GOVERNMENT OF KERALA
KERALA STATE PLANNING BOARD

FOURTEENTH FIVE-YEAR PLAN
(2022-2027)

WORKING GROUP ON
DRINKING WATER AND SEWERAGE

SOCIAL SERVICES DIVISION
March 2022

FOREWORD

Kerala is the only State in India to formulate and implement Five-Year Plans. The Government of Kerala believes that the planning process is important for promoting economic growth and ensuring social justice in the State. A significant feature of the process of formulation of Plans in the State is its participatory and inclusive nature.

In September 2021, the State Planning Board initiated a programme of consultation and discussion for the formulation of the 14th Five-Year Plan. The State Planning Board constituted 44 Working Groups, with more than 1200 members in order to gain expert opinion on a range of socio-economic issues pertinent to this Plan. The members of the Working Groups represented a wide spectrum of society and include scholars, administrators, social and political activists and other experts. Members of the Working Groups contributed their specialised knowledge in different sectors, best practices in the field, issues of concern, and future strategies required in these sectors. The Report of each working Group reflects the collective views of the members of the Group and the content of each Report will contribute to the formulation of the 14th Five-Year Plan. The Report has been finalised after several rounds of discussions and consultations held between September to December 2021.

This document is the Report of the Working Group on "Drinking Water and Sewerage". The Co-Chairpersons of Working Group were Sri. T. K. Jose IAS and Prof. K.P Sudheer. Dr. P.K Jameela, Member of the State Planning Board co-ordinated the activities of the Working Group. Dr. Bindu P. Verghese, Chief, Social Services Division was the Convenor of the Working Group and Smt.Roopa.R.V, Research Officer, Social Services Division was Co-Convenor. The terms of reference of the Working Group and its members are in Appendix I of the Report.

Member Secretary

PREFACE

The provision of drinking water and waste water services is critical for ensuring public health and well-being of the society. Both the Central and State Governments have focussed on management of water and waste water since independence and have proposed various programs. Nonetheless, rural sector of the country still have only limited access to protected water supply and safe sanitation facilities. It is pertinent to note that the Kerala State is placed in the lower quarter as compared to several other states in terms of providing piped water supply and sewerage services, according to a statistics published by the NITI Ayog.

Our state, though falling short on the piped water supply coverage, is better placed with respect to access to water, thanks to the millions of traditional dug wells in our backyards. However, the quality of water, especially the microbiological contamination of wells is a concern warranting immediate attention. Proximity of poorly designed septic tanks/leech pits and absence of sustainable systems for collection, treatment and disposal of sewage/septage have been identified as the major reasons for the water quality issues.

With the rapid urbanisation, fragmented land holdings and falling water table, demand for piped water supply and organised sewerage is ever increasing. The effects of climate change is already visible and so the sector needs meticulous planning as the freshwater availability is limited and unpredictable. We need to look at supply side and demand side management: plan conjunctive use of surface and groundwater sources, identify alternative sources like brackish water/sea water, develop recycling and re-use programs, focus on reduction in non-revenue water, adaptation of emerging technologies, etc. Several schemes and programs that lead to effective water and waste management are to be seriously explored and adopted.

Kerala State also needs to develop better sewerage/septage management services, if it has to sustain its highly acclaimed development indices. The challenges are multifarious, the NIMBY attitude, huge investment requirements, need for trained manpower, social, environmental and economic impacts, etc., are among the important ones.

This report, prepared by the working group, is a roadmap for the water and wastewater sector for the next five years. It provides strategies, timelines and targets on various sub sectors with the objective of achieving 100% functional household water supply coverage and also on a prioritised implementation of sewerage systems and septage management services.

Expert Co-Chairperson	Official Co-Chairperson
(Prof. K.P Sudheer)	(Sri. T. K. Jose IAS)

CONTENTS

SUMMARY

The 14th Five Year Plan Working Group on Drinking Water and Sewerage aims to outline a clear roadmap for the development of water and sanitation sector in the State as well as to improve its position with respect to the Composite Water Management Index (CWMI) ranking.

Although water covers more than 70% of the Earth's surface, less than 1% of it is available as fresh water. The scarce resource needs to be conserved, reused and recycled as well to have a sustainable ecosystem and development. Drinking water supply being primary requirement of public health and economic development, has been receiving due attention in the plans and policies of both the central and state governments.

Kerala Water Authority (KWA), Kerala Rural Water Supply and Sanitation Agency (KRWSA) and Ground Water Department (GWD) are the three government agencies in the sector.

Kerala in view of its consumption pattern has adopted a service level of 150 lpcd and 100 lpcd in urban and rural areas as against the national standards of 135 and 100 lpcd respectively. Our objective is to provide sustainable and equitable water supply services in terms of service level - quality, quantity and regularity at affordable cost. In order to achieve the target of 100% coverage, the sector requires a multi-pronged approach including development of fresh sources, augmentation of existing sources, water treatment and network infrastructure, control of Non-Revenue Water (NRW), Demand management, revenue management along with capacity building and training of personnel in the sector.

Ensuring adequacy of water sources is critical especially considering the dwindling fresh water resources, spike in demand and the uncertainties of climate change. Existing Irrigation and Hydel reservoirs can be linked to supplement the drinking water supply schemes. An optimal operation policy may have to be followed without impacting the purposes for which water is impounded. The success stories of Malampuzha and Peechi tempts one to think of this option.

As per Institute for the Management of Information Systems (IMIS) database maintained by Ministry of Drinking Water and Sanitation (MoDWS)-Government of India, contamination rate is high. Emerging Contaminants (EC) like micro plastics, pharmaceutical residues, natural and synthetic hormones, etc are a cause of concern and the water quality monitoring infrastructure will have to be equipped to address them. Also, the conventional treatment plant is not capable of removing the ECs and requires advanced treatment technologies.

To equip the State for providing facilities for water quality analysis, a multipronged approach is recommended. It is suggested to launch a program with an objective for developing infrastructure facilities for determining water quality analysis for the common man. We may set up a Water Quality Monitoring & Surveillance model with the cooperation of LSGs, Educational Institutions and labs in Public sector. A three-tier system with level

1 addressing compulsory parameters, level 2 for optional parameters and level 3 for heavy metals and pesticides may be adopted.

The main source of income of Kerala Water Authority is collection of water charges. From the formation of Kerala Water Authority, it has never earned any surplus income and is continuously running at deficit, which is made good to some extent by the plan and non-plan grant received from Government of Kerala. Introduction of a Regulatory Authority in the water sector is proposed to improve the operational efficiencies of the sector organisations while at the same time ensuring their financial viabilities.

Wastewater disposal is a major challenge in the State. As much as 61% of the families are disposing their wastewater directly to either the drainage channels/irrigation channels or to the open spaces. The septic tanks, the most widely adopted on-site sanitation system in the State are mostly faulty in design and construction resulting in wide-spread water pollution and groundwater contamination. Further, it is highly necessary to convert the leach-pits to septic tanks considering that the groundwater table in Kerala is relatively high. Septage load of Kerala is estimated to be about 2.4 million ton per year. Hence proper septage management system is required as part of the integrated sanitation program. Proper regulation/guidelines for safe handling transport and disposal of septage is essential to ensure the protection of water bodies and environmental hygiene. A combination of technologies including large sewerage network with centralised treatment plants, decentralised systems, septage management systems, etc. will be implanted in the cities and towns in a prioritised manner.

