IN THE HON'BLE NATIONAL GREEN TRIBUNAL,

PRINCIPAL BENCH, NEW DELHI

EXECUTION APPLICATION NO. 34/2023

IN

ORIGINAL APPLICATION NO. 526/2019

IN THE MATTER OF –

Mahesh Chandra Saxena .....**APPLICANT**

VERSUS

CPCB & ORS. .....**RESPONDENT**

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29.04.25

VINOD KUMAR DHAUNDIYAL
Administrator
Central Ground Water Authority
Government of India
Ministry of Jal Shakti
Department of Water Resources, RD & GR
New Delhi

Filed by
Through

New Delhi
Dated 29/4/25

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ACTION TAKEN REPORT ON BEHALF OF CENTRAL GROUND WATER AUTHORITY

MOST RESPECTFULLY SHOWETH:-

1. This Execution Application has been filed by the Applicant seeking compliance of order dated 11.09.2019 passed in OA No. 526/2019. In the said O.A. i.e. 526/2019, the issue relating to the **Rain Water Harvesting System** in Delhi was raised and the Tribunal by order dated 11.09.2019 had directed as under:

"*Accordingly, we direct that the suggestions of the Committee be acted upon. RWHS may not be installed close to storm water drains to avoid contamination of ground water in the process of recharging the ground water from the RWHS. Piezometers are installed near the RWHS for monitoring of ground water level and water quality of recharged water. Separators be installed to separate pollutants before recharging. Depth of*

the borewells should be at least 5m above the Static Water Table. Deficient RWHS be closed. In light of observations of the Committee, the Delhi JalBoard(DJB), Delhi Development Authority (DDA), Public Works Department (PWD), Delhi; New Delhi Municipal Corporation (NDMC) and South Delhi Municipal Corporation (SDMC) are directed to take appropriate remedial measures for mitigation."

2. That the Hon'ble Tribunal vide order dated 24.04.2024 directed all the respondents to file their response on the following specific points:

(a). Number of RWHS erected along with the location details and contact details of the officer responsible for maintaining.

(b). whether the RWHS erected are as per the suggestions of the Committee constituted earlier by Hon'ble NGT.

(c). Number of the structures erected near to the storm water drains.

(d). Status and number of piezometers installed near the RWHS for monitoring of ground water level.

(e). Number of Deficient RWHS.

In pursuance to the direction of Hon'ble Tribunal, CGWA filed status report on 15.05.2024.

Further, Hon'ble Tribunal vide para 9 of order dated 25.05.2024 granted four week time to applicant to file objections to the report /response filed by the respondents.

Accordingly, applicant filed objection report before Hon'ble Tribunal. In the said report, applicant vide para 11 objected the status report of CGWA stating that "*the status report/ reply filed by CGWB, it was stated that three R.W.H systems were installed in Jahan Panah Park or forest area, and one in Nehru Place Park. Upon inspecting these systems, the*

applicant found that the recharge bore-wells were filled with mud and silt due to the absence of end caps, which allowed debris to enter. While no damage to groundwater was observed, RWHS were not functioning as intended. It was also noted Nehru Place Park, which spans 100 acres and contains 10 lakh litre, remains dry even after 1000 mm of rainfall. Instead of installing RWHS, CGWA should have created a water body in JahanPanah Park to better manage water resources."

In response to the objection raised by the applicant, all the structures were cleaned by removing mud and silt and tested with putting the water. As a result, all installed RWHSs are now fully functional. The photographs and detail of RWHSs is annexed as **Annexure-I**

3. That Hon'ble NGT vide para 18 and 19 of the order dated 16.01.2025 directed CGWA to prevent the contamination of the groundwater and also to ensure that the order dated 11.09.2019 in O.A. 526 of 2019 of the Tribunal is fully complied with which could have helped in preservation of contamination of groundwater in Delhi and also directed to submit the action taken report within ten weeks.
4. In pursuance of the direction of Hon'ble Tribunal, ATR on behalf of CGWA is submitted below:-

   The CGWA has from time to time, issued directions and advisories to the States/UTs regarding regulation, management and prevention of groundwater contamination. The kind attention of the Hon'ble Tribunal is also invited to the action taken report submitted in relation to the prevention of groundwater contamination. In this context, reference is made to a similar matter Original Application No. 147/2021 before the Hon'ble Tribunal, wherein the issue of deficiencies in rainwater harvesting systems leading to the mixing of polluted water with

groundwater was duly raised and considered. Hon'ble Tribunal vide order dated 10.12.2021 had issued following directions: "*In the light of experience gained in the present case, it appears that at many places where RWH systems are installed, the same are either not functional or resulting in contamination of ground water which situation needs to be remedied not only in Delhi but pan India. This may be urgently looked into by a joint committee of CPCB, Ministry of Jal Shakti (MoJS) and Ministry of Urban Development, Government of India. Ministry of Jal Shakti (MoJS) will be nodal agency for the purpose. The Secretary, MoJS may call a meeting of stakeholders for further course of action in the light of above observations, followed by issuance of appropriate directions to all the States/UTs*".

Accordingly, MoJS constituted a committee and directed to submit its report considering the following Terms of References (TOR):-

TOR-1: Operational status including design parameters of the installed Rainwater Harvesting (RWII) systems. The Committee may identify few sites in States/ UTs for verification and preparation of reports.

TOR-2: To check the contamination status of Ground Water aquifers due to faulty design of RWH systems, if any, in the country. Committee may identify few sites for this purpose.

TOR-3: To suggest remedial measures to improve existing RWH system and also recommended preventive actions to avoid installation of faulty RWH systems in future including addressing of maintenance issues.

TOR-4: Any other activity considered appropriate by the committee.

5. That the Joint committee after several meetings, discussions, site inspection located in various parts of India is Delhi, Haryana, Karnataka,

Rajasthan, Tamil Nadu prepared report which is annexed **as Annexure -II** which has been further submitted to the Hon'ble Tribunal on 03.04.2023. Furthermore, CGWA vide letter dated 31/03/2023 (copy annexed as **Annexure-III**) forwarded the advisory dated 31.03.2023 issued by Ministry of Jal Shakti, directing all the states/UTs for prevention of potential contamination of ground water from Rain Water Harvesting systems in Urban Areas. The detailed reference to the said advisory is provided in the next Para (Para-6).

6. That the Ministry of Jal Shakti issued advisory dated 31/03/2023 along with SOP with dos and don'ts and for strictly adhering to the BIS Standard - IS 15797:2008 for implementation of Roof Top Rain Water Harvesting System in the country. The Chief Secretary of States/UTs were requested to direct/ instruct concerned Departments/agencies to strictly follow the guidelines including Do's & Dont's while implementing the RWH systems in their respective States/UTs. It has also been directed that the concerned department / agency in the State may approach Regional Director Offices of Central Ground Water Board (CGWB) for technical guidance/support, if any vide letter dated 31/3/2023 and also issued advisory to all the states / UTs for implementation and strict compliance. Copy of advisory along with SOP with Dos & Don'ts and BIS Standard - IS 15797:2008 for implementation of Roof Top Rain Water Harvesting System arc annexed as **Annexure-IV & Annexure-V** respectively.

That the Central Ground Water Authority is committed to assist the State Governments in the implementation of Rain Water Harvesting System as per the advisories issued by the Ministry of Jal Shakti.

7. That the present ATR may kindly be taken on record for consideration of the Hon'ble Tribunal.

29-04-2025

VINOD KUMAR DHAUNDIYAL
Administrator
Central Ground Water Authority
Government of India
Ministry of Jal Shakti
Department of Water Resources, RD & GR
New Delhi

Through

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New Delhi
Dated 29-04-2025

1. Rain Water Harvesting Structure in Wing 3, West block - 2 SUO, CGWB R K Puram, New Delhi

1	Name of Organization	CGWB,SUO, New Delhi
2	Name of Building	Wing -3,West Block -II,R.K. Puram Sector-1
3	Location of Building	Latitude -28.568044214998938 Longitude-77.17899400201755
4	No and type of existing structure	Recharge trench (6m x 1 m x 1 m) with two recharge bore of depth of 30m
5	Recharge capacity	Recharge capacity of 765 m3/year
6	Remarks	In building of West Block – 2, no proper parapet wall is there so water for harvesting is coming from paved area through infiltration gallery in the recharge structure.
7	Date of commencement of work	27.09.2024
8	Date of Completion of work	30.09.2024

Fig. - 1 Recharge Trench with two recharge bore in West Block -2 along with paved area and gallery

2. Rain water Harvesting Structure in Jahapnanah City Forest Recharge trench (10m x 1m x 3 m) with 3 recharge bore wells

1	Name of Organization/Prepared by organization	CGWB,SUO, New Delhi
2	Name of Building	Jahapnanah City Forest, Greater Kailash, Chirag Delhi New Delhi
3	Location of Building	Latitude - 28.53944, Longitude -77.23333
4	No and type of existing structure	Recharge trench (10 m x 1m 3 m) with 3 recharge wells recharge bore is depth of
5	Monitoring well along with DWLR	35 m depth of monitoring well fitted with DWLR for ground water Monitoring
6	Recharge capacity of Structure	Do not have information
7	Date of commencement of work	25.09.2024
8	Date of Completion of work	27.09.2024

Fig. - 2 Recharge Trench with three recharge bore (10m x 1m X 3 m) in Jhanpanah City Forest along with Monitoring well fitted with DWLR for Ground Water Monitoring

3. Rain water Harvesting Structure in Jahapnanah City Forest Recharge trench (10m x 1m x 3 m) with 3 recharge bore wells

1	Name of Organization/Prepared by organization	CGWB,SUO, New Delhi
2	Name of Building	Jahapnanah City Forest, Greater Kailash, Chirag Delhi New Delhi
3	Town	Municipal Corporation of Delhi
4	Location of Building	Latitude - 28.53944, Longitude -77.23333
5	No and type of existing structure	Recharge trench (10m x 1m 3 m) with 2 Recharge wells of 30 m depth
6	Recharge capacity of Structure	Do not have information
7	Date of commencement of work	25.09.2024
8	Date of Completion of work	27.09.2024

Figure - 3 Recharge Trench with two Recharge bore (6 m x 1 m x 3m) in Jhanpanah City Forest

4. Rain water Harvesting Structure in Jahapnanah City Forest Recharge trench (10m x 1m x 3 m) with 3 recharge bore wells

1	Name of Organization/Prepared by organization	CGWB,SUO, New Delhi
2	Name of Building	Jahapnanah City Forest, Greater Kailash, Chirag Delhi New Delhi
3	Town	Municipal Corporation of Delhi
4	Location of Building	Latitude - 28.53944, Longitude-77.2333
5	No and type of existing structure	Recharge trench (6 m x 1m 3 m) with two Recharge bore of 30 m depth
6	Recharge capacity of Structure	Do not have information
7	Date of commencement of work	25.09.2024
8	Date of Completion of work	27.09.2024

Figure - 4 Recharge Trench with two recharge bore (4m x 1m x 3m) in Jhanpanah City Forest

5. Rain water Harvesting Structure in Astha Kunj Park (1 number of structure)

1	Name of Organization/Prepared by organization	CGWB,SUO, New Delhi
2	Name of Building	Astha Kunj Park, Sant Nagar, East of Kailash, New Delhi, Delhi 110048,
3	Town	Municipal Corporation of Delhi
4	Location of Building	Latitude - 28.5536111 Longitude-77.2511111
5	Type of existing structure	Recharge shaft with recharge bore (6 m diameter X 4 m Depth) of 30 m depth
6	Recharge capacity of Structure	Do not have information
7	Date of commencement of work	27.09.2024
8	Date of Completion of work	28.09.2024

Figure - 5 Recharge Shaft with one bore hole (6 m diameter X 4 m Depth) in Astha Kunj Park along with Monitoring Well fitted with DWLR

REPORT OF THE JOINT COMMITTEE CONSTITUTED TO LOOK INTO THE MATTER OF RAIN WATER HARVESTING SYSTEMS IN INDIA IN COMPLIANCE TO THE DIRECTION OF HON'BLE NGT IN THE MATTER, OA NO. 147/2021 – MAHESH CHANDRA SAXENA *VS* THE CHIEF SECRETARY, GOVERNMENT OF NCT OF DELHI & ORS

A. BACKGROUND/ INTRODUCTION

A-1: HON'BLE NGT DIRECTIVES

In Original Application No. 147/2021 in Hon'ble NGT, issue of deficiencies in rain water harvesting systems resulting in polluted water mixing with the groundwater, wasraised before the Hon'ble National Green Tribunal. The matter initially pertained to 40 Societies in Dwarka Area, Delhi. The Tribunal while disposing off the matter considered the need of joint inspection of rain water harvesting systems in all areas of Delhi to ensure proper functional design, depth of borewell, use of gravel and coarsesand in filter media.

Hon'ble NGT, Principal Bench, New Delhi, vide Order dated 10.12.2021 **further directed** the following.

> "*In the light of experience gained in the present case, it appears that at many places where RWH systems are installed, the same are either not functional or resulting in contamination of ground water which situation needs to be remedied not only in Delhi but pan India. This may be urgently looked into by a joint committee of CPCB, Ministry of Jal Shakti (MoJS) and Ministry of Urban Development, Government of India. Ministry of Jal Shakti (MoJS) will be nodal agency for the purpose. The Secretary, MoJS may call a meeting of stakeholders for further course of action in the light of above observations, followed by issuance of appropriate directions to all the States/UTs*".

A-2: CONSTITUTION OF COMMITTEE AND TOR

In pursuance to the directives of Hon'ble NGT, a Committee under the Chairmanship of Chairman, Central Ground Water Board (CGWB) was constituted by MoJSvide Order Dated 19.01.2022 (**Appendix:A-1**) with the following members.

S. No.	Committee Position	Representation	Nomination
1.	**Chairman**	Chairman, CGWB	**----**
2.	Member Secretary	Member, CGWA	-----
3.	Member	Representative of Central Pollution Control Board (**CPCB**)	Shri J Chandra Babu, Scientist, CPCB/ MsAlpanaNarula, Sr Scientific Assistant, CPCB
4.	Member	Representative of Ministry of Housing and Urban Affairs (**MoHUA**)	Dr Ramakant, Dy Advisor, PHE, CPHEEO
5.	Member	Representative of State of Delhi, Rajasthan, Haryana, Karnataka, Tamil Nadu	

ToR of the committee are as following.

TOR-1: Operational status including design parameters of the installed Rainwater Harvesting (RWH) systems. The Committee may identify few sites in States/ UTs for verification and preparation of reports.

TOR-2: To check the contamination status of Ground Water aquifers due to faulty design of RWH systems, if any, in the country. Committee may identify few sites for this purpose.

TOR-3: To suggest remedial measures to improve existing RWH system and also recommend preventive actions to avoid installation of faulty RWH systems in future including addressing of maintenance issues.

TOR-4: Any other activity considered appropriate by the committee.

A-2: VC MEETING OF COMMITTEE ON 03.03.2022

A meeting of committee was convened to decide course of action on 03.03.2022. Following action points emerged during the meeting held on **03.03.2022** (Minutes enclosed as **Appendix: A-2**).

1. Selected Member States, i.e Delhi, Haryana, Karnataka, Rajasthan and Tamil Naduwill share information/ data as below:

- **a.** Provide list of Rain Water Harvesting structures sites to CGWA by 04.02.2020 for site visits / field inspections by the committee.
- **b.** Provide Building Bye laws and rules that have been enacted by the states related to RWH system.
- **c.** Provide standard design for RWH recharge structures formulated by concerned state departments.
- **d.** Provide water quality impact assessment related to contamination of Ground Water, if available.
- **e.** Provide existing penal provisions, if any, for groundwater contamination.

