

REPORT OF THE OVERSIGHT COMMITTEE, NGT, U.P, LUCKNOW

IN THE MATTER OF:-

ORIGINAL APPLICATION NO. 164/2018

IN RE: ASHWANI KUMAR DUBEY

VERSUS

UNION OF INDIA & ORS.

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UPDATED PROGRESS REPORT OF THE OVERSIGHT COMMITTEE DATED 14.01.2022 REGARDING O.A. NO. 164/2018 (EARLIER O. A. NO. 276/2013) IN RE: ASHWANI KUMAR DUBEY VS. UNION OF INDIA & ORS.

I. BACKGROUND

The Hon'ble NGT in the matter of OA No. 164/2018 (earlier O.A. No. 276/2013) in re: *Ashwani Kumar Dubey Vs. Union of India & Ors.* has dealt with the issue of pollution being caused by Thermal Power Plants in District Sonbhadra of Uttar Pradesh and District Singrauli of Madhya Pradesh on account of their activities resulting in the continued destruction of the environment. The industries are discharging mercury beyond prescribed norms affecting the nervous system causing disorders and other ailments to inhabitants. The mentioned areas are critically polluted as per the '**Comprehensive Environmental Pollution Index Report**'. According to the studies, fly ash created and stored by the industries and crushers are main sources of high level of pollution in this area. Transportation of coal by trucks from the coal companies also contribute to pollution.

II. DIRECTIONS OF THE HON'BLE NGT

1. Vide order dated 14.07.2020, the Hon'ble NGT reiterated the following directions issued on 12.02.2020 in OA No.117/2014, *Shantanu Sharma vs. Union of India & Ors.* for compliance by the concerned TPPs:

"a. The TPPs may take prompt steps for scientific disposal of fly ash in accordance with the statutory notification issued by the MoEF&CC under the provisions of the EP Act requiring 100% utilization and disposal of fly ash.

b. For the non-compliant TPPs, environmental compensation needs to be determined w.e.f. the cut-off date of 31.12.2017 as stipulated in the Notification dated 27.01.2016.

c. CPCB may accordingly compute and levy Environmental Compensation in accordance with the formula referred to above w.r.t. individual TPPs in accordance with law and submit compliance report to this Tribunal before the next date.

d. CPCB Guidelines of May 2019 for Utilization/Disposal of Fly ash for Reclamation of Low-Lying Areas and in Stowing/Back filling of Abandoned Mines/Quarries may be complied.

e. Task Force of Ministry of Power and Ministry of Coal may recommend list of abandoned mines/quarries for mine back filling purposes to the CPCB. CPCB may notify the same accordingly for use by the TPPs as per applicable guidelines and permission from State PCBs/PCCs.

f. A Committee comprising of CPCB and IIT Roorkee may assess the environmental damage with regard to the breach sites at Vidhyanchal TPP an Essar TPP in Singrauli area and submit

its recommendation within three months. CPCB shall be at liberty to engage any other technical expert for this purpose.

g. The Committee comprising of Collector, CPCB and Member Secretary of MP State Pollution Control Board may assess the damage with regard to the breach sites at Vindhyachal TPP and Essar TPP in Singrauli area to the crop and agricultural productivity and ensure effective restoration/remediation of affected sites within three months.

h. CPCB may ensure implementation of action plans approved by it in accordance with timeline as provided in the statute.

i. A joint Committee comprising of MoEF&CC, CPCB, IIT Roorkee and any other member considered necessary may submit quarterly progress report on recommendations of Expert Committee of Niti Aayog for enhanced utilization of fly ash in various sectors: mines, roads, cement, industries and bricks etc., along with its implementation status.

j. The present order is subject to proceedings pending before the Hon'ble Supreme Court and where stay is operative, this order will not operate till stay continues and thereafter abide by orders of Hon'ble Supreme Court."

2. Vide the same order dated 14.07.2020 following additional directions were also issued:

i. Fly ash disposal may be undertaken as per the directions in the order of this Tribunal dated 12.02.2020.

ii. Fly ash disposal in mounds and backfilling of ash in abandoned mines may be undertaken as per the CPCB guidelines, if necessary, Indian Bureau of Mines, Dhanbad may also be consulted so that latest technology is utilized and all necessary safeguards are adopted.

iii. Report of CPCB regarding Cost apportionment for desilting/restoration of Rihand Reservoir is accepted and further steps, including further study be undertaken as recommended by CPCB. The U.P. Irrigation Department may coordinate such study.

iv. Anpara TPS and Lanco-Anpara power plants may stop ash pond overflow discharge into Rihand Reservoir to the extent the work remains unexecuted.

v. NTPC, Vindhyachal may deposit amount of Rs. 10 Crores as recommended by the Oversight Committee with the State PCB towards interim compensation, deducting the amount already deposited. The plant may also develop RCC wall around the plant in the matter recommended.

vi. The liability for environmental compensation in respect of UPVUN, Anpara and NTPC Vindhyachal may be assessed by joint Committee of CPCB and State PCB within two months. The nodal agency will be the State PCB for coordination and compliance.

vii. The transportation measures may be adopted as per suggestions of the Committee and directions of the Hon'ble Supreme Court.

III. PROGRESS REPORT

The Oversight Committee had submitted its report in this regard on 01.03.2021 for the consideration of the Hon'ble NGT. The report could not be considered as the hearing was adjourned. **The updated progress report in this matter has been divided into major four parts which are as under:**

- A. Thermal Power Plants & Industries**
- B. Coal Mines of M/s Northern Coalfields Limited (NCL)**
- C. Stone Crushers**
- D. UPPCB, CPCB and MOEF&CC**

A. Thermal Power Plants (TPPs) & Industries

S. No.	Issues/ Directions by the Hon'ble NGT	Compliance Status	Updated Progress			
1.	100% Utilization and Disposal of Flyash	Partially Complied	Except M/s Hindalco industries, Renusagar and Renukoot, ash utilization is abysmally low in all the units. Even these two units have not met the norm in Financial Year 2019-20 & 2020-21 and 2020-21 & 2021-22 respectively. The unit wise utilization details are given in the following table:			
Table						
TPPs/Industries	Year	Total Ash Generated (in Lac MT)	Total Ash Utilized (in Lac MT)	Disposal in ash pond (in Lac MT)	Ash Utilization (in %)	
M/s UPRVNL Anpara	2019-20	36.24	1.41	34.83	3.69%	
	2020-21	33.61	9.19	24.42	27.34%	
	2021-22 (Upto Sep., 2021)	17.61	0.70	16.46	3.97%	
M/s Obra Thermal Power Plants	2019-20	11.14	0.86	10.28	7.71%	
	2020-21	14.09	0.80	13.28	5.73%	
	2021-22 (Upto Sep., 2021)	7.13	0.36	6.77	5.04%	
M/s Lanco Anpara Power Ltd., Anpara	2019-20	15.77	3.58	12.19	22.71%	
	2020-21	17.49	2.95	14.54	16.88%	
	2021-22 (Upto Sep., 2021)	8.57	1.09	7.48	12.70%	
M/s NTPC Rihand	2019-20	39.01	16.84	22.17	43.18%	
	2020-21	39.21	20.39	18.82	52.02%	
	2021-22	20.54	9.49	11.05	46.21%	

		(Upto Sep., 2021)				
NTPC Shaktinagar		2019-20	32.06	12.58	19.48	39.24%
		2020-21	29.84	9.97	19.87	33.41%
		2021-22 (Upto Sep., 2021)	14.80	3.34	11.46	22.55%
M/s Hindalco Industries Ltd., Renusagar		2019-20	16.01	9.82	6.19	61.33%
		2020-21	15.04	11.17	3.87	74.26%
		2021-22 (upto Sep., 2021)	6.71	7.40	-	110.28%
M/s Hindalco Industries Ltd. Renukoot		2019-20	2.98	2.98	-	100%
		2020-21	1.54	1.24	0.30	80.51%
		2021-22 (upto Sep., 2021)	0.99	0.91	0.08	91.91%
2.	Imposition and Realization of EC on the non-compliance by the TPPs	Partially Complied	EC of total Rs. 23,14,80,000/- was imposed on these industrial units for the period 2019-2020. However, the amount has been realized only from M/s Lanco, Anpara and not from others as a stay has been granted to all of them by the Hon'ble Supreme Court.			
3.	Utilization/Disposal of Fly Ash	Partially Complied	<p><u>M/s Anpara TPS</u></p> <ol style="list-style-type: none"> After getting consent from the UPPCB, Anpara TPS has filled up ash (about 3.19 lac MT) in a low-lying area (village- Dibulganj) in Feb,2021. No further filling of ash is possible in it. Now, soil cover is being provided for plantation to be done in June/July-2022 in coordination with the Forest Department, U.P. It has requested the District Administration to allot 07 abandoned stone mines/quarries in Billi Markundi area (8.4 acre) for fly ash disposal. The District Administration has assured to allot these mines. Out of the 07 mines, 04 mines (approx. 4 Lac MT capacity) are undisputed while 03 mines (approx. 3.0 Lac MT capacity) have ownership dispute between Revenue and Forest Department. After the dispute resolution, these mines would be made available to UPRVUNL. A feasibility study for developing an Eco Park on the old mounds of fly ash, has been done by the IIT-BHU. Work for preparation of design/drawing/ estimate of Eco-Park has been completed and a comparative study with the existing NTPC Eco- Park work is being done. These efforts will take care of how much quantity of ash has not been revealed to the Committee. Fly ash generated from the 07 units of Anpara is also utilized by issuing it free of cost to cement industries and ash brick industries. The quantity of ash being utilized in this manner has not been revealed. 			

		<p>Partially Complied</p>	<p><u>M/s Obra TPS:</u></p> <ol style="list-style-type: none"> 1. After obtaining Consent to Establish (CTE) from the UPPCB, the unit has done the following for backfilling of ash in- <ol style="list-style-type: none"> a. Bid Part-I of Tender for disposal of 2.4 Lac CuM ash in Obra Sector- 2 & 3 in the first phase was opened but the bidders did not qualify the Pre-Qualification Criteria, therefore fresh bid has been invited. Subsequently, about 5-10 Lac CuM ash is also proposed to be disposed here in the second phase. b. Bid Part-I of Tender for disposal of 3.0 Lac CuM in abandoned stone quarries has been opened and is under process for opening the financial bid. c. Approval for inviting tenders from the Headquarter regarding ash filling (1.8 Lac CuM) in low-lying area near Lodhi Toll Plaza is awaited. 2. Agreement with M/s ACC Ltd. for lifting 1.35 Lac MT/month of fly ash is in the final stage. After the agreement, ash lifting will be done from Obra B as well as Obra C. 3. M/s Zaak Technologies, Germany has agreed for taking minimum 1.0 Lac MT/month of fly ash for manufacturing Grade Sand. 4. Flyash generated from the unit is partly utilized by issuing fly ash free of cost to cement and ash brick industries. The quantity of ash being utilized in this manner has not been revealed. The remaining quantity is discharged in the form of ash slurry to ash dyke.
		<p>Partially Complied</p>	<p><u>M/s Lanco Anpara Power Ltd., Anpara</u></p> <ol style="list-style-type: none"> 1. Several request letters dated 18.11.2015, 24.02.2016, 16.05.2016, 20.11.2018, 01.07.2020 and 23.07.2021 have been sent to NCL for allotment of abandoned mines. Response is still awaited. 2. A request letter dated 13.11.2019 have been sent to DM, Sonbhadra for allotment of abandoned mines. Response is still awaited. 3. Agreement/MOU signed with M/s J.S Enterprises, Renusagar on 20.01.2021 (duration 23.01.2021 to 22.1.2022) to coordinate with cement industries for utilization of approx. 60000 MT/month of fly ash generated. In the FY 2021-2022 (till Sep., 2021), 108885 MT ash has been lifted. 4. Agreements have been signed with the following brick manufacturing units for supply of fly ash:

		<p>Partially Complied</p>	<p>a. M/s Jai Bricks, Pipri, Anpara (20.11.2018) to take upto 200 MT/month of flyash.</p> <p>b. M/s Birendra Singh Inta Bhatta, Auri More, Anpara (20.11.2018) to take upto 200 MT/month of flyash.</p> <p>c. M/s HIBA Infratech, Auraiya (18.08.2021) to take upto 200 MT/month of fly ash for the period 01.09.2021 to 31.8.2022.</p> <p>d. M/s KS Enterprises, Lalganj, Mirzapur (20.09.2021) to take upto 5000 MT/month of fly ash for the period 20.09.2021 to 19.09.2022.</p> <p>However, no ash has been lifted by the above first three units till Sep., 2021.</p> <p>5. Letters dated 07.02.2019 and 08.07.2021 were sent to the Regional office, NHAI, Varanasi for entering into an MoU to take fly ash for road construction projects. Response is still awaited.</p> <p><u>M/s NTPC Rihand</u></p> <p>1. It is presently manufacturing ash bricks through 02 fully automatic ash brick plants. Approx. 1206 MT flyash has been used to manufacture 5.32 Lacs bricks/month. These bricks are utilized in the Plant, townships and ash dykes.</p> <p>2. To promote the offtake of dry fly ash, the Plant has procured 03 Bogey Tank for Alumina Powder (BTAP) rakes for transportation of fly ash. Till 30.09.2021, approx. 81,000 MT of fly ash has been transported to the cement plants.</p> <p>3. It has given permission to M/s ACC Ltd. for transportation of fly ash in 10 rakes of tarpaulin covered BOXN wagon. Out of 10 rakes, 5 rakes have been dispatched to different cement plants of ACC Ltd. Similarly, 2 rakes have been sent to Dalmia Cement Plant, Nagoan, Assam.</p> <p>4. 03 MoUs have been signed with NHAI- Varanasi for the supply of approx. 06 Lac CuM of pond ash (NH-56, NH-29 and bypass road project Varanasi). Approx. 4.22 Lac MT of pond ash was lifted by NHAI during 26.06.2020 to 30.09.2021.</p> <p>5. It has requested NCL authorities on 05.08.2020 for allocation of mines for backfilling of abandoned coal mines but no mines have been allocated to it till now.</p> <p><u>M/s NTPC Shaktinagar</u></p> <p>1. Ash filling in abandoned stone quarries having 60 Hectare area located at Billi, Markundi has been offered on lease basis and the NTPC is the getting the feasibility assessment done.</p>
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		<p style="text-align: center;">Partially Complied</p>	<p>2. It has installed 05 semi-automatic fly ash brick plants and 02 old brick machines have been replaced with new brick machines. Presently 4.5 lac/month bricks are being manufactured.</p> <p>3. It has signed a contract with NHAI for the supply of 11.75 Lac MT Pond ash for road projects. (Supply started on 27.06.2020). Steps are also being taken for finalization of contract for additional supply of 5.2 lac MT of pond ash for Varanasi Ring Road project.</p> <p><u>M/s Hindalco Industries Ltd., Renusagar</u></p> <p>1. Approx. 34800 MT/month of fly ash & 84000 MT/month of pond ash is being transported through rail rakes and bulkers on continuous basis for its utilization by the following cement & cement sheet making companies-</p> <p>a. M/s Hyderabad Industries Ltd., Jaunpur (3000 MT/month of fly ash, for the period of 01.05.2020 to 30.04.2025)</p> <p>b. M/s Prism Cement, Satna (13500 MT/month of fly ash, for the period of 01.05.2019 to 30.04.2024)</p> <p>c. NU Vista Ltd., Bihar (7800 MT/month of fly ash, for the period of 01.09.2019 to 31.08.2022)</p> <p>d. M/s Kanodia Infratech Ltd., Bihar (10500 MT/month of fly ash, for the period of 01.12.2019 to 30.11.2024)</p> <p>e. M/s ACC Ltd. Tikariya Sultanpur (U.P.) (4000-8000 MT/month of pond ash, for the period of 01.08.2021 to 01.08.2022)</p> <p>f. M/s Shree Cement, Bihar (60000 to 80000 MT/month of pond ash, for the period of 01.08.2021 to 31.07.2022)</p> <p>g. Fly Ash Movers Ltd., Satna (4000 to 8000 MT/month of pond ash, for the period of 01.09.2021 to 31.08.2022)</p> <p>2. Approx. 4030 MT/month of flyash is used for bricks manufacturing at their own Brick making plant at Renusagar and for supply to other brick-making units viz. M/s Bharat Hume & Pipe, Karhiya Sonbhadra & M/s Puja Industries Bhairwa Sonbhadra.</p> <p>3. Approx. 19786 MT/month of ash is supplied for road projects of Varanasi.</p> <p><u>M/s Hindalco Industries Ltd., Renukoot</u></p> <p>1. The preliminary assessment of site suitability study of an abandoned quarry in Dalla region by M/s Genstru, Pune has been completed. The final</p>
		<p style="text-align: center;">Partially Complied</p>	

			<p>report is awaited.</p> <p>2. Approx. 9930.02 MT/month of fly ash is being transported through bulkers on a continuous basis for its utilization by the following cement-making companies-</p> <ol style="list-style-type: none"> M/s Tabsio Infratech- 79.03 MT/month M/s Eco Cement - 747.00 MT/month M/s Diamond Industries- 280.65 MT/month Himalaya Height C. Pvt. Ltd., Durgawat- 787.64 MT/month M/s F. S. Fertilizers- 74.78 MT/month M/s Kanodia Infratech Ltd., Bhabhua- 433.81 MT/month M/s Abhinav Road Carrier/ Brij Cement- 988.64 MT/month M/s J. P. Chunar- 4400.65 MT/month M/s Alakhnanda, Ramnagar- 92.52 MT/month M/s Emami Cement, Durgawati- 1100.35 MT/month Bharat Infra Cement Ltd, Chandauli- 981.78 MT/month M/s Amba Cement, Bhadoi-164.46 MT/month Ultratech Cement, Dala- 37.29 MT/month R.L.J. Infra Cement, Chunar- 323.04 MT/month M/s Trinani Cement- 93.27 MT/month M/s Laxmi Cement- 55.11 MT/month <p>3. Approx. 643.33 MT/month of dry ash is utilized for Varanasi National Highway.</p> <p>4. Approx. 4015 MT/month of bottom ash is utilized for Varanasi & Garhwa road projects.</p> <p><u>M/s Grasim Industries Ltd. (Chemical Division), Renukoot</u></p> <ol style="list-style-type: none"> Reclamation activity has been started from Aug, 2021 by tree plantations in low-lying areas within the plant premises. Plantation activity is expected to be completed by the end of monsoon season, 2022. For intermittent storage in adverse scenario, the industry is in process of obtaining abandoned mines in Obra region. The Pre-feasibility Study for the same has been completed by M/s Genstru Consultant Pvt. Ltd. The industry has received the Permission to carry out site suitability study of abandoned stone quarry/mine voids at Dalla, Sonbhadra (UP) to fill & rehabilitate the same by fly ash & bottom Ash.
4.	Ash dyke management of TPS	Partially Complied	<p><u>Anpara TPS:</u></p> <p>Ash dyke's height is being raised to the extent of 5 meters for disposal of wet ash. The ash pond has been divided into two lagoons each having a</p>

			<p>decantation well. On completion of work, one lagoon has been made operational since 02.06.2021. The work of 2nd lagoon was expected to be complete by Dec., 2021.</p>
		Partially Complied	<p><u>Obra TPS:</u></p> <ol style="list-style-type: none"> 1. It has got the design and drawing of raising of ash dyke prepared by IIT-Roorkee. The first raising work of ash dyke has been completed and the 2nd raising work has been started from October, 2021. As per the report of IIT-Roorkee, the ash dyke is structurally safe, sound and sustainable and there is no chance of breach. 2. In order to maintain zero discharge from ash dyke, all the systems i.e., ash slurry pump, seepage of the ash dyke and Ash Water Recirculation System (AWRS) are functioning properly and its regular maintenance work is being done. AWRS also facilitates recirculation of ash pond water. 3. The unit is yet to install flow meters to measure the quantity of ash slurry disposed in the ash dyke and the amount of water recycled from the ash pond.
		Partially Complied	<p><u>M/s Lanco Anpara Power Ltd.</u></p> <ol style="list-style-type: none"> 1. The AWRS is fully functional and flow meters in all three lines have been installed on 05.12.2021. 2. Regular monitoring is being done to keep ash dykes in proper condition to avoid any overflow.
		Partially Complied	<p><u>NTPC Rihand</u></p> <ol style="list-style-type: none"> 1. Ash dyke has been constructed with approved engineering design provided by the Corporate Centre. Third party assessment of ash dyke is being done by IIT-Roorkee. 2. It has awarded the ash dyke stability study to IIT-Hyderabad for the year 2021. Two visits of experts (in Feb.,2021 & July, 2021) for dyke stability assessment have been done and their report is still awaited. 3. Flow meters are installed. During April, 2021 to Sept., 2021, approx. 17016721 KL of ash slurry has been discharged and out of that 15388800 KL water has been recycled through the AWRS.
		Partially Complied	<p><u>M/s NTPC Shaktinagar</u></p> <ol style="list-style-type: none"> 1. Regular monitoring is being done to keep ash dykes in proper condition to avoid any overflow.

		<p>Partially Complied</p>	<p>2. It has awarded the ash dyke stability study to IIT- Hyderabad. Two visits (in Feb.,2021 & July, 2021) of experts of IIT- Hyderabad for dyke stability assessment has been done and their report is awaited.</p> <p>3. The unit has installed flow meters. The unit discharged 7724990 KL ash slurry and recycled 6257242 KL water during the quarter July, 2021 to Sep., 2021.</p> <p>4. In order to increase the offtake of dry fly ash, installation of Dry Ash Extraction System (DAES) in all units of Stage- I is in progress with a plan to discard old DAES in 02 units. In Stage- II, U#6 DAES has been commissioned and U#7 commissioning is in progress.</p> <p><u>M/s Hindalco Industries, Renusagar</u></p> <p>1. Ash Dyke at Bichari is around 8 kms from Renusagar Power Plant which was constructed in the year 2004 as per the approved design of the CBRI, Roorkee and is maintained strictly as per the standard operating procedure with round the clock monitoring.</p> <p>2. The stability assessment of the ash dyke is being conducted by reputed agencies i.e., CBRI, Roorkee/ IIT BHU/ MIT Moradabad.</p> <p>3. The unit has installed flow meters to measure quantity of ash slurry disposed in the ash dyke and the amount of water recycled from the ash pond. During April, 2021 to July, 2021, a total of 1048824 KL ash slurry was discharged and 883682 KL water was recycled.</p> <p>4. It has also initiated the process for getting 48.55 hectare of forest land for making new ash dyke.</p>
		<p>Partially Complied</p>	<p><u>M/s Hindalco Industries, Renukoot:</u> Entire fly ash (which is 80% of the total ash generated) is handled by dry ash system. Ash is being loaded into bulkers from ash silos and bottom ash is also being sent to various users routed through intermediate settling ponds in dry form. All the ash is being disposed in environment friendly manner; only temporary ash storage area is in place. This area is of earthen construction using well-compacted soil which is structurally sound and stable. Since, the ash is in dry form there is no seepage of water out of the storage area.</p>
5.	Measures for transportation, storage & handling of coal by TPPs	<p>Complied</p>	<p>M/s Anpara TPP (Unit-A, B & D)- Entire coal transportation is being done by railway wagon (MGR system). It has never transported coal through road. There is no fugitive emission in the Coal Handling Plant (CHP). Sprinkling of water is done to control</p>

			<p>the coal- dust near the crushers.</p> <p>M/s Obra TPP (Unit-B)- Coal transportation is being done by railway wagon and covered shed is provided for unloading. No transportation of coal being done through road. The unit has installed water sprinklers in coal storage area and dust suppression system at loading- unloading points.</p> <p>M/s Lanco Anpara Power Ltd.- About 70% of coal is transported through railway rakes and the rest 30% is transported through tarpaulin covered trucks. Sprinkling of water on the road is also being done. The unit has installed water sprinklers in coal storage area and dust suppression system at loading-unloading points.</p> <p>M/s NTPC Rihand-</p> <ol style="list-style-type: none"> 1. It is transporting 100% coal from the linked mines of Northern Coalfield Ltd. (NCL) through Merry-Go-Round (MGR) railway system and a covered shed is provided for unloading of coal. 2. Water sprinklers, dust and dry fog dust suppression systems have also been installed and the same are operational in the CHP. 3. Installation of cold fog dust suppression system is proposed in Stage-I system. Notice Inviting Tender has been issued for the same and the system is expected to be commissioned by Dec., 2022. <p>M/s NTPC Shaktinagar:</p> <ol style="list-style-type: none"> 1. It is transporting 100% coal from the linked mines of NCL through MGR railway system and unloading takes place in a covered shed. 2. Water sprinklers in the coal storage areas and dust suppression systems have also been installed and the same are operational. 3. The fugitive emission is in the range of prescribed norms. The unit is in process to further improvise the condition by installing a fog system. <p>M/s Hindalco Industries Ltd., Renuagar:</p> <ol style="list-style-type: none"> 1. The industry is transporting approximately 80% of coal through BPC and the balance of 20% is transported through tarpaulin-covered trucks. 2. It has installed a belt pipe conveyor (BPC) system (4.65 km) from the Krishnashila coal mine for coal transportation. 3. Fugitive emission of dust is being controlled by the Dust Extraction System installed at the coal
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			<p>final stage. After completion of pump house, the pumps which already have an ETP will be transferred to new pump house and effluent from power house will be taken into pump and same will be discharged into the ETP for treatment and re-circulation.</p> <p>Complied <u>M/s Lanco Anpara Power Ltd.</u> The unit is achieving ZLD. All treated waste water is being used in horticulture and in the ash plant. It has also installed a flow meter on 05.12.2021 at inlet and at recycling point.</p> <p>Complied <u>NTPC Rihand</u> It has installed 03 ETPs and 02 STPs. Treated water is fully recycled and reused. ZLD is being maintained. Flow meters are installed to measure the amount of waste water received and treated through ETP.</p> <p>Complied <u>NTPC Shaktinagar</u> The unit is recycling the treated waste water from ETP and has also installed a flow meter to measure the amount of waste water received through ETP. ZLD is being achieved.</p> <p>Partially Complied <u>M/s Hindalco Industries, Ltd., Renusagar:</u> The industry has developed a road map and timeline for creating the sludge drying bed/filter press to be installed at ETP. The process to select a vendor for this purpose has been initiated in Dec., 2021.</p> <p>Partially Complied <u>M/s Hindalco Industries Ltd., Renukoot:</u> The industry has commissioned Process Water Recycling Plant (PWRP) on 23.11.2021 in order to achieve ZLD. Treated waste water from STP is being used in horticulture, other miscellaneous works and the rest is discharged into Murdhawa Nala (i.e. natural drain).</p> <p>Complied <u>M/s Grasim Industries Ltd. (Chemical Division), Renukoot:</u> ZLD condition fully complied for plant ETP & STP (w.e.f. 17.11.2017) and residential colony STP (w.e.f. 24.11.2019). For further utilization of treated sewage, the industry has installed a 1000 m³ ultrafiltration (UF) system which is operational since 10.03.2021. The treated STP water from the UF system is utilized in plant cooling towers.</p>
7.	Installation of Flue-Gas Desulfurization	Partially Complied	<p><u>M/s Anpara TPS</u> 1. A & B-Plant: Central Electricity Authority vide its letter dated 23.10.2021 has rejected the tender of</p>

	(FGD) for control of gaseous emission		<p>M/s Beijing SPC. The notice for re-tendering has been issued.</p> <p>2. D-Plant: LOA dated 04.07.2019 was issued to M/s Beijing SPC Environment Protection Tech Co, China for installation of FGD. 40% of civil work has been completed.</p> <p><u>Obra TPS:</u> Retendering for Part- I will be done on 27.01.2022. Installation of FGD is expected to be complete by June, 2023.</p> <p><u>M/s Lanco Anpara Power Ltd.</u> The unit is in the process to install FGD system for achieving standards notified for gaseous emissions before specified timeline.</p> <p><u>NTPC Rihand</u> Bids received for the installation of FGD are under technical evaluation. The work of the installation of FGD in Stage- II & Stage- III units is in progress and will be completed by December and September, 2023 respectively.</p> <p><u>NTPC Shaktinagar</u> Work of chimney construction, absorber and associated work is in progress. Efforts are being made to complete FGD installation within the revised timeline i.e., 31.12.2024.</p> <p><u>M/s Hindalco Industries, Ltd., Renusagar:</u> The technology has been finalized for FGD installation in one boiler unit. In July, 2021, the industry has placed LOI to the vendor. It will take about 17.5 months to receive the material. The work is expected to be complete by April, 2023. On the basis of successful working of FGD system in one boiler, it shall be replicated in other nine boilers.</p>
8.	Maintenance of the capacity and quality of the water of Rihand Reservoir along with its preservation	<p>Partially Complied</p> <p>Complied</p> <p>Partially Complied</p>	<p>Anpara TPS: The spillway is being raised to minimize the chances of overflow by the Mochana into the Rihand reservoir. After raising of spillway, there will be no overflow into the reservoir. The timeline for completing this work has not been revealed by the unit.</p> <p>NTPC Rihand and Shaktinagar are not discharging any pollutants into the Rihand Reservoir.</p> <p>M/s Lanco Anpara Power Ltd.: The unit has entered into facility & Service Agreement with UPRUVNL Anpara on 12.11.2006 for the use of ash dyke as one of the common facilities.</p>

			<p><u>Comments by UPPCB</u></p> <p>As per the information furnished by the UPPCB, the Ministry of Water Resources River Development and Ganga Rejuvenation Central Water & Power Research has assessed the cost of Hydrographic/capacity survey of Rihand Reservoir to be Rs. 69.09 lac. Accordingly, payment of this amount has been made to the Central Water and Power Research Station (CWPRS) Khadakwasla, Pune, Maharashtra, which has been engaged by the Irrigation Department, UP for this study. Study work has been reported to be delayed due to COVID-19. Further information in this regard is awaited from Executive Engineer Rihand Dam, Civil Division, Pipari.</p>																						
9.	Ambient Air quality around Anpara TPS	Partially Complied	<p>Anpara TPS has installed 03 CAAQMS for ambient air quality monitoring at 03 different locations. All are working properly and are linked with the CPCB server. The status of the Ambient Air Quality at these locations is as follows:</p> <ol style="list-style-type: none"> The concentration of PM10 exceeded the standard limit of 100 µg/Nm³ in the month of January to June, 2021 and Nov., 2021 for Anpara Colony near Auri More. The limit was exceeded in Anpara Admin Building near Bajrang Nagar for the months of January to May, 2021 and Nov., 2021. At Anpara DTPS Admin Building near Coal Handling Plant (CHP), the concentration of PM10 was high in the months of January, March, April, May, September and November, 2021. (Refer Appendix- I) 																						
10.	CAAQMS installed by TPPs in Sonbhadra	Complied	<table border="1"> <thead> <tr> <th>Name of Industry</th> <th>No. of CAAQMS installed</th> </tr> </thead> <tbody> <tr> <td>M/s UPRVUNL Anpara</td> <td>01</td> </tr> <tr> <td>M/s UPRVUNL Obra</td> <td>03</td> </tr> <tr> <td>M/s NTPC Rihand</td> <td>03</td> </tr> <tr> <td>M/s NTPC Shaktinagar</td> <td>02</td> </tr> <tr> <td>M/s NCL Khadia</td> <td>01</td> </tr> <tr> <td>M/s NCL Bina</td> <td>01</td> </tr> <tr> <td>M/s NCL Kakri</td> <td>01</td> </tr> <tr> <td>Hindalco Industries Ltd., Renuagar</td> <td>01</td> </tr> <tr> <td>Hindalco Industries Ltd., Renukoot</td> <td>01</td> </tr> <tr> <td>M/s Lanco- Anpara Power Ltd.</td> <td>01</td> </tr> </tbody> </table> <p>All the CAAQMS are using four parameters viz.</p>	Name of Industry	No. of CAAQMS installed	M/s UPRVUNL Anpara	01	M/s UPRVUNL Obra	03	M/s NTPC Rihand	03	M/s NTPC Shaktinagar	02	M/s NCL Khadia	01	M/s NCL Bina	01	M/s NCL Kakri	01	Hindalco Industries Ltd., Renuagar	01	Hindalco Industries Ltd., Renukoot	01	M/s Lanco- Anpara Power Ltd.	01
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			SO ₂ , NO _x , PM ₁₀ and PM _{2.5} to assess the air quality. The details of the Air Quality for Sep., 2021 regarding the above mentioned TPPs/industries are enclosed as Appendix- II.
11.	Continuous operation of ESPs and installation of OCEMS connected with the CPCB/SPCB server	Complied	<p><u>M/s Anpara TPS</u></p> <ol style="list-style-type: none"> 1. During the period from July to Sep., 2021, 11 SMS alerts were generated. 2. Stack Emission: Due to shut down of units, ESPs went out of order, changes in the ESP field and coal mills, soot blowing, load variation etc. occurred. Immediate action was taken to normalize the plant and to lower down the PM-value of Unit No 1, 2, 3, 4, 5 below 100 mg/Nm³ & 6, 7 below 50 mg/Nm³.
		Complied	<p><u>M/s Obra TPS</u></p> <p>Electronic Precipitators (ESPs) have been upgraded and their effective functioning is being ensured. OCEMS is installed in all the operational stacks and connected with the CPCB server for online monitoring of data. During the period from July to Sep., 2021, 39 SMS alerts were generated. PM level is being maintained within the prescribed limit of 100 mg/NM₃</p>
		Complied	<p><u>M/s Lanco Anpara Power Ltd.</u></p> <p>Effective operations of ESPs are ensured. OCEMS is installed in all the operational stacks and connected with the CPCB server. During the period from July to Sep., 2021, no SMS alerts were generated. The unit has stated that PM level is within the prescribed limit of 50 mg/NM₃.</p>
		Complied	<p><u>NTPC Rihand</u></p> <ol style="list-style-type: none"> 1. It has installed 06 ESPs (one for each unit) and OCEMS in all stacks and these are connected with the CPCB server. 2. During the period from July to Sep., 2021, 119 SMS alerts were generated. 3. The alerts appeared on few occasions in EQMS due to technical problems in the sensors of the monitoring equipment. It has been reported by the unit that the actual quality of the treated effluent was always well below the prescribed limits. 4. The PM alerts mainly appeared in the OCEMS during unit light-up after shut down and its stabilization. The alerts appeared intermittently for a very short period and not for a long duration.
		Complied	<p><u>NTPC Shaktinagar</u></p> <p>Effective operations of ESPs are ensured. OCEMS</p>

		<p>Complied</p> <p>Complied</p> <p>Complied</p>	<p>was installed in all the operational stacks and connected with the CPCB server. During the period from July to Sep., 2021, 242 SMS alerts were generated.</p> <p><u>M/s Hindalco Industries Ltd., Renusagar</u> 1. OCEMS has been installed on Sep., 2015 in all the boilers/Stacks & ETP. The emission level is well within prescribed limit of 100 mg/NM3. 2. During the period from July to Sep., 2021, 27 SMS alerts were generated for which the industry has replied to the CPCB.</p> <p><u>M/s Hindalco Industries Ltd., Renukoot</u> 1. The unit has installed OCEMS and ESP in 04 boilers which are connected with the CPCB server. During the period from July to Sep., 2021, 27 SMS alerts were generated. 2. Industry has achieved an emission limit of 50 mg/Nm³ for particulate matter in respect of all baking furnaces.</p> <p><u>M/s Grasim Industries Ltd. (Chemical Division), Renukoot:</u> The unit has installed OCEMS. During the period from July to Sep., 2021, 26 SMS alerts were generated for which the industry has replied to the CPCB.</p> <p>The details regarding the SMS alerts generated on OCEMS installed in TPPs/industries for monitoring of emission during the period from July to Sep., 2021 is enclosed as Appendix- III.</p>
12.	Utilization of Bauxite Residue (BR) (Red Mud)/ Flyash in Hindalco Industries Ltd., Renukoot	Partially Complied	<p><u>M/s Hindalco Industries Ltd., Renukoot</u> 1. Approx. 487196 MT Red mud which is 93% of the total red mud generated has been supplied to various cement manufacturers by rail/road during April, 2021 to September, 2021 while the remaining 7% is disposed in dumpsites/landfills. 2. DFO, Obra has granted permission vide letter dated 10.05.2021 for conducting site suitability study for filling of red mud in 6-7 hectare of void stone quarry. M/s Genstru, Pune has completed the study and the final report is awaited. 3. No leachate has been established. 4. 04 Piezo wells have been installed.</p>
13.	Installation of RO Plant and their actual operationalization	Complied	<p>Anpara TPS has installed 08 RO plants and all are operational. Each has capacity of 1000 litre/hr and supplying drinking water from Jan., 2015 onwards to Auri More (Anpara Colony), Kashi More, Lal Tower, Belwadah near pipeline, Belwadah near Semritat and Kunda Bharti- 1, 2 & 3 villages.</p>

	Complied	Obra TPS has installed 11 RO Plants to provide pure drinking water in nearby areas and all are functioning properly. It is also supplying drinking water through tankers to nearby residents whenever required. No information has been given about the villages.
	Complied	M/s Lanco Anpara Power Ltd. has installed 07 RO plants and all are operational. Each has capacity of 1000 litre/hr and supplying drinking water since Oct., 2020 to Dibulganj, Auri, Anpara, Pipri-1, Pipri-2, Sonwani-1 and Sonwani-2 villages.
	Complied	NTPC Rihand: 04 RO Plants have been installed near the plant area and it is also supplying water in nearby areas through water tankers. No information has been given about the villages.
	Complied	NTPC Shaktinagar: 06 RO Plants have been installed near the plant area and it is also supplying drinking water in steel tankers in village Paraswar Raja.
	Not Complied	M/s Hindalco Industries Ltd., Renusagar: No RO plant has been installed. Drinking water is supplied through pipeline from Renusagar to Garbandha & Partaliya villages.
	Complied	M/s Hindalco Industries Ltd., Renukoot: It has installed 13 RO Plants in Kushma & Kirvani villages and is providing pure drinking water since Jan., 2015. It is also supplying drinking water through stainless steel tankers to the villages.
	Complied	M/s Grasim Industry, Renukoot: It has installed 04 RO Plants of 5000 litre/hr capacity in Khairahi- 1 & 2, Gambhirpur, Kushmaha- 2 villages and all are operational.