The Kerala Water Policy, which is under revision, may have to take cognizance of the emerging challenges. In the drinking water sector, a shift in focus from creating fresh supplies to optimising operational efficiency, asset management, demand side management and NRW management will be required. Introduction of a water regulator as in the power sector is considered as an essential policy initiative to save the sector organisations from the financial mess which they are in now.

Specific targets are identified under drinking water supply, sewerage, water conservation, revenue improvement, etc. for time bound achievement during the 14th Five Year Plan Period.

CHAPTER-I
INTRODUCTION

Water the elixir of life is intertwined with human history since time immemorial. It is one of the essential requirements for life. All living things need water for their survival. Water is used for a variety of purposes, including drinking, agriculture, food preparation, irrigation and manufacturing. Although water covers more than 70% of the Earth's surface, less than 1% of that resource is available as fresh water and this is not evenly distributed throughout the world. More than one billion people worldwide, mostly in developing countries, lack safe drinking water. Apart from the scarcity of water, there are many other challenges in providing a safe, adequate and reliable water supply in many parts of the world. The scarce resource viz water needs to be conserved, usage reduced, reused and recycled as well to have a sustainable ecosystem and development.

India as a nation with the climate changes has been left at the vagaries of monsoon. The geographical extent and the variations in the climate patterns ensure that as a whole India lives in scarcity in plenty vis a vis water. The Government of India through the Department of Drinking Water and Sanitation provides technical and financial assistance to the States to provide safe and adequate drinking water to rural India with focus on service delivery. The Department's Centrally Sponsored Scheme, the National Rural Drinking Water Programme (NRDWP), was restructured and subsumed into Jal Jeevan Mission (JJM) to provide Functional Household Tap Connection (FHTC) to every rural household i.e., Har Ghar Jal, by 2024.

The kinds of works/ schemes which are proposed to be taken up under JJM include In-village water supply (PWS) infrastructure for tap water connection to every household; reliable drinking water source development/ augmentation of existing sources; transfer of water (multi-village scheme; where quantity & quality issues are there in the local water sources); technological intervention for treatment to make water potable (where water quality is an issue, but quantity is sufficient); retrofitting of completed and ongoing piped water supply schemes to provide FHTC and raise the service level; grey water management and capacity building of various stakeholders and support activities to facilitate the implementation.

It could be seen that the waste water management has taken a back seat in the quest for fulfilling the needs of the billion population. This intern has resulted in the pollution of the water bodies affecting the entire ecosystem. The country as a whole has now trained its attention towards good water management policies to ensure sustainable growth.

Formulation of 14th Five Year Plan

As part of the formulation of 14th Five- Year Plan, the Working Group on "Drinking Water and Sewerage" was constituted with the following Terms of Reference.

1. To formulate a time-bound plan to ensure that every resident of the State has access to clean, safe drinking water in their place of residence.
2. To suggest a time-bound plan to ensure that every residence, commercial establish-

ment, or other institution in the State that produces sewage is equipped with the means of disposal of that sewerage.

3. To suggest effective interventions to improve the position of Kerala in the Composite Water Management Index (CWMI).
4. To suggest methods for regular monitoring of drinking water supply schemes in Kerala (this point may be subsumed by (1) above).

The Working Group discussed all the above points and the findings are summarized in the succeeding chapters.

CHAPTER-II

WATER MANAGEMENT IN INDIAN STATES- AN OVERVIEW

NITI Aayog- CWMI (Composite Water Management Index)

The National Institution for Transforming India (NITI) Aayog has developed the Composite Water Management Index (CWMI) to enable effective water management in Indian states. The CWMI is the first comprehensive collection of country-wide water data in India based on in-depth structured questionnaires followed by focus group discussions to generate qualitative information. It represents a major step towards creating a culture of data-based decision-making for water in India, which can encourage "competitive and cooperative federalism" in the country's water governance and management. The Index and the associated report are expected to:

(1) establish a clear baseline and benchmark for state-level performance on key water indicators;

(2) uncover and explain how states have progressed on water issues over time, including identifying high-performers and under-performers, thereby inculcating a culture of constructive federal competition amongst states; and

(3) identify areas for deeper engagement and investment on the part of the states.

Eventually, NITI Aayog plans to develop the Index into a composite, national-level data management platform for all water resources in India.

2.1 Scope and Structure of the Index

1. Overall/comparative analysis across states
2. Thematic analysis for each of the nine themes
3. Indicator-level analysis
4. Select case studies on best practices for water management across states

At each level, the CWMI provides detailed, relevant analyses and insights on state performance across time, appropriate commentary on the broader context and background for the indicators, and key lessons and best practices to be kept in mind going forward.

Data collection and validation

The Independent Validation Agency (IVA)—IPE Global—reviewed the data (indicator-wise) entered for each state in the NITI Portal by validating it against the source data, published data, supporting documents shared by the state, and other sources in the public domain.

The data was checked at three different levels:

• **Completeness:** The overall aim of this initiative by NITI Aayog was to arrive at a water index in order to assess the incremental progress made by states on several key parameters. Given this, completeness in input data was highly desirable, as an accurate comparative picture cannot be presented using incomplete datasets. Completeness of data was ensured by reviewing the following:

(1) all districts of the state must submit data,

(2) all data elements (numerator, denominators, sub-components) must be reported.

• **Consistency:** To compare states effectively with each other, it was essential that all states used the same data sources, reporting methodology, and format. Thus, to ensure consistency across indicators, the information sources (department, data collection method, etc.), data entry formats, and timelines were carefully examined. This was primarily ensured through the following
(1) identification and resolution of data entry errors for data taken from reliable/acceptable sources,
(2) check for internal consistency across indicators, as well as over a period of time, and
(3) identification of statistical outliers.

• **Validity/triangulation:** Finally, the dataset was analysed through multiple processes, such as
(1) comparison with reliable, secondary sources of information in the water sector domain,
(2) rapid primary validation by visiting select field locations, and
(3) feedback from key stakeholders

2.2 Themes and Indicators

The Index comprises nine themes (each having an attached weight), covering groundwater and surface water restoration, major and medium irrigation, watershed development, participatory irrigation management, on-farm water use, rural and urban water supply, and policy and governance.

It should be highlighted that the data collection exercise necessary to develop and populate the Index is unprecedented. Not only is data on several indicators being collected for the first time, but the exercise also involves deep collaboration amongst states, as well as extensive Centre-State coordination.

Table 2.1 Indicator themes and weights

No.	Themes	Weights
A	Source augmentation and restoration of water bodies	5
B	Source augmentation (Groundwater)	15
C	Major and medium irrigation—Supply side management	15
D	Watershed development—Supply side management	10
E	Participatory irrigation practices—Demand side management	10
F	Sustainable on-farm water use practices—Demand side management	10
G	Rural drinking water	10
H	Urban water supply and sanitation	10
I	Policy and governance	15
	Total	100

For the current report, parameters A, B, G, H and I are considered for brevity in line with Kerala.

