Rev 01
1st Jun
2012

NOTICE INVITING TENDER

(Document No PS:MSX:NIT)

Bharat Heavy Electricals Limited

Ref: **BHEL/NR/SCT/KOSTI/SOIL STABILIZATION/984**
Date: ---/---/-------

==========

NOTICE INVITING TENDER (NIT)

NOTE: BIDDER MAY DOWNLOAD FROM WEB SITES OR PURCHASE TENDERS FROM THIS OFFICE ALSO

==========

To

Dear Sir/Madam

Sub : NOTICE INVITING TENDER

Sealed offers in two part bid system are invited from reputed & experienced bidders (meeting PRE QUALIFICATION CRITERIA as mentioned in Annexure-I) for the subject job by the undersigned on the behalf of BHARAT HEAVY ELECTRICALS LIMITED as per the tender document. Following points relevant to the tender may please be noted and complied with.

1.0 Salient Features of NIT

SL NO	ISSUE	DESCRIPTION	
i	TENDER NUMBER	**BHEL/NR/SCT/KOSTI/SOIL STABILIZATION/984**	
ii	Broad Scope of job	**"Work of Soil stabilization of RWIPH, CWPH & switchyard area, by compaction grouting at 4X125 MW TPS, Kosti, Sudan."**	
iii	DETAILS OF TENDER DOCUMENT		
a	Volume-IA	*Technical Conditions of Contract (TCC) consisting of Scope of work, Technical Specification, Drawings, Procedures, Bill of Quantities, Terms of payment, etc*	*Applicable*
b	Volume-IB	*Special Conditions of Contract (SCC)*	*Applicable*
c	Volume-IC	*General Conditions of Contract (GCC)*	*Applicable*
d	Volume-ID	*Forms and Procedures*	*Applicable*
e	Volume-II	*Price Schedule (Absolute value).*	*Applicable*
iv	Issue of Tender Documents	***1. Sale from BHEL PS Regional office at :*** ***Start : 13/01/2015, Time : 0900 Hrs (IST)*** ***Closes: 04/02/2015, Time : 1200 Hrs (IST)*** **2. From BHEL website (www.bhel.com)** Tender documents will be available for downloading from website till due date of submission	*Applicable*
v	DUE DATE & TIME OF OFFER SUBMISSION	***Date : 04/02/2015, Time :1500 Hrs (IST)*** ***Place : BHEL-PSNR-Noida***	*Applicable*
vi	OPENING OF TENDER	***Date : 04/02/2015,*** *(within 2 hours of the latest due date and time of offer*	*Applicable*

		submission). *Notes:* *(1) In case the due date of opening of tender becomes a non-working day, then the due date & time of offer submission and opening of tenders get extended to the next working day.* *(2) Bidder may depute representative to witness the opening of tender*	
vii	**EMD AMOUNT**	*Rs 2,00,000/- or Euro 2600/-*	*Applicable*
viii	**COST OF TENDER**	*Nil*	*Not Applicable*
ix	**LAST DATE FOR SEEKING CLARIFICATION**	*Date**: 23/01/2015*** *Along with soft version also, addressing to undersigned & to others as per contact address given below*	*Applicable*
x	**SCHEDULE OF Pre Bid Discussion (PBD)**		*Not applicable.*
xi	**INTEGRITY PACT & DETAILS OF INDEPENDENT EXTERNAL MONITOR (IEM)**	*Shri D.R.S Chaudhary, IAS (Retd.)* *Flat No. L-202 & L-203 (1st Floor)* *Ansal Lake View Enclave* *Shamla Hills* *Bhopal- 462 013 (M.P.)* *dilip.chaudhary@icloud.com*	*Applicable*
xii	**Latest updates**	Latest updates on the important dates, Amendments, Correspondences, Corrigenda, Clarifications, Changes, Errata, Modifications, Revisions, etc to Tender Specifications will be hosted in BHEL webpage (www.bhel.com -->Tender Notifications →View Corrigendums) **and not in the newspapers**. Bidders to keep themselves updated with all such information	

2.0 The offer shall be submitted as per the instructions of tender document and as detailed in this NIT. Bidders to note specifically that all pages of tender document, including these NIT pages of this particular tender together with subsequent correspondences shall be submitted by them, duly signed & stamped on each page, as part of offer. **Rates/Price including discounts/rebates, if any, mentioned anywhere/in any form in the techno-commercial offer other than the Price Bid, shall not be entertained.**

3.0 Unless specifically stated otherwise, bidder shall remit cost of tender and courier charges if applicable, in the form of Demand Draft drawn in favour of Bharat Heavy Electricals Ltd, payable at Power Sector Regional HQ at Noida issuing the Tender, along with techno-commercial offer. Bidder may also choose to deposit the Tender document cost by cash at the Cash Office as stated above against sl no iv of 1, on any working day; and in such case copy of Cash receipt is to be enclosed with the Techno Commercial offer. Sale of tender Documents shall not take place on National Holidays, holidays declared by Central or State Governments and BHEL PS HQ at Noida, Sundays and second/ last Saturdays

4.0 Unless specifically stated otherwise, bidder shall deposit EMD through Demand Draft/Pay Order in favour of Bharat Heavy Electricals Ltd, payable at Noida. For other details and for 'One Time EMD' please refer General Conditions of Contract.

Note:-
Foreign bidders may also deposit EMD amount at Kosti Sudan site and a receipt of deposited EMD should be submitted along with your offer.

5.0 **Procedure for Submission of Tenders**: The Tenderers must submit their Tenders to Officer inviting Tender, as detailed below:

- PART-I consisting of 'PART-I A (Techno Commercial Bid)' & 'PART-I B (EMD/COST of TENDER)' in two separate sealed and superscribed envelopes (ENVELOPE-I & ENVELOPE-II)
- PART-II (Price Bid) – in sealed and superscribed envelope (ENVELOPE-III)
- One set of tender documents shall be retained by the bidder for their reference

6.0 The contents for ENVELOPES and the superscription for each sealed cover/Envelope are as given below. **(All pages to be signed and stamped)**

Sl no	Description	Remarks
	Part-I A	
	ENVELOPE – I superscribed as : PART-I (TECHNO COMMERCIAL BID) TENDER NO : NAME OF WORK : PROJECT: DUE DATE OF SUBMISSION: **CONTAINING THE FOLLOWING**:-	
i.	Covering letter/Offer forwarding letter of Tenderer.	
ii.	Duly filled-in `No Deviation Certificate' as per prescribed format to be placed after document under sl no (i) above. **Note:** a. In case of any deviation, the same should be submitted separately for technical & commercial parts, indicating respective clauses of tender against which deviation is taken by bidder. The list of such deviation shall be placed after document under sl no (i) above. It shall be specifically noted that deviation recorded elsewhere shall not be entertained. b. BHEL reserves the right to accept/reject the deviations without assigning any reasons, and BHEL decision is final and binding. i). In case of acceptance of the deviations, appropriate loading shall be done by BHEL ii). In case of unacceptable deviations, BHEL reserves the right to reject the tender	
iii.	Supporting documents/ annexure/ schedules/ drawing etc as required in line with Pre-Qualification criteria. It shall be specifically noted that all documents as per above shall be indexed properly and credential certificates issued by clients shall distinctly bear the name of organization, contact ph no, FAX no, etc.	
iv.	All Amendments/Correspondences/Corrigenda/Clarifications/Changes/ Errata etc pertinent to this NIT.	
v.	Integrity Pact Agreement (Duly signed by the authorized signatory)	If applicable
vi.	Duly filled-in annexures, formats etc as required under this Tender Specification/NIT	
vii.	Notice inviting Tender (NIT)	
viii.	Volume – I A : Technical Conditions of Contract (TCC) consisting of Scope of work, Technical Specification, Drawings, Procedures, Bill of Quantities, Terms of payment, etc	
ix.	Volume – I B : Special Conditions of Contract (SCC)	
x.	Volume – I C : General Conditions of Contract (GCC)	
xi.	Volume – I D : Forms & Procedures	
xii.	Volume – II (UNPRICED – without disclosing rates/price, but mentioning only 'QUOTED' or 'UNQUOTED' against each item	
xiii.	Any other details preferred by bidder with proper indexing.	

	PART-I B	
	ENVELOPE – II superscribed as: PART-I (EMD/COST of TENDER) TENDER NO : NAME OF WORK : PROJECT: DUE DATE OF SUBMISSION: **CONTAINING THE FOLLOWING**:-	
i.	1. Earnest Money Deposit (EMD) in the form as indicated in this Tender **OR** Documentary evidence for 'One Time EMD' with the Power Sector Region of BHEL floating the Tender 2. Cost of Tender (Demand Draft or copy of Cash Receipt as the case may be)	

	PART-II	
	PRICE BID consisting of the following shall be enclosed	
	ENVELOPE-III superscribed as: PART-II (PRICE BID) TENDER NO : NAME OF WORK : PROJECT: DUE DATE OF SUBMISSION: **CONTAINING THE FOLLOWING**	
i	Covering letter/Offer forwarding letter of Tenderer enclosed in Part-I	
ii	Volume II – PRICE BID (Duly Filled in Schedule of Rates – rate/price to be entered in words as well as figures)	

	OUTER COVER	
	ENVELOPE-IV (MAIN ENVELOPE / OUTER ENVELOPE) superscribed as: TECHNO-COMMERCIAL BID, PRICE BID & EMD TENDER NO: NAME OF WORK: PROJECT: DUE DATE OF SUBMISSION: **CONTAINING THE FOLLOWING:**	
i	o Envelopes I o Envelopes II o Envelopes III	

SPECIAL NOTE : All documents/ annexures submitted with the offer shall be properly annexed and placed in respective places of the offer as per enclosure list mentioned in the covering letter. BHEL shall not be responsible for any missing documents.

7.0 Deviation with respect to tender clauses and additional clauses/suggestions in Techno-commercial bid / Price bid shall NOT be considered by BHEL. Bidders are requested to positively comply with the same.

8.0 BHEL reserves the right to accept or reject any or all Offers without assigning any reasons thereof. BHEL also reserves the right to cancel the Tender wholly or partly without assigning any reason thereof. Also BHEL shall not entertain any correspondence from bidders in this matter (except for the refund of EMD).

9.0 Not used.

10.0 Since the job shall be executed at site**,** bidders must visit site/ work area and study the job content, facilities available, availability of materials, prevailing site conditions including law & order situation, applicable wage structure, wage rules, etc before quoting for this tender. They may also consult this office before submitting their offers, for any clarifications regarding scope of work, facilities available at sites or on terms and conditions.

11.0 For any clarification on the tender document, the bidder may seek the same in writing or through e-mail, as per specified format, within the scheduled date for seeking clarification, from the office of the undersigned. BHEL shall not be responsible for receipt of queries after due date of seeking clarification due to postal delay or any other delays. Any clarification / query received after last date for seeking clarification may not be normally entertained by BHEL and no time extension will be given.

12.0 BHEL may decide holding of pre-bid discussion [PBD] with all intending bidders as per date indicated in the NIT. The bidder shall ensure participation for the same at the appointed time, date and place as may be decided by BHEL. Bidders shall plan their visit accordingly. The outcome of pre-bid discussion (PBD) shall also form part of tender.

13.0 In the event of any conflict between requirement of any clause of this specification/ documents/drawings/data sheets etc or requirements of different codes/standards specified, the same to be brought to the knowledge of BHEL in writing for clarification before due date of seeking clarification (whichever is applicable), otherwise, interpretation by BHEL shall prevail. Any typing error/missing pages/ other clerical errors in the tender documents, noticed must be pointed out before pre-bid meeting/submission of offer, else BHEL's interpretation shall prevail.

14.0 Unless specifically mentioned otherwise, bidder's quoted price shall deemed to be in compliance with tender including PBD.

15.0 Bidders shall submit Integrity Pact Agreement (Duly signed by authorized signatory who signs in the offer), **if applicable**, along with techno-commercial bid. This pact shall be considered as a preliminary qualification for further participation. **The names and other details of Independent External Monitor (IEM) for the subject tender is as given at point (1) above.**

16.0 The Bidder has to satisfy the Pre Qualifying Requirements stipulated for this Tender in order to be qualified. The Price Bids of only those bidders will be opened who will be qualified for the subject job on the basis of satisfying the Pre Qualification Criteria specified in this NIT as per Annexure-I (as applicable), past performance etc. and date of opening of price bids shall be intimated to only such bidders. BHEL reserves the right not to consider offers of parties under HOLD.

17.0 In case BHEL decides on a `Public Opening', the date & time of opening of the sealed PRICE BID shall be intimated to the qualified bidders and in such a case, bidder may depute one authorised representative to witness the price bid opening. BHEL reserves the right to open 'in-camera' the 'PRICE BID' of any or all Unsuccessful/Disqualified bidders under intimation to the respective bidders.

18.0 Validity of the offer shall be for **six months** from the latest due date of offer submission (including extension, if any) unless specified otherwise.

19.0 BHEL reserves the right to decide the successful bidder on the basis of Reverse Auction process. In such case all qualified bidders will be intimated regarding procedure/ modality for Reverse Auction process prior to Reverse Auction and price will be decided as per the rules for Reverse Auction. .

However, if reverse auction process is unsuccessful as defined in the RA rules/procedures, or for whatsoever reason, then the sealed 'PRICE BIDs' will be opened for deciding the successful bidder. BHEL's decision in this regard will be final and binding on bidder.

20.0 On submission of offer, further consideration will be subject to compliance to tender & qualifying requirement and customer's acceptance, as applicable.

21.0 In case the bidder is an "Indian Agent of Foreign Principals", 'Agency agreement has to be submitted along with Bid, detailing the role of the agent along with the terms of payment for agency commission in INR, along with supporting documents.

22.0 The bidders shall not enter into any undisclosed M.O.U. or any understanding amongst themselves with respect to tender.

23.0 **Not Used**

24.0 The bidder shall submit documents in support of possession of 'Qualifying Requirements' duly self-certified and stamped by the authorized signatory, indexed and properly linked in the format for PQR. In case BHEL requires any other documents/proofs, these shall be submitted immediately.

25.0 The bidder may have to produce original document for verification if so decided by BHEL.

26.0 The offers of the bidders who are on the banned list as also the offer of the bidders, who engage the services of the banned firms, shall be rejected. The list of **banned firms** is available on BHEL web site www.bhel.com.

27.0 BHEL reserves the right to go for **Reverse Auction (RA**) instead of opening the sealed envelope price bid, submitted by the bidder. This will be decided after techno-commercial evaluation. All bidders to give their acceptance for participation in RA. Non-acceptance to participate in RA may result in non-consideration of their bids, in case BHEL decides to go for RA.

In case BHEL decides to go for Reverse Auction, only those bidders who have given their acceptance to participate in RA will be allowed to participate in the Reverse Auction. Those bidders who have given their acceptance to participate in Reverse Auction will have to necessarily submit „online sealed bid" in the Reverse Auction. Non-submission of „online sealed bid" by the bidder will be considered as tampering of the tender process and will invite action by BHEL as per extant guidelines in vogue."

Information and General Terms and Conditions governing RA shall form part of the RFQ/ Enquiry.

28.0 It may please be noted that **guidelines/rules** in respect of Suspension of Business dealings', 'Vendor evaluation format', 'Quality, Safety & HSE guidelines', etc may **undergo change** from time to time and the latest one shall be followed.

29.0 **Micro and Small Enterprises (MSE)**

Any Bidder falling under MSE category, shall furnish the following details & submit documentary evidence/ Govt. Certificate etc. in support of the same along with their techno-commercial offer

Type under MSE	SC/ST owned	Others
Micro		
Small		

Note: - If the bidder does not furnish the above, offer shall be processed construing that the bidder is not falling under MSE category.

MSE suppliers can avail the intended benefits only if they submit along with the offer, attested copies of either EM-II certificate having deemed validity (five years from the date of issue of acknowledgement in EM-II) or valid NSIC certificate or EM-II certificate along with attested copy of a CA certificate (format enclosed as Annexure – 3 where deemed validity of EM-II certificate of five years has expired) applicable for the relevant financial year (last audited). Date to be reckoned for determining the deemed validity will be the date of bid opening (Part 1 in case of two part bid). Non submission of such documents will lead to consideration of their bids at par with other bidders. No benefits shall be applicable for this enquiry if any deficiency in the above required documents are not submitted before price bid opening. If the tender is to be submitted through e-procurement portal, then the above required documents are to be uploaded on the portal. Documents should be notarized or attested by a Gazetted officer. .

30.0 Order of Precedence

In the event of any ambiguity or conflict between the Tender Documents, the order of precedence shall be in the order below:

a. Amendments/Clarifications/Corrigenda/Errata etc issued in respect of the tender documents by BHEL
b. Notice Inviting Tender (NIT)
c. Price Bid
d. Technical Conditions of Contract (TCC)—Volume-1A
e. Special Conditions of Contract (SCC) —Volume-1B
f. General Conditions of Contract (GCC) —Volume-1C
g. Forms and Procedures —Volume-1D

for BHARAT HEAVY ELECTRICALS LTD
(SCT)

Enclosure

01. Annexure-1: Pre Qualifying criteria.
02. Annexure-2: Check List.
03. Annexure-3: Chartered Accountant certificate for MSMED
04. Other Tender documents as per this NIT.

ANNEXURE - 1

PRE QUALIFYING REQUIREMENTS

JOB	**"Work of Soil stabilization of RWIPH, CWPH & Switchyard area, by compaction grouting at 4X125 MW TPS, Kosti, Sudan."**
TENDER NO	**BHEL/NR/SCT/KOSTI/SOIL STABILIZATION/984**

SL. NO.	PRE QUALIFICATION CRITERIA	Bidders claim in respect of fulfilling the PQR Criteria Name and Description of qualifying criteria
A	**Submission of Integrity Pact duly signed**	**Applicable**
B	**Technical** Tenderer who wish to participate should have executed during the last seven years, ending last day of month previous to one in which applications are invited, work related to soil stabilisation, as per following: 1.1 One single work of value not less than Rs. 20 Crores. 'OR' 1.2 Two works of value not less than Rs. 15 Crores each. 'OR' 1.3 Three works of value not less than Rs. 10 Crores each.	**Applicable**
C-1	**Financial** **TURNOVER** Bidders should have achieved an average annual financial turnover (Audited) of Rs. 750 Lakhs or more during last three Financial Years (FY) i.e 2011-12, 2012-13 & 2013-14.	**Applicable**
C-2	**NETWORTH (only in case of Companies)** Net worth of the Bidder based on the latest Audited Accounts as furnished for 'C-1' above should be positive.	**Applicable**
C-3	**PROFIT** Bidder must have earned cash profit (i.e PAT + Non Cash Expenditure viz depreciation) in any one of the three Financial Years as applicable in the last three Financial Years defined in 'C-1' above based on latest Audited Accounts. Bidder to submit Audited Balance Sheet and Profit & Loss Account of above three Financial years meeting the requirement at "C-1" above.	**Applicable**

	In case the audited Financial statements are not submitted for all the three years as indicated at "C-1" above, then the applicable audited statements submitted by the bidders against the requisite three years, will be averaged for three years i.e. total divided by three.	
D	**Assessment of Capacity of Bidder to execute the work as per sl. no. 9 of NIT**	**Not Applicable**
E	**Approval of Customer**	**Not Applicable**
F	**Consortium criteria**	**Not Applicable**
	Explanatory Notes for QR 'B' 1. For the word 'executed' means the bidder should have achieved the criteria specified in the QR even if the total contract has not been completed or closed. 2. For B-1.1, B-1.2 and B-1.3, value of work is to be updated as per the PVC formula of GCC with indices for "All India Avg. Consumer Price Index for Industrial Workers' (i.e. 'K' in this case shall be 80%) with base month as date of execution (completion of contract/ work) and indexed upto two months prior to bid opening months. This condition will be applicable only for the completed jobs and not for the jobs in progress as on date of technical bid opening. 3. If the qualifying work is completed in the Seven (7) years period specified above, even if it has been started earlier, the same will also be considered meeting the qualifying requirements. 4. For conversion from Bidder's document's Currency to INR as required for QR points sl. no. B, C and sl. no. 2 of Explanatory notes, SBI TT selling rate prevailing on the date of technical bid opening shall be considered.	

BIDDER SHALL SUBMIT ABOVE PRE-QUALIFICATION CRITERIA FORMAT, DULY FILLED-IN, SPECIFYING RESPECTIVE ANNEXURE NUMBER AGAINST EACH CRITERIA AND FURNISH RELEVANT DOCUMENT INCLUSIVE OF WORK OREDER AND WORK COMPLETION CERTIFICATE ETC IN THE RESPECTIVE ANNEXURES IN THEIR OFFER

.

ANNEXURE - 2

CHECK LIST

NOTE:- Tenderers are required to fill in the following details and no column should be left blank

1	Name and Address of the Tenderer		
2	Details about type of the Firm/Company		
3.a	Details of Contact person for this Tender	Name : Mr/Ms Designation: Telephone No: Mobile No: Email ID: Fax No:	
3.b	Details of alternate Contact person for this Tender	Name : Mr/Ms Designation: Telephone No: Mobile No: Email ID: Fax No:	
4	EMD DETAILS	DD No: Date : Bank : Amount: Please tick (√) whichever applicable:- ONE TIME EMD / ONLY FOR THIS TENDER	
5	Validity of Offer	TO BE VALID FOR SIX MONTHS FROM DUE DATE	
		APPLICABILITY (BY BHEL)	ENCLOSED BY BIDDER
6	Whether the format for compliance with **PRE QUALIFICATION CRITERIA** (ANNEXURE-I) is understood and filled with proper supporting documents referenced in the specified format	Applicable	YES / NO
7	Audited profit and Loss Account for the last three years	Applicable/Not Applicable	YES/NO
8	Copy of PAN Card	Applicable/Not Applicable	YES/NO
9	Whether all pages of the Tender documents including annexures, appendices etc are read understood and signed	Applicable/Not Applicable	YES/NO
10	Integrity Pact	Applicable/Not Applicable	YES/NO
11	Declaration by Authorised Signatory	Applicable/Not Applicable	YES/NO
12	No Deviation Certificate	Applicable/Not Applicable	YES/NO
13	Declaration confirming knowledge about Site Conditions	Applicable/Not Applicable	YES/NO
14	Declaration for relation in BHEL	Applicable/Not Applicable	YES/NO
15	Non Disclosure Certificate	Applicable/Not Applicable	YES/NO
16	Bank Account Details for E-Payment	Applicable/Not Applicable	YES/NO
17	Capacity Evaluation of Bidder for current Tender	Applicable/Not Applicable	YES/NO
18	Tie Ups/Consortium Agreement are submitted as per format	Applicable/Not Applicable	YES/NO

19	Power of Attorney for Submission of Tender/Signing Contract Agreement	Applicable/Not Applicable	YES/NO
20	Analysis of Unit rates	Applicable/Not Applicable	YES/NO

NOTE : STRIKE OFF 'YES' OR 'NO', AS APPLICABLE. TENDER NOT ACCOMPANIED BY THE PRESCRIBED **ABOVE APPLICABLE DOCUMENTS** ARE LIABLE TO BE SUMMARILY REJECTED.

DATE :

AUTHORISED SIGNATORY
(With Name, Designation and Company seal)

ANNEXURE - 3

Certificate by Chartered Accountant on letter head

This is to Certify that M/S ..... , (hereinafter referred to as 'company') having its registered office at ..... is registered under MSMED Act 2006, (Entrepreneur Memorandum No (Part—II) ..... dtd:..... , Category: ..... (Micro/Small)). (Copy enclosed).

Further verified from the Books of Accounts that the investment of the company as per the latest audited financial year..... as per MSMED Act 2006 is as follows:

1. **For Manufacturing Enterprises:** Investment in plant and machinery (i.e. original cost excluding land and building and the items specified by the Ministry of Small Scale Industries vide its notification No. S.O.1722(E) dated October 5, 2006:
   Rs.....Lacs

2. **For Service Enterprises:** Investment in equipment (original cost excluding land and building and furniture, fittings and other items not directly related to the service rendered or as may be notified under the **MSMED** Act, 2006:
   Rs.....Lacs

(Strike off which is not applicable)

The above investment of Rs.....Lacs is within permissible limit of Rs.....Lacs for ..... Micro / Small **(Strike off which is not applicable)**

Category under MSMED Act 2006.

Or

The company has been graduated from its original category (Micro/Small) (Strike off which is not applicable) and the date of graduation of such enterprise from its original category is ..... (dd/mm/yyyy) which is within the period of 3 years from the date of graduation of such enterprise from its original category as notified vide S.O. No. 3322(E) dated 01.11.2013 published in the gazette notification dated 04.11.2013 by Ministry of MSME.

Date:

(Signature)

Name -

Membership number -

Seal of Chartered Accountant

ANNEXURE - 4

GENERAL TERMS AND CONDITIONS OF REVERSE AUCTION (RA)

Against this enquiry for the subject item/ system with detailed scope of supply as per enquiry specifications, BHEL may resort to "REVERSE AUCTION PROCEDURE" i.e., ON LINE BIDDING (THROUGH A SERVICE PROVIDER). The philosophy followed for reverse auction shall be English Reverse (No ties).

1. For the proposed reverse auction, technically and commercially acceptable bidders only shall be eligible to participate.

2. Those bidders who have given their acceptance for Reverse Auction (quoted against this tender enquiry) will have to necessarily submit "online sealed bid" in the Reverse Auction. Non submission of "online sealed bid" by the bidder for any of the eligible items for which techno commercially qualified, will be considered as tampering of the tender process and will invite action by BHEL as per extant guidelines in vogue.

3. BHEL will engage the services of a service provider who will provide all necessary training and assistance before commencement of on line bidding on internet.

4. In case of reverse auction, BHEL will inform the bidders the details of Service Provider to enable them to contact & get trained.

5. Business rules like event date, time, bid decrement, extension etc. also will be communicated through service provider for compliance.

6. Bidders have to fax the Compliance form before start of Reverse auction. Without this, the bidder will not be eligible to participate in the event.

7. In line with the NIT terms, BHEL will provide the calculation sheet (e.g., EXCEL sheet) which will help to arrive at "Total Cost to BHEL" like Packing & forwarding charges, Taxes and Duties, Freight charges, Insurance, Service Tax for Services and loading factors (for non-compliance to BHEL standard Commercial terms & conditions) for each of the bidder to enable them to fill-in the price and keep it ready for keying in during the Auction.

8. Reverse auction will be conducted on scheduled date & time.

9. At the end of Reverse Auction event, the lowest bidder value will be known on auction portal.

10. The lowest bidder has to fax/e-mail the duly signed and filled-in prescribed format for price breakup including that of line items, if required, as provided on case-to-case basis to Service provider within two working days of Auction without fail.

11. In case BHEL decides not to go for Reverse Auction procedure for this tender enquiry, the Price bids and price impacts, if any, already submitted and available with BHEL shall be opened as per BHEL"s standard practice.

12. Bidders shall be required to read the "Terms and Conditions" section of the auctions site of Service provider, using the Login IDs and passwords given to them by the service provider before reverse auction event. Bidders should acquaint themselves of the

"Business Rules of Reverse Auction", which will be communicated before the Reverse Auction.

13. If the Bidder or any of his representatives are found to be involved in Price manipulation/ cartel formation of any kind, directly or indirectly by communicating with other bidders, action *as per extant BHEL guidelines*, shall be initiated by BHEL and the results of the RA scrapped/ aborted.

14. The Bidder shall not divulge either his Bids or any other exclusive details of BHEL to any other party.

15. In case BHEL decides to go for reverse auction, the H1(s) bidder (whose quote is highest in online sealed bid) may not be allowed to participate in further RA process.

ANNEXURE – 4

Authorization of representative who will participate in the on line Reverse Auction Process;

1	NAME & DESIGNATION OF OFFICIAL	
2	POSTAL ADDRESS (COMPLETE)	
3	TELEPHONE NOS. (LAND LINE & MOBILE BOTH)	
4	FAX NO.	
5	E-MAIL ADDRESS	
6	NAME OF PLACE/ STATE/ COUNTRY, WHEREFROM S/HE WILL PARTICIPATE IN THE REVERSE AUCTION	

INTEGRITY PACT

Between

Bharat Heavy Electricals Ltd. (BHEL), a company registered under the Companies Act 1956 and having its registered office at "BHEL House", Siri Fort, New Delhi – 110049 (India) hereinafter referred to as "The Principal", which expression unless repugnant to the context or meaning hereof shall include its successors or assigns of the ONE PART

and

_____, (description of the party along with address), hereinafter referred to as "The Bidder/ Contractor" which expression unless repugnant to the context or meaning hereof shall include its successors or assigns of the OTHER PART

Preamble

The Principal intends to award, under laid-down organizational procedures, contract/s for _____

_____

_____. The Principal values full compliance with all relevant laws of the land, rules and regulations, and the principles of economic use of resources, and of fairness and transparency in its relations with its Bidder(s)/ Contractor(s).

In order to achieve these goals, the Principal will appoint Independent External Monitor(s), who will monitor the tender process and the execution of the contract for compliance with the principles mentioned above.

Section 1 – Commitments of the Principal

1.1 The Principal commits itself to take all measures necessary to prevent corruption and to observe the following principles:-

1.1.1 No employee of the Principal, personally or through family members, will in connection with the tender for, or the execution of a contract, demand, take a promise for or accept, for self or third person, any material or immaterial benefit which the person is not legally entitled to.

1.1.2 The Principal will, during the tender process treat all Bidder(s) with equity and reason. The Principal will in particular, before and during the tender process, provide to all Bidder(s) the same information and will not provide to any Bidder(s) confidential / additional information through which the Bidder(s) could obtain an advantage in relation to the tender process or the contract execution.

1.1.3 The Principal will exclude from the process all known prejudiced persons.

1.2 If the Principal obtains information on the conduct of any of its employees which is a penal offence under the Indian Penal Code 1860 and Prevention of Corruption Act 1988 or any other statutory penal enactment, or if there be a substantive suspicion in this regard, the Principal will inform its Vigilance Office and in addition can initiate disciplinary actions.

Section 2 – Commitments of the Bidder(s)/ Contractor(s)

2.1 The Bidder(s)/ Contractor(s) commit himself to take all measures necessary to prevent corruption. He commits himself to observe the following principles during his participation in the tender process and during the contract execution.

2.1.1 The Bidder(s)/ Contractor(s) will not, directly or through any other person or firm, offer, promise or give to the Principal or to any of the Principal's employees involved

in the tender process or the execution of the contract or to any third person any material, immaterial or any other benefit which he / she is not legally entitled to, in order to obtain in exchange any advantage of any kind whatsoever during the tender process or during the execution of the contract.

2.1.2 The Bidder(s)/ Contractor(s) will not enter with other Bidder(s) into any illegal or undisclosed agreement or understanding, whether formal or informal. This applies in particular to prices, specifications, certifications, subsidiary contracts, submission or non-submission of bids or any other actions to restrict competitiveness or to introduce cartelization in the bidding process.

2.1.3 The Bidder(s)/ Contractor(s) will not commit any penal offence under the relevant IPC/ PC Act; further the Bidder(s)/ Contractor(s) will not use improperly, for purposes of competition or personal gain, or pass on to others, any information or document provided by the Principal as part of the business relationship, regarding plans, technical proposals and business details, including information contained or transmitted electronically.

2.1.4 The Bidder(s)/ Contractor(s) will, when presenting his bid, disclose any and all payments he has made, and is committed to or intends to make to agents, brokers or any other intermediaries in connection with the award of the contract.

2.2 The Bidder(s)/ Contractor(s) will not instigate third persons to commit offences outlined above or be an accessory to such offences.

Section 3 – Disqualification from tender process and exclusion from future contracts

If the Bidder(s)/ Contractor(s), before award or during execution has committed a transgression through a violation of Section 2 above, or acts in any other manner such as to put his reliability or credibility in question, the Principal is entitled to disqualify the Bidder(s)/ Contractor(s) from the tender process or take action as per the separate "Guidelines on Banning of Business dealings with Suppliers/ Contractors". framed by the Principal.

Section 4 – Compensation for Damages

4.1 If the Principal has disqualified the Bidder from the tender process prior to the award according to Section 3, the Principal is entitled to demand and recover the damages equivalent Earnest Money Deposit/Bid Security.

4.2 If the Principal has terminated the contract according to Section 3, or if the Principal is entitled to terminate the contract according to section 3, the Principal shall be entitled to demand and recover from the Contractor liquidated damages equivalent to 5% of the contract value or the amount equivalent to Security Deposit/Performance Bank Guarantee, whichever is higher.

Section 5 – Previous Transgression

5.1 The Bidder declares that no previous transgressions occurred in the last 3 years with any other company in any country conforming to the anti-corruption approach or with any other Public Sector Enterprise in India that could justify his exclusion from the tender process.

5.2 If the Bidder makes incorrect statement on this subject, he can be disqualified from the tender process or the contract, if already awarded, can be terminated for such reason.

Section 6 – Equal treatment of all Bidders/ Contractors/ Sub-contractors

6.1 The Bidder(s)/ Contractor(s) undertake(s) to obtain from all subcontractors a commitment consistent with this Integrity Pact and report Compliance to the Principal. This commitment shall be taken only from those sub-contractors whose contract value is more than 20 % of Bidder's/ Contractor's contract value with the Principal. The Bidder(s)/ Contractor(s) shall continue to remain responsible for any default by his Sub-contractor(s).

6.2 The Principal will enter into agreements with identical conditions as this one with all Bidders and Contractors.

6.3 The Principal will disqualify from the tender process all bidders who do not sign this pact or violate its provisions.

Section 7 – Criminal Charges against violating Bidders/ Contractors /Sub-contractors

If the Principal obtains knowledge of conduct of a Bidder, Contractor or Subcontractor, or of an employee or a representative or an associate of a Bidder, Contractor or Subcontractor which constitutes corruption, or if the Principal has substantive suspicion in this regard, the Principal will inform the Vigilance Office.

Section 8 –Independent External Monitor(s)

8.1 The Principal appoints competent and credible Independent External Monitor for this Pact. The task of the Monitor is to review independently and objectively, whether and to what extent the parties comply with the obligations under this agreement.

8.2 The Monitor is not subject to instructions by the representatives of the parties and performs his functions neutrally and independently. He reports to the CMD, BHEL.

8.3 The Bidder(s)/ Contractor(s) accepts that the Monitor has the right to access without restriction to all contract documentation of the Principal including that provided by the Bidder(s)/ Contractor(s). The Bidder(s)/ Contractor(s) will grant the monitor, upon his request and demonstration of a valid interest, unrestricted and unconditional access to his contract documentation. The same is applicable to Sub-contractor(s). The Monitor is under contractual obligation to treat the information and documents of the Bidder(s)/ Contractor(s) / Sub-contractor(s) with confidentiality.

8.4 The Principal will provide to the Monitor sufficient information about all meetings among the parties related to the contract provided such meetings could have an impact on the contractual relations between the Principal and the Contractor. The parties offer to the Monitor the option to participate in such meetings.

8.5 As soon as the Monitor notices, or believes to notice, a violation of this agreement, he will so inform the Management of the Principal and request the Management to discontinue or take corrective action, or heal the situation, or to take other relevant action. The Monitor can in this regard submit non-binding recommendations. Beyond this, the Monitor has no right to demand from the parties that they act in a specific manner, refrain from action or tolerate action.

8.6 The Monitor will submit a written report to the CMD, BHEL within 8 to 10 weeks from the date of reference or intimation to him by the Principal and, should the occasion arise, submit proposals for correcting problematic situations.

8.7 The CMD, BHEL shall decide the compensation to be paid to the Monitor and its terms and conditions.

8.8 If the Monitor has reported to the CMD, BHEL, a substantiated suspicion of an offence under relevant IPC / PC Act, and the CMD, BHEL has not, within reasonable time, taken visible action to proceed against such offence or reported it to the Vigilance Office, the

Monitor may also transmit this information directly to the Central Vigilance Commissioner, Government of India.

8.9 The number of Independent External Monitor(s) shall be decided by the CMD, BHEL.

8.10 The word 'Monitor' would include both singular and plural.

Section 9 – Pact Duration

9.1 This Pact begins and shall be binding on and from the submission of bid(s) by bidder(s). It expires for the Contractor 12 months after the last payment under the respective contract and for all other Bidders 6 months after the contract has been awarded.

9.2 If any claim is made / lodged during this time, the same shall be binding and continue to be valid despite the lapse of this pact as specified as above, unless it is discharged/ determined by the CMD, BHEL.

Section 10 – Other Provisions

10.1 This agreement is subject to Indian Laws and jurisdiction shall be registered office of the Principal, i.e. New Delhi.

10.2 Changes and supplements as well as termination notices need to be made in writing. Side agreements have not been made.

10.3 If the Contractor is a partnership or a consortium, this agreement must be signed by all partners or consortium members.

10.4 Should one or several provisions of this agreement turn out to be invalid, the remainder of this agreement remains valid. In this case, the parties will strive to come to an agreement to their original intentions.

10.5 Only those bidders/ contractors who have entered into this agreement with the Principal would be competent to participate in the bidding. In other words, entering into this agreement would be a preliminary qualification.

For & On behalf of the Principal

(Office Seal)

For & On behalf of the Bidder/ Contractor

(Office Seal)

Place----------

Date----------

Witness: _____

(Name & Address) _____

_____

Witness: _____

(Name & Address)_____

_____

TECHINICAL CONDITIONS OF CONTRACT

For

Work of Soil Stabilization of RWIPH, CWPH & Switchyard Area, by Compaction Grouting

at

4 x 125 MW KOSTI THERMAL POWER STATION SUDAN

Bharat Heavy Electricals Limited

(A Govt. Of India Undertaking)

Power Sector – Northren Region,

Plot No. 25 , Sector - 16A

Distt. Gautam Budh Nagar, NOIDA – 201 301 (INDIA)

INDEX

CHAPTER-I: PROJECT INFORMATION

1.0 Project Information

Owner : Sudan Thermal Power Generation

Owner Consultant : Fitchner, Germany

Location : Kosti, which is about 310 km from Khartoum, Sudan

Nearest Railway Station : Kosti

Ambient Air Temperature:

a. Absolute Mean Maximum Temperature: 45.0 Deg.C
b. Lowest Mean Minimum Temperature: 16.0 Deg.C

Relative Humidity : Mean Design Annual Humidity of Maximum 71% in August and 26% in April

Rainfall: : Average Annual Rainfall between 300mm to 450mm

Chapter - 2: SCOPE OF WORK

TECHNICAL CONDITIONS OF CONTRACT

2.0 SCOPE OF WORK

2.1 BHEL has been awarded the work of setting up 4 x 125 MW Power Plant in Kosti, Sudan on EPC basis.

2.2 The scope of work under this tender shall be Design, supply and execution of soil stabilization by compaction grouting on Engineering Procurement Construction (EPC) basis so as to ensure an in-situ dry density of at least 1.88 gm/cc is achieved for the sub-soil in the area/depth of the soil under stabilization. However the detailed scope of work is as follows.

i. Design of compaction grouting for various areas
ii. Preparation and release of construction drawings including getting approval from BHEL/Owner/Owner's Consultant.
iii. Field trials for validation of the design before implementation.
iv. Supply of all materials required for completion of the compaction grouting.
v. Execution of compaction grouting as per approved drawings and procedure including providing necessary labour, tools and plants/ equipment/ machineries etc. required for successful completion of work.
vi. Quality control

2.3 The scope of work shall also include pumping sand (sand shall be non- plastic with fine content limited to a maximum of 10%) under pressure below the ground floor slabs so as to fill the void between the bottom of floor and the sub-soil. The area of work shall be as follows:

2.3.1 River water intake pump house including adjacent areas for a depth of 4m, 8m and 12m below ground level.

2.3.2 CW pump house including adjacent areas for a depth of 10m below ground level.

2.3.3 Isolator pedestal foundations including adjacent areas in switchyard area for a depth of 4m below ground level.

2.3.4 It is to be ensured that after completion of grouting works, existing machineries/ equipment are **in** same condition as before the start of grouting work. If any existing machineries/ equipment are damaged, the same shall be rectified/ replaced along

with all accessories by the bidder at his/ her own risk and cost without any financial implication on BHEL/ Owner.

2.4 The customer M/s STPG, Sudan and / or their **Consultant M/s. Fichtner** may depute their representative for checking and supervision of important stages of work. The contractor shall be required to provide all facilities for inspection of works, without any cost implications to the BHEL. Any defect in quality of work or deviations from drawings / specifications pointed out during such inspection shall be made good by the contractor in the same way as if pointed out by the BHEL Engineer, without any cost implication to BHEL.

2.5 Present status of Building /Structure:

2.5.1 The buildings viz. River Water Intake Pump House (RWPH), CW Pump House (CWPH) and isolator pedestal foundations in switchyard are already constructed and equipment/ panels/ cable trenches are already installed in position at ground floor level. It has been presently observed that the ground floor slab/ equipment foundation/panel/cable trenches etc. in MCC room of both RWPH and CWPH got settled/ tilted due to the settlement of sub-soil. In switchyard, the isolator pedestal foundation got settled about 50mm unequally. The general arrangement and the ground floor foundation drawings are in drawing no PE-DG-250-683-C001, titled "River Side Intake Pump House & Electrical Building Foundation & Ground Floor Plan", PE-DG-250-653-C006, titled "CW Pump house-General arrangement of RCC Structure" and for Switchyard drawing no TB-0-279-607-609-A, titled "Layout & RCC details of trenches and road crossing" are enclosed for reference.

In addition, a drawing titled "Raw water intake pump house and adjacent areas-Compaction grouting" and "CW pump house and adjacent areas-Compaction grouting" are enclosed for reference.

2.6 Geotechnical investigation

2.6.1 BHEL had carried out post construction stage geo-technical investigation near the above mentioned buildings/structures. The Borehole BH-8, 9, 10, 11 and 12 are drilled near River water intake pump house are enclosed annexure I to V. Bore Hole 3 and 5 are drilled near CW pump house and enclosed VI to VII. In switchyard area there is no bore hole drilled at site. However it is to be mentioned that there is about 12m thick compacted backfill below the ground floor of MCC room at River Intake pump house, 10m thick compacted backfill below the ground floor of

MCC room in CW pump house and 2m thick compacted backfill below the isolator pedestal foundation in Switchyard.

During the Investigation it is revealed that the backfilled material is of collapsible soil which in contact with water caused settlement of the fill. Few Voids are also observed below the ground floor slabs. **The geo-technical investigation report available with BHEL is attached along with the specification**. The geotechnical data attached shall be solely for the purpose of guidance to the bidder. BHEL/owner does not take any responsibility about the accuracy and applicability of the geo-technical data furnished herewith. The onus of correct assessment/interpretation and understanding of the existing sub-strata conditions is on the bidder. Any variation in the data between the one furnished and to that found during execution of the work at site shall not constitute a valid reason in affecting the terms & conditions of this bid and the bidder shall note that nothing extra will be payable on this account. The bidder shall fully satisfy himself about the nature of sub-strata expected to be encountered including existing structures, ground water table etc. prior to the submission of the bid.

The geo-technical investigation report with BHEL shall be made available to the successful bidder during contract engineering stage. If the bidder desires to carry out additional geo-technical investigation it may do so with prior information/permission of BHEL/owner at no extra cost to BHEL/owner. No extension in time schedule shall be permitted on this account. The bidder shall obtain approval on the agency for conducting geo-technical investigation work, field and laboratory testing schedule proposed by the bidder etc. from BHEL/owner before undertaking the geo-technical investigation work.

2.7 Design of Grouting

The compaction grouting shall be properly analysed and designed for the specific site conditions. The following parameters need to be finalised such that a minimum of 1.88 gm/ cc in-situ dry density at site is achieved.

a) Size of grouting hole. However the same shall not be less than 50mm.
b) Spacing between two adjacent grouting holes. The maximum spacing between adjacent holes shall not exceed 1250mm in square pattern.
c) Grouting pressure required such that grout mix fill the void/compacted properly without heaving the floor slab.

2.8 Grouting Equipment:

2.8.1 The bidder shall provide all necessary equipment, machineries, Tools & Plants etc. required for completion of work as specified elsewhere. The boring/drilling equipment shall be capable of drilling RCC/PCC, overburden soil and advancing the grout pipe through RCC slab, overburden soil and other natural obstructions to the specified depth or as required meeting the project objectives.

2.8.2 **The list of equipment includes but not the limited to the following:**

2.8.2.1 Hydraulic drilling rig capable of drilling and installation of stinger rods down to required depth, drilling equipment capable of drilling through the reinforced ground floor slab, RCC/PCC pavement and sub-surface materials. The drilling equipment must be capable of installing the casing. The steel casing must have adequate strength to maintain the hole and to withstand the required jacking and pumping pressures.

2.8.2.2 Compaction Grout Pump should be capable of supplying grout at variable pressures up to 40 MPa.

2.8.2.3 The grouting mixer to ensure complete mixing of the stiff grout or a mixer as approved by the engineer. The compaction grout mixer should be of sufficient capacity to continuously deliver grout materials.

2.8.2.4 Compaction grout hose of size as required with non-restrictive full flow couplings and having sufficient strength for the pressures anticipated.

2.8.2.5 Drill tools (e.g. stinger rods, stinger shoe, drill head adopter, swivel, T-connection) and water/grout high-pressure hoses with respective clamp connections.

2.8.2.6 Samplers for collecting undisturbed soil samples and field density testing apparatus etc.

2.8.2.7 Any other Machinery/equipment/tool etc. which are required for successful completion of all the works.

2.9 Grout Pipes and Installation:

2.9.1 Grout pipes, casings and connections shall be steel casing of adequate strength to maintain the hole and to withstand the required installation, jacking and pumping stresses. The size of pipes shall be as required in order to adequately handle the grout material. All casing shall be flush joint threaded or a single piece tubing to

provide a smooth inner wall and unobstructed inside diameter. All fittings (elbows, bends, adapters, reducers, etc.) shall be long sweep, gradual transition pieces specifically designed and manufactured for high pressure grout and concrete pumping applications.

2.9.2 Casings shall be sized and installed such that grout material will not travel in the annulus space between the pipe and adjacent ground escaping at the ground surface when pumped.

2.10 **Grouting Material:**

2.10.1 A grout mix of cement and water having a water cement ratio not exceeding 0.5 with suitable admixtures (if required) having minimum compressive strength of 25 Mpa at 7 days. Ordinary Portland cement shall be used.

2.11 **Compaction grouting process:**

2.11.1 Once drilling of grout hole is completed the grout mix shall be pumped through the stinger rods, to form a bulb like element in the loose soils, in stages from bottom to the top of the working platform. During grouting continuously monitor grouting pressure and flow rate at the grout pipe head and at the pump by pressure gauges and flow meters. If necessary, to initiate the flow of grout at the start of pumping, the stinger rod may be pulled for one stage (typically 0.5m) to form a void at the toe of the stinger rod. Each stage grouting shall be completed based on the specified termination criteria (to be finalised during design/filed trials) and the following stage grouting shall be continued up to the top of the working platform. Inclined holes shall be provided wherever required to suit the site condition for grouting. The designed grouting pattern shall be sample tested before actually implemented at desired locations. Prior to grouting, sand shall be pumped under pressure so as to fill the void being formed below the floors.

2.12 **Field Trails**

2.12.1 Field trials shall be executed at site to validate the approved grouting pattern/scheme for the required design parameters before actual execution at the desired building/structure location. Minimum two field trails at each building/area shall be conducted. For each field trail, the area to be stabilized shall not be less than 5m x 5m (i.e., 25 sqm). Termination criteria shall be finalised at this stage. No separate payment for field trials will be made.

2.13 **Quality Assurance:** The quality checks shall not be limited to the following:

2.13.1 Grouting properties such as cement/water quality, water cement ratio and compressive strength of grout mix.

2.13.2 Gradation of sand.

2.13.3 **Field dry density test at every 1.5m depth interval. The first testing shall be conducted at 1m depth below ground level and the maximum test depth shall be up to the depth of stabilization. The field dry density test shall be carried out either by in- situ testing or by testing after collection of UDS. The test bores shall be back filled with cement grout. The number of test locations shall be at least one per every 100 sqm area for Rate Schedule Item No 1 (a) & 1 (b) and at least one per every 200 sqm area for Rate Schedule Item No 1 (c)**

2.13.4 The surface movement of floor monitoring by laser levels or by any visible signs.

2.13.5 Successful bidder shall submit field quality plan for approval of BHEL/Owner/Owner's Consultant.

2.14 Contractor shall ensure daily housekeeping and keep proper cleanliness of work place and do the disposal of wastes to certified area.

2.15 The Contractor shall be responsible for the transport of their tools, plant and equipment and construction materials, from their place of origin to the Site and more precisely to their exact point of utilisation at the Site.

2.16 The Contractor shall be responsible for the transport of their tools, plant and equipment and construction materials, from their place of origin to the Site and more precisely to their exact point of utilisation at the Site.

2.17 **COMPLIANCE TO REGULATIONS AND BYELAWS**

2.17.1 The Contractor shall conform to the provisions of any statute relating to the work and regulations and bylaws of any local authority and of any water and lighting Companies or Undertaking with whose system the work is proposed to be connected. He shall, before making any variation from the drawings or the specifications that may be necessitated for such connections give the Engineer, notice specifying the variation proposed to be made and the reasons therefore and shall not carry out any such variation until he has received instructions from the Engineer in respect thereof. The Contractor shall be bound to give all notices

required by statute, regulations or bye-laws as aforesaid and to pay all fees and taxes payable to any authority in respect thereof.

2.17.2 The Contract shall be governed by the applicable Laws of Sudan Govt. and the bidders to ensure considering latest Sudanese Laws before quoting. If during Contract execution there may be any Change in such Law which might cause additional or reduced cost to the Contractor in the execution of the works such additional or reduced cost, if fully justified and approved by BHEL or its Customer (M/s STPG), shall be paid to or recovered from the Contractor, as the case may be.

2.17.3 The Contractor shall ensure conformance in all respects with the provisions of all state and local laws, regulations or other laws in force in Sudan or elsewhere including all regulations and by-laws of any local or other duly constituted authority within Sudan or elsewhere which may be applicable to the performance of the Contract and the rules and regulations of all public bodies and companies whose property or rights are affected or may be affected in any way by the Works or any Temporary Works (which are herein referred to as "Laws"), and shall give all notices and pay all fees required to be given or paid thereby and shall keep BHEL and/or its Customer (M/s STPG) indemnified against all penalties and liability of any kind for breach of any of the same.

2.17.4 The Contractor shall comply with all applicable Sudan Government's safety and sanitary laws, transportation rules, regulations and ordinances, as well as the established safety rules and practices of BHEL's Customer (M/s STPG). The Contractor shall also provide insurance cover for his workmen throughout the contract period, under prevailing local Laws.

Chapter - III: Facilities in the scope of Contractor/BHEL

3.0 FACILITIES TO BE PROVIDED BY BHEL / CONTRACTOR

3.1 The Contractor shall during the progress of the work, provide, erect and maintain at his own expenses all necessary temporary workshops, stores, consumables, offices, etc. required for the proper and efficient execution of the work. The planning, setting and erection of these buildings shall have the approval of the Engineer and the Contractor shall at all times keep them tidy and clean and sanitary condition to the entire satisfaction of the Engineer. BHEL shall provide free of charge limited open space for office & storage shed, as and where made available by BHEL's customer. It is the responsibility of the contractor to construct sheds, provide all utilities and dismantle and clear the site after completion of work or as and when required, as a part of his scope of work. On completion of work or as and when required by BHEL, all the temporary buildings, structures, pipe lines, cables etc. shall be dismantled and levelled and debris shall be removed as per instruction of BHEL by the contractor at his cost. In the event of his failure to do so, same will be got done by the Engineer and expenses incurred shall be recovered from the contractor along with prevailing overhead. The decision of BHEL Engineer in this regard shall be final.

3.2 Contractor shall be responsible for providing all necessary facilities like residential accommodation, transport, electricity, water, medical facilities etc. as required under various labour laws and statutory rules and regulations framed there under to the personnel employed by him. Land for construction of temporary accommodation for the contractor's personnel including labour colony shall be provided by BHEL free of cost. This land shall be within/near plant boundary wall of the power station. The contractor shall at his own cost, provide temporary housing and / or camp accommodation for his site personnel, including sanitary facilities, canteen facilities etc. The contractor shall submit for prior approval of BHEL, plans for all such accommodation he proposes to erect before any construction commences. The contractor shall be responsible for all costs associated with any temporary housing and / or camp accommodation provided by him.

3.3 BHEL or its Customer (M/s STPG) shall provide approach roads (one for movement of materials/ fuels and one for general use) from highway to plant boundary.

3.4 All temporary housing and camp accommodation shall be run and maintained by the Contractor in efficient condition in accordance with the laws in force in Sudan.

3.5 The sanitary facilities shall be kept in clean and orderly conditions to the approval of BHEL and public health authorities of Sudan. The Contractor shall comply with sanitary laws, regulations and ordinances of Sudan Govt.

3.6 BHEL shall provide Power supply at 240 V, 1 phase for labour colony free of charge at one point. Further distribution will be done by the Contractor. BHEL shall provide potable/drinking water supply for labour colony free of charge, at one point. Further distribution will be done by the Contractor at his own cost.

3.7 The Contractor shall be responsible for providing adequate transport to and from the site for his own and his personnel who may be brought in daily from their living quarters or housing areas.

3.8 Medical facilities available to BHEL staff shall be extended to Contractor's personnel, if possible. However, the Contractor shall bear all costs in respect of the Doctor's fees and all other expenses.

3.9 The Contractor shall be fully responsible for the death or injury to any person employed by him for the purposes of or in connection with the execution of the Contract. The Contractor shall also provide insurance cover to all persons employed/engaged by him throughout the period of Contract under prevailing local laws.

3.10 Construction power, for construction purposes will be provided free of cost and at one point near erection/ construction site from supply point. Further distribution of power shall be done by contractor at his cost. All wiring must comply with local regulations and will be subject to BHEL's inspection and approval before connecting supply.

3.11 Provision of distribution lines of power from the central points to the required place with proper distribution boards observing the safety rules laid down by the authorities of the state shall be done by the contractor, supplying all the materials like cables, distribution board, switch boards, TPN, CBS, ELCBS/ MCCBS / Copper / Brass clamps, copper conductor, change over switches pipes etc. at his own cost. If any failure is caused in supply of the power and water, it is the responsibility of the contractor to make alternate arrangements at his cost. The contractor shall adjust his working shift / hours accordingly and deploy additional manpower if necessary so as to achieve the target.

3.12 Following points should be strictly adhered to by the contractor while drawing construction power supply from Distribution Board.

a) All electrical installations should be as per Sudan / International Electricity rules.
b) All distribution Boards installed by the contractor should be constructed with fire proof materials viz. Steel frames, Bakelite sheets etc.
c) Connection for single phase should be taken from phase and neutral. Nowhere the connection should be taken with earth as neutral.

d) All electrical connections should be made through connectors, nuts and bolts, switches, plug and sockets. Loose connections or hooking up of wires shall not be permitted.
e) Contractor has to make their own earthing arrangement for their equipment / DB earthing. Earthing connection has to be done with copper conductor and copper / brass clamps with BHEL's prior permission.
f) All electrical equipment / tools and plants should be properly earthed. DBs to be earthed diagonally opposite at two points.
g) Contractor should use "MCCB" and "ELCB" either on incoming or outgoing connections to the DBs.
h) Contractor should ensure that all the CBs / TPNs / Fuses / MCCB / ELCB cables etc. Should be of adequate rating/ capacity.
i) For permission of supply connections contractor has to submit a test report of their installations with a single line diagram of connected / proposed loads. Contractor will also submit a report on all electrical connected loads by the 7th of every month.
j) ELCB will be tested once in a week or as deemed fit by BHEL Engineer by actually simulating the earth leakage for all installations and the same shall be recorded by BHEL Engineer in the log book to be maintained by the contractor.
k) In case of power cuts / load shedding no compensation for idle labour or extension of time for completion of work will be given to contractor.

3.13 Adequate lighting facilities such as flood lamps, hand lamps and area lighting shall be arranged by the contractor at the site of construction, contractor's material storage area etc. within finally accepted rates.

3.14 BHEL will make available water for construction/testing purposes close to the construction areas including potable/drinking water supply for site free of charge. Distribution within the plant area will be done by the Contractor at his own cost. BHEL will provide support and assistance to the contractor in arranging necessary connections with the local water supply authority. However, the contractor shall bear all cost on this account. Contractor shall arrange at their cost, adequate water storage along with pumping facility to ensure availability of construction water required by them Contractor to satisfy himself that the water drawn by him

is fit for construction / consumption and adequately treat such water at his cost when it is not found fit for the said purposes.

3.15 Though the contractor will be provided electricity and water free of charges at one point, the contractor shall however ensure that there is no wastage. Periodical audits will be held to ensure that these resources are being optimally used .In case any wastage is observed, BHEL reserves the right to recover any charges /penalty as deemed fit to be decided by BHEL Engineer.

CHAPTER - IV: T&PS AND MMES TO BE DEPLOYED BY CONTRACTOR

4.0 T&P AND MMD DEPLOYED BY CONTRACTOR

SN	DESCRIPTION	CAPACITY (MINIMUM)	*MINIMUM* QUANTITY	*REMARKS*
1	Hydraulic drilling rigs	Adq. capacity	APR	
2	Compaction grout pump	Adq. capacity	APR	
3	Drill tools (e.g. stinger rods, stinger shoe, drill head adopter, swivel etc.)	Adq. capacity	APR	
4	Compaction grout hose of with non-restrictive full flow couplings	Adq. capacity	APR	
5	Compaction grout mixer	Adq. capacity	APR	

APR- As per requirement (Contractor shall have to deploy the T&P whenever required at site as decided by BHEL ENGINEER)

NOTES:

1. **The above list specifies only major T&P (may not be complete) to be deployed by the contractor. All additional/ other tools and plants which are required for satisfactory & timely completion of work shall also be deployed by the contractor within finally accepted rate/ price.**

2. If work gets delayed due to non-availability/breakdown of T&P and MMD, BHEL reserves the right to get work done at the risk & cost of contractor without prejudice to right of BHEL as in GCC.
3. Contractor must re-ascertain/ recheck range and accuracy of each IMTE from BHEL Engineer well in advance before arranging calibration/ deployment.
4. Other terms and conditions regarding above items shall be as per T&P clause in SCC.

Chapter - V: T&P AND MMD DEPLOYED BY BHEL ON SHARING BASIS

5.0 T&P AND MMD DEPLOYED BY BHEL ON SHARING BASIS

NA (Not Applicable)

Chapter - VI: TIME SCHEDULE

6.0 TIME SCHEDULE

6.1 The erection work shall be commenced on the mutually agreed date between the bidder and BHEL engineer. The decision of BHEL in this regard shall be final and binding on the bidder. After receipt of fax LOI, contractor shall discuss with Project Manager/Construction Manger regarding initial mobilization.

6.2 Entire work as detailed in the tender specifications shall be completed within 04 (four) months from the date of commencement of work at site.

6.3 The work under the scope of this contract shall be deemed to be complete in all respects, only when the contractor has discharged all the responsibilities laid down in the contract. The decision of BHEL on completion date shall be final and binding on the contractor.

Chapter - VII: TERMS OF PAYMENT

7.0 TERMS OF PAYMENT

7.1 The 'Engineer' will certify regarding the actual work executed in the measurement books and bills, which shall be accepted by the contractor in measurement book.

7.2 Contractor shall submit bills for the work completed under the specification, once in a month detailing work done during the month. The format for billing shall be approved by BHEL before raising invoices.

