be accessed via the Internet with the use of a password.

12.2 PROJECT SCHEDULE

During the period between LOI award and Contract signing the following activities are need to be performed:

- Project alignment among Contractors Team and Project Authority
- Site Survey
- Site geotechnical study and preparations of the report

- Finalize site construction facilities
- Develop Site excavation and drainage design
- Develop concrete specification for batching plants
- Establish temporary construction power and potable water service
- Establish communications
- Mobilize site construction facilities and excavation contractors
- Preparation for permits and clearances

The 5 years O&M (Extendable to another 5 years on mutual agreement) would start at the successful completion of the performance test.

Contractor would proceed on the above basis for execution of the project to meet the project schedule upon award of the contract.

12.2.1 **ENGINEERING**

Contractor to have proven experience in both Design and engineering activities for the project and will be directed by the Engineering / Design Manager.

Major engineering activities that will be developed are:

- Design Calculations and Analysis
- Design Basis Packages
- Specifications
- Systems Definitions
- Vendor Data
- Systems Descriptions
- Construction Drawings
- Project System Lists
- As Built Drawings
- Project Studies and Reports
- Changes : Design as requested by JDA

Thorough planning and integration of these activities results in a quality project that meets the project schedule and Project Authority objectives.

ENGINEERING EXECUTION PLAN

Team Focus

Focused engineering work sharing approach and the use of state-of-the-art engineering and communication tools, would allow the Contractor to work together to accomplish the entire engineering within a tight schedule.During construction, engineering support will have be provided.

Engineering Tools

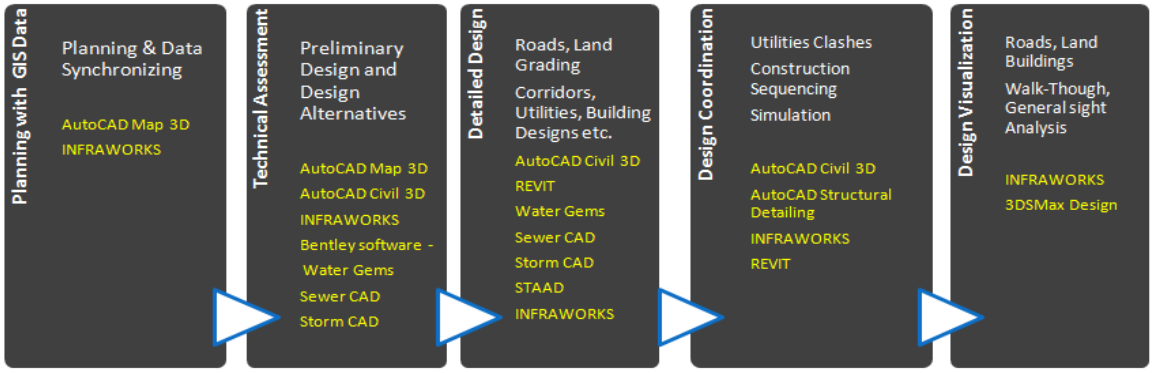
Contractor to use state of the art engineering tools proven successful on other similar projects. Contractor to have significant plant design, construction, and start-up experience. This experience is enhanced with the tools that are used by the engineering team.

A modelling system will be used for design where it can be most effectively utilized. This system has proved successful for other projects by:

- Enhancing construction planning and scheduling
- Minimizing construction interferences
- Providing all engineering team members with a common understanding of the system and plant designs
- Ensuring adequate space is allocated for maintenance and operability needs

The Contractor with its operating principles mandate will involve experienced construction and operations personnel to finalize the layout

and design of the facility. This ensures that the project can be safely and efficiently constructed for successfully maintaining by the O & M staff of the utility.



Projects are executed with a database approach. Engineering design elements are placed into the project database. Data is added by various discipline functions. Engineering, procurement, construction, warehousing and start-up all contribute. By having data on-line, each functional area is able to utilize relevant data without having to re-input it. This ensures consistency.

12.2.2 **PROCUREMENT**

The Contractor has to under a firm proposed schedule, procure equipment and materials and ensure timely delivery to the site. For such requirement, the Contractor to have:

- Extensive experience in countrywide procurement of plant equipment's
- Including:
  - Procurement of equipment and material
  - Countrywide Inspection and expediting services
  - Clearance, shipping and transport

Management of all procurement activities for the project is the responsibility of the Procurement Manager who will be physically located

with the Project Manager and his task force staff. As necessary, the Procurement Manager will be assisted at the task force level by Engineering, Inspection, Expediting, Subcontracting, and Document management personnel.

- Procurement of all major equipment and engineered materials will be completed by the procurement staff. Bulk materials needed will be purchased locally.

The Procurement Manager prepares periodic status reports indicating the status of procurement activities as it relates to the overall project. This report is ERP based and tracks all pertinent purchasing activities on the project by Purchase Order/ Contract package.

Assigning all procurement responsibility to the Procurement Manager facilitates planning and promotes consistency in the procurement process. Properly tailoring provisions that address commercial terms to equipment purchase specifications eliminates the potential for inconsistency between supplier or subcontractor requirements and project specifications. Other requirements such as schedules, inspection provisions, and shipping requirements also benefit from this approach.

This approach will result in numerous significant advantages and benefits.

Experience

- Utilize proven, competent local suppliers and subcontractors from recent projects
- Competitive supplier base
- Highly skilled and experienced personnel to perform Inspection and Expediting services
- A group of logistics specialists to perform transport services

Expertise to Enhance the Commercial Integrity of Project

- Establish Procurement Practices guide consistency of performance
- Assignment of procurement personnel qualified in mega construction projects
- All the material procured shall follow national codes and standards.