Table 2.2 Review Indicators relevant to Kerala

No.	Indicators	Data sources	Methodology
A. Source augmentation and restoration of water bodies			
1	Area irrigated by water bodies restored during the financial year 2016-17 & 2017-18 as compared to the irrigation potential area of total number of water bodies identified for restoration.	Water Resources Departments of states / State Reports/ Water MIS	1. Review of formulas and calculations of the final value - errors documented, resolved and submitted. 2. Review of supporting documents (list of water bodies restored) to ensure accuracy. 3. Outliers/inconsistencies in the data identified and resolved with the State Nodal Officer(s) (SNOs). 4. Documentation submitted to NITI Aayog
B. Source augmentation (Groundwater)			
2	Percentage of over-exploited and critical assessment units those have experienced rise in water table [recorded by the observation wells tapping the shallow aquifer monitored by the State (piezometers installed for the purpose) and CGWB] to total number of assessment units in pre-monsoon 2016-17 in comparison to pre-monsoon 2017-18	Central Ground Water Board (CGWB)/ Water Resources Department (MIS,where available)	1. Review of supporting documents provided by SNOs against the portal entries. 2. Counter-checks with CGWB data on critical and over-exploited assessment units. 3. Outliers/inconsistencies in the data identified and resolved with the State Nodal Officer(s). 4. Documentation submitted to NITIAayog.
3	Percentage of areas of major groundwater re-charging identified and mapped for the State as on 31.3.2017 & 31.3.2018	State Administrative Report/GIS Maps Central Ground Water Board (CGWB)	1. Review of supporting documents & GIS map (link if available) provided by SNOs against the portal entries. 2. Review of state portal for updated information on area to be re-charged, mapped and structures constructed. 3. Outliers/inconsistencies in the data identified and resolved with the State Nodal Officer(s). 4. Documentation submitted to NITIAayog.
4	Percentage of mapped area covered with infrastructure for re-charging groundwater to the total mapped area as on 31.03.2017 & 31.3.2018	State Administrative Report/ Central Ground Water Board	

No.	Indicators	Data sources	Methodology
5	Has the State notified any Act or a regulatory framework for regulation of Groundwater use/ management?	Copy of Act/ Government Order(GO)	1. Collection of hard copies of the GO/Act. 2. Documentation submitted to NITI Aayog.
G. Rural drinking water			
20(a), (b)	Proportion of total rural habitations fully covered with drinking water supply as on 31.03.2017 and on 31.3.2018	State Administrative Report; data available on National drinking water supply and sanitation report – specific years	1. Counter checked with data available on the national drinking water supply and sanitation portal. 2. Information provided by state reviewed. 3. Review of state submission against accepted norms w.r.t provision of water supply in rural areas (~40 lpcd). 4. Outliers/inconsistencies in the data identified and resolved with the State Nodal Officer(s). 5. Documentation submitted to NITI Aayog.
20 (c), (d)	Number of villages provided with 24*7 piped water supply as on 31.03.2017 and 31.03.2018		
20 (e), (f)	Number of villages having individual household water meters as on 31.03.2017 and 31.03.2018		
21 (a), (b)	% reduction in rural habitations affected by Water Quality problems during the Financial Year 2016-17 and 2017-18		

No.	Indicators	Data sources	Methodology
H. Urban water supply and sanitation			
22 (a), (b)	% of urban population being provided drinking water supply as on 31.03.2017 and as on 31.03.2018	State Administrative report; data available on National drinking water supply and sanitation report –specific years; Urban Development Plans Formulation and Implementation (UDPFI) Norms/State planning guidelines w.r.t drinking water supply and sanitation	1. Counter checked with data available on the national drinking water supply and sanitation portal. 2. Review of state submission against accepted norms w.r.t provision of water supply in urban areas (~135 lpcd). 3. Outliers/inconsistencies in the data identified and resolved with the State Nodal Officer(s). 4. Documentation submitted to NITI Aayog.
23 (a)	Total estimated generation of wastewater in the urban areas as on 31.03.2017		
23 (b)	Capacity installed in the state to treat the urban waste-water as a proportion of the total estimated wastewater generated in the urban areas of the state as on 31.03.2017	State Administrative report; List of wastewater treatment facilities with capacities; State report; List of wastewater treatment facilities with capacities State Urban Department– reports	1. Review of supporting documents (list of wastewater facilities, their capacities and the output). 2. Sample field visits to review wastewater treatment facilities/check estimations with available norms on wastewater (80% of water supplied). 3. Outliers/inconsistencies in the data identified and resolved with the State Nodal Officer(s). 4. Documentation submitted to NITI Aayog.
24(a), (b)	% waste-water treated during FY 2016-17 & FY 2017-18		
I. Policy and governance			
25	Whether the State has enacted any legislation for protection of water bodies and water-supply channels and prevention of encroachment into/on them?	Copy of legislation and orders/ reports	1. Review of supporting documents provided by SNOs against the portal entries. 2. Outliers/inconsistencies in the data identified and resolved with the State Nodal Officer(s). 3. Documentation submitted to NITI Aayog
26	Whether the State has any Framework for rain water harvesting in public and private buildings?		
27	Percentage of households being provided water supply and charged for water in the urban areas as on 31.3.2017 and as on 31.3.2018	State Reports, annual report, National drinking water supply and sanitation data	
28 (a)	Does the State have a separate integrated Data Centre for water resources?	Online portal link/ Departments incorporation and GO	

28 (b)	Whether the data is being updated on the integrated data centre on a regular basis?	Online portal link/ Departments incorporation andGO	1. Review of government orders, date of incorporation, evidence onestablishment of data centre along with links to website. 2. Documentation submitted to NITIAayog.

Source: CWMI Report of NITI Aayog

Box: 2.1

CWMI- KERALA STATUS

Overview of Kerala's CWMI performance

Non-Himalayan states: Kerala

STATE

KERALA

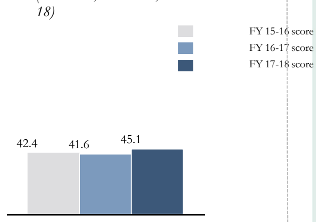
KEY INDICATORS

- **Population:** 3.3 crore
- **Proportion of national economic output[1]:** 4.1%
- **Proportion of national agri. output[2]:** 0.1%
- **Proportion of national rainfall[3]:** 4.4%
- **Proportion of national GW[4]:** 1.4%

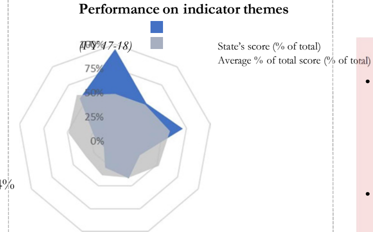
PERFORMANCE

State index scores

(FY 15-16, FY 16-17, FY 17-18)



Performance on indicator themes



LEARNINGS

Things going well

- *Surface water restoration:* The state has restored 95% of the irrigation potential of identified water bodies
- *Irrigation utilization:* Kerala utilizes 80% of its irrigation potential

Things to improve

- *Groundwater restoration:* <30% major groundwater recharge areas have been mapped, and only 5% of such mapped areas are covered with recharge infra
- *Drinking water access:* More than two- third of rural population and one-third of urban population remain uncovered under drinking water supply

Notes: 1. Measured as % of Net Domestic Product at Current Prices (2011-12 series) for FY 2015-16 2. Measured as % of principal crops produced for FY 2015-16 3. Measured as % of annual rainfall for 2017 4. Measured as % of annual replenishable groundwater resources (2013) 5. Indicator themes are: 1-Source augmentation and restoration of water bodies 2-Source augmentation (GW) 3-Major and medium irrigation 4-Watershed development 5-Participatory irrigation practices 6-Sustainable on-farm water use practices 7- Rural drinking water 8-Urban water supply and sanitation 9-Policy and governance.