7.3 Subject to any deduction, which BHEL may be authorised to make under the Contract and statutory requirements, the contractor on the certificate of the Engineer at site shall be entitled for payment as explained hereunder.

7.3.1 Interest bearing recoverable advance: Applicable as per Clause No. 2.13 of GCC.

7.3.2 PROGESSIVE PAYMENT ON PRORATA BASIS (For Item No. 1, 2 & 3 of rate schedule)

7.3.2.1 : 5% will be released on completion of compact grout design & approval of related drawings by BHEL/Customer as certified by BHEL Engineer.

7.3.2.2 : 5% will be released on completion of field trails before actual execution as certified by BHEL Engineer.

7.3.2.3 : 90 % will be released, on pro-rata basis, on execution as per drawings released and certified by BHEL Engineer.

NOTE : Payment of retention amount and final bill shall be as per clause No 2.22 and 2.23.2 of GCC

7.3.3 Currency of Payment and Exchange Rate

Payment in EUROS

7.3.3.1 100 % of the Total Contract Price will be paid in EUROS subject to Reserve Bank of India (RBI)/ Govt of Sudan's guidelines.

Chapter - VIII: TAXES & OTHER DUTIES

8.0 TAXES & OTHER DUTIES

8.1 **LOCAL TAXES AT SUDAN:** BHEL and / or its Customer has already taken from the competent Sudanese authorities all taxes exemption certificate vide ref. no. nil dtd. 28.05.2009 relating to the project including Business Profit Tax and Value Added Tax etc. However, Income Tax for personnel shall be borne by the Contractor.

8.2 Taxes as required to be deducted at source as per Local Sudanese Laws/ Indian Law (applicable in case of only those contractors having their office in India), if any, at prevailing rates shall be deducted on gross invoice value from the running bills unless Exemption Certificate from appropriate Tax Authority is furnished.

8.3 The bidder shall quote their rates inclusive of all taxes/ duties/ service tax in India, if any applicable for this work. The Contractor shall be responsible for paying any and all Taxes/ Duties assessed on the Contractor either in Sudan or outside Sudan, its Sub-Contractor and Suppliers or their respective employees.

8.4 If during Contract execution there may be any Change in taxes in Sudan which might cause additional or reduced cost to the contractor in the execution of the works such additional or reduced cost, if fully justified and approved by BHEL or its Customer (STPG), shall be paid to or recovered from the Contractor, as the case may be.

Chapter - IX: ANY OTHER SPECIAL REQUIREMENT

9.0 CUSTOM DUTY & CUSTOM CLEARANCE

9.1 Custom duty and demurrage occurred in Port Sudan and Khartoum airport for all equipment, facilities and materials imported by the Contractor for the Project shall be paid by BHEL's Customer (M/s STPG). The contractor shall furnish list of all such items including their temporary imported equipments (temporary imported equipments to be defined and listed clearly) well in advance. However, custom duty, if any, paid by the Contractor for any reason whatsoever shall not be reimbursed.

9.2 BHEL or its Customer (M/S STPG) shall be responsible for the custom clearance agency to clear out the Equipment, tools, and materials imported (Plant Materials) and Contractor's equipment and vehicles temporarily imported for the Project as per Procedure given below at 9.3. However, the Contractor shall take all actions for chasing/follow up and bear all expenditure on his own for the same. A bank guarantee shall be issued by the Contractor, if necessary according to the custom authority for custom clearance The Contractor shall submit all relevant dispatch/shipment documents to Project Coordinator - Sudan, BHEL, PSNR, NOIDA(UP)-India / Construction Manager, BHEL Site, Kosti TPP. The Contractor shall take delivery of materials at Port of Sudan or at Khartoum airport and responsibility of handling (unloading/loading etc.) and its transportation to Kosti Power Plant shall be of Contractor at their own cost. Payment of any Que/Quay dues at Port will be the responsibility of the Contractor.

9.3 Indian Bidders has to ensure that total imports (CIF Value) from 3rd country i.e. steel (wherever required), cement and other materials which is going directly from the 3rd Country to Kosti Site in Sudan shall not be more than 50% of the Total Contract Price to ensure that total Imports from the 3rd country going directly to Sudan Site shall meet the Reserve Bank of India (RBI) guidelines.

9.4 **CUSTOMS CLEARANCE PROCEDURE**

(A) For all the supplies/ dispatches related to this Project, the consignee will be M/S STPG, SUDAN and the name of supplier to be mentioned either as "BHEL" or "on account of BHEL". The Contractor will submit original + 7 copies of dispatch documents to BHEL /BHEL's bankers after dispatch of consignment from India.

BHEL bankers in India will forward these documents after necessary endorsement to Bank of Sudan in Sudan.

Bank of Sudan after stamping will send these original documents to M/S STPG, Khartoum (BHEL's Customer).

(B) The Contractor shall submit scanned / fax copies of documents such as invoice, packing list, certificate for country of origin, insurance, bill of landing etc. to BHEL/ M/S STPG, Khartoum after dispatch of consignment from India.

(C) M/S STPG (BHEL's customer) at Khartoum will process the document and obtain certification from Sudan customs / Government for zero custom duty and payment exemption for all other applicable taxes, duties, levies etc.

(D) M/S STPG (BHEL's customer) at Khartoum shall forward these documents with certification to M/s STPG-Port Sudan.

(E) M/S STPG (BHEL's customer) at Port Sudan after necessary clearance permit will hand over the documents to the Contractor through BHEL's representative/Transporter for taking delivery and transport to power plant site at Kosti. The Contractor will sign that he has received the consignment.

9.5 In case the temporary imported equipment is not defined and listed by the Contractor, the responsibility of custom clearance and payment of custom duty/taxes shall lie with them. When it is produced at any time it shall be considered as part of this Contract (i.e. it will be considered as BHEL's Customer property).

9.6 Any demurrage incurred due to the reason of the Contractor's delay in unloading at the Port Sudan or airport shall be the Contractor's responsibility. Any other demurrage incurred during custom clearance for reasons other than those attributable to BHEL or its Customer (M/s STPG), shall also be borne by the Contractor.

9.7 For all the items like T&Ps, Erection equipments, consumables, establishment items etc. to be exported by the Contractor to Sudan on repatriable basis, the Contractor shall furnish list and value of such items to BHEL prior to dispatch. The Contractor shall also give an undertaking to BHEL prior to dispatch declaring these items as returnable/consumable.

9.8 PACKING, MARKING AND TRANSPORTATION :

9.8.1 All equipment and material, together with the applicable instruction book, packing list, and special site storage instructions, shall be carefully boxed, crated, or otherwise adequately protected for overseas shipment by the Contractor.

9.8.2 The Contractor shall be responsible for the transport of the tools and plant and construction equipment for site work from their place of origin to the Site and more precisely to their exact point of utilization at the Site.

9.8.3 The Contractor shall take care that if the machinery is disassembled into components, the weight and size of which are in line with actual transport possibilities.

9.8.4 Within the limits imposed by law, the Contractor shall be entitled to utilise all the roads and other communication facilities existing in the country, to the same extent as any other user. BHEL and its Customer (M/S STPG) shall assist the Contractor for obtaining licenses, permits, etc. from all the local authorities. However, all the expenditure on this account shall be borne by the Contractor.

9.8.5 The Contractor shall repair or replace the Works lost, damaged, or destroyed, without waiting for the settlement of claims from insurance company to ensure completion in accordance with the Overall Project Schedule.

9.8.6 The Contractor shall be responsible for the safety and security of all the Works and shall replace promptly at Site each part of any and all Works which may be lost or damaged or destroyed due to fire, explosion, lightning, earthquake, theft, flood, storm, tempest, aircraft and other aerial devices or articles dropped therefrom, malicious damage, etc. and the actions of the BHEL or its Customer (M/s STPG) in the operation of appliances on behalf of the Contractor in case the contractor do not act from the date of arrival of equipment, plant, materials, machinery, etc. at the Site until Provisional Acceptance Certificate has been issued.

9.8.7 The Contractor shall repair or replace the Works lost, damaged, or destroyed, within shortest possible time at Site to ensure commissioning and operation of the Works without delay. If the Contractor shall fail to promptly replace or repair the Works damaged as per above clause, the Employer, at his discretion, will get such works repaired or replaced as the case may be and such costs will be reimbursed by the Contractor.

9.9 **Additional safety requirement of BHEL's Customer (M/S STPG), if any, shall be provided by the Contractor without any extra cost. Non adherence of safety requirements will attract penalty, which shall be as follows**;

- Penalty equivalent to EURO 15 for the first violation.
- Penalty equivalent to EURO 30 for the subsequent violations.
- For serious lapses, as decided by BHEL, even fines up to EURO 500 at a time can be imposed.
- The Contractor shall be fully responsible for accidents caused due to him or workmen's negligence or carelessness in regard to the observance of the safety requirements and shall be liable to pay compensation for injuries.
- The amount towards fine as above will be deducted from running bills of the Contractor.

Chapter - X: OTHERS

10.1 COMPLIANCE TO REGULATIONS AND BYELAWS

10.1.1 The Contractor shall conform to the provisions of any statute relating to the work and regulations and bylaws of any local authority and of any water and lighting Companies or Undertaking with whose system the work is proposed to be connected. He shall, before making any variation from the drawings or the specifications that may be necessitated for such connections give the Engineer, notice specifying the variation proposed to be made and the reasons therefore and shall not carryout any such variation until he has received instructions from the Engineer in respect thereof. The Contractor shall be bound to give all notices required by statute, regulations or bye-laws as aforesaid and to pay all fees and taxes payable to any authority in respect thereof.

10.1.2 The Contract shall be governed by the applicable Laws of Sudan Govt. and the bidders to ensure considering latest Sudanese Laws before quoting. If during Contract execution there may be any Change in such Law which might cause additional or reduced cost to the Contractor in the execution of the works such additional or reduced cost, if fully justified and approved by BHEL or its Customer (STPG), shall be paid to or recovered from the Contractor, as the case may be.

10.1.3 The Contractor shall ensure conformance in all respects with the provisions of all state and local laws, regulations or other laws in force in Sudan or elsewhere including all regulations and by-laws of any local or other duly constituted authority within Sudan or elsewhere which may be applicable to the performance of the Contract and the rules and regulations of all public bodies and companies whose property or rights are affected or may be affected in any way by the Works or any Temporary Works (which are herein referred to as "Laws"), and shall give all notices and pay all fees required to be given or paid thereby and shall keep BHEL and/or its Customer (STPG) indemnified against all penalties and liability of any kind for breach of any of the same.

10.1.4 The Contractor shall comply with all applicable Sudan Government's safety and sanitary laws, transportation rules, regulations and ordinances, as well as the established safety rules and practices of BHEL's Customer (STPG). The Contractor shall also provide insurance cover for his workmen throughout the contract period, under prevailing local Laws.

10.2 MODIFICATION/ DELETION IN STANDARD CLAUSES OF GCC:-

10.2.1 Clause no. 1.7 (i) INCOME TAX PERMANENT ACCOUNT NUMBER modified as:-

(Not applicable for foreign parties) Certified copies of Permanent Account Numbers as allotted by Income Tax Department for the Company/ Firm/ Individual Partners, etc. shall be furnished along with tender.

10.2.2 Clauses no. 1.9 (EMD) modified as: To be submitted in INR or Euro.

10.2.3 Addition of following clause in Standard Clause no. 1.10 (Security Deposit):-

(A) Following guidelines which is to be followed during the submission of Bank Guarantees by successful foreign bidder:-

BG from Foreign Banks (wherein Foreign Vendors intend to provide BG from local branch of the Vendor's country's Bank)

(i) In such case, Bank Guarantee issued by any Consortium Banks (as per list enclosed) will be accepted by BHEL. As such, foreign vendor needs to make necessary arrangements for issuance of Counter- Guarantee by their Foreign Bank in favor of the Indian Bank (BHEL's Consortium Bank (as per list attached)). All charges for issuance of Bank Guarantee/ counter-Guarantee should be borne by the vendor.

(ii) In case, Foreign Vendors intend to provide BG from Overseas Branch of BHEL's Consortium Bank (e.g. if a BG is to be issued by SBI Frankfurt), the same is acceptable. However, the procedure at sl.no. (i) will require to be followed.

(iii) The BG issued will be subject to Uniform Rules for Demand Guarantees (URDG) 758.

(iv) The BG should clearly specify that the demand or other document can be presented in electronic form.

(B) The contractor shall submit Security Deposit in Euros within 15 days from the date of issue of LOI as per the General Conditions of Contract (GCC). For calculation purpose, SD as per GCC will be worked out in Euros based on the SBI TT selling rate prevailing on the date of technical bid opening. For conversion of any amount in this tender/contract from one currency to the other currency, wherever required, exchange rates as applicable on the date of technical bid opening shall be considered.

(C) The furnished Bank Guarantee as a part of Security Deposit shall be issued as per the Performa enclosed in this tender.

10.2.4 Clause nos. 2.8.3, 2.8.4, 2.8.6, 2.8.7, 2.12, 2.15.1 to 2.15.6, 2.16.1 & 2.28.1:– Not Applicable

10.2.5 Clause no. 2.17 (PRICE VARIATION COMPENSATION) modified as:- Price shall remain firm throughout the contract period including the extended period if any.

10.5 MODIFICATION/ DELETION IN STANDARD CLAUSES OF SCC:-

10.5.1 Clause nos. 2, 4.2.2, 5.6 to 5.8, 6.0, 7.0, 8.1.2 to 8.1.12, 8.2 to 8.5, 10.0 & 11.0:– Not Applicable

10.5.2 Clause no. 4.1 (Consumables & other items) modified as:- To be provided as per TCC.

10.5.3 Clause no. 8.1.1 (Inspection, Quality Assurance & Quality Control) modified as:- Preparation of quality assurance log sheets and protocols with customer/ consultants/statutory authority, other quality control and quality assurance documentation as per BHEL engineer's instructions, is within the scope of work/specification as per TCC.

10.6 MODIFICATION IN HSE CLAUSES OF SCC:-

10.6.1 New Clause 6.1.11 to be added as: - Wherever IS codes have been mentioned in the tender documents, same to be read as – "IS code or equivalent International standards."

10.6.2 Following points of Clause no. 7.2.1:-

- ***"Shall arrange for all necessary PPEs like safety helmets, belts, full body harness, shoes, face shield, hand gloves etc. before starting the job. Shall ensure that no working men/women carry excessive weight more than stipulated in Factory Rule Regulation R57."***

  Modified as:

  "Shall arrange for all necessary PPEs like safety helmets, belts, full body harness, shoes, face shield, hand gloves etc. before starting the job. Shall ensure that no working men/women carry excessive weight more than stipulated in local laws."

- ***"Shall ensure that provisions stipulated in contract Labour Regulation Act 1970, Chapter V C.9, canteen, rest Rooms / washing facilities to contracted employees at site."***

  Modified as:

  "Shall ensure the provisions as stipulated in Sudanese Labour laws regarding canteen, rest Rooms/ washing facilities, to contracted employees at site."

10.6.3 Following points of Clause no. 8.2:- Not applicable

- ***The subcontractor shall arrange induction and regular health check of their employees as per schedule VII of BOCW rules by a registered medical practitioner.***
- ***The subcontractor shall take special care of the employees affected with occupational diseases under rule 230 and schedule II of BOCW Rules. The employees not meeting the fitness requirement should not be engaged for such job.***

10.6.4 Radiography (**Serial no. 9 of table) of Clause no. 8.3 (Provision of PPEs) modified as: -** Radiography: As per International guidelines.

10.6.5 Clause no. 8.4.5 (Medical Facilities) modified as:- The contractor shall provide necessary first aid facilities as per TCC. The first aid boxes should be placed at work place so as to make them available within the reach and at the quickest possible time. The contractor should conduct periodical first –aid classes to keep his supervisor and Engineers properly trained for attending to any emergency.

10.6.6 Clause no. 11.3.6, 12.5 & 12.8:- Not Applicable

10.6.7 Following point of Clause no. 11.3.7:-

- ***The subcontractor shall use only properly insulated and armored cables which conform to the requirement of Indian Electricity Act and Rules for all wiring, electrical applications at site.***

  Modified as:-

  The contractor shall use only properly insulated and armored cables which conform to the requirement of relevant Act and Rules for all wiring, electrical applications at site.

10.6.8 Serial no. 7 & 8 of table of Clause no. 13 (HSE Performance) modified as: -

(7) Non- conducting of health check-up as per rules and regulation at Sudan.

(8) Non availability of proper first-aid facility, adequate labour welfare initiatives.

10.6.9 Addition in Clause no. 16.0 (Non Compliance):- Fine **i**n equivalent USD/ EURO. Exchange rate as on date of violation of rule/ reported (date selection is on discretion of BHEL).

Chapter - XI: UNPRICED RATE SCHEDULE

Sub: Work of Soil Stabilization of RWIPH, CWPH & Switchyard Area, by Compaction Grouting.

SL. NO	ITEM	UNIT	QTY.	RATE (EURO)	AMOUNT (EURO)
1	Design, supply and execution of soil stabilization by compaction grouting on Engineering Procurement Construction (EPC) basis so as to achieve an in-situ dry density of at least 1.88 gm/cc for sub-soil including preparation of drawings and getting it approved, pumping sand below floors, boring / drilling in soil /concrete, field trials for validation of design, supply of all materials, equipment, labours, plants & tools, machineries, quality testing /quality control, **back filling of test holes with cement grout** etc. all complete as per specification and as directed by engineer-in-charge At river water intake pump house and adjacent areas AS FOLLOWS: .				
1(a)	For a depth of **12m** below ground level.	SQM	**880**		
1(b)	For a depth of **8m** below ground level.	SQM	**520**		
1(c)	For a depth of **4 m** below ground level.	SQM	**190**		

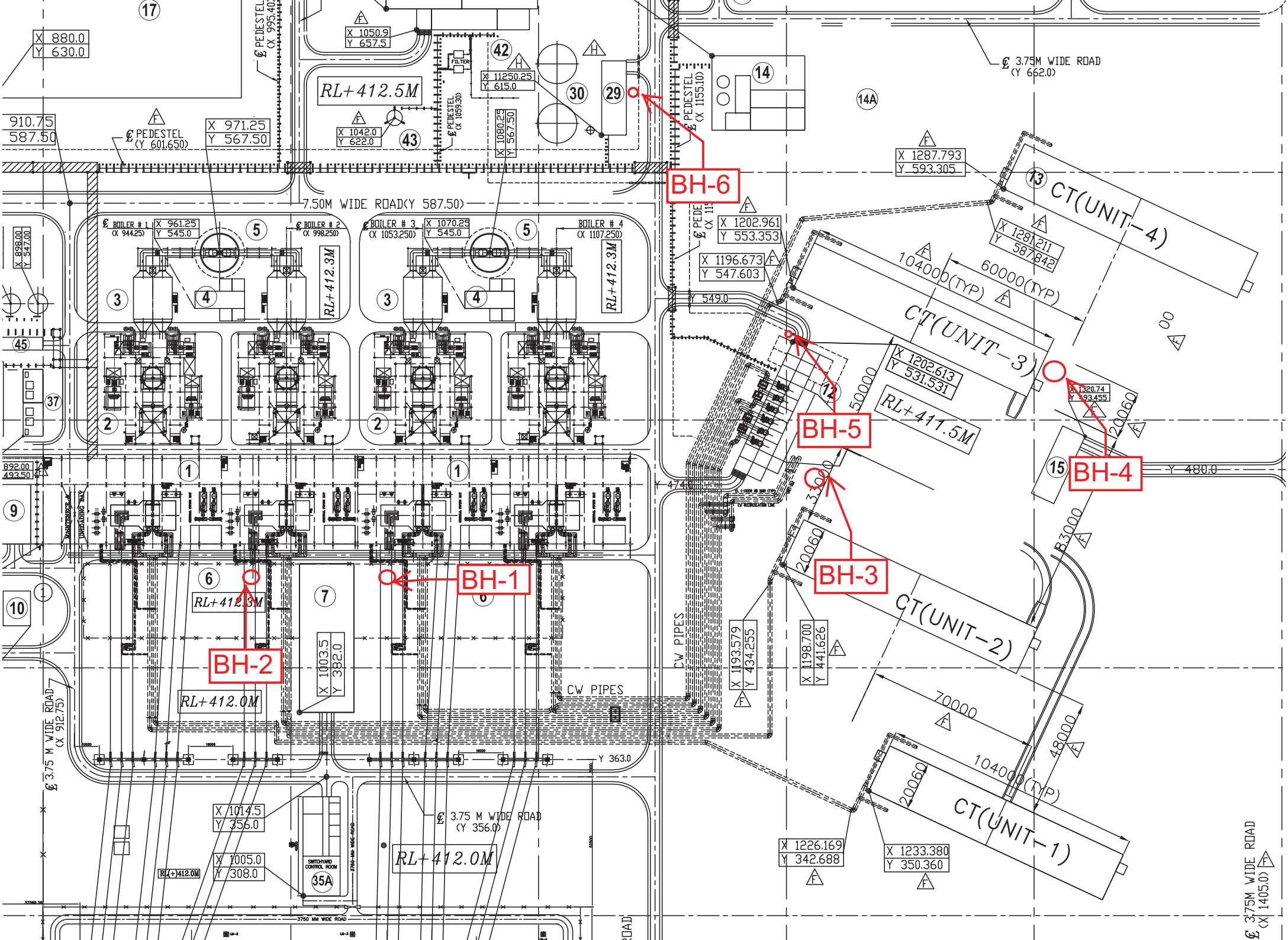
SL. NO	ITEM	UNIT	QTY.	RATE (EURO)	AMOUNT (EURO)
2	Design, supply and execution of soil stabilization by compaction grouting on Engineering Procurement Construction (EPC) basis so as to achieve an in-situ dry density of at least 1.88 gm/cc for sub-soil including preparation of drawings and getting it approved, pumping sand below floors, boring / drilling in soil /concrete, field trials for validation of design, supply of all materials, equipment, labours, plants & tools, machineries, quality testing /quality control, **back filling of test holes with cement grout** etc. all complete as per specification and as directed by engineer-in-charge At CW Pump house and adjacent areas for a depth of **10m** below ground level	SQM	**670**		
3	Design, supply and execution of soil stabilization by compaction grouting on Engineering Procurement Construction (EPC) basis so as to achieve an in-situ dry density of at least 1.88 gm/cc for sub-soil including preparation of drawings and getting it approved, pumping sand below floors, boring / drilling in soil /concrete, field trials for validation of design, supply of all materials, equipment, labours, plants & tools, machineries, quality testing /quality control, **back filling of test holes with cement grout** etc. all complete as per specification and as directed by engineer-in-charge for Isolator pedestal foundations including adjacent area in switchyard area for a depth **of 4m** below ground level	SQM	**4400**		
TOTAL AMOUNT IN EURO					

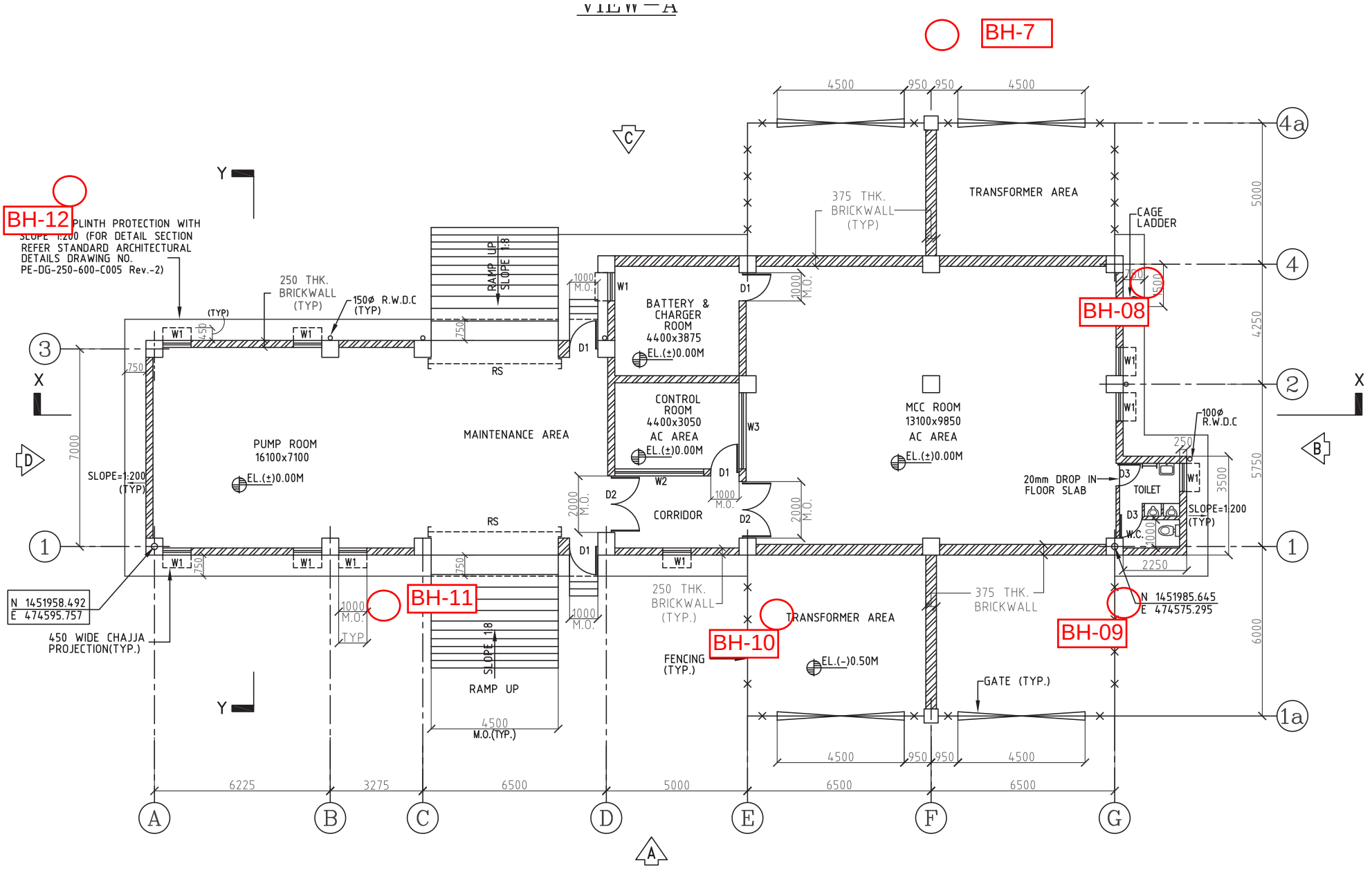
Note:-

1. The item of work in the Rate Schedule describes the work very briefly. The various items shall be read in conjunction with the corresponding sections in the specification including amendments & additions if any. The bidder's rate for each item shall include all the activities covered in the description of item as well as for all necessary operations in details described in the specification.
2. The unit rate quoted shall include minor details which are obviously and fairly intended and which may not have been included in this document but are essential for the satisfactory completion of the work.
3. The quoted rate shall include breaking of concrete if required, disposal of debris, surplus materials etc. as per the direction of engineer-in-charge.
4. Conditional price bids or price bids with any deviation/ clarification etc. are liable to be rejected. No cutting / erasing / over writing shall be done.
5. In case of any mismatch in rate and amount on price discrepancy, the same will be dealt as per clause no. 1.4 of GCC.

Chapter - XII: LIST OF DRAWINGS / DOCUMENTS

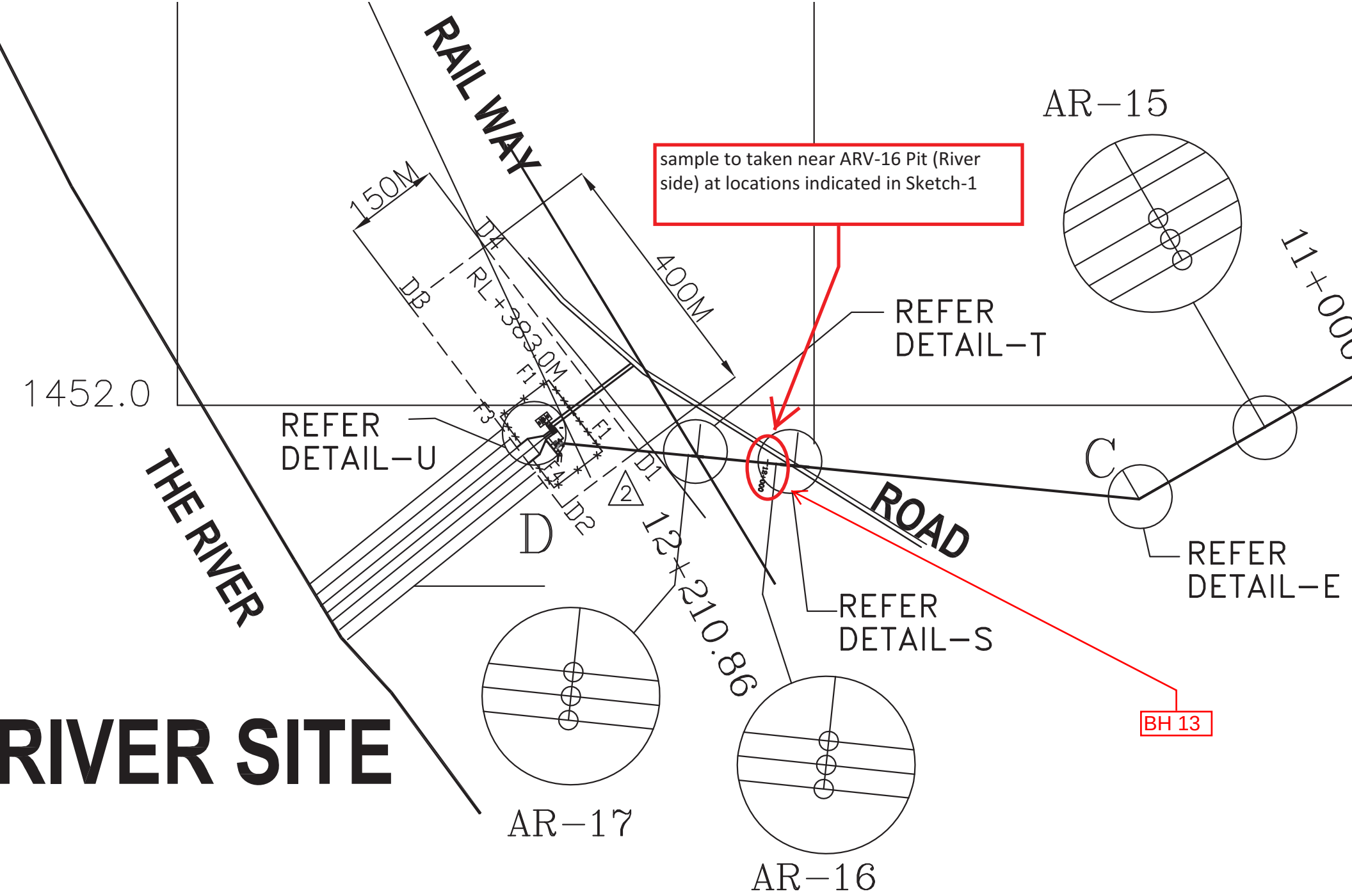
S. No.	Description	Drawing No.
1	Location of boreholes for Geo-technical investigation	ENCLOSED
2	CW PUMP HOUSE – MC room DRAWING	PE-DG-250-653-C002
3	CW PUMP HOUSE – GA OF RCC STRUCTURE	PE-DG-250-653-C006
4	CW PUMP HOUSE and adjacent areas-Compaction grouting	PE-DG-XX-XX-XX (for CW Pump House)
5	RIVER SIDE INTAKE PUMP HOUSE & Electrical Building Foundation & Ground Floor Plan	PE-DG-250-683-C001
6	RIVER SIDE INTAKE PUMP HOUSE and adjacent areas-Compaction grouting	PE-DG-XX-XX-XX (RIVER SIDE INTAKE PUMP HOUSE)
7	Layout & RCC details of trenches and road crossing (Switchyard location)	TB-0-279-607-609-A
8	Geo Technical Investigation Report	ENCLOSED


BH-1
BH-2
BH-3
BH-4
BH-5
BH-6
CT(UNIT-4)
CT(UNIT-3)
CT(UNIT-2)
CT(UNIT-1)
RL+412.5M
RL+412.3M
RL+412.0M
RL+411.5M
7.50M WIDE ROAD(Y 587.50)
3.75M WIDE ROAD (Y 662.0)
3.75 M WIDE ROAD (Y 912.75)
3.75 M WIDE ROAD (Y 356.0)
3.75M WIDE ROAD (X 1405.0)
CW PIPES
BOILER # 1 (X 944.25)
BOILER # 2 (X 998.250)
BOILER # 3 (X 1053.250)
BOILER # 4 (X 1107.250)
PEDESTEL (Y 601.650)
PEDESTEL (X 995.40)
PEDESTEL (X 1059.30)
PEDESTEL (X 1155.10)
FILTER
SWITCHYARD CONTROL ROOM
3750 MM WIDE ROAD
X 880.0
Y 630.0
X 910.75
Y 587.50
X 971.25
Y 567.50
X 1050.9
Y 657.5
X 11250.25
Y 615.0
X 1042.0
Y 622.0
X 1080.25
Y 567.50
X 961.25
Y 545.0
X 1070.25
Y 545.0
X 898.00
Y 547.00
X 892.00
Y 493.50
X 1003.5
Y 382.0
X 1014.5
Y 356.0
X 1005.0
Y 308.0
X 1287.793
Y 593.305
X 1202.961
Y 553.353
X 1196.673
Y 547.603
X 1281.211
Y 587.842
X 1202.613
Y 531.531
X 1320.74
Y 493.455
X 1193.579
Y 434.255
X 1198.700
Y 441.626
X 1226.169
Y 342.688
X 1233.380
Y 350.360
104000(TYP)
60000(TYP)
50000
33000
20060
70000
48000
R3000
Y 549.0
Y 474.0
Y 480.0
Y 363.0
Y 1405.0
37560.38
RL(+)412.0M

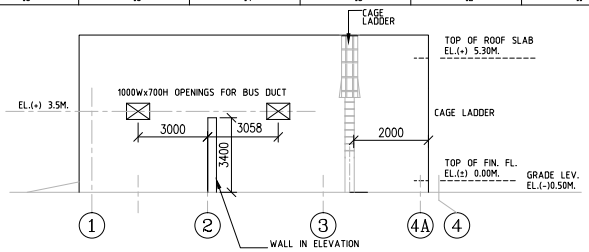


RIVER WATER INTAKE PUMP HOUSE

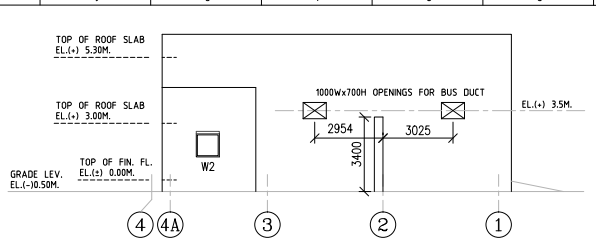
PLAN AT EL.(±)0.00M.


RAIL WAY
150M
400M
DA
DB
RL+383.0M
F1
F2
F3
F4
D1
D2
2
D
1452.0
REFER
DETAIL–U
THE RIVER
sample to taken near ARV-16 Pit (River side) at locations indicated in Sketch-1
REFER
DETAIL–T
AR–15
11+000
C
ROAD
REFER
DETAIL–E
REFER
DETAIL–S
12+210.86
BH 13
AR–17
AR–16
RIVER SITE

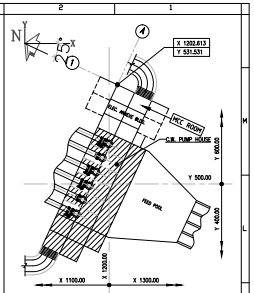
BO



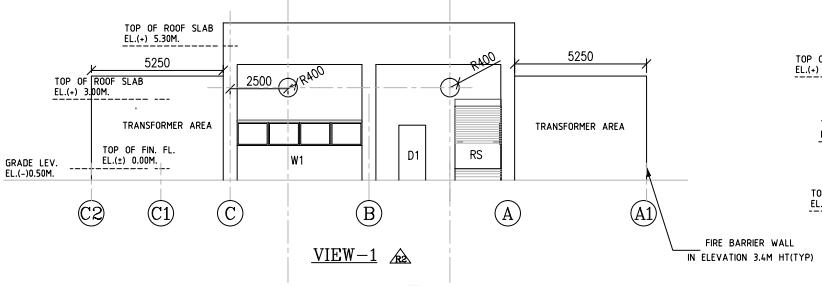
VIEW–2



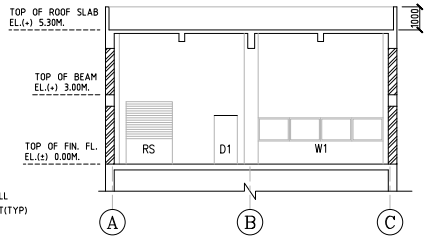
VIEW–3



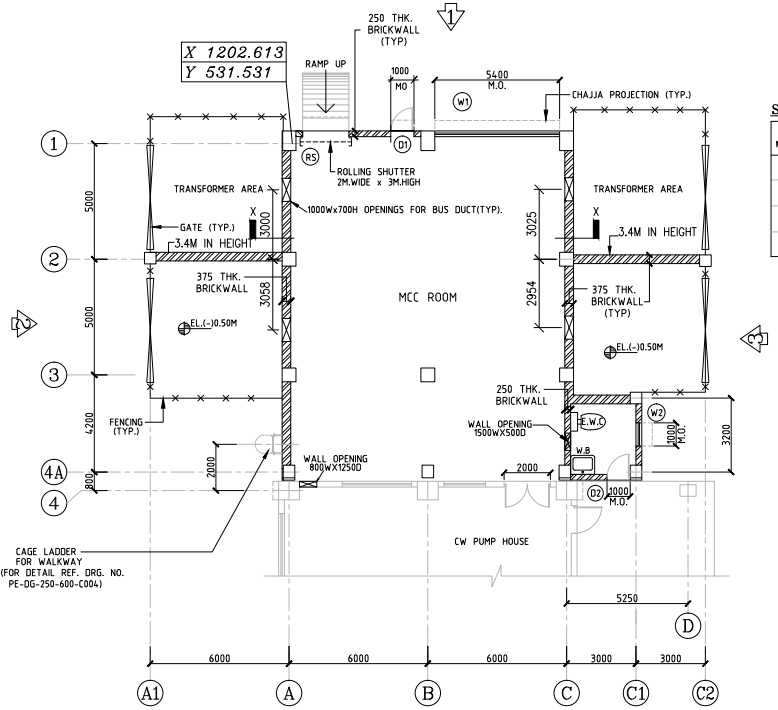
KEY PLAN



VIEW–1



SECTION X–X



PLAN AT EL.(±)0.00M.

SCHEDULE OF DOORS/ROLLING SHUTTER

DOOR MARKED	NOS. REQD.	MASONRY OPENING W	MASONRY OPENING H	DOOR SIZE W	DOOR SIZE H	DESCRIPTION
D1	1	1000	2500	1980	2480	HOLLOW STEEL FLUSH DOOR WITH PRESSED STEEL FRAMES (DOUBLE LEAF)
D2	1	1000	2100	980	2080	HEAVY-DUTY PVC DOOR WITH PVC FRAME. (SINGLE LEAF)
RS	1	2000	3000	–	–	STEEL ROLLING SHUTTER

SCHEDULE OF WINDOWS (AS PER IS 1038)

WINDOW MARKED	NOS. REQD.	MASONRY OPENING W	MASONRY OPENING H	WINDOW SIZE W	WINDOW SIZE H	DESCRIPTION	GLASS
W1	1	5400	1000	5380	980	OPENABLE STEEL WINDOW WITH STEEL FRAME.	5.5mm THK. CLEAR FLOAT GLASS
W2	1	1000	1000	980	980	FIXED STEEL WINDOW WITH STEEL FRAME	–DO–

SCHEDULE OF FINISHES

AREA	FLOORING/SKIRTING	INTERNAL WALL PAINTING	CEILING PAINTING
TRANSFORMER AREA.	HEAVY-DUTY IPS FLOORING		
MCC ROOM	IPS FLOORING	DRY DISTEMPER.	DRY DISTEMPER.
TOILET	TERRAZO TILE FLOORING WITH GLAZED TILE FULL HEIGHT DADO.	DRY DISTEMPER.	DRY DISTEMPER.
INTERNAL WALL	12mm THK. PLASTERING 1:6 CEMENT/SAND MORTAR		
EXTERNAL WALL	2 COATS OF WATER PROOF CEMENT BASED PAINT OVER 18mm THK. PLASTERING 1:5 CEMENT/SAND MORTAR		
CEILING	6mm THK. PLASTERING 1:4 CEMENT/SAND MORTAR		

LEGENDS:–

E.W.C. EUROPEAN WATER CLOSET

WB WASH BASIN

NOTES:–

1. THIS DRAWING SHALL BE READ IN CONJUNCTION WITH CONTRACT TERMS, CONDITIONS AND SPECIFICATION.
2. ALL DIMENSIONS ARE IN mm AND LEVELS ARE IN METRE UNLESS OTHERWISE NOTED.
3. GRADE OF STRUCTURAL CONCRETE SHALL BE M25 UNLESS NOTED OTHERWISE.
4. FOR ALL OTHER GENERAL NOTES & STANDARD DETAILS REFER DWG. NO. PE-DG-250-600-C003.
5. EL(±) 0.00 CORRESPONDS TO RL(+) 412.50m ABOVE M.S.L.

REFERENCE DRAWINGS:–

1. CW PUMP HOUSE-PLAN, ELEVATIONS & SCHEDULES – PE-DG-250-653-C001
2. ELECTRICAL EQUIPMENTS LAYOUT IN CW PUMP HOUSE – PE-DG-250-100-E105_R2

CAT-1
APPROVED
Checked and approved with regard to the system requirements and/or main dimensions and/or the overall arrangement. The Contractor is responsible for design calculation, detail dimensions and operability.
FICHTNER
Signature: Date:

REV.	DATE	ALTD	CHD	APPD
2	17.12.11	SC	PRAVANK	AN
	REVISED TO SHOW VENTILATION OPENINGS AND MKD AS A.			
1	05.02.10	SC	PRAVANK	AN
	REVISED AS PER COMMENTS GIVEN BY NEC/FCE MKD AS A.			

JOB No.
STATUS
DISTRIBUTION

KOSTI THERMAL POWER STATION 4X125 MW
NATIONAL ELECTRICITY CORPORATION (NEC)
THE REPUBLIC OF THE SUDAN

FICHTNER
Fichtner GmbH & Co. KG
Stuttgart, Germany

BHARAT HEAVY ELECTRICALS LTD
POWER SECTOR
PROJECT ENGINEERING MANAGEMENT
NEW DELHI

DEPT CODE		NAME	SIGN	DATE
	DRN	A.D.	-SD-	10.12.10
	DESN	D.R.	-SD-	10.12.10
I	CHD	D.R.	-SD-	10.12.10
	APPD			

CONSULTANT
CONSULTING ENGINEERING SERVICES (INDIA) PRIVATE LIMITED
KOLKATA NEW DELHI

TITLE
CW PUMP HOUSE–MCC ROOM
PLAN AT EL.(±)0.00M, ELEVATIONS,CROSS SECTION & SCHEDULES

DEPT.
SIGN
DATE

DRAWING No.
PE-DG-250-653-C002

SHEET 1 OF 1 REV. 2

FORMAT SIZE A1

PE-DG-250-653-C006

SCHEDULE OF BEAMS

BEAM MKD.	WIDTH (mm)	DEPTH (mm)
RB-1	400	1000
RB-2	250	500
RB-3	300	600
RB-4	300	550
B-1	300	700
B-1A	300	700
B-2	300	700
B-3	400	700
B-4	300	600
B-5	300	700
B-6	250	500
FB-1	300	600
FB-2	300	600
FB-3	1200	600
FB-4	600	1200
TB-1	250	500
GB-1	300	600
GB-2	300	800

SCHEDULE OF COLUMNS

COLM. MKD.	WIDTH (mm)	DEPTH (mm)
C1	800	900
C2	800	600
C3	500	700

EMBEDDED PLATE 1800x800x16THK. SEE DETAIL 'Z'

⚠ INSERTS FOR SLIDING SUPPORTS MKD. S1, S2, S3, S4, S5 & S6

DETAIL 'Z' ⚠

⚠ SECTION X–X

SECTION B–B ⚠

DETAIL 'A' ⚠
(READ THIS DRG. IN CONJUNCTION WITH DRG. NO. 3-80-468-26370 FROM PIPING CENTRE). (PUDDLE FLANGE SUPPLY IS BY SUPPLIER OF CW PIPES & TO BE FIXED BY CIVIL CONTRACTOR WHILE CASTING OF RETAINING WALL).

⚠ SECTION–1–1

PLAN AT GROUND FLOOR LEVEL AT EL. (–)0.040M ⚠

PLAN AT FOUNDATION LEVEL AT EL. (–)8.500M. ⚠
(ALSO SHOWING TIE BEAMS)

PLAN AT EL.(+) 15.950M (T.O. ROOF)

PLAN AT EL.(+) 7.50M

SECTION–2–2

SECTION–5–5 ⚠

SECTION–6–6

KEY PLAN

CAT-1
APPROVED
Checked and approved with regard to the system requirements and/or main dimensions and/or the overall arrangement. The Contractor is responsible for design calculations, dimensions and operability.
FICHTNER
Signature: Date:

REFERENCE MECHANICAL DRG.–

1. BHEL DRG. NO. PE-DG-25-165-N003 (SH 1 OF 1), REV. 0 : FOR GA
2. BHEL DRG. NO. 1 162 0/S 4013, REV. 00 : FOR CW PUMP
3. BHEL DRG. NO. PE-DG-250-653-C001 : FOR ARCH. DETAILS
4. PRADEEP STRUCTURAL DEVELOPMENT DRG. NO. PSDPL/KOST/CW/01 : GENERAL ARRANGEMENT OF STOPLOG GATE
5. PRADEEP STRUCTURAL DEVELOPMENT DRG. NO. PSDPL/KOST/CW/02 : DETAIL OF EMBEDDED PARTS FOR STOPLOG GATE
6. PRADEEP STRUCTURAL DEVELOPMENT DRG. NO. PSDPL/KOST/CW/00 : ARRANGEMENT AND DETAIL OF BAR SCREEN
7. MECH LAYOUT OF CW PIPING IN & AROUND C.W. PUMP HOUSE : PE-DG-250-165-M003_REV C SHT 1 OF 1
8. LAYOUT OF CW PIPING IN & AROUND C.W PUMP HOUSE DGN : DGN-01 TO PE-DG-250-165-M003_RC
9. PUDDLE FLANGE ASSEMBLY(FOR PIPE NB 1600)–PIPING CENTRE,CHENNAI : 3-80-468-26370_REV 0

NOTES :

1. ALL DIMENSIONS ARE IN MM. AND LEVELS ARE IN M. UNLESS NOTED OTHERWISE.
2. ELEVATIONS ARE GIVEN WITH RESPECT TO EL. ± 0.0, WHICH IS THE FFL OF THE OPERATING FLOOR OF C.W. PUMPHOUSE AND CORRESPONDS TO EL. 412.5M ABOVE MSL.
3. LEAN CONCRETE BELOW FOUNDATIONS SHALL BE OF GRADE M10 AND OF MINIMUM THICKNESS 75mm UNLESS NOTED OTHERWISE.
4. GRADE OF STRUCTURAL CONCRETE SHALL BE M25 UNLESS NOTED OTHERWISE.
5. ALL REINFORCING BARS WITH DIAMETER DESIGNATED AS Y SHALL BE HIGH STRENGTH DEFORMED STEEL BARS OF GRADE Fe 415 CONFORMING TO IS 1786, UNLESS NOTED OTHERWISE.
6. FOR OTHER GENERAL NOTES AND STANDARD DETAILS REFER DRG. NO. PE-DG-250-600-C003
7. GATES AND SCREENS SHALL BE FIXED AS PER GATE VENDOR DRAWING USING HILTI BOLTS. ⚠

SECTIONS 3–3 & 4–4 NOT USED

REV.	DATE	ALTD	CHD	APPD
8	REVISED TO SUIT AS BUILT CONDITION WITH MODIFIED ARRANGEMENT OF GATES & SCREENS ⚠	01.08.11	SC	AM	SN
7	DETAIL OF INSERTS & BOND & PUDDLE FLANGE ADDED AS PER MPL/SITE COMMENTS & MKD AS ⚠	16.12.10	SP	SN	SN
6	REVISED TO INCORPORATE GROOVES AND EMBEDDED PARTS FOR GATES & SCREENS	03.05.10	PS	SN	SN
5	REVISED AS PER COMMENTS GIVEN BY MCL/PCE	23.04.10	RPB	SC	SN
4	REVISED AS DISCUSSED DURING DRWG ON 18/11/08	18.11.08	RPB	GK	SN
3	REVISED AS PER COMMENTS GIVEN BY MCL/PCE	12.06.08	RPB	GK	SN
2	REVISED AS PER ARCH. DRG.	15.09.07	RPB	AD	SN
1		03.10.05	RPB	GK	SN

JOB No.
STATUS
DISTRIBUTION

KOSTI THERMAL POWER STATION 4X125 MW
NATIONAL ELECTRICITY CORPORATION (NEC)
THE REPUBLIC OF THE SUDAN

FICHTNER Fichtner GmbH & Co. KG Stuttgart, Germany

		NAME	SIGN	DATE
DESIGNED BY	BHARAT HEAVY ELECTRICALS LTD POWER SECTOR PROJECT ENGINEERING MANAGEMENT NEW DELHI	DEPT CODE	DRN	RPB		05.08.07
			DESIGN	AD		24.08.07
			CHD	SN		31.08.07
			APPD			

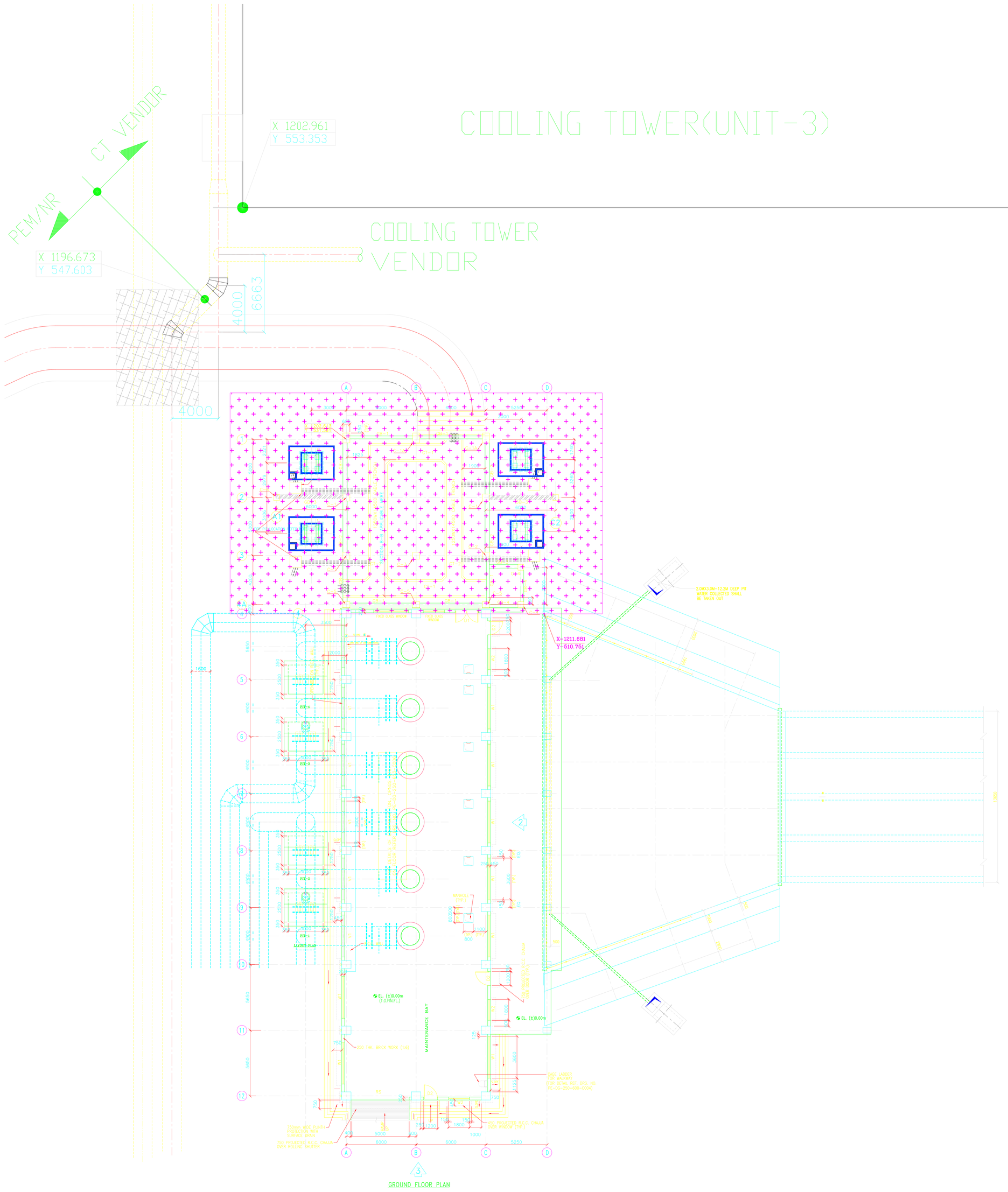
CONSULTANT: CONSULTING ENGINEERING SERVICES (INDIA) PRIVATE LIMITED KOLKATA NEW DELHI

TITLE: C.W. PUMP HOUSE
GENERAL ARRANGEMENT OF RCC STRUCTURE

SCALE 1:100 | DRAWING No. PE-DG-250-653-C006 | SHEET OF | REV. 8

DRAWING NO. PE-DG-XX-XX-XX

COOLING TOWER(UNIT-3)



LEGEND:

AREA FOR WHICH DEPTH OF GROUTING SHALL BE 10 M.

AREA IS INDICATIVE ONLY.