B. Coal Mines of M/s Northern Coalfields Limited (NCL)

S.No.	Issues/ Directions by the Hon'ble NGT	Compliance Status	Updated Progress
1.	Backfilling of active mines situated within 50 km from a power plant by using at least 25% fly ash	Not Complied Due to technical difficulty	Mixing fly ash with coal mine overburden has serious safety implications which were deliberated in the 44th meeting of the Standing Committee on Safety in coal mines held on 12.02.2020. As per its decision, a work order has been issued on 10.07.2021 to the IIT-BHU for carrying out a scientific study of the stability of overburden (OB)

			dumps mixed with fly ash in running/active mines of NCL Bina, Dudhichuwa and Khadia. The outcome of the study is awaited.
2.	Bringing down ash content to equal to or below 34% by the NCL	Partially Complied	As per the information received about all the mines of the NCLs (except NCL Kakri Project) from RO, Sonbhadra, the ash content in the coal dispatched from all the units is below 34%, thus, coal beneficiation is not required.
3.	Control of Air Pollution during coal storage, handling and transportation	Partially Complied	<p><u>NCL Krishnashila Project</u></p> <ol style="list-style-type: none"> 1. Till Sep,2021 40% of coal is transported through rail; 44% through Belt Piped Conveyor (BPC) and the remaining 16% through tarpaulin-covered trucks. 2. The 4 MT/annum Coal Handling Plant (CHP) is operational. It is equipped with a silo for the rapid loading of coal onto railway wagons. Throughout the length of the CHP, a cold fog dust suppression system has been provided. The road from coal yard to weighbridge is sprayed with a permanent sprinkling system, while the remaining area is sprayed with 10 mobile water sprinklers (4 with total volumetric capacity of 28 KL and 06 with capacity of 12 KL) and 01 truck-mounted mist gun. 3. Dust survey is conducted on regular basis. 18 CCTVs have been put throughout the mine to monitor the operations, dust suppression systems and sprinkling frequency. <p><u>NCL Khadia Project:</u></p> <ol style="list-style-type: none"> 1. Till Sep,2021,70.70 % of coal has been transported through rail and 29.30 % through tarpaulin-covered trucks. 2. It has installed 02 CHP having capacity of 4 MT/annum and 6 MT/annum through which coal is being transported through Merry-Go-Round (MGR) (rail transport). For further increment in the dispatch capacity through rail mode, a wharf wall (railway siding) of 4 MT/annum was expected to be made operational by Dec, 2021. 3. Mobile water sprinklers are deployed on haul roads. 4. Dust extraction system is operational in the Coal Handling Plant (CHP-Phase-1). 5. Fixed sprinklers around coal yard-1. 6. Drills are provided with dust extractors. 7. Approach road to mines is covered with blacktopping. 8. Wetting of Run-of-mine (ROM) coal before

			<p>crushing in the CHP is done through automatic water sprinklers installed at the receiving pit.</p> <ol style="list-style-type: none"> 9. Routine maintenance and periodic overhauling of Heavy Earth Moving Machinery (HEMM) is being done. 10. Thick green belts around the mine and colony are maintained. 11. Vegetative covers provided on the non-active OB dump. 12. For continuous monitoring of particulate matter (PM) levels in the air, it has established one Continuous Ambient Air Quality Monitoring Station (CAAQMS) linked with the CPCB server. 13. Truck-mounted mist spray machine and road sweeping machine has been installed (date not revealed). 14. Water sprinklers and dust extraction system at the CHP receiving Pit Phase- I has been renovated. 15. Approx. 2 km WBM haul road for prevention of fugitive dust emission has been constructed. 16. Fixed fogging machine near the coal yard to control dust emission has been installed. 17. Biological reclamation through the plantation on 20 hectares dump slope and grassing on the area beside it has been done. <p><u>NCL Kakri Project</u></p> <ol style="list-style-type: none"> 1. Till Sep., 2021, 57.66% of coal is transported through rail and 42.34% is transported through tarpaulin-covered trucks. 2. Dust Suppression system is installed in coal loading silo area, loading and unloading point at the CHP. Coal Stockyard is sprinkled through a firefighting truck. Water sprinkling on haul roads is being done through water tankers. <p><u>NCL Dudhichuwa Project</u></p> <ol style="list-style-type: none"> 1. Till Sep, 2021, 86.28% of coal is transported through rail and 13.72% through road. Pipe Conveyor transportation is used for internal transportation from CHP to Silo loading of railway wagon. 2. 06 tankers with total volumetric capacity of 70KL, 03 tankers of 28 KL & 04 tankers of 22KL are deployed for dust suppression in haul road and coal yard. 3. 02 road sweeping machines are deployed for sweeping the colony and industrial road. 4. 02 truck-mounted fogging machines are deployed in the mine and colony for
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			<p>suppression of dust.</p> <p>5. Installation of 01 fixed fogging guns at Warf Wall Siding is in progress.</p> <p><u>NCL Bina Project</u></p> <ol style="list-style-type: none"> 1. Approx. 85.22% of coal is transported through rail and the remaining 14.78% of coal is transported through road by tarpaulin-covered trucks. 2. Fixed sprinklers were fitted at the CHP in August, 2021. 3. 02 fixed fog canon machines with a throw of approx. 100 m were commissioned in September, 2021. 4. Fixed sprinklers were installed on transportation road of 1.5 km length. 5. 02 truck-mounted fogging machines are operational. 6. 01 truck-mounted road sweeping machine is operational. 7. Mist spraying arrangements in the CHP, crusher & all transfer points have been made. 8. 17500 saplings planted within the premises in the year 2020-21. 9. 15 mobile water sprinklers are working. 10. All drill machines are provided with cyclone dust separator & dust guards. 11. One surface miner has been procured to control dust due to drilling & blasting.
4.	Installation of CCTV cameras at strategic locations in the coal mines	Complied	It has been reported that in all the mines of the NCL, cameras have been installed at the exit. No information has been furnished about installation of cameras at other strategic locations.
5.	Management of waste water generated from different processes and achieving ZLD.	<p>Complied</p> <p>Complied</p> <p>Partially Complied</p>	<p>NCL Krishnashila Project: An ETP of 0.4 MLD is operational. It is provided with a collection tank, oil & grease trap, primary settling tank, flash mixer, clarifloculator, sludge tank and drying beds etc. The treated water is reused for sprinkling and horticulture purposes. No water is discharged outside the mine premises. ZLD is being maintained.</p> <p>NCL Khadia Project has installed ETP of 38 MLD capacity. The treated effluent is being reused in dust suppression, firefighting etc. and ZLD is being maintained.</p> <p>NCL Kakri Project has installed an ETP of 27.6 MLD capacity to treat the waste water generated from different sources. The treated effluent from the ETP is used for sprinkling on haul roads and the CHP, washing of dumpers, dozers and light</p>

		<p>Partially Complied</p> <p>Complied</p>	<p>vehicles, firefighting and in other service buildings. The remaining water is partly stored at the siltation pond and partly dissipated in the low-lying areas around the mine. No information has been revealed about the quantity and quality of water being discharged outside.</p> <p>It has re-invited bids on GeM Portal for the hiring of a ‘Truck Mounted fog canon sprinkler system’ to further enhance its water utilization capacity.</p> <p>NCL Dudhichuwa Project has installed an ETP of 30 MLD. Flow meters have been installed at the inlet and outlet of the ETP. Effluent from the CHP and workshop is taken into the collection tank and is pumped to the ETP for treatment and then utilized for dust suppression on haul road using mobile tankers.</p> <p>A proposal for relocation of ETP to avoid flooding during the rainy season has been sent to the civil department. No information has been revealed about achieving ZLD.</p> <p>NCL Bina Project: Waste water generated from different processes after treatment at ETP (i.e., 31.2 MLD capacity) is being re-used for different purposes viz., dust suppression, firefighting, CHP, HEMM etc. ZLD is being maintained.</p>
6.	Fire due to coal overburden/ reject	Complied	<p>NCL Krishnashila Project: It has been informed that there has never been an incidence of fire due to coal overburden. The coal yard has sufficient number of fire hydrants to meet any such eventuality. The stock of coal (presently approx. 9000 Ton) is also kept at low height for better air circulation.</p> <p>NCL Bina Project: Fire in the coal reject storage generated from Deshaling plant has been extinguished completely.</p>

C. Stone Crushers

S.No.	Issues/ Directions by the Hon’ble NGT	Compliance Status	Updated Progress
1.	All stone crushers in the Singrauli area have not taken adequate pollution control measures as the level of air pollution in the vicinity of the stone	Partially Complied	<p>In the operational 279 stone crushers, closed metal sheet enclosures have been installed at all the dust emitting points and water sprinkling systems are also installed for dust suppression.</p> <p>As per information given by the RO, Sonbhadra, the environment is very dusty and hazy in the area where stone crushers are situated. This indicates that the several stone crushers are not</p>

	crusher is high and causes a health hazard. Relocation of stone crushers may also be explored.		operating the water sprinkling system and air pollution control systems effectively. No information has been submitted regarding the air quality either by the industries or by the UPPCB.										
2.	Status of 384 stone crusher units established in Sonbhadra	Partially Complied	<table border="1"> <tr> <td>Total no. of Stone Crusher Units identified</td> <td>384</td> </tr> <tr> <td>Total no. of Stone Crusher Units has installed proper APCS & have CTO from UPPCB</td> <td>269</td> </tr> <tr> <td>Total no. of Stone Crusher Units Applied for CTO</td> <td>01</td> </tr> <tr> <td>Total no. of Stone Crusher Units which have not installed proper APCS & are sealed</td> <td>76</td> </tr> <tr> <td>Total no. of Stone Crusher Units is not in working condition/not applied for CTO/Self- closed/ Dismantled</td> <td>38</td> </tr> </table>	Total no. of Stone Crusher Units identified	384	Total no. of Stone Crusher Units has installed proper APCS & have CTO from UPPCB	269	Total no. of Stone Crusher Units Applied for CTO	01	Total no. of Stone Crusher Units which have not installed proper APCS & are sealed	76	Total no. of Stone Crusher Units is not in working condition/not applied for CTO/Self- closed/ Dismantled	38
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D. UPPCB, CPCB & MOEF&CC

S.No.	Issues/ Directions by the Hon'ble NGT	Compliance Status	Updated Progress
1.	The regional carrying capacity of the entire Singrauli region is to be assessed before any expansion scheme concerning the existing industries.	Not Complied	No new expansion of any project/ industries is being allowed in Singrauli (U.P.) region. Assessment of regional carrying capacity of the Singrauli region is yet to be started.
2.	At least three continuous monitoring systems for mercury (Hg) monitoring in the ambient air should be installed at suitable locations in Singrauli area by the industries on Polluters Pay Principle. Besides this, mercury in the surface and groundwater should also be monitored manually once in three months.	Partially Complied	1. Mercury monitoring in the ambient air, soil & groundwater in the area is being done by the NEERI, Nagpur. 2. The assessment of mercury bearing sludge, ground water and soil around the secured landfill (SLF) sites of Chemical Division, Grasim Industries Ltd., Renukoot, Sonbhadra done by the NEERI, Nagpur in the year 2019 revealed that mercury was not leaching from the SLF and not contaminating the groundwater. (Refer Appendix- IV)
3.	Notification of abandoned mines/quarries	-	No information has been furnished about it.

4.	A Joint Committee comprising of MOEF&CC, CPCB, IIT Roorkee and any other member considered necessary may submit a quarterly progress report on recommendation of Expert Committee of NITI Aayog for enhanced utilization of fly ash in various sectors	-	No information has been furnished about it.
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Recommendations

1. Majority of the Thermal Power Plants (TPPs)/industries located in Sonbhadra district of UP are not utilizing/ disposing 100% fly ash as per the CPCB guidelines. From the aforementioned progress report, it appears that these TPPs/industries have taken certain measures but their adequacy for 100 % utilization/ disposal of fly ash cannot be ascertained for want of relevant information not forthcoming from these TPPs/industries in spite of repeated reminders. The TPPs/industries may be directed to submit its action plan along with quarterly progress report to the Oversight Committee for purposeful and objective monitoring and rendering effective assistance to the Hon'ble NGT.
2. As per the direction of the Hon'ble NGT, the CPCB was required to notify the list of abandoned mines/quarries for being used by the TPPs/industries but from the information received from these TPPs/industries, it appears that no such list has been notified by the CPCB as yet. The CPCB may be directed to notify the same at the earliest.
3. The filling of abandoned coal mines and stone quarries is a key avenue for ash disposal, but there is a substantial delay in processing the requests of the TPPs/industries owing to the necessary conditions of repeated inspections, studies and approvals by different authorities which take a very long time. There is an urgent need to simplify this procedure. For this purpose, a Committee may be constituted under the Chairpersonship of the District Magistrates and all the district level officers of concerned departments as well as Heads of the stakeholder units as members, who should deliberate on this issue and submit its report to the respective departmental heads in the State and the Central Government for revision of the procedure. All the guidelines should be oriented towards giving single-window clearance in a time-bound manner from the district level.
4. The quarterly progress report of the Joint Committee comprising of the MOEF&CC, CPCB, IIT Roorkee and any other member considered necessary for enhanced utilization of fly ash in various sectors viz., mines, roads, cement, industries and bricks etc. along with its

implementation status may be shared with the State and District Level Committees and all stakeholders as well as the Oversight Committee for increasing awareness about the possible alternative uses of flyash.

5. The UPPCB had imposed Environmental Compensation (EC) on the TPPs/industries erring in achieving 100% fly ash utilization for the year 2019-2020. But no information has been provided about any such action being taken by the UPPCB against the continued violation of the Environment Protection (EP) Act and related rules/guidelines by the TPPs/industries. It is pertinent to mention that the Hon'ble Supreme Court has stayed the realization of EC but not granted them immunity from continued violation of the law. Therefore, the UPPCB may be directed to discharge their statutory responsibility in its letter and spirit until these TPPs/industries fully comply with the Environmental Laws in respect of 100% utilization/disposal of fly ash.
6. The TPPs/industries may be directed to share their action plan for protecting the environment as approved by the CPCB to the Oversight Committee along with the quarterly progress report for ensuring timely implementation of the same with a view to save the environment from further deterioration and provide a dignified healthy living to the local people.
7. Online Continuous Emission Monitoring System (OCEMS) and Continuous Ambient Air Quality Monitoring Stations (CAAQMS) have been installed and linked with the CPCB server by all the TPPs/industries for continuous online data transmission to determine the source emissions and effluent discharge. The UPPCB may be directed to submit a monthly analysis report of the air and water quality to the Oversight Committee to facilitate monitoring of the action plan as well as their correlation with the impact on the environment.
8. It was noticed earlier that a natural drain (Morcha Nala) is discharging a huge amount of water into the ash pond at Anpara TPP, which was directed by the Hon'ble NGT to be diverted by the Irrigation Department, UP. After a meeting held under the chairmanship of the Additional Chief Secretary, Department of Irrigation and Water Resource, Govt of UP, a decision has been taken not to divert the Nala but to up-grade the ash dyke. Accordingly, steps have been reported to be taken by the Anpara TPP. In this regard, the UPPCB may be directed to monitor the situation on the ground and send a report to this Committee within three months.
9. As per the compliance report received from the TPPs/industries, Anpara, Obra and Hindalco Industries (Renukoot and Renusagar) are not maintaining Zero Liquid Discharge (ZLD). The UPPCB may be directed to levy EC on them till they achieve ZLD.
10. There is a cluster of 350 stone crusher units in Sonbhadra out of which 279 are operational. In operational stone crushers, closed metal sheet enclosures are installed at all dust emitting

points and a water sprinkling system is also installed for dust suppression. However, it is observed that the environment is very dusty and hazy in the area where stone crushers are situated. This indicates that several stone crushers are not operating the water sprinkling system and air pollution control systems effectively. The District Level Committee may be directed to take note of the prevailing situation and take effective remedial steps within the ambit of environment laws.

11. The Hydrographic/capacity survey and stability study of the Rihand reservoir, which is a source of water including drinking water to the entire area, is pending for a very long time. As a result, the restoration work has not begun as yet. The Additional Chief Secretary, Irrigation Department, Govt. of UP may be directed to expedite the study by making it a regular agenda point in his monthly meeting relating to environmental issues.

The Member Secretary, UPPCB is directed to send this report to the Registrar General, National Green Tribunal, Principal Bench, New Delhi for placing the same before the Hon'ble Tribunal with a copy to the Chief Secretary, Government of Uttar Pradesh for necessary action. The report also be uploaded on the website of the Committee.

14-Jan-22

14-Jan-22

X Anant Kumar Singh

Anant Kumar Singh
Member, Oversight Committee
Signed by: ANANT KUMAR SINGH

X SVS Rathore

Justice SVS Rathore
Chairman, Oversight Committee
Signed by: SURENDRA VIKRAM SINGH RATHORE

Jan 14, 2022

Appendix- I: Ambient Air quality around Anpara TPS

Appendix- II: Details of the Ambient Air Quality for the month of Sep., 2021 of some mentioned TPPs/industries

Appendix- III: Details regarding the SMS alerts generated on OCEMS installed in TPPs/industries for monitoring of emission during the period from July to Sep., 2021

Appendix- IV: Assessment Report of mercury bearing sludge, ground water and soil around the secured landfill (SLF) sites of Chemical Division, Grasim Industries Ltd., Renukoot, Sonbhadra

Please visit our website: oscngt.upsdc.gov.in for more information.

Appendix- I

Ambient Air quality around Anpara TPS:

S.N.	Month	Anpara Colony near Auri more	Anpara Admin Building near Bajrang Ngar	Anpara DTSP Admin Building Coal Handling Plant
		PM 10 ($\mu\text{g}/\text{Nm}^3$) (100 $\mu\text{g}/\text{Nm}^3$)		
1	January, 2021	142.0	227	117.98
2	February, 2021	138.6	182	93.45
3	March, 2021	160.0	144.5	114.7
4	April, 2021	172	214.20	136
5	May, 2021	159.4	188	112
6	June, 2021	183	68.6	46.7
7	July, 2021	58.0	27.1	45.2
8	August, 2021	86	24.4	69.3
9	September, 2021	43	38.2	103
10	October, 2021	76.28	88.2	91.3
11	November, 2021	131.0	158.9	112.3

Appendix- II

Monthly Average Ambient Air Quality Data of Month September-2021

INDUSTRY NAME	NTPC SHAKTINAGAR																				
	Near Vidyal Vihar colony				Near C.W. Pump House				NIGR				NTPC RIHAND NAGAR								
CAQMS STATION	SO ₂	NO ₂	PM ₁₀	PM _{2.5}	SO ₂	NO ₂	PM ₁₀	PM _{2.5}	SO ₂	NOx	PM ₁₀	PM _{2.5}	SO ₂	NOx	PM ₁₀	PM _{2.5}	SO ₂	NOx	PM ₁₀	PM _{2.5}	
	Parameter Name	µg/m ³	µg/m ³	µg/m ³	µg/m ³	µg/m ³	µg/m ³	µg/m ³	µg/m ³	µg/m ³	µg/m ³	µg/m ³	µg/m ³	µg/m ³	µg/m ³	µg/m ³	µg/m ³	µg/m ³	µg/m ³	µg/m ³	µg/m ³
Permissible Limit	80	80	100	60	80	80	100	60	80	80	100	60	80	80	100	60	80	80	100	60	60
Monthly Average																					
Sep-21	16.9	18.0	26.9	14.0	17.7	16.7	31.3	19.2	25.7	70.9	45.9	13.4	17.7	32.3	27.1	19.0	13.5	37.2	30.5	18.7	

Monthly Average Ambient Air Quality Data of Month September-2021

INDUSTRY NAME	NORTHERN COALFIELDS LIMITED Bina Project, Bina, Sonbhadra					NORTHERN COALFIELDS LIMITED Kakri Project, Kakri, Sonbhadra					NORTHERN COALFIELDS LIMITED Khandia Project, Khandia, Sonbhadra				
CAAQMS STATION	CAAQMS_1_Bina_Radiakrishn, Bina Project					CAAQMS_1_VTC_Kakri_Project Kakri Project					CAAQMS_1_Chantany_Khandia Khandia Project				
Parameter Name	SO ₂	NOx	PM ₁₀	PM _{2.5}	Permissible Limit	SO ₂	NOx	PM ₁₀	PM _{2.5}	Permissible Limit	SO ₂	NOx	PM ₁₀	PM _{2.5}	Permissible Limit
Monthly Average	22.88	12.87	24.11	8.36	80	11.20	36.19	59.91	39.94	60	9.16	15.4	55.78	27.61	60
Sep-21	12.63	10.93	56.60	28.46	80	12.90	10.23	58.95	27.96	60	15.46	18.41	46.63	24.34	60

INDUSTRY NAME	Jaypee Chark Industrial Complex (A Unit of Jaiprakash Associates Limited)															Chunari Cement Factory (A Unit of Jaiprakash Associates Limited)									
CAAQMS STATION	Near Main Gate					Near Store					COP DM Plant					Near Water Storage Tank					Township(Near Guest House)				
Parameter Name	SO ₂	NOx	PM ₁₀	PM _{2.5}	Permissible Limit	SO ₂	NOx	PM ₁₀	PM _{2.5}	Permissible Limit	SO ₂	NOx	PM ₁₀	PM _{2.5}	Permissible Limit	SO ₂	NOx	PM ₁₀	PM _{2.5}	Permissible Limit	SO ₂	NOx	PM ₁₀	PM _{2.5}	Permissible Limit
Monthly Average	12.63	10.93	56.60	28.46	80	12.90	10.23	58.95	27.96	60	15.46	18.41	46.63	24.34	60	15.6	18.65	44.04	17.51	60	10.95	14.43	42.11	16.09	60
Sep-21	12.63	10.93	56.60	28.46	80	12.90	10.23	58.95	27.96	60	15.46	18.41	46.63	24.34	60	15.6	18.65	44.04	17.51	60	10.95	14.43	42.11	16.09	60

Monthly Average Ambient Air Quality Data of Month September-2021

INDUSTRY NAME	Hindalco Ind. Ltd. (Aluminium Division)																		
	Renuskoot					AAQMS 1					AAQMS 2					AAQMS 3			
CAAQMS STATION	SO ₂	NOx	PM ₁₀	PM _{2.5}	SO ₂	NOx	PM ₁₀	PM _{2.5}	SO ₂	NOx	PM ₁₀	PM _{2.5}	SO ₂	NOx	PM ₁₀	PM _{2.5}			
Parameter Name	µg/m ³	µg/m ³	µg/m ³	µg/m ³	µg/m ³	µg/m ³	µg/m ³	µg/m ³	µg/m ³	µg/m ³	µg/m ³	µg/m ³	µg/m ³	µg/m ³	µg/m ³	µg/m ³			
Permissible Limit	80	80	100	60	80	80	100	60	80	80	100	60	80	80	100	60			
Monthly Average																			
Sep-21					40.50	4.26	125.80	28.93	20.87	31.89	185.50	133.17	19.39	17.96	116.46	188.99			

INDUSTRY NAME	Hindalco Ind. Ltd. (Power division)															
	Renusagar					lanco Anpara Power Ltd. Anpara central store					UPRVUNL, Anpara, Sonbhadra					
CAAQMS STATION	SO ₂	NO ₂	PM ₁₀	PM _{2.5}	SOx	NOx	PM ₁₀	PM _{2.5}	SO ₂	NOx	PM ₁₀	PM _{2.5}	SO ₂	NOx	PM ₁₀	PM _{2.5}
Parameter Name	µg/m ³	µg/m ³	µg/m ³	µg/m ³	µg/m ³	µg/m ³	µg/m ³	µg/m ³	µg/m ³	µg/m ³	µg/m ³	µg/m ³	µg/m ³	µg/m ³	µg/m ³	µg/m ³
Permissible Limit	80	80	100	60	80	80	100	60	80	80	100	60	80	80	100	60
Monthly Average																
Sep-21	20.79	3.18	25.97	16.45	17.74	10.94	36.85	10.18	12.56	12	17.3	7.56				

Note: Hindalco Renuskoot Ltd.(Aluminium Division)-CAAQMS Details will be send tomorrow



सन्दर्भ संख्या

Ref No.

दिनांक

Date

To,

Oversight Committee.
NGT, Uttar Pradesh,
Lucknow.

Subject: Regarding SMS alerts generated on OCEMS (Online Continuous Emission Monitoring System) installed in Industries for Monitoring of Emissions during period July -2021to September-2021.

Sir,

Please refer the subject cited above. In this context, the SMS alerts received towards OCEMS installed in respective industries is listed below:-

S.No.	Name of Industries	No. of SMS Alert Received Between July-2021 to September-2021	Cause of SMS Alerts
01	M/s NTPC Shaktinagar, Sonbhadar	242	-
02	M/s Grasim Industries Ltd, Power Plant Division, Renukoot, Sonbhadra	26	Comment have been done on dated:17 July 2021 i.e Malfunctioning of Hopper level Switch caused tripping of ESP field # 1 & 20 Sep 2021, hence emission has crossed above Permissible limit & Dated: 20.09.2021 i.e Emission crossed because of Standby of ID Fan Charge-Over
03	M/s NTPC Rihand, Rihandnagar, Sonbhadra	119	Comment have been done on Dated: 18.08.2021, i.e Alert have been appeared during light up after shut down and synchronization, dated:17.08.2021 i.e. Alert have been appered due to unit tripping on BCP problem, Dated:06.08.2021 i.e. Alert have been appeared during light up after shut down and synchronization, 04.08.2021 i.e. Alert received bec. Unit was under Shut Down and sensor was in maintenance, dated:30.7.2021 i.e Alert appeared due to maintenance of CEMS, dated:13.07.2021 05.07.2021 i.e. Alert have been appeared during light up after shut down and synchronization.
04	M/s Hindalco Industries Ltd., Renukoot, Sonbhadra	27	In July 2021- 10 Nos of alerts generated during preventive maintenance In Boiler #2. In August 2021 In -06 Nos. of alert generated due to ID Tripped in Baking Furnace #6. In September 2021-02 Nos. of alerts generated due Plant was tripped and due to ESP

			transformers of FCB Calciner tripped in Calciner #2 and 03 Nos. of Alets generated because of power fluctuation and low air pressure in Baking Furnace #4.
05	M/s Lanco Anpara Thermal Power Plant, Anpara, Sonbhadra.	00	No SMS alert had been received between July-2021 to September-2021
06	M/s Jaypee Churk Industrial Complex, Churk, Sonbhadra	00	No SMS alert had been received between July-2021 to September-2021
09	M/s Hindalco Industries Limited, Renuagar, Sonbhadra	27	In July 2021 No SMS alert had been received. In Aug-2021 -10 Nos. of SMS alerts received. Due to disturbance in ash conveying line. In September 2021-17 Nos. of SMS alert received, due to Boiler #9 was taken shut down as a result emission accumulated.
10	M/s Birla Carbon, Renukoot, Sonbhadra	00	No SMS alert had been received during July-2021 to September-2021.
11	M/s Chunar Cement Factory (A Unit of Jai Prakash Associates Ltd.)	00	No SMS alert had been received between July-2021 to September-2021.
12	M/s UPRVUNL, Anpara, Sonbhadra	11	Probable cause of exceedence of PM value had been mailed to CPCB & Service Provider.
13	M/s UPRVUNL, Anpara, Sonbhadra	39	In July 2021-02 No. of SMS alerts received in Unit 11 & 09. In August 2021-35 No. of SMS alert received in Aug-2021. In September 2021-02 No. of SMS alerts received in Unit 10 & 11. Probable cause of exceedence of PM value had been mailed to CPCB & Service Provider.
14	M/s Ultratech Cement Limited Unit Dalla Cement, Dalla, Sonbhadra	00	No SMS alert had been received regarding exceeding of PM between July-2021 to September-2021.

Regards,

(Dr. T.N. Singh)
Regional officer

Copy To:

1. CEO 2, Uttar Pradesh Pollution Control Board, Lucknow for Kind information.

Regional officer

ASSESSMENT OF THE MERCURY BEARING SLUDGE, GROUNDWATER AND SOIL AROUND THE SECURED LANDFILL SITES OF CHEMICAL DIVISION, GRASIM INDUSTRIES LTD, RENUKOOT, SONEBHADRA DIST., UP

Sponsor
Chemical Division, Grasim Industries Ltd.
Renukoot



PROJECT PERSONNEL

CSIR- NEERI, HYDERABAD ZONAL CENTER

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DR. MEGANATHAN. P. R

MR. S. HARIRAMA KUMAR

MR. SHAIK FAREED

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MS ANJANI MAMIDALA

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PROJECT COORDINATOR

DR. S.CHANDRASEKHAR

DIRECTOR, CSIR-NEERI, NAGPUR

FOREWORD

Grasim Renukoot Chemical Division (GRCD), a unit of M/s Grasim Industries Ltd. is situated in Renukoot, District, Sonbhadra (U.P.) about 160 km from Varanasi. The mercury brine sludge was produced during the manufacturing of caustic soda and the same was disposed in a secured landfill within their premises. From May 2011 onwards Caustic soda production by mercury cell was stopped, as per the directives of Govt. of India. The Industry has three capped secured landfill sites (SLFs) which have been closed as per the CPCB guidelines.

UPPCB has issued the letter no. H52509 dated 02.09.2020 stating the NGT case that directed GRCD, Renukoot to undertake the study for assessing the chemicals of concern with general parameters and heavy metals in mercury containing sludge, groundwater and soil surrounding the SLFs. In this regard, M/s GRCD, Renukoot retained CSIR-National Environmental Engineering Research Institute (NEERI) to undertake the study for assessment of the parameters of concern, heavy metals in mercury containing sludge, groundwater and soil surrounding the SLFs.

CSIR-NEERI had carried out the survey of the landfill site, groundwater and soil in the study area covering 3 km buffer around Grasim Industries during October 2020. The analysis results stated that the values for mercury were within the limits of BIS for all the samples around the landfill site. It was also inferred from the leaching tests that mercury does not leach from the landfill site of Grasim Industries, Renukoot.

The help and cooperation extended by officials of Grasim, Renukoot and the people in and around the villages is gratefully acknowledged.



(S. Chandrasekhar)

Director

April 2021

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CHAPTER - 1

INTRODUCTION

1.0 PREAMBLE

Grasim Renukoot Chemical Division (GRCD), a unit of M/s Grasim Industries Ltd. is situated in Renukoot, District – Sonbhadra (U.P.), about 160 km from Varanasi. This plant was previously operated by M/s Kanoria Chemicals & Industries Ltd. (KCIL). Later the plant was acquired by Aditya Birla Group. Grasim is the largest Caustic Soda producer in India. The mercury brine sludge was produced during the manufacturing of caustic soda and the same was disposed in a secured landfill within their premises. From May 2011 onwards Caustic soda production by mercury cell was stopped, as per the directives of Govt. of India.

The Industry has three capped secured landfill sites (SLFs). Three SLFs were capped and closed as per the CPCB guidelines. The three closed SLFs were filled with the sludges containing Mercury (Hg), which was generated then in the mercury cell, also known as Castener-Kellner process.