2. Constitute working group in 5 states drawing members from regional offices of CGWB and States government departments to supportthe joint committee and coordinate with them. Details of nominated officers are to be shared with all concerned.

Accordingly, teams were constituted for different States with representatives of states as members (**Table A-1**).

Table A-1: Teams for Visit to Different States

State	Team Members
Delhi	1. Shri Sunil Kumar, Chairman, CGWA & CGWB 2. Dr P K Naik, Scientist E, CGWA, New Delhi 3. Shri Faizal Abrar, Scientist CGWB, New Delhi 4. MsAlpanaNarula, Sr Scientific Assistant, CPCB 5. Shri Harish Chander, Addl Chief Engineer (C-8), DJB 6. Shri VimalBelani, Executive Engineer, (RWH-I), DJB 7. Shri Rakesh Sharma, AE (RWH-I), DJB
Haryana	1. Dr Rajesh Chandra, Scientist E, CGWA, New Delhi 2. MsAlpanaNarula, Sr Scientific Assistant, CPCB 3. Shri Rakesh Kumar, Chief Hydrologist, GW Cell, Haryana 4. Shri Pankaj Mahaliya, Chief Hydrologist, GW Cell, Haryana
Karnataka	1. Shri N JyothiKmar, Scientist, CGWB, Bengaluru 2. Shri A K Patre, Scientist, CGWA 3. Dr Vikas Ranjan, Scientist CGWA, New Delhi 4. Shri Rahul R Shende, Scientist, CGWB, Bengaluru

	5. Shri J Chandra Babu, Scientist, CPCB, New Delhi* 6. Shri Jayanna, Dy Director, KGWA 7. MsAmbika T. Dy Director, GWD 8. MsChhaya, Sr Geologist, GWD 9. Shri Lakshmi Narayana N, Superintendent, GWD 10. Dr U T Vijay, Chief Scientific Officer, KSCST, IISc Campus, Bengaluru
Rajasthan	1. Shri A K Patre, Scientist, CGWA 2. Shri Anmol Sharma, Scientist, CGWA, New Delhi 3. Shri Sujit Kumar, Scientist, CGWB, Jaipur 4. Shri J Chandra Babu, Scientist, CPCB, New Delhi* 5. Shri AnoopThereja, Sr Hydrogeologist, GWD, Jaipur Division, Rajasthan
Tamil Nadu	1. Dr Vikas Ranjan, Scientist CGWA, New Delhi 2. Shri J Chandra Babu, Scientist, CPCB, New Delhi* 3. Shri S P Nayagam, Scientist, CGWB, Chennai 4. Er. S. Raja, Jt Chief Engineer, WRD, Tamil Nadu**

*Presently posted at CPCB, Bengaluru; **Presently retired

Working groups in the States formed to support and coordinate with central teams which were headed by respective Regional Director of CGWB and assisted by officers of CGWB Regional offices and State Government departments.

State-wise details of visited sites are given in following table (**Table A-2**) sites visited.

Table A-2: RWH Sites visited in Different States

State	Date(s) of Visit	Sites Visited
Delhi (**DL**)	07.03.2022	**DL-1** Gold Croft CGHS Ltd., Plot No. 4, Sector-11, Dwarka, Delhi **DL-2** Hind CGHS Ltd., Plot No. 12, Sector-5, Dwarka, Delhi **DL-3** Guru Tegh Bahadur Institute of Technology, G-8 Area, Rajouri Garden, New Delhi **DL-4** Siri Fort Auditorium, August Kranti Marg, New Delhi
Haryana (**HR**)	22.02.2022	**HR-1** Maruti Suzuki India Ltd, IMT, Manesar, Haryana **HR-2** Corporate Office Complex, Bestech India Pvt Ltd, Sector-44, Gurugram, Haryana
Karnataka (**KA**)	26.02.2022	**KA-1** Sir M. Visvesaraiyaa RWH Theme Park, Bengaluru. **KA-2** Falcon City Residential Complex, Bengaluru **KA-3** ABB Limited, Bengaluru
Rajasthan (**RJ**)	19.02.2022 & 20.02.2022	**RJ-1** Ankit Roofings Ltd, Vill. DahamiKhurd, Sanganer Block, Jaipur **RJ-2** State GWD Campus, Sanganer Block, Jaipur **RJ-3** Rajbhawan, Jhothwara Block, Jaipur
Tamil Nadu (**TN**)	24.02.2022 & 25.02.2022	**TN-1** Rain Centre, Akash Ganga Trust Adyar, Chennai. **TN-2** Tharamani Campus of WRD, Chennai **TN-3** Phoenix Market City Velachery Chennai **TN-4** SSM Residential Complex, Nedunkundram village, Vandalur Chengalpattu District. **TN-5** Putlur Check Dam, Tiruvallur District, Tamilnadu **TN-6** Asian Paints Ltd, Pondura, Sriperumbudur, Kancheepuram district

On-the-spot study of RWH Structures were carried out by different teams keeping in view the ToRs of the committee.

A-4: LAYOUT OF PRESENTATION OF OBSERVATIONS, CONCLUSIONS AND SUGGESTIONS OF COMMITTEE AS PER TOR

Section-Bsummarizes State-wise **Observations/ Findings** of the Committee, which include **summary** of relevant rules and findings based on the site visits. State-wise **Rules**and

regulations promulgated, as well as **reports of the individual site visits** are **attached as Appendices**. Name of the States in this report are abbreviated for convenience as following: Delhi-**DL**; Haryana-**HR**; Karnataka-**KA**; Rajasthan-**RJ**; Tamil Nadu-**TN**.

Section-C summarizes salient conclusions based on the rules/ visits as per **ToR-1&2**, followed by **suggestions** (**Section-D**) as per **ToR-3&4**.

B. STATE-WISE OBSERVATIONS/ FINDINGS FROM THE VISIT/ STUDY OF RULES

B-1: DELHI (DL)

B-1.1: RWH Rules & Regulations, Delhi (Appendix B-1.1: DL RWH Rules)

i. **Implementation** of RWH is governed by '**Building By-laws, 1983 (Amendment, 2001)**'of Ministry of Urban Development and its further reinforcement through provisions in '**Delhi Water & Sewer (Tariff & Metering) Regulation, 2012 and its Amendment, 2016** of Delhi Jal Board (**DJB**).

ii. Provisions in DJB's regulations make it mandatory to install RWH system depending upon Plot size (more than 100 sqm).

iii. RWH is not mandatory in areas having depth to ground water levels less than 5m below ground.

iv. It is also not mandatory to construct borewell for recharge. Only RWH through Roof Top is mandatory (Amendment, 2016 to Delhi Water & Sewer (Tariff & Metering Regulation). The amendment has been made to avoid misuse of borewell for groundwater extraction in the name of recharge.

v. There is incentivization for installation of RWH system through rebate, and also penal provisions for non-installation of RWH in the form of 1.5 times tariff (water charges).

vi. New water/ sewer connections are sanctioned by DJB, subject to installation of RWH System. To ensure installation in existing buildings Public Notices have been issued, notifying penal provisions, if the concerned fail to inform about the installation of RWH system in existing buildings.

vii. RWH Guidelines of DJB advise that '*only non-polluted rainwater from the roof tops and other catchment areas has to be diverted to recharge structure through connection of downpipe*'. However, **there is no penal provision for contamination of groundwater due to faulty recharge**.'

B-1.2: Inspection Visit, Delhi (Appendix B-1.2: DL RWH Insp)

i. **Four sites** were visited upon.

- **DL-1** Gold Croft CGHS Ltd., Plot No. 4, Sector-11, Dwarka, Delhi
- **Dl-2** Hind CGHS Ltd., Plot No. 12, Sector-5, Dwarka, Delhi
- **DL-3** Guru Tegh Bahadur Institute of Technology, G-8 Area, Rajouri Garden, New Delhi
- **DL-4** Siri Fort Auditorium, August Kranti Marg, New Delhi

ii. **Gold Croft CGHS Ltd (DL-1):** Water levels of nearest Piezometer at Dwarka (less than **1 Km from DL-1**) show rise of 7m from 2019 to 2021. Water sample from this piezometer has all the basic chemical parameters within permissible limits. Heavy

Metals concentrations (Cr, Mn, Fe, Ni, Cu, Zn, As, Se, Ag, Cd, Pb, U) are also within permissible limits.

iii. **Hind CGHS Ltd** (**DL-2):** The**piezometer**representing DL-1 is alsorepresenting DL-**2.** It is also located at a distance of around **1 Km from DL-2**.

iv. **Guru Tegh Bahadur Institute** (**DL-3):** RWH system comprises 5 recharge pits (without borewell) of approximate 2m depth each. Post-monsoon water levels recorded in the nearest piezometers at Tagore Garden (**≈ 2 Km** from site) and Mayapuri (≈4 Km from site) show decline of 5-7m in last 12 years. **Water sample from Tagore Garden Pz shows high EC and other basic chemical parameters**. However, heavy metals concentrations (Cr, Mn, Fe, Ni, Cu, Zn, As, Se, Ag, Cd, Pb, U) are within permissible limits in ground water.

v. **Siri Fort Auditorium** (**DL-4):** RWH System comprises of 10 Recharge Pits (without recharge well) of 2.2m depth each. Water levels recorded in the nearest piezometer at Hauz Khas (**≈1 Km**) shows rise of 6-7m from 2006-2021 (15 years). Basic parameters and Heavy Metals concentrations in water sample taken from HauzKhasPz are within permissible limits except Uranium concentration (78 ppb).

vi. **At all the four sites visited**, Rain water harvesting pits were found to be clean and working. Terrace of the building blocks were also found to be clean.

vii. As per information provided, all structures and filter media are regularly cleaned. Inspection Team rendered advice as regard to proper maintenance of RWH system and **Geo-tagging of RWH/ Recharge structures**.

B-2: HARYANA (HR)

B-2.1: <u>RWH Rules & Regulations, Haryana/ Gurgaon (Appendix B-2.1: HR RWH Rules)</u>

i. **Implementation** of RWH is governed by '**The Haryana Building Code, 2016**'. The Code also uses provisions of Water (Prevention & Control) of Pollution Act, 1974 with some amendments.

ii. **Roof top RWH**is mandatory for roof area 100 Sqm or more **and Recharge**is mandatory for any building on plot area 500 Sqm or more, parks, vehicles' parking places, plazas, playgrounds and other common areas. Water so harvested is to be utilized for non-potable uses and recharge of aquifer.

iii. Recognized Architect/ Engineer is to certify that RWH is functional and any misrepresentation by them shall attract penal proceedings.

iv. RWH system is to be properly designed so that **contaminated water does not enter** into RWH/ recharge system.

v. Recharge well should be at least 10m away from any structure handling sewage/ industrial effluent (not applicable on manholes/ sewer lines although it shall be ensured that these are leak-proof).

B-2.2: <u>Inspection Visit, Haryana/ Gurugram (Appendix B-2.2: Haryana RWH Insp)</u>

i. **Two sites** were visited upon.

HR-1 Maruti Suzuki India Ltd, IMT, Manesar, Haryana

HR-2 Corporate Office Complex, Bestech India Pvt Ltd, Sector-44, Gurugram, Haryana

ii. **Maruti Suzuki India Ltd, IMT (HR-1)**: At Maruti Suzuki Unit, there are 6 Lagoons having RWH cumulative capacity of 119660 CUM. At the time of visit, lagoons were completely dry and recharge wells were in running condition. Two Piezometers with DWLR are installed in the premises. There are separate and isolated pipelines for channelization of storm water to lagoons (RWH Storage). Dedicated and separate pipelines are laid for collection of Sewage and effluent to Effluent Treatment Plant (**ETP** Capacity: 5840 KL/Day) and Sewage Treatment Plant (**STP** Capacity: 1187). As per the company representative, storm water is completely insulated from sewage and effluent. To prevent contamination of run-off from paved area, trap has been provided for capturing oil/silt and transferring them to ETP. RWH system is totally insulated from sewage and wastewater from areas likely to have oil and grease, or other pollutants and that all the structures and filter media are regularly cleaned. Sample collected from TW near Gate No. 3 has all basic parameters and heavy metals analysed within permissible limits, except nitrate (65 mg/L), which is above permissible limit (45 mg/L). The inspection team rendered advice as regard to installation of **Piezometer in vicinity** of every Lagoon to keep regular checkup on water level and Quality of ground water.

iii. **Bestech India Pvt Ltd (HR-2):** RWH system comprises of one Recharge Pit with Recharge Well. STP of 20 KLD capacity with MBBR Technology has been installed in the premises. As per representative of the firm, RWH system is totally insulated from sewage that all the structures and filter media are cleaned annually. Sample collected from RWH structure has all basic parameters and heavy metals analysed within permissible limitsThe team advised to clean the system 4 times a year.

B-3: KARNATAKA (KA)

B-3.1: <u>RWH Rules & Regulations, Karnataka/ Bengaluru (Appendix B-3.1: KA RWH Rules)</u>

i. **Implementation** of RWH is governed by **Bangalore Water Supply and Sewerage (Amendment) Bill** 2009, 2020 & 2021, **BWSSB Rain Water Harvesting Act 72A Amendment 2021** and **State Ground Water Act 2011**

ii. Guidelines for RWH issued by BWSSB contains chapter on water quality and treatment to prevent contamination of recharged water. A chapter on RWH is included in the SGW Act.

iii. RWH is mandatory in existing buildings having site dimension of 216 sqm and above and in new buildings constructed on site measuring 108 sqm and above.

iv. Vide Amendment, 2020, capacity of Roof Top TRWH recharge structure was enhanced from 20 lt/sqm to 60 lt/sqm, whereas in respect of land based RWH, the capacity was enhanced from 10 lt /sqm to 20 lt/sqm.

v. Dual pipe system is to be installed for RWH structure for utilization of harvested water for purposes other than drinking, cooking and bathing.

vi. There is penal provision in case of non-compliance to RWH conditions in the form of additional charges in Monthly Water Bill till RWH is implemented. RWH system is inspected by the representative at the time of visit for water meter reading.

vii. Regular monitoring by BWSSB of RWH schemes already implemented and organizing awareness programmes.

viii. As per Act, Municipal Corporations, local authorities are to impose mandatory RWH conditions while according approval for construction (100 Sqm or more); permanent water and electricity connections shall be extended only after compliance of directions.

ix. However, there are **no penal provisions** for **ground water contamination, neither** in **BWSSB guidelines, nor** in the **State Ground Water Act**.

B-3.2: <u>Inspection Visit to Karnataka/ Bengaluru (Appendix B-3.2: Karnataka RWH Insp)</u>

i. **Three sites** were visited upon.

KA-1 M. Visvesaraiyaa RWH Theme Park, Bengaluru.