TENDER PURPOSE ONLY

NATIONAL ELECTRICITY CORPORATION (NEC)
THE REPUBLIC OF THE SUDAN
4x125MW KOSTI THERMAL POWER PLANT

BHARAT HEAVY ELECTRICALS LTD
POWER SECTOR
PROJECT ENGINEERING MANAGEMENT
NEW DELHI

JOB NO. 251
STATUS CONTRACT
DISTRIBUTION

FICHTNER Fichtner GmbH & Co. KG Stuttgart, Germany

DEPT CODE		NAME	SIGN	DATE
C	DRN	S.ND	-sd-	04.08.2014
	DES.N	W	-sd-	04.08.2014
	CHD	TMSR	-sd-	04.08.2014
	APPD	CPK	-sd-	04.08.2014

REV.	DATE	ALTD	CHD	APPD

TITLE: CW PUMP HOUSE & ADJACENT AREAS COMPACTION GROUTING

DEPT. SIGN DATE | SCALE 1:100 | DRAWING NO. PE-DG-XX-XX-XX | SHEET 1 OF 1 | REV. 0

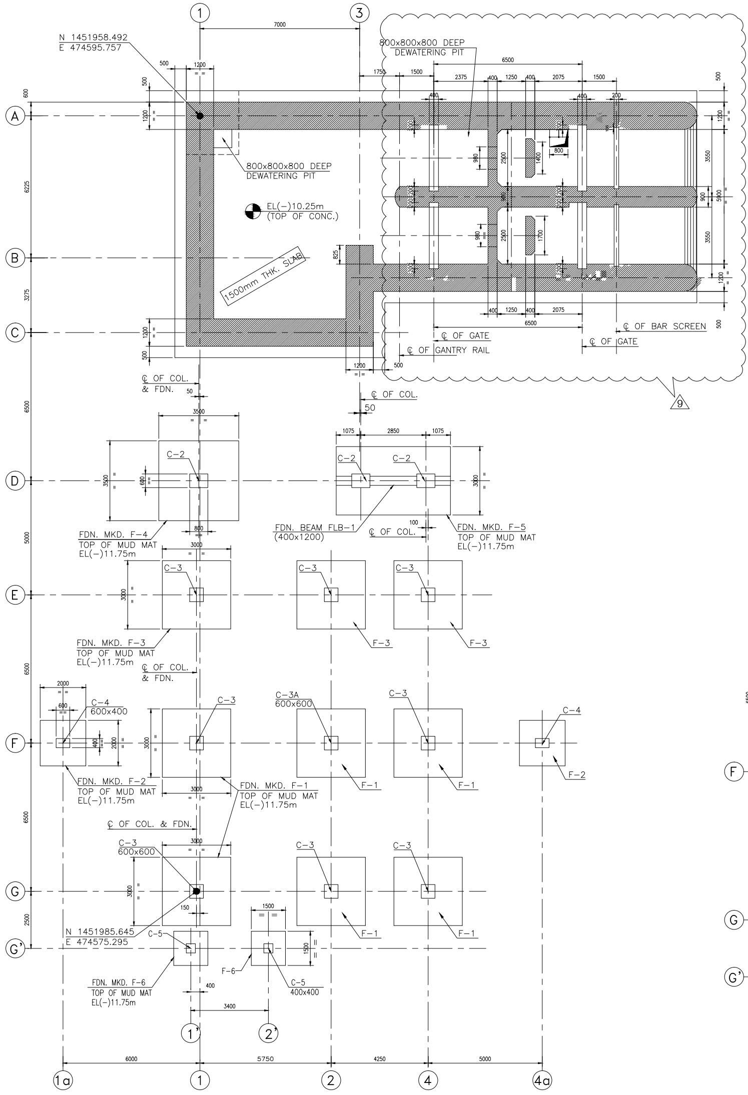
COMPUTER FILE NAME:

FORMAT SIZE A1

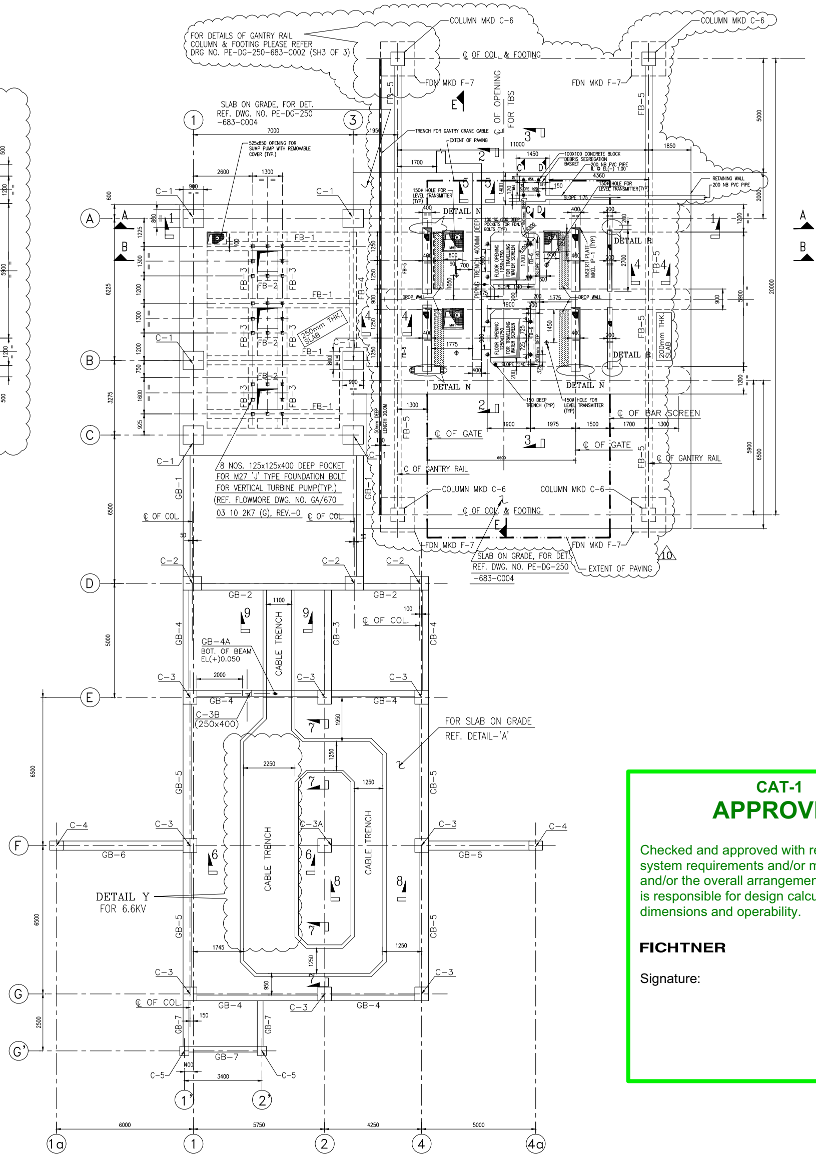
FIRST ANGLE PRJECTION

ALL DIMENSIONS ARE IN MM

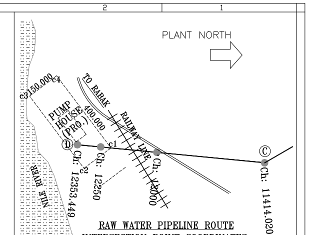
PE-DG-250-683-C001



PLAN AT FOUNDATION LEVEL 9



PLAN AT EL(±)0.00m LEVEL 10



RAW WATER PIPELINE ROUTE INTERSECTION POINT COORDINATES

I.P	EASTING	NORTHING
A	480293.176	1460098.890
B	480913.000	1454948.707
C	475510.195	1451853.428
D	474575.120	1451944.110

KEY PLAN (NOT TO SCALE)

REFERENCE DWGS:

1. PE-DG-250-100-E110 (ELEC. EQPT. LAYOUT IN RAW WATER INTAKE PUMP HOUSE)
2. PE-DG-250-172-N105 (G.A. OF RAW WATER INTAKE PUMP HOUSE)
3. GA/670 03 10 2K7(G)(REV.0) OF FLOWMORE PRIVATE LIMITED (GENERAL ARRANGEMENT DRAWING FOR VERTICAL TURBINE PUMP.
4. PRADEEP STRUCTURAL DEVELOPMENT DRG. NO. PSDPL/KOSTI/RWI/01 : GENERAL ARRANGEMENT OF STOPLOG GATE
5. PRADEEP STRUCTURAL DEVELOPMENT DRG. NO. PSDPL/KOSTI/RWI/02 : DETAIL OF EMBEDDED PARTS FOR STOPLOG GATE
6. PRADEEP STRUCTURAL DEVELOPMENT DRG. NO. PSDPL/KOSTI/RWI/08 : ARRANGEMENT AND DETAIL OF BAR SCREEN
7. GENERAL MECHANICAL WORKS DRG. NO. PE-VO-250-165-N504 : CIVIL DETAIL OFTRAVELLING WATER SCREEN
8. PE-VO-250-165-N504 (R-1) (CIVIL DETAILS OF TRAVELING WATER SCREEN)

NOTES :

1. THIS DRAWING SHALL BE READ IN CONJUNCTION WITH CONTRACT TERMS, CONDITIONS AND SPECIFICATIONS.
2. ALL DIMENSIONS ARE IN mm AND LEVELS ARE IN METRE UNLESS OTHERWISE NOTED.
3. GRADE OF STRUCTURAL CONCRETE SHALL BE M25.
4. FOR ALL OTHER GENERAL NOTES & STANDARD DETAILS REFER DWG. NO. PE-DG-250-600-C003.
5. EL(±) 0.00 CORRESPONDS TO RL(+) 383.50m ABOVE M.S.L.
6. READ THIS DRAWING IN CONJUNCTION WITH DWG. NO. PE-DG-250-683-C002 AND PE-DG-250-683-C003 AND PE-DG-250-683-C004, C005, C006 & C008
7. LEAN CONC. BELOW FOUNDATIONS SHALL BE OF GRADE M15 AND OF MINIMUM THICKNESS 100mm U.N.O.
8. SULPHATE RESISTANT CEMENT SHALL BE USED FOR SUBSOIL CONSTRUCTION
9. FOR STOP LOG GATES, TBS AND BAR SCREENS EMBEDMENT & GROOVES ARE SHOWN IN THIS DRAWING. SECOND STAGE CONCRETE & INSERTS ARE IN RELEVANT VENDORS SCOPE.
10. FOR TYP. DETAIL OF FLOOR CUTOUT FOR 6.6KVA PANEL REFER PE-DG-250-100-E110 SHT1.
11. LAP LENGTH (Ld) FOR REINFORCEMENT SHALL BE 50 DIA OF SMALLEST BAR BEING LAPPED.
12. i) FOR DETAILS OF RUNGS ,
    ii) FOR DETAILS OF EMBEDDED PLATE (EP),
    iii) FOR DETAILS OF CJ & IJ REFER DWG NO. PE-DG-292-600-C002,
    iv) FOR CHEQUERED PLATE & GRATING SUPPORT DETAILS,
    v) FOR FIXING DETAILS OF HAND RAILS.
    REFER DWG NO. PE-DG-250-600-C003
13. RETAINING WALL AT END OF SUMP WALL NOT SHOWN. REFER RELEVANT DRAWING FOR DETAILS.
14. FOR WALLS IN CONTACT WITH EARTH & WATER PVC WATER STOP SHALL BE PROVIDED AT ALL CONSTRUCTION, EXPANSION/ISOLATION JOINTS RESPECTIVELY U.N.O.
15. GATES AND SCREENS SHALL BE FIXED AS PER GATE VENDOR DRAWING USING HILT BOLTS.
16. DCN02 INCORPORATED IN THIS REVISION.

LEGEND

- ℄ – CENTER LINE
- EL – ELEVATION
- FFL – FINISHED FLOOR LEVEL
- TB – TIE BEAM
- TOC – TOP OF CONCRETE
- BOC – BOTTOM OF CONCRETE
- R – REMOVABLE GRATING
- TBS – TRAVELLING BAND SCREEN
- TOG TOP OF GROUT
- TYP – TYPICAL
- UNO – UNLESS NOTED OTHERWISE
- FGL – FINISHED GROUND LEVEL
- LVL – LEVEL
- EP – EMBEDDED PLATE
- SLG – STOP LOG GATE
- MH – MAN HOLE
- C/C – CENTRE TO CENTRE

CAT-1
APPROVED

Checked and approved with regard to the system requirements and/or main dimensions and/or the overall arrangement. The Contractor is responsible for design calculation, detail dimensions and operability.

FICHTNER

Signature: Date:

READ THIS DRAWING IN CONJUNCTION WITH DRAWING NO PE-DG-250-683-C001-SH3

REV.	DATE	ALTD	CHD	APPD	DESCRIPTION
10	21.07.11	T.K	A.N.	A.N.	DRAWING REVISED AS PER COMMENTS RECEIVED FROM SITE.
9	02.06.11	S.C.	A.N.	A.N.	REVISED TO SUIT AS BUILT CONDITION WITH MODIFIED ARRANGEMENT OF GATES & SCREENS.
8	05.10.10	T.K.	T.K.	A.N.	REVISED AS PER THE COMMENTS RECEIVED FROM SITE. INTERFACING COMMENTS FROM ELECT. INCORPORATED.
7	27.09.10	S.C.	T.K.	A.N.	GENERALLY REVISED TO MATCH THE REQUIREMENTS OF THE LATEST INPUTS.
6	01.09.10	DU	AN	AN	REVISED TO INCLUDE CABLE TRENCH DETAILS.
5	16.08.10	P.S.	S.N.	SN	REVISED TO INCORPORATE GROOVES AND EMBEDDED PARTS FOR GATES & SCREENS AND RELATED TO TWS.
4	04.09.09	RPB	SK	SPM	REVISED DUE TO TOILET ADDED AND HOLD REMOVED & AS MKD. 4
3					REVISED AS PER THE DISCUSSIONS ON THE DRM # 9 ON 17/11/08
2	03.11.08	RPB	PP	SN	REVISED AS PER COMMENTS GIVEN BY NEC/FCE.
1	02.09.08	RPB	PP	SN	REVISED AS PER COMMENTS GIVEN BY NEC/FCE.

JOB No. 250
STATUS
DISTRIBUTION

KOSTI THERMAL POWER STATION 4X125 MW
NATIONAL ELECTRICITY CORPORATION (NEC)
THE REPUBLIC OF THE SUDAN

FICHTNER
Fichtner GmbH & Co. KG
Stuttgart, Germany

BHARAT HEAVY ELECTRICALS LTD
POWER SECTOR
PROJECT ENGINEERING MANAGEMENT
NEW DELHI

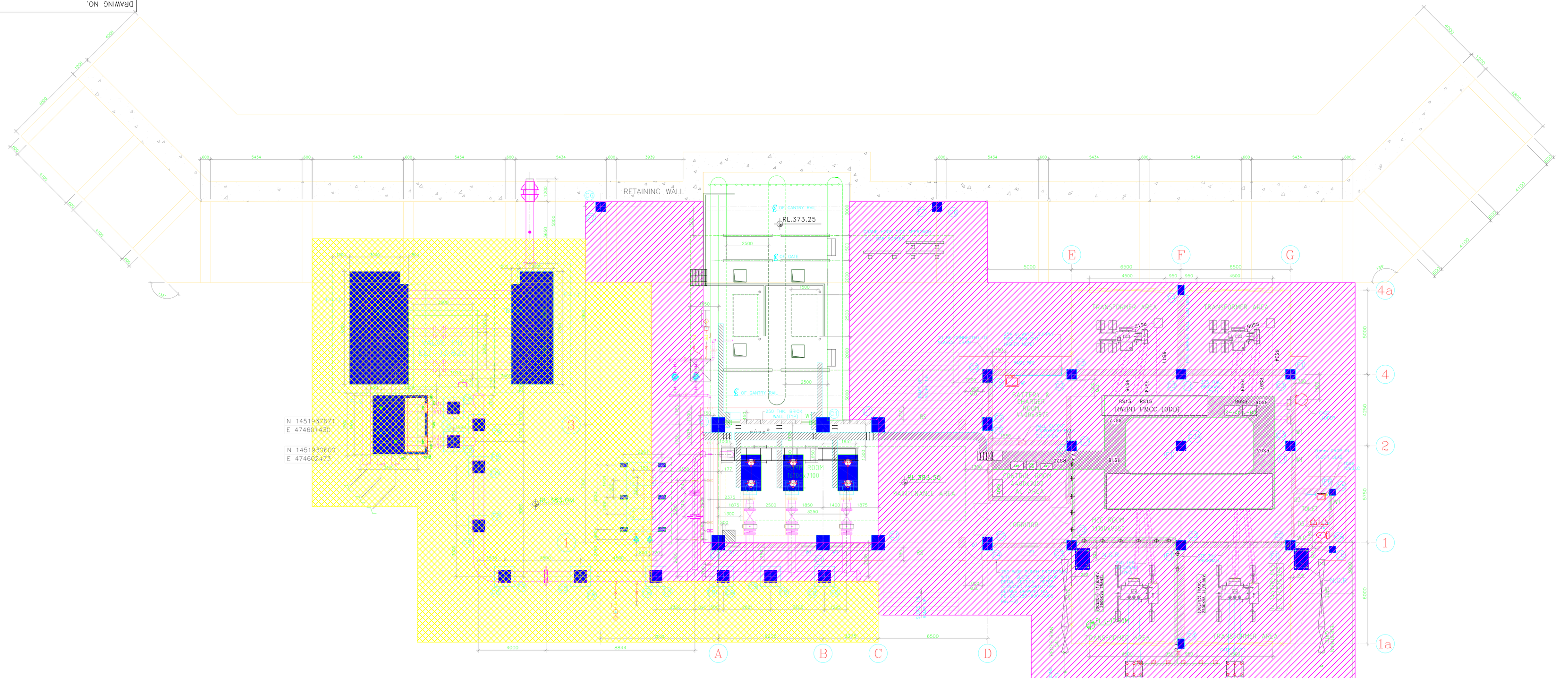
DEPT CODE		NAME	SIGN	DATE
C	DRN	S. C.		07.01.08
	DESN	A. D.		04.01.08
	CHD	S. N.		18.01.08
	APPD			

CONSULTANT
CONSULTING ENGINEERING SERVICES (INDIA) PRIVATE LIMITED
KOLKATA NEW DELHI

TITLE
RIVER SIDE INTAKE PUMP HOUSE & ELECTRICAL BUILDING
FOUNDATION & GROUND FLOOR PLAN

DEPT. SIGN DATE
SCALE 1:100
DRAWING No. PE-DG-250-683-C001
SHEET 1 OF 3 REV. 10

DRAWING NO. PE-DG-XX-XX-XX



LAY OUT PLAN

COLUMN		FOOTING TYPE		
TYPE	SIZE	TYPE	SIZE	BOTT. OF FTG.
C1	800x900	F1	–	EL (–)11.750
C2	600x800	F2	2000X2000	
C3	600x600	F3	3000X3000	
C3A	600x600	F3A	3000X3000	
C4	400x600	F4	3500X3500	
C5	400x400	F5	1500X1500	
C6	400x400	F6	1500X1500	
		F7	1500X1500	EL (–)2.00
C8	750x750	F8	1200X1200	EL (–)1.00
		F9	3400X3700	EL (–)4.493
		F10	5500X7700	EL (–)4.550 WITH ADDITIONAL 1M DEPTH SHEAR KEY
		F11	4500X7700	EL (–)4.550 WITH ADDITIONAL 1M DEPTH SHEAR KEY

LEGEND:

AREA FOR WHICH DEPTH OF GROUTING SHALL BE 12 M.

AREA FOR WHICH DEPTH OF GROUTING SHALL BE 8 M.

AREA FOR WHICH DEPTH OF GROUTING SHALL BE 4 M.

AREA IS INDICATIVE ONLY.

TENDER PURPOSE ONLY

COMPUTER FILE NAME:

REV.	DATE	ALTD	CHD	APPD

NATIONAL ELECTRICITY CORPORATION (NEC)
THE REPUBLIC OF THE SUDAN
4x125MW KOSTI THERMAL POWER PLANT

BHARAT HEAVY ELECTRICALS LTD
POWER SECTOR
PROJECT ENGINEERING MANAGEMENT
NEW DELHI

FICHTNER — Fichtner GmbH & Co. KG, Stuttgart, Germany

JOB NO. 250
STATUS CONTRACT
DISTRIBUTION

DEPT CODE		NAME	SIGN	DATE
C	DRN	S.ND	–sd–	04.08.2014
	DESN	W.	–sd–	04.08.2014
	CHD	TMSR	–sd–	04.08.2014
	APPD	CPK	–sd–	04.08.2014

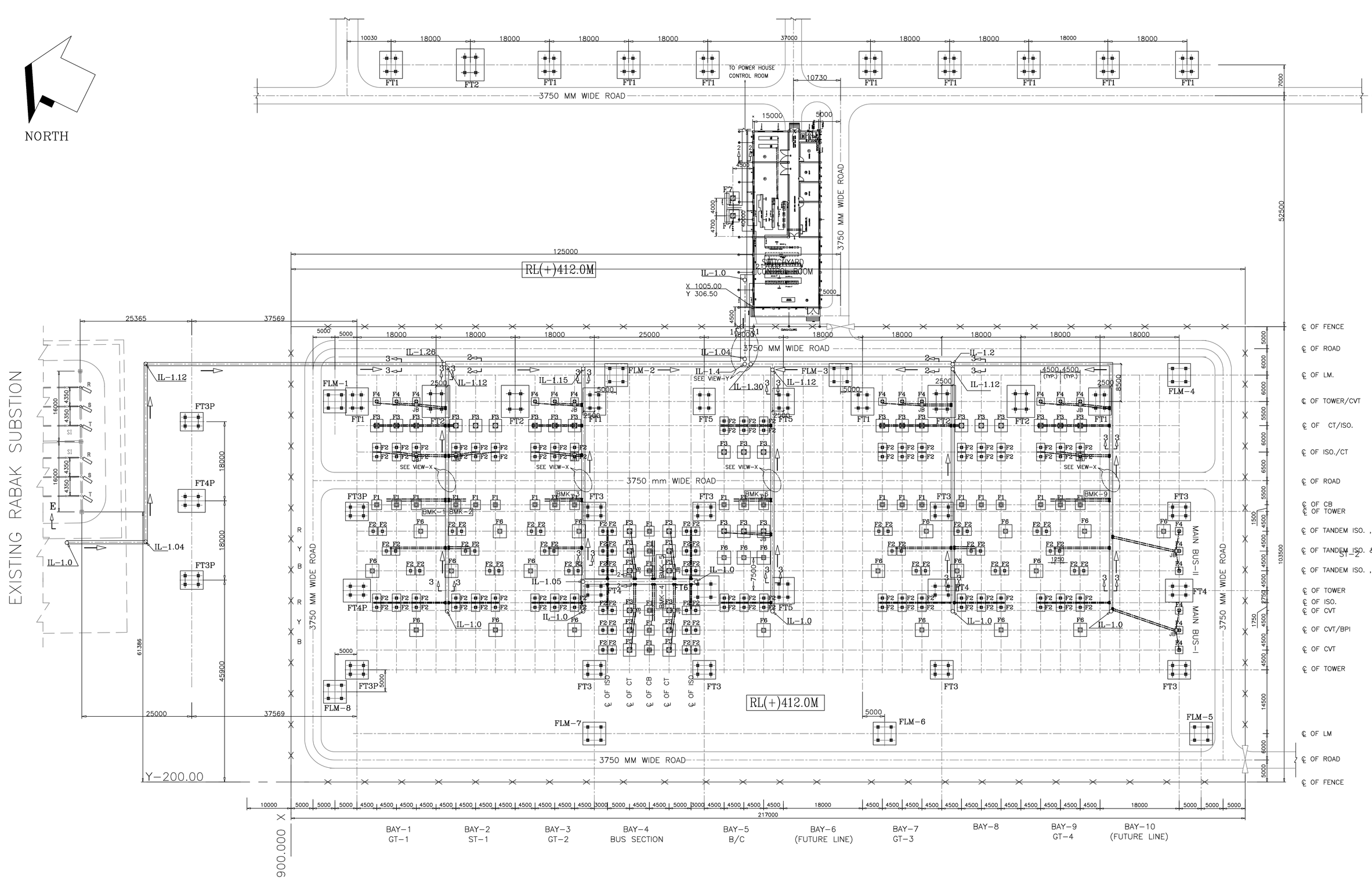
TITLE: RAW WATER INTAKE PUMP HOUSE & ADJACENT AREAS COMPACTION GROUTING

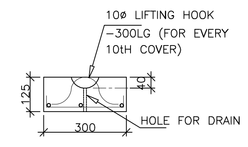
DEPT. | SCALE 1:100 | DRAWING NO. PE-DG-XX-XX-XX
SIGN
DATE
SHEET 1 OF 1 | REV. 0

FORMAT SIZE A1

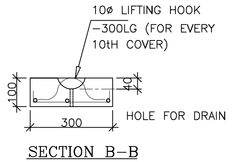
COMPUTER DRG. PATH NAME :

INVENTORY No.	SIGN. & DATE	REF. DRG. No.

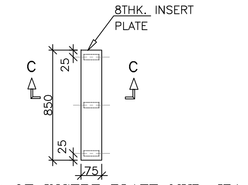




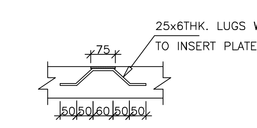
SECTION A–A



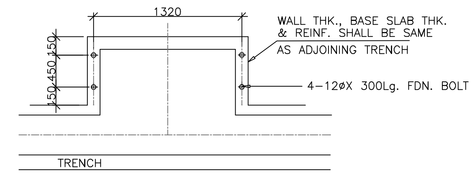
SECTION B–B



DETAIL OF INSERT PLATE MKD. IP1



SECTION C–C



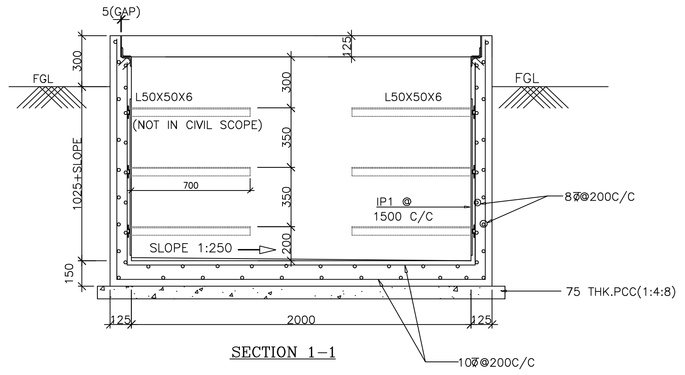
DETAIL OF MK FOUNDATION

LEGEND :–

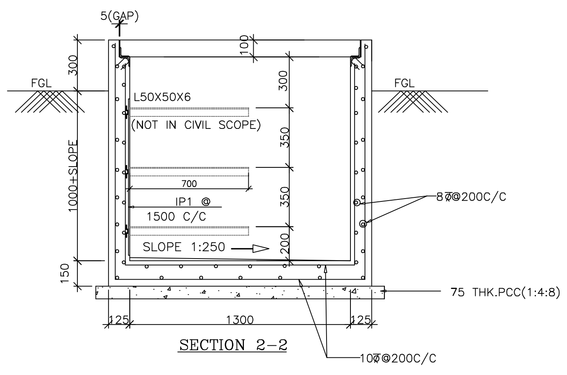
A	———	PROPOSED SCOPE
B	- - - - - -	EXISTING/ FUTURE (NOT IN BHEL SCOPE)
C	⋈	GATE
D	×—×—×	FENCE
E	—·—·—	ROAD

NOTES:–

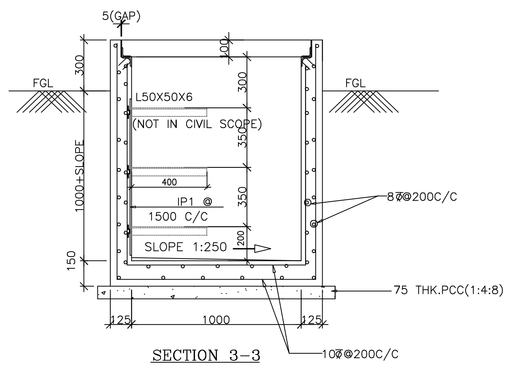
1. ALL DIMENSIONS ARE IN MILLIMETER AND LEVELS IN METER.
2. DO NOT SCALE. FOLLOW WRITTEN DIMENSION ONLY.
3. UNLESS SPECIFIED OTHERWISE, GRADE OF CONCRETE SHALL BE M–25 IN CONFORMITY WITH IS–456
4. THE SPECIFIED DEPTH OF CABLE TRENCH IN SECTIONS REPRESENTS THE MINIMUM DEPTH. THE SAME SHALL BE INCREASED TO ACHIEVE A SLOPE OF 1:500 ALONG RUN OF THE CABLE TRENCH.
5. A SLOPE OF 1:250 SHALL BE GIVEN IN THE DIRECTION PERPENDICULAR TO THE RUN OF THE TRENCH FOR ALL SECTIONS.
6. CLEAR COVER TO MAIN REINFORCEMENT SHALL BE AS FOLLOWS.
   a). BASE SLAB & WALL IN CONTACT WITH EARTH 40mm AND COVER AT INNER FACE SHALL BE 25mm.
   b). PRE CAST COVER SLAB 15mm.
7. THIS DRAWING SHALL BE READ IN CONJUCTION TO DRAWING NO. TB–0–297–316–007.
8. OPENING FOR 100MM & 50MM DIA PIPES. SHALL BE PROVIDED AS PER DWG. NO. TB–0–297–316–007.



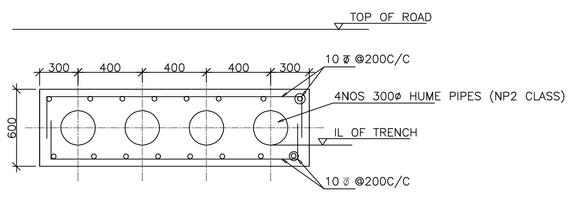
SECTION 1–1



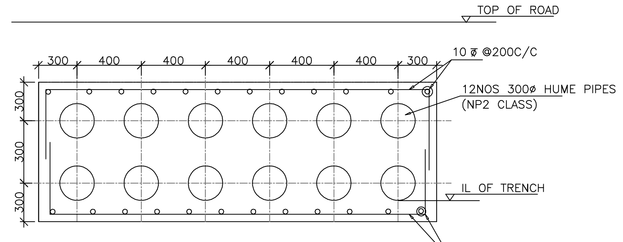
SECTION 2–2



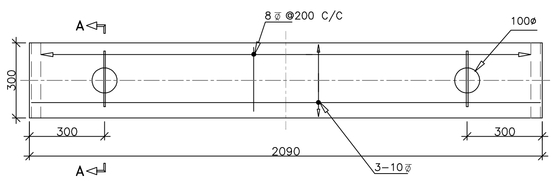
SECTION 3–3



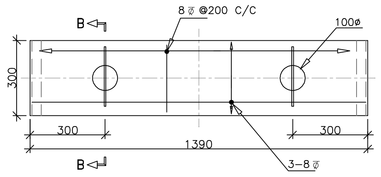
DETAIL OF VIEW X



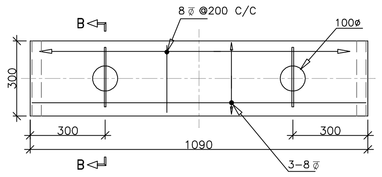
DETAIL OF VIEW Y



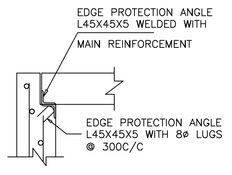
TRENCH COVER DETAIL FOR SECTION 1–1



TRENCH COVER DETAIL FOR SECTION 2–2



TRENCH COVER DETAIL FOR SECTION 3–3



DETAIL – A

REV.	DATE	DESCRIPTION	PREPARED	CHECKED	REVIEWED	APPROVED
A	02.12.09	REVISED AS PER COMMENTS	JUGENDRA	AA	SVG	RMS
00	02.12.09	FIRST SUBMISSION	JUGENDRA	AA	SVG	RMS

KOSTI, Thermal Power Station 4 x 125 MW

NATIONAL ELECTRICITY CORPORATION (NEC)
THE REPUBLIC OF THE SUDAN

FICHTNER — Fichtner GmbH & Co. KG, Stuttgart, Germany

Bharat Heavy Electrical Ltd., Delhi, India

Subcontractor

DRWG. NO : TB–0–279–607–609–A

CHIEF. ENG.		PROJECT ENG.	
DESIGN MANAGER		CHECK	
DEPT. CHIEF		DESIGN ENG.	
SECTION CHIEF		SCALE	
CAD-FILE		DATE :	

DRWG. NO : KTPS–AD–00–DW–609–A

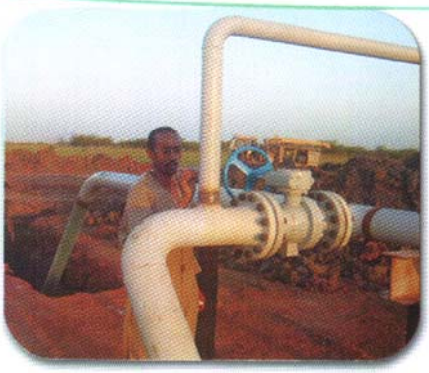
DRAWING TITLE :
LAYOUT & RCC DETAILS OF TRENCHES & ROAD CROSSING

List of Consortium Bank			
	Nationalised Bank		**Nationalised Bank**
1	Allahabad bank	19	Vijaya Bank
2	Andhra bank		**Public Sector Banks**
3	Bank of Baroda	20	IDBI
4	Canara Bank		**Foreign bank**
5	Corporation bank	21	CITI Bank N.A
6	Central bank	22	Deutsche Bank AG
7	Indian Bank	23	The Hongkong and Shanghai Banking Corporation Limited
8	Indian Oversea Bank	24	Standard Chartered Bank
9	Oriental bank of Commerce	25	The Royal Bank of Scotland N.V.
10	Punjab National Bank	26	J P Morgan
11	Punjab & Sindh Bank		**Private bank**
12	State Bank of India	27	Axis Bank
13	State Bank of Hyderabad	28	The Federal Bank Limited
14	Syndicate Bank	29	HDFC
15	State Bank of Travancore	30	Kotak Mahindra Bank
16	UCO Bank	31	ICICI
17	Union Bank of India	32	Indusind Bank
18	United Bank of India	33	Yes Bank

ESD

Engineering Services and Design Since 1982

WHEN YOU NEED
ENGINEERING SOLUTIONS



REPORT ON

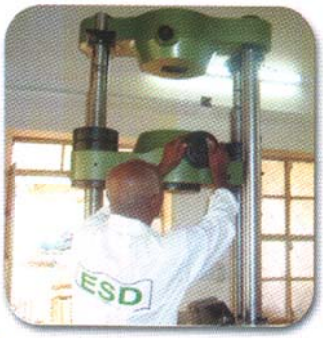
GEOTECHNICAL INVESTIGATION

FOR

ASSESSMENT ON SOIL SETTELMENT OF COMPACTED FILLS
AT 4X125 MW KOSTI THERMAL POWER STATION
RABAK, WHITE NILE STATE
SUDAN

SUBMITTED TO
BHARAT HEAVY ELECCTRICALS LIMITED
(BHEL)

FEBRUARY 17, 2014



32 Years of Service Excellence

Khartoum : Tel: +249183248886
Fax: +249183248866
P.O.Box : 95 Khartoum North
esdengco@yahoo.com
www.esd-sudan.com.sd
esd.eng.co@gmail.com

Contents

1.0 Introduction:

BHEL contracted with **E**ngineering **S**ervices & **D**esign (**ESD**), geotechnical consulting office, to carry out soil investigation to assess soil settlement of compacted fills at 4x125MW Kosti Thermal Power Station**,** in Rabak town, White Nile State.

The site investigation consisted of drilling thirteen (13) boreholes.Six borholes; BH.1, BH.2, BH.3, BH.4, BH.5 and BH.6 were drilled at power station area. Another six boreholes; BH.7, BH.8, BH.9, BH.10, BH.11and BH.12 were drilled at river water intake pump house location. Last borehole; BH.13 was drilled at intake water pipeline route;. Undisturbed and disturbed soil samples are taken as well as carried out appropriate field and laboratory testing. The field work was conducted during the period from 18th to the 26th of November 2013.

The following conditions were part of the agreement;

1. The client has determined the number of borehole to be drilled, their locations and depth, as well as frequencies of field tests. ESD followed the proposal with that specific program for testing and drilling.

2. Sampling in both disturbed and undisturbed tube had been difficult because some of layers at boreholes were very soft and almost saturated. At some of the depths, undisturbed tubes were recovered empty as shown in profile.

3. Two bulk soil samples marked SPILE & PCL collected from borrow areas were handed over by the client. Laboratory tests carried out for these samples are Atterberg limit, Sieve Analysis, Specific Gravity, Hydrometer, Compaction, Single and Double oedometre. Results of these tests are shown seperately in Appendix (F).

This report presents the results of the field investigations, laboratory tests, analysis of the results and recommendations for the remedial measures.

2.0 The Field Investigation:

2.1 Drilling of Boreholes

Thirteen boreholes were drilled in the specified locations. The location of these boreholes are shown in Fig (1). The boreholes were drilled using a rotary soil mechanics drilling rig. Disturbed soil samples and undisturbed samples were collected at one-meter depth intervals for visual inspection, identification of the soil type and laboratory testing. The Standard Penetration Test (SPT) was performed at a depth interval of 1.5m at some boreholes (shown the soil profile). A split spoon sampler, 50mm out side diameter was driven by the blows of a standard hammer weighing 64-kg and falling freely from a height of 760mm. The number of blows required to drive the tube a penetration of 300mm was taken as the SPT N-value of the soil tested at a specified borehole depth. The SPT results are shown in Appendix (A) at the corresponding borehole depths in terms of the measured N values.

It's to be mentioned that the boreholes at river intake pump house and power station were all in the compacted fill area.

2.2 Groundwater

The level of the ground water table was not observed at most of boreholes. In borehole No.7 ground water was observed at 8.0m depth. The moisture content in most of borehole were high and soil almost saturated below 2.0m depth, this may be due to ingress of water from rainfall or other sources in stations.

3.0 Soil Conditions:

The soil profile for the boreholes is shown in Fig. (2) and Appendix (A). The soil profile at most of boreholes are relatively similar. In power station the boreholes BH.1, BH.2, BH.3, BH.4, BH.5 and BH.6 indicate dark brown to light grey clayey sand (SC) layer and silty clay of low plasticity (CL) layer, followed by high plasticity (CH) layer. This three layers may happen in different sequences. The Boreholes arround the river water pump house BH.7, BH.8, BH.9, BH.10, BH.11 and BH.12 indicate dark brown and greyish brown,

clayey sand (SC) layer and low plasticity silty clay (CL) layer. The SPT results for these boreholes indicate loose and soft soil. Except borehole No.10 where the SPT were high. BH.13 near pipe line, profile indicate to reddish brown poorly graded of silty sand (SP-SM) layer, followed by light brown clayey sand (SC) layer.

4.0 Laboratory Testing:

4.1 Objectives of the Testing Program

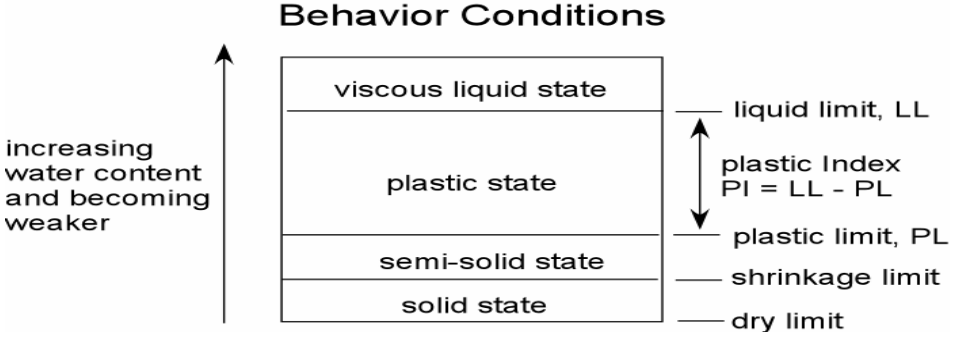
Laboratory testing program was conducted to evaluate the physical and chemical properties of the soils encountered during the boring. The tests included bulk density and moisture content, atterberg limits, grain size distribution, specific gravity, chemical tests, free swell index, consolidation, sensitivity, collapse potential using single and double oedometer, pinhole and permeability. The procedures followed were in general conformance with those recommended in the British Standard BS 1377 (1990) and American Society for Testing and Materials ASTM.

4.2 Classification Tests

The objective of these tests is to reveal soil types encountered at different depths of the boreholes. Tests carried out included atterberg limits, shrinkage limit and grain size analysis. All these classification tests confirmed the soil profiles shown in Appendix (A). Unified Soil Classification System (USCS) was followed for soil classification. See Fig. A-1 and Fig. B-1.

4.2.1 Consistency of Clays

The physical properties of clays are considerably influenced by the amount of water percent. Atterberg limits are the limits of water content used to define soil behavior. The consistency of soils according to Atterberg limits gives the following diagram.



4.2.1.1 Plastic Limit (PL) and Liquid Limit(LL)

The program of tests were carried out on clayey soil samples taken from different depths, based on standard test procedures at ASTM D 4313-03.

At boreholes in power station area, the results gave liquid limit values ranging between 75% to 34% and plastic index in the range of 45% to 16%, this range of Atterberg limits indicate possibility of occurence medium to high potential for swelling. At the boreholes in the river water intake pump house area, results gave liquid limit values ranging between 42% to 20% and plastic index range between 23% to 10%, the range indicate possibility of occurence medium to low swelling potential. Liquid limit values in the pipe line borehole between 23% to None and plastic index in range 8% to None, this range indicate to low swelling potential for swelling for the clayey samples.

4.2.1.2 Shrinkage Limit

The shrinkage is a measure of the average oven dry length of the sample after shrinkage to the original length which occurs at an initial water content at or above the Liquid Limit. According to the standared (ASTM D 427-98), results for samples from the boreholes are shown in soil profile. Range of the results at power station area between 7.71% to 20.0%, at river water intake pump house area between 5.34% to 10.79% and at pipe line nearly 2.07%. All of this results indicate to low shrink properties.

4.2.2 Grain Size Distribution

Grain size distribution or the percentage of the various size of soil grains percent in a given dry soil sample is carried out by mechanical sieve analysis for coarse grain and whereas fine-grained soils are analysed by the hydrometer method.

4.2.2.1 Sieve Analysis Test

The grain size distribution curve of the soil samples was determined in the laboratory. The results of the tests are shown in Appendix (B-1). Test was carried out according to ASTM D 1140-03.

4.2.2.2 Hydrometer Test

Distribution of soil particles having sizes less than 75 micron (Fine Grained soils) is determined by a sedimentation process using a hydrometer to obtain the necessary data such as the borderline between clay and silt. In appendix (B-2), results are shown for the hydrometer curves to different some samples.

4.2.3 Natural Moisture Content

The natural moisture content was determined from undisturbed soil samples. The test was performed according to ASTM D 2216-98. The test results are shown in the soil profile at Appendix (A) and figures(2). As mentioned previously, inspection by visual description reference a high moisture content at upper layers between 2.0m and 6.0m depth was observed.

4.3 Specific Gravity

Test is performed to determine the specific gravity of soil by using a pycnometer. Specific gravity is the ratio of the mass of unit volume of soil at a stated temperature to the mass of the same volume of gas-free distilled water at a stated temperature. standard reference for this test is ASTM D 854-02. Table (4.1) shows the results of specific gravity at different location.

BH. No.	Depth (m)	Specific Gravity
1	3.0	2.78
2	2.0	2.82
4	2.0	2.74
7	8.0	2.72
7	6.0	2.69
8	8.0	2.86
9	10.0	2.85
12	8.0	2.78

Table No.(4.1) Specific Gravity Test Results

4.4 Bulk Density Test

Table (4.2) shows the results of bulk density at different location in boreholes.

BH. No.	Depth (m)	Bulk Density (g/cm^3)
1	4.0	1.8187
2	2.0	2.1626
6	2.0	1.8468
6	4.0	2.0104
8	6.0	2.1349
12	8.0	1.8950

Table No.(4.2) Bulk Density Test Results

4.5 Permeability Test

This test is conducted in an apparatus using the procedure of falling head Test method. Performed in accordance with ASTM D 5856. Samples for this results were compacted at the laboratory, Results for this test are shown in table (4.3).

BH.No.	Depth	Cofficient of Permeability (K) (cm/s)
1	3.0	0.02282
4	2.0	0.02322
7	6.0	0.022699
8	8.0	0.02426
9	10.0	0.02378
12	8.0	0.022794

Table (4.3) Results of permeability test

4.6- Free Swelling

Free Swell Index is the increase in volume of a soil on submergence in water, without any external constraints. Test procedure carried out with standard (BS 1377-1990). Results are shown in Table(4.4),

BH.No.	*Depth (m)*	*Initial Volume of Specimen (I)*	*Final Volume of Specimen (F)*	*Free Swell (F.S %)*
1	3.0	156.3	250	60
4	2.0	120.4	170	41.17
6	1.0	149.3	235	57.45
7	6.0	104.2	125	20.0
7	8.0	58.6	81	38.27
8	8.0	124.6	180	44.45
10	10.0	126.8	185	45.94
12	8.0	114.4	155	35.48
13	2.0	58.2	80	37.50

Table (4.4) Free Swelling Test Results

4.7- Swelling Pressure Test

The swelling pressure tests were conducted on undisturbed soil samples. The volume of the soil was kept constant in an odometer cell, while the soil was saturated with water during the test.The results are shown in Table (4.5). Results reflected to very low of swelling pressures.

Borehole No.	**Depth (m)**	**Initial moisture content (%)**	**Final moisture content (%)**	**Swelling Pressure Kpa**	**Plasticity Index (%)**	**Classification of the Samples**
1	4.0m	25.94	28.40	20	41	CH
2	2.0m	14.50	15.54	0	17	SC
8	6.0m	9.21	14.14	10	20	SC
8	10.0m	10.23	15.12	0	16	SC
12	10.0m	10.42	15.97	10	18	SC

Table (4.5): Swelling Pressure Test Results

4.8 Consolidation Test

Consolidation tests provide information for use in evaluating the compressibility of the soils and estimating the settlement of foundations established on these soils. The consolidation tests were performed on clayey samples, according to the ASTM D 2435-03. Swelling pressure was conducted on the samples. Then the samples were loaded beyond the swelling pressure to allow consolidation to proceed. The results of these tests are shown in Appendix (C). Table (4.6) illustrate the summary results of consolidation parameters.

B.H. No.	Depth (m)	Initial moisture content	Final moisture content	Void ratio (e_o)	Degree of saturation (S_r)	Pre consolidation Pressure (P_C)	Over Consolidation Ratio (OCR)
1	4.0	25.937	28.398	0.8696	80.5336	52	0.728
2	2.0	14.498	15.538	0.4295	91.13961	78	1.83
6	2.0	28.116	31.301	0.873	87.2755	90	2.48
6	4.0	10.419	14.196	0.4829	58.25096	90	1.14
8	6.0	9.211	14.136	0.3812	65.243	58	0.45
12	10.0	10.918	15.966	0.5732	49.0731	370	1.99

Table (4.6) Consolidation Test Parameters

4.9 Collapse Potential Test

4.9.1 Single Oedometer Collapse Test

The undisturbed soil specimen at natural moisture content loaded in the conventional oedometer to a stress level ranging between 200 KPa and 400 KPa, and then inundation by distilled water is applied to induce collapse. Abelev (1948) used stress level of 300 KPa and defined the collapse potential (I_e) as: $I_e = \Delta e_c / 1+e_1$

Δe_c: change in void ratio resulting from saturation

e_1: void ratio just before saturation recommended the using of stress level of 200 KPa, and calculate the collapse potential according to the following equation: $Ie= \Delta e_c/1+e_o$

Δe_c: change in void ratio resulting from saturation

e_o: natural void ratio

The stress level of 200 KPa adopted by (ASTM D 5333-96, 2000) to classify the severity of the collapse problem. Since the idea behind this test is to predict the amount of deformation that a foundation may experience upon subsurface wetting; a loading to the anticipated field loading conditions is recommended. A results obtained from this test in boreholes are shown in Appendix(C-1) and Table(4.7)

BH. No.	Depth	e_o	e_1	e_2	C_P
1	3.0	0.7122	0.6320	0.6206	0.6664
2	4.0	0.4537	0.4105	0.3950	1.0704
4	2.0	0.4780	0.4349	0.4317	0.2118
7	6.0	0.5371	0.4734	0.4635	0.6467
7	8.0	0.6382	0.5781	0.5703	0.4743
8	8.0	0.2690	0.1720	0.1610	0.8684
8	10.0	0.3756	0.3467	0.3158	2.2499
9	10.0	0.3559	0.3185	0.3026	1.1712
11	6.0	0.4740	0.4509	0.4204	2.0706

Table(4.7) Single oedometer and Collapse potential Results

4.9.2 Double Oedometer Collapse Test

Two identical samples are placed in oedometers; one tested at in-situ natural moisture content, and the other is fully saturated before the test begins, and then subjected to identical loading.

Two stress versus strain curves are generated. The difference between the compression curves is the amount of deformation that would occur at any stress level at which the soil get saturated. Critical stress (σcr) represents the stress level at which the dry sample loose structure breaks down and beyond it the

two curves converge. This behavior could be explained also by that at high stress level, the limiting void ratio for the saturated sample is approached for particles packing It is common for natural soil that the initial void ratio of the two samples are not initiating from the same point; in this case adjustment of the two curves according to the procedure proposed by shall be adopted for the normally and overconsolidated clays. Results for double oedometer collapse test are shown in Appendix(C-2).

4.10 Pin Hole Test

In the pinhole test, a sample of soil at its natural water content is compacted into a plastic cylinder. A hole is formed in the specimen by inserting a needle through the center of the specimen. Distilled water under specified heads flows through the hole in the specimen. The water is carefully observed for turbidity, and the flow rate is closely monitored to determine if the hole in the sample is enlarging by erosion. Dispersive clays will rapidly erode as water flows through the 1 millimeter hole under a small water head pressure. Rapid enlargement of the hole is reflected in an increasing flow rate and the turbidity of the collected water.

Test was according the BS 1377- part 5, for compacted disturbed samples in the laboratory. Results for samples are shown in Table (4.8).

Pinhole tests results are recorded and interpreted using the following system:

A rating of D-1 or D-2 indicates the soils are dispersive enough to require special designs if the soils must be used in the project.

A rating of ND-1 indicates the soil is not dispersive.

A rating of ND-2, ND-3, or ND-4 indicates the soils are slightly to moderately dispersive. Only one sample gave the result of D2, which indicate dispersive, Other results are non dispersive.

Depth (m)	B.H NO.	Max Hydraulic Head Applied (mm)	Average of Last Head Rate of flow (ml/sec)	Classification
1	3	1020	3.13	ND2
2	4	1020	1.25	ND2
4	2	1020	2.56	ND1
6	1	1020	1.98	ND1
7	6	50	0.9	D2
8	8	50	0.9	ND4
9	10	50	0.8	ND4
11	6	50	0.8	ND4

Table (4.8) Pin hole Test Results

4.11 Sensitivity Tests

For many naturally deposited clayey soil, the unconfined compression strength (q_u) is greatly reduced when the soil is tested after remolding without any change in moisture content. This referred to as sensitivity and defined as

$$St = \frac{qu(undisturbed)}{qu(remolded)}$$

Results of samples for evaluation of sensitivity test are shown in Table(4.9).

BH. No.	Depth (m)	(q_u) unconfined compressive strength (undisturbed) (kpa)	(q_u) unconfined compressive strength (remolded) (kpa)	Sensitivity (S_t)	Description
1	3.0	4048.42	2146.58	1.886	Slightly sensitive
2	4.0	5305.22	2439.74	2.175	Medium sensitivity
7	6.0	2415.77	679.51	3.555	Medium sensitivity
8	8.0	20406.69	825.12	24.732	Medium quick
9	10.0	6784.28	1027.41	6.603	Very sensitive
12	8.0	344.43	586.44	0.587	Slightly sensitive

Table (4.9) Sensitivity Test Results

4.12 Chemical Tests

The test are preformed to determine the PH, organic matter, chloride, sulphate, PH of 1:2.5 soil/water suspension, Na+ and Mg++).

Chemical tests were performed according to BS 1377, Part 3- 1990 on soil samples taken from different depths of borehole. The results are shown in tables at appendix(D).

5.0 Analysis of the Results:

5.1 General review

Problematic soils in Sudan include expansive soils, collapsible soils as well as dispersive soils. The increase in water content of the soil has caused some difficulties in problematic soils and this geotechnical problem may lead to reduction in shear strength or excessive deformations, and consequently increase or decrease in soil thickness or volume. Knowledge of collapsible soils is not widely covered in Sudan, i.e, Generally, the areas where most of development projects were constructed didn't include collapsible soils. This is

why many engineers were not exposed to this type of soils. However, now collapsible soils are been encountered more and new studies have been published as ref. "An Experimental Study on the Identification and Classification of Collapse Potential of Some Soils in Sudan", (E.M.Ali and M.A. Osman) 18th International Conference on Soil Mechanics and Geotechnical Engineering, Paris 2013).

Collapsible soils have high porosity rates and they are subset of unsaturated soils. In general, collapsibility in soils occurs when fabric of soils with partial saturation and metastable cause the formation of metastable structure under constant stress, and together with increase in water content high inter-aggregate suction or cementing agent becomes weaker or disappears and consequently causes soil structure to be collapsed. And this will cause reduction in volume and sudden collapse of the soil, which is possible with or without applying additional load. Therefore, collapsibility is possible either in the form of increase in water content or simultaneously together with applying the load.

Internationally such soils have recently been studied. These are soils that are found in arid and semiarid zoned and are now studied as partially saturated media.

5.2 Origins of Collapsible Soils

Collapsible soils include Aeolian, alluvial, colluvial, residual deposits as well as volcanic tuff material. Loess is the most known collapsible sand deposit; however compacted fill materials have been reported in the literature. Indiana, USA is one location where compacted fill has been studied and documented. (Identification and Behavior of Collapsible Soils, Joint Transportation Research Program, Purdue University).

5.3 Collapsible Soil Behavior:

Collapse soil is distinguished by high voids with low degree of saturation. In situ strength of natural condition may be high. Collapsible soils experience significant volume change as the moisture content increase whether associated with changes in confining pressures or not. Such volume changes if not

considered in the geotechnical studies of the project will lead to differential settlements and major risks to the project.

5.4 Identification of Collapsible Soil

To be able to identify such soils, many methods were introduced. Table(5.1) gives a summary of some of the identification methods.

No.	Investigator , year	Criteria
1	Abelev,1948	$\delta_s=(\Delta e/1+e_L)$ Collapse is probable when: $\delta_s > 2\%$
2	Denisov, 1951	$K=e_L/e_o$ If k = 0.5-0.75 ; highly Collapsible If k = 1.0 ; non Collapsible loam If k = 1.5-2.0 ; non Collapsible soil
3	Priklonski, 1952	$K_D=(N.M.C-P.L)/PI$ If $k_D < 0$; highly Collapsible soil If $k_D > 0.5$; non Collapsible loam If $k_D > 1.0$; Swelling soil
4	Clevenger, 1958	$\gamma_{dry} < 12.6$ kn/m^3; Significant Settlement $\gamma_{dry} < 14.1$ kn/m^3; transitional Settlement
5	Gibbs and Bara, 1962	Collapse is probable when $\gamma_{dry} < 162.3/(1+0.026*L.L)$ Ib/ft^3 or when: $e_o > 2.6*L.L/100$
6	Soviet Building Code,1962	Collapse is probable when :is S > 60% and $(e_o-e_L)/(1+e_o) > -0.10$
7	Feda 1964 , 1966	$K_L=(N.M.C/S)-(PL/PI)$ If $K_L > 0.85$; Collapseible Soil
8	Handy, 1973	Clay Content <16% ; high probability for collapse 24%> Clay Content > 16% ; probably collapsible 32%> Clay Content >25% ; probability of collapse of less than 50% Clay Content > 32%; non collapsible
9	Zur and wiseman 1973	$\gamma_{dry} / \gamma_{dry\ L.L} < 1.1$; Soil prone to collapse $\gamma_{dry} / \gamma_{dry\ L.L} < 1.3$; Soil prone to swell

Table (5.1) Summary of Identification methods for collapse soil

5.5 Evaluation of Collapse Potential

A simplification of the volume change in the consolidation e-log-p graph given in Fig(3) leads to

$C_P = (e_2 - e_1)/ (1+e_o)$

Where

C_P : Collapse potential

e_o: initial void ratio

e_1: void ratio

e_2: void ratio

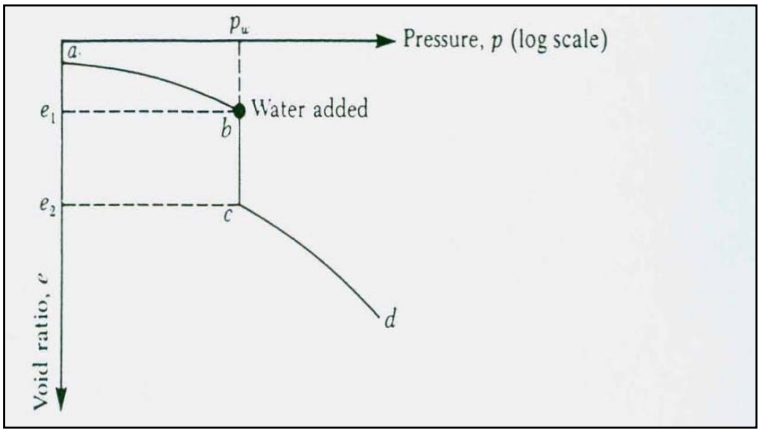


Fig.(3) Nature of variation of void ratio with pressure for a collapsing soil

5.6 Classification of Collapsible soil

Classification of collapsible soils as non-collapsible, low, medium, high, very high collapsibility potential as given in Table (5.2).

C_p: Collapse Classification

Collapsibility degree	Percentage of soil collapsibility
0	Non-collapsible
0.1- 2	Low collapsible
2.1- 6	medium collapsible
6.1- 10	Almost high collapsibe
>10	High collapsible

Table (5.2) Collapse soil classification

5.7 Use of Collapsible Soils as A compaction Fill Material

Some compacted fill materials may have some collapse potential and the engineer may be compelled to use them. A detailed study was carried out for the Indiana loess (identification and Behavior of collapsible soils, Joint Transportation Research Program, Purdue University). The recommendations of this study were:

1- Compaction effort should be high as needed.
2- Compaction should be carried out wet of optimum.
3- Preloading of compacted fill may be considered
4- Sometime stabilization or grouting, maybe appropriate.

Estimates of collapse of a compacted fill due to increase in moisture content may be estimated from C_P values determined from results of single or double oedometer tests.

5.8 The Actual Situation in Kosti Thermal Power Station, Rabak is the Following:

1- For all foundation units in the power plant main elements and river water intake pump house, the existing expansive soils were excavated and main foundations are rested on the natural non expansive soil. But the backfilling was done using local fill materials from borrow areas, located outside power station area. However this fill, was not identified originally as possessing any collapse potential. The fill was placed and compacted by the client. The client has all the details about fill material, compaction testing, compaction operation and quality control.
2- The compacted backfill area was exposed for some periods of time and the rainy season may have caused wetting of those fills or other sources of moisture may also have contributed to wetting. The in situ moisture content and consequently the degree of saturation of subsoil as shown in soil profile is high.

3- After the installation, differential settlement were observed at few location in floors resting on compacted backfill. It is expected that collapse may have occurred.

4- The current soil investigation was carried out in the soil that has already experienced significant volume change due to soil collapse. The client has determined the number of borehole to be drilled and locations and depth. Laboratory test were carried out on collected soil samples. Few samples slipped during collection and at depths sample quantity is very less due to which some tests were carried out on the sample collected from other depths than those specified by the client.

5.9 Identification of Collapsible Soil

Due to the fact that compacted fill has already collapsed and experienced settlement it is expected that volumetric, density, moisture content characteristics cannot be used fully to identify the potential of the soil.

However published literature about collapse behavior of compacted fill in Indiana has indicated that plot fall between A-Line & U-Line as shown in figure (6).

The plot of LL against PL for Kosti power station, Rabak are shown in same fig. which shows very high level of consistency with the result from Indiana.

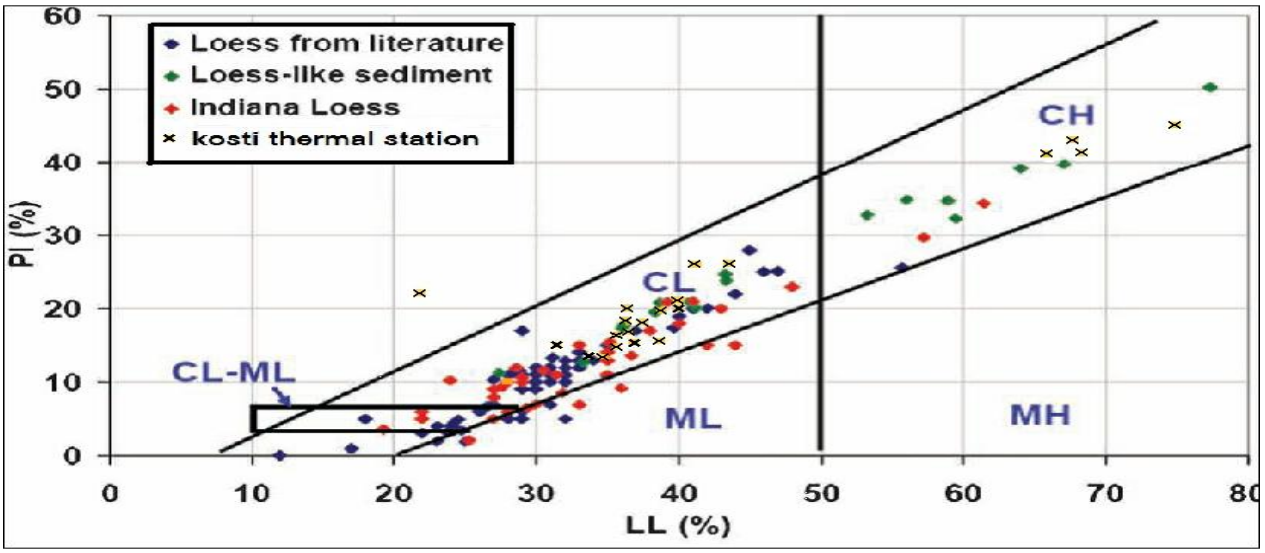
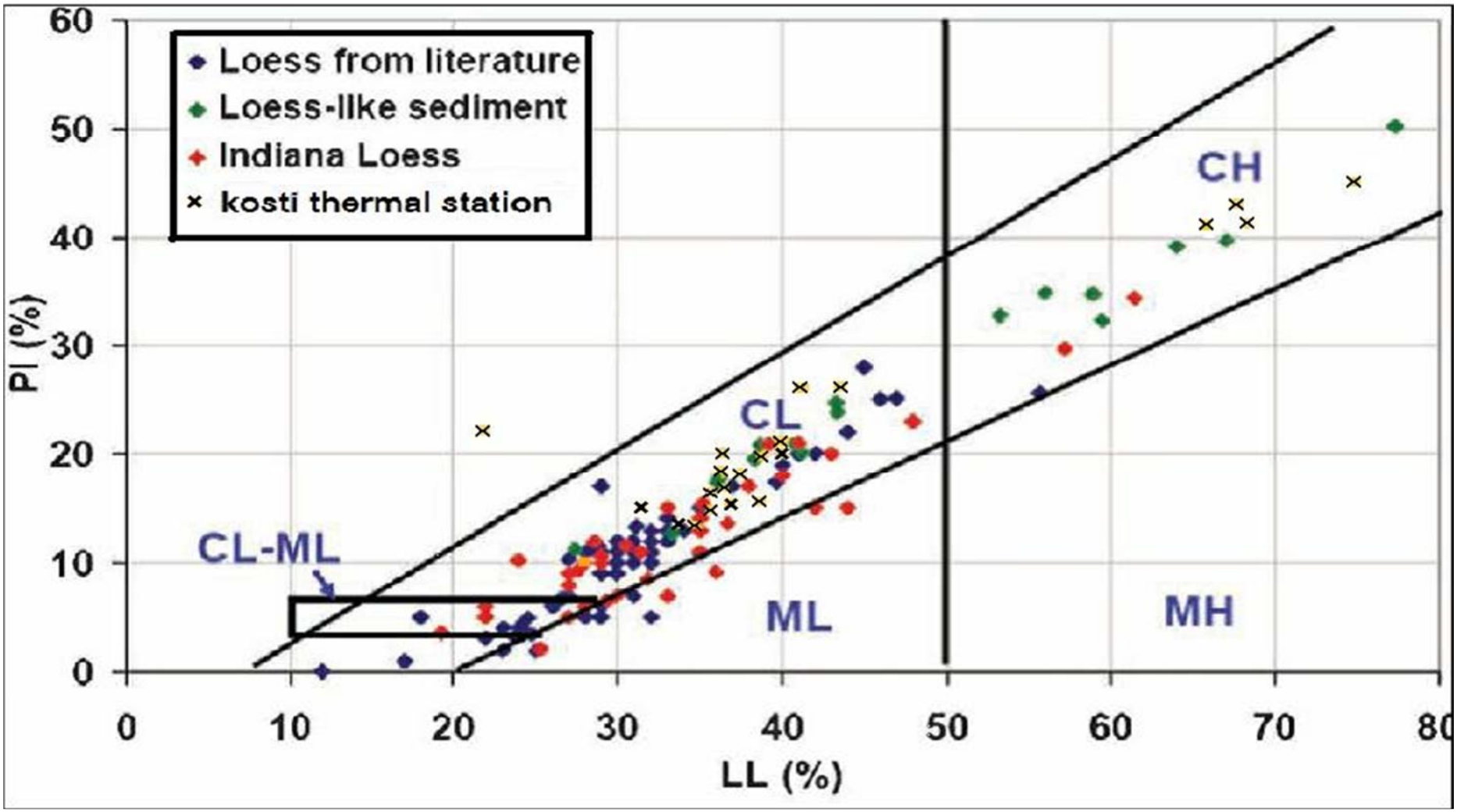


Fig.(6) Behavior of compacted fill in Indiana, A- Line & U- Line


Loess from literature
Loess-like sediment
Indiana Loess
kosti thermal station
CH
CL
CL-ML
ML
MH
PI (%)
LL (%)
0
10
20
30
40
50
60
70
80

The grain size in Indiana and other location indicate that for (CL) compacted fill, clay content between (10 – 30 %) is critical for collapse potential. When silt is mixed with clay at about equal value the potential of collapse is greater. For sandy clay the same condition exist.