UPPCB has issued the letter no. H52509 dated 02.09.2020 referring to the NGT case and directed GRCD, Renukoot to undertake the study for assessing the chemicals of concern, general parameters and heavy metals in mercury containing sludge, groundwater and soil surrounding the SLFs. In this regard, M/s GRCD, Renukoot has requested CSIR-NEERI HZC to undertake the study for assessment of the parameters of concern, heavy metals in mercury containing sludge, groundwater and soil surrounding the SLFs. Accordingly, the objectives and scope of work of the study were proposed as follows:

1.1 Objectives

- To assess the general parameters, heavy metals of the mercury containing sludge in the SLFs
- To understand the leaching characteristics of the mercury containing sludge by conducting TCLP tests
- To assess the groundwater quality around the landfill sites of GRCD To assess the soil quality around the SLFs
- Identification of potential impacts due to the existing SLF on the major environmental components viz., groundwater, soil etc
- To delineate environmental management measures

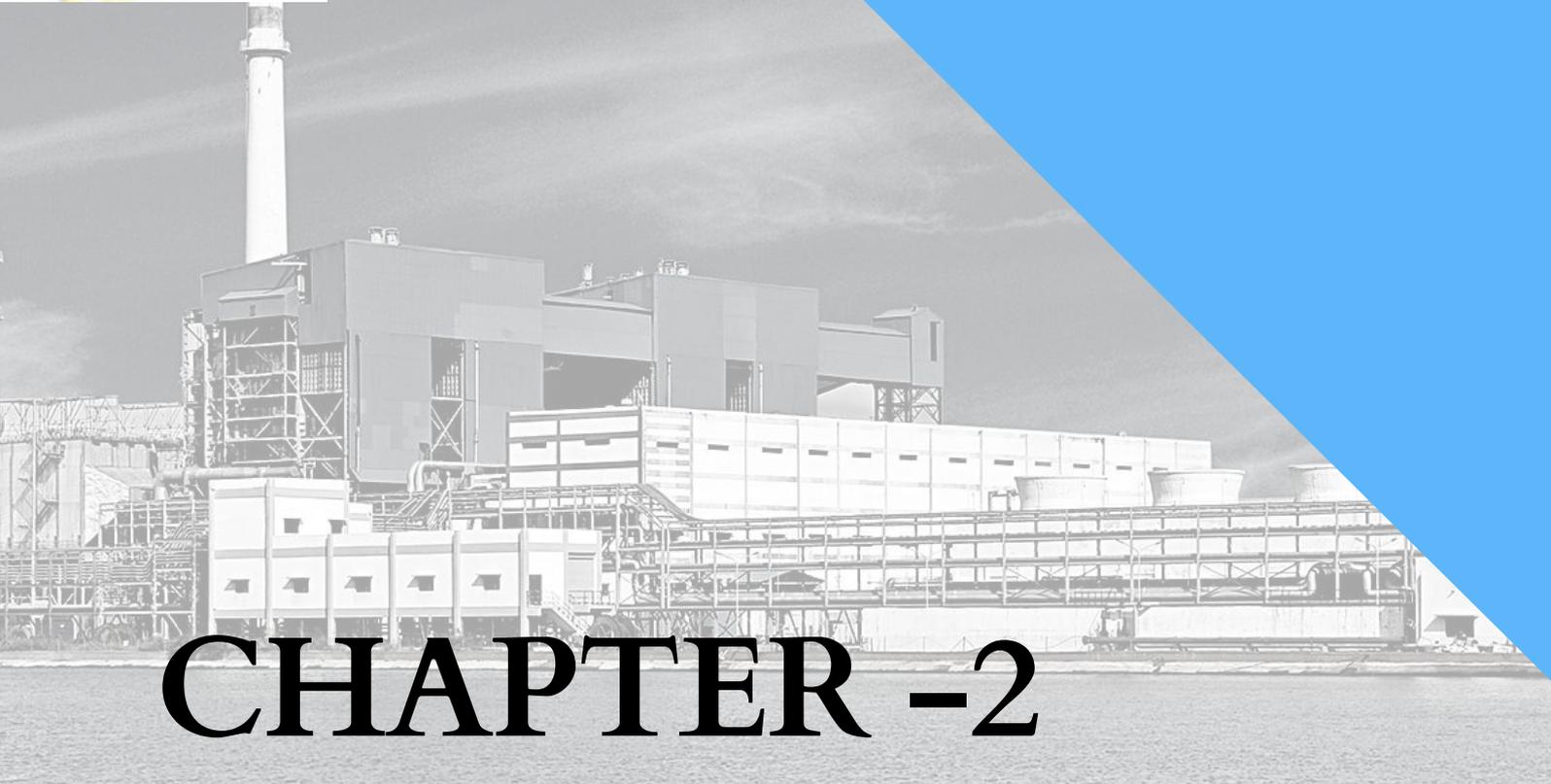
1.2 Scope of Work and Methodology

- Delineation of the study area on the Survey of India Toposheet (1:50,000 scale) demarcating the secured landfill (SLF) site
- Establishment of the well network for groundwater level measurement and groundwater quality assessment around the SLF site
- Collection of the sludge from the landfill site of GIL
- Assessment of the leaching characteristics of sludge of landfill site by TCLP (Toxicity Characteristic Leaching Procedure) procedure to assess the hazardous nature of the sludge
- Leaching experiments were set up at the laboratory level to understand the leaching characteristics of sludge in terms of heavy metals
- Collection and analysis of groundwater samples in and around the landfill site for groundwater quality parameters (Physico-chemical and Heavy metals) as per standard protocols (APHA protocol) for major cations, anions (pH, EC, TDS, Total alkalinity, Ca, Mg, Na, K, Cl, SO₄, PO₄, NO₃), oil and grease and heavy metals (Al, B, Cd, Co, Cr, Fe, Mn, Ni, Pb, Zn, Hg and As).
- The soil samples in the study area were collected from the identified locations. Soil samples were analyzed for umber grid pH, Conductivity, Soil permeability, Texture, Particle Density, Bulk density, Porosity, Water holding capacity, Soluble Cations and anions, organic carbon, Exchangeable Sodium percentage, Exchangeable cations, CEC, available N, P, K and heavy metals specifically mercury to understand the soil quality.
- A detailed assessment of Soil quality and Groundwater level and quality status was carried out and reported for the study area to assess the leaching characteristics of landfill site
- The remedial measures for groundwater and soil contamination shall be recommended, if necessary

1.3 Layout of the report

The report is presented in the following structure:

- Chapter 1: Introduction (this chapter)
- Chapter 2: Project Description
- Chapter 3: Description of Study Area
- Chapter 4: Environmental Quality Status around the Secured Landfill Site
- Chapter 5: Conclusion and Recommendations



CHAPTER -2

PROJECT DESCRIPTION

2.0 Introduction

2.1 Caustic Soda

The installed production capacity for caustic soda is 353 TPD. The main raw materials for the caustic soda manufacture are power and common salt. The power is received by GRCD through 132 KV transmission line directly from Rihand Power Station and also from our 2 x 25 MW CPP and salt is procured from Salt works in Gujarat. The solution of salt in water is prepared and is purified by addition of sodium carbonate, barium carbonate, caustic soda etc. The calcium and magnesium impurities are precipitated and removed by settling and filtration from the process fluid. The clarified brine is made ultrapure by passing through polish brine filter and Ion exchange column before being fed to the electrolyzers which consists of anode segment and cathode segment separated by a high-performance membrane. DC current coming from Rectifier then flows from anode to Cathode and after electrolysis of Ultrapure brine, it decomposes into sodium and chlorine ions. Sodium ions pass through the membrane and goes to cathode side and combine with water to form Caustic soda (NaOH) and Hydrogen is liberated. The chloride ions which remain in the anode side combine to form chlorine gas which is then sent out for drying and liquefaction. The installed production capacity of the plant for different products is shown in Table 2.1. The reaction is shown below:



Table 2.1: Production capacities - GIL, Renukoot

Sr. No.	Product	UOM	Consent Capacity
1	Caustic Soda Lye	TPM	10950
2	Liquid Chlorine	TPM	8630
3	Hydrochloric acid	TPM	2107
4	Stable Bleaching Powder	TPM	5400
5	Aluminium Chloride	TPM	1500
6	Poly Aluminium Chloride	TPM	6000
7	Chlorinated paraffin	TPM	1800
8	Hydrogen	TPM	275

The hydrogen so produced is used as fuel in Hydrogen fired boiler, caustic concentration plant, in the synthesis of Hydrochloric acid, and bottling in cylinders. Hydrogen is highly inflammable; therefore, proper care is taken to keep it away from the fire. No other chemical reactions of dangerous nature occur during caustic soda manufacture. The depleted brine from the electrolyzers is saturated again by dissolution of common salt. The product caustic soda is collected in production tank and then transferred to main storage tank.

2.2 Liquid Chlorine

The chlorine is a by-product of caustic soda plant. After its dissociation from common salt in the electrolyser it is taken to the liquefaction section where it is first scrubbed with water to remove impurities of Sodium Chloride in scrubbing towers. So washed chlorine gas, which is saturated with water vapours, is dried by contact with sulphuric acid in drying towers. In the liquefaction operation of chlorine no chemical reaction takes place as such, but care is taken to ensure that chlorine is absolutely dry after the drying operation. This is being done by constant monitoring of the concentration of sulphuric acid in the drying towers and the chlorine compressors, which are checked at every two hour interval and proper operating record is maintained.

After compressing the gas to 3 kg/cm² pressure, it is liquefied in refrigeration system by cooling it to about minus 10°C. The liquefied product is taken to the main storage tank. Grasim is having capacity of storing 500 MT of liquid chlorine in five number storage tanks, with 100 MT capacity of each which are properly insulated and dyked. The flow diagram of Chlorine plant is depicted in Figure 2.1. All rules regulations of department of Explosive are followed for safe storage of Liquid Chlorine.

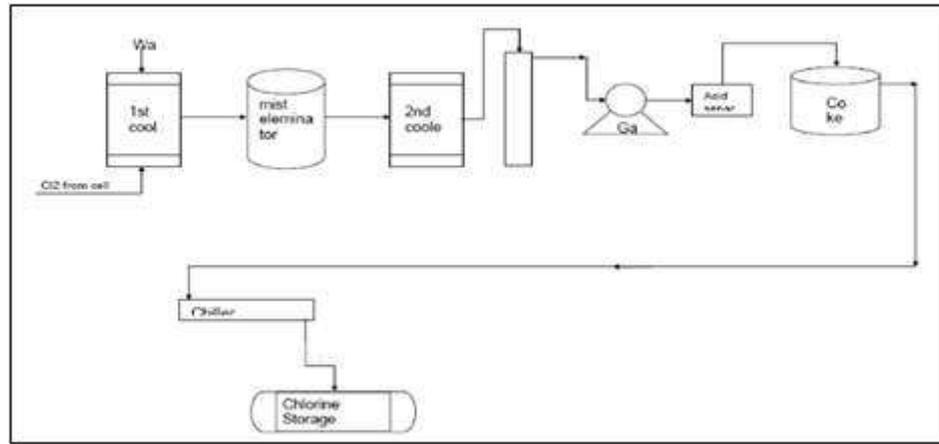


Figure 2.1: Flow Diagram - Chlorine Plant

Hydrochloric Acid

Hydrochloric acid is also a by-product of caustic soda manufacturing plant. The scrubbed chlorine from scrubbing tower is contacted at high temperature with hydrogen which is also a by-product of caustic soda unit, to form hydrochloric acid vapours which after absorbing in water make 33% (w/w) of Hydrochloric Acid. Hydrochloric Acid so produced is stored in storage tanks. Hydrochloric acid is also produced as a by-product in the CPW plant where unreacted chlorine is absorbed in a graphite absorber where water is circulated to form HCl. The process flow diagram of Hydrochloric Acid plant is depicted in Figure 2.2.

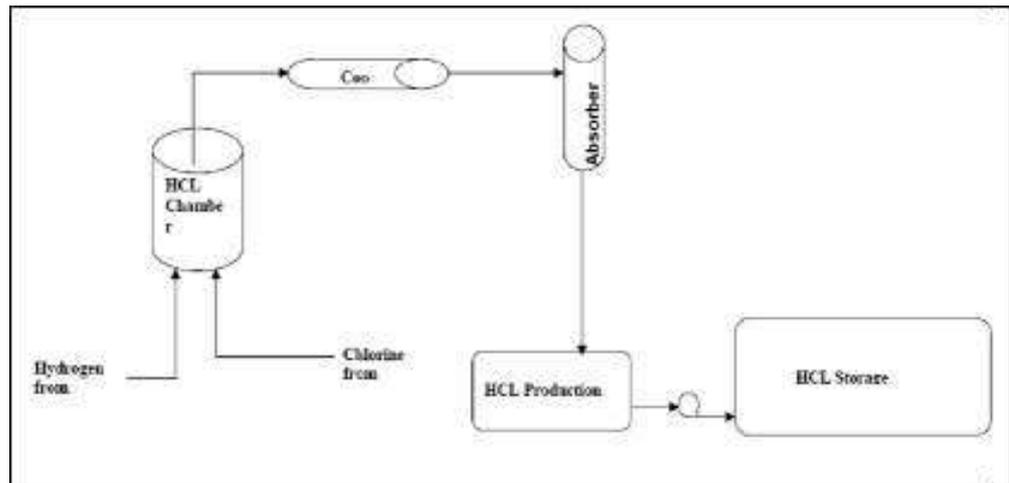


Figure 2.2: Flow Diagram - Hydrochloric Acid

2.3 Caustic Soda Flakes

Caustic Soda produced in caustic soda unit has concentration of 50% (w/w) only and is in solution form. The 50% water is evaporated by application of heat by burning of hydrogen gas along with furnace oil. After concentrating the lye to about 99% it is cooled by indirect method with water to make its flakes, which are packed in HDPE bags.

2.4 Stable Bleaching Plant (SBP)

The main basic materials used for bleaching powder production are quick lime, liquid chlorine. About 95% pure chemical lime is purchased which is slacked with water to make calcium hydroxide with 1% moisture. Slacked lime is allowed to mature for some time and classified for bigger particles in an air classifier. The Ca(OH)_2 so produced is reacted with liquid chlorine in chlorine drums under vacuum so that the reaction water is removed simultaneously. The reaction is as follows:



After complete chlorination of hydrated lime, the product is packed in HDPE bags/Airtight containers. The process flow diagram of Stable Bleaching plant is presented in Figure 2.3.

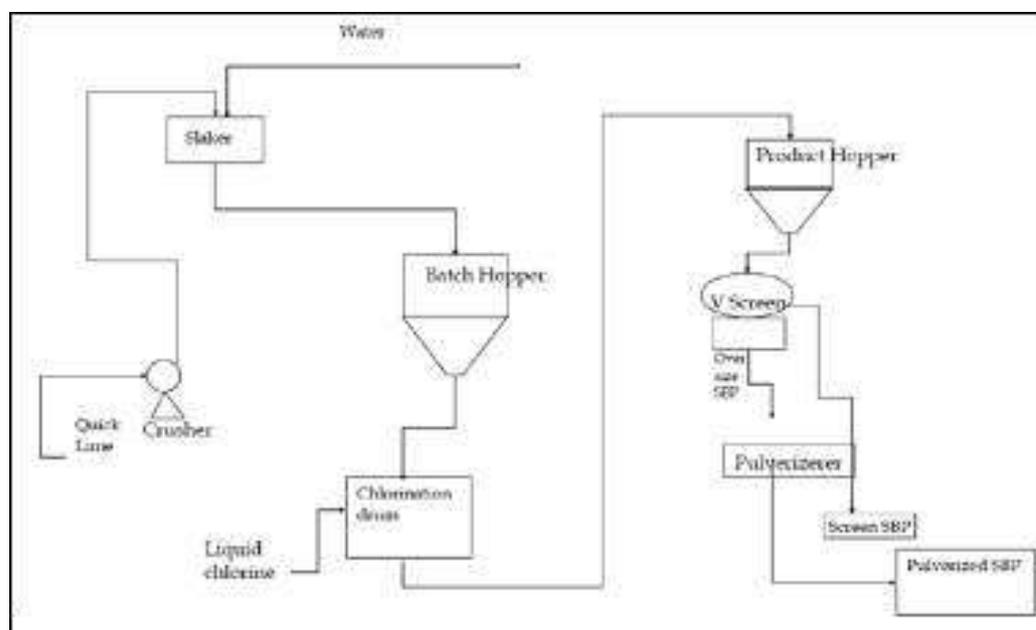


Figure 2.3: Flow Diagram – Stable Bleaching Powder

2.5 Aluminum Chloride

Aluminium Chloride is manufactured by passing Chlorine Gas over molten Aluminium metal. Aluminium ingots are charged in brick lined MS vessel, called reactor and melted by means of gas or any other heat source. Chlorine gas is then passed over it. Aluminium Chloride vapours come out and condense in M.S. hollow chamber called condenser. It is discharged from the condenser at a regular interval in a specially made container and transferred to the main silo. The reaction being exothermic, initially metal is heated but later on reaction is auto thermal and melting of aluminium ingot is self-sustaining. Excess heat is removed by means of cooling water spread over the reactor. Suction blowers continuously suck un-reacted Chlorine through series of scrubbing towers having water, lime and caustic solutions.

The product is then crushed and screened and packed in PVC lined HDPE bags and/or 200 Litres open mouth M.S. Drums. The process flow diagram of Aluminium Chloride plant is depicted in Figure 2.4.

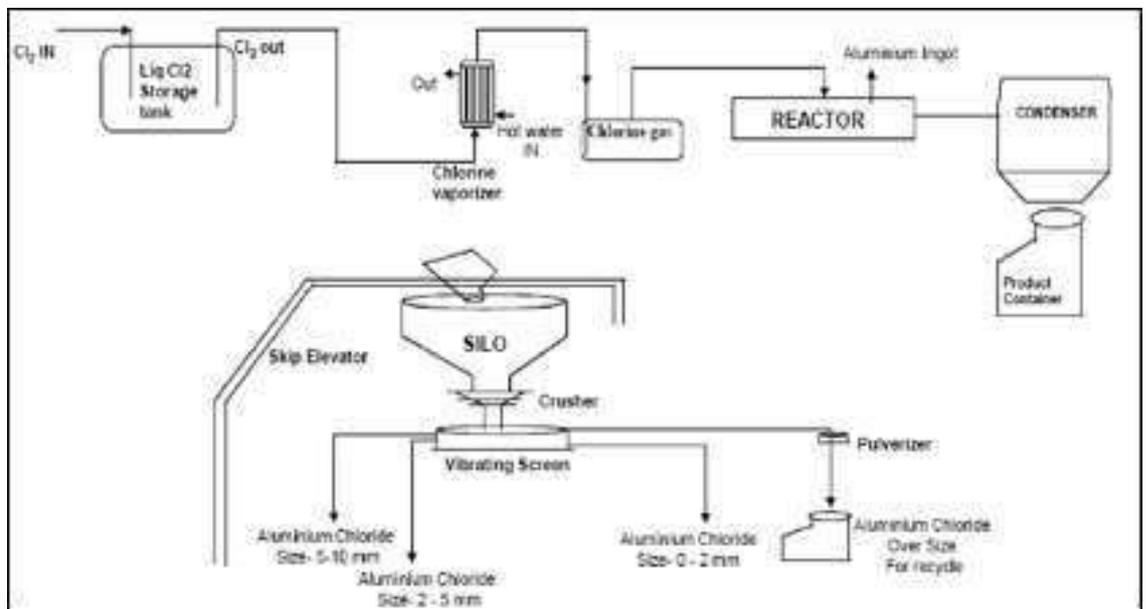


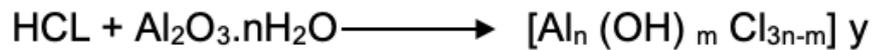
Figure 2.4: Flow Diagram - Aluminium Chloride

2.6 Hydrogen Bottling

The hydrogen purified by cooling and filtration is fed to hydrogen bottling plant. The before bottling it, is further purified to make it Caustic soda free by using water spray. The hydrogen, so purified is compressed in hydrogen compressors to about 150 Kg/cm pressure and bottled in hydrogen bottles approved by CCE.

2.7 Poly – Aluminum Chloride

Poly-aluminium Chloride is produced by high temperature (160°C) and high pressure (5 to 6 bar) reaction between Hydrochloric Acid (32% (w/w) approx) and Hydrated Alumina (62% (w/w) Al₂O₃ approx) as shown below:



HCl is charged in a glass-lined reactor at room temperature and then hydrated Alumina is charged in the reactor. Reactor is then closed and contents of the reactor are heated by steam to initiate the reaction. Reaction is exothermic and reactor temperature is maintained at 160°C for 4 to 6 hours, depending on acid strength and active alumina content in reactor feed material, to form Poly-Aluminium Chloride (PAC) slurry. PAC slurry is cooled to 110°C and is discharged from the reactor and cooled to nearly 70°C in a heat exchanger. PAC slurry is filtered through a filter press at a temperature not less than 50°C for easier filtration to obtain PAC product. The process flow diagram of Poly Aluminium Chloride plant is depicted in Figure 2.5.

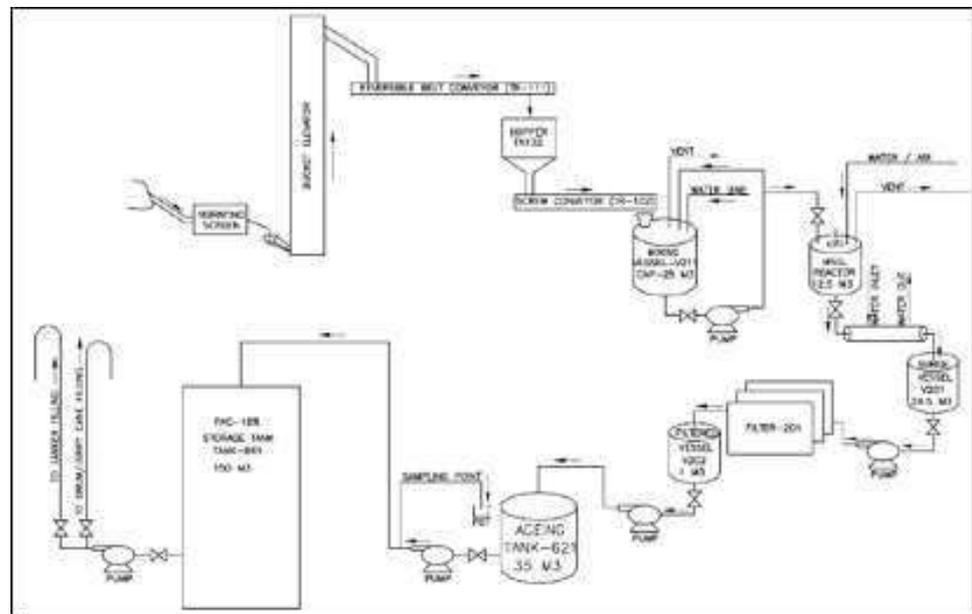


Figure 2.5: Flow Diagram - Poly Aluminium Chloride

2.8 Chlorinated Paraffin Wax

Chlorinated Paraffin wax is produced by chlorination of liquid paraffin wax. The chlorination is carried out in a lead lined reactor where chlorine is passed through a sparger at the bottom of the reactor. HCl is produced as a by-product. During reaction un-reacted chlorine is led to graphite absorber where water is circulated to form HCl.

2.9 Electricity Generation

Thermal Power is generated by burning coal in IRCFC boiler generating high pressure steam and passing through the turbo generator of 2 x 25 MW capacities. The generated electricity is at 11 KV where from it is distributed to our Chemical plant for various uses. The process flow diagram of power generation plant and steam generation plant is depicted in Figures 2.6 & 2.7.

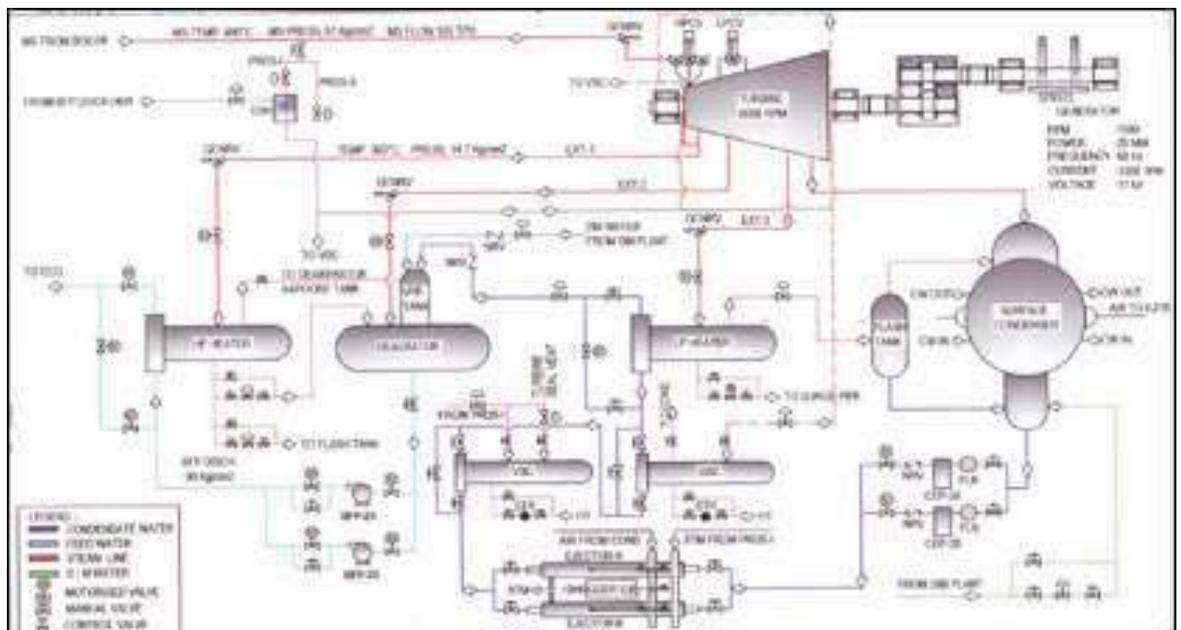


Figure 2.6: Flow Diagram - Thermal Power Plant

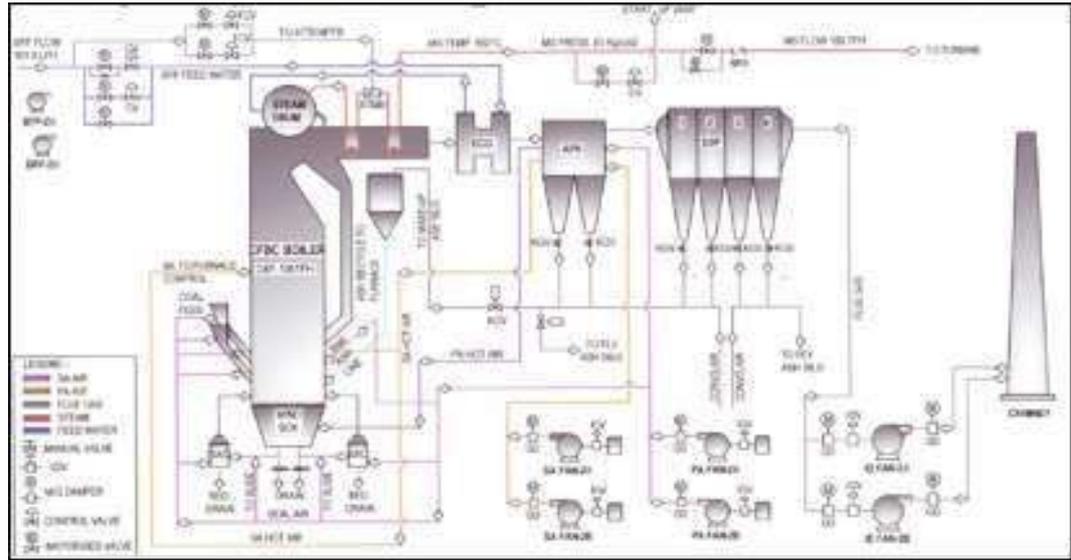


Figure 2.7: Flow Diagram - Steam Generation (Boiler) Plant

2.10 Existing Waste Management Practices

Each section of the plant has a dedicated effluent collection pit in the section. Maximum reduction, reuse and recycle of effluent is done in the section itself. The unused effluent from the sections is sent to effluent treatment plant for treatment (Figure 2.8). The effluent from various sections is collected in effluent collection pit where it is collected for equalization. The pH of the effluent after equalization is maintained in the desired range with alkali or acid, whatever may be the requirement. The neutralized effluent is then passed through pipe flocculator into flocculation tank where dosing of polyelectrolyte is done using flash mixer. Effluent dosed with polyelectrolyte then goes to lamella clarifier where sufficient retention time is given for settling and clarification. By gravity, suspended solids settle down and are removed as sludge from the bottom. The sludge is then dewatered in filter press. The water from filter press is again recycled back in collection tank. The filter cake is filled in bags and stored for disposal in TSDF.

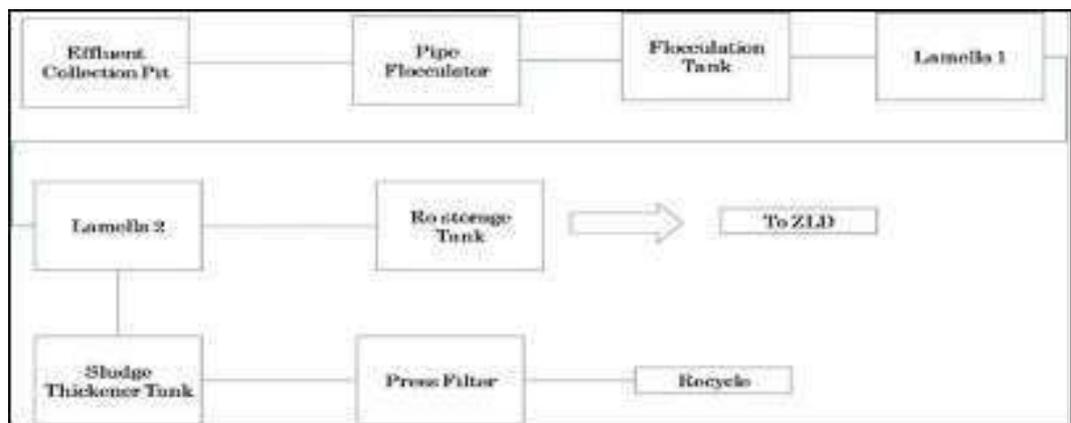


Figure 2.8: Schematic Flow Diagram of ETP

Clarifier overflow is stored in treated water tank and then passed through multi-grade filter (MGF) followed by ACF. The filtered water is stored in ultra-filter tank. Then it is pumped through bag filter into UF unit. UF permeate is fed to RO unit. RO unit is installed in 2 stages. RO-1 which is Brackish water RO to treat effluent with TDS 2500 ppm. Reject from BW RO is fed to Sea Water RO which treats effluent upto TDS 10000 ppm. Reject of SW RO goes to MEE feed tank. The permeate of RO stages is used for cooling tower make up. The Schematic diagram is presented in Figure 2.9.

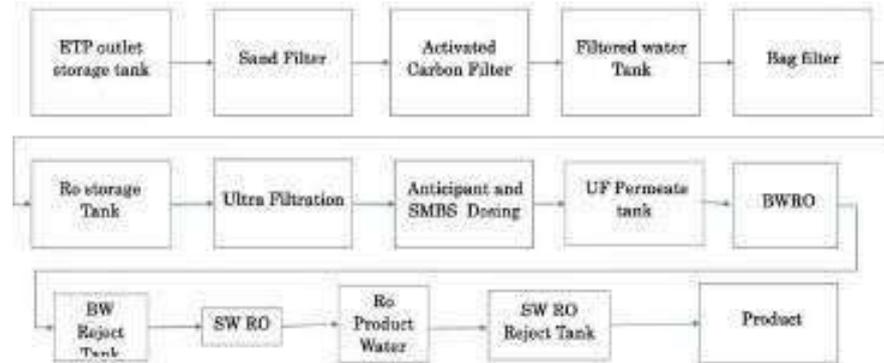


Figure 2.9: Flow Diagram - Filters

Multiple Effective Evaporator (MEE) permeate is used for cooling tower make and the reject is sent to ATFD (Agitated Thin Film Drier). Semi solid salt is generated at this stage. Condensate is sent to ETP collection tank. The salt is collected in bags, stored and finally disposed in TSDF. No water is left for discharge. Hence, completing the ZLD process requirement. The schematic diagram is presented hereunder in Figure 2.10.

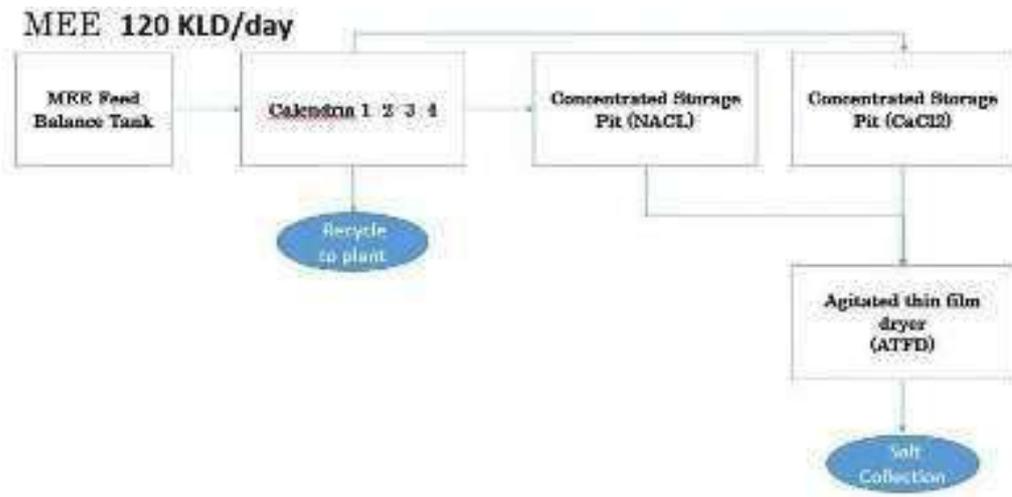


Figure 2.10: Flow Diagram - MEE

Waste details which are generated from process and disposal practice of units:

- **Brine Sludge** – Generated from the brine purification process is non-hazardous. Brine sludge in semi solid brine mud cake form is stored in HDPE lines secured landfill within plant premises and disposed to TSDF of M/s. Ramky and Bharat Oil & Waste Management, Kanpur.
- **MEE & ATFD Salts/ETP Sludge** – The salt sludge is generated from the ATFD section of ETP and ETP sludge is generated filter press. Both the sludge is stored in separate bags at an isolated location in plant and disposed to authorized TSDF.

E-Waste: Generated from various sections of the plant consists of electronic and instrument obsolete equipments. The waste generated is collected and is sent to Authorized Recycler

Acid-Battery Waste: Used battery is sent to Authorized Recycler or buyback agreement is done with the supplier. Used battery is disposed within 6months.

Bio-Medical waste is sent to common disposal facility (Incineration), The waste is stored in colored coding bags/container.

Used Oil is collected in adequate storage facilities such as barrels, drums and kept at an isolated location in the plant maintained under lock and key with all safety and environment protection measures. Used oil stored is then sold off to authorized recycler.

Fly Ash & Bed Ash It is non-hazardous waste and is utilized 100% for ash-based product (bricks and other building materials-Cement), road construction

Plastic Waste is sold off to Authorized Recycler for new product or raw material

Other wastes – Such as spent resin, exhausted activated carbon, used activated carbon, glass wool, asbestos etc is sent to authorized vendor. Interim storages are developed for all other wastes and are being transferred to TSDF.

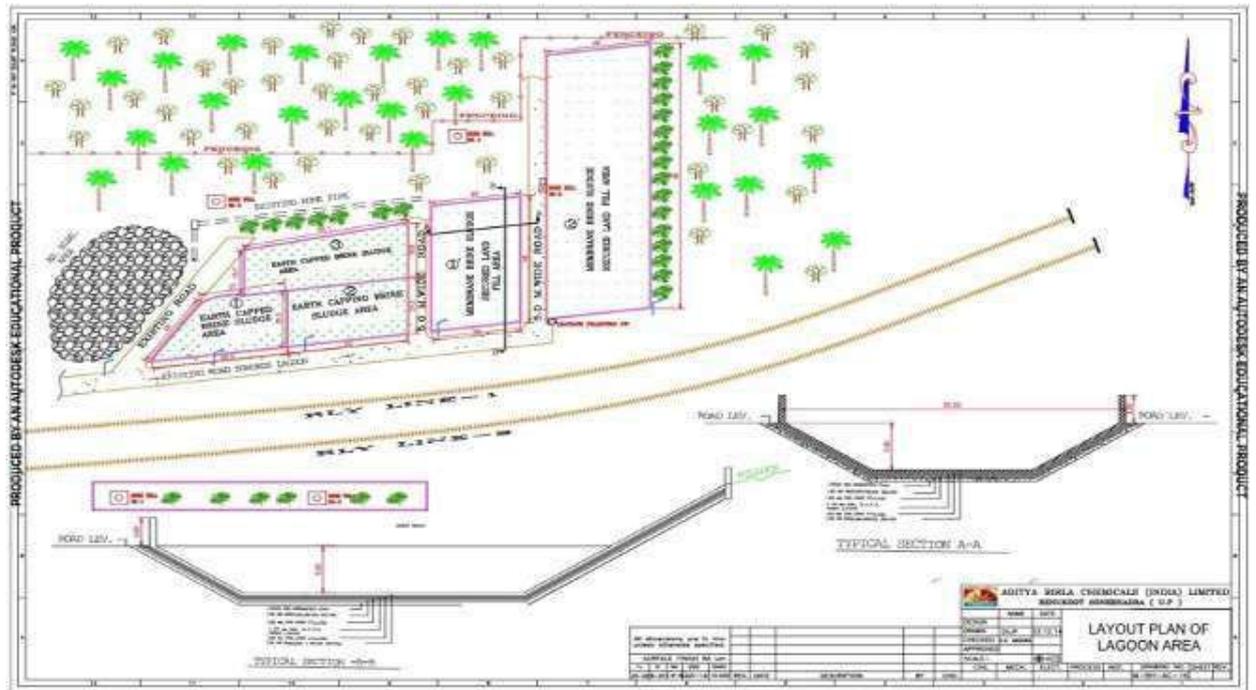


Figure 2.11: Layout of Secured Landfill Site at Chlor-Alkali Plant, Renukoot, Sonbhadra (U.P)





CHAPTER -3

DESCRIPTION OF THE STUDY AREA

(Source: Central Groundwater Board (CGWB) Report)

3.0 Introduction

The study area falls in the Survey of India Toposheet No 63P/4. The study area lies in between the latitudes N 24° 09' 30" to N 24° 15' 00" and longitudes E 83° 00' 00" to E 83° 06' 00". A 5 km radius buffer has been prepared around GRCD, Renukoot. The study area location is shown in the Figure 3.1.

3.1. Climate and Rainfall

The annual rainfall on an average is 1115mm. The temperature rises in February and the highest temperatures are recorded in May with average maximum temperature of 45.5°C and average minimum temperature of 2.5°C. Temperature on an average varied from 16.15 to 39.80°C.

