Water and Wastewater Management

Guru Nanak Dev University
Amritsar

राष्ट्रीय मूल्यांकन एवं प्रत्यायन परिषद

विश्वविद्यालय अनुदान आयोग का स्वायत्त संस्थान

NATIONAL ASSESSMENT AND ACCREDITATION COUNCIL

An Autonomous Institution of the University Grants Commission

Certificate of Accreditation

The Executive Committee of the
National Assessment and Accreditation Council
on the recommendation of the duly appointed
Peer Team is pleased to declare the
Guru Nanak Dev University
Amritsar, Punjab as
Accredited
with CGPA of 3.51 on four point scale
at A grade
valid up to December 09, 2021

Date : December 10, 2014

Director

EC(SC)/04/RAR/87

Preserve Protect Environment Save

Er. S.K.Goyal
M.E. (Env.), FIE (India)
Sr. Env. Engineer(Retd.)
Punjab Pollution Control Board(PPCB)

EIA Co-ordinator (QCI)
Chartered Engineer,PPCB

Certificate

Certified that a team of faculty members & students, under the leadership of **Prof. Ashwani Luthra, Director IQAC** of Guru Nanak Dev University, Amritsar has conducted a detailed **Environmental Green Audit of various Green Initiatives taken by the university** covering different aspects such as Green Cover, Green Mobility, Air Quality Monitoring, Water and Wastewater Management, Green Energy Initiatives, Solid Waste Management, Bio-Medical Waste Management, and E-Waste Management, for the preservation and protection of environment in its campus. Data and credentials in the report have been scrutinised and are found **Satisfactory**.

Efforts made by the leadership, faculty and students of the University towards environment and sustainability are commendable and worth appreciating.

Dated: NOV.25,2021

(Er. Samarjit K. Goyal)
Chartered Engineer
Pb Pollution Control Board

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CENTRE FOR SCIENCE AND ENVIRONMENT

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LEAVES OF IMPORTANT SURVIVAL TREES IN INDIA — MAHUA, KHEJDI, ALDER, PALMYRA AND OAK

November 29, 2021

The Coordinator
Centre for Sustainable Habitat
Guru Nanak Dev University
Amritsar

Subject: Certification for different Audits under Green Campus Initiatives

Dear Sir,

From the past six years, Centre for Science and Environment (CSE) and Guru Nanak Dev University (GNDU) Amritsar have been working together on CSE's Green Campus Initiative and audit programme. Under this engagement, CSE has supervised multiple environmental audits and trained the faculty, staff and students at GNDU as well as other universities and colleges across India. The results and outcomes of this engagement have been published by CSE in multiple reports such as 'A Green Campus Compendium: Incubation, Experimentation and Demonstration of a Green Future' and 'Green Campus Movement'. Appreciation letters have also been shared at the various stages of this programme. CSE appreciates that the faculty at GNDU has prepared the following audit reports:

1. Green Cover of GNDU
2. Green Mobility Initiatives
3. Air Quality Monitoring
4. Liquid Waste Management
5. Green Energy Initiatives
6. Solid Waste Management
7. Bio-Medical Waste Management
8. E-Waste Management

CSE commends GNDU's efforts towards realising Sustainable Development Goals and extends its full support and expertise in its future endeavours.

Yours' cordially,

Rajneesh Sareen

Rajneesh Sareen
Programme Director
Sustainable Buildings and Habitat Programme
Centre for Science and Environment

Preface

Providing portable water to all in the society is one of the important goal of any Government. The individual campuses are the role model in sitting examples regarding sustainable water provision practices. They also act as prime institutes to showcase best use of their wastewater. Guru Nanak Dev University has been practicing water and wastewater management to make itself a zero discharge campus. This report is prepared for Internal Quality Assurance Cell of the University by Dr. Manpreet Singh Bhatti, Professor, Department of Botanical and Environmental Sciences, and Dr. Kiran Sandhu, Associate Professor, Guru Ramdas School of Planning to highlight the salient characteristics of water management; wastewater management and water conservation; and rainwater harvesting practices being followed by the University.

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GURU NANAK DEV UNIVERSITY

With the glorious history of past fifty years, Guru Nanak Dev University was established at Amritsar on November 24, 1969 to mark the Birth Quincentenary of Sri Guru Nanak Dev Ji, the apostle of universal brotherhood, truthfulness, non-violence, compassion, tolerance, harmony, humanity, strict observance of moral & ethical values in daily life, who is also revered as the founder of Sikhism. It won't be an exaggeration to state that His teachings and preaching & His own personal life are perfect examples to be emulated by the entire mankind even after about four and half a centuries and will remain so eternally. Ever since its foundation the endeavour of the university has always been to meet the objectives enshrined in the Guru Nanak Dev University Act 1969, which emphasized that the new University would make provision for imparting education and promoting research in the humanities, learned professions, sciences, especially of applied nature and technology. Studies and research on the life and teachings of Guru Nanak, in addition to working towards the promotion of Punjabi language and spreading education among educationally backward classes and communities are the other commitments. In consonance with these expectations, the university in its eventful history of 50 years has taken long strides in spreading the message of Guru Nanak Dev ji and promoting education in such fields as Science, Arts, Management, Information Technology, Industrial Technology, Environment, Planning and Architecture. To fulfil its commitment, the tuition fee charged from the students of the departments of Guru Nanak Studies and the School of Punjabi Studies has been waived. The UGC conferred this University with status of "University with Potential for Excellence" in 2012. The National Assessment and Accreditation Council (NAAC), Bangalore in November 2014 reaccredited the university in 3rd cycle with CGPA of 3.51 out of 4 point scale at "A++" grade, the highest in the region.

Guru Nanak Dev University is a high performing state public university as it has improved its ranking from 80 in 2017 to 51 in 2020 among all Central, Public and Private Universities in the country (NIRF, MHRD, GoI). It is reckoned among top 9% universities of the world and top 10 state public universities of India by Centre for World University Ranking (CWUR), a leading international agency engaged in grading the top ranking universities world-wide since 2012. QS I-GAUGE Rating System has rated the university in the Diamond Category in the field of 'research, faculty quality and infrastructure' by the. It was also shortlisted for the University of the Year Award in the 16th FICCI Higher Education Summit 2021 organized by FICCI jointly with the Ministry of Education and Ministry of Commerce & Industry, Government of India. High quality research has improved the H-index of the university from 64 to 119 with top 10 percent highly cited papers in Scopus. The university is placed among the top 4 Institutions in Punjab and 10 Institutions in North India by Nature Index,

The University today boasts of 43 teaching departments at the Campus and 149 affiliated colleges, 16 Constituent & University Colleges and 53 Associate Institutes, many of which are located in the rural areas. The university has always strived hard to make the benefits of higher education accessible to the rural masses. More than twenty thousand students, an overwhelming majority of them being women, are enrolled in various Departments at University Campus and Constituent Colleges. On-line admission, on-line counselling, on-line re-evaluation, introduction of Credit Based Continuous Evaluation Grading System etc. are a few hallmarks of the university. All the results have been computerized and OMR (Optical Magnetic Recognition) system is being used to bring in more efficiency and transparency. This is the first University in the region to have computerized its examination and registration system. The students now have an all-time access to their results through SMS service. It acts as a model higher

education institution for digital initiatives like e-office management system, digital library, Wi-Fi enabled campus, high speed online teaching modules, and smart classrooms to name a few.

Academically also, the university has carved a niche for itself in the field of Higher Education in the country. Our University is recognized as one of the leading institutions in North India in the domain of Science and Technology. Many coveted projects from the apex bodies like the DST, CSIR, BARC and other organizations worth crores of rupees have been awarded to our faculty members. One of the four Nodal Calibration Centres established by Bhabha Atomic Research Centre is set up at our campus. The Centre of Emerging Life Sciences equipped with the state-of-the-art scientific instruments worth crores of rupees, well-maintained Botanical Garden, Department of Sports Medicine & Physiotherapy are a few of the jewels in the crown of the university. To more strengthen the university infrastructure and to prepare students for employments, computer lab with the help of TCS is also established. Further, the UGC has granted the University the Centre with Potential for Excellence in Life Sciences and Centre for Advanced Study in Chemistry.

In the field of culture and sports also, the achievements of the university are noteworthy. The university has been national Champion for 10 times & the winner of the North-Zone-Inter-Varsity Cultural Championship for 13 times. The winning of the coveted Maulana Abul Kalam Azad Trophy, the highest sports award for a university in the country, for a record number of 23 times, speaks volumes about its supremacy in the field of sports. An Astro Turf for hockey, a swimming pool of international standards, a velodrome, a Gymnasium hall, shooting range & many other state-of-the art sports facilities are the prized possessions of the university. The Lifelong Learning Department of the university is successfully catering to the female folk of the region to make them self-dependent by offering various skill development programmes. The Track record of employment of our students by big business Houses and Multi-National Companies has been very satisfactory. Our students of engineering, management and commerce field are employed by companies in India and abroad. They are all contributing to the creditworthiness of the University by their hard work and diligence. In the last year alone, almost all our engineering and management students were recruited by various companies through campus placements. It goes without saying that all these achievements would not have been achieved, but for the heart and soul put in by the students, faculty members, and administration of the university. Undoubtedly, the university remains committed to achieve the lofty goals, for which it was founded after the name of Sri Guru Nanak Dev Ji.

The university is known for its GREEN CAMPUS initiatives in the field of energy, water, solid waste management, micro mobility and health and hygiene. Some of the key initiatives of the university are energy efficient buildings, rooftop solar energy plant, solar water heaters, censor based urinals, toilets and wash basins, maintenance of lawns as water recharge systems, rooftop rainwater harvesting, on campus sewerage water treatment plant, organic waste management through bio-gas plant and vermi-compositing, natural processing to convert agro-waste into compost, involvement in recycling and reuse of paper, plastic, mettle and other waste, efficient medical waste management, regular thickening of tree cover by planning tree each year, making the campus car free, facilitating the students, staff and the visitors by free of charge e-vehicle facility for micro mobility within the campus, developing lush green covered footpaths, regular sweeping of the roads and buildings at least twice a day and regular disinfectant spray to help the university bag the second cleanest State University in India awarded by the Ministry of Human Resource Development, Government of India under Swachh Campus Ranking for the last two years continuously.

