Before the Hon'ble NATIONAL GREEN TRIBUNAL
EASTERN ZONE BENCH, KOLKATA, WEST BENGAL
Original Application No.76/2025/EZ

In the
matter of :

...Applicant

Rahul Kumar

Versus

The District Magistrate Banka & Ors.

...Respondents

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S.L. No. 24/25

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BEFORE THE NATIONAL GREEN TRIBUNAL, EASTERN ZONE BENCH

Original Application No.76/2025/EZ

Rahul Kumar

...Applicant

Versus

The District Magistrate Banka &

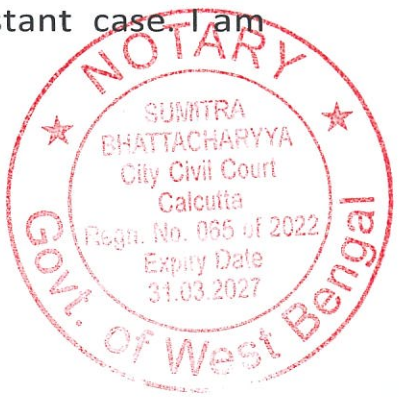
Ors.

...Respondents

REPLY AFFIDAVIT ON BEHALF OF RESPONDENT NO.2

I, Achyuta Nand Singh, son of Sachidanand Singh , aged about 57 years, by occupation – service, working for gain as Executive Engineer, irrigation division Baunsi, District Banka, Bihar – 813104, do hereby solemnly affirm and say as follows:-

1. I am the respondent No.2 herein and am conversant with the facts and circumstances of the instant case. I am competent to affirm this affidavit.



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2. A copy of the instant Original Application No.76/2025/EZ (hereafter the "instant OA") has been served upon me.

3. I have perused the instant OA and understood the contents and purport thereof.

4. I have been advised to traverse and/or to deal with only those statements and/or allegations contained in the instant OA and to refer to such facts as may be material and/or relevant for the disposal of the same.

5. As such, save what would be borne out by the admitted records or what may be specifically admitted by me hereinafter, all statements and/or allegations contained in the instant OA should be deemed to have been denied and disputed by me as if each one has been set out hereunder and denied in seriatim.

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6. Before dealing with the statements and/or allegations contained in the instant OA, I beg to place the following facts and contentions on record:-

a) I say that the instant OA has been filed for collateral purposes and in abuse of the process of law.

b) I say that the applicant has no locus standi to file the instant OA and has no cause of action for the same. The Applicant has not demonstrated how he is affected or aggrieved by the proposed Desilting and Dredging project.

c) I say that The Chandan reservoir is major irrigation project in the Banka district. Its command area falls in the Banka, Barahat, Rajaun and Dhuraiya block of Banka district.

d) I say that a detailed project report for desiltation of Chandan reservoir was done periodically from 2016 to 2019 to study the Hydrology of the reservoir.

e) I say that the Detailed Project Report was done by WAPCOS is a central public sector enterprise wholly owned by the Government of India ("GOI") under the administrative

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control of the Ministry of Jal Shakti

f) I say that Chandan Reservoir has a catchment area of 549 km and is an irrigation scheme. The gross capacity of the reservoir is 157.23 mcm, the DPR records that the gross capacity of the reservoir reduced from 157.23 mcm to 56 mcm on account of the sediment deposit over 48 years. The silt deposition is 2.1mcm per year. Copy of the Relevant pages of the DPR is annexed herewith and marked as Annexure A.

g) I say that Environment Impact Assessment of the Chandan reservoir was also conducted where the environment impact on dredging was also done and environment management plan was also prepared. A detailed water and soil study was conducted and measures were suggested in the Plan. Copy of the relevant pages of the EIA and EMP is annexed herewith and marked as Annexure B.

h) I say that the dredging process is being undertaken in accordance with the national framework for sediment management 2022 and relevant provisions of Environment Protection Act 1986 & EIA notification

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2006.

i) I say that the applicant is neither a social activist nor an environmental activist. It is not stated in the instant OA as to how the dredging process would in any way effect the Applicant. I say that absolutely no material has been disclosed by the applicant to show any act or action on his part justifying his claim that there is environmental degradation caused by an e- tender for dredging in Chandan reservoir.

j) I say that the applicant appears to have been set up by persons inimical to the said project for collateral purposes.

k) I say that the allegations made in the instant OA are vague and lacking in material particulars.

l) I say that the applicant never submitted any representation before the answering respondent ventilating their grievances regarding environmental degradation caused by dredging in Chandan reservior.

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m) It is reiterated that the dredging is essential to restore the Irrigation potential of the Reservoir. Presently the stored water is grossly insufficient to meet the Irrigation needs of the farmers in Banka and Bhagalpur Regions

n) I say that due to continuous deposition of silt through water flow of river in the Chandan Resvoir since 5 decade, the storage capacity of Chandan Reservoir heavily decreased and the storage capacity of Chandan reservoir decreased from 157 MCm to 56.25 MCM. It is further stated that irrigation of the Banka & Bhagalpur district is being done through the water of Chandan reservoir and it is also on proposal to make available the water to the Godda district of Jharkhand. It is further stated that total 74,640 Hectare irrigation to be done through the water of Chanadn reservoir. It is further stated that due to deposition of silt as well as due to decreasing storage capacity of Chandan reservoir it is not even possible to make available the water to the Banka & Bhagalpur district.

o) I say that the department of deponent invited the E-Tender bearing NIT No. 03/SBD/2024-25 for the de-

siltation work of Chandan Reservoir through dredging process for 10 years strictly in compliance with the all the rules and regulation as well as provision of the Environment (Protection) Act, 1986 and the EIA Notification, 2006. It is further stated that the work of de-siltation will be done on 216 hectare available land of the Water Resources Department, Government of Bihar.

p) I say that the District Survey Report was prepared in 2022 whereas in 29/12/23 it was decided that dredging is required in Chandan reservoir so the DSR do not reflect the desiltation of Chandan reservoir. That in this regard on 29.12.2023 a joint meeting was convened amongst the Secretary, Environment, Forest & Climate Change department Government of Bihar & Additional secretary cum Mines Commissioner, Mines and Geology department, Government of Bihar and Additional Chief Secretary Water Resources Department, Government of Bihar for considering the work of de-siltation, it has been decided to remove the silt in Chandan reservoir by way of dry excavation and dredging through Water Resources Department, Government of Bihar on the pattern of Bilashpur Dam & Gudha dam in Rajsthan and Managlam Reservoir in Kerala. It is also pertinent to mention Annexure

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D ,the letter of MOEF that suggest immediate suitable measures must be taken up to recover the lost storage capacity of the Chandan Reservoir.

7. Without prejudice to the aforesaid, I say that the instant OA is bad and illegal and is liable to be dismissed.

8. Without waiving the aforesaid, but fully relying thereon, I now deal with the statements and/or allegations contained in the instant OA as under.

9. With reference to the statements and/or allegations contained in paragraphs 1,2, 3 & 4 of the said application, I deny and dispute the same. I say that the applicant has not produced any material to show as to how the dredging process would in any way effect the Applicant. I say that absolutely no material has been disclosed by the applicant to show any act or action on his part justifying his claim that there is environmental degradation caused by an e- tender for dredging in Chandan reservoir

I put the applicant to strict proof of his assertions at paragraph 1 of the instant OA. I say that the instant OA has been filed for collateral purposes. I say that the applicant appears to have been set up by persons having

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vested interest. In this connection, I repeat and reiterate the statements made in paragraph 6 above and the various sub-paragraphs thereunder.

10. With reference to the statements and/or allegations contained in paragraph 5,6,7,8 &9 of the instant OA, I deny and dispute the same as if each one has been set out hereunder and denied in seriatim. I say that for dredging of rivers and reservoirs the national framework for sediment management 2022 is required to be followed. It is submitted that the answering respondent have already prepared a Detailed Project Report which brings forth the fact that the gross capacity of the reservoir reduced from 157.23 mcm to 56 mcm on account of the sediment deposit over 48 years. The silt deposition is 2.1mcm per year. It is repeated that the main focus of this tender is Desilting of the Chandan Reservoir for its maintenance, upkeep , disaster management and irrigation. As per norms and rules, this desilting tender is based on DPR duly prepared by a renowned government body – WAPCOS , GOI .I deny that the e- tender is permitting commercial exploitation of dredged sand without complying with the Environmental safeguards. I say that the e tender particularly provides that all necessary statutory clearances

are to be obtained within a maximum period of six months from the date of the agreement. I say that it is already stated in the e tender that An Environmental Impact Assessment shall be carried out every year from the commencement of the work through third party monitoring.

In this connection, I repeat and reiterate the statements made in paragraph 6 above and the various sub-paragraphs thereunder.

11. With reference to the statements and/or allegations contained in sub paragraphs 1 to 6 of paragraph 10 of the instant OA, I deny and dispute the same as if each one has been set out hereunder and denied in seriatim. I repeat that Detailed Project Report required for de-siltation and dredging (Detailed Project Report is required to estimate the amount of sedimentation in the river or reservoir, based on which it is decided if dredging is to be undertaken in the water body) that is already prepared by the answering respondent, the report is annexed as annexure A to this reply. I deny that the tender suffers from legal infirmities as it lacks DPR. I say that the tender is based on the detailed DPR where the Hydrological survey is also

conducted by the answering respondent. I say that the District Survey report may not contain the area and name of the water body to be dredged as during the time the DSR was prepared, the respondent authority have not decided to dredge Chandan reservoir. I repeat that in the event of dredging of waterbody specific DPR is required to measure the amount of sedimentation along with Hydrological survey and Topographical survey is required to be conducted based on which it is decided if at all dredging in the particular water body is required. I repeat that the respondent authority have complied with all the requirements and conducted Hydrological survey and Topographical survey in Chandan reservoir.

It is pertinent to mention here that India is an agricultural Country and a large number of people/farmers are depended upon the irrigation. It is further stated that the farmers of the Banka and Bhagalpur district is completely dependent upon the Chandan Reservoir for irrigation. That due to heavy deposition of Silt in the Chandar Reservoir and due to decrease of the Water Storage Capacity of the Chandan Reservoir, as decreased from 157 MCM to 56.22 MCM, people are suffering due to scarcity of the water for irrigation in the Banka district & Bhagalpur district and Godda district. It is emphasized that agriculture being the backbone

of the local economy, the urgency of restoring irrigation capacity through dredging cannot be overstated

It is pertinent to mention here that the e tender have only floated and is at an initial stage as the financial bid is not yet opened. I deny that there is any arbitrary or capricious or whimsical or bad action or inaction on the part of the respondents or any of them.

In this condition I repeat and reiterate the statements made in paragraph 6 above and the various sub-paragraphs thereunder.

12. With reference to the statements and/or allegations contained in paragraph 10 and the various sub- paragraphs (being sub-paragraphs 7 to 19) thereunder, I deny and dispute the same, as if each one has been set out hereunder and denied in seriatim. That in this regard on 29.12.2023 a joint meeting was convened amongst the Secretary, Environment, Forest & Climate Change department Government of Bihar & Additional secretary cum Mines Commissioner, Mines and Geology department, Government of Bihar and Additional Chief Secretary Water Resources Department, Government of Bihar Patna for considering the work of de-siltation in river,

Barrage & Upyojn of forest land. In the said meeting, it has been decided to remove the silt in Chandan reservoir by way of dry excavation and dredging through Water Resources Department, Government of Bihar on the pattern of Bilashpur Dam & Gudha dam in Rajsthan and Managlam Reservoir in Kerala. It has also been decided that the work of de-siltation of sand & silt will be done through contractor on commercial basis and the contractor will deposit the minimum amount for royalty . Photo/typed copy of the minutes of the meeting dated 29.12.2023 is annexed herewith and marked as Annexure C.

13. I say that the tender document specifically mandates the selected agency to obtain all necessary environmental clearance and other specific clearance/ approvals required for mining, transportation, storage and sale of sand. I deny that the tender process is at advance stage and possess an imminent threat of irreversible damage and creation of third party rights. I say that only the bid is floated and the financial bid is not opened , nothing further is processed. In Letter dated 10/12/24, it is stated By MOEF that sedimentation process of Chandan reservoir in 2019-20 has been estimated as 52.73 MCM, to recover the lost storage capacity suitable measures are needed to be adopted and commercial utilization of the sediment shall be explored to develop revenue based model to carry out

desiltation process. The letter suggest that immediate suitable measures must be taken up to recover the lost storage capacity of the Chandan Reservoir .Copy of the Letter dated 10/12/24 is annexed herewith and marked as annexure D . It is mandatory for the successful bidder to obtain Environmental clearance for commercial exploitation.

14. I say that the purported grounds contained in the said sub-paragraphs I to XIII are no grounds in the eye of law and they do not hold any water. I say that the said allegations couched in the form of grounds are identical to the alleged factual statements made in the sub-paragraphs 1 to 19 of paragraph 10 under reply and accordingly, for the sake of brevity and to avoid prolixity, I refrain from dealing with each and every purported ground and crave leave to rely upon my traverses to the sub-paragraphs of paragraph 10, in answer to the said purported grounds. I, however, reserve my right to deal with each and every purported ground sought to be canvassed in the said sub-paragraphs in order to indicate the hollowness thereof.

In this connection, I repeat and reiterate the statements made in paragraph 6 above and the various sub-paragraphs thereunder.

15. With reference to the statements and/or allegations contained in

paragraph C of the instant OA, I deny and dispute the same, as if each one has been set out hereunder and denied in seriatim. I deny that there is any cause of action in the instant case. I say that since there is no cause of action, the question of any cause of action having arisen on February 27, 2025 or the question of such alleged cause of action continuing on a day-to-day basis does not and/or cannot arise at all.

In this connection, I repeat and reiterate the statements made in paragraph 6 above and the various sub-paragraphs thereunder.

16. With reference to the statements and/or allegations contained in paragraphs D and E of the instant OA, I deny and dispute each of the interim, ad interim or final relief as contained in the instant OA. I say that the instant OA is an abuse of the process. I say that the applicant does not have the right to sue. I say that the applicant does not have any cause of action. I say that the applicant is not entitled to any relief in the instant OA either in the interim or final form. I say that the instant OA being an abuse of the process is liable to be dismissed with exemplary costs and an appropriate penal action against

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the applicant. The prayers sought in the instant OA are devoid of any merit. The applicant has failed to establish a legal right or demonstrated any environmental violation, the OA deserves to be dismissed with explanatory cost

In this connection, I repeat and reiterate the statements made in paragraph 6 above and the various sub-paragraphs thereunder.

17. With reference to the verification clause of the instant OA, I strongly deny that the applicant in the instant OA is well conversant with the facts and circumstances of the instant OA. I say that the said assertion has been made only for the purpose of artificially creating locus to file the instant OA. I say that in reality, the applicant is a stooge and an associate of persons inimical to the said project and/or persons with vested interests. As regards the affidavit in support of the instant OA, I say that the jurat portion thereof is ex facie incorrect, the identification of the Applicant is done by an advocate who is not the advocate - on – record, the vokalatnama of the instant OA is signed by an advocate who have not identified the deponent, as a result whereof, the allegations and/or contentions raised by the applicant deserve no credence in the eye of law.

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In this connection, I repeat and reiterate the statements made in paragraph 6 above and the various sub-paragraphs thereunder.

18. I say and submit that the instant OA is bad, illegal, frivolous, misconceived, vexatious and clear abuse of the process of law and the same is liable to be dismissed. I say and submit that this Hon'ble Tribunal will be pleased to dismiss the instant OA with costs.

Identified by me

Deponent

Advocate

Solemaly Affirmed and Declared befour me U/S 139 CPC, (C)

Notary

Sumitra Bhattacharyya
Notary, Govt. of W.B
Regd. No. 065 of 2022
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VERIFICATION :

I, Achyuta Nand Singh, son of Sachidanand Singh , aged about 57 years, by occupation – service, working for gain as Executive Engineer, irrigation division Baunsi, District Banka, Bihar – 813104, do hereby verify and declare that the statements contained in paragraphs 1-6(e), 6(h) to 6(p), 7, 11, and 14 to 18 of the instant reply affidavit are true to my knowledge and those contained in paragraphs 6(f), 6(g), 12, 13 are based on information derived from records which I verily believe to be true and the rest are my humble submissions before this Hon'ble Tribunal.

22/7/25

Identified by me

Deponent

Advocate

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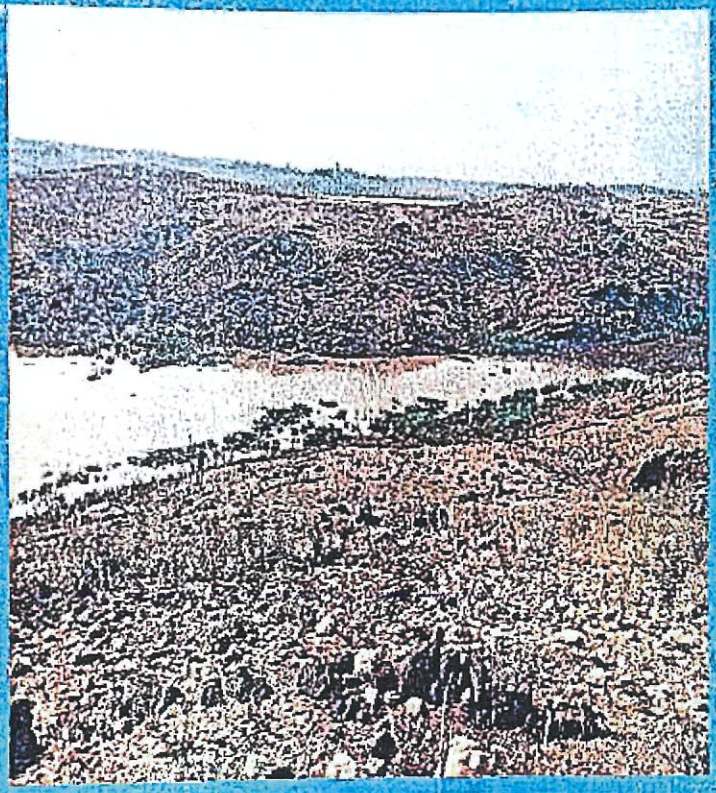
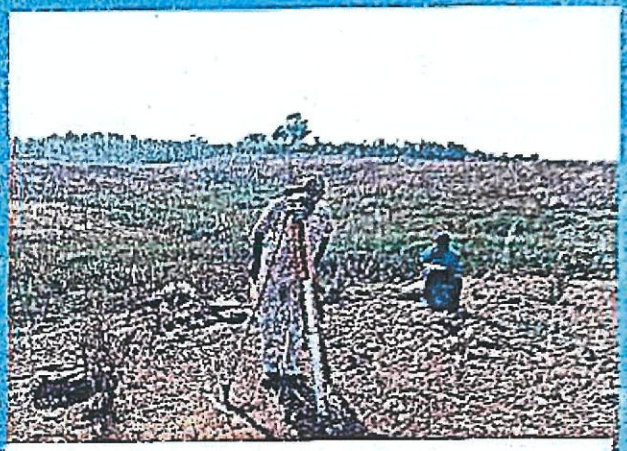
Annexure - A Dir copy

WATER RESOURCES DEPARTMENT.
(GOVERNMENT OF BIHAR)

DESILTING OF CHANDAN RESERVOIR





FINAL DETAILED PROJECT REPORT
& EIA REPORT

वाप्कोस

WAPCOS

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OCTOBER, 2016
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Drawing VI	Embankment Section

Abbreviation

N.A	Not Applicable
MCM	Million Cubic Meter
M.sqm	Million Square Meter
M.cft	Million Cubic Feet
Th.cum	Thousand Cubic Meter
TMC	Thousand Million Cubic feet
FRL	Full Reservoir Level
LS	Longitudinal section
Ch.	Chainage
Ha	Hectare
SC	Scheduled Caste
ST	Scheduled Tribe
MOEF	Ministry of Environment, Forest and Climate changes
CCA	Cultivable Command Area
GCA	Gross Command Area

DESILTING OF CHANDAN RESERVOIR

SECTION 1

CHECKLIST

Checklist

No.	Particulars	Remarks
1.	Was the original project given investment clearance by Planning Commission?	N.A
2.	Has the performance evaluation of the existing project been carried out?	N.A
3.	Have the salient features of the project as envisaged at the time of execution of project and as at present, been indicated?	Yes
4.	Have the irrigation potential of the existing project as originally envisaged, potential created and reasons for variations been indicated?	Yes
5.	Has the culturable command area been actually assessed and compared with that at the time of planning of the project and shortfalls/excesses, if any discussed?	Does not arise
6.	Has the hydraulic survey of canal/distribution system been carried out?	N.A
7.	Have the deficiencies in the existing irrigation system been identified?	N.A
8.	Has the need for modernisation been justified?	N.A
9.	Has the hydrological studies been reviewed, compared with those made at the time of preparation of the original project if available and reasons for variations recorded in respect of.	Does not arise
	(i) Rainfall	-
	(ii) Runoff	-
	(iii) Flood	-
	(iv) Sediment	-

No.	Particulars	Remarks
	(v) Ground water	–
	(vi) Evaporation	–
10.	(a) Have changes in the upstream withdrawals / diversion for industrial use, power generation drinking requirement and other developments in the upper catchment to the extent witch can be collected with reasonable efforts been described?	N.A
	(b) Have the charge in power generation/consumption in power for the lift irrigation scheme been described?	N.A
11.	Have the semi-detailed soil survey been carried out for the entire commend (if not entire commend then extent covered) and soil and land irritability classification brought out in the report (for the project to be acceptable, semi detailed soil survey in at least 50% of commend should have been carried out.)	N.A
12.	Is the crop Water Requirement determined by the modified penmen method?	N.A
13.	Is the crop Water Requirement determined by the modified penmen method?	N.A
14.	Have water requirement for other uses been worked out?	N.A
15.	Has justification for the proposed cropping pattern been furnished?	N.A
16.	Have the cropping pattern & proper cropping calendar been devised with a view to maximise the production and canal closures for maintenance etc. ensured? Have these been concurred by the Agriculture Department?	N.A

No.	Particulars	Remarks
17.	Are the areas and percentage of CCA that will be irrigated during Kharif, Rabi two seasonal hot weather and perennials been indicated and compared with cropping pattern as existing prior to taking of the project , originally envisaged and actually developed after completion of the project?	N.A
18.	Is the justification furnished for continuing with/or taking up perennial and hot weather crops from the reservoir?	N.A
19.	Have the most suitable depths and frequencies of irrigation to be adopted. Based on the characteristics of the soil and crops been worked out?	N.A
20.	Have the values of conveyance efficiency, field application efficiency and overall water use efficiency been indicated with basis thereof?	N.A
21.	Has the pattern of releases (10 daily / monthly) from the diversion/storage headwork been worked out & compared with those envisaged originally?	N.A
22.	Has the canal been redesigned to cater for peak requirement with 10 present increase (20% for small reservoirs) for rush irrigation. If not have the alternative proposals for carrying the required discharge been discussed?	N.A
23.	Whether supplementation from ground water has been considered?	N.A
24.	Are the supplies available sufficient to meet the requirements for ensuring 75 per cent dependability? If not have the possibilities of augmenting the supplies been discussed either by increasing the storage or supplementing by ground water etc.? Have the revised reservoir operation tables been furnished?	N.A

No.	Particulars	Remarks
25.	Has a study of the ground water potential commend area the present level of the ground water use the scope of failure ground water utilisation, been carried out and included in the project report?	N.A
26.	Have the economics of ground water development been studied?	N.A
27.	Has the possible impact on ground water recharge on account of lining of the system been kept in view for irrigation areas not commanded by the canal system considered?	N.A
28.	Has the quality of surface water for irrigating areas not commanded by the canal system been considered?	N.A
29.	Has the quality of surface water as also ground water & drainage water, if intended for irrigation use been tested?	N.A
30.	Have the requirements of drainage in the command area, been studied and a suitable integrated drainage plan drawn up and provided for in the cost estimate?	N.A
31.	Have the arrangements for the following been considered and provided for?	
	(a) Execution of OFD works	N.A
	(b) Training programmes for field staff and farmers – existing position and proposals for strengthening	N.A
	(c) Participatory irrigation Management (PIM) Water Users Associations (WUA) and turnover of the system to WUAS.	N.A
	(d) Provision of extension services	N.A

No.	Particulars	Remarks
	(e) Providing important inputs like seeds. Fertilizers etc.	N.A
32.	Have adequacy of road communication facilities and not. The necessity of improvements been and provided for?	Existing road communication facilities adequate
33.	Have matters about the improvement in reliability/dependability of the annul irrigation in the existing/proposed commend area been discussed in the light of modernisation?	N.A
34.	Have the net benefits due to the project been estimated and concurred by the Agricultural Department?	Yes
35.	Has the concurrence of the state finance department been obtained for taking up the project at the estimated cost?	Yes
36.	Whether the scheme has already been started? If so, is the present stage of construction indicated?	Not Yet started
37.	Is the scheme included in the plan? If not what is the present position regarding its inclusion the plan?	Yes
38.	Have the year wise requirement of funds been indicated?	Yes
39.	Is the scheme covered under state sector or Central sector?	State Sector
40.	Is the scheme covered or proposed to be covered under any foreign assistance/aid agreement?	No

No.	Particulars	Remarks
41.	Are the detailed cost estimates included in the report?	Yes
42.	Has the benefit-cost ratio been worked out? Whether depreciated cost of completed works has been included in the calculations?	B.C ratio worked out but without considering depreciated cost of completed works.
43.	Whether internal rate of Return (IRR) has been worked out?	-
44.	Are the Financial returns attached?	-
45.	Are there any special reasons to undertake the project if it is unproductive and whether these have been recorded in the report?	The benefits of the project are productive.
46.	Have the rates of betterment levy proposed, the period of recovery and the estimated total recovery been indicated?	No N.A
47.	Are there any charges levied for irrigation facilities as distinct from water charges?	No, N.A
48.	Are the water rates for different crops indicated?	N.A
49.	Have the rates of betterment levy, water charges, etc. been compared with those obtained in other regions of the state?	No
50.	Has the concurrence of the state revenue Department been obtained for these rates?	-

No.	Particulars	Remarks
51.	Have the O&M aspects (both financial as well as management been Discussed? How are the O&M costs proposed to be met?	-
52.	Have the programme of construction and the expenditure involved been furnished?	Yes
53.	Has the requirement of staff been estimated and furnished with justification?	Yes
54.	Has the adequacy of the existing irrigation laws and revision, if any considered necessary been discussed?	Existing laws adequate
55.	Has the impact of the scheme on the overall development of water resources in the basin/state been discussed?	Yes
56.	Whether views of water users about proposed works in modernisation project been obtained and described in the report?	Yes
57.	Have environmental /ecological obtained been discussed in the report & environmental clearance obtained from MOEF?	N.A
58.	Does the project involve acquisition of forest land? Has the MOE&F been approached for clearance under forest conservation act 1980?	NA
59.	Does the project involve any re-settlement? Whether rehabilitation of PAPs provided for?	No resettlement involved
60.	Does project involve rehabilitation of SC/ST population? Has the rehabilitation package for them been cleared by Ministry of Social justice & Empowerment?	N.A

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Desilting of Chandan Reservoir

No.	Particulars	Remarks
61.	Have the socio economic Studies (bench mark surveys) been carried out?	N.A
62.	Have the interstate aspects been examined & discussed?	No interstate aspects are involved.
63.	Have the list of on-going programs of Agriculture Department in Comment area been given?	N.A
64.	Have the provisions of Indus water treaty, 1960 for scheme on western rivers of Indus Basin been examined and discussed?	N.A

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DESILTING OF CHANDAN RESERVOIR

SECTION 2

SALIENT FEATURES

Salient features

1.0	Name of the Project	Preparation of detailed project report for Desilting of Chandan Reservoir	
2.0	General Data		
2.1	District(s)	Banka	
2.2	Block	Bounsi	
2.3	River/Tributary	Chandan	
2.4	Location of Dam/Diversion Structures	near village Laxmipur under Bounsi block of Banka District	
2.5	Name of River/Basin	Ganga	
2.6	Longitude and Latitude (at dam site)		
	a) Longitude	86^0 55' 00"E	
	b) Latitude	24^0 40' 27"N	
3.0	Socio-economic aspects	Original	Revised
		N.A	
3.1	District(s) Benefited	Banka, Bhagalpur & Godda	
3.2	Income	N.A	N.A
3.3	Land holdings	N.A	N.A
3.4	Population benefited	N.A	N.A
	a) Total	N.A	N.A
	b) Schedule cast	N.A	N.A
	c) Schedule Tribe	N.A	N.A
	d) Other Backward casts	N.A	N.A
4.0	Hydrological Data		
4.1	Catchment area at dam site (Sqkm)	549	
4.2	Rainfall (mm)	Original	Revised
	a) Maximum annual rainfall	N.A	

	b) Minimum annual rainfall	N.A	
	c) Mean annual rainfall	1176.8	
4.3	Annual runoff (MCM)	Original	
	a) Average	292.3	
	b) Maximum	N.A	
	c) Minimum	N.A	
	d) 75% Dependabillity	N.A	
4.4	Design Flood(m^3/s)	Original	Revised
		3113	3113
5.0	Water Utilization (TMC)	Present	Proposed
	a) Reservation for upstream use	N.A	N.A
	b) Reservation for downstream use	N.A	N.A
	c) Utilisation through the project	N.A	N.A
	i) Irrigation	N.A	N.A
	ii) Power Generation	N.A	N.A
	iii) Drinking water	N.A	N.A
	iv) Industrial Use	N.A	N.A
	v) Others (Evaporation)	N.A	N.A
	d) Water saved through Modernization		
6.0	Groundwater (TMC)		
	a) Potential	N.A	
	b) Present use	N.A	
	c) Proposed use after Modernisation	N.A	
	d) Balance for future utilization after Modernisation	N.A	
7.0	Reservoir data	Existing	Proposed

	a) Storage (MCM)		
	i) Gross storage	157.23	157.23
	ii) Dead storage	21.49	21.49
	iii) Live storage	135.74	135.74
	iv) Annual carry over	N.A	N.A
	b) Elevation (El-m)	Original	Proposed
	i) Maximum water level (MWL)	157.01	157.01
	ii) Full reservoir level (FRL)	152.44	152.44
	iii) Lowest water level (LWL)	N.A	N.A
	iv) Minimum Draw down levek (MDDL)	131.09	131.09
	v) River bed level (RBL)	119.81	119.81
	vi) Irrigation outlet level (IOL)	131.09	131.09
	c) Water spread area (sq.km) at	Original	Proposed
	i) Dead storage level		
	ii) Full reservoir level		
	iii) Maximum water level		
	d) Water Quality	Reservoir /canal / River(downstream)	
	i) Physical		
	ii) Chemical		
	iii) Bacteriological		

8.0	Canal system (Irrigation) Information to be furnished for each Main/Branch canal separately	Existing	Proposed
	a) Length of canal(Km)	N.A	N.A
	b) Full supply level at canal head (m)	N.A	N.A
	c) Full supply discharge at canal head (m3/sec)	N.A	N.A
	d) Length of complete distribution system up to minors	N.A	N.A
	e) Number of villages surveyed		No change in existing number
	f) Area (Ha)		
	i) Gross command area (GCA)		
	ii) Culturable command area (CCA)	89528	
	iii) Annual Irrigation (AI)		
	iv) Intensity of Irrigation (% of CCA)		
9.0	Power	Existing	Proposed
	a) Power Details	N.A	
	i) Installed capacity (MW)		
	ii) Unit size		
	iii) Size of power house		
	iv) Type of turbine		
	v) Rated head		
	vi) Rated/Design unit discharge		
	vii) Specific speed		
	viii) Generator type	N.A	

	ix) Capacity	
	x) Voltage	
	b) Power Benefits	
	i) Firm Power	
	ii) Energy	
	c) Evacution System	

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DESILTING OF CHANDAN RESERVOIR

SECTION 3

EXECUTIVE SUMMARY

Project Report Summary

This Project, having estimated cost of Rs. 1537.46 crores, has been prepared for the desiltation of Chandan Reservoir in Banka District (Bihar).

Under Chandan Reservoir Project, Chandan dam was constructed in the year 1967 across river Chandan River near village Laxmipur in the Bounsi block of Banka district of the state of Bihar. The reservoir had a gross capacity of 157.23 MCM (Million Cubic Meter) and a live storage capacity of 135.74 MCM above DSL (Dead Storage Level).

As per the survey conducted by WAPCOS in May 2015, the gross storage capacity of the reservoir has come down from 157.23 MCM to 56.23 MCM due to the continuous deposition of sediments in the reservoir area over a period of 48 years. Thus, 101.00 MCM silt has got deposited in the reservoir area during this period of 48 years. Leaving the Dead Storage Capacity of 21.49 MCM aside, remaining 79.51 MCM storage capacity has been lost due to the deposition of silt. This loss in storage capacity has directly resulted in a loss in stored water, which in turn has very badly affected the irrigation facility being provided to the farmers. At present, the stored water is not sufficient even to fulfill the Kharif irrigation requirement of the farmers of the Banka and Bhagalpur district of Bihar. Also no water is normally available for Rabbi irrigation.

The Addl. Chief Secretary WRD Bihar along with Principal Secretary RCD and Secretary RWD visited the Chandan reservoir site on 04.06.2019 and it was decided to use this silt for the construction of roads under RCD/RWD and for the construction of new buildings under BCD. They had been requested to make available their demand for the quantity of silt to be used by their department.

The project has been formulated for the disposal of the 79.51 MCM deposited silt, for which a dumping area of about 64 hectares, owned by the WRD department, has been located in the downstream of the dam. The silt extracted from the reservoir area will be first disposed off in this area and then it will be carried away simultaneously by the RCD, RWD and BCD department as per their requirement.

The cost estimate has been prepared as per latest Schedule of Rate of WRD Bihar.

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DESILTING OF CHANDAN RESERVOIR

SECTION 4

REPORT

Chapter 1.
Introduction

1.1. General

Chandan reservoir scheme is an Irrigation scheme. The dam was constructed in the year 1967 across the river Chandan at Latitude 24^0 40' 27" N and Longitude 86^0 55'00" E near village Laxmipur under Bounsi block of Banka District in the state of Bihar. The Dam is approached by Bhagalpur, Dumka, Deoghar National High way. The dam site is connected by 22.86 Km pucca road from Bounsi which is 50 Km from Bhagalpur and 50 Km from Dumka. The reservoir was impounded in 1967 for the first time. The earthen dam has a length of 1554 Meters. At chainage 43.00, an outlet has been constructed for irrigation purpose to feed the water in Chandan high level Canal. At chainage 51.00 to chainage 56.40 a spillway has been constructed to spill surplus water in the flood period beyond the FRL i.e 152.44 m (500 ft)

Fig 1.1: Index map of Chandan Reservoir.

1.2.Salient features

Table 1.1 Salient features of dam

I. Hydraulic Particulars of Chandan Dam		
1	Latitude at Dam	24^0 40' 27"N
2	Longitude at Dam	86^0 55' 00"E
3	Type of Dam	Earthen Dam
4	Length of Dam	1554.00m
5	Full Reservoir Level	EL 152.44m
6	M.W.L	EL 157.01m
7	Sill level of canal outlet	EL. 131.09m
8	Top of Dam	EL 160.06 m
9	Top width of Dam	NA
10	Capacity	157.23 M.m3
11	Dead Storage	21.49 M.m3
12	Full Capacity	157.23 M.m3
13	Max. Height from Sill Level	NA
14	Deepest bed level of the river	El. 119.81m.
II	**Surplus Escape (abandoned)**	
1	Length	NA
2	Sill Level	Na
III	**Spillway**	
1	Type	Ungated
2	Length	169.2 m
3	Maximum Flood Discharge	3113 cumecs
4	Crest level	152.44m

IV	**Canal Sluice**	
1	Ayacut Designed	NA
2	Sill	131.09m
3	Vent	2 Nos.
4	Size of Vent	NA
5	Bed width of Canal	NA
6	Discharge	NA
7	Length of Canal	NA
V	**Other Details**	
1	Catchment Area	549 Sq.km.
2	Water spread Area	10.81 Sq.km.
3	Average annual yield	292.3 MCM
4	Avergae Annual rainfall	1176.8 mm.
5	Maximum Height of dam from deepest foundation level	NA
6	Maximum Width at deepest foundation	NA

1.3. Sedimentation of Reservoirs - General Scenario

1.3.1. General

In the state of Bihar the surface and ground water have been more or less totally harnessed for the purpose of agriculture, domestic and industrial uses. This has led to chronic water crisis due to increased use of water for irrigation purpose, industrial needs and domestic needs of the increasing population. Hence assurance of timely irrigation assumes significance.

1.3.2. Seriousness of Sedimentation Problems of Reservoirs

I.S 12182-1987 specifies procedure for rough assessment of seriousness of the sediment problem as insignificant, significant or serious. The expected average annual volume of

sediment deposition compared with the gross capacity of the reservoir is made. If the ratio is more than 0.5 percent per year, the problem is considered to be serious and special care is required in estimating the sediment yields from the catchment. If it is less than 0.1 percent per year, the problem of siltation may be insignificant and changes in reservoir capacity can be neglected for studies of reservoir performance. For cases falling between these two limits, the sedimentation is considered significant and further studies are required.

1.4. Original Elevation-Area –Capacity of Chandan Reservoir

Chandan Reservoir is having a gross storage of 157.23 MCM and dead storage of 21.49 MCM. Water is released for irrigation through high-level sluices. There are no sediment observation sites on the Chandan River U/S of the dam site maintained by the State Government. The original Elevation –Area -Capacity of Chandan reservoir is given under.

Table 1.2: Original Elevation-Area-Capacity table of CHANDAN Reservoir (Source: Report on post-facto study of CHANDAN Reservoir, Nov 1990)

Elevation (m)	Area (Sq km)	Gross capacity (MCM)	Remarks
120	0.01	0.01	
121	0.15	2.20	
122	0.18	4.50	
123	0.21	6.00	
124	0.22	8.00	
125	0.25	9.00	
126	0.29	10.00	
127	0.33	11.50	
128	0.42	12.60	
129	0.60	15.50	
130	0.75	16.85	
130	0.85	17.00	
130.3	0.95	17.50	
130.6	1.00	19.00	
130.7	1.12	21.00	
131.09	**1.15**	**21.49**	**DSL**
131.5	1.18	22.00	
131.8	1.20	22.50	
132.1	1.25	23.50	

132.4	1.30	25.00	
132.7	1.35	26.00	
133.0	1.50	28.00	
133.3	1.56	29.00	
133.6	1.58	31.00	
133.9	1.60	33.00	
134.2	1.65	36.00	
134.5	1.70	37.00	
134.8	1.80	38.00	
135.1	1.85	41.98	
135.4	1.90	43.22	
135.7	2.00	44.21	
136.0	2.10	45.69	
136.4	2.30	46.92	
136.7	2.32	47.54	
137.0	2.50	48.78	
137.3	2.56	50.63	
137.6	2.60	51.86	
137.9	2.80	53.10	
138.2	2.85	54.09	
138.5	2.90	55.32	
138.8	2.92	56.80	
139.1	2.96	58.66	
139.4	2.98	59.89	
139.7	3.00	62.36	
140.0	3.20	62.73	
140.3	3.25	64.22	
140.6	3.27	65.45	
140.9	3.80	66.69	
141.2	3.85	68.54	
141.5	3.90	69.77	
141.8	3.93	71.63	
142.1	4.00	74.10	
142.4	4.10	75.95	
142.7	4.20	77.80	
143.0	4.25	79.04	
143.3	4.40	80.27	
143.6	4.65	82.13	
143.9	4.75	83.36	

144.2	4.79	85.22	
144.5	4.80	87.07	
144.8	5.00	88.92	
145.1	5.10	91.39	
145.4	5.30	93.24	
145.7	5.40	95.89	
146.0	5.45	97.81	
146.3	5.60	99.71	
146.7	6.20	101.64	
147.0	6.30	103.54	
147.3	6.50	105.51	
147.6	6.55	107.50	
147.9	6.90	109.51	
148.2	7.10	111.55	
148.5	7.20	113.62	
148.8	7.25	115.71	
149.1	7.45	119.07	
149.4	7.56	122.46	
149.7	8.10	125.89	
150.0	8.35	128.12	
150.3	8.40	130.41	
150.6	8.55	132.75	
150.9	8.60	135.17	
151.2	8.90	138.93	
151.5	9.20	141.61	
151.8	9.60	147.49	
152.1	10.75	151.47	
152.440	**10.81**	**157.23**	**FRL**

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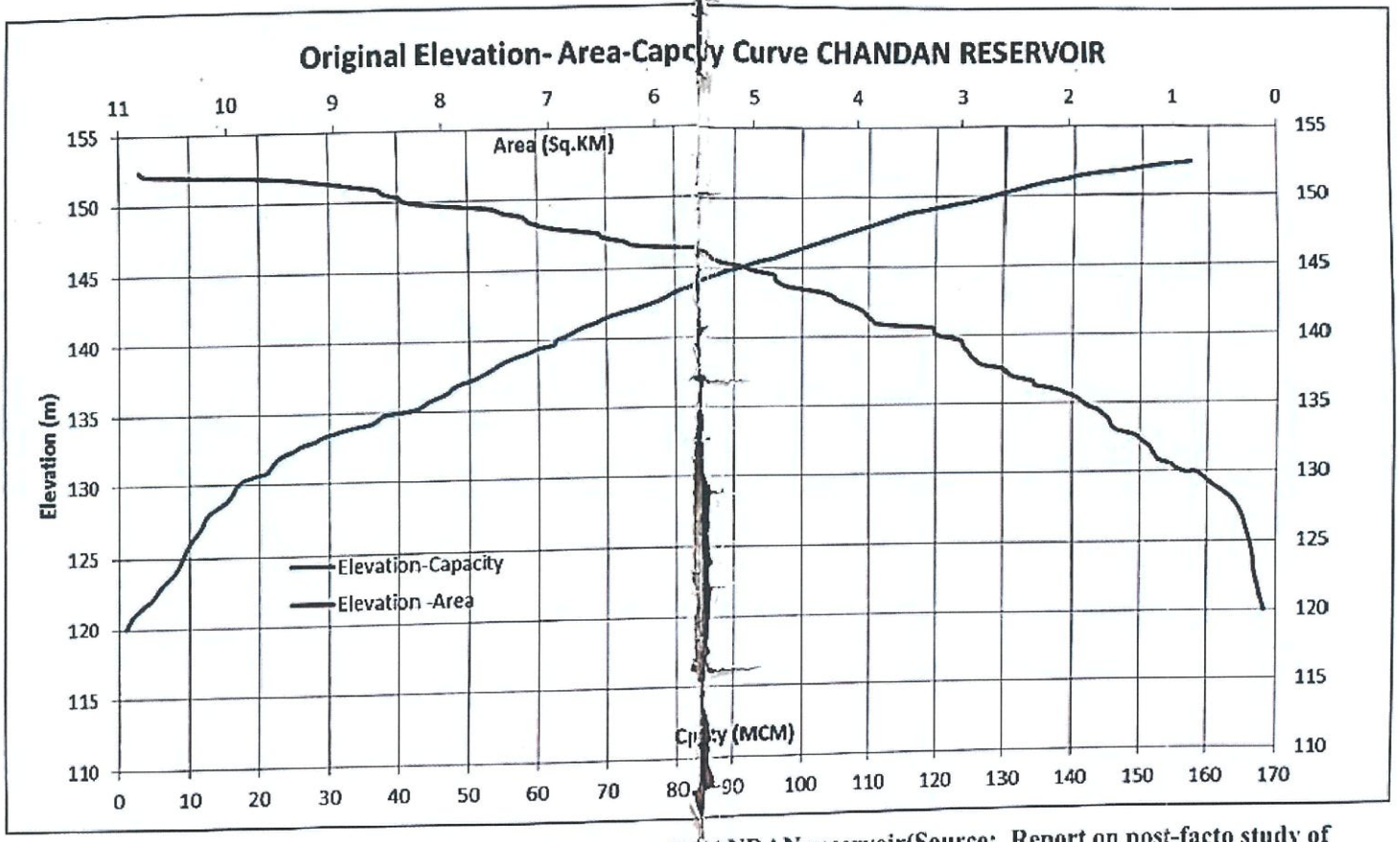

FIGURE 1 : Original Elevation –Area-Capacity curve of CHANDAN reservoir(Source: Report on post-facto study of chandan Reservoir Nov 1990)

1.5. Reservoir Silting

1.5.1. Its Importance

Reservoir silting may have both a long range and short range impact. The short range impact is its effect on the economics of project development. In the long range the large reservoir sites which are rare, they will be lost forever if such existing ones are allowed to fill by the sediment. Any effort to increase the useful storage capacity of such reservoir, should ascertain in the first hand the mechanics and rate of reservoir sedimentation, by proper estimation of sediment inflow into the reservoir. This would be based on the systematic capacity surveys of the reservoir undertaken. The effective ways of controlling/ combating the silting damage can be thought of only if a realistic assessment of sediment inflow into the reservoir is made.