5.10 Evaluation

We carried out oedemeter test to determine the collapse potential. The oedemeter test carried out by single and double oedemeter type.

Because of the reason mentioned about the collapse in field, the result of the oedemeter test gave values that are small compared with the actual value if collapse did not happen earlier.

Results from the single oedometer are given in table (4.7) and show that the collapse potential vary between (1.0 – 2.0) with indicate low to medium collapse potential.

For the double oedemeter test two tests were carried out for undisturbed samples one sample was conduct without adding any more water in the test. In second sample water was added from the beginning. Five tests were carried out with double oedemeter method, it is noted that the initial moister content for both test were not equal although the samples were physically near to each other. This may be due to heterogeneity in the soil or due to stress release or other sample disturbance. This condition was reported also in Indiana soil for samples that where treatment from compacted fill materials. (Identification and Behavior of Collapsible Soils, Joint Transportation Research Program, Purdue University).

In order to asses the collapse potential of the original fill material from borrow areas, the two samples given by he client were tested and the report is furnished in appendix (F).

5.11 Collapse Classification

According to table (5.2) and based on the assumption and results mentioned previously, the collapse potential of the backfill soil at site is expected to be in

the range C_P value from (1 to 2). These low values may be due to the reason that existing backfill has already experienced significant volume change due to soil collapse.

But the C_p values of the original soil from borrow area ranges between 1 to 7 (Ref. Appendix (F) Table.3). However, the C_p Values of this soil compacted at 8% moisture content (which is less by about 2% – 3% from O.M.C) is ranging between 3 to 7 which shows medium to high collapsible nature of the soil.

5.12 Data About the Fill Material

The client has supplied ESD with some data about the fill materials. This included proctor compaction test and quality control records for fill in river water intake pump house area. Presentation of the results of the compaction controll is given in figure (7). This shows the moisture content values of different layers with the average moisture content (amc) ± standard deviation value.

The optimum moisture content from the compaction test is also shown. The final moisture content determined by ESD also, plotted for all boreholes in the project, it's clear that;

1. Compaction was carried out at dry than optimum moisture content.
2. Moisture content has increased directly after wards.

6.0 Discussion of the Results:

After review of all the results of this study, the consultant believes that the major cause of the settlement is due to the soil collapse induced by increase of moisture content in compacted fill materials.

6.1 Proposal of Remedial Measure

For the existing condition of the installed equipment/ground floor slab already constructed in power plant, one of the remedial option is to use soil

stabilization with grouting to stabilize the fill material. This is a specialized procedure calling for experienced sub contractor in this field.

Second option is to remove the equipments and floors, then recompact the exsiting fill at high moisture content, so that the collapse potential of the fill soil is minimuzed.

Third option is to excavate the fill and make a new fill with non collapsible, non expansive and non dispersive fill materials.The fill should be compacted at the wet than optimum moisture content and high compacted effort. This should be based on detailed study of compaction process of the fill materials.

Drainage of the site should be a high priority, so that rain or other site sources of water should not cause problems to the fills.

7.0 Conclusion

A geotechnical of investigation was carried out at Kosti power plant, Rabak to study the settlement after construction. It's found that the backfill soil below ground floor level was soaked and moisture content increased considerably. It's believed that the major cause of the settelment is collapse of the fill material. This material has not been identified to have collapse potential prior to construction. The compaction operation did not address this issue. The fact, that the compaction was carried dry of optimum moisture content values and surface with poor drainage led to collapse induced by change in moisture content.

Three remedial options are given in the report:

1. Stablization by cement grouting carried out by highly experienced specialized subcontractor.
2. Remove the equipments and floors, then compact the exsiting fill at high moisture content.
3. Excavate the fill and make a new fill with non collapsible, non expansive and non dispersive fill materials.

This report is based on laboratory and field tests made on boreholes that were drilled in the present site and two soil samples from borrow areas. ESD is not responsible for soil conditions at site different from those exposed at the boreholes drilled in this investigation.

8. References:

1- Joesph E. Bowles, Foundation Analysis and Design, Fifth Edition, 1994
2- Muni Budhu, Soil Mechanics & Foundations, 2000, John Wiley & Sons, Inc.
3- El Howayek, A., P. Huang, R. Bisnett, and M. C. Santagata. Identification and Behavior of Collapsible Soils. Publication FHWA/IN/JTRP-2011/12. Joint Transportation Research Program, Indiana Department of Transportation and Purdue University, West Lafayette, Indiana, 2011.
4- Engineering and Design - Settlement Analysis, 30 September 1990, Department of the Army, U.S. Army Corps of Engineers, Washington, DC 20314-1000.
5- Materials Testing, Field Manual 5-472*, NAVFAC M0 330, AFJMAN 32-1221(I), Headquarters Department of the Army Department of the Navy Department of the Air Force Washington, DC, 27 October 1999.
6- American Society for Testing and Materials (ASTM).
7- BS 5930: 1999: Code of Practice for Site Investigations
8- BS 1377: 1990: Methods of Test for Soils for Civil Engineering Purposes
9- N.E.Simons and B.K.Menzies, A Short Course in Foundation Engineering

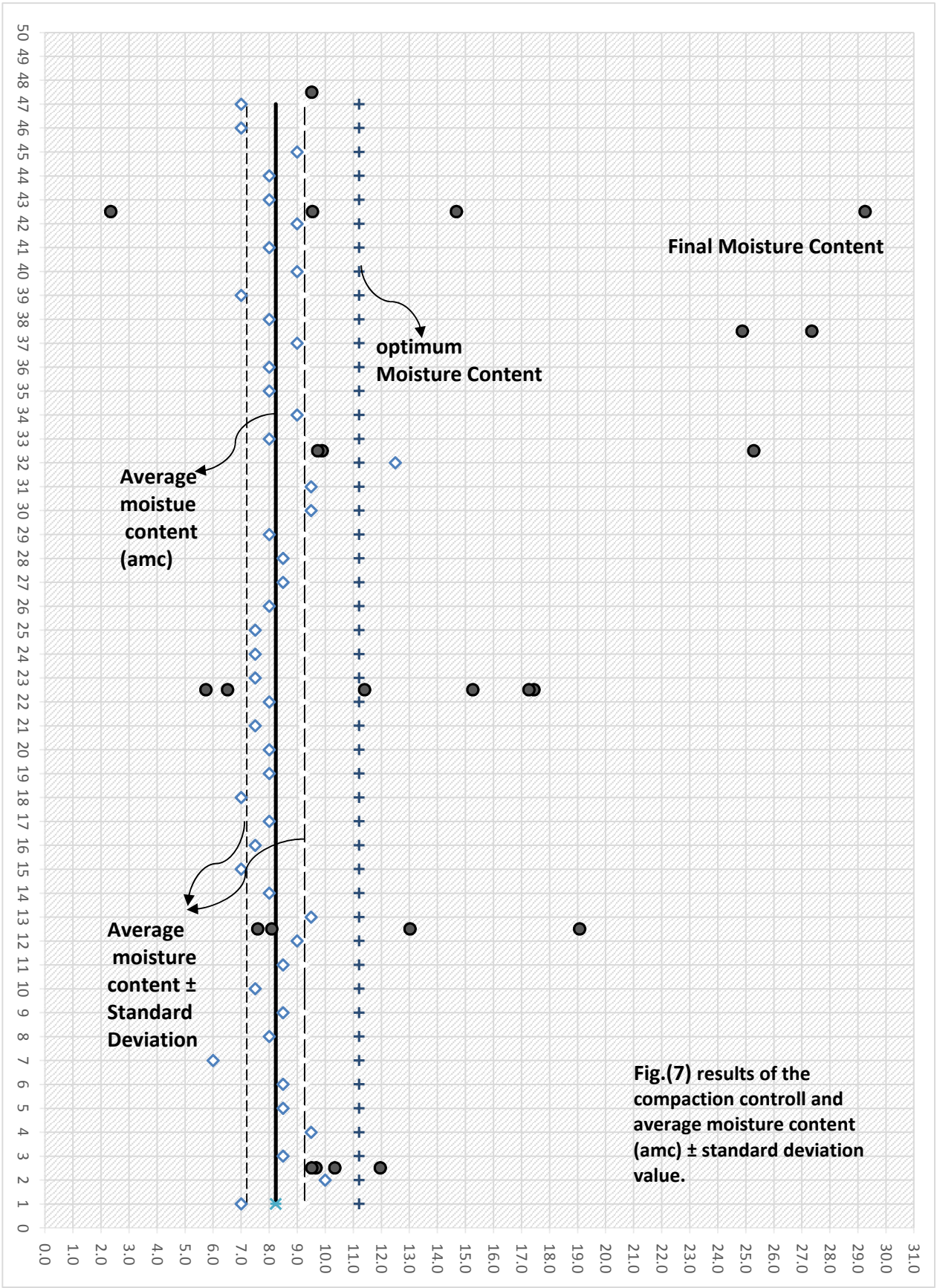


Fig.(7) results of the compaction controll and average moisture content (amc) ± standard deviation value.

APPENDIX (A)

LOCATION OF BOREHOLES

AND

SUMMARY OF

LABORATORY TEST RESULTS

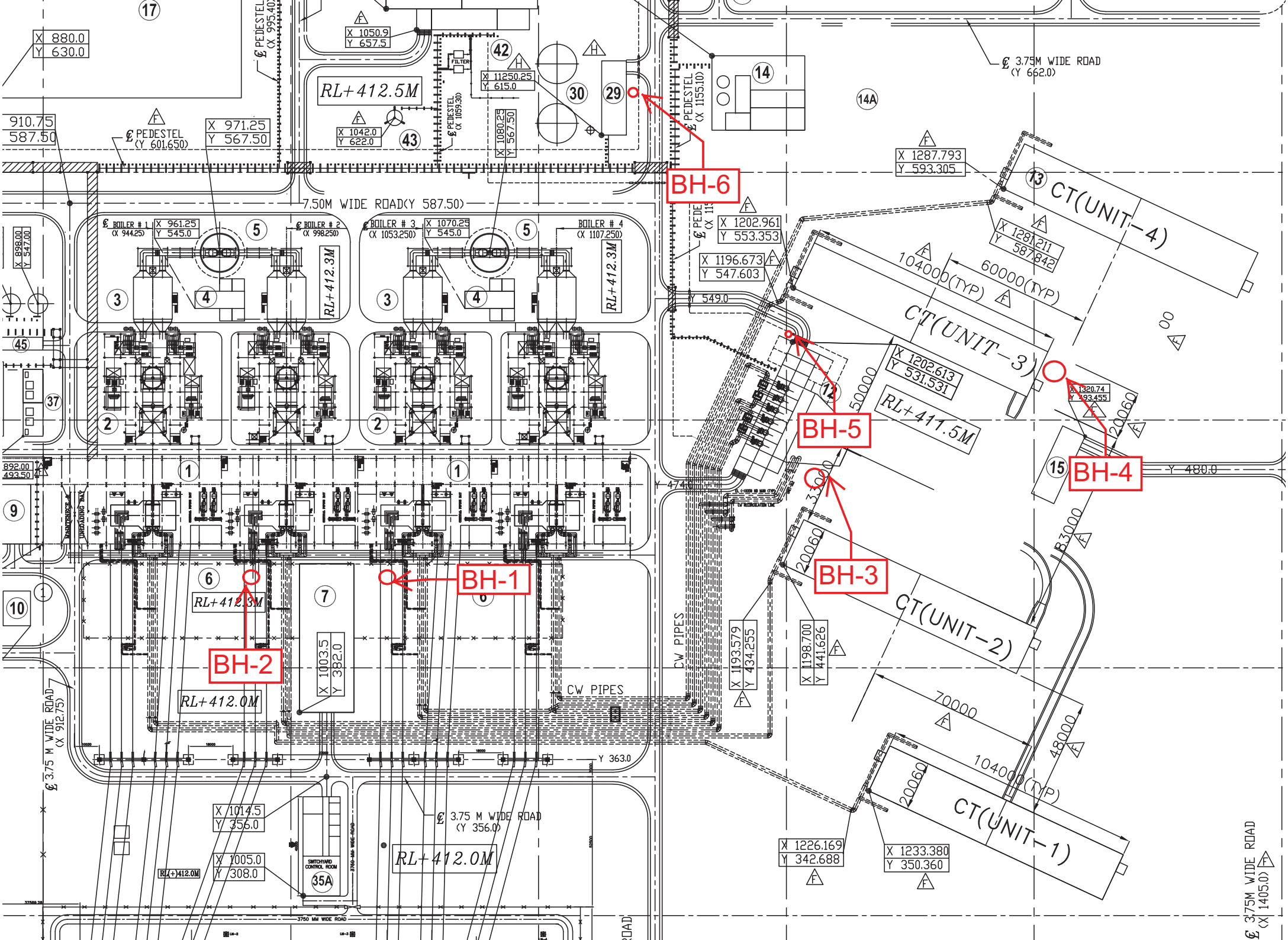
FIGURES (1)

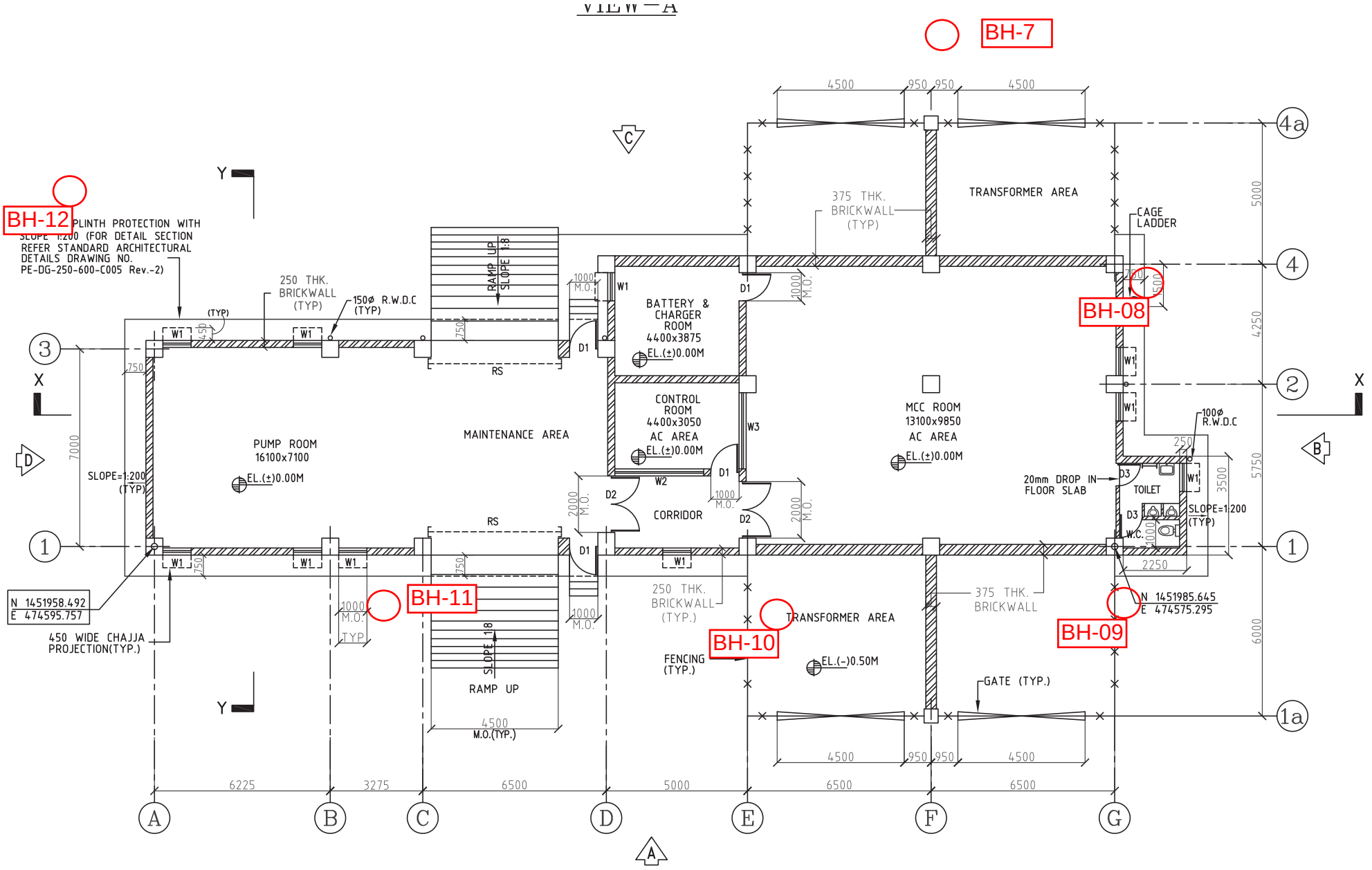
LOCATION OF BOREHOLES

Kosti Thermal Power Station
Power Station Area
Location of Boreholes

Kosti Thermal Power Station
Pump Station Area
Location of Boreholes

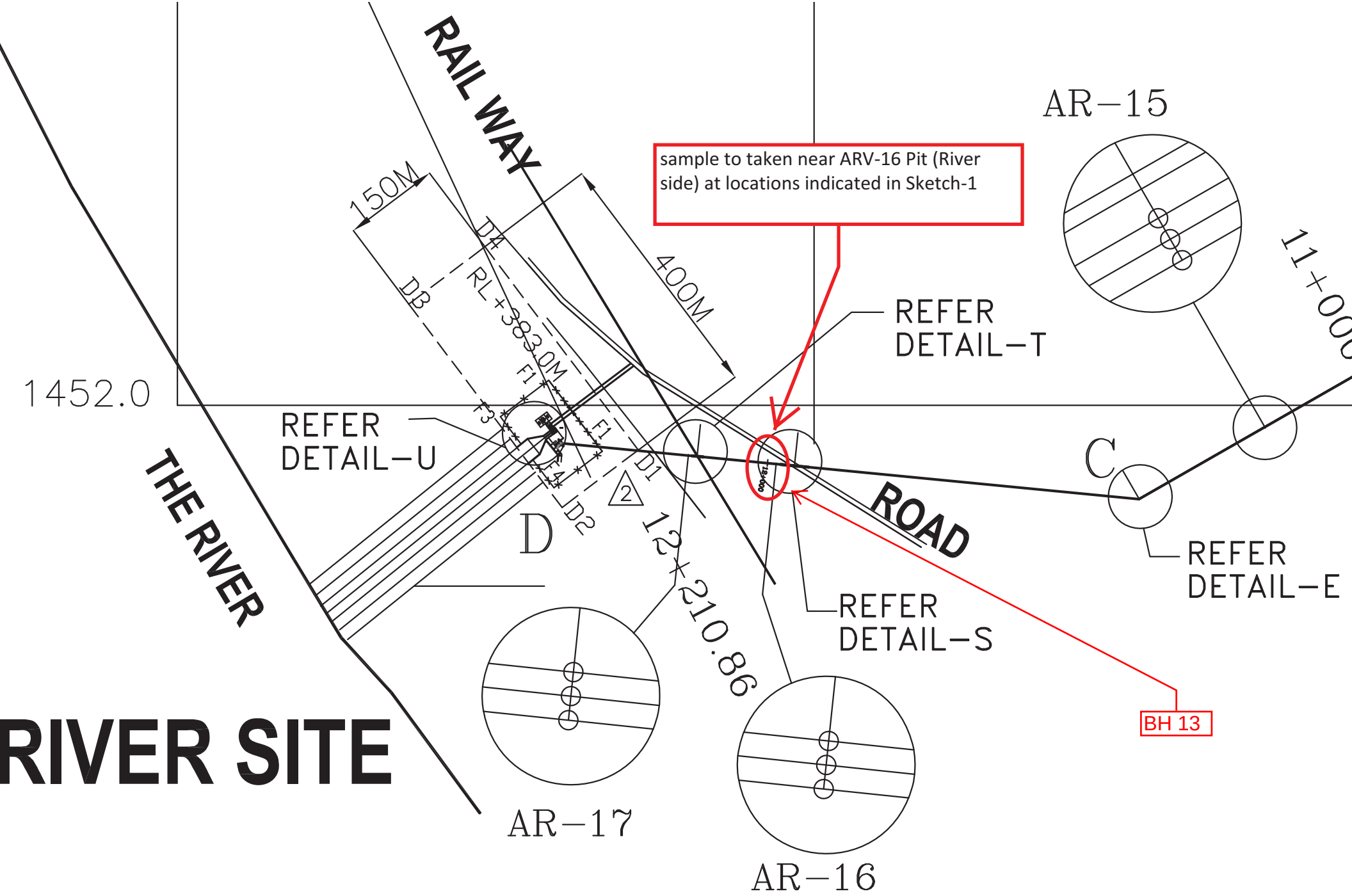

Kosti Thermal Power Station
Pipe Line Area
Location of Boreholes
BH -13
© 2013 Google
Image © 2013 DigitalGlobe
Google earth
58 متر


BH-1
BH-2
BH-3
BH-4
BH-5
BH-6
CT(UNIT-4)
CT(UNIT-3)
CT(UNIT-2)
CT(UNIT-1)
RL+412.5M
RL+412.3M
RL+412.0M
RL+411.5M
7.50M WIDE ROAD(Y 587.50)
3.75M WIDE ROAD (Y 662.0)
3.75 M WIDE ROAD (Y 912.75)
3.75 M WIDE ROAD (Y 356.0)
3.75M WIDE ROAD (X 1405.0)
CW PIPES
BOILER # 1 (X 944.25)
BOILER # 2 (X 998.250)
BOILER # 3 (X 1053.250)
BOILER # 4 (X 1107.250)
PEDESTEL (Y 601.650)
PEDESTEL (X 995.40)
PEDESTEL (X 1059.30)
PEDESTEL (X 1155.10)
FILTER
SWITCHYARD CONTROL ROOM
3750 MM WIDE ROAD
X 880.0
Y 630.0
X 910.75
Y 587.50
X 971.25
Y 567.50
X 1050.9
Y 657.5
X 11250.25
Y 615.0
X 1042.0
Y 622.0
X 1080.25
Y 567.50
X 961.25
Y 545.0
X 1070.25
Y 545.0
X 898.00
Y 547.00
X 892.00
Y 493.50
X 1003.5
Y 382.0
X 1014.5
Y 356.0
X 1005.0
Y 308.0
X 1287.793
Y 593.305
X 1202.961
Y 553.353
X 1196.673
Y 547.603
X 1281.211
Y 587.842
X 1202.613
Y 531.531
X 1320.74
Y 493.455
X 1193.579
Y 434.255
X 1198.700
Y 441.626
X 1226.169
Y 342.688
X 1233.380
Y 350.360
104000(TYP)
60000(TYP)
50000
33000
20060
70000
48000
R3000
Y 549.0
Y 474.0
Y 480.0
Y 363.0
Y 1405.0
37560.38
RL(+)412.0M



RIVER WATER INTAKE PUMP HOUSE

PLAN AT EL.(±)0.00M.


RAIL WAY
150M
400M
DA
DB
RL+383.0M
F1
F2
F3
F4
D1
D2
2
D
1452.0
REFER
DETAIL–U
THE RIVER
sample to taken near ARV-16 Pit (River side) at locations indicated in Sketch-1
REFER
DETAIL–T
AR–15
11+000
C
ROAD
REFER
DETAIL–E
REFER
DETAIL–S
12+210.86
BH 13
AR–17
AR–16
RIVER SITE

BO

FIGURE (2)

BOREHOLE LOGS AND SUMMARY OF LABORATORY TEST RESULTS

Soil Profile

Kosti Thermal Power Station Area

B.H # 1 Coordinates: E: 480719 N: 1460153 Starting date: 24/11/2013

Elevation : From the existing ground surface level Ground Water Level : Not observed Finishing date: 24/11/2013

Depth (m)	Description	Group Symbol	Atterberg Limits			Shrinkage Limit (%)	N.M.C %	%pass sieve #200	SPT Result					Remarks
			L.L %	P.L %	P.I %				Blows for inch 6	3	3	3	N Value	pen. inch	
1.0	Dark brown silty clay of low plasticity	CL	37	21	16		9.51	54.14							UDS
2.0	Light grey moist poorly graded silty sand	SP-SM		N.P	N.P		2.34	5.64							UDS
3.0	Dark gery silty clay of high plasticity	CH	68	25	43	19.07	24.87	84.72							UDS
4.0			67	26	41	19.00	25.28	74.42							UDS
	Bottom of borehole @ 4.0m														

Soil Profile
Kosti Thermal Power Station
Power Station Area

B.H # 2 Coordinates: E: 480705 N:1460207 Starting date: 24/11/2013

Elevation : From the existing ground surface level Ground Water Level : Not observed Finishing date: 24/11/2013

Depth (m)	Description	Group Symbol	Atterberg Limits			Shrinkage Limit (%)	N.M.C %	%pass sieve #200	SPT Result							Remarks
			L.L %	P.L %	P.I %				Blows for inch					N Value	pen. inch	
									6	3	3	3	3			
1.0	Dark brown dry silty clay of low plasticity	CL	45	19	26			58.13								
2.0	Light grey moist clayey sand	SC	39	22	17	11.14	14.67	41.61								UDS
3.0	Geryish brown moist silty clay of high plasticity	CH	68	27	41	15.0	27.35	80.53								UDS
4.0	Geryish brown moist clayey sand	SC	44	18	26		9.89	29.21								UDS

Bottom of borehole @ 4.0m

Soil Profile
Kosti Thermal Power Station
Power Station Area

B.H # 3 Coordinates: E: 480877 N:1460040 Starting date: 25/11/2013

Elevation : From the existing ground surface level Ground Water Level: Not observed Finishing date: 25/11/2013

Depth (m)	Description	Group Symbol	Atterberg Limits			Shrinkage Limit (%)	N.M.C %	%pass sieve #200	SPT Result							Remarks
			L.L %	P.L %	P.I %				Blows for inch					N Value	pen. inch	
									6	3	3	3	3			
1.0	Soft dark brown moist silty clay of low plasticity	CL	45	18	27	12.29		63.13								
									1	1	1	1		3		
2.0																
3.0	Very loose dark brown moist clayey sand	SC	37	19	20	9.71		45.72	1	1	1	1	1	4		
4.0			40	18	22	10.00		29.69								
									2	1	1	1	1	4		
5.0			45	23	22	9.21		33.54								
6.0	Soft dark brown silty clay of low plasticity .	CL	43	21	22	9.86		59.77	2	1	1	1		3		UDS (Empty)
7.0	Dark brown clayey sand .	SC	48	26	22	7.71		36.66								
8.0	Soft dark brown silty clay of low plasticity .	CL	43	23	20	9.14		53.23	2	1	1	1		3		UDS (Empty)
9.0																
10.0																UDS (Empty)
Bottom of borehole @ 10.0m																

Soil Profile

Kosti Thermal Power Station

Power Station Area

B.H # 4 Coordinates: E: 480944 N:1469983 Starting date: 26/11/2013

Elevation : From the existing ground surface level Ground Water Level : Not observed Finishing date:26/11/2013

Depth (m)	Description	Group Symbol	Atterberg Limits			Shrinkage Limit (%)	N.M.C %	%pass sieve #200	SPT Result					Remarks
			L.L %	P.L %	P.I %				Blows for inch				N Value	pen. inch
									6	3	3	3	3	
1.0	Dark brown moist clayey sand													
2.0	Light grey moist poorly graded silty sand	SC	41	19	22	11.71	9.54	21.44						UDS
3.0														UDS (Empty)
4.0														
	Bottom of borehole @ 4.0m													

Soil Profile
Kosti Thermal Power Station
Power Station Area

B.H # 5 Coordinates: E: 480920 N:1460080 Starting date: 25/11/2013

Elevation : From the existing ground surface level Ground Water Level :Not observed Finishing date: 25/11/2013

Depth (m)	Description	Group Symbol	Atterberg Limits			Shrinkage Limit (%)	N.M.C %	%pass sieve #200	SPT Result							Remarks
			L.L %	P.L %	P.I %				Blows for inch					N Value	pen. inch	
									6	3	3	3	3			
1.0	Loose dark brown moist clayey sand															
									2	1	1	1	1	4		
2.0																
3.0									4	3	1	2	1	7		
4.0			48	20	28	10.79		35.93								
									3	2	1	1	2	6		
5.0																
6.0	Dark brown moist clayey sand	SC	40	19	21		17.44	13.81								UDS
7.0																
8.0	Same but poorly and dense	SP-SC	34	18	16			10.11	5	11	9	8	7	35		UDS (Empty)
9.0																
10.0	Same but very dense		20	6	14			39.07	51					51		UDS (Empty)
Bottom of borehole @ 10.0m																

Soil Profile
Kosti Thermal Power Station
Power Station Area

B.H # 6 Coordinates: E: 480988 N:1460171 Starting date: 26/11/2013

Elevation : From the existing ground surface level Ground Water Level : Not observed Finishing date: 26/11/2013

Depth (m)	Description	Group Symbol	Atterberg Limits			Shrinkage Limit (%)	N.M.C %	%pass sieve #200	SPT Result							Remarks
			L.L %	P.L %	P.I %				Blows for inch					N Value	pen. inch	
									6	3	3	3	3			
1.0	Dark brown moist clayey sand															UDS (Empty)
2.0	Light grey moist silty clay of high plasticity	CH	75	30	45	20.00	29.25	89.89								UDS
3.0	Medium dense greyish brown moist clayey sand	SC	43	20	23	11.38		24.80	6	5	4	4	3	16		UDS (Empty)
4.0			36	16	20	10.57	9.73	48.70								UDS
Bottom of borehole @ 4.0m																

Soil Profile
Kosti Thermal Power Station
Pump Station Area

B.H # 7 Coordinates: E: 474637 N:1452189 Starting date: 18/11/2013

Elevation : From the existing ground surface level Ground Water Level : 8.0m Finishing date: 18/11/2013

Depth (m)	Description	Group Symbol	Atterberg Limits			Shrinkage Limit (%)	N.M.C %	%pass sieve #200	SPT Result							Remarks
			L.L %	P.L %	P.I %				Blows for inch					N Value	pen. inch	
									6	3	3	3	3			
1.0	Medium dense dark brown moist clayey sand	SC	42	24	18	7.50		40.55								
2.0									7	5	5	5	5	20		
3.0	Dark brown moist silty clay of low plasticity	CL	20	9	11			53.37	7	3	2	3	4	12		
4.0			38	15	23			72.61								
5.0	same but medium stiff.								2	2	2	1	2	7		
6.0			34	19	15	7.29	17.26	75.63								UDS
7.0																
8.0	same but greyish brown .		35	20	15	6.79	19.07	73.91								UDS
9.0																
10.0																

Bottom of borehole @ 10.0m

Soil Profile
Kosti Thermal Power Station
Pump Station Area

B.H # 8 Coordinates: E: 475637 N:1452202 Starting date: 19/11/2013

Elevation : From the existing ground surface level Ground Water Level : Not observed Finishing date: 19/11/2013

Depth (m)	Description	Group Symbol	Atterberg Limits			Shrinkage Limit (%)	N.M.C %	%pass sieve #200	SPT Result							Remarks
			L.L %	P.L %	P.I %				Blows for inch					N Value	pen. inch	
									6	3	3	3	3			
1.0	Dark brown moist clayey sand															
2.0	Light grey moist poorly graded silty sand					10										
3.0																
4.0																
5.0																
6.0		SC	39	19	20	10.79	6.51	29.58								UDS
7.0																
8.0	Dark brown silty clay of low plasticity.	CL	32	16	16	9.14	7.59	56.61								UDS
9.0																
10.0	Dark brown clayey sand	SC	36	20	16	8.64	9.67	39.08								UDS

Bottom of borehole @ 10.0m

Soil Profile
Kosti Thermal Power Station
Pump Station Area

B.H # 9 Coordinates: E: 475649 N:1452204 Starting date: 22/11/2013

Elevation : From the existing ground surface level Ground Water Level : Not observed Finishing date: 23/11/2013

Depth (m)	Description	Group Symbol	Atterberg Limits			Shrinkage Limit (%)	N.M.C %	%pass sieve #200	SPT Result							Remarks
			L.L %	P.L %	P.I %				Blows for inch					N Value	pen. inch	
									6	3	3	3	3			
1.0																
	Loose dark brown moist clayey sand								2	1	2	1		4		
2.0																
3.0	same but medium dense								6	4	5	4	6	19		
4.0																
	same but dense								9	9	10	9	11	39		
5.0																
6.0		SC														UDS (Empty)
7.0																
8.0	same but very dense		39	20	19	8.00		41.79	24	13	14	17	7	51		UDS (Empty)
9.0																
10.0	same but greyish brown		41	22	19		9.51	29.06								UDS

Bottom of borehole @ 10.0m

Soil Profile
Kosti Thermal Power Station
Pump Station Area

B.H # 10 Coordinates: E: 474670 N:1452189 Starting date: 21/11/2013

Elevation : From the existing ground surface level Ground Water Level : Not observed Finishing date: 22/11/2013

Depth (m)	Description	Group Symbol	Atterberg Limits			Shrinkage Limit (%)	N.M.C %	%pass sieve #200	SPT Result							Remarks
			L.L %	P.L %	P.I %				Blows for inch					N Value	pen. inch	
									6	3	3	3	3			
1.0																
	Very dense dark brown moist clayey sand								20	12	13	16	10	51		
2.0																
3.0									17	14	15	16	6	51		
4.0																
									21	13	15	15	8	51		
5.0																
6.0		SC	37	18	19	9.86	5.74	42.76								UDS
7.0																
8.0	Greyish brown moist silty clay of low plasticity .	CL	38	20	18	7.29		74.88	51					51		UDS (Empty)
9.0																
10.0			35	20	15	7.86	11.96	73.77								UDS
Bottom of borehole @ 10.0m																

Soil Profile
Kosti Thermal Power Station
Pump Station Area

B.H # 11 Coordinates: E: 474667 N:1452182 Starting date: 23/11/2013

Elevation : From the existing ground surface level Ground Water Level : 3.0m Finishing date: 23/11/2013

Depth (m)	Description	Group Symbol	Atterberg Limits			Shrinkage Limit (%)	N.M.C %	%pass sieve #200	SPT Result							Remarks
			L.L %	P.L %	P.I %				Blows for inch					N Value	pen. inch	
									6	3	3	3	3			
1.0																
	Loose dark brown moist clayey sand	SC							1	1	2	2	1	6		
2.0																
3.0									2	1	2	1	2	6		
4.0																
									2	1	2	2	2	7		
5.0																
6.0	Dark brown moist silty clay of low plasticity	CL	38	19	19	9.14	15.26	51.41								UDS
7.0																
8.0	Dark brown moist clayey sand	SC	28	18	10	8.00	8.09	45.91								UDS
9.0																
10.0	same but greyish brown		36	19	17	7.86	10.34	35.05								UDS
Bottom of borehole @ 10.0m																

Soil Profile
Kosti Thermal Power Station
Pump Station Area

B.H # 12 Coordinates: E: 474635 N:1452175 Starting date: 20/11/2013

Elevation : From the existing ground surface level Ground Water Level : Not observed Finishing date: 20/11/2013

Depth (m)	Description	Group Symbol	Atterberg Limits			Shrinkage Limit (%)	N.M.C %	%pass sieve #200	SPT Result							Remarks
			L.L %	P.L %	P.I %				Blows for inch					N Value	pen. inch	
									6	3	3	3	3			
1.0																
	Dark brown moist clayey sandy gravel															
2.0																
3.0																
4.0																
5.0																
6.0	Light brown clayey sand	SC	40	18	22	8.79	11.40	32.55								UDS
7.0																
8.0	same but greyish brown		37	19	18	5.34	13.02	43.25								UDS
9.0																
10.0																UDS (Empty)

Bottom of borehole @ 10.0m

Soil Profile
Kosti Thermal Power Station
Pipe Line Area

B.H # 13 Coordinates: E: 480988 N:1460171 Starting date: 24/11/2013

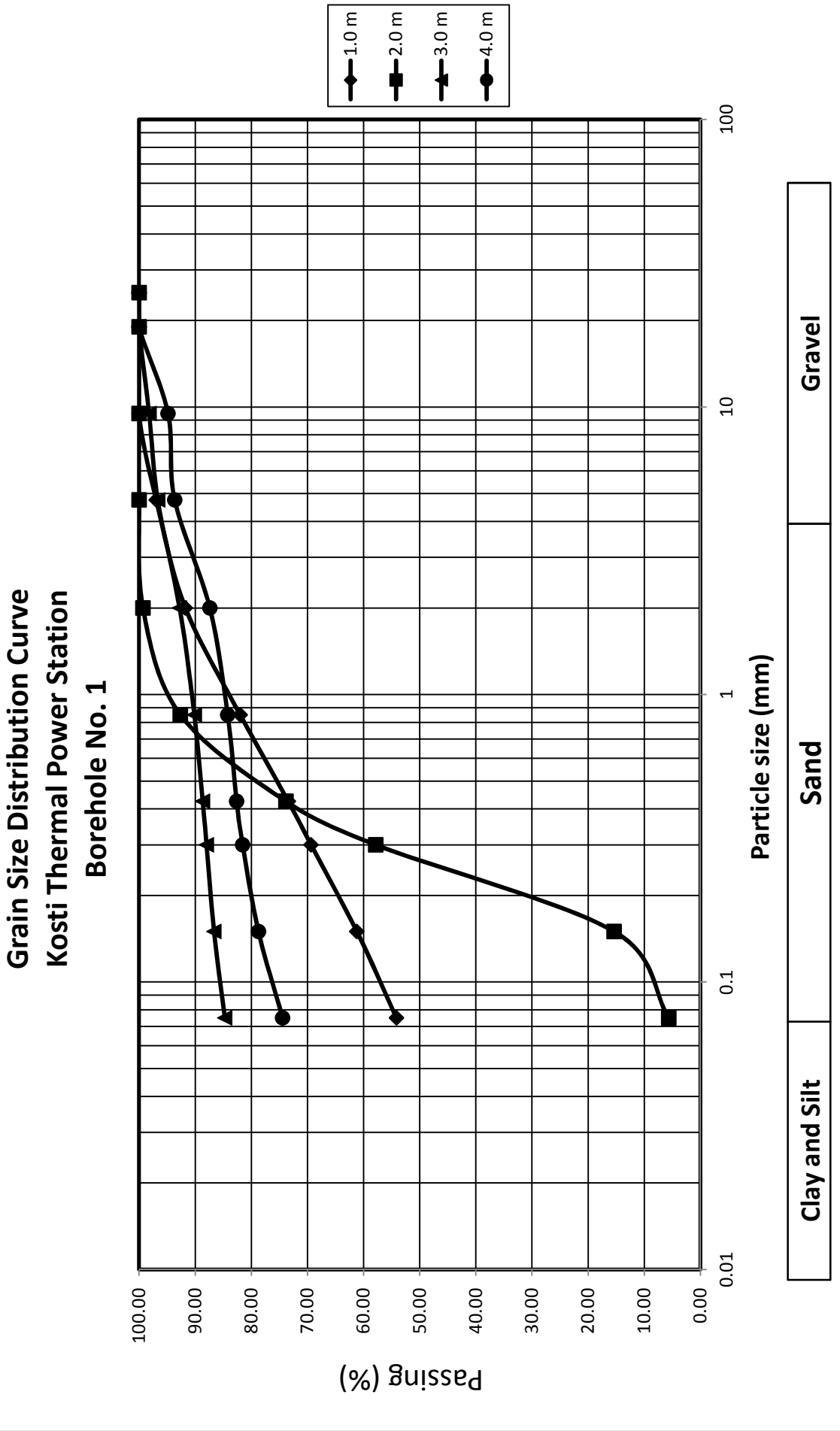
Elevation : From the existing ground surface level Ground Water Level : Not observed Finishing date: 24/11/2013

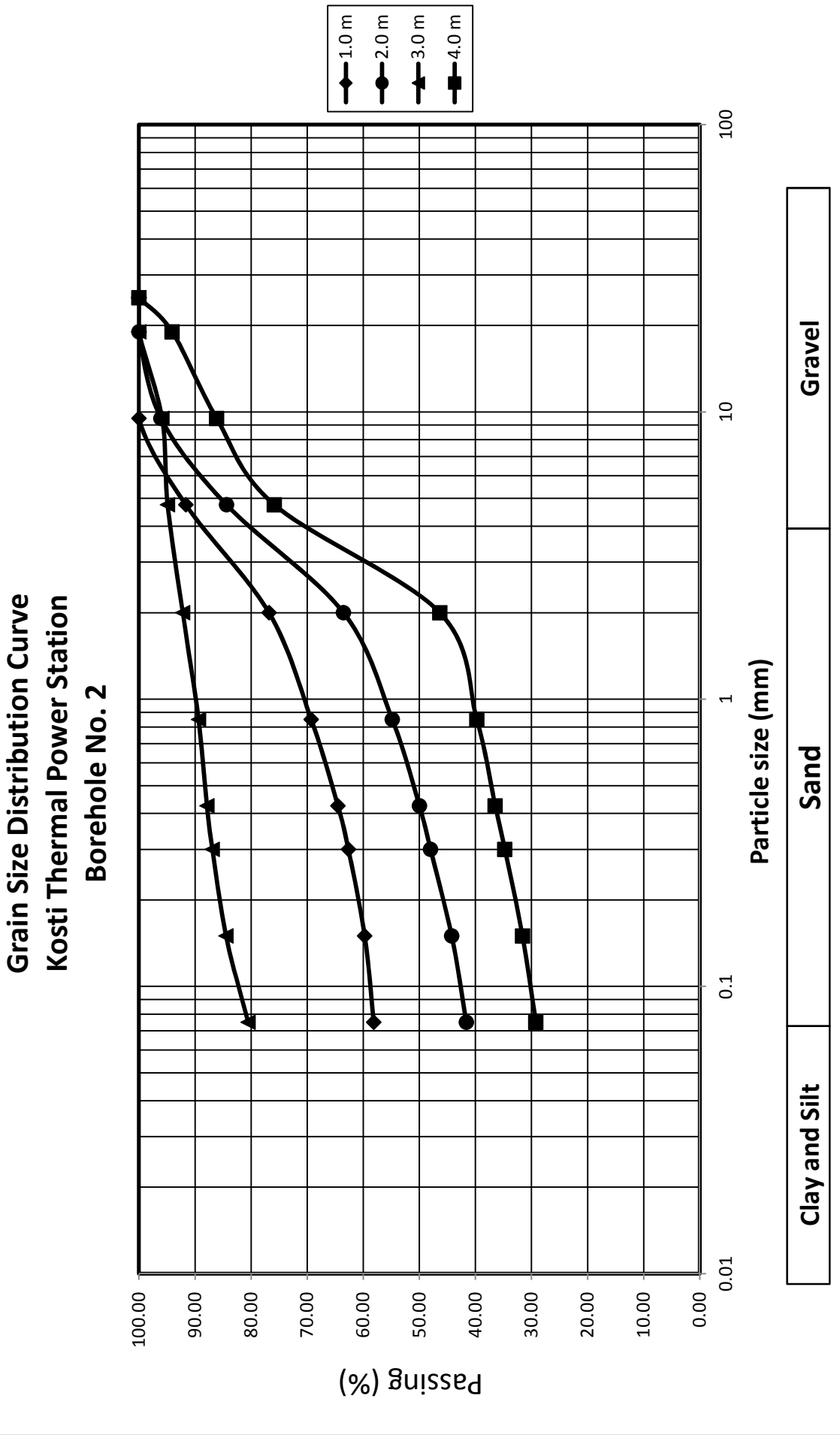
Depth (m)	Description	Group Symbol	Atterberg Limits			Shrinkage Limit (%)	N.M.C %	%pass sieve #200	SPT Result							Remarks
			L.L %	P.L %	P.I %				Blows for inch					N Value	pen. inch	
									6	3	3	3	3			
1.0	Reddish brown poorly graded silty sand	SP-SM		NP	NP			9.12								
2.0	Same but loose.	SM		NP	NP			14.78	1	1	2	1		4		UDS (Empty)
3.0				NP	NP			17.90	1	1	1	1		3		UDS (Empty)
4.0	Medium dense light brown clayey sand	SC	23	15	8	2.07		29.25	5	3	5	5	6	19		UDS (Empty)
	Bottom of borehole @ 4.0m															

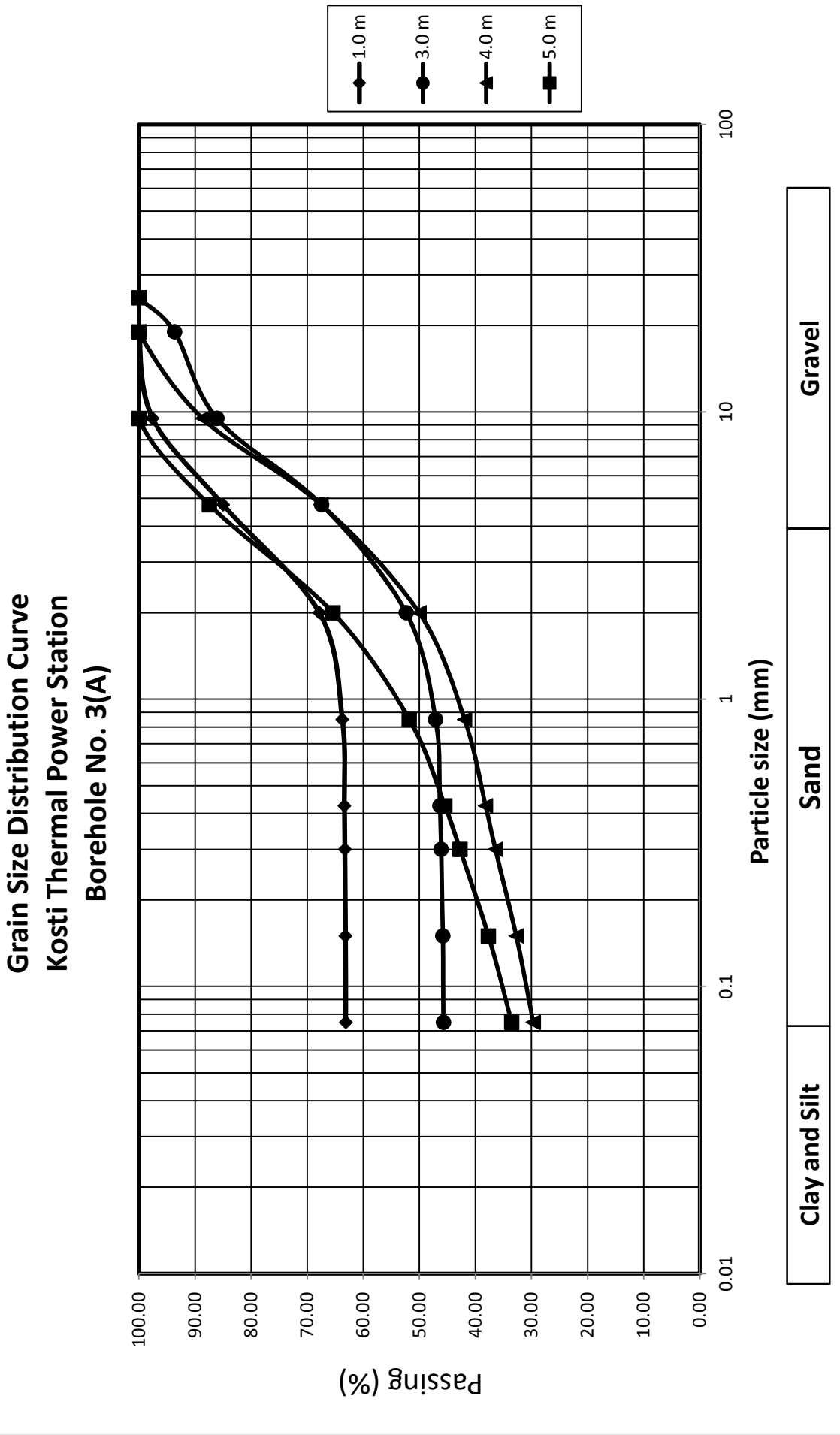
APPENDIX (B-1)

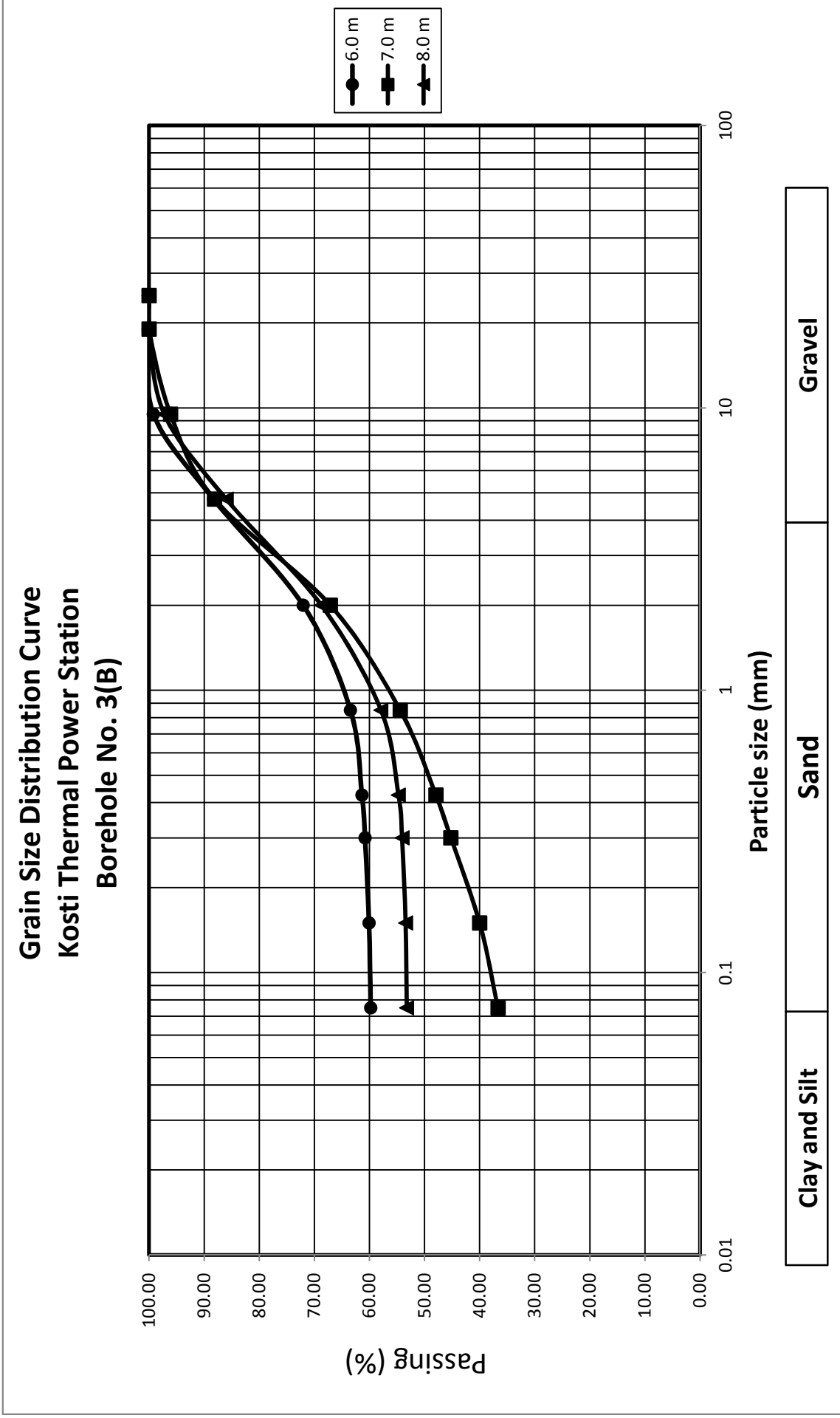
GRAIN SIZE DISTRIBUTION RESULTS

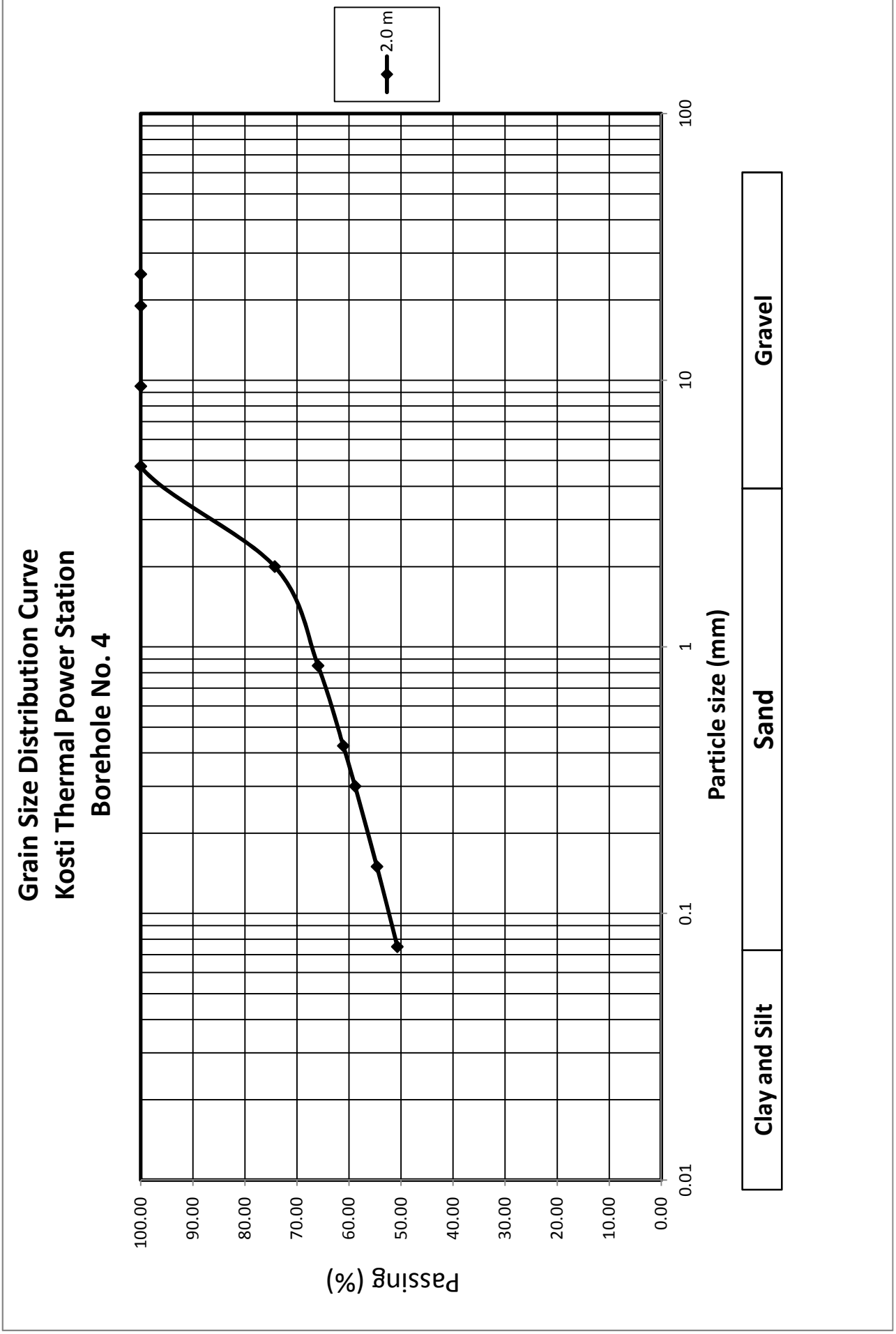
SIEVE ANALYSIS TESTT

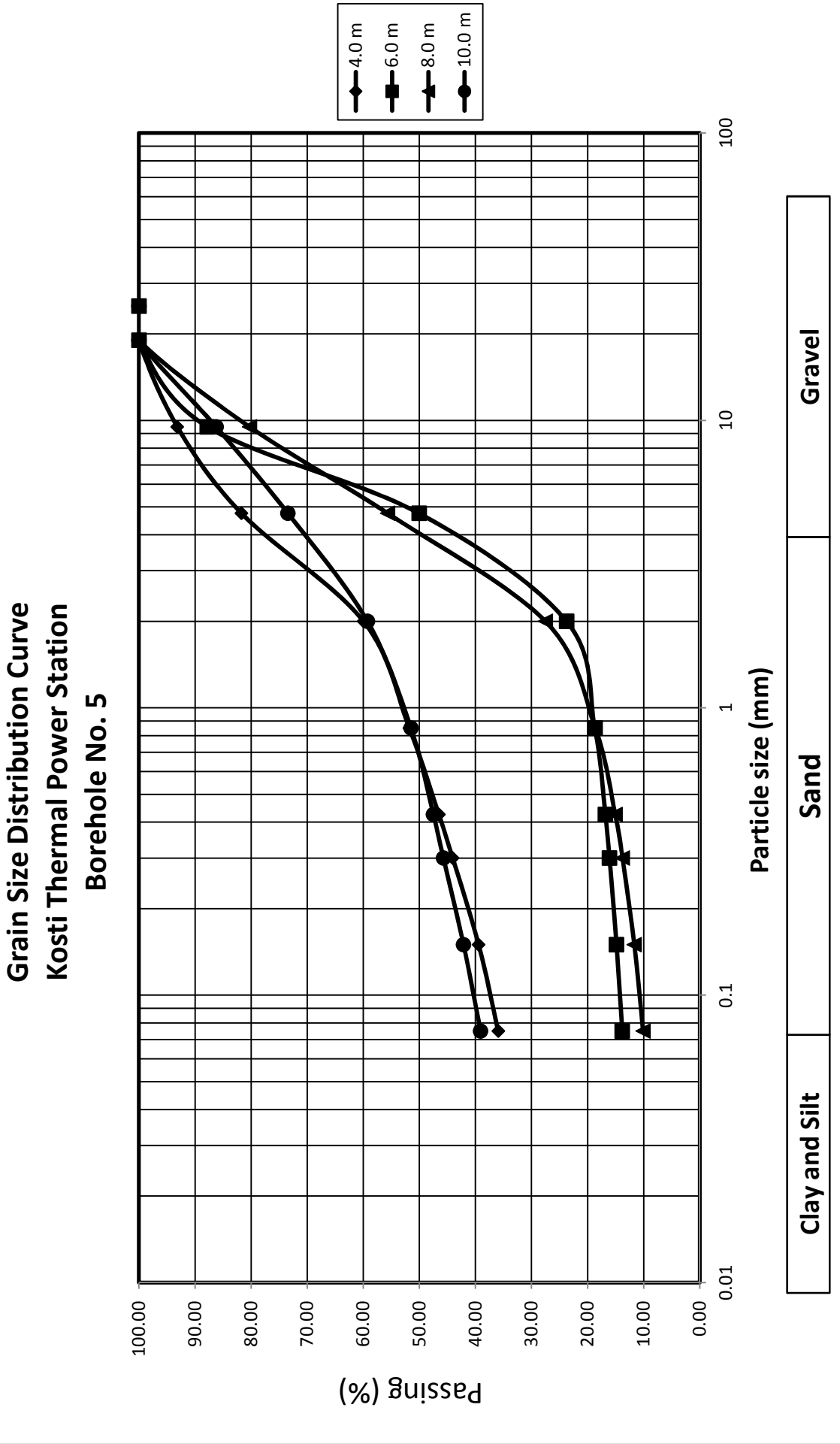

Grain Size Distribution Curve
Kosti Thermal Power Station
Borehole No. 1
1.0 m
2.0 m
3.0 m
4.0 m
Passing (%)
100.00
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
Particle size (mm)
100
10
1
0.1
0.01
Gravel
Sand
Clay and Silt