Preventive Shop Inspection and Expediting Capability to Reduce Jobsite Rework and Downtime

- Global network of certified shop inspectors/expediters reduces costs
- Contractor to have a full-fledged inspection and expediting division consisting of:
  - Rotating Equipment Inspection
  - Pipes / valves Inspection
  - Fabrication Inspection
  - Electrical/Instrumentation Inspection
  - Field Quality Control and
  - Quality Assurance

Each group consists of experts in the respective fields with wide experience in inspection of equipment supplied

- Maintain priority scheduling and verify equipment conforms to requirement prior to transportation to site
- Surveillance of supplier quality plans and assist with corrective action when required
- Assist in obtaining vendor engineering drawings, spare parts lists, O&M manuals, and other related data

Qualified Procurement Manager, with significant experience in similar project, Directs Materials Management Activities as member of Project Team

- Single contact for all procurement related matters reporting to the Project Director
- Integrate material processes with engineering and construction to achieve schedule and budget goals
- Informs JDA and other project team disciplines of major material activity and overall procurement progress

Advanced Material Management Systems

- ERP based system allows flexibility and tailoring to fit the needs of the Project
- Consolidates document and material tracking in a single system to effectively manage material requirements
- Expediting reports specifically tailored for the Project are used to inform JDA and other project team disciplines of major material related activities

For the development of equipment and material requirements associated with the various process systems, the following approach will apply.

- The enquiry specifications and technical data for the request for quotation packages (RFQ's) will be prepared by the Contractors Engineering Team.
- The selection of domestic bidders is based on past experience and performance, and on current price and delivery information.
- Upon selection of the subcontract, the Project Team will have negotiations as required with regard to scope, price, terms and conditions, delivery and guarantees and will place the order.

Procurement activities to be accomplished shortly after the Pre – LOI Phase are as follows :

Project Procurement:

- Bring proposed equipment and materials procurement to Project Team
- Prepare procurement and contract section for Project Execution Plan
- Prepare procurement and contract procedures for project
- Finalize bidder and subcontractors list with project team
- Produce purchasing and subcontract document formats that reflect project requirements
- Set up material management system for project

Contracting:

- Finalize list of available subcontractors to be considered for Requests for Proposal Packages
- Develop plans for major subcontract requirements with the project team and site construction manager to ensure scopes of work and schedules are aligned with the construction plan
- Participate in refining overall schedule of subcontracting activities
- Work with engineering, construction and project management in detailing the scope of work and special site conditions for the major supply and erection contracts
- Issue Request for Proposals to subcontractors and develop those major contracts to support the delivery of equipment for erection and/or installation contracts to enable construction of the facility
- Prepare site subcontract packages must be developed in conjunction with construction/engineering/project management to enable work to commence immediately upon issuance of the LOI

Purchasing:

- Align with engineering to expedite the flow of technical documents and evaluation of supplier quotations
- Finalize the engineering requirements for Main packages such that they can issue required purchase order to their second tier suppliers for release of long lead time components
- Finalize details with selected supplier(s) to have purchase orders ready-to-issue
- Issue formal purchase orders when necessary to meet the schedule

SHOP INSPECTION AND EXPEDITING

Delays in receiving scheduled supplier engineering information or fabrication slippages can be very costly to the Project schedule. We intend to utilize our experienced shop inspectors / expediters on other current projects for both engineering data and equipment shipments.

12.2.3 CONSTRUCTION

Organization

Contractor will assign a Resident Construction Manager (RCM) with significant experience to be responsible for all site activities. The RCM will report to the Project Director for overall project direction. He will work with Project Manager to successfully meet the project's goals and objectives on a day to day basis. The Site Construction Staff reporting to the Resident Construction Manager will include the Site Manager, Site Planning Engineer, Start-up Manager, Quality Manager and Safety Manager.

The construction staffs works closely with design personnel, construction crew, subcontractors and others involved in the project. The subcontracted work will be managed by a combination of supervisors and construction engineers for field activities and a contract administrator for the commercial aspects. Construction engineers will work with in-house team and subcontractors to assure that the facility is constructed as per design documents, to resolve erection problems and to act as a liaison with the design team. Construction engineers will work closely with design engineers who will be assigned to the field to resolve problems and to maintain as-built information. We have found from past projects that this approach eliminates many problems before they are constructed, develops teamwork between construction and design and contributes to a successful project.

CONSTRUCTION CONTRACTING PLAN

Work Packages

The contracting strategy for the project will include a combination of supply and construction contracts and self-performed work utilizing labour supply contracts. The major work packages for construction of the project include:

Utilities, Roads and Drainage works
Electrical works
Treatment Plant
Solid waste management system

CRITICAL ACTIVITIES TO THE SCHEDULE

The critical intermediate schedule activities by JDA which will drive the project are shown below. These activities or milestones will be critical to the projects schedule objectives.

- Award of Contract
- Notice to Proceed
- Project related statutory studies and approvals
- Engineering Approvals (if any)
- Construction Installation Approvals (if any)
- Commissioning of various equipment and performance acceptance
- Handing and Taking over of Site post completion of O&M period

CONSTRUCTION PERMITS

The construction team will initiate the process to obtain the necessary construction permits to be obtained from the state and local governmental authorities. Applicable permits to be obtained include:

- Inspectorate of Explosives
- Inspector of Weights and Measures Department
- Labour Office for Deployment of Construction Labour

- Department of Telecommunication System (for using wireless communication)
- State Building Control Department for Building Control Regulation
- Public Works Department for Regulation on Civil/Road (for movement of equipment by road)

EXECUTION PLAN

The construction staff will be on site from mobilization until Project Completion. They will coordinate construction activities from mobilization through the systematic turnover of the plant to the start-up team and then support the start-up team until the plant completes unit performance test and project completion. These functions include staffing, payroll, scheduling, controls, accounting, purchasing, contract administration and warehousing. Prior to mobilization Project Authority and Contractor will hold a pre-mobilization kick-off meeting to review site details, roles and responsibilities and requirements of site mobilization and project construction.