KA-2 Falcon City Residential Complex, Bengaluru

KA-3 M/sABB Limited, Bengaluru

ii. **Sir M. Visvesaraiyaa RWHTheme Park** (**KA-1**): The Theme Park has been set up **to demonstrate different techniques** of **Rain Water Harvesting** to common people through RWH storage structures with different methods of storage of rain water and recharge wells within the premises. The park is popularizing the idea of RWH to the general public, students, NGO's, architects, engineers, plumbers etc. As per BWSSB officials maintaining the park, there is no scope of contamination of ground water due to artificial recharge in the premises. However, total **coliform** was **found present** in groundwater sample from the Recharge Well in Theme Park premises. **The presence of coliform in ground water sample may be** because of extraneous reasons. *Sample from borewell within the premises analysed has **Uranium** concentration beyond the permissible limit of 30 ppb, which may be **geogenic in nature**.*

iii. In **Falcon City Residential Complex** (**KA-2**), rooftop run-off is collected in Storage tanks for non-potable purposes. Chemical analyses of groundwater samples from recharge pit and nearest borewell within the premises has all basic chemical parameters within permissible limits of BIS Drinking Water Specifications (IS:10500-2012). All the recharge and storage structures are well maintained. Proper mechanism is in place to prevent sewage water from mixing into run-off/ recharged water. However, the management could not provide design of system and structures.

iv. **ABBLtd** (**KA-3**) has constructed rain water **storage-cum-recharge structures using cross wave technology** – i.e storage tanks made of Polypropylene (highly water-resistant resin) with a **highvoid ratio** (Claimed as almost 95%**)**, enabling creation of larger water storage space in a smaller area compared to conventional tanks. Strength of such structure is high and therefore; space above can be utilized for parking etc. The company has installed flow-meter at storage-cum recharge structure to ascertain quantum of recharge. Trial of flow-meter has shown that initial intake capacity of structure is around 3 cum/Hr. However, the structure was yet to get its first monsoon rain, when field visit was made. There are **separate pipelines for sewage collection which are connected directly from building toilets to STP collection tank**. The firm has plan for periodic maintenance and checking to avoid

any leakage in sewage pipeline. **Recharge wells were dry during inspection**. **Ground waterquality** report of the **nearest borewell** within the premises (77m Deep) indicates that the measured values for the allbasic chemical parameters are **within BIS** Drinking Water Specifications/ **permissible limits**. The efficacy of cross-wave reservoir was also studied later by CGWB by filling the cross-wave reservoir through tank water supply and observing the capacity of the tank. It was found that storage space of the structure is ≈ 95%. It was also observed from water levels recorded during the study that recharge is taking place through recharge well.

v. The management/ maintenance team of all the above sites have been advised to by-pass first flush and to prevent entry of water from paved area having vehicular movement from entering into the RWH system.

B-4: RAJASTHAN (RJ)

B-4.1: <u>RWH Rules & Regulations Rajasthan/ Jaipur (Appendix B-4.1: RJ RWH Rules)</u>

i. **Implementation of RWH** is governed by **Urban Area (Name of City) Building Regulation, 2020**.

ii. There is mandatory RWH Unit/ Structure in plot areas 225 Sqm or more.

iii. Security deposit for construction of RWH System is refunded only after submission of verification report by retired engineer.

iv. There is **no mention of ground water quality** aspect in the regulation.

B-4.2: <u>RWH Inspection Visit Rajasthan/ Jaipur (Appendix B-4.2: RJ RWH Insp)</u>

i. Three sites were visited upon.
- **RJ-1** Ankit Roofings Ltd, Vill. DahamiKhurd, SanganerBlick, Jaipur
- **RJ-2** State GWD Campus, Sanaganer Block, Jaipur
- **RJ-3** Rajbhawan, Jhothwara Block, Jaipur

ii. **Ankit Roofings Ltd (RJ-1)**: RWH System was installed in the year 2005-06, and comprises of storage tank of 25 m^3 capacity and filter pit (3.6 m deep) with 60m deep injection well. Run-off from Roof Top and Paved Area is diverted to the storage tank. Water level recorded in Piezometer installed in the premises was **32.92mbgl** in **pre-monsoon 2013**. During the visit in **February, 2022**, water level in the same piezometer was recorded as **36.98 mbgl**. EC of water sample has increased marginally from 1153 mmhos/cm in 2017 to 1541 mmhos/cm in February, 2022. As per representatives of firm, roof top is cleaned twice a year and filter media is cleaned/ replaced annually.

iii. **GWD Campus (RJ-2):** RWH System was constructed in the year 2000-01 under Central Sector Scheme. It is a Roof Top TRWH system (Run-off from paved area is not harvested) and comprises of Main Collection/ Desiltation Chamber and Recharge Trench with 40m deep Injection Well / Recharge Shaft. At the time of visit there was no debris or water in the trench, indicating that system was working fine. Rise in water level of about 10m (≈63mbgl to ≈53mbgl) over last 10 years (2012-2021) has been observed in the piezometer installed in the premises. There is increase in EC value from 760 mmhos/cm (in 2001) to 1150 mmhos/cm (in 2022 – present visit) of the samples collected from TW in the premises. **Nitrate has increased significantly**

from 30 mg/l (permissible limit is 45 mg/l) to 140 mg/l, **indicating mixing of polluted water**. As informed by GWD officials, roof top is cleaned 2-3 times a year. Filter media is cleaned/ desilted annually.

iv. **Raj Bhawan (RJ-3):** RWH System was constructed in the year 2000-01 under Central Sector Scheme. It is a RTRWH system (Run-off from paved area is not harvested) having 19m Injection Well/ Recharge Shaft for ground water recharging. **3.7m rise** in water level (26.4mbgl to 22.7mbgl) has been observed over last 10 years (2012-2021) in the piezometer installed in the premises. There is **increase in EC value** from 910 mmhos/cm (in 2014) to 1850 mmhos/cm (in 2022 – present visit) also. The ground water samples has been taken from TW located in the premises. **Nitrate has increased significantly** from 89 mg/l to 200 mg/l during this period (permissible limit of 45 mg/l). However, EC and nitrate in water sample collected in desiltation chamber have been found to be 560 mmhos/cm and 2.3 mg/l respectively. As informed by GWD officials, roof top is cleaned 2-3 times a year. Filter media is cleaned/ desilted annually.

v. The State Government officials maintained that increase in EC and/ or nitrate is not attributable to fault in RWH system, but to extraneous factors.

B-5: TAMIL NADU (TN)

B-5.1: <u>RWH Rules & Regulations Tamil Nadu/ Chennai (Appendix B-5.1: TN RWH Rules)</u>

i. Implementation of RWHis governed by **Tamil Nadu Combined Development & Building Rules, 2019** of **Municipal Administration and Water Supply Department**.

ii. In Non-High-Rise buildings up to 12m, Roof Top water is to be collected in a sump through a filter for immediate use and surplus is to be diverted to Source Well/ Dug Well (where existing) or to a Recharge Well (where no Dug Well is existing). Run-off from paved area is to be intercepted near gate and is to be led to a Recharge Well.

iii. In Non-High-rise such as above on plots with small area, Roof Top harvested water is to be diverted to Percolation Pits.

iv. In Non-High Rise between 12-18.3m / industries/ institutional buildings, as well as in High Rise buildings, similar methods as (i) or (ii) or combination of two can be applied.

B-5.2: <u>RWH Inspection Visit Tamil Nadu/ Chennai (Appendix B-5.2: TN RWH Insp)</u>

i. **Six sites** were visited upon by the Joint Team. Out of these, one site was a Check Dam built outside the Thiruvallur city limits and does not have much relevance in the present context. Hence, **report of5 sites** has been attached in this report.

- **TN-1** Rain Centre, Akash Ganga Trust Adyar, Chennai.
- **TN-2** Tharamani campus of WRD, Chennai
- **TN-3** Phoenix Market City Velachery Chennai
- **TN-4** SSM Residential Complex, Nedunkundram village, Vandalur Chengalpattu district.
- **TN-5** Putlur Check dam, Tiruvallur district.
- **TN-6** Asian Paints Ltd, Pondura, Sriperumbudur, Kancheepuram district

ii. **Akash Ganga Rain Centre (TN-1):** The run-off from paved areas is being collected through drains covered with perforated slabs and water is allowed into recharge shaft/ well of 15 feet depth directly, without passage through any filter media. Founder of Rain Centre Shri. SekarRaghavan maintains that providing filter retards recharge as the filter media gets choked quickly after one or two rains. He has been popularizing this technique among common people.There is always a possibility of aquifer material getting choked if recharge water is not passed through filter. Hence, Shri Raghvan has been advised to let the water pass through filter media before recharge. It was observed that TDS of sump water was 120 mg/l and that of open well 1214 mg/l. Concentration of other chemical constituents were considerably high in ground water samples of open well. This may be due to mixing of water from additional natural flow into open well.

iii. **GWD, Tharamani (TN-2):** Main structure is underground storage tank/ sump, made **largely using uPVC pipes Technique.** Top of the sump is being used as Parking Space. Water stored in the structure provides adequate amount of water for the office use for 5 to 6 months in a year. After implementation, sufficient water is available to augment water supply to the office establishment for non-potable purposes. There has been no requirement of frequent cleaning in the past five years. Water is being tested for quality periodically and found suitable for domestic purposes.The **technique used is unique and easy to construct**. But, considering the cost of imported material being used, cost of total system is on higher side by around 30% in comparison to conventional system.

iv. **Phoenix Mall (TN-3):** RWH System comprises of recharge pits with 15m deep recharge shaft. In the event of over-flow, the surplus run-off is diverted to nearest lake (Velachery Lake), approximately 250m south of Phoenix Market City. Run-off from paved area having vehicular movement is also being diverted towards RWH system.

v. **SSM Residential Complex (TN-4):** The RWH system comprises of Recharge Pits (3m deep) with filter and Sumps/ Storage Tanks. **The complex is divided into linear blocks with alternate bays for sewage and RWH channels.** Overflow from recharge pits is stored in Sumps/ Storage Tanks for non-potable uses. The RWH system provides adequate amount of water for gardening for this Residential Building Complex nearly for 5 to 6 months in a year. Committee observed that RWH system has been implemented within the **SSM Residential Complex though ground water level is shallow as the complex is close to coastal waters.** Only one pit was shown to the team.

vi. **Asian Paints (TN-6):** Rooftop rainwater is collected through pipes and trenches into a large storage tank having holding capacity of 6000 kilo liters. Efficiency of structure provides adequate amount of water for the industrial use nearly for 5 to 6 months. The industry is ZLD. Hence, chances of contamination are virtually non-existent. **Industry took necessary step to close down the recharge pits after notification of CGWA guidelines**, which advise only conservation for certain category of industries. **However**, **State Government, does not have any such restriction on recharge.** Chemical quality results are included in the respective report of site visit.

vii. Management and maintenance team at all the visited sites informed that all the structures and filter media are regularly cleaned/ replaced. They were advised to by-pass the first flush. It was also advised to avoid water from car parking areas into the system.

C. SALIENT CONCLUSIONS BASED ON THE STUDY OF RULES AND OBSERVATIONS FROM RWH SITE VISITS (AS PER TOR-1 &2)

ToR-1&2 of the Committee state the following.

ToR – 1: *Operational status including design parameters of the installed Rain Water Harvesting (RWH) systems. The Committee may identify few sites in States/ UTs for verification and preparation of reports.*

ToR – 2: *To check the contamination status of Ground Water aquifers due to faulty design of RWH systems, if any, in the country. Committee may identify few sites for this purpose.*

Accordingly, visits were undertaken to selected sites and rules pertaining to RWH were studied (**Section-B** above). A matrix summarizing the site-wise observations on some key aspects is enclosed as **Appendix-C**. Salient collective observations and conclusions are summarized here.

ToR–1: Operational status including design parameters of the installed Rain Water Harvesting (RWH) systems

(a) In all the visited States, RWH in urban areas has been made mandatory under Building Rules or other State Acts/ Rules.**However, penal provisions for ground water contamination due to faulty RWHdesign** or due to lack ofproper and timely maintenance are **missing.** Overall, RWH systems were found as per design and norms of Central/ State Agencies at all the visited sites.

(b) In general, the collected/ harvested water is used for non-potable and/ or recharge purposes. Out of 17 RWH systems visited, 9 systems have Recharge Pits and 6 systems have both Recharge Well and Recharge Pits. Remaining 2 sites have storage/ conservation structures only.

(c) In some**individual houses**, recharge structures have been found deviating from **scientific design**. It was observed in Chennai that**recharge structures have been made without filter media** (**ParaB-5.2(ii)**).

(d) It was observed that Industrial units follow prevailing guidelines for RWH and AR. (**Para B-2.2(ii)**; (**Para-B-3.2(iv)**); (**Para-B-5.2(vi)**)).

(e) RWH structures were found maintained at the time of inspection.

ToR–2: To check the contamination status of Ground Water aquifers due to faulty design of RWH systems

(f) During monsoon season, recharge takes place and ***if any*** contamination has taken place, its spread/ signature/ indications should be present in nearby well-samples during

post-monsoon period.Keeping the above in view, groundwater samples were collected from nearby wells. At some places, where water was available in structure itself, sample of the same was also collected.

(g) In general, chemical quality of water,has been found within the permissible limit. However, total **coliform** was **found** in groundwater sample from RWH well in Theme Park premises, Bengaluru (**Para B-3.2(ii)**). It is also observed that recharging water at Akash Ganga Rain Centre, Chennai may be getting mixed with water from other places. Water from other places may get diverted into open well (known as Source Well), hence, the chemical constituents have considerably higher values in comparison to sump water (**Para B-5.2(ii)**).

At **all the three sites** visited in **Jaipur**, Rajasthan (**Para B-4.2(ii); B-4.2(iii) & B-4.2(iii)**), it has been observed that **EC/ TDS and/ or nitrate** content in tube-wells located within the premises of RWH system have **increased** over past few years.

(h) Rain water harvesting techniques are popular, due to improper and unscientificimplementation, the ground water **recharge component of RWH system is not functioning as desired**. **Presence of coliform and Nitrate in ground water (Para –g above)**indicate that the design adopted does not address the site-specific conditions. **The damage to aquifer in such cases would be permanent.** Lack of insulation of overland flow from contamination may pollute aquifer (**Para – 5.2(iv)**).

D. SUGGESTIONS OF THE COMMITTEE (AS PER TOR-3 &4)

ToR-3& ToR-4 of the Committee state the following.

ToR – 3: *To suggest remedial measures to improve existing RWH system and also recommend preventive actions to avoid installation of faulty RWH systems in future including addressing of maintenance issues.*

ToR – 4: *Any other activity considered appropriate by the committee.*

Based on the salient conclusions drawn from study of rules pertaining to RWH in the visited areas and implementation of RWH at selected sites, following suggestions can be made as per ToR of the Committee.

ToR–3: To suggest remedial measures to improve existing RWH system

(a) Bureau of Indian Standards (**BIS**) has a dedicated Committee – **Ground Water and Related Investigations Sectional Committee, WRD 03**. The Committee, in consultation with experts have developed the following BIS standards.

- **(i)** Indian Standard – Artificial Recharge to Ground WaterGuideline (IS 15792: 2008)
- **(ii)** Indian Standard – Roof Top Rainwater Harvesting – Guidelines (IS 15797: 2008)

The BIS standard **IS 15797:2008** for Roof Top Rainwater Harvesting - Guidelines (enclosed as **Appendix-D**) may be popularized among the user agencies for implementation of RTRWH system in **urban areas**. **Section 6.5 of the document** deal with general 'Management and Maintenance' of the system and **Section 7.4** specifically with 'Management of Catchment Area, Drains and Recharge Structures'. **Section 7** provides

designs of AR structures suitable to different situations. The States may be mandated to adopt these standards in major cities.

(b) RWH schemes may have Artificial Recharge provisions depending upon local hydrogeological/ site-specific conditions. However, **recharge**needs to be **avoided** in areas where there is possibility of contamination of groundwater. In such cases storage of rainwater should be encouraged.

(c) Strict guidelines for protecting aquifer from contamination and damageneed to be formulated. Depending upon groundwater flow direction, RWH/ AR sites need to be located as far as possible frompotential contaminant source such as sewage drains/ landfill sites/ cesspool/ sewage system having hydrogeological connectivity with the aquifer.