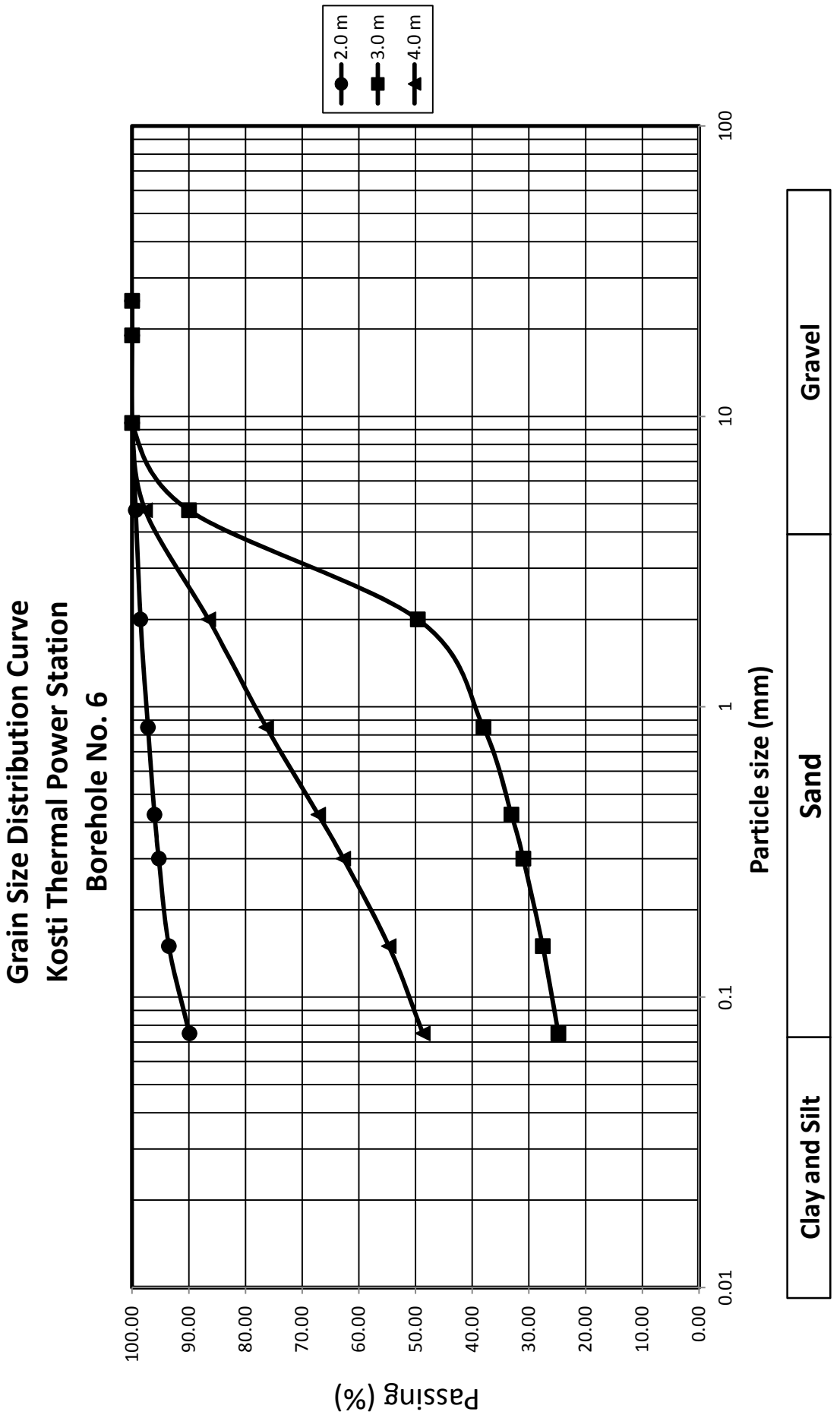

Grain Size Distribution Curve
Kosti Thermal Power Station
Borehole No. 2
1.0 m
2.0 m
3.0 m
4.0 m
Passing (%)
100.00
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
Particle size (mm)
100
10
1
0.1
0.01
Gravel
Sand
Clay and Silt

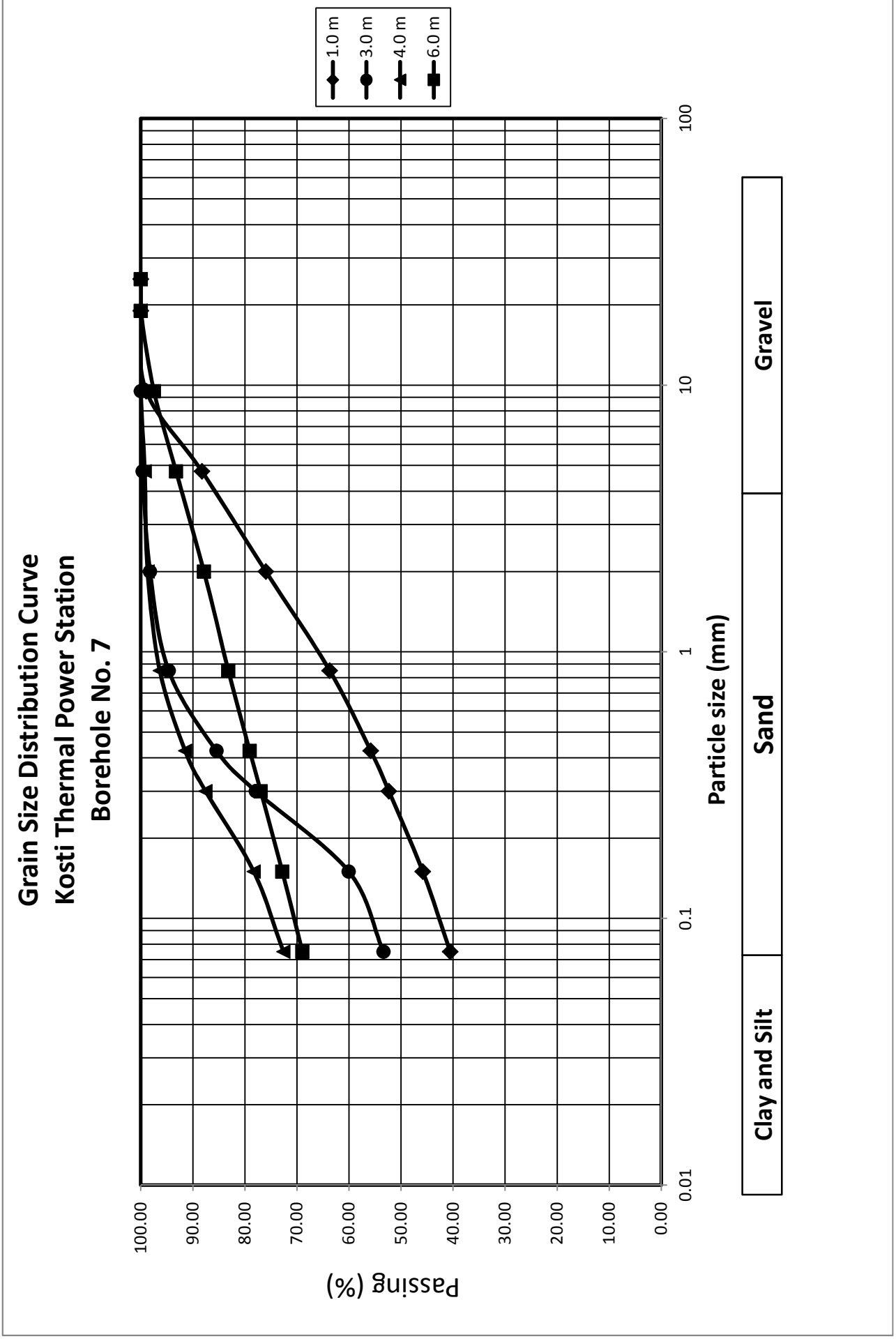

Grain Size Distribution Curve
Kosti Thermal Power Station
Borehole No. 3(A)
1.0 m
3.0 m
4.0 m
5.0 m
Passing (%)
100.00
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
Particle size (mm)
100
10
1
0.1
0.01
Gravel
Sand
Clay and Silt

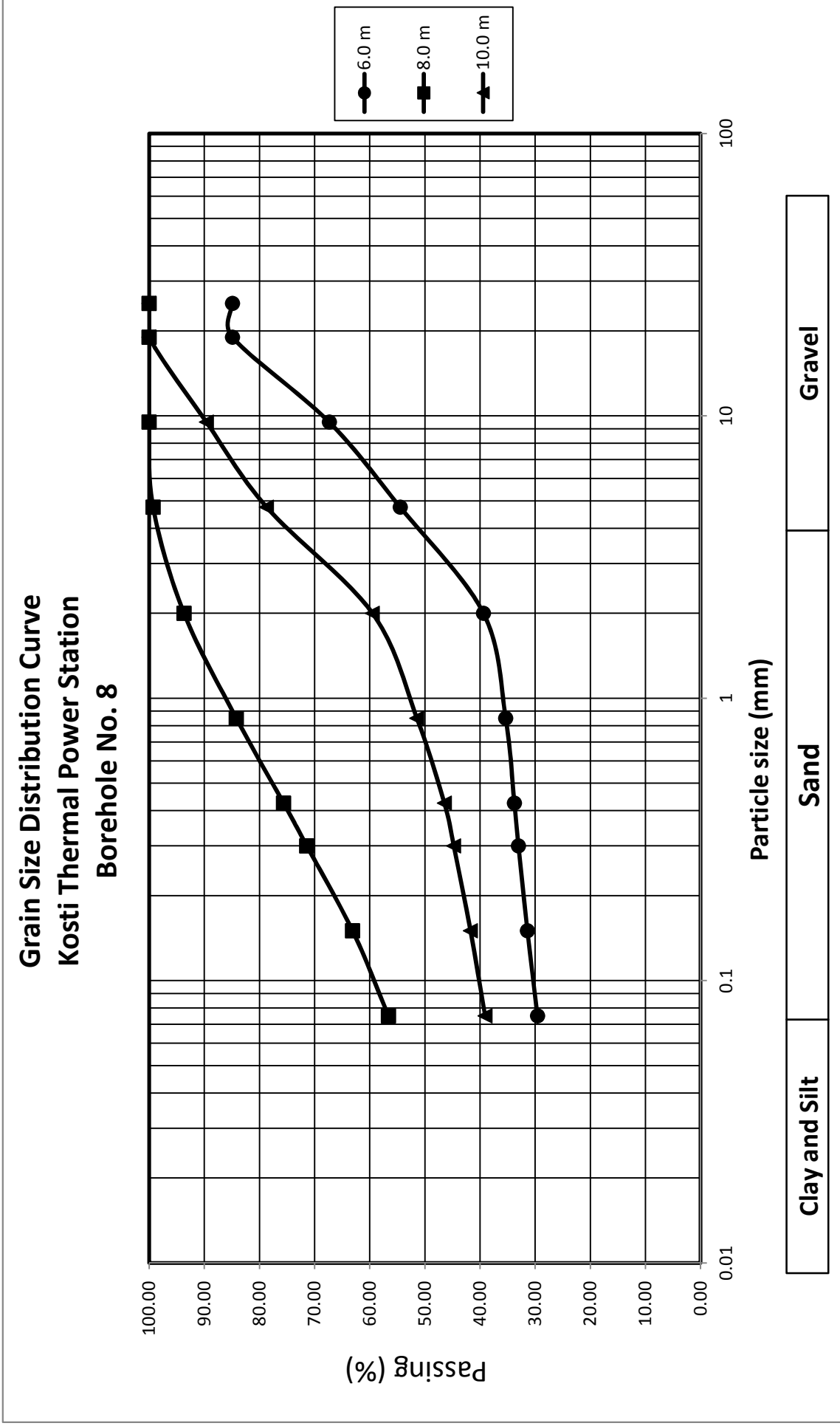

Grain Size Distribution Curve
Kosti Thermal Power Station
Borehole No. 3(B)
6.0 m
7.0 m
8.0 m
Passing (%)
100.00
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
Particle size (mm)
100
10
1
0.1
0.01
Gravel
Sand
Clay and Silt

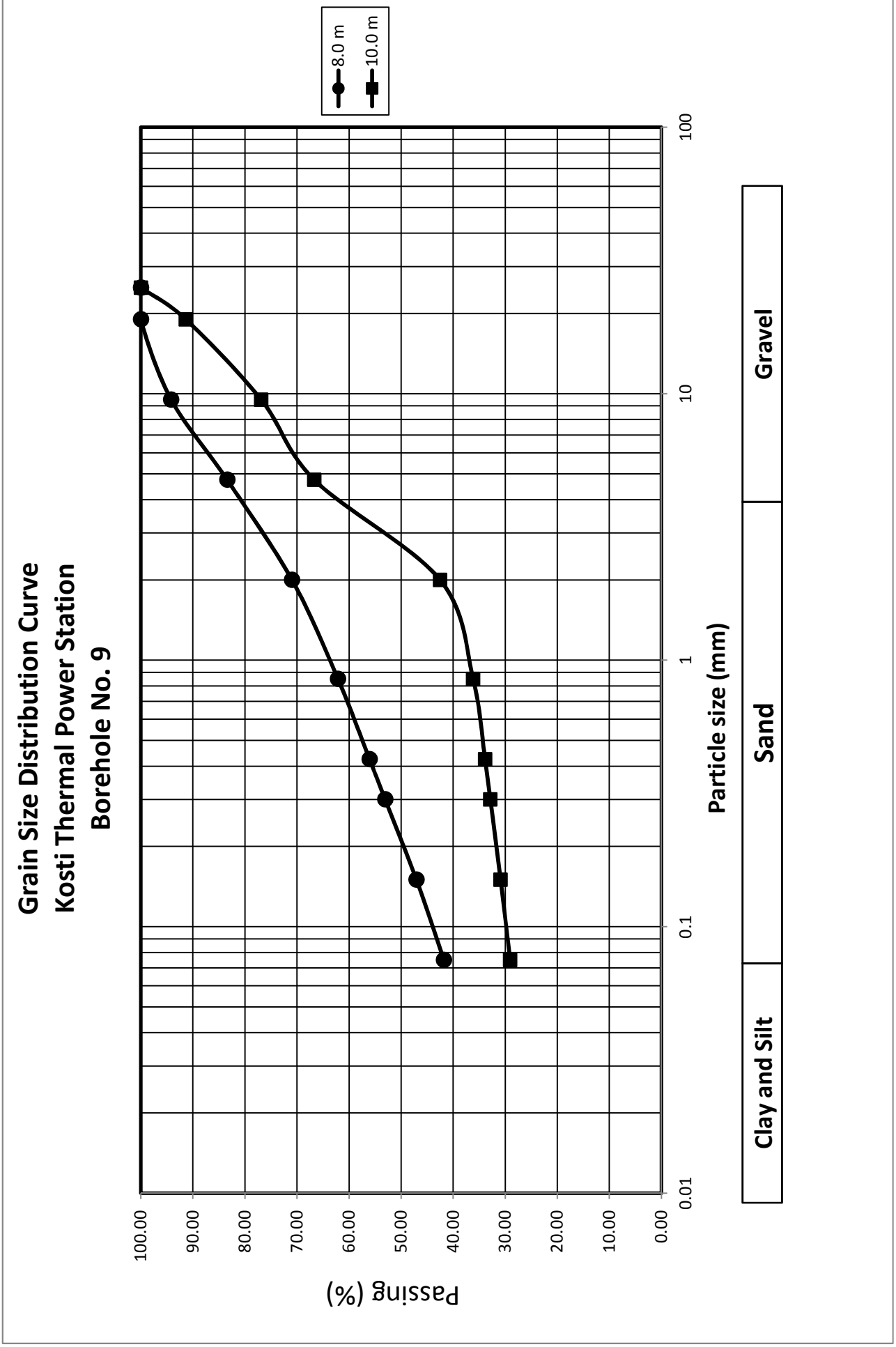

Grain Size Distribution Curve
Kosti Thermal Power Station
Borehole No. 4
2.0 m
Passing (%)
100.00
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
Particle size (mm)
100
10
1
0.1
0.01
Gravel
Sand
Clay and Silt

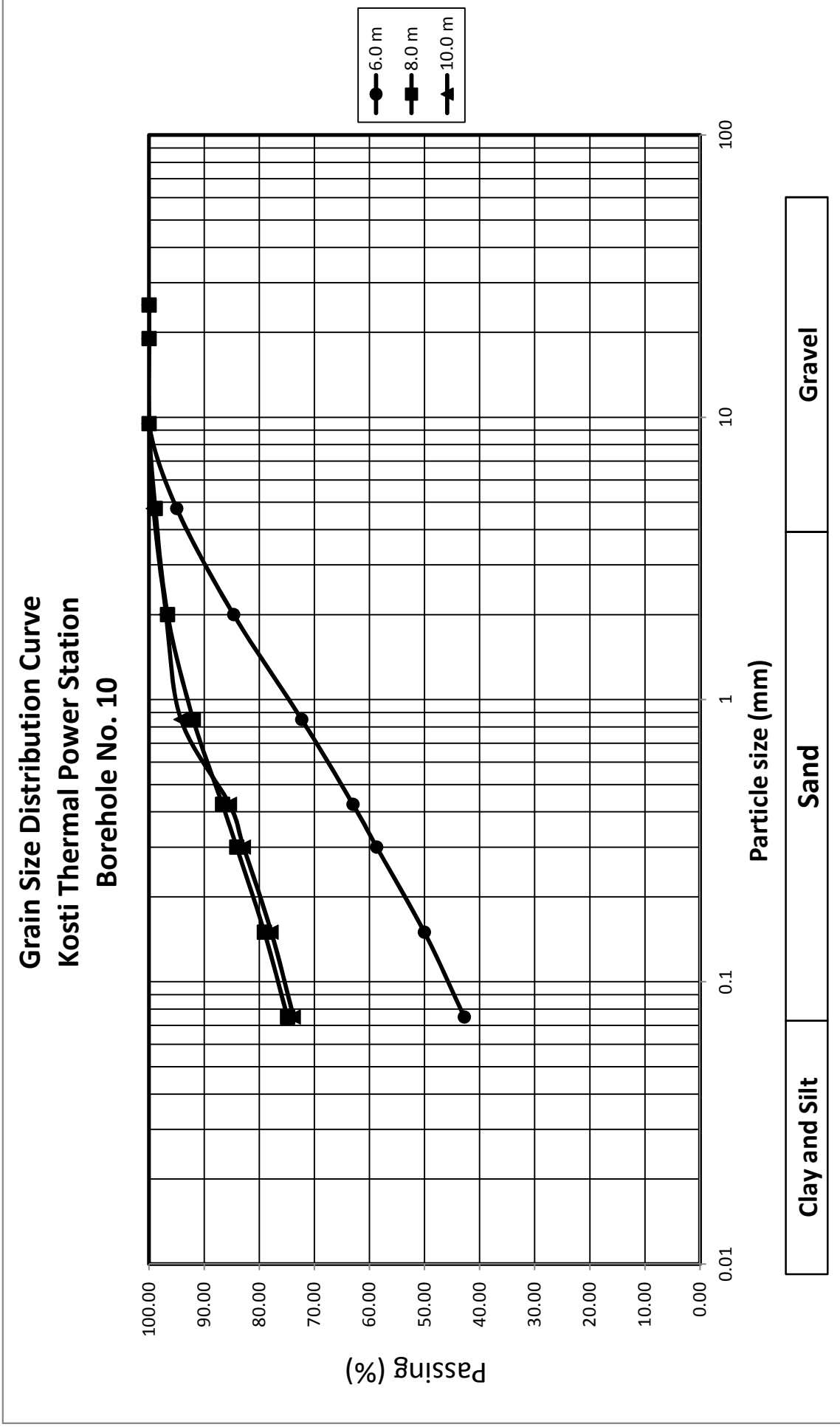

Grain Size Distribution Curve
Kosti Thermal Power Station
Borehole No. 5
4.0 m
6.0 m
8.0 m
10.0 m
Passing (%)
100.00
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
Particle size (mm)
100
10
1
0.1
0.01
Gravel
Sand
Clay and Silt

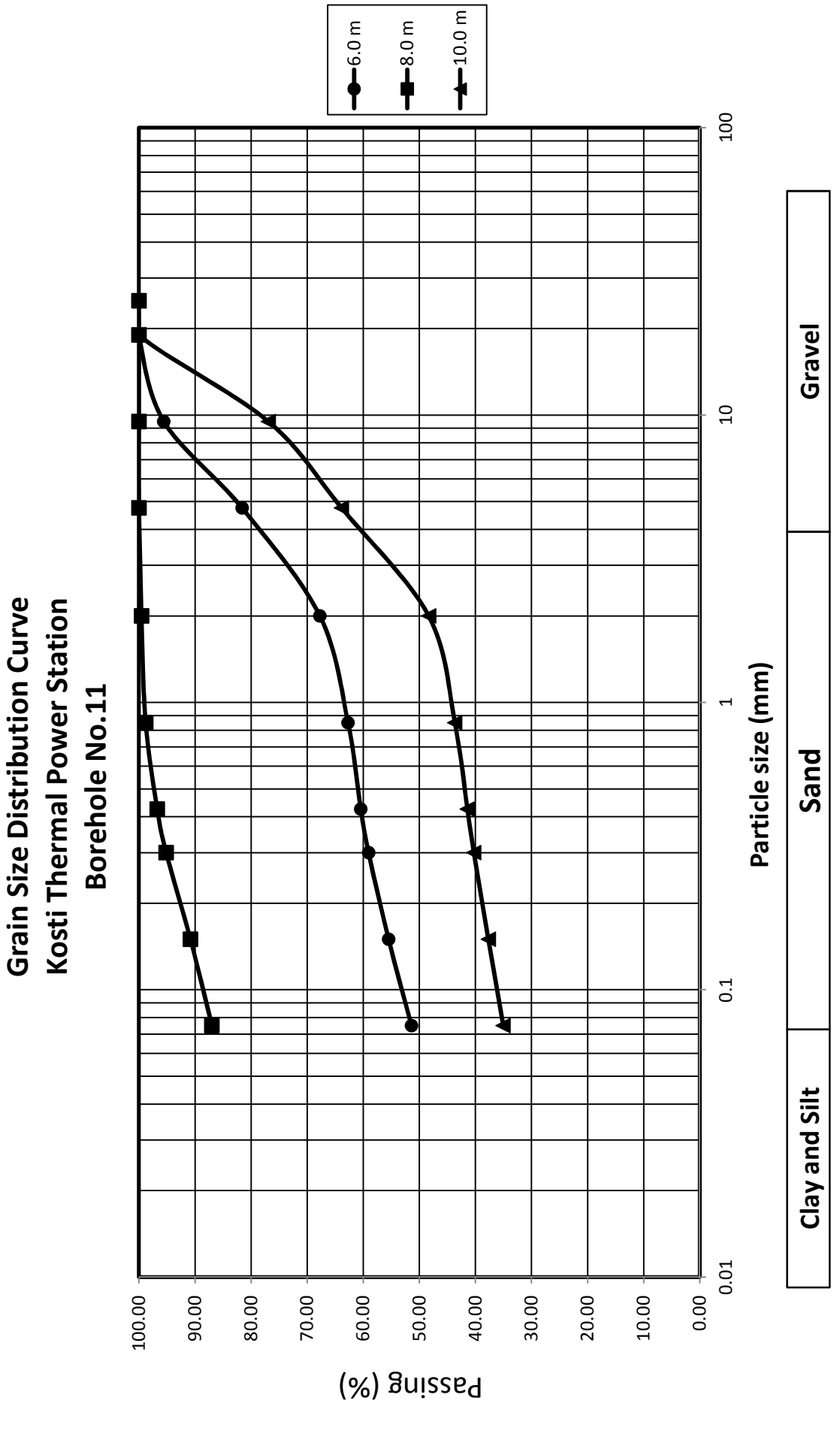

Grain Size Distribution Curve
Kosti Thermal Power Station
Borehole No. 6
2.0 m
3.0 m
4.0 m
Passing (%)
100.00
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
Particle size (mm)
100
10
1
0.1
0.01
Gravel
Sand
Clay and Silt

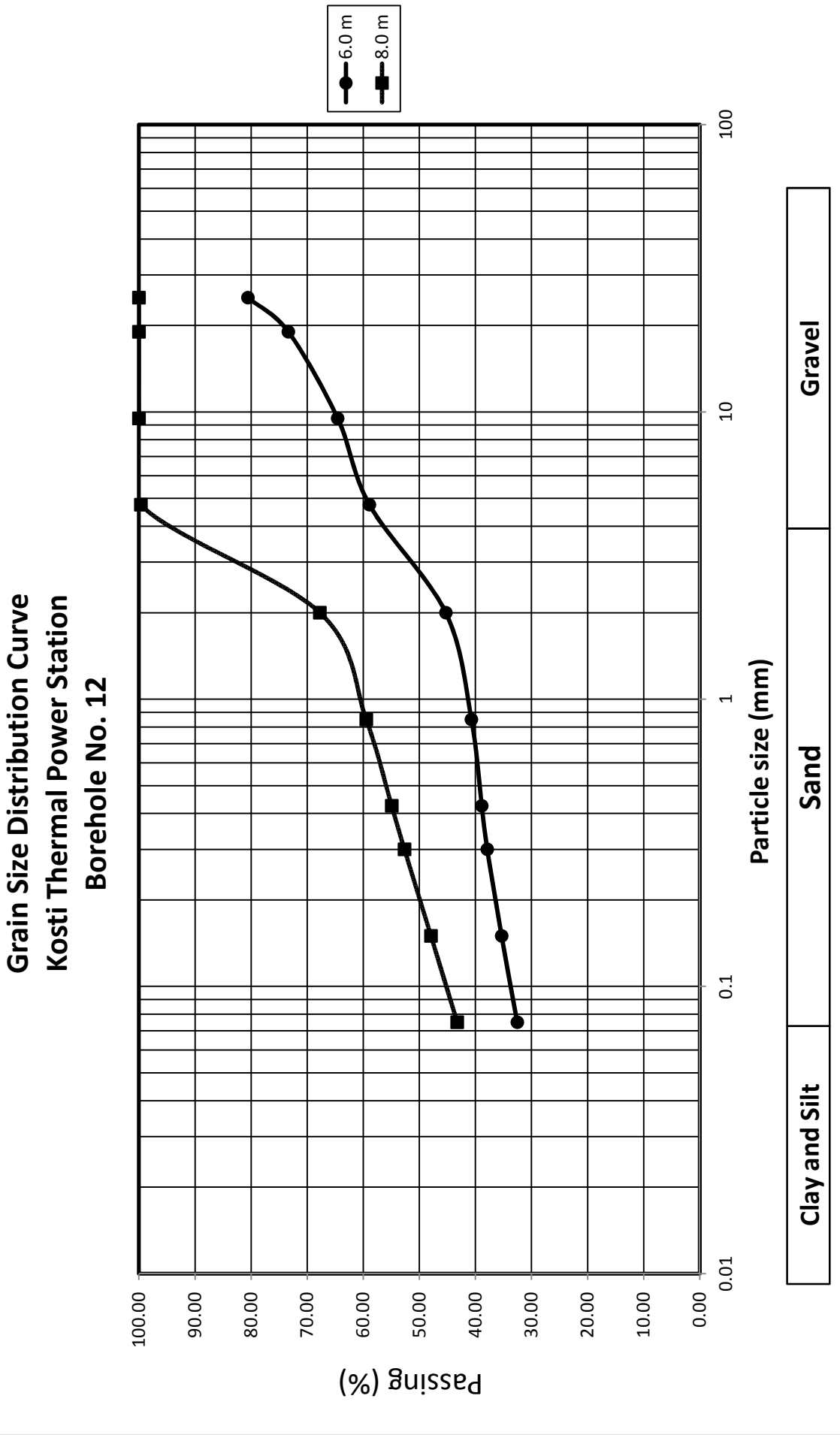

Grain Size Distribution Curve
Kosti Thermal Power Station
Borehole No. 7
1.0 m
3.0 m
4.0 m
6.0 m
Passing (%)
100.00
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
Particle size (mm)
100
10
1
0.1
0.01
Gravel
Sand
Clay and Silt

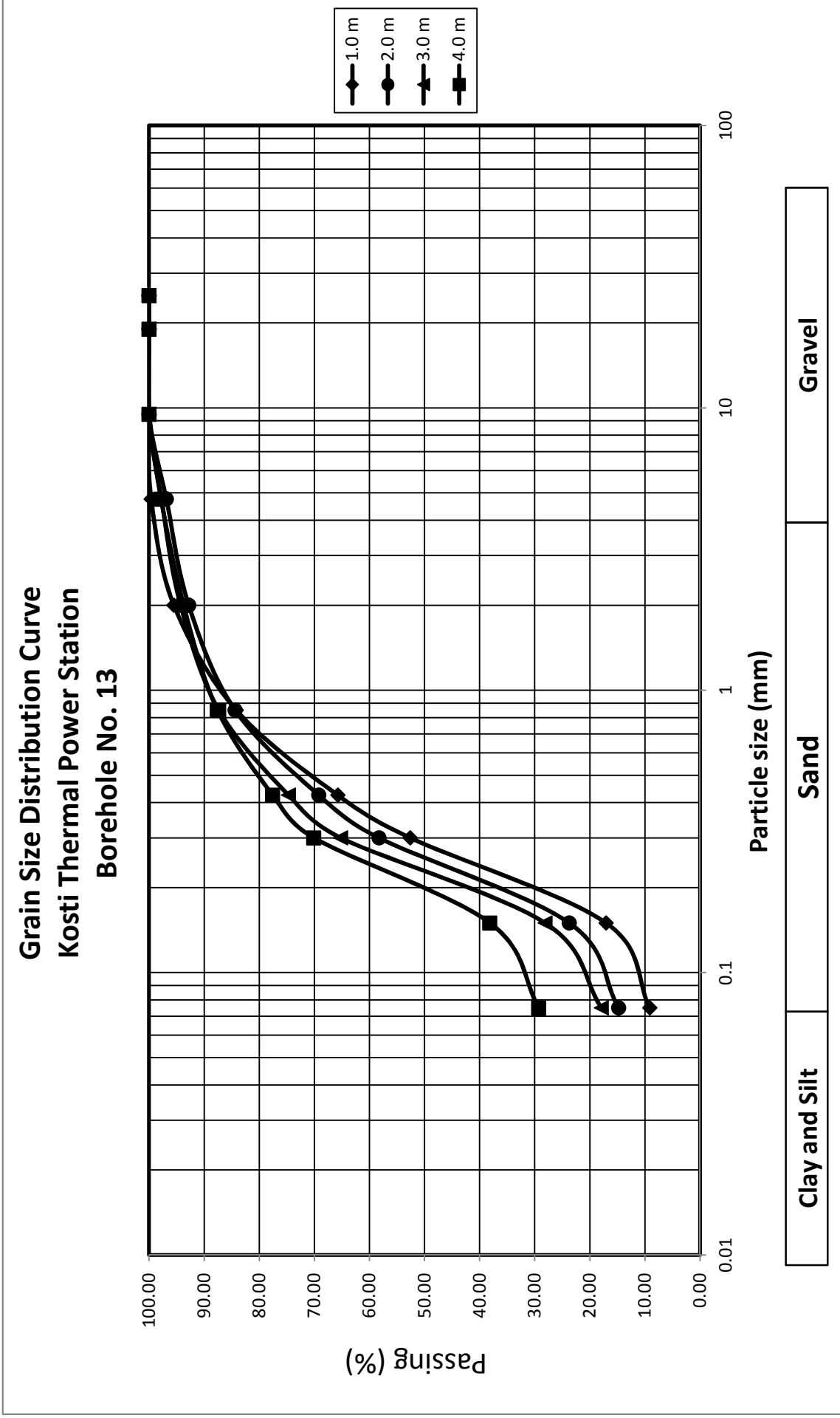

Grain Size Distribution Curve
Kosti Thermal Power Station
Borehole No. 8
6.0 m
8.0 m
10.0 m
Passing (%)
100.00
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
Particle size (mm)
100
10
1
0.1
0.01
Gravel
Sand
Clay and Silt


Grain Size Distribution Curve
Kosti Thermal Power Station
Borehole No. 9
8.0 m
10.0 m
Passing (%)
100.00
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
Particle size (mm)
100
10
1
0.1
0.01
Gravel
Sand
Clay and Silt


Grain Size Distribution Curve
Kosti Thermal Power Station
Borehole No. 10
6.0 m
8.0 m
10.0 m
Passing (%)
100.00
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
Particle size (mm)
100
10
1
0.1
0.01
Gravel
Sand
Clay and Silt


Grain Size Distribution Curve
Kosti Thermal Power Station
Borehole No.11
6.0 m
8.0 m
10.0 m
Passing (%)
100.00
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
Particle size (mm)
100
10
1
0.1
0.01
Gravel
Sand
Clay and Silt

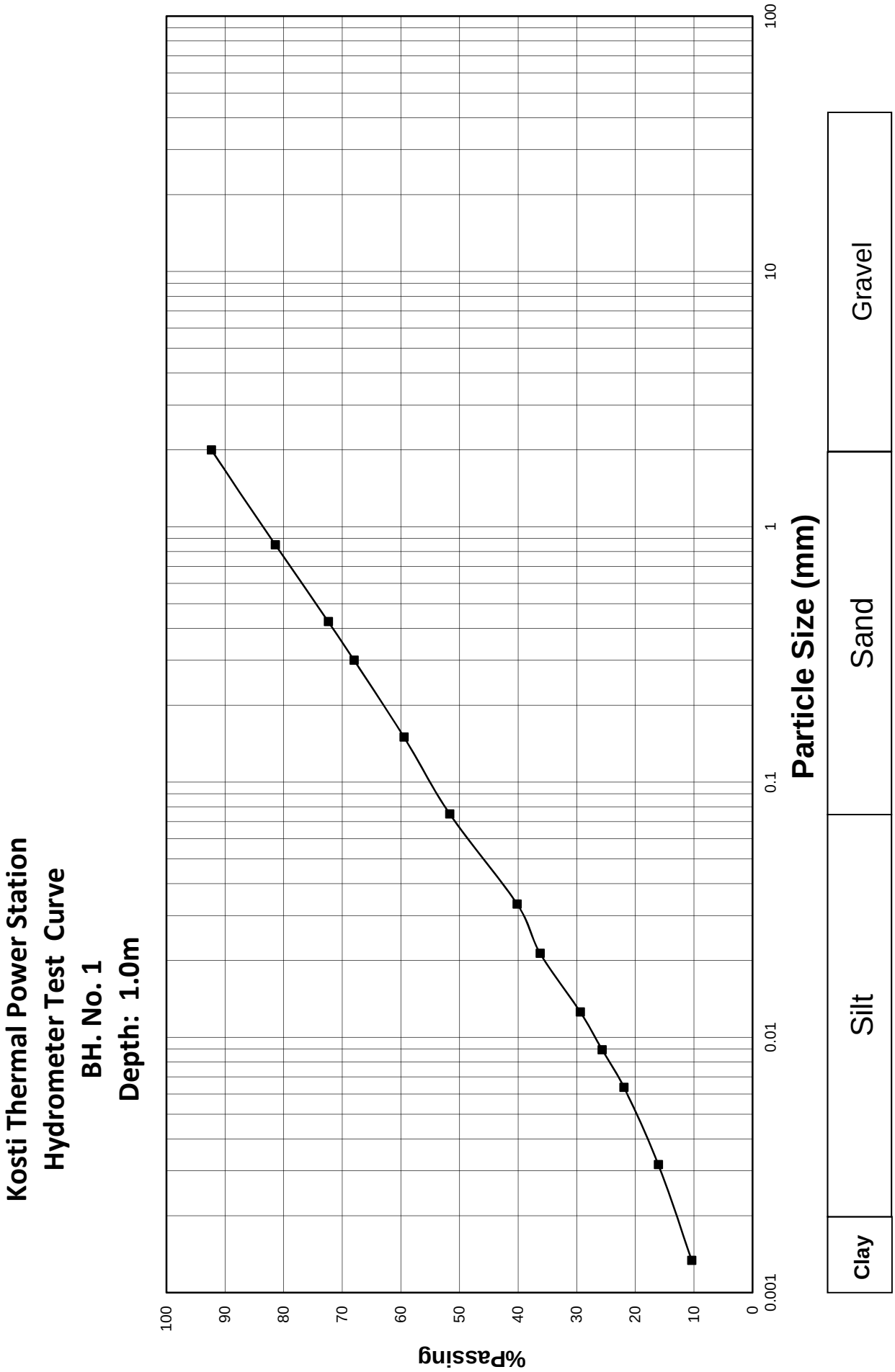

Grain Size Distribution Curve
Kosti Thermal Power Station
Borehole No. 12
6.0 m
8.0 m
Passing (%)
100.00
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
Particle size (mm)
100
10
1
0.1
0.01
Gravel
Sand
Clay and Silt

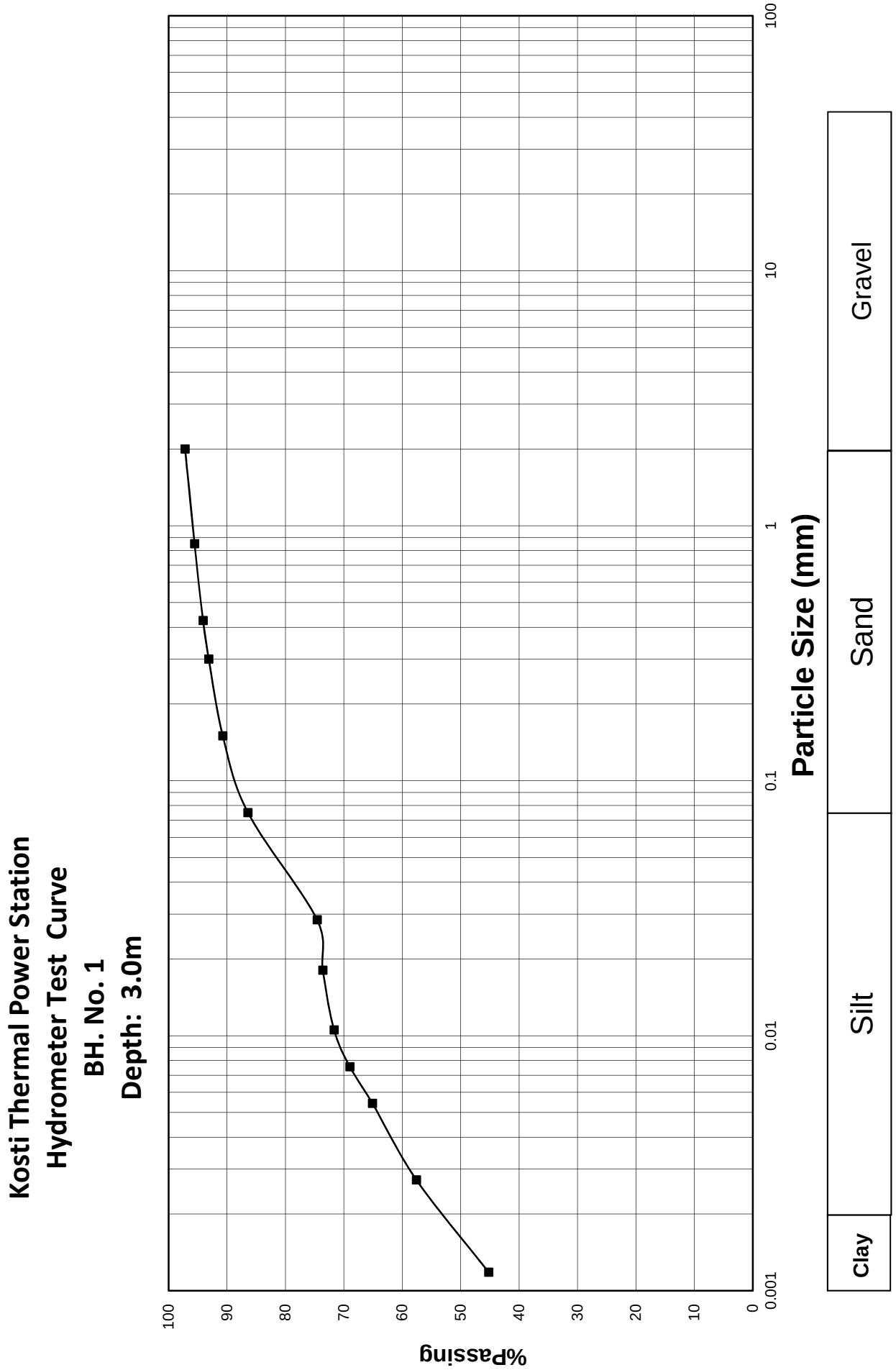

Grain Size Distribution Curve
Kosti Thermal Power Station
Borehole No. 13
1.0 m
2.0 m
3.0 m
4.0 m
Passing (%)
100.00
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
Particle size (mm)
100
10
1
0.1
0.01
Gravel
Sand
Clay and Silt

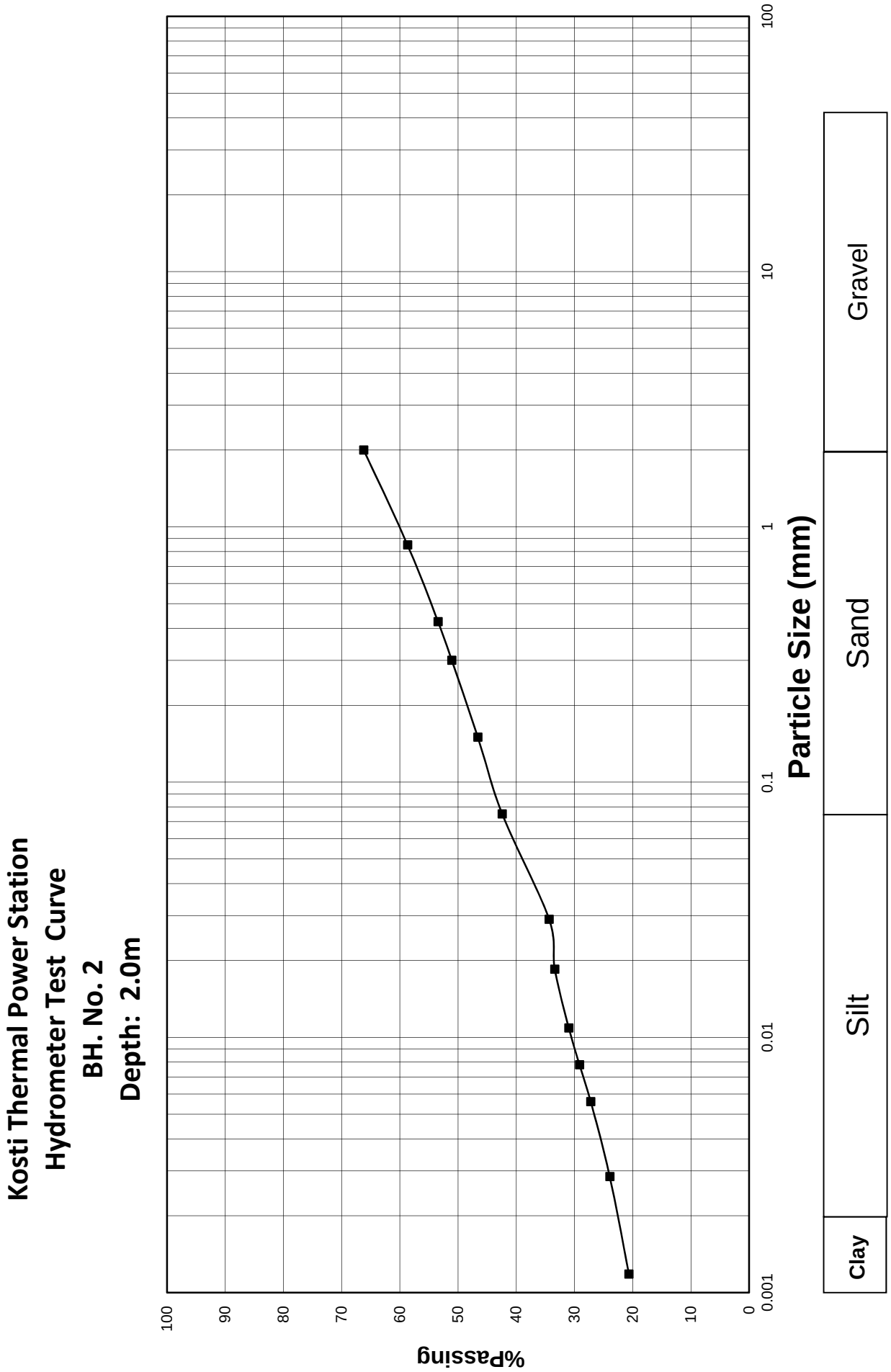
APPENDIX (B-2)

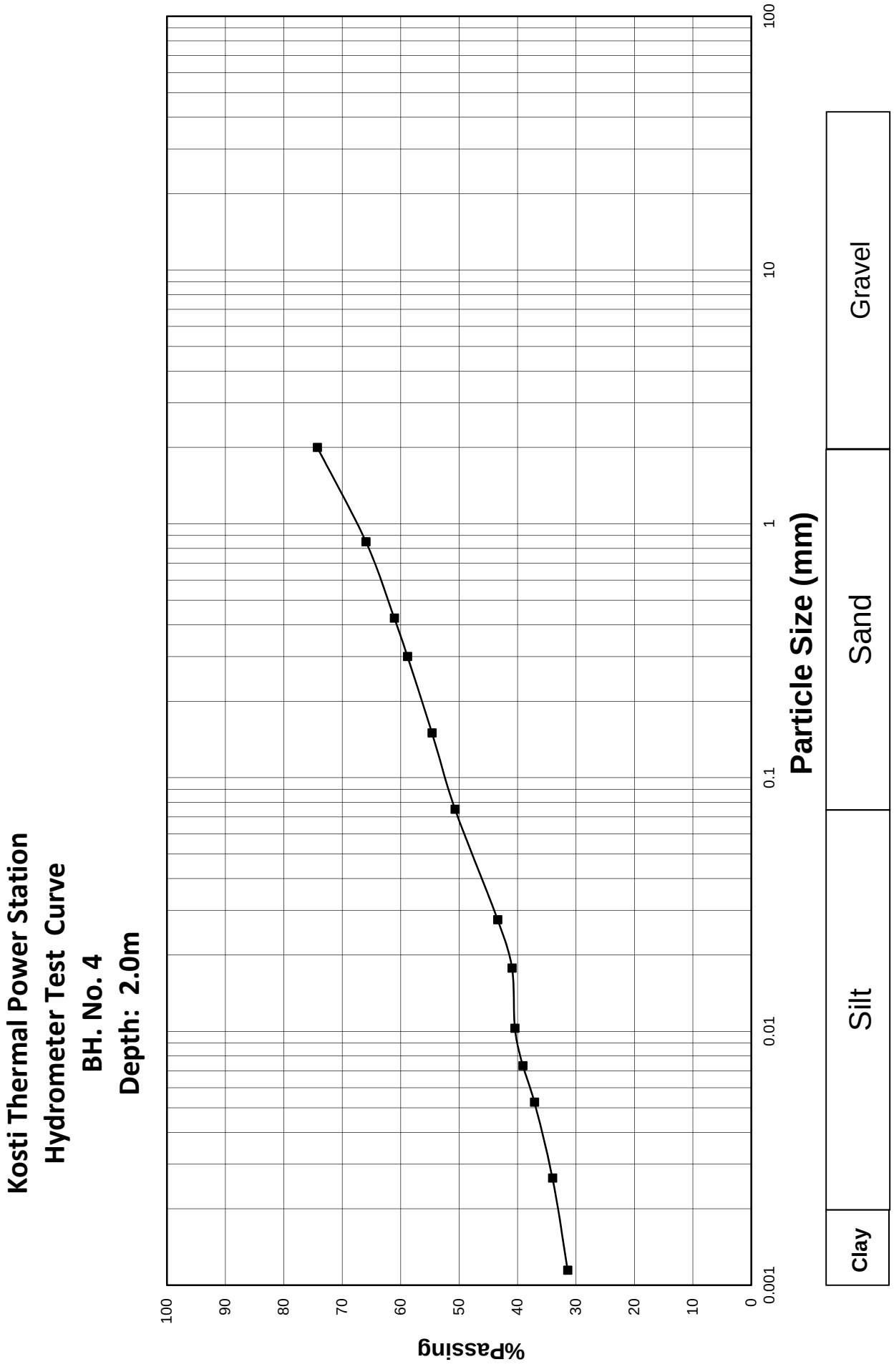
GRAIN SIZE DISTRIBUTION RESULTS

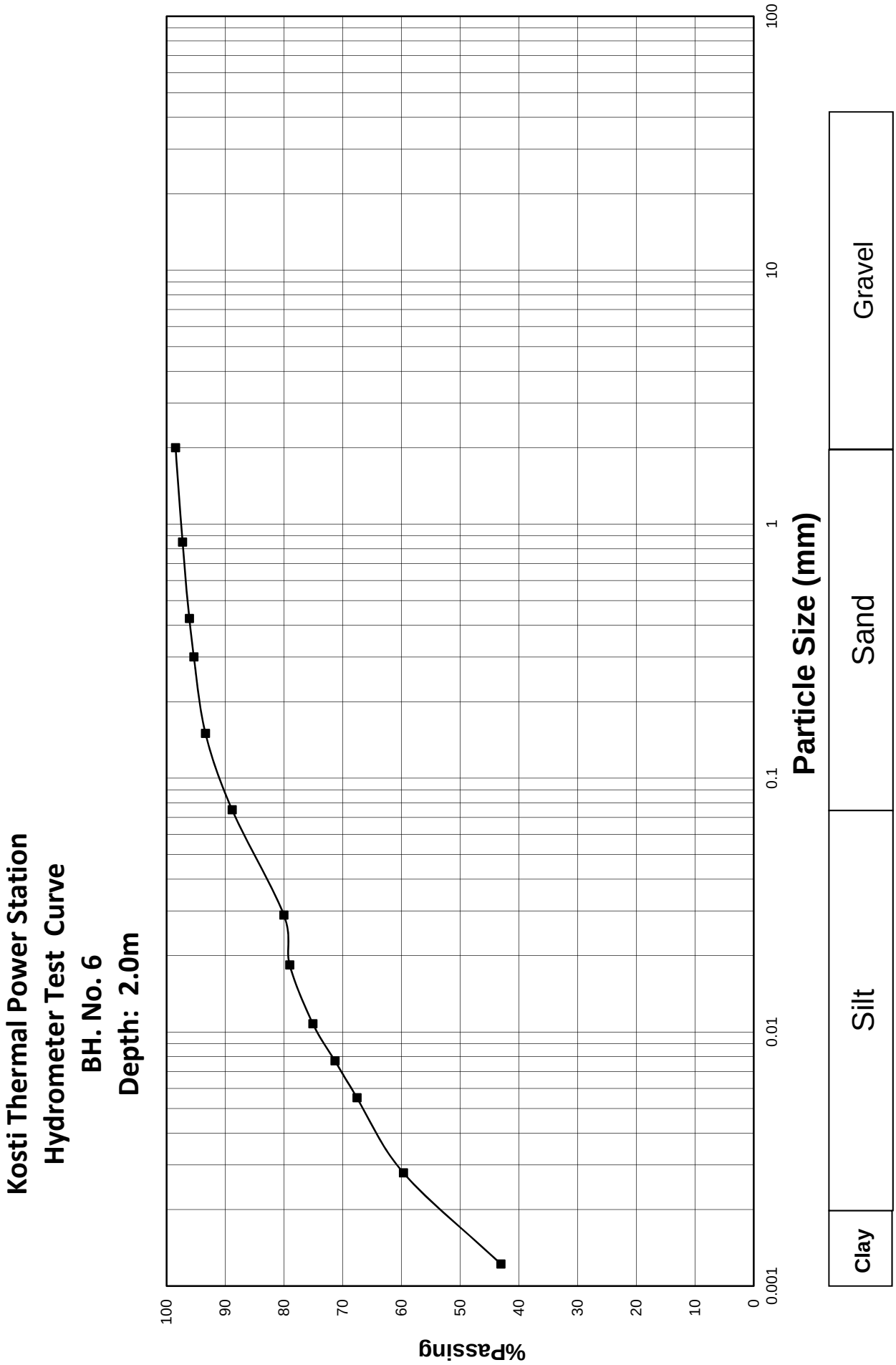
HYDROMETER TESTT

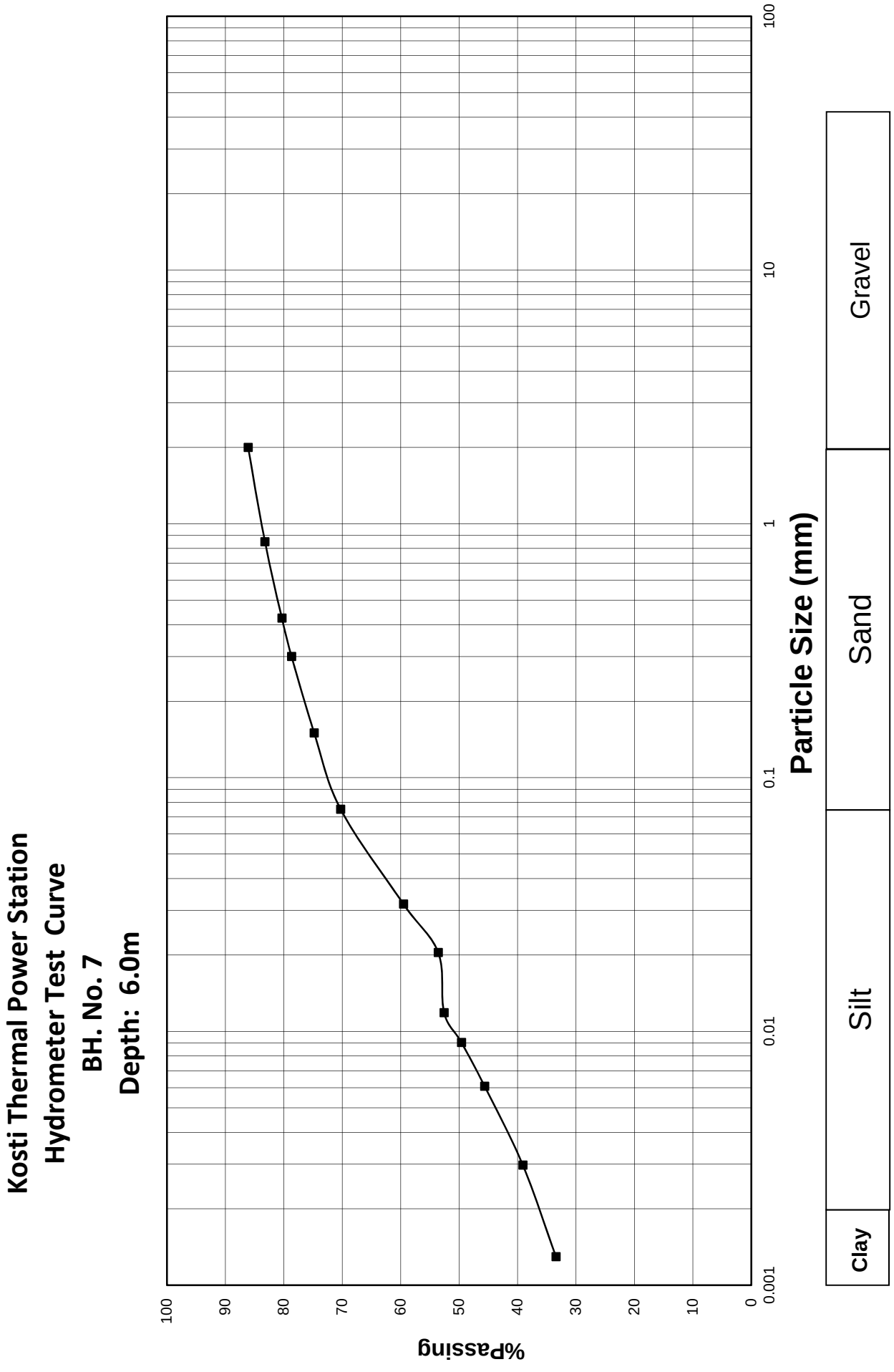

Kosti Thermal Power Station
Hydrometer Test Curve
BH. No. 1
Depth: 1.0m
%Passing
100
90
80
70
60
50
40
30
20
10
0
0.001
0.01
0.1
1
10
100
Particle Size (mm)
Clay
Silt
Sand
Gravel