1. BACKGROUND

Water management is one of the key agendas in the light of the United Nations Sustainable Development Goal (*Goal 11 Sustainable Cities & Communities*). The Punjab Water Resources (Regulation and Management) Act of 2020 established the Punjab Water Regulation and Development Authority (PWRDA), which is in charge of regulating and managing the state's water resources in a reasonable, equitable, and long-term manner. As a result, an effort was made at Guru Nanak Dev University in Amritsar to get access to the judicial use of water. In addition, efforts are being made to guarantee that the water supply management system, as well as the reuse of treated wastewater on campus, are working smoothly. Guru Nanak Dev University is committed to follow guidelines for water efficiency management systems-Requirements with guidance for use as per ISO 46001: 2019 (***Annexure-1***).

2. OBJECTIVES AND PRACICES

- System of water supply management in the campus
- Drinking water quality in the campus as per drinking water specifications (IS 10500: 2012)
- Wastewater treatment scheme and its compliance
- Performance evaluation of wastewater treatment plant and reuse potential of treated wastewater
- Water conservation and harvesting practices

3. TOPOGRAPHY AND WEATHER CONDITIONS

The campus terrain is plain as seen from Google Earth Pro **(Figure 1)**. It is developed on rich alluvial soil having bearing capacity. Most than 2/3rd of its land is used for lawns and agriculture. The overall climate is classified as tropical, semi-arid, and hot. The average temperature and precipitation profile along with wind rose is depicted in **Figure 2** and **Figure 3** respectively. Winters are cold with a minimum night temperature of 4℃ and predominant wind directions are west and north-east with a maximum wind velocity of 12 km/hour.

Figure1: Terrain Map of GNDU from Google Earth Pro

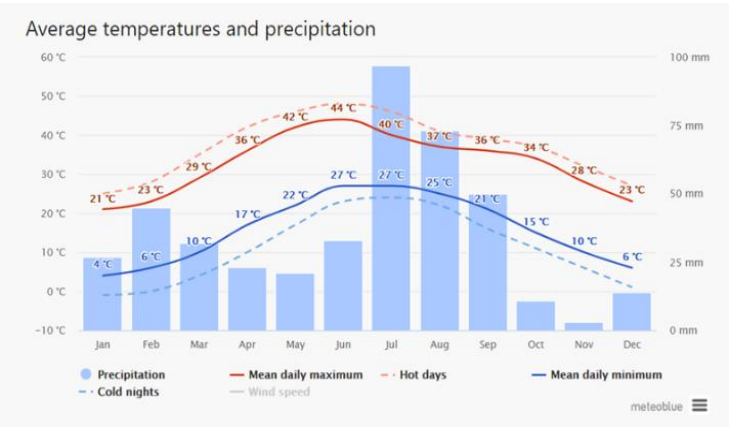

Figure 2: Average Temperature and Precipitation in Amritsar (2019)

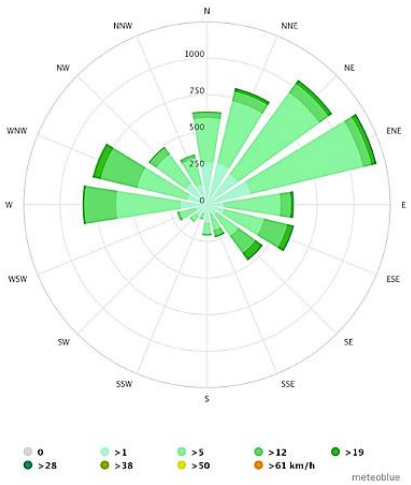

Figure 3 Wind Rose Profile of Amritsar City (2019)

4. WATER MANAGEMENT

Water abstraction and wastewater generation are complementary to each other. As per Manual of Water Supply and Sewerage by Ministry of Urban Development, wastewater generation is about 80% of the water consumption.

4.1 Source of Water Supply

GNDU has its water supply network and water is abstracted using seven tube wells installed at different locations in it. GPS details and locations are given in **Table 1** and **Figure 4**. A total of 2.94 MLD of water is extracted from these tube wells and it meets institutional, residential, agricultural, and landscaping demands of the campus.

Table 1: GPS Coordinates of Borewells

Tube Well Number	Latitude	Longitude	Location
TW-2	31.642680°N	74.823170°E	Near OHR
TW-3	31.640970°N	74.823610°E	Near Water Supply Dept.
TW-4	31.636956°N	74.823569°E	Near Biotechnology
TW-5	31.638278°N	74.827718°E	Inside Boy's Hostel
TW-6	31.635111°N	74.822007°E	Outside Girl's Hostel
TW-7	31.636609°N	74.825375°E	Near Generator House
TW-8	31.641230°N	74.827330°E	Near MYAS

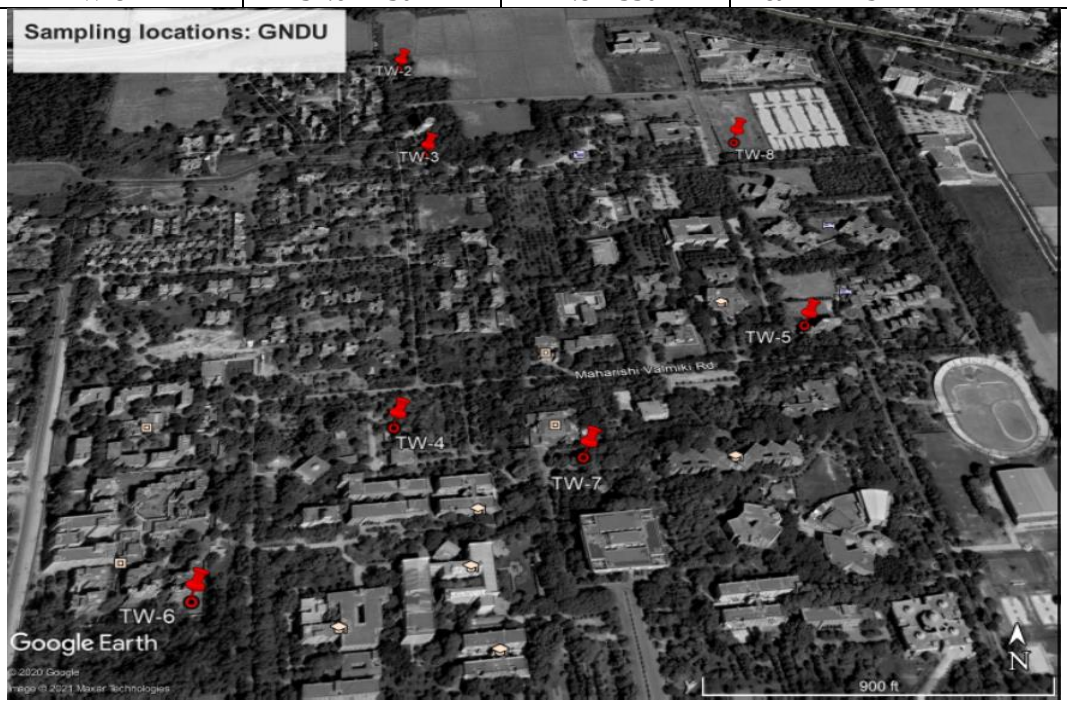

Figure 4: Map of the Borewell Locations

4.2. Water Supply Network

Water supply lines are interconnected with each other. The water supply network in the campus is interconnected with pipes ranging from 14", 12", 10", 8" and 6" in diameter. Based on the total water supplied in the university, per capita water supplied is 185.7 liters per person per day. The water pressure is maintained using a pressure gauge (**Figure 5**) installed in the water cell of the university and about 40-45 psi pressure is maintained during the daytime. During night hours, supply is given through Over Head Reservoir (**Figure 6**) with the capacity of two lakh gallons.

Figure 5: Pressure Gauge

Figure 6: Over Head Reservoir

4.3. Borewell Profile

The typical borewell profile of the tube well in the campus is given in ***Annexure-2.*** The water abstraction is done through different layers tapped (Layer contained coarse sand are used for water abstraction) with a borewell depth of 505 feet.

4.4. Water Quality Analysis

The water quality in the campus is checked periodically through testing of water samples collected from the seven tube wells. The Department of Botanical & Environmental Sciences conducted a water quality analysis for GNDU **(Figure 7)**. For testing, the American Public Health Association's 19th edition of "Standard Methods for the Examination of Water and Wastewater Analysis," released in 1995, was used. During the year 2020, the Department of Botanical and Environmental Sciences collected and analysed the samples. The results of the tests are compared with Indian Drinking Water Specifications as given in IS 10500: 2012 (**Annexure-3**). **Table 2 to Table 8** shows the results of the drinking water quality from different borewells in the campus.