(d) As stated in previous Section (Para C-(a)), penal provisions for ground water contamination caused due to faulty RWH/ designs or due to negligence in maintenance are lacking or weak. Legal provisions should be introduced in State Government rules as per EPA, 1986 for contamination of groundwater owing to faulty RWH designs and/or due to poor maintenance. Penal provisions may, however, be applied as the last resort.

(e) There should be web-based, area-specific model design for guidance on the basis of hydrogeological set-up of the area.

(f) In respect of small households, cluster-based RWH system should be promoted in place of individual household scheme.

(g) Model similar to Bengaluru for ensuring compliance to mandatory RWH conditions(**Para B-3.1 (vi)**)may be adopted in other urban areas too. **However**, the monitoring mechanism has to be made more effective through involvement of officials trained to evaluate functioning of installed RWH systemas per **BIS Standards**.

(h) There should be incentivization for adopting RWH, either in the form of rebate or subsidy **in water-stressed areas**. Also, penalty on non-compliance or non-adherence to the norms can be imposed, say in the form of additional water charges ((**Para B-3.1 (vi)**).

(i) Large-scale RWH system, such as those in large industrial, residential and commercial complexes, should have piezometer(s) installed at appropriate site(s) for periodic monitoring of water level and water quality. These parameters are the most important and reliable indicators of functioning status and health of RWH system.

(j) The design of RWH should by-pass first flush. Mixing of drain water with rooftop run off or with runoff from paved areas,where vehicular movement takes place, should be prevented.

ToR–4: Any other activity considered appropriate by the committee

(k) As water quality may not be strictly checked, the water stored in harvesting structures may be **used for non-potable purposes.**

(l) **Concept** like **RWH Theme Park, Bengaluru** (**Para B-3.2(ii)**) run by Government Body may be promoted for proper guidance to general public/ individual households. It may be adopted in other urban areas too.

(m) Underground Storage tank/ sump, made **using cross-wave technology** (**Para B-3.2(iv)**) **or uPVC pipes** (**Para B-5.2(iii)**) **saves space, besides providing strength to the structure**. As it is **costly**, the technology may be used in large **Government Buildings**, commercial complexes and industrial premises.

(n) All RWH sites should be geo-tagged for better visibility for monitoring purpose.

(o) There should be mechanism to avoid misuse of the recharge tubewells for pumping purposes.

(p) Online filters can also be recommended to avoid minor contaminations, if any, for diverting the rooftop rainwater to the recharge tubewells.

(q) New residential complexes may be divided in a way to have alternate bays for sewerage and RWH channels.

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File No: CGWA-26/1/2022-CGWA **Date:** 31.03.2023

To
The Additional Chief Secretary/ Principal Secretary/ Secretary
Irrigation/ Water Resources/ Ground Water/ PHE
All States/ UTs (as per list)

Sub: Prevention of potential contamination of ground water from Rain Water Harvesting systems – Reg

Sir/ Madam

May I invite your kind attention towards Hon'ble NGT observations, expressing concern over Rain Water Harvesting system being one of the potential sources of contamination of ground water The Principal Bench, Delhi of Hon'ble NGT, in its order dated **10.12.2022** while disposing of matter related to societies in Dwarka area, Delhi (OA 147/2021 ground water in the country. The Principal Bench, Delhi of Hon'ble NGT, while disposing of matter related to societies in Dwarka area, Delhi (OA 147/2021), vide their order dated 10.12.2021 directed that '*at many places where RWH systems are installed, the same are either not functional or resulting in contamination of ground water which situation needs to be remedied not only in Delhi but pan India. This may be urgently looked into by a joint Committee of CPCB, Ministry of Jal Shakti (MoJS) and Ministry of Urban Development, Government of India. MoJS will be the nodal agency for the purpose.'*

A committee constituted by the Ministry visited selected RWH sites in 5 States – Delhi, Haryana, Karnataka, Rajasthan and Tamil Nadu and submitted its report. On the basis of the findings of committee, Department of Water Resources, RD & GR, Ministry of Jal Shakti has issued advisory to all States vide letter No. T-81011/77/2021 - GW Section-MOWR, dated 31.03.2023 along with recommendations of committee and SOP for implementing Rain Water Harvesting schemes.

The advisory is enclosed herewith for compliance. Action taken on the advisory may please be communicated by 04.04.2023 for submission to Hon'ble NGT before the next hearing scheduled on 10.04.2023.

Yours faithfully

(**A K Agrawal**)
Member Secretary
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I/82355/2023

3

ANNEXURE - IV

By-Email

F.No. T-81011/77/2021 - GW Section-MOWR
भारत सरकार
Government of India
जल शक्ति मंत्रालय
Ministry of Jal Shakti
जल संसाधन, नदी विकास और गंगा संरक्षण विभाग
D/o WR, RD & GR
(भूजल अनुभाग / Ground Water Section)
****

Shram Shakti Bhawan, Rafi Marg
New Delhi, Dated: 31/03/2023

To,

The Chief Secretaries/Administrators of all the States/UTs of India. (as per the Standard list)

Subject:- Prevention of potential contamination of ground water from Rain Water Harvesting systems in Urban Areas – reg.

Sir/ Madam,

I am directed to invite your kind attention towards Hon'ble NGT's observations, expressing concern over Rain Water Harvesting (RWH) system being one of the potential source of contamination of ground water in the country. The Principal Bench, Delhi of Hon'ble NGT, while disposing of matter related to societies in Dwarka area, Delhi (OA 147/2021), vide their order dated 10.12.2021 directed that *at many places where RWH systems are installed, the same are either not functional or resulting in contamination of ground water which situation needs to be remedied not only in Delhi but pan India. This may be urgently looked into by a joint Committee of CPCB, Ministry of Jal Shakti (MoJS) and Ministry of Urban Development, Government of India. MoJS will be the nodal agency for the purpose.*

2. In this regard, a Committee as per directions of Hon'ble NGT was constituted by this Department which visited selected RWH sites in 05 States i.e. Delhi, Haryana, Karnataka, Rajasthan and Tamil Nadu and submitted its report. The committee found that deficiency do exist in implementation of RWH system at certain places and due attention

I/82355/2023

was not given to possibility of contaminants breaching into the RWH system and eventually finding way into groundwater, particularly where the harvested water is directly used for Artificial Recharge (AR). From the report of the committee and their experience gained during site visits, it is quite likely that similar situations may exist in other States too. In view of this, a **guideline on RWH** system and **SoP with Do's and Dont's** as per **Annexure-I & Annexure-II** recpectively are enclosed herewith.

3. It is requested to kindly direct/ instruct concerned Departments/ agencies to strictly follow the guidelines including Do's & Dont's while implementing the RWH systems in your State. Further, the concerned Department/agency in the State may approach Regional Director Offices of Central Ground Water Board (CGWB) for technical guidance/ support, if any.

4. This issues with the approval of the Competent Authority.

Yours sincerely,

Signed by Rajendra Kumar Sahu
Date: 31-03-2023 18:00:55
Reason: Approved

(**Rajendra Kumar Sahu)**
Under Secretary to the Govt. of India
Ph: 011-23766907
Email: **gwdesk-mowr@nic.in**

Copy to:

i. Sr. PPS to Secretary, DoWR, RD & GR, MoJS
ii. SPPS to Special Secretary, DoWR, RD & GR, MoJS
iii. Sr PPS to AS&MD, NWM
iv. PPS to JS(A,GW & IC), DoWR,RD & GR, MoJS
v. Sr PPS to Secretary, MoH&UA
vi. PPS to Chairman, CPCB
vii. PPS to Chairman, CGWB

Annexure-I

i. The Committee recommended to give stress on contamination

aspect while designing and implementing the RWH systems and suggested for strictly adhering to the **BIS Standard - IS 15797:2008 (for implementation of Roof Top Rain Water Harvesting System in the country)** which is a very comprehensive document (a copy is enclosed for ready reference). Section 6.5 of the document deals with general 'Management and Maintenance' of the system and Section 7.4 specifically tells about 'Management of Catchment Area, Drains and Recharge Structures'. Section 7 provides designs of AR structures suitable at various different situations.

ii. It has also been suggested to avoid Rain Water Harvesting System for the purpose of Artificial Recharge in certain urban areas especially in congested places in the vicinity of sewerage system components/ landfill sites etc where chances of contamination are high through mingling of untreated sewerage water/domestic wastes.

iii. The Committee has further suggested that in case of small households, cluster based RWH system should be promoted in place of individual household schemes.

iv. States may promote incentivization for adopting RWH, either in the form of rebate or subsidy in water-stressed areas.

v. Large-scale RWH system, such as those in large industrial, residential and commercial complexes, should have piezometer(s) installed at appropriate site(s) for periodic monitoring of water level and water quality. These parameters are the most important and reliable indicators of functioning status and health of RWH system.

vi. The design of RWH should by-pass first roof top harvested rainwater. Mixing of drain water with rooftop run off or with runoff from paved areas, where vehicular movement takes place, should be prevented.

vii. As water quality may not be strictly checked, the water stored in harvesting structures may be used strictly for non-potable purposes.

viii. Concept like RWH Theme Park, Bengaluru may be promoted for proper guidance to general public/ individual households.

ix. All RWH sites should be geo-tagged for better visibility for monitoring purpose.

x. There should be mechanism to avoid misuse of the recharge tube-wells for pumping purposes.

xi. Suitable online filters can be considered in the pipeline to avoid minor contaminants, if any, while harvesting the rooftop rainwater to the recharge tube-wells.

xii. District Jal Shakti Kendras may be strengthened and general public may be sensitised to follow correct RWH system through regular awareness generation by means of mass media, print media etc.

xiii. District administration may randomly check few RWH sites on monthly basis and suitable directions/corrective action may be suggested to the owner(s) of the RWH system(s) and the same may be followed up for strict implementation post inspection.

Annexure-II

DOS AND DON'TS WHILE IMPLEMENTING ROOF TOP RAIN WATER HARVESTING AND ARTIFICIAL RECHARGE

A. While Planning Implementation of Scheme/ Construction of Structures

Dos

- **Choose the right recharge technique**: RWH schemes should have Artificial Recharge provisions depending upon local hydrogeological/ site-specific conditions. In this regard, the BIS Standard - IS 15797:2008, for implementation of Roof Top Rain Water Harvesting System may be referred to. Section 7 provides designs of AR structures suitable to different situations.
- **Source Water**: Only non-polluted rainwater from the roof tops and other catchment areas has to be diverted to recharge structure through connection of downpipe.
- **RWH/ AR Sites at Safe Distance**: Depending upon groundwater flow direction, RWH/AR sites should be located at safe distance from possible contaminant source such as sewage drains/ landfill sites/ cesspool/ sewage system having hydrogeological connectivity with the aquifer.
- **Insulation from Possible Contaminant Source**: There should be proper arrangements in place to prevent sewage water or contaminated water from paved area from mixing into run-off/ recharged water.
- **Provision of Filters**: There should be proper mechanism to let the water pass through filter media before entering into recharge system in order to minimize the possibility of aquifer material getting choked. Online filters (filters fitted in pipelines carrying roof top water) can also be used to avoid minor contaminants, if any, for diverting the rooftop rainwater to the recharge tubewells.
- **Provision for By-pass of First Flush**: RWH system should be designed in a way to allow by-pass first flush (first rainwater).
- **Provision for pre-treatment of water**: The Water should be pre-treated to remove suspended solids, organic matter, and other contaminants before recharge. This will help prevent clogging of the recharge structure and protect the groundwater quality.
- **Dual pipe system for utilization of harvested water**: Dual pipe system should be
  installed for utilization of harvested water for non-potable purposes, i.e other than drinking, cooking and bathing.
- **Cluster-based RWH System**: In the areas of only small households, cluster-based RWH system should be promoted in place of individual household scheme.
- **Installation of Piezometers**: Large-scale RWH system, such as those in large residential and commercial complexes, should have piezometer(s) installed at appropriate site(s) for periodic monitoring of water level and water quality. These parameters are the most important and reliable indicators of functioning status and
  health of RWH system.
- **Geotagging of RWH/ AR Sites**: All RWH/ AR sites should be geo-tagged for better visibility for monitoring purpose.

Don'ts

- It is better to avoid RWH/ AR in areas having shallow ground water levels (say shallower than 5 metre below ground level (mbgl).
- Recharge should be avoided in areas where there is possibility of contamination of
  groundwater. RTRWH with AR in buildings such as hospital buildings may be avoided. In such cases storage of rainwater for non-potable uses should be encouraged.
- There should be no mixing of drain water with rooftop run off.
- Run-off from paved area having vehicular movement should not be diverted towards RWH system.
- RWH/ AR sites should not be located in the vicinity of possible contaminant source such as sewage drains/ landfill sites/ cesspool/ sewage system having hydrogeological connectivity with the aquifer.
- Contaminated water should not be recharged as it can pollute the groundwater and make it unfit for human consumption.
- Domestic waste water should not be diverted directly to Recharge Pits, particularly in areas where water levels are shallow.
- Recharge wells should not be constructed beyond water level. Direct recharging below water level should not be done.
- Recharge structures should not be constructed in areas prone to flooding as they can be damaged or washed away during heavy rains.
- Recharge should not be unplanned. Unplanned recharge can lead to groundwater contamination, soil erosion, and other environmental problems.

B. Maintenance and Monitoring of RWH/ AR System

Maintenance of recharge structures is important to ensure their long-term effectiveness and sustainability. Here are some key maintenance practices that can help keep recharge structures functioning properly.

- First flush should be by-passed.
- Rooftops should be cleaned regularly.
- Filter material should be regularly cleaned/ replaced.
- Sediment and debris can accumulate in recharge structures over time, which can clog the pores and reduce the infiltration capacity. Regular cleaning can prevent clogging and help maintain the recharge capacity of the structure
- Regular monitoring and inspection of recharge structures can help detect any signs of damage, erosion, or clogging or damage early on, before they become more serious. This can include checking for cracks or damage to the structure, as well as monitoring the inflow and outflow of water.
- Water level and groundwater quality around the recharge structure should be regularly monitored through purpose-built piezometers.
- Monitoring mechanism should be effective through involvement of officials trained to evaluate functioning of installed RWH system as per BIS.
- Any damage or erosion to the recharge structure should be repaired immediately to prevent further damage. For example, if a recharge well has a

crack or a hole, it should be repaired as soon as possible to prevent soil from entering the well and clogging it. Prompt repair and maintenance can help prevent further damage and ensure the long-term effectiveness of the recharge structure.
- Vegetation can grow around recharge structures and block the inflow of water. Regular trimming of vegetation can help maintain the flow of water into the recharge structure.
- Keep a record of maintenance activities and observations for each recharge structure. This can help identify patterns or trends in maintenance needs and guide future maintenance activities.

Don'ts

- Do not dump pollutants or waste near or inside the RWH/ AR structure.
- Never leave the covers of RWH chamber/ AR structures open.
- Do not allow wastewater to flow towards RWH/ AR structures.

C. Other Suggestions

- Underground Storage tank/ sump, made using cross-wave technology or uPVC pipes saves space, besides providing strength to the structure. As it is costly, the technology may be used in large Government Buildings, commercial complexes and industrial premises.
- In the new buildings, the complex is divided in a way to have alternate bays for sewage and RWH channels.

File no:-CGWA-21/31/2020-CGWA-Part(1) -329
Government of India,
Ministry of Jal Shakti,
Central Ground Water Authority
18/11, Jamnagar House
Mansingh Road, New Delhi – 110011
E-mail: cgwa@nic.in
Date – 13.09.2022

To,
As per list attached.

Subject: Compliance of Hon'ble NGT Order dated 25.02.2022 in Shailesh Singh vs. Hotel Holiday Regency, Moradabad and Ors. (O.A. No. 176/2015) – reg.