1.5.2. Sedimentation Process

Sedimentation is a process initiated by the soil erosion, which is caused by moving wind and water. Water is the primary agent of erosion and transportation of eroded material. Wherever the flow is obstructed by the structure like Anicut, Lake, Barrage, Dam etc., the sediment contents are deposited and if the flow enters into a still water basin, the silt, clay and sand deposition takes place rather in a severe form. While natural erosion is a slow process, the disturbance of the historic geological formations, uncontrolled deforestation, forest fires, overgrazing, indiscriminate ploughing and agricultural practices caused by humans in the catchment area result in accelerated soil erosion leading to the large increase in sediment content in the streams and rivers.

Sediment deposition along stream or reservoirs is a complex process. It creates a variety of problems, the more important among them being raising of stream beds and consequent increasing of flood heights meandering and flow along the banks, choking up of irrigation canals and lastly the depletion of capacity in storage reservoirs.

Sediment measurements carried out have shown that the sediment has deposited not only in the dead storage space provided, as anticipated but also encroached in to the live storage space also.

It has also been noticed that in the basins where full integrated development has not yet taken place, the sedimentation rate in the downstream reservoirs has been significantly higher as a consequence of not having fully implemented the scheme in the upstream as originally envisaged in the integrated plan. Formation of delta in the upper reaches of the reservoir is

taking place with the building up of beds. Shrubs and other vegetation growth over them are favorable in trapping the sediment entering the reservoir, causing further damage.

1.6. Problems associated with Sedimentation in reservoirs

1.6.1. Upstream Consequences

a. **Storage loss**-The loss in the active storage capacity may reduce the capacity of the reservoir to deliver the benefits contemplated while planning the reservoir. If the spillway capacity provided in the dam is based on the usable flood storage available within the reservoir, sedimentation can render the dam unsafe, when such flood storage is lost.

b. **Delta deposition**: The coarser portion of the inflowing sediment load is deposited where the river enters the reservoir, forming delta deposit, which not only depletes reservoir storage, but also causes channel aggradation extending to many kilo Meter, upstream from reservoir. If delta deposition area at the start of the reservoir becomes heavily vegetated, the upstream flood level can get further and trap sediments, promoting additional aggradation.

c. **Abrasion**: In hydropower installations, there is a limit on the size of sediment particle entering turbines in order to protect the turbine runner, Pelton wheel blades and nozzles from undue erosion. The abrasion effect of rolling pebbles and the coarser sediments in steep stream may damage the provision of gate seals, outlet works, and apron and spillway profile.

d. **Ecology**: Changes in sediment load and sediment accumulation within the pool can alter the reservoir ecology, affecting fauna and flora in it. A large fraction of the organic, nutrients and contaminants occurs in the sediments brought in, and can may play a large role in the oxygen demand of the reservoir water.

1.6.2. Downstream consequences

Large environmental impacts are felt due to flow reduction, changes in sediment load, altered nutrient dynamics etc.

Stream morphology downstream of dams can be dramatically impacted by increase or reduction in supply of bed material. River channel degradation can increase bank heights and bank erosion rates, increase scour depth at downstream of bridges.

1.7.Justification / need for Desilting

Reservoir silting may have both a long range and short range impact. The short range impact is the effect of silting, and its effect on the economics of project development. In the long range as the large reservoir sites have become rare, they will be lost forever if such existing ones are allowed to fill by the sediment. Any effort to increase the useful storage capacity of such reservoir, should ascertain in the first hand the mechanics and rate of reservoir sedimentation, by proper estimation of sediment flow into the reservoir. This would be based on the systematic capacity surveys of the reservoir undertaken. Then only, effective ways of controlling/ combating the silting damage can be thought of.

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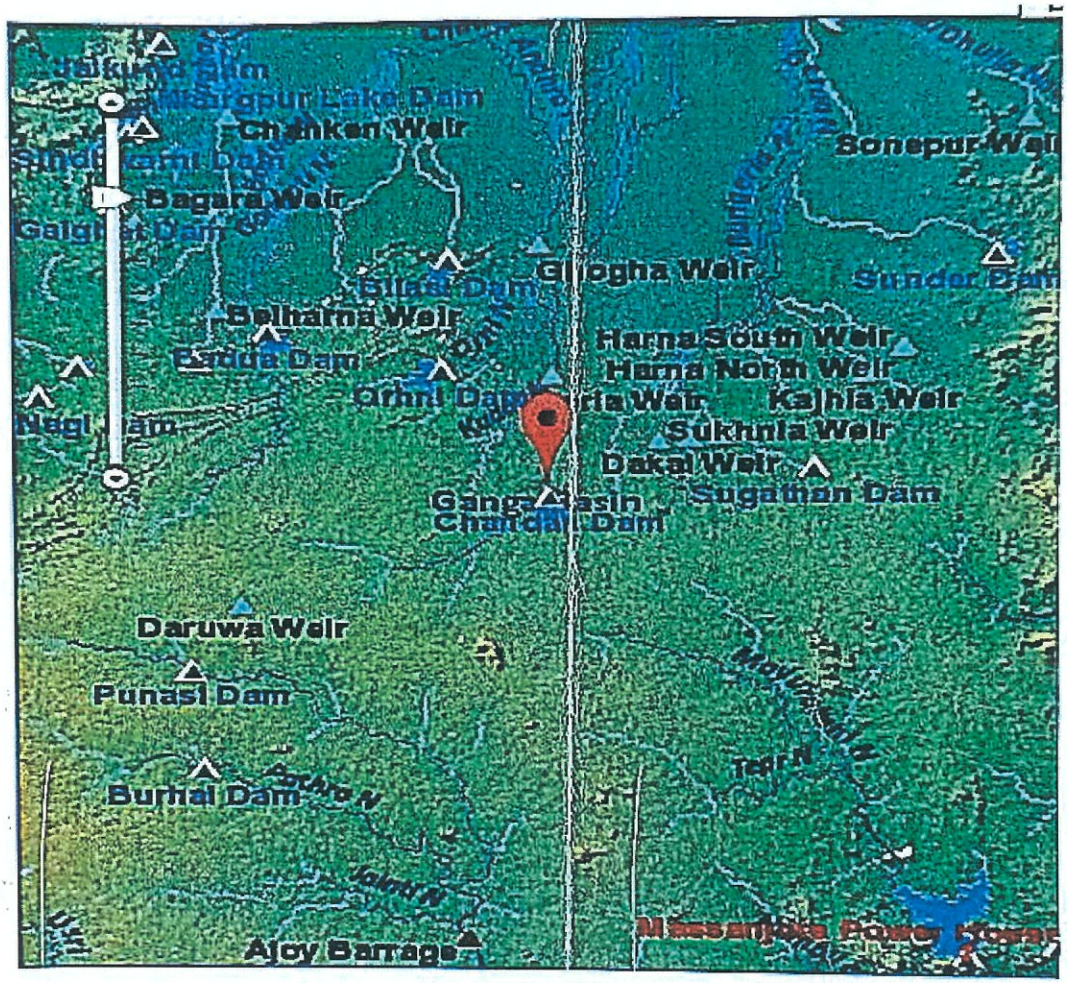
Chapter 2.
River

2.1. Chandan River

The Chandan river originates from north of Deoghar Hills, flows in an easterly direction and crosses the Eastren Railway Main line at Bhairukhi between Jasidih and Simultala railway stations. After flowing 23 km with an average bed slope of 1 in 350 it is met by its tributary Chhatini river on its right bank and bends in a north easterly direction. After about 10 km further downward when the slope flattens to 1 in 440, another tributary- River Dharwa, meets it on its right bank only about a kilometer below village Hathmania. It travels further 14.5 km in the same north-easterly direction with an average bed slope of 1 in 415 when its tributary, river Panchkotia meets it on the right bank just above Rasonia. From Rasonia the river moves in the northerly direction for about 3.2 km and its cuts through a range of hills and about 1.5 km upstream of Lakshmipur which is the present dam site. The bed of the river at this place is rocky and is located at elevation 119.82 m. The catchment area of the river at this site is 549 Sq.km. The Chandan dam was constructed at this site. About 15 km below this dam site a major tributary of the river named Kudar meets it on its left bank at Jamdaha. About 13 km above this confluence there is a site for dam across river. Kudar in village Kulharia where its catchment area is 1191.7 sq.km. About 6.5 km below the confluence with kudar, a 243.9 m long diversion weir had been constructed under Chandan Phase I across Chandan river at Ikoria (70km from source) from where a 1000 cusecs capacity canal takes off on the right bank. The catchment area of the river is 893.55 sq.km at this site comprising of 634.55 sq.km of river Chandan and 259 sq.km of its tributary river Kudar. Eight kilometers below the diversion weir the river is bridged by screw pile bridge on the Dhaka-Banka road at Banka. About 3 km below Banka at Nonihari a tributary named Orni meets it on the left bank. About 18km above this confluence, Orni reservoir project with a dam across the river Orni where its catchment area of 152.8 sq.km is nearing completion. About 18 km below Banka in village Gogha an inundation canal called Chandan Bilasi canal takes off on the left bank with a design discharge of 12.2 cumecs to feed river Bilasi which runs eight km west or river Chandan in a northerly direction. River Bilasi is not having good catchment area but has got very rich command suitable for paddy area under Bhagalpur district. The river Chandan about 11 km below Ghogha i.e. starts branching off into a number of channels with characteristics of a deltaic river. It fans out in a width of about 29 km and merges into a Tal (Low lying area) with one narrow and

deep channel falling in the river Ganga near Gogha Railway station on the Eastern Railway Loop Line.

Fig 2.1: WRIS Map showing various structures in Chandan River



2.2 Agro-Climatic Zones of Chandan Basin

According to the report of the Committee on Agricultural Productivity in Eastern India, Chandan Basin falls under East Alluvial Plains Zone. Districts included in this zone are Purnea, Kathar, Saharsa, Begusarai, Bhagalpur and Monghyr. It comprises alluvial plains of Kosi Mahananda the Ganges and its tributaries. The topography is slightly undulating to rolling with long stretches of nearly flat landscape. The area is full of streams, small lakes and shallow marshes. Vast areas in this zone remain water logged for a considerable part of the year. The dominant groups are (i) recent alluvium, (ii) tal land (iii) old alluvium grey heavy textured and old alluvium

yellow of foot hills. The soils especially the very light textured and old are poor in nitrogen and very poor to medium in phosphorus and potash.

2.3 Weirs/Barrages/Canals on the river

The Chandan Reservoir project is located in Bhagalpur district of Bihar state. The project is executed in phases during first to third five year plan. The project envisages a dam and number of Pickup weir on river Chandan. Low level canal takes - off from these weirs and high level canal directly takes off from the reservoir with six weirs to serve as level crossing on river namely Sukhanai, Dakai, Tribeni, Kajhai, Harna (S), Harna (N) which it crosses en-route and also to augment of canal supllies by diverting waters from these rivers as and when necessary. The various Components are as under:

1. **Ikoria Weir:** The weir is 312.5 meter long with under sluices 54.90 meter on left bank with peirs divide wall and abutment. The canal taking off from the weir is 7.86 km long & has discharge capacity of 25.75 cumecs.
2. **Pickup weir at Ghogha:** This diversion weir is further located downstream of Ikoria weir on river Chandan. Two canals takes off rom the weir namely Left bank canal and Chandan Bilas link canal takes off from 1.07 km of Link canal ex Left bank of Ghoga weir, The left bank canal is 19.51 km long and full supply discharge is 5.66 cumecs which is meant for providing irrigation to Kharif area of 5668 hectare. Chandan Bilas canal is 10.06 km long and its full supply discharge capacity is 6.51 cumec and Kharif command area is 6882 hectare.
3. **Chandan High Level Canal:** The canal is 105.60 km long of which 36.30 km falls in Banka district of Bihar and rest 69.30 km lies in Godda district of Jharkhand state. The design discharge capacity is 10.19 cumec which is to be maintained throughout its length by utilizing uncontrolled catchment of 6 weirs namely Sukhanaia, Dakai, Tribeni, Khajia, Harna North, Harna South.

   After the formation of Jharkhand the project is now an interstate between Bihar and Jharkhand. The CCA of the project is 89528 hectare and potential is 71600 hectare. The district benefitted are Godda, Bhagalpur & Banka.

The line diagram of Chandan Reservoir scheme is given in Figure 2.1

Chapter 3.
Hydrology

3.1. Climate and Meteorology

The climate of this district is characterized by hot summer and a pleasant winter season. The cold season starts in November and lasts till February. The period from March to the first week of June is the summer season and this is followed by the south-west monsoon season which lasts till the end of September. October is a transition month.

3.1.1. Rainfall

The rain gauges influencing the project catchment and the month wise normal rainfalls "the normals of rainfall are based on the data for the period 1951 to 2000" of respective stations are indicated under.

Normal Rainfall in mm

STATION	No. of Years of Data	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Annual
Banka	41	7.5	8.2	6.9	12.8	36.5	120.7	270.7	227.5	198	78.8	5	4.6	977.2
Baunsi	36	9.8	9.8	12.2	16.5	57.2	145.4	313.7	263.9	205.2	85.5	16.5	4.2	1139.9
Katoria	40	11.8	9.3	15.5	18.5	54.3	155.8	274.2	255.1	235.3	93.3	5.8	6.1	1135

3.1.2 Temperature Data

The meteorological observatory at Sabaur is considered representative for the project. The temperature data shows a steady increase of temperature after February. May is the hottest month with the mean daily maximum temperature at 41.6°C and the mean daily minimum at 19.1°C. January and February are generally the coldest months with mean daily maximum at 30.6°C in February and the mean daily minimum at 4.5°C in January. The mean daily maximum and minimum temperature as collected are presented in the table below:

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean Daily Maximum in °C	28	31.8	35.9	39.3	41.7	40.4	33.4	32.4	32.3	32.3	29.2	27.7
Mean Daily Minimum in °C	5.8	7.8	12	16	18.4	20.1	19.5	20.2	19.3	14.5	9.7	6.3

3.1.3 Evaporation

Monthly evaporation losses on the basis of Sabaur, in mm/day is given in the table below, and this is proposed to be considered in the simulation studies of the project

Mean Monthly Lake evaporation Rates in mm/day at Sabaur

Month	Jan	Feb	mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
Mesh covered data	1.5	2.8	4.7	6.7	6.5	5.4	4.2	4.1	3.9	3.1	2.2	1.5	3.9
Open Pan data	1.72	3.2	5.38	7.66	7.44	6.18	4.8	4.69	4.46	3.55	2.52	1.72	4.46
Lake evaporation data	1.03	1.92	3.77	5.36	5.95	4.94	3.84	3.75	3.12	2.48	1.52	1.03	3.12

3.1.4 Wind Speed and Direction

Wind is generally gentle except during the South West monsoon. During the South West monsoon season, wind blows from direction South West or West. In the post monsoon and winter season southerly or southeasterly winds prevail in the mornings while in the afternoons wind blows from directions between East and North. In the summer season wind blows from directions between South and North West. The mean wind speed data at Sabaur station is given in the table below.

Month	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Wind speed in km/hr	3.5	4.9	6	8.2	9.3	9	7.8	8.4	6.5	3.5	2.5	2.9	6

3.1.5 Humidity

The table given under gives relative humidity in % as observed at Sabaur observatory

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec

Relative Humidity in %	73	64	50	49	60.5	72.5	162.5	162.5	162.5	76	70	71.5

3.2. Characteristics of reservoir sedimentation

3.2.1. Apparent Changes

These include amount, distribution, configuration and composition of reservoir deposits. As water enters a reservoir, its velocity diminishes because of the increased cross sectional areas of the channel. If the water stored in the reservoir is clear and the inflow is muddy, the two fluids have different densities and the heavy turbid water flows along the channel bottom towards the dam under the influence of gravity. This condition is known as "stratified flow" and the underflow is called a "density current".

The magnitudes of these relative changes and their effects upon sediments deposition depends on many factors such as reservoir shape, channel slopes, relation of outflow to inflow and density differences.

3.2.2. Sources of sediments

The principal sources of sedimentation are

- Deforestation
- Excessive erosion in the catchment
- Disposal of industrial and public wastes
- Farming Practices
- River Channelization works
- Land development, highways and mining

3.2.3. Control of sedimentation

The measures, which can be employed to limit sedimentation and turbidity, are:

- Soil and water conservation measures within the drainage basin.
- Contour ploughing, strip cropping.
- Construction of small dams /ponds / terraces check dams in gullies.
- Revetment and vegetation cover.
- Evacuations of sediment in reservoir shoreline protection.
- Stream bank and flood plain protection.
- Ridge plantation.

3.3. Water availability & Water requirement

From the report "Post-Facto Study of Chandan Reservoir" it is gathered that the average annual rainfall is 1176.8 mm of Katoria Rain gauge Station. The average annual yield of Chandan Catchment is 292.3 MCM. The planning of the reservoir was based on the criteria that the required storage of the reservoir should be such as to meet the requirement of water during the critical period of Kharif. The total requirement of water which was proposed to be supplied from Chandan Reservoir including all the losses was 143.8 MCM against which live storage provided 135.7 MCM.

22.6.17 JE

21.6.17 AC

NOTARY
SUMITRA BHATTACHARYYA
City Civil Court
Calcutta
Regn. No. 086 of 2022
Expiry Date
31.03.2027
Govt. of West Bengal

Chapter 4.
Interstate Aspects

Not applicable

Chapter 5.
Investigation and Estimation of Desilting Requirement

5.1 Usefulness

Reservoir surveys are necessary to get more realistic data/estimate regarding the rate of sedimentation and to provide reliable criteria for studying the implications of annul loss of storage over a definite period of time with particular reference to reduction in the intended benefits in the form of irrigation potential, hydropower, flood absorption capacity and water supply for domestic and industrial uses etc.

Reservoir Sedimentation Surveys determine the amount of material deposited in a reservoir and show where and how far the deposition occurs. The practical objective is to assess more accurately the length of period before which the purpose of the reservoir is interfered with. The information will also be useful for,

a. Determining the prevailing and probable future sedimentation damages to a particular reservoir
b. Periodically correcting the capacity curve to assure more efficient operation.
c. In combination with similar data from other reservoirs preparing regional sediment production indexes for developing design data.
d. For determining the most effective and economical control measure needed to reduce the rate of sedimentation. Information on the density of deposited sediment is one of the important aspects of reservoir sedimentation study.

5.1.1. Status of the surveys

The sedimentation surveys of reservoirs in India although dates back to as early as 1870, the systematic surveys started only in 1958, when the task was entrusted to several research stations in the country. Under the scheme, 28 major reservoirs have been surveyed. Appreciating the gravity of the problem and the need for taking up remedial measures, the state Governments have also carried out capacity surveys of thirty important reservoirs in the country through consultants available in the field , one of the objectives being to introduce high technology in the field of capacity survey of the reservoirs.

5.1.2. Planning of the surveys

Central water commission reviewed the work of sedimentation surveys in fifties based on the data available for 200 reservoirs all over the world, and developed enveloping curves for annual sedimentation rate for major and minor catchments above and below 1000 sq miles (2560 sq.kms) respectively. It was then concluded that the sediment rate for major catchments varies from 0.357 to 0.476 mm/sq.km/year and for minor catchments from 0.38 to 1.28 mm/Sq.km/year.

The assumption that the sediments would settle within the dead storage intended for the purpose was not supported by the experience in India and other countries. That the sedimentation takes place throughout the reservoir was realized and also that the sediment inflow rates need to be checked up through reservoir surveys.

In 1974, CWC decided that 50 year sedimentation position of the reservoir should be used in the simulation studies for the project. This practice has become mandatory on the state governments while submitting detailed project report of major and medium irrigation projects.

These practices were also incorporated in the **IS Code: 12182 "Guidelines for determination of effects of sedimentation to planning and performance of reservoirs".**

The present practice as incorporated in IS: 12182 (1987) has following main features:

1. The sedimentation rate is to be decided on the basis of observations of river sediment flow and reservoir surveys.
2. Methodologies for trapping efficiency and sediment distribution have been specified.
3. The live storage is to be so planned that the benefits do not reduce for a period of 50 year (full service time) for irrigation or 25 year for hydropower on account of sedimentation.
4. The outlet levels are to be so planned that Sedimentation beyond the outlet, causing operational problems, would not occur for 100 years.

5. For simulation, if sedimentation is not serious, the conditions obtained at the end of full service period are to be used throughout the simulation period. If the problem is serious, studies are to be done by redistributing sediment and recalculating trap efficiency in 10 year blocks.

5.2. Techniques of Measurements of Sedimentation

There are broadly two methods for measurements of sedimentation in reservoir

(i) Stream flow analysis

(ii) Capacity Survey of the Reservoir

Stream flow Analysis is a continuous observation process consisting of measurements of inflows and outflows with sediment sampling .In this method, the sediment inflow into the reservoir including estimated bed load and the outflow there from are measured at all significant points of entry and exit. The difference gives the quantity of deposit during the period of analysis. The analysis consists of two main parts,

(i) Measurements of water inflows and outflows and

(ii) Simultaneous measurements of sediment concentration

In the capacity survey method, the depth of the reservoir are recorded with help of echo sounder along a Pre – determined range line across the reservoir , normally spaced up to one km apart , along the length of the reservoir. With the help of data collected from the site by the above surveys, the volume of silt deposited in the reservoir between two successive surveys is calculated.

5.3. Computation of Reservoir Capacity

5.3.1. Contour areas interval Method

Multiplying the contour interval with the average of lower and upper contour area.

For Example: If area with in the contour of E1 elevation is A1 and area for E2 elevation is A2.

Volume = (A1+A2)/2 * difference in elevation (E2-E1)

5.3.2. **Modified Prismoidal Method:** $VX = \frac{2h}{6}(A+4B+C) - Vy$

Where,

VX = the volume between the contours B&C.

A = the area of bottom contour.

B = the area of middle contour.

C = the area of top contour.

H = Contour interval

Vy = Volumes between A and B previously computed.

5.3.3. Grid Method

Grids of 100m x100m (or) 200m x 200m numbered serially are marked on the contour plan of reservoir spread. The junction level value of the grid is interpolated from the contours. The grid area multiplied by difference between FRL and the average bed over the grid gives the volume of water over that grid. Summing up the volumes of all grids will be the reservoir capacity. This is considered as more accurate than any other method.

5.4. Quantum of Sediments to be removed from Chandan Reservoir

5.4.1. Reservoir Capacity Surveys

For Chandan Reservoir, so far, two capacity surveys have been conducted during the years 2005, and 2015 respectively and found the reservoir capacities are as below.

Table 5.1 Reservoir Capacity Surveys

No	Year	Capacity (MCM)
1	1967 (Original)	157.263
2	2005	75.47
3	2015	56.23

The Chandan Reservoir water spread was also surveyed by satellite remote sensing techniques, in the years 2005-06. According to this survey, the reservoir silted as per their analysis is 52% of

the reservoir capacity as information received by the officials Irrigation Bounsi after 38 years of completion of Dam.

As per the WAPCOS survey carried out in 2015, the capacity the reservoir left is only 56.23M.cm i.e the reservoir silted as per the WAPCOS analysis is 64% as on date of survey May 2015. i.e after 48 years of completion of Dam

Details of capacity surveys and rate of silting of Chandan Reservoir are indicated at **Annexe - I** Further the net sediment deposition as has been computed from these surveys over the years is at **Annexe - II**

From these, it is seen that total sediment accumulation in the last 48 years (from the time the reservoir was impounded) which may be still be in the reservoir is about 101.00 MCM

Earlier, it was believed that sediment always get deposited at the bottom elevations of reservoir affecting the dead storage rather than depositing throughout the reservoir reducing the incremental capacity at all elevations.

5.5. Reservoir Capacity Surveys by WAPCOS (2015)

Reservoir capacity surveys are necessary to get more realistic data estimate regarding the rate of siltation and to provide reliable criteria for studying the implication of annual loss of storage over a definite period of time with particular reference to reduction of intended benefits in the form of irrigation potential, hydro power, flood absorption capacity and water supply for domestic and industrial uses etc. and periodic reallocation of available storage for various pool levels.

WAPCOS conducted the hydrographic and topographic survey of Chandan Reservoir (Chandan Dam) in banka district, Bihar, spot levels are observed at every 30 m grid (provided no feature is missed) in dry area with total station up to 1 m above MWL and or through Eco-sounder in submerged area from the bottom of reservoir. The Submergence area is about 1081 Ha . Survey team mobilized at the Bounsi on 07/05/2015 and the field work was completed on 03/07/2015.

Methodology & Procedure:

- Firstly a reconnaissance survey was done to locate the reservoir area to be surveyed.
- The field work was started simultaneously to establish control points (CP) both Horizontal and Vertical which was consider as the base point for the entire survey work.
- A close traverse survey have been conducted through the entire submerged area (up to RL of 158.1 m i.e. maximum water level + 1m) of the reservoir considering the existing Gauge Post (154.534m) as the reference Bench Mark. Level was established on control points with Auto Level instrument by DT leveling method. Co-ordinates reference was UTM co-ordinate system with GPS and was established on control points after close traversing by Total Station Instrument.
- With the help of control points detail Topographic survey have been conducted as per specification by Total Station instrument and 158.1m RL was marked on permanent features like Rock, existing pillars etc.
- Hydrographic survey was conducted by the combination of Total Station and Eco-sounder keeping on a boat with the reference of previously established control points.
- After downloading the data as collected by Total Station through Pro-link Software and Way-points Software for Eco-sounder transferred all those data to Auto-CAD. Thereafter the whole data were exported to Civil-3D Software.
- Detail Plan drawing have been prepared showing all features, contours, spot-level etc. and exported to Auto CAD for final Report.
- Hydrographic and Topographic survey of **Chandan Reservoir (Chandan Dam)** had been done by Total Station Sokkia 630R, Auto level DGS SUN 320, hand held GPS GARMIN Etrex 30 & Eco sounder GARMIN 580 with a boat, photograph taken during survey is given under Drawing II
- Detail Plan drawing have been prepared showing all features, contours, spot-level etc. and exported to Auto CAD. The surveyed map CHANDAN Reservoir is given Drawing II

Table 5.1 : LIST OF CONTROL POINTS

SL-NO	NORTHING	EASTING	RL	DESCRIPTION
1	2729188.492	491029.873	160.275	CW-1
2	2728883.177	490911.97	151.185	CW 2
3	2728631.585	490907.956	151.702	CW-3
4	2728369.21	490888.395	151.899	CW-4
5	2727968.817	490980.924	152.369	CW-5
6	2727639.698	490603.065	151.03	CW-6
7	2727176.845	490783.913	151.691	CW-7
8	2727085.091	490949.417	151.653	CW-8
9	2727050.249	491279.813	152.499	CW9
10	2727188.737	491503.026	151.685	CW10
11	2727367.029	491707.182	151.337	CW-11
12	2726936.845	491698.326	150.823	CW-12
13	2726644.509	491474.555	151.821	CW-13
14	2726597.466	491127.122	151.119	CW-14
15	2726147.573	490909.808	152.773	CW-15
16	2725496.932	490561.633	153.705	CW-16
17	2725523.31	490084.823	151.89	CW-17
18	2725402.709	489471.495	154.523	CW-18
19	2725295.654	489535.727	156.677	CW-19
20	2725435.23	490026.715	158.387	CW-20
21	2725348.735	490331.841	153.649	CW-21
22	2725544.756	490849.665	152.074	CW-22
23	2725941.779	491026.527	151.765	CW-23
24	2725938.04	491395.228	159.074	CW-24
25	2725610.273	491729.803	152.281	CW-25
26	2725852.87	492076.434	151.186	CW-26
27	2725974.619	492463.398	151.865	CW-27
28	2726359.795	492690.358	152.63	CW-28
29	2726455.402	493004.018	149.365	CW-29
30	2726681.431	493064.461	147.806	CW-30
31	2726970.024	492879.643	150.101	CW-31
32	2727113.237	492773.565	150.469	CW-32
33	2727510.22	492614.222	149.489	CW-33
34	2727591.102	492179.572	148.8	CW-34
35	2728042.587	492138.397	149.466	CW-35
36	2728398.69	492101.831	151.178	CW-36
37	2728751.828	492172.704	149.366	CW-37
38	2728807.718	492134.794	137.01	CW-38

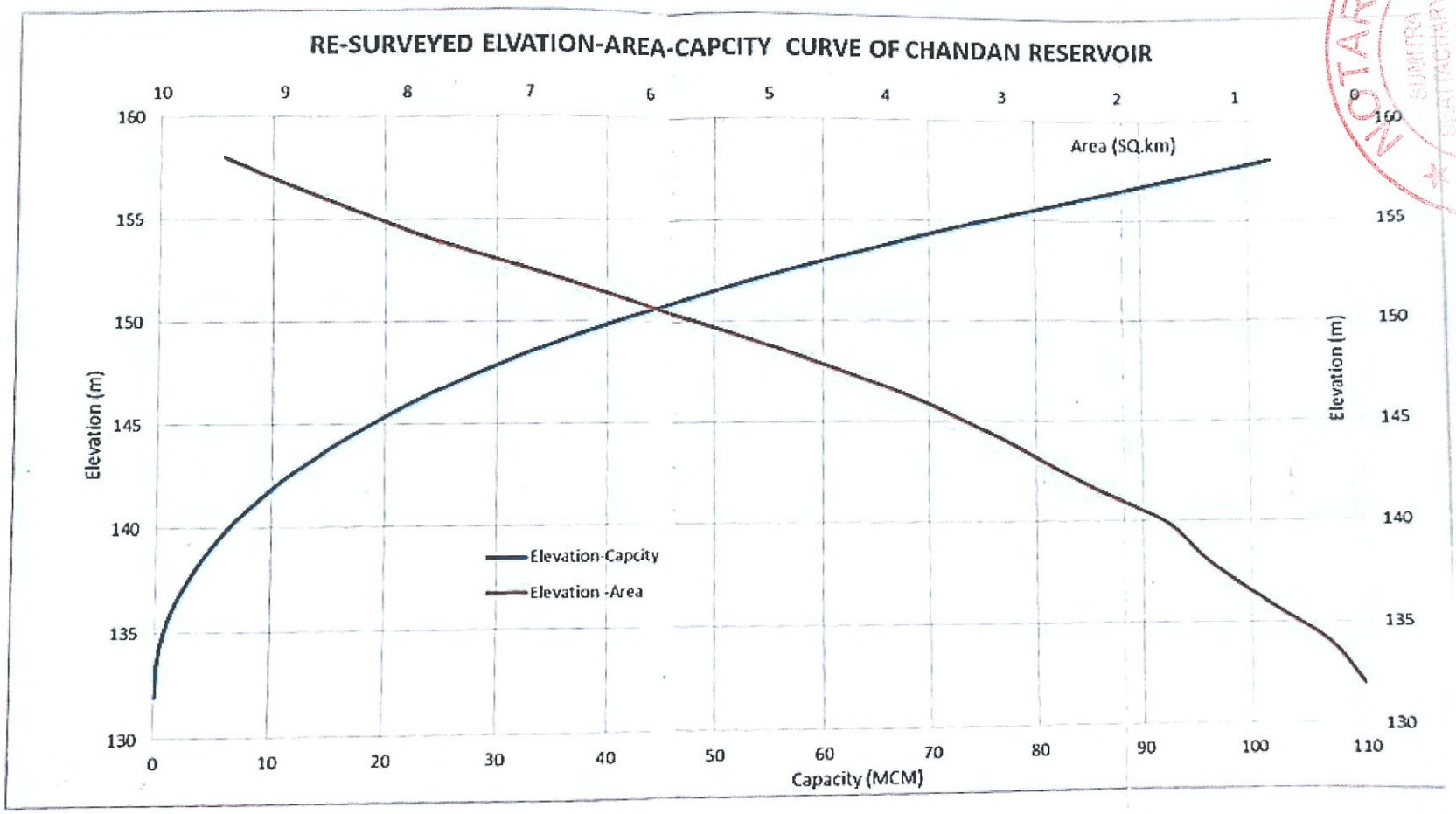
39	2725321.833	489324.187	156.573	CW-39
40	2725168.247	489572.326	155.111	CW-40
41	2725053.707	489485.846	163.238	CW-41
42	2724673.623	489042.631	162.608	CW-42
43	2725350.109	489033.244	155.61	CW-44
44	2725306.64	488793.262	160.279	CW-44
45	2725422.672	488395.754	157.799	CW-45
46	2725353.872	488187.597	158.477	CW-46
47	2724973.182	488049.526	158.899	CW-47
48	2724943.302	487880.643	162.547	CW-48

Table 5.2 : Re-Surveyed Elevation-Area Capcity Table Of Chandan Reservoir By WAPCOS IN 2015

ELEVATION (M)	AREA (SQ KM)	Capcity (MCM)
132	0.000	0.00
134	0.266	0.27
136	0.769	1.30
138	1.260	3.33
140	1.635	6.23
142	2.353	10.21
144	2.990	15.56
146	3.692	22.24
148	4.609	30.54
150	5.606	40.76
152	6.683	53.05
154	7.767	67.50
155	8.231	75.50
156	8.672	83.95
157	9.098	92.83
158	9.480	102.12

Kishore 22-6-19 JE.

22.6.19 AE



5.6 Silting Of Reservoir

The Report of the Govt of India's National Commission of Integrated Water Resources Development implies that

- We are losing about 1.3 BCM of storage capacity each year. That should be alarming enough for everyone as at today's rates creation of 1.3 BCM storage capacity would cost Rs 1448 crores. That means that on an average, each day we are losing Rs 4 crores worth of storage capacity through siltation.
- Heavily silted reservoirs As revealed by the SRS studies, some of the heavily silted reservoirs of India are listed below.
- Matatila 38% gross capacity lost between 1956 and 1998-90. The dead storage up to the original Minimum Draw Down Level (MDDL) of 295.66 m is completely filled with silt. Even further level upto 296.15 m is now completely filled with silt. Total capacity loss by 1999 = 430.47 MCM (million cubic meters).
- Gumti (Tripura): Lost 63.83 MCM, that is 20.4% live storage capacity in 19 years.
- Maithon 25.29% Live Storage Capacity silted up in 46 years.
- Kadana 12.85% LS capacity (278.6 MCM) silted up in 11 years.
- Srisailam 2013.33 MCM or 28.096% live storage capacity lost in 15 years.
- High Siltation Rates In case of at least 14 of the 23 reservoirs, the actual siltation rate was found to be higher than the design siltation rate, as given in table below. The comparison was not possible in a number of other cases as the design rate is not given in the SRS reports.
- Actual Vs Design Siltation Rates

Reservoir	River	Design rate,	Actual rate, mm/year	Actual rate as
Gumti (Tripura)	Gumti	0.362	9.94	2746
Kyredemkulai	Umtru	0.138	0.144	104.35
Halali (MP)	Betwa	0.476	2.032	427
Matatila (UP)	Betwa	0.132	0.370	280.3
Parbati (Rajasthan)	Parbati (Chambal)	0.157	0.524	333.8
Ramsagar	Bamani (Chambal)	0.081	0.274	338.3
Kadana (Gujarat)	Mahi	0.13	1.146	881.5
Panam (Gujarat)	Mahi	0.357	0.475	133.1
Isapur (Mah)	Penganga	0.357	0.379	106.2
Mayurakshi	Mayurakshi	0.364	0.696	191.2
Maithon	Damodar	0.905	1.282	141.7
Sondur	Mahanadi	0.357	5.768	1615.7

Rengali (Orissa)	Brahmani	0.39	0.427	109.5
Kallada (Kerala)	Kallada	1.45	4.78	330
Ukai (Gujarat-1992)	Tapi	0.149	0.814	546.3

- Note: Most design siltation rates are given for gross storage, while the actual rates above are for live storages.

  This study is carried out by Himanshu Thakkar and Swarup Bhatacharya , siltation rate of Chandan reservoir will also be worked out and analysis shall be incorporated in the DPR.

5.7. Soil Profile of the Sediment Deposited

The spread of the sediment deposits across the reservoir area, especially location of zones of concentrated quantum of deposits is difficult to ascertain properly unless elaborate surveys in grid pattern covering the entire reservoir is undertaken. However, conceptually it can be said that the coarser sediments are dropped right at the place; the river flow meets the still reservoir body, to form a delta at the location. Finer particles travel further downstream along with the density currents to settle and form a muddy lake right at the dam face.

5.8. Soil Sample analysis

Soil Samples have been collected from the auger holes through the reservoir, from the location as indicated in the reservoir water spread is shown in **Annexe –V**. The results of the gradation analysis carried out on the 24 samples are indicated at **Annexe – IV.**

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22.6.19 AE

SITE PHOTOPGRAPHS

FIGURE- 5.1 : TOPOGRAPHICAL SURVEY BY TOTAL STATION

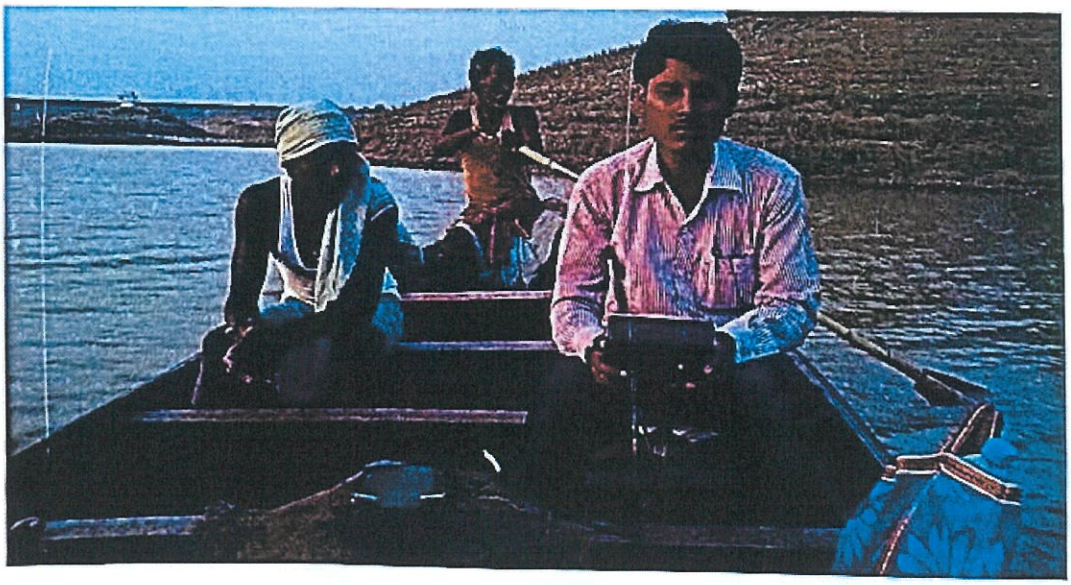

FIGURE 5.2 : HYDROGRAPHIC SURVEY OF CHANDAN RESERVOIR BY ECO-SOUNDER:

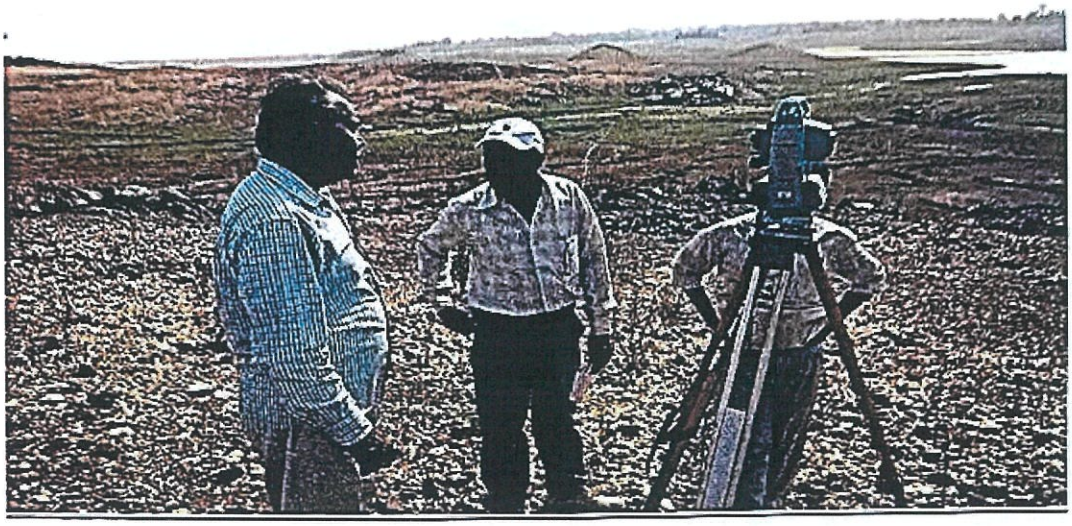

FIGURE-5.3 : TOPOGRAPHICAL SURVEY BY TOTAL STATION

Chapter 6.
Desilting Approach and Methodology

6.1. General

The Problem of sedimentation of the reservoir and its effect on useful life of the reservoir is complex and had been the matter of study over many years .In strict terms ,reservoirs do not have a defined 'life'. This can be of two functional statuses - ON and OFF. They belong to the system which shows gradual degradation of performance without any sudden non – functional stage. They can be classified under the following phases.

Phase - I: The reservoir shows no adverse effect and is able to deliver full planned benefits for which it was created known as **Full Service Period.**

Phase – II: The reservoir delivers progressively smaller benefits, but its continued operation for the reduced benefits is still economically beneficial known as **Feasible Service Period.**

Phase – III: The sedimentation causes difficulties in operation such as jamming the passage of flow in channels or flow in canals or through turbine known as **End of physical life.**

Phase – IV: The phase - III difficulties become so serious that the operations become impossible known as **End of Economical life.**

Phase- V: The benefits reduce to such an extent that it is no longer beneficial to operate the reservoir

6.2. In Practice

Life of a reservoir is the period of its service for the designed purpose. When the reservoir reaches 30% of its original design capacity on account of sedimentation etc., it can be no longer useful for the purpose for which it has been created to serve.

6.3. Methods for Estimating the Life of the Reservoir

Several methods are considered and adopted.

- Hachiro Kira of Khagwa University, Japan has developed the following equation for the Life of reservoir.

$$C_I = 0.214\,(C / I)^{-0.473}$$

$$\text{and } Y_s = 467\,(C / I)^{0.473}$$

Where,

C1 = Sediment rate in percent

C = Original capacity in m3

I = Average annual inflow m^3

Ys = Average number of years during which the silt will fill up the reservoir

- **Taylor method of Texas University,**

  USA evaluated the following equation for the capacity of reservoir after 'n' years from its inception.

  Cn = Capacity after 'n' years = CRn

  C = Original Capacity

  R = Ratio of capacity of reservoir after one year to that of the previous year

- **Trap Efficiency Method**

Gunnar Brune has developed envelope curves keeping the capacity inflow ratio as abscissa and trap efficiency as ordinate on a semi log paper. Using the median curve of the graph and capacity inflow relations for different capacities, the average trap efficiency is found out. Sediment load trapped is calculated from the above value and dividing the volume interval by sediment load will give the number of years to be filled up the reservoir volume. The years required to fill up the volume intervals 30% of its original capacity is worked out and adding to get the useful life of the reservoir.

6.4. Available methods.

In case of usage of earth moving machinery, obviously their entry into the reservoir will be for limited stretches, up to the point where the depth of water will not affect the machine. Further the sediment being in a submerged condition, will have added weight of water. As for the suction dredger / pumping, these may be preferred for the reservoir. But the disadvantages are that a significant quantity of the reservoir water stored will also be lost in the pumping. The desilting operation itself being ideally planned when the reservoir is at low stage, losing so much of stored water cannot be afforded to.

The method that will be used presently is by employing earth moving machineries of medium capacity and then trekking the collected sediment by means of heavy duty tipper, from the dam communication will be through existing roads to dumping yard.

6.5. Acceptable method

Hence the acceptable methodology would be to locate a number of places of entry into the river bank, which have convenience connection to the main road running parallel to the bank ramp for the tipper to enter the river by utilizing multiple entry point approaches the entire desilting can be done by arranging suitable number of trips per day.

6.5.1. Direct Benefits from the Desilting

The most direct benefit from the reservoir desilting scheme would be increase in the quantum of water available mainly for irrigation purposes, followed by the others such as drinking water supply etc.

The gross capacity of Reservoir at FRL was 157.23 MCM, when the project got completed in the year 1967-68. As per Reservoir survey carried out in the year 2015, by WAPCOS the gross capacity has come down to 56.23 MCM Thus the loss in the capacity had been nearly 101.00 MCM , if the dead storage capacity of 21.49 MCM is deducted, the real loss of usable water on account of sedimentation works out of 79.51 MCM

6.5.2. Other benefits

Next to the availability of additional quantum of stored water year after, the major onetime benefit would be the availability and usage of the sediment collected over the 48 years. The sediment collected and removed in the operation that may be carried out for say 7 months every year for 9 years when the reservoir is at its low storage.