Figure 7: Sampling from Boys Hostel (10.12.2020)

Table -2 Drinking Water Quality of TW-2

Location of Sample/Tube well No : Near Over Head Reservoir / **TW – 2**
Depth of Bore well : 500 feet
Year of Installation : 20-08-2008
Date of sampling : 10-12-2020

S. No.	Parameter	Method	TW-2	BIS Guidelines	
				Acceptable	Permissible
1	Colour (Pt-Co scale) Hazen	Visual comparison	Clear	< 5	< 15
2	Odour	Test cold and when heated	Nil	-	
3	pH	Electrometric	7.5	6.5 - 8.5	-
4	Taste	-	Agreeable	Agreeable	
5	Turbidity	Nephelometric	< 1	<1 NTU	< 5 NTU
6	Total Dissolved Solids	Gravimetric	340	< 500 mg/L	< 2000 mg/L
7	Calcium	EDTA Titrimetric	66	< 75 mg/L	< 200 mg/L
8	Chloride	Argentometric	9	< 250 mg/L	< 1000 mg/L
9	Fluoride	SPANDS	0.42	< 1 mg/L	< 1.5 mg/L
10	Iron (as Fe)	Phenanthroline	0.08	< 0.3 mg/L	-
11	Magnesium	Calculation method	24	< 30 mg/L	< 100 mg/L
12	Nitrate (as NO_3)	UV absorbance, 220 nm	1.5	< 45 mg/L	-
13	Sulfate, mg/L	Gravimetric	8	< 200 mg/L	< 400 mg/L
14	Total Alkalinity (as $CaCO_3$)	Titration method	**300**	< 200 mg/L	< 600 mg/L
15	Total Hardness (as $CaCO_3$)	EDTA Titrimetric	**228**	< 200 mg/L	< 600 mg/L
16	Conductivity (microS/cm)	Conductivity meter	690	-	-

Opinion: Total Hardness and Total Alkalinity exceeds acceptable limit but well below the permissible limit. Sample pass the Indian Standard IS 10500: 2012 test for Drinking Water Quality in terms of the above parameters.

Water Quality: Very Good

Table 3: Drinking Water Quality of TW-3

Location of Sample/Tube well No : Near Water Supply Department / **TW – 3**
Depth of Bore well : 500 feet
Year of Installation : 16-01-2016
Date of sampling : 10-12-2020

S. No.	Parameter	Method	TW-3	BIS Guidelines	
				Acceptable	Permissible
1	Colour (Pt-Co scale) Hazen	Visual comparison	Clear	< 5	< 15
2	Odour	Test cold and when heated	Nil	-	
3	pH	Electrometric	7.5	6.5 - 8.5	-
4	Taste	-	Agreeable	Agreeable	
5	Turbidity	Nephelometric	< 1	<1 NTU	< 5 NTU
6	Total Dissolved Solids	Gravimetric	330	< 500 mg/L	< 2000 mg/L
7	Calcium	EDTA Titrimetric	60	< 75 mg/L	< 200 mg/L
8	Chloride	Argentometric	10	< 250 mg/L	< 1000 mg/L
9	Fluoride	SPANDS	0.31	< 1 mg/L	< 1.5 mg/L
10	Iron (as Fe)	Phenanthroline	0.08	< 0.3 mg/L	-
11	Magnesium	Calculation method	22	< 30 mg/L	< 100 mg/L
12	Nitrate (as NO_3)	UV absorbance, 220 nm	1.5	< 45 mg/L	-
13	Sulfate, mg/L	Gravimetric	10	< 200 mg/L	< 400 mg/L
14	Total Alkalinity (as $CaCO_3$)	Titration method	**240**	< 200 mg/L	< 600 mg/L
15	Total Hardness (as $CaCO_3$)	EDTA Titrimetric	**224**	< 200 mg/L	< 600 mg/L
16	Conductivity (microS/cm)	Conductivity meter	680	-	-

Opinion: Total Hardness and Total Alkalinity exceeds acceptable limit but well below the permissible limit. Sample pass the Indian Standard IS 10500: 2012 test for Drinking Water Quality in terms of above parameters.

Water Quality: Very Good

Table 4: Drinking Water Quality of TW-4

Location of Sample/Tube well No : Near Biotechnology Dept. / **TW – 4**
Depth of Bore well : 500 feet
Year of Installation : 20-11-1995
Date of sampling : 10-12-2020

S. No.	Parameter	Method	TW-4	BIS Guidelines	
				Acceptable	Permissible
1	Colour (Pt-Co scale) Hazen	Visual comparison	Clear	< 5	< 15
2	Odour	Test cold and when heated	Nil	-	
3	pH	Electrometric	7.4	6.5 - 8.5	-
4	Taste	-	Agreeable	Agreeable	
5	Turbidity	Nephelometric	< 1	<1 NTU	< 5 NTU
6	Total Dissolved Solids	Gravimetric	430	< 500 mg/L	< 2000 mg/L
7	Calcium	EDTA Titrimetric	70	< 75 mg/L	< 200 mg/L
8	Chloride	Argentometric	19	< 250 mg/L	< 1000 mg/L
9	Fluoride	SPANDS	0.20	< 1 mg/L	< 1.5 mg/L
10	Iron (as Fe)	Phenanthroline	0.08	< 0.3 mg/L	-
11	Magnesium	Calculation method	26	< 30 mg/L	< 100 mg/L
12	Nitrate (as NO_3)	UV absorbance, 220 nm	1.5	< 45 mg/L	-
13	Sulfate, mg/L	Gravimetric	20	< 200 mg/L	< 400 mg/L
14	Total Alkalinity (as $CaCO_3$)	Titration method	**310**	< 200 mg/L	< 600 mg/L
15	Total Hardness (as $CaCO_3$)	EDTA Titrimetric	**316**	< 200 mg/L	< 600 mg/L
16	Conductivity (microS/cm)	Conductivity meter	880	-	-

Opinion: Total Hardness and Total Alkalinity exceeds acceptable limit but well below the permissible limit. Sample pass the Indian Standard IS 10500: 2012 test for Drinking Water Quality in terms of the above parameters.

Water Quality: Good

Table 5: Drinking Water Quality of TW-5

Location of Sample/Tube well No : Inside Boy's Hostel / **TW – 5**
Depth of Bore well : 500 feet
Year of Installation : 14-02-2017
Date of sampling : 10-12-2020

S. No.	Parameter	Method	TW-2	BIS Guidelines	
				Acceptable	Permissible
1	Colour (Pt-Co scale) Hazen	Visual comparison	Clear	< 5	< 15
2	Odour	Test cold and when heated	Nil	-	
3	pH	Electrometric	7.4	6.5 - 8.5	-
4	Taste	-	Agreeable	Agreeable	
5	Turbidity	Nephelometric	< 1	<1 NTU	< 5 NTU
6	Total Dissolved Solids	Gravimetric	320	< 500 mg/L	< 2000 mg/L
7	Calcium	EDTA Titrimetric	56	< 75 mg/L	< 200 mg/L
8	Chloride	Argentometric	8	< 250 mg/L	< 1000 mg/L
9	Fluoride	SPANDS	0.15	< 1 mg/L	< 1.5 mg/L
10	Iron (as Fe)	Phenanthroline	0.05	< 0.3 mg/L	-
11	Magnesium	Calculation method	20	< 30 mg/L	< 100 mg/L
12	Nitrate (as NO_3)	UV absorbance, 220 nm	1.5	< 45 mg/L	-
13	Sulfate, mg/L	Gravimetric	9	< 200 mg/L	< 400 mg/L
14	Total Alkalinity (as $CaCO_3$)	Titration method	**250**	< 200 mg/L	< 600 mg/L
15	Total Hardness (as $CaCO_3$)	EDTA Titrimetric	**224**	< 200 mg/L	< 600 mg/L
16	Conductivity (microS/cm)	Conductivity meter	660	-	-

Opinion: Total Hardness and Total Alkalinity exceeds acceptable limit but well below the permissible limit. Sample pass the Indian Standard IS 10500: 2012 test for Drinking Water Quality in terms of above parameters.

Water Quality: Very Good

Table 6: Drinking Water Quality of TW-6

Location of Sample/Tube well No : Outside Girl's Hostel / **TW – 6**
Depth of Bore well : 300 feet
Year of Installation : 06-12-2011
Date of sampling : 10-12-2020

S. No.	Parameter	Method	TW-6	BIS Guidelines	
				Acceptable	Permissible
1	Colour (Pt-Co scale) Hazen	Visual comparison	Clear	< 5	< 15
2	Odour	Test cold and when heated	Nil	-	
3	pH	Electrometric	7.4	6.5 - 8.5	-
4	Taste	-	Agreeable	Agreeable	
5	Turbidity	Nephelometric	< 1	<1 NTU	< 5 NTU
6	Total Dissolved Solids	Gravimetric	460	< 500 mg/L	< 2000 mg/L
7	Calcium	EDTA Titrimetric	**79**	< 75 mg/L	< 200 mg/L
8	Chloride	Argentometric	41	< 250 mg/L	< 1000 mg/L
9	Fluoride	SPANDS	0.49	< 1 mg/L	< 1.5 mg/L
10	Iron (as Fe)	Phenanthroline	0.05	< 0.3 mg/L	-
11	Magnesium	Calculation method	29	< 30 mg/L	< 100 mg/L
12	Nitrate (as NO_3)	UV absorbance, 220 nm	1.5	< 45 mg/L	-
13	Sulfate, mg/L	Gravimetric	24	< 200 mg/L	< 400 mg/L
14	Total Alkalinity (as $CaCO_3$)	Titration method	**310**	< 200 mg/L	< 600 mg/L
15	Total Hardness (as $CaCO_3$)	EDTA Titrimetric	**356**	< 200 mg/L	< 600 mg/L
16	Conductivity (microS/cm)	Conductivity meter	960	-	-

Opinion: Total Hardness and Total Alkalinity exceeds acceptable limit but well below the permissible limit. Sample pass the Indian Standard IS 10500: 2012 test for Drinking Water Quality in terms of above parameters.