Source: Census of India, 2011; Economic Survey 2017-18, Statistical Appendix; IMD, 'Rainfall Statistics of India', 2017; CGWB, 'Groundwater Year Book', 2016-17; Statistical Year Book India, 2018

CHAPTER-III
ROLE OF LOCAL SELF GOVERNMENTS (LSGS)

The 73rd and 74th constitutional amendments has ensured that more powers and responsibilities are devolved to grass root levels of administration. The 73rd Amendment to the constitution of India in 1992, added a new part IX to the constitution titled "The Panchayats" covering provisions from Article 243 to 243 (O); and a new Eleventh Schedule covering 29 subjects within the functions of the Panchayats. Entry 11 of this schedule is drinking water, devolving its management to Panchayat Raj Institutions. The LSGs in Kerala, especially the municipalities were responsible for water distribution till the early 1990s. Even now there is the example of Thrissur municipal corporation, which is running its water and electricity distribution.

Unlike many other states, Kerala has a well evolved and empowered Local Self Government System, which was further strengthened through the people's plan campaign. The LSGs particularly since early 2000, have promoted thousands of small piped water supply schemes in the rural sector. The World Bank assisted Jalanidhi project which has been the torch bearer of the demand driven, community managed water supply schemes were also implemented with the active participation of the GPs. The ownership of these schemes are shared equally between the GPs and the beneficiary communities.

The GoI also envisages a pivotal role for the LSGs in water supply service delivery and their flagship JJM project intended to provide Functional Household Tap Connections (FHTC) to the entire rural sector is designed with the GP and beneficiary community at the centre. The GPs and local community will play the key role in planning, implementation, management, operation and maintenance of in-village water supply systems including drinking water sources. The GPs will be the owners of the schemes. Such a decentralized model is expected to instill sense of ownership among the community and also transparency in the whole process leading to better implementation and long term sustainability of water supply systems.

The role of the LSGs is bound to increase further with the unfolding fiscal/fund flow scenario; more and more resources are being channelized through the LSGIs, by way of budget/SFC and CFC grants and also under specified direct funding schemes, to empower local governments in their mandatory responsibilities such as water and sanitation.

The role of sector institutions like KWA, KRWSA and GWD will be to facilitate GPs to perform their duties as envisaged in the constitution. With this well-defined roles and responsibilities of key actors and service providers, there will be a marked deviation from the existing system of fragmented institutions and overlapping responsibilities.

Till recently, the people of Kerala have been depending on homestead wells, surangams, ponds, etc. for all their water needs. Even now there are over 6.5 million dug wells and the primary source of drinking water in the rural sector is still dug wells. The severe climate events in recent years have been an eye opener and the public in general have understood the need and urgency for water conservation.

There has been concerted effort from many stakeholders including LSGs, Govt. Departments, NGOs and general public under the aegis of Harithakeralam Mission in implementing water conservation activities. There have been exemplary projects like the "Jala Samrudhi" in Kattakkada LAC which proved the potential of coordinated efforts in water conservation.

As per the provisions of Kerala Municipal Building Rules (KMBR), all residential buildings with a floor area of more than 300 m2 and commercial buildings with floor area more than 100 m2 shall have RWH systems. By enforcing this provision the LSGIs can ensure water conservation to a great extent. The LSGs can also strive for convergence in water conservation activities through various projects and funding sources including the MGNREGA.

LSGIs thus have a leading role in the life cycle of the water supply schemes as well as in source recharge and protection. They will be both in the service authority and service provider functions as LSGIs are progressively assuming its leadership role in the water supply and sewerage sector.

CHAPTER-IV
CONSUMER RIGHTS AND STATE OBLIGATION

Potable clean drinking water availability in the households is the right of every single citizen. It is the State's obligation to ensure drinking water is provided to the citizens. Consumer orientation has gained prominence recently in the water sector as well, in spite of the monopolistic supply institutions nature.

Water utilities have been recognized as engineering organizations focusing on supply of water rather than service delivery and customer satisfaction. Three parameters are widely considered for ensuring better service delivery and consumer satisfaction. They are right quality, right quantity at right time. It is obligatory on the part of the state/agencies to ensure that these parameters are satisfied and provided in a public domain to instill confidence in the minds of the consumers.

The water utilities are normally operating at net loss due to populist policy of the Governments. With the financial stability taken into account the water utilities are forced to increase their basic tariff at least at the break-even point. The consumer awareness and availability of information with the public due to high internet penetration entails that the service delivery also is improved.

In the future, the provision of water services will be based more on the ethics, values, rights, responsibilities, and expectations of all relevant stakeholders. The utilities will be judged based on service delivery, price, billing and payment, conservation, communications and customer service.

CHAPTER-V
DRINKING WATER SUPPLY

5.1 Sector Institutions

Drinking water sector is given much importance in Kerala as water remains pivotal for sustainable development and is linked to several local and global challenges. Kerala Water Authority is the major service provider both in urban and rural areas. Kerala Rural Water Supply and Sanitation Agency (KRWSA) and Ground Water Department (GWD) are the other two players in the sector.

Kerala Water Authority (KWA)

It was established on 1st April 1984 under the Kerala Water and Waste Water Ordinance, 1984 by converting the erstwhile Public Health Engineering Department to provide for the development and regulation of water supply and waste water collection and disposal in the State of Kerala and for matters connected there with. The Kerala Water Supply and Sewerage Act 1986 (Act 14 of 1986) replaced the ordinance.

The Authority was established by vesting the properties and assets of the erstwhile Public Health Engineering Department under section 16 of the Act, and the assets, rights and liabilities of the local bodies and Kerala State Rural Development Board in so far as they pertain to the execution of water supply and sewerage schemes under 18 of the Act.

The main functions of the Authority are the following,

1. Preparation, execution, promotion, maintenance and financing of the schemes for the supply of water and disposal of waste water.
2. Planning for the State's water supply and sewerage requirements.
3. Fixation and revision of tariff, taxes and charges of water supply and maintenance service in the areas covered by the water supply and waste water system of the Authority.
4. Establishment of standards for water supply and waste water services.
5. Assessment of the requirements for man power and training in relation to water supply and sewerage services in the State.
6. Carrying out applied research for efficient discharge of the functions of the Authority.
7. Making provisions for manufacture and marketing of packaged drinking water, mineral water, aerated water or any other processed water and of goods or articles necessary for water supply and sewerage.