3.2 Physiography and Drainage

The study -region is drained by the River Son, which itself forms a part of the Ganga River System. It forms a dendritic pattern of drainage. The main tributaries of the river Son are the Kanhar, Rihand, Pandu and Bijul. The slope varies from place to place largely due to the erosion of the Rihand and the Kanhar, the two important tributaries of the Son. On the basis of the variations in drainage pattern and water divides, there are five well marked drainage sub-systems (i) The southern Son (ii) The Bijul (iii) The Rihand (iv) The Kanhar and (v) The Pandu. The southern valley plain of the Son valley is associated with a Perennial Nadi called the Charkighaghiya and a narrow-elongated flood plain of the river Son. The Rihand River has one left bank tributary i.e. the Deohar and two right bank tributaries namely, Ajhir and Laira. The river Rihand divides the Rihand valley into the eastern and the western parts. The eastern part is wider than the western part. The notable left bank tributaries of the Kanhar are Pangan, Thema, Louwa and the Hathinala. The important right bank tributaries are Malia and Goitha. Almost parallel East-West lines of hillocks are identified in its valley. Before passing through the gorge, the Kanhar forms two typical basins namely, the Singrauli and Dudhi which are agriculturally most fertile. Tributaries of these major rivers follow the direction of maximum gradient, east or west, the Pandu flowing in easterly direction forms a dissected saucer shaped depression in the northeastern part of the region.

3.3 Geology

Geologically the study area including Grasim Industries Limited, Renukoot is located in the southern part of Sonbhadra District; U.P. Geologically the study area is comprised of Precambrian rocks of central India belonging to Mahakoshal Group and Chotanagpur Granite Gneiss Complex (CGGC). The Mahakoshal Group is represented chiefly by slate and phyllites while the CGGC is formed of granites and gneisses with subordinated schists.

The Sonbhadra District area shows very little structural variation excepting some folding contortion and local warping. Folding is tighter in southern part of the Vindhyan formation. The lower Vindhyan in the Son valley presents crumpling and it is probably due to eroded bed of the upper Vindhyan. The folds are seen south of Billi station along the railway line and along the road to Obra, give resemblance of local folding of simple type. Faulting has been reported previously by different authors but there is no authentic evidence on the surface with which it may be said to be present in the area under investigation. But adjacent to the present area, the following fault zone has been accounted in the Vindhyan i.e. (i) Rajkhar - Singrauli fault zone and (ii) The Son valley fault zone. Both indicates rather the weak zones between the Archaeans and the Bijawar and between the Bijawar and Vindhyan. It provides evidence that the northern block has been the down thrown side.

The Singrauli Rajkhar fault may be much older than the Son valley fault. In the Son valley the two fault lines tending East-West may be accounted as (i) the Jamul-Markundi fault and (ii) Billi - Kajarhat -Hardi fault. These two have guided the Son River and are reserved in nature with Bijawar being thrust over the Vindhyan. It is a normal vertical type of fault that has caused the abrupt truncation in the rocks of Rohatas and lower Kaimur stage. These are also noted as the 'boundary fault'. Apart from these two major faults, the Son valley is also traversed by cross faults such as (i) Agori -Ghathila fault (ii) Mangeshar fault, and (iii) Reverse fault in Kheinjua, which are observed near the Kota, Khattai, Mangeshar hill and East of Deora respectively. These faults have brought out remarkable changes in the surface of the area in the general. The Jamul Markundi fault along with Mangeshar fault may be responsible for the fault scarp of western Agari uplands, Markundi scarp, the great gorge of Mangeshar as well as the diversion of the river Ghaghar to join the Son. The relative horizontal displacements have also probably changed the confluence of the River Ghaghar and Rihand with the Son and formation of the Soucer shaped depression opposite to Chopan in the Son valley. The Billi-Hardi alignment has assisted the consequent undercutting of the Kaimur and consequent slip-off slope of the river Son which has resulted further steepening of the scarp the limestone shows different joint pattern but generally most of these are vertical. The dolomitic limestone and parcellanite also show more or less the same pattern of joints. The strike of different rock formation generally tends in east -west direction and the rock beds show variable dips in different directions.

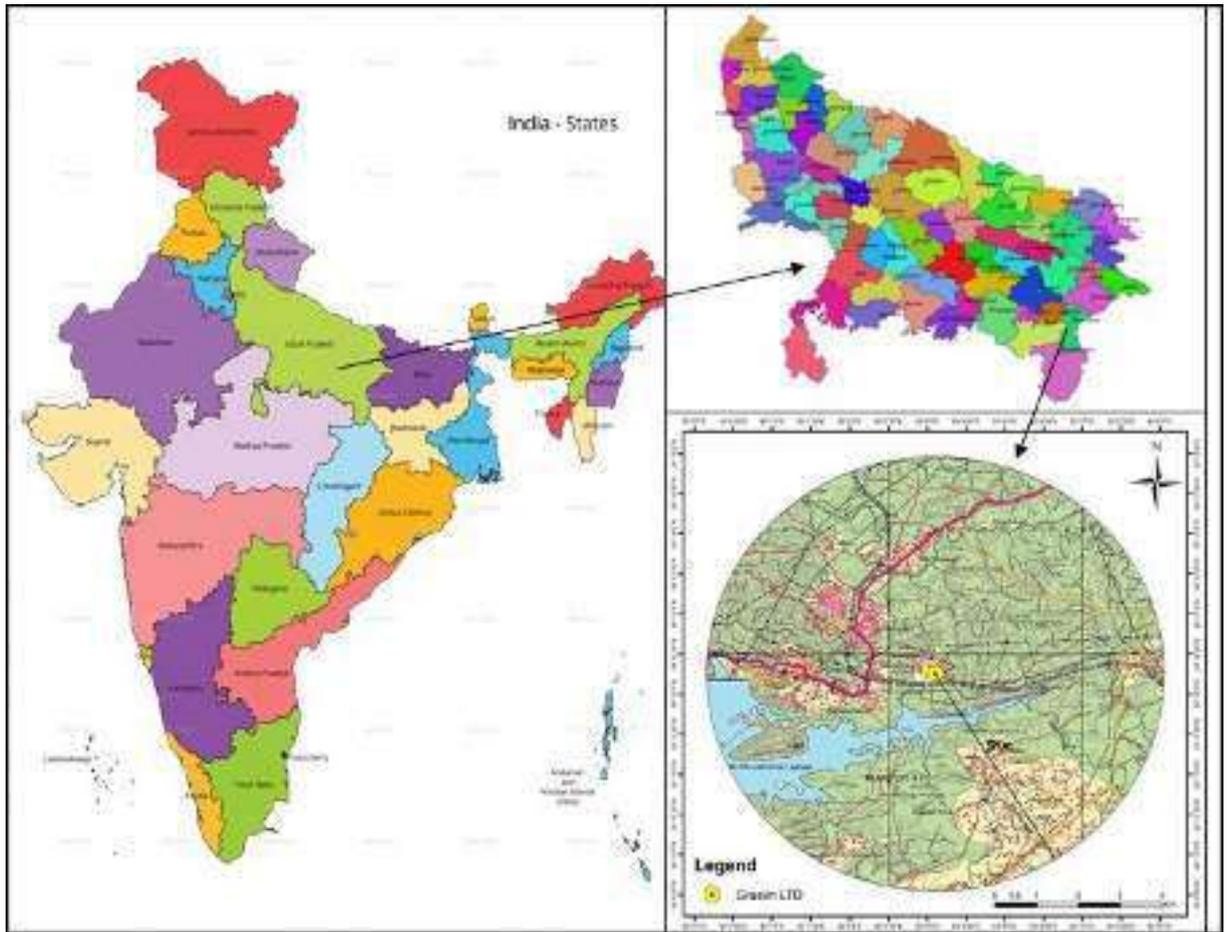


Fig. 3.1 Study area location



CHAPTER -4
ENVIRONMENTAL
QUALITY STATUS
AROUND THE SECURED
LANDFILL SITE

4.0 Introduction

M/s Grasim Chloro-alkali Plant at Renukoot, Sonbhadra District, in U.P the mercury bearing brine sludge was produced during the manufacturing of caustic soda and the same was disposed in a secured landfill within their premises. From 2011 onwards, the production of Caustic soda by mercury cell route was discontinued as per the directives of Govt. of India. The mercury brine sludge has been stored in the secured landfill was capped and closed according to the then existing Hazardous Waste Rules 2008 as also the Hazardous Rules 2016 and compliance with the directions received from UPPCB/CPCB.

Disposal of mercury-containing waste creates many pathways by which mercury may be released into the environment. Mercury is a persistent, mobile and bioaccumulative element in the environment and retained in organisms. Usually, mercury found in the environment is inorganic since mercury is never broken down into other chemical and harmless form. Once, it enters into the environment, mercury permanently exists in the environment by changing its chemical forms depending on the environment. The possible behavior of mercury in the environment is depicted in Figure 4.1.1.

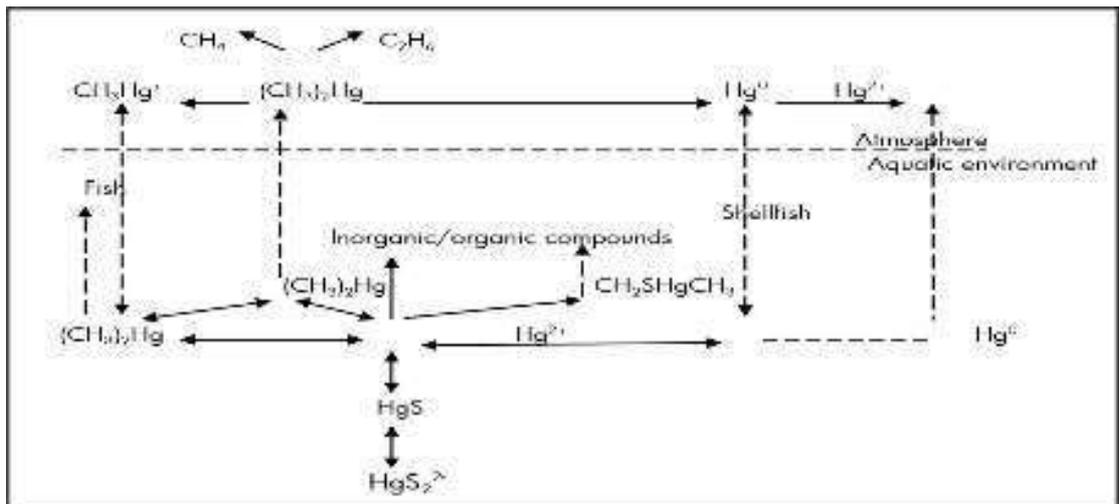


Fig. 4.1.1 : Pathways of mercury

4.1 Details of the Secured Landfill Site

There are five landfill sites existing in the Chloro-alkali Grasim Industrial premises and detailed layout of these is presented in Chapter 2. There are three secured landfill sites are closed by capping as per the CPCB guidelines. The details of these secured landfills are mentioned in Table 4.1.1. Two more secured landfills are in operation to dispose the brine sludge (non-hazardous) generated presently in the process plant. The total area of the plant premises is 323 Acres and the details of the Capped Secured Landfill site are as below:

Table 4.1.1 : Details of hazardous landfill site

Landfill Site	Area (sq.m)	Quantity (MT)
Site -1	856	6134
Site -2	1071	7808
Site -3	950	5883
Total	2877	19825

CSIR-NEERI team had visited the site on October 14-24, 2020. The team has visited the secured landfill site along with the PCB officials. CSIR-NEERI team had collected the sludge and ash samples in the presence of PCB officials. The site has been properly capped after the collection of sludge and ash samples from the landfill site area. The cross section of the landfill site is as given in Fig. 4.1.2. The sludge and ash layer collected from the landfill site have been characterized and the results are presented in following sections.

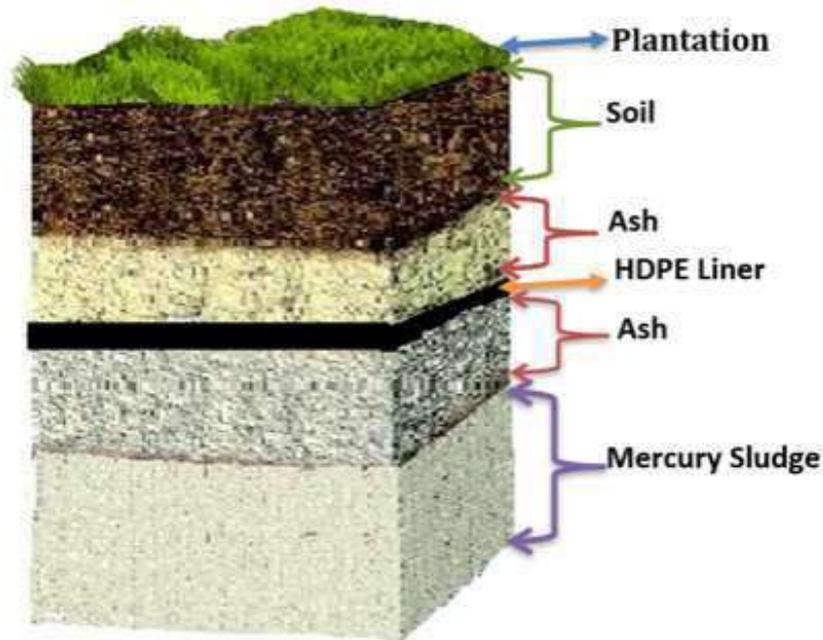


Fig. 4.1.2: Cross section of the landfill site area

4.2 Mercury Bearing Sludge & Ash Characterization

The Mercury bearing sludge, Top soil and Ash samples were collected from secured landfill site. Sampling Locations are presented in Table 4.2.1 and Fig. 4.8.3 A&B. Collected samples were air dried, Sieved and analyzed for various physico chemical parameters and heavy metals including mercury.

4.2.1 Physical Characteristics

Physical characteristics of sludge, ash and top soil samples are described through specific parameters, viz., particle size distribution, bulk density, porosity etc. Particle size distribution is a major factor which influences water holding capacity, bulk density, moisture availability. Particle size in between 0.05 to 0.25mm is predominant in the sludge and ash samples, whereas size between 0.002 to 0.05 mm size is more in top soil samples (Table 4.2.2).

Bulk density is the mass of bulk solid that occupies a unit volume of a bed, including the volume of all interparticle voids. The bulk density and particle density of sludge samples are 0.98 g/cm³ and 3.33 g/cm³, respectively. Ash layer and top soil was observed with Bulk density of 1.04 to 1.39 g/cm³ (Table 4.2.3).

4.2.2 Chemical Characteristics

The collected sludge, ash samples and top soil were analysed for parameters, viz. pH, electrical conductivity, soluble cations and anions (Tables 4.2.4). pH is the parameter that helps us to ascertain the alkaline or acidic nature of the particle. Top soil, Ash and Sludge samples are strongly alkaline in nature with pH variation from 8.48 to 10.26.

Soluble salts were estimated from water saturated extract (1:2). The soluble salts in sludge samples are indicated in terms of electrical conductivity (EC) and Electrical Conductivity of Sludge and Ash layer have been observed to be 20.6 to 25mS/cm, whereas EC of top soil and Ash layer HDPE is observed to be in the range of 3.17 to 4.26 respectively. Therefore, Sludge, Ash Layer and top soil samples were observed to be saline in nature. Calcium and Magnesium are observed in the range of 0.01 to 0.05 meq/100gm and 0.14 to 0.87 meq/100g, Sodium and Potassium are in the ranges of 3.59 to 44.57 meq/100 gm and 0.001 to 0.097 meq/100g, respectively. Chlorides ranged from 5.60 to 60.0 meq/100gm and sulphates content ranged from 4.06 to 36.1 meq/100gm. Sodium, chloride and sulphate content is high in sludge and HDPE Ash layer.

4.2.3 Heavy Metals

The sludge, Ash and top soil were investigated for Heavy metals viz., Arsenic (BDL to 1.3mg/kg), Boron (21.7 to 46.1 mg/kg), Cadmium (0.7 to 3.9 mg/kg), Chromium (9.9 to 72.8 mg/kg), Cobalt (2.1 to 11.4 mg/kg), Copper (20.1 to 64.58 mg/kg), Iron (4921 to 20056 mg/kg), Mercury (10.07 to 40 mg/kg), Manganese (125 to 363 mg/kg), Nickel 28.4 to 184.7 mg/kg, Lead (6.0 to 36.8 mg/kg) and Zinc (41.6 to 172.2 mg/kg). The observed concentrations are presented in Table 4.2.5. Concentration of Mercury in the sludge and HDPE Ash layer samples were found to be high (40 mg/kg) as compared to Top soil (10.07 mg/kg) and Ash layer (29.19 mg/kg). Heavy metal concentrations were more in HDPE Ash layer samples as compared to others.

4.2.4 Toxicity Characteristic Leaching Procedure (TCLP)

Toxicity Characteristic Leaching Procedure is process which is used to determine the presence of hazardous elements in the waste. Accordingly, TCLP analysis was carried out following USEPA hazardous waste test method SW 846 (1311) to determine inorganic analytes in the leachate using Hazardous waste filtration assembly. The solid phase is separated with extraction fluid quantity equivalent to 20 times the solid phase weight. The extraction fluid used depends on the alkalinity of the solid phase waste. After the extraction, the liquid is separated from the solid phase by passing through glass fibre filter of 0.7 μm size. The heavy metals results of the TCLP leachate are shown in Table 4.2.6. It was observed that heavy metals are below TCLP concentration Limit (Hazardous and Other Wastes (Management & Transboundary Movement) Rules, 2016 (Annexure III)). Therefore possibility of leaching of metals including mercury from the mercury bearing sludge and ash layers from the secured land fill is minimal.

Table 4.2.1 : Sampling Location details

1.	Samples	GPS Location	Type
2.	Sludge	24°12'18.00"N 83° 3'17.00"E	Sludge sample
3.	RMS-Top Soil	24°12'18.00"N 83° 3'17.00"E	Top Soil
4.	RMS-Ash Layer	24°12'18.00"N 83° 3'17.00"E	Ash
5.	RMS-Ash Layer HDPE	24°12'18.00"N 83° 3'17.00"E	Ash

Table 4.2.2 : Particle size distribution

S.No	Sample Code	Particle Size Distribution (%)			
		0.25 to 2.00 mm (Coarse sand)	0.05 to 0.25 mm (Fine sand)	0.002 -0.05 mm (Silt)	<0.002 mm (Clay)
1	Sludge	25.98	45.13	21.18	7.71
2	RMS-Top Soil	0.53	23.96	60.66	14.85
3	RMS-Ash Layer	1.40	77.45	4.46	16.69
4	RMS-Ash Layer HDPE	12.67	41.52	37.77	8.05

Table 4.2.3 Physical Properties of Sludge samples

S.No	Sample Code	Bulk Density (g/cc)	Porosity (%)	Water Holding Capacity (%)
1	Sludge	0.98	70.58	75.00
2	RMS-Top Soil	1.39	44.32	46.30
3	RMS-Ash Layer	1.16	61.56	63.80
4	RMS-Ash Layer HDPE	1.04	61.45	67.02

Table 4.2.4 : Chemical Properties (water soluble extract) of Sludge samples

S.No	Sample Code	pH	EC (mS/cm)	----- (meq/100gm) -----					
				Ca ⁺⁺	Mg ⁺⁺	Na ⁺	K ⁺	SO ₄ ⁻	Cl ⁻
1.	Sludge	10.25	25.00	0.05	0.35	36.3	0.090	36.1	60.0
2.	RMS-Top Soil	8.93	4.26	0.06	0.76	3.59	0.001	5.88	15.4
3.	RMS-Ash Layer	10.26	20.60	0.05	0.87	5.11	0.004	4.06	5.60
4.	RMS-Ash Layer HDPE	8.48	3.17	0.01	0.14	44.57	0.097	31.0	40.2

Table 4.2.5 :Heavy Metals in Sludge Samples

S.No.	Sample Code	As	B	Cd	Co	Cr	Cu	Fe	Hg	Mn	Ni	Pb	Zn
		mg/kg											
1.	Sludge	BDL	39.8	0.7	2.1	9.9	90.1	4921	40	125	41.4	6.0	41.8
2.	Top Soil	1.3	43.9	2.6	11.4	38.8	20.1	20056	10.07	363	36.6	8.0	56.8
3.	Ash Layer	BDL	21.7	1.4	10.8	37.0	32.4	11417	29.19	310	28.4	10.2	59.9
4.	Ash Layer HDPE	BDL	46.1	3.9	9.1	72.8	645.8	16776	40	302	184	36.8	172

Table 4.2.6 :Heavy Metals in TCLP Leachate

S. No.	Sample Code	As	B	Cd	Co	Cr	Cu	Fe	Hg	Mn	Ni	Pb	Zn
		(mg/L)											
1.	Sludge	BDL	0.02	BDL	BDL	0.0002	0.0001	BDL	0.05	BDL	BDL	BDL	BDL
2.	Top Soil	BDL	0.005	BDL	0.00001	BDL	0.0001	BDL	0.003	0.01	BDL	0.0001	0.01
3.	Ash Layer	0.00001	0.002	BDL	0.0001	BDL	0.0001	BDL	0.003	0.02	BDL	0.0001	0.005
4.	Ash Layer HDPE	BDL	0.02	BDL	BDL	0.0001	0.0001	BDL	0.065	0.001	0.001	0.0001	BDL
*TCLP leachable Concentration Limit (mg/L)		5.0	-	1.00	80	5.00	25	-	0.2	10.00	20	5.00	250

**Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016*

4.3 Groundwater Quality around SLF site

Groundwater chemistry is primarily controlled by the weathering of source rock and atmospheric deposition. In addition, characteristics of soil, climatic conditions, types of rocks, topography, intrusion of sea water and anthropogenic activities have significant effect on the chemistry of groundwater. The human activities such as urbanization, ever-increasing population and deforestation have interrupted the natural hydrological cycle. Geochemical processes that are taking place within the groundwater system due to the reaction with the aquifer material have profound effect on water quality. Groundwater quality is of utmost importance in assessing the usage for drinking, irrigation, domestic and industrial purposes. Therefore, protection and management of quality of groundwater is emerging as a matter of concern in India and the World.

The prevailing environmental data is useful for identification of significant environmental concerns in the area. Groundwater samples were collected around the landfill site to assess the groundwater quality due to impact of capped landfill site. The quality of water in the study area serves as the prevailing status for assessing the impacts on environment.

4.3.1 Groundwater Quality

4.3.1.1 Field Survey

The study area is a buffer zone of 5 km radius surrounding secured landfill site of GRCD, Renukoot. Field studies were undertaken to understand the background of the area, collection of preliminary information, groundwater and surface water sample collection, and groundwater level. Suitable sites were identified and sampled considering the drainage pattern of the study area. The water samples were collected from the available groundwater sources (dug wells, hand pumps etc) present within the 5km radius buffer zone. Subsequently, groundwater level was also measured along with sample collection. Majority of the villages in study area utilize groundwater for agricultural and domestic uses. The map showing the sampling locations is shown in Figure 4.3.1. The samples were collected at representative locations so that they are uniformly distributed in the study area. A total of 22 nos. samples were collected around the Industry, out of which 14 nos. are monitoring wells and 8 nos. are groundwater samples around the Industry. The details of the groundwater samples are presented in Table 4.3.1.

4.3.1.2 Groundwater Quality

The impact on water environment due to development and operations of industry on surrounding groundwater environment will be in two ways, one is in the form of stress through withdrawal of water resources and the other is discharge of effluents from the industry into surrounding environment causing impacts on water quality. To address these issues, it is important to consider available water resource information along with collection of data of water quality of the area. The data collected is the prevailing status of water environment as part of assessment study. The conventional water quality parameters such as physical, inorganic, nutrient, demand, and metals having health, aesthetic significance are determined to understand the prevailing status of the quality of water. The standard methods prescribed for sampling of groundwater and surface water, analysis of individual parameters were followed in this study.

Samples of groundwater were collected and stored in 1 litre and 100 ml Poly Propylene bottles which were cleaned thoroughly and cleansed with distilled water before collection of the sample. The collected samples were labelled properly as per the project area. The samples collected in 1litre bottles are analyzed for physico-chemical parameters while 100 ml PP bottles for heavy metal analysis. The 100 ml bottles are then acidified with conc. HNO_3 to retain the metals present in groundwater and surface water samples.

The analysis of physico-chemical parameters was carried out by adopting standard protocols given by APHA, 2012. The temperature was measured by using thermometer in the field. The pH and conductivity were measured with respective meters. TDS was calculated by using the gravimetric method. The chemical parameters like Total hardness, Chloride, Calcium Hardness, Alkalinity were determined titrimetrically. Magnesium Hardness (Mg) was calculated by taking the deducting Calcium Hardness from Total Hardness. Potassium and Sodium were determined by Flame Photometer. Sulphate was determined by turbidity method using visible Spectrophotometer. Heavy metals like Arsenic (As), Chromium (Cr), Copper (Cu), Boron (B), Cadmium (Cd), Nickel (Ni), Lead (Pb) and Zinc (Zn), Cobalt (Co), Iron (Fe), Manganese (Mn) were determined using ICP-MS.

4.3.1.3 Physico-chemical characteristics

Monitoring and analysis of groundwater quality is one of the major objectives of the study. The analysis of major cations, anions and heavy metals (Tables 4.3.2 to 4.3.6) of the groundwater samples which were taken into consideration brings out the following findings about the key parameters of groundwater quality during the study period. Groundwater quality analysis for all the 18 groundwater locations was carried out. The physico-chemical parameters were analyzed and compared with the Bureau of Indian Standards (BIS 10500:2012) of drinking water and presented below.

A. Groundwater quality of the monitoring Wells

pH: The pH of the monitoring wells varied from 6.5 to 8.5. The groundwater samples collected from all monitoring wells were observed to be within the permissible limit (6.5 – 8.5) of BIS standards.

Total Dissolved Solids (TDS): TDS of monitoring wells varied from 224 to 5920mg/l. High TDS was observed at eight locations in the monitoring wells which may be attributed to high sodium and high chloride contents. High TDS levels also attributed to the leaching of major cations/anions from the underlying rocks in the study area which consequently increases the TDS. The underlying rocks consist of granites and gneiss of the Mahakoshal and Chotanagpur granite gneiss group. They fall under the hard rock areas which increase the TDS of the groundwater samples.

Alkalinity: It signifies the acid neutralising ability of the water. The primary sources of alkalinity in groundwater are rocks, which contain carbonate, bicarbonate, hydroxide compounds and phosphates. Alkalinity is directly related to hardness and pH. The value of alkalinity in monitoring wells ranged from 44 to 250mg/l. The values of all the groundwater samples had total alkalinity within the permissible limit of BIS.

Sodium (Na): The sodium concentration varied from 16 to 2587mg/l. High levels of sodium in groundwater is due to the underlying hard rocks in the area.

Chloride (Cl): Chloride values ranged from 78 – 3177mg/l. It was observed that chloride content was above the BIS limit of 1000mg/l at eight monitoring wells. The high chloride concentration may be attributed to the underlying rocks such as granite and gneiss group which consists of chlorite, quartzites, limestone etc. Excess chloride content in water could lead to laxative effect and unsuitable for irrigation purpose.

Sulphate (SO₄²⁻): Sulphate ions exists naturally in water and no major health implications are recorded till date due to their presence in groundwater. However, elevated levels of sulphate in water lead to increase in pH causing acidosis. The sulphate concentration varied from 25 to 161mg/l. All the monitoring well samples showed sulphate content within the permissible limit i.e., 400mg/l of BIS.

Nitrate (NO₃⁻): The nitrate content of groundwater samples ranged from 1.04 to 17.10mg/l. All samples had nitrate concentration within BIS limits.

Fluoride (F^-): The values of fluoride varied from 0.57 to 1.32mg/l in all monitoring wells. All the samples showed fluoride content within BIS limits.

Heavy Metals: Heavy metals concentrations in monitoring wells suggest that all metals were within the BIS limits except for the Iron, Manganese, Nickel and lead

- Iron, Manganese, Nickel concentrations at some of the locations were found to be higher than the permissible limits. The high levels of these metals may be attributed to the underlying geological rocks that include quartzites, alumina, magnetite, alluvium etc. All these rocks contain the heavy metals like iron, manganese etc which contribute to the elevated levels in groundwater samples. Both Fe and Mn are the most abundant metallic elements in natural water. Mn^{2+} salts have high solubility but under aeration conditions, they are oxidized precipitating oxyhydroxides.

B. Water quality of the groundwater samples around the SLF

pH: pH of the groundwater samples ranged from 7.1 to 8.0. The groundwater samples collected from all samples were observed to be within the permissible limit (6.5 – 8.5) of BIS.

Total Dissolved Solids (TDS): TDS concentration varied in between 323 – 681mg/l in the area. All monitored samples had TDS within the BIS limit of 2000mg/l.

Alkalinity: The value of alkalinity in groundwater ranged from 88 to 172mg/l. The total alkalinity of all the samples were within the permissible limit of BIS.

Sodium (Na): The sodium concentration was found to be in the range of 24 to 101mg/l. No BIS standards exist for sodium.

Chloride (Cl⁻): Chloride concentration ranged from 32 to 199mg/l. It was observed that chloride content was within 1000 mg/l as per BIS limit.

Sulphate (SO₄²⁻): Sulphate concentration varied from 11 to 91mg/l. Sulphate content was within the permissible limit i.e. 400mg/l of BIS for all the samples.

Nitrate (NO³⁻): The nitrate content varied from 0.2 to 18mg/l in the study area and concentrations for all the samples were within the desirable limits of BIS.

Fluoride (F⁻): The fluoride concentration ranged in between 0.57 to 1.40mg/l in the area. All the samples showed fluoride content below the BIS limits.

Heavy Metals: Heavy metals concentrations in groundwater reveal all the heavy metals were within the BIS limits except for the iron, manganese, nickel and lead. Mercury was not detected at any location.

Table 4.3.1 Groundwater Locations

S.No	Sample Code	Sample Location	GPS Locations	Water Level (m)	Elevation (m)	Source Type	Remarks
Monitoring Wells							
1.	RMS-1	Piezometer sample inside the industry	24°12'16.00"N 83°03'16.00"E	05.07	310	Piezometer	Piezometer sample beside the power plant. Piezometer used only for recording water level and temperature
2.	RMS-8	Monitoring well beside SLF	24°12'18.61"N 83°03'16.09"E	05.19	327	Monitoring well	The well beside SLF
3.	RMS-10	NEERI-EISD drilled site	24°12'15.79"N 83°03'16.64"E	05.37	314	Monitoring well	Adjacent Rly track near capacitive power plant. Near SLF site adjacent to Grasim online piezometer
4.	RMS-11	Monitoring well near SLF	24°12'16.06"N 83°03'16.92"E	05.18	308	Monitoring well	Grasim monitoring well no. 1 as per Grasim. Near railway track adjacent to EISD-NEERI drilled point
5.	RMS-12	Grasim Monitoring well 4	24°12'19.96"N 83°03'19.04"E	03.13	311	Monitoring well	Near SLF area adjacent to leachate collection tank of SLF
6.	RMS-13	Grasim Monitoring well 3	24°12'19.86"N 83°03'17.85"E	04.17	320	Monitoring well	Near SLF area-towards hill side-adjacent to monitoring well 2
7.	RMS-14	SLF leachate	24°12'19.05"N 83°03'19.65"E	--	316	Leachate sample	Leachate pump, leachate near SLF, adjacent to railway track near and
8.	RMS-15	Monitoring well	24°12'09.61"N 83°03'06.32"E	09.61	322	Monitoring well	DM plant area near cooling towers adjacent to membrane cell ETP tank
9.	RMS-16	Grasim Monitoring well 10	24°12'10.93"N 83°03'00.25"E	10.41	312	Monitoring well	Near STP area, adjacent to toilet backside of Lindone building
10.	RMS-17	Monitoring well adjacent to SLF	24°12'17.51"N 83°03'17.39"E	03.49	334	Monitoring well	Grasim monitoring well 5, adjacent to the wall of SLF
11.	RMS-18	Monitoring well adjacent to SLF	24°12'16.52"N 83°03'16.01"E	02.77	318	Monitoring well	Grasim Monitoring well no. 6
12.	RMS-19	Grasim Monitoring well 8	24°12'09.90"N 83°03'22.79"E	15.30	319	Monitoring well	Near brick manufacturing plant
13.	RMS-20	Monitoring well near truck parking area	24°12'25.37"N 83°03'11.98"E	18.57	340	Monitoring well	Monitoring well inside truck parking area opposite to small shop
14.	RMS-21	Monitoring well- Lal bungalow	24°12'32.76"N 83°03'08.76"E	12.57	333	Monitoring well	Lal Bungalow area – monitoring well of Grasim
Groundwater samples around Industry							
15.	RMS-2	Near Renukoot police chowki and railway station	24°12'14.39"N 83°02'21.47"E	23.22	322	Hand Pump with Bore well	Water is used for drinking and cooking
16.	RMS-3	Renukoot	24°11'54.38"N 83°02'28.44"E	24.15	300	Hand Pump with Bore well	Katel No.1, Dongiya Nala, used for drinking and cooking
17.	RMS-4	Near mahanaya mandir, Lanke colony	24°11'56.67"N 83°01'39.63"E	08.50	284	Hand Pump	Water used for drinking when RO water is not supplied
18.	RMS-5	Infront of government inter college GIC	24°12'04.13"N 83°01'20.64"E	03.52	281	Hand Pump	Renukoot
19.	RMS-6	Infront of Rihand	24°12'32.40"N 83°00'22.50"E	16.67	212	Hand Pump	Sometimes the water is used for drinking and used for domestic purposes
20.	RMS-7	Besides shivmandir, Muligedi	24°12'27.70"N 83°01'21.37"E	11.52	293	Hand Pump	--
21.	RMS-25	Old Shiv park area near shiv mandir gate	24°13'12.35"N 83°02'07.73"E	18.12	302	Hand Pump	Sardar patel nagar-old shiv park area adjacent to adharsh Garments shop
22.	RMS-26	Grasim-Hitech carbon colony	24°14'02.80"N 83°03'20.55"E	--	293	Tube Well	Near children park

Table 4.3.2 Groundwater Quality - Physical Parameters

Sr. No	Sample Code	pH	Temp (°C)	Turbidity (NTU)	TSS (mg/l)	TDS (mg/l)	Conductivity (µS/cm)
Monitoring Wells							
1.	RMS-1	8.5	28.5	1.0	69	4660	7770
2.	RMS-8	7.2	27.5	0.5	5.2	224	408
3.	RMS-10	6.9	28.2	0.1	59.8	5920	10070
4.	RMS-11	7.6	27.8	0.5	11.8	3850	6417
5.	RMS-12	7.9	26.9	0.4	29.4	531	921
6.	RMS-13	7.5	26.2	1.0	20.6	252	414
7.	RMS-14	7.4	27.0	1.2	16.2	3760	7470
8.	RMS-15	8.4	36.1	1.0	98.2	3627	6045
9.	RMS-16	7.0	28.8	0.1	19.2	1950	3650
10.	RMS-17	7.9	28.6	0.2	43.6	4790	11060
11.	RMS-18	7.8	28.7	1.0	53	3466	6250
12.	RMS-19	6.5	31.8	0.1	38.2	3764	6273
13.	RMS-20	7.7	30.2	0.1	6.8	568	1114
14.	RMS-21	7.1	29.6	0.2	29.6	822	1703
Groundwater Samples around the SLF							
15.	RMS-2	7.1	28.3	0.1	10	380	600
16.	RMS-3	7.1	27.5	0.1	0.4	393	656
17.	RMS-4	7.1	27.5	0.3	11.4	401	671
18.	RMS-5	7.4	28.0	0.1	17.8	276	483
19.	RMS-6	7.3	26.9	0.1	3.2	460	768
20.	RMS-7	7.7	27.2	1.1	26.6	259	472
21.	RMS-25	8.0	28.0	0.2	2.2	505	887
22.	RMS-26	7.5	27.6	0.1	0.4	681	1215
	Desirable	6.5 – 8.5	-	1	-	500	-
	Permissible	NR	-	5	-	2000	-

Table 4.3.3 Groundwater Quality- Inorganic Parameters

Sr. No	Sample Code	Total Hardness (as CaCO ₃)	Calcium (as Ca)	Magnesium (as Mg)	Sodium (as Na)	Potassium (as K)
		mg/l				
Monitoring wells						
1.	RMS-1	546	123	57	1423	6.0
2.	RMS-8	148	34	15	18	1.0
3.	RMS-10	860	171	104	1730	7.0
4.	RMS-11	320	85	456	1125	8.0
5.	RMS-12	189	50	15	106	2.0
6.	RMS-13	192	38	23	16	1.0
7.	RMS-14	356	80	37	1840	7.0
8.	RMS-15	133	336	148	1770	6.0
9.	RMS-16	1280	296	130	380	4.0
10.	RMS-17	404	106	34	2587	17.0
11.	RMS-18	672	158	66	940	5.0
12.	RMS-19	1500	194	155	320	6.0
13.	RMS-20	368	85	37	80	1.0
14.	RMS-21	450	96	63	82	2.0
Groundwater samples around the industry						
15.	RMS-2	180	45	16	69	1.0
16.	RMS-3	192	43	20	79	2.0
17.	RMS-4	192	46	18	70	1.0
18.	RMS-5	240	46	30	24	1.0
19.	RMS-6	280	42	42	68	2.0
20.	RMS-7	172	44	15	70	2.0
21.	RMS-25	196	42	22	99	1.0
22.	RMS-26	344	84	32	101	1.0
Desirable		200	75	30	-	-
Permissible		600	200	100	-	-