Water Quality: Good

Table 7: Drinking Water Quality of TW-7

Location of Sample/Tube well No : Near Generator House / **TW – 7**
Depth of Bore well : 300 feet
Year of Installation : 08-08-2020
Date of sampling : 10-12-2020

S. No.	Parameter	Method	TW-7	BIS Guidelines	
				Acceptable	Permissible
1	Colour (Pt-Co scale) Hazen	Visual comparison	Clear	< 5	< 15
2	Odour	Test cold and when heated	Nil	-	
3	pH	Electrometric	7.4	6.5 - 8.5	-
4	Taste	-	Agreeable	Agreeable	
5	Turbidity	Nephelometric	< 1	<1 NTU	< 5 NTU
6	Total Dissolved Solids	Gravimetric	440	< 500 mg/L	< 2000 mg/L
7	Calcium	EDTA Titrimetric	64	< 75 mg/L	< 200 mg/L
8	Chloride	Argentometric	19	< 250 mg/L	< 1000 mg/L
9	Fluoride	SPANDS	0.32	< 1 mg/L	< 1.5 mg/L
10	Iron (as Fe)	Phenanthroline	0.10	< 0.3 mg/L	-
11	Magnesium	Calculation method	24	< 30 mg/L	< 100 mg/L
12	Nitrate (as NO_3)	UV absorbance, 220 nm	1.2	< 45 mg/L	-
13	Sulfate, mg/L	Gravimetric	24	< 200 mg/L	< 400 mg/L
14	Total Alkalinity (as $CaCO_3$)	Titration method	**320**	< 200 mg/L	< 600 mg/L
15	Total Hardness (as $CaCO_3$)	EDTA Titrimetric	**292**	< 200 mg/L	< 600 mg/L
16	Conductivity (microS/cm)	Conductivity meter	920	-	-

Opinion: Total Hardness and Total Alkalinity exceeds acceptable limit but well below the permissible limit. Sample pass the Indian Standard IS 10500: 2012 test for Drinking Water Quality in terms of above parameters.

Water Quality: Good

Table 8: Drinking Water Quality of TW-8

Location of Sample/Tube well No : Near MYAS / **TW – 8**
Depth of Bore well : 300 feet
Year of Installation : 12-12-2017
Date of sampling : 10-12-2020

S. No.	Parameter	Method	TW-8	BIS Guidelines	
				Acceptable	Permissible
1	Colour (Pt-Co scale) Hazen	Visual comparison	Clear	< 5	< 15
2	Odour	Test cold and when heated	Nil	-	
3	pH	Electrometric	7.5	6.5 - 8.5	-
4	Taste	-	Agreeable	Agreeable	
5	Turbidity	Nephelometric	< 1	<1 NTU	< 5 NTU
6	Total Dissolved Solids	Gravimetric	330	< 500 mg/L	< 2000 mg/L
7	Calcium	EDTA Titrimetric	56	< 75 mg/L	< 200 mg/L
8	Chloride	Argentometric	9	< 250 mg/L	< 1000 mg/L
9	Fluoride	SPANDS	0.18	< 1 mg/L	< 1.5 mg/L
10	Iron (as Fe)	Phenanthroline	0.05	< 0.3 mg/L	-
11	Magnesium	Calculation method	20	< 30 mg/L	< 100 mg/L
12	Nitrate (as NO_3)	UV absorbance, 220 nm	2.0	< 45 mg/L	-
13	Sulfate, mg/L	Gravimetric	10	< 200 mg/L	< 400 mg/L
14	Total Alkalinity (as $CaCO_3$)	Titration method	**250**	< 200 mg/L	< 600 mg/L
15	Total Hardness (as $CaCO_3$)	EDTA Titrimetric	**228**	< 200 mg/L	< 600 mg/L
16	Conductivity (microS/cm)	Conductivity meter	680	-	-

Opinion: Total Hardness and Total Alkalinity exceeds acceptable limit but well below the permissible limit. Sample pass the Indian Standard IS 10500: 2012 test for Drinking Water Quality in terms of the above parameters.

Water Quality: Very Good

TDS levels in all tube wells are less than 500 mg/L, which is well within the permissible range for drinking water. Except for TW-6, when both hardness and alkalinity levels surpass 300 mg/L, both hardness and alkalinity values are in the range of 220-320 mg/L. This could be a variety of subsurface strata. TW-6 also extracts water up to 300 feet, according to verbal discussions with water supply department personnel.

4.5. Water Saving Potential

Table 9 shows the current situation of water abstraction as reported by the GNDU Water Cell. The entire power use (estimate) is around 831 KWh, which equates to Rs 5849 per day at Rs 7 per kWh electricity rates. As a result, the annual water bill is Rs 21 lakhs. If you take conservation measures (say, a 20% reduction in water consumption), you can save Rs 4 lakh per year. In addition, this cost-cutting will save 21 crore litres of water every year.

Table 9: Details of Tube Wells along with Motor Horsepower and Energy Consumption

Tube Well No	Pipe Dia (inches)	Horse Power	Power (KWh)	Working Hours	Total KWh	Flow Rate (LPM)	Total Flow (KL/day)
TW-2	6”	50	37.3	3	112	2150	387
TW-3	6”	50	37.3	3	112	2150	387
TW-4	6”	50	37.3	6	224	2150	774
TW-5	6”	50	37.3	6	224	2150	774
TW-6	4”	30	22.4	2	45	1500	180
TW-7	4”	30	22.4	2	45	1500	180
TW-8	6”	50	37.3	2	75	2150	258
			231	24	836	13750	2940

The total water abstraction is calculated to be about 2940 KL/day on a working day. This translates to 245 Litre per capita demand (LPCD) by taking a campus population of 12000. This is on the higher side (135 LPCD is as per government norms) but it includes water consumption in construction activity, horticulture, etc. Although, the wastewater treatment plant showed a wastewater consumption of 1800 KL/day (80% of the freshwater demand). This gap may be due to wrong calculation in pumping efficiency or working hours.

5. WASTEWATER MANAGEMENT

In the year 2008, GNDU installed a low-cost wastewater treatment plant with a maximum capacity of 2500 KL/day at a cost of approximately 38 lakhs.

5.1. Treatment Scheme

Bar Screen→ Aeration Tank→Tube Settler → Oxidation Pond (1st Stage)→ Oxidation Pond (2nd Stage)→ Reuse of Treated Wastewater in Agriculture and Social Forestry.

The satellite view and line diagram are given in **Figure 8** and **Figure 9** respectively.

Figure 8: Satellite View of STP

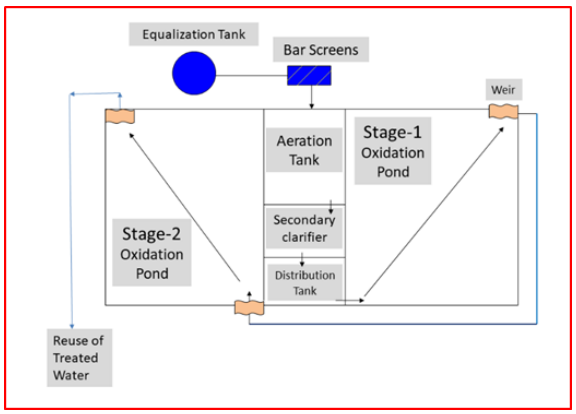

Figure 9: Layout of STP

Dimensions of different unit operations and processes are given in **Table 10**. The volume of sewage treated is ~1800 KL/day as per V-notch (**Figure 10**) and ultrasonic flow meter (**Figure 11**) installed at Sewage Treatment Plant. The treated wastewater has a mode of disposal on to land for plantation and social forestry. The validity of the consent as per the Water (Prevention & Control) Act, 1974 is up to 07-02-2023 (***Annexure-4***).

Table 10. Dimensions of Different Unit Operations and Processes

Unit Processor	Dimensions (m)
Aeration Tank	10 m x 5 m x 3 m SWD
Secondary Clarifier (Tube Settler)	5 m x 5 m x 60° tube settler
Oxidation Pond (1st Stage)	120 m x 60 m x 1.2 SWD
Oxidation Pond (2nd Stage)	120 m x 60 m x 1.2 SWD

Figure 10: V-notch for Flow Measurement

Figure 11: Ultrasonic Flow Meter at STP

5.2. Treated Wastewater Quality

Treated wastewater quality is well within the discharge standards prescribed by Punjab Pollution Control Board. The self-monitoring report is attached for reference (**Table 11**). Treated wastewater was clear and no visible suspended solids. Also, BOD (calculation-based) value is well within the limit of 30 mg/L. Overall, samples pass the prescribed guidelines and are well within pollution control board norms.

Table 11: Wastewater Analysis of Untreated and Treated Wastewater

Source of sample : **Sewage Treatment Plant, GNDU**

Date of sampling : 15-02-2021 at 3.45 PM

No. of Samples taken : **2 (Inlet & Outlet)**

Parameter	**Method**	**Untreated Wastewater**	**Treated Wastewater**	**Discharge Standards by PPCB**
	Location→	V-notch	Outlet weir of oxidation pond (2nd stage)	
pH	pH meter	8.3 ± 0.1	8.4 ± 0.1	6.5-9.5
Colour	Visual	Yellowish	Clear	Clear
Total Dissolved Solids	Gravimetric method	520	490	2100 mg/L
Total Suspended Solids	Gravimetric method	150	10	100 mg/L
Chemical Oxidation Demand	Closed reflux method	60	24	250 mg/L
Biochemical Oxygen Demand	Calculation method*	40	8	30 mg/L
Ammonia as NH^{3-}	Ion-selective electrode	13	9.2	50 mg/L

* COD/BOD ratio=1.5 (Inlet), 3 (Treated)

5.3. Suitability of Treated Wastewater for Irrigation Purposes

Treated wastewater was analysed for sodium, calcium, and magnesium content using Flame Photometer (Make: *Systronics*). Calibration curves were prepared for all three ions and samples were injected to get concentration within the input standards. Sodium adsorption ratio (SAR) is a measure of the amount of sodium (Na) relative to calcium (Ca) and magnesium (Mg) in the water extract from saturated soil paste. It is the ratio of the Na concentration divided by the square root of one-half of the (Ca + Mg) concentration. Sodium Absorption Ratio (SAR) is calculated as per formula was found to be 2.7 (**Table 12**), well below the limit of 10 as per IS 11624: 1986. Overall, the treated wastewater is fit for irrigation.