During the financial year 2019-20, 27 schemes were commissioned thereby increasing coverage and the population benefitted. Many new projects were sanctioned under KIIFB, State plan, RKI and NABARD to cover the uncovered areas. KWA distributes water through House Service Connections (HSC) and street taps. As part of implementation of Jal Jeevan Mission, KWA aims to cover 100% households in the rural sector with FHTCs by the year 2024.

Major Achievements

Production and Supply

KWA have so far provided cumulative water connections of 27.87 lakh across the state which includes 26,23,273 domestic water connection, 1,62,490 non-domestic and 1,777 industrial connections beside 2 lakh public taps. 2873 MLD water is produced and supplied from the schemes with WTPs and without WTPs. 107 projects which cumulatively produce 1247.2 MLD from the WTPs is under construction.

Jal Jeevan Mission (JJM)

Provided 4.04 lakh connections in rural sector as part of JJM in 6 months in FY 2020-21 and 1.10 lakh connections provided so far in this financial year. Total of 5.15 lakh rural FHTCs were provided under JJM in the last 8 months. The construction works of the production components of new schemes are progressing in a rapid pace, which will help to provide more FHTCs in the coming years.

Kerala Government is taking keen measures to implement the Central Government's JJM project to provide safe and adequate drinking water through Functional Household Tap Connections (FHTC) by 2024 to all rural households.

Table 5.1 Coverage in rural area in Kerala

Total Rural Households in Kerala	67.15 lakh
No of households provided with FHTCs (coverage as on 01.04.2021)	21.54 lakh
Balance households to be provided by 2024	45.61 lakh

Source: KWA

Kerala Water Authority is implementing several new water supply and sewerage related works in Kerala under the following major funding heads

Table 5.2 Project Abstract Status in KWA (as on 28.10.2021)

Sl. No.	Funding Agency	Total No. of Projects	Total No. of Projects above 1 Cr.	AS Amount (Cr)
1	GOK	798	102	1548
2	JJM	601	485	7812
3	DEPOSIT	341	28	205
4	KIIFB	104	97	4065
5	DC-LAC/ADS/SDF	65	2	1.66
6	AMRUT	58	58	1064
7	GOI	21	15	288
8	NABARD	17	17	541
9	RKI	10	9	197
10	ITDP	1	1	0.402

11	JNNURM	1	1	8.71
12	SMART CITY	1	0	0.1
13	VISL (Vizhinjam Project)	1	1	0.174
	Total	2019	816	15731.05

Source: KWA

Sewerage

Compared to water supply the coverage of sewerage is minimum in the state with 40 % coverage of Thiruvananthapuram Corporation and 5% of Kochi Corporation. A new scheme for Guruvayur is technically commissioned. Thiruvananthapuram city has about 602.5 km sewerage coverage and for Ernakulam, it is 28 Kms. The state and KWA is taking necessary initiative to provide 100% sewerage coverage for the urban areas. KWA is taking steps to implement and expand sewerage networks in Thiruvananthapuram, Kochi, Thrissur, Kollam and Kozhikode.

Although sewerage projects were taken up in Kollam and Kozhikode under KSUDP, both could not be implemented due to social issues, non – availability of land etc. Huge fund requirement, public protest against sewage treatment plants / pump houses, delay in getting land, sanctions for road cutting etc. are some of the issues to be addressed while taking up sewerage projects.

5.2 Rural Water Supply

According to NITI Aayog, performance of the state of Kerala in terms of Theme 7 – Rural drinking water is 15 out of 17 Non-Himalayan States. This conclusion is based on several indicators. Indicator 20 (b): Proportion of total rural habitations fully covered with drinking water supply in Kerala is only 28%, which is 17th position out of 17 Non-Himalayan states. Indicator 20 (d): Number of villages provided with 24*7 piped water supply in Kerala is zero.

Kerala Rural Water Supply and Sanitation Agency (KRWSA) was entrusted with rural water supply schemes, popularly known as Jalanidhi, in 2000 as part of a World Bank-supported project. The second phase of the Jalanidhi project started in March 2012. 5886 Jalanidhi schemes were in operation under Phases I and II covering 2.2 million people. In these schemes water is drawn from nearby traditional sources.

Unlike KWA schemes, 10% of the cost is borne by the beneficiaries and the scheme is handed over to the beneficiary groups. Hence responsibility of operation & maintenance is borne by the beneficiary groups.

Jalanidhi- Phase -1 {2001-2008}

Jalanidhi Phase I Project was implemented during 2001-2008 covering 112 Grama Panchayaths in 13 districts of the state except Alappuzha. During this period 3710 water supply schemes have been implemented {3694 Small Water Supply schemes and 15 LWSS and 1 MGP}. The schemes covered households ranging from 20 to 21000. Project provided water service to 188115 HHs across all 112 GPs. The project also provided better sanitation facility nearly 1,00,000 HHs of the rural public in 112 project implemented GPs, even in most difficult and tribal areas with a total project outlay of Rs.411crore. Salient feature of this project is the community contracting and fund management at the user level to ensure more accountability, transparency and ownership. The project gives enhanced capacity to the beneficiaries in managing the assets in a sustainable way. By implementing the project the community capacity and leadership skill enhanced to shoulder the implementation of any kind of development project.

Main project components of phase -1 are water supply schemes, household sanitation, ground water recharge, environmental management and rain water harvesting schemes. The phase -1 project has demonstrated the willingness to share the capital cost and full recovery of operation and maintenance cost. Successfully implemented the rehabilitation of single GP Kerala Water Authority schemes and transfer the management to the communities with improved service delivery. The project has also demonstrated substantial savings when implemented through community contracting mode. Participation of local communities, Grama Panchayaths and NGOs helped to implement the project in an enhanced responsibility and accountability.

Jalanidhi- Phase II {2012-2019}

After the successful implementation of Phase-I project, Government of Kerala has moved for second project and it was approved by the GOI and the World Bank. The Second Kerala Rural Water Supply and Sanitation Project has been envisaged to implement from January 2012 to June 2017 for a period of 5.5 years and it was extended for another 1.5 years up to December 2018. Considering the severe damages caused by the exceptional rain and flood, during the last year of the project, the closing period of the project extended up to June 2019. The project has taken up 115 Grama Panchayaths in all districts except Alappuzha and Kollam. Total outlay of the project is Rs.1022.2 crore and due to the dollar rupee fluctuations during the mid-term review, the project has been restricted to Rs.1358 crore. Water supply, sanitation, ground water recharge, rain water harvesting, tribal development, awareness creation and capacity building of various stakeholders are the components of this project. Out of these 2176 schemes, 2145 are small water supply schemes, 15 are bulk water supply schemes and 13 are large water supply schemes and 3 Multi-Grama Panchayath schemes. Beneficiary households ranges from 40 to 30000 comes under second phase of project. Out of these, 115 GPs taken up for the implementation, community managed distribution systems are implemented to provide treated piped water supply by utilizing the excess treated water capacity of KWA. About 65000 HHs in 24 GP is utilizing this by either tapping spare treated water available or enhancing capacity of KWA assets.