Grading of the site area will be the first priority along with preparation of an independent access gate, access roads, office and lay down areas, and other construction facilities. Additional work activities will commence such as structural steel erection, underground piping, structural concrete wall and elevated floors as per approved drawings made available to site. As the major structures are completed, mechanical and electrical equipment, materials and bulks will be installed. When approximately 80% of construction is complete for the unit, the emphasis of construction will change from bulk commodity installation to system completion. System completion will be scheduled to support the start-up schedule beginning with the basic plant auxiliary systems such as air, water, fire protection.

Equipment Operating Manual

The information contained in this manual primarily consists of technical and operational information provided by equipment suppliers. The responsibility to finalize vendor manuals for incorporation into the Operating Manuals will be assigned to the vendors and Engineering with input from the Start-up Team. The information provided in these vendor manuals is required for development of the System Operating Manual.

System Operating Manual

This manual, which consists of operating procedures for plant systems, will be developed by the Start-up Team. Development of the procedures will be based on a system and integrated plant operational basis. Equipment operating procedures provided by the vendor manuals will be referenced as necessary.

Maintenance Instructions

This manual consists of equipment Maintenance Instructions. The Start-up Team is responsible for the development of the instructions contained in this manual. Maintenance instructions provided by the vendor manuals will be referenced as necessary.

Operating and Maintenance Instructions Updates

As the project progresses, additional “as built” information will be organized and inserted into the appropriate sections.

Operating and Maintenance Instructions Turnover

The Operating and Maintenance Instructions Manuals will be shared with Project Authority on Project Completion.

12.2.4 QUALITY ASSURANCE PROGRAM

Contractor has to be committed to quality in all aspects. This commitment is to be recognized by the Certification of the Quality System to the

requirements of International Standard ISO 9001, “Quality Systems Model for Quality Assurance in Engineering Procurement and Construction.

PROJECT EXECUTION PLAN

The Project Execution Plan (PEP) is a formal document prepared and issued early in the project by the Project Director. Its purpose is to describe in broad terms the Contractor’s strategy for successful execution. It defines the project scope and requirements, identifies required resources and describes how those resources will be deployed. The PEP incorporates agreements with Project Authority into the overall project strategy to assure that requirements are met.

PROJECT QUALITY PLAN

The Project Quality Plan defines a quality operating system. It identifies the tasks to be performed, the procedures required to perform the tasks and the roles and responsibilities of project personnel. It also includes specific requirements regarding Quality audits and corrective action.

Practical & contractual requirements are incorporated into specific procedures, so that routine project activities can be carried out in accordance with written procedures, rather than through repetitive direct reference to the Contract.

PROJECT PROCEDURE MANUAL

The Project Procedure Manual (PPM) is a formal set of procedures that provides project personnel with uniform direction for performing and controlling project activities. The procedures can be Contractors own corporate procedures fine-tuned to meet this Projects demands, or can be uniquely developed procedures to meet the specific requirements in this Project.

The PPM is a dynamic document and will be revised at any time to reflect desired changes, improve the procedural processes or incorporate changed requirements. As the project proceeds, experience and feedback may indicate the need for additions, deletions or revisions to the PPM. Also, some procedures are not initially required and will not be prepared until later in the project execution schedule (e.g., details of Start-up procedures). The content of the PPM is continually reviewed to ensure that it reflects all policies and procedures necessary for effective execution.

RESPONSIBILITY

Overall responsibility for Quality lies with the Project Manager. The Project Quality Manager (PQM) will report to the Project Manager. Along with the Project Manager, the PQM's responsibilities include:

- Provide project quality leadership
- Conduct a contract review and establish a statement of scope definition
- Conduct one or more kick-off meetings and alignment sessions which develop Key Results Areas (KRA's) in line with JDA, project and Partnership needs
- Identify project execution needs and prepare the Project Execution Plan along with the Project Quality Plan and Project Procedure Manual
- Ensure, in practice that the steps and procedures documented above are understood and are being applied satisfactorily during the course of the project
- Be the direct point of contact for communication with JDA on Quality matters

The Project Quality Manager is supported by the Corporate Quality Manager. For each project, the Corporate Quality Manager is responsible to :

- Review Project Execution Plan and Project Quality Plan

- Develop and administer the Quality function in line with the best practices in Quality.
- Ensure that project and non-project audits are conducted as scheduled or required
- Perform management review activities
- Ensure the effective performance of the Quality program
- Communicate as required with JDA Representatives on Quality Matters

Each project has a designated Project Quality Representative or Quality Manager on site who is responsible to:

- Develop and administer the Quality function on site to assure it complies with the Project Execution Plan, Project Quality Plan and Project Procedures Manual
- Assist (if required) the Resident Project Manager in developing an orientation program to ensure the project team members, including suppliers and subcontractors, are familiar with the requirements of the Project Quality Plan
- Assist as lead project auditor, as required
- Prepare and issue audit reports (internal and external) noting system on conformances and verifying effective corrective action
- Follow-up on audit findings and corrective actions
- Assess (if required by the Resident Project Manager) suppliers and subcontractors capability to meet the quality requirements of the project
- Assist the Resident Project Manager, if required, in other quality matters
- Communicate with the JDA Representatives on Quality Matters

The Quality Manager on site has an independent quality reporting responsibility to the Corporate Quality Manager and the Project Quality Manager.

DESIGN ENGINEERING

Contractor to ensure that all project design work be quality controlled.

- The Project Quality Plan, Project Execution Plan and Project Procedures Manual establish an appropriately detailed definition of project scope of services and facilities, including unambiguous and adequate design requirements

The design process is described so that :

- Work is scheduled in a logical sequence
- Scheduling and reporting are performed in a manner that allow control at Management, Project and discipline levels
- Authorized design procedures are used
- Control interfaces and document transmittal requirements are identified
- Document management principles and procedures are applied
- The design process is adequately documented to ensure compliance with the appropriate revision of regulatory and JDA requirements

Concepts, calculations and decisions are sufficiently documented to enable the basis of each decision to be established.

Design is verified using:

- Techniques that review or check acceptability of the design output
- Independent reviews
- Other appropriate means such as qualification tests and demonstrations, alternative calculations, etc.