6.6. Approach to the river for desilting operation

6.6.1. Accessibility to the River bed for desilting

The approach roads area proposed along the left side periphery of the reservoir and connecting existing road near the dumping side. The left side approach road will facilitate for desilting of all Zones as shown in the lead plan with an average lead of 5 km.

6.7.Dumping yard

6.7.1. General

Water spread area of Chandan reservoir is shown in Drawing - III. The map shows the reservoir rim in its entire length. It may be seen that the reservoir is surrounded by Forest area, requiring permission even for entry.

6.7.2. Location chosen

After Reconnaissance survey, the location selected in concerned with respective officials of Chandan reservoir, Department suggested the area d/s of the dam. The average lead from the desilting location to dumping yard is about 5 km. The dumping activity will be in concurrence with the demand for material by the various departments such RCD, Building etc.

6.8. Usage of the Sediment Removed

6.8.1. Use for Construction of building activities

The desilted material consist of coarse sand, fine sandy and silty material. The adjoining towns such as Banka and Bhagalpur have a lot of building/ construction activities and the construction material is in great demand. The collected material can be utilised for making bricks and can be used for other construction activities, about 11.71 MCM of desilted material is proposed to be used for these activities like making bricks, other construction activities like road embankment filling of low lying area etc .

6.9. Time period involved

The dumping area identified is about 319 Ha available just d/s of dam which belongs to Irrigation department and adjoining forest area, Quantum of sediment involved is being 79.51 MCM (Million Cubic Meter) the period involved will not be less than 9 years. Hence per year the sediment to be removed is 79.51/9 =8.8 MCM

6.10. Logistics of Transportation

6.10.1. Consider, the quantity of silt to be remove from above Dead storage level

Consider a total fleet of 150 tipper of 10 cum capacity tipper being pressed into service, and each tipper able to make 30 round trips per day, the total quantities that can be moved per day work out to 45000 cum. Considering 200 days working in a year, Per year, the quantum moved will be 45000 x 200 days = 9.0 MCM For removing 79.51 MCM silted material at this rate will take 9.0 years.

6.11. Dumping area utilisation

The identified dumping area of 64 Ha, which is just d/s of the dam, which is government land as shown in drawing no.III.

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Chapter 7.
Cost Estimation

7.1. General Abstract of Cost

No.	Particulars	Amount in Lakhs	Remarks
I	Direct Charges of Works		
1	A- Preliminary	20	
2	B- Land	100	
3	C- Works	Nil	
4	D- Regulators and Measuring devices	Nil	
5	E- Falls(for canals only)	Nil	
6	F- Cross Drainage works(for canals only)	Nil	
7	G- Bridges (for canals only)	Nil	
8	H- Escapes	Nil	
9	I- Navigation works	Nil	
10	J- Power plants civil works	Nil	
11	K- Buildings	Nil	
12	L-for canals only	Nil	
	Earth work of canal including lining	Nil	
13	M-Plantation	200	
14	N- Tank and Reservoir	1,53,225.92	
15	O- Miscellaneous	200	
16	P- Maintainace	Nil	
17	Q- Special T and P (LS)	Nil	
18	R- Communication (LS)	Nil	
	Total cost of I works	**1,53,745.92**	
	Grand Total	**1537.46 Cr.**	

Desilting and Transposal

No.	Description	Amount (Rs) in Lakhs	Remarks
Desilting of Chandan Reservoir			
1	Total Cost of desilting of reservoir and transposal of same to dumping location	1,53,225.92	Details enclosed
	Total	1,53,225.92	

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Chapter 8.
Project evaluation

8.1.General

Normally for any project, there will be certain specified benefits achievable on completion of the project. The benefits will be in the form of area brought under irrigation, increase in yield, etc. Against known estimate of cost, the benefits/cost Ratio can be worked out But in this, the only Direct known benefit will be increased availability of stored water. The following benefits are likely to accrue.

8.2.Agriculture Production

The crop water requirement by modified Penman method program for Rabi crops of medium variety in the area works out to be 216 ha/MCM for Wheat, 146 ha/MCM for Pulses, 220 ha/MCM for Vegetable and Mustard 220 ha/MCM Thus with the saving /additional availability of water on account of removal of sediments of 101.00 MCM total, the 79.51 MCM from the live storage of the reservoir will be available. This will involve a 9 year operation for availing the entire benefit. For the first year, due to availability of about 9.0MCM of water on desilting, the area that can be brought under irrigation is about 1740Ha as depicted in the table below.

Table 8.1: Increase in Agriculture Production after Desilting

Total Live Storage available after desilting				79.51	MCM
Rabi (crops)	Irri (Ha/MCM)	% of crops as per designed cropping pattern	Water available for irrigation (MCM)	Area to be brought under irrigation after desilting (ha)	
wheat	216	25	19.88	4294	
Pulses	146	50	39.76	5804	
Vegetable	220	10	7.95	1749	
Mustard	175	15	11.93	2087	
		Total	79.51	13934	

Table 8.2: Benefit due Agriculture Production after Desilting, Annually

Total Live Storage available after desilting in a year						9 MCM	
Rabi (crops)	Ha/MCM	% of crops as per designed cropping pattern	Water available for irrigation (MCM)	Area to be brought under irrigation (ha)	Benefit (Rs/ha)	Benefit Per year	
wheat	216	25	2.25	486	44324	21541464	
Pulses	146	50	4.50	657	49280	32376960	
Vegetable	220	10	0.90	198	91000	18018000	
Mustard	175	15	1.35	236	56000	13230000	
		Total	9.00	1577	240604	85166424	say 8.52 Cr.

Table 8.3: Benefit due Agriculture Production after Desilting, till life of Reservoir (which is 82 yrs as Original design)

Benefit	INR (Crore)		
After 1yr	8.52		
After 2yr	17.04		
After 3yr	25.56		
After 4yr	34.08		
After 5yr	42.6		
After 6yr	51.12		
After 7yr	59.64		
After 8yr	68.16		
After 9yr	76.68		
	383.4		
Benefit After complete desilting for another 25 yr as per the estimated life of Project		1917	Crore
Net Benfit after delsiting by agriculture till the life of reservoir		2300.4	Crore

Thus a total benefit of Rs 8.52 crores on account of availability of additional water may be expected from agriculture production per annum.The life of reservoir is worked out in the original DPR is 82 years

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8.3. Cost estimate for Desilting of Reservoir

8.3.1. Cost of Excavation with lead (consider silt to be removed in above DSL)

Abstract Estimate

No	Description	Unit	Quantity	Rate Rs Ps	Amount in Rs
1	**Desilting / Excavation**				
	Earth work by excavator and spreader or tractor leveler in lower level canal or flood embankment or dhar (like Minor, Sub-minor, Jamindari bund, Pynes etc. where tipper is not needed) all types of work like filling and making of canal banks or embankment of earth free from logs, roots or any other gradients, desilting of canal bed and dhar in proper profile with dressing and finishing including new construction, repair or restoration in ordinary soil including cutting, loading, carriage from pit to banks or embankments, unloading, spreading, clod breaking and laying in layers properly with lead below 15 metre and with all lifts all complete job as per specification and direction of E/I. (mode of measurement-sectional measurement of compacted earth)	Cum	79510000	59.0	4691090000
2	Carriage of Materials [Lead 5 km (4 unsurface + 1 kaccha)				
	a) Earth	Cum	79510000	121.90	9692269000
a.	**Total**				**14383359000**
b.	1% cess on Total				143833590
c.	5% GST on Total				719167950
d.	**Gross Total**				**15246360540**
e.	0.5 % CNC on Gross Total				76231802.70
	Grand Total				**15322592342.70**
				Say	**1532.25 Cr.**

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31.03.2027
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8.3.2. Rate Analysis

Earth work by excavator and spreader or tractor leveler in lower level canal or flood embankment or dhar (like Minor, Sub-minor, Jamindari bund, Pynes etc. where tipper is not needed) all types of work like filling and making of canal banks or embankment of earth free from logs, roots or any other gradients, desilting of canal bed and dhar in proper profile with dressing and finishing including new construction, repair or restoration in ordinary soil including cutting, loading, carriage from pit to banks or embankments, unloading, spreading, clod breaking and laying in layers properly with lead below 15 metre and with all lifts all complete job as per specification and direction of E/I. (mode of measurement-sectional measurement of compacted earth)

Rate Derived from SR Item.No.5.1.47 Govt. of Bihar WRD
Basic Rate = Rs 59/ cum

(A)	Cost of cutting, loading , unloading & placing by excavator 1 m^3 capacity					
	Use rate of Excavator(Rupees per hour)			1958		
	Output of Excavator = 60 Cum per hour					
	Cost				32.63	
(B)	Cost of spreading by D-80 Dozer					
	Use rate of D-80 Dozer(Rupees per hour)			5598		
	Output of D-80 Dozer =300 Cum per Hour					
	Cost				18.66	
(C)	For dressing & finishing one labour for 100 m^3					
	Unskilled labour	0	No.	268	0	
					51.29	
	Add Overhead charge & C.P@15%				7.69	
					58.99	
					58.99	58.99
		Say Rs.		59	Per m^3	

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CARRIAGE OF MATERIAL BY TIPPER OF 5.5 CUM CAPACITY INCLUDING OVER HEAD CHARGES & C.P.

Sr.No	Name of Materials	Unit	Gross Tipper Capacity per trip	(FOr void) Multiplying Factor	Net Tippeer capacity (Payable Qyantity) Per Triop	Cost of loading,Unloading & Stacking per Trip Of Tipper (Tipper capacity 5.5 cumx Xa)	Cost Of Haulage Per cum			Cost of Haulage per Tipper of 5.5 cum capacity (Tipper capacity 5.5cumx H)			Lead in KM			Cost of Carriage= [(5.5Hsa.Ls+5.5Hua.Lu+5.5Hka.Lk)+5.5Xa]	Per Unit Rate =(col17/Net Payable capacity)
							For Surface Road	For Unsurfaced graveted Road	For Hatcha track & Track in river bed/ Nallah bed & Choe Bed	For Surface Road	For Unsurfaced graveted Road	For Hatcha track & Track in river bed/ Nallah bed & Choe Bed	For Surface Road	For Unsurfaced graveted Road	For Hatcha track & Track in river bed/ Nallah bed & Choe Bed		
						$5.5X_a$	H_{sa}	H_{ua}	H_{ka}	$5.5H_{sa}$	$5.5H_{ua}$	$5.5H_{ka}$	L_s	L_u	L_k		
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	Lime, Moorum, Rubbish	M^3	6	1	6	0	14.70	17.70	35.60	80.85	97.35	195.80	INPUT	INPUT	INPUT	#VALUE!	#VALUE!
2	Earth	M^3	6	0.8	4.8	0	14.70	17.70	35.60	80.85	97.35	195.8	0	4	1	585.20	121.9
3	Manur or Sludge	M^3	6	0.92	5.52	0	14.70	17.70	35.60	80.85	97.35	195.80	INPUT	INPUT	INPUT	#VALUE!	#VALUE!
4	Excavated Rock (120lbs)	M^3	6	0.67	4.02	0	14.70	17.70	35.60	80.85	97.35	195.80	INPUT	INPUT	INPUT	#VALUE!	#VALUE!
5	Stone metal (above 50 mm)	M^3	5.4	0.85	4.59	0	14.70	17.70	35.60	80.85	97.35	195.80	INPUT	INPUT	INPUT	#VALUE!	#VALUE!
6	Boulder	M^3	6	0.8	4.8	0	14.70	17.70	35.60	80.85	97.35	195.80	INPUT	INPUT	INPUT	#VALUE!	#VALUE!
7	Stone chips / Sand /	M^3	5.4	0.92	4.99	0	14.70	17.70	35.60	80.85	97.35	195.80	3	0	0	242.55	48.6
8	Soling stone	M^3	5	0.85	4.25	0	14.70	17.70	35.60	80.85	97.35	195.80	INPUT	INPUT	INPUT	#VALUE!	#VALUE!

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8.4. Generation of Revenue cost

The Government of Bihar has fixed rates for Sand, Silt & Clay at Rs 64.02 / cum and Rs 20 / cum respectively vide (Rate Derived from SR CH-II, Govt. of Bihar WRD, and P.No.15 for 2014 for sand) for Silt and clay as adopted by Govt of Tamil Nadu.

The de silted material will be conveyed to the dumping yard / intermediate storage area and stacked. It is required that the material will be made available at this single point from where the end user / consumer has to make his own arrangements to transport it by paying the above charges to the department.

The revenue generated on account of this would be about **Rs 55.32 crores** only as indicated below

Table 8.1 Total quantity of minerals from desilting quantity

Total quantity of minerals from desilting quantity			
No.	**Description**	**Unit**	**Quantity**
1.	Sediment to be removed from reservoir	MCM	79.51
	According to soil sample analysis,		
2.	Silt & Clay is 6% of the total sediment quantity	MCM	4.77
3.	Sand is 9 % of the total sediment quantity	MCM	7.15

Note:

These percentage figures are obtained from the soil sampling test conducted by the WAPCOS.

Table 8.2 **Total cost for selling minerals from desilting quantity**

Total cost for selling minerals from desilting quantity				
No.	**Description**	**Rate per Cum(RS)**	**Quantity (Cum)**	**Cost in RS**
1.	Revenue cost of Silt & Clay	20	4770600	95412000
2.	Cost of Sand	64.02	7150000	457743000
3.	Sub Total Cost of the minerals			553155000
4.	Adding for miscellaneous and round off			45000
5.	Total Cost of the minerals			553200000
6.	Say in crores			55.32

Chapter 9.
Conclusions

9.1. General

Chandan reservoir project has a catchment area of 549 sq.km and is an Irrigation scheme. The dam was constructed in the year 1967 across the river Chandan at Latitude 24^0 40' 27" N and Longitude 86^0 55'00" E near village Laxmipur under Bounsi block of Banka District in the state of Bihar. The Dam is approached by Bhagalpur, Dumka, Deoghar National High way. The dam site is connected by 22.86 Km pucca road from Bounsi which is 50 Km from Bhagalpur and 50 Km from Dumka. The reservoir was impounded in 1967 for the first time. The earthen dam has a length of 1554 Meters. At chainage 43.00 an outlet has been constructed for irrigation purpose to feed the water in Chandan high level Canal. At chainage 51.00 to chainage 56.40 a spillway has been constructed to spill surplus water in the flood period beyond the FRL i.e 152.44 m (500 ft)

The reservoir formed has a gross capacity of 157.23MCM, the live capacity being 135.74 MCM

As per the survey conducted by WAPCOS in May, 2015 the gross capacity of 157.23 MCM of the reservoir in 1967 has been reduced to 56.23 MCM, on account of the sediment accumulation over the 48 years .Thus 79.51M cum lost due to sedimentation, leaving aside the dead storage capacity of 21.49 MCM, is restored on desiltation.

The methodology proposed is to approach the river through earth moving equipment to remove the sediment and load them by heavy 10 cum tipper and move them out. The approach to the reservoir is good.

The dumping area identified is about 64 Ha available just d/s of dam partly belongs to Irrigation department. Quantum of sediment involved being 79.51 MCM, the period involved may not be less than 9 years. Hence per year the sediment to be removed will be 79.51/9=8.8 MCM

At the 2017 Rates, the cost works out to Rs. 1,537.46 Crores, spread over a period of 9 years.

9.2. Benefits

Against the expenditure the benefits that may accrue will be.

a) Direct benefits 2300.4 crores at the end of 34 years on account of availability of additional water for agriculture.

b) In direct benefits such as usage of sediment application as manure, for brick making raising tank bunds etc. will fetch around Rs.55.32 crores.

9.3. Disposal plan: The dumping area as identified for disposal of silt from the Chandan reservoir is about 64 Ha available just d/s of Dam which under Irrigation division Bounsi.

1. Excavation of the different zones demarked in the reservoir area will be taken up as per the prevailing site condition.
2. Approach road to excavation area should be maintained properly at the desired gradient for smooth moving of machinery.
3. The dumping activity will be in concurrence with the demand for material by the various departments such RCD, Building etc.
4. For dumping surplus material, if required adjoining private or government land can be acquired in future with the lead of 5 km.

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~~85~~ "Annexure - B"

GOVERNMENT OF BIHAR

(WATER RESOURCES DEPARTMENT)

DESILTING OF CHANDAN RESERVOIR

Annexe - I

Capacity Survey of CHANDAN RESERVOIR in BIHAR

In 2015 by WAPCOS

Annexe: - I

Re-Surveyed Elevation-Area Capcity Table Of Chandan Reservoir By WAPCOS IN 2015

ELEVATION (M)	AREA (SQ KM)	Capcity (MCM)
132	0.000	0.00
134	0.266	0.27
136	0.769	1.30
138	1.260	3.33
140	1.635	6.23
142	2.353	10.21
144	2.990	15.56
146	3.692	22.24
148	4.609	30.54
150	5.606	40.76
152	6.683	53.05
154	7.767	67.50
155	8.231	75.50
156	8.672	83.95
157	9.098	92.83
158	9.480	102.12

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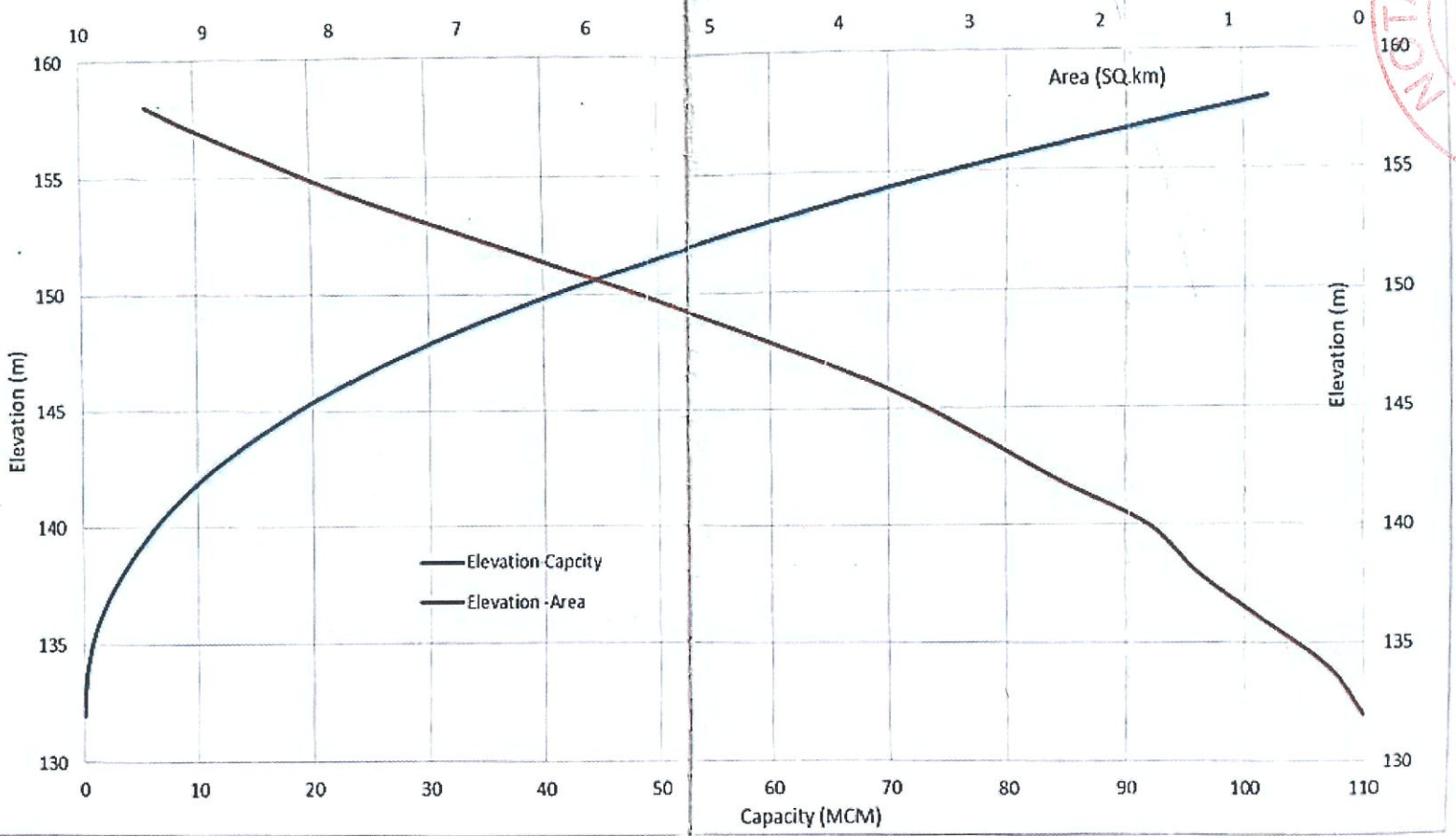
RE-SURVEYED ELVATION-AREA-CAPCITY CURVE OF CHANDAN RESERVOIR



GOVERNMENT OF BIHAR

(WATER RESOURCES DEPARTMENT)

DESILTING OF CHANDAN RESERVOIR

Annexe - II

Net Sedimentation

Annexe: - II

Chandan Reservoir - computation of net silt deposition

Capacity of CHANDAN Reservoir	*1967-68*	*2015*
	(Original)	*(Present)*
	157.23	56.229
	MCM	MCM

I. Silt deposition from 1968 to 2015

For 48 years = 157.23-56.229 101.00MCM

Silt deposition per year = 2.1 MCM

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GOVERNMENT OF BIHAR

(WATER RESOURCES DEPARTMENT)

DESILTING OF CHANDAN RESERVOIR

Annexe - III

Capacity of Reservoir and rate of Silting

Annexe: - III

Details of Capacity Surveys and Rate of Silting of Chandan Reservoir

Name of River/ State: **Chandan / Bihar**

Catchment Area: 549 Sq.Km

Assumed rate of silting: N.A

Reservoir Area at FRL: 14.57 Sq.Km

No	Year of Survey *i*	Capacity in M.Cu.M	Silt deposited between two consecutive surveys in M.Cu.M	Period in years	Silt deposited between two consecutive surveys	Loss of capacity (Cumulative)		Remarks
					M.Cu.m/ year	M.Cu.m	% to Original Capacity	
1.	1967	157.263						Year of impounding
2.	2002	75.47	81.79	35	2.33	81.79	52	As per Satellite survey conducted as informed by field office
3.	2015 (WAPCOS)	56.23	19.207	48	1.92	101	64	

Average rate of silting in 48 years (2015-1967) * 101/48 = 2.1 M. cum/ year

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GOVERNMENT OF BIHAR

(WATER RESOURCES DEPARTMENT)

DESILTING OF CHANDAN RESERVOIR

Annexe - IV

Soil Sample Analysis

SUMMARY OF LABORATORY TEST RESULTS

TEST REPORT NO. EMTC/T/44/2015-16

CLIENT:	Wapcos Limited											
PROJECT:	Chandanpur Dam in Bihar											
Job No.			T-44/01	T-44/02	T-44/03	T-44/04	T-44/05	T-44/06	T-44/07	T-44/08	T-44/09	T-44/10
Borehole/Trial Pit No:			BH-01	BH/CC-01	BH-02	BH-05	BH-22	BH-26	BH-39	BH-43	BH-52	BH-66
Sample No:												
Depth: (m)			4.00	-	5.00	3.00	3.50	4.00	3.00	4.00	2.10	3.25
Field-In-Situ-density												
Natural Moisture Content		%	21.7			22.5						
Bulk Density	BD	Mg/m³	1.76			1.87						
Dry Density	DD	Mg/m³	1.45			1.53						
Grain Size Analysis	Gravel (>4.75mm)	%	3	3	13	0	2	1	2	0	5	0
	Sand (4.75 to 0.075 mm)	%	80	18	61	39	35	40	30	32	29	86
	Silt (0.075 to 0.002mm)	%	17	41	26	26	28	46	30	33	41	14
	Clay (<0.002 mm)	%		38		35	35	13	38	35	25	
Atterberg Limit	Liquid Limit	%	22	50	23	41	44	37	40	37	33	22
	Plastic Limit	%	NP	26	NP	24	20	19	18	20	21	NP
	Plasticity Index	%	NP	24	NP	17	24	18	22	17	12	NP
IS Classification			SM	CI/CH	SM	CI	CI	CI	CI	CI	CL	SM
Void ratio,e (g/γ_d-1)		%										
Free Swell Index		%										
Specific Gravity												
Shrinkage Limit		%		11.7		12.4	13.2	14.3	11.6	15.7	13.4	
Unconfined Compression	Shear Strength	kN/m2										
	Uncon.Comp.strength	kN/m2										
Triaxial Shear Test	Type of Test											
	Cohesion	kN/m2										
	Phi Angle	degree										
Direct Shear Test	Density	Mg/m³										
	Cohesion	kPa										
	Phi Angle	degree										
	Type of Test											
Consolidation	Initial Void Ratio											
	Preconsolidation Press.	kN/m2										
	Compression Index											
	Recompression Index											
Compaction	OMC	%										
	MDD	Mg/m³										
CBR	Unsoaked											
	97% MDD	%										
	FDD	%										
	Soaked											
	97% MDD	%										
	FDD	%										
Lab Permeability		cm/sec										
*Chemical Analysis	pH Value	-			6.4						6.6	
	Chloride as Cl	mg/kg			73.2						82.3	
	Sulphate as SO4	mg/kg			340						319.8	
	Total Kjeldal Nitrogen	mg/kg			710						645.6	
	Phosphorus Available as P	mg/kg			88.5						79.6	
	Potassium Available as K	mg/kg			138.4						135.6	
	Organic Carbon	%			0.69						0.63	
	Zinc	mg/kg			84.7						78.5	
	Lead	mg/kg			ND						ND	
	Arsenic	mg/kg			ND						ND	
	Cadmium	mg/kg			ND						ND	
	Copper	mg/kg			69.0						67.4	
	Mercury	mg/kg			ND						ND	

Remarks:
NP = Non Plastic
* Not Carried out in NABL Scope.

Checked by:

Date:

Approved by:

NOTARY
HUMTRA
CHATTACHARYYA
City Civil Court
Calcutta
Regn. No. 065 of 2022
Expiry Date
31.03.2027
Govt. of West Bengal

SUMMARY OF LABORATORY TEST RESULTS

TEST REPORT NO. EMTC/T/44/2015-16

CLIENT:	Wapcos Limited											
PROJECT:	Chandanpur Dam in Bihar											
Job No.			T-44/01	T-44/02	T-44/03	T-44/04	T-44/05	T-44/06	T-44/07	T-44/08	T-44/09	T-44/10
Borehole/Trial Pit No:			BH-01	BH/CC-01	BH-02	BH-05	BH-22	BH-26	BH-39	BH-43	BH-52	BH-66
Sample No:												
Depth: (m)			4.00	-	5.00	3.00	3.50	4.00	3.00	4.00	2.10	3.25
Field-In-Situ-density												
Natural Moisture Content		%	21.7			22.5						
Bulk Density	FBD	Mg/m^3	1.76			1.87						
Dry Density	FDD	Mg/m^3	1.45			1.53						
Grain Size Analysis	Gravel (>4.75mm)	%	3	3	13	0	2	1	2	0	5	0
	Sand (4.75 to 0.075 mm)	%	80	18	61	39	35	40	30	32	29	86
	Silt (0.075 to 0.002mm)	%	17	41	26	26	28	46	30	33	41	14
	Clay (<0.002 mm)	%		38		35	35	13	38	35	25	
Atterberg Limit	Liquid Limit	%	22	50	23	41	44	37	40	37	33	22
	Plastic Limit	%	NP	26	NP	24	20	19	18	20	21	NP
	Plasticity Index	%	NP	24	NP	17	24	18	22	17	12	NP
IS Classification			SM	CI/CH	SM	CI	CI	CI	CI	CI	CL	SM
Void ratio,e (g/Y_d-1)		%										
Free Swell Index		%										
Specific Gravity												
Shrinkage Limit		%		11.7		12.4	13.2	14.3	11.6	15.7	13.4	
Unconfined Compression	Shear Strength	kN/m2										
	Uncon,Comp,strength	kN/m2										
Triaxial Shear Test	Type of Test											
	Cohesion	kN/m2										
	Phi Angle	degree										
Direct Shear Test	Density	Mg/m^3										
	Cohesion	kPa										
	Phi Angle	degree										
	Type of Test											
Consolidation	Initial Void Ratio											
	Preconsolidation Press.	kN/m2										
	Compression Index											
	Recompression Index											
Compaction	OMC	%										
	MDD	Mg/m^3										
CBR	Unsoaked											
	97% MDD	%										
	FDD	%										
	Soaked											
	97% MDD	%										
	FDD	%										
Lab Permeability		cm/sec										
*Chemical Analysis	pH Value	-			6.4						6.6	
	Chloride as Cl	mg/kg			73.2						82.3	
	Sulphate as SO4	mg/kg			340						319.8	
	Total Kjehldal Nitrogen	mg/kg			710						645.6	
	Phosphorus Available as P	mg/kg			88.5						79.6	
	Potassium Available as K	mg/kg			138.4						135.6	
	Organic Carbon	%			0.69						0.63	
	Zinc	mg/kg			84.7						78.5	
	Lead	mg/kg			ND						ND	
	Arsenic	mg/kg			ND						ND	
	Cadmium	mg/kg			ND						ND	
	Copper	mg/kg			69.0						67.4	
	Mercury	mg/kg			ND						ND	

Remarks:
NP = Non Plastic
* Not Cover in NABL Scope.

Checked by:

Approved by:

Date:

SUMMARY OF LABORATORY TEST RESULTS

TEST REPORT NO. *EMTC/II/44/2015-16*

CLIENT:	Wapcos Limited											
PROJECT:	Chandanpur Dam in Bihar											
Job No.			T-44/11	T-44/12	T-44/13	T-44/14	T-44/15	T-44/16	T-44/17	T-44/18	T-44/19	T-44/20
Borehole/Trial Pit No:			BH-72	BH-80	BH-83	BH-85	BH-90	BH-98	BH-104	BH-113	BH-117	BH-120
Sample No:												
Depth: (m)			2.29	3.90	4.20	3.60	4.00	3.30	3.15	2.50	3.45	3.90
Field-In-Situ-density												
Natural Moisture Content		%										
Bulk Density	FBD	Mg/m³										
Dry Density	FDD	Mg/m³										
Grain Size Analysis	Gravel (>4.75mm)	%	0	14	0	2	0	0	3	1	1	0
	Sand (4.75 to 0.075 mm)	%	98	84	12	34	6	6	8	47	44	33
	Silt (0.075 to 0.002mm)	%	2	2	43	24	46	46	44	35	27	19
	Clay (<0.002 mm)	%			45	40	48	48	45	17	28	48
Atterberg Limit	Liquid Limit	%	20	21	43	39	45	51	51	40	39	38
	Plastic Limit	%	NP	NP	25	24	21	26	25	22	24	21
	Plasticity Index	%	NP	NP	18	15	24	25	26	18	15	17
IS Classification			SP	SP	CI	CI	CI	CH	CH	CI	CI	CI
Void ratio e (γ_d-1)		%										
Free Swell Index		%										
Specific Gravity												
Shrinkage Limit		%			14.1	14.8	15.4	14.9	12.2	15.9	10.5	14.0
Unconfined Compression	Shear Strength	kN/m²										
	Uncon.Comp.strength	kN/m²										
Triaxial Shear Test	Type of Test											
	Cohesion	kN/m²										
	Phi Angle	degree										
Direct Shear Test	Density	Mg/m³										
	Cohesion	kPa										
	Phi Angle	degree										
Consolidation	Type of Test											
	Initial Void Ratio											
	Preconsolidation Press.	kN/m2										
	Compression Indx											
	Recompression Index											
Compaction	OMC	%	11.8	11.2	12.9						13.0	
	MDD	Mg/m³	1.76	1.78	1.82						1.83	
CBR	Unsoaked											
	95% MDD	%										
	FDD	%										
	Soaked											
	95% MDD	%										
	FDD	%										
Lab Permeability		cm/sec										
*Chemical Analysis	pH Value	-				7.5				6.9		
	Chloride as Cl	mg/kg				99.4				86.4		
	Sulphate as SO4	mg/kg				290.4				288.2		
	Total Kjeldal Nitrogen	mg/kg				658.4				670.8		
	Phosphorus Available as P	mg/kg				86.5				75.9		
	Potassium Available as K	mg/kg				120.7				142.8		
	Organic Carbon	%				0.66				0.7		
	Zinc	mg/kg				75.8				79.5		
	Lead	mg/kg				ND				ND		
	Arsenic	mg/kg				ND				ND		
	Cadmium	mg/kg				ND				ND		
	Copper	mg/kg				65.8				62.4		
	Mercury	mg/kg				ND				ND		

Remarks:

Checked by:

Date:

Approved by:

9AXA

SUMMARY OF LABORATORY TEST RESULTS

TEST REPORT NO. EMTC/T/44/2015-16

CLIENT:	Wapcos Limited											
PROJECT:	Chandanpur Dam in Bihar											
Job No.			T-44/11	T-44/12	T-44/13	T-44/14	T-44/15	T-44/16	T-44/17	T-44/18	T-44/19	T-44/20
Borehole/Trial Pit No:			BH-72	BH-80	BH-83	BH-85	BH-90	BH-98	BH-104	BH-113	BH-117	BH-120
Sample No:												
Depth: (m)			2.29	3.90	4.20	3.60	4.00	3.30	3.15	2.50	3.45	3.00
Field-In-Situ-density												
Natural Moisture Content		%										
Bulk Density	FBD	Mg/m^3										
Dry Density	FDD	Mg/m^3										
Grain Size Analysis	Gravel (>4.75mm)	%	0	14	0	2	0	0	3	1	1	0
	Sand (4.75 to 0.075 mm)	%	98	84	12	34	6	6	8	47	44	33
	Silt (0.075 to 0.002mm)	%	2	2	43	24	46	46	44	35	27	19
	Clay (<0.002 mm)	%			45	40	48	48	45	17	28	48
Atterberg Limit	Liquid Limit	%	20	21	43	39	45	51	51	40	39	38
	Plastic Limit	%	NP	NP	25	24	21	26	25	22	24	21
	Plasticity Index	%	NP	NP	18	15	24	25	26	18	15	17
IS Classification			SP	SP	CI	CI	CI	CH	CH	CI	CI	CI
Void ratio,e (g/Y_d-1)		%										
Free Swell Index		%										
Specific Gravity												
Shrinkage Limit		%			14.1	14.8	15.4	14.9	12.2	15.9	10.5	14.0
Unconfined Compression	Shear Strength	kN/m2										
	Uncon.Comp.strength	kN/m2										
Triaxial Shear Test	Type of Test											
	Cohesion	kN/m2										
	Phi Angle	degree										
Direct Shear Test	Density	Mg/m^3										
	Cohesion	kPa										
	Phi Angle	degree										
	Type of Test											
Consolidation	Initial Void Ratio											
	Preconsolidation Press.	kN/m2										
	Compression Index											
	Recompression Index											
Compaction	OMC	%	11.8	11.2	12.9						13.0	
	MDD	Mg/m^3	1.76	1.78	1.82						1.83	
CBR	Unsoaked											
	97% MDD	%										
	FDD	%										
	Soaked											
	97% MDD	%										
	FDD	%										
Lab Permeability		cm/sec										
*Chemical Analysis	pH Value	-				7.5				6.9		
	Chloride as Cl	mg/kg				90.4				86.4		
	Sulphate as SO4	mg/kg				290.4				288.2		
	Total Kjehldal Nitrogen	mg/kg				658.4				670.8		
	Phosphorus Available as P	mg/kg				86.5				78.9		
	Potassium Available as K	mg/kg				120.7				142.8		
	Organic Carbon	%				0.66				0.7		
	Zinc	mg/kg				75.8				79.5		
	Lead	mg/kg				ND				ND		
	Arsenic	mg/kg				ND				ND		
	Cadmium	mg/kg				ND				ND		
	Copper	mg/kg				65.8				62.4		
	Mercury	mg/kg				ND				ND		

Remarks:
NP = Non Plastic
* Not Cover in NABL Scope.

Checked by:

Date:

Approved by:

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SUMMARY OF LABORATORY TEST RESULTS

TEST REPORT NO. EAEC/E/01/2015-16

CLIENT:	Wapcos Limited												
PROJECT:	Chandanpur Dam in Bihar												
Job No.			T-44/21	T-44/22									
Borehole Trial Pit No.			BH-124	BH-130									
Sample No.													
Depth (m)			3.10	2.15									
Field In-Situ density													
Natural Moisture Content		%											
Bulk Density	FBD	Mg/m³											
Dry Density	FDD	Mg/m³											
Grain Size Analysis	Gravel (>4.75mm)	%	1	4									
	Sand (4.75 to 0.075 mm)	%	33	60									
	Silt (0.075 to 0.002mm)	%	41	36									
	Clay (<0.002 mm)	%	25										
Atterberg Limit	Liquid Limit	%	37	24									
	Plastic Limit	%	20	NP									
	Plasticity Index	%	17	NP									
IS Classification			CI	SM									
Void ratio ($e=V_v/V$)		%											
Free Swell Index		%											
Specific Gravity													
Shrinkage Limit		%	13.5										
Unconfined Compression	Shear Strength	kN/m2											
	Uncon.Comp.strength	kN/m2											
Triaxial Shear Test	Type of Test												
	Cohesion	kN/m2											
	Phi Angle	degree											
Direct Shear Test	Density	Mg/m³											
	Cohesion	kPa											
	Phi Angle	degree											
	Type of Test												
Consolidation	Initial Void Ratio												
	Preconsolidation Press.	kN/m2											
	Compression Index												
	Recompression Index												
Compaction	OMC	%		12.9									
	MDD	Mg/m³		1.74									
CBR	Unsoaked												
	97% MDD	%											
	FDD	%											
	Soaked												
	97% MDD	%											
	FDD	%											
Coefficient of Permeability		cm/sec											
Chemical Analysis	pH Value	-		6.7									
	Chloride as Cl	mg/kg		92.5									
	Sulphate as SO4	mg/kg		310.7									
	Total Kjeldahl Nitrogen	mg/kg		659.4									
	Phosphorus Available as P	mg/kg		76.5									
	Potassium Available as K	mg/kg		137.5									
	Organic Carbon	%		0.59									
	Zinc	mg/kg		81.2									
	Lead	mg/kg		ND									
	Arsenic	mg/kg		ND									
	Cadmium	mg/kg		ND									
	Copper	mg/kg		72.1									
	Mercury	mg/kg		ND									

Remarks:
NP = Non Plastic
* Dry Sieve as per IS 2386 Design

Checked by:

Date:

Approved by:

SUMMARY OF LABORATORY TEST RESULTS

TEST REPORT NO. EMTC/T/44/2015-16

CLIENT:	Wapcos Limited			
PROJECT:	Chandanpur Dam in Bihar			
Job No.			T-44/21	T-44/22
Borehole/Trial Pit No:			BH-124	BH-130
Sample No:				
Depth: (m)			3.10	2.15
Field-In-Situ-density				
Natural Moisture Content		%		
Bulk Density	FBD	Mg/m^3		
Dry Density	FDD	Mg/m^3		
Grain Size Analysis	Gravel (>4.75mm)	%	1	4
	Sand (4.75 to 0.075 mm)	%	33	60
	Silt (0.075 to 0.002mm)	%	41	36
	Clay (<0.002 mm)	%	25	
Atterberg Limit	Liquid Limit	%	37	24
	Plastic Limit	%	20	NP
	Plasticity Index	%	17	NP
IS Classification			CI	SM
Void ratio,e (g/γ_d-1)		%		
Free Swell Index		%		
Specific Gravity				
Shrinkage Limit		%	13.5	
Unconfined Compression	Shear Strength	kN/m2		
	Uncon.Comp.strength	kN/m2		
Triaxial Shear Test	Type of Test			
	Cohesion	kN/m2		
	Phi Angle	degree		
Direct Shear Test	Density	Mg/m^3		
	Cohesion	kPa		
	Phi Angle	degree		
	Type of Test			
Consolidation	Initial Void Ratio			
	Preconsolidation Press.	kN/m2		
	Compression Index			
	Recompression Index			
Compaction	OMC	%		12.9
	MDD	Mg/m^3		1.74
CBR	Unsoaked			
	97% MDD	%		
	FDD	%		
	Soaked			
	97% MDD	%		
	FDD	%		
Lab Permeability		cm/sec		
*Chemical Analysis	pH Value	-		6.7
	Chloride as Cl	mg/kg		92.5
	Sulphate as SO4	mg/kg		310.7
	Total Kjehldal Nitrogen	mg/kg		659.4
	Phosphorus Available as P	mg/kg		76.5
	Potassium Available as K	mg/kg		137.5
	Organic Carbon	%		0.59
	Zinc	mg/kg		81.2
	Lead	mg/kg		ND
	Arsenic	mg/kg		ND
	Cadmium	mg/kg		ND
	Copper	mg/kg		72.1
	Mercury	mg/kg		ND

Remarks:
NP = Non Plastic
* Not Cover in NABL Scope.