According to World Bank, Jalanidhi schemes were rated satisfactory based on relevance, efficacy, and efficiency. However, its performance towards the end of the project was less than its demonstrated potential.

As the Jalanidhi schemes depend on local sources, water shortage in summer months is a serious problem. It is having other drawbacks like, poor quality of water, lack of technical and executive hands for maintenance, dearth of experienced NGOs, dependence on donor agency for maintenance cost, institutional problems related to repair of major damages to community schemes. Investment deficit for aging infrastructure is also another area of concern.

Certain economically backward beneficiaries find it difficult to raise funds for operation and maintenance cost of the scheme and hence some schemes became defunct. However, several schemes are running well and hence it is necessary to support the community managed water supply systems by establishing a support mechanism.

5.2.1 Service Level

Till recently the service level adopted in the rural sector based on NRDWP norms was 70 lpcd. But Kerala being of rurban character, there is not much difference in the consumption pattern between urban and rural sectors. The KWA has therefore adopted a service level of 100 lpcd in all its new rural projects. The rural water supply sector has gained immense momentum with the commencement of JJM projects all across the country. Kerala also has set a target of 100% rural household coverage by 2024.

Scheme Details in KWA in Nos (as of Oct 2021)

- Total Schemes -928
- Urban schemes- 91
- Rural schemes- 772
- Urban/Rural Schemes- 65
- Non - WTP based schemes – 687
- WTP based schemes- 241

Connection details in KWA in Nos (as of Oct 2021)

- Domestic- 26,23,273
- Non Domestic – 1,53,084
- Industrial – 1777
- Special – 9406
- Total – 27,87,540

Table 5.3 Plan for full saturation under JJM

Total Rural Households in Kerala		67.15 lakh
No of households provided with FHTCs (coverage as on 01.04.2021)		21.54 lakh
Balance households to be provided by 2024		45.61 lakh
Year 2021-22	Year 2022-23	Year 2023-24
29.38 lakh	6.69 lakh	9.54 lakh

Gap in Treated Water Availability

Total installed capacity of water supply schemes (catering to both urban and rural areas) is about 3500 MLD in Kerala. Of which, about 2500 million litres is produced every day in Kerala (2500 MLD) translating into more than 70% utilization. The installed capacity can be further bifurcated into two categories namely – Treated Water (capacity of water supply scheme with WTP) and Untreated Water (capacity of water supply scheme without

WTP but with simple treatment like chlorination). Details of on-going WTP works as on 30.10.2020 are given below.

Table 5.4 On-going WTP works as on 30.10.2020

SL No	Head	MLD
1	KIIFB	804
2	AMRUTH	265
3	State Plan	189.5
4	NABARD	62.7
5	NRDWP	111
	TOTAL	1432.2

Source: KWA

5.2.2 Quality

Inadequate Water Supply, Sanitation and Hygiene facilities and practices leads to significant environmental damage ~ estimated at 0.82% of India's GDP

The World Bank Report on "Diagnostic Assessment of Select Environmental Challenges (2013)" presents break-up of the annual costs of environmental damage. It is seen that about 14% of environmental damage is due to Inadequate Water Supply, Sanitation and Hygiene facilities. For India this translates to around 0.82% of India's GDP. The main health impacts of inadequate water supply, sanitation and hygiene facilities and practices are diarrheal diseases, typhoid and paratyphoid and cost of averting expenditures. About 88 % of diarrheal cases globally are attributed to water, sanitation and hygiene (Pruss-Ustun et al, 2004). In addition there are costs in the form of averting expenditures to reduce health risk like cost of bottled water, cost of households boiling and filtering water. It is seen that almost about 85% of cost of environmental damage in India is caused by mortality and morbidity due to diarrheal diseases, typhoid and paratyphoid.

Protected drinking water sources in Kerala needs attention

Based on a nationwide survey by NSSO 69th round, nearly 88.5% of households in rural India have access to improved source of drinking water while the corresponding figure for urban India is 95%. In rural households in Kerala, only 29.5% have access to safe drinking water. An improved drinking water source is the one that is protected from outside contamination and it includes bottled water, piped water into dwellings, piped water to yard/ plot, public tap/ stand pipe, tube well/ bore well, protected wells, protected spring and rain water collection.

High levels of bacteriological contamination of water sources across the state

As per IMIS database maintained by MoDWS-Government of India, out of a total of 4.35 lakh water sources tested around 95% of the sources have been tested as contaminated either though bacteriological contamination or chemical contamination. Of the contaminated water sources, 85% of sources were tested positive for bacteriological contamination whereas only 15% samples only have been tested positive for chemical contamination. As per IMIS, districts of Alappuzha, Kollam, Palakkad, Pathanamthitta, and Thrissur are heavily contaminated with chemicals (more than 20% sources).

High Coliform contamination in majority of water sources in Kerala
As per IMIS database, Coliform and E-Coli forms the major portion of the overall contamination of the water sources in Kerala. Based on IMIS estimates, more than 70% of the water sources are contaminated with coliform. Alappuzha, Thiruvananthapuram and Thrissur have high incidence of e-coli.

Chemical contamination only prevalent in some districts
Fluoride problem exist in district of Palakkad & Alappuzha. Coastal regions and regions near estuaries / backwater lagoons particularly suffer from saline intrusion and is prevalent in Alappuzha and Kasargod. In some districts, chemical contamination due to heavy presence of fertilizer and pesticides industries is also seen. The state has taken number of initiatives to address the water quality problems.

5.2.3 Quantity
The Central Public Health & Environmental Engineering Organisation (CPHEEO) criterion for service level in rural areas is 70 lpcd. Kerala in view of its consumption pattern has adopted a service level of 100 lpcd. All new KWA schemes are designed with this enhanced service level. The urgent requirement is to ensure equity in distribution so that the tail ends receive sufficient quantity. Usage of IOT equipment's, automation in the distribution network, management on the basis of micro units/zones etc are to be implemented.

5.2.4 Regularity
Considering the natural variability and uncertainties in long term predictions, ensuring reliability in water supply is a critical factor particularly in rural areas. In these days wherein the climate imposed water deficiencies are on the rise, ensuring a reliable water supply is becoming more difficult. However with an efficient strategy to proper management of water supply risk, reliability in water supply can be ensured. As per the Detailed Project Reports (DPR) for various water supply schemes by the Kerala Water Authority (KWA), most of the water supply schemes are designed for 24 hours of operation. However, as per the 12th Five Year Plan (2012-17) by the State Planning Board, single GP rural water supply schemes implemented by KWA are designed for 8 hours of supply whereas majority of the multi-GP water supply schemes are designed for 16 hours of operation. However, small Gram Panchayat water supply schemes including the Swajaldhara schemes are designed for 4 hours of operation in a day.