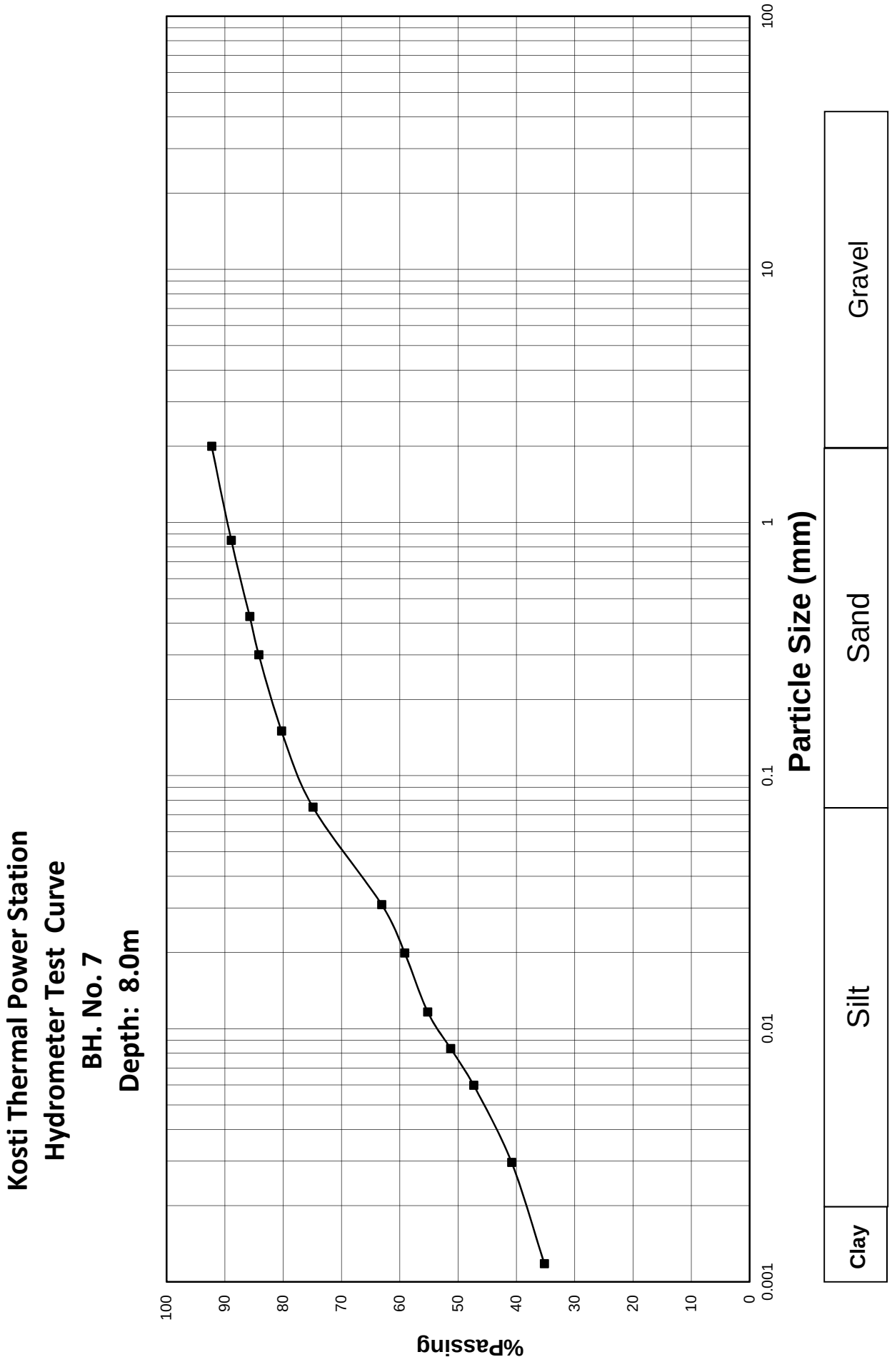

Kosti Thermal Power Station
Hydrometer Test Curve
BH. No. 1
Depth: 3.0m
%Passing
100
90
80
70
60
50
40
30
20
10
0
0.001
0.01
0.1
1
10
100
Particle Size (mm)
Clay
Silt
Sand
Gravel

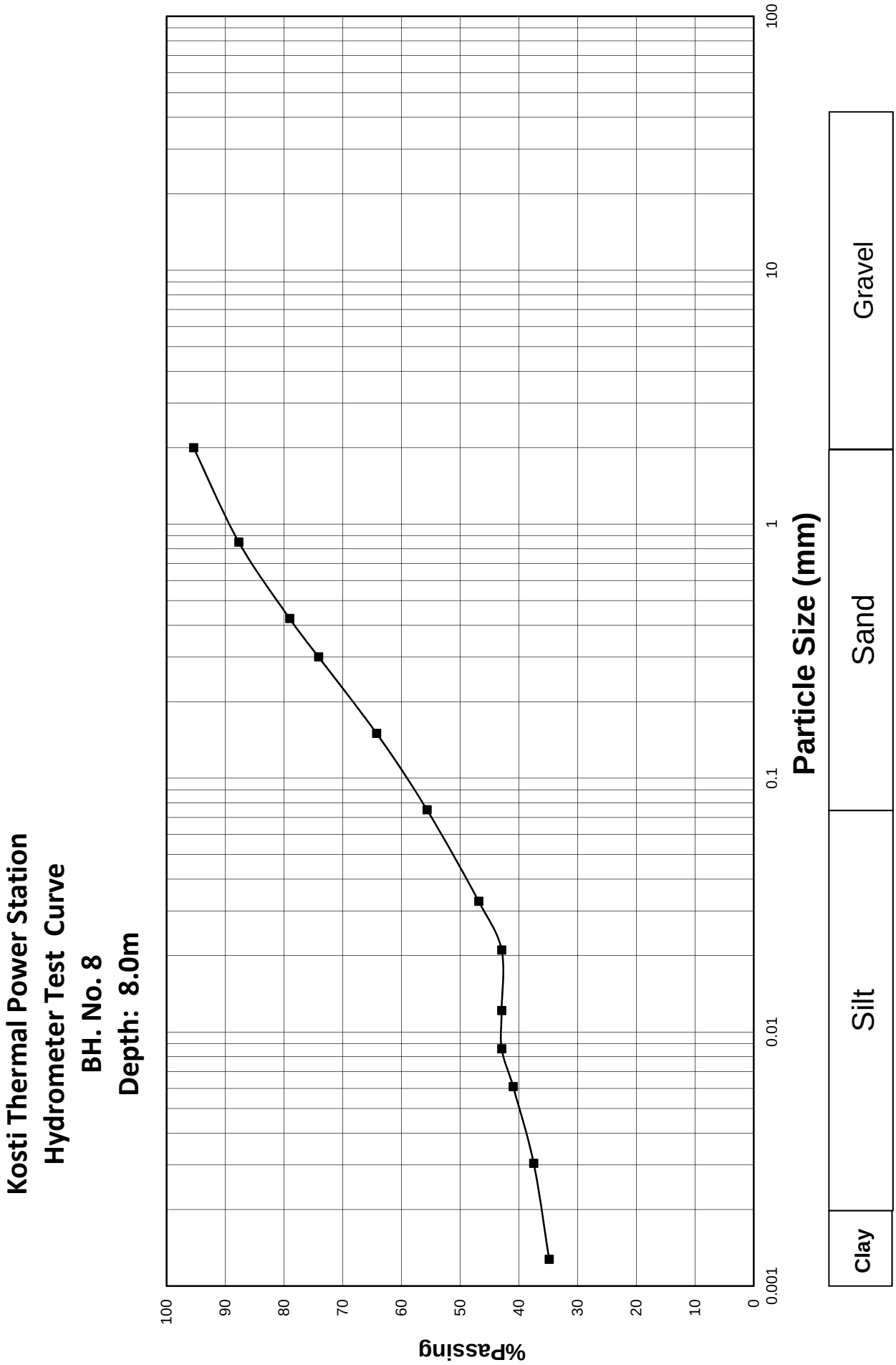

Kosti Thermal Power Station
Hydrometer Test Curve
BH. No. 2
Depth: 2.0m
%Passing
100
90
80
70
60
50
40
30
20
10
0
0.001
0.01
0.1
1
10
100
Particle Size (mm)
Clay
Silt
Sand
Gravel

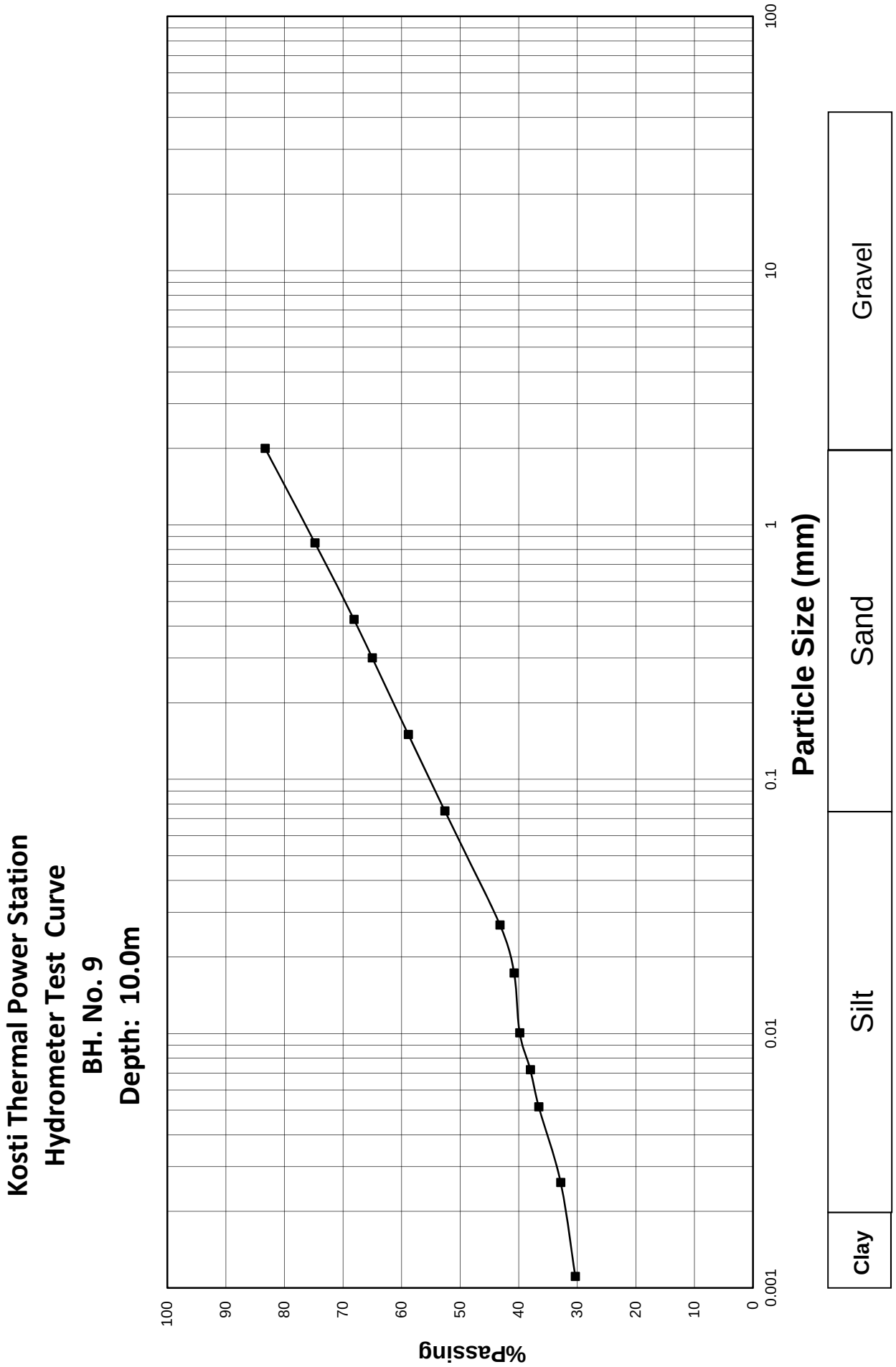

Kosti Thermal Power Station
Hydrometer Test Curve
BH. No. 4
Depth: 2.0m
%Passing
100
90
80
70
60
50
40
30
20
10
0
0.001
0.01
0.1
1
10
100
Particle Size (mm)
Clay
Silt
Sand
Gravel

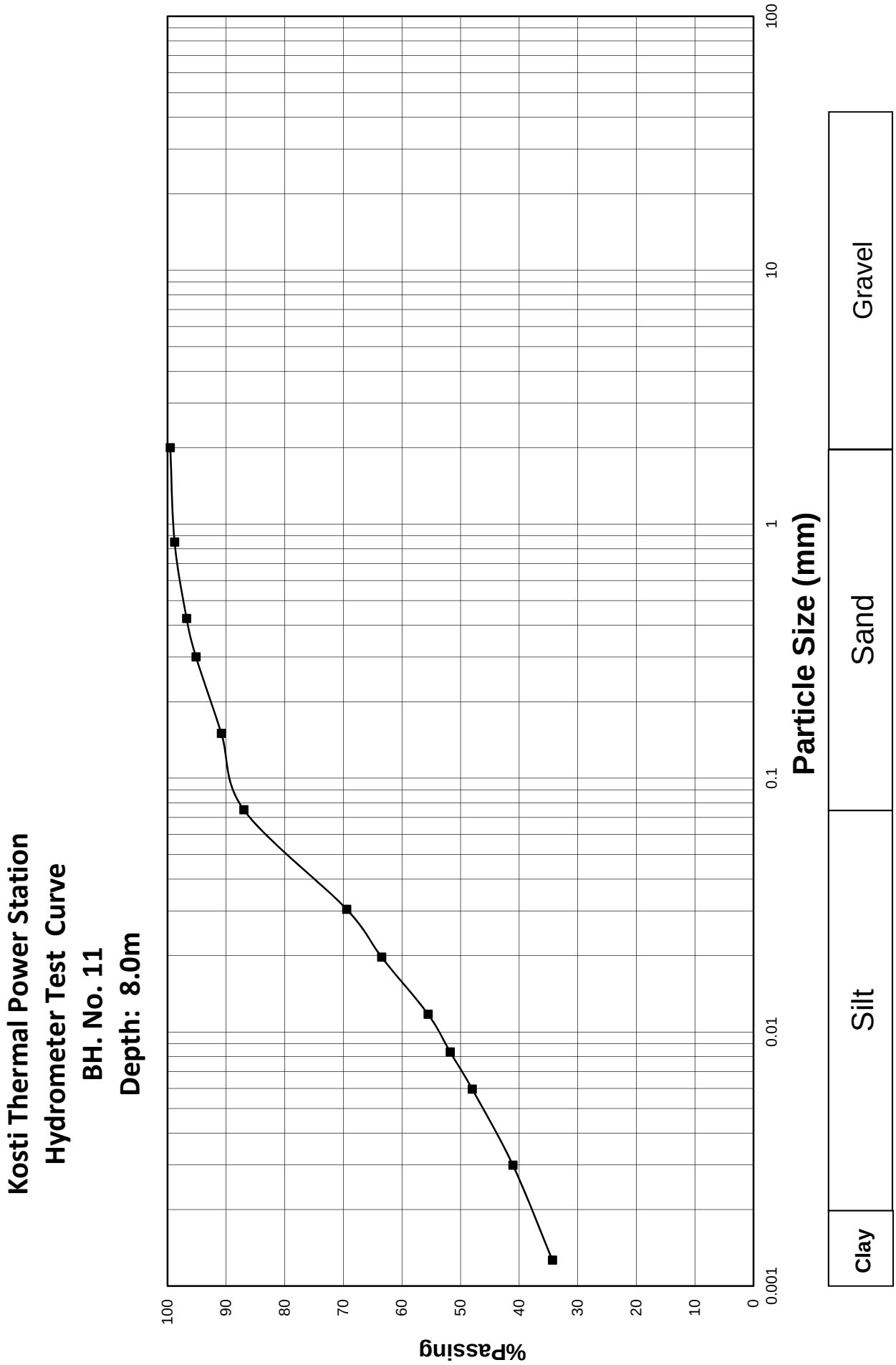

Kosti Thermal Power Station
Hydrometer Test Curve
BH. No. 6
Depth: 2.0m
%Passing
100
90
80
70
60
50
40
30
20
10
0
0.001
0.01
0.1
1
10
100
Particle Size (mm)
Clay
Silt
Sand
Gravel

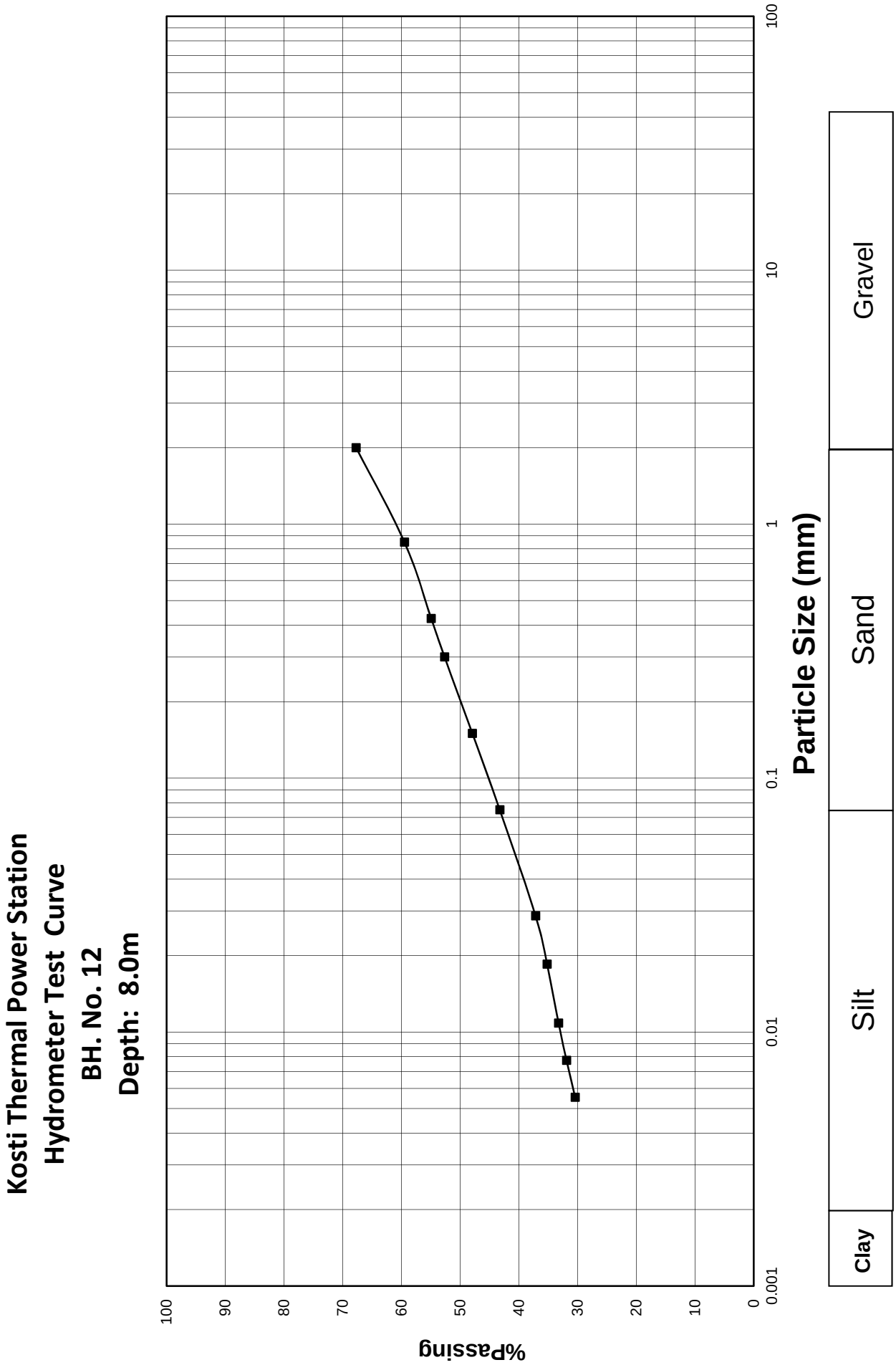

Kosti Thermal Power Station
Hydrometer Test Curve
BH. No. 7
Depth: 6.0m
%Passing
100
90
80
70
60
50
40
30
20
10
0
0.001
0.01
0.1
1
10
100
Particle Size (mm)
Clay
Silt
Sand
Gravel


Kosti Thermal Power Station
Hydrometer Test Curve
BH. No. 7
Depth: 8.0m
%Passing
100
90
80
70
60
50
40
30
20
10
0
0.001
0.01
0.1
1
10
100
Particle Size (mm)
Clay
Silt
Sand
Gravel


Kosti Thermal Power Station
Hydrometer Test Curve
BH. No. 8
Depth: 8.0m
%Passing
100
90
80
70
60
50
40
30
20
10
0
Particle Size (mm)
100
10
1
0.1
0.01
0.001
Clay
Silt
Sand
Gravel

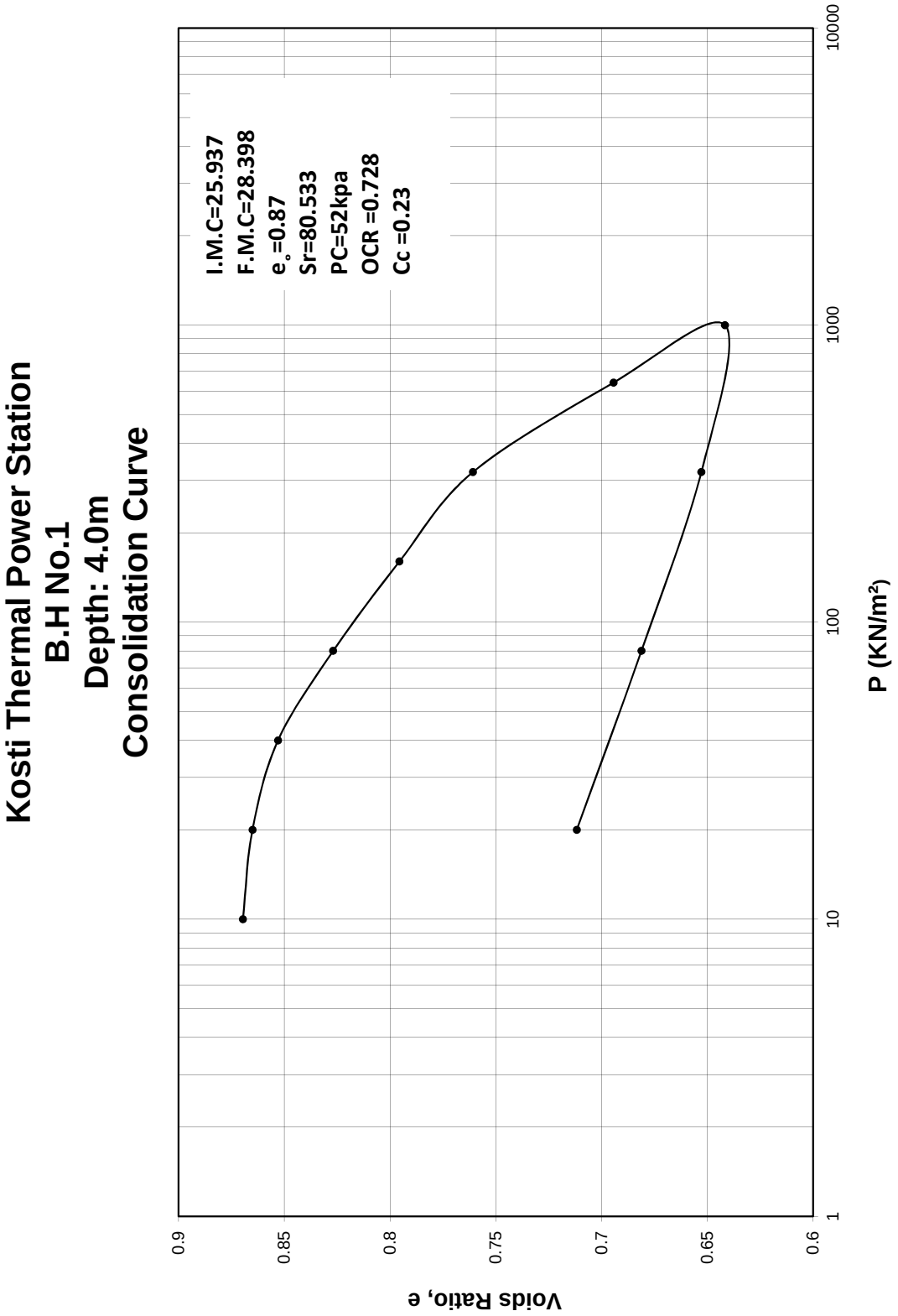

Kosti Thermal Power Station
Hydrometer Test Curve
BH. No. 9
Depth: 10.0m
%Passing
100
90
80
70
60
50
40
30
20
10
0
Particle Size (mm)
100
10
1
0.1
0.01
0.001
Clay
Silt
Sand
Gravel

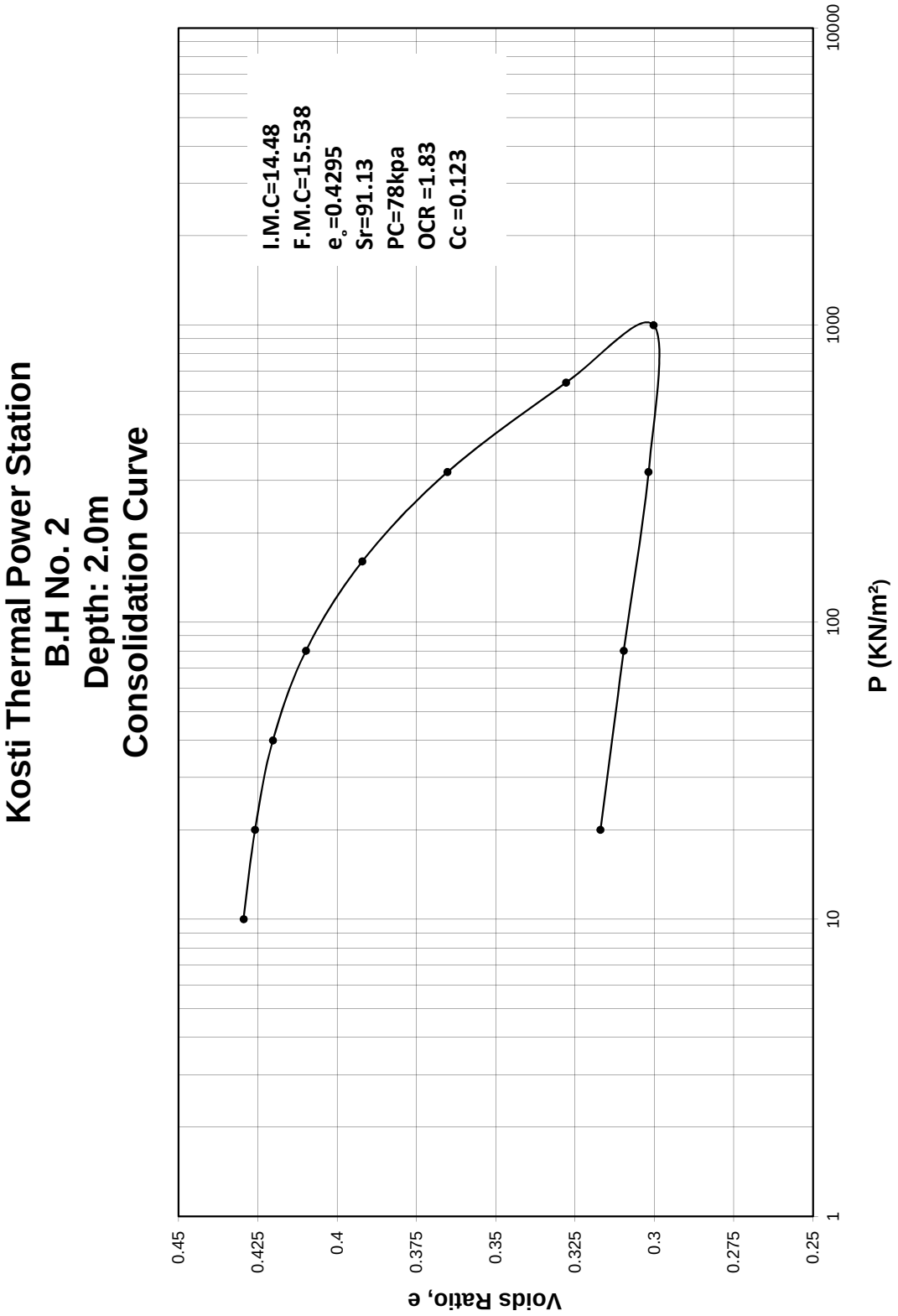

Kosti Thermal Power Station
Hydrometer Test Curve
BH. No. 11
Depth: 8.0m
%Passing
100
90
80
70
60
50
40
30
20
10
0
0.001
0.01
0.1
1
10
100
Particle Size (mm)
Clay
Silt
Sand
Gravel

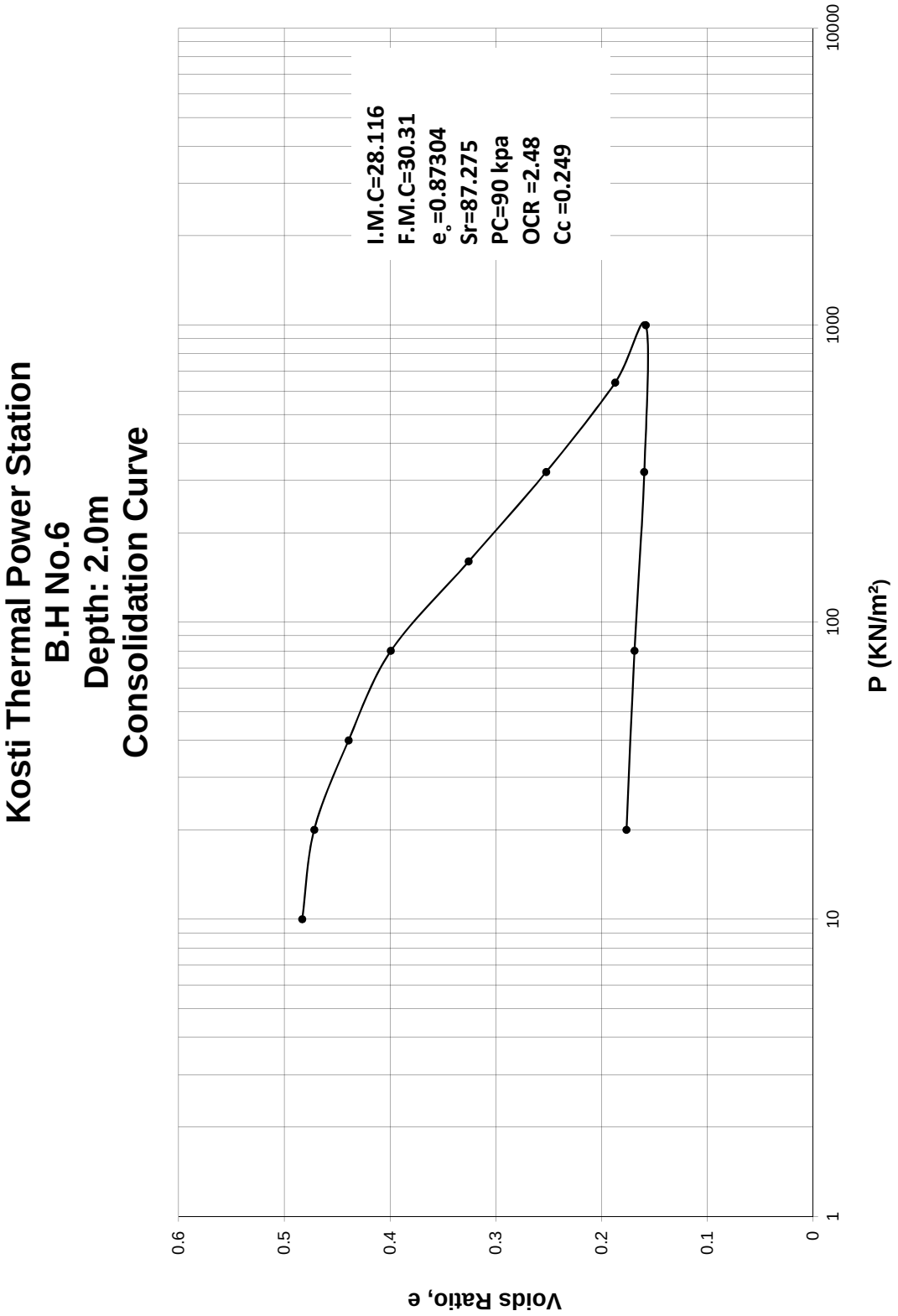

Kosti Thermal Power Station
Hydrometer Test Curve
BH. No. 12
Depth: 8.0m
%Passing
100
90
80
70
60
50
40
30
20
10
0
Particle Size (mm)
100
10
1
0.1
0.01
0.001
Clay
Silt
Sand
Gravel

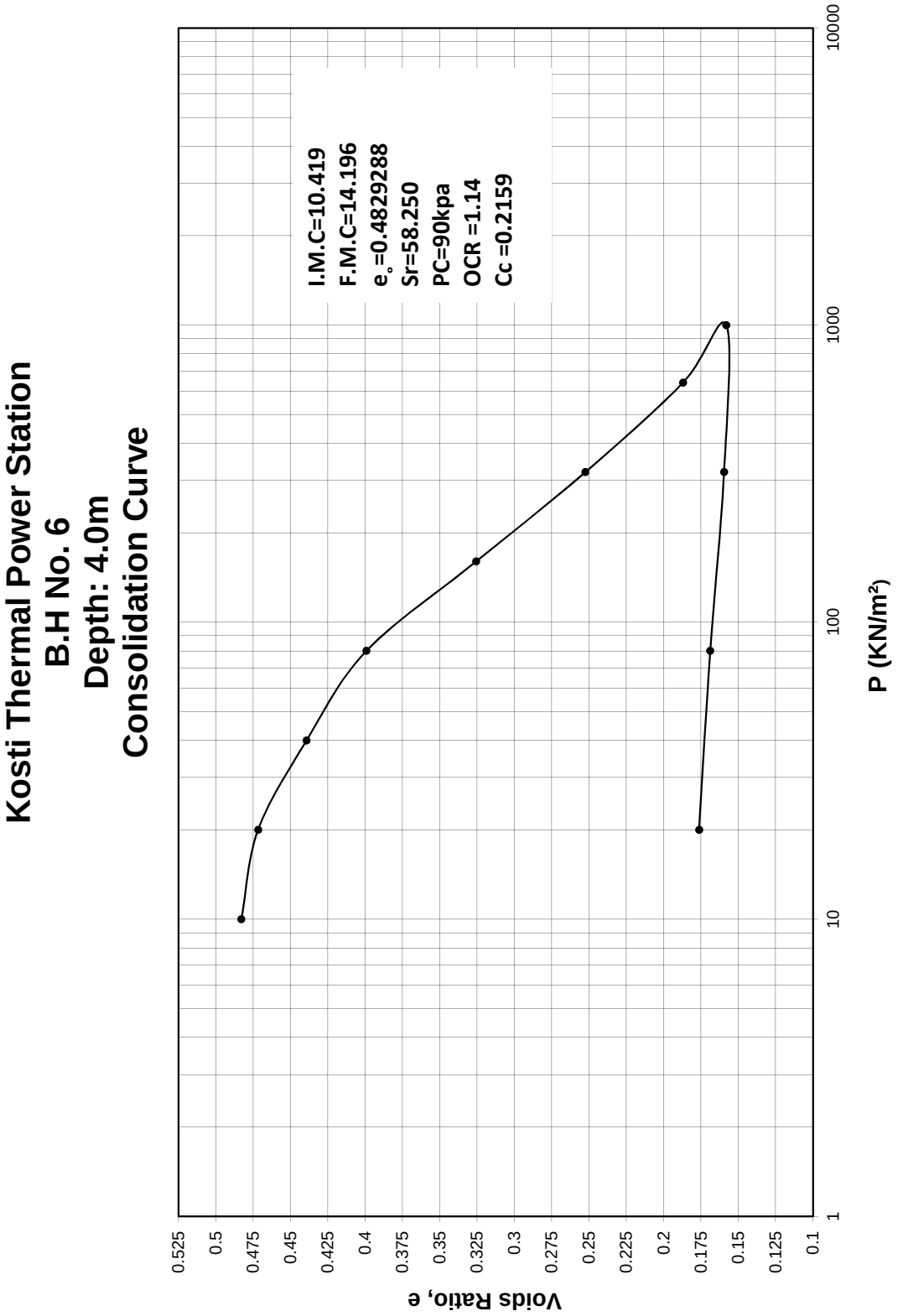
APPENDIX (C)

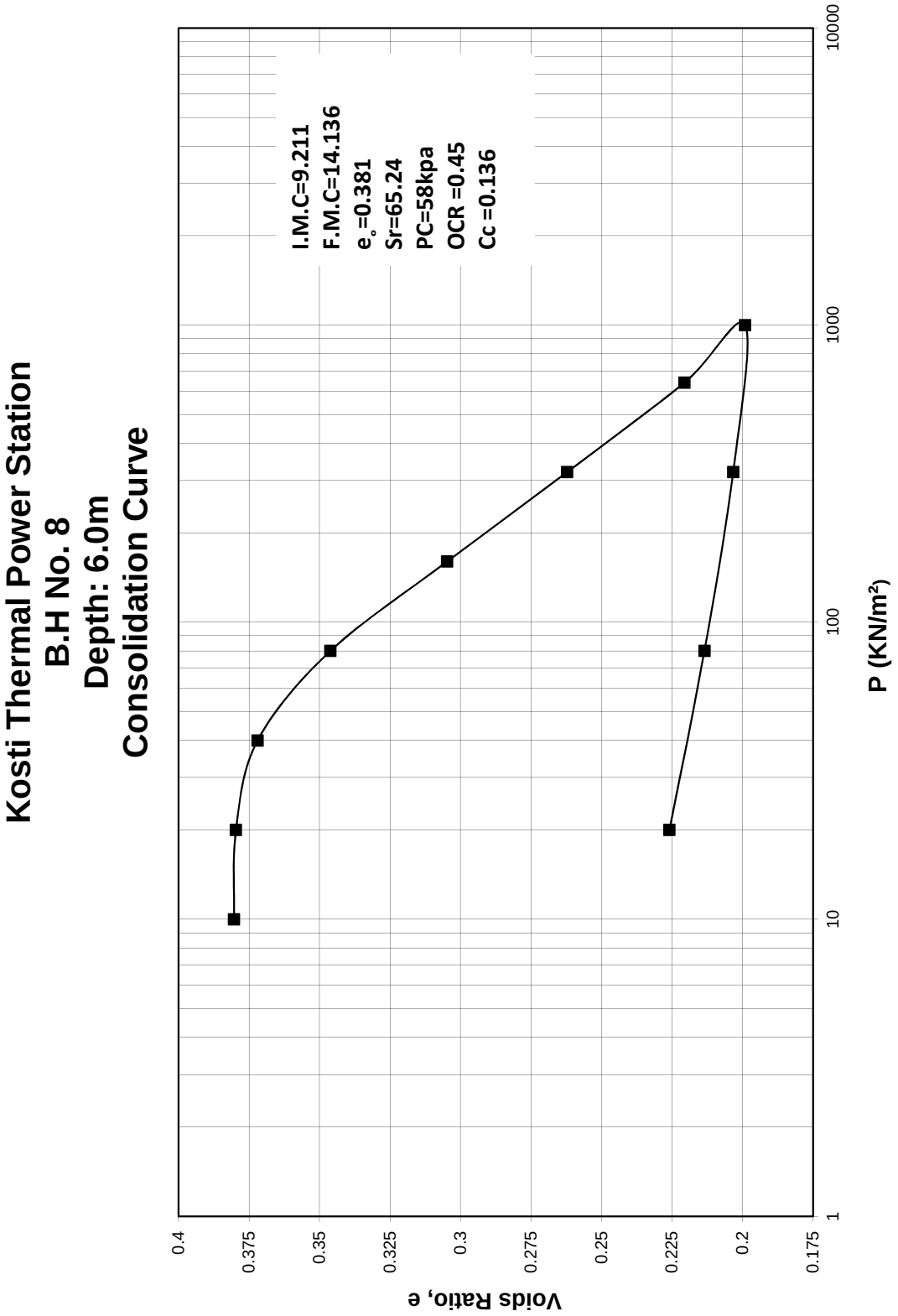
CONSOLIDATION TEST RESULTS

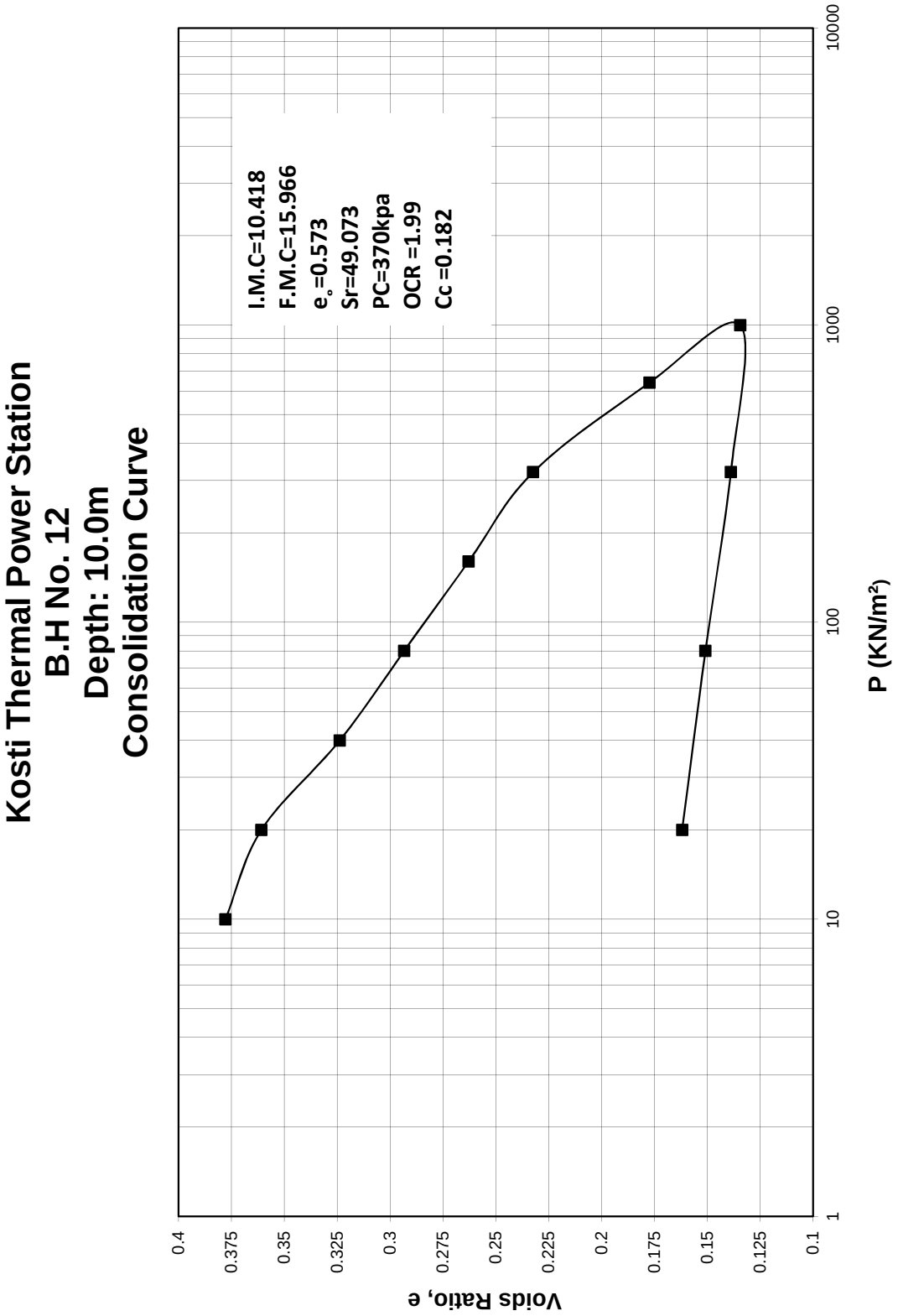

Kosti Thermal Power Station
B.H No.1
Depth: 4.0m
Consolidation Curve
I.M.C=25.937
F.M.C=28.398
e。=0.87
Sr=80.533
PC=52kpa
OCR =0.728
Cc =0.23
Voids Ratio, e
0.9
0.85
0.8
0.75
0.7
0.65
0.6
P (KN/m²)
1
10
100
1000
10000


Kosti Thermal Power Station
B.H No. 2
Depth: 2.0m
Consolidation Curve
I.M.C=14.48
F.M.C=15.538
e₀=0.4295
Sr=91.13
PC=78kpa
OCR =1.83
Cc =0.123
Voids Ratio, e
0.45
0.425
0.4
0.375
0.35
0.325
0.3
0.275
0.25
P (KN/m²)
1
10
100
1000
10000


Kosti Thermal Power Station
B.H No.6
Depth: 2.0m
Consolidation Curve
I.M.C=28.116
F.M.C=30.31
e°=0.87304
Sr=87.275
PC=90 kpa
OCR =2.48
Cc =0.249
Voids Ratio, e
0.6
0.5
0.4
0.3
0.2
0.1
0
1
10
100
1000
10000
P (KN/m²)


Kosti Thermal Power Station
B.H No. 6
Depth: 4.0m
Consolidation Curve
I.M.C=10.419
F.M.C=14.196
e°=0.4829288
Sr=58.250
PC=90kpa
OCR =1.14
Cc =0.2159
Voids Ratio, e
0.525
0.5
0.475
0.45
0.425
0.4
0.375
0.35
0.325
0.3
0.275
0.25
0.225
0.2
0.175
0.15
0.125
0.1
P (KN/m²)
1
10
100
1000
10000


Kosti Thermal Power Station
B.H No. 8
Depth: 6.0m
Consolidation Curve
I.M.C=9.211
F.M.C=14.136
e°=0.381
Sr=65.24
PC=58kpa
OCR =0.45
Cc =0.136
Voids Ratio, e
0.4
0.375
0.35
0.325
0.3
0.275
0.25
0.225
0.2
0.175
P (KN/m²)
1
10
100
1000
10000


Kosti Thermal Power Station
B.H No. 12
Depth: 10.0m
Consolidation Curve
I.M.C=10.418
F.M.C=15.966
e°=0.573
Sr=49.073
PC=370kpa
OCR =1.99
Cc =0.182
Voids Ratio, e
0.4
0.375
0.35
0.325
0.3
0.275
0.25
0.225
0.2
0.175
0.15
0.125
0.1
P (KN/m²)
1
10
100
1000
10000

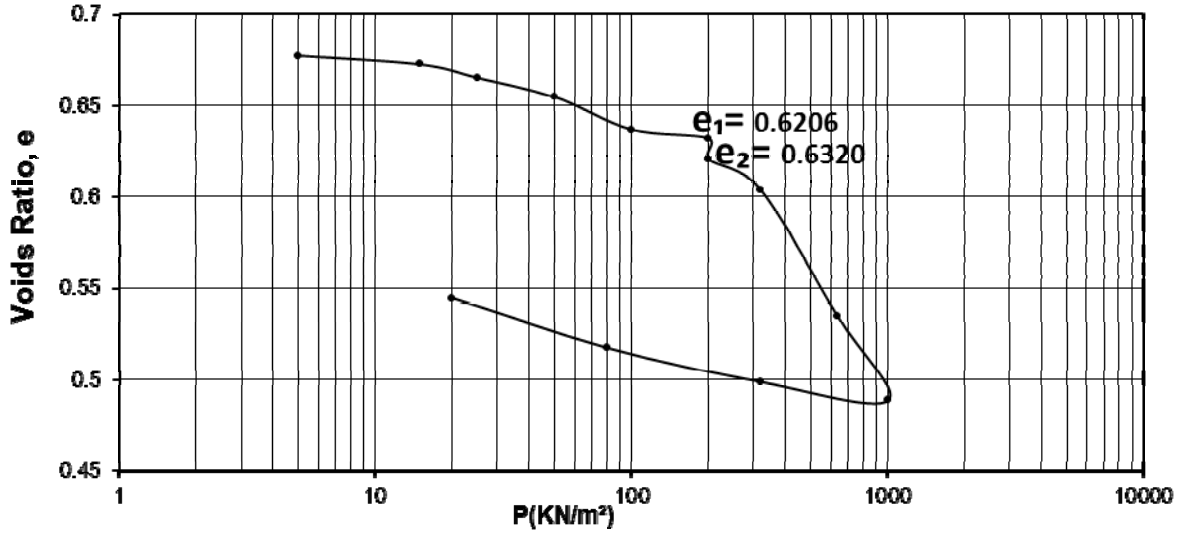
APPENDIX (C-1)

SINGLE OEDOMETER TEST RESULTS

Sample of Single Oedometrer Test

Sample of Calculations:

1. BH.No.1 Depth 1.5m



Calculation:

For e_o=0.7122

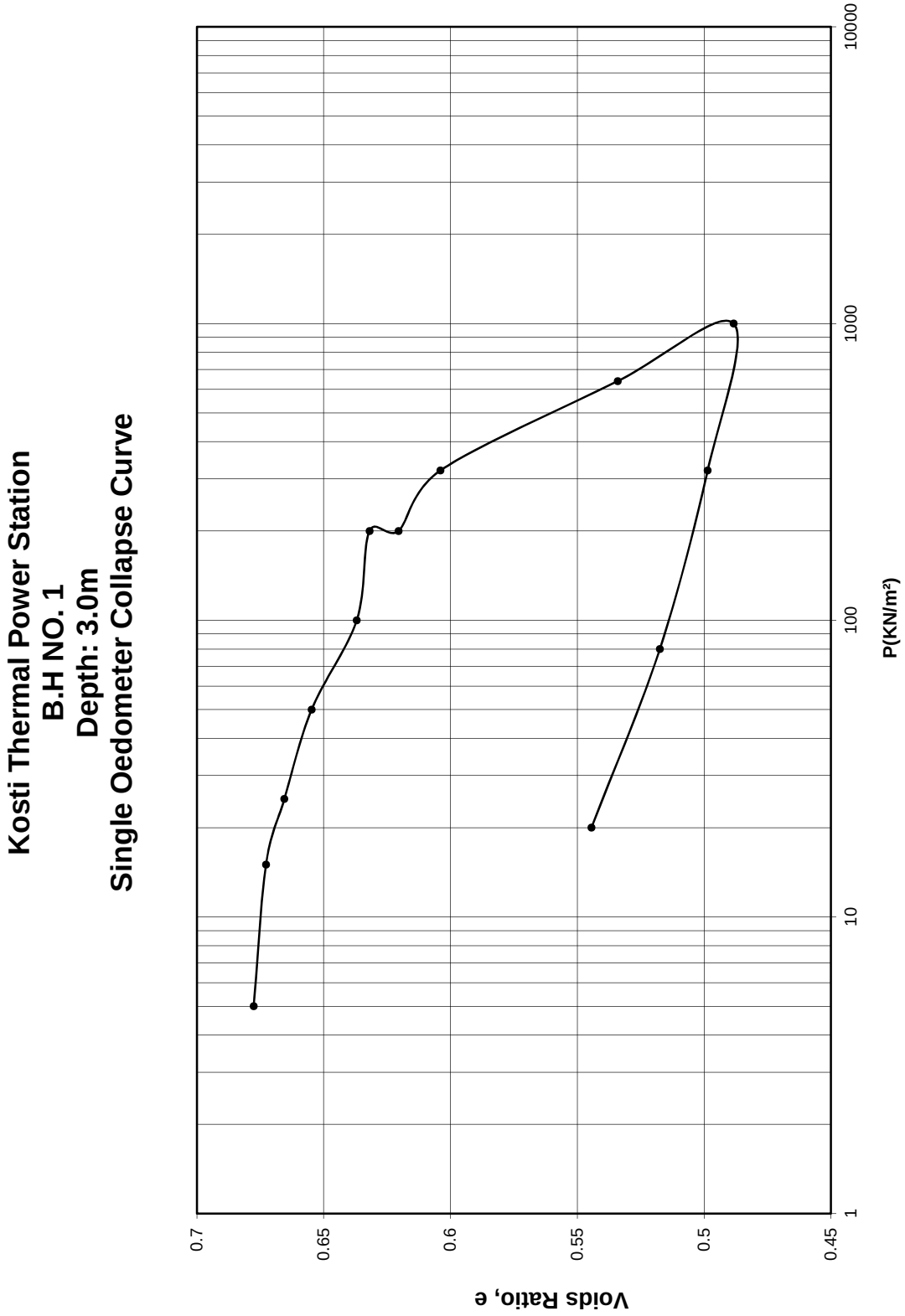
$$Cp(\%) = \frac{(e_2 - e_1)}{1 + e_o} = \frac{(0.6320 - 0.6206)}{1 + 0.7122} x100 = 0.67$$

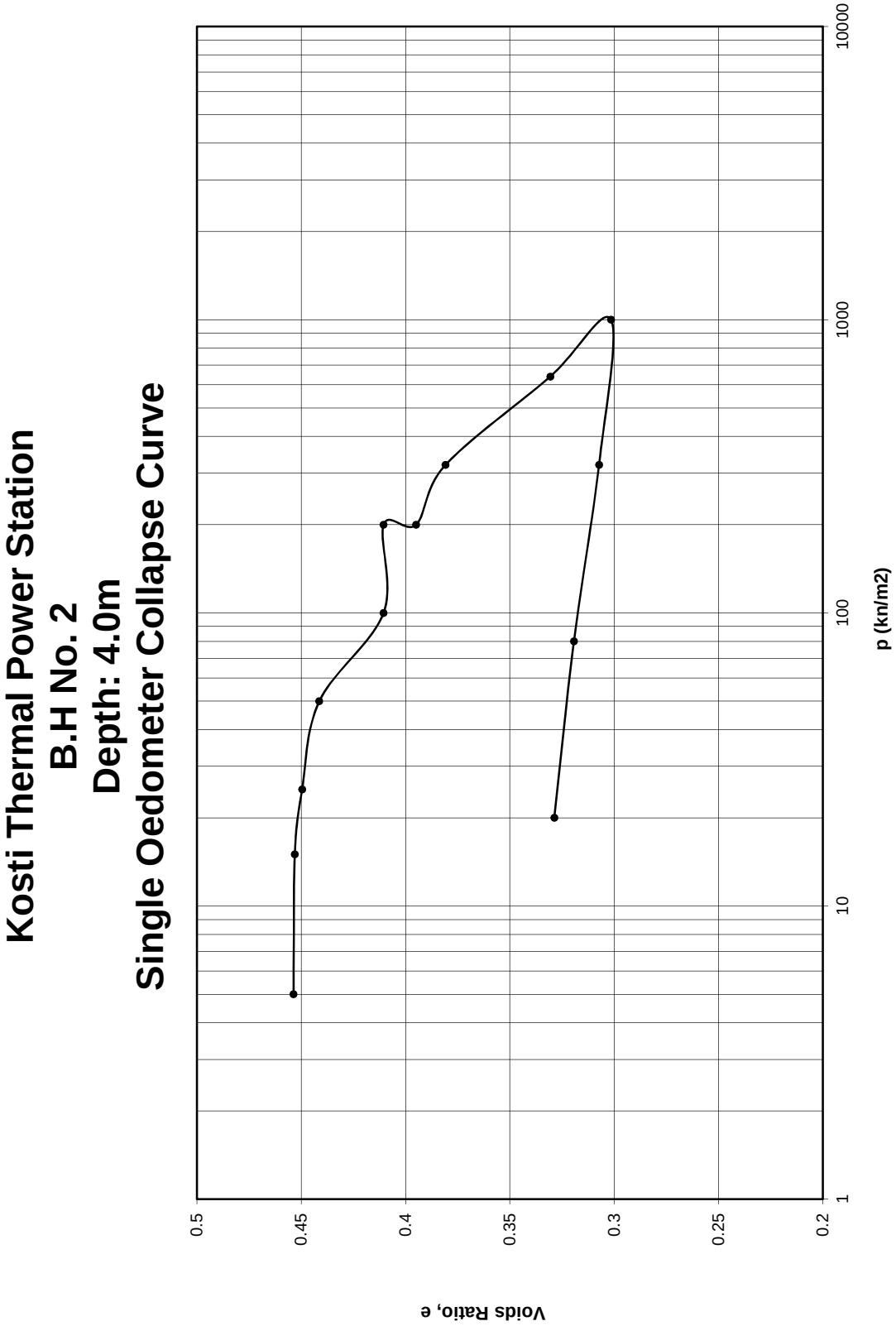
where e_o: natural void ratio and

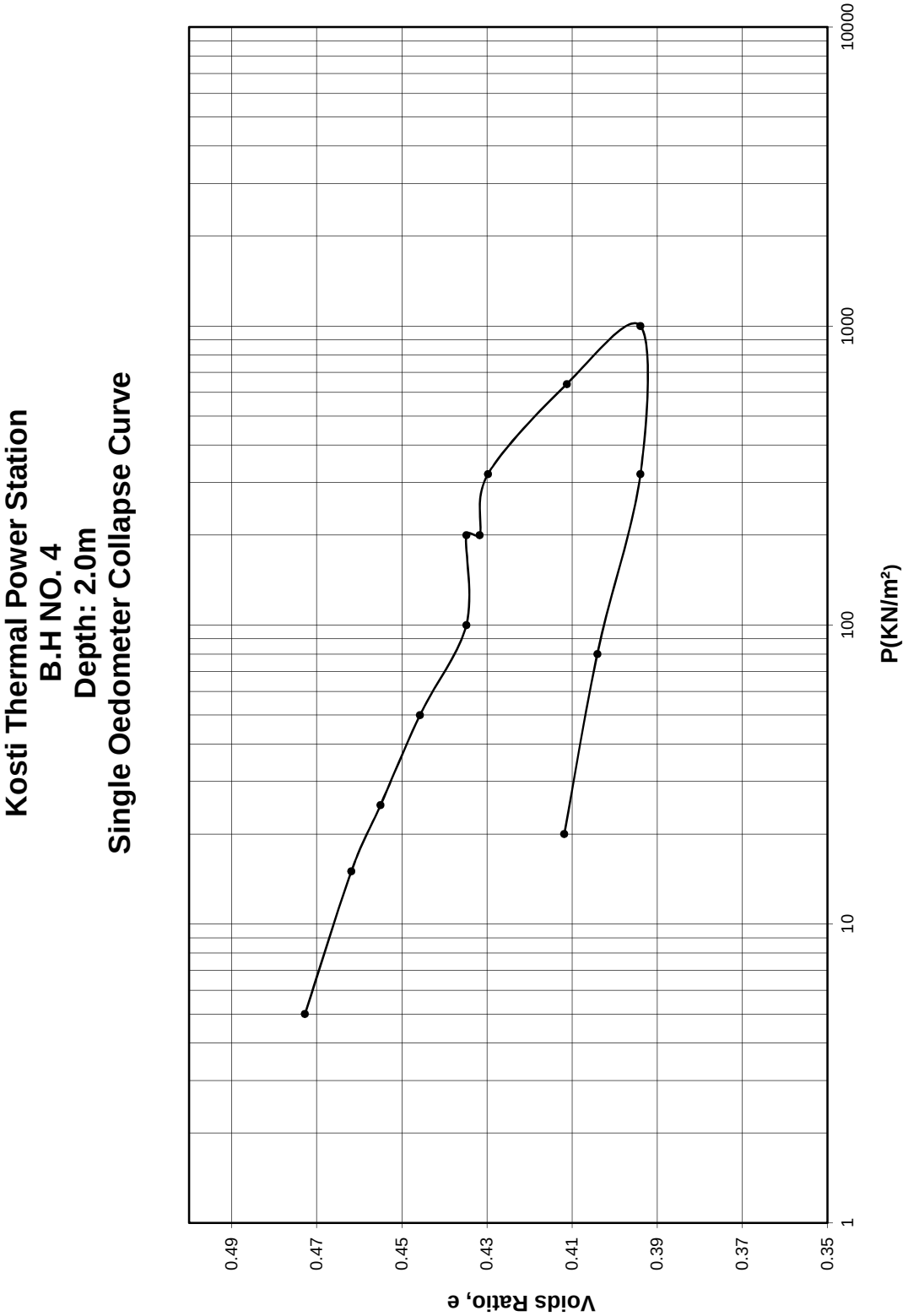
$(e_2 - e_1)$: vertical strain

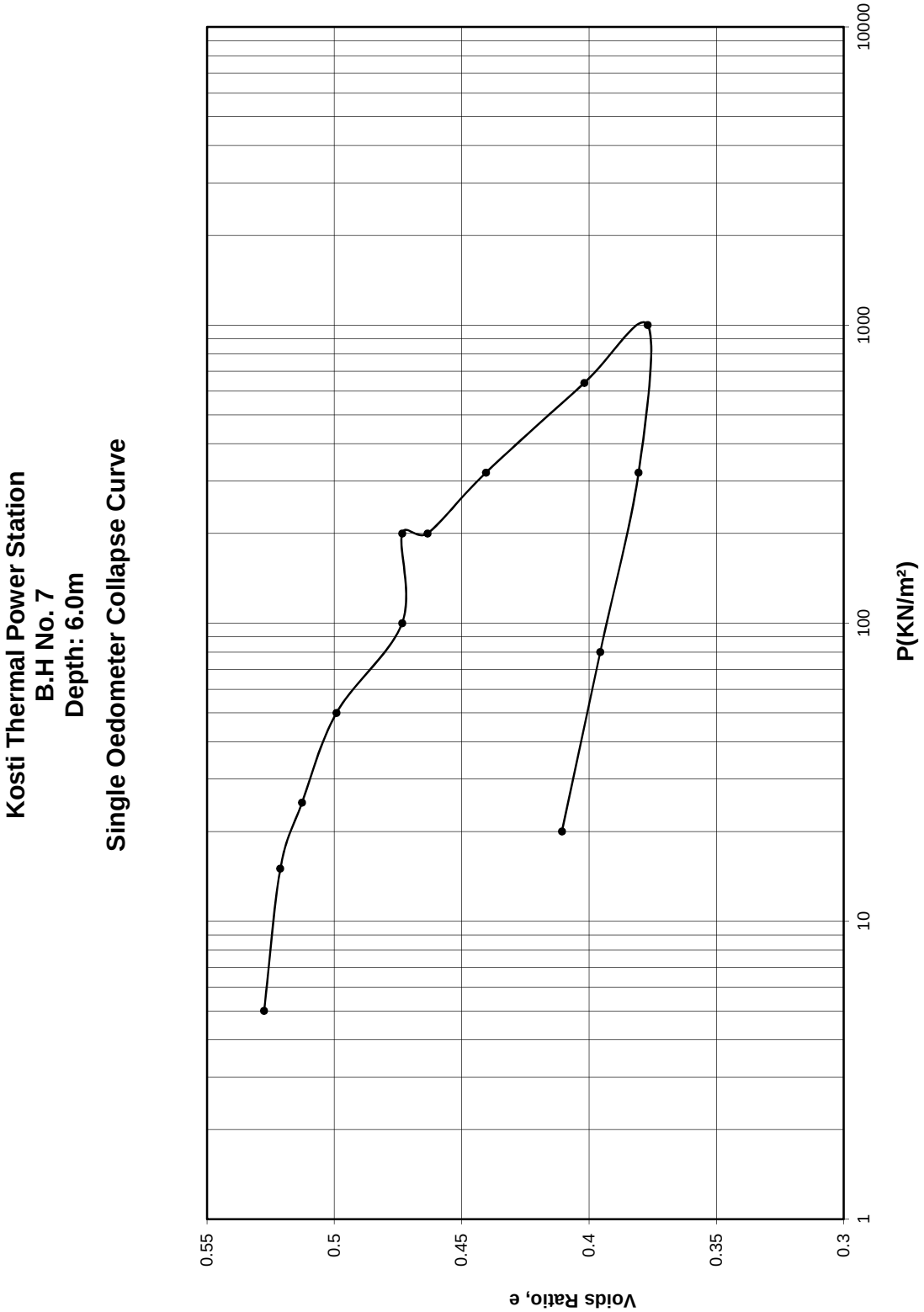
2. Table Below shows the results of C_P in single Oedometer Test