Table 12: Suitability of Treated Wastewater for Irrigation as per IS 11624: 1986

Source of sample : **Sewage Treatment Plant, GNDU**

Date of sampling : 15-02-2021 at 3.45 PM

No. of Samples taken : **2 (Inlet & Outlet)**

Parameter	Method	Untreated Wastewater	Treated Wastewater
Sodium (mg/L)	Flame Photometer	94	95
Calcium (mg/L)	EDTA Titration	58	56
Magnesium (mg/L)	Calculation method	21	22
Sodium Absorption Ratio (SAR)		2.68	2.71

5.4. Reuse of Treated Wastewater

Treated wastewater is being pumped using 15 Hp motors (2 no's) to increase the head so that treated wastewater can be transported to any part of the university for social forestry and irrigation to plants. The pumping station is shown in **Figure 12**. Also, water tankers (**Figure 13**) are used during the summer months. Any excess wastewater will be used in the artificially constructed water tank whenever required.

Figure 12: Filling Point for Reuse

Figure 13: Tanker for Treated Wastewater Reuse

6. WATER CONSERVATION AND HARVESTING PRACTICES

The university has a vast rainwater conservation and harvesting potentials as there is high annual rainfall accounting for 201mm and 191 mm in the month of July and August. To assess the rainwater potential in the campus, detailed estimation has been done based on three types of surfaces i.e. **paved areas** consisting of roads, parkings and footpaths; **buildings;** and **unpaved areas** comprising of lawns and other dense or little vegetation areas. Based on the rainfall, different types of surface areas and respective runoff coefficient, total potential rainwater harvesting has been calculated as 2,26,348 kilo liters of water per year.

- All the unpaved lawns within or surrounding the administrative, academic and residential buildings act as open recharge wells in the campus. Kerbs along the roads of the campus act as retaining walls around the lawns and parks, which restrict the rainwater runoff out of them. Hence, the rainwater collected in these lawns goes down the unpaved surface through seepage **(Figure 14)** and betters the water level of the campus and the city.

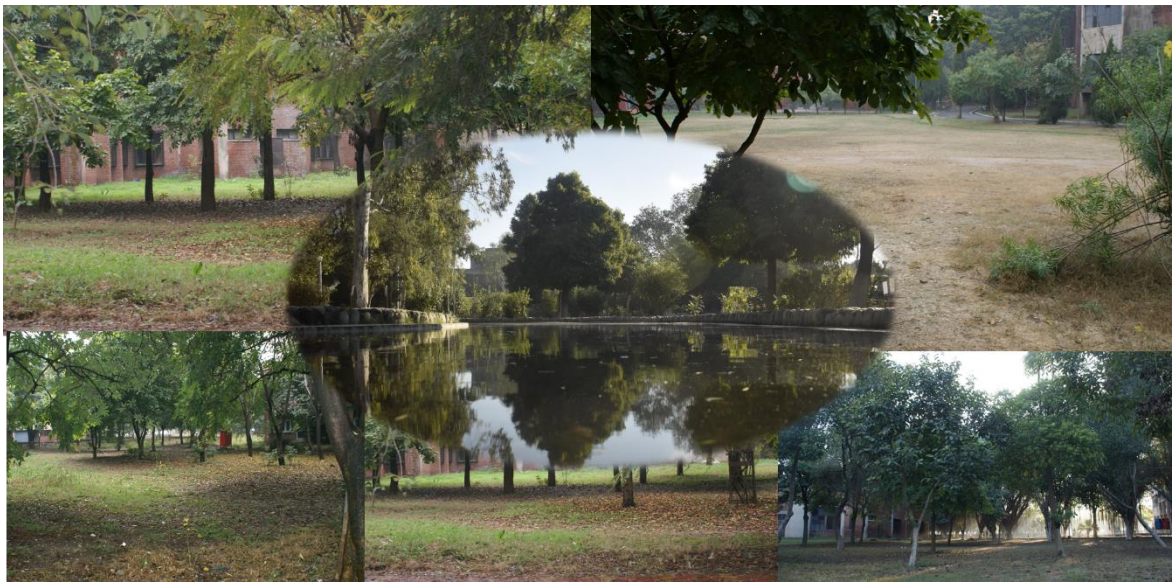

Figure 14: Unpaved Lawns as Rainwater Recharge Wells

- Majority of the buildings of the campus are designed to have open well structures. The rooftop rainwater of these buildings is routed to these unpaved areas of the wells, which recharges the underground water through seepage **(Figure 15).**

Figure 15: Unpaved Wells of the Buildings as Recharge Points

- The footpaths have been constructed in the university to facilitate the pedestrians but due care is given to their contribution to rainwater harvesting as well. Inter-locking tiles are used in their construction, which allow the rainwater to seep into the unpaved ground. Also, the slope of the footpaths is inclined either way so that the rainwater gets drained onto the unpaved surface on their either side (**Figure 16)**.

Figure 16: Rainwater Harvesting Promoting Footpaths

- The Botanical Garden of the university is spread in 100000 square meters area, which has the potential to harvest 17 kiloliters of rainwater harvesting per year. The unpaved lawns and a small lake within the garden act as huge rainwater recharge wells **(Figure 17)**.

Figure 17: Lawns and Lake of Botanical Garden

- Though the parking lots of the university are paved but the slope of the surface is so kept that the rainwater routes to the lawns of the campus. Special provisions have been made at the newly constructed parking lots on either of the entry gates to the university.

Figure 18: Rainwater Harvesting system in the Parking Lot

- The university has renovated the washrooms and toilets of boys and girls hostels, administrative buildings and some of the academic blocks. With an aim to conserve water, timer based and sensor based urinals and water taps are installed **(Figure 19)**. In some academic blocks dry urinals have also been installed. Water closets in the toilet are fitted with dual mode system to save and conserve the water.

Figure 19: Water Saving Washrooms and Toilets

- The university harvests the storm water through two tanks, one in the botanical garden and second in the western side of the university. The surface runoff the roads is channelized through a well-designed drainage network of the university. The storm water is channelized to a tank in the western side of the university for harvesting.

Thus, the initiatives of natural recharge wells, reuse of wastewater for landscaping, water conservation through water efficient fixtures and appliances in toilets and bathrooms and minimising the leakage through effective complaint redressal are a few initiatives that make the campus water sensitive.

7. SWOC ANALYSIS

Strengths	***Weakness***
• Drinking water quality is good as per IS 10500: 2012. • State of the art sewage treatment plant. • Reuse of treated wastewater in the campus. • Rainwater recharge and harvesting.	• Poor pressure in high rise buildings during power failure
Opportunities	***Concerns***
• Real-time water audit using IoT • Application of advanced water conservation technologies	• Depleting ground and abstraction of water from the sixth water table (beyond 500 feet).

8. RECOMMENDATIONS

- Installing a flow meter at each borewell to measure the water abstraction on a monthly basis.
- To maximise the rainwater harvesting capacity, an automatic rainfall sensor may be installed and used to build the rainwater harvesting structures.
- Installing ground water level sensors in a few locations in the campus to check the depleting water table.
- A real-time ultrasonic flow metre may be installed at the treated wastewater pumping station to check the reuse potential.
- Level sensors will be used to synchronise the pumping operations of the equalisation tank and the final effluent.
- Installing water metres in buildings and residences to monitor excessive water consumption.
- Water audit cell may be formed with members from engineering department, civil engineering and electronics technology to streamline water management in the university.
- Establishing flow monitoring and IoT based lab scale experiments in the Civil/Electronics engineering department.
- Adopting decentralized wastewater treatment mechanism to treat the grey, hazardous and black water.
- Installation of water conserving fittings in the remaining administrative, academic and residential buildings.
- Creation of separate budget head for liquid waste management in the campus.

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5. ISO 46001 Water efficiency management systems-Requirements with guidance to use
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INTERNATIONAL STANDARD

ISO 46001

First edition
2019-07

Water efficiency management systems — Requirements with guidance for use

Systèmes de management de l'utilisation efficace de l'eau — Exigences et recommandations d'utilisation

Reference number
ISO 46001:2019(E)

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 224, *Service activities relating to drinking water supply, wastewater and stormwater systems*.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

Water is essential to life and forms part of the environment. Global concern for the state of the environment has identified that water resources are subject to significant pressures from water demand and from the impacts of climate change. The pressures on organizations to implement water efficiency programmes can arise from limited water resources and exist particularly in resource exploitation activities such as mining, forestry, oil and gas extraction, and in agriculture. They might also arise from commercial, institutional and industrial activities whether water is supplied by water utilities or comes directly from the environment.

As pressure grows to improve the quality of the environment and increase sustainability, organizations of all types and sizes are increasingly turning their attention to the environmental impacts of their activities, products and services. This might include measuring the water footprint of an activity or striving towards a more efficient use of water within an organization. Achieving sound water efficiency performance requires organizational commitment to a systematic approach and to the achievement of continual improvement in water use through a water efficiency management system.

Water efficiency management, like quality management, environmental management and energy management could be a matter of vital interest in promoting sustainable economic activities, industries and ultimately a sustainable environment. The introduction of water efficiency programs is often, but not always, triggered by a shortage in water supply.

The purpose of this document is to enable organizations to assess and account for their water use, and to identify, plan and implement measures to achieve water savings through the systematic management of water. Successful implementation depends on commitment from all levels and functions within the organization, especially commitment by top management.

This document specifies water efficiency management system requirements and contains guidance for its use. Using this document, an organization can develop and implement a water efficiency policy through the establishment of objectives, targets, action plans, monitoring, benchmarking, and review programs. These should take into account any requirements related to significant water use. A water efficiency management system enables an organization to achieve its relevant policy commitments and take action as needed to improve its water management according to the requirements of this document. This document can apply to some or all of the activities under the control of the organization. Application of this document may be tailored to fit the specific requirements of the organization, including the complexity of its system, the degree of documentation and available resources.