Only the Comprehensive Regional Water Supply Schemes which are covering more than 2 GPs are designed for 23 hours of operation wherein this 23 hours operation is not achieved due to non-availability of power at required voltage during peak hours. During the summer season mainly due to the low electricity voltage, the average supply hours in single GP water supply schemes is between 4-6 hours whereas for multi GP water supply schemes it is between 8-12 hours. Most of the water supply schemes implemented by Jalanidhi are based on water sources available locally primarily open wells and ground water sources such as tube wells and bore wells. As these schemes are based on these local water sources, water supply hours vary across the scheme wherein some schemes it provides around 8-10 hours of supply daily and in some cases, the water is supplied for once in 3 days. However, the recently launched JJM Projects envisages to cover 100% rural households with FHTCs ensuring regularity & quality of water supplied. Also the newly designed schemes are for 24x7 supply at a service level of 100 lpcd.

Strategies & Action Plan for improvement

- Measures for protection and development of sources.
- Water security plans and water safety plans to be prepared for all GPs.
- Time bound completion of projects ensuring quality of assets created.
- Private expertise to be utilized effectively to solve the problems in water supply schemes.
- Proactive measures to control NRW shall be ensured.
- Establish Water Quality Monitoring and Surveillance Protocol with the involvement of educational institutions and beneficiary communities.
- Services of engineering colleges having water management centers to be availed to conduct data collection, feasibility study, design, DPR preparation, supervision, maintenance etc. Thus the local problems can be addressed effectively and engineering students will have access to the field problems.
- Kudumbasree units may be trained to take up works in water sector including the day-to-day operation and maintenance of various schemes.
- Efforts should be made to transform all the intermittent rural water supply schemes to 24x7 system with 100% coverage within the 14th FYP period.
- It is necessary to adopt technologies and methods which fit into IWRM, as enunciated at Dublin and Rio Conference. This calls for an integrated approach where traditional and modern trends merge together to achieve sustainable development. This is all the more important in a State like Kerala with a 'well culture' and limited and ephemeral surface water sources. Climate change factor is also to be considered, especially possibilities of erratic rainfall and sea water rise and its impact on coastal water sources, both ground and surface.
- Government should have a scheme to sanitize the local sources like open wells, springs in the high ranges and 'Surangams' in north Kerala, which is in line with IWRM. Also, it is necessary to rejuvenate wells in identified areas for recharging groundwater, where level is going down fast. Government (and local bodies) must come forward with programs for the protection of existing open wells and measures to ensure quality so that dependence on piped water in such locations is minimized and the vision of full coverage of the state with safe water supply can be achieved in next 3 years. A campaign for conserving our assets like wells (including public), ponds, springs and Surangams is essential. It can begin from schools. It is also necessary to ensure that households staying near these sources use properly designed septic tanks. Water Audit may be conducted in every panchayat. Local bodies should give sufficient importance to water supply schemes and make the land available for water supply schemes.

5.2.5 Requirements

In order to achieve the target of 100% coverage with FHTCs, the sector requires a multi-pronged approach which includes development of fresh sources, augmentation of existing sources, water treatment and network infrastructure. The physical infrastructure development requires tremendous human efforts and so capacity building and training of personnel in the sector is critical for achieving the targets. For achieving 100% saturation heavy infrastructure investment has to be made. In Kerala, a decentralized approach will ensure the load on the individual LSGs will be minimal.

5.2.5.1 Source Augmentation and Development

Reliable sources in terms of quality, quantity and availability round the year is a primary requirement for establishing a sustainable water supply system. Kerala, in spite of having 3000 mm of rainfall has been experiencing recurring droughts and floods and in recent years the climate events have been getting severe. The drinking water sources has to be made climate resilient to make the water supply systems calamity ready. Efforts are already on to build more check dams, desilt reservoirs, deepening wells, prevent sand mining, preventing waste disposal, etc. Traditional knowledge and water conservation techniques will help in source protection, augmentation as well as creation of new sources.

5.2.5.2 Infrastructure Development

The capital flow in the water supply sector has been witnessing tremendous increase in recent years, especially with funding from KIIFB and JJM. The absorption capacity of the sector organizations also has to be enhanced commensurate with the increased fund flow.

5.2.5.3 Human Resource and Capacity Building

Kerala Water Authority is the major provider of drinking water in the state of Kerala. KWA is still following the staff pattern followed by the erstwhile PHED, even though there is considerable increase in coverage and production has been achieved since inception. Also various projects are in the anvil, supervision of those projects in a satisfactory manner and maintenance of service quality (through preventive maintenance, customer friendly approach etc.) after commissioning requires additional man power to be allotted urgently. The skill of existing staff is to be developed and kept updated through proper planned training sessions and other initiatives. Modernisation of working environment through state wide implementation of e-office facilities, SCADA, leak detection equipments etc. Training from premier institutions for improving the overall efficiency of the organisation covering project implementation, customer interaction, managerial skill development etc. to be made available.

State of the art techniques including computerization, automation etc. are to be adopted wherever feasible to make the system efficient and economical. Existing procedures need a thorough review. Sensor based, IoT enabled techniques for monitoring quality and quantity to be adopted. GIS based asset mapping & informed decision making should become the practice.

KWA engineers may be effectively used in engineering activities like, studying the problems, designing and executing the water supply schemes and providing technical assistance to O&M operators. Modernization of KWA with suitable revision of duties and delegation of powers can improve the present situation. Cost of governance shall be brought to minimum.

5.3 Urban Water Supply (Challenges and Way Forward)

5.3.1 Service Level

As per the NITI Aayog report on Composite Water Management Index, the State of Kerala is positioned as 14 out 17 Non-Himalayan states in theme 8 – Urban Water Supply and Sanitation. The report consists of the performance of the state during the year 2015-16, 2016-17, 2017-18. The report says that there was no significant improvement during the above three years. NITI Aayog report also says that water demand will double by 2030 compared to the demand in 2019.

As far as the coverage of urban water supply is concerned, NITI Aayog report says that it was 53% in 2015-16 and 2016-17. The coverage was improved to 63% in 2017-18. At present water is supplied to two-third population in urban area. Comparing with the other non-Himalayan states, the state is positioned as 13 out of 17.

5.3.2 Quality

Unlike in rural schemes most urban schemes are having water treatment plants which ensures quality of water produced and supplied. The treatment plants have inbuilt quality control labs in addition to the surveillance activities carried out by the Quality Control wing of KWA. However most of the existing WTPs are designed to satisfy CPHEEO Standards whereas there has been changes in standards, especially in the limits of turbidity and iron. KWA needs to modify its existing plants to achieve the recently introduced water quality standards.2

Even though KWA is able to ensure water quality standards at the production stage, there are report ailed water samples collected from distribution systems. This may be because of failure to ensure residual chlorine or because of pollutants entering the system. This may be addressed by ensuring adequate level of chlorination including online chlorination and online monitoring of water quality, etc.

5.3.3 Quantity

The CPHEEO criterion for service level in urban areas is 135 lpcd. Kerala in view of its consumption pattern has adopted a service level of 150 lpcd. All new KWA schemes are designed with this enhanced service level. The urgent requirement is to ensure equity in distribution so that the tail ends receive sufficient quantity. Usage of IOT equipment, automation in the distribution network, management on the basis of micro units/zones etc are to be implemented.