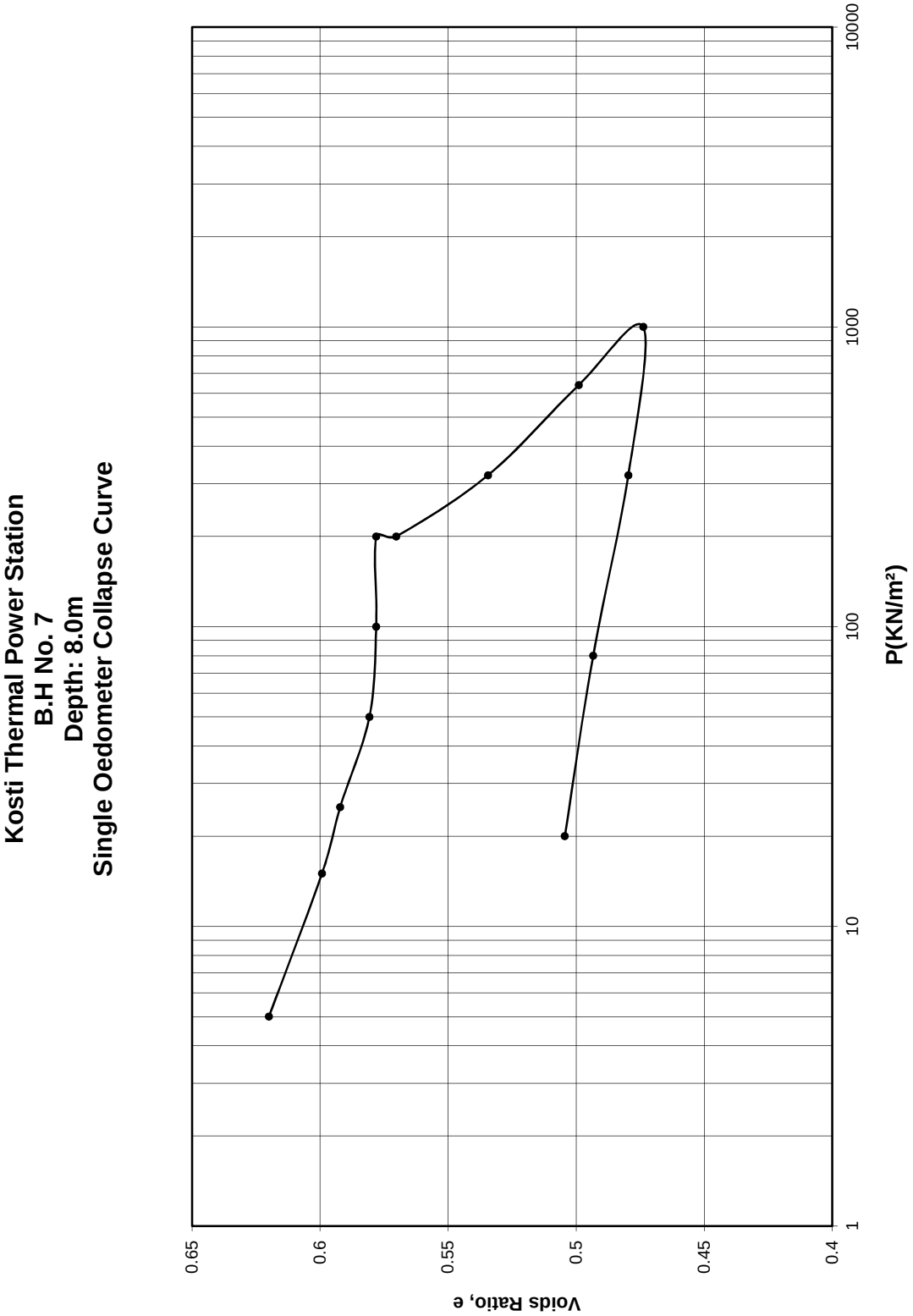
BH. No.	Depth	e_o	e_1	e_2	$C_P(\%)$
2	4	0.4537	0.4105	0.395	1.07
4	2	0.478	0.4349	0.4317	0.22
7	6	0.5371	0.4734	0.4635	0.64
7	8	0.6382	0.5781	0.5703	0.48
8	8	0.269	0.172	0.161	0.87
8	10	0.3756	0.3467	0.3158	2.25
9	10	0.3559	0.3185	0.3026	1.17
11	6	0.474	0.4509	0.4204	2.07

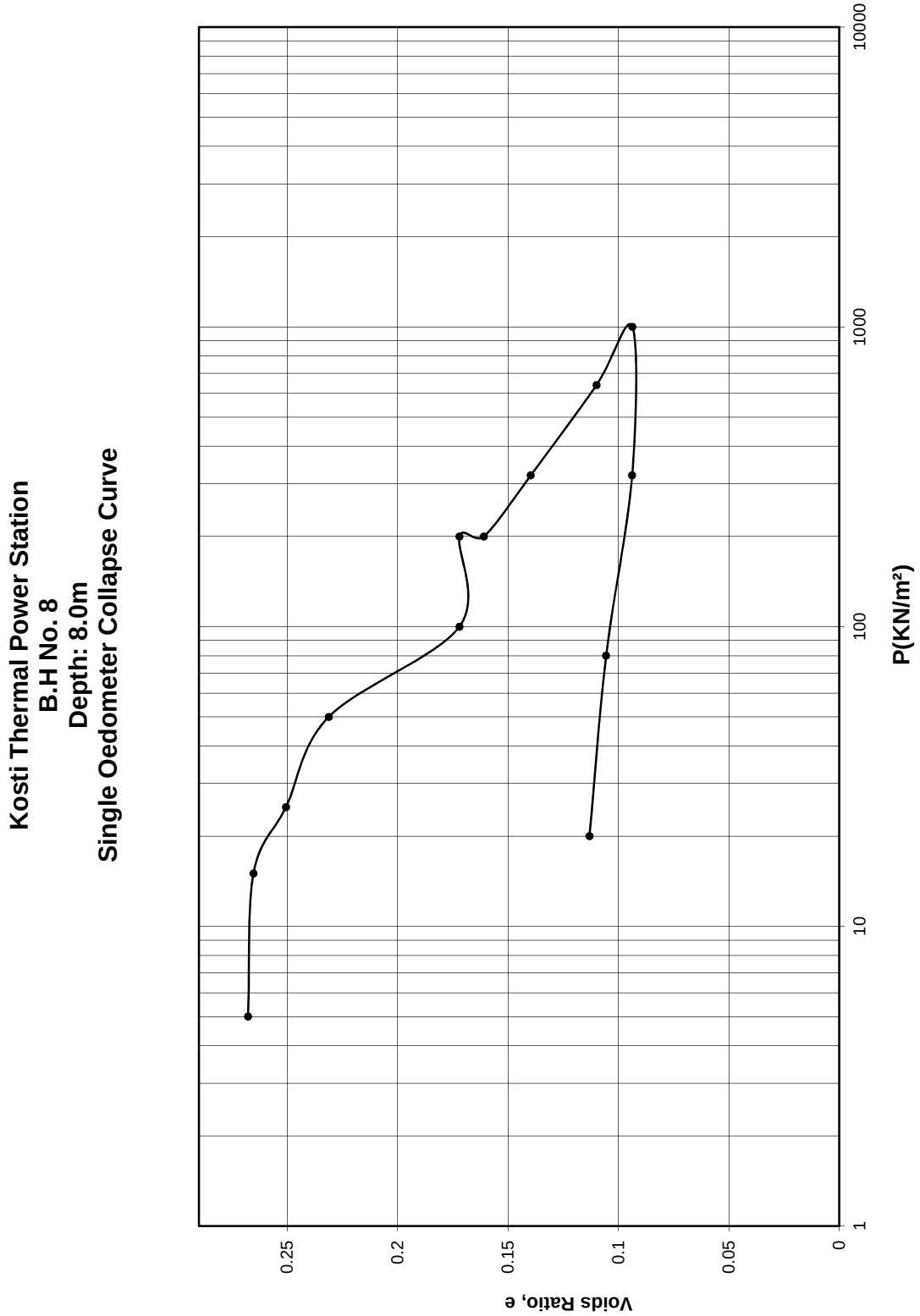

Kosti Thermal Power Station
B.H NO. 1
Depth: 3.0m
Single Oedometer Collapse Curve
Voids Ratio, e
0.7
0.65
0.6
0.55
0.5
0.45
P(KN/m²)
1
10
100
1000
10000

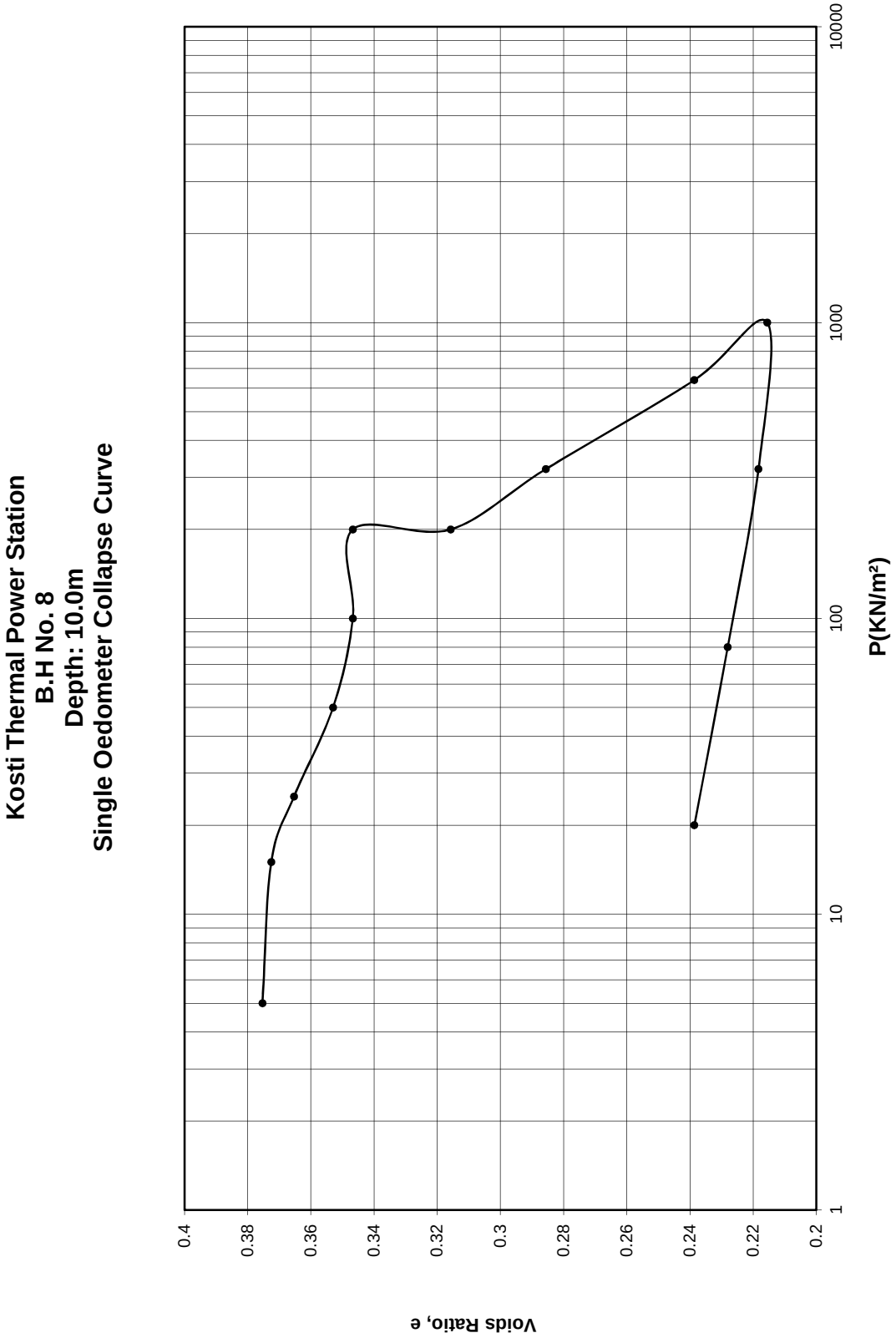

Kosti Thermal Power Station
B.H No. 2
Depth: 4.0m
Single Oedometer Collapse Curve
Voids Ratio, e
0.5
0.45
0.4
0.35
0.3
0.25
0.2
p (kn/m2)
1
10
100
1000
10000

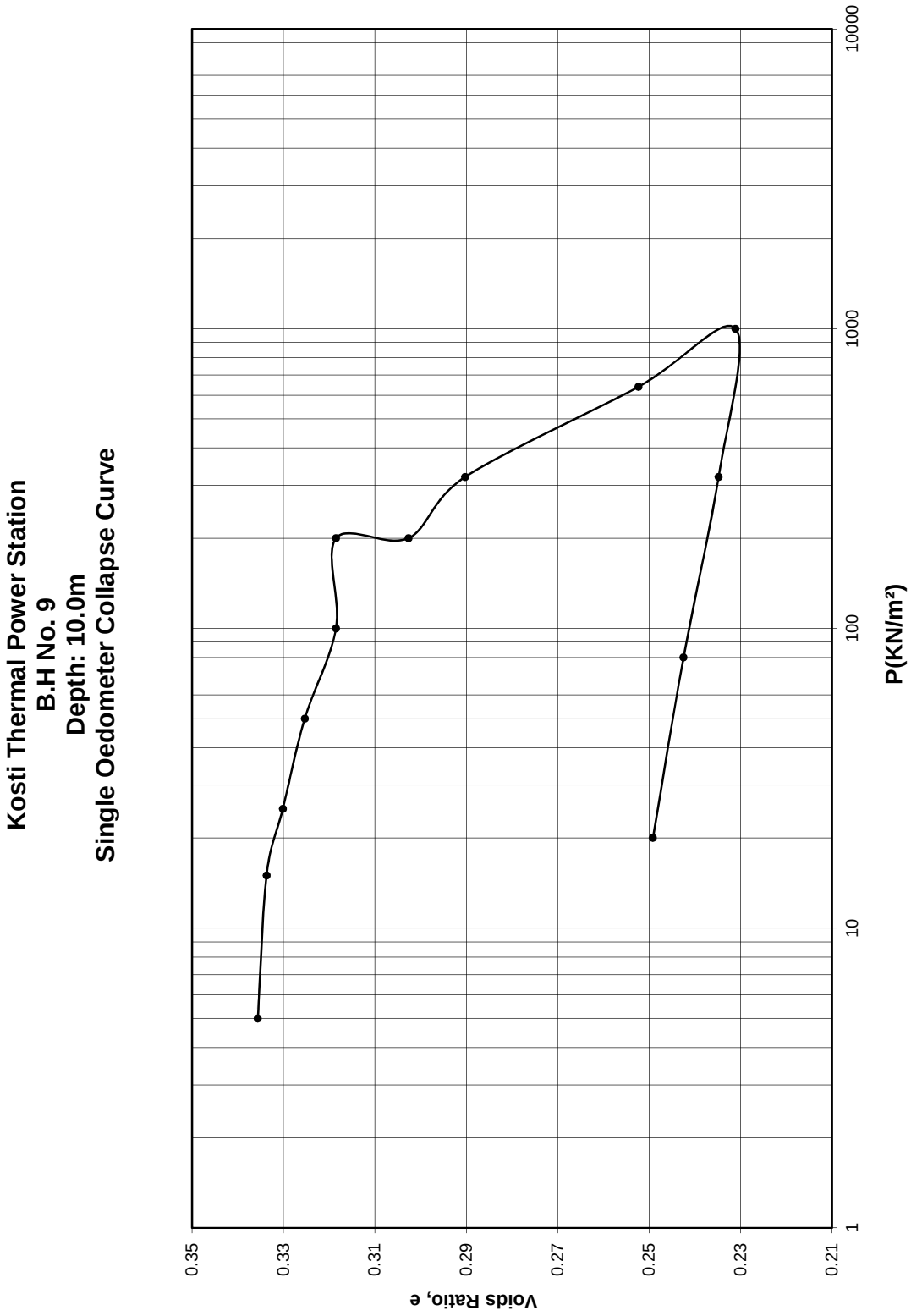

Kosti Thermal Power Station
B.H NO. 4
Depth: 2.0m
Single Oedometer Collapse Curve
P(KN/m²)
10000
1000
100
10
1
Voids Ratio, e
0.49
0.47
0.45
0.43
0.41
0.39
0.37
0.35

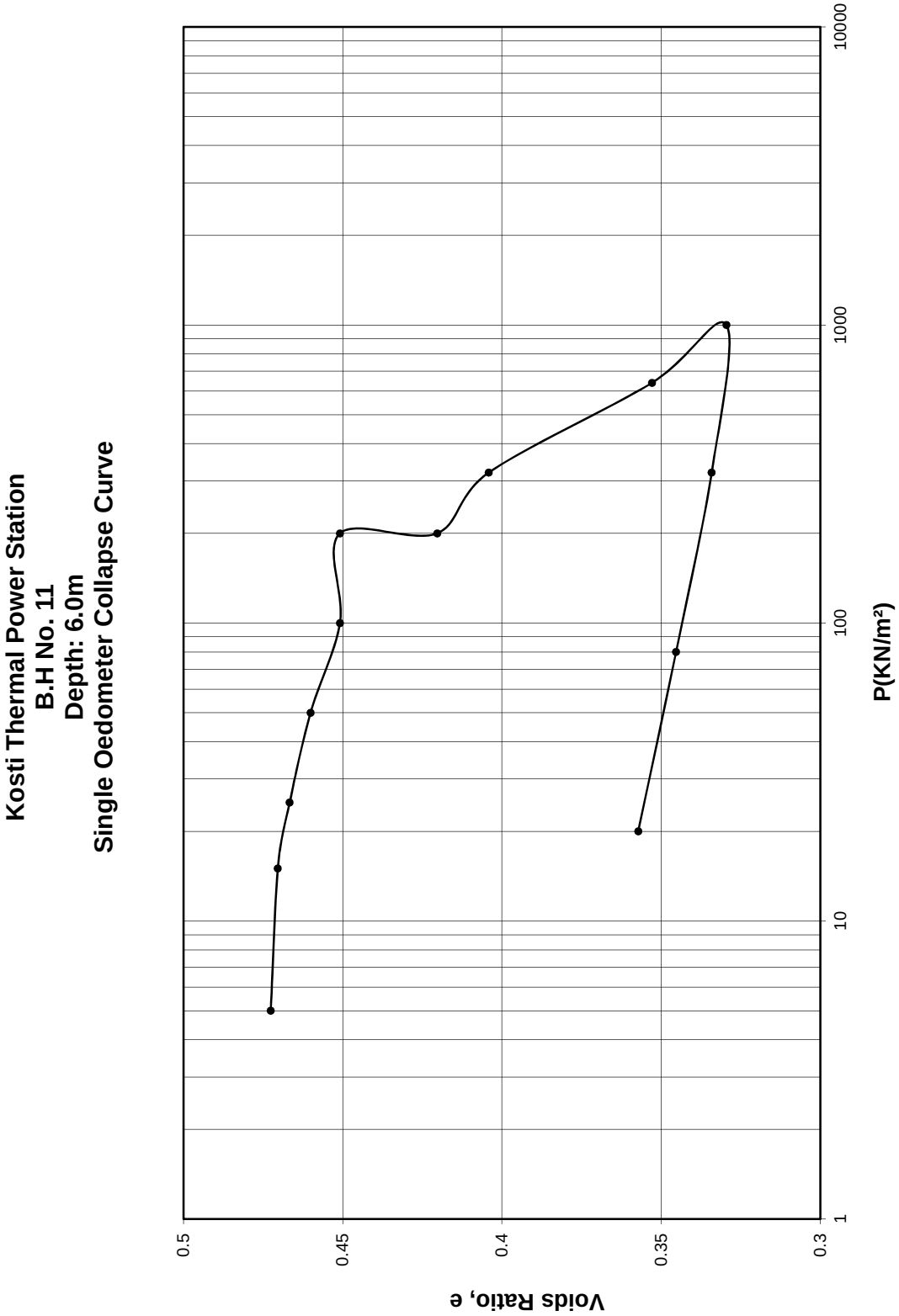

Kosti Thermal Power Station
B.H No. 7
Depth: 6.0m
Single Oedometer Collapse Curve
P(KN/m²)
10000
1000
100
10
1
0.55
0.5
0.45
0.4
0.35
0.3
Voids Ratio, e


Kosti Thermal Power Station
B.H No. 7
Depth: 8.0m
Single Oedometer Collapse Curve
Voids Ratio, e
0.65
0.6
0.55
0.5
0.45
0.4
P(KN/m²)
1
10
100
1000
10000


Kosti Thermal Power Station
B.H No. 8
Depth: 8.0m
Single Oedometer Collapse Curve
Voids Ratio, e
0.25
0.2
0.15
0.1
0.05
0
P(KN/m²)
1
10
100
1000
10000

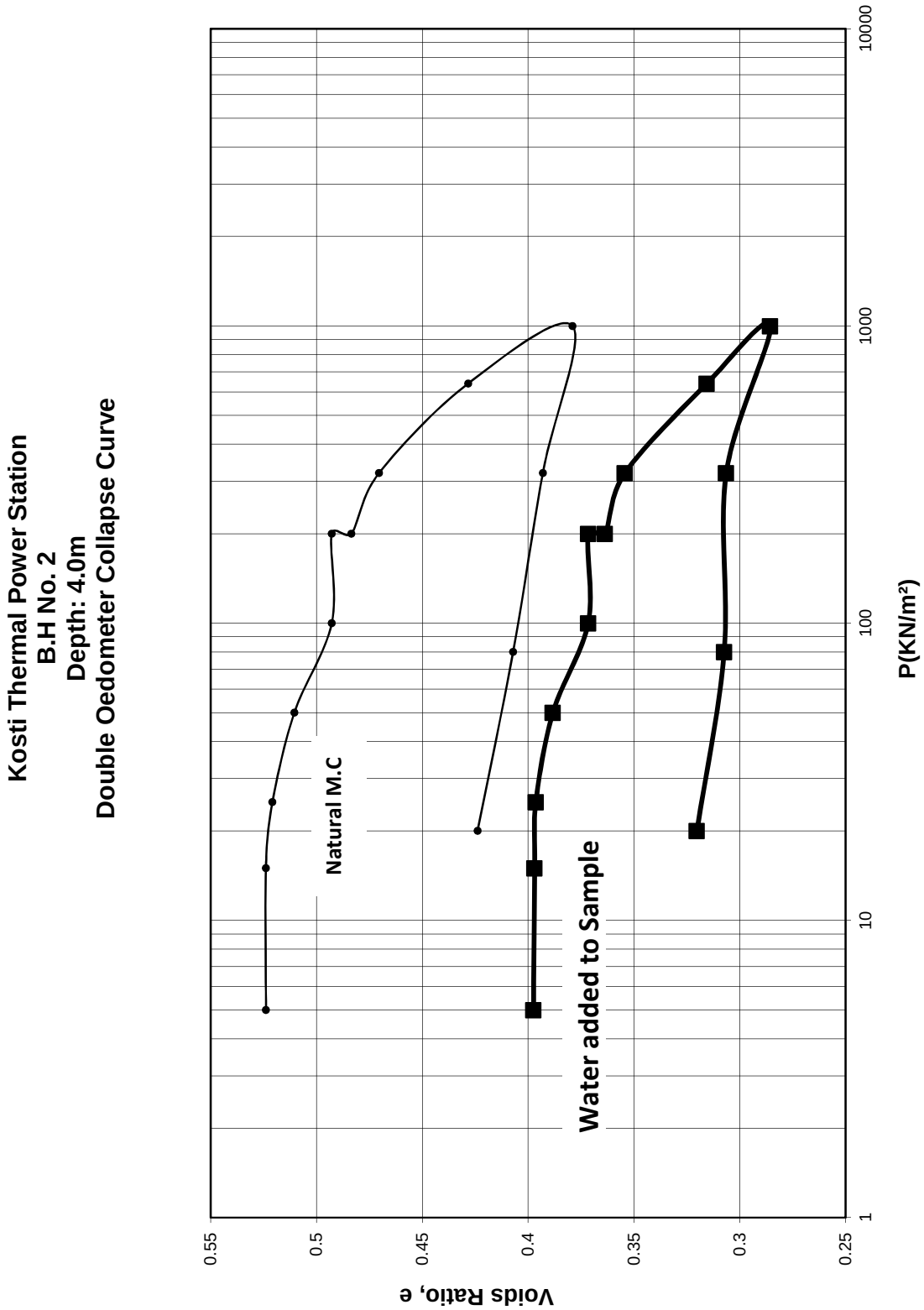

Kosti Thermal Power Station
B.H No. 8
Depth: 10.0m
Single Oedometer Collapse Curve
P(KN/m²)
10000
1000
100
10
1
0.4
0.38
0.36
0.34
0.32
0.3
0.28
0.26
0.24
0.22
0.2
Voids Ratio, e

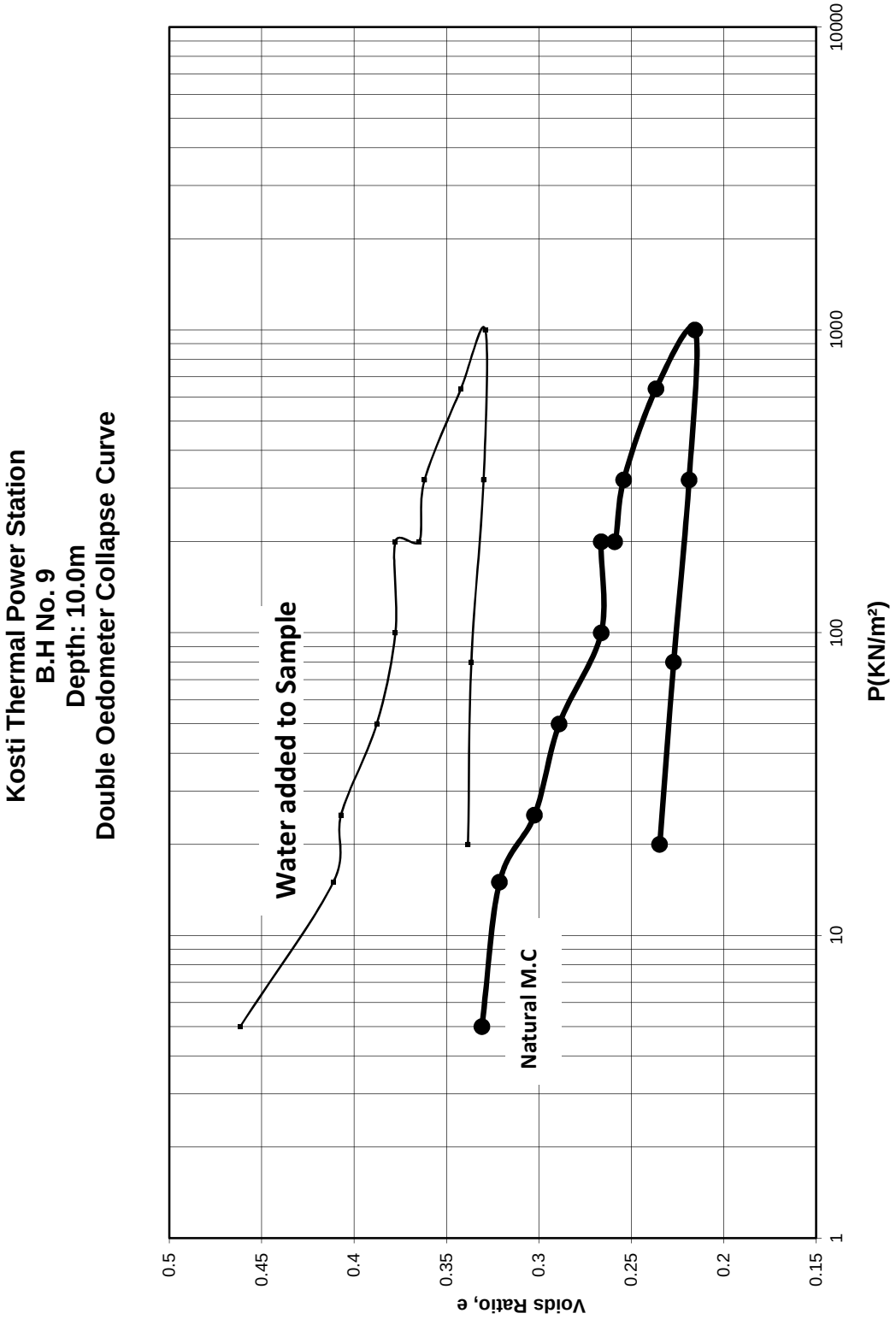

Kosti Thermal Power Station
B.H No. 9
Depth: 10.0m
Single Oedometer Collapse Curve
Voids Ratio, e
0.35
0.33
0.31
0.29
0.27
0.25
0.23
0.21
P(KN/m²)
1
10
100
1000
10000

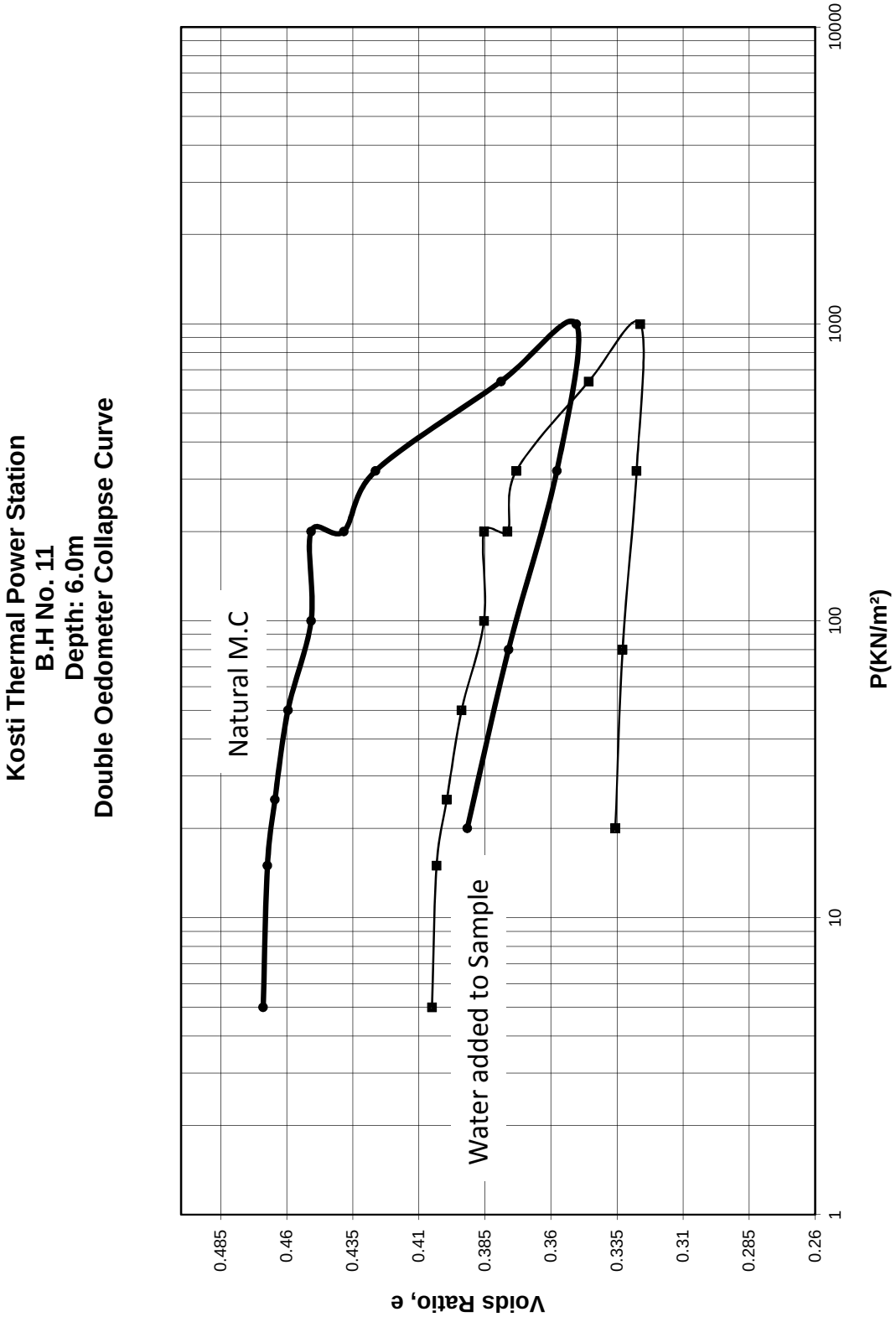

Kosti Thermal Power Station
B.H No. 11
Depth: 6.0m
Single Oedometer Collapse Curve
Voids Ratio, e
0.5
0.45
0.4
0.35
0.3
P(KN/m²)
1
10
100
1000
10000

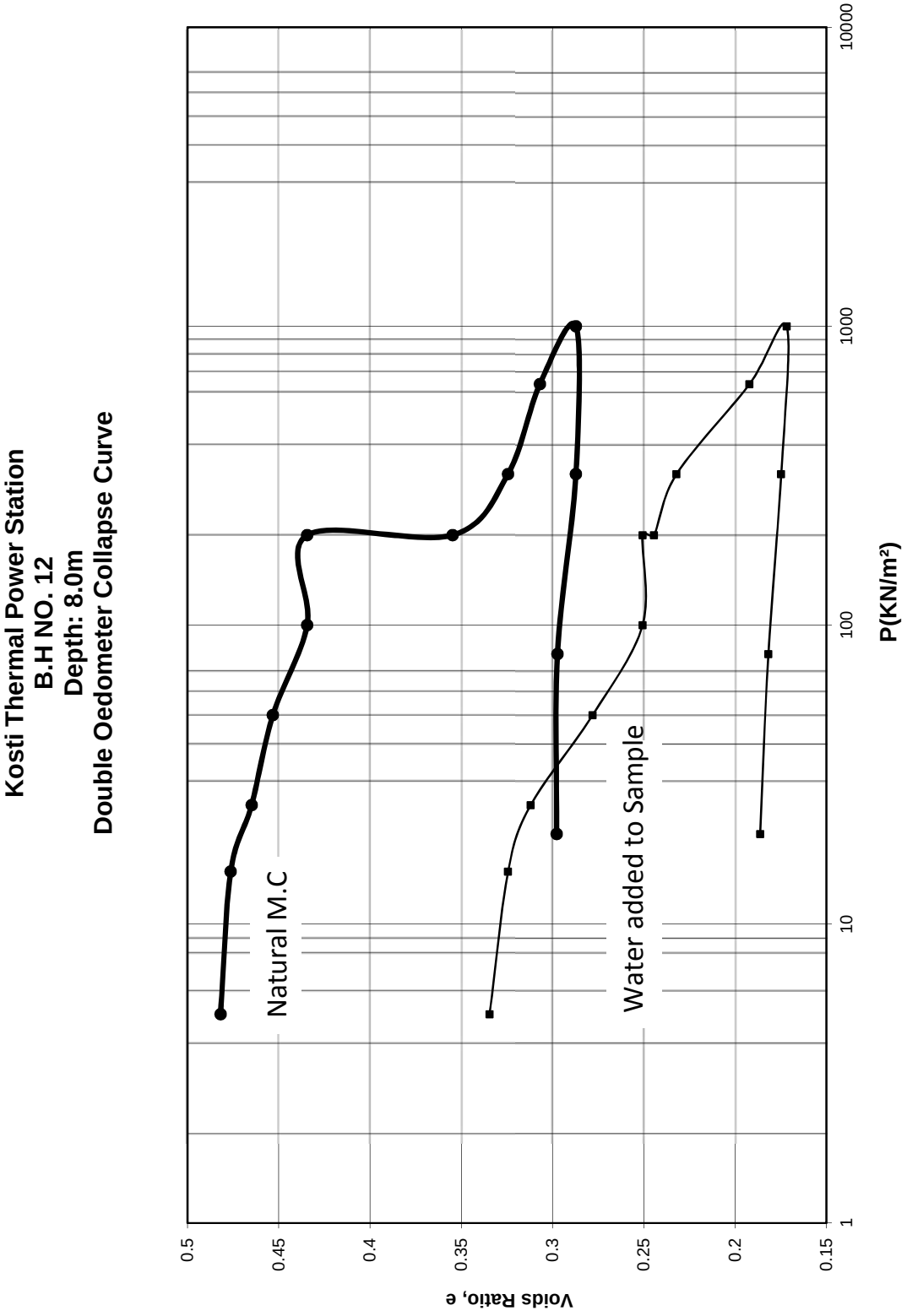
APPENDIX (C-2)

DOUBLE OEDOMETER TEST RESULTS


Kosti Thermal Power Station
B.H No. 2
Depth: 4.0m
Double Oedometer Collapse Curve
Natural M.C
Water added to Sample
Voids Ratio, e
0.55
0.5
0.45
0.4
0.35
0.3
0.25
P(KN/m²)
1
10
100
1000
10000


Kosti Thermal Power Station
B.H No. 9
Depth: 10.0m
Double Oedometer Collapse Curve
Water added to Sample
Natural M.C
Voids Ratio, e
P(KN/m²)
0.5
0.45
0.4
0.35
0.3
0.25
0.2
0.15
1
10
100
1000
10000


Kosti Thermal Power Station
B.H No. 11
Depth: 6.0m
Double Oedometer Collapse Curve
Natural M.C
Water added to Sample
Voids Ratio, e
0.485
0.46
0.435
0.41
0.385
0.36
0.335
0.31
0.285
0.26
P(KN/m²)
1
10
100
1000
10000


Kosti Thermal Power Station
B.H NO. 12
Depth: 8.0m
Double Oedometer Collapse Curve
Natural M.C
Water added to Sample
Voids Ratio, e
0.5
0.45
0.4
0.35
0.3
0.25
0.2
0.15
P(KN/m²)
1
10
100
1000
10000

APPENDIX (D)

CHEMICAL ANALYSIS TEST RESULTS

Chemical Test Report **KostiThermal Power Station**

Chemical and Physical Analysis

Methods of Tests: BS 1377 - Part 3 -1990

B.H. No.	Depth	T.Hardness	Calcium	Magnesium	Sodium	Unit
1	3.0	680	204	40.8	28.13	Mg/l
1	4.0	650	260	NIL	24.65	Mg/l
2	2.0	110	NIL	26.4	14.43	Mg/l
3	2.0	80	NIL	19.2	14.99	Mg/l
3	9.0	80	NIL	19.8	14.03	Mg/l
4	2.0	150	12	28.8	21.76	Mg/l
4	4.0	190	16	36	13.7	Mg/l
5	6.0	60	NIL	14.4	13.07	Mg/l
6	1.0	280	100	7.2	22	Mg/l
6	4.0	110	24	12	20.8	Mg/l
7	6.0	100	NIL	24	15.71	Mg/l
7	8.0	100	NIL	24	14.75	Mg/l
7	10.0	90	NIL	21.6	14.67	Mg/l
8	6.0	140	NIL	30.6	17.15	Mg/l
8	8.0	80	NIL	19.2	15.79	Mg/l
8	10.0	90	NIL	21.6	15.07	Mg/l
9	10.0	100	NIL	24	15.39	Mg/l
10	6.0	70	NIL	16.8	16.83	Mg/l
10	10.0	240	12	50.4	16.91	Mg/l
11	10.0	170	NIL	40.8	14.11	Mg/l
11	6.0	100	NIL	24	14.92	Mg/l
12	6.0	90	NIL	21.6	14.43	Mg/l
12	8.0	100	12	16.8	14.91	Mg/l
12	10.0	90	NIL	21.6	16.27	Mg/l
13	2.0	100	NIL	24	14.92	Mg/l

Table (D - 1) Chemical Tests Results

Chemical Test Report **KostiThermal Power Station**

Chemical and Physical Analysis

Methods of Tests: BS 1377 - Part 3 -1990

B.H. No.	Depth	PH	PH 1:2.5 soil/Water	Sulphate	Chloride	Organic Matter
1	3.0	8.18	8.54	0.0856	0.0142	2.7894
1	4.0	8.29	8.56	0.0687	0.0689	2.9068
2	2.0	7.9	8.3	0.0514	0.0142	1.3284
3	2.0	7.92	7.15	0.0343	0.0142	1.3178
3	9.0	8.22	7.17	0.0341	0.0352	1.2164
4	2.0	8.63	7.25	0.0343	0.0312	2.6174
4	4.0	8.4	8.15	0.0685	0.0284	2.0146
5	6.0	7.98	6.55	0.0685	0.0173	3.835
6	1.0	7.25	6.88	0.1714	0.0312	4.8281
6	4.0	8.2	9.25	0.0513	0.0355	4.6853
7	6.0	7.68	8.69	0.0339	0.0173	1.1982
7	8.0	7.85	8.05	0.0342	0.0242	1.145
7	10.0	7.86	8.2	0.0857	0.0173	0.8446
8	6.0	7.68	7.76	0.0343	0.0379	2.13
8	8.0	7.6	7.7	0.0684	0.0312	2.3886
8	10.0	7.7	7.92	0.0685	0.0379	2.01
9	10.0	8.79	8.86	0.0343	0.0213	2.5838
10	6.0	8.7	8.69	0.0513	0.0379	4.7553
10	10.0	9.3	9.04	0.0685	0.0448	1.9028
11	10.0	8.82	7.65	0.0343	0.0379	3.2761
11	6.0	8.95	9.26	0.0342	0.0158	1.986
12	6.0	8.07	7.76	0.0514	0.0379	2.00887
12	8.0	7.9	7.75	0.0514	0.0448	3.8077
12	10.0	7.9	7.86	0.0857	0.0312	2.0296
13	2.0	9.14	8.8	0.0342	0.0071	0.5596

Table (D - 1) Chemical Tests Results

APPENDIX (E)

TABLES AND TESTS RESULTS

- **Specific Gravity**

BH. No.	Depth (m)	Specific Gravity
1	3.0	2.78
2	2.0	2.82
4	2.0	2.74
7	8.0	2.72
7	6.0	2.69
8	8.0	2.86
9	10.0	2.85
12	8.0	2.78

Table No.(4.1) Specific Gravity Test Results

- **Bulk Density Test**

BH. No.	Depth (m)	Bulk Density (g/cm^3)
1	4.0	1.8187
2	2.0	2.1626
6	2.0	1.8468
6	4.0	2.0104
8	6.0	2.1349
12	8.0	1.8950

Table No.(4.2) Bulk Density Test Results

- **Permeability Test**

BH.No.	Depth	Cofficient of Permeability (K) (cm/s)
1	3.0	0.02282
4	2.0	0.02322
7	6.0	0.022699
8	8.0	0.02426
9	10.0	0.02378
12	8.0	0.022794

Table (4.3) Results of permeability test

- **Free Swelling**

BH.No.	*Depth (m)*	*Initial Volume of Specimen (I)*	*Final Volume of Specimen (F)*	*Free Swell (F.S %)*
1	3.0	156.3	250	60
4	2.0	120.4	170	41.17
6	1.0	149.3	235	57.45
7	6.0	104.2	125	20.0
7	8.0	58.6	81	38.27
8	8.0	124.6	180	44.45
10	10.0	126.8	185	45.94
12	8.0	114.4	155	35.48
13	2.0	58.2	80	37.50

Table (4.4) Free Swelling Test Results

- **Swelling Pressure Test**

Borehole No.	**Depth (m)**	**Initial moisture content (%)**	**Final moisture content (%)**	**Swelling Pressure Kpa**	**Plasticity Index (%)**	**Classification of the Samples**
1	4.0m	25.94	28.40	20	41	CH
2	2.0m	14.50	15.54	0	17	SC
8	6.0m	9.21	14.14	10	20	SC
8	10.0m	10.23	15.12	0	16	SC
12	10.0m	10.42	15.97	10	18	SC

Table (4.5): Swelling Pressure Test Results

- **Pin hole Test**

Depth (m)	B.H NO.	Max Hydraulic Head Applied (mm)	Average of Last Head Rate of flow (ml/sec)	Classification
1	3	1020	3.13	ND2
2	4	1020	1.25	ND2
4	2	1020	2.56	ND1
6	1	1020	1.98	ND1
7	6	50	0.9	D2
8	8	50	0.9	ND4
9	10	50	0.8	ND4
11	6	50	0.8	ND4

Table (4.8) Pin hole Test Results

- **Sensitivity Tests**

BH. No.	Depth (m)	(q_u) unconfined compressive strength (undisturbed) (kpa)	(q_u) unconfined compressive strength (remolded) (kpa)	Sensitivity (S_t)	Description
1	3.0	4048.42	2146.58	1.886	Slightly sensitive
2	4.0	5305.22	2439.74	2.175	Medium sensitivity
7	6.0	2415.77	679.51	3.555	Medium sensitivity
8	8.0	20406.69	825.12	24.732	Medium quick
9	10.0	6784.28	1027.41	6.603	Very sensitive
12	8.0	344.43	586.44	0.587	Slightly sensitive

Table (4.9) Sensitivity Test Results

- **Summary of Identification Methods for Collapse Soil**

No.	Investigator , year	Criteria
1	Abelev,1948	$\delta_s=(\Delta e/1+e_L)$ Collapse is probable when: $\delta_s > 2\%$
2	Denisov, 1951	$K=e_L/e_o$ If k = 0.5-0.75 ; highly Collapsible If k = 1.0 ; non Collapsible loam If k = 1.5-2.0 ; non Collapsible soil
3	Priklonski, 1952	$K_D=(N.M.C-P.L)/PI$ If $k_D < 0$; highly Collapsible soil If $k_D > 0.5$; non Collapsible loam If $k_D > 1.0$; Swelling soil
4	Clevenger, 1958	$\gamma_{dry} < 12.6$ kn/m^3; Significant Settlement $\gamma_{dry} < 14.1$ kn/m^3; transitional Settlement
5	Gibbs and Bara, 1962	Collapse is probable when $\gamma_{dry} < 162.3/(1+0.026*L.L)$ Ib/ft^3 *or when:* $e_o > 2.6*L.L/100$
6	Soviet Building Code,1962	Collapse is probable when :is S > 60% *and* $(e_o-e_L)/(1+e_o) > -0.10$
7	Feda 1964 , 1966	$K_L=(N.M.C/S)-(PL/PI)$ If $K_L > 0.85$; Collapseible Soil
8	Handy, 1973	Clay Content <16% ; high probability for collapse 24%> Clay Content > 16% ; probably collapsible 32%> Clay Content >25% ; probability of collapse of less than 50% Clay Content > 32%; non collapsible
9	Zur and wiseman 1973	$\gamma_{dry} / \gamma_{dry\ L.L} < 1.1$; Soil prone to collapse $\gamma_{dry} / \gamma_{dry\ L.L} < 1.3$; Soil prone to swell

Table (5.1) Summary of Identification methods for collapse soil

APPENDIX (F)

SAMPLES CLASSIFICATION ON BORROW AREA SOIL SAMPLES GIVEN BY BHEL MARKED SPILE AND PCL

Introduction:

The client has selected two samples from borrow areas, PCL and SPILE. Tests are carried out on these two samples for Atterberg limit, Sieve analysis, Hydrometer, Specific Gravity, Compaction Test, Single and Double Oedometer Test.

Classification Results for these samples are shown in table (1) below.

Sample No.	Description	LL%	PL%	PI%	%Pass Sieve #200	Classification of sample	MDD g/cm³	OMC %
SPILE	Dark brown clayey gravel	40	23	17	24.04	GC	2.05	10.4
PCL	Dark brown to light clayey sand	38	22	16	40.50	SC	1.97	11.4

Table (1) Soil Samples Classificaion

The classificatoion results are shown in table (1) illustrated, soil is dark brown clayey gravel (GC) for SPILE sample and dark to light brown clayey sand (SC) for PCL sample. Optimum moisture content is 10.4% for SPILE sample and 11.4% for PCL sample in compaction test results which are shown in Appendix A. Also, maximum dry density equal 2.05g/cm^3 and 1.97g/cm^3 for SPILE sample and PCL sample respectively.

At SPILE sample, the results gave liquid limit value around 40% and plastic index is 17%. At PCL, results gave liquid limit value is 38% and plastic index around 16%, these results of Atterberge limits indicate possibility of occurence medium potential for swelling.

Grain size distribution are the percentage of the various size of soil grains percent in a given dry soil sample is carried out by mechanical sieve analysis for coarse grain and whereas fine-grained soils are analysed by the hydrometer method. Graphs are shown in Appendix G**.**

Specific gravity results determined in Table (2) for the soil samples by using a pycnometer.

Samples No. (m)	Specific Gravity
SPILE	2.74
PCL	2.74

Table No.(2) Specific Gravity Test Results

Single Oedometer Collapse Test carried out for samples in four stages with different moisture content. **First**, by using 8% moisture content which is less than the optimum moisture content, and loaded in the conventional oedometer to a stress level 200kpa and then inundation by distilled water is applied to induce collapse. Two rings for test are taken, one at a Top of the mould other in the Bottom for samples SPILE and PCL separately. (disturbed sample compacted with 8% moisture content at the mould in three layers, then two consolidation rings pushed entire the samples, one at top side and other in bottom side)**.**

Second by using 13% of moisture content which is more than the optimum moisture content for two rings at top and bottom. Graphs and results are shown in appendix G.

The sample results which used 8% moisture content shows that, the difference between void ratio from saturation values Δe_c is high compared to that of moisture content 13%.

Table (3) shows the results of single oedometer test and results of collapse potential.

Sample	Case	e_o	e_1	e_2	C_P
SPILE	8% moisture content **(TOP)**	0.36817	0.33279	0.25166	5.90%
SPILE	8% moisture content **(BOTTOM)**	0.37301	0.27274	0.23016	3.12%
SPILE	13% moisture content **(TOP)**	0.30847	0.27689	0.27596	0.071%
SPILE	13% moisture content **(BOTTOM)**	0.25847	0.23317	0.23228	0.071%
PCL	8% moisture content **(TOP)**	0.62009	0.49638	0.43158	4.0%
PCL	8% moisture content **(BOTTOM)**	0.54476	0.50044	0.39621	6.74%
PCL	13% moisture content **(TOP)**	0.34157	0.30146	0.29861	0.212%
PCL	13% moisture content **(BOTTOM)**	0.31702	0.27339	0.27060	0.212%

Table(3) Single oedometer and Collapse potential Results

Double Oedometer Collapse Test is carried out by two identical samples are placed in oedometers; one tested at in-situ natural moisture content, and the other is fully saturated before the test begins, and then subjected to identical loading. These were taken for samples SPILE and PCL,

Two, stress versus strain curves are generated. The difference between the compression curves is the amount of deformation that would occur at any stress level at which the soil get saturated. Results for double oedometer collapse test are shown in Appendix G indicated low void ratio at the difference between natural moistue and added water to sample in collapse soil for samples SPILE and PCL. Also, at same initial void ratio of natural moisture content and water added curves at appendix G and Tables (4-1) and (4-2), the collapse potential C_p indicated medium to high collapse.