Checked by:

Approved by:

Date:

MOISTURE CONTENT TEST OF SOIL
IS: 2720 , PART-2-1973

PROJECT: Chandanpur Dam		TEST REPORT NO: EMTC/T/44/2015-16			
SITE REF:		JOB NO: T-44/02.04			
BOREHOLE NO:					
Location/Borehole	CC-01	CC-05			
Sample No.	UDS-1	UDS-1			
Chainage:(km)	-	-			
Depth(cm)	-	-			
Oven No.	EMTC/T/OV-1	EMTC/T/OV-1			
Sample Extruder No.	EMTC/T/SE-1	EMTC/T/SE-1			
Balance No.	EMTC/T/DWB-02	EMTC/T/DWB-02			
Soil Type	Silty Clay	Silty Clay			
Container No.	ST-11	ST-25			
Wt.Can. W1,g	11.84	11.60			
Wt.Can.+ Wet Soil,(W2),g	42.14	45.2			
Wt.Can.+ Dry Soil,(W3),g	36.74	39.02			
Wt.Water (W2-W3),g	5.40	6.18			
Wt.Dry Soil (W3-W1),g	24.90	27.42			
Water Content, w, %= [(W2-W3)/(W3-W1)]x 100	21.7	22.5			
IN-SITU DENSITY					
Balance No.	EMTC/T/DWB-01	EMTC/T/DWB-01			
Measuring Tape No.	EMTC/T/MT-01	EMTC/T/MT-01			
Container No.	B-25	B-30			
Wt. Tube+Soil, g	2141.30	2025.60			
Wt.of Tube	875.2	845.2			
Dia of Tube, g(Average) cm	7	7			
Length of sample, cm	18.7	16.4			
Wt Soil (W)	1266	1180			
Vol. Soil (V), cm^3	720.0	631.4			
In-Situ Density, g_t =(W/V) g/cm^3	1.76	1.87			
DRY DENSITY, g_d =[g_t/(1+w)] g/cm^3	1.45	1.53			
Tested by :	Checked by:		Approved by:		
Date :	Date:		Date:		

22-6-19 JE

22.6.19 AE

NOTARY
SUMITRA BHATTACHARYYA
City Civil Court
Calcutta
Regn. No. 005 of 2022
Expiry Date
31.03.2027
Govt. of West Bengal

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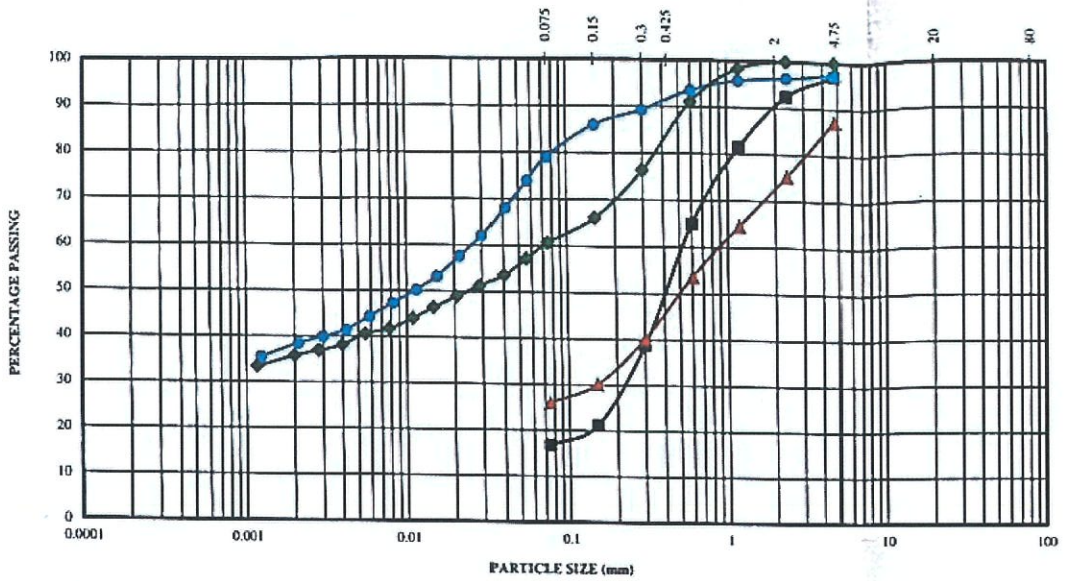
GRADING CURVE BASED ON IS : 2720 : PART IV



CLAY	SILT	SAND			GRAVEL		C
		FINE	MEDIUM	COARSE	FINE	COARSE	

Job No.	S.No.	Syb	Borehole No.	Sample No.	Depth (m)	Description	GRAVEL %	SAND %	SILT %	CLAY %	D_{60}	D_{30}	D_{10}	C_u	C_c
44/01	1	■—■	BH-1	0	0.00	Brownish Silty Sand (SM)	3	80	17						
44/02	2	●—●	BH/CC-01	0	0.00	Brownish Silty CLAY (CI/CH)	3	18	41	38					
44/03	3	▲—▲	BH-02	0	0.00	Brownish Silty Sand (SM)	13	61	26						
44/04	4	◆—◆	BH-05	0	0.00	Brownish Silty CLAY (CI)	0	39	26	35					

GRAIN SIZE ANALYSIS (IS : 2720 : PART IV)

Project: Chandanpur Dam
Site Ref:

TEST REPORT NO.EMTC/T/44/2015-16

Tested by: Date: 22-6-19

Checked by: Date:

Approved by:

NOTARY SUMITRA BHATTACHARYYA City Civil Court Calcutta Regn. No. 005 of 2022 Expiry Date 31.03.2027 Govt. of West Bengal

1273

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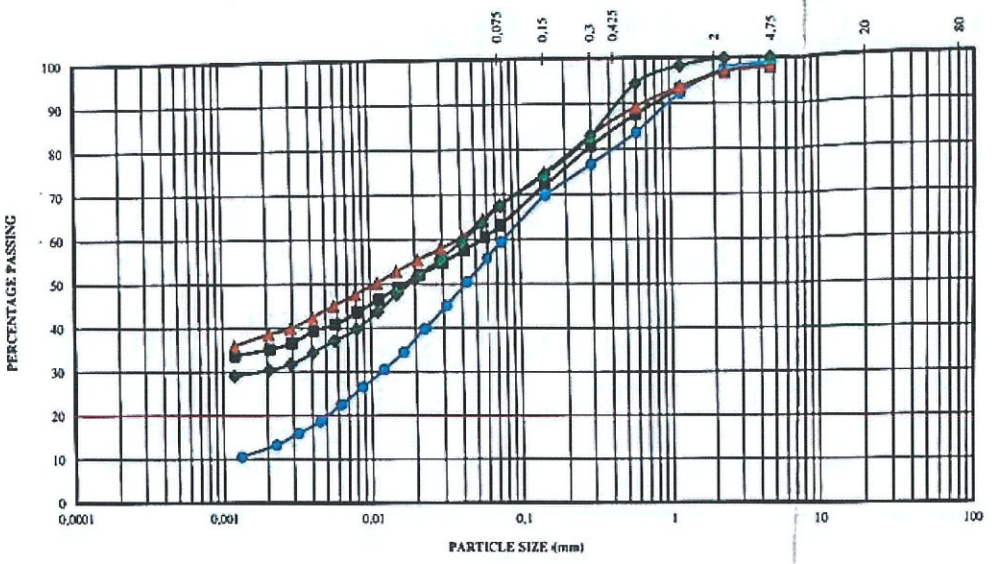
GRADING CURVE BASED ON IS : 2720 : PART IV



CLAY	SILT	FINE	MEDIUM	COARSE	FINE	COARSE	C
		SAND			GRAVEL		

Job No.	S.No.	Syb	Borehole No.	Sample No.	Depth (m)	Description	GRAVEL %	SAND %	SILT %	CLAY %	D_{60}	D_{30}	D_{10}	C_u	C_v
44/05	1	■—■	BH-22	0	0.00	Brownish Silty CLAY (CI)	2	35	28	35					
44/06	2	●—●	BH-26	0	0.00	Brownish Silty CLAY (CI)	1	40	46	13					
44/07	3	▲—▲	BH-39	0	0.00	Brownish Silty CLAY (CI)	2	30	30	38					
44/08	4	◆—◆	BH-43	0	0.00	Brownish Silty CLAY (CI)	0	32	33	35					

Project: Chandanpur Dam
Site Ref:

TEST REPORT NO.EMTC/T/44/2015-16

Tested by: Date: 22.6.19

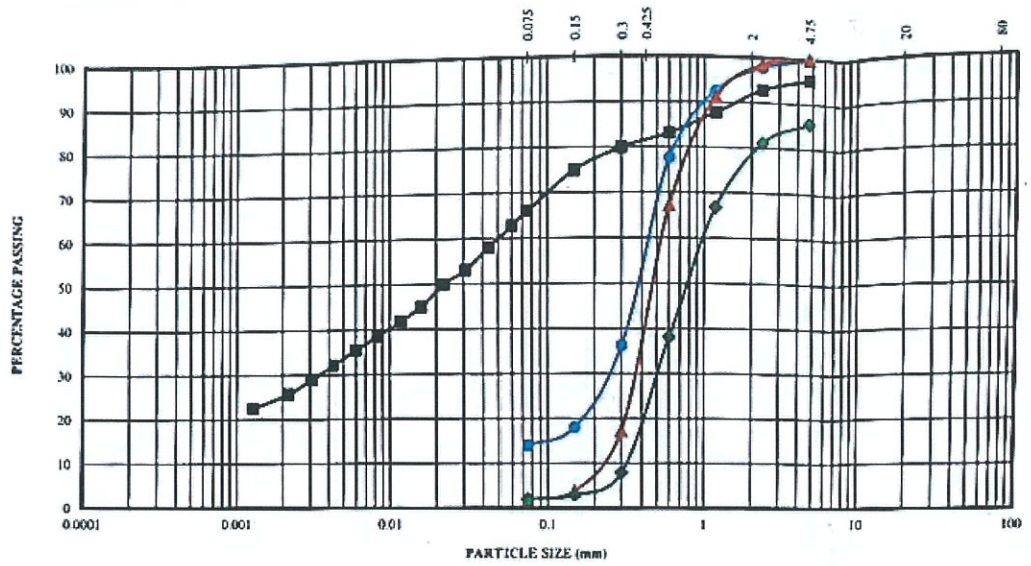
Checked by: Date:

Approved by:

GRAIN SIZE ANALYSIS (IS : 2720 : PART IV)

NOTARY
SUMITRA BHATTACHARYYA
City Civil Court
Calcutta
Regn. No. 065 of 2022
Expiry Date
31.03.2027
Govt. of West Bengal

GRADING CURVE BASED ON IS : 2720 : PART IV



CLAY	SILT	SAND			GRAVEL		C
		FINE	MEDIUM	COARSE	FINE	COARSE	

Job No.	S.No.	Syb	Borehole No.	Sample No.	Depth (m)	Description	GRAVEL %	SAND %	SILT %	CLAY %	D_{60}	D_{30}	D_{10}	C_u	Cc
44/09	1	■—■	BH-52	0	0.00	Brownish Silty CLAY (CL)	5	29	41	25					
44/10	2	●—●	BH-66	0	0.00	Brownish Silty Sand (SM)	0	86	14						
44/11	3	▲—▲	BH-72	0	0.00	Redish Poorly Graded Sand (SP)	0	98	2		0.55	0.4	0.14	3.93	0.63
44/12	4	◆—◆	BH-80	0	0.00	Redish Poorly Graded Sand (SP)	14	84	2		1	0.5	0.2	5	1.25

GRAIN SIZE ANALYSIS (IS : 2720 : PART IV)

NOTARY Govt. of West Bengal
Sumitra [illegible]
City Civil Court
Calcutta
Regn. No. One of 2022
Expiry Date
31.03.2027

Project: Chandanpur Dam
Site Ref:

TEST REPORT NO EMEC/T/44/2015-16

Tested by: Date: 22.6.19

Checked by: Date:

Approved by:

22.6.19

1275

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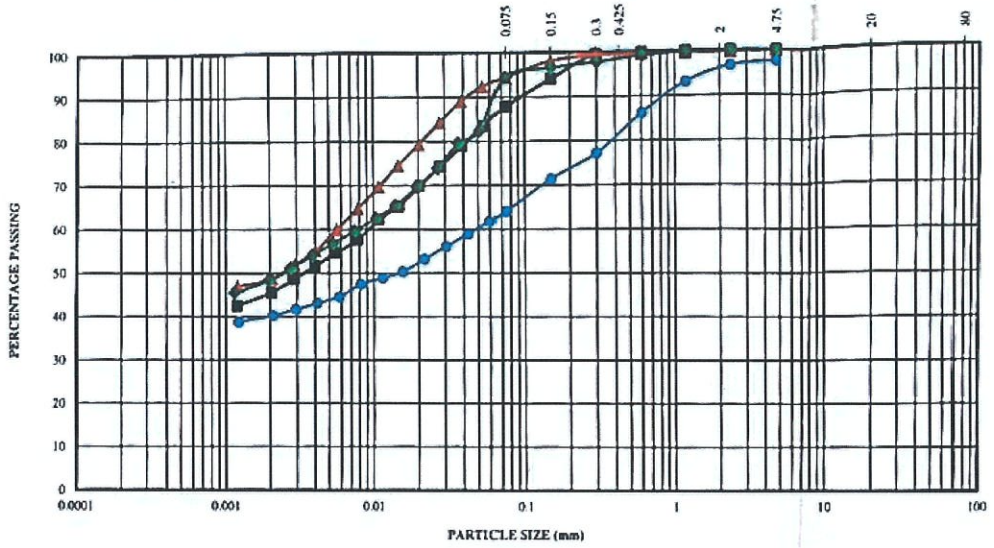
GRADING CURVE BASED ON IS : 2720 : PART IV



CLAY	SILT	SAND			GRAVEL		C
		FINE	MEDIUM	COARSE	FINE	COARSE	

Job No.	S.No.	Syb	Borehole No.	Sample No.	Depth (m)	Description	GRAVEL %	SAND %	SILT %	CLAY %	D_{60}	D_{30}	D_{10}	C_u	C_c
44/13	1	■—■	BH-83	0	0.00	Brownish Silty CLAY (Cl)	0	12	43	45					
44/14	2	●—●	BH-85	0	0.00	Brownish Silty CLAY (Cl)	2	34	24	40					
44/15	3	▲—▲	BH-90	0	0.00	Brownish Silty CLAY (Cl)	0	6	46	48					
44/16	4	◆—◆	BH-98	0	0.00	Brownish Silty CLAY (CH)	0	6	46	48					

Project: Chandanpur Dam
Site Ref:

TEST REPORT NO.EMTC/T/44/2015-16

Tested by: Date: 22.6.19

Checked by: Date:

Approved by:

GRAIN SIZE ANALYSIS (IS : 2720 : PART IV)

NOTARY Govt. of West Bengal

1276

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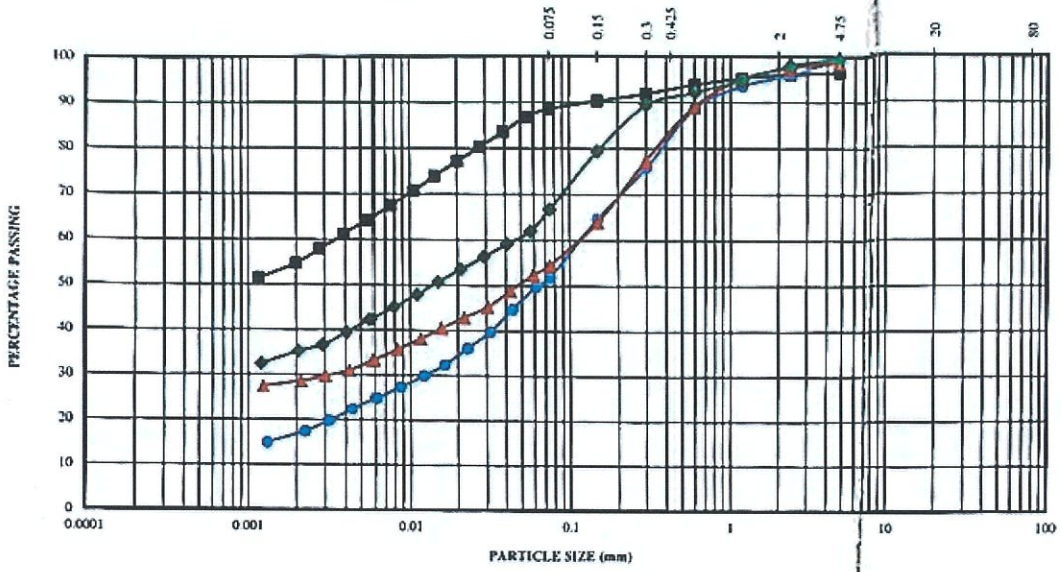
GRADING CURVE BASED ON IS : 2720 : PART IV



CLAY	SILT	SAND			GRAVEL		C
		FINE	MEDIUM	COARSE	FINE	COARSE	

Job No.	S.No.	Syb	Borehole No.	Sample No.	Depth (m)	Description	GRAVEL %	SAND %	SILT %	CLAY %	D_{60}	D_{30}	D_{10}	C_u	C_c
44/17	1	■—■	BH-104	0	0.00	Brownish Silty CLAY (CH)	3	8	44	45					
44/18	2	●—●	BH-113	0	0.00	Brownish Silty CLAY (CI)	1	47	35	17					
44/19	3	▲—▲	BH-117	0	0.00	Brownish Silty CLAY (CI)	1	44	27	28					
44/20	4	◆—◆	BH-120	0	0.00	Brownish Silty CLAY (CI)	0	33	19	48					

GRAIN SIZE ANALYSIS (IS : 2720 : PART IV)

Project: Chandanpur Dam
Site Ref:

TEST REPORT NO.EMTC/T/44/2015-16

Tested by: Date: 22.6.17

Checked by: Date:

Approved by:

NOTARY ★ SUBHRA BHATTACHARYYA ★ City Civil Court Calcutta Regn. No. 065 of 2022 Expiry Date 31.03.2027 Govt. of West Bengal

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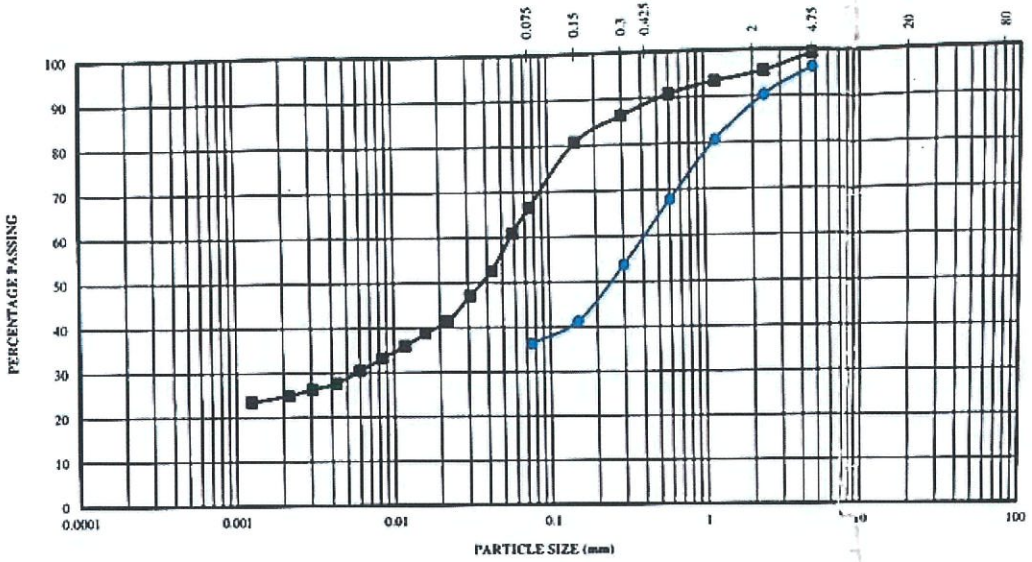
GRADING CURVE BASED ON IS : 2720 : PART IV



CLAY	SILT	SAND			GRAVEL		C
		FINE	MEDIUM	COARSE	FINE	COARSE	

Job No.	S.No.	Syb	Borehole No.	Sample No.	Depth (m)	Description	GRAVEL %	SAND %	SILT %	CLAY %	D_{60}	D_{30}	D_{10}	C_u	C_c
44/21	1	■—■	BH-124	0	0.00	Brownish Silty CLAY (CI)	1	33	41	25					
44/22	2	●—●	BH-130	0	0.00	Brownish Silty Sand (SM)	4	60	36						

GRAIN SIZE ANALYSIS (IS : 2720 : PART IV)

NOTARY
SUMITRA BHATTACHARYYA
City Civil Court
Calcutta
Regn. No. 065 of 2022
Expiry Date 31.03.2027
Govt. of West Bengal

Project: Chandanpur Dam
Site Ref:

TEST REPORT NO.EM|C/T/44/2015-16

Tested by: Date: 22.6.15 AE

Checked by: Date:

Approved by:

22-6-15 JE

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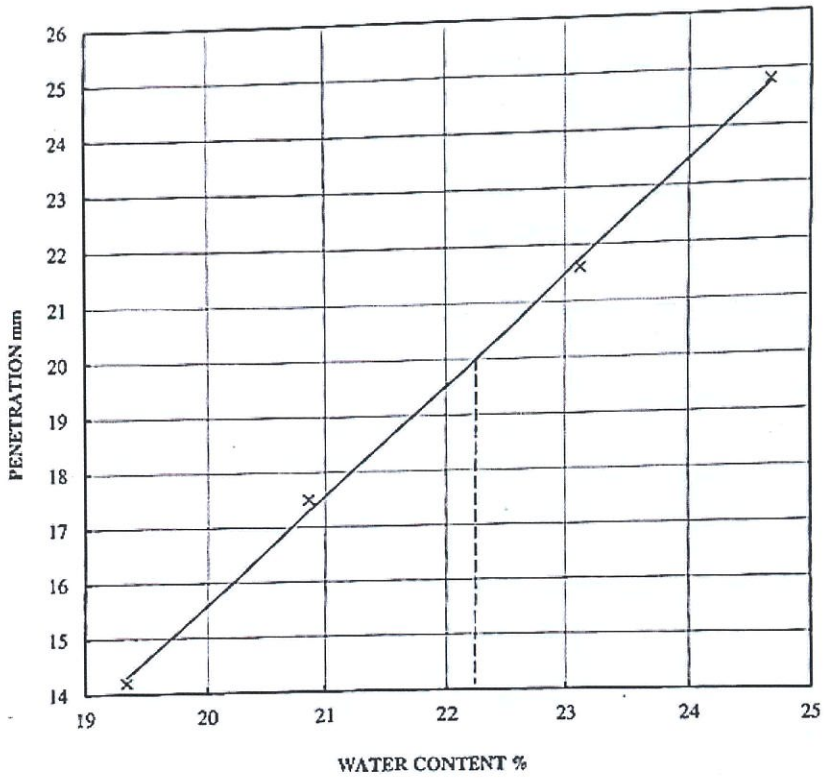
LIQUID AND PLASTIC LIMIT TEST RESULTS
IS: 2720 (PART-5) 1985

PROJECT: Chandanpur Dam	TEST REPORT NO: EMTC/T/44/2015-16
SITE REF:	JOB NO: T-44/01
BOREHOLE NO: BH-01 SAMPLE NO:	DEPTH (M):



HISTORY OF SAMPLE : Natural

Percentage of passing 0.425mm B.S.Sieve =

	LIQUID LIMIT %				PLASTIC LIMIT %
Wet Weight + Container g)	42.14	42.10	40.25	39.65	
Dry Weight + Container (g)	37.20	36.90	34.89	34.14	NON PLASTIC
Container Weight (g)	11.66	11.98	11.72	11.80	
Water Content (%)	19.34	20.87	23.13	24.66	
Penetration (mm)	14.20	17.50	21.60	24.80	

LIQUID LIMIT	(%)	22
PLASTIC LIMIT	(%)	NP
PLASTICITY INDEX	(%)	NP

Tested by:	Checked by:	Approved by :
Date :	Date:	Date:

NOTARY
SUMITRA BHATTACHARYYA
City Civil Court
Calcutta
Regn. No. 065 of 2022
Expiry Date
31.03.2027
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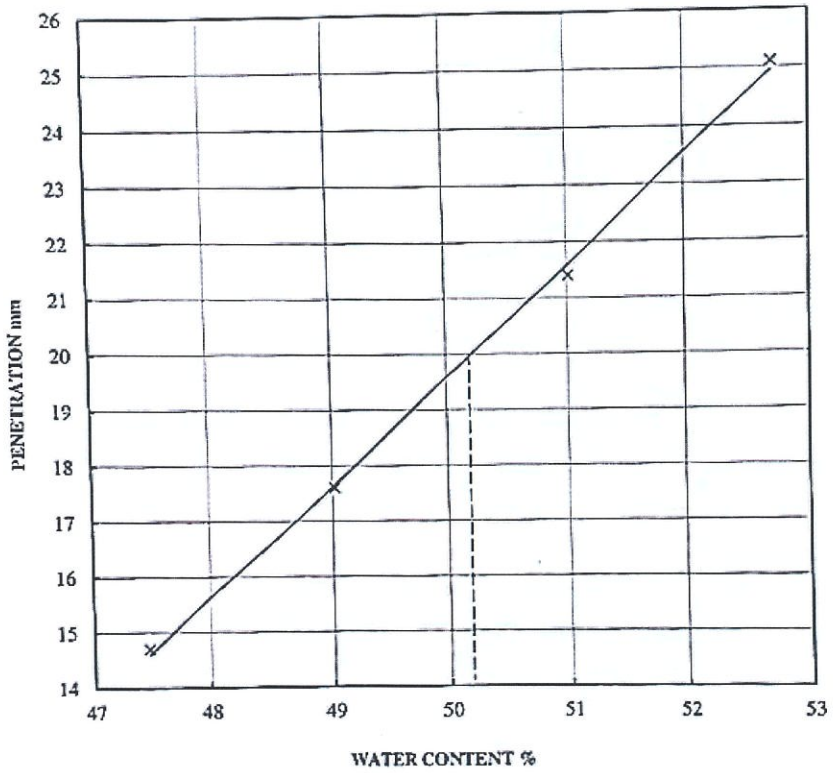
LIQUID AND PLASTIC LIMIT TEST RESULTS
IS: 2720 (PART-5) 1985

PROJECT: Chandanpur Dam	TEST REPORT NO: EMTC/T/44/2015-16
SITE REF:	JOB NO: T-44/02
BOREHOLE NO: BH/CC-01 SAMPLE NO:	DEPTH (M):



HISTORY OF SAMPLE : Natural

Percentage of passing 0.425mm B.S.Sieve =

	LIQUID LIMIT %				PLASTIC LIMIT %	
Wet Weight + Container g)	40.15	42.16	45.21	44.35	18.26	14.40
Dry Weight + Container (g)	31.50	32.12	33.89	33.04	17.33	13.84
Container Weight (g)	13.28	11.64	11.70	11.58	13.81	11.71
Water Content (%)	47.48	49.02	51.01	52.70	26.42	26.29
Penetration (mm)	14.70	17.60	21.40	25.10		

LIQUID LIMIT	(%)	50
PLASTIC LIMIT	(%)	26
PLASTICITY INDEX	(%)	24

Tested by:	Checked by:	Approved by :
Date :	Date:	Date:

NOTARY
SUMITRA BHATTACHARYYA
City Civil Court
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Regn. No. 065 of 2022
Expiry Date 31.03.2027
Govt. of West Bengal

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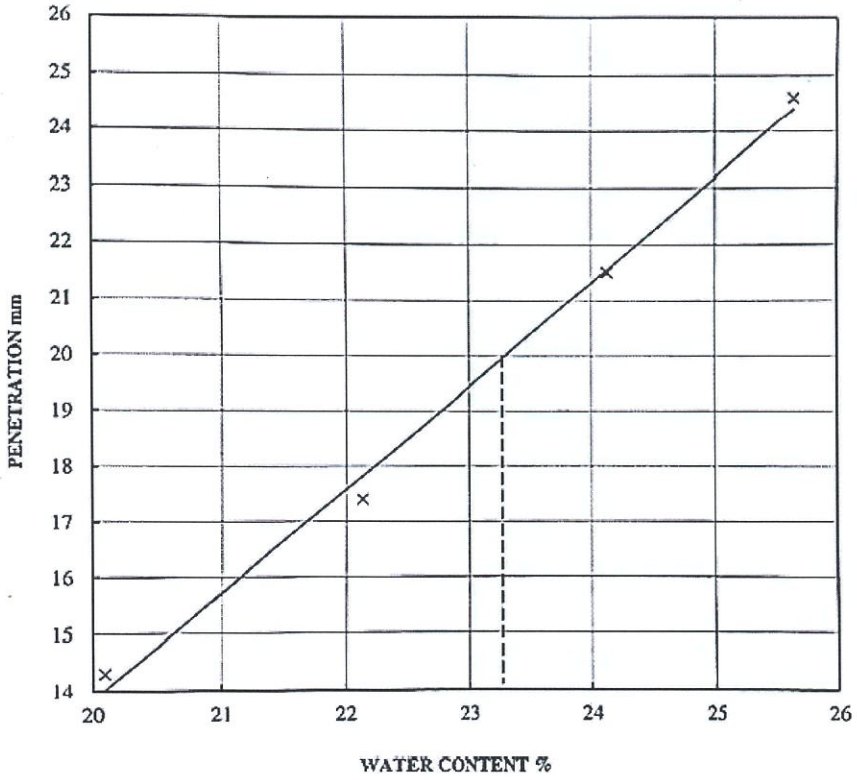
LIQUID AND PLASTIC LIMIT TEST RESULTS
IS: 2720 (PART-5) 1985

PROJECT: Chandanpur Dam	TEST REPORT NO: EMTC/T/44/2015-16
SITE REF:	JOB NO: T-44/03
BOREHOLE NO: BH-02 SAMPLE NO:	DEPTH (M):



HISTORY OF SAMPLE : Natural

Percentage of passing 0.425mm B.S.Sieve =

	LIQUID LIMIT %				PLASTIC LIMIT %
Wet Weight + Container g)	40.15	42.14	40.36	40.32	
Dry Weight + Container (g)	35.42	36.65	34.82	34.44	NON PLASTIC
Container Weight (g)	11.88	11.84	11.86	11.52	
Water Content (%)	20.09	22.13	24.13	25.65	
Penetration (mm)	14.30	17.40	21.50	24.60	

LIQUID LIMIT	(%)	23
PLASTIC LIMIT	(%)	NP
PLASTICITY INDEX	(%)	NP

Tested by:	Checked by:	Approved by :
Date :	Date:	Date:

NOTARY
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City Civil Court
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Regn. No. 065 of 2022
Expiry Date
31.03.2027
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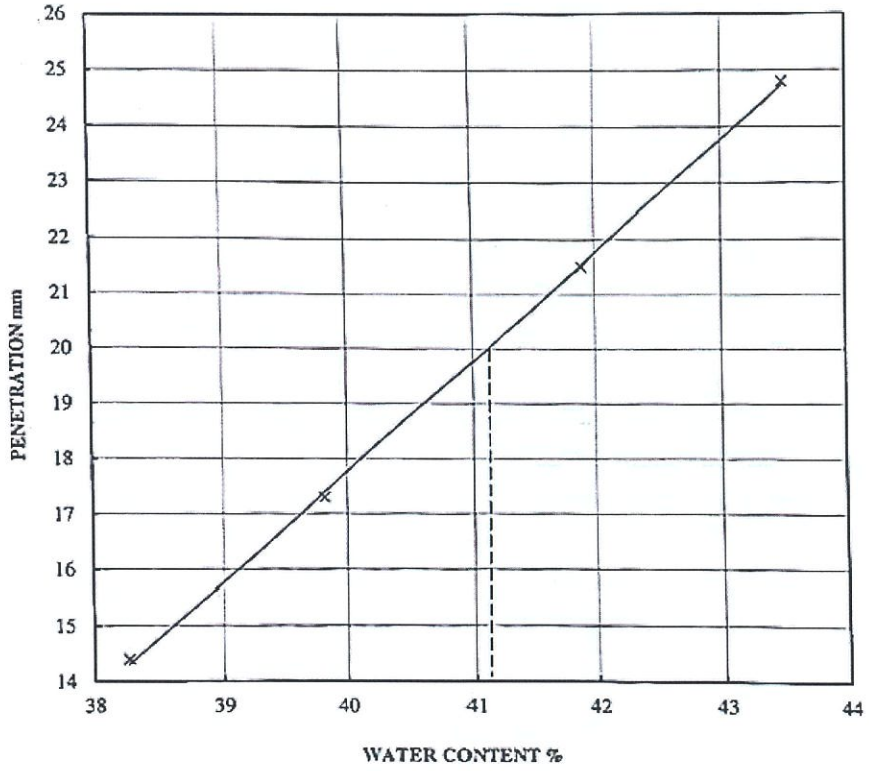
LIQUID AND PLASTIC LIMIT TEST RESULTS
IS: 2720 (PART-5) 1985

PROJECT: Chandanpur Dam	TEST REPORT NO: EMTC/T/44/2015-16
SITE REF:	JOB NO: T-44/04
BOREHOLE NO: BH-5 SAMPLE NO:	DEPTH (M):



HISTORY OF SAMPLE : Natural

Percentage of passing 0.425mm B.S.Sieve =

	LIQUID LIMIT %				PLASTIC LIMIT %	
Wet Weight + Container g)	40.12	42.10	40.25	43.25	16.26	16.80
Dry Weight + Container (g)	32.22	33.42	31.78	33.70	15.64	16.06
Container Weight (g)	11.58	11.62	11.56	11.74	13.09	13.02
Water Content (%)	38.28	39.82	41.89	43.49	24.31	24.34
Penetration (mm)	14.40	17.30	21.50	24.80		

LIQUID LIMIT	(%)	41
PLASTIC LIMIT	(%)	24
PLASTICITY INDEX	(%)	17

Tested by:	Checked by:	Approved by :
Date :	Date:	Date:

NOTARY SUMITRA BHATTACHARYYA City Civil Court Calcutta Regn. No. 065 of 2022 Expiry Date 31.03.2027 Govt. of West Bengal

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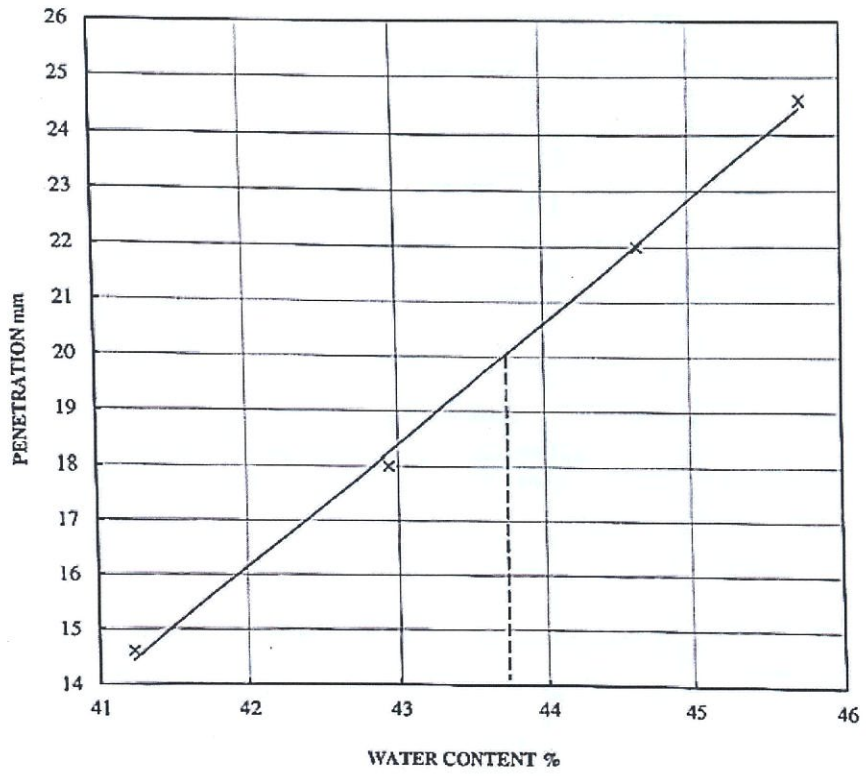
LIQUID AND PLASTIC LIMIT TEST RESULTS
IS: 2720 (PART-5) 1985

PROJECT: Chandanpur Dam	TEST REPORT NO: EMTC/T/44/2015-16
SITE REF:	JOB NO: T-44/05
BOREHOLE NO: BH-22 SAMPLE NO:	DEPTH (M):



HISTORY OF SAMPLE : Natural

Percentage of passing 0.425mm B.S.Sieve =

	LIQUID LIMIT %				PLASTIC LIMIT %	
Wet Weight + Container g)	40.25	41.25	39.55	42.15	16.32	17.62
Dry Weight + Container (g)	32.30	32.89	30.96	32.65	15.55	16.65
Container Weight (g)	13.02	13.42	11.72	11.88	11.81	11.89
Water Content (%)	41.23	42.94	44.65	45.74	20.59	20.38
Penetration (mm)	14.60	18.00	22.00	24.60		

LIQUID LIMIT	(%)	44
PLASTIC LIMIT	(%)	20
PLASTICITY INDEX	(%)	24

Tested by:	Checked by:	Approved by :
Date :	Date:	Date:

NOTARY
BHATTACHARYYA
City Civil Court
Calcutta
Regn. No. 065 of 2022
Expiry Date
31.03.2027
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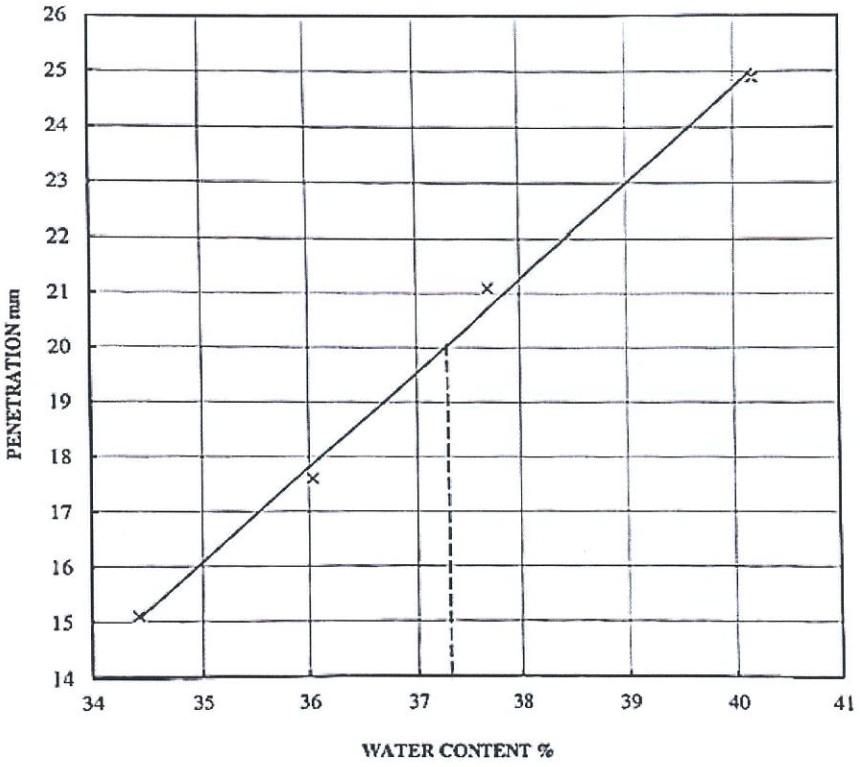
LIQUID AND PLASTIC LIMIT TEST RESULTS
IS: 2720 (PART-5) 1985

PROJECT: Chandanpur Dam	TEST REPORT NO: EMTC/T/44/2015-16
SITE REF:	JOB NO: T-44/06
BOREHOLE NO: BH-26 SAMPLE NO:	DEPTH (M):



HISTORY OF SAMPLE : Natural

Percentage of passing 0.425mm B.S.Sieve =

	LIQUID LIMIT %				PLASTIC LIMIT %	
Wet Weight + Container g)	51.06	46.19	39.34	34.41	15.58	17.52
Dry Weight + Container (g)	41.30	37.04	31.85	27.92	15.01	16.65
Container Weight (g)	12.94	11.65	11.98	11.77	11.98	12.03
Water Content (%)	34.41	36.04	37.70	40.19	18.81	18.83
Penetration (mm)	15.10	17.60	21.10	24.90		

LIQUID LIMIT	(%)	37
PLASTIC LIMIT	(%)	19
PLASTICITY INDEX	(%)	18

Tested by:	Checked by:	Approved by :
Date :	Date:	Date:

NOTARY SUMITRA BHATTACHARYYA City Civil Court Calcutta Regn. No. 065 of 2022 Expiry Date 31.03.2027 Govt. of West Bengal

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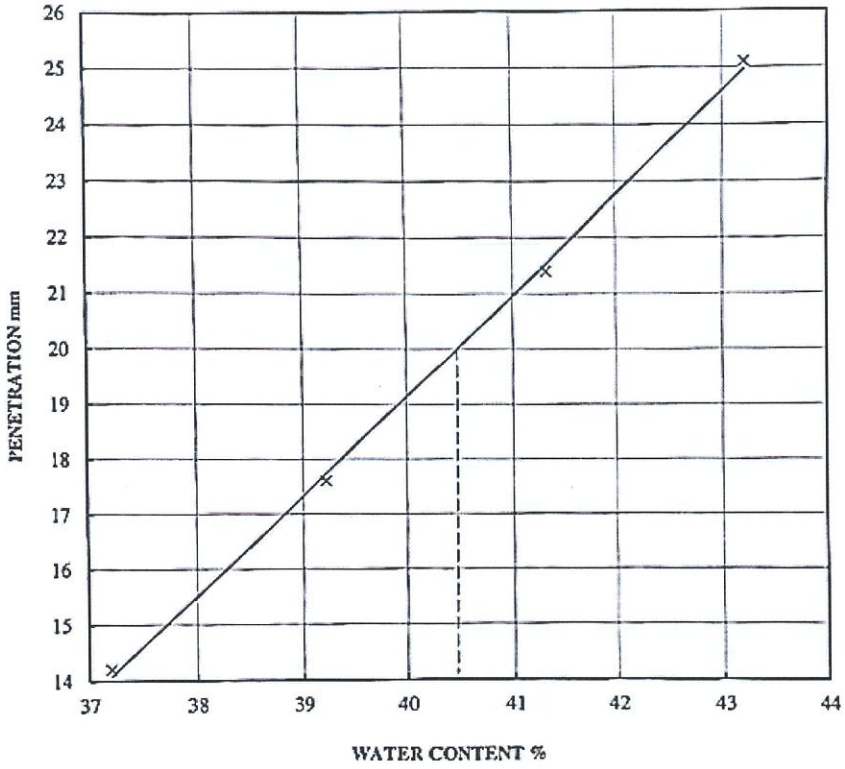
LIQUID AND PLASTIC LIMIT TEST RESULTS
IS: 2720 (PART-5) 1985

PROJECT: Chandanpur Dam	TEST REPORT NO: EMTC/T/44/2015-16
SITE REF:	JOB NO: T-44/07
BOREHOLE NO: BH-39 SAMPLE NO:	DEPTH (M):



HISTORY OF SAMPLE : Natural

Percentage of passing 0.425mm B.S.Sieve =

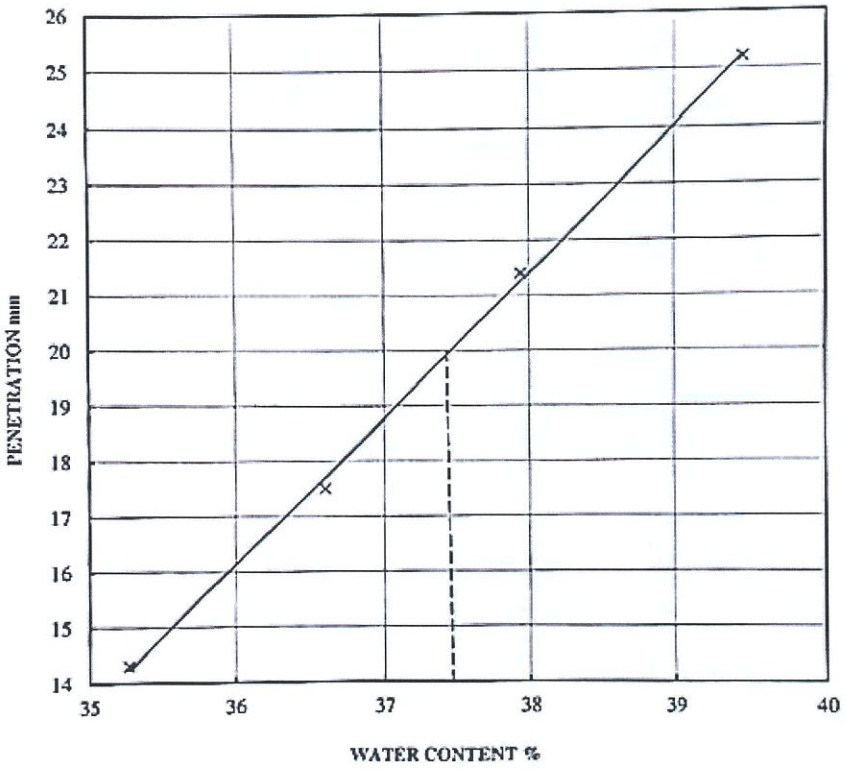
	LIQUID LIMIT %				PLASTIC LIMIT %	
Wet Weight + Container g)	41.20	43.25	44.12	40.25	14.43	15.87
Dry Weight + Container (g)	33.55	34.41	34.69	31.65	13.99	15.44
Container Weight (g)	12.98	11.88	11.86	11.74	11.61	13.11
Water Content (%)	37.21	39.23	41.32	43.21	18.49	18.45
Penetration (mm)	14.20	17.60	21.40	25.10		

LIQUID LIMIT	(%)	40
PLASTIC LIMIT	(%)	18
PLASTICITY INDEX	(%)	22

Tested by:	Checked by:	Approved by :
Date :	Date:	Date:

LIQUID AND PLASTIC LIMIT TEST RESULTS
IS: 2720 (PART-5) 1985

PROJECT: Chandanpur Dam	TEST REPORT NO: EMTC/T/44/2015-16
SITE REF:	JOB NO: T-44/0%
BOREHOLE NO: BH-43 SAMPLE NO:	DEPTH (M):



HISTORY OF SAMPLE : Natural

Percentage of passing 0.425mm B.S.Sieve =

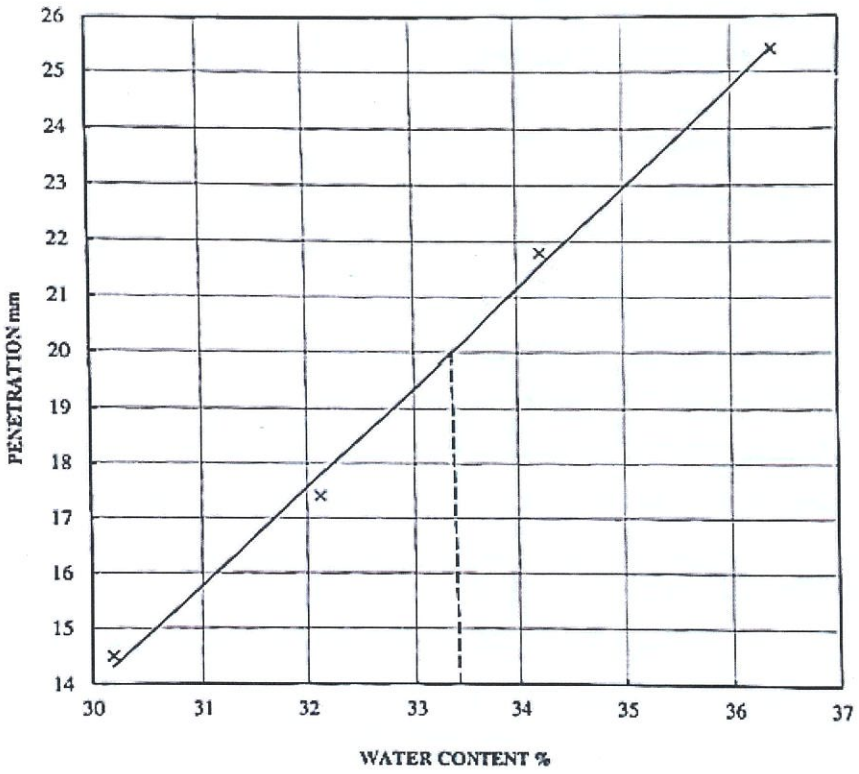
	LIQUID LIMIT %				PLASTIC LIMIT %	
Wet Weight + Container g)	45.12	43.25	40.54	43.25	16.22	15.13
Dry Weight + Container (g)	36.75	35.12	32.59	34.30	15.80	14.55
Container Weight (g)	13.02	12.90	11.64	11.62	13.75	11.68
Water Content (%)	35.27	36.59	37.95	39.46	20.49	20.21
Penetration (mm)	14.30	17.50	21.40	25.20		