Table 4.3.4 Groundwater Quality- Inorganic Parameters

Sr. No	Sample Code	Total Alkalinity (as CaCO ₃)	Sulphate (as SO ₄)	Chloride (as Cl)	Salinity	Fluoride (as F)
		mg/l			‰	mg/l
Monitoring Wells						
1.	RMS-1	172	91	2432	4.3	1.32
2.	RMS-8	44	27	79	0.14	0.94
3.	RMS-10	64	157	3177	5.74	0.79
4.	RMS-11	250	65	1520	2.12	1.9
5.	RMS-12	80	28	232	0.42	0.77
6.	RMS-13	60	35	78	0.14	1.06
7.	RMS-14	100	64	3044	5.50	1.10
8.	RMS-15	121	148	1069	0.48	1.4
9.	RMS-16	72	133	1420	2.56	1.32
10.	RMS-17	100	200	4085	7.38	1.05
11.	RMS-18	96	204	1710	3.10	1.23
12.	RMS-19	175	165	1445	1.24	1.16
13.	RMS-20	72	45	290	0.52	0.60
14.	RMS-21	58	25	822	0.91	0.57
Groundwater samples around the industry						
15.	RMS-2	172	91	32	0.06	0.57
16.	RMS-3	88	53	162	0.29	1.06
17.	RMS-4	164	30	93	0.17	0.99
18.	RMS-5	172	11	79	0.14	0.89
19.	RMS-6	176	50	120	0.22	1.40
20.	RMS-7	108	24	125	0.23	1.23
21.	RMS-25	136	54	144	0.26	1.02
22.	RMS-26	168	91	199	0.36	0.81
Desirable		200	200	250	-	1.0
Permissible		600	400	1000	-	1.5

Table 4.3.5 Groundwater Quality – Nutrient Parameters

Sr. No.	Sample Code	Nitrate (as NO ₃)	Total Phosphorus (as P-PO ₄)	Available Phosphorus (as P-PO ₄)	O&G
		mg/l			
Monitoring Wells					
1.	RMS-1	5.22	0.317	0.162	BDL
2.	RMS-8	3.26	0.057	0.031	BDL
3.	RMS-10	6.04	0.016	0.004	BDL
4.	RMS-11	9.45	0.121	0.099	BDL
5.	RMS-12	1.04	0.034	0.020	BDL
6.	RMS-13	2.48	0.088	0.044	BDL
7.	RMS-14	4.65	0.028	0.002	BDL
8.	RMS-15	14.47	0.816	0.297	BDL
9.	RMS-16	14.7	0.013	BDL	BDL
10.	RMS-17	1.06	0.020	0.002	BDL
11.	RMS-18	10.02	0.022	0.001	BDL
12.	RMS-19	18.19	0.256	0.204	BDL
13.	RMS-20	17.10	0.011	0.001	BDL
14.	RMS-21	15.13	0.108	0.050	BDL
Groundwater samples around the Industry					
15.	RMS-2	14.58	0.025	0.014	BDL
16.	RMS-3	18.0	0.031	0.020	BDL
17.	RMS-4	7.22	0.185	0.016	BDL
18.	RMS-5	0.20	0.019	0.005	BDL
19.	RMS-6	13.79	0.016	0.005	BDL
20.	RMS-7	0.20	0.031	0.001	BDL
21.	RMS-25	16.56	0.008	BDL	BDL
22.	RMS-26	10.44	0.038	0.007	BDL
Desirable		45	-	-	-
Permissible		NR	-	-	-

Table 4.3.6 Groundwater Quality –Heavy Metals

Sr. No	Sample Code	As	B	Cd	Co	Cr	Cu	Fe	Mn	Ni	Pb	Zn	Hg
		mg/l											
Monitoring Wells													
1.	RMS-1	BDL	BDL	BDL	0.001	0.052	0.013	1.342	BDL	0.032	0.532	BDL	<0.001
2.	RMS-8	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.230	0.003	0.043	BDL	<0.001
3.	RMS-10	BDL	BDL	0.003	0.007	BDL	0.005	2.585	0.454	0.028	0.131	BDL	<0.001
4.	RMS-11	BDL	BDL	BDL	0.001	0.032	0.005	0.050	BDL	0.022	BDL	BDL	<0.001
5.	RMS-12	BDL	0.044	BDL	BDL	BDL	BDL	0.937	0.042	BDL	0.543	0.080	<0.001
6.	RMS-13	BDL	BDL	BDL	BDL	BDL	BDL	0.570	0.153	BDL	0.033	0.069	<0.001
7.	RMS-14	BDL	0.078	BDL	BDL	BDL	BDL	0.660	0.049	BDL	0.006	0.105	<0.001
8.	RMS-15	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.001	BDL	0.001
9.	RMS-16	BDL	0.269	BDL	0.014	0.013	BDL	0.715	0.938	BDL	0.060	0.130	0.001
10.	RMS-17	BDL	0.105	BDL	0.025	0.005	BDL	4.786	1.622	BDL	0.216	0.134	<0.001
11.	RMS-18	BDL	0.197	BDL	0.001	0.002	BDL	1.706	0.260	BDL	0.093	0.177	<0.001
12.	RMS-19	BDL	0.178	BDL	0.005	BDL	BDL	0.392	2.766	BDL	0.059	0.065	<0.001
13.	RMS-20	BDL	BDL	BDL	0.001	BDL	BDL	0.468	0.019	BDL	0.017	0.090	<0.001
14.	RMS-21	BDL	0.009	BDL	0.016	0.002	BDL	0.520	0.302	BDL	0.038	0.085	<0.001
Groundwater samples around the Industry													
15.	RMS-2	BDL	BDL	BDL	BDL	BDL	BDL	0.075	BDL	BDL	BDL	BDL	<0.001
16.	RMS-3	BDL	BDL	BDL	BDL	BDL	0.003	BDL	BDL	BDL	BDL	BDL	<0.001
17.	RMS-4	BDL	BDL	0.005	0.001	BDL	0.009	7.551	0.572	0.004	0.006	1.126	<0.001
18.	RMS-5	BDL	BDL	BDL	BDL	BDL	0.002	8.022	0.874	0.022	0.004	BDL	<0.001
19.	RMS-6	BDL	BDL	BDL	BDL	BDL	0.002	2.307	BDL	BDL	BDL	BDL	<0.001
20.	RMS-7	BDL	0.029	BDL	0.004	0.002	0.029	3.796	BDL	0.019	0.029	BDL	<0.001
21.	RMS-25	BDL	0.039	BDL	BDL	BDL	0.013	2.359	0.009	BDL	0.005	0.111	<0.001
22.	RMS-26	BDL	0.022	0.004	0.002	0.004	0.015	0.146	0.086	0.002	0.033	0.141	<0.001
Desirable		0.01	0.5	0.003	-	0.05	0.05	0.3	0.1	0.02	0.01	5	0.001
Permissible		0.05	1.0	NR	-	NR	1.5	NR	0.3	NR	NR	15	NR

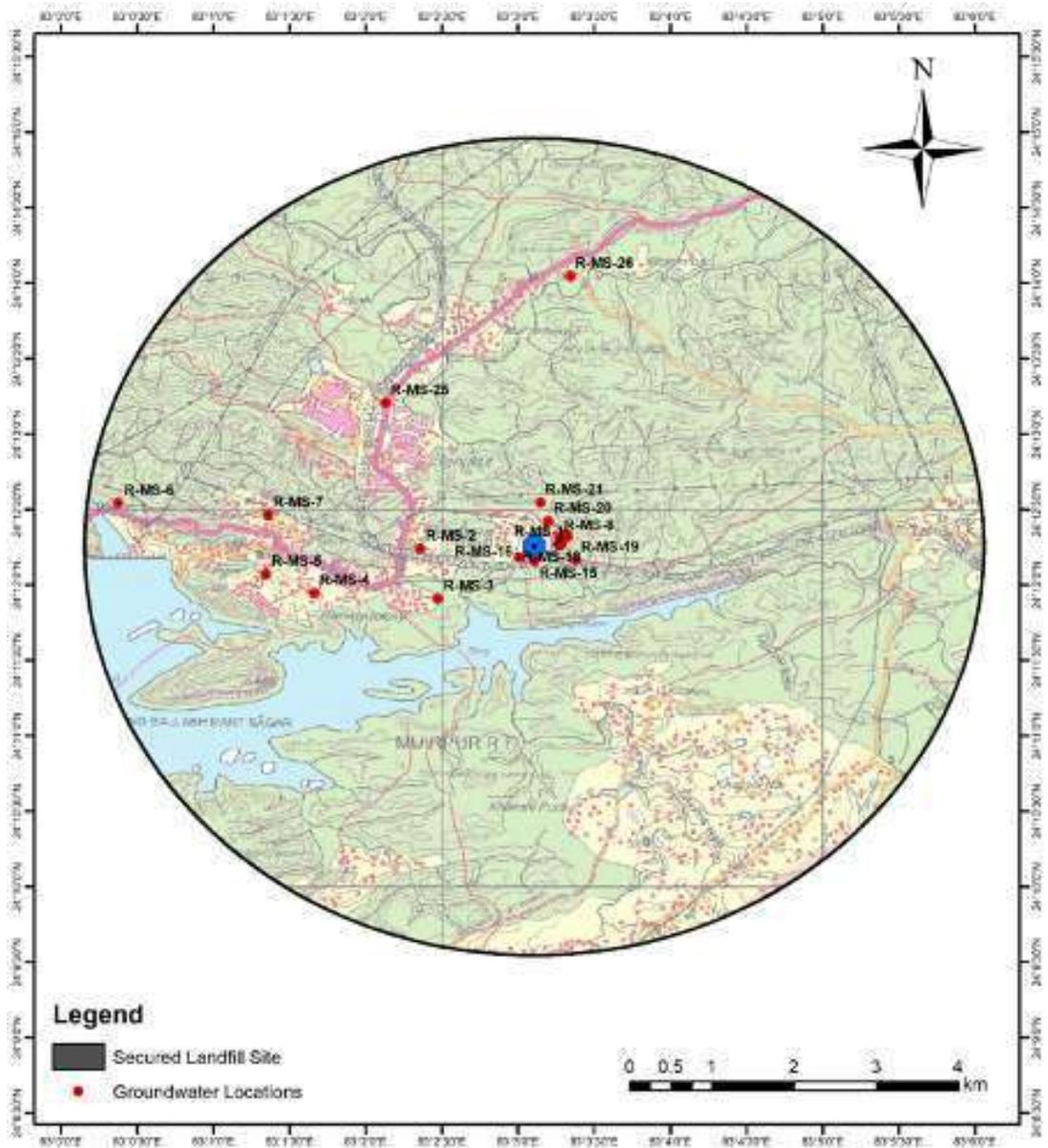


Fig. 4.3.1A Groundwater and surface water sampling locations around GRCD, Renukoot

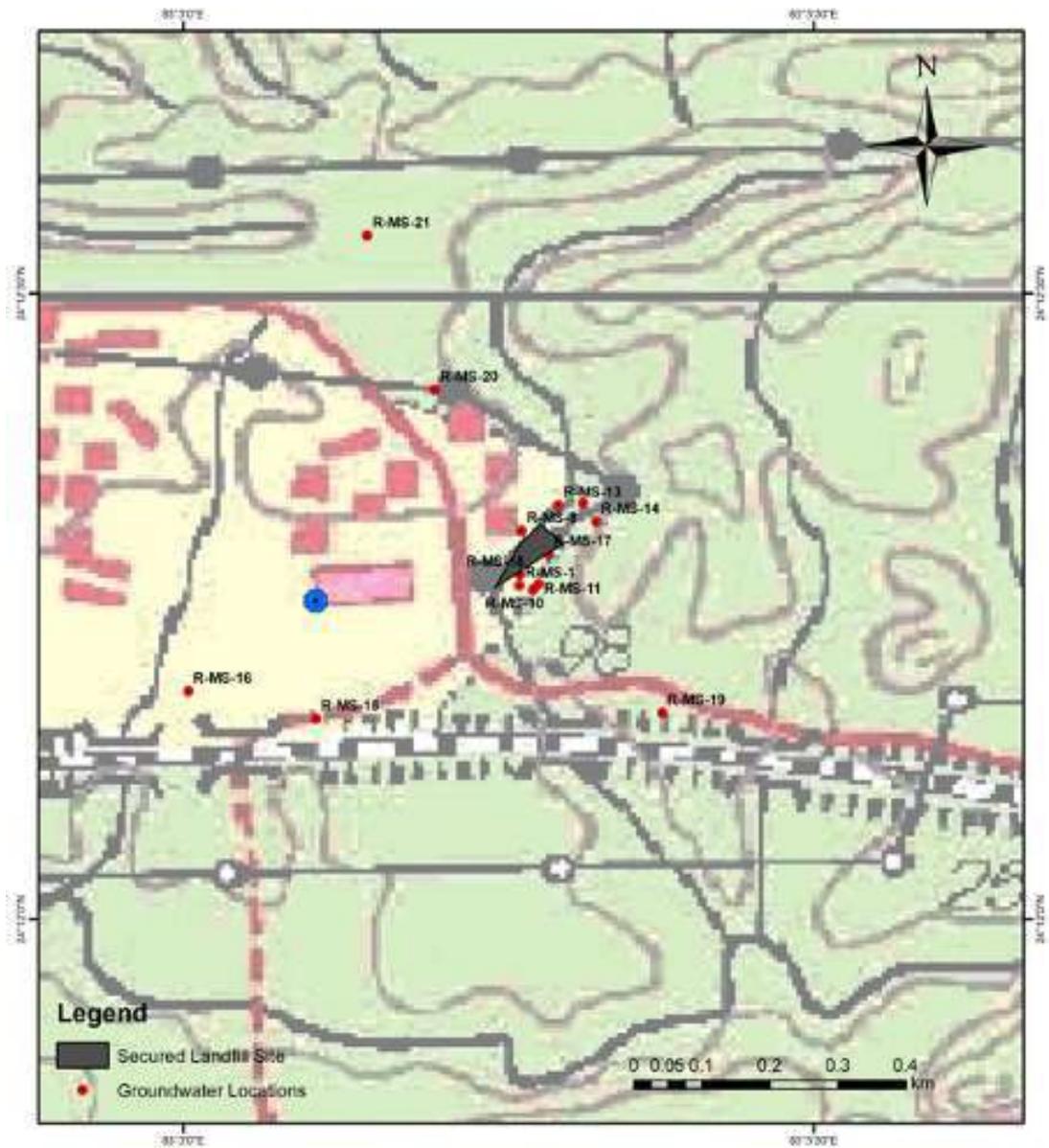


Fig. 4.3.1B Secured Landfill Site of GRCD, Renukoot

4.4 Hydrogeochemistry

The groundwater parameter analysis reveals the various concentrations of parameters present in groundwater. A more robust presentation of the groundwater quality has been done by the hydrochemical diagrams viz., Piper Plot, Gibbs Plot and Wilcox Diagram. The details of the plot with respect to the groundwater quality have been explained in detail below:

4.4.1 Piper Plot

Hydrogeochemistry of groundwater are greatly depend on lithology, groundwater flow pattern, and resident time. Based on chemical composition, groundwater is usually grouped into three main categories such as bicarbonate, sulfate, and chloride types. Piper diagram is a useful tool to identify different hydrochemical facies by plotting the content of cations and major anions in groundwater indicating the origin, source of dissolved salts and processes that affect the characteristics of groundwater. Arthur M Piper in 1944 proposed the piper plot which is an useful procedure in presenting the chemistry data to help in understanding the sources of the dissolved constituents in water. It is based on the fact that cations and anions are in equilibrium in water.

Piper plot is constructed in AQUACHEM software to understand the hydrochemical evolution of groundwater in the study area (Figure 4.4.1). It can be observed from the Piper plot that most of the samples are concentrated in the chloride side of the anion triangle and sodium forms the major cation part of the cation triangle. This indicates that the major ion types are chloride in the anions and sodium in the cations part. The high concentration of sodium and chloride indicates the interaction of rock with water in the area. The superior water types are in the order of mixed Na-Cl > Na-Mg-Ca-Cl > Na-Ca-Cl. The majority of samples are mixed Na-Ca-Cl, Na-Mg-Ca-Cl, Na-Ca-Cl types of water that indicate mineral dissolution, rock-water interaction. The piper plot indicates that the high values of the groundwater quality parameters is mainly from the interactions between rock and water which is the main reason elevated values of TDS and other parameters.

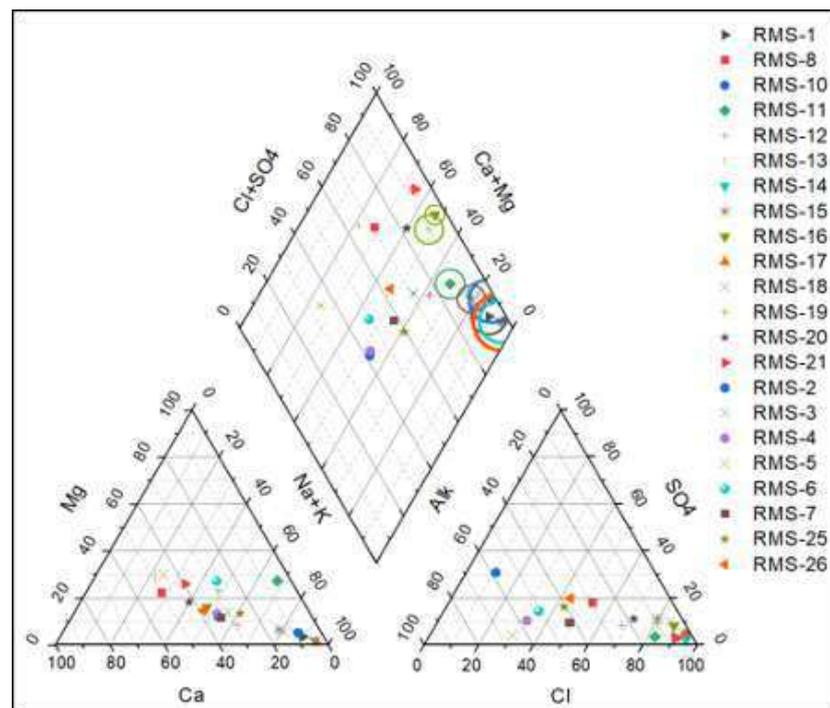


Fig. 4.4.1 Piper plot of the samples of the study area

4.4.2 Gibbs plot

The relation between aquifer characteristics and water composition such as rock-water interaction, rainfall dominance (chemistry of the rain water) and evaporation dominance (rate at which the evaporation takes place) is obtained by plotting the Gibbs plot. The Gibbs plot is shown in Figure 4.4.2. The cation plot shows that all the samples fall in the rock dominance. Majority of samples that fall in the rock dominance indicate the weathering of rock forming minerals that influence the groundwater quality by dissolution of rocks in groundwater.

The anion Gibbs plot show that all the samples fall in the rock dominance. As mentioned before the rock weathering process greatly influences the groundwater quality. The anion plot indicates the primary mechanism the rock weathering process. The concentration of ions is greatly influenced by rock weathering processes. This increases the sodium and chloride content in groundwater which in turn increases the TDS value of groundwater samples.

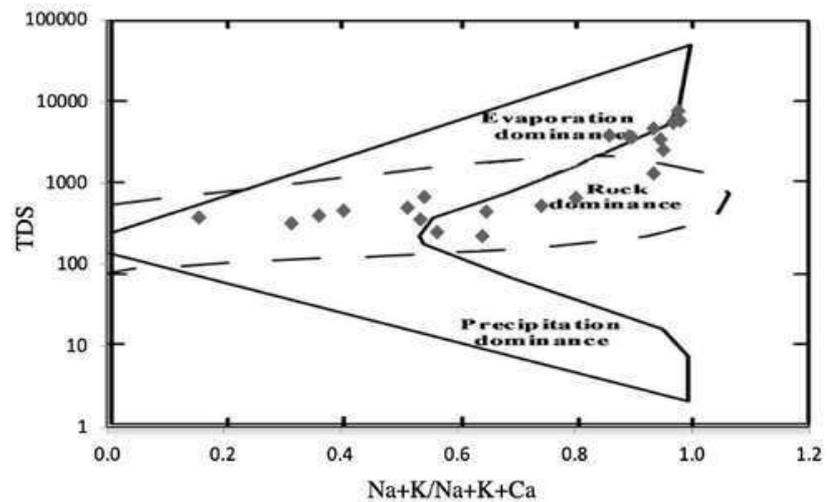


Fig. 4.4.2A Cations plot of the study area

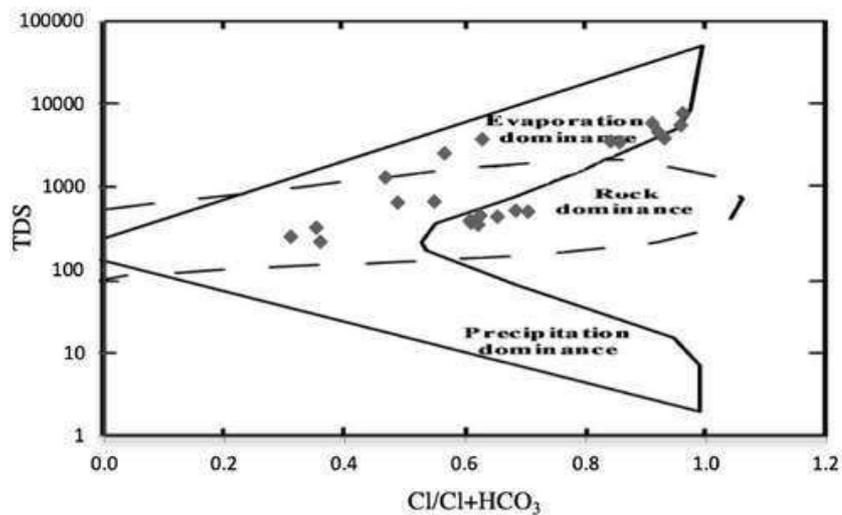


Fig. 4.4.2B Anions of the study area

The groundwater chemistry is usually controlled by chemical composition of the rock, evaporation rate, the and the rainwater. The hydrochemical diagrams displayed the mechanisms that control the chemistry of groundwater from the relationship of chemical components with their respective lithologies in the aquifer, representing the water–rock interaction and evaporation.

4.5 Groundwater Quality Index

Many studies have assessed the water quality based on the calculation of water quality index. Groundwater Quality Index gives an indication of quality of groundwater.

4.5.1 Calculation of groundwater quality index

Groundwater Quality Index is one of the useful tools for the groundwater quality evaluation and management. This method is used in the present work for evaluation of water quality index that was developed by Brown et al. (1970). The water quality index was prepared using the measured values of the groundwater quality. The parameters were determined based on their importance in the groundwater quality. The standard values of drinking water of BIS were used in the study and the step by step procedure for water quality index calculation are presented below:

- A weight is assigned to each parameter (w_i) based on their importance in groundwater. The highest value is assigned to parameters having major effects on the groundwater quality and the lowest value is assigned to parameters not considered harmful.
- Each parameter relative weight is calculated as per the following equation:

$$W_i = \frac{w_i}{\sum_{i=1}^n w_i}$$

where, W_i is the relative weight of the parameter and w_i is the weight of each parameter

- The quality rating scale for every parameter is computed by dividing the value in each groundwater sample by its respective standard according to BIS standards and the result was multiplied by 100

$$q_i = \left(\frac{C_i}{S_i} \right) \times 100$$

where, q_i is the quality rating for each parameter, C_i is the concentration of each parameter and S_i is the BIS norm for each parameter

- For computing the WQI, the water quality sub index (S_i) for each parameter is first determined and then the following equation is used to calculate the WQI of the groundwater sample

$$S_i = W_i q_i$$

$$WQI = \sum_{i=1}^n S_i$$

where, S_i is the sub index of the i th parameter

The WQI index values are classified as per the following table water quality scale table:

S.No.	WQI	Water Quality Status	Usage
1.	0 – 25	Excellent	Drinking, irrigation and industrial
2.	26 – 50	Good	Domestic, irrigation and industrial
3.	51 – 75	Poor	Irrigation
4.	76 – 100	Very poor	Restricted use for irrigation
5.	> 100	Unsuitable for drinking	Proper treatment before use

Based on the above calculation, the groundwater samples have been classified based on the WQI of the groundwater sample (Table 4.5.1).

The weighted arithmetic average method used in the present work considers the maximum permissible limits of BIS. However, it has certain limitations, such as that it is not possible to evaluate all the risks present in the water, and the weighting required for each parameter according to its importance could become subjective.

The results obtained in the study area ranged from 15 to 145 (Table 4.5.1), observing water of excellent to very poor. One groundwater sample has excellent water quality which can be used for drinking, irrigation and industrial purpose, 14 samples have good water quality that can be used for domestic, irrigation and industrial purpose, 02 samples have poor water quality that can be used only for irrigation and one groundwater sample has very poor quality that can be used for irrigation but restricted.

Table 4.5.1 Water Quality Index values of the groundwater samples

S.No	Code	WQI	Usage
1	RMS-1	109	Proper treatment before use
2	RMS-2	16	Drinking, irrigation and industrial
3	RMS-3	21	Drinking, irrigation and industrial
4	RMS-4	18	Drinking, irrigation and industrial
5	RMS-5	20	Drinking, irrigation and industrial
6	RMS-6	27	Domestic, irrigation and industrial
7	RMS-7	23	Drinking, irrigation and industrial
8	RMS-8	15	Drinking, irrigation and industrial
9	RMS-10	121	Proper treatment before use
10	RMS-11	116	Proper treatment before use
11	RMS-12	25	Drinking, irrigation and industrial
12	RMS-13	20	Drinking, irrigation and industrial
13	RMS-14	107	Proper treatment before use
14	RMS-15	88	Restricted use for irrigation
15	RMS-16	84	Restricted use for irrigation
16	RMS-17	145	Proper treatment before use
17	RMS-18	87	Restricted use for irrigation
18	RMS-19	94	Restricted use for irrigation
19	RMS-20	30	Domestic, irrigation and industrial
20	RMS-21	41	Domestic, irrigation and industrial
21	RMS-25	28	Domestic, irrigation and industrial
22	RMS-26	29	Domestic, irrigation and industrial

Table 4.5.2 Summary of the GWQI values

Water Quality Status	Usage	No. of samples
Excellent	Drinking, irrigation and industrial	08
Good	Domestic, irrigation and industrial	05
Poor	Irrigation	00
Very poor	Restricted use for irrigation	04
Unsuitable for drinking	Proper treatment before use	05
Total no. of samples		22

From the groundwater quality index values, following conclusions can be made:

- All the above values calculated are empirical in nature. Eight samples fall in the “Excellent” water quality status which means the possible usage of those wells can be for drinking, irrigation and industrial purposes. However, the well water must be properly treated before using for drinking purpose.
- Five samples fall in the “Good” water quality status which means the possible usage of those wells can be for domestic, irrigation and industrial purposes.
- Four samples fall in the “Very Poor” water quality status which means the possible usage of those wells can be irrigation purposes with restriction.
- Eight samples fall in the “Unsuitable for drinking” water quality status which means the water of those wells if used for any other purposes should properly be treated before any usage

4.6 Surface Water Quality

Four surface water samples have been collected in the area. The surface water locations details are given in the Tables 4.6.1 to 4.6.7. The samples have been analysed for physico chemical and heavy metals. The results of the surface water samples reveal the following:

- pH varied from 8.3 to 8.5 in the surface water samples
- TDS of the samples varied from 113 - 2515mg/l. The high value of TDS in Dongiya Nallah due to the sewage flow from the adjoining villages
- Chloride ranged from 39 - 977mg/l in the surface water samples. Oil and Grease was BDL in all the water samples
- COD was in the range of 40-76mg/l, BOD varied from 0.9 to 1.5mg/l

Table 4.6.1 : Surface Water Sampling Locations

S. No	Sample Code	Sample Location	GPS Location	Remarks
1.	RMS-9	Dongiya Nala Sample	24°11'56.32"N 83°02'35.97"E	Sewage from hiteer colony and others flow through this Nallah and meets Rihand dam
2.	RMS-10	Rihand dam-near Grasim-intake well	24°11'41.11"N 83°03'04.04"E	Near Grasim – intake well pump house Rihand dam
3.	RMS-11	Near Dongia Nallah confluence point	24°11'54.74"N 83°02'37.85"E	Sample collected near dongia nallah after confluence point river
4.	RMS-12	Downstream after dongia nallah	24°11'31.86"N 83°02'33.50"E	Surface water sample collected after Dongia nallah confluence point downstream

Table 4.6.2 : Surface water Quality - Physical Parameters

Sr. No	Sample Code	pH	Temp (°C)	Turbidity (NTU)	TSS (mg/l)	TDS (mg/l)	Conductivity (µS/cm)
1.	RMS-9	8.3	32.1	0.7	14.6	2515	4190
2.	RMS-10	8.5	32.0	0.2	5.3	113	192
3.	RMS-11	8.5	31.7	0.1	3.0	122	201
4.	RMS-12	8.5	31.5	0.2	2.2	121	198

Table 4.6.3 : Surface water Quality- Inorganic Parameters

Sr. No	Sample Code	Total Hardness	Calcium	Magnesium	Sodium	Potassium
		mg/l				
1.	RMS-9	568	114	68	483	6.0
2.	RMS-10	64	16	6.0	11	3.0
3.	RMS-11	56	13	6.0	18	2.0
4.	RMS-12	80	19	8.0	10	2.0

Table 4.6.4 : Surface water Quality- Inorganic Parameters

Sr. No	Sample Code	Total Alkalinity	Sulphate	Chloride	Salinity	Fluoride
		mg/l			‰	mg/l
1.	RMS-9	52	82	977	1.78	0.79
2.	RMS-10	24	11	42	0.08	0.66
3.	RMS-11	16	12	51	0.09	0.74
4.	RMS-12	28	15	39	0.07	0.44

Table 4.6.5: Surface water Quality – Nutrient Parameters

Sr. No.	Sample Code	Nitrate (as NO ₃)	Total Phosphorus (as P-PO ₄)	Available Phosphorus (as P-PO ₄)	O&G
		mg/l			
1.	RMS-9	7.49	0.112	0.078	BDL
2.	RMS-10	0.74	0.011	0.004	BDL
3.	RMS-11	0.20	0.025	0.005	BDL
4.	RMS-12	0.74	0.026	0.014	BDL

Table 4.6.6 : Surface water Quality- Nutrient Parameters

Sr. No	Sample Code	Available N	Nitrites	TKN	O&G	COD	DO	BOD	TC	FC	TVC
		mg/l								CFU/100ml	CFU/ml
1.	RMS-9	2.5	0.070	2.8	BDL	40	7.0	1.0	-	-	-
2.	RMS-10	0.7	BDL	1.4	BDL	64	7.0	1.5	TNC	ND	11×10 ⁵
3.	RMS-11	BDL	0.010	0.56	BDL	40	6.5	0.9	TNC	ND	300×10 ⁵
4.	RMS-12	0.69	BDL	0.84	BDL	76	6.7	1.1	TNC	100	240×10 ⁵

Table 4.6.7 : Groundwater Quality –Heavy Metals

Sr. No	Sample Code	As	B	Cd	Co	Cr	Cu	Fe	Mn	Ni	Pb	Zn	Hg
		mg/l											
1.	RMS-9	BDL	BDL	BDL	0.001	BDL	0.004	BDL	BDL	BDL	BDL	BDL	<0.001
2.	RMS-10	BDL	0.003	BDL	BDL	BDL	BDL	0.240	BDL	BDL	0.008	0.027	<0.001
3.	RMS-11	BDL	0.018	BDL	BDL	BDL	0.002	BDL	BDL	BDL	0.001	0.012	<0.001
4.	RMS-12	BDL	0.063	0.001	BDL	BDL	0.007	BDL	BDL	BDL	0.004	BDL	<0.001

4.7 Sediment Quality

4.7.1 Sediment Characterization

Suspended matter may be divided into different categories that generally are divided as organic and inorganic suspended matter. Organic suspended matter contains mainly phytoplankton. Inorganic part contains mainly sediments that are suspended by currents and waves, or taken to the water column by human activities like dredging and dumping.

Sediment of Dongiya nala was collected as per the standard procedure using Van Veen Grab Sampler to assess the prevailing status of sediment quality. The location of Dongia Nala (R-MS-3) identified within project area are given in Table 4.7.1 & Fig. 4.8.3 A&B. The analysis of sediment samples have been carried out as per the standard methods. Sediment quality have been determined viz., texture, distribution of particle size, Total Organic carbon and Heavy Metals.

The sediment texture is observed to be predominantly sandy as coarse and fine sand are dominant with a value of 80.62% and 14.55% as compared to clay and silt content (2.31% and 2.52%) in the sediment sample. TOC content of Dongiya Nala sediment was observed to be 1.12%. Sediment quality is furnished in Tables 4.7.1 to 4.7.2.

4.7.2 Heavy Metals

Sediment sample was analyzed for heavy metals such as Arsenic (BDL), Chromium (14.6 mg/kg), Boron (48.2 mg/kg), Zinc (81.5 mg/kg), Lead (12.3mg/kg), Nickel (28.0 mg/kg), Cadmium (3.0 mg/kg), Iron (22194 mg/kg), Manganese (911 mg/kg), Copper (15.6 mg/kg), Cobalt (15.0mg/kg), Mercury (0.23 mg/kg) (Table 4.7.3). Results were compared with the sediment quality guidelines of USEPA (1999) National recommended water quality criteria-correction-United State Environmental Protection Agency EPA 822-Z-99-001 and Consensus based sediment quality Guidelines, Recommendations for use and application, December 2003, Wiscosin, Dept of Natural Sources (ANNEXURE IV).

The heavy metal concentrations in the sample was below the Threshold Effect concentration limit as per above mentioned sediment quality guidelines (Annexure IV).

Table 4.7.1 Particle Size Distribution

S.No.	Sample Code	Particle Size Distribution (%)				Soil Texture
		Coarse Sand	Fine Sand	Silt	Clay	
1.	R-MS-3	80.62	14.55	2.52	2.31	Sand (S)

Table 4.7.2 Nutrient Parameters

S.No	Sample Code	Parameters		
		Total Nitrogen (%)	Total Phosphorus (%)	TOC (%)
1.	R-MS-3	0.07	0.05	1.12

Table 4.7.3 Heavy Metals in Sediment Sample

(unit : mg/kg)

S. No.	Sampling Locations	As	B	Cd	Co	Cr	Cu	Fe	Hg	Mn	Ni	Pb	Zn
1.	R-MS-3	BDL	48.2	3.0	15.0	14.6	15.6	22194	1.03	911	28.0	12.3	81.5

4.8 Soil Quality Assessment

The area under study is situated at Renukoot, Sonbhadra (U.P.). Sonbhadra district represents broadly 3 major soil groups: alfisols, ultisols, and vertisols. The alfisols and ultisols are formed in the northern and central part of Sonbhadra district. The ultisols type of soils are developed in the southern part of Sonbhadra District, with Dudhi complex granite gneissic parent rock. The chemical weathering of granite gneiss releases important nutrients like potassium, sodium, calcium, aluminium, iron, magnesium and silica, all important for agriculture.