In any organization, water might be used for a variety of purposes, including the following:

a) cleaning;

b) transportation;

c) heating and cooling;

d) manufacturing a product and as part of a product;

e) drinking;

f) sanitation;

g) irrigation;

h) fire suppression;

i) recreational, water sport and aesthetic purposes.

The adoption and proper implementation of a water efficiency management system is intended to result in improved water efficiency and can help to achieve the following outcomes:

1) identifying water as a resource that can be considered as part of organizational and budgetary planning;

2) assisting an organization to better manage water use and optimize water demand;

3) recognizing the impact on others that can occur with changing water use;

4) ensuring a greater level of accountability in water use;

5) providing a process for regular review for possible improvement and adoption of opportunities arising in water efficiency.

Water efficiency management systems — Requirements with guidance for use

1 Scope

This document specifies requirements and contains guidance for its use in establishing, implementing and maintaining a water efficiency management system. It is applicable to organizations of all types and sizes that use water. It is focused on end-use consumers.

This document is applicable to any organization that wishes to:

a) achieve the efficient use of water through the 'reduce, replace or reuse' approach;

b) establish, implement and maintain water efficiency;

c) continually improve water efficiency.

This document specifies requirements and contains guidance for its use regarding organizational water use. It includes monitoring, measurement, documentation, reporting, design and procurement practices for equipment, systems, processes and personnel training that contribute to water efficiency management.

NOTE 1 'Reduce' includes the use of water-efficient fittings and equipment and, for example, putting in place a proper monitoring system for usage and leak detection.

NOTE 2 'Replace' includes substitution of drinking water with reclaimed water, sea water and rainwater wherever feasible.

NOTE 3 'Reuse' includes recycling of, for example, process water or grey water. For utilizing water reuse systems, ISO/TC 282 documents can be referred to as guidelines.

NOTE 4 Guidance in the annexes provides additional practical information to support implementation. Annex A provides guidance on the use of this document and Annex B gives examples of scenarios in water efficiency.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 24513, *Service activities relating to drinking water supply, wastewater and stormwater systems — Vocabulary*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 24513 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1
audit
systematic, independent and documented *process* (3.24) for obtaining audit evidence and evaluating it objectively to determine the extent to which the audit criteria are fulfilled

Note 1 to entry: An audit can be an internal audit (first party) or an external audit (second party or third party), and it can be a combined audit (combining two or more disciplines).

Note 2 to entry: An internal audit is conducted by the organization itself, or by an external party on its behalf.

Note 3 to entry: "Audit evidence" and "audit criteria" are defined in ISO 19011.

[SOURCE: ISO/IEC Directives Part 1, 2019, Annex L, Appendix 2, 3.17]

3.2
baseline water efficiency indicator
reference level of water used per *business activity indicator* (3.4)

Note 1 to entry: "Used" in the context of this indicator means the net amount of water used (including any water consumed) in the course of the *business activity* (3.3), discounting the amount of water applied that is reclaimed or recycled for further use.

Note 2 to entry: The indicator can be established in the initial *water use review* (3.40) considering a data period suitable to the *organization's* (3.20) *water use* (3.39) (including any water consumed).

3.3
business activity
umbrella term covering all the functions, *processes* (3.24), activities and transactions of an *organization* (3.20) and its employees

Note 1 to entry: Includes public administration as well as commercial business.

[SOURCE: ISO 16175-2:2011, 3.4, modified — "an" deleted; 2nd sentence becomes Note 1 to entry.]

3.4
business activity indicator
measure of *business activity* (3.3) that takes into account core business operations specific to the application site

Note 1 to entry: Depending on the business activity indicator, *water use* (3.39) (including any water consumed) will vary. For example, m^3 of water/kg of product; l/person supplied; m^3 of water/guestroom.

EXAMPLE Quantity of products produced, number of staff and visitors, number of guestrooms.

3.5
competence
ability to apply knowledge and skills to achieve intended results

[SOURCE: ISO/IEC Directives Part 1, 2019, Annex L, Appendix 2, 3.10]

3.6
conformity
fulfilment of a *requirement* (3.26)

Note 1 to entry: In English the word "conformance" is synonymous but deprecated. In French the word "compliance" is synonymous but deprecated.

[SOURCE: ISO/IEC Directives Part 1, 2019, Annex L, Appendix 2, 3.18, modified — Note 1 to entry added.]

3.7
continual improvement
recurring activity to enhance *performance* (3.22)

Note 1 to entry: The process of establishing *objectives* (3.19) and finding opportunities for improvement is a continual process through the use of audit findings and audit conclusions, analysis of data, management reviews or other means, and generally leads to *corrective action* (3.8) or preventive action.

Note 2 to entry: In the case of this document the recurring process is one of enhancing the *water efficiency management system* (3.36) in order to achieve improvements in overall *water efficiency performance* (3.37) consistent with the *organization's* (3.20) *water efficiency policy* (3.35).

[SOURCE: ISO/IEC Directives Part 1, 2019, Annex L, Appendix 2, 3.21, modified — Notes 1 and 2 to entry added.]

3.8
corrective action
action to eliminate the cause of a *nonconformity* (3.18) and to prevent recurrence

Note 1 to entry: There can be more than one cause for a nonconformity.

[SOURCE: ISO/IEC Directives Part 1, 2019, Annex L, Appendix 2, 3.20, modified — Note 1 to entry added.]

3.9
documented information
information required to be controlled and maintained by an *organization* (3.20) and the medium on which it is contained

Note 1 to entry: Documented information can be in any format and media, and from any source.

Note 2 to entry: Documented information can refer to:

— the *management system* (3.15), including related *processes* (3.24);

— information created in order for the organization to operate (documentation);

— evidence of results achieved (records).

[SOURCE: ISO/IEC Directives Part 1, 2019, Annex L, Appendix 2, 3.11]

3.10
effectiveness
extent to which planned activities are realized and planned results achieved

[SOURCE: ISO/IEC Directives Part 1, 2019, Annex L, Appendix 2, 3.6]

3.11
full-time equivalent
ratio of the total number of occupant hours spent in the facility divided by the standard working hours per day

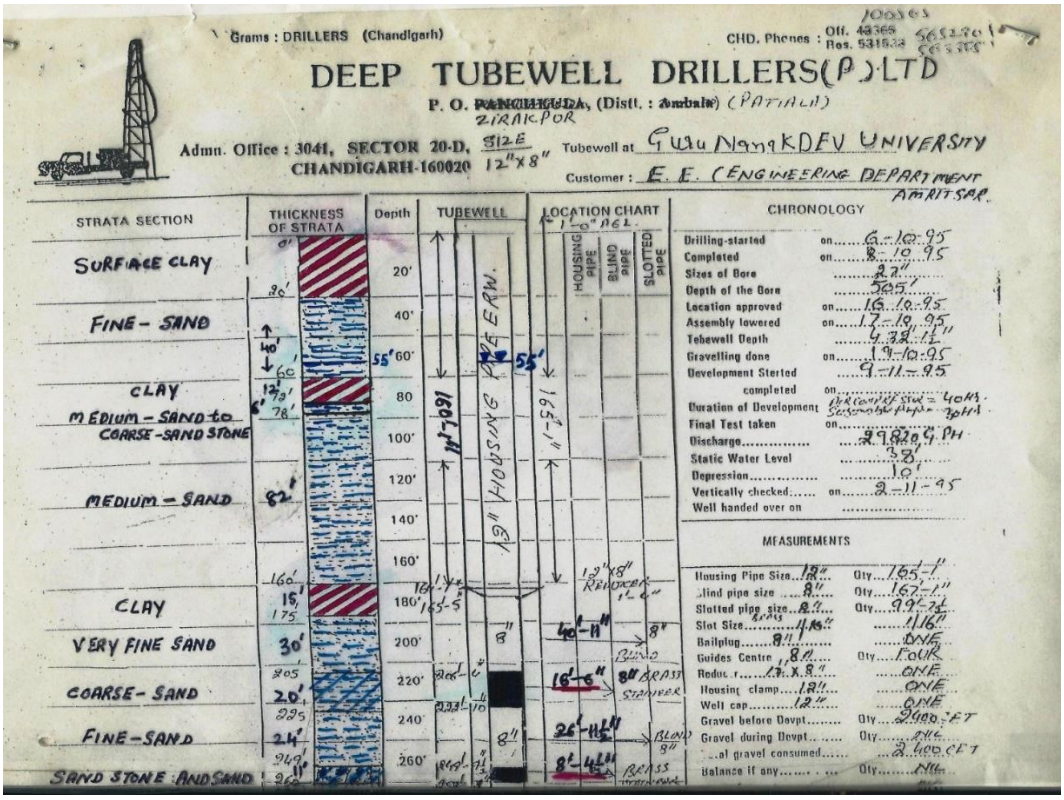
Note 1 to entry: The ratio provides an estimation of actual facility occupancy in terms of hours occupied per day and is used to determine the number of occupants for the facility.