LIQUID LIMIT	(%)	37
PLASTIC LIMIT	(%)	20
PLASTICITY INDEX	(%)	17

Tested by:	Checked by:	Approved by :
Date :	Date:	Date

LIQUID AND PLASTIC LIMIT TEST RESULTS
IS: 2720 (PART-5) 1985

PROJECT: Chandanpur Dam	TEST REPORT NO: EMTC/T/44/2015-16
SITE REF:	JOB NO: T-44/09
BOREHOLE NO: BH-52 SAMPLE NO:	DEPTH (M):



HISTORY OF SAMPLE : Natural

Percentage of passing 0.425mm B.S.Sieve =

	LIQUID LIMIT %				PLASTIC LIMIT %	
Wet Weight + Container g)	41.25	44.15	42.15	41.25	17.35	17.85
Dry Weight + Container (g)	34.44	36.77	34.44	33.81	16.59	16.98
Container Weight (g)	11.88	13.80	11.92	13.38	13.02	12.90
Water Content (%)	30.19	32.13	34.24	36.39	21.29	21.32
Penetration (mm)	14.50	17.40	21.80	25.40		

LIQUID LIMIT	(%)	33
PLASTIC LIMIT	(%)	21
PLASTICITY INDEX	(%)	12

Tested by:	Checked by:	Approved by :
Date :	Date:	Date:

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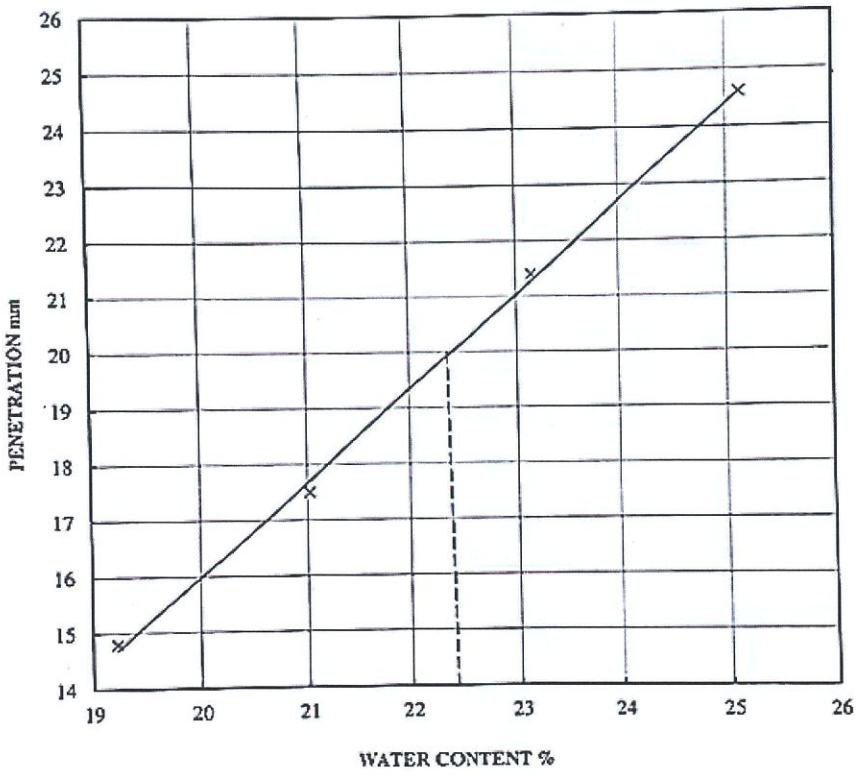
LIQUID AND PLASTIC LIMIT TEST RESULTS
IS: 2720 (PART-5) 1985

PROJECT: Chandanpur Dam	TEST REPORT NO: EMTC/T/44/2015-16
SITE REF:	JOB NO: T-44/10
BOREHOLE NO: BH-66 SAMPLE NO:	DEPTH (M):



HISTORY OF SAMPLE : Natural

Percentage of passing 0.425mm B.S.Sieve =

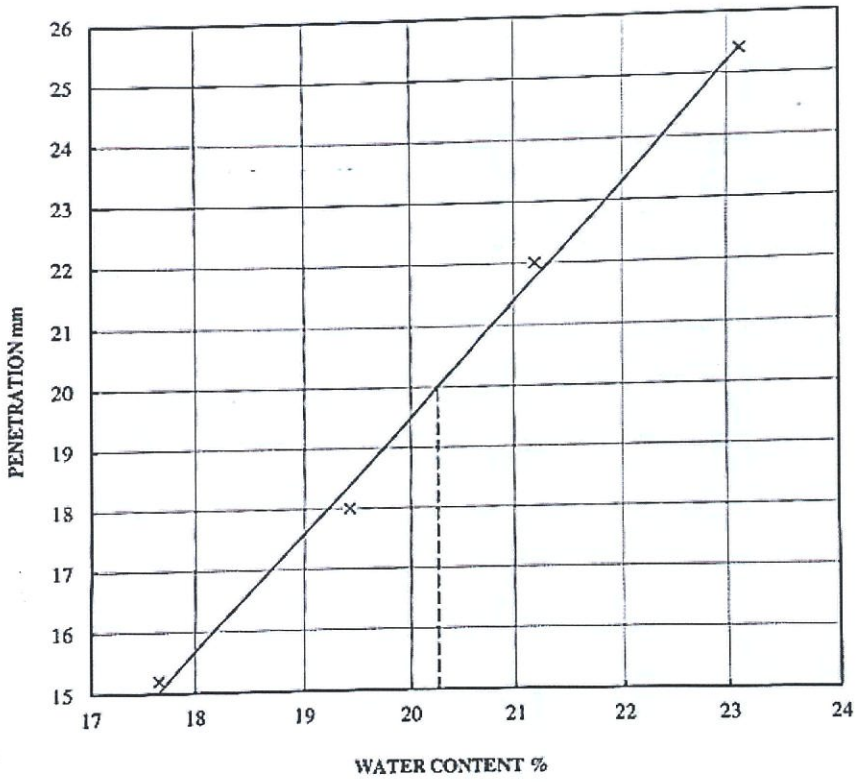
	LIQUID LIMIT %				PLASTIC LIMIT %
Wet Weight + Container g)	40.15	39.85	38.42	37.65	
Dry Weight + Container (g)	35.59	34.97	33.37	32.47	NON PLASTIC
Container Weight (g)	11.88	11.76	11.56	11.86	
Water Content (%)	19.23	21.03	23.15	25.13	
Penetration (mm)	14.80	17.50	21.40	24.60	

LIQUID LIMIT	(%)	22
PLASTIC LIMIT	(%)	NP
PLASTICITY INDEX	(%)	NP

Tested by:	Checked by:	Approved by :
Date :	Date:	Date:

LIQUID AND PLASTIC LIMIT TEST RESULTS
IS: 2720 (PART-5) 1985

PROJECT: Chandanpur Dam	TEST REPORT NO: EMTC/T/44/2015-16
SITE REF:	JOB NO: T-44/11
BOREHOLE NO: BH-72 SAMPLE NO:	DEPTH (M):



HISTORY OF SAMPLE : Natural

Percentage of passing 0.425mm B.S.Sieve =

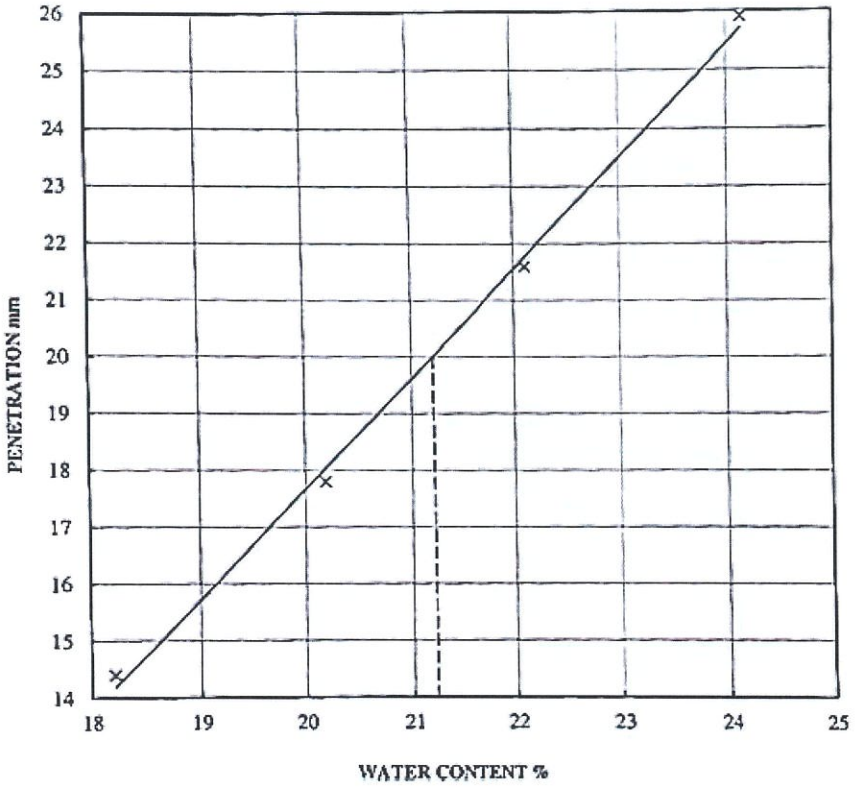
	LIQUID LIMIT %				PLASTIC LIMIT %
Wet Weight + Container g)	38.65	37.45	40.12	42.15	
Dry Weight + Container (g)	34.63	33.26	35.51	36.69	NON PLASTIC
Container Weight (g)	11.84	11.70	13.74	13.10	
Water Content (%)	17.65	19.42	21.20	23.12	
Penetration (mm)	15.20	18.00	22.00	25.40	

LIQUID LIMIT	(%)	20
PLASTIC LIMIT	(%)	NP
PLASTICITY INDEX	(%)	NP

Tested by:	Checked by:	Approved by :
Date :	Date:	Date:

LIQUID AND PLASTIC LIMIT TEST RESULTS
IS: 2720 (PART-5) 1985

PROJECT: Chandanpur Dam	TEST REPORT NO: EMTC/T/44/2015-16
SITE REF:	JOB NO: T-44/12
BOREHOLE NO: BH-80 SAMPLE NO:	DEPTH (M):



HISTORY OF SAMPLE : Natural

Percentage of passing 0.425mm B.S.Sieve =

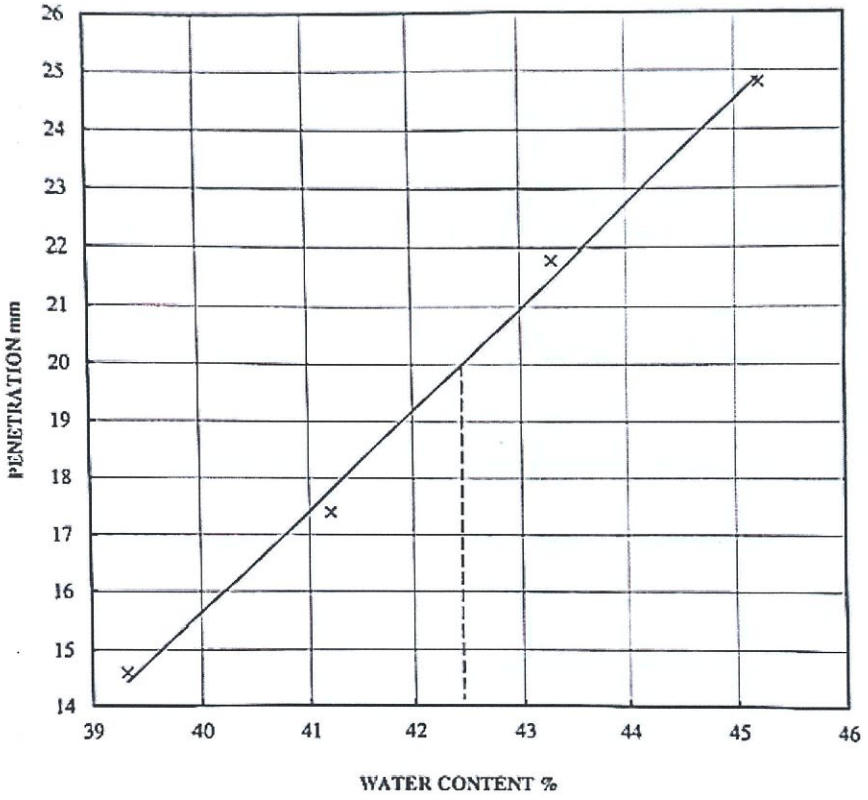
	LIQUID LIMIT %				PLASTIC LIMIT %
Wet Weight + Container g)	40.36	43.25	45.15	40.26	
Dry Weight + Container (g)	36.00	38.00	39.11	34.73	NON PLASTIC
Container Weight (g)	12.06	12.00	11.80	11.82	
Water Content (%)	18.21	20.19	22.12	24.14	
Penetration (mm)	14.40	17.80	21.60	25.90	

LIQUID LIMIT	(%)	21
PLASTIC LIMIT	(%)	NP
PLASTICITY INDEX	(%)	NP

Tested by:	Checked by:	Approved by :
Date :	Date:	Date:

LIQUID AND PLASTIC LIMIT TEST RESULTS
IS: 2720 (PART-5) 1985

PROJECT: Chandanpur Dam	TEST REPORT NO: EMTC/T/44/2015-16
SITE REF:	JOB NO: T-44/13
BOREHOLE NO: BH-83 SAMPLE NO:	DEPTH (M):



HISTORY OF SAMPLE : Natural

Percentage of passing 0.425mm B.S.Sieve =

	LIQUID LIMIT %				PLASTIC LIMIT %	
Wet Weight + Container g)	40.19	45.25	43.25	42.15	15.65	17.42
Dry Weight + Container (g)	32.15	35.56	33.76	32.70	14.87	16.25
Container Weight (g)	11.72	12.06	11.84	11.80	11.78	11.64
Water Content (%)	39.33	41.21	43.29	45.22	25.24	25.38
Penetration (mm)	14.60	17.40	21.80	24.80		

LIQUID LIMIT	(%)	43
PLASTIC LIMIT	(%)	25
PLASTICITY INDEX	(%)	18

Tested by:	Checked by:	Approved by :
Date :	Date:	Date:

NOTARY ★ SUPATRA BHATTACHARYYA City Civil Court Calcutta Regn. No. 065 of 2022 Expiry Date 31.03.2027 ★ Govt. of West Bengal

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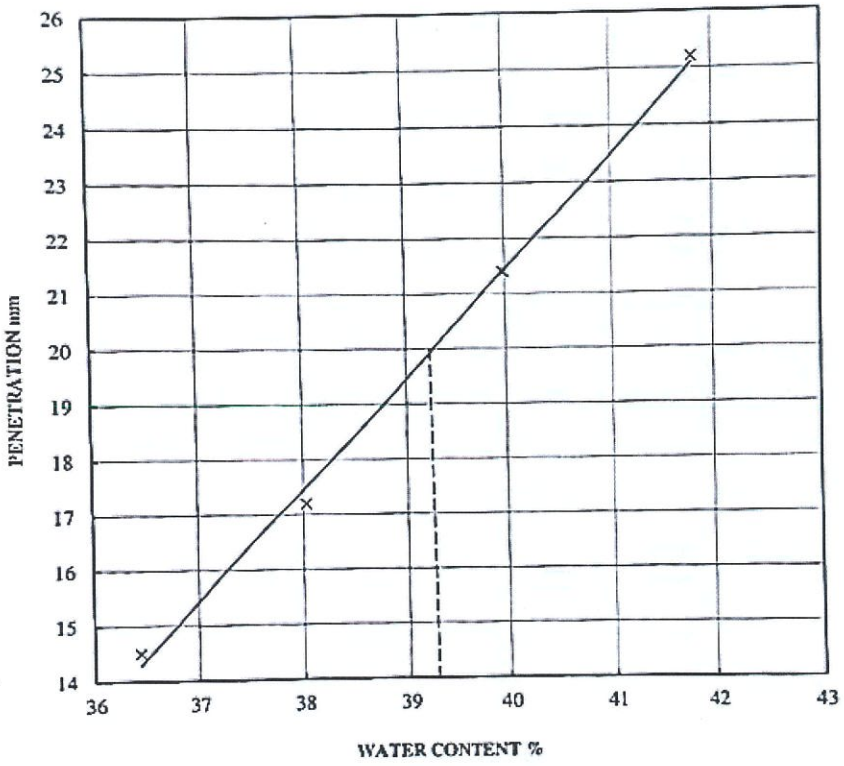
LIQUID AND PLASTIC LIMIT TEST RESULTS
IS: 2720 (PART-5) 1985

PROJECT: Chandanpur Dam	TEST REPORT NO: EMTC/T/44/2015-16
SITE REF:	JOB NO: T-44/14
BOREHOLE NO: BH-85 SAMPLE NO:	DEPTH (M):



HISTORY OF SAMPLE : Natural

Percentage of passing 0.425mm B.S.Sieve =

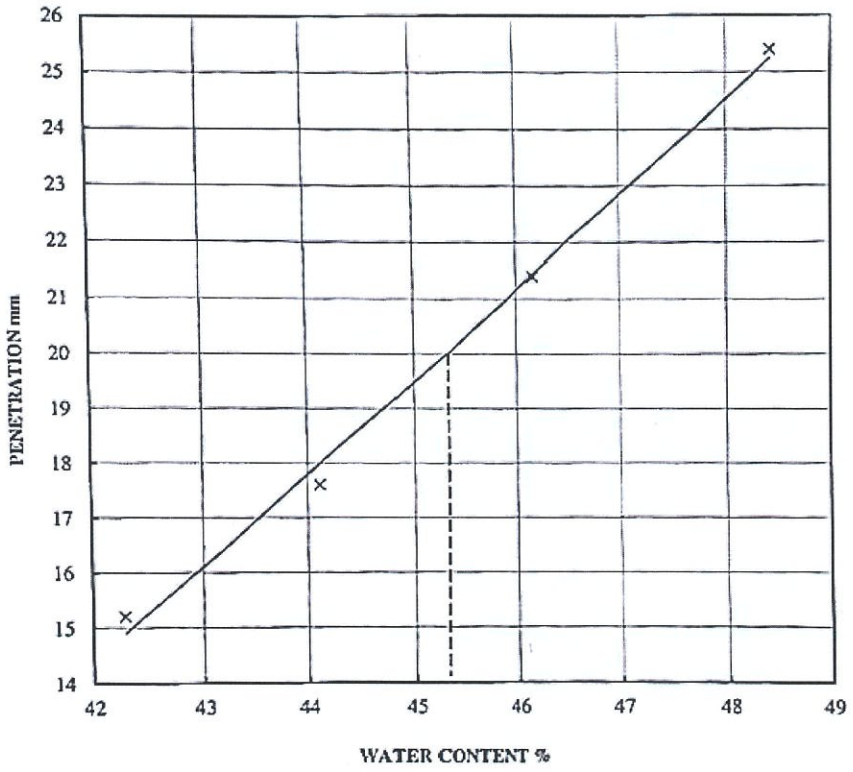
		LIQUID LIMIT %				PLASTIC LIMIT %	
Wet Weight + Container g)		40.12	41.62	45.15	42.15	16.83	14.52
Dry Weight + Container (g)		32.98	33.31	35.59	33.19	15.83	13.98
Container Weight	(g)	13.38	11.46	11.68	11.76	11.71	11.78
Water Content	(%)	36.43	38.03	39.98	41.81	24.27	24.55
Penetration	(mm)	14.50	17.20	21.40	25.20		

LIQUID LIMIT	(%)	39
PLASTIC LIMIT	(%)	24
PLASTICITY INDEX	(%)	15

Tested by	Checked by:	Approved by :
Date	Date	Date

LIQUID AND PLASTIC LIMIT TEST RESULTS
IS: 2720 (PART-5) 1985

PROJECT: Chandanpur Dam	TEST REPORT NO: EMTC/T/44/2015-16
SITE REF:	JOB NO: T-44/15
BOREHOLE NO: BH-90 SAMPLE NO:	DEPTH (M):



HISTORY OF SAMPLE : Natural

Percentage of passing 0.425mm B.S.Sieve =

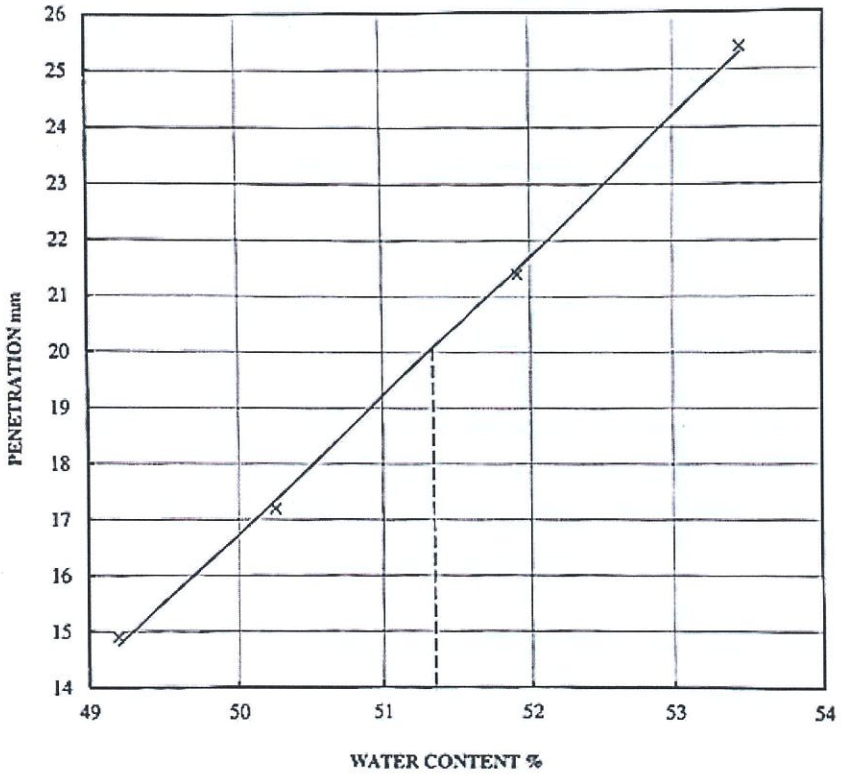
	LIQUID LIMIT %				PLASTIC LIMIT %	
Wet Weight + Container g)	42.15	45.17	40.14	46.21	18.46	17.23
Dry Weight + Container (g)	33.60	34.85	31.15	34.97	17.10	16.42
Container Weight (g)	13.38	11.46	11.68	11.76	11.56	11.88
Water Content (%)	42.28	44.12	46.17	48.43	24.55	17.84
Penetration (mm)	15.20	17.60	21.40	25.40		

LIQUID LIMIT	(%)	45
PLASTIC LIMIT	(%)	21
PLASTICITY INDEX	(%)	24

Tested by:	Checked by:	Approved by :
Date :	Date:	Date:

LIQUID AND PLASTIC LIMIT TEST RESULTS
IS: 2720 (PART-5) 1985

PROJECT: Chandanpur Dam	TEST REPORT NO: EMTC/T/44/2015-16
SITE REF:	JOB NO: T-44/16
BOREHOLE NO: BH-98 SAMPLE NO:	DEPTH (M):



HISTORY OF SAMPLE : Natural

Percentage of passing 0.425mm B.S.Sieve =

	LIQUID LIMIT %				PLASTIC LIMIT %	
Wet Weight + Container g)	50.25	39.42	42.15	39.42	15.12	14.89
Dry Weight + Container (g)	37.56	30.27	31.84	29.79	14.41	14.25
Container Weight (g)	11.77	12.06	11.98	11.77	11.72	11.81
Water Content (%)	49.21	50.25	51.91	53.44	26.39	26.23
Penetration (mm)	14.90	17.20	21.40	25.40		

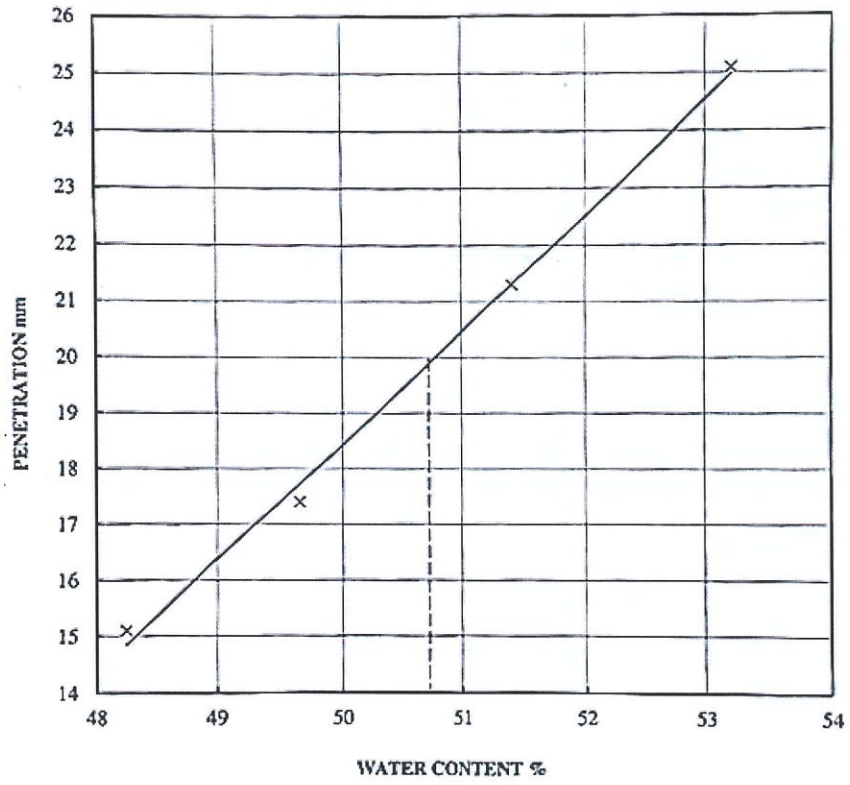
LIQUID LIMIT	(%)	51
PLASTIC LIMIT	(%)	26
PLASTICITY INDEX	(%)	25

Tested by:	Checked by:	Approved by :
Date :	Date:	Date:

NOTARY SUMITRA BHATTACHARYYA City Civil Court Calcutta Regn. No. 065 of 2022 Expiry Date 31.03.2027 Govt. of West Bengal

LIQUID AND PLASTIC LIMIT TEST RESULTS
IS: 2720 (PART-5) 1985

PROJECT: Chandanpur Dam	TEST REPORT NO: EMTC/T/44/2015-16
SITE REF:	JOB NO: T-44/17
BOREHOLE NO: BH-104 SAMPLE NO:	DEPTH (M):



HISTORY OF SAMPLE : Natural

Percentage of passing 0.425mm B.S.Sieve =

	LIQUID LIMIT %				PLASTIC LIMIT %	
Wet Weight + Container g)	42.15	40.25	41.25	43.25	15.98	15.66
Dry Weight + Container (g)	32.80	30.79	31.65	32.34	15.19	14.93
Container Weight (g)	13.42	11.74	12.98	11.84	12.05	12.06
Water Content (%)	48.25	49.66	51.42	53.22	25.16	25.44
Penetration (mm)	15.10	17.40	21.30	25.10		

LIQUID LIMIT	(%)	51
PLASTIC LIMIT	(%)	25
PLASTICITY INDEX	(%)	26

Tested by:	Checked by:	Approved by :
Date :	Date:	Date:

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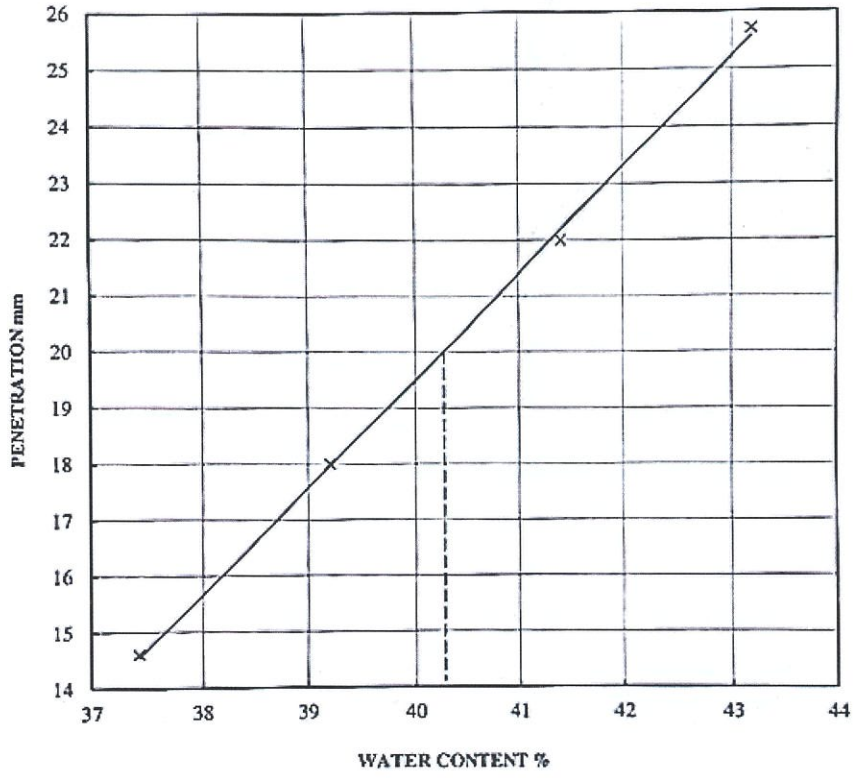
LIQUID AND PLASTIC LIMIT TEST RESULTS
IS: 2720 (PART-5) 1985

PROJECT: Chandanpur Dam	TEST REPORT NO: EMTC/T/44/2015-16
SITE REF:	JOB NO: T-44/18
BOREHOLE NO: BH-113 SAMPLE NO:	DEPTH (M):



HISTORY OF SAMPLE : Natural

Percentage of passing 0.425mm B.S.Sieve =

	LIQUID LIMIT %				PLASTIC LIMIT %	
Wet Weight + Container g)	42.14	43.25	44.25	45.20	17.43	17.23
Dry Weight + Container (g)	33.89	34.82	34.69	35.13	16.46	16.25
Container Weight (g)	11.86	13.32	11.60	11.82	11.98	11.72
Water Content (%)	37.42	39.21	41.42	43.18	21.65	21.63
Penetration (mm)	14.60	18.00	22.00	25.70		

LIQUID LIMIT	(%)	40
PLASTIC LIMIT	(%)	22
PLASTICITY INDEX	(%)	18

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Date :	Date:	Date:

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Regn. No. 068 of 2022
Expiry Date 31.03.2027
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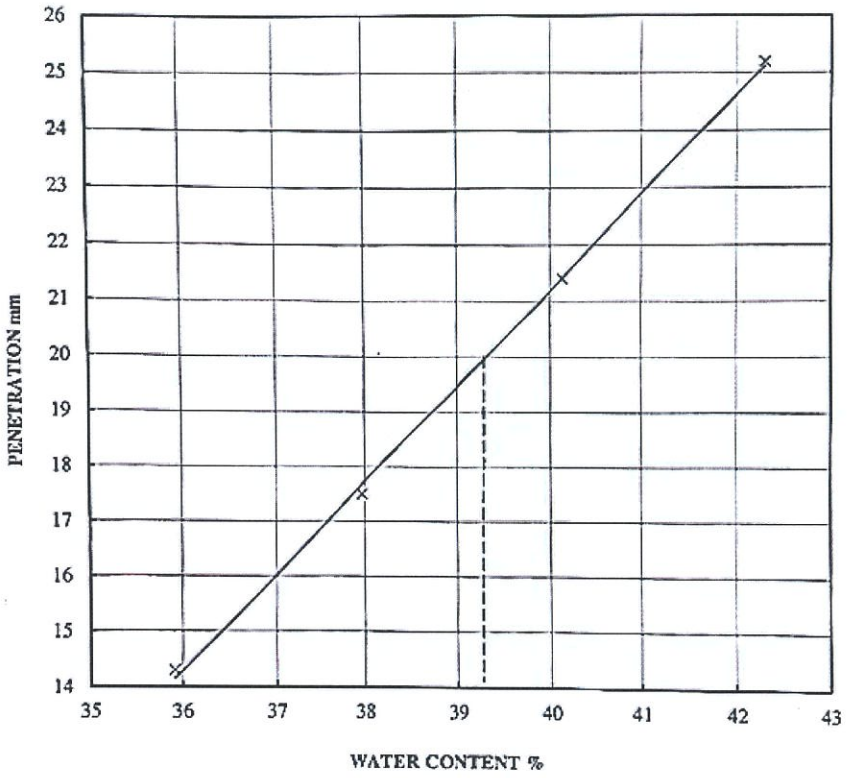
LIQUID AND PLASTIC LIMIT TEST RESULTS
IS: 2720 (PART-5) 1985

PROJECT: Chandanpur Dam	TEST REPORT NO: EMTC/T/44/2015-16
SITE REF:	JOB NO: T-44/19
BOREHOLE NO: BH-117 SAMPLE NO:	DEPTH (M):



HISTORY OF SAMPLE : Natural

Percentage of passing 0.425mm B.S.Sieve =

	LIQUID LIMIT %				PLASTIC LIMIT %	
Wet Weight + Container g)	42.15	40.36	45.25	41.25	16.88	16.28
Dry Weight + Container (g)	34.52	32.45	35.68	32.45	16.28	15.46
Container Weight (g)	13.28	11.62	11.84	11.64	13.81	12.09
Water Content (%)	35.92	37.97	40.14	42.29	24.29	24.33
Penetration (mm)	14.30	17.50	21.40	25.20		

LIQUID LIMIT	(%)	39
PLASTIC LIMIT	(%)	24
PLASTICITY INDEX	(%)	15

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NOTARY
BHATTACHARYYA
City Civil Court
Calcutta
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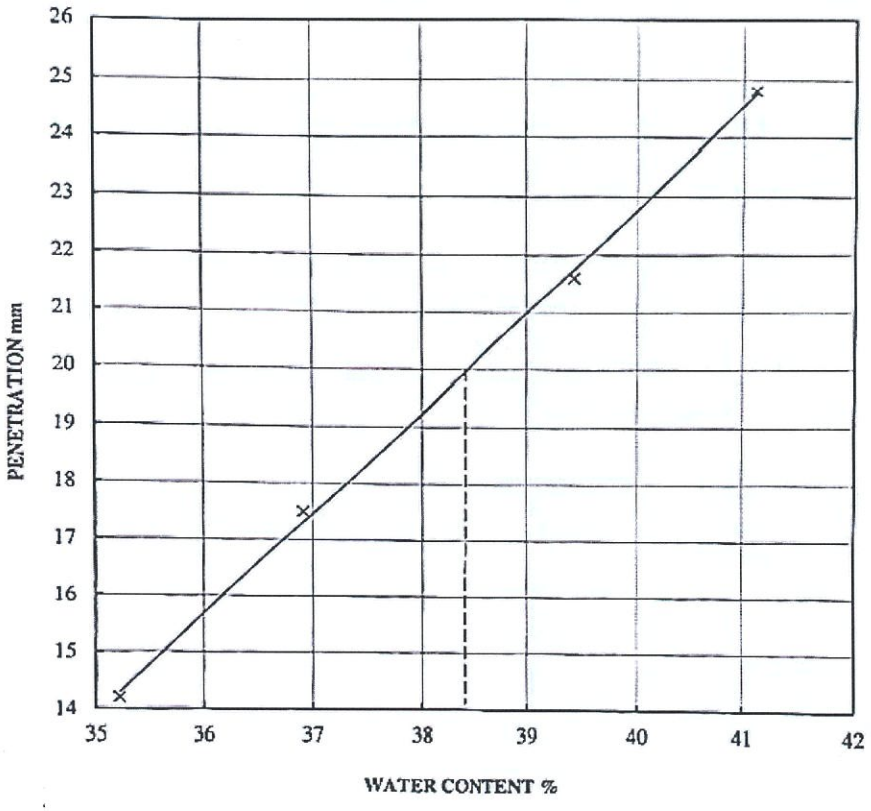
LIQUID AND PLASTIC LIMIT TEST RESULTS
IS: 2720 (PART-5) 1985

PROJECT: Chandanpur Dam	TEST REPORT NO: EMTC/T/44/2015-16
SITE REF:	JOB NO: T-44/20
BOREHOLE NO: BH-120 SAMPLE NO:	DEPTH (M):



HISTORY OF SAMPLE : Natural

Percentage of passing 0.425mm B.S.Sieve =

	LIQUID LIMIT %				PLASTIC LIMIT %	
Wet Weight + Container g)	43.25	42.15	44.12	40.25	15.60	16.41
Dry Weight + Container (g)	35.58	33.95	34.89	31.94	14.94	15.57
Container Weight (g)	13.80	11.74	11.48	11.72	11.82	11.65
Water Content (%)	35.21	36.92	39.43	41.12	21.15	21.43
Penetration (mm)	14.20	17.50	21.60	24.80		

LIQUID LIMIT	(%)	38
PLASTIC LIMIT	(%)	21
PLASTICITY INDEX	(%)	17

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NOTARY
SUMITRA BHATTACHARYYA
City Civil Court
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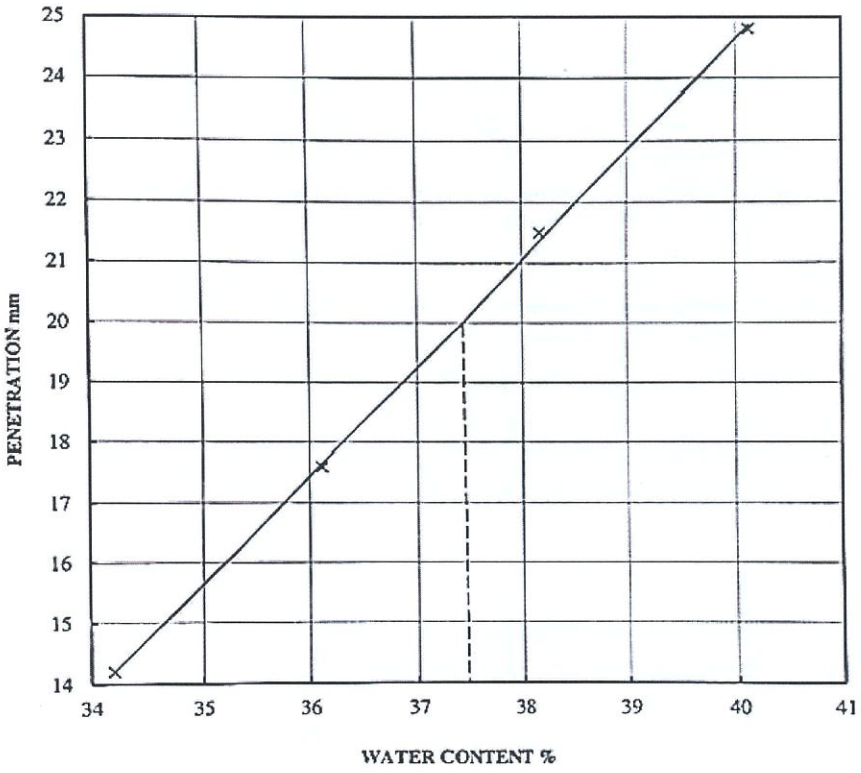
LIQUID AND PLASTIC LIMIT TEST RESULTS
IS: 2720 (PART-5) 1985

PROJECT: Chandanpur Dam	TEST REPORT NO: EMTC/T/44/2015-16
SITE REF:	JOB NO: T-44/21
BOREHOLE NO: BH-124 SAMPLE NO:	DEPTH (M):



HISTORY OF SAMPLE : Natural

Percentage of passing 0.425mm B.S.Sieve =

	LIQUID LIMIT %				PLASTIC LIMIT %	
Wet Weight + Container g)	41.25	43.20	42.10	46.21	17.94	19.09
Dry Weight + Container (g)	34.15	34.78	33.69	36.35	16.91	18.12
Container Weight (g)	13.38	11.46	11.68	11.76	11.82	13.32
Water Content (%)	34.20	36.12	38.18	40.12	20.24	20.21
Penetration (mm)	14.20	17.60	21.50	24.80		

LIQUID LIMIT	(%)	37
PLASTIC LIMIT	(%)	20
PLASTICITY INDEX	(%)	17

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Date :	Date:	Date:

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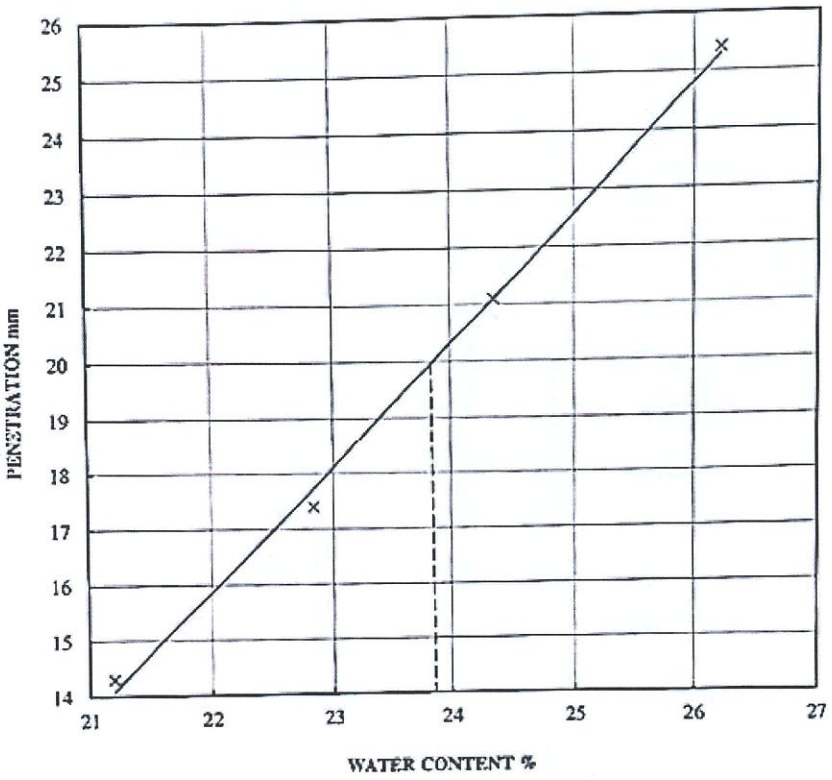
LIQUID AND PLASTIC LIMIT TEST RESULTS
IS: 2720 (PART-5) 1985

PROJECT: Chandanpur Dam	TEST REPORT NO: EMTC/T/44/2015-16
SITE REF:	JOB NO: T-44/22
BOREHOLE NO: BH-130 SAMPLE NO:	DEPTH (M):



HISTORY OF SAMPLE : Natural

Percentage of passing 0.425mm B.S.Sieve =

		LIQUID LIMIT %				PLASTIC LIMIT %
Wet Weight + Container g)		40.15	39.42	42.15	44.56	
Dry Weight + Container (g)		35.18	34.62	36.92	37.71	NON PLASTIC
Container Weight	(g)	11.74	13.60	15.44	11.58	
Water Content	(%)	21.20	22.84	24.35	26.22	
Penetration	(mm)	14.30	17.40	21.10	25.40	

LIQUID LIMIT	(%)	24
PLASTIC LIMIT	(%)	NP
PLASTICITY INDEX	(%)	NP

Tested by:	Checked by:	Approved by :
Date :	Date:	Date:

22.6.22

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31.03.2027
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SHRINKAGE LIMIT
TEST METHOD IS: 2720 PART-6 (1979)

PROJECT: Chandanpur Dam	Test Report No. EMTC/T/44/2015-16
SITE REF:	