Clear authorities and responsibilities are established for review, checking and approval, (including supplier design) of all design work.

Project specific requirements for checking and approval are detailed and approved in the Project Quality Plan.

PROCUREMENT

Contractor ensures that all procured products and services conform to specifications. The detailed methods of carrying out procurement activities are recorded in the Contractors Procurement Practices and Procedures Manual and referenced in the Project Execution Plan and Project Quality Plan for each project. The Procurement Manager will ensure that all activities related to procurement are conducted as necessary. He is responsible to prepare Request for Quotation (RFQ) and Request for Proposal (RFP) packages containing clear and adequate descriptions and/or definitions.

For purchases that project management identifies as critical, the supplier's quality management system is approved by a third party. Contractor to use Supplier Quality Surveillance staff to audit suppliers, their quality programs, fabrication and shipment as required. Surveillance reports are prepared and forwarded to project management.

PROJECT SITE QUALITY

The designated Quality Manager on site has overall quality responsibility for the site. Reporting to him are the Quality organization, surveyors, subcontractor Quality Managers and any independent inspection agencies. Independent inspection agencies are typically used in such areas as soil, concrete testing, batch plant testing, radiography and other non-destructive testing and any outside surveillance organizations. All inspection activities are completed in accordance with the Project Site Procedures Manual.

CORRECTIVE ACTION

The Project Manager is responsible for monitoring the effectiveness of the Project Quality Program. He may review trend reports, sample inspection records and audit reports, interview project team members, suppliers, subcontractors, independent.

The Project Manager will typically use the following methods to identify required corrective actions:

- Engineering and project review meetings with Project Authority
- Audit reports
- Periodic reviews by engineering of the Request for Information (RFI) forms to evaluate for trends and corrective actions
- Procurement's equipment inspection program
- Construction inspection and testing for items in the Project Procedure Manual
- Alignment sessions
- Project Authority's quality audits at the site

If the Project Manager identifies deficiencies in the program or its implementation, he will assign responsibility for corrective action to the appropriate discipline managers and follow up to ensure corrective action.

AUDITS

The Project Quality Manager will establish a schedule of audits to verify compliance with the Quality Program established in the Project Quality Plan. The Project Quality Manager will define the scope of activities to be reviewed in each audit based on the phase of the project and the level of activity in each discipline. Audits will be led by a qualified lead auditor and carried out by qualified auditors, none of whom have direct responsibility for the activities being audited. The audit team will prepare a written report listing activities observed, records reviewed, deficiencies noted, good practices noted and corrective actions recommended.

The Project Quality Manager will assign corrective action to the appropriate discipline manager, follow up to ensure effectiveness and document the results. The Project Quality Manager will request a follow up audit if he deems it warranted by the severity of the deficiencies.

Audit findings must be acted on by those responsible at the project or functional level as necessary. The auditor will verify that effective corrective action is complete.

12.2.5 INFORMATION AND COMMUNICATION SERVICES

The foundation of MIS in Infrastructure is based on distributed data centers which would be connected to centralized file servers for storage, retrieval and sharing of information. This network of workstations and servers is connected to a worldwide network allowing electronic mail and access files of all types virtually from anywhere.

ELECTRONIC MAIL

The ability to originate an electronic mail message and involve all parties is essential to communications and superior project execution. Effective communications are fundamental to a successful project. Contractor is committed to ensuring effective communications between all project participants.

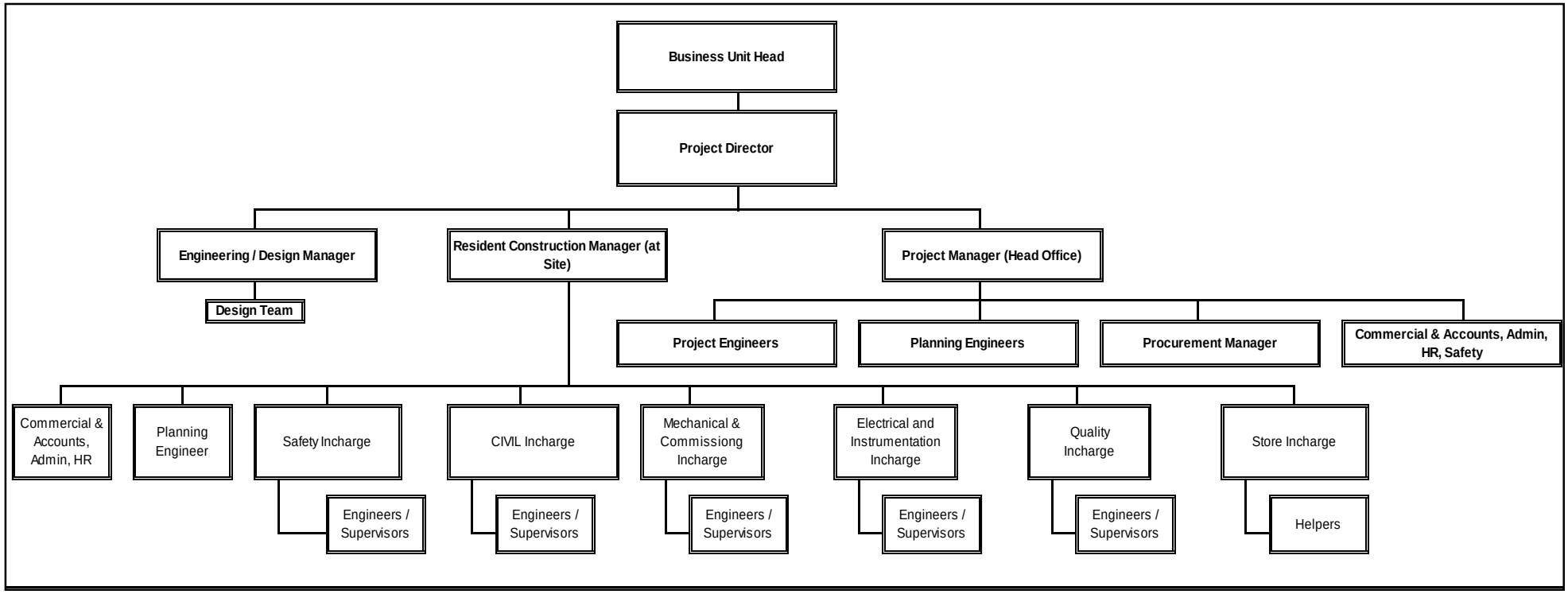
Electronic mail is used extensively, offering both rapid communications and file transfer capability to all users on the network. Electronic mail transfer capabilities extend into other commercially available mail systems including Internet mail, MCI mail and CompuServe. This connectivity is widely used to communicate worldwide. The time to originate and distribute a message has been reduced to a matter of minutes.