These granitic parent rocks have undergone intense weathering under hot and humid climate to the extent that they have developed laterites. The soil taxonomic units encountered in the study area are Lithic Ustorthents and Typic Ustorthents. Lithic Ustorthents are associated with Hills/Ridges/Rock outcrops and occur in recently exposed or as thin regolith over hard rocks. Typic Ustorthents soils are not so extensive and are found in association with colluvial plain areas. Soil Map of Sonbhadra district is presented in Fig. 4.8.1

The major crops of the district are Paddy, Wheat, Arhar, Gram, Lentil, Linseed, Sesamum, Pea and Vegetables like Tomato, Brinjal, Chilli, Cucurbits and broad beans. The lack of irrigation facilities is one of the major factors affecting production and productivity of crops in this district. Major source of irrigation is canal supplying water from the reservoirs after storing rain water. Management of red, black soils with shallow depth and rocky nature located in undulated terrain is another problem of the district. Land use and land cover map of Sonbhadra district is presented in Fig. 4.8.2 (Source : Chopra Narayan, Land use planning of southern part of Sonbhadra District, U.P., using Remote Sensing Techniques, International Journal of Geomatics And Geosciences Vol. 2, No 4 2012).

4.8.1 Soil Characteristics

Field survey was undertaken to assess the soil quality in and around the secure land fill (SLF) site of Grasim, Renukoot. Locations are identified in and around SLF site for subsoil investigation. Thirteen The samples of soil from six locations were collected in and around the secured land filled sites (SLFs). The soil sample details are given in Table 4.8.1 and their respective locations are depicted in Fig. 4.8.3A&B. Representative soil samples were collected from depths of 0–15 cm, 15–30 cm and 30–45 cm at each of the identified locations near SLF and from 15–30 cm depth from locations of surrounding area for the analysis of physico-chemical characteristics including soil fertility parameters and heavy metals.

4.8.2 Methodology

The standard methods have been followed for the analysis. The international pipette method (Black, 1965 and Piper 1966) was adopted for determination of particle size analysis. The textural diagram was derived using “SEE soil class 2.0 version based on the United States Department of Agriculture (USDA) classification of soils. Physical parameters such as bulk density, porosity and water holding capacity were determined by KR Box method (Keen and Raczkowski, 1921). Soil permeability was determined by Constant Head method (ASTM D 2434).

The chemical characteristics of soil and Soluble cations & anions were measured by preparing soil extract in distilled water in ratio 1:2 (Jackson, 1967). Exchangeable cations and CEC were determined by Centrifuge / Sodium saturation method (EPA 9081, C A Black 1965). Organic carbon was determined by Walkey and Black method (1979). Fertility status of soil in terms of available nitrogen was determined by Kjeldhal method and available phosphorus by chlorostannous reduced molybdophosphorous blue colour method (Olsen method, 1954). Potassium was determined by flame photometric method (Jackson ML 1967). Heavy metals in soil were determined by extracting soil with conc. H₂SO₄ and conc. HNO₃ followed by analysis on Inductively Coupled Plasma Spectrometer (ICP) (APHA, 2017). Mercury was analyzed in Direct Mercury Analyzer 80 (DMA) (USEPA, Method 7473).

4.8.3 Physical Characteristics

Physical characteristics of soil samples are described through specific parameters, such as particle size distribution, texture, bulk density, porosity and water holding capacity and soil permeability. (Tables 4.8.2 to 4.8.3). The particle size distribution in terms of total sand, silt and clay is furnished in Table 4.8.2.

Particle size distribution: It is also known as gradation, refers to the proportions by dry mass of a soil distributed over specified particle-size ranges. Soil particles vary in size and are classified into sand, silt, and clay. Starting with the finest, clay particles are smaller than 0.002 mm in diameter. Particle size distribution is a major factor as it influences water holding capacity, bulk density, Soil moisture availability, and nutrient content. Fine sand content (14.55 to 78.16%) and Coarse Sand (1.49 to 80.62%) of the soil samples collected from the study area are found to be higher as compared to silt and clay content.

Soil Texture: Texture indicates the relative content of particles of various sizes, such as sand, silt and clay in the soil. Soil texture is a classification of soil based on its physical texture and characteristics, particularly the size of the particles that make up the soil. The predominant texture of soil in study area is sandy loam followed by Sand and loamy sand (Fig. 4.8.4). The coarser the soil texture, the smaller the active surface area of the soil particles, and the smaller is the resistance of the soil to erosion.

Soil density: Soil bulk density is the mass of dry soil per unit of bulk volume, including the air space while particle density is volumetric mass of solid soil. The bulk density and particle density of soils in the region are in the range of 1.17 to 1.45 g/cm³ and 2.00 to 2.94 g/cm³ (Table 4.8.3).

Soil Porosity: Soil porosity is a measure of air-filled pore spaces and gives information about movement of gases, inherent moisture, and development of root system and strength of soil. It is mainly controlled by the soil texture and the soil organic matter content. The porosity of soil samples in study area are found in the range of 38.56 to 55.72%, as the soils of the study area are mostly sandy loam in texture.

Water holding capacity: Water holding capacity is the ability of a certain soil texture to physically hold water against the force of gravity. It is primarily controlled by the texture and the organic matter content of soil. Water holding capacity of the samples ranged from 36.36 to 52.41% (Table 4.8.3).

Soil Permeability: Soil permeability, also called as hydraulic conductivity, is the rate of the flow of water through soil materials. It is an important parameter in estimating the rate at which a fluid will actually flow through a particular type of soil. Soil permeability of the soil samples were found to be moderately slow to moderate (0.36 cm/hr to 2.16 cm/hr as per soil permeability Class (Annexure SI).

4.8.4 Chemical Characteristics

The soil samples were analysed for various chemical parameters, viz. pH, electrical conductivity, soluble cations and anions, Sodium Adsorption Ration (SAR), nutrients and organic carbon content and presented in Tables 4.8.4 to 4.8.6.

Soil pH: It is an key parameter to indicate the alkaline or acidic nature of the soil. It also affects the microbial population, solubility of metal ions and regulates nutrient availability. Variation in pH of soil within the study area is presented in Table 4.8.4. The majority of the soil samples are moderately alkaline to strongly alkaline in nature with pH variation from 7.71 to 9.6.

Electrical conductivity: The soluble salts were determined from soil saturated extract (1:2). The soluble salts in soil samples are expressed in terms of electrical conductivity (EC) and have been observed in the range: 0.04 to 1.00 mS/cm, which fall in the salt free category (<2 mS/cm) (Annexure SII).

Soluble Cations & Anions: Soluble cations and anions in soils were determined in water and soil extract of 2:1 ratio. Soluble cations (in solution) can be removed by leaching or can be precipitate when soil is dried. Amongst the soluble cations, Ca and Mg are found in the range of 0.01 to 0.06 and 0.03 to 1.11meq/100g and Na and K are in the ranges of 0.01 to 0.94 and 0.001 to 0.007meq/100g of soil extract, respectively (Table 4.8.4). The most important anions present in soluble state in the soil are chlorides and sulphates. Chlorides ranged from 0.16 to 1.04 meq/100g and sulphates content ranged from 0.08 to 0.42 meq/100g. Many samples from the study area are found to be in Non-Salinized range with respect to Chloride except RMS S4 samples which are weakly salinized.

Sodium Adsorption ratio: Sodium adsorption ratio (SAR), along with pH, characterizes salt-affected soils. It is an easily measured property that gives information on the comparative concentrations of Na^+ , Ca^{2+} , and Mg^{2+} in soil solutions. SAR of most of the soil samples of the study area ranged from 0.10 to 0.69 except in samples near SLF -RMS S4 (11.03 to 14.46).

Soils that have SAR values of 13 or more may be characterized by an increased dispersion of organic matter and clay particles, reduced aeration, and a general degradation of soil structure (NRSC, USDA 2017).

Exchangeable Cations and CEC: The CEC of a soil together with exchangeable bases, provides a measure for evaluating the fertility status of soil. Amongst the exchangeable cation, the concentration of calcium and magnesium vary from 0.4 to 3.08 meq/100g and 3.39 to 10.61 meq/100g, respectively. Whereas sodium and potassium are in the range of 0.95 to 2.81 meq/100g and 0.128 to 0.64 meq/100g of soil, respectively. CEC of soil samples varied from 8.5 to 16.12 cmol (p+) kg⁻¹. Soil pH is important for CEC because as pH increases (becomes less acid), the number of negative charges on the colloids increase, thereby increasing CEC. Exchangeable sodium percentage (ESP) is varied from 10.32 to 26.82 (Table 4.8.5). The presence of sodium in exchangeable form may have deleterious effect on the chemical and physical properties of soil. ESP of soil is below 5% can be considered as normal in respective alkalinity level. Soils of the study area are more alkaline with respect to exchangeable sodium percentage which is above 15.

Organic Carbon & Available N, P, K: Organic carbon in soil samples varied in the range 1.0 to 2.9% which is in the fertile range. Available Nitrogen (N) in soil refers to the fraction of the total N which is converted in to forms accessible to the plant. In the soil samples of the study area, available nitrogen levels are poor (87.8 to 201 kg/ha) as per soil fertility ratings. Available phosphorus (P) refers to the inorganic form, occurring in the soil solution that may be available to plants. Available potassium (K) are water soluble and exchangeable K which are potentially available or fixed. Available K levels are found to be in the range of poor to medium (40.3 to 148 kg/ha) and Available P levels are in fertile range (39.45 to 99.85 kg/ha) as per Soil fertility ratings as per ICAR listed in Annexure II. The results show that the soil in study area is poor in Available nitrogen and Potassium level and fertile w.r.t organic carbon and available phosphorous. The fertility status of soil is presented in Table 4.8.6.

Heavy Metals: Trace levels of metals in soil are very important for the quality of soil and environment, however, excessive levels can cause toxicity in plants, foods and ultimately in animals and humans that feed upon them. All soils naturally contain trace levels of metals (Clain et al., 2007). The presence of metals in soil is not indicative of contamination as soils contain heavy metals naturally. Depending on the local geology, the concentration of metals in a soil may exceed the ranges (from literature) listed in Annexure-VI.

Soil samples were analyzed for heavy metals such as Arsenic (BDL to 12.2 mg/L), Boron (21.47 to 79.84 mg/kg), Cadmium (1.32 to 4.63 mg/kg), Chromium (3.09 to 39.36 mg/kg), Cobalt (6.62 to 28.03 mg/kg), Copper (10.42 to 39.79 mg/kg), Iron (11375 to 29722 mg/kg), Manganese (204 to 1094 mg/kg), Nickel (12.9 to 37.12 mg/kg), Lead (3.68 to 49.3 mg/kg) and Zinc (39.5 to 93.06 mg/kg). The observed levels of heavy metals are presented in Table 4.6.7. The heavy metal concentrations in the study area are below the screening level for Industrial area as per MoEF & CC Guidelines for contaminated sites in India (Annexure SIV) and concentration of Heavy metals in the sample of Location RMS-S7 (far way from SLF) are found to be below the screening levels for Residential and Agricultural area.

The mercury concentration in the soil samples collected adjacent to the SLF site are in the range of 0.1 to 40.0 mg/kg. The maximum concentration of mercury was found in the soils collected nearby the SLF site (RMS S2). However, mercury levels of all the soil samples were found to below the screening level for Industrial area as per MoEF & CC Guidance document for assessment and remediation of contaminated sites in India, 2015.

(https://cpcb.nic.in/uploads/hwmd/MoEFCC_guidelines_contaminatedsites.pdf).

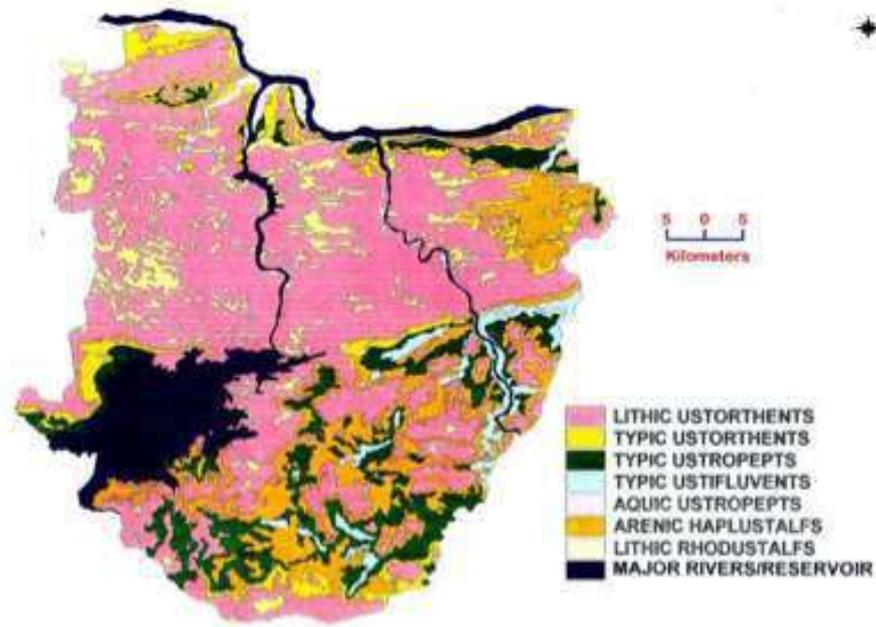


Fig. 4.8.1: Soil map

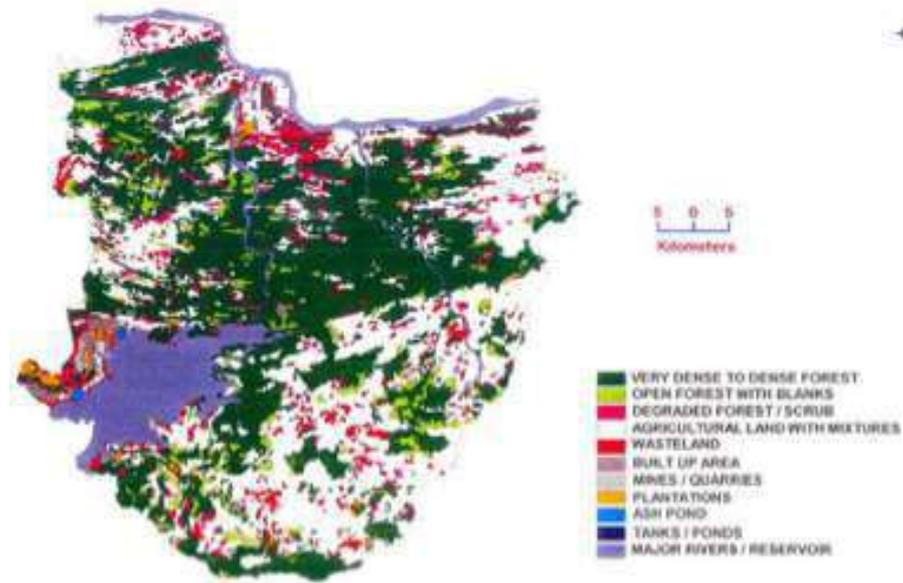


Fig. 4.8.2 : Landuse/ Land cover map

Source: Chopra Narayan, Land use planning of southern part of Sonbhadra District, U.P., using Remote Sensing Techniques, International Journal of Geomatics And Geosciences Vol. 2, No 4 (2012)

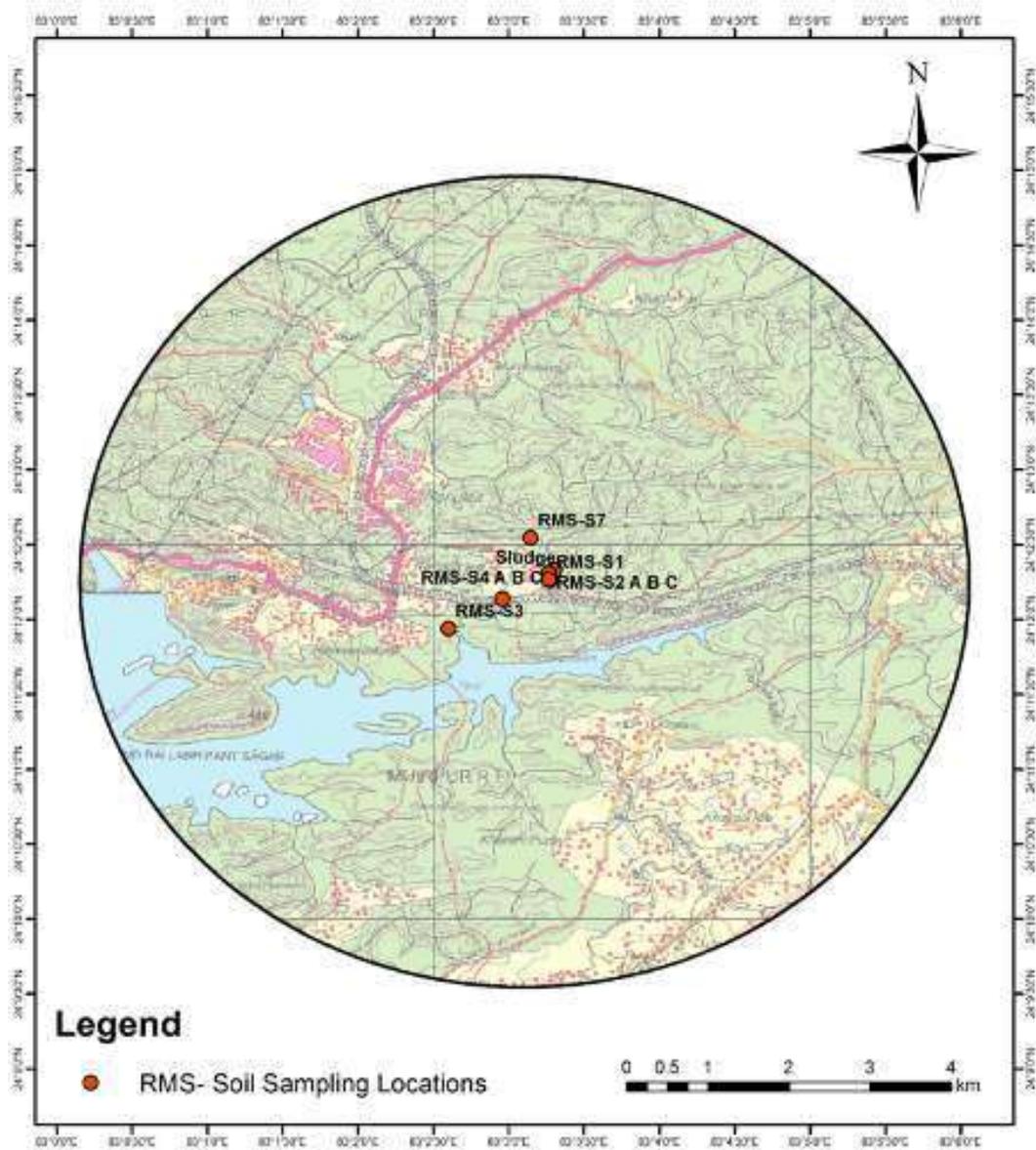


Fig. 4.8.3A : Soil sampling locations (3km radius)

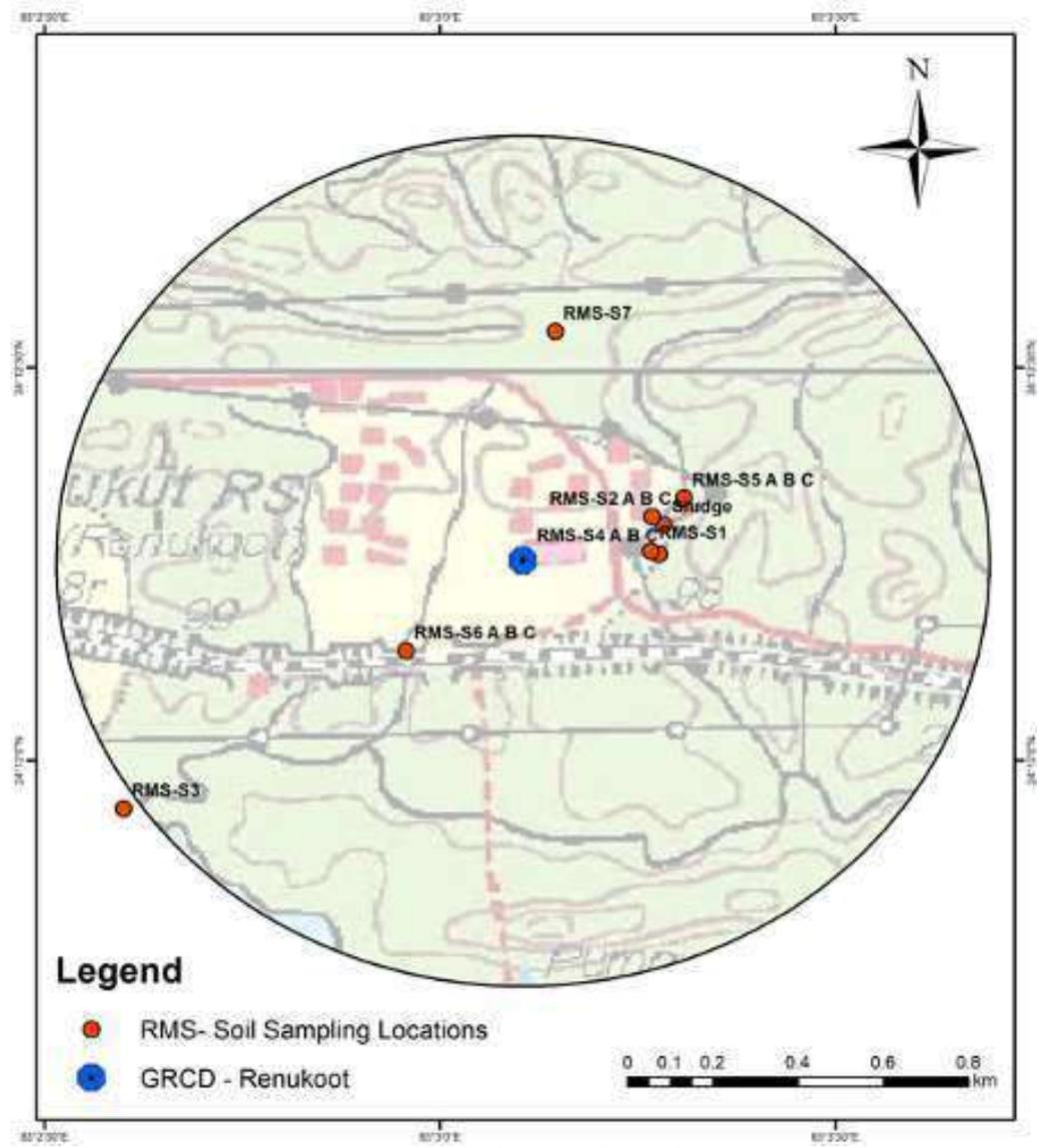


Fig. 4.8.3 B : Soil sampling locations

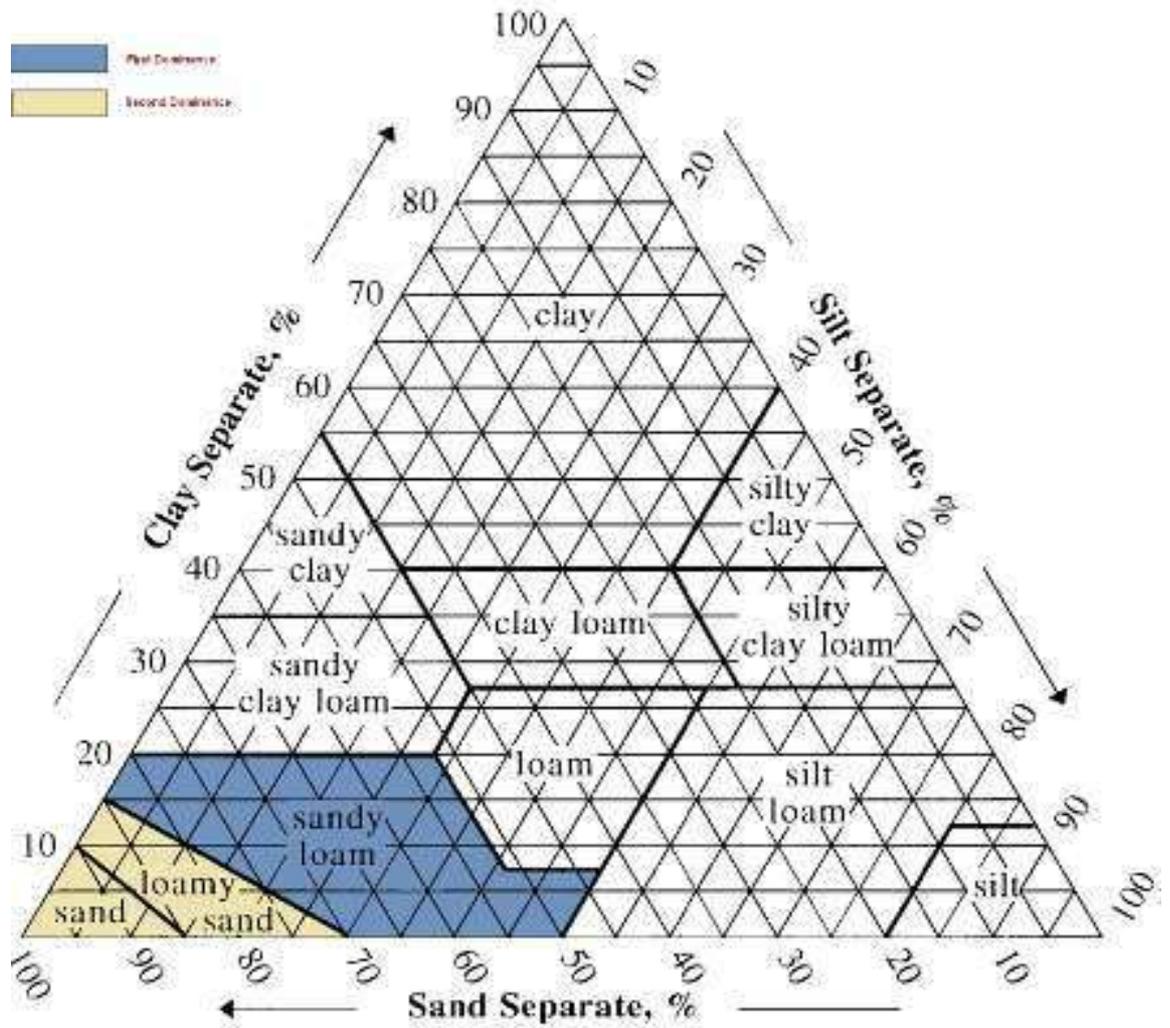


Fig. 4.8.4 : Predominant Soil Texture in Study Area

Table 4.8.1 Soil & Sediment Sampling Locations

S.No	Sample Code	Sample Location	GPS Location	Sample Type	Remarks
6.	RMS-S1	Near Peizometer inside the industry	24°12'16.00"N 83°03'16.00"E	Soil	-
7.	RMS-S2 A	Beside SLF	24°12'18.61"N 83°03'16.09"E	Soil (0-15cm)	-
8.	RMS-S2 B	Beside SLF	24°12'18.61"N 83°03'16.09"E	Soil (15-30 cm)	-
9.	RMS-S2 C	Beside SLF	24°12'18.61"N 83°03'16.09"E	Soil (30-45 cm)	-
10.	RMS-S3	Dongiya nala	24°11'56.32"N 83°02'35.97"E	Sediment	Sediment Sample
11.	RMS-S4 A	Near SLF	24°12'15.79"N 83°03'16.64"E	Soil (0-15cm)	Between Ely track and power plant
12.	RMS-S4 B		24°12'15.79"N 83°03'16.64"E	Soil (15-30 cm)	
13.	RMS-S4 C		24°12'15.79"N 83°03'16.64"E	Soil (30-45 cm)	
14.	RMS-S5 A	Near SLF	24°12'20.05"N 83°03'18.53"E	Soil (0-15cm)	Soil sample collected adjacent to SLF near hill side
15.	RMS-S5 B		24°12'20.05"N 83°03'18.53"E	Soil (15-30 cm)	
16.	RMS-S5 C		24°12'20.05"N 83°03'18.53"E	Soil (30-45 cm)	
17.	RMS-S6 A	Near boundary wall of STP/ETP discharge point	24°12'08.37"N 83°02'57.43"E	Soil (0-15cm)	Adjacent to Railway track.
18.	RMS-S6 B		24°12'08.37"N 83°02'57.43"E	Soil (15-30 cm)	
19.	RMS-S6 C		24°12'08.37"N 83°02'57.43"E	Soil (30-45 cm)	
20.	RMS-S7	Lal Bungalow Area	24°12'32.76"N 83°03'08.76"E	Soil (0-15 cm)	Opposite to Buildings adjacent to banyan tree

Table 4.8.2 Soil - Particle size distribution

Sr. No.	Sampling Locations	Particle Size Distribution (%)				Soil Texture
		Coarse sand	Fine sand	Silt	Clay	
1.	RMS-S1	29.18	56.06	3.08	11.69	loamy sand (LS)
2.	RMS-S2 A	33.52	46.74	14.62	5.12	loamy sand (LS)
3.	RMS-S2 B	10.66	61.22	20.51	7.61	sandy loam (SL)
4.	RMS-S2 C	14.30	73.16	10.97	1.57	sand (S)
5.	RMS-S4 A	80.62	14.55	2.52	2.31	sand (s)
6.	RMS-S4 B	23.61	26.17	39.58	10.64	loam (L)
7.	RMS-S4 C	28.81	41.13	13.54	16.53	sandy loam (SL)
8.	RMS-S5 A	2.55	63.62	30.88	2.96	sandy loam (SL)
9.	RMS-S5 B	32.66	38.06	15.49	13.79	sandy loam (SL)
10.	RMS-S5 C	11.18	78.16	2.05	8.61	sand (S)
11.	RMS-S6 A	1.49	74.00	18.49	6.02	sandy loam (SL)
12.	RMS-S6 B	27.62	44.32	15.92	12.14	sandy loam (SL)
13.	RMS-S6 C	26.57	45.26	15.80	12.37	sandy loam (SL)
14.	RMS-S7	31.25	31.07	21.54	16.14	sandy loam (SL)

Table 4.8.3 : Physical Properties of soil

Sr. No.	Sampling locations	Density(g/cc)		Porosity Percent (%)	Water Holding Capacity (%)	Permeability (cm/sec)
		Bulk	particle			
1.	RMS-S1	1.45	2.50	42.10	36.36	0.36
2.	RMS-S2 A	1.41	2.70	47.82	40.25	0.72
3.	RMS-S2 B	1.38	2.27	39.20	38.80	
4.	RMS-S2 C	1.36	2.50	45.71	45.41	
5.	RMS-S4 A	1.17	2.63	55.72	52.00	1.08
6.	RMS-S4 B	1.22	2.00	38.96	52.32	
7.	RMS-S4 C	1.24	2.56	51.78	42.57	
8.	RMS-S5 A	1.37	2.94	53.53	52.41	2.16
9.	RMS-S5 B	1.33	2.22	40.14	48.02	
10.	RMS-S5 C	1.34	2.86	53.07	48.56	
11.	RMS-S6 A	1.25	2.04	38.56	47.48	0.36
12.	RMS-S6 B	1.25	2.27	44.81	41.07	
13.	RMS-S6 C	1.22	2.56	52.44	47.52	
14.	RMS-S7	1.14	2.50	54.35	51.44	0.72

Table 4.8.4 Chemical Properties of Soil Extract (water soluble)

Sr. No.	Sampling Locations	pH	EC mS/cm	Ca ⁺⁺	Mg ⁺⁺	Na ⁺	K ⁺	SO ₄ ⁻	Cl ⁻	SAR (meq/l)
				----- (meq/100gm) -----						
1.	RMS-S1	7.92	0.09	0.01	0.07	0.04	0.004	0.16	0.24	0.69
2.	RMS-S2 A	8.91	0.13	0.03	0.35	0.03	0.001	0.22	0.16	0.24
3.	RMS-S2 B	9.58	0.12	0.02	0.10	0.04	0.001	0.27	0.20	0.54
4.	RMS-S2 C	9.32	0.14	0.02	0.17	0.04	0.001	0.23	0.20	0.46
5.	RMS-S4 A	9.33	1.02	0.01	0.14	0.94	0.002	0.19	1.00	11.03
6.	RMS-S4 B	9.6	1.00	0.01	0.03	0.64	0.001	0.33	1.04	14.46
7.	RMS-S4 C	9.09	0.84	0.01	0.03	0.91	0.002	0.42	1.12	11.13
8.	RMS-S5 A	8.04	0.07	0.01	1.18	0.03	0.002	0.16	0.24	0.12
9.	RMS-S5 B	7.99	0.09	0.01	1.04	0.04	0.001	0.19	0.24	0.15
10.	RMS-S5 C	8.26	0.05	0.01	1.11	0.03	0.001	0.20	0.24	0.13
11.	RMS-S6 A	8.37	0.04	0.03	0.35	0.01	0.005	0.29	0.20	0.10
12.	RMS-S6 B	8.43	0.04	0.01	0.07	0.03	0.006	0.08	0.16	0.25
13.	RMS-S6 C	8.1	0.05	0.01	0.03	0.04	0.007	0.09	0.28	0.45
14.	RMS-S7	7.71	0.27	0.06	0.21	0.02	0.002	0.39	0.32	0.14

Table 4.8.5: Exchangeable Cations

S. No	Sampling Locations	Ca ⁺⁺	Mg ⁺⁺	Na ⁺	K ⁺	CEC	ESP%
		←----- (meq/100gm) -----→					
1.	RMS-S1	2.44	4.86	1.37	0.164	12.53	15.50
2.	RMS-S2 A	1.04	6.94	0.95	0.264	11.24	10.32
3.	RMS-S2 B	1.16	6.25	1.24	0.164	9.82	14.09
4.	RMS-S2 C	2.64	4.39	2.01	0.128	10.46	21.89
5.	RMS-S4 A	0.64	6.83	2.81	0.192	8.54	26.82
6.	RMS-S4 B	0.40	9.03	2.67	0.192	16.12	21.72
7.	RMS-S4 C	0.69	10.61	2.34	0.154	13.79	16.97
8.	RMS-S5 A	0.68	9.03	1.96	0.128	8.50	16.64
9.	RMS-S5 B	1.03	7.22	1.78	0.128	12.04	17.50
10.	RMS-S5 C	1.72	3.39	1.23	0.164	9.41	18.91
11.	RMS-S6 A	2.02	4.39	1.26	0.321	11.74	15.81
12.	RMS-S6 B	1.50	6.81	1.33	0.640	13.41	12.96
13.	RMS-S6 C	1.98	8.81	1.83	0.192	10.27	14.32
14.	RMS-S7	3.08	4.08	1.81	0.264	10.17	19.56

Table 4.8.6 : Soil Fertility Status

S. No.	Sample Code	Organic Carbon (%)	Available		
			N	P	K
			Kg/ha		
1.	RMS-S1	0.68	125	98.94	55.2
2.	RMS-S2 A	1.42	100	99.24	40.3
3.	RMS-S2 B	0.80	138	99.85	37.3
4.	RMS-S2 C	0.60	113	70.11	44.8
5.	RMS-S4 A	1.68	151	77.39	43.7
6.	RMS-S4 B	1.21	125	67.07	41.7
7.	RMS-S4 C	1.07	138	83.46	54.9
8.	RMS-S5 A	0.82	87.8	57.97	48.6
9.	RMS-S5 B	0.78	201	64.34	56.3
10.	RMS-S5 C	0.76	100	39.45	54.9
11.	RMS-S6 A	1.21	201	67.07	141
12.	RMS-S6 B	0.96	251	87.10	148
13.	RMS-S6 C	1.11	138	72.84	116
14.	RMS-S7	0.51	176	77.39	105
Poor soil		< 0.5	< 280	<10	<108
Medium soil		0.5-0.75	280-560	10-24.6	108-280
Fertile soil		>0.75	> 560.0	> 24.6	>280

Nutrient status Classification: Source: Soil Testing in India, Dept. of Agri. And Cooperation, Ministry of Agriculture, Govt. of India, 2011

Table 4.8.7 Heavy metal content of the Soil

S.No	Sample Code	As	B	Cd	Co	Cr	Cu	Fe	Hg	Mn	Ni	Pb	Zn
		mg/kg											
1.	RMS-S1	0.20	40.0	2.6	6.9	12.1	20.5	18404	0.10	283	13.0	7.0	65.7
2.	RMS-S2 A	10.2	41.5	2.3	10.8	3.1	24.9	18263	27.0	363	33.0	49.4	76.3
3.	RMS-S2 B	11.1	35.2	2.0	11.8	5.3	27.2	17961	40.0	355	25.7	18.0	68.6
4.	RMS-S2 C	12.2	50.9	3.0	14.3	22.0	36.7	22629	35.8	466	29.3	26.1	93.1
5.	RMS-S4 A	8.10	30.6	1.7	6.6	13.9	10.4	16381	2.82	204	13.8	3.7	39.5
6.	RMS-S4 B	7.7	42.0	2.3	8.4	27.0	14.2	18705	4.35	263	19.0	9.6	61.9
7.	RMS-S4 C	9.4	33.1	1.9	8.8	15.6	15.7	16244	9.74	306	16.8	8.6	59.0
8.	RMS-S5 A	11.2	79.8	4.6	28.0	39.4	39.8	29722	0.48	1094	37.1	9.6	69.0
9.	RMS-S5 B	10.4	63.7	3.7	24.3	27.6	30.8	25657	0.36	1078	33.3	9.1	60.2
10.	RMS-S5 C	8.90	48.8	2.8	17.6	17.8	24.1	22478	0.34	680	20.7	4.0	44.9
11	RMS-S6 A	0.10	48.0	2.8	12.0	22.5	18.6	21301	0.23	390	21.3	19.2	78.8
12	RMS-S6 B	6.80	43.9	2.5	10.6	7.3	20.2	19829	0.37	336	19.2	15.8	71.4
13	RMS-S6 C	0.30	52.3	3.4	11.3	20.0	20.9	22501	0.24	381	22.2	19.7	92.4
14	RMS-S7	BDL	21.5	1.3	6.7	11.0	16.9	11376	3.04	224	17.5	6.4	54.3



CHAPTER -5

CONCLUSIONS & RECOMMENDATIONS



5.0 Summary & Conclusions

A systematic study on assessment of groundwater and sludge/soil quality in and around secured land fill sites of Grasim Renukoot Chemical Division, Renukoot was conducted through monitoring of piezometers/bore wells/hand pumps/open wells as well as mercury bearing sludge and soils within 5km radius of the SLF site. The field work was conducted in the study area for collecting the groundwater samples from monitoring wells (13 nos.), piezometer (1 no.), wells (8 nos. of bore wells/tube wells) and soil/sludge samples (13 nos.) and collected samples were analyzed for assessing the impacts of SLF site on groundwater and soil quality.