Job No.	T-44/02	T-44/04	T-44/05	T-44/06	T-44/07	T-44/08	T-44/09
Borehole No./Pit No.	BH/CC-01	BH-05	BH-22	BH-26	BH-39	BH-43	BH-52
Sample No.							
Depth (m)							
Balance No.	DWB-02	DWB-02	DWB-02	DWB-02	DWB-02	DWB-02	DWB-02
Soil type	Silty clay	Silty clay	Silty clay	Silty clay	Silty clay	Silty clay	Silty clay
Soil:Undisturbed/Remoulded	Remoulded	Remoulded	Remoulded	Remoulded	Remoulded	Remoulded	Remoulded
Shrinkage limit Apparatus No :	SL-06	SL-03	SL-07	SL-08	SL-07	SL-05	SL-08
Wt.of Shrinkage Dish (gm)	63.90	62.43	61.71	63.54	61.71	64.70	63.54
Wt.of Shrinkage Dish + wet soil pat (gm)	107.98	107.8	106.96	107	106.96	110.81	107
Wt.of Shrinkage Dish + dry soil pat (gm)	95.44	95.94	94.85	94.67	94.85	100.01	94.67
Wt.of water (gm)	12.54	11.86	12.11	12.33	12.11	10.8	12.33
Wt.of dry soil pat, Wo(gm)	31.54	33.51	33.14	31.13	33.14	35.31	31.13
Wt of Mercury (Hg)+ Shrinkage Dish	398.8	400.35	400.45	398.11	400.45	400.79	398.11
Volume of wet soil pat, V (ml)	24.63	24.85	24.91	24.60	24.91	24.71	24.60
Moisture Content W (%)	39.76	35.39	36.54	39.61	36.54	30.59	39.61
Wt. of Mercury displaced (Hg)	278.36	295.57	295.40	227.40	288.04	329.40	223.60
Volume of dry soil pat, Vo (ml)	15.77	17.14	17.18	16.72	16.64	19.46	16.44
Wt.of Shrinkage Dish+Oven dry specimen(gm)							
Wt.of oven dry specimen, Wos(gm)							
Volume of oven dry specimen, Vos(ml)							
Specific gravity of soil, G							
Remoulded Soil:SL(Ws%)=W-[V-Vo/Wo]x100	11.7	12.4	13.2	14.3	11.6	15.7	13.4
Undistirbed Soil:SL(Ws%)=W-[(Vos/Wos)-1/G]x100							

Tested by	Checked by	Approved by
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NOTARY
SUMITRA BHATTACHARYYA
City Civil Court
Calcutta
Regn. No. 005 of 2022
Expiry Date
31.03.2027
Govt. of West Bengal

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SHRINKAGE LIMIT
TEST METHOD IS: 2720 PART-6 (1979)

PROJECT: Chandanpur Dam	Test Report No. EMTC/T/44/2015-16
SITE REF:	

Job No.	T-44/13	T-44/14	T-44/15	T-44/16	T-44/17	T-44/18	T-44/19
Borehole No./Pit No.	BH-83	BH-85	BH-90	BH-98	BH-104	BH-113	BH-117
Sample No.							
Depth (m)							
Balance No.	DWB-02	DWB-02	DWB-02	DWB-02	DWB-02	DWB-02	DWB-02
Soil type	Silty clay	Silty clay	Silty clay	Silty clay	Silty clay	Silty clay	Silty clay
Soil:Undisturbed/Remoulded	Remoulded	Remoulded	Remoulded	Remoulded	Remoulded	Remoulded	Remoulded
Shrinkage limit Apparatus No :	SL-01	SL-05	SL-01	SL-04	SL-04	SL-04	SL-09
Wt.of Shrinkage Dish (gm)	64.13	64.70	64.13	61.73	61.73	61.73	63.37
Wt.of Shrinkage Dish + wet soil pat (gm)	108.02	110.81	108.02	103.97	103.97	103.97	109.23
Wt.of Shrinkage Dish + dry soil pat (gm)	95.49	100.01	95.49	90.71	90.71	90.71	98.32
Wt.of water (gm)	12.53	10.8	12.53	13.26	13.26	13.26	10.91
Wt.of dry soil pat, Wo(gm)	31.36	35.31	31.36	28.98	28.98	28.98	34.95
Wt of Mercury (Hg)+ Shrinkage Dish	399.32	400.79	399.32	397.92	397.92	397.92	399.24
Volume of wet soil pat, V (ml)	24.65	24.71	24.65	24.72	24.72	24.72	24.70
Moisture Content W (%)	39.96	30.59	39.96	45.76	45.76	45.76	31.22
Wt. of Mercury displaced (Hg)	225.00	325.10	230.40	214.50	203.78	218.60	300.73
Volume of dry soil pat, Vo (ml)	16.54	19.15	16.94	15.77	14.98	16.07	17.45
Wt.of Shrinkage Dish+Oven dry specimen(gm)							
Wt.of oven dry specimen, Wos(gm)							
Volume of oven dry specimen, Vos(ml)							
Specific gravity of soil, G							
Remoulded Soil:SL(Ws%)=W-[V-Vo/Wo]x100	14.1	14.8	15.4	14.9	12.2	15.9	10.5
Undistirbed Soil:SL(Ws%)=W-[(Vos/Wos)-1/G]x100							

Tested by	Checked by	Approved by
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Govt. of West Bengal

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SHRINKAGE LIMIT
TEST METHOD IS: 2720 PART-6 (1979)

PROJECT: Chandanpur Dam	Test Report No. EMTC/T/44/2015-16
SITE REF:	

Job No.	T-44/20	T-44/21					
Borehole No./Pit No.	BH-120	BH-124					
Sample No.							
Depth (m)							
Balance No.	DWB-02	DWB-02					
Soil type	Silty clay	Silty clay					
Soil:Undisturbed/Remoulded	Remoulded	Remoulded					
Shrinkage limit Apparatus No :	SL-10	SL-02					
Wt.of Shrinkage Dish (gm)	41.01	50.24					
Wt.of Shrinkage Dish + wet soil pat (gm)	83.55	91.28					
Wt.of Shrinkage Dish + dry soil pat (gm)	71.19	82.47					
Wt.of water (gm)	12.36	8.81					
Wt.of dry soil pat, Wo(gm)	30.18	32.23					
Wt of Mercury (Hg)+ Shrinkage Dish	366.04	336.02					
Volume of wet soil pat, V (ml)	23.90	21.01					
Moisture Content W (%)	40.95	27.33					
Wt. of Mercury displaced (Hg)	255.40	275.20					
Volume of dry soil pat, Vo (ml)	15.76	16.54					
Wt.of Shrinkage Dish+Oven dry specimen(gm)							
Wt.of oven dry specimen, Wos(gm)							
Volume of oven dry specimen, Vos(ml)							
Specific gravity of soil, G							
Remoulded Soil:SL(Ws%)=W-[V-Vo/Wo]x100	14.0	13.5					
Undistirbed Soil:SL(Ws%)=W-[(Vos/Wos)-1/G]x100							

Tested by	Checked by	Approved by
Date:	Date:	Date:

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SUMITRA BHATTACHARYYA
City Civil Court
Calcutta
Regn. No. 005 of 2022
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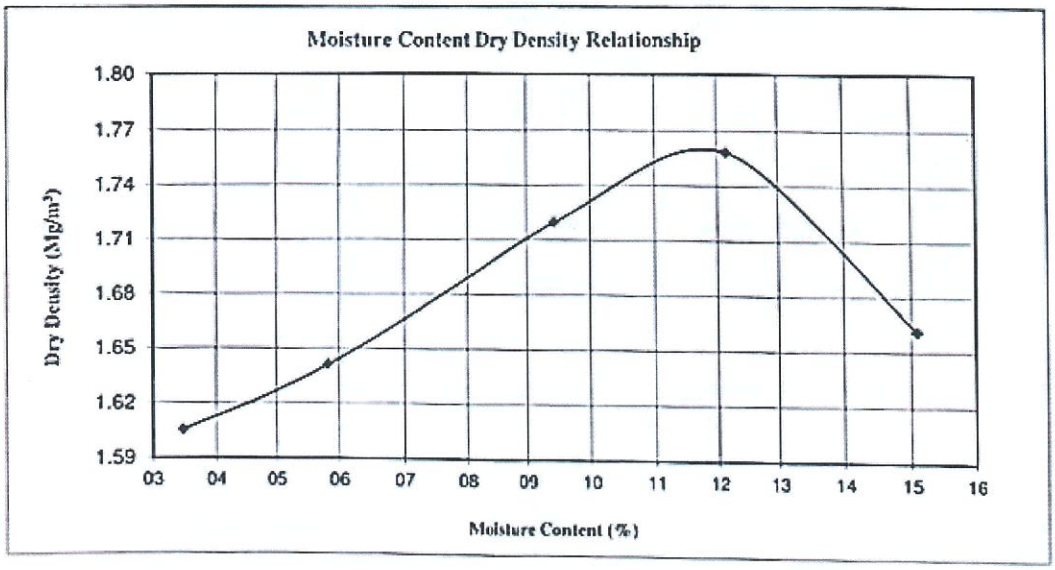
COMPACTION TEST
TEST METHOD IS: 2720 PART-7 1980

PROJECT : Chandanpur Dam	TEST REPORT NO: EMTC/T/44/2015
SITE REF:	JOB NO: T-44/11

Borehole No. 72 SAMPLE NO: DEPTH(M):

Volume of Mould, V (cc)= 1000 Type of Compaction: Light Dynamic

Determination Number	1	2	3	4	5	
Weight of Mould+Compacted Soil (gm), M_2	3674	3750	3895	3985	3925	
Weight of Mould (gm), M_1	2013	2013	2013	2013	2013	
Bulk Density, γ_b Mg/m^3, $(M_2-M_1)/V$	1.66	1.74	1.88	1.97	1.91	
Wt of cup + wet soil (gm), ml	43.01	48.7	45.89	38.81	45.4	
Wt of cup + dry soil (gm), m2	41.97	46.70	42.95	35.89	41.02	
Wt of cup (gm), m3	12.03	11.91	11.82	11.86	11.74	
Moisture content, w (%), (m1-m2)/(m2-m3)	3.5	5.8	9.4	12.2	15.1	
Dry Density, Mg/m^3 $\gamma_b/(1+w)$	1.61	1.64	1.72	1.76	1.66	



Soil Classification: Redish Poorly graded SAND (SP)

OMC 11.8 %

MDD 1.76 Mg/m^3

Tested by	Checked by	Approved by
Date	Date	Date

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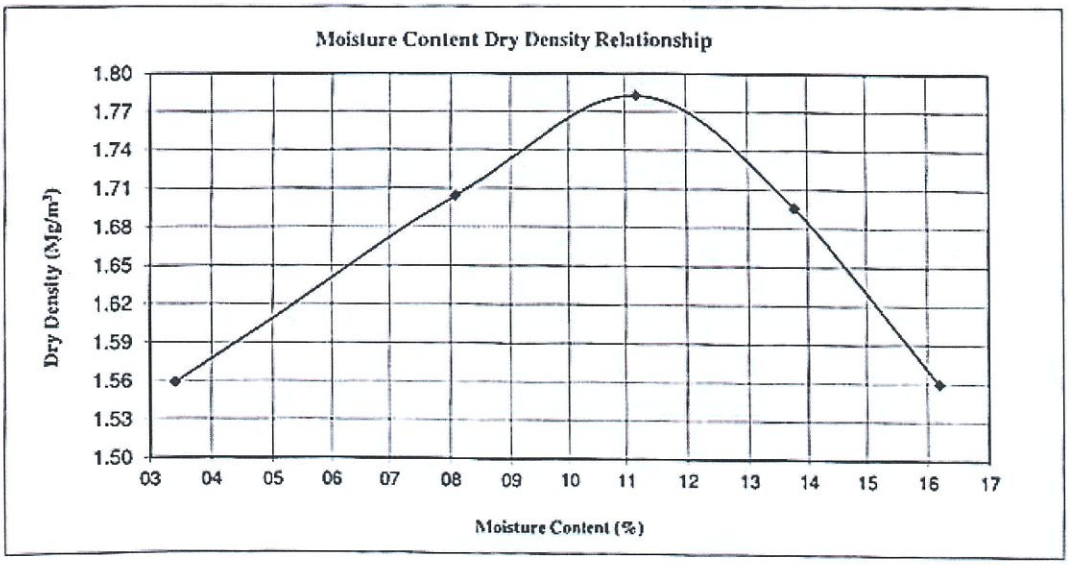
COMPACTION TEST
TEST METHOD IS: 2720 PART-7 1980

PROJECT.: Chandanpur Dam	TEST REPORT NO: EMTC/T/44/2015
SITE REF:	JOB NO: T-44/12

Borehole No. 80 SAMPLE NO: DEPTH(M):

Volume of Mould, V (cc)= 1000 Type of Compaction: Light Dynamic

Determination Number	1	2	3	4	5	
Weight of Mould+Compacted Soil (gm), M_2	3625	3855	3995	3942	3825	
Weight of Mould (gm), M_1	2013	2013	2013	2013	2013	
Bulk Density, γ_b Mg/m^3, $(M_2-M_1)/V$	1.61	1.84	1.98	1.93	1.81	
Wt of cup + wet soil (gm), m1	45.20	42.2	43.25	49.3	45.2	
Wt of cup + dry soil (gm), m2	44.10	39.88	40.09	44.75	40.51	
Wt of cup (gm), m3	11.82	11.8	11.86	11.72	11.56	
Moisture content, w (%), (m1-m2)/(m2-m3)	3.4	8.1	11.2	13.8	16.2	
Dry Density, Mg/m^3 $\gamma_b/(1+w)$	1.56	1.70	1.78	1.70	1.56	



Soil Classification: Redish Poorly graded SAND (SP)

OMC 11.2 %

MDD 1.78 Mg/m^3

Tested by	Checked by	Approved by
Date :	Date	Date

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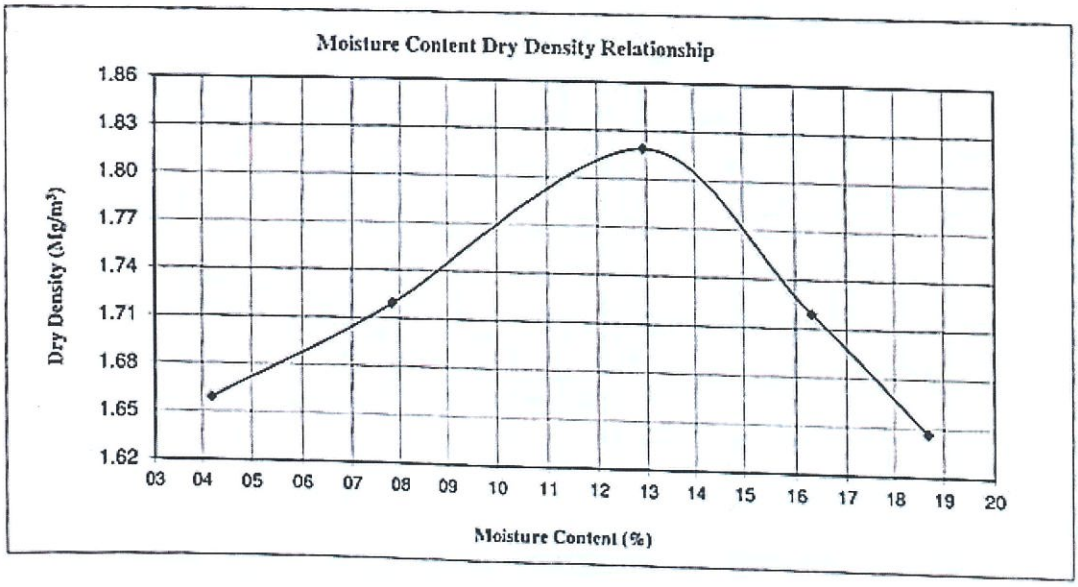
COMPACTION TEST
TEST METHOD IS: 2720 PART-7 1980

PROJECT : Chandanpur Dam	TEST REPORT NO: EMTC/T/44/2015
SITE REF:	JOB NO: T-44/13

Borehole No. 80 SAMPLE NO: DEPTH(M):

Volume of Mould, V (cc)= 1000 Type of Compaction: Light Dynamic

Determination Number	1	2	3	4	5	
Weight of Mould+Compacted Soil (gm), M_2	3740	3865	4065	4011	3965	
Weight of Mould (gm), M_1	2011	2011	2011	2011	2011	
Bulk Density, γ_b Mg/m^3, $(M_2-M_1)/V$	1.73	1.85	2.05	2.00	1.95	
Wt of cup + wet soil (gm), m1	36.25	39.6	47.56	51.2	45.32	
Wt of cup + dry soil (gm), m2	35.31	37.65	43.47	45.65	40.04	
Wt of cup (gm), m3	13.02	13.28	11.84	11.64	11.78	
Moisture content, w (%), (m1-m2)/(m2-m3)	4.2	7.8	12.9	16.3	18.7	
Dry Density, Mg/m^3 $\gamma_b/(1+w)$	1.66	1.72	1.82	1.72	1.65	



Soil Classification: Brownish Silty CLAY (CI)

OMC 12.9 %

MDD 1.82 Mg/m^3

Tested by	Checked by	Approved by
Date :	Date	Date

NOTARY SUMITRA BHATTACHARYYA City Civil Court Calcutta Regn. No. 0165 of 2022 Expiry Date 31.03.2027 Govt. of West Bengal

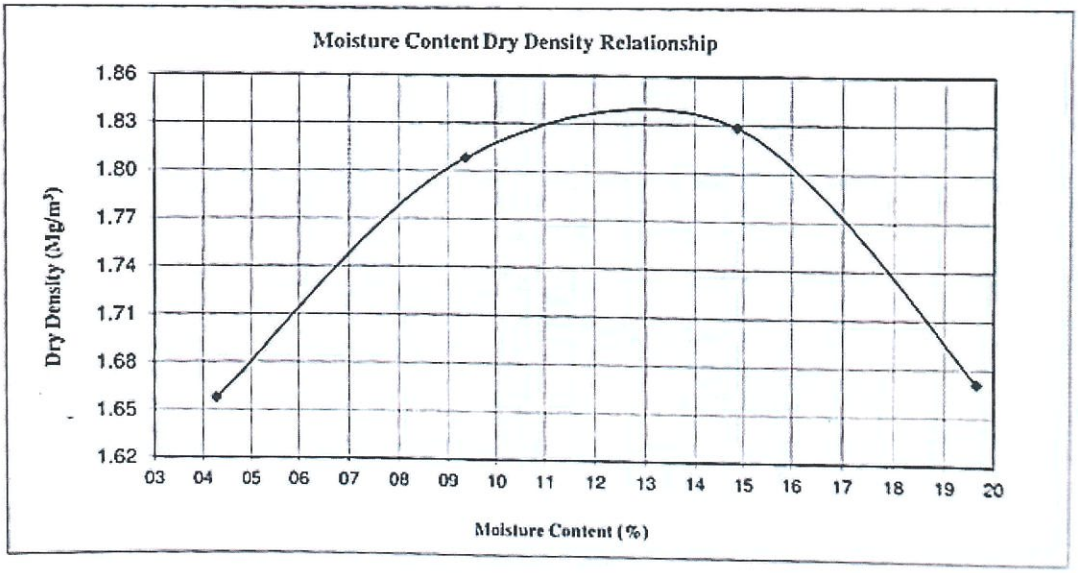
COMPACTION TEST
TEST METHOD IS: 2720 PART-7 1980

PROJECT : Chandanpur Dam	TEST REPORT NO: EMTC/T/44/2015
SITE REF:	JOB NO: T-44/19

Borehole No. S0 SAMPLE NO: DEPTH(M):

Volume of Mould, V (cc)= 1000 Type of Compaction: Light Dynamic

Determination Number	1	2	3	4		
Weight of Mould+Compacted Soil (gm), M_2	3740	3988	4112	4011		
Weight of Mould (gm), M_1	2011	2011	2011	2011		
Bulk Density, γ_b Mg/m^3, $(M_2-M_1)/V$	1.73	1.98	2.10	2.00		
Wt of cup + wet soil (gm), m1	37.92	45.0	61.66	72.72		
Wt of cup + dry soil (gm), m2	36.85	42.15	55.37	62.74		
Wt of cup (gm), m3	11.83	11.89	13.09	11.97		
Moisture content, w (%), (m1-m2)/(m2-m3)	4.3	9.4	14.9	19.7		
Dry Density, Mg/m^3 $\gamma_b/(1+w)$	1.66	1.81	1.83	1.67		



Soil Classification: Brownish Silty CLAY (CI)

OMC 13.0 %

MDD 1.83 Mg/m^3

Tested by	Checked by	Approved by
Date :	Date	Date

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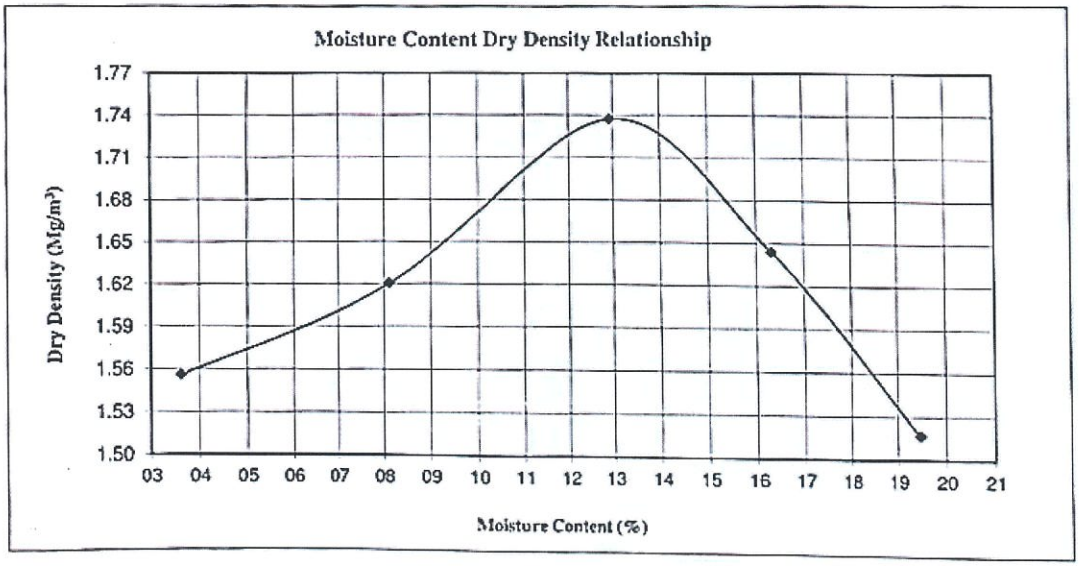
COMPACTION TEST
TEST METHOD IS: 2720 PART-7 1980

PROJECT : Chandanpur Dam	TEST REPORT NO: EMTC/T/44/2015
SITE REF:	JOB NO: T-44/22

Borehole No. 130 SAMPLE NO: DEPTH(M):

Volume of Mould, V (cc)= 1000 Type of Compaction: Light Dynamic

Determination Number	1	2	3	4	5	
Weight of Mould+Compacted Soil (gm), M_2	3625	3765	3975	3925	3825	
Weight of Mould (gm), M_1	2013	2013	2013	2013	2013	
Bulk Density, γ_b Mg/m^3, $(M_2-M_1)/V$	1.61	1.75	1.96	1.91	1.81	
Wt of cup + wet soil (gm), m1	40.65	42.2	44.15	45.14	39.7	
Wt of cup + dry soil (gm), m2	39.65	39.89	40.45	40.45	35.12	
Wt of cup (gm), m3	12	12.06	11.82	11.7	11.86	
Moisture content, w (%), (m1-m2)/(m2-m3)	3.6	8.1	12.9	16.3	19.5	
Dry Density, Mg/m^3 $\gamma_b/(1+w)$	1.56	1.62	1.74	1.64	1.52	



Soil Classification: Redish Silty SAND (SM)

OMC 12.9 %

MDD 1.74 Mg/m^3

Tested by	Checked by	Approved by
Date :	Date	Date

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Sr. No.	Borehole No.	Job No.	pH	Chloride (as Cl') mg/kg	Sulphate (as SO_4) mg/kg	Total Kjehldal Nitrogen mg/kg	Phosphorus (as P) mg/kg	Potassium Available (as K) mg/kg	Organic Carbon %
1	BH-02	T-44/03	6.4	73.2	340.0	710.0	88.5	138.4	0.69
2	BH-52	T-44/09	6.6	82.3	319.8	645.6	79.6	135.6	0.63
3	BH-85	T-44/14	7.5	90.4	290.4	658.4	86.5	120.7	0.66
4	BH-113	T-44/18	6.9	86.4	288.2	670.8	78.9	142.8	0.70
5	BH-130	T-130/22	6.7	92.5	310.7	659.4	76.5	137.5	0.59

Sr. No.	Borehole No.	Job No.	Zinc mg/kg	Lead mg/kg	Arsenic mg/kg	Cadmium mg/kg	Copper mg/kg	Mercury mg/kg
1	BH-02	T-44/03	84.7	ND	ND	ND	69.0	ND
2	BH-52	T-44/09	78.5	ND	ND	ND	67.4	ND
3	BH-85	T-44/14	75.8	ND	ND	ND	65.8	ND
4	BH-113	T-44/18	79.5	ND	ND	ND	62.4	ND
5	BH-130	T-130/22	81.2	ND	ND	ND	72.1	ND

ND = Not Detective

Tested by: 22-6-19 JE 22.6.19 AE

Approved by:

NOTARY
SUMITRA BHATTACHARYYA
City Civil Court
Calcutta
Regn. No. 065 of 2022
Expiry Date
31.03.2027
Govt. of West Bengal

GOVERNMENT OF BIHAR

(WATER RESOURCES DEPARTMENT)

DESILTING OF BIHAR RESERVOIR

Annexe - V

Auger boring location Map

GOVERNMENT OF BIHAR

(WATER RESOURCES DEPARTMENT)

DESILTING OF CHANDAN RESERVOIR

Drawing - I
Index Map


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136.12

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GOVERNMENT OF BIHAR

(WATER RESOURCES DEPARTMENT)

DESILTING OFCHANDAN RESERVOIR

Drawing - II
Survey Map

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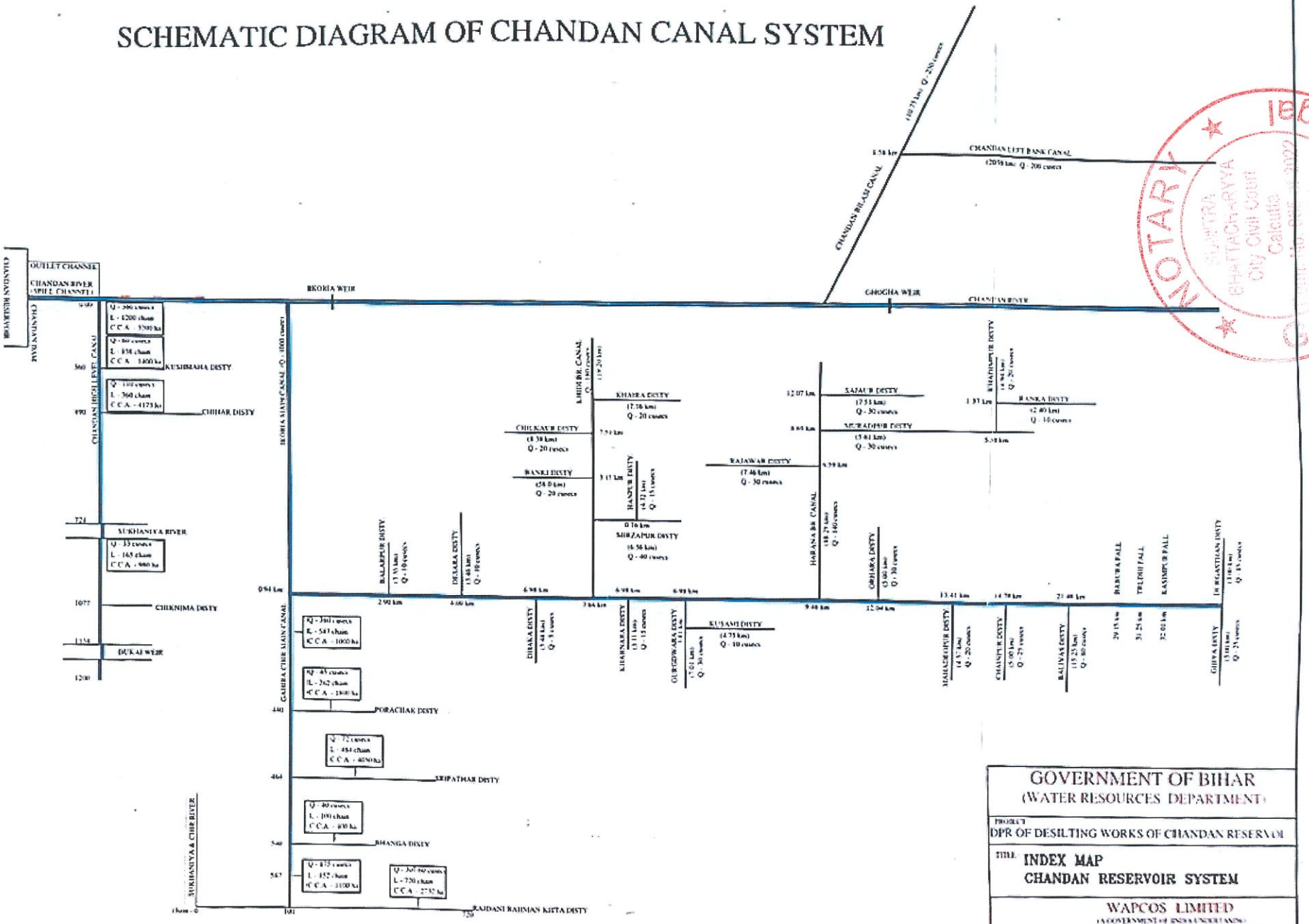
SCHEMATIC DIAGRAM OF CHANDAN CANAL SYSTEM



GOVERNMENT OF BIHAR (WATER RESOURCES DEPARTMENT)	
PROJECT: DPR OF DESILTING WORKS OF CHANDAN RESERVOI	
TITLE: INDEX MAP CHANDAN RESERVOIR SYSTEM	
WAPCOS LIMITED (A GOVERNMENT OF INDIA UNDERTAKING) 76 - C, Institutional Area, Sector 18 Gurgaon (Haryana) Pin 122015	
SHEET No 1	FIGURE NO 1.1

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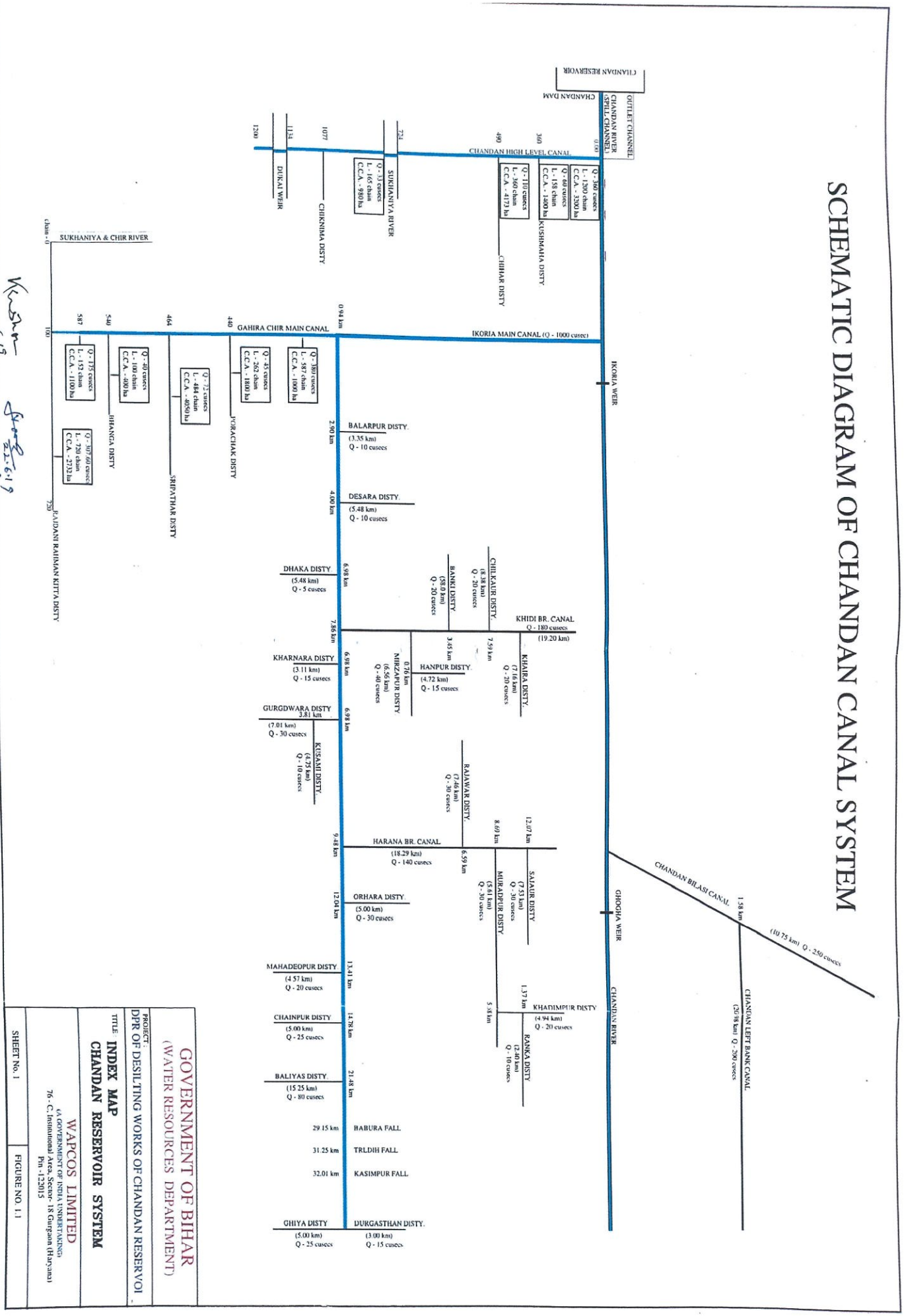

SCHEMATIC DIAGRAM OF CHANDAN CANAL SYSTEM
CHANDAN RESERVOIR
CHANDAN DAM
OUTLET CHANNEL
CHANDAN RIVER (SPILL CHANNEL)
CHANDAN HIGH LEVEL CANAL
Q - 360 cusecs
L - 1200 chain
C.C.A. - 3200 ha
Q - 60 cusecs
L - 158 chain
C.C.A. - 1400 ha
KUSHMAHA DISTY.
Q - 110 cusecs
L - 360 chain
C.C.A. - 4173 ha
CHHHAR DISTY.
Q - 33 cusecs
L - 165 chain
C.C.A. - 980 ha
SUKHANIYA RIVER
CHIKNIMA DISTY.
DHKA WEIR
SUKHANIYA & CHIR RIVER
GAHIRA CHIR MAIN CANAL
IKORIA MAIN CANAL (Q - 1000 cusec)
IKORIA WEIR
GHOGHA WEIR
CHANDAN RIVER
CHANDAN BILASI CANAL
(10.75 km) Q - 250 cusecs
CHANDAN LEFT BANK CANAL
(20.98 km) Q - 200 cusecs
Q - 380 cusecs
L - 587 chain
C.C.A. - 1000 ha
Q - 45 cusecs
L - 262 chain
C.C.A. - 1800 ha
PORACHAK DISTY.
Q - 72 cusecs
L - 484 chain
C.C.A. - 4050 ha
SRIPATHAR DISTY.
Q - 40 cusecs
L - 100 chain
C.C.A. - 400 ha
JHANGA DISTY.
Q - 175 cusecs
L - 152 chain
C.C.A. - 1100 ha
Q - 307.60 cusecs
L - 220 chain
C.C.A. - 2733 ha
RAJDANI RAHMAN KITTA DISTY.
BALARPUR DISTY.
(3.35 km)
Q - 10 cusecs
DESARA DISTY.
(5.48 km)
Q - 10 cusecs
DHAKA DISTY.
(5.48 km)
Q - 5 cusecs
KHARNARA DISTY.
(3.11 km)
Q - 15 cusecs
GURGDWARA DISTY
3.81 km
(7.01 km)
Q - 30 cusecs
KUSAMI DISTY.
(4.75 km)
Q - 10 cusecs
BANKI DISTY.
(58.0 km)
Q - 20 cusecs
CHILKAUR DISTY.
(8.38 km)
Q - 20 cusecs
KHIDI BR. CANAL
Q - 180 cusecs
(19.20 km)
KHAIRA DISTY.
(7.16 km)
Q - 20 cusecs
HANPUR DISTY.
(4.72 km)
Q - 15 cusecs
NIRZAPUR DISTY.
(6.56 km)
Q - 40 cusecs
RAJAWAR DISTY.
(7.48 km)
Q - 30 cusecs
HARANA BR. CANAL
(18.29 km)
Q - 140 cusecs
SAIAUR DISTY
(7.53 km)
Q - 30 cusecs
MURADPUR DISTY.
(5.61 km)
Q - 30 cusecs
KHADIMPUR DISTY
(4.94 km)
Q - 20 cusecs
RANKA DISTY
(2.40 km)
Q - 10 cusecs
ORHARA DISTY.
(5.00 km)
Q - 30 cusecs
MAHADEOPUR DISTY
(4.57 km)
Q - 20 cusecs
CHAINPUR DISTY
(5.00 km)
Q - 25 cusecs
BALIYAS DISTY.
(15.25 km)
Q - 80 cusecs
29.15 km BABURA FALL
31.25 km TRLDIH FALL
32.01 km KASIMPUR FALL
GHIYA DISTY
(5.00 km)
Q - 25 cusecs
DURGASTHAN DISTY.
(3.00 km)
Q - 15 cusecs
GOVERNMENT OF BIHAR
(WATER RESOURCES DEPARTMENT)
PROJECT : DPR OF DESILTING WORKS OF CHANDAN RESERVOI
TITLE : INDEX MAP
CHANDAN RESERVOIR SYSTEM
WAPCOS LIMITED
(A GOVERNMENT OF INDIA UNDERTAKING)
76 - C, Institutional Area, Sector - 18 Gurgaon (Haryana)
Pin -122015
SHEET No. 1
FIGURE NO. 1.1

~~140~~

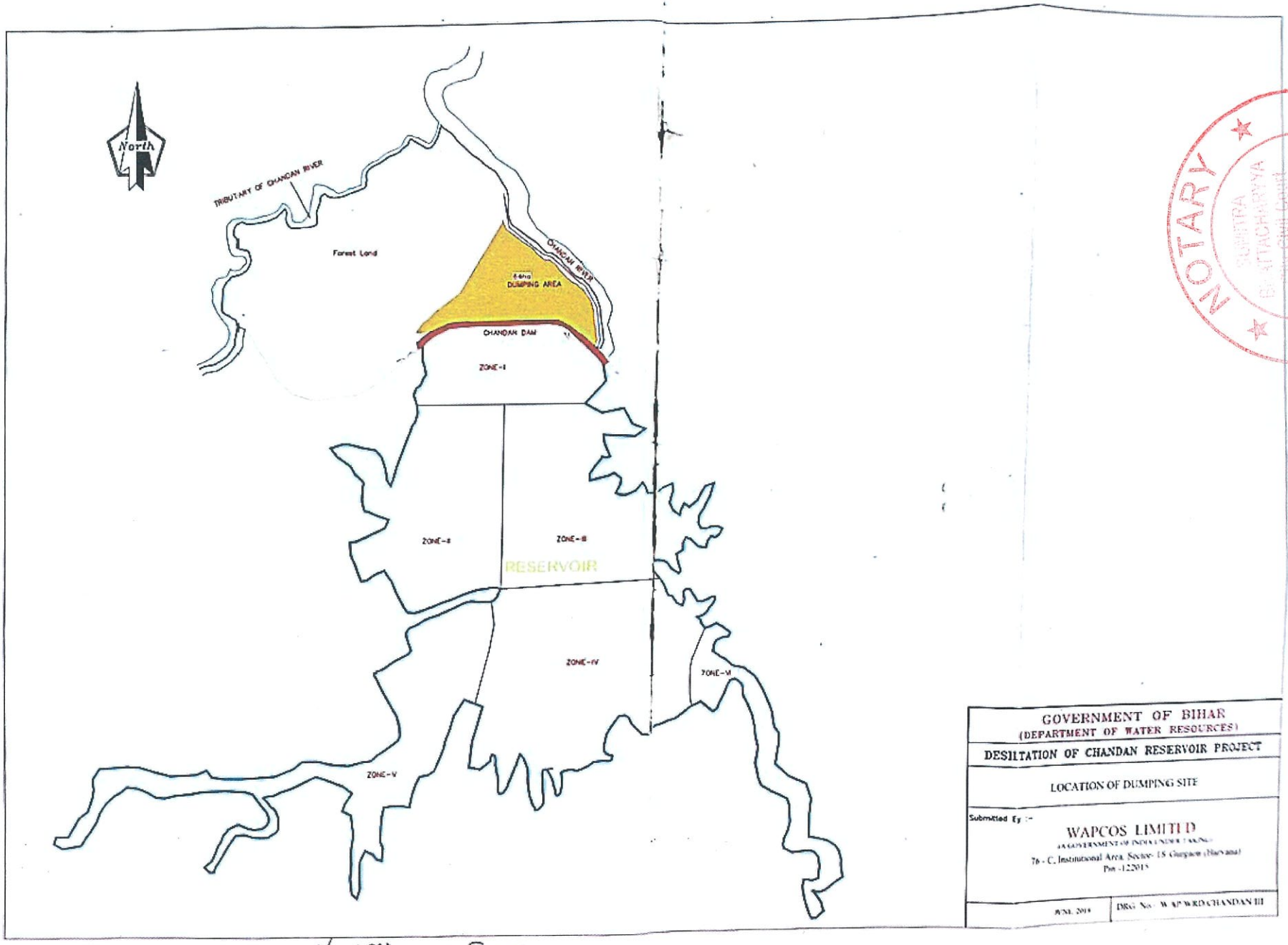
GOVERNMENT OF BIHAR

(WATER RESOURCES DEPARTMENT)

DESILTING OF CHANDAN RESERVOIR

Drawing - III
Topomap of the Reservoir
Showing Location of Dumping Site

1319



GOVERNMENT OF BIHAR
(DEPARTMENT OF WATER RESOURCES)

DESILTATION OF CHANDAN RESERVOIR PROJECT

LOCATION OF DUMPING SITE

Submitted By :-

WAPCOS LIMITED
(A GOVERNMENT OF INDIA UNDERTAKING)
76 - C, Institutional Area, Sector- 18 Gurgaon (Haryana)
Pin -122015

JUNE 2019 | DRG No. : W.A.P.WRD/CHANDAN III

NOTARY Govt. of West Bengal
SUMITRA BHATTACHARYYA
City Civil Court
Calcutta
Regn. No. 016 of 2022
Expiry Date
31.03.2027