NETWORK INTERCONNECTIBILITY

Information sharing between Contractor and Project Authority can be accomplished through the exchange of electronic data and information. The benefit of the more sophisticated information sharing methods is the ability to exchange information quickly which enables smoother project

execution. With the appropriate software and hardware at each location, aninterconnect can allow on-line viewing, retrieval, and comment on drawings and other project documents.

Distribution of engineering and supplier/subcontractor documents with reviews and comments to JDAs, vendors, or project sites can be performed. The final issue of engineering documents can be provided in all of the electronic file formats used by major CAD systems.


Business Unit Head
Project Director
Engineering / Design Manager
Design Team
Resident Construction Manager (at Site)
Project Manager (Head Office)
Project Engineers
Planning Engineers
Procurement Manager
Commercial & Accounts, Admin, HR, Safety
Commercial & Accounts, Admin, HR
Planning Engineer
Safety Incharge
Engineers / Supervisors
CIVIL Incharge
Engineers / Supervisors
Mechanical & Commissiong Incharge
Engineers / Supervisors
Electrical and Instrumentation Incharge
Engineers / Supervisors
Quality Incharge
Engineers / Supervisors
Store Incharge
Helpers

CHAPTER 13: IMPLEMENTATION SCHEDULE

QUARTERWISE IMPLEMENTATION SCHEDULE FOR CONSTRUCTION OF AMANISHAH NALLAH													
NO	**ITEMS**	**Work Reach**	**Q-1**	**Q-2**	**Q-3**	**Q-4**	**Q-5**	**Q-6**	**Q-7**	**Q-8**	**Q-9**	**Q-10**	**Q-11**
1	Detailed survey	Total reach	√										
2	Creation of designated project authority (by JDA)		√										
3	Site handing over with RoW	Total reach	√										
4	Marking of central line by JDA	Total reach	R1-R6	R7-R13									
5	Demolition of existing structures	R-5, R-6	R-5	R-6									
6	Statutory clearance / permissions - NEERI , railways / military etc.												
7	Detailed Design												
	a) Longitudinal ,cross sectional drgs.every 50 m.	Total reach	√										
	b) Approval of GLA		√										
	c) Interfacing details with the existing bridges / culverts		√										

SL.NO.	ITEMS	Work Reach	Q-1	Q-2	Q-3	Q-4	Q-5	Q-6	Q-7	Q-8	Q-9	Q-10	Q-11
8	Construction of approach roads	Total reach	R1-R4	R5-R6	R7		R8	R9-R10	R11-R12 Part		R12Part-R13		
9	Catchment area treatment	R1 - R2	R-1	R-2									
10	Excavation of diversion channel (upstream of Mazar dam)	R 2	√										
11	Preparation of business master plan of surplus land parcels	Total reach	√	√									
12	Demarcation and cutting of jungle , removal of garbage , slush	Total reach	R1-R4	R5-R6	R7		R8	R9-R10	R11-R12 Part		R12Part-R13		
13	Earth work excavation and making of embankment and cmpction of earth	Total reach			R3	R1, R2, R4	R5, R6, R7	R8, R9,R10	R11R12, R13				
14	Laying of two layers of concrete lining	R3-R11					R3, R4	R5, R6, R7	R8, R9 R10	R11			
15	Pitching	R12-R13								R12, R13			

SL.NO.	ITEMS	Work Reach	Q-1	Q-2	Q-3	Q-4	Q-5	Q-6	Q-7	Q-8	Q-9	Q-10	Q-11
16	Extending colony sewer line upto Nallah bank	Total reach		R1-R4	R5-R6	R7	R8	R9-R10	R11-R12 Part		R12Part-R13		
17	Finalization of STP sites		√										
18	Laying of trunk sewer line (both LHS/ RHS)	R3-R13			R3	R4	R5, R6, R7	R8, R9, R10	R11, R12, R13				
19	Civil works of STP's					STP-1 STP-2	STP-3	STP-4 STP-5 STP-6	STP-7 STP-8 STP-9	STP-10 STP 11			
20	STP's 1,2,3,4,5,6,7,8							STP-1 & STP-2	STP-3	STP 4, STP 5, STP 6	STP-7 STP-8 STP-9	STP -10 STP -11	
21	Construction of check dams	R 3-R 11					R 3,,4,5	R 6,7	R 8, 9,10,		R 11		
22	Fixing Karauli stone on footpath along Nallah	R 3-R 11			R 3,4		R 5,6	R 7,8	R 9,10,		R 11		
23	Sitting place near foot path, garden lighting for foot path	R 3-R 11			R 3,4		R 5,6	R 7,8	R 9,10,		R 11	`	
24	Lighting along Nallah	R 3-R 11			R 3,4		R 5,6	R 7,8	R 9,10,		R 11		