The pH of water samples was normal and varied from 6.5 to 8.5. Groundwater temperatures were recorded more than 25°C in all the samples of groundwater and this may be attributed to climatic conditions prevailing in that area. TDS values varied from 224 - 4790mg/l in the study area. High TDS levels in the groundwater attributed to high sodium and high chloride contents. High levels of EC in monitoring wells indicate corrosive nature of water. The alkalinity values in study area are ranged from 44 to 250mg/l. The sodium concentration varied from 16 to 2587mg/l.

Chloride concentration in groundwater varied in the range of 32 to 4085mg/l. High chloride values (>1000mg/l) is due to the underlying rocks such as Precambrian belonging to Mahakoshal Group and Chotanagpur Granite Gneiss Complex (CGGC). The sulphate concentration varied from 11 to 204mg/l in the area. Fluoride concentration ranged from 0.57 to 1.32 mg/l and is within permissible limits as per BIS.

Iron, Manganese, Nickel and lead concentrations at some of the locations were found to be higher than the permissible limits. The high levels of these metals may be attributed to the underlying geological rocks. These rocks contain the heavy metals like chromium, iron, manganese etc which contribute to the elevated levels in groundwater samples. Both Fe and Mn are the rich metallic elements in natural water. Mn present in igneous and metamorphic rocks as a minor constituent. Mn²⁺ salts have high solubility but under aeration conditions, they are oxidized precipitating oxyhydroxides.



Groundwater parameter analysis has been performed by the hydrochemical diagrams viz., Piper Plot, Gibbs Plot and Wilcox using AQUACHEM software for assessing the dissolved constituents sources in water. Piper plot revealed that most of the samples are mixed Na-Ca-Cl dominant fluids, suggest mineral dissolution. The cation and anion Gibbs plot indicates that the samples lie in rock dominance. Thus, the hydrochemical diagrams revealed that the chemistry of groundwater is influenced by the relation of parameters with their respective lithologies in the aquifer, representing the rock-water interaction. Plots indicate that the high values of groundwater quality are due to the interactions between the rock and water.

The weighted arithmetic average method is applied for the calculation of water quality index considering maximum permissible limits of BIS. The groundwater quality index values ranged between 15 - 145, revealing water of excellent to poor quality. Any well water in case to be used for drinking purposes should possibly be treated before drinking.

Thirteen samples of soil were collected from six locations to assess soil quality in and around secure land fill (SLF) site of Grasim, Renukoot. Samples were collected from various depths of 0-15 cm, 15-30 cm and 30-45 cm at each of the identified locations near SLF and from 15-30 cm depth from locations of surrounding area. Fine sand (14.55 to 78.16%) and coarse sand (1.49 to 80.62%) of the soil samples are found to be higher as compared to silt and clay content. The porosity of soil samples in study area are found in the range of 38.56 to 55.72%, as the soils are mostly sandy loam in texture. Soil permeability were found to be moderately slow to moderate (0.36 to 2.16cm/hr as per soil permeability Class). Most of the soil samples are moderately alkaline to strongly alkaline with pH variation from 7.71 to 9.6. Soils in the study area are found to be in Non-Salinized range with respect to Chloride. Soils are poor in available nitrogen and potassium level and fertile w.r.t organic carbon and available phosphorous. The heavy metal concentrations in the soils are below the screening level for Industrial area as per MoEF&CC Guidelines for contaminated sites in India. The mercury concentration in the soil samples were found to below the screening level for Industrial area as per MoEF&CC Guidance document.



The mercury bearing sludge, top soil and ash samples were collected from secured land fill site and analyzed for various physico chemical parameters and heavy metals including mercury. Top soil, ash and sludge samples are strongly alkaline in nature with pH variation from 8.48 to 10.26. EC of sludge and ash layer have been observed to be 20.6 to 25mS/cm, whereas EC of top soil and ash layer HDPE is observed to be in the range of 3.17 to 4.26, respectively. Sludge and ash layer were observed to be highly saline and top soil samples are moderately saline in nature. Concentration of mercury in the sludge and HDPE Ash layer samples were found to be high (40 mg/kg) as compared to Top soil (10.07 mg/kg) and Ash layer (29.19 mg/kg). TCLP analysis was carried out following USEPA hazardous waste test method to determine inorganic analytes in the leachate and observed that heavy metals are below TCLP concentration Limit (Management & Transboundary Movement Rules, 2016). Therefore, possibility of leaching of metals including mercury from the mercury bearing sludge and ash layers from the secured land fill is minimal.

As per the study conducted by CSIR-NEERI during 2019, it was observed that mercury was not leaching from the SLF and also not contaminating the groundwater. In view of this, it was not recommended to decommission the stabilised SLF for shifting the mercury contaminated sludge. The report recommended the construction of storm water drainage (leachate collection system) around the SLF and treating this in the existing ETP.

During the current study, it was observed that GRCD has installed leachate collection system and the leachate is being treated in the existing ETP. The system is shown in Annexure – A.

To summarise, the study has revealed that the mercury sludge in SLF is stabilized and there is no considerable evidence for leaching of mercury from SLF. Geologically, the study area is comprised of Precambrian rocks, which is very hard rock and have no permeability.



References

APHA (2012). Standard methods for analysis of the water and waste water analysis, 22nd editions.

BIS (2012). Indian standard specification for drinking water. IS: 10500.

Groundwater Broacher of Sonbhadra District, Uttar Pradesh, By Dr.H.K.Pandey, Scientist C, 2012-2013, Central Groundwater Board, Government of India



Leachate Collection System

Year Wise Disposal Details of Waste From April 2019 to February 2021

YEAR WISE DISPOSAL DETAILS OF WASTE FROM APR'19 TO FEB'21

Sl No	Material Description	Unit	Despatched Qty	
			FY_2019-20	FY_2020-21 (Up to Feb'21)
1	FRP Waste	MT	0.00	12.46
2	MEE Salt Sludge	MT	910.97	306.09
3	ETP Sludge	MT	60.35	31.90
4	E-Waste	MT	2.78	0.41
5	Waste Oil	Drum (210 Ltr)	31.00	19.00
6	Brine Sludge (Membrane cell process)	MT	6294.03	13525.16
7	Lead Acid Batteries	NOS	0.00	4.00
8	Bio Medical Waste	KG	100.50	88.47
9	Plastic Waste	MT	195.18	114.28

Ref. No : 13583/UPPCB/Sonebhadra(UPPCBRO)/HWM/SONBHADRA/2020

Dated :02/03/2021

To,

M/s GRASIM INDUSTRIES LIMITED CHEMICAL DIVISION RENUKOOT

GRASIM INDUSTRIES LIMITED CHEMICAL DIVISION RENUKOOT
,SONBHADRA,231217

Tehsil :Duddhi

District :SONBHADRA

Sub :- Authorisation issued under the provisions of Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016

1.Number of authorization and date of issue 13583 and02/03/2021 .

2.Reference of application (No. and date) 10586194 and31/12/2020 .

3.Mr SHRIDHARA SASTRY of M/s GRASIM INDUSTRIES LIMITED CHEMICAL DIVISION RENUKOOT is hereby granted an authorization based on the enclosed signed

inspection report for generation, collection, utilization, storage and disposal or any other use of hazardous or other wastes or both on the premises situated at GRASIM INDUSTRIES LIMITED CHEMICAL DIVISION .

Details of Authorisation



S No.	Category of Hazardous Waste as per the Schedules I,II and III of these rules	Authorised mode of disposal or recycling or utilization or co-processing, etc.	Quantity(ton/annum)
1	Spent ion exchange resin containing toxic metals (Sch-1, S.No. 35.2)	Through TSDF	50 Ton/Annum
2	Spent Carbon or filter medium (Sch.-1, S No.-36.2)	Through TSDF	20 Ton/Annum
3	Used or spent oil (Sch.-1, S.No.-5.1)	Authorized Recyclers	50 Ton/Annum
4	Wastes or residues containing oil (Sch.-1, Cat.-5.2)	Through TSDF	5 Ton/Annum
5	Brine Sludge (Sch.1, S.No. 16.3)	Through TSDF	10000 Ton/Annum
6	Residue or sludges and filter cakes (Sch-1, S.No. 16.2)	Through TSDF	6 Ton/Annum
7	Asbestos (Sch-II, B21)	Through TSDF	100 Ton/Annum
8	Spent Carbon or filter medium (Sch.-1, Cat.-36.2)	Through TSDF	5 ton/annum
9	Empty barrels/ containers/liners contaminated with hazardous chemicals /wastes (Sch.-1, Cat.-33.1)	Through TSDF	100 Ton/Annum
10	Rubber Wastes (Sch-III, B3040)	Through TSDF	5 Ton/Annum
11	Ferro Silicate and alloys (Sch-II, B28)	Through TSDF	1 Ton/Annum
12	Chemical sludge from waste water treatment (Sch.-1, Cat.-35.3)	Through TSDF	150 Ton/Annum
13	Chemical sludge from waste water treatment (Sch.-1, Cat.-35.3)	Through TSDF	2800 Ton/Annum
14	Drosses and Waste from treatment of salt sludge (Schedule-1 S.No. 11.5)	Through TSDF	100 Ton/Annum
15	Exhaust Air or Gas cleaning residue (Sch-I, S.No. 35.1)	Through TSDF	10 ton/annum
16	Halogen- containing compounds which produce acidic vapours on contact with humid air or water e.g. silicon tetrachloride, aluminum chloride, titanium tetrachloride (Sch-II, B30)	Through TSDF	120 Ton/Annum
17	Halogen- containing compounds which produce acidic vapours on contact with humid air or water e.g. silicon tetrachloride, aluminum chloride, titanium tetrachloride (Sch-II, B30)	Through TSDF	800 Ton/Annum

1. The authorization shall be valid for a period of 02/03/2026 from the date of issue of this letter.
2. The authorization is subject to the following general and specific conditions (please specify any conditions that need to be imposed over and above general conditions, if any).

A General Conditions of Authorization -

1. The authorised person shall comply with the provisions of the Environment (Protection) Act, 1986, and the rules made there under .
2. The authorisation or its renewal shall be produced for inspection at the request of an officer authorised by the State Pollution Board .
3. The person authorized shall not rent, lend, sell, transfer or otherwise transport the hazardous and other wastes except what is permitted through this authorization .
4. Any unauthorized change in personnel, equipment or working conditions as mentioned in the application by the person authorized shall constitute a breach of his authorisation .
5. The person authorised shall implement Emergency Response Procedure (ERP) for which this authorisation is being granted considering all site specific possible scenarios such as spillages, leakages, fire etc. and their possible impacts and also carry out mock drill in this regard at regular interval of time .
6. The person authorised shall comply with the provisions outlined in the Central Pollution Control Board guidelines on Implementing Liabilities for Environmental Damages due to Handling and Disposal of Hazardous Waste and penalty .
7. It is the duty of the authorised person to take prior permission of the State Pollution Control Board to close down the facility .
8. The imported hazardous and other wastes shall be fully insured for transit as well as for any accidental occurrence and its clean-up operation .
9. The record of consumption and fate of the imported hazardous and other wastes shall be maintained .
10. The hazardous and other waste which gets generated during recycling or reuse or recovery or pre-processing or utilisation of imported hazardous or other wastes shall be treated and disposed of as per specific conditions of authorisation .
11. The importer or exporter shall bear the cost of Import or export and mitigation of damages if any
12. An application for the renewal of an authorisation shall be made as laid down under these Rules .
13. Any other conditions for compliance as per the Guidelines issued by the Ministry of Environment, Forest and Climate Changes or Central Pollution Control Board from time to time .
14. Annual return shall be filed by June 30th for the period ensuring 31st March of the year .
15. The Unit will file the renewal application at least 2 months prior to the expiry of this Order.

B Specific Conditions of Authorization

1. The wastes must be safely collected in leak proof containers and shall be duly marked in a manner suitable for handling, storage and transport and the packaging shall be easily visible and be able to withstand physical conditions and climatic factors. All hazardous waste containers / bags shall be provided with a general label. The storage area should be at an isolated spot in the premises and must be fenced, covered and duly marked.
2. The authorized person/agency shall ensure that no adverse impact on the air, soil and water including groundwater takes place due to activities for which authorization has been requested. Comprehensive safety measures must be followed in handling of wastes and the staff must be properly trained.
3. The authorized person shall not receive, collect, or store any hazardous waste from any unauthorized occupier or generator of hazardous wastes. In case any hazardous wastes is sold to any other reprocessing unit it must be ensured that such unit is fully complying with environmental requirements and has a valid authorization of the Board.
4. In no case any hazardous wastes shall be disposed off on land, in any drain or stream. All spillages of hazardous chemicals, used containers, of hazardous chemicals such as flammable corrosive, explosive and toxic nature must be safely collected and stored. Non-compatible wastes must be suitably and safely handled.
5. It is within the powers and functions of the U.P. Pollution Control Board to modify / revoke the terms and conditions of the authorization issued under the Rule – 7 of Hazardous and Other Wastes (Management & Transboundary Movement) Rules, 2016.
6. You are directed to display board outside the main factory gate with regard to quantity and nature of hazardous chemicals being handled in the plant, including waste water and air emission and solid hazardous waste generated within the factory premises. Necessary compliance should be sent within 15 days of receipt of this letter.
7. It is the mandatory duty of the authorized person to comply with the guidelines for transportation of hazardous waste in accordance with rule 18 of Hazardous and Other Waste (Management and Transboundary Movement) Rules, 2016.
8. It should be ensured that hazardous wastes shall be properly collected and packed in HDPE bags and then temporarily stored in a lined RCC tank/pit with suitable shed.
9. An ETP sludge/salt test report of a laboratory approved under E.P. Act shall be submitted along with compliance of this letter of this office.
10. Used oil shall be sold only to recyclers registered with U.P. Pollution Control Board. The record shall be maintained.
11. The occupier, transporter and operator of a facility shall be liable for damages caused to the environment resulting due to improper handling and disposal of hazardous waste listed in schedule 1,2, and 3 and shall be liable to pay a fine as levied by the State Pollution Control Board under the rules.
12. You shall have the valid membership of any common TSDF for S.L.F. (M/S U.P. Waste Management Project Kumbhi Kanpur Dehat or M/s Bharat Oil and Waste Management Ltd., Kumbhi, Akbarpur, Kanpur Dehat. permitted by U.P.P.C.B.), and start sending the stored hazardous wastes for final disposal to the TSDF and report back to U.P.P.C.B. with the required manifesto (document of proof) within three month of this letter. The authorized incinerator is with M/s Bharat Oil Company, Sahibabad, Ghaziabad for oily waste and paint sludge only.
13. You are required to store the hazardous waste safely and send it to TSDF/incinerator within stipulated time period.
14. This authorization is valid till the industry is having valid consent as per the provisions of Air (Prevention and Control of Pollution) Act 1981 and Water (Prevention and Control of Pollution) Act, 1974.

(Authorized Signatory)

Ajay Kumar

Digitally signed by Ajay
Kumar Sharma
Date: 2021.03.05 10:47:10

UTTAR PRADESH POLLUTION CONTROL BOARD

Copy to: To the Regional Officer, U.P. Pollution Control Board,
Sonbhadra for information and
necessary action .

Ajay Kumar Sharma
CEO/EE, I/C Circle

Digitally signed by Ajay
Kumar Sharma
Date: 2021.03.05 10:47:10



Annexure-I

Specifications for Drinking Water - (IS 10500: 2012)

S. No.	Substance or characteristic	Requirement (Acceptable limit)	Permissible limit in the absence of alternate source	Remarks
Essential Characteristics				
1.	Colour Hazen Units, max	5	15	Extended to 15 only if toxic substances are not suspected in absence of alternate sources
2.	Odour	Agreeable	Agreeable	a. test cold and when heated b. test after several dilutions
3.	Taste	Agreeable	Agreeable	Test to be conducted only after safety has been established
4.	Turbidity (NTU) Max	1	5	-
5.	pH value	6.5 to 8.5	No relaxation	-
6.	Total hardness (mg/l, CaCO ₃) Max.	200	600	-
7.	Iron (mg/l, Fe) Max	0.3	No relaxation	Total concentration of manganese (as Mn) and iron (as Fe) shall not exceed 0.3 mg/l
8.	Chlorides (as Cl) mg/l Max	250	1000	-
9.	Free residual chlorine (mg/l), Min	0.2	1	To be applicable only when water is chlorinated. Tested at consumer end. When protection against viral infection is required, it should be minimum 0.5 mg/L
Desirable Characteristics				
10.	Total dissolved solids, mg/l, max	500	2000	-
11.	Calcium (mg/l, Ca) Max.	75	200	-
12.	Magnesium (mg/l, Mg) Max.	30	100	-
13.	Copper (mg/l, Cu) Max.	0.05	1.5	-
14.	Manganese (mg/l, Mn) Max.	0.1	0.3	Total concentration of manganese (as Mn) and iron(as Fe) shall not exceed 0.3 mg/l
15.	Sulphate (mg/l, SO ₄) Max.	200	400	May be extended upto 400 provided Magnesium (as Mg) does not exceed 30
16.	Nitrate(mg/l, NO ₃) Max.	45	No relaxation	-
17.	Fluoride(mg/l, F) Max.	1.0	1.5	-

S. No.	Substance or characteristic	Requirement (Acceptable limit)	Permissible limit in the absence of alternate source	Remarks
18.	Phenolic compounds (mg/l C ₆ H ₅ OH) Max.	0.001	0.002	-
19.	Mercury (mg/l, Hg) Max	0.001	No Relaxation	-
20.	Cadium (mg/l, Cd) Max.	0.003	No Relaxation	-
21.	Selenium (mg/l, Se) Max.	0.01	No Relaxation	-
22.	Total Arsenic (mg/l, As) Max.	0.01	0.05	-
23.	Cyanide(mg/l, CN) Max.	0.05	No Relaxation	-
24.	Lead (mg/l, Pb) Max.	0.01	No Relaxation	-
25.	Zinc(mg/l, Zn) Max.	5	15	-
26.	Anionic detergents (mg/l, MBAS) Max	0.2	1.0	-
27.	Total Chromium(mg/l),Max.	0.05	No relaxation	-
28.	Polynuclear aromatic hydrocarbons (mg/l, PAH) Max.	0.0001	No relaxation	-
29.	Mineral oil (mg/l) Max.	0.05	No relaxation	-
30.	Pesticides (mg/l) Max.	-	No relaxation	-
Radioactive materials				
31.	Alpha emitters (Bq/l) Max.	0.1	No relaxation	-
32.	Beta emitters (pci/l) Max.	1.0	No relaxation	-
33.	Alkalinity (mg/l) Max.	200	600	-
34.	Aluminium (mg/l, Al) Max.	0.03	0.2	-
35.	Boron(mg/l) Max.	0.5	1.0	-

Annexure-II

Methods for Preservation and Analysis of Water Samples

S. No.	Parameter	Units of Expression	Preservative and Storage Condition	Reference: APHA 21 st Edition Methods
Physical Parameters				
1.	Temperature	°C	Analyze immediately	2550 – B: (Thermometer)
2.	pH	--	Analyze immediately	4500-H' - B: (Electrode)
3.	Conductivity	µs/ms	Refrigeration at 4°C	2510 – B: (Conductivity meter)
4.	Total dissolved solids	mg/l	Refrigeration at 4°C	2540 – C: (dried at 180°C & gravimetric)
5.	Total suspended solids	mg/l	Refrigeration at 4°C	2540 – D: (dried at 103°C-105°C & gravimetric)
6.	Turbidity	NTU	Refrigerate and Analyze immediately	2130 – B: (Nephelometric)
Inorganic Parameters				
7.	Total alkalinity	as CaCO ₃ mg/l	Refrigerate and Analyze immediately	2320 – B: (Titration)
8.	Hardness	as CaCO ₃ mg/l	Add HNO ₃ to pH < 2 and refrigerate	2340 – C: (EDTA Titrimetric)
9.	Chloride	mg/l	Not Required	4500-Cl' - B: (Argentometric)
10.	Sulphate	mg/l	Refrigeration at 4°C	4500-SO ₄ ²⁻ - E: (Turbidimetric)
11.	Fluoride	mg/l	Not Required	4500-F - D: (SPADNS)
12.	Sodium and potassium	mg/l	Not Required	3500- K, Na-B: (Flame Photometric)
Nutrient and Demand Parameter				
13.	Nitrate	as NO ₃ ⁻ - N mg/l	Refrigerate and analyze immediately	4500-NO ₃ B: (UV spectrophotometric)
14.	Total Phosphate	mg/l	Refrigeration at 4°C	4500-P-D: (Stannous Chloride)
15.	Dissolved Oxygen [DO]	mg/l	Analyze immediately	4500-O-C: (Azide modification)
16.	COD	mg/l	Add H ₂ SO ₄ at pH <2 refrigerate & analyze immediately	5220-B: (Open Reflux)
17.	BOD	mg/l	Refrigeration at 4°C & analyze immediately	5210-B: (BOD Test at 27 °C)
18.	Total Kjeldhal Nitrogen	mg/l	Refrigerate and Add H ₂ SO ₄ to pH<2	4500- N _{ORG} -B: (Macro-kjeldhal)
19.	Oil and grease	mg/l	Add H ₂ SO ₄ at pH <2 refrigerate	5220 –B: (Liquid-Liquid Partition Gravimetric)
Heavy Metals				
20.	Heavy metals	mg/l	Add HNO ₃ to pH <2	3030 –E, 3125 - B: (ICP- MS)

Annexure III

SCHEDULE II

[See rule 3 (1) (17) (ii)]

List of waste constituents with concentration limits

Class A: Based on leachable concentration limits [Toxicity Characteristic Leaching Procedure (TCLP) or Soluble Threshold Limit Concentration (STLC)]

Class	Constituents	Concentration in mg/l
(1)	(2)	(3)
A1	Arsenic	5.0
A3	Cadmium	1.0
A4/A 64	Chromium	5.0
A5	Lead	5.0
A6	Manganese	10.0
A7	Mercury	0.2
A65	Cobalt	80.0
A66	Copper	25.0
A68	Nickel	20.0
A71	Zinc	250

Hazardous and Other Wastes (Management & Transboundary Movement) Rules, 2016

Soil permeability classes for agriculture and conservation

Annexure SI

Soil permeability classes	Permeability rates	
	cm/hour	cm/day
Very slow	Less than 0.13	Less than 3
Slow	0.13 - 0.3	3 - 12
Moderately slow	0.5 - 2.0	12 - 48
Moderate	2.0 - 6.3	48 - 151
Moderately rapid	6.3 - 12.7	151 - 305
Rapid	12.7 - 25	305 - 600
Very rapid	More than 25	More than 600

http://www.fao.org/tempref/FI/CDrom/FAO_Training/FAO_Training/General/x6706e/x6706e09.htm

Annexure SII

Soil Fertility Ratings

S.No.	Soil Nutrients	Soil Fertility Ratings		
		Low	Medium	High
1	Organic carbon as a measure of available Nitrogen (%)	<0.5	0.5-0.75	>0.75
2	Available N as per alkaline permanganate method (kg/ha)	<280	280-560	>560
3	Available P by Olsen's method (kg/ha) in Alkaline soil	<10	10-24.6	>24.6
4	Available K by Neutral N, ammonia acetate method (kg/ha)	<108	108-280	>280

pH Range	Soil Reaction Rating
<4.6	Extremely acid
4.6-5.5	Strongly acid
5.6-6.5	Moderately acid
6.6-6.9	Slightly acid
7.0	Neutral
7.1-8.5	Moderately alkaline
>8.5	Strongly alkaline

General interpretation of EC values

S. No.	Soil	EC (mS/cm)	Total salt content (%)	Crop reaction
1.	Salt free	0-2	<0.15	Salinity effect negligible, except for more sensitive crops
2.	Slightly saline	4-8	0.15-0.35	Yield of many crops restricted
3.	Moderately saline	8-15	0.35-0.65	Only tolerant crops yield satisfactorily
4.	Highly saline	>15	>0.65	Only very tolerant crops yield satisfactorily

(Source : Methods Manual, Soil Testing in India, Dept. of Agri. and Cooperation, Ministry of Agriculture, Govt. of India, 2011)

Annexure–SIII

Metals Concentrations Typically Found in Unpolluted Soil and Soil Clean Up Standards

Metal (Symbol)	Typical Concentrations in Natural Soils (mg/kg)
Aluminium (Al)	10000 - 300000*
Antimony (Sb)	< 1 - 8.8
Arsenic (As)	< 0.1 - 73
Barium (Ba)	10-1500
Beryllium (Be)	<1 - 7
Cadmium (Cd)	<0.010 - 2
Chromium (Cr)	1-1000
Cobalt (Co)	< 0.3 - 70
Copper (Cu)	< 0.6-495
Iron (Fe)	7000 - >550000*
Lead (Pb)	2 - 200*
Magnesium (Mg)	50 - 50000
Manganese (Mn)	< 2 -7000
Mercury (Hg)	3.40
Molybdenum (Mo)	0.2 - 5*
Nickel (Ni)	5 - 500*
Potassium (K)	50 - 37000
Selenium (Se)	< 0.1 - 3.9
Silver (Ag)	0.01 - 8
Strontium (Sr)	50 - 1000*
Thallium (Tl)	0.1 - 0.8
Tin (Sn)	2 - 200*
Titanium (Ti)	1000 - 10000
Zinc (Zn)	< 3.0 - 264
Zirconium (Zr)	60 - 2000 *

(Source : Frink, Charles R., 1996. "A Perspective of Metals in Soils", Journal of Soil Contamination, 5(4):329- 359. Table A8: Most Likely Concentrations of EPA Target Analytes in Uncontaminated Soils of the Northeast (mg/kg [ppm] dry weight. www.newhallinfo.org)* Lindsay, W. 1979. Chemical Equilibrium in Soils. New York: John Wiley and Sons. (in: US EPA, 1987. A Compendium of Superfund Field Operations Methods, Exhibit 16-2. "The Content of Various Elements in Soils." www.epa.gov, # Criteria are 100 mg/kg for hexavalent chromium and 3900 mg/kg for trivalent chromium

Annexures IV

Soil (Screening and Response levels)							
S.No	Chemical Name	Chemical Group	Response levels	Screening Levels			
				Agril.	Residential /- parkland	Commercial	Industrial
				mg/kg			
1.	Arsenic	Metal	50	12	12	12	12
2.	Boron	Inorganic	-	2	-	-	-
3.	Cadmium	Metal	13	1.4	10	22	22
4.	Chromium	Metal	-	64	64	87	87
5.	Cobalt	Inorganic	190	40	50	300	300
6.	Copper	Metal	190	63	63	91	91
7.	Iron	Inorganic	-	-	-	-	-
8.	Mercury	Metal	36	6.6	6.6	24	50
9.	Manganese	Inorganic	-	-	-	-	-
10.	Nickle	Metal	-	-	-	-	-
11.	Lead	Metal	530	70	140	260	600
12.	Zinc	Metal	720	200	200	360	360

Guidance document for assessment and remediation of contaminated sites in India : volume II-2.1-b Screening and Response levels, 1st Edition, December 2015, by MoEF&CC, GoI
https://cpcb.nic.in/uploads/hwmd/MoEFCC_guidelines_contaminatedsites.pdf

IS 10500 : 2012

भारतीय मानक
पीने का पानी — विशिष्टि
(दूसरा पुनरीक्षण)

Indian Standard
DRINKING WATER — SPECIFICATION
(*Second Revision*)

ICS 13.060.20

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BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

May 2012

Price Group 6

**AMENDMENT NO. 1 JUNE 2015
TO
IS 10500 : 2012 DRINKING WATER — SPECIFICATION**

(Second Revision)

[Page 2, Table 2, Sl No. xii), col 3] — Substitute '1.0' for '0.3'.

[Page 3, Table 3, Sl No. x) , col 4] — Substitute 'No relaxation' for '0.05'.

(FAD 14)

Publication Unit, BIS, New Delhi, India

FOREWORD

This Indian Standard (Second Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Drinking Water Sectional Committee had been approved by the Food and Agriculture Division Council.

This standard was originally published in 1983. A report prepared by the World Health Organization in cooperation with the World Bank showed that in 1975, some 1 230 million people were without safe water supplies. These appalling facts were central to the United Nations decision to declare an International Drinking Water Supply and Sanitation decade, beginning in 1981. Further, the VI Five-Year Plan of India had made a special provision for availability of safe drinking water for the masses. Therefore, the standard was formulated with the objective of assessing the quality of water resources, and to check the effectiveness of water treatment and supply by the concerned authorities.

The first revision was undertaken to take into account the up-to-date information available about the nature and effect of various contaminants as also the new techniques for identifying and determining their concentration. Based on experience gained additional requirements for alkalinity; aluminium and boron were incorporated and the permissible limits for dissolved solids, nitrate and pesticides residues modified.

As per the eleventh five year plan document of India (2007-12), there are about 2.17 lakh quality affected habitations in the country with more than half affected with excess iron, followed by fluoride, salinity, nitrate and arsenic in that order. Further, approximately, 10 million cases of diarrhoea, more than 7.2 lakh typhoid cases and 1.5 lakh viral hepatitis cases occur every year a majority of which are contributed by unclean water supply and poor sanitation. The eleventh five year plan document of India (2007-2012) recognizes dealing with the issue of water quality as a major challenge and aims at addressing water quality problems in all quality affected habitations with emphasis on community participation and awareness campaigns as well as on top most priority to water quality surveillance and monitoring by setting up of water quality testing laboratories strengthened with qualified manpower, equipments and chemicals.

The second revision was undertaken to upgrade the requirements of the standard and align with the internationally available specifications on drinking water. In this revision assistance has been derived from the following:

- a) EU Directives relating to the quality of water intended for human consumption (80/778/EEC) and Council Directive 98/83/EC.
- b) USEPA standard — National Primary Drinking Water Standard. EPA 816-F-02-013 dated July, 2002.
- c) WHO Guidelines for Drinking Water Quality, 3rd Edition Vol. 1 Recommendations, 2008.
- d) Manual on Water Supply and Treatment, third edition — revised and updated May 1999, Ministry of Urban Development, New Delhi.

This standard specifies the acceptable limits and the permissible limits in the absence of alternate source. It is recommended that the acceptable limit is to be implemented as values in excess of those mentioned under 'Acceptable' render the water not suitable. Such a value may, however, be tolerated in the absence of an alternative source. However, if the value exceeds the limits indicated under 'permissible limit in the absence of alternate source' in col 4 of Tables 1 to 4, the sources will have to be rejected.

Pesticide residues limits and test methods given in Table 5 are based on consumption pattern, persistence and available manufacturing data. The limits have been specified based on WHO guidelines, wherever available. In cases where WHO guidelines are not available, the standards available from other countries have been examined and incorporated, taking in view the Indian conditions.

In this revision, additional requirements for ammonia, chloramines, barium, molybdenum, silver, sulphide, nickel, polychlorinated biphenyls and trihalomethanes have been incorporated while the requirements for colour, turbidity, total hardness, free residual chlorine, iron, magnesium, mineral oil, boron, cadmium, total arsenic, lead, polynuclear aromatic hydrocarbons, pesticides and bacteriological requirements have been modified.

In this revision, requirement and test method for virological examination have been included. Further, requirements and test methods for cryptosporidium and giardia have also been specified.

Routine surveillance of drinking water supplies should be carried out by the relevant authorities to understand the risk of specific pathogens and to define proper control procedures. The WHO Guidelines for Drinking Water Quality, 3rd Edition, Vol. 1 may be referred for specific recommendations on using a water safety approach incorporating risk identification. Precautions/Care should be taken to prevent contamination of drinking water from chlorine resistant parasites such as cryptosporidium species and giardia.

Indian Standard

DRINKING WATER — SPECIFICATION

(*Second Revision*)

1 SCOPE

This standard prescribes the requirements and the methods of sampling and test for drinking water.

2 REFERENCES

The standards listed in Annex A contain provisions which through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated in Annex A.

3 TERMINOLOGY

For the purpose of this standard the following definition shall apply.

3.1 Drinking Water — Drinking water is water intended for human consumption for drinking and cooking purposes from any source. It includes water (treated or untreated) supplied by any means for human consumption.

4 REQUIREMENTS

Drinking water shall comply with the requirements given in Tables 1 to 4. The analysis of pesticide residues given in Table 3 shall be conducted by a recognized laboratory using internationally established test method meeting the residue limits as given in Table 5.

Drinking water shall also comply with bacteriological requirements (*see 4.1*), virological requirements (*see 4.2*) and biological requirements (*see 4.3*).

4.1 Bacteriological Requirements

4.1.1 Water in Distribution System

Ideally, all samples taken from the distribution system including consumers' premises, should be free from coliform organisms and the following bacteriological quality of drinking water collected in the distribution system, as given in Table 6 is, therefore specified when tested in accordance with IS 1622.

4.2 Virological Requirements

4.2.1 Ideally, all samples taken from the distribution

Table 1 Organoleptic and Physical Parameters
(Foreword and Clause 4)

SI No.	Characteristic	Requirement (Acceptable Limit)	Permissible Limit in the Absence of Alternate Source	Method of Test, Ref to Part of IS 3025	Remarks
(1)	(2)	(3)	(4)	(5)	(6)
i)	Colour, Hazen units, <i>Max</i>	5	15	Part 4	Extended to 15 only, if toxic substances are not suspected in absence of alternate sources
ii)	Odour	Agreeable	Agreeable	Part 5	a) Test cold and when heated b) Test at several dilutions
iii)	pH value	6.5-8.5	No relaxation	Part 11	—
iv)	Taste	Agreeable	Agreeable	Parts 7 and 8	Test to be conducted only after safety has been established
v)	Turbidity, NTU, <i>Max</i>	1	5	Part 10	—
vi)	Total dissolved solids, mg/l, <i>Max</i>	500	2 000	Part 16	—

NOTE — It is recommended that the acceptable limit is to be implemented. Values in excess of those mentioned under 'acceptable' render the water not suitable, but still may be tolerated in the absence of an alternative source but up to the limits indicated under 'permissible limit in the absence of alternate source' in col 4, above which the sources will have to be rejected.