Sir,

This is in reference to Order dated 25.02.2022 (copy enclosed) in Shailesh Singh vs. Hotel Holiday Regency, Moradabad and Ors. (O.A. No. 176/2015) before Hon'ble NGT, New Delhi, wherein the Hon'ble Tribunal under Para 42 has observed the need of the following-:

> *"(xi) Checking of contamination of ground water by discharge of untreated effluents in water bodies need comprehensive planning and execution and on priority basis, it is necessary, failing whereof, has led to emergency situation in certain areas;*

It is, therefore, requested to kindly take up all necessary measures in your State/UT to formulate a comprehensive policy on checking of contamination of ground water by discharge of untreated effluents in water bodies. An ATR in this regard may be forwarded to this Authority at an early date.

Yours faithfully,

(A.K. Agrawal) 13/9/22
Member Secretary

List of SGWAs

1	Andhra Pradesh	Commissioner, PR & RD & Administrator, APWALTA, D. No. 12-47, PVS Empire, Pathuru Road, Besides Reliance Digitals, Tadepalli, Guntur District, Andhra Pradesh
2	Goa	Chief Engineer, Water Resource Department, Sinchai Bhawan, Near Police Station, Porvorim, Goa -403501
3	Himachal Pradesh	Engineer-in-Chief, Jal Shakti Vibhag, Jal shakti Bhawan Shimla-171005
4	Jammu & Kashmir	Chairperson, Jammu & Kashmir Water Resources Regulatory Authority, Ashok Nagar, Satwari , Jammu - 180004
5	Karnataka	Director, 2nd Floor, KSFC Bhawan, #1/1,Thimmiah Road, Bengaluru-560052
6	Kerala	Member Secretary, Ground Water Department, Govt. of Kerala Room No. 390,1st Floor, Main Block, Secretariat, Thiruvananthapuram
7	NCT Delhi (through Govt. Orders)	Delhi Jal Board, Varunalaya Complex, Staff Colony, Block E, Jhandewalan Extension, Jhandewalan, New Delhi, Delhi 110005
8	Tamil Nadu (through Govt. Orders)	Chief Engineer, Public Works Department, Water Resources Department, WRD, State Ground Water & Surface Water Resources Data Center, Taramani,Chennai-600113
9	Telangana	Commissioner, PR & RD & Administrator, TSWALTA, 1-3-1028, DWACRA Buildings, Gandhi Nagar, Hyderabad-500080
10	West Bengal	Director, State Water Investigation Directorate(SWID), Water Resources Investigation & Development Department, Govt. of West Bengal, Nirman Bhawan, 1st Floor, Salt Lake, Sector-III, Kolkata - 700091
11	Chandigarh (through bye-laws)	Commissioner Department of Water Resources, Municipal Cooperation, Sector-17, Chandigarh
12	Puducherry	No.15, III Cross(Extn), Mariamman Nagar, Karamanikuppam, Puducherry - 605004
13	Lakshadweep	Administrator, UT of Lakshadweep, Kavaratti – 682055, Email: lk-admin@nic.in
14	Punjab	The Secretary, Punjab water Regulation and Development Authority, SCO 149-152, 3rd floor Sector 17C, Chandigarh - 160017
15	Uttar Pradesh	The Member Secretary, Uttar Pradesh State Ground Water Management & Regulatory Authority,Ground Water Department, UP, 9th Floor, Indira Bhawan,
16	Haryana	The Chief Technical Officer, Haryana Water Resources Authority,Sinchai Bhawan, Sector 5, Panchkula, Haryana 134109 Email: cto.hwra@gmail.com

List of SPCBs

1	Chhattisgarh	Chhattisgarh Environment Conservation Board,Paryavas Bhavan, North Block Sector-19, Naya Raipur, Chhattisgarh- 492002
2	Madhya Pradesh	Madhya Pradesh Pollution Control Board, E-5, Arera Colony, Paryavaran Parisar, Bhopal, Madhya Pradesh-462 016
3	Rajasthan	Rajasthan Pollution Control Board,4, Jhalana Institutional Area, Jhalana Doongri, Jaipur, Rajasthan - 302 004
4	Goa	Goa State Pollution Control Board, Nr. Pilerne Industrial Estate,Opp. Saligao Seminary,Saligao - Bardez Goa - 403511
5	Karnataka	Karnataka State Pollution Control Board, Parisara Bhavan, 4th & 5th Floor,# 49, Church St., Bangalore-560 001
6	Kerala	Kerala State Pollution Control Board, Plamoodu Jn., Pattom Palace P.O. Thiruvananthapuram-695 004
7	Chandigarh	Chandigarh Pollution Control Committee, Paryavaran Bhawan, Ground Floor,Sector-19 B
8	Lakshadweep	Lakshadweep Pollution Control Committee, Department of Science, Technology & Environment,Kavarati-682555, Madhya Marg, Chandigarh
9	Delhi	Delhi Pollution Control Committee,Government of N.C.T. Delhi4th Floor, ISBT Building, Kashmere Gate,Delhi-110006
10	Haryana	Haryana State Pollution Control Board, C-11, Sector-6. Panchkula-134109, Haryana
11	Himachal Pradesh	Himachal Pradesh Pollution Control Board, Him Parivesh, Phase-III, New Shimla, Himachal Pradesh 171009

12	Jammu and Kashmir	Jammu & Kashmir State Pollution Control Board,(2) Shiekh-ul-Campus, behind Govt. Silk Factory, Raj Bagh, Srinagar(J&K). (May - Oct)
13	Punjab	Punjab Pollution Control Board, Vatavaran Bhawan, Nabha Road, Patiala, Punjab
14	Andhra Pradesh	Andhra Pradesh State Pollution Control Board,D.No. 33-26-14 D/2, Near Sunrise Hospital,Pushpa Hotel Centre, Chalamvari Street,Kasturibaipet, Vijayawada - 520 010
15	Pondicherry	Pondicherry Pollution Control Committee, Housing Board Complex,Anna Nagar, Pondicherry-600 005
16	Tamil Nadu	Tamil Nadu Pollution Control Board, 76, Mount Salai, Guindy, Chennai-600 032
17	Telangana	Telangana State Pollution Control Board, Paryavaran Bhawan,A-3, I.E. Sanath Nagar,Hyderabad-500 018
18	Andaman and Nicobar Islands	Andaman & Nicobar Islands Pollution Control Committee,Department of Science & Technology, Dollygunj Van Sadan, Haddo P.O., Port Blair - 744102
19	Bihar	Bihar State Pollution Control Board, Parivesh Bhawan, Plot No. NS-B/2 Paliputra Industrial Area, Patliputra, Patna (Bihar) - 800 023
20	Jharkhand	Jharkhand Pollution Control Board, T.A Building, HEC, P.O. Dhurwa, Ranchi - 834004
21	Odisha	Odisha Pollution Control Board, A-118, Nilakanta Nagar, Unit -VIII, Bhubaneshwar - 751012.
22	West Bengal	West Bengal Pollution Control Board, Paribesh Bhavan, 10A, Block-L.A., Sector III, Bidhan Nagar, Kolkata - 700 106
23	Uttar Pradesh	Uttar Pradesh Pollution Control Board, Building.No. TC-12V Vibhuti Khand, Gomti Nagar Lucknow-226 010

24	Uttarakhand	Uttarakhand Pollution Control Board,Gaura Devi Bhawan, 46 B IT Park Sahastradhara, Dehradun, Uttarakhand - 248001
25	Maharashtra	Maharashtra Pollution Control Board, Kalpataru Point, 2nd - 4th Floor Opp. Cine Planet Cinema, Nr. Sion Circle, Sion (E), Mumbai - 400 022
26	Arunachal Pradesh	Arunachal Pradesh State Pollution Control Board, Paryavaran Bhawan, Papu Hill, Yupia Road, Naharlagun- 791110
27	Assam	Assam Pollution Control Board, Bamunimaidan, Guwahati, Assam - 781021
28	Manipur	Manipur Pollution Control Board, Lamphelpat, Near Imphal West D.C. Office, Imphal
29	Meghalaya	Meghalaya Pollution Control Board Arden-Lumpyngngad, Shillong: 793014
30	Mizoram	Mizoram Pollution Control Board, New Secretariat Complex, Khatla Thlanmual Peng, Khatla, Aizawl, Mizoram: 796001
31	Nagaland	Nagaland Pollution Control Board, Signal, Point, Dimapur, Nagaland:797112
32	Sikkim	Sikkim State Pollution Control Board, Department of Forest, Environment & Wildlife Management Government of Sikkim, Deorali, Gangtok, -737102
33	Tripura	Tripura Pollution Control Board, Vigyan Bhawan, Pandit Nehru Complex, Gorkhabasti, PO: Kunjaban Agartala: 799006
34	Dadar and Nagar Haveli and Daman and Diu	Pollution Control Committee, Dadra and Nagar Haveli and Daman and Diu 1st Floor, Udhyog Bhavan Bhenslore, Dunetha Nani Daman, Daman - 396210
35	Gujarat	Gujarat Pollution Control Board Paryavan Bhavan, Sector 10- A Gandhinagar - 382 043

IS 15797 : 2008

भारतीय मानक

छतों पर वर्षा जल संग्रहण — मार्गदर्शी सिद्धान्त

Indian Standard

ROOF TOP RAINWATER HARVESTING — GUIDELINES

ICS 13.060.10

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

May 2008

Price Group 7

FOREWORD

This Indian Standard was adopted by the Bureau of Indian Standards, after the draft finalized by the Ground Water and Related Investigations Sectional Committee had been approved by the Water Resources Division Council.

Rainwater harvesting is an option which has been adopted in many parts of the world where due to increase in population conventional water supply system has failed to meet the needs of the people. The term 'Water Harvesting' connotes collection and storage of rainwater and also other activities aimed at harvesting surface water, prevention of loss through evaporation and seepage.

Natural recharge to ground water has reduced due to shrinkage of open area consequent to increased urban activities. Ground water levels have registered a marked decline, unplanned disposal of waste has resulted in deterioration of ground water quality. In view of the gap between demand and supply there is an utmost need for adopting roof top rainwater harvesting and augmenting ground water storage.

The composition of the Committee responsible for the formulation of this standard is given in Annex A.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

ROOF TOP RAINWATER HARVESTING — GUIDELINES

1 SCOPE

This standard lays down guidelines for roof top rainwater harvesting.

2 REFERENCE

The following standard contains provision, which through reference in this text constitutes provision of this standard. At the time of publication, the edition indicated was 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 edition of the standard given below:

IS No.	*Title*
14476 (Part 6) : 1998	Test pumping of water wells — Code of practice: Part 6 Special tests

3 GENERAL

Roof top rainwater collection is one of the solutions for solving or reducing the problem of water availability, where there is inadequate ground water supply and surface sources are either lacking or insignificant. In this system, rainwater falling on roofs of houses and other buildings is collected through a system of pipes and semi-circular channels of galvanized iron or PVC and stored in tanks suitably located on the ground or underground for direct use or for recharging ground water aquifers. Urban housing complexes/residential buildings and institutional buildings have large roof area and are amendable for rainwater harvesting. This practice is in vogue at the individual household level in remote hilly areas with high rainfall and in some semi-arid areas in the plains.

4 ADVANTAGES OF ROOF TOP RAINWATER HARVESTING

a) One of the appropriate options for augmenting ground water recharge/storage in urban areas, where natural recharge has been considerably reduced due to increased urban activities and not much land is available for implementing any other artificial recharge measure. In rural areas also, roof top rainwater harvesting can supplement the domestic requirements.

b) Rainwater runoff, which otherwise flows through sewers and storm drains and is wasted, can be harvested and utilized.

c) Helps in reducing the frequent drainage congestion in urban areas where fast rate of urbanization has reduced availability of open surfaces.

d) Recharging of aquifers with harvested water improves the quality of ground water through dilution.

e) The harnessed rainwater can be utilized when needed at the time and place of scarcity.

f) The structures required for harvesting are simple, economical and Eco-friendly.

g) In coastal areas over extraction of ground water leads to saline water ingress. Therefore, recharging of ground water aquifer in such areas helps to control saline water ingress.

h) Storing of harvested water under ground through aquifer recharge, wherever feasible, is advantageous as such storage is not exposed to evaporation and pollution. Aquifers serve as a distribution system as well supplying water when required.

5 FACTORS DETERMINING TYPE/SYSTEM OF RAINWATER HARVESTING

5.0 There are many factors that determine the total quantity of rainwater that can be harvested in a particular area and the system that would be appropriate for efficiently harvesting this quantity. Some of these are given in **5.1** to **5.5**.

5.1 Rainfall Quantity

The total volume of rainwater available from any roof top surface is a product of total rainfall and the surface area of collection. A runoff coefficient is usually applied to account for infiltration, evaporation and other losses and it varies from 0.8 to 0.95. In order to estimate the average annual/monsoon runoff from rooftop area in any location, the average annual/monsoon rainfall data for the location need to be used and using Tables 1 and 2, the water availability for flat and sloping roof can be worked out.

5.2 Rainfall Pattern

Rainfall pattern as well as total rainfall, will often determine the feasibility of a rainwater harvesting system. In areas where rainfall occurs regularly in most parts throughout the year, implies that the storage requirement is low and hence the system cost will be

Table 1 Water Availability for a Given Roof Top Area and Rainfall (For Flat Roofs)
(*Clause* 5.1)

Sl No.	Roof Top Area m^2	Rainfall, mm												
		100	200	300	400	500	600	800	1 000	1 200	1 400	1 600	1 800	2 000
		Water availability (m^3)												
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
i)	20	1.6	3.2	4.8	6.4	8	9.6	12.8	16	19.2	22.4	25.6	28.8	32
ii)	30	2.4	4.8	7.2	9.6	12	14.4	19.2	24	28.8	33.6	38.4	43.2	48
iii)	40	3.2	6.4	9.6	12.8	16	19.2	25.6	32	38.4	44.8	51.2	57.6	64
iv)	50	4	8	12	16	20	24	32	40	48	56	64	72	80
v)	60	4.8	9.6	14.4	19.2	24	28.8	38.4	48	57.6	67.2	76.8	86.4	96
vi)	70	5.6	11.2	16.8	22.4	28	33.6	44.8	56	67.2	78.4	89.6	100.8	112
vii)	80	6.4	12.8	19.2	25.6	32	38.4	51.2	64	76.8	89.6	102.4	115.2	128
viii)	90	7.2	14.4	21.6	28.8	36	43.2	57.6	72	86.4	100.8	115.2	129.6	144
ix)	100	8	16	24	32	40	48	64	80	96	112	128	144	160
x)	150	12	24	36	48	60	72	96	120	144	168	192	216	240
xi)	200	16	32	48	64	80	96	128	160	192	224	256	288	320
xii)	250	20	40	60	80	100	120	160	200	240	280	320	360	400
xiii)	300	24	48	72	96	120	144	192	240	288	336	384	432	480
xiv)	400	32	64	96	128	160	192	256	320	384	448	512	576	640
xv)	500	40	80	120	160	200	240	320	400	480	560	640	720	800
xvi)	1 000	80	160	240	320	400	480	640	800	960	1 120	1 280	1 440	1 600
xvii)	2 000	160	320	480	640	800	960	1 280	1 600	1 920	2 240	2 560	2 880	3 200
xviii)	3 000	240	480	720	960	1 200	1 440	1 920	2 400	2 880	3 360	3 840	4 320	4 800

Table 2 Water Availability for a Given Roof Top Area and Rainfall (For Sloping Roofs)
(*Clause* 5.1)