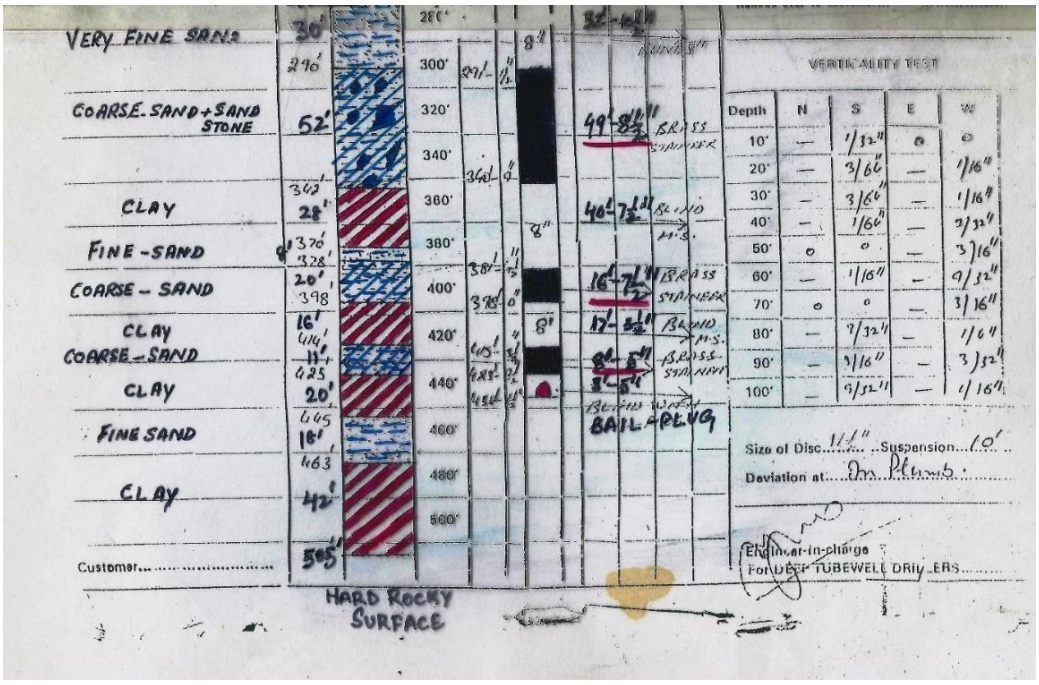
[SOURCE: ISO 24513:2019, 3.1.15]

3.12
grey water
greywater
graywater
wastewater from bathtubs and showers, hand basins, kitchen sinks, clothes washing and laundry tubs but excluding excreta and *trade effluent* (3.30)

Note 1 to entry: It excludes used water from urinals or toilet bowls.

Annexure-2





Borewell profile

भारतीय मानक

पीने का पानी — विशिष्टि

(दूसरा पुनरीक्षण)

Indian Standard

DRINKING WATER — SPECIFICATION

(Second Revision)

ICS 13.060.20

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

May 2012 **Price Group 6**

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

(Second Revision)

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

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

(FAD 14)

Publication Unit, BIS, New Delhi, India

FOREWORD

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

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

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

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

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

a) EU Directives relating to the quality of water intended for human consumption (80/778/EEC) and Council Directive 98/83/EC.

b) USEPA standard — National Primary Drinking Water Standard. EPA 816-F-02-013 dated July, 2002.

c) WHO Guidelines for Drinking Water Quality. 3rd Edition Vol. 1 Recommendations, 2008.

d) Manual on Water Supply and Treatment, third edition — revised and updated May 1999, Ministry of Urban Development, New Delhi.

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

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

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

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

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

Indian Standard

DRINKING WATER — SPECIFICATION

(Second Revision)

1 SCOPE

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

2 REFERENCES

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

3 TERMINOLOGY

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

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

4 REQUIREMENTS

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

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

4.1 Bacteriological Requirements

4.1.1 *Water in Distribution System*

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

4.2 Virological Requirements

4.2.1 Ideally, all samples taken from the distribution

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

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

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

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

Sl No.	Characteristic	Requirement (Acceptable Limit)	Permissible Limit in the Absence of Alternate Source	Method of Test, Ref to	Remarks
(1)	(2)	(3)	(4)	(5)	(6)
i)	Aluminium (as Al), mg/l, *Max*	0.03	0.2	IS 3025 (Part 55)	—
ii)	Ammonia (as total ammonia-N), mg/l, *Max*	0.5	No relaxation	IS 3025 (Part 34)	—
iii)	Anionic detergents (as MBAS) mg/l, *Max*	0.2	1.0	Annex K of IS 13428	—
iv)	Barium (as Ba), mg/l, *Max*	0.7	No relaxation	Annex F of IS 13428* or IS 15302	—
v)	Boron (as B), mg/l, *Max*	0.5	1.0	IS 3025 (Part 57)	—
vi)	Calcium (as Ca), mg/l, *Max*	75	200	IS 3025 (Part 40)	—
vii)	Chloramines (as Cl_2), mg/l, *Max*	4.0	No relaxation	IS 3025 (Part 26)* or APHA 4500-Cl G	—
viii)	Chloride (as Cl), mg/l, *Max*	250	1 000	IS 3025 (Part 32)	—
ix)	Copper (as Cu), mg/l, *Max*	0.05	1.5	IS 3025 (Part 42)	—
x)	Fluoride (as F) mg/l, *Max*	1.0	1.5	IS 3025 (Part 60)	—
xi)	Free residual chlorine, mg/l, *Min*	0.2	1	IS 3025 (Part 26)	To be applicable only when water is chlorinated. Tested at consumer end. When protection against viral infection is required, it should be minimum 0.5 mg/l
xii)	Iron (as Fe), mg/l, *Max*	0.3	No relaxation	IS 3025 (Part 53)	Total concentration of manganese (as Mn) and iron (as Fe) shall not exceed 0.3 mg/l
xiii)	Magnesium (as Mg), mg/l, *Max*	30	100	IS 3025 (Part 46)	—
xiv)	Manganese (as Mn), mg/l, *Max*	0.1	0.3	IS 3025 (Part 59)	Total concentration of manganese (as Mn) and iron (as Fe) shall not exceed 0.3 mg/l
xv)	Mineral oil, mg/l, *Max*	0.5	No relaxation	Clause **6** of IS 3025 (Part 39) Infrared partition method	—
xvi)	Nitrate (as NO_3), mg/l, *Max*	45	No relaxation	IS 3025 (Part 34)	—
xvii)	Phenolic compounds (as C_6H_5OH), mg/l, *Max*	0.001	0.002	IS 3025 (Part 43)	—
xviii)	Selenium (as Se), mg/l, *Max*	0.01	No relaxation	IS 3025 (Part 56) or IS 15303*	—
xix)	Silver (as Ag), mg/l, *Max*	0.1	No relaxation	Annex J of IS 13428	—
xx)	Sulphate (as SO_4) mg/l, *Max*	200	400	IS 3025 (Part 24)	May be extended to 400 provided that Magnesium does not exceed 30
xxi)	Sulphide (as H_2S), mg/l, *Max*	0.05	No relaxation	IS 3025 (Part 29)	—
xxii)	Total alkalinity as calcium carbonate, mg/l, *Max*	200	600	IS 3025 (Part 23)	—
xxiii)	Total hardness (as $CaCO_3$), mg/l, *Max*	200	600	IS 3025 (Part 21)	—
xxiv)	Zinc (as Zn), mg/l, *Max*	5	15	IS 3025 (Part 49)	—

NOTES

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

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

Table 3 Parameters Concerning Toxic Substances

(*Foreword* and *Clause* 4)

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

NOTES

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

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

Table 4 Parameters Concerning Radioactive Substances

(*Foreword* and *Clause* 4)

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

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

Table 5 Pesticide Residues Limits and Test Method

(*Foreword* and *Table* 3)

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

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

Table 6 Bacteriological Quality of Drinking Water[1)]

(*Clause* 4.1.1)

Sl No.	Organisms	Requirements
(1)	(2)	(3)
i)	*All water intended for drinking*:	
	a) *E. coli* or thermotolerant coliform bacteria[2), 3)]	Shall not be detectable in any 100 ml sample
ii)	*Treated water entering the distribution system*:	
	a) *E. coli* or thermotolerant coliform bacteria[2)]	Shall not be detectable in any 100 ml sample
	b) Total coliform bacteria	Shall not be detectable in any 100 ml sample
iii)	*Treated water in the distribution system*:	
	a) *E. coli* or thermotolerant coliform bacteria	Shall not be detectable in any 100 ml sample
	b) Total coliform bacteria	Shall not be detectable in any 100 ml sample

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

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

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

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

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

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

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

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

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

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

4.3 Biological Requirements

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

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

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

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

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

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

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

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

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

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

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

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

5 SAMPLING

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

ANNEX A
(*Clause* 2)

LIST OF REFERRED INDIAN STANDARDS

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

ANNEX B

(*Clause* 4.2.7)

POLYMERASE CHAIN REACTION (PCR) METHOD

B-1 GENERAL

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

B-2 CONCENTRATION OF DRINKING WATER

B-2.1 Apparatus

B-2.1.1 *Pressure Pump*

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

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

B-2.1.4 *Inter-connecting Pressure Tubes*

B-2.2 Reagents

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

B-2.2.1 *Aluminium Chloride*

B-2.2.2 *HCl/NaOH Urea (Extra Pure)*

B-2.2.3 *Disodium Hydrogen Phosphate* ($Na_2HPO_4.2H_2O$) — 0.2 M, filter sterilized.

B-2.2.4 *Sodium Dihydrogen Phosphate* ($NaH_2PO_4.2H_2O$) — 0.2 M, filter sterilized.

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

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

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

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

B-2.2.9 *McII Vaines Buffer* (*p*H *5.0*) — Mix 9.7 ml of 0.1 M citric acid with 10.3 ml of 0.2 M $Na_2HPO_4.2H_2O$ under sterile conditions.

B-2.3 Procedure

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

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

B-3 RNA EXTRACTION

B-3.1 Apparatus

B-3.1.1 *Cooling Centrifuge*

B-3.1.2 *Deep Freezer (–20°C)*

B-3.1.3 *Vortex Mixer*

B-3.1.4 *Pipette Man*

B-3.2 Reagents

B-3.2.1 *Cetyl Trimethyl Ammonium Bromide (CTAB) Buffer*

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

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

B-3.2.3 *Ethanol*

B-3.2.4 *TE Buffer (p*H *8.0)*

Tris base	:	1 M
EDTA	:	0.5 M

B-3.2.5 *Sodium Acetate* — 3 M.