IS 10500 : 2012

Table 2 General Parameters Concerning Substances Undesirable in Excessive Amounts
 (Foreword and Clause 4)

Sl No.	Characteristic	Requirement (Acceptable Limit)	Permissible Limit in the Absence of Alternate Source	Method of Test, Ref to	Remarks
(1)	(2)	(3)	(4)	(5)	(6)
i)	Aluminium (as Al), mg/l, <i>Max</i>	0.03	0.2	IS 3025 (Part 55)	—
ii)	Ammonia (as total ammonia-N), mg/l, <i>Max</i>	0.5	No relaxation	IS 3025 (Part 34)	—
iii)	Anionic detergents (as MBAS) mg/l, <i>Max</i>	0.2	1.0	Annex K of IS 13428	—
iv)	Barium (as Ba), mg/l, <i>Max</i>	0.7	No relaxation	Annex F of IS 13428* or IS 15302	—
v)	Boron (as B), mg/l, <i>Max</i>	0.5	1.0	IS 3025 (Part 57)	—
vi)	Calcium (as Ca), mg/l, <i>Max</i>	75	200	IS 3025 (Part 40)	—
vii)	Chloramines (as Cl ₂), mg/l, <i>Max</i>	4.0	No relaxation	IS 3025 (Part 26)* or APHA 4500-Cl G	—
viii)	Chloride (as Cl), mg/l, <i>Max</i>	250	1 000	IS 3025 (Part 32)	—
ix)	Copper (as Cu), mg/l, <i>Max</i>	0.05	1.5	IS 3025 (Part 42)	—
x)	Fluoride (as F) mg/l, <i>Max</i>	1.0	1.5	IS 3025 (Part 60)	—
xi)	Free residual chlorine, mg/l, <i>Min</i>	0.2	1	IS 3025 (Part 26)	To be applicable only when water is chlorinated. Tested at consumer end. When pro- tection against viral infec- tion is required, it should be minimum 0.5 mg/l
xii)	Iron (as Fe), mg/l, <i>Max</i>	0.3	No relaxation	IS 3025 (Part 53)	Total concentration of man- ganease (as Mn) and iron (as Fe) shall not exceed 0.3 mg/l
xiii)	Magnesium (as Mg), mg/l, <i>Max</i>	30	100	IS 3025 (Part 46)	—
xiv)	Manganese (as Mn), mg/l, <i>Max</i>	0.1	0.3	IS 3025 (Part 59)	Total concentration of man- ganease (as Mn) and iron (as Fe) shall not exceed 0.3 mg/l
xv)	Mineral oil, mg/l, <i>Max</i>	0.5	No relaxation	Clause 6 of IS 3025 (Part 39) Infrared partition method	—
xvi)	Nitrate (as NO ₃), mg/l, <i>Max</i>	45	No relaxation	IS 3025 (Part 34)	—
xvii)	Phenolic compounds (as C ₆ H ₅ OH), mg/l, <i>Max</i>	0.001	0.002	IS 3025 (Part 43)	—
xviii)	Selenium (as Se), mg/l, <i>Max</i>	0.01	No relaxation	IS 3025 (Part 56) or IS 15303*	—
xix)	Silver (as Ag), mg/l, <i>Max</i>	0.1	No relaxation	Annex J of IS 13428	—
xx)	Sulphate (as SO ₄) mg/l, <i>Max</i>	200	400	IS 3025 (Part 24)	May be extended to 400 pro- vided that Magnesium does not exceed 30
xxi)	Sulphide (as H ₂ S), mg/l, <i>Max</i>	0.05	No relaxation	IS 3025 (Part 29)	—
xxii)	Total alkalinity as calcium carbonate, mg/l, <i>Max</i>	200	600	IS 3025 (Part 23)	—
xxiii)	Total hardness (as CaCO ₃), mg/l, <i>Max</i>	200	600	IS 3025 (Part 21)	—
xxiv)	Zinc (as Zn), mg/l, <i>Max</i>	5	15	IS 3025 (Part 49)	—

NOTES

1 In case of dispute, the method indicated by '*' shall be the referee method.

2 It is recommended that the acceptable limit is to be implemented. Values in excess of those mentioned under 'acceptable' render the water not suitable, but still may be tolerated in the absence of an alternative source but up to the limits indicated under 'permissible limit in the absence of alternate source' in col 4, above which the sources will have to be rejected.

Table 3 Parameters Concerning Toxic Substances
(Foreword and Clause 4)

Sl No.	Characteristic	Requirement (Acceptable Limit)	Permissible Limit in the Absence of Alternate Source	Method of Test, Ref to	Remarks
(1)	(2)	(3)	(4)	(5)	(6)
i)	Cadmium (as Cd), mg/l, <i>Max</i>	0.003	No relaxation	IS 3025 (Part 41)	—
ii)	Cyanide (as CN), mg/l, <i>Max</i>	0.05	No relaxation	IS 3025 (Part 27)	—
iii)	Lead (as Pb), mg/l, <i>Max</i>	0.01	No relaxation	IS 3025 (Part 47)	—
iv)	Mercury (as Hg), mg/l, <i>Max</i>	0.001	No relaxation	IS 3025 (Part 48)/ Mercury analyser	—
v)	Molybdenum (as Mo), mg/l, <i>Max</i>	0.07	No relaxation	IS 3025 (Part 2)	—
vi)	Nickel (as Ni), mg/l, <i>Max</i>	0.02	No relaxation	IS 3025 (Part 54)	—
vii)	Pesticides, µg/l, <i>Max</i>	See Table 5	No relaxation	See Table 5	—
viii)	Polychlorinated biphenyls, mg/l, <i>Max</i>	0.000 5	No relaxation	ASTM 5175*	—
ix)	Polynuclear aromatic hydrocarbons (as PAH), mg/l, <i>Max</i>	0.000 1	No relaxation	APHA 6440	or APHA 6630 —
x)	Total arsenic (as As), mg/l, <i>Max</i>	0.01	0.05	IS 3025 (Part 37)	—
xi)	Total chromium (as Cr), mg/l, <i>Max</i>	0.05	No relaxation	IS 3025 (Part 52)	—
xii)	Trihalomethanes:				
a)	Bromoform, mg/l, <i>Max</i>	0.1	No relaxation	ASTM D 3973-85* or APHA 6232	—
b)	Dibromochloromethane, mg/l, <i>Max</i>	0.1	No relaxation	ASTM D 3973-85* or APHA 6232	—
c)	Bromodichloromethane, mg/l, <i>Max</i>	0.06	No relaxation	ASTM D 3973-85* or APHA 6232	—
d)	Chloroform, mg/l, <i>Max</i>	0.2	No relaxation	ASTM D 3973-85* or APHA 6232	—

NOTES

1 In case of dispute, the method indicated by '*' shall be the referee method.

2 It is recommended that the acceptable limit is to be implemented. Values in excess of those mentioned under 'acceptable' render the water not suitable, but still may be tolerated in the absence of an alternative source but up to the limits indicated under 'permissible limit in the absence of alternate source' in col 4, above which the sources will have to be rejected.

Table 4 Parameters Concerning Radioactive Substances
(Foreword and Clause 4)

Sl No.	Characteristic	Requirement (Acceptable Limit)	Permissible Limit in the Absence of Alternate Source	Method of Test, Ref to Part of IS 14194	Remarks
(1)	(2)	(3)	(4)	(5)	(6)
i)	Radioactive materials:				
a)	Alpha emitters Bq/l, <i>Max</i>	0.1	No relaxation	Part 2	—
b)	Beta emitters Bq/l, <i>Max</i>	1.0	No relaxation	Part 1	—

NOTE — It is recommended that the acceptable limit is to be implemented. Values in excess of those mentioned under 'acceptable' render the water not suitable, but still may be tolerated in the absence of an alternative source but up to the limits indicated under 'permissible limit in the absence of alternate source' in col 4, above which the sources will have to be rejected.

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Table 5 Pesticide Residues Limits and Test Method
 (Foreword and Table 3)

SI No.	Pesticide	Limit µg/l	Method of Test, Ref to	
			USEPA (4)	AOAC/ ISO (5)
(1)	(2)	(3)		
i)	Alachlor	20	525.2, 507	—
ii)	Atrazine	2	525.2, 8141 A	—
iii)	Aldrin/ Dieldrin	0.03	508	—
iv)	Alpha HCH	0.01	508	—
v)	Beta HCH	0.04	508	—
vi)	Butachlor	125	525.2, 8141 A	—
vii)	Chlorpyrifos	30	525.2, 8141 A	—
viii)	Delta HCH	0.04	508	—
ix)	2,4- Dichlorophenoxyacetic acid	30	515.1	—
x)	DDT (<i>o, p</i> and <i>p, p</i> – Isomers of DDT, DDE and DDD)	1	508	AOAC 990.06
xi)	Endosulfan (alpha, beta, and sulphate)	0.4	508	AOAC 990.06
xii)	Ethion	3	1657 A	—
xiii)	Gamma — HCH (Lindane)	2	508	AOAC 990.06
xiv)	Isoproturon	9	532	—
xv)	Malathion	190	8141 A	—
xvi)	Methyl parathion	0.3	8141 A	ISO 10695
xvii)	Monocrotophos	1	8141 A	—
xviii)	Phorate	2	8141 A	—

NOTE — Test methods are for guidance and reference for testing laboratory. In case of two methods, USEPA method shall be the reference method.

Table 6 Bacteriological Quality of Drinking Water¹⁾
 (Clause 4.1.1)

SI No.	Organisms	Requirements
(1)	(2)	(3)
i)	<i>All water intended for drinking:</i>	
a)	<i>E. coli</i> or thermotolerant coliform bacteria ^{2),3)}	Shall not be detectable in any 100 ml sample
ii)	<i>Treated water entering the distribution system:</i>	
a)	<i>E. coli</i> or thermotolerant coliform bacteria ²⁾	Shall not be detectable in any 100 ml sample
b)	Total coliform bacteria	Shall not be detectable in any 100 ml sample
iii)	<i>Treated water in the distribution system:</i>	
a)	<i>E. coli</i> or thermotolerant coliform bacteria	Shall not be detectable in any 100 ml sample
b)	Total coliform bacteria	Shall not be detectable in any 100 ml sample

¹⁾Immediate investigative action shall be taken if either *E.coli* or total coliform bacteria are detected. The minimum action in the case of total coliform bacteria is repeat sampling; if these bacteria are detected in the repeat sample, the cause shall be determined by immediate further investigation.

²⁾Although, *E. coli* is the more precise indicator of faecal pollution, the count of thermotolerant coliform bacteria is an acceptable alternative. If necessary, proper confirmatory tests shall be carried out. Total coliform bacteria are not acceptable indicators of the sanitary quality of rural water supplies, particularly in tropical areas where many bacteria of no sanitary significance occur in almost all untreated supplies.

³⁾It is recognized that, in the great majority of rural water supplies in developing countries, faecal contamination is widespread. Under these conditions, the national surveillance agency should set medium-term targets for progressive improvement of water supplies.

system including consumers' premises, should be free from virus.

4.2.2 None of the generally accepted sewage treatment methods yield virus-free effluent. Although a number of investigators have found activated sludge treatment to be superior to trickling filters from this point of view, it seems possible that chemical precipitation methods will prove to be the most effective.

4.2.3 Virus can be isolated from raw water and from springs, enterovirus, reovirus, and adenovirus have been found in water, the first named being the most resistant to chlorination. If enterovirus are absent from chlorinated water, it can be assumed that the water is safe to drink. Some uncertainty still remains about the virus of infectious hepatitis, since it has not so far been isolated but in view of the morphology and resistance of enterovirus it is likely that, if they have been inactivated hepatitis virus will have been inactivated also.

4.2.4 An exponential relationship exists between the rate of virus inactivation and the redox potential. A redox potential of 650 mV (measured between platinum and calomel electrodes) will cause almost instantaneous inactivation of even high concentrations of virus. Such a potential can be obtained with even a low concentration of free chlorine, but only with an extremely high concentration of combined chlorine. This oxidative inactivation may be achieved with a number of other oxidants also, for example, iodine, ozone and potassium permanganate, but the effect of the oxidants will always be counteracted, if reducing components, which are mainly organic, are present. As a consequence, the sensitivity of virus towards disinfectants will depend on the *milieu* just as much as on the particular disinfectant used.

4.2.5 Viruses are generally resistant to disinfectants as well as get protected on account of presence of particulate and organic matter in water. Because the difference between the resistance of coliform organisms and of virus to disinfection by oxidants increases with increasing concentration of reducing components, for example, organic matter, it cannot be assumed that the absence of available coliform organisms implies freedom from active virus under circumstances where a free chlorine residual cannot be maintained. Sedimentation and slow sand filtration in themselves may contribute to the removal of virus from water.

4.2.6 In practice, >0.5 mg/l of free chlorine for 1 h is sufficient to inactivate virus, even in water that was originally polluted provided the water is free from particulates and organic matter.

4.2.7 MS2 phage are indicator of viral contamination in drinking water. MS2 phage shall be absent in 1 litre of water when tested in accordance with USEPA method 1602. If MS2 phage are detected in the drinking water, virological examination shall be done by the Polymerase Chain Reaction (PCR) method for virological examination as given in Annex B. USEPA method in Manual of Method for Virology Chapter 16, June 2001 shall be the alternate method. If viruses are detected, the cause shall be determined by immediate further investigation.

4.3 Biological Requirements

4.3.1 Ideally, all samples taken including consumers premises should be free from biological organisms. Biological examination is of value in determining the causes of objectionable tastes and odours in water and controlling remedial treatments, in helping to interpret the results of various chemical analysis, and in explaining the causes of clogging in distribution pipes and filters. In some instances, it may be of use in demonstrating that water from one source has been mixed with that from another.

4.3.2 The biological qualities of water are of greater importance when the supply has not undergone the conventional flocculation and filtration processes, since increased growth of methane-utilizing bacteria on biological slimes in pipes may then be expected, and the development of bryozoal growths such as *Plumatella* may cause operational difficulties.

4.3.3 Some of the animalcules found in water mains may be free-living in the water, but others such as *Dreissena* and *Asellus* are more or less firmly attached to the inside of the mains. Although these animalcules are not themselves pathogenic, they may harbour pathogenic organisms or virus in their intestines, thus protecting these pathogens from destruction by chlorine.

4.3.4 Chlorination, at the dosages normally employed in waterworks, is ineffective against certain parasites, including amoebic cysts; they can be excluded only by effective filtration or by higher chlorine doses than can be tolerated without subsequent dechlorination. *Amoebiasis* can be conveyed by water completely free from enteric bacteria; microscopic examination after concentration is, therefore, the only safe method of identification.

4.3.5 Strict precautions against back-syphonage and cross-connections are required, if amoebic cysts are found in a distribution system containing tested water.

4.3.6 The *cercariae of schistosomiasis* can be detected by similar microscopic examination, but there is, in

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any case, no evidence to suggest that this disease is normally spread through piped water supplies.

4.3.7 The cyclops vector of the embryos of *Dracunculus medinensis* which causes dracontiasis or Guinea-worm disease can be found in open wells in a number of tropical areas. They are identifiable by microscopic examination. Such well supplies are frequently used untreated, but the parasite can be relatively easily excluded by simple physical improvements in the form of curbs, drainage, and apron surrounds and other measures which prevent physical contact with the water source.

4.3.8 Cryptosporidium shall be absent in 10 liter of water when tested in accordance with USEPA method 1622 or USEPA method 1623* or ISO 15553 : 2006.

4.3.9 Giardia shall be absent in 10 liter of water when tested in accordance with USEPA method 1623* or ISO 15553 : 2006.

4.3.10 The drinking water shall be free from microscopic organisms such as algae, zooplanktons, flagellates, parasites and toxin producing organisms. An illustrative (and not exhaustive) list is given in Annex C for guidance.

NOTE — In case of dispute, the method indicated by '*' in 4.3.8 and 4.3.9 shall be referee method.

5 SAMPLING

Representative samples of water shall be drawn as prescribed in IS 1622 and IS 3025 (Part 1).

ANNEX A
(Clause 2)

LIST OF REFERRED INDIAN STANDARDS

IS No.	Title	IS No.	Title
1622 : 1981	Methods of sampling and microbiological examination of water (<i>first revision</i>)	(Part 41) : 1992	Cadmium (<i>first revision</i>)
		(Part 42) : 1992	Copper (<i>first revision</i>)
3025	Methods of sampling and test (physical and chemical) for water and waste water:	(Part 43) : 1992	Phenols (<i>first revision</i>)
(Part 1) : 1987	Sampling (<i>first revision</i>)	(Part 46) : 1994	Magnesium
(Part 2) : 2002	Determination of 33 elements by inductively coupled plasma atomic emission spectroscopy	(Part 47) : 1994	Lead
(Part 4) : 1983	Colour (<i>first revision</i>)	(Part 48) : 1994	Mercury
(Part 5) : 1983	Odour (<i>first revision</i>)	(Part 49) : 1994	Zinc
(Part 7) : 1984	Taste threshold (<i>first revision</i>)	(Part 52) : 2003	Chromium
(Part 8) : 1984	Tasting rate (<i>first revision</i>)	(Part 53) : 2003	Iron
(Part 10) : 1984	Turbidity (<i>first revision</i>)	(Part 54) : 2003	Nickel
(Part 11) : 1983	pH value (<i>first revision</i>)	(Part 55) : 2003	Aluminium
(Part 16) : 1984	Filterable residue (total dissolved solids) (<i>first revision</i>)	(Part 56) : 2003	Selenium
(Part 21) : 1983	Total hardness (<i>first revision</i>)	(Part 57) : 2005	Boron
(Part 23) : 1983	Alkalinity (<i>first revision</i>)	(Part 59) : 2006	Manganese
(Part 24) : 1986	Sulphates (<i>first revision</i>)	(Part 60) : 2008	Fluoride
(Part 26) : 1986	Chlorine residual (<i>first revision</i>)	13428 : 2003	Packaged natural mineral water — Specification (<i>first revision</i>)
(Part 27) : 1986	Cyanide (<i>first revision</i>)	14194	Radionuclides in environmental samples — Method of estimation:
(Part 29) : 1986	Sulphide (<i>first revision</i>)	(Part 1) : 1994	Gross beta activity measurement
(Part 32) : 1988	Chloride (<i>first revision</i>)	(Part 2) : 1994	Gross alpha activity measurement
(Part 34) : 1988	Nitrogen (<i>first revision</i>)	15302 : 2002	Determination of aluminium and barium in water by direct nitrous oxide-acetylene flame atomic absorption spectrometry
(Part 37) : 1988	Arsenic (<i>first revision</i>)	15303 : 2002	Determination of antimony, iron and selenium in water by electrothermal atomic absorption spectrometry
(Part 39) : 1989	Oil and grease		
(Part 40) : 1991	Calcium		

ANNEX B (Clause 4.2.7)

POLYMERASE CHAIN REACTION (PCR) METHOD

B-1 GENERAL

The method involves the concentration of viruses from 100 litre of drinking water to 1 ml by membrane filter technique. The concentrate is subjected to amplification using polymerase chain reaction (PCR) and primers based on highly conserved regions of viral genomes. This method can detect as low as 10 genome copies. Stringent precautions are needed to avoid contamination with amplified DNA products leading to false positive reactions. Detection of hepatitis A virus (HAV) RNA and enterovirus (EV) RNA is considered as an indication of presence of viruses in water. Steps involved include concentration of water, RNA extraction, complementary DNA (cDNA) synthesis and PCR.

B-2 CONCENTRATION OF DRINKING WATER

B-2.1 Apparatus

B-2.1.1 Pressure Pump

B-2.1.2 Membrane Filter Assembly with 144 mm Diameter with Tripod Stand

B-2.1.3 Pressure Vessel (50 litre capacity) with Pressure Gauge

B-2.1.4 Inter-connecting Pressure Tubes

B-2.2 Reagents

Autoclaved double distilled water shall be used for the preparation of reagents/buffers in this study.

B-2.2.1 Aluminium Chloride

B-2.2.2 HCl/NaOH Urea (Extra Pure)

B-2.2.3 Disodium Hydrogen Phosphate ($\text{Na}_2\text{HPO}_4 \cdot 2\text{H}_2\text{O}$) — 0.2 M, filter sterilized.

B-2.2.4 Sodium Dihydrogen Phosphate ($\text{NaH}_2\text{PO}_4 \cdot 2\text{H}_2\text{O}$) — 0.2 M, filter sterilized.

B-2.2.5 Citric Acid — 0.1 M, filter sterilized.

B-2.2.6 L-Arginine — 0.5 M, filter sterilized.

B-2.2.7 Urea-Arginine Phosphate Buffer (U-APB) — Mix 4.5 g of urea with 2 ml of 0.2 M NaH_2PO_4 and 2 ml of 0.5 M L-Arginine and make up the volume to 50 ml with sterile distilled water. The pH of the eluent shall be 9.0.

B-2.2.8 Magnesium Chloride (MgCl_2) — 1 M.

B-2.2.9 McIl Vaines Buffer (pH 5.0) — Mix 9.7 ml of

0.1 M citric acid with 10.3 ml of 0.2 M $\text{Na}_2\text{HPO}_4 \cdot 2\text{H}_2\text{O}$ under sterile conditions.

B-2.3 Procedure

Filter 100 litre of drinking water sample through membrane filter assembly using either positively charged membrane of 144 mm diameter or 0.22 micron diameter pore size nitrocellulose membrane. For positively charged membrane the test water pH need not be adjusted. But for the 0.22 micron nitrocellulose membrane adjust the pH to 3.5 after adding the aluminium chloride as a coagulant to a final concentration of 0.000 5 M.

At lower pH pass the water through the membrane. The flow rate shall be 40 litre/h approximately. After the completion of the filtration, elute the adsorbed particles using 100 ml of urea-arginine phosphate buffer (U-APB). Precipitate the suspended particles using 1 ml of magnesium chloride (1 M). Dissolve the resultant precipitate centrifuged out of the sample in 800-1.0 ml of McIl Vaines buffer. The processed sample can be stored at refrigerator until required.

B-3 RNA EXTRACTION

B-3.1 Apparatus

B-3.1.1 Cooling Centrifuge

B-3.1.2 Deep Freezer (-20°C)

B-3.1.3 Vortex Mixer

B-3.1.4 Pipette Man

B-3.2 Reagents

B-3.2.1 Cetyl Trimethyl Ammonium Bromide (CTAB) Buffer

CTAB	:	1 percent
Sodium Dodecyl Sulphate (SDS)	:	1 percent
EDTA	:	20 mM
Sodium Chloride	:	1 M

B-3.2.2 Phenol, Chloroform and Isoamylalcohol in the ratio of 25:24:1 (PCI)

B-3.2.3 Ethanol

B-3.2.4 TE Buffer (pH 8.0)

Tris base	:	1 M
EDTA	:	0.5 M

B-3.2.5 Sodium Acetate — 3 M.

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B-3.3 Procedure

Treat 300 μ l of concentrated water sample with equal volume of CTAB and 1/10th volume of PCI. Vortex and centrifuge at 5 000 \times g for 30 min at 4°C. Add 1/10th volume of 3 M sodium acetate and double the volume of cold ethanol to the aqueous layer. Keep the mixture at either at -20°C for overnight or in liquid nitrogen for 2-5 min. Centrifuge at 10 000 \times g, for 30 min at 4°C. Discard the supernatant and air dry the pellet and dissolve it in 20 μ l TE buffer.

B-4 COMPLEMENTARY DNA (cDNA) SYNTHESIS

B-4.1 Apparatus

B-4.1.1 PCR Machine

B-4.1.2 Deep Freezer (-20°C)

B-4.2 Reagents

B-4.2.1 cDNA Synthesis Kit

B-4.3 Procedure

Suspend the extracted RNA in 20 μ l of cDNA reaction mixture, which consists of 4 μ l of 5X reverse transcriptase reaction buffer [250 mM TRIS-HCl (pH 8.5), 40 mM KCl, 150 mM MgCl₂, 5 mM dithiothreitol (DTT)], 0.5 μ l of 10 mM deoxynucleotide phosphate (dNTP), 2 μ l of hexa nucleotide mixture, 1 μ l of 25 U of Maloney Murine Leukaemia Virus (M-MuLV) reverse transcriptase, 0.5 μ l of 20 U of human placental RNase inhibitor. Heat the reaction mixture to 95°C for 5 min and rapidly chill on ice, this is followed by the addition of 1 μ l (25 U/ μ l) of M-MuLV reverse transcriptase. Incubate the reaction mixture as given by the manufacturer of the kit and quickly chill the reaction tube on ice.

B-5 PCR AMPLIFICATION

B-5.1 Apparatus

B-5.1.1 PCR Machine

B-5.1.2 Deep Freezer (-20°C)

B-5.1.3 Micropipette

B-5.2 Reagents

B-5.2.1 Primers for EV and HAV

EV	sense primer, 5' — TCC TCC GGC CCC TGA ATG CG — 3'
	antisense primer, 5' — ATT GTC ACC ATA AGC AGC CA — 3'
HAV	sense primer, 5' — GTTTT GCTCC TCTTT ATCAT GCTAT G-3'

antisense primer, 5' — GGAAA TGTCT
CAGGT ACTTT CTTTG-3'

B-5.2.2 PCR Master Mix

B-5.2.3 Mineral Oil

B-5.3 Procedure

B-5.3.1 PCR Amplification for Hepatitis A Virus (HAV)

In 5 μ l of cDNA, add 95 μ l of a PCR Master Mix (10 mM TRIS-HCl (pH 8.3), 50 mM KCl, 2.5 mM MgCl₂, 0.01 percent gelatin (1 \times PCR buffer), 200 μ M of each dNTP, 1.5 U of *Thermus aquaticus* polymerase). Add 25 pico moles of sense and antisense oligonucleotide primers of HAV and overlay with mineral oil. Appropriate positive and negative controls shall be included with each run. Set the following reaction at thermo cycler:

Denaturation at 94°C for 2 min	} 35 cycles
Denaturation for 1.0 min at 94°C	
Annealing for 1.0 min at 57°C	
Extension for 1.3 min at 72°C	}
Final extension at 72°C for 7 min.	

B-5.3.2 PCR Amplification for Enterovirus (EV)

In 5 μ l of cDNA, add 95 μ l of a PCR Master Mix (10 mM TRIS-HCl (pH 8.3), 50 mM KCl, 2.5 mM MgCl₂, 0.01 percent gelatin (1X PCR buffer), 200 μ M of each dNTP, 1.5 U of *Thermus aquaticus* polymerase). Add 25 pico moles of sense and antisense oligonucleotide primers of EV and overlay with mineral oil. Appropriate positive and negative controls shall be included with each run. Set the following reaction at thermo cycler:

Denaturation at 94°C for 2 min	} 35 cycles
Denaturation for 1.0 min at 94°C	
Annealing for 1.0 min at 42°C	
Extension for 2.0 min at 72°C	}
Final extension at 72°C for 7 min.	

B-6 AGAROSE GEL ELECTROPHORESIS

B-6.1 Apparatus

B-6.1.1 Micropipette

B-6.1.2 Electrophoresis Apparatus

B-6.1.3 Gel Documentation System

B-6.2 Reagents

B-6.2.1 Running Buffer — 50X TAE buffer

Tris base/Tris buffer : 121.00 g

Glacial acetic acid	: 28.55 ml
0.5 M EDTA	: 50.00 ml
Distilled water (autoclaved)	: 300.45 ml

Make the final volume upto 1 000 ml with deionised distilled water, sterilize and store at 4°C. The final concentration for the preparation of agarose gel and to run the gel shall be 1X.

B-6.2.2 Tracking Dye — 6X bromophenol blue.

B-6.2.3 Ethidium Bromide — 0.5 µg/ml.

B-6.3 Procedure

Run the PCR amplified product of EV and HAV on 1.5 percent agarose gel using 1X TAE buffer. Load 10 µl of amplified product after mixing it with 1 µl 10X loading dye. Run the molecular weight marker along with the samples. Run the electrophoresis at 100 V for 30 min. Stain the gel with ethidium bromide (0.5 µl/ml) for 20 min. Wash it with distilled water and view under UV transilluminator and photograph the gel to analyse the band pattern. EV gives the band as 155 base pair and the HAV gives band as 225 base pair.

ANNEX C (Clause 4.3.10)

ILLUSTRATIVE LIST OF MICROSCOPIC ORGANISMS PRESENT IN WATER

Sl No.	Classification of Microscopic Organism	Group and Name of the Organism	Habitat	Effect of the Organisms and Significance
(1)	(2)	(3)	(4)	(5)
i)	Algae	a) Chlorophyceae:		
		1) <i>Species of</i> Coelastrum, Gomphospherium, Micractinium, Mougeotia, Oocystis, Euastrum, Scenedesmus, Actinastrum, Gonium, Eudorina Pandorina, Pediastrum, Zygnema, Chlamydomonas, Careteria, Chlorella, Chroococcus, Spirogyra, Tetradron, Chlorogonium, Stigeoclonium	Polluted water, impounded sources	Impart colouration
		2) <i>Species of</i> Pandorina, Volvox, Gomphospherium, Staurastrum, Hydrodictyon, Nitella	Polluted waters	Produce taste and odour
		3) <i>Species of</i> Rhizoclonium, Cladotrix, Ankistrodesmus, Ulothrix, Micrasterias, Chromulina	Clean water	Indicate clean condition
		4) <i>Species of</i> Chlorella, Tribonema, Clostrium, Spirogyra, Palmella	Polluted waters, impounded sources	Clog filters and create impounded difficulties
		b) Cyanophyceae:		
		1) <i>Species of</i> Anacystis and Cylandrospermum	Polluted waters	Cause water bloom and impart colour
		2) <i>Species of</i> Anabena, Phormidium, Lyngbya, Arthrospira, Oscillatoria	Polluted waters	Impart colour
		3) <i>Species of</i> Anabena, Anacystis, Aphanizomenon	Polluted waters, impounded sources	Produce taste and odour
		4) <i>Species of</i> Anacystis, Anabena, Coelospherium, Cleotrichina, Aphanizomenon	Polluted waters	Toxin producing
		5) <i>Species of</i> Anacystis, Rivularia, Oscillatoria, Anabena	Polluted waters	Clog filters

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Sl No.	Classification of Microscopic Organism	Group and Name of the Organism	Habitat	Effect of the Organisms and Significance
(1)	(2)	(3)	(4)	(5)
		6) <i>Species of Rivularia</i>	Calcareous waters and also rocks	Bores rocks and calcareous strata and causes matted growth
		7) <i>Species of Agmenellum, Lemanea</i>	Microcoleus, Clean waters	Indicators of purification
		c) Diatoms (Bacillareophyceae):		
		1) <i>Species of Stauroneis</i>	Fragillaria, Stephanodiscus, —	Cause discoloration
		2) <i>Species of Asterionella</i>	Tabellaria	Taste and odour producing clog filters
		3) <i>Species of Synedra and Fragillavia</i>	Hill streams high altitude, torrential and temperate waters	Taste and odour producing
		4) <i>Species of Nitzschia, Gomphonema</i>	Polluted waters	Cause discoloration
		5) <i>Species of Cymbella, Synedra, Melosira, Navicula, Cyclotella, Fragillaria, Diatoma, Pleurosigma</i>	Moderately polluted waters and Rivers streams impounded sources	Clog filters and cause operational difficulties
		6) <i>Species of Pinnularia, Cyclotella, Meridion, Cocconeis</i>	Surinella, Clean waters	Indicators of purification
		d) Xanthophyceae:		
		<i>Species of Botryococcus</i>	Hill streams, high altitude and temperate waters	Produces coloration
ii)	Zooplankton	a) Protozoa:		
		1) Amoeba, Giardia, Lamblia, Arcella, Diffugia, Actinophrys	Polluted waters	Pollution indicators
		2) Endamoeba, Histolytica	Sewage and activated sludge	Parasitic and pathogenic
		b) Ciliates:		
		Paramoecium, Vorticella, Carchesium, Stentor, Colpidium, Coleps, Euplotes, Colopoda, Bodo	Highly polluted waters, sewage and activated sludge	Bacteria eaters
		c) Crustacea:		
		1) Bosmina, Daphnia	Stagnant polluted waters	Indicators of pollution
		2) Cyclops	Step wells in tropical climate	Carrier host of guinea worm
iii)	Rotifers	a) Rotifers:		
		Anurea, Rotaria, Philodina	Polluted and Algae laden waters	Feed on algae
		b) Flagellates:		
		1) Ceratium, Glenodinium, Dinobryon	Peridinium	Rocky strata, iron bearing and acidic waters
		2) Euglena, Phacus	Polluted waters	Impart colour and fishy taste
				Impart colour

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<i>Sl No.</i>	<i>Classification of Microscopic Organism</i>	<i>Group and Name of the Organism</i>	<i>Habitat</i>	<i>Effect of the Organisms and Significance</i>
(1)	(2)	(3)	(4)	(5)
iv)	Miscellaneous Organisms	a) Sponges, Hydra	Fresh water	Clog filters and affect purification systems
		b) Tubifex, Eristalls, Chironomids	Highly polluted waters, sewage and activated sludge and bottom deposits	Clog filters and render water unaesthetic
		c) Plumatella	Polluted waters	Produces biological slimes and causes filter operational difficulties
		c) Dreissena, Asellus	Polluted waters	Harbour pathogenic organisms

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Western : Manakalaya, E9 MIDC, Marol, Andheri (East) MUMBAI 400093	{ 2832 9295, 2832 7858 2832 7891, 2832 7892

Branches: AHMEDABAD. BANGALORE. BHOPAL. BHUBANESHWAR. COIMBATORE. DEHRADUN. FARIDABAD. GHAZIABAD. GUWAHATI. HYDERABAD. JAIPUR. KANPUR. LUCKNOW. NAGPUR. PARWANOO. PATNA. PUNE. RAJKOT. THIRUVANANTHAPURAM. VISAKHAPATNAM.

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PLATES

<u>RENUKOOT R-MS SAMPLING LOCATION PHOTOS</u> <u>(OCTOBER-2020)</u>		
S.No	LOCATION NAME	SAMPLING PHOTOS
1.	Peziometer R-MS-1 (15-10-2020)	 
2.	Renukoot Railway Station R-MS-2 (15-10-2020)	 

<p>3.</p>	<p>Renukoot Dondiya Nala R-MS-3 (15-10-2020)</p>	
<p>4</p>	<p>Renukoot Lanka Colony R-MS-4 (15-10-2020)</p>	

<p>5.</p>	<p>Renukoot Govt. Inter College R-MS-5 (15-10-2020)</p>	
		
<p>6.</p>	<p>Renukoot opposite Rihad Dam R-MS-6 (15-10-2020)</p>	
		

<p>7.</p>	<p>Renukoot Murligadi Shiv Mandir R-MS-7 (15-10-2020)</p>	
<p>8.</p>	<p>Monitoring well near SLF R-MS-8 (16-10-2020)</p>	

<p>9.</p>	<p>Dongia Nallah R-MS-9 (16-10-2020)</p>	
		
<p>10.</p>	<p>Neeri ESID Drilled point R-MS-10 (16-10-2020)</p>	
		

<p>11.</p>	<p>Monitoring well 1 Grasim R-MS-11 (16-10-2020)</p>	
<p>12.</p>	<p>Monitoring well 4 R-MS-12 (16-10-2020)</p>	 
<p>13.</p>	<p>Monitoring well 3 R-MS-13 (16-10-2020)</p>	

<p>14.</p>	<p>Leachate R-MS-14 (16-10-2020)</p>	
<p>15.</p>	<p>Monitoring well near DM plant cooling tower R-MS-15 (17-10-2020)</p>	 
<p>16.</p>	<p>Monitoring well 10 R-MS-16 (17-10-2020)</p>	

		
<p>17.</p>	<p>Monitoring well R-MS-17 (17-10-2020)</p>	 
<p>18.</p>	<p>Monitoring well R-MS-18 (17-10-2020)</p>	

		
<p>19.</p>	<p>Monitoring well 8 R-MS-19 (17-10-2020)</p>	 
<p>20.</p>	<p>Monitoring well R-MS-20 (17-10-2020)</p>	

		
<p>21.</p>	<p>Monitoring well Lal bungalow R-MS-21 (17-10-2020)</p>	
<p>22.</p>	<p>Grasim Intake R-MS/PL-22 (17-10-2020)</p>	
<p>23.</p>	<p>Dongia Nallah confluence with river R-MS/PL-23 (17-10-2020)</p>	

		
<p>24.</p>	<p>D/S River sample R-MS/PL-24 (17-10-2020)</p>	 
<p>25.</p>	<p>Shiv Park Area R-MS-25 (17-10-2020)</p>	

		
26.	Grasim Hitech Colony R-MS-26 (17-10-2020)	 