Sl No.	Roof Top Area m^2	Rainfall, mm												
		100	200	300	400	500	600	800	1 000	1 200	1 400	1 600	1 800	2 000
		Water availability (m^3)												
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
i)	20	1.9	3.8	5.7	7.6	9.5	11.4	15.2	19	22.8	26.6	30.4	34.2	38
ii)	30	2.9	5.7	8.6	11.4	14.3	17.1	22.8	28.5	34.2	39.9	45.6	51.3	57
iii)	40	3.8	7.6	11.4	15.2	19	22.8	30.4	38	45.6	53.2	60.8	68.4	76
iv)	50	4.8	9.5	14.3	19	23.8	28.5	38	47.5	57	66.5	76	85.5	95
v)	60	5.7	11.4	17.1	22.8	28.5	34.2	45.6	57	68.4	79.8	91.2	102.6	114
vi)	70	6.7	13.3	20.0	26.6	33.3	39.9	53.2	66.5	79.8	93.1	106.4	119.7	133
vii)	80	7.6	15.2	22.8	30.4	38	45.6	60.8	76	91.2	106.4	121.6	136.8	152
viii)	90	8.6	17.1	25.7	34.2	42.8	51.3	68.4	85.5	102.6	119.7	136.8	153.9	171
ix)	100	9.5	19	28.5	38	47.5	57	76	95	114	133	152	171	190
x)	150	14.3	28.5	42.8	57	71.3	85.5	114	142.5	171	199.5	228	256.5	285
xi)	200	19	38	57	76	95	114	152	190	228	266	304	342	380
xii)	250	23.8	47.5	71.3	95	118.8	142.5	190	237.5	285	332.5	380	427.5	475
xiii)	300	28.5	57	85.5	114	142.5	171	228	285	342	399	456	513	570
xiv)	400	38	76	114	152	190	228	304	380	456	532	608	684	760
xv)	500	47.5	95	143	190	237.5	285	380	475	570	665	760	855	950
xvi)	1 000	95	190	285	380	475	570	760	950	1 140	1 330	1 520	1 710	1 900
xvii)	2 000	190	380	570	760	950	1 140	1 520	1 900	2 280	2 660	3 040	3 420	3 800
xviii)	3 000	285	570	855	1 140	1 425	1 710	2 280	2 850	3 420	3 990	4 560	5 130	5 700

correspondingly low and *vice versa*. Conversely, areas where total rainfall occurs during 1-2 months, the water collected during the monsoon has to be stored for use in remaining months throughout the year, which requires large storage structures as well as arrangement for some treatment.

5.3 Intensity of Rainfall

The maximum intensity of rainfall will decide the peak flow, which is to be harvested and depending upon the peak flow, the gutter size for sloping roof and diameter of drainage pipe has to be calculated.

5.4 Collection Surface Area

For roof top rainwater harvesting, the collection area is restricted by the size of the roof of the dwelling unit. Sometimes other surfaces such as terrace, balconies and other projections are used to supplement the roof top collection area.

5.5 Storage Capacity

The storage tank is usually the most expensive component of rainwater harvesting system. Hence a careful analysis is required for design of storage tank capacity.

6 STORAGE OF WATER IN A STORAGE TANK FOR DIRECT USE

6.1 Design of System Components

A roof top catchment system has three main components, namely, a roof, a guttering and first flush device and a storage tank:

a) *Roof* — In this system, only roof top is the catchment as shown in Fig. 1 and Fig. 2. The roofing should be of galvanized iron sheets (G.I.), aluminium, clay tiles, asbestos or concrete. In case of thatch-roof, it may be covered with waterproof LDPE sheeting. The roof should be smooth, made of non-toxic material sufficiently large to fill the tank with the available rainfall conditions. Existing roofs of houses and public buildings can be used for a roof top catchment system. In some cases enlarged or additional roofed structures can be built.

b) *Guttering and First-Flush Device* — Guttering is intended to protect the building by collecting the water running of the roof and direct it, via a downpipe, to the storage tank. Gutter is provided along the edge of the roof. It is fixed with a gentle slope towards down-pipe, which is meant for free flow of water to the storage tank. This may be made up of G.I. sheet, wood, bamboo or any other locally available material. The downpipe used should be at least 100 mm diameter and be provided with a 20 mesh wire screen at the inlet to prevent dry leaves and other debris from entering it. The gutter size may be worked out using any standard formula of hydraulics or using Table 3.

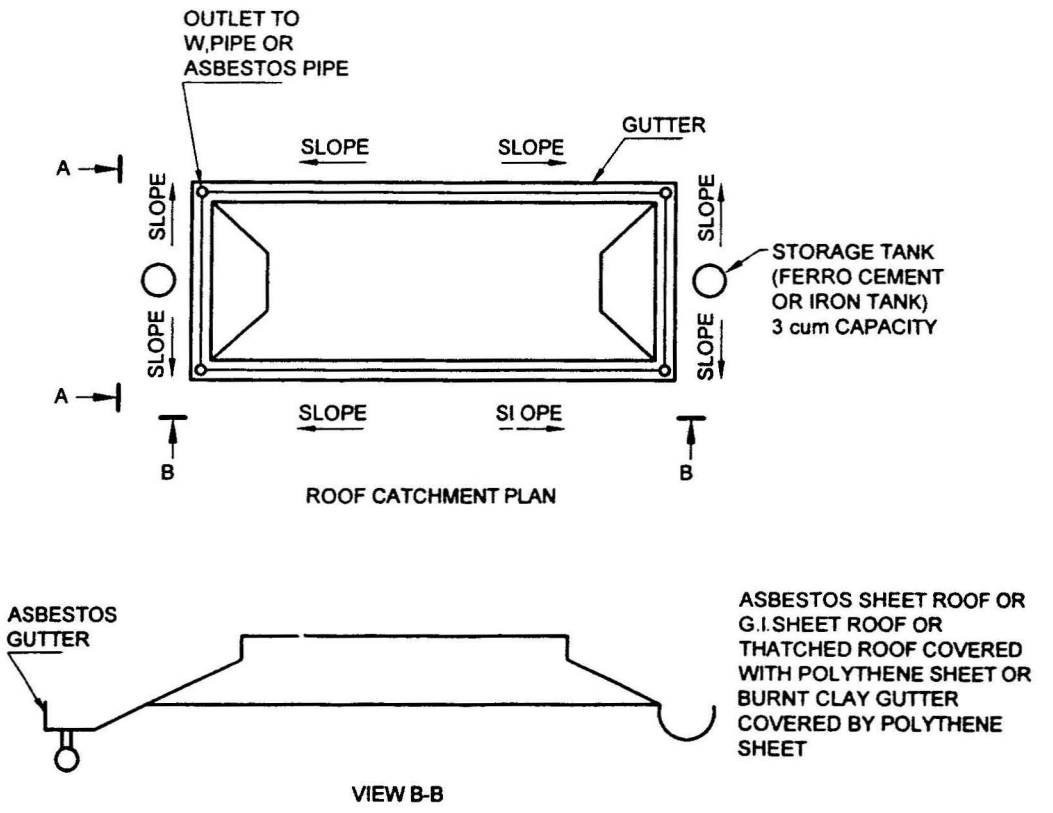
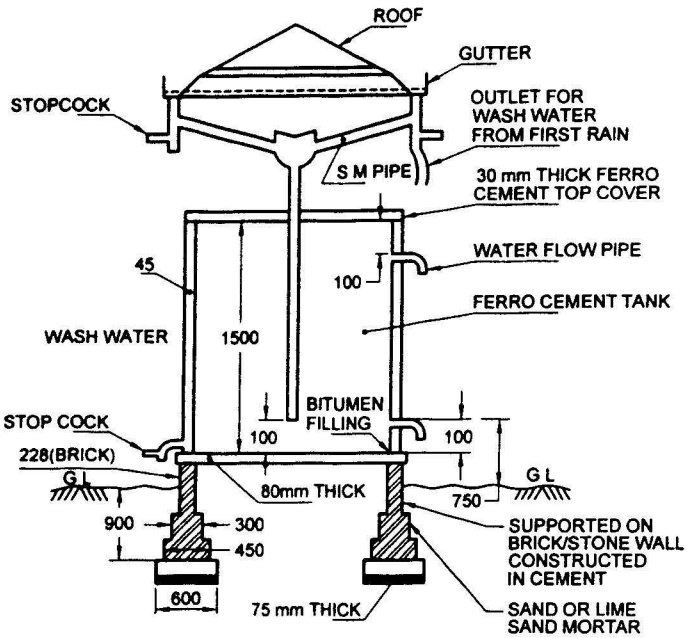
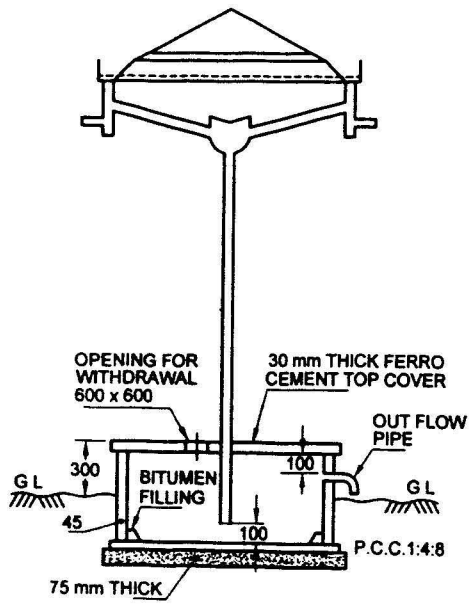


FIG. 1 RAINWATER HARVESTING SYSTEM



WATER TANK ABOVE GROUND



WATER TANK UNDER GROUND

All dimensions in millimetres.

FIG. 2 RAINWATER HARVESTING STRUCTURES

Table 3 Diameter of Gutter and Width of G.I. Sheet

[*Clause* 6.1(b)]

Sl No.	Roof Top Area		Rainfall Intensity, mm h													
	m^2		10	15	20	25	30	35	40	45	50	60	70	80	90	100
			Diameter (*D*) of Channel and Width (*W*) of G.I. Sheet (mm)													
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
i)	10	*D*	20	23	26	28	30	32	33	35	36	39	41	43	45	47
		W	51	56	60	64	67	70	72	74	77	81	84	88	91	93
ii)	20	*D*	26	30	33	36	39	41	43	45	47	50	53	56	58	61
		W	60	67	72	77	81	84	88	91	93	99	103	108	112	115
iii)	30	*D*	30	35	39	42	45	48	50	52	54	58	62	65	68	71
		W	67	74	81	86	91	95	99	102	106	112	117	122	127	131
iv)	40	*D*	33	39	43	47	50	53	56	58	61	65	69	72	76	79
		W	72	81	88	93	99	103	108	112	115	122	128	134	139	144
v)	50	*D*	36	42	47	51	54	58	61	63	66	71	75	79	82	86
		W	77	86	93	100	106	111	115	120	124	131	138	144	149	154
vi)	60	*D*	39	45	50	54	58	62	65	68	71	76	80	84	88	92
		W	81	91	99	106	112	117	122	127	131	139	146	152	158	164
vii)	70	*D*	41	48	53	58	62	65	69	72	75	80	85	89	93	97
		W	84	95	103	111	117	123	128	133	138	146	153	160	167	172
viii)	80	*D*	43	50	56	61	65	69	72	76	79	84	89	94	98	102
		W	88	99	108	115	122	128	134	139	144	152	160	167	174	180
ix)	90	*D*	45	52	58	63	68	72	76	79	82	88	93	98	102	107
		W	91	102	112	120	127	133	139	144	149	158	167	174	181	188
x)	100	*D*	47	54	61	66	71	75	79	82	86	92	97	102	107	111
		W	93	106	115	124	131	138	144	149	154	164	172	180	188	194
xi)	150	*D*	54	63	71	77	82	87	92	96	100	107	113	119	124	129
		W	106	120	131	141	149	157	164	170	176	188	197	207	215	223
xii)	200	*D*	61	71	79	86	92	97	102	107	111	119	126	132	138	144
		W	115	131	144	154	164	172	180	188	194	207	218	228	237	246
xiii)	250	*D*	66	77	86	93	100	105	111	116	121	129	137	144	150	156
		W	124	141	154	166	176	186	194	202	209	223	235	246	256	266
xiv)	300	*D*	71	82	92	100	107	113	119	124	129	138	146	154	161	167
		W	131	149	164	176	188	197	207	215	223	237	250	262	273	283
xv)	400	*D*	79	92	102	111	119	126	132	138	144	154	163	172	179	186
		W	144	164	180	194	207	218	228	237	246	262	276	290	302	313
xvi)	500	*D*	86	100	111	121	129	137	144	150	156	167	177	186	195	203
		W	154	176	194	209	223	235	246	256	266	283	299	313	326	339
xvii)	1 000	*D*	111	129	144	156	167	177	186	195	203	217	230	242	253	263
		W	194	223	246	266	283	299	313	326	339	361	381	400	417	433
xvii)	2 000	*D*	144	167	186	203	217	230	242	253	263	282	298	314	328	341
		W	246	283	313	339	361	381	400	417	433	462	489	513	535	556
xviii)	3 000	*D*	167	195	217	236	253	268	282	294	306	328	347	365	382	397
		W	283	326	361	391	417	441	462	482	501	535	566	594	620	644

NOTES

1 Provide minimum diameter of channel of 100 mm and width of sheet 176 mm.

2 Diameter to be limited to 300 mm and width of sheet 510 mm.

For all tanks having roof catchment, the first runoff of rainwater from the roof should be discarded. This helps keep the water potable because this first flush contains large quantities of dust, leaves and other impurities. This can also be prevented by installation of a gate valve at the end of down pipe at ground level.

c) *Tank* — Storage tank can be constructed underground or above ground. The underground tank may be of masonry or R.C.C. structure suitably lined with water proofing materials. The surface tank may be of G.I. Sheet, R.C.C., Plastic/HDP or Ferrocement Tank placed at elevation on a raised platform as shown in Fig. 3. Choice of the tank depends on locally available materials and space available. When the tank is constructed underground, at least 30 cm of the tank should remain above ground. Water

tanks using ferrocement technology come in different designs with volumes ranging between 2 m^3 and 200 m^3. For example, a free standing cylindrical tank can be built in sizes between 10 m^3 and 30 m^3, while a capacity of up to 200 m^3 is possible with sub-surface covered tanks. The latter is economical when the capacity exceeds 50 m^3.

An alternate design, avoiding framework, involves erecting a circular frame made of welded-mesh bars spaced at 15 cm and covered with chicken wire mesh (2.5 cm gauge) onto a reinforced concrete base. This is then covered on the outside with sacks or cloth and two coats of a 1.5 cm layer of mortar (1 part cement, 3 parts sand) and plastered along the inner walls to produce the tank wall. Two further coats of plaster are added, one on the outside after removing the sacks and one on the inside to provide a tank wall thickness of 5 cm. A waterproof coat of cement and water is then added to the tank's inner wall.

When the wall is complete, a wooden frame is constructed inside the tank to support the metal template made from old oil drums, which forms the mould for the domed roof. The roof is also reinforced with welded-mesh and chicken wire. For quality, the floor, walls and the roof need to be cured by moistening their surface for at least a week. This should start immediately after each component is ready.

To facilitate cleaning of the tank, an outlet pipe may be fitted and fixed in the tank at bottom level. The size of the tank will depend upon the factors such as daily demand, duration of dry spell, catchment area and rainfall.

The tank is provided with:

a) A manhole of 0.60 m × 0.60 m size with cover,

b) Vent pipe/overflow pipe of 100 mm diameter, and

c) Drain pipe of 100 mm diameter at bottom.