SL.NO.	ITEMS	Work Reach	Q-1	Q-2	Q-3	Q-4	Q-5	Q-6	Q-7	Q-8	Q-9	Q-10	Q-11
25	Grassing on slopes along Nallah	R 3-R 11				R 1 - R 7				R 8 - R 11			
26	Tree plantation along Nallah bank	Total reach					R1, 2	R 3, 4	R5,6,7	R8, 9	R10, 11, 12	R13	
27	Construction of falls	Total reach					R 1,2	R 3, 4	R5,6,7	R8, 9	R10, 11, 12	R13	
28	Construction of service road	R-3, R-8, R-10-12											
	a) WBM				R 3			R 8		R 10	R 11	R 12	
	b) Bitumenous carpet				R 3			R 8			R 10-R 11	R 12	
29	Public toilets				R 3 - R 4	R 5 - R 6	R 7 - R 8	R 9 - R 10	R 11 - R 12	R 13			
30	Buildings				R 3 - R 4	R 5 - R 6	R 7 - R 8	R 9 - R 10	R 11 - R 12	R 13			
31	Water lines for services				R 3 - R 4	R 5 - R 6	R 7 - R 8	R 9 - R 10	R 11 - R 12	R 13			
32	Development inter sections of colony road with Nallah					R 3- R 4	R 5 - R 6	R 7 - R 8	R 9 - R 10	R 11	R 12	R 13	
33	Security systems					R 3- R 4	R 5 - R 6	R 7 - R 8	R 9 - R 10	R 11	R 12	R 13	

CHAPTER 14: PROJECT O&M FRAMEWORK

14.1 SCOPE

Operation & Maintenance for Amanishah Nallah shall include following components:

1) **General maintenance to keep the entire 47.5 KM stretch in good condition**
2) **Sewerage interception and Sewage Treatment Plants (STP) totalling to 170 MLD capacity**
3) **Landscape preservation and upkeep**

14.2 OBJECTIVE

The scope of work basically covers O&M of components as indicated above, with minimum outages based on approved procedures and as per the directives of JDA Engineer complying with the safety norms. Following considerations are made for delivering operations and maintenance services to JDA.

- Preparation of a plan for operation and maintenance.
- Providing required personnel to operate and maintain.
- Providing Capacity building program for the O.& M. personnel
- Availability of spares and tools for ensuring maintenance.
- Preparation of GIS based maps of the system
- Preparation of a water and energy audit and leakage control plan
- Maintaining MIS records on the system including history of equipment, costs, life etc.

14.3 DURATION

10 years Operations & Maintenance for the components listed above.

The following list gives briefly, the anticipated works/activities to be carried out.

As a general practice, the O&M manuals of OEM (Original Equipment Manufacturers) are referred and followed for guidance in both Operations and Maintenance. The support of OEMs is also taken in training, supply of spares and expert intervention when required.

14.4 OPERATIONS SCOPE DETAIL

1) **Water Systems**

   a. **Operation schedule**

   Principle and procedure for operation shall be as under:

   i. Optimized operations of Pumps with minimum starting and stopping

   ii. Running the number of pumps in three shifts for supply of treated water shall be as per designed standard and shall be confirmed time to time through co-ordination with JDA staff.

   b. **Laboratory testing**

   i. Routine tests shall be performed and recorded to control the operation. All testing and sampling procedures shall be carried out in accordance with standard methods for the examination of water published by the Indian Public Health Association. All analysis shall be recorded in the Register as per predetermined formats based on guideline given in CPHEEO manual on water supply.

2) **Sewage Treatment Plant Operations in round the clock in shifts:**

   Operation of Sewerage treatment Plant equipment's like pumps, blowers including lifting station meeting the technical requirement enabling to treat the raw sewerage as per design standards. This activity consists of operation of several mechanical, electrical equipment's, sampling of treated water and also

handling chemicals and disposal of treated effluent and sludge, operation of all process units.

b. STP General shift operation

Reviewing plant operation, coordinating with maintenance agencies for maintenance activities, preparing various reports, reviewing data sheets, performance evaluation of equipment's, keeping chemical consumption and stock records arranging for disposal of the dried sludge and submitting routine samples assisting morning and evening shift operators during pumping out of lifting stations.

c. Safety supervision of auxiliary plants (STP) in general shift:

Safety supervision of STP includes supervision of operation and maintenance, various tank cleaning, preparation of monthly safety reports and submitting to ENC, ensuring safety of the operation and maintenance manpower and co- coordinating with JDA safety section for ensuring safety norms.

d. Housekeeping of STP

Housekeeping of STP by cleaning in and around the plant area. This includes cleaning of MCC panel room, office room and toilets and removing sludge from drying beds, storing & disposing and maintaining greenery around the plant. Removal of all floating debris in Lifting Stations and collection sump.

e. **Laboratory testing**

Routine tests shall be performed and recorded to control the operation. All testing and sampling procedures shall be carried out in accordance with standard methods for the examination of waste water published by the Indian Public Health Association. All analysis shall be recorded in the Register as per predetermined formats based on guideline given in CPHEEO manual on water supply.

3) **Electricity Supply:** Liaisoning with concerned Electric Authority for power supply and in case of electric power failure (break down/shut down) to inform all the concerned and also to contact concern authorities to restore the power supply to resume services.

4) **Handling of chemicals:**

Handling of chemicals needs special attention. Safety and facilities to the staff for handling of chemicals and equipment's has prime consideration.

5) **Operation of auxiliary systems equipment's:**

Operations including start-up, shutdown, Monitoring, of auxiliary system for landscaping, street lighting etc. and recording the process parameters of the system and operating equipment's, maintaining the chronological log book, recording relevant plant parameters.

6) **Data Centers (with data entry operators)**

Work shall include preparation of documents, entry of data, compiling reports and other works like segregation, archiving, photocopying, scanning, filing of documents in order, etc. using latest Microsoft office version programs with windows XP and windows vista operating systems.

7) Safety

Provision of all personal protective equipment's to personal such as safety helmet, safety shoes, Gasmask, earmuffs etc. as applicable to the nature of work with necessary furniture for keeping personal clothing safety gear etc. for contract personnel

8) Deployment of manpower

The operators deputed will be suitably qualified in academic career and having relevant and adequate experience according to various fields in the plant areas (like Electrical, Mechanical, Chemical and Instrumentation.)