P KN/m^2	e_1	e_2	e_o	**C_P(%)**
80	0.421	0.459	0.501	2.532
160	0.392	0.438	0.501	3.051
320	0.361	0.420	0.501	3.924
640	0.318	0.392	0.501	4.930

Table (4-1) Double collapse Results of C_P for PCL sample

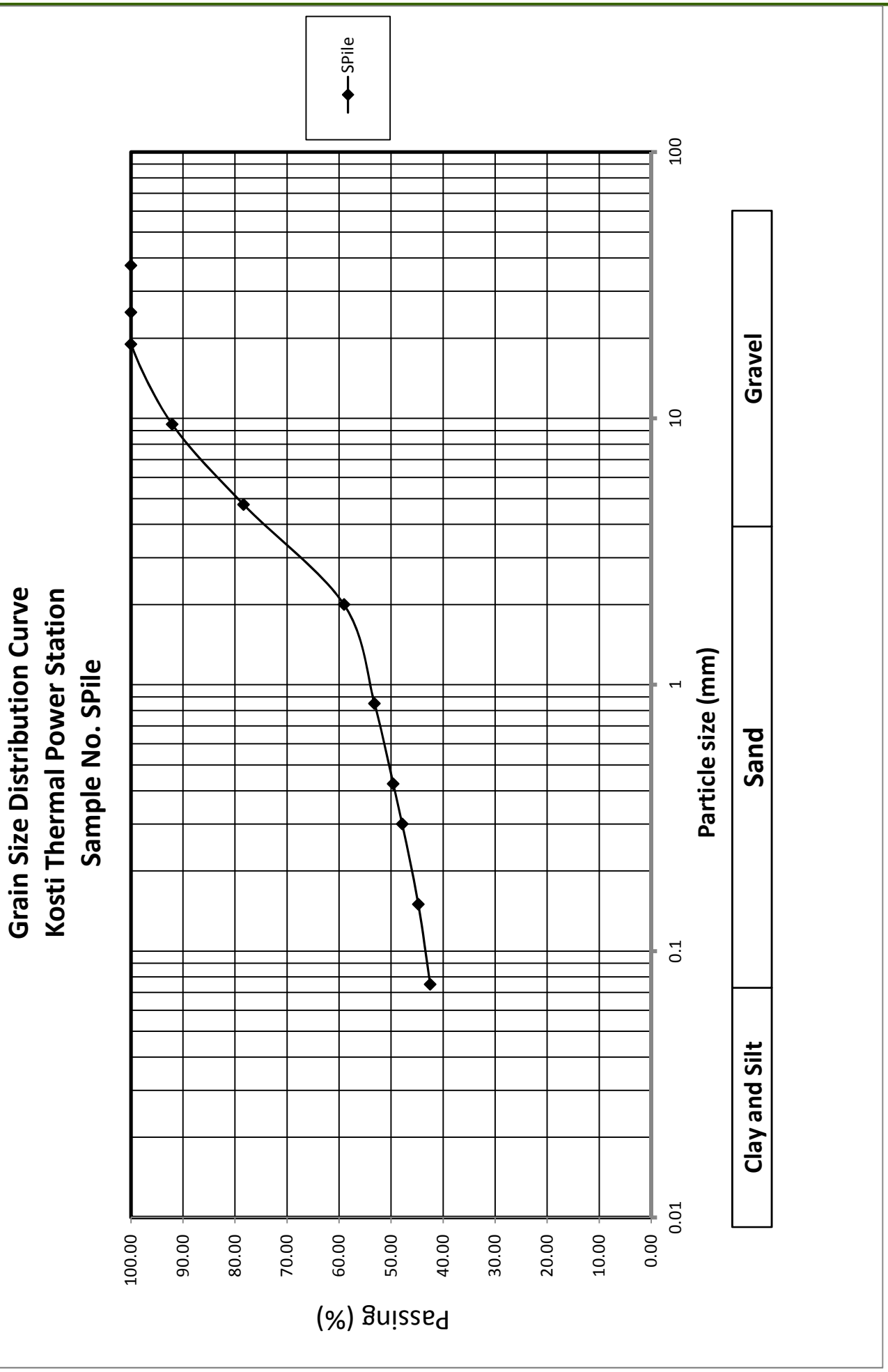
P KN/m^2	e_1	e_2	e_o	C_P(%)
160	0.3460	0.3530	0.3658	0.5125
320	0.3200	0.3390	0.3658	1.3911
640	0.2830	0.3200	0.3658	2.7090

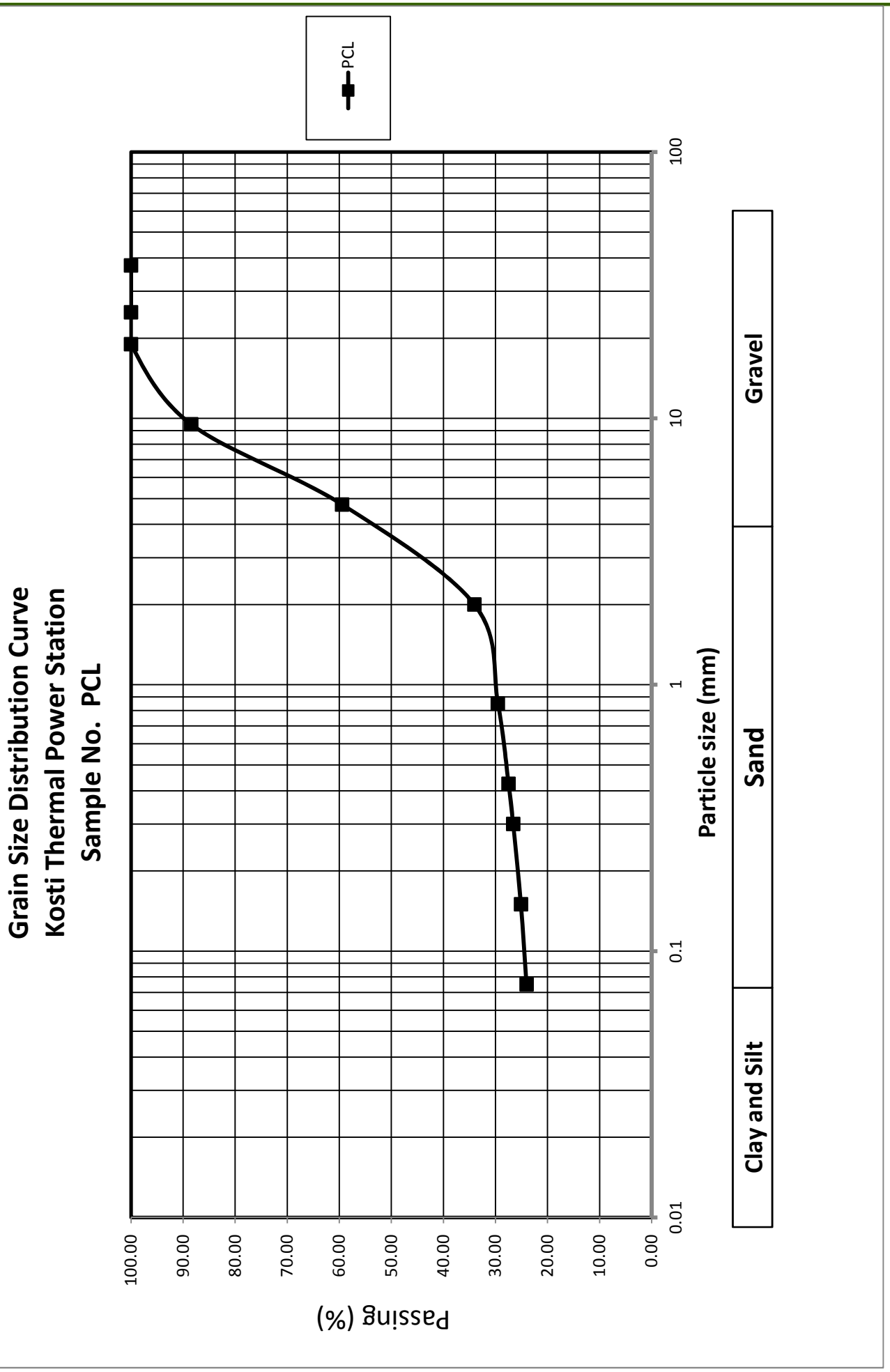
Table (4-2) Double collapse Results of C_p for SPILE sample

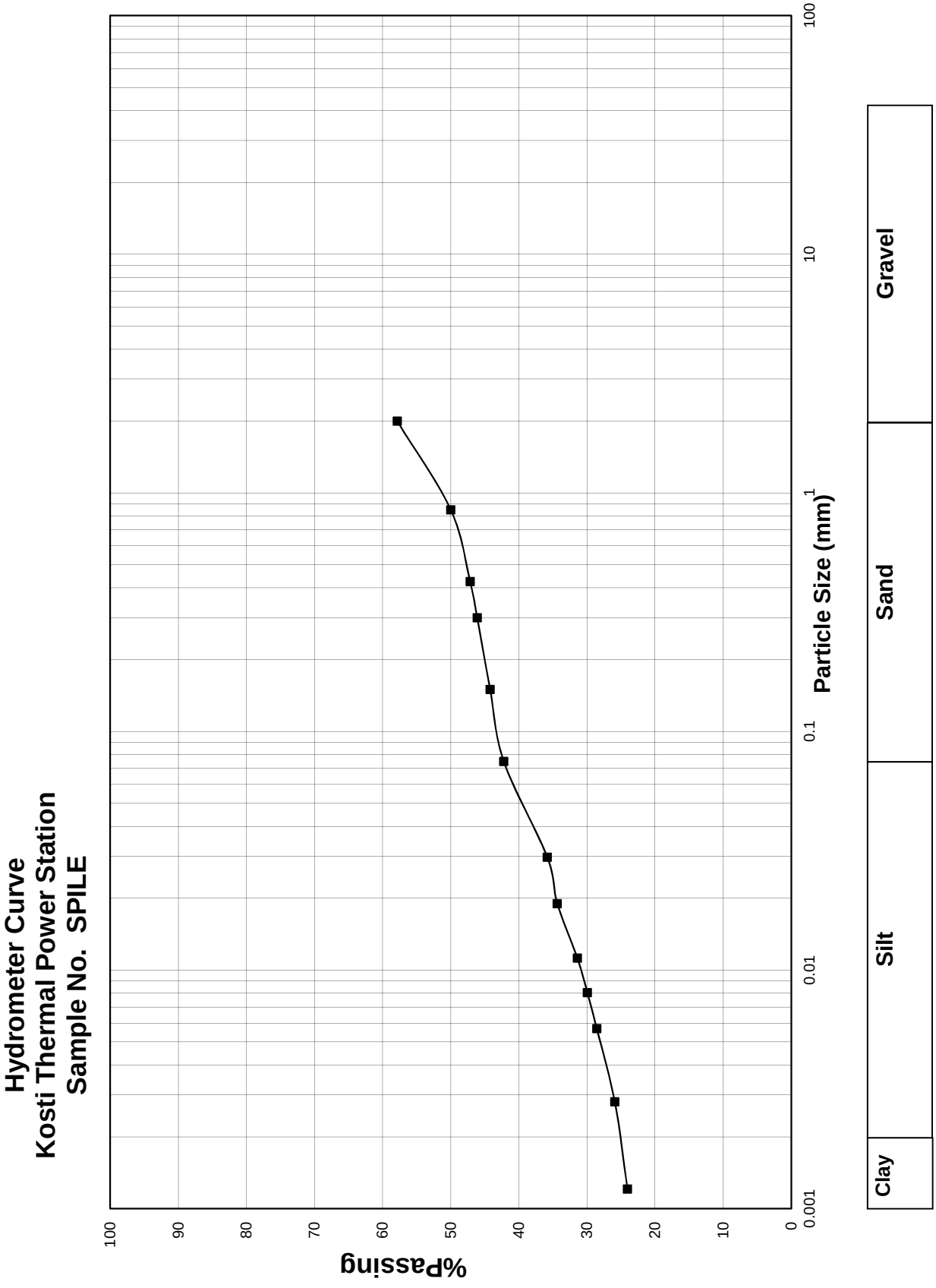
APPENDIX (G)

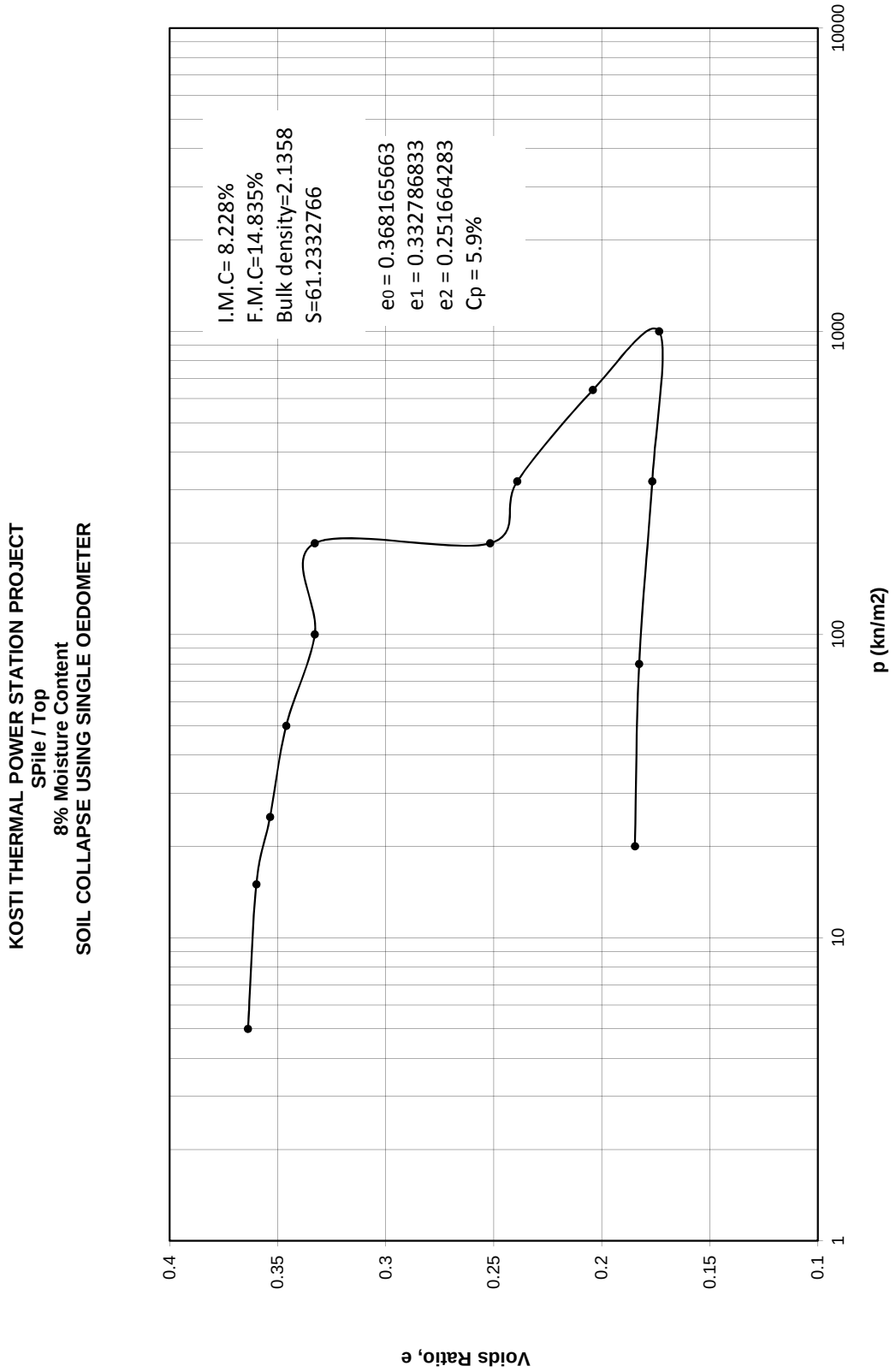
RESULTS FOR TESTS OF SAMPLES

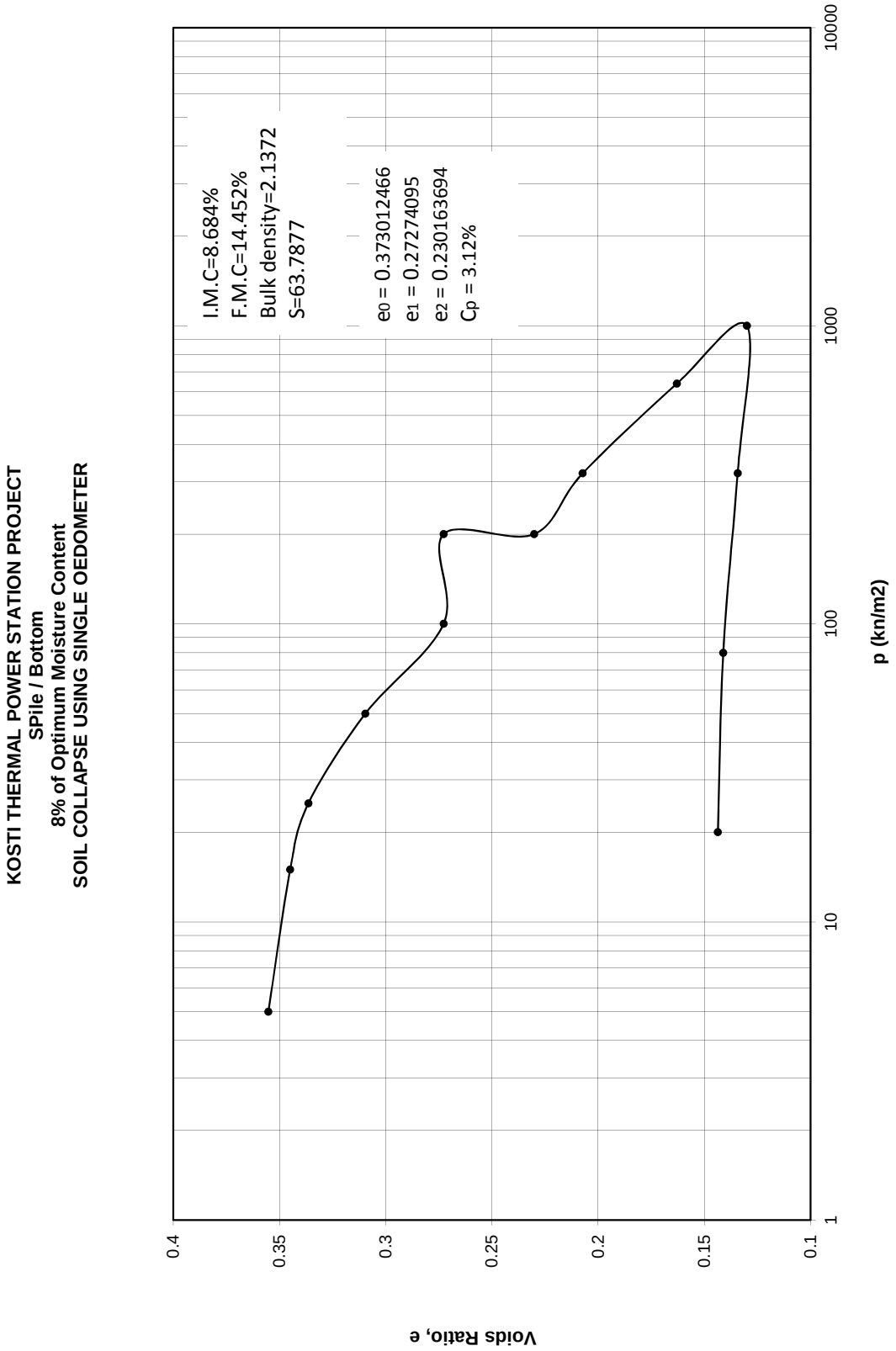
SPILE AND PCL

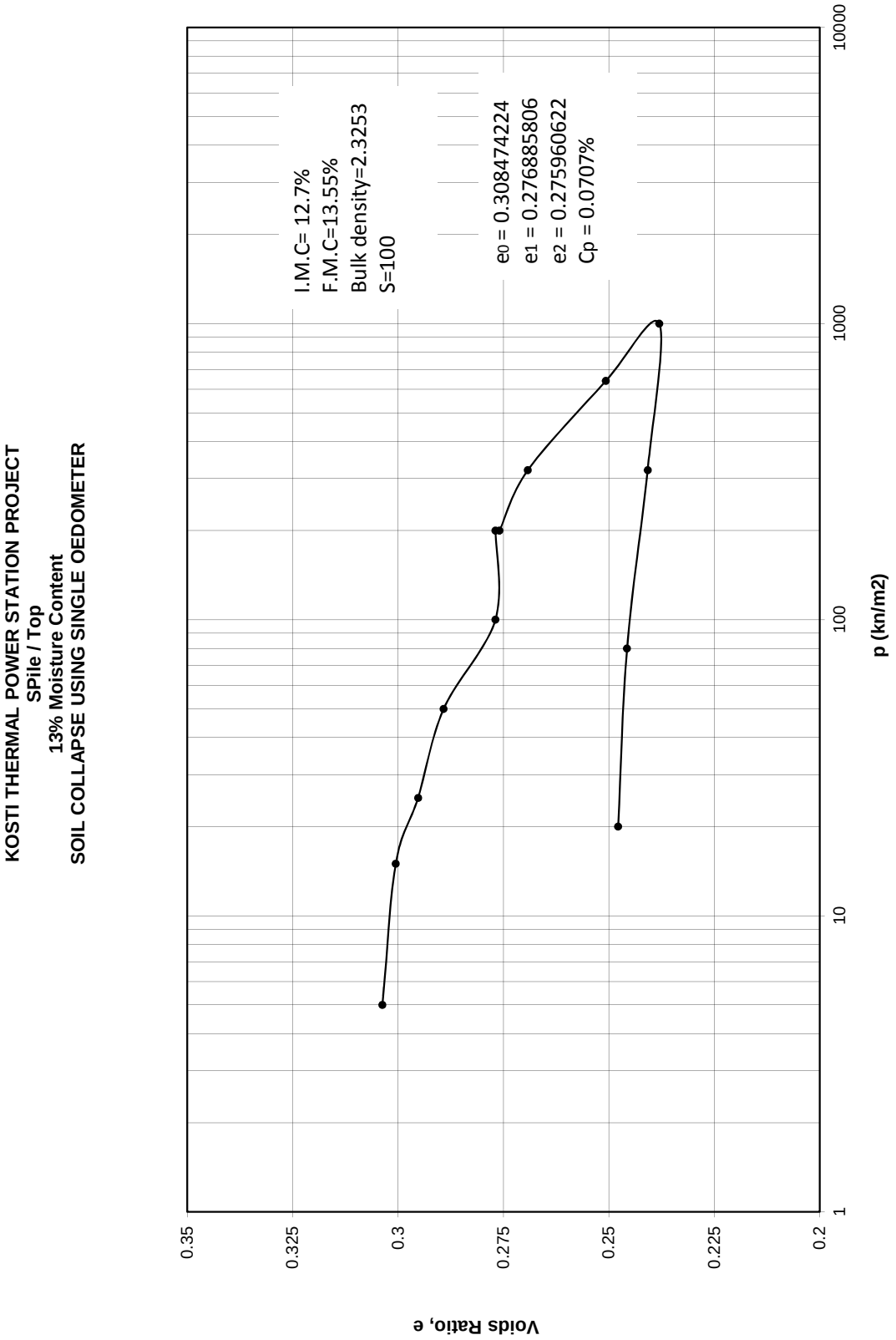

Grain Size Distribution Curve
Kosti Thermal Power Station
Sample No. SPile
SPile
Passing (%)
100.00
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
Particle size (mm)
100
10
1
0.1
0.01
Gravel
Sand
Clay and Silt

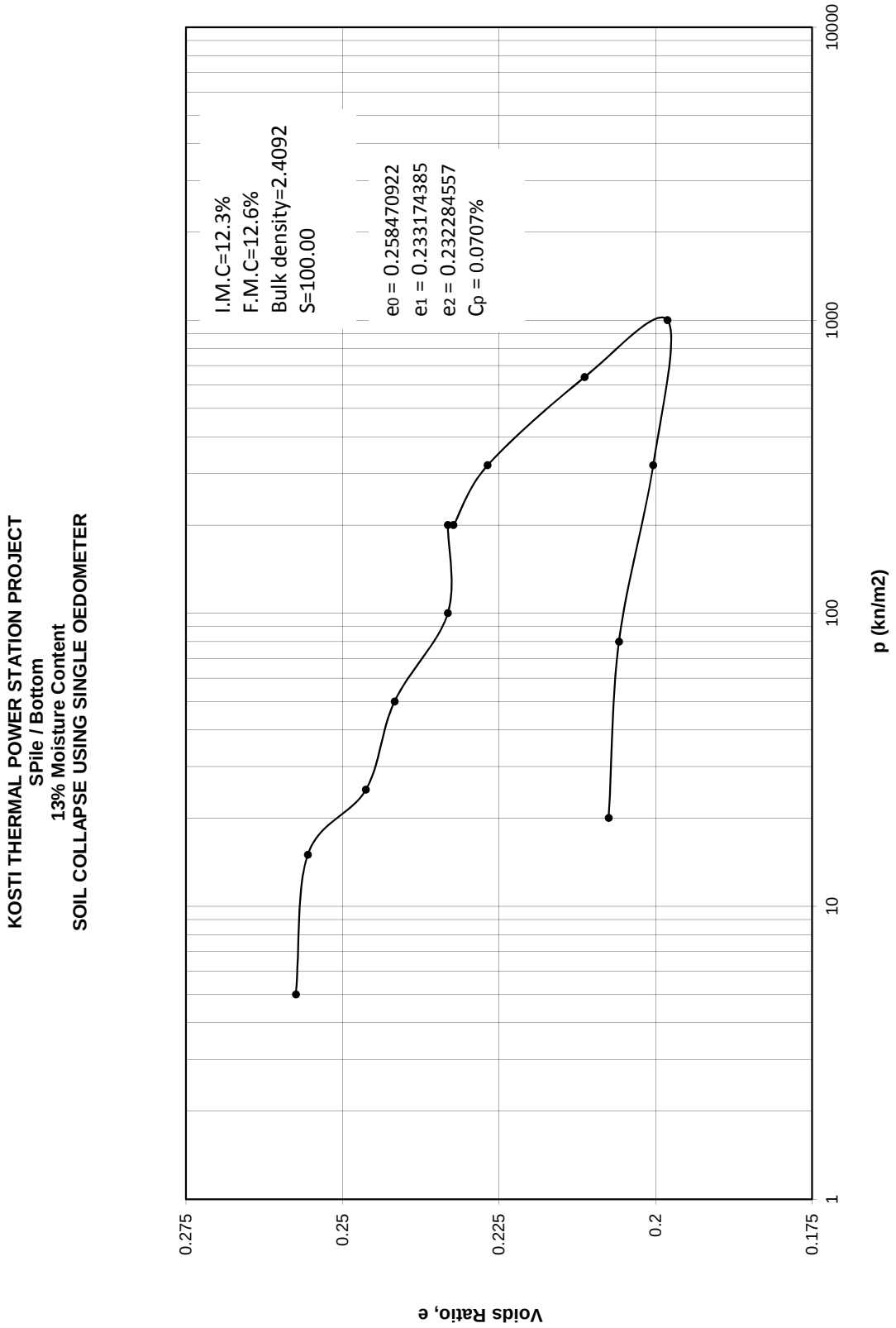

Grain Size Distribution Curve
Kosti Thermal Power Station
Sample No. PCL
PCL
Passing (%)
100.00
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
Particle size (mm)
100
10
1
0.1
0.01
Gravel
Sand
Clay and Silt

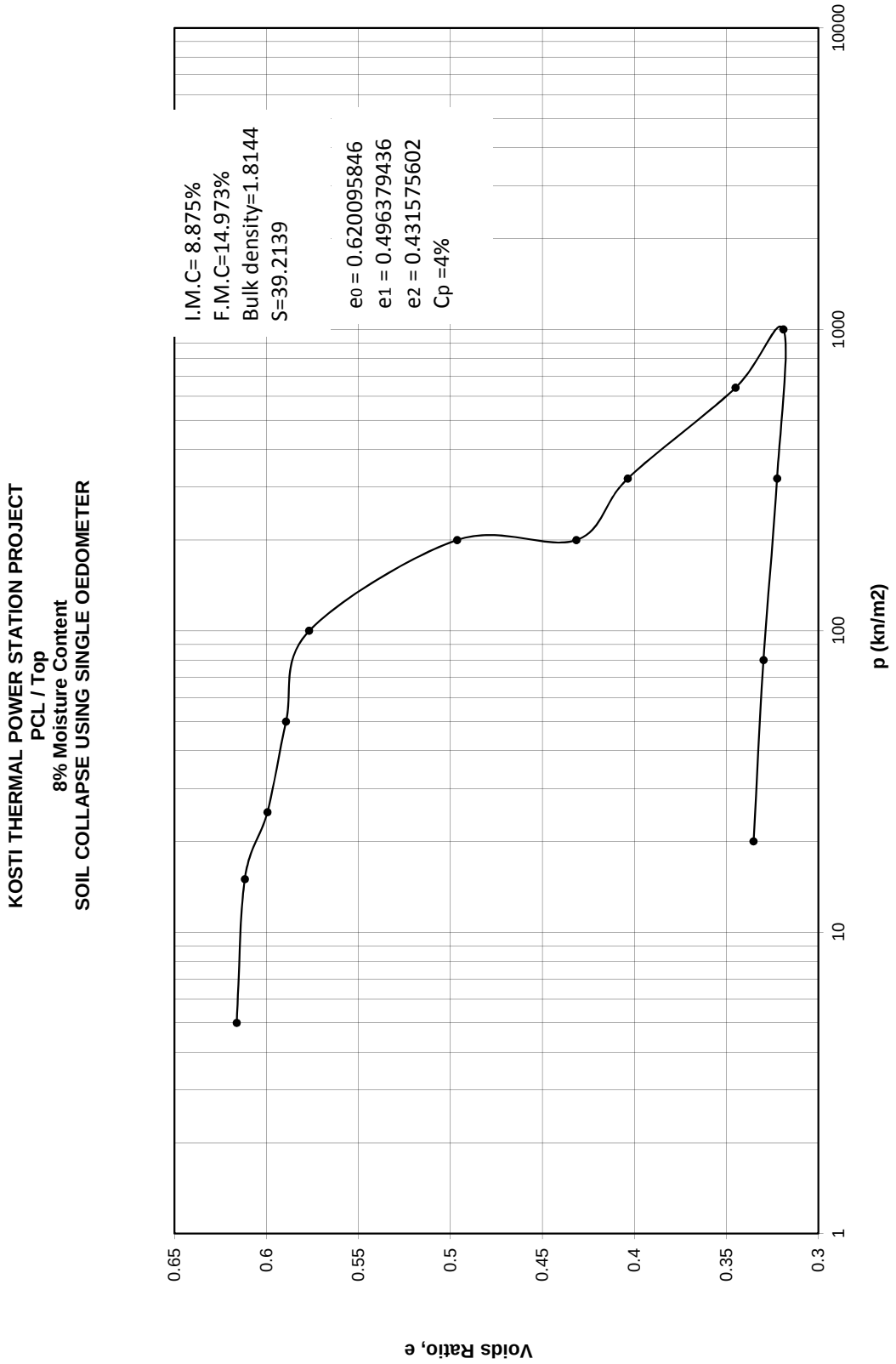

Hydrometer Curve
Kosti Thermal Power Station
Sample No. SPILE
%Passing
100
90
80
70
60
50
40
30
20
10
0
0.001
0.01
0.1
1
10
100
Particle Size (mm)
Clay
Silt
Sand
Gravel

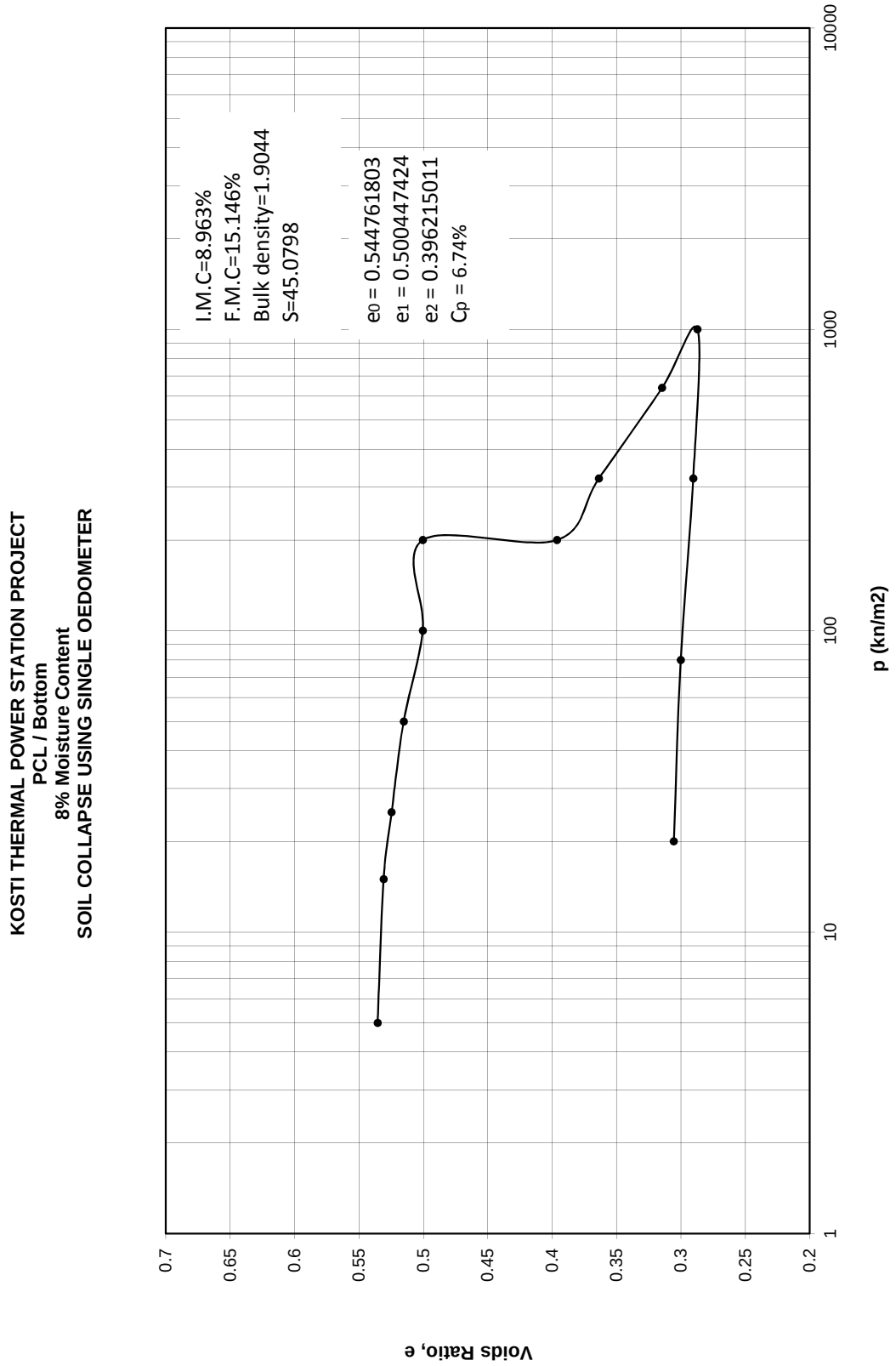

KOSTI THERMAL POWER STATION PROJECT
SPile / Top
8% Moisture Content
SOIL COLLAPSE USING SINGLE OEDOMETER
I.M.C= 8.228%
F.M.C=14.835%
Bulk density=2.1358
S=61.2332766
e0 = 0.368165663
e1 = 0.332786833
e2 = 0.251664283
Cp = 5.9%
Voids Ratio, e
0.4
0.35
0.3
0.25
0.2
0.15
0.1
p (kn/m2)
1
10
100
1000
10000

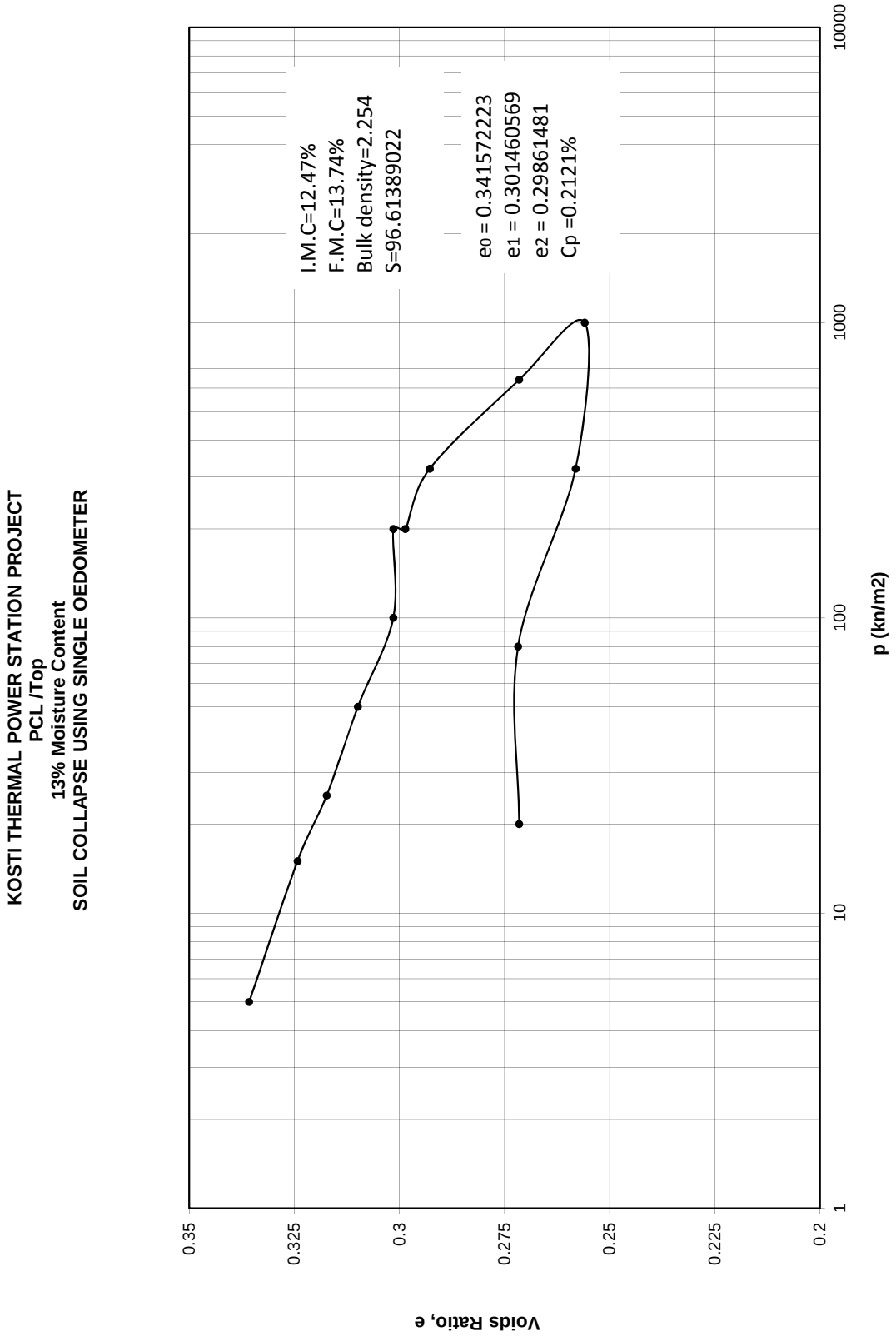

KOSTI THERMAL POWER STATION PROJECT
SPile / Bottom
8% of Optimum Moisture Content
SOIL COLLAPSE USING SINGLE OEDOMETER
I.M.C=8.684%
F.M.C=14.452%
Bulk density=2.1372
S=63.7877
e0 = 0.373012466
e1 = 0.27274095
e2 = 0.230163694
Cp = 3.12%
Voids Ratio, e
0.4
0.35
0.3
0.25
0.2
0.15
0.1
1
10
100
1000
10000
p (kn/m2)

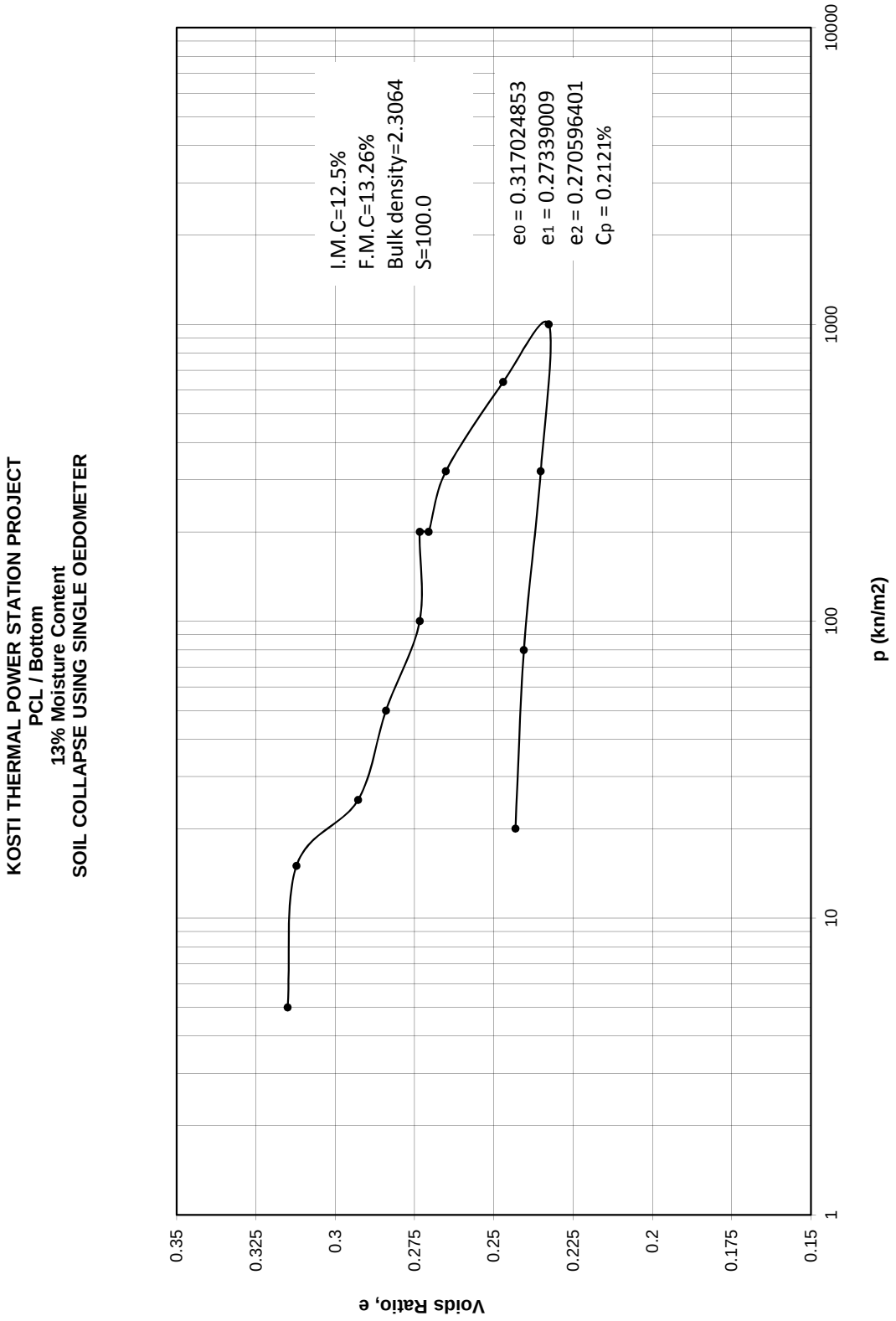

KOSTI THERMAL POWER STATION PROJECT
SPile / Top
13% Moisture Content
SOIL COLLAPSE USING SINGLE OEDOMETER
I.M.C= 12.7%
F.M.C=13.55%
Bulk density=2.3253
S=100
e0 = 0.308474224
e1 = 0.276885806
e2 = 0.275960622
Cp = 0.0707%
Voids Ratio, e
0.35
0.325
0.3
0.275
0.25
0.225
0.2
p (kn/m2)
1
10
100
1000
10000

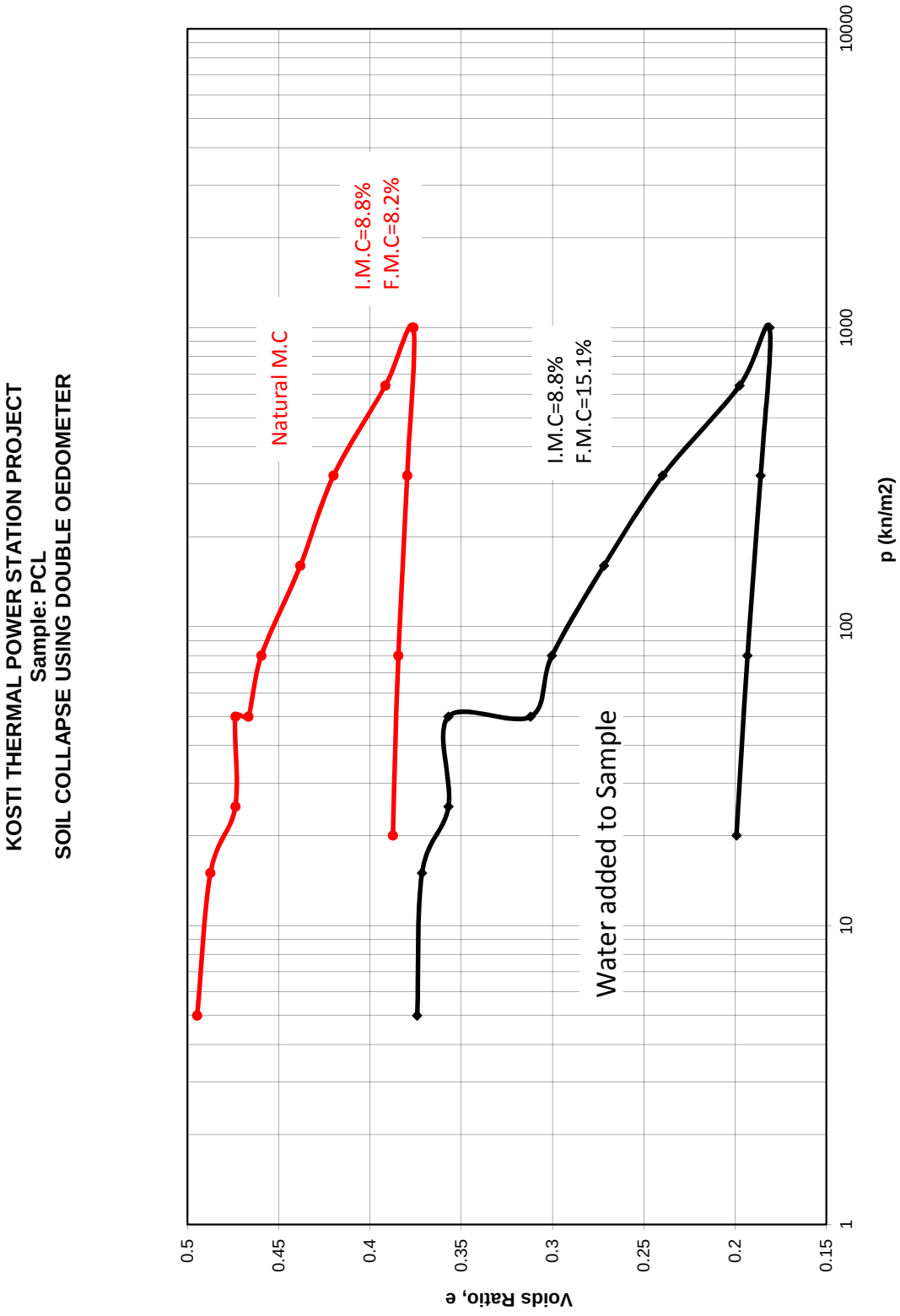

KOSTI THERMAL POWER STATION PROJECT
SPile / Bottom
13% Moisture Content
SOIL COLLAPSE USING SINGLE OEDOMETER
I.M.C=12.3%
F.M.C=12.6%
Bulk density=2.4092
S=100.00
e0 = 0.258470922
e1 = 0.233174385
e2 = 0.232284557
Cp = 0.0707%
Voids Ratio, e
0.275
0.25
0.225
0.2
0.175
p (kn/m2)
1
10
100
1000
10000

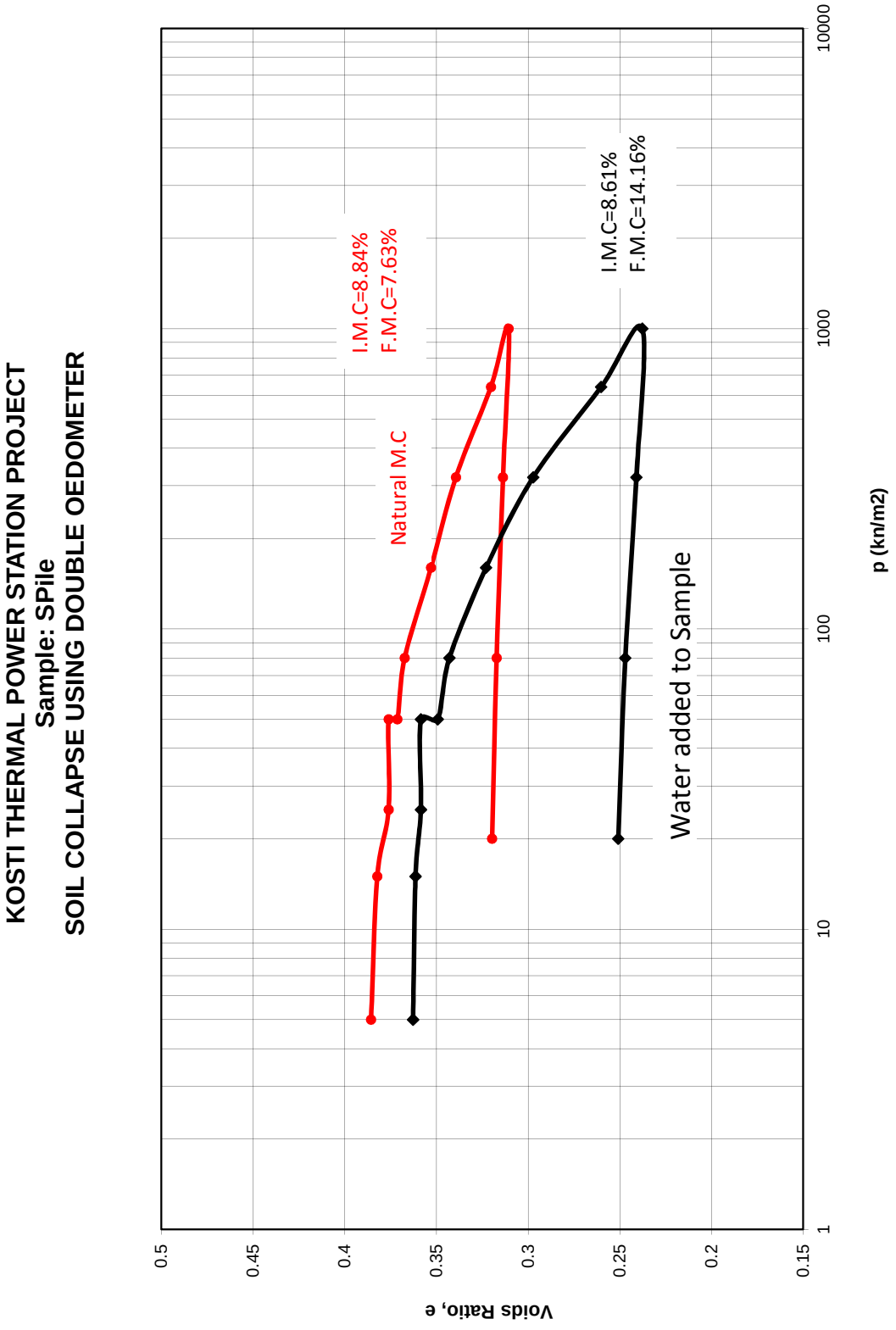

KOSTI THERMAL POWER STATION PROJECT
PCL / Top
8% Moisture Content
SOIL COLLAPSE USING SINGLE OEDOMETER
I.M.C= 8.875%
F.M.C=14.973%
Bulk density=1.8144
S=39.2139
e0 = 0.620095846
e1 = 0.496379436
e2 = 0.431575602
Cp =4%
Voids Ratio, e
0.65
0.6
0.55
0.5
0.45
0.4
0.35
0.3
p (kn/m2)
1
10
100
1000
10000

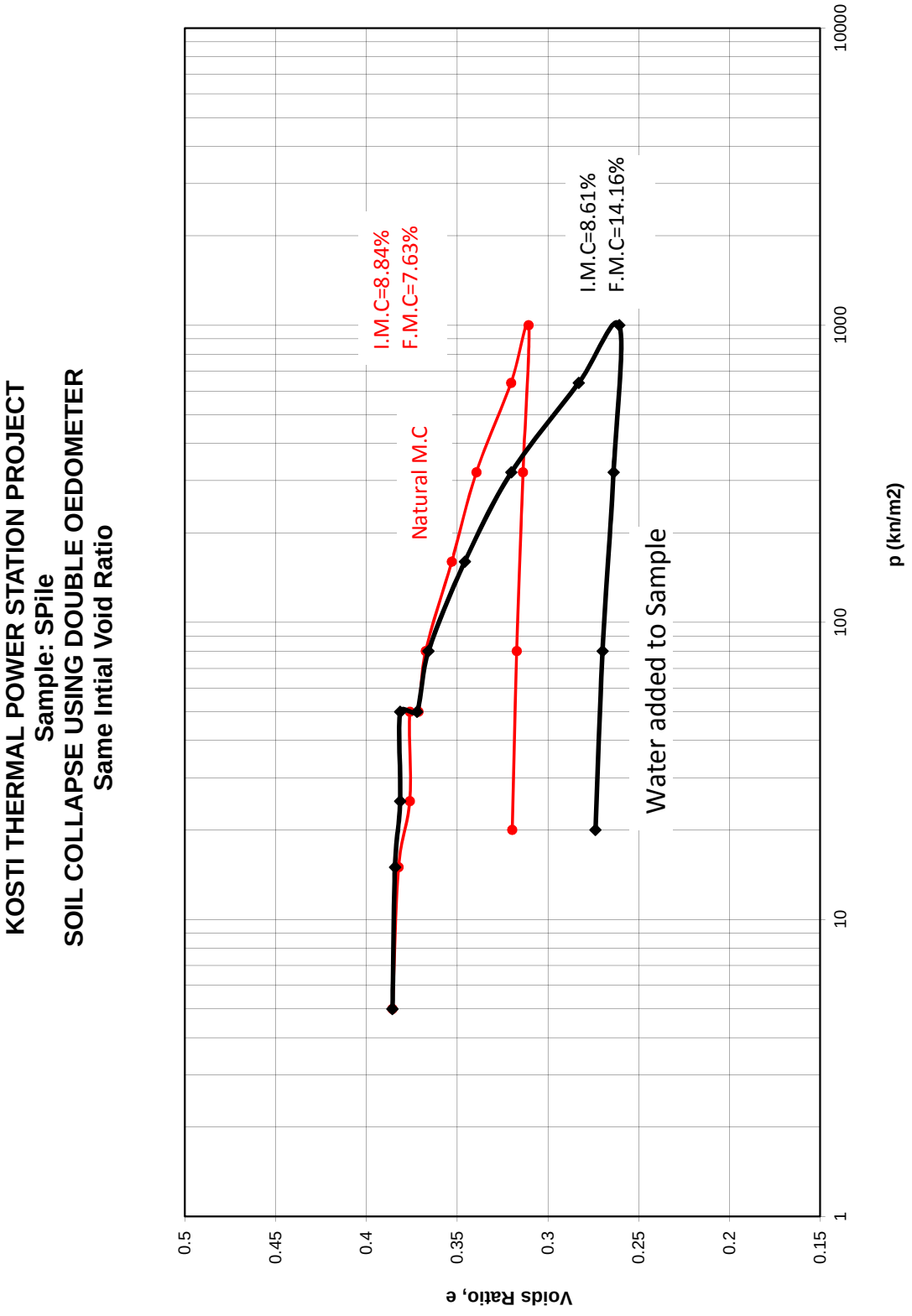

KOSTI THERMAL POWER STATION PROJECT
PCL / Bottom
8% Moisture Content
SOIL COLLAPSE USING SINGLE OEDOMETER
I.M.C=8.963%
F.M.C=15.146%
Bulk density=1.9044
S=45.0798
e0 = 0.544761803
e1 = 0.500447424
e2 = 0.396215011
Cp = 6.74%
Voids Ratio, e
0.7
0.65
0.6
0.55
0.5
0.45
0.4
0.35
0.3
0.25
0.2
1
10
100
1000
10000
p (kn/m2)

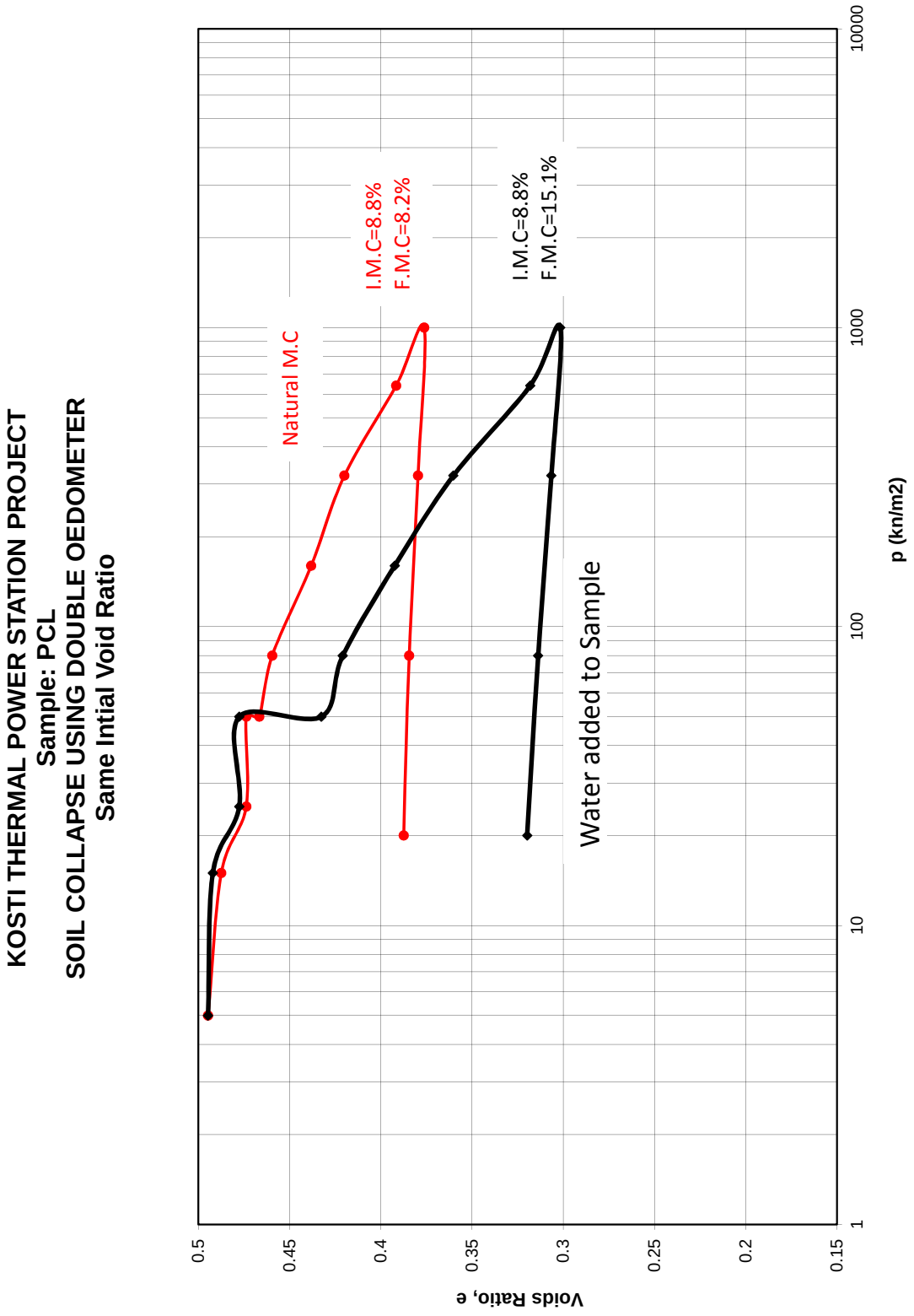

KOSTI THERMAL POWER STATION PROJECT
PCL /Top
13% Moisture Content
SOIL COLLAPSE USING SINGLE OEDOMETER
I.M.C=12.47%
F.M.C=13.74%
Bulk density=2.254
S=96.61389022
e0 = 0.341572223
e1 = 0.301460569
e2 = 0.29861481
Cp =0.2121%
Voids Ratio, e
0.35
0.325
0.3
0.275
0.25
0.225
0.2
p (kn/m2)
1
10
100
1000
10000


KOSTI THERMAL POWER STATION PROJECT
PCL / Bottom
13% Moisture Content
SOIL COLLAPSE USING SINGLE OEDOMETER
I.M.C=12.5%
F.M.C=13.26%
Bulk density=2.3064
S=100.0
e0 = 0.317024853
e1 = 0.27339009
e2 = 0.270596401
Cp = 0.2121%
Voids Ratio, e
0.35
0.325
0.3
0.275
0.25
0.225
0.2
0.175
0.15
p (kn/m2)
1
10
100
1000
10000


KOSTI THERMAL POWER STATION PROJECT
Sample: PCL
SOIL COLLAPSE USING DOUBLE OEDOMETER
Natural M.C
I.M.C=8.8%
F.M.C=8.2%
I.M.C=8.8%
F.M.C=15.1%
Water added to Sample
Voids Ratio, e
0.5
0.45
0.4
0.35
0.3
0.25
0.2
0.15
p (kn/m2)
1
10
100
1000
10000


KOSTI THERMAL POWER STATION PROJECT
Sample: SPile
SOIL COLLAPSE USING DOUBLE OEDOMETER
I.M.C=8.84%
F.M.C=7.63%
Natural M.C
I.M.C=8.61%
F.M.C=14.16%
Water added to Sample
Voids Ratio, e
0.5
0.45
0.4
0.35
0.3
0.25
0.2
0.15
p (kn/m2)
1
10
100
1000
10000


KOSTI THERMAL POWER STATION PROJECT
Sample: SPile
SOIL COLLAPSE USING DOUBLE OEDOMETER
Same Intial Void Ratio
I.M.C=8.84%
F.M.C=7.63%
Natural M.C
I.M.C=8.61%
F.M.C=14.16%
Water added to Sample
Voids Ratio, e
0.5
0.45
0.4
0.35
0.3
0.25
0.2
0.15
p (kn/m2)
1
10
100
1000
10000


KOSTI THERMAL POWER STATION PROJECT
Sample: PCL
SOIL COLLAPSE USING DOUBLE OEDOMETER
Same Intial Void Ratio
Natural M.C
I.M.C=8.8%
F.M.C=8.2%
I.M.C=8.8%
F.M.C=15.1%
Water added to Sample
Voids Ratio, e
0.5
0.45
0.4
0.35
0.3
0.25
0.2
0.15
p (kn/m2)
1
10
100
1000
10000