The withdrawal of water from the underground tank is

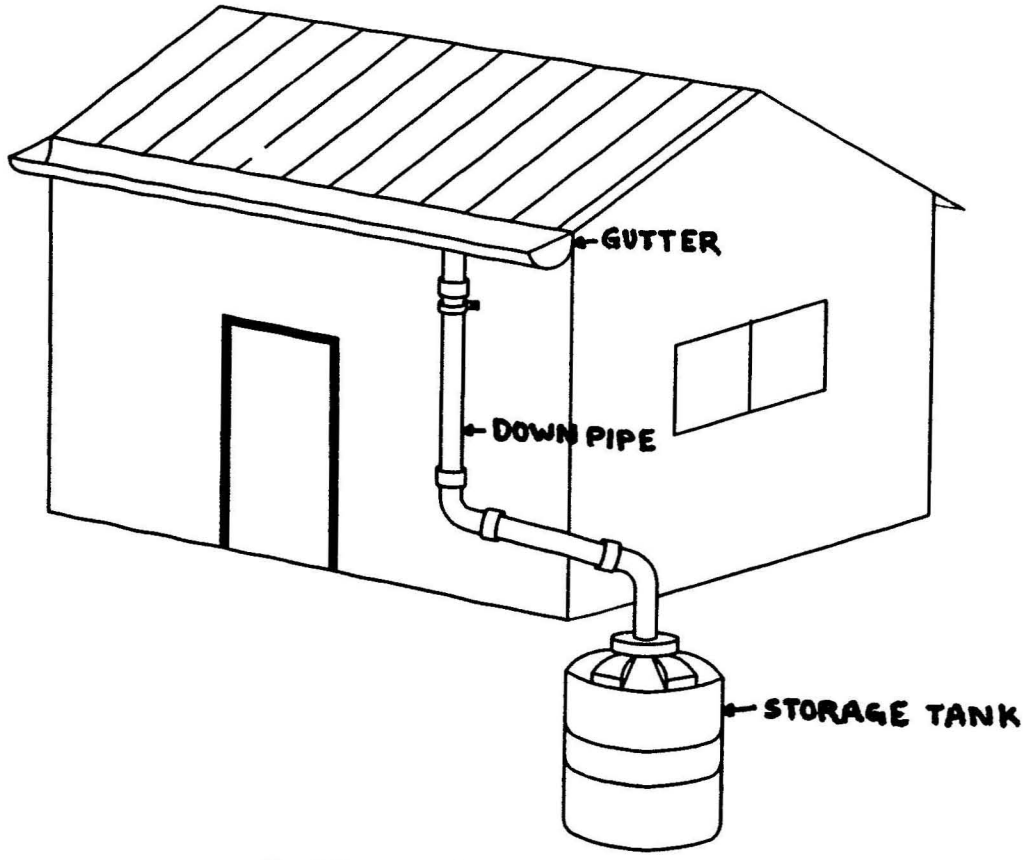


FIG. 3 STORAGE OF RAINWATER IN A HDPE TANK

done by installing a hand pump . In case of surface tank, taps may be provided. The overflow pipe should be connected to a drain/recharge pit.

Before the tank is put into use it should be thoroughly cleaned and disinfected with high dosage of chlorine. Since the water should remain stored for quite a long time, periodical disinfection of stored water is essential to prevent growth of pathogenic bacteria.

6.2 Site Assessment

Assessing the site conditions is the first step towards a sound system design. The five main site conditions to be assessed are:

a) Availability of suitable roof catchment,
b) Foundation characteristics of soil near the house,
c) Location of trees,
d) Estimated runoff to be captured per unit area of the roof, and
e) Availability and location of construction material.

6.3 Estimating the Size of the Required System

The size of the catchment area and tank should be enough to supply sufficient water for the users during the dry period. Assuming a full tank at the beginning of the dry season (and knowing the average length of the dry season and the average water use), the volume of the tank can be calculated by the following formula:

$$V = t \times n \times q$$

where

V = volume of tank, in litres;
t = length of the dry season (days);
n = number of people using the tank; and
q = consumption in litres per capita per day.

If, for example, 20 lpd (q) is agreed upon and a dry period of 100 days (t) is normally not exceeded, a storage volume of 10 m^3 would be required for a family of 5 members (n).

$V = 100\ (t) \times 5\ (n) \times 20\ (q) = 10\ 000$ litre or 10 m^3

The required catchment area (that is the area of the roof) can be determined by dividing the volume of the tank by the accumulated average rainfall volume (in litres) per unit area (in m^2) over the preceding wet months and multiplying this with the runoff coefficient, which varies from 0.8 to 0.95 depending upon type of roof.

6.4 General Design Features

Roof top water harvesting systems can provide good quality potable water, if the design features outlined below are taken into account:

a) The substances that go into the making of the roof should be non-toxic and chemically inert.
b) Roof surfaces should be smooth, hard and dense since they are easier to clean and are less likely to be damaged and release materials/fibres into the water.
c) Roof painting is not advisable since most paints contain toxic substances and may peel off.
d) No overhanging trees should be left near the roof.
e) Nesting of birds on the roof should be prevented.
f) All gutter ends should be fitted with a wire mesh screen to keep out leaves, etc.
g) Appropriate arrangement for discarding the first flow of rainfall should be made.
h) A hygienic soak away channel should be built at water outlets and a screened overflow pipe should be provided.
j) The storage tank should have a tight fitting roof that excludes light, a manhole cover and a flushing pipe at the base of the tank (for standing tanks).
k) There should be a reliable sanitary extraction device such as a gravity tap or a hand pump to avoid contamination of the water in the tank.
m) There should be no possibility of contaminated wastewater flowing into the tank (especially for tanks installed at ground level).
n) Water from other sources, unless it is a reliable source, should not be emptied into the tank through pipe connections or the manhole cover.

6.5 Management and Maintenance

Roof top catchment tanks, like all water supply systems, demand periodic management and maintenance to ensure reliable and quality water supply. If the various components of the system are not regularly cleaned, water use is not properly managed, problems are not identified or necessary repairs not performed, the roof catchment system will cease to provide reliable and good quality water.

Following is a time table of maintenance and management requirements that can provide a basis for monitoring and checking:

a) During the rainy season, the whole system (roof catchment, gutters, pipes, screens, first-

flush and overflow) should be checked before and after each rain and preferably cleaned after every dry period exceeding a month.

b) At the end of the dry season and just before the first shower of rain is anticipated, the storage tank should be scrubbed and flushed of all sediment and debris (the tank should be refilled afterwards with a few centimeters of clean water to prevent cracking). Ensure timely service (before the first rains are due) of all tank fixtures, including replacement of all worn screens and servicing of the outlet tap or hand pump.

6.6 Water Use Management

Control over the quantity of water abstracted from the tank is important to optimize water use. Water use should be managed so that the supply is sufficient to last through the dry season. Failure to do so will mean exhausting all the stored water. On the other hand, underutilization of the water source due to severe rationing should also be avoided.

7 RECHARGE OF HARVESTED RAINWATER IN AQUIFERS

7.0 The runoff water collected from roof tops can artificially recharge and augment the depleting ground water resources especially in the urban areas, where the natural recharge has diminished considerably. The areas having depth to water table greater than 8 m below ground level and underlain by permeable strata are suitable for artificial recharge.

7.1 Design of Efficient Artificial Recharge Structures

The design involves consideration of data on hydrological and hydrogeological aspects and hydrometeorological parameters. The background information to be collected is as given below:

a) Layout plan of the area.
b) Demarcation of the roof, paved and open areas.
c) Delineation of storm water drains and flow of storm water.
d) Details of the existing ground water abstraction structures in and around the vicinity of the project site.
e) Computation of the runoff for recharge.

Apart from the above mentioned parameters, selection of appropriate recharge structure depends on the availability of space for construction of recharge structures and invert levels of storm water drains at inlets to recharge structures. While preparing the recharge scheme, depth and shape of the storage facility in recharge structure depends on the availability of runoff, depth of storm water drainage and space availability in an area. The recharge scheme as prepared may also be got vetted by appropriate authorities and experts to incorporate suggestions for improvement.

7.2 Recharge Structures

The most suitable recharge structures for roof top rain water harvesting are:

a) Recharge pits;
b) Recharge trenches;
c) Recharge through dry or operational dugwells;
d) Recharge through abandoned/existing tube wells; and
e) Recharge wells, etc.

7.2.1 *Recharge Pits*

a) In alluvial areas where permeable rocks are exposed on the land surface or at very shallow depth, recharge pits are suitable for artificial recharge of water collected from the roof tops.
b) The technique is suitable for buildings having a roof area of 100 m^2. The recharge pits are constructed for recharging the shallow aquifers.
c) Recharge pits may be of any shape and size and are generally constructed 1 to 2 m wide and 2 to 3 m deep which are backfilled with boulders (5-20 cm), gravels (5-10 mm), and coarse sand (1.5-2 mm) in graded form — boulders at the bottom, gravels in between and coarse sand at the top so that the silt content that will come with runoff will be deposited on the top of the coarse sand layer and can easily be removed. For smaller roof area, pit may be filled with broken bricks/cobbles.
d) A mesh should be provided at the roof so that leaves or any other solid waste/debris are prevented from entering the pit and a desilting/ collection chamber may also be provided at the ground to arrest the flow of finer particles to the recharge pit.
e) The top layer of sand should be cleaned periodically to maintain the recharge rate.

7.2.2 *Recharge Trenches*

a) Recharge trenches are suitable for buildings having roof area of 200-300 m^2 and where permeable strata is available at shallow depths.
b) Trench may be 0.5 to 1 m wide, 1 to 1.5 m

deep and 10 to 20 m long depending upon availability of water to be recharged.

c) These are backfilled with boulders (5-20 cm), gravels (5-10 mm), and coarse sand (1.5-2 mm) in graded form — boulders at the bottom, gravel in between and coarse sand at the top so that the silt content that will come with runoff will be deposited on the top of the sand layer and can easily be removed.

d) A mesh should be provided at the roof so that leaves or any other solid waste/debris is prevented from entering the trench and a desilting/collection chamber may also be provided on ground to arrest the flow of finer particles to the trench.

e) The top layer of sand should be cleaned periodically to maintain the recharge rate.

7.2.3 *Recharge Through Dry or Operational Dug Wells* (*see* Fig. 4)

a) Dry/operational dug wells if exist in the area may be utilized as recharge structures after cleaning and desilting the same.

b) Recharge water is guided through a pipe from desilting chamber to the bottom of the well or below the water level to avoid scouring of bottom and entrapment of air bubbles in the aquifer.

c) Recharge water should be silt-free. For removing the silt content, the runoff water should pass either through a desilting chamber or filter chamber.

d) Periodic chlorination should be done for controlling the bacteriological contamination in operational dug well.

e) Wire mesh filter should be provided just before the inlet to avoid entry of any foreign material, tree leaves, etc, in to the dug well.

7.2.4 *Recharge Through Abandoned/Existing Tube Wells* (*see* Fig. 5 and Fig. 6)

a) Abandoned/existing tube wells may be used as recharge structures.

b) The abandoned tube well should be properly developed before use as recharge structure.

c) PVC pipes of 10 cm diameter are connected to roof drains to collect rainwater.

d) The first roof runoff is drained through the bottom of drain pipe if existing tube well is used as recharge structure. After closing the bottom pipe, the rainwater of subsequent rain showers is taken through a 'Tee' to an online PVC filter in case of small roofs. If the roof area is larger, a filter pit may be provided. Rainwater from roofs is taken to collection/