9) Operation Planning and co-ordination activities

Reviewing the deficiencies reported by the shift crew on day to day basis, Planning and coordinating with maintenance agencies for the various maintenance activities, preparation of various reports, up keeping of plant operating records

14.5 MAINTENANCE SCOPE DETAILS

1) Maintenance activities planning and scheduling:

Planning and scheduling all mechanical, electrical and instrumentation maintenance activities such as preventive maintenance, condition monitoring, corrective maintenance, fabrication works, painting works, welding works, rotary and static equipment's including

pumps, filters, pipe lines, valves, blowers, Transformers, Motors, MCC's, valve actuators, UPS, DG & emergency lighting batteries, area lighting,

chlorination system equipment's & transmitters, Gauges, transducers, switches, tubing and fittings, various sensors like pH, conductivity meter etc., preparation of reports, maintenance of records and maintaining spares inventory.

Housekeeping in and around plant to keep the area clean. Carrying out preventive maintenance activities of all equipment's as per the schedule approved by the Engineer in charge and regular maintenance. This generally includes replacing gland packing of pumps, replacement of bearings of pumps and motors, making up of bearing oil, cleaning of equipment's, replacement of worn out spares of equipment's, valves maintenance, pump maintenance, making up of media (Pebbles, Silex, Sand, Anthracite) in filters, cleaning of pumps suction strainers, replacing worn out fuses in MCC's, Breaker and MCC maintenance, insulation resistance value checking of motors, attending to leaks of tubing's and fittings, cleaning of contacts in breakers and MCC's and equipment's and in control panels etc. Carrying out weekly, monthly, quarterly, half yearly and yearly condition monitoring checks of all equipment's like temperature measurement of bearings, motor body ,vibration measurement of equipment's etc. as per the procedure and schedule approved by the Engineer in charge.

Attending to breakdown of equipment's promptly and restoring the equipment's back to health condition with minimum possible outage so as to maintain uninterrupted processing of sewerage water and filing the report to the Engineer in charge with root cause analysis. Ensuring implementation of corrective measures/actions as advised by Project Authority, Ensuring compliance of stipulation laid down by Project Authority and PCB. Periodical disposal of sludge. Monthly analysis of treated water sample and for maintaining records to meet pollution control board requirement.

2) Civil and Landscape Maintenance activities:

Carrying out maintenance of utility corridors, roads and up keeping of landscaped areas with greens, social infrastructure and auxiliary systems.

3) Mechanical maintenance activities:

Carrying out all mechanical maintenance activities such as preventive maintenance, condition monitoring, corrective maintenance, fabrication works, painting works, welding works, rotary and static equipment's including pumps, filters, pipe lines, valves, blowers, etc., preparation of reports, maintenance of records etc.

Essential Spares, mandatory spares, Tools & tackles shall be made available for smooth Operations.

4) Electrical maintenance activities:

Carrying out all electrical maintenance activities such as preventive maintenance, condition monitoring, corrective maintenance, painting works, rotary and static equipment's including Transmission cables, Transformers, Motors, MCCs, valve actuators, UPS, DG & emergency lighting batteries, area lighting, chlorination system equipment's etc., preparation of reports, maintenance of records etc.

Essential Spares, mandatory spares, Tools & tackles shall be made available for smooth Operations.

5) Control maintenance activities:

Carrying out all instrumentation maintenance activities such as preventive maintenance,

condition monitoring, corrective maintenance of equipment's including transmitters, Gauges, transducers, switches, tubings and fittings, various sensors like pH, conductivity meter and chlorination system equipment's etc., preparation of reports, maintenance of records etc.

Essential Spares, mandatory spares, Tools & tackles shall be made available for smooth Operations.

6) Deployment of manpower

The maintenance personnel deputed will be suitably qualified in academic career and having relevant and adequate experience according to various fields in the plant areas (like Electrical, Mechanical, Chemical and Instrumentation.)

14.6 OPERATION AND MAINTENANCE COORDINATION

Coordination and Execution of all operation and maintenance activities of Water Supply, Electricity transmission and supply, STPs, Sewerage Network and pumping stations by managing the deployed resource, coordinating with Engineer in charge, ensuring preparation of various reports and on demand by JDA and producing all relevant documentation.

Government of Rajasthan

Urban Development & Housing Department, through
Jaipur Development Authority

BID DOCUMENT

FOR

Selection of a Bidder under Swiss Challenge Method for Rejuvenation of Amanishah Nallah (Dravyavati River), Jaipur (Rajasthan) including Area Development on Turnkey Basis, and its Operation & Maintenance (O&M) for a Period of 10 Years

Volume-3

Price Bid

(8th December, 2015)

Issued on: 24/12/2015

Notice Inviting Bids (NIB) No. 17/2015-16

Volume-3
Section-11
Price Bid

Section 11: Letter of Price Bid

Date:

Notice Inviting Bid No.:

To:
The Secretary/ Director Engineering II,
Jaipur Development Authority,
R.K. Vyas Bhawan,
Indira Circle, JLN Marg,
Jaipur, Rajasthan

We, the undersigned, declare that:

(a) We have examined and have no reservations to the Bid Documents, including Addenda issued vide nos ..... dated..... and ..... dated.....in accordance with Instructions to Bidders (ITB) 8;

(b) We understand that Bid Process is based on the Swiss Challenge procurement process.

(c) We further understand that Design-Build as well as Operation Services are on Turnkey Basis.

(d) We offer to execute the Works in conformity with the Bid Documents, General Conditions of Contract (GCC), Particular Conditions of Contract (PCC) Part A and Part B and Employer's Requirements (ERQ), which inter alia briefly include the following:

Part-1: Design-Build Part

- Course Correction/Strengthening of Amanishah Nallah
- Sewerage Interception, Treatment, Reuse and Disposal
- Improving Water Quality Standard
- Improving Water Availability
- Land Area Development along the Amanishah Nallah

Part-2: Operation Services (Operation & Maintenance)

- Operation Services (Operation & Maintenance) for a period of 10 years after completion of Design-Build part of the Contract

(e) We confirm that we have quoted for Part-1 (Design-Build) and for Part-2 Operation Services (Operation & Maintenance) as per requirement of Bid Document in EXCEL FORMAT (Volume-III).