B-3.3 Procedure

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

B-4 COMPLEMENTARY DNA (c DNA) SYNTHESIS

B-4.1 Apparatus

B-4.1.1 *PCR Machine*

B-4.1.2 *Deep Freezer (–20°C)*

B-4.2 Reagents

B-4.2.1 *cDNA Synthesis Kit*

B-4.3 Procedure

Suspend the extracted RNA in 20 µl of cDNA reaction mixture, which consists of 4 µl of 5X reverse transcriptase reaction buffer [250 mM TRIS–HCl (*p*H 8.5), 40 mM KCl, 150 mM $MgCl_2$, 5 mM dithiothreitol (DTT)], 0.5 µl of 10 mM deoxynucleotide phosphate (dNTP), 2 µl of hexa nucleotide mixture, 1 µl of 25 U of Maloney Murine Leukaemia Virus (M-MuLV) reverse transcriptase, 0.5 µl of 20 U of human placental RNase inhibitor. Heat the reaction mixture to 95°C for 5 min and rapidly chill on ice, this is followed by the addition of 1 µl (25 U/µl) of M-MuLV reverse transcriptase. Incubate the reaction mixture as given by the manufacturer of the kit and quickly chill the reaction tube on ice.

B-5 PCR AMPLIFICATION

B-5.1 Apparatus

B-5.1.1 *PCR Machine*

B-5.1.2 *Deep Freezer (–20°C)*

B-5.1.3 *Micropippette*

B-5.2 Reagents

B-5.2.1 *Primers for EV and HAV*

EV sense primer, 5' — TCC TCC GGC CCC TGA ATG CG — 3'

antisense primer, 5' — ATT GTC ACC ATA AGC AGC CA — 3'

HAV sense primer, 5' — GTTTT GCTCC TCTTT ATCAT GCTAT G-3'

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

B-5.2.2 *PCR Master Mix*

B-5.2.3 *Mineral Oil*

B-5.3 Procedure

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

In 5 µl of cDNA, add 95 µl of a PCR Master Mix (10 mM TRIS–HCl (*p*H 8.3), 50 mM KCl, 2.5 mM $MgCl_2$, 0.01 percent gelatin (1× PCR buffer), 200 µM of each dNTP, 1.5 U of *Thermus aquaticus* polymerase). Add 25 pico moles of sense and antisense oligonucleotide primers of HAV and overlay with mineral oil. Appropriate positive and negative controls shall be included with each run. Set the following reaction at thermo cycler:

Denaturation at 94°C for 2 min

Denaturation for	1.0 min	at 94°C	} 35 cycles
Annealing for	1.0 min	at 57°C	
Extension for	1.3 min	at 72°C	

Final extension at 72°C for 7 min.

B-5.3.2 *PCR Amplification for Enterovirus (EV)*

In 5 µl of cDNA, add 95 µl of a PCR Master Mix (10 mM TRIS–HCl (*p*H 8.3), 50 mM KCl, 2.5 mM $MgCl_2$, 0.01 percent gelatin (1X PCR buffer), 200 µM of each dNTP, 1.5 U of *Thermus aquaticus* polymerase). Add 25 pico moles of sense and antisense oligonucleotide primers of EV and overlay with mineral oil. Appropriate positive and negative controls shall be included with each run. Set the following reaction at thermo cycler:

Denaturation at 94°C for 2 min

Denaturation for	1.0 min	at 94°C	} 35 cycles
Annealing for	1.0 min	at 42°C	
Extension for	2.0 min	at 72°C	

Final extension at 72°C for 7 min.

B-6 AGAROSE GEL ELECTROPHORESIS

B-6.1 Apparatus

B-6.1.1 *Micropippette*

B-6.1.2 *Electrophoresis Apparatus*

B-6.1.3 *Gel Documentation System*

B-6.2 Reagents

B-6.2.1 *Running Buffer* — 50X TAE buffer

Tris base/Tris buffer : 121.00 g

Glacial acetic acid	:	28.55 ml
0.5 M EDTA	:	50 .00 ml
Distilled water (autoclaved)	:	300.45 ml

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

B-6.2.2 *Tracking Dye* — 6X bromophenol blue.

B-6.2.3 *Ethidium Bromide* — 0.5 µg/ml.

B-6.3 Procedure

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

ANNEX C

(*Clause* 4.3.10)

ILLUSTRATIVE LIST OF MICROSCOPIC ORGANISMS PRESENT IN WATER

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

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

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

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Amendments Issued Since Publication

Amend No.	Date of Issue	Text Affected

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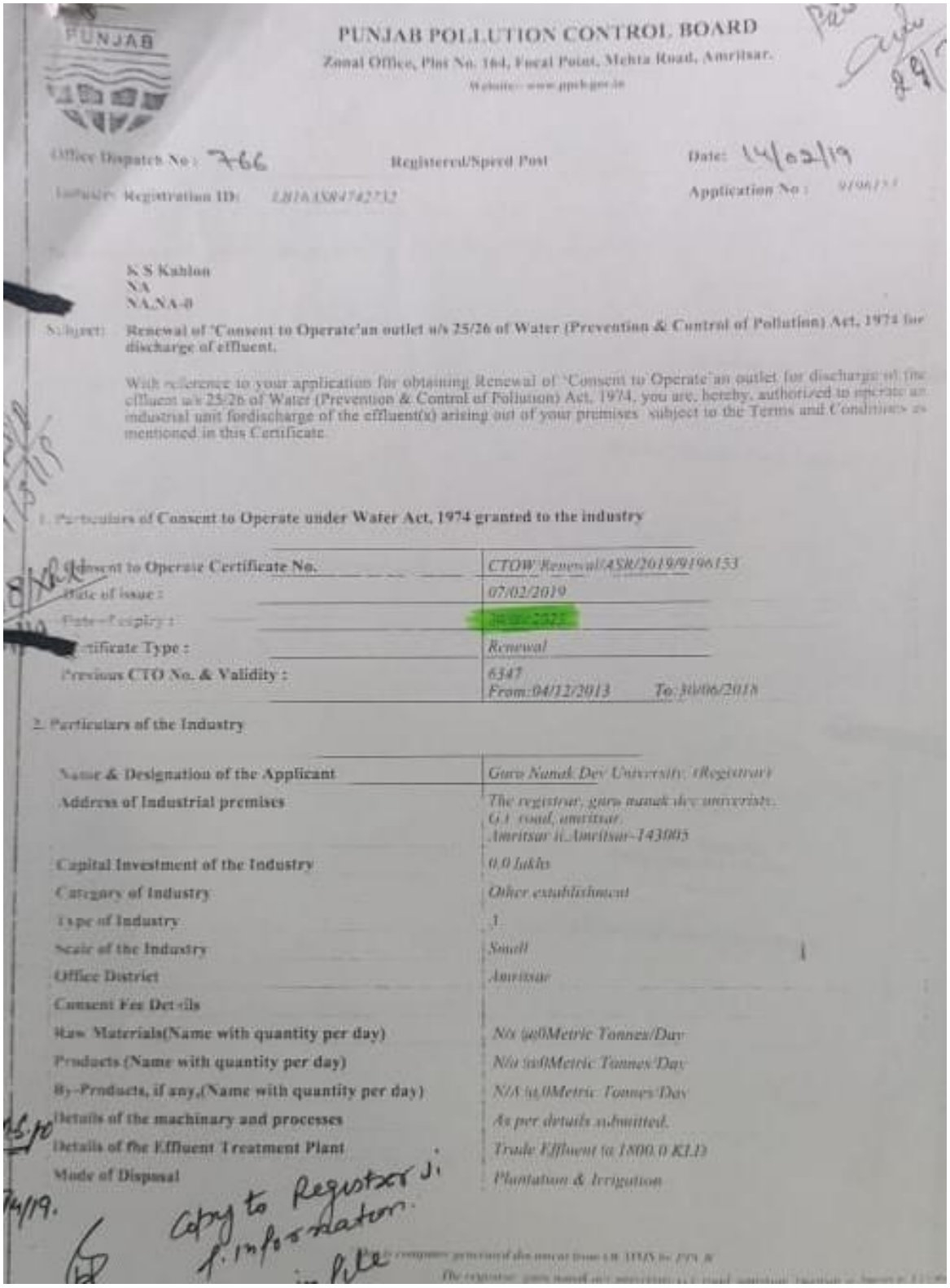

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Registration ID: EB1633584742732 Application No : 9196153

K S Kahlon
NA
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Subject: Renewal of 'Consent to Operate'an outlet u/s 25/26 of Water (Prevention & Control of Pollution) Act, 1974 for discharge of effluent.

With reference to your application for obtaining Renewal of 'Consent to Operate'an outlet for discharge of the effluent u/s 25/26 of Water (Prevention & Control of Pollution) Act, 1974, you are, hereby, authorized to operate an industrial unit fordischarge of the effluent(s) arising out of your premises subject to the Terms and Conditions as mentioned in this Certificate.

1. Particulars of Consent to Operate under Water Act, 1974 granted to the industry

Consent to Operate Certificate No.	CTOW Renewal/458/2019/9196153
Date of issue :	07/02/2019
Date of expiry :	30/06/2022
Certificate Type :	Renewal
Previous CTO No. & Validity :	6347 From:04/12/2013 To:30/06/2018

2. Particulars of the Industry

Name & Designation of the Applicant	Guru Nanak Dev University, (Registrar)
Address of Industrial premises	The registrar, guru nanak dev university, G.T. road, amritsar. Amritsar ii, Amritsar-143005
Capital Investment of the Industry	0.0 Lakhs
Category of Industry	Other establishment
Type of Industry	3
Scale of the Industry	Small
Office District	Amritsar
Consent Fee Details	
Raw Materials(Name with quantity per day)	N/A |n0Metric Tonnes/Day
Products (Name with quantity per day)	N/a |n0Metric Tonnes/Day
By-Products, if any,(Name with quantity per day)	N/A |n0Metric Tonnes/Day
Details of the machinary and processes	As per details submitted.
Details of the Effluent Treatment Plant	Trade Effluent |n 1800.0 KLD
Mode of Disposal	Plantation & Irrigation

14/19.

Copy to Registrar J. for information. in file


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