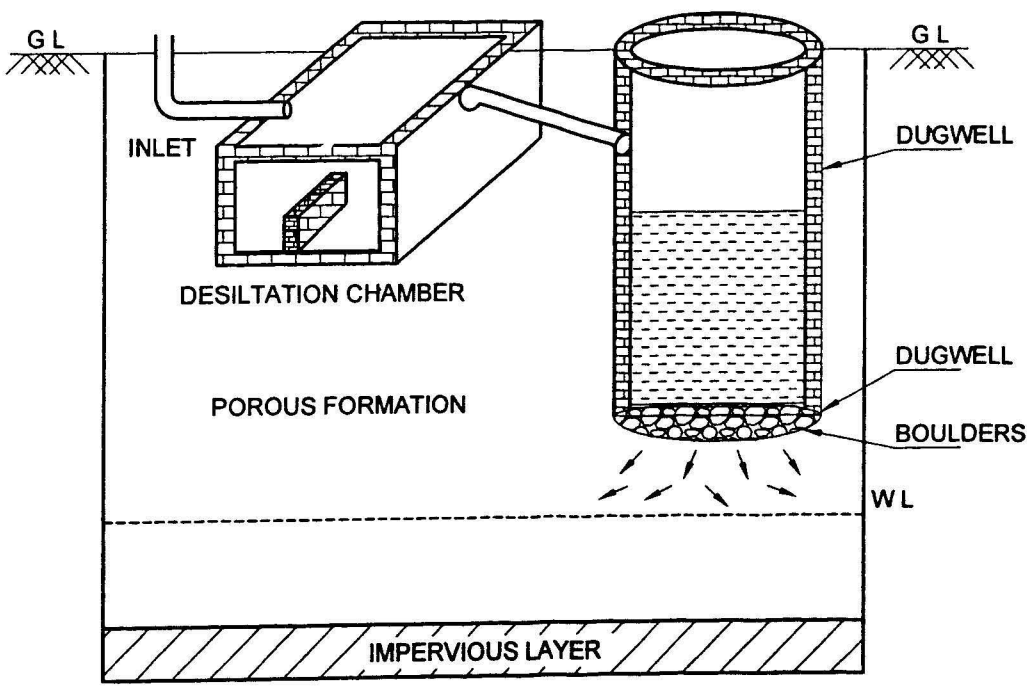


FIG. 4 RECHARGE THROUGH DUG WELL

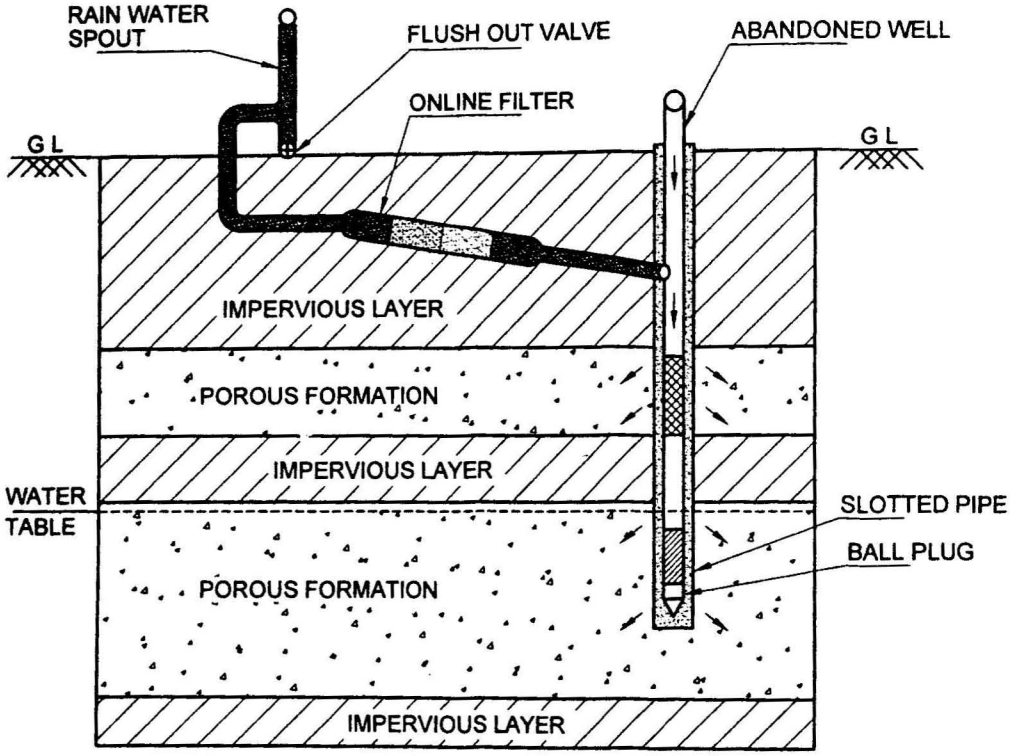
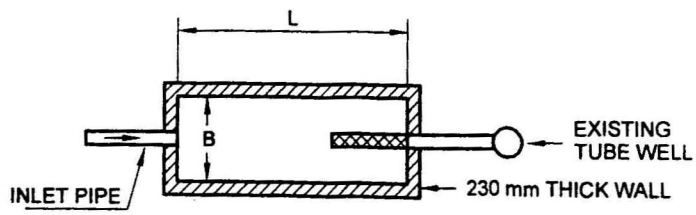
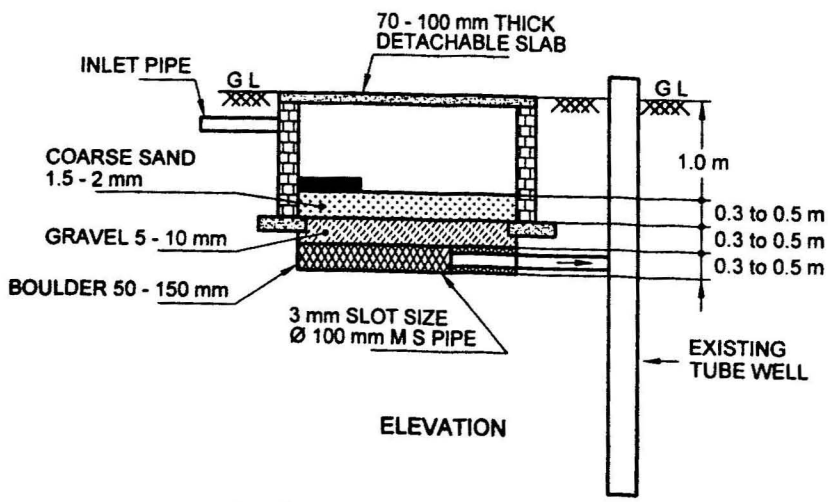


FIG. 5 RECHARGE THROUGH ABANDONED TUBE WELL



PLAN



ELEVATION

FIG. 6 RECHARGE THROUGH EXISTING TUBE WELL

desilting chambers located on ground. These collection chambers are interconnected as well as connected to the filter pit through pipes.

e) A connecting pipe with recharge well is provided at the bottom of the pit for recharging of filtered water through well.

f) Wire mesh filter should be provided just before the inlet to avoid entry of any foreign material, tree leaves, etc., in to the system.

7.2.5 *Recharge Wells* (*see* Fig. 7)

a) In areas where the aquifers are overlain by a considerable thickness of impervious formation, a new recharge tube well can be constructed for recharging the harvested rainwater.

b) It is used for recharging single/multiple aquifers.

c) A settlement-cum-storage tank is constructed near the tube well for settlement of silt particles and storage of excess water.

d) Roof top water is diverted to the settlement tank through pipes.

e) Clear water of storage tank is diverted to the recharge tube well for recharge.

f) It is suitable for recharging roof top rainwater of big buildings/blocks.

g) If runoff availability is less, then online filter may be used in the pipe line connecting roof water with recharge well.

7.2.5.1 *Construction of recharge well*

These are drilled by deploying the appropriate rig unit or by hand boring as per the site conditions and depth of the tube wells.

A well assembly of pipes with diameters varying from 100 to 250 mm may be lowered throughout the depth. Both M.S. and PVC pipes can be used. PVC pipes are rigid, light pipes in 6 or 9 m lengths available in all diameters. The main advantage of PVC pipes is their resistance to corrosion and slots of the pipes will not close with time. As the slotted pipes in recharge wells are in fluctuation zones of water levels, slots of M.S. pipes may become closed due to rusting. The main drawback of PVC pipes is that, these pipes can not be used in large diameter recharge wells. M.S. Pipes may be coated with bituminous coating to avoid rusting.

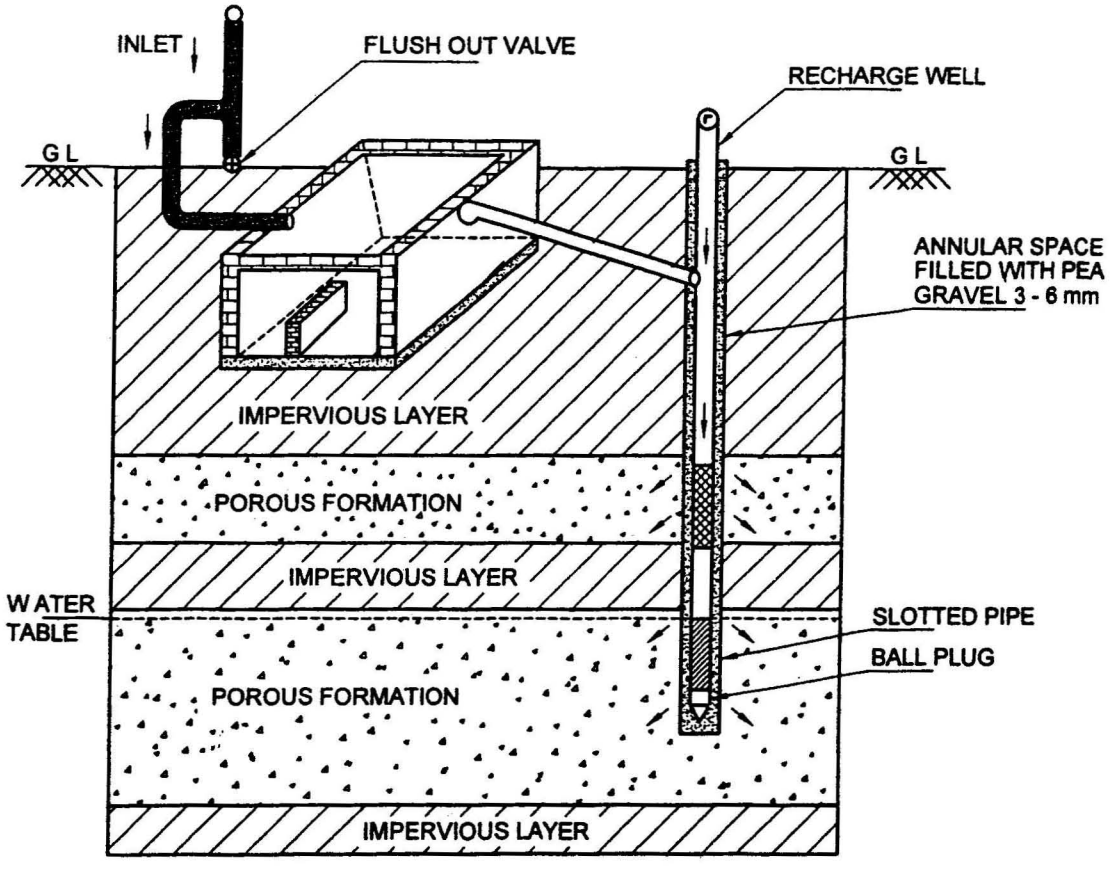


FIG. 7 RECHARGE THROUGH BORE WELL

After excavation of the recharge trench/shaft or filtration chamber is over, pipes should be rechecked and cleaned with wire brush. Depth sounding of recharge wells should be taken with tape to make sure that no silt or soil has gone into the recharge wells during the excavation of trench/shaft. Width of slots in recharge well should be in accordance with the aquifer system encountered. Slotted pipes should be placed against the aquifer or dried-up aquifers encountered in the recharge wells. A slotted pipe at the top of the recharge well will need to be placed to permit the entry of clean/clear water into the recharge well.

The annular space around the well assembly may be shrouded with appropriate size of gravel. The gravel should be washed so that it is silt-free. The recharge tube well should be developed by low capacity air compressor or by bailing method as required. The well may also be cleaned and developed by pouring the water from outside if required. The water levels of the tube well should be recorded and the well covered with cap with a provision to monitor the well in future. A vent pipe of about one inch diameter is also recommended which can act as escape for gases and for measuring the water levels. Once the recharge trench or shaft is constructed around the recharge tube well, recharge wells may be developed with hand bailers to avoid the disturbance of filter media.

7.2.5.2 *Recharge ability test*

To test the recharge ability of the tube well, a slug test may be conducted [*see* IS 14476 (Part 6)].

7.3 Filters

Generally, the following two types of filters are used :

a) *Online Filter*

1) This filter is used when availability of runoff as well as recharge rate of recharge well is less.
2) Manufactured from reinforced engineering plastic material.
3) Available in various sizes and flow rates ranging from 3 to 25 m^3/h.
4) Easy to open and clean.

b) *Purpose Built Filter*

1) The filter material recommended is coarse sand of 1.5 to 2 mm size at the top, followed by gravel of 5 to 10 mm size, and boulders of 5 to 20 cm at bottom. The thickness of each layer should be about 0.5 m. Coarse sand should be placed at the top so that the silt content that comes with runoff will be deposited on the top of the coarse sand/ pea gravel and can easily be removed. For smaller roof area the pit may be filled with overburnt broken bricks/cobbles.
2) After excavation of filter chamber, boulders and gravel should be filled up first to the foundation of wall of the structure.
3) After filling of boulder and gravel, filter material should be covered with polythene/jute bags to avoid spilling of construction material, which may damage the filter bed. After the construction of walls, the polythene/jute bags should be removed and the sand/pea gravels filled up to the recommended depth as per the design.
4) Filter media should be free from silt and any other foreign material. Before putting the filter material into the chamber, filter material should be sieved and washed to remove all the finer material. During operation the scouring effect of flow of water into the structure should be checked upon and if flow is disturbing the filter media, the water can be released near the filter media. This can be done by providing an 'I' shape joint in the inlet pipe in trench.
5) Regular inspection of filter material is essential in recharge structures. Silt deposited on the filter media should be cleaned regularly. Once in a year the top 5-10 cm sand/pea gravel layer should also be scraped to maintain a constant recharge rate through filter material.
6) Growth of grass or bushes hampers the filtration rate of the chamber. The grass and bushes should be cleared regularly.

7.4 Maintenance of Catchment Area, Water Drains and Recharge Structures

a) The catchments should be neat and clean. The roof top/terrace of the building spaces around the buildings should not be used for dumping of unwanted items and scrap material.
b) The washing machine water having heavy dose of detergents should not be allowed to enter into the water drains which are connected with recharge structures.
c) Open water drains covered with perforated detachable RCC slabs are best as the maintenance of these drains is easy and pollution, especially bacteriological pollution, can be avoided. If the storm water drainage is through pipe system, provide manholes and

chambers at regular intervals as well as close to the suspected silt and waste accumulation places within the channel.

d) Protect the drainage system from tree leaves, polythene bags, plastic bottles and pouches of eatables.

e) Put up sign boards mentioning that the campus of building is equipped with rainwater harvesting system which is being recharged to the ground water system. Mention the ill effects and health impacts if the storm water drains are not properly maintained. Educate the staff maintaining the storm water drains to keep the drains neat and clean.

f) Provide wire mesh filter just before the inlet. Provide silt check wall within the drain bed at a convenient place. If more silt is expected provide check wall at regular intervals in the storm water drains.

g) The periodic removal of the material deposited on the surface be done by scraping the silt accumulated on top of the filter bed regularly.

h) Precaution should be taken to avoid domestic waste water entering into the recharge structures.

j) Recharge tube wells should be developed periodically by hand bailers to avoid clogging of the slots.

k) Before the arrival of monsoon, the roof top as well as drains should be properly cleaned.

m) Length and placement of the slotted pipe should be finalized after drilling of pilot hole for tube well.

n) Recharge water should be introduced into the structure at its lowest point to prevent erosion and disturbance of filter material.

p) A wire mesh should be placed at the entrance of recharge structures.

q) Periodic cleaning of collection chambers should be carried out to remove the plastic bags, leaves, etc, which may choke the entry of water recharge structures.

ANNEX A

(*Foreword*)

COMMITTEE COMPOSITION

Ground Water and Related Investigations Sectional Committee, WRD 3

Organization	*Representative(s)*
Central Ground Water Board, New Delhi	SHRI B. M. JHA (***Chairman***) [Member (SAM)]
Central Electricity Authority, Hyderabad	SHRI MAJOR SINGH SHRI S. B. ATRI (*Alternate*)
Central Ground Water Board, Faridabad	DR S. K. JAIN SHRI S. K. SINHA (*Alternate*)
Central Pollution Control Board, New Delhi	DR R. C. TRIVEDI DR SANJEEV AGRAWAL (*Alternate*)
Central Soil and Salinity Research Institute, Karnal	DR S. K. GUPTA
Central Water & Power Research Station, Pune	DR N. GHOSH SHRI R.S. RAMTEKA (*Alternate*)
Central Water Commission, Faridabad	SUPERINTENDING ENGINEER (PLANNING CIRCLE) DIRECTOR (WM) (*Alternate*)
Centre for Water Resources Development & Management, Kozhikode	HEAD Dr E. J. JAMES (*Alternate*)
Geological Survey of India, Lucknow	SHRI S. KUMAR SHRI Y. DEVA (*Alternate*)
Ground Water Surveys and Development Agency, Pune	DR B. S. CHANDRASEKHAR SHRI S. P. BAGDE (*Alternate*)

Organization	*Representative(s)*
Gujarat Water Resources Development Corporation, Gujarat	SHRI J. P. RAVAL SHRI A. D. GOHIL (*Alternate*)
India Meterological Department, New Delhi	SHRI N. Y. APTE
Indian Institute of Technology, Roorkee	DR DEEPAK KHARE
Irrigation Department, Government of Punjab, Chandigarh	CHIEF ENGINEER DIRECTOR (*Alternate*)
Irrigation Department, Government of Uttarakhand, Dehra Dun	CHIEF ENGINEER SUPERINTENDING ENGINEER (I & PI) (*Alternate*)
Ministry of Environment & Forests, New Delhi	ADVISOR DR (SMT) NALINI BHAT (*Alternate*)
National Bureau of Soil Survey & Land Use Planning, New Delhi	DIRECTOR
National Geophysical Research Institute, Hyderabad	DR D. MURALIDHARAN
National Hydroelectric Power Corporation Ltd, Faridabad	SHRI IMRAN SAYEED SHRI P. PUNETHA (*Alternate*)
National Institute of Hydrology, Roorkee	DR A. K. BHAR DR N. C. GHOSH (*Alternate*)
National Remote Sensing Agency, Hyderabad	HEAD, HYDRO GEOLOGY DIVISION
North Eastern Region, Tejpur	DR P. V. SEETHAPATHI DR S. C. PATRA (*Alternate*)
River Research Institute, Government of West Bengal, Kolkata	SHRI R. CHAKRABORTY
Survey of India, New Delhi	BRIG G. S. CHANDELA SHRI C. B. SINGH (*Alternate*)
Water & Land Management Institute, Aurangabad	DR B. M. SAHNI SHRI B. B. JADIA (*Alternate*)
Water Technology Centre for Eastern Region, Orissa, Bhubaneshwar	SHRI R. C. SRIVASTAVA
BIS Directorate General	SHRI A. M. DAVID, Director (WRD) [Representing Director General (*Ex-officio*)]

Member Secretary
MS BHAVANA SHARMA
Assistant Director (WRD), BIS

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