(f) Our Bid shall be valid for a period of 180 days from Bid Due Date in accordance with the Bid Documents, and it shall remain binding upon us and may be accepted at any time before the expiration of that period;

(g) If our Bid is accepted, we commit to furnish a Performance Security in accordance with the Bid Documents;

(h) 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 Agreement is made with us;

(i) We understand that you are not bound to accept the lowest evaluated Bid or any other Bid that you may receive.

(j) We agree to permit the Employer or its representative to inspect our accounts and records and other documents relating to the Bid submission and to have them audited by auditors appointed by the Employer

(k) Our Price Bid is inclusive of all applicable taxes, duties, cess, surcharges, levies

Yours faithfully,

(Authorized Signatory)

Name .....

In the capacity of .....

Signed .....
.....

Duly authorized to sign the Bid for and on behalf of .....

Date .....
.....

PREAMBLE

1. The prices are to be quoted in lump sum for the entire Design-Build component for which no Adjustments for Changes in Costs (Sub-Clause 13.8 of PCC Part B) escalation shall be admissible. The quoted lump sum cost shall include all applicable taxes, duties, cess, surcharges, levies, such as sales tax, VAT, excise duty, service tax, swatch bharat cess, education cess, etc.
2. The Annual O&M Cost (excluding power) shall be quoted based on the prices as on 28 (twenty eight) days prior to the date of submission of the Bid. The quoted cost shall include all applicable taxes, duties, cess, surcharges, levies, such as sales tax, VAT, excise duty, service tax, swatch bharat cess, education cess, etc. The Annual O&M Cost shall be at least 1% of the cost of the Design Build component. Adjustments for Changes in Costs shall be admissible on O&M cost as per Sub-Clause 13.8 of PCC Part B.
3. The prices quoted as per para 1 and 2 above shall include all Works required to be executed as per terms of the Contract which shall be in conformity with the specifications included in the Bid Documents. The Works components shall be operational.
4. The breakup of quoted amount for Design-Build part of the works shall be as included at Schedule I: Schedule of Payments, Sub-Clause 14.4 of PCC Part B.
5. The Successful Bidder shall submit a further break up of prices for each of the parts stated in Schedule I: Schedule of Payments Sub-Clause 14.4 of PCC Part B. Such breakup shall be submitted after completing Survey, Investigation, Planning and Design (Part A of Schedule I). Such breakup shall be submitted by the Contractor to fully justify its proposal. This break up shall be approved by the Employer after satisfying himself regarding its justification to avoid any front loading and appropriateness. The payments to the Contractor while executing the Works (Design-Build Part) shall be made on the basis of such approved breakup.
6. The prices quoted are to be inclusive of all contingencies and investigations that maybe required for finalizing the designs, completing the work and will also take into account the soil and water table conditions likely to be encountered during the execution and no additional payment shall be admissible on these accounts.
7. The Power Cost for the Operation & Maintenance contract shall be reimbursed to the Contractor every month in accordance with the provisions contained in Adjustments for Changes in Costs (Sub-Clause 13.8 of PCC Part B).
8. The Guaranteed Power Requirement as quoted in TECH 1, and Loaded Land Cost as per TECH 2 shall be used for the purpose of evaluation of the Price Bid.
9. The Price Bid would be evaluated as per the details set out in Section 3 of ITB. Thus, the computation for arriving at the Evaluated Price Bid would be as under:
10. Evaluated Price Bid = Design Build Cost + Evaluated O&M Cost + Evaluated Power Cost + Loaded Land Cost

Price Bid Format

Uploaded in Separate Excel Sheet

Validate Print Help

Item Rate BoQ

Tender Inviting Authority : JAIPUR DEVELOPMENT AUTHORITY, JAIPUR.

Name of Work: Selection of a Bidder under Swiss Challenge Method for Rejuvenation of Amanishah Nallah (Dravyavati River), Jaipur (Rajasthan) including Area Development on Turnkey Basis, and its Operation & Maintenance (O&M) for a Period of 10 Years

Contract No: E.E.-7_17/2015-16

Bidder Name :				
PRICE SCHEDULE **(This BOQ template must not be modified/replaced by the bidder and the same should be uploaded after filling the relevent columns, else the bidder is liable to be rejected for this tender. Bidders are allowed to enter the Bidder Name and Values only)**				
NUMBER	**TEXT #**	**NUMBER #**	**NUMBER #**	**TEXT #**
Sl. No.	**Item Description**	**Rate (Rs. In Crore)**	**Amount (Rs. In Crore)**	**TOTAL AMOUNT In Words**
1	**2**	**3**	**4**	**5**
1	**PART-I DESIGN BUILD COST**			
1.01	The prices are to be quoted in lump sum for the entire Design-Build component for which no Adjustments for Changes in Costs (Sub-Clause 13.8 of PCC Part B) escalation shall be admissible. The quoted lump sum cost shall include all applicable taxes, duties, cess, surcharges, levies, such as sales tax, VAT, excise duty, service tax, swatch bharat cess, education cess, etc.		**0.00**	INR Zero Only
2	**PART-II OPERATION & MAINTENANCE (O&M) COST**			
2.01	The Annual O&M Cost (excluding power) shall be quoted based on the prices as on 28 (twenty eight) days prior to the date of submission of the Bid. The quoted cost shall include all applicable taxes, duties, cess, surcharges, levies, such as sales tax, VAT, excise duty, service tax, swatch bharat cess, education cess, etc. **The Annual O&M Cost shall be at least 1% of the cost of the Design Build component. Adjustments for Changes in Costs shall be admissible on O&M cost as per Sub-Clause 13.8 of PCC Part B.**		**0.00**	INR Zero Only
Total in Figures			**0.00**	INR Zero Only
Quoted Rate in Words		**INR Zero Only**		