22-6-19

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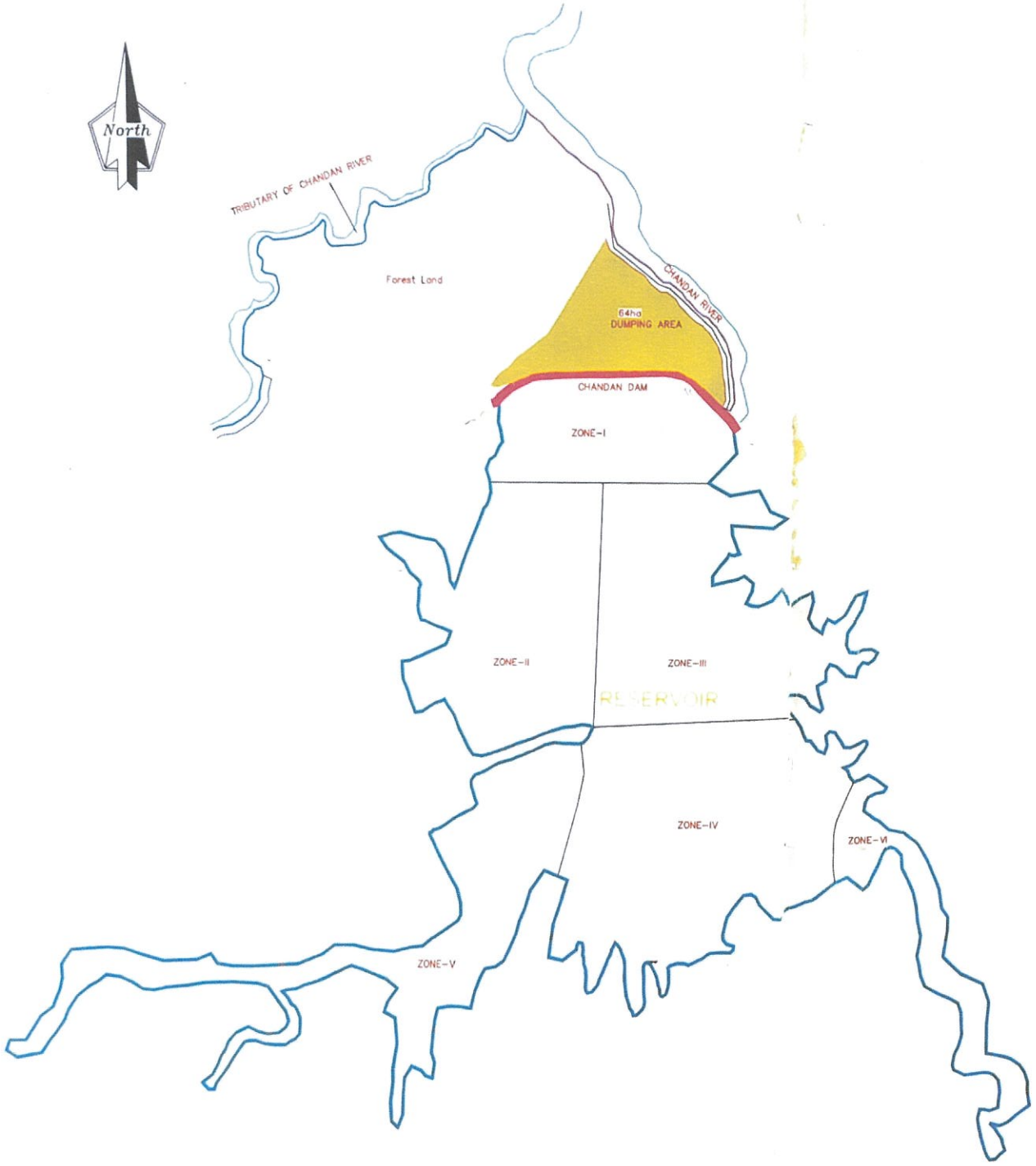


GOVERNMENT OF BIHAR
(DEPARTMENT OF WATER RESOURCES)

DESILTATION OF CHANDAN RESERVOIR PROJECT

LOCATION OF DUMPING SITE

Submitted By :-

WAPCOS LIMITED
(A GOVERNMENT OF INDIA UNDER TAKING)
76 - C, Institutional Area, Sector- 18 Gurgaon (Haryana)
Pin -122015

JUNE, 2019	DRG. No.- WAP/WRD/CHANDAN/III

22-6-19

22.6.19

~~1X2~~

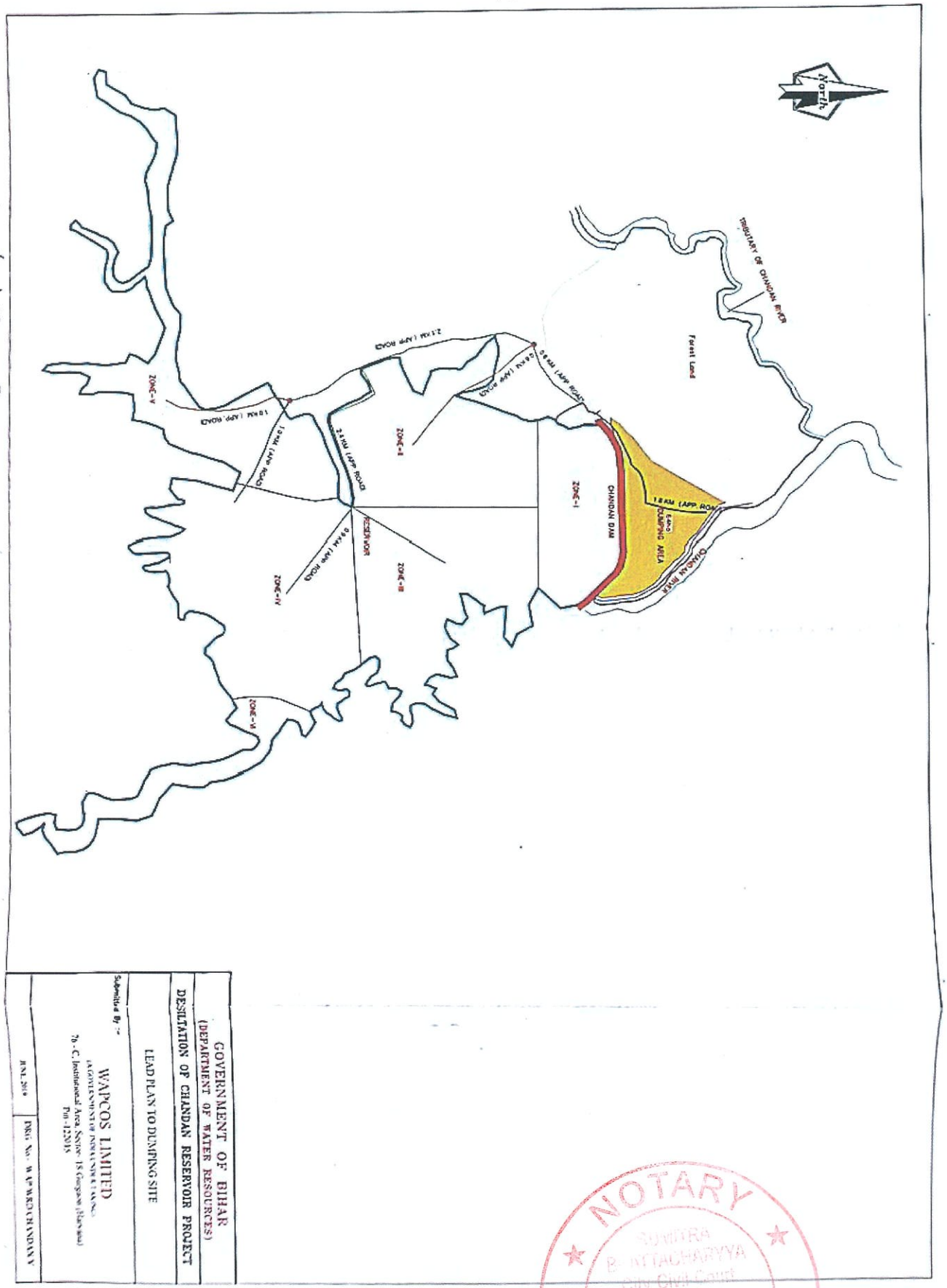
GOVERNMENT OF BIHAR

(WATER RESOURCES DEPARTMENT)

DESILTING OF CHANDAN RESERVOIR

Drawing - IV
Zonewise Volume of Desiltation

1X3



GOVERNMENT OF BIHAR
(DEPARTMENT OF WATER RESOURCES)

DESILTATION OF CHANDAN RESERVOIR PROJECT

LEAD PLAN TO DUMPING SITE

Submitted By :-

WAPCOS LIMITED
(A GOVERNMENT OF INDIA UNDERTAKING)
76-C, Institutional Area, Sector 18, Gurgaon (Haryana)
Pin-122015

DRG. No. : WAPCOS/CHANDAN/

JUNE, 2019

NOTARY
SUMITRA
B. MUKHERJEE
City Civil Court
Calcutta
Regn. No. 06/ of 2022
Expiry Date
31.03.2027
Govt. of West Bengal

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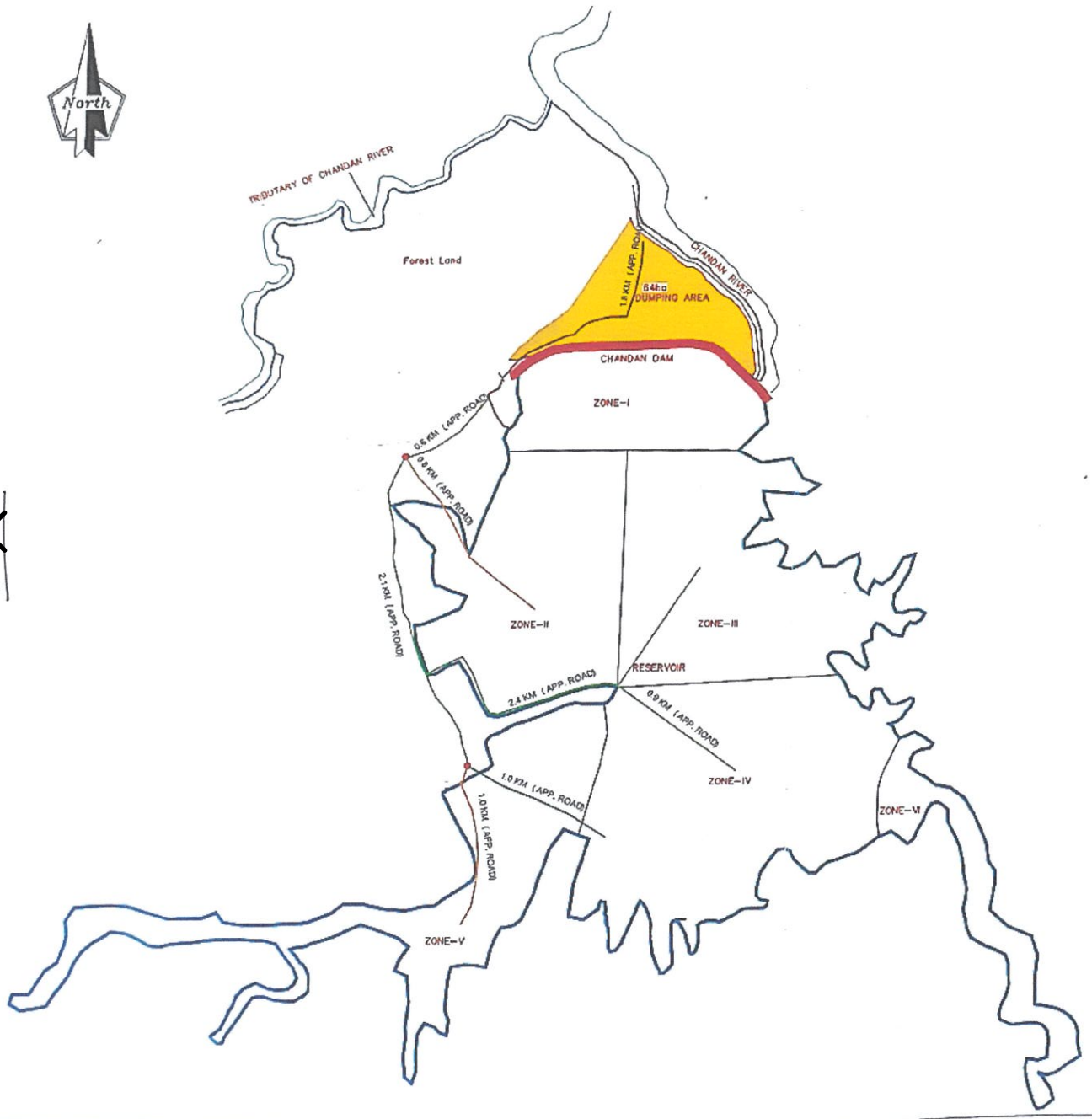


GOVERNMENT OF BIHAR
(DEPARTMENT OF WATER RESOURCES)

DESILTATION OF CHANDAN RESERVOIR PROJECT

LEAD PLAN TO DUMPING SITE

Submitted By :-

WAPCOS LIMITED
(A GOVERNMENT OF INDIA UNDER TAKING)
76 - C, Institutional Area, Sector- 18 Gurgaon (Haryana)
Pin -122015

JUNE, 2019 | DRG. No.- WAP WRD CHANDAN V

Krishna 22.5.19 SE

22.5.19 AE

1X4

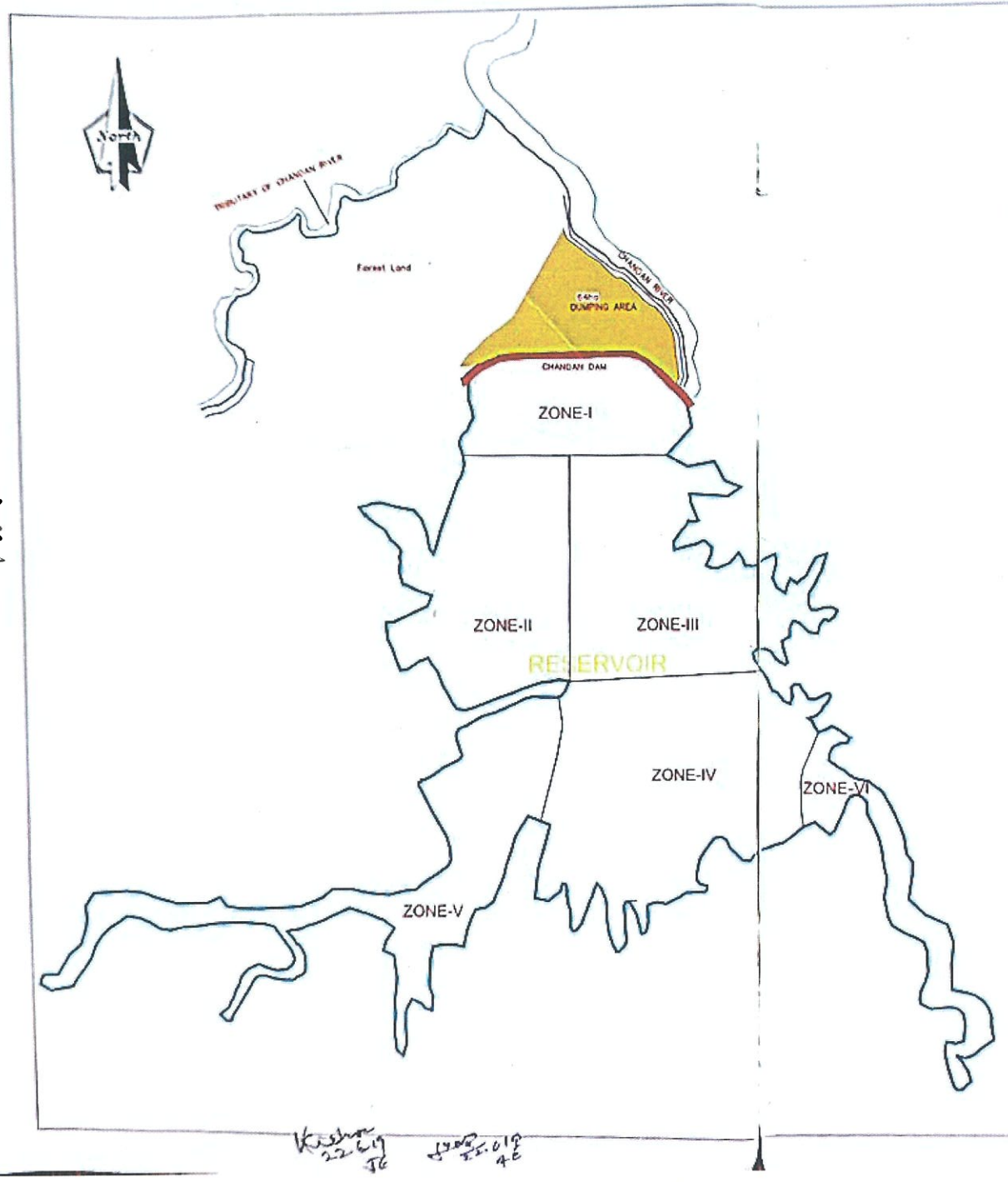
GOVERNMENT OF BIHAR

(WATER RESOURCES DEPARTMENT)

DESILTING OF CHANDAN RESERVOIR

Drawing - V
Lead Plan to Dumping Site

1325



ZONE	VOLUME (MCM)
ZONE–I	9.96
ZONE–II	12.62
ZONE–III	15.42
ZONE–IV	19.11
ZONE–V	15.65
ZONE–VI	7.00

NOTARY Govt. of West Bengal
SUMITRA BHATTACHARYYA
City Civil Court
Calcutta
Regn. No. 065 of 2022
Expiry Date
31.03.2027

NOTES: –

1. SELECTED GRAVELY MATERIAL WOULD BE USED IN SLOPE SECTION 1:4 TO DRAIN RAIN WATER QUICKLY
2. APPROACH TO THE DUMPING AREA MAY BE DECIDED IN CONSULTATION WITH PROJECT AUTHORITIES
3. THE DUMPED MATERIALS SHALL BE COMPACTED TO AN AV. DENSITY EQUAL TO 100% STANDARD PROCTER'S DENSITY (SPD)
4. TURFING SHOULD BE PROVIDED ON TOP OF DUMPING AREA AS WELL AS ON SLOPES

GOVERNMENT OF BIHAR
(DEPARTMENT OF WATER RESOURCES)

DESILTATION OF CHANDAN RESERVOIR PROJECT

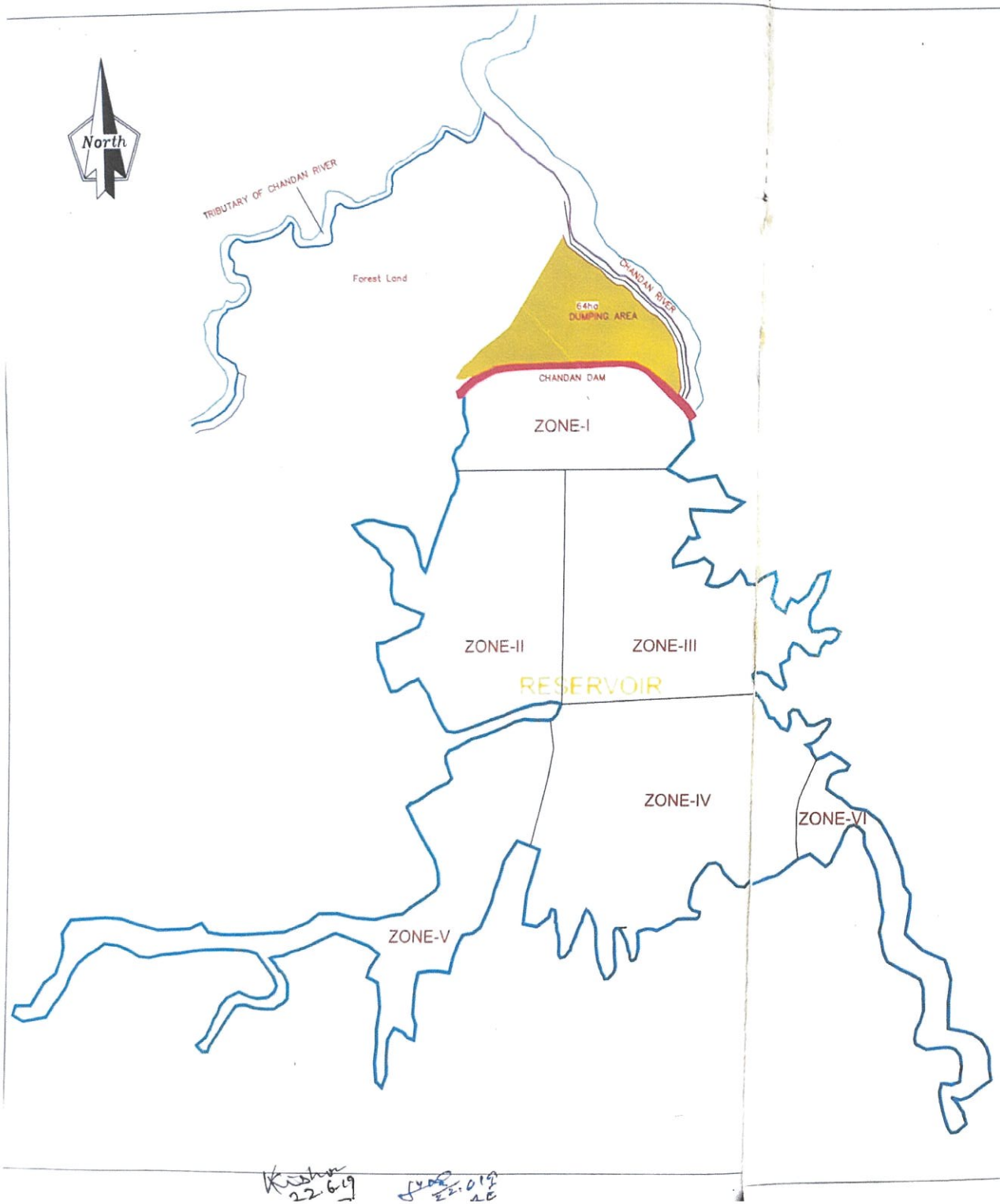
ZONEWISE VOLUME OF DESILTATION

Submitted By :–

WAPCOS LIMITED
(A GOVERNMENT OF INDIA UNDERTAKING)
"B" C Institutional Area Sector 18 Gurgaon Haryana
Pin 122015

	DRG. No. WAPCOS/BANDANTS

1326



ZONE	VOLUME (MCM)
ZONE–I	9.96
ZONE–II	12.62
ZONE–III	15.42
ZONE–IV	19.11
ZONE–V	15.65
ZONE–VI	7.00

NOTES: –

1. SELECTED GRAVELY MATERIAL WOULD BE USED IN SLOPE SECTION 1–1 TO DRAIN RAIN WATER QUICKLY.
2. APPROACH TO THE DUMPING AREA MAY BE DECIDED IN CONSULTATION WITH PROJECT AUTHORITIES.
3. THE DUMPED MATERIALS SHALL BE COMPACTED TO AN AV. DENSITY EQUAL TO 100% STANDARD PROCTER'S DENSITY (SPD).
4. TURFING SHOULD BE PROVIDED ON TOP OF DUMPING AREA AS WELL AS ON SLOPES.

GOVERNMENT OF BIHAR
(DEPARTMENT OF WATER RESOURCES)

DESILTATION OF CHANDAN RESERVOIR PROJECT

ZONEWISE VOLUME OF DESILTATION

Submitted By :–

WAPCOS LIMITED
(A GOVERNMENT OF INDIA UNDER TAKING)
'6 - C, Institutional Area, Sector- 18 Gurgaon (Haryana)
Pin -122015

JUNE, 2019 | DRG. No.- WAP/WRD/CHANDAN/IV

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DESILTING OF CHANDAN RESERVOIR

EIA/EMP REPORT

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Contents

Contents

ENVIRONMENTAL ASPECTS

1. INTRODUCTION

The Chandan project comprises of a dam, which was constructed in 1967 across river Chandan. The coordinates of the dam site are 24°40'27" N and 86°55'00" E and is located near village Laxmipur under Bounsi block of Banka District in Bihar. The dam is approachable via Bhagalpur, Dumka, Deoghar National High way. The dam site is connected by a 22.86 km pucca road from Bounsi which is 50 km from Bhagalpur and 50 km from Dumka. The reservoir was impounded in 1967 for the first time. The earthen dam has a length of 1554 m. At chainage 43.00 an outlet has been constructed to feed water in Chandan high level Canal for meeting irrigation water requirements. At chainage 51.00 to chainage 56.40 a spillway has been constructed to spill surplus water in flood season beyond the FRL i.e 152.44 m (500 ft)

2. STUDY AREA

The study area includes the areas within 10 km radius in and around the periphery of Chandan reservoir.

3. ENVIRONMENTAL BASELINE STATUS

The description of environmental setting or baseline environmental status is an integral part of any EIA study. The objectives of the assessment of baseline environmental status of the study area are to:

- assess the existing environmental quality, as well as the environmental impacts of the alternatives being studied.
- identify environmentally significant factors or areas that could preclude the proposed development.
- provide sufficient information so that decision-makers and reviewers can develop an understanding of the project needs as well as the environmental characteristics of the area.

The environmental baseline status has been described in the following sections.

3.1 METEOROLOGY

The climate in the project area varies significantly with altitude. Climatologically, following four seasons are identified in the project area:

- Summer: Mid April to Mid June
- Monsoon: Mid June to Mid-September
- Post-monsoon: Mid-September to Mid-November
- Winter: Mid-November to Mid-April.

The climate of the project area district is characterized by hot summer and a pleasant winter. The cold season starts in November and lasts till February. The period from March to first week of June is the summer season and this is followed by the south-west monsoon season which lasts till the end of September. October is a transition month.

The meteorological observatory at Sabaur is considered representative for the project. The temperature data shows a steady increase of temperature after February. May is the hottest month of the year with mean daily maximum temperature at 41.6°C and the mean daily minimum at 19.1°C. January and February are generally the coldest months, with mean daily maximum at 30.6°C in February and the mean daily minimum at 4.5°C in January.

Wind is generally gentle except during the south west monsoon season, and in this season, wind blows from south western or western directions. In the post monsoon and winter season southerly or southeasterly winds prevail in the mornings while in the afternoons wind blows from directions between east and north. In summer season, wind blows from directions between south and north-west.

The relative humidity is high during monsoon months. During rest of the year, relative humidity is slightly lower. During monsoon months, sky is heavily overcast, while for the rest of the year, it is lightly or moderately clouded. Cloud cover increases in May.

3.2 SEDIMENTS

As a part of the study five samples were collected from reservoir to check the quality of the sediment. The sampling locations are shown in Figure-1. The results are given in Table-1

Table-1: Sediment Quality Analysis of the Reservoir Area

Parameters	Unit	S1	S2	S3	S4	S5
pH		6.4	6.6	7.5	6.9	6.7
Chloride (as Cl^-)	mg/kg	73.2	82.3	90.4	86.4	92.5
Sulphate (as SO_4)	mg/kg	340	319.8	290.4	288.2	310.7
Total Kjehldal Nitrogen	mg/kg	710	645.6	658.4	670.8	659.4
Phosphorus (as P)	mg/kg	88.5	79.6	86.5	78.9	76.5
Available Potassium (as K)	mg/kg	138.4	135.6	120.7	142.8	137.5
Organic Carbon %	%	0.69	0.63	0.66	0.7	0.59
Zinc	mg/kg	84.7	78.5	75.8	79.5	81.2
Lead	mg/kg	ND	ND	ND	ND	ND
Arsenic	mg/kg	ND	ND	ND	ND	ND
Cadmium	mg/kg	ND	ND	ND	ND	ND
Copper	mg/kg	69	67.4	65.8	62.4	72.1
Mercury	mg/kg	ND	ND	ND	ND	ND

pH

The sediment pH showed maximum value 7.5 at station 3 and minimum 6.4 at station station-1.

Chloride

Chloride concentration ranged from 73.2 to 92.5 mg/kg.

Sulphate

The sulphate ranged between 288.2 and 340 mg/kg. The maximum level (340 mg/kg) was found at station-1 and low (288.2 mg/kg) at station-4.

Total Kjehldal Nitrogen

Total Kjeldahl nitrogen (TKN) is the sum of organic nitrogen, ammonia (NH_3), and ammonium (NH_4^+). The TKN values in various samples ranged from 645.6 to 710 mg/kg with maximum was recorded in station-1 and the minimum concentration was recorded in station-2.

Phosphorus

Concentration of Phosphorus in the sediment sample ranged between 76.5 (station 5) and 88.5 (Station-1) mg/kg. Samples show moderate productivity.

Available Potassium

Potassium in the sediment samples ranged between 120.7 and 142.8 mg/kg. The maximum level was recorded in (142.8 mg/kg). The sediment samples showed high productivity. It can be used in the agricultural fields nearby.

Total organic Carbon

The total organic carbon ranged between 0.59 and 0.7% indicating moderate productivity.

Zinc

The concentration of zinc in the sediment sample varied from 75.8 to 84.7 mg/kg and the maximum concentration was recorded in station-1 and the minimum was recorded in station-3.

Copper

The concentration of copper in various sediment samples ranged from 62.4 to 72.1 mg/kg and the maximum concentration was recorded in station-5 and the minimum concentration was recorded in station-4.

Lead, Arsenic, Cadmium and Mercury

The concentration of lead, Arsenic, Cadmium and Mercury in the sediment sample were below detectable limit.

The results shows that sediment samples have BDL concentration of heavy metals. It can be interpreted from the above results that disposal of sediment will not pose any harmful effect on the environment.

3.3 TERRESTRIAL FLORA

The district has some forest areas under Banka, Bounsi Katoriya forest ranges. The forests Banka range are observed on Hill slopes and those in the other two ranges lie in undulating land. The predominant tree species is Sal which is usually found associated with Abuns, Asan, Kendu and Mahua. Tasar worms are reared on Asan trees. The other trees reported in the areas are Bahera, Kadam, Amaltas.

Amongst fruits trees, Mango and Jack fruits are common. Plantains, Date plants, Plums, Jamun are some of the other important fruits trees reported for the area. The list of commonly observed floral species are listed in Table-2

Table-2: Commonly found floral species

Common Name	Scientific Name
Sal	*Shorea robusta*
Bamboo	*Dendrocalamus strictus*
Khair	*Acacia catechu*
Salai	*Boswellia serrate*
Kawa	*Terminalia Arjuna*
Mango	*Mangifera Indica*
Mahua	*Bassia latifolia*
Kanthal	*Artocarpus integrifolia*
Plantain or Kela	*Musa sapientum*
Jamun	*Eugenia jambolana*
Anar	*Punica granatum*
Grape	*Vitis vinifera*
Badam	*Amygdalus communis*

3.4 FAUNA

The commonly observed faunal species reported in the area are monkey, particularly the Hanuman. So are Jackal, deer, lion, bear, Barsingha, Sambhar etc. Wild geese, Duck, and Quail are some of the game birds inhabiting the district. The commonly observed birds species in the area are Peacocks, Parrots, Hawks, Doves, Sparrows, Crows, Vultures etc.

The list of commonly observed faunal species found the project area are given in Table-3.

Table-5: Commonly found faunal Species in the Project Area

Common Name	Scientific Name
Mammals	
Langur	*Presbytis entellus*
Mangoose	*Herpestes malactcensis*
Indian wolf	*Canis pallipes*
Squirrel	*Sciurus palmarum*
Indian Wild Boar	*Sus indicus*
Swamp deer	*Rucervus Duvancellii*

Common Name	Scientific Name
Barking Deer	*Cervulus aureus*
Buffaloes	*Babalus arni*
Birds	
Peacock	*Pavo cristatus*
Parrot	*Phaethontidae Psittaciformes*
Hawk	*Diurnus Accipitridae*
Dove	*Columbidae Colombiformes*
Sparrow	*Ploceidae Passer*
Crow	*Corvous Corone*
Vulture	*Diurnilis Neophron*

3.5 FISH

The major species of fish found in the area are members of the great carp family including the well-known Rohu (*Labeo rohita*). Katla (*Catla buchanani*), Boari (*Wallago attu*), tengra (*Macrows tengra*), Lilpa (*Clapea ilisha*), Jhinga pothia and feather backs, etc. Fish is found in the rivers, streams and low lying fields.

The commonly reported fish species in the area are listed in Table-4.

Table-4: Commonly reported Fish species in the project area

Common Name	Scientific Name
Rohu	*Labeo rohita*
Katla	*Catla buchanani*
Boari	*Wallago attu*
Tengra	*Macrows tengra*
Jhinga	*Fenneropenaeus indicus*

4 PREDICTION OF IMPACTS

Based on the project details and the baseline environmental status, potential impacts as a result of the proposed Project have been identified. The Impact Assessment for quite a few disciplines is subjective in nature and cannot be quantified. Wherever possible, the impacts have been quantified and otherwise, qualitative assessment has been undertaken. The present Chapter outlines the anticipated impacts due to the proposed Project.

The impacts on following aspects of environment have been covered as a part of this Report:

- Land Environment
- Water quality
- Terrestrial Ecology
- Aquatic Ecology
- Noise Environment
- Air quality
- Public health

4.1 IMPACTS ON LAND ENVIRONMENT

a) Desilting Phase

It is estimated that quantum of silt material removed from six zones. The total quality of silt to be removed from the reservoir is 92.64 Mm^3. It is proposed to re-use about 13.13 Mm^3 of silt and balance quantity (79.51Mm^3) will be dumped on open area available at the department's office campus about 2.0 km from dam site. The distance from the desilting location to dumping yard is about 3-4 km. The process would take 3 years for moving the total estimated silt. Majority of the environmental impacts during desilting phase are temporary in nature, lasting mainly during desilting phase. However, if these issues are not properly addressed, impacts can continue even after the desilting activity for a longer duration.

The major impacts anticipated on Land Environment during desilting phase are as follows:

- Environmental degradation due to immigration of labour population.
- Impact on Desilting and Desilting material
- Operation of desilting equipment.
- Solid waste management

Environmental degradation due to immigration of labour population

The peak labour and technical staff congregation would be of the order of 150 and total increase in population shall be about 500. Thus, for assessment of impacts, a total of 500 labour and technical staff along with their families have been assumed to be involved in desilting and related activities. The congregation of labour force is likely to create problems of sewage disposal, solid waste management and felling of

trees for meeting fuel requirements, etc. These aspects have been adequately covered in various sections of this Chapter.

Impact on Desilting and Desilted Material

The dumping area as identified for disposal of silt from the Chandan reservoir is about 81 ha available just d/s of Dam which under Irrigation division Bounsi and about 250 ha of the adjoining forest area to be acquired.

- Excavation of Zones IV & V will start simultaneously from both sides of the reservoir and will commence from FRL to MDDL, as this will give additional time for excavation work.
- After excavation of zones IV & V zone VI & II will be followed.
- Zones I & III will be taken up at the end.
- Approach road to excavation area shall be maintained properly at the desired gradient for smooth moving of machinery.
- Dumping in the disposal area shall commence from the toe of the dam embankment by laying 1.0m layer of the disposal material and dumping will continue from dam toe to towards river left bank. This operation will give additional advantage of compaction of desilted material by the movement of vehicles.
- Dumping material will be dumped by maintaining 2:1 (H:V) outer side slopes and 6.0 m wide berm at every 6.0m lift.
- In first stage, area under Irrigation department Bounsi shall be filled and after filling this area, dumping in the forest area shall be taken up in the same process by maintaining outer slope
- The height of dumping area can be raised about 10 to 12 m above the top of bank of Dam.
- 60 cm wide and 1.0 m deep drain at every berm shall be constructed around the dumping material for maintaining proper drainage and to avoid any damage to the outer slopes of the dumped material.
- Turfing on the outer slopes of the disposed material shall be done to check the erosion of outer slope of disposal embankment.
- Disposed material shall be properly compacted.
- Forest area used for disposal shall be re-developed.

The land used for disposal belongs to Irrigation Department is about 81 ha and shall be created as re-creational center by developing landscapes, parks, etc.

Increase in agricultural productivity

As observed in the nutrient characteristics of silt material in Table-1, the soil is alkaline with Nitrogen, Phosphorus, Potassium and Organic Matter in good quantities as primary nutrients. Thus top silt and clay of the sediment is thus rich in plant nutrients, which can be used by farmers. Paddy is the main crop grown in area. The sediments in Chandan Reservoir are suitable for paddy cultivation, with a sufficiently good yield.

Operation of desilting equipment

During desilting, various types of equipment will be brought to the site. These include earth moving equipments and trucks, etc. The parking of these equipment would require significant amount of space. Efforts must be made for proper sitting of these facilities. Various criteria for selection of these sites would be:

- Proximity to the site of use
- Sensitivity of forests in the nearby areas
- Proximity from habitations
- Proximity to drinking water source

Efforts must be made to site the contractor's working space in such a way that the adverse impacts on environment are minimal, i.e. to locate the desilting equipment, so that impacts on human and faunal population are minimal.

Efforts shall be made that such facilities are located on Government or Panchayat land only, so that hardships caused as a result of land acquisition, though temporarily on this account are minimized to the extent possible.

Solid waste management

The labour colonies will generate substantial amount of municipal wastes. In view of the condition that normally exists in the labour camps of such projects, solid wastes are likely to contain mainly vegetable matters followed by paper cans and glasses. About 150 persons are likely to congregate during the desilting phase at seven identified approcahe sites resulting in generation of about 0.11 tonnes of solid waste/day. Adequate facilities for collection and conveyance of municipal

wastes generated to the disposal site shall be developed. The composition of various waste materials is in the municipal refuse is detailed in Table-5.

Table-5: Composition of waste material in municipal refuse

Ingredient	Percentage by weight (%)
Paper	4.71
Rubber, Leather and synthetics	0.71
Glass	0.46
Metals	0.49
Total compostable matter	38.95
Inert matter	44.73
Others/ plastic	9.95
Total	**100.00**

A detailed plan for disposal of solid waste generated from labour camps is given as a part of the Environmental Management Plan.

Impacts due to land acquisition

Another most important deleterious impact during construction phase will be that, pertaining to land acquisition. About 331 ha of land proposed to be acquired to dispose the sediments from the Chandan reservoir. About 81 ha available just d/s of dam which belongs to Irrigation department, and about 250 ha of the adjoining forest area to be acquired. Compensation of Forest land will be given as per the Indian Forest Conservation Act (1980).

b) Post desilting Phase

Increase in Capacity

The proposed project will lead to increase in capacity of the Reservoir. The total increased capacity will be 135.7433.50 Mm^3.

Increase in the yield from agriculture

Due to increase in water availability in reservoir will lead to increased farm produce at a large amount per year.

Hence the proposed desilting activity will have positive impacts on the local farmers, besides the increased storage capacity of the reservoir.

4.2 IMPACTS ON WATER RESOURCES AND QUALITY

a) Desilting Phase

Impacts due to sewage generation from labour camps

The major sources of water pollution during project desilting phase are the sewage generated from the labour camps. The project desilting is likely to last for a period of 3 years. As mentioned earlier about 150 workers and 50 technical staff are likely to be involved during desilting phase. The desilting phase also leads to various allied activities to meet the demands of the labour population in the project area. The increase in the population is expected to be of the order of 500. The labour population is likely to be congregated at three to four labour colonies.

The total domestic water requirements of the labour population (including families) is expected to be of the order of 0.07 mld @ 135 lpcd. It is assumed that about 80% of the water supplied will be generated as sewage. Thus, the total quantum of sewage generated is expected to be of the order of 0.05 mld. The total BOD load contributed by various labour camps/colonies will be about 22.5 kg/day. The disposal of sewage without treatment could lead to adverse impacts on land environment or water environment in which the effluent from the labour camps are disposed. In the present project, it is recommended that the sewage generated from various labour camps be treated prior to its disposal.

Impact on aquatic ecology due to desilting

Desilting activities normally increase the turbidity levels in the water column. The change in water-column turbidity during desilting is a short-term impact. The increase in turbidity lasts as long as the material is being removed. The turbidity level returns to the pre-project level some time after the stoppage of the disposal of the silt material. The time required for the turbidity level to return to its original turbidity level increases with the increase in clay content. The turbidity increase also depends on the type of desilting method adopted. It can be concluded that apart from short-term increase in turbidity levels, no other significant effect on water quality due to desilting is anticipated.

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Redox potential (eH) and pH are two variables that control the characteristics of chemicals and heavy metals in water and sediment. As long as the pH remains around 8 and eH < 150 mV, most of the chemicals and metals will remain bound to the solid phase without being released into the surrounding water. Only anoxic conditions reduce the eH below this level and hence if dissolved oxygen level is within the normal range, no leaching of chemicals and heavy metals is expected to occur.

At the present site, pH is in normal range, and analysis of sediments indicates that, there are no sources of pollution. The sediment samples collected from all the sites were uncontaminated. As such no adverse impact due to desilting on the chemical characteristics of water or sediment is expected.

- **Impacts due to contaminated sediments**

  Sediment samples analyzed from the project area did not show the presence of any appreciable levels of contamination and hence may not pose any problems of contamination.

4.3 IMPACTS ON TERRESTRIAL ECOLOGY

a) Desilting Phase

Flora

During desilting phase, labour population is likely to congregate near Chandan dam site. The workers and other population groups residing in the area may use fuel wood (if no alternate fuel is provided) for whom firewood could be provided. Hence to minimize impacts, community kitchens have been recommended. These community kitchens shall use LPG or diesel as fuel. The details are covered in Environmental Management Plan.

The other major impact on the flora in and around the project area would be due to increased level of human interferences. The workers may also cut trees to meet their requirements for construction of houses and other needs. Thus, if proper measures are not undertaken, adverse impacts on terrestrial flora is anticipated.

Since, labour camps are proposed to be constructed by the contractor along with necessary facilities, such impacts are not envisaged.

Fauna

During desilting phase, a large number of machinery and labours will have to be mobilized. This activity may create some disturbance to the wildlife population. The operation of various desilting equipment is likely to generate significant noise. Since the project area has very little area under dense vegetation and the land use pattern is mainly agriculture land interspersed with settlements. As a result of absence of forest or vegetal cover in the project area and due to increased level of human interferences, wildlife is generally absent in the area. This is also confirmed by the field observations, and interaction with locals, etc. and it can be said that no major fauna is observed in the project area. Hence, impacts on terrestrial fauna are expected to be insignificant.

b) Post Desilting Phase

Various impacts to be covered are listed as below:

- Impacts on vegetal cover
- Impacts on wildlife
- Impacts on vegetal cover

No Rare, Endangered or Threatened species are reported in the project area. Due to the proposed desilting of Chandan Reservoir, there will be increase in the agriculture productivity of the area, leading to the increased availability of fodder as a result of increased agricultural by products and residues. The increased level of fodder availability would reduce the presence on existing pasture and vegetal cover, which is a significant positive impact.

4.4 IMPACTS ON NOISE ENVIRONMENT

a) Desilting Phase

Noise due to desilting equipment

In the proposed project, the impacts on ambient noise levels are expected only during the project desilting phase, due to earth moving machinery, increased

vehicular movement, etc. will have some adverse impacts. The noise level due to operation of various equipment is given in Table-6.

Table-6 Noise level due to operation of various equipment

Equipment	Sound Level at 7 m (dB(A))
Earth movers	82
Generator	82
Pumps	69

Under the worst case scenario, considered for prediction of noise levels during desilting phase, it has been assumed that all these equipment generate noise from a common point. The increase in noise levels due to operation of various equipments is given in Table-7.

Table-7 Increase in noise levels due to operation of various equipment

Distance	Ambient noise levels	Increase in noise level due to desilting activities	Noise levels due to desilting activities	Increase in ambient noise level due to desilting activities
m	dB(A)	dB(A)	dB(A)	dB(A)
100	45	86	86	41
200	45	70	70	25
500	45	62	62	17
1000	45	56	56.3	11
1500	45	52	52.8	7
2000	45	50	51.2	6.2
2500	45	50	49.8	4.6
3000	45	46	48.5	3.5

As per Table-7, the increase in noise level shall be of the order of 11, 7, 6.2, 4.6 and 3.5 dB(A) at a distance of 1000 m, 1500 m, 2000 m, 2500 m and 3000 m respectively. Since all the equipment have been assumed to operate from a common point this assumption has lead to over-estimation of the increase in noise levels. It is a known fact that there is a reduction in noise level as the sound wave

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passes through a barrier. The transmission loss values for common construction materials are given in Table-8.

Table-8 Transmission loss values through common construction material

Material	Thickness (inches)	Decrease in noise level (dB(A))
Light concrete	4	38
	6	39
Dense concrete	4	40
Concrete block	4	32
	6	36
Brick	4	33
Granite	4	40

As per Table-8, it can be concluded that the walls of various houses will attenuate at least 30 dB(A) of noise. In addition there are attenuation due to the following factors.

- Air absorption
- Atmospheric inhomogeneties and atmospheric turbulence.
- Vegetal foliage.

Thus, no increase in noise levels is anticipated as a result of desilting. There could be marginal impacts on the population residing in proximity to the reservoir as a result of desilting.

b) Post desilting Phase

In the proposed project, noise pollution occurs mainly during desilting phase. During post desilting phase, no major impacts are envisaged.

4.5 IMPACTS ON AIR QUALITY

a) Desilting Phase

Pollution due to fuel combustion in earth moving equipment

The operation of various earth moving equipment requires combustion of fuel. Normally, diesel is used in such equipment. The major pollutant which gets emitted as a result of diesel combustion is SO_2. The SPM emissions are minimal due to low ash content in diesel. The short-term increase in SO_2, even assuming

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that all the equipment are operating at a common point, is quite low, i.e. of the order of less than 1µg/m³. Hence, no major impact is anticipated on this account.

Fugitive Emissions from various sources

During desilting phase, there will be increased vehicular movement especially trucks used for transportation of silt. Normally, due to blowing of winds, especially when the environment is dry, the temporarily stored silt material can get entrained in the atmosphere. However, such impacts are visible only in and around the temporary storage sites. The impacts on this account are generally, insignificant in nature.

b) Post Desilting Phase

In the proposed project, air pollution occurs mainly during project desilting phase. During post desilting phase, no major impacts on air environment are envisaged.

4.6 SOCIAL IMPACT ASSESSMENT

The desilting of Chandan reservoir would increase the capacity of the reservoir, improving the water availability for meeting irrigation water requirements. This will lead to the following positive impacts:

- Improved agricultural productivity
- Increase in form income levels
- Improvement in employment potential
- Overall improvement in the quality of life of the farmers

Farmers are well aware of the valuable nutrient- rich top soil from the catchment area which is carried along the running water and deposited as silt in the tanks and in minor and major dams. Transporting the silt back to the agricultural land as soil addition helps to improve the soil quality of the agricultural fields and increase the productivity of the soil. Hence, generally farmers living in the surrounding areas transport the silt and dump in their fields particularly in the rain fed fields before they start the next season ploughing. Sometimes this has been considered as a substitute to fertilizer to the soil. This would also reduce the quantity and cost of fertilizer by the farmers in the region.

Studies done by the researchers supports this, silt collected from the tanks and dams is very useful in release of nutrients such as total nitrogen and beneficial to sandy and alkaline soils. It contains organic carbon, microbial biomass carbon, etc.

5. ENVIRONMENTAL MANAGEMENT PLAN

The Environmental Management Plan proposes to integrate the baseline conditions, impacts likely to occur, and the supportive and assimilative capacity of the system. The most reliable way to achieve the above objective is to incorporate the management plan into the overall planning and implementation of the project. The Environmental Management Plan (EMP) for the proposed project is described in following sections.

5.1 SAFEGUARDS MEASURES

During the desilting phase, various adverse impacts on the forests and wildlife are anticipated in the surrounding areas of the proposed project. To avoid and minimize the negative impacts from the proposed activities project authorities are advised to prepare strict guidelines as follows:

During Desilting Phase:

- Project proponent shall ensure that the process of desilting should not lead to bank collapse along rim of reservoir. This can be ensured by restricting the desilting operation near to the banks with a minimum distance of 100m.
- Project proponent should ensure the safety of the Dam by restricting the desilting operation with a minimum distance of 500m from the dam, to have little impact.
- Project proponent shall ensure that the existing water supply from the reservoir is neither affected qualitatively nor quantitatively during desilting operations.
- Spillage of fuel / engine oil and lubricants from the work site are a source of organic pollution which impacts aquatic life, particularly benthos. This shall

be prevented by suitable precautions and also by providing necessary mechanisms to trap the spillage.

- Desilted material must not be deposited within a watercourse, lake or floodplain of watercourse.
- The silt material shall be disposed safely in the designated disposal areas and in no case shall be disposed in the aquatic environment.
- Desilting shall be carried out in confined manner to reduce the impacts on aquatic environment. To avoid impacts on aquatic environment, desilting should not be carried out during the fish breeding season (April – May).
- Suitable desilting method shall be selected to minimize the loss of sediments into the neighboring water column.
- The trucks used for transporting silt material will be managed to produce a smooth flow instead of a noise producing stop and start flow. Necessary training/orientation will be provided to the drivers. Sounding of loud horns, etc. in the forested areas should be banned.
- Strict restrictions has to be imposed on the workers at project sites to ensure that they do not harvest any species/produce from the vegetation in the area forests and cause any danger or harm to the animals and birds in the wild life.
- Fuel wood to the labourers shall be provided by the project proponents so that there is no pressure for cutting of trees to meet fuel wood requirements.
- Interference of human population would be kept to a minimum in the adjacent forest areas and it should be ensured that the contractors do not set up labour colonies/camps in the vicinity of forests and wilderness areas.
- Only well maintained/new equipment that produces lesser noise would be installed at the work sites. Certain equipment that needs to be placed permanently at one place like generators, etc. would be housed in enclosed structures to cut off the noise.

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During Post Desilting Phase:

- Catchment Area treatment needs to be taken on priority so that the reservoir does not get silted up fast again.
- Reservoirs, over the years may have accumulated toxic pollutants from agriculture, industries and towns upstream from the dam could pose the additional hazard of the silt & sand being contaminated with such toxic substances. Routine sediment analysis should be done at least once in two years.

5.2 COMPENSATORY AFFORESTATION

Total quantity of forest land to be acquired for the project is 250 ha. If the forest is degraded forest, then double the quantity (2*250ha), i.e 500ha area to be afforested.

5.3 FACILITIES IN LABOUR CAMPS

a) Housing

The aggregation of large number of workers (about 500) in the project area during the desilting is likely to put considerable stress on the prevailing biotic and abiotic environment of the area. The aim of the EMP is to minimize these stresses. The contractor should ensure the housing facilities for the labourers with minimum impacts on the surrounding environment.

b) Water supply

Appropriate water supply sources need to be identified. Proper infrastructure for storage and if required treatment e.g. disinfection or other units, should also be provided.

c) Septic Tank

One community toilet needs to be provided for 20 persons. The sewage from the community toilets can be treated in a bio-digester with reed bed. The treated effluent can be used for meeting irrigation requirements of nearby areas or greenbelt development .

d) Provision of Free Fuel

The project proponents in association with the State Government of Bihar shall make necessary arrangements for supply of kerosene/LPG. The fuel would be supplied at sub-sidised rates to the local/contract labour for which provision should be kept in the cost estimate.

5.4 SOLID WASTE MANAGEMENT

About 500 persons are likely to congregate during the desilting phase at various sites resulting in generation of about 0.11 tonnes of solid waste/day. Adequate facilities for collection and conveyance of municipal wastes generated to the disposal site shall be developed.

Various aspects of solid waste management include:

- Refuse storage
- Collection and Transportation
- Disposal

Refuse Storage

It is proposed to locate a separate common container for the storage of degradable and non-degradable solid wastes. The size and type of such common bins would depend on the refuse generated in the area, number of sweepings made and population served by the solid waste collector. Workers and their family members engaged in desilting activities shall segregate the degradable and non-degradable solid waste in their houses, i.e. store them in separate bins. A person from each labour family shall unload the dust bins of their houses to the common bins for collection of degradable and non-degradable solid waste.

Collection and Transportation

In this system one solid waste collection tractor or trailer at the labour camps are proposed to be commissioned. They will travel on a regular route at prescribed intervals and stop at various common collection bins.

A crew of 4 to 6 persons may be needed.

Disposal

The degraded portion of the solid waste would be disposed off at the disposal sites. The non-degradable portion such as plastic bottles, cans, etc. shall be segregated and disposed off at separate sites and recycling opportunities would be explored in consultation with the local administration.

5.5 TRAFFIC MANAGEMENT DURING DESILTING

Temporary diversions will be constructed with the approval of the Engineer. Detailed Traffic Control Plans will be prepared and submitted to the Engineer for approval, at least 5 days prior to commencement of works on any section of road. The traffic control plans shall contain details of temporary diversions, details of arrangements for desilting under traffic, details of traffic arrangement after cessation of work each day, safety measures for transport of hazardous material and arrangement of flagmen.

The Contractor will ensure that the diversion/detour is always maintained in running condition, particularly during the monsoon to avoid disruption to traffic flow. He shall inform local community of changes to traffic routes, conditions and pedestrian access arrangements. The temporary traffic detours will be kept free of dust by frequent application of water.

5.6 AIR POLLUTION CONTROL

5.6.1 Control of Emissions

Minor air quality impacts will be caused by emissions from vehicles, equipment and DG sets, and emissions from transportation traffic. Frequent truck trips will be required during the desilting for removal of excavated material.

The following measures are recommended to control air pollution:

- The contractor will be responsible for maintaining properly functioning desilting equipment to minimize exhaust.
- Desilting equipment and vehicles will be turned off when not used for extended periods of time.
- Unnecessary idling of vehicles to be prohibited.

- Effective traffic management to be undertaken to avoid significant delays in and around the project area.
- Road damage caused by sub-project activities will be promptly attended to with proper road repair and maintenance work.

5.6.2 Air Pollution control due to DG sets

The Central Pollution Control Board (CPCB) has issued emission limits for generators upto 800 KW and the same are outlined in Table-10.

Table-10 Emission limits for DG sets prescribed by CPCB

Parameter	Emission limits (gm/kwhr)
NOx	9.2
HC	1.3
CO	2.5
PM	0.3
Smoke limit*	0.7

Note : * Light absorption coefficient at full load (m^{-1})

The above standards need to follow by the contractor while operating the DG sets. The other measures are recommended as below:

- Location of DG sets and other emission generating equipment should be decided keeping in view the predominant wind direction so that emissions do not effect nearby residential areas.
- Stack height of DG sets to be kept in accordance with CPCB norms, which prescribes the minimum height of stack to be provided with each generator set to be calculated using the following formula:

$$H = h + 0.2 \times \sqrt{KVA}$$

H = Total height of stack in metre

h = Height of the building in m where the generator set is installed

KVA = Total generator capacity of the set in KVA

5.6.3 Dust Control

The project authorities will work closely with representatives from the community living in the vicinity of project area to identify areas of concern and to mitigate dust-related impacts effectively (e.g., through direct meetings, utilization of proper

management and inspection program, and/or through the complaint response program). To minimize issues related to the generation of dust during the desilting phase of the project, the following measures have been identified:

- When practical, excavated spoils will be removed as the contractor proceeds along the length of the activity.
- When necessary, the temporary stockpiling of excavated material will be covered or staged offsite location with muck being delivered as needed during the reuse.
- Excessive soil on paved areas will be sprayed (wet) and/or swept and unpaved areas will be sprayed and/or mulched. The use of petroleum products or similar products for such activities will be strictly prohibited.
- Contractor shall ensure that there is effective traffic management at site. The number of trucks/vehicles to move at desilting sites to be fixed.

5.7 NOISE CONTROL MEASURES

The contractors will be required to maintain properly functioning equipment and comply with occupational safety and health standards. The desilting equipment will be required to use available noise suppression devices and properly maintained mufflers.

- Vehicles to be equipped with mufflers recommended by the vehicle manufacturer.
- Staging of desilting equipment and unnecessary idling of equipment within noise sensitive areas to be avoided whenever possible.
- Notification will be given to residents within 100 m of major noise generating activities. The notification will describe the noise abatement measures that will be implemented.
- Monitoring of noise levels will be conducted during the project.
- In case of exceeding of pre-determined acceptable noise levels by the machinery will require the contractor(s) to stop work and remedy the situation prior to continuing desilting.

The following Noise Standards for DG sets are recommended for the running of DG sets during the desilting operation:

- Maximum permissible sound pressure level for new diesel generator sets with rated capacity upto 1000 KVA shall be 75 dB(A) at 1 m from the enclosure surface.
- Noise from the DG set shall be controlled by providing an acoustic enclosure or by treating the enclosure acoustically.
- Acoustic Enclosure should be made of CRCA sheets of appropriate thickness and structural/ sheet metal base. The walls of the enclosure should be insulated with fire retardant foam so as to comply with the 75 dB(A) at 1m sound levels specified by CPCB, Ministry of Environment & Forests.
- Acoustic enclosure/acoustic treatment of the room should be designed for minimum 25 dB(A) Insertion Loss or for meeting the ambient noise standards, whichever is on the higher side.
- DG set should also be provided with proper exhaust muffler.
- Proper efforts to be made to bring down the noise levels due to the DG set, outside its premises, within the ambient noise requirements by proper siting and control measures.
- A proper routine and preventive maintenance procedure for the DG set should be set and followed in consultation with the DG set manufacturer which would help prevent noise levels of the DG set from deteriorating with use.

It is known that continuous exposure to noise levels above 90 dB(A) affects the hearing of the workers/operators and hence has to be avoided. Other physiological and psychological effects have also been reported in literature, but the effect on hearing acuity has been specially stressed. To prevent these effects, it has been recommended by international specialist organizations namely Occupational Safety and Health Administration (OSHA) that the exposure period of affected persons be limited as specified in Table-11.

Table-11 Maximum Exposure Periods specified by OSHA

Maximum equivalent continuous noise level dB(A)	Unprotected exposure period per day for 8 hrs/day and 5 days/week
90	8
95	4
100	2
105	1
110	½
115	¼
120	No exposure permitted at or above this level

5.8 CONTROL OF IMPACTS OF DESILTING ON AQUATIC ENVIRONMENT

The impact on aquatic ecology during the desilting phase would be largely confined within the desilting period itself. An important factor in minimizing adverse impacts would be optimizing the desilting period and avoidance of activities beyond the specified area of implementation. Hence, as a part of the management strategy various activities should be well coordinated and optimized to avoid time and cost over-run. The recommended measures suggested in Cl. 6.1 should be followed to control the impacts.

5.9 SELECTION OF RELATED FACILITIES

The following recommendations shall be implemented:

- Workers' camp away from the habitation area,
- Contractor to provide safe drinking water as per IS 10500 standards for drinking water.
- Sanitation for male and female workers.
- Collection and disposal of solid waste of the worker's camp

5.10 OCCUPATIONAL HEALTH AND SAFETY AT DESILTING SITE AND LABOUR CAMPS

- Provide personal protective equipment to the labours.
- Ensure the labours are trained to work on the specific project.
- For untrained labour – training should be provided before permission to work on the site.

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- The contractor shall provide, if required, erect and maintain necessary (temporary) living accommodation and ancillary facilities during the progress of work for labour to standards and scales approved by the Engineer- In charge.
- Contractor shall follow all relevant provisions of the Factories Act, 1948 and the Building & other Construction Workers (Regulation of Employment and Conditions of Service) Act, 1996 for construction & maintenance of labor camp.
- Labour camps shall not be proposed within 1000m or sufficiently away from nearest habitation to avoid conflicts and stress over the infrastructure facilities, with the local community.
- Safety and sanitation facility should be provided in the labour camp. Uncontaminated water shall be supplied to the workers at labour camps.
- The contractor shall arrange for a readily available first aid unit including an adequate supply of sterilized dressing materials and appliances as per the Factories Rules in every work zone, Availability of suitable transport at all times to take injured or sick person(s) to the nearest hospital
- Always maintain a fully equipped first aid box in the labour camp.

Some of the safety sign boards to be displayed at construction site is as follows;

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6. ENVIRONMENTAL MONITORING PROGRAMME

Environmental Monitoring is an essential tool in relation to environmental management as it provides the basis for rational management decisions regarding impact control. Environmental monitoring shall be performed during Desilting Phase, to ensure that the adverse impacts have been mitigated efficiently and to verify the impact predictions. The monitoring program will indicate where changes to procedures or operations are required, in order to reduce impacts on the environment or local population. The objective of the Environmental Monitoring programme is as follows:

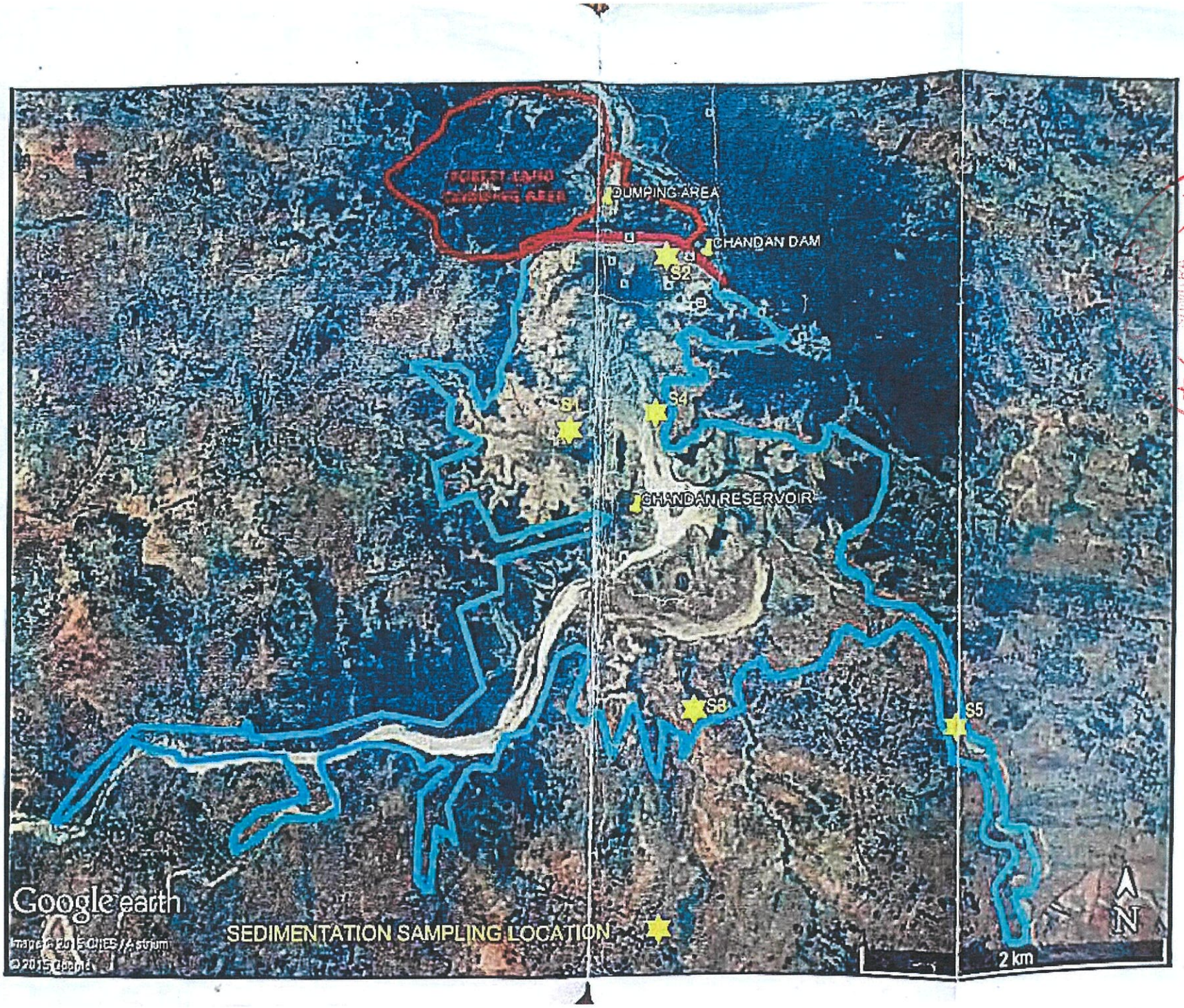
- Monitor the environmental conditions of areas and impacts by the project;
- Check on whether mitigation and benefit enhancement measures have actually been adopted, and are proving effective in practice;
- Provide information on the actual nature and extent of key impacts
- Check effectiveness of mitigation and benefit enhancement measures which, through a feedback mechanism, can improve the planning and execution of future, similar projects.

The environmental monitoring programme for the proposed study is summarized in Table-12.

Table-12: Environmental Monitoring Programme

Project Stage	Parameters to be Monitored	Location	Measurement	Frequency
Desilting Phase	Preparation of desilting plan	NA	Inspection of plan	One-off before start of Desilting
	Implementation of mitigation measures	Desilting area	• Site visits •Consultation with local people, workers •Inspection of desilting records	Weekly
	Ambient air quality	6 locations were desilting activity taking place. The final locations will be decided by the contractor and project proponent	PM10, PM2.5, NO_2 and SO_2	Once in a season at 6 monitoring stations. At each station, monitoring shall be done twice a week for consecutive weeks of three seasons.
	Noise	• 6 locations locations were desilting activity taking place	Sound level, Leq	Once in a month at 6 monitoring stations
	Surface Water and Ground Water	• 5 locations Upstream and downstream of Desilting area. • 5 location of Ground Water	Temperature, pH, BOD, COD, DO, Conductivity, TDS, TSS, Turbidity, coliform	Once in a season for desilting phase

Project tage	Parameters to be Monitored	Location	Measurement	Frequency
	Aquatic Ecology	• 6 locations in and around the desilting area	Presence and abundance of various aquatic species	Once in a season for desilting phase



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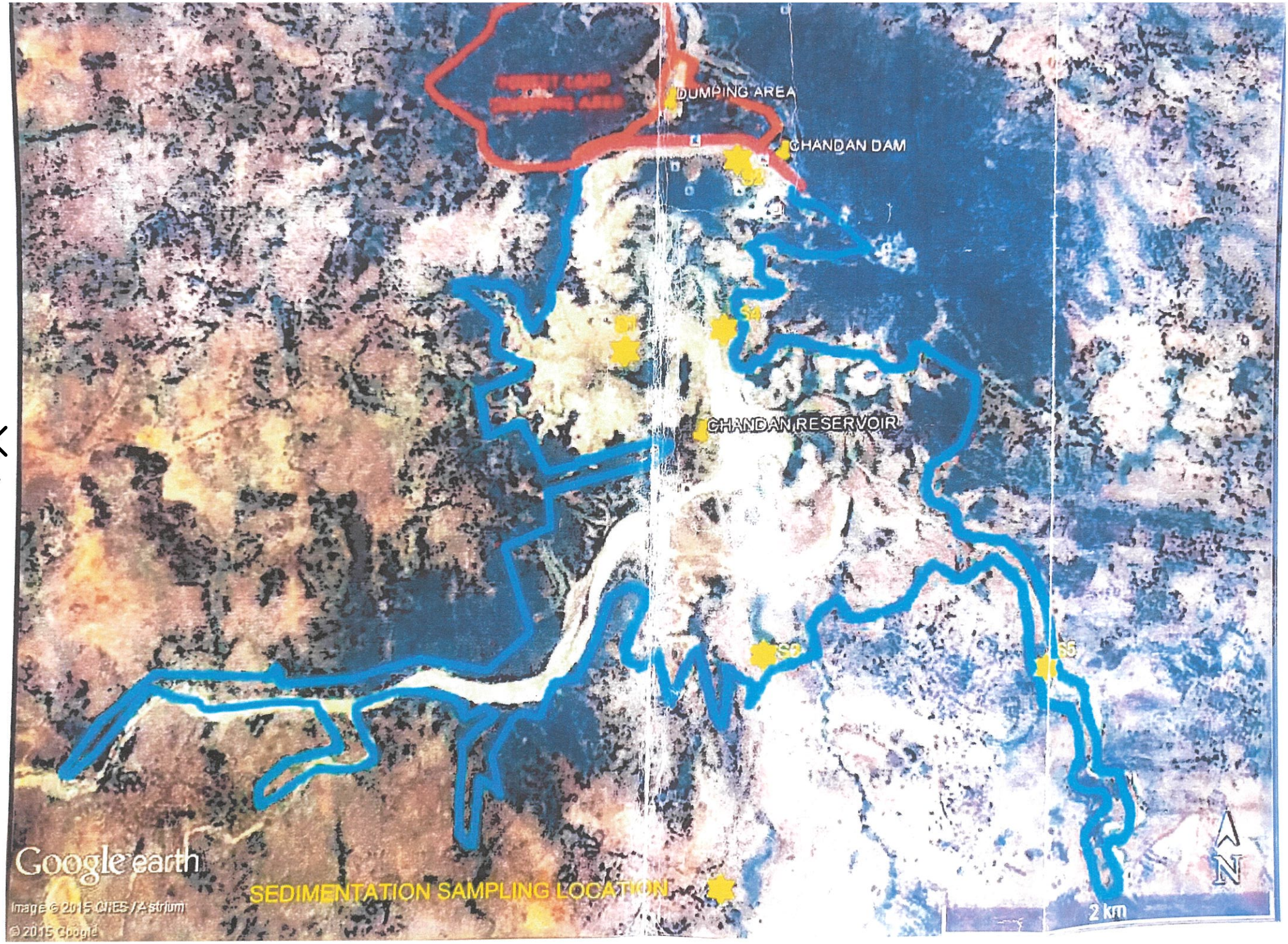
DUMPING AREA
CHANDAN DAM
S4
CHANDAN RESERVOIR
S3
S5
SEDIMENTATION SAMPLING LOCATION
Google earth
Image © 2015 CNES / Astrium
© 2015 Google
N
2 km

वाप्कोस लिमिटेड

WAPCOS LIMITED

(भारत सरकार का उपक्रम - जल संसाधन, नदी विकास और गंगा संरक्षण मंत्रालय)

(A Government of India Undertaking - Ministry of Water Resources, River Development & Ganga Rejuvenation)

"Annexure - C"

दिनांक 29.12.2023 को बिहार राज्य अंतर्गत बराज, जलाशयों एवं नदियों का डिसिल्टेशन तथा बरनार जलाशय योजना हेतु वन भूमि अपयोजन से संबंधित बैठक की कार्यवाही।

बैठक में उपस्थित पदाधिकारीगण :–

1. श्री चैतन्य प्रसाद, अपर मुख्य सचिव, जल संसाधन विभाग, पटना।
2. श्री परमार रवि मनुभाई, अपर मुख्य सचिव–सह–खान आयुक्त, खान एवं भूतत्व विभाग, पटना।
3. श्रीमती बन्दना प्रेयषी, सचिव, पर्यावरण, वन और जलवायु परिवर्तन विभाग, पटना।
4. श्री धर्मेन्द्र सिंह, सचिव, खान एवं भूतत्व विभाग, पटना।
5. मो० नैय्यर इकबाल, निदेशक खान, खान एवं भूतत्व विभाग, पटना।
6. श्री राकेश कुमार, अभियंता प्रमुख, सिंचाई सृजन, जल संसाधन विभाग, पटना।
7. श्री अरविन्दर सिंह, अपर प्रधान मुख्य वन संरक्षक (कैम्पा), पटना।
8. श्री अभय कुमार, क्षेत्रीय मुख्य वन संरक्षक, भागलपुर (RCCF)।
9. श्री जितेन्द्र कुमार, अधीक्षण अभियंता, योजना एवं मोनिटरिंग अंचल–3, पटना।
10. श्री प्रमोद कुमार, अधीक्षण अभियंता, योजना एवं मोनिटरिंग अंचल–1, पटना।
11. मो० सोहेल अहमद अंसारी, अधीक्षण अभियंता, योजना एवं मोनिटरिंग अंचल–4, पटना।
12. श्री शैलेन्द्र कुमार, कार्यपालक अभियंता, योजना एवं मोनिटरिंग प्रमंडल–08, पटना।
13. श्री शशि रंजन कुमार, कार्यपालक अभियंता, योजना एवं मोनिटरिंग प्रमंडल–11, पटना।
14. श्री तनय कुमार, कार्यपालक अभियंता, योजना एव मोनिटरिंग प्रमंडल–3, पटना।

1. बिहार राज्य अंतर्गत बराज, जलाशयों एवं नदियों का डिसिल्टेशन

- बिहार राज्य में निर्मित बराज एवं जलाशयों में जमा बालू/गाद के कारण जल भंडारण क्षमता में लगातार हो रहे ह्रास से कृषकों को समुचित सिंचाई सुविधा उपलब्ध कराने में कठिनाई हो रही है। साथ ही नदियों में सिल्टेशन होने से भी बाढ़ की समस्या उत्पन्न हो रही है। इसके समाधान हेतु जल संसाधन विभाग, पर्यावरण, वन एवं जलवायु परिवर्तन विभाग तथा खान एवं भूतत्व विभाग के बीच बैठक की गयी। बैठक में अभियंता प्रमुख, सिंचाई सृजन, जल संसाधन विभाग द्वारा प्रस्तुतीकरण दिया गया।
- प्रस्तुतीकरण के माध्यम से बताया गया कि बराज, जलाशय एवं नदियों में बालू/गाद की निकासी Dry Excavation एवं Dredging के द्वारा की जा सकती है। Dry

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Excavation सामान्यतः सूखे क्षेत्र में किया जाता है एवं Dredging जल से डूबे हुए क्षेत्र में किया जाता है। Dry Excavation के कार्य हेतु खान एवं भूतत्व विभाग बालूघाट सृजित कर बंदोबस्ती करने हेतु अधिकृत है। Dredging के माध्यम से बालू/गाद की निकासी जल संसाधन विभाग द्वारा करायी जा सकती है।

(क) बराज एवं जलाशयों में **Dredging** कार्य :–

- राजस्थान राज्य के BISALPUR DAM & GUDHA DAM तथा केरल राज्य के MANGALAM RESERVOIR में जमा बालू/गाद को Dredging के माध्यम से निकासी करायी जा रही है। इन राज्यों में जमा बालू/गाद की निकासी के साथ–साथ इसके वाणिज्यक उपयोग संवेदक के माध्यम से कराया जा रहा है। इन संवेदकों को BISALPUR DAM, GUDHA DAM, MANGALAM RESERVOIR में क्रमशः 20, 10, 3 वर्षों के लिए कार्य आवंटित किया गया है, जिसके लिए संबंधित विभागों को न्यूनतम निश्चित राशि का भुगतान संवेदक द्वारा किया गया है तथा इसके अतिरिक्त उस राज्य में लागू रॉयल्टी एवं अन्य कर का भुगतान संबंधित विभागों को संवेदक द्वारा किया जा रहा है। इन संवेदक के द्वारा ही संबंधित विभागों से सभी तरह का Clearance प्राप्त किया जाता है।
- उक्त वर्णित राज्यों के तरह ही बिहार राज्य के बराज एवं जलाशयों में जल संसाधन विभाग के माध्यम से रॉयल्टी एवं अन्य करो के भुगतान एवं सभी वैधानिक अनापत्ति प्राप्त करने के उपरांत Dredging के द्वारा जमा बालू/गाद की निकासी करायी जा सकती है। इसपर पर्यावरण, वनं एवं जलवायु परिवर्तन विभाग तथा खान एवं भूतत्व विभाग द्वारा सहमति व्यक्त की गयी।

(ख) नदियों में **Dry Excavation/Mining** कार्य:–

- नदियों से गाद/बालू की निकासी Dry Excavation/Mining के माध्यम से बालूघाट सृजित कर बंदोबस्ती के द्वारा पर्यावरणीय स्वीकृति प्राप्त करते हुए खान एवं भूतत्व विभाग द्वारा कराया जा सकता है। इस संबंध में खान एवं भूतत्व विभाग के साथ–साथ संबंधित जिला के जिला पदाधिकारियों को अत्यधिक गाद वाले क्षेत्रों के Coordinates के साथ सूची उपलब्ध करा दी गयी है। खान एवं भूतत्व विभाग के अपर मुख्य सचिव

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से नदियों से बालूघाट सृजित कर बंदोबस्ती करते हुए पर्यावरणीय स्वीकृति प्राप्त कर Shoal निकालने के लिए अनुरोध किया गया।

(ग) चांदन जलाशय में **Dredging/Mining** कार्यः –

- चांदन जलाशय का निर्माण वर्ष 1967 में चांदन नदी पर किया गया था। इस जलाशय का वर्ष 2015 में परामर्शी WAPCOS Ltd, Gurgaon के द्वारा विस्तृत सर्वेक्षण किया गया। सर्वेक्षणोपरांत पाया गया कि जलाशय का सकल जल भंडारण क्षमता 157.23 MCM से घटकर 56.22 MCM रह गया है। सर्वेक्षण के अनुसार 1084 हे० भूमि जलाशय के डूब क्षेत्र के अधीन है। इसमें 216 है० रैयती भूमि जल संसाधन विभाग के स्वामित्व में है एवं शेष 868 है० भूमि पर पर्यावरण, वन एवं जलवायु परिवर्तन विभाग द्वारा स्वामित्व का दावा किया जा रहा है।
- उक्त के क्रम में जल संसाधन विभाग का मंतव्य है कि चांदन जलाशय के निर्माण के समय स्वामित्व की जाँच करने के पश्चात् ही जलाशय निर्माण हेतु रैयती भूमि का अधिग्रहण किया गया होगा। पर्यावरण, वन एवं जलवायु परिवर्तन विभाग, बिहार, पटना द्वारा किये जा रहे 868 हे० भूमि के दावे को अगर मान भी लिया जाय, तो जलाशय के डूब क्षेत्र में जलाशय के अस्तित्व को समाप्त किये बिना वन क्षेत्र को विकसित किया जाना संभव नहीं है, तो वैसी स्थिति में जलाशय से बालू उत्खनन कार्य की अनुमति दी जानी चाहिए।
- इस प्रकार अन्य राज्यों के तरह ही बिहार राज्य में चांदन जलाशय के डूबे हुए भाग में बालू/गाद की निकासी तथा निर्धारित रॉयल्टी का भुगतान करते हुए Dredging के माध्यम से जल संसाधन विभाग द्वारा कराया जा सकता है। साथ ही आवश्यकतानुसार सूखे हुए क्षेत्र में Dry Excavation (Mining) का कार्य खान एवं भूतत्व विभाग के द्वारा बालूघाट सृजित कर बंदोबस्ती के माध्यम से कराया जा सकता है।

(घ) <u>निष्कर्ष/निर्णय :–</u>

- सचिव, पर्यावरण, वन एवं जलवायु परिवर्तन विभाग द्वारा बताया गया कि F.C. Act,1980 के लागू होने के पश्चात् वन भूमि पर गैर वानकी कार्य कराये जाने के पूर्व अनापत्ति प्रमाण–पत्र प्राप्त किया जाना आवश्यक है।

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- चांदन जलाशय एवं अन्य बराज/जलाशयों में गैर वन भूमि पर Environmental Clearance प्राप्त करते हुए तथा निर्धारित रॉयल्टी का भुगतान करते हुए जलाशय के डूबे हुए भाग में बालू/गाद की निकासी Dredging के माध्यम से जल संसाधन विभाग द्वारा कराया जा सकता है। आवश्यकतानुसार सूखे हुए क्षेत्र में Dry Excavation (Mining) का कार्य खान एवं भूतत्व विभाग के द्वारा बालूघाट सृजित कर बंदोबस्ती के माध्यम से कराया जा सकता है।
- Dredging के दौरान बालू/गाद के परिवहन हेतु नियमानुसार रॉयल्टी भुगतान के पश्चात् खान एवं भूतत्व विभाग के विभागीय NIC पोर्टल से ई–चालान निर्गत करने की सुविधा उपलब्ध कराई जाएगी।
- राजस्थान एवं केरल राज्यों के पैटर्न पर जल संसाधन विभाग/खान एवं भूतत्व विभाग द्वारा निम्नवत् कार्य कराया जा सकता है :–
    i. चांदन जलाशय अंतर्गत जल संसाधन विभाग के स्वामित्व वाले भूमि पर Environmental Clearance प्राप्त करते हुए तथा निर्धारित रॉयल्टी का भुगतान करते हुए जलाशय के डूबे हुए भाग में बालू/गाद की निकासी Dredging के माध्यम से जल संसाधन विभाग द्वारा कराया जा सकता है। आवश्यकतानुसार सूखे हुए क्षेत्र में Dry Excavation (Mining) का कार्य खान एवं भूतत्व विभाग के द्वारा बालूघाट सृजित कर बंदोबस्ती के माध्यम से कराया जा सकता है।
    ii. चांदन जलाशय अंतर्गत पर्यावरण, वन एवं जलवायु परिवर्तन विभाग के भूमि पर F.C. Act, 1980 के तहत अनापत्ति प्रमाण–पत्र प्राप्त करते हुए Dredging/ Dry Excavation (Mining) का कार्य कराया जा सकता है।
    iii. चांदन जलाशय एवं अन्य बराज/जलाशयों में जल संसाधन विभाग द्वारा Dredging कार्य हेतु चयनित संवेदक एवं खान एवं भूतत्व विभाग द्वारा Dry Excavation (Mining) कार्य हेतु चयनित बालूघाट बन्दोबस्तधारी के द्वारा ही संबंधित विभागों से सभी तरह का Clearance प्राप्त करना अनिवार्य होगा।

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2. बरनार जलाशय योजना

- जमुई जिलांतर्गत बरनार जलाशय योजना के वन भूमि अपयोजन से संबंधित मामले की समीक्षा के क्रम में बताया गया कि पर्यावरण, वन एवं जलवायु परिवर्तन विभाग को हस्तांतरित की जाने वाली 1335.55 एकड़ कुल भूमि के विरूद्ध 1050 एकड़ भूमि का भौतिक सत्यापन जिलाधिकारी, जमुई द्वारा गठित संयुक्त समिति से कराया जा चुका है। पर्यावरण, वन एवं जलवायु परिवर्तन विभाग द्वारा चयनित भूमि में से 299 एकड़ भूमि को लेने पर कोई आपत्ति नहीं व्यक्त की गयी है, परन्तु शेष 751 एकड़ भूमि पर अतिक्रमण की समस्या होने एवं क्षेत्रीय ग्रामीणों द्वारा खेती किये जाने के कारण आपत्ति व्यक्त की जा रही है। इस क्रम में जल संसाधन विभाग द्वारा बताया गया कि भूमि हस्तांतरण करते समय स्थानीय प्रशासन की सहायता से अतिक्रमण को हटाकर पिलरिंग करते हुए भूमि हस्तांतरित की जाती है।
- बैठक में निर्णय लिया गया कि मुख्य अभियंता, सिंचाई सृजन, भागलपुर, जिला पदाधिकारी, जमुई एवं पर्यावरण, वन एवं जलवायु परिवर्तन विभाग के संबंधित पदाधिकारी आपसी समन्वय स्थापित करते हुए उपरोक्त वर्णित मामले का शीघ्र निपटारा करें।

29/12/2023

(बन्दना प्रेयषी)
सचिव,
पर्यावरण, वन और जलवायु
परिवर्तन विभाग।

29/12/23

(परमार रविकुमार भाई)
अपर मुख्य सचिव–सह–खान
आयुक्त,
खान एवं भूतत्व विभाग।

29/12/2023

(चैतन्य प्रसाद)
अपर मुख्य सचिव,
जल संसाधन विभाग।

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ज्ञापांक : 1/PMC/विविध/944/2014–पार्ट–II– 330 पटना, दिनांक : 22-2-2024
प्रतिलिपि : माननीय मंत्री, जल संसाधन विभाग के आप्त सचिव को सूचनार्थ प्रेषित।

22/2/24
(पद्म कांत झा)
अभियंता प्रमुख, सिंचाई सृजन

ज्ञापांक : 1/PMC/विविध/944/2014–पार्ट–II– 330 पटना, दिनांक : 22-2-2024
प्रतिलिपि : अपर मुख्य सचिव, जल संसाधन विभाग के आप्त सचिव को सूचनार्थ प्रेषित।

22/2/24
अभियंता प्रमुख, सिंचाई सृजन

ज्ञापांक : 1/PMC/विविध/944/2014–पार्ट–II– 330 पटना, दिनांक : 22-2-2024
प्रतिलिपि : अपर मुख्य सचिव–सह–खान आयुक्त के आप्त सचिव को सूचनार्थ एवं आवश्यक कार्रवाई हेतु प्रेषित।

22/2/24
अभियंता प्रमुख, सिंचाई सृजन

ज्ञापांक : 1/PMC/विविध/944/2014–पार्ट–II– 330 पटना, दिनांक : 22-2-2024
प्रतिलिपि : सचिव, पर्यावरण, वन और जलवायु परिवर्तन विभाग के आप्त सचिव को सूचनार्थ एवं आवश्यक कार्रवाई हेतु प्रेषित।

22/2/24
अभियंता प्रमुख, सिंचाई सृजन

ज्ञापांक : 1/PMC/विविध/944/2014–पार्ट–II– 330 पटना, दिनांक : 22-2-2024
प्रतिलिपि : अभियंता प्रमुख, बाढ़ नियंत्रण एवं जल निस्सरण, जल संसाधन विभाग/ अभियंता प्रमुख, मुख्यालय, जल संसाधन विभाग/मुख्य अभियंता, योजना एवं मोनिटरिंग, जल संसाधन विभाग, पटना/ अधीक्षण अभियंता, बाढ़ नियंत्रण योजना एवं मोनिटरिंग अंचल/ अधीक्षण अभियंता, सिंचाई, योजना एवं मोनिटरिंग अंचल/अधीक्षण अभियंता, योजना एवं मोनिटरिंग अंचल–1,2,4/ मुख्य अभियंता, सिंचाई सृजन, भागलपुर/अधीक्षण अभियंता, सिंचाई अंचल, भागलपुर/ अधीक्षण अभियंता, सिंचाई अंचल, जमुई/कार्यपालक अभियंता, सिंचाई प्रमंडल, बौंसी/कार्यपालक अभियंता, सिंचाई प्रमंडल, झाझा को अपने स्तर से संबंधित पदाधिकारियों को अनुपालन सुनिश्चित कराने हेतु प्रेषित।

22/2/24
अभियंता प्रमुख, सिंचाई सृजन

ज्ञापांक : 1/PMC/विविध/944/2014–पार्ट–II– 330 पटना, दिनांक : 22-2-2024
प्रतिलिपि : कार्यपालक अभियंता, आई०टी०, जल संसाधन विभाग को विभागीय वेबसाईट पर प्रकाशन हेतु सूचनार्थ प्रेषित।

22/2/24
अभियंता प्रमुख, सिंचाई सृजन

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सरबजीत सिंह बख्शी
मुख्य अभियन्ता
पर्यावरण प्रबंधन संगठन

Sarbjit Singh Bakshi
Chief Engineer,
Environment Management
Organisation

सत्यमेव जयते

भारत सरकार
जल शक्ति मंत्रालय, जल संसाधन नदी विकास एवं गंगा संरक्षण विभाग
केंद्रीय जल आयोग
Government of India
Ministry of Jal Shakti
Dept. of Water Resources, RD&GR
Central Water Commission

D.O.S-16/3/2022-REM SEN DTE-Pt(1)/२०५

Date: 10th Dec 2024

Respected Shri Santosh Kumar ji

Dams / Reservoirs have played a significant role in the development of the country. To meet the increasing demands for water for agriculture, domestic and industrial use, optimal management of water resources must be ensured. To achieve effective and cost-efficient management of our water resources, it is essential to regularly update systems for assessing and analysing data.

Sedimentation in a dam is a natural phenomenon, which has impacted storage capacity of the reservoirs, thus affected their performance and reduced their benefits. During these years, loss of storage capacity in the dams, mainly due to sedimentation, has become one of the major concerns for dam safety and water security. Reservoir capacity surveys are conducted for updating the elevation-area-capacity relationship and establishing reliable criteria for assessing the annual loss of storage over a defined period.

Central Water Commission has been carrying out capacity surveys of reservoirs, using Hydrographic and Remote Sensing Techniques, under the National Hydrology Project. The data collected reveals that the average annual loss in Gross storage capacity for Indian reservoirs is 0.74 % as against the world average of 0.96%. The average annual loss in Live Storage capacity in India is 0.49 %. The reservoir sedimentation study published by CWC (2024), has revealed that out of 200.30 BCM of total Gross Storage capacity of 439 reservoirs, 30.96 BCM of the Gross Storage capacity has already been lost and out of total Live storage capacity of 150.97 BCM of 330 reservoirs,15.39 BCM has been lost.

CWC has recently completed the study on sedimentation assessment of **Chandan** and **Badua** reservoirs in Bihar, by utilizing Sentinel -1 satellite data.

1. The **Chandan Project** was commissioned in 1967. Earlier, the Satellite Remote Sensing Survey of the reservoir was carried out by CWC in 2004. The Live Storage Capacity at FRL, assessed as per survey of 1967 was 124.58 MCM and as per the recent study based upon data of 2019-20, it has been estimated as 52.73 MCM. This indicates a loss of 71.85 MCM during the last 53 years, which is about 57.68% of the original live storage capacity of the reservoir.

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6th Floor (South), Sewa Bhawan,
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•Conserve Water- Save Life•

2. The Badua Project was commissioned in 1965. Earlier, the Hydrographic Survey of the reservoir was carried out by CWC in 2006; and Satellite Remote Sensing Survey was carried out by CWC in 2008. The Live Storage Capacity at FRL, assessed as per survey of 1965 was 109.656 MCM and as per the recent study based upon Sentinel -1 data of 2019-20, it has been estimated as 95.612 MCM. This indicates a loss of 14.044 MCM during the last 55 years, which is about 12.81% of the original live storage capacity of the reservoir.

Keeping in view the above, it is suggested that suitable measures shall be taken up to recover the lost storage capacity. Also, Comprehensive Catchment Area Treatment Plan should be planned, and adequate measures shall be adopted to arrest the soil erosion from the catchment. The commercial utilisation of the sediment shall be explored to develop revenue-based model for carrying out desiltation process. It is recommended that Bathymetric Survey of the reservoir shall be carried out at every five years for evaluating their remaining lifespan, ensuring optimal reservoir operations and planning of sediment control measures

A copy of the Study report on Sedimentation Assessment of these reservoirs using Satellite Remote Sensing technique is attached herewith for kind information and reference.

Yours Sincerely

(Sarbjit S Bakshi) 10/12/2024
Chief Engineer

Encl :as above

Sh Santosh Kumar Mall
Principal Secretary,
Water Resources Department
Government of Bihar
(wrd-bih@nic.in)

Copy alongwith set of reports to:

1. Joint Secretary (PP&RD), DoWR, RD&GR, MoJS, New Delhi
2. Engineer-in-Chief, Headquarter, WRD, Govt. of Bihar (eicheadquarter@gmail.com)
3. Chief Engineer HSO/ P&D/DSO, CWC, New Delhi
4. Chief Engineer, LGBO, CWC(celgbo-cwc@nic.in)

Copy for kind information to:

1. PPS to Chairman, CWC
2. PPS to Member (WP&P), CWC

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