5.3.4 Regularity

Though all urban schemes are designed for continuous supply, most systems in India are unable to satisfy this criterion mainly because of network operational issues, high level of NRW including physical loses. In order to ensure regularity in supply, we need to ensure that the installed capacity of WTPs are utilized to the maximum and distribution system is operated optimally. Dual filter media, liquid chlorination, plate settler, etc will ensure that incremental investments in WTP infrastructure yields greater outputs. Control of NRW including active leak detection and rectification, online monitoring of the system using pressure and flow sensors, automated systems for water balance etc may be introduced. Demand management and supply side management including educating the customers on judicious use of water will go a long way in reducing consumption and thereby achieving regularity of supply.

5.3.5 Requirements

The quality, quantity and regularity of the water supply systems depends on several parameters like adequate source, necessary infrastructure and efficient human resources.

Source Augmentation and Development

Most of the urban water supply schemes in the state are surface water-based systems. But these sources, especially which are located in rivers without upstream storage structures face shortage issues during summer. As a water security measure, the state has adopted a principle of converting rivers as storage structures by building check dams, regulators etc at vantage points. Also in major cities the possibility of dual source is being explored and adopted.

Kochi already is supplied from Periyar and Muvattupuzha rivers. A new system based on Karuvannoor river is under implementation for Thrissur Corporation. Similarly Thiruvananthapuram is going to have additional supply from Neyyar.

Recycling of used water especially in urban areas where source availability ensurement is difficult has to be taken up in a massive scale. Twenty percentage of the drinking water source in the next 5 years should be made available through recycling. As both urban and rural areas in Kerala along the 560 km of coastal line has geographical advantage of taking desalinated water for consumption. Twenty percentage of the drinking water source along with recycling as mentioned above has to be made available through these methods.

Infrastructure Development

The urban areas in Kerala already have a coverage of over 65%. All Municipalities except the three recently formed ones have full-fledged water supply systems. Also new systems and augmentation projects are under way wherever there is gap in production and distribution of water. With JJM urban having a target of 100 % saturation of urban areas before 2026, huge infrastructure investment in the distribution network has to be made. In urban areas as time is of essence, O&M, complaints redressal mechanism, automation etc needs to be developed and corresponding investment to be made.

Strategies & Action Plan for Improvement

1. Source development and watershed management is quite important for any sustainable water supply. Special attention is necessary in the urban water supply schemes where shortage of water is experienced especially in the summer months. The low-income group, densely populated areas, areas with high rise buildings, industrial parks, commercial business areas to be given preference.
2. Immediate steps should be taken to reduce the expenditure of KWA and improve the revenue.

3. Unskilled & semiskilled works for daily operation of the KWA schemes need to be outsourced.
4. Private expertise to be utilized effectively to solve the problems in water supply schemes through PPP model.
5. Services of engineering colleges having water management centers to be availed to conduct data collection, feasibility study, design etc.
6. Kudumbasree units may be trained to take up works in water sector including the day-to-day operation of various schemes. This will become a direct help to the women and marginalizes sections of the society, while reducing the expenditure of KWA.
7. Efforts should be made to transform all the intermittent urban water supply schemes to 24x7 system with 100% coverage within the 14th FYP period. At least reliable water supply shall be ensured to all consumers.

Action Plan

1. Frequent flood and draught faced by the state is a direct threat to the water sources which supply water to several water supply schemes. Climate change makes the situation more complex. Immediate steps for long term sustainance of these sources should be taken up on priority basis.
2. Even certain water supply schemes in the coastal belt are facing problems of salinity intrusion due to low flow in summer season and rising sea water level. Magnitude of these problems are likely to intensify in the near future. Effective steps to provide safe drinking water on long term basis is essential.
3. Aim should be not only to meet the requirement by making available water for part of the time on a day but all through the day in an economic manner also. Awareness shall be created among all concerned on the optimal use of water.
4. Existing Irrigation and Hydel reservoirs can be linked to supplement the drinking water supply schemes in the higher elevations not having sufficient sources for drinking water. An optimal operation policy may have to be followed without impacting the purposes for which water is harvested. The success stories of Malampuzha and Peechi tempts one to think of this option.
5. As far as possible, a single agency should be made responsible for water supply in a region and aim at achieving single water tariff for all schemes.
6. KWA engineers may be effectively used in engineering activities like, studying the problems, designing and executing the water supply schemes and providing technical assistance to O&M operators. Modernization of KWA with suitable revision of duties and delegation of powers can improve the present situation. Cost of governance shall be brought to minimum by utilizing IT solutions.
7. Computerized hydraulic simulation model for all water supply schemes may be developed and maintained for identification of problems, evaluation of alternative solutions, augmentation of existing systems etc. There should be a well updated and calibrated model of all the schemes to study at any time. Engineering colleges can be effectively utilized for these simulation studies.
8. KWA revenue needs to be improved through water audits and reduction of non-reve-

nue water. Lots of work in this connection can be carried out without any additional manpower or any costly equipment. After initial study, further improvement can be achieved with the help of sophisticated equipment. Overall 40% Non-Revenue Water is reported in Kerala. Focused effort to reduce the same is necessary. KWA should have a time-bound action plan for this purpose and the same may be implemented with the existing infrastructure.

9. Among different sizes of water meters, bigger size water meters used for non-domestic connections are less in number which fetch major revenue to KWA. Hence it is necessary to give special attention to these meters with continuous monitoring. Meters with Automated Meter Reading (AMR) facility with dedicated software can monitor these consumptions effectively through a central monitoring system. It can improve the revenue of KWA as well as develop confidence among consumers. Meter policy adapted by KWA contains the preventive maintenance aspects and these need to be strictly enforced.
10. At present the consumer is responsible for providing and maintaining water meter. The utility providers should ensure that empaneled vendors provide water meter for rent. This will ensure that the empaneled vendor brings in quality water meter as prescribed by the utility provider. The consumer will be liable only to pay the meter charges and will not be liable for faulty meters. The water meters typically have a life span of 5 to 7 years. The empaneled vendor may refurbish the same meters after its life span there by extending its life period, providing at reduced cost and reducing wastage.
11. It is necessary to assess economic viability of each scheme. It is reported that schemes in Thiruvananthapuram and Ernakulam are economically viable projects even now. This need to be studied in detail. Every scheme should be made economically viable and if necessary, manpower may be re-deployed. At least operation and maintenance of every scheme should be met from the revenue from consumers, like Jalanidhi schemes.
12. It is impossible to have substantial increase in water tariff to cover the entire expenditure of KWA. However, an upward revision is inevitable. Restructuring of water tariff can be thought of. Lessons can be drawn from Delhi tariff. Any increase in tariff may be implemented after detailed study.
13. A regulatory body in Kerala water sector on the lines of KSEB will ensure operational independence and corresponding tariff revisions based on the overall economic situation.
14. Automation of operations in treatment plants need to be examined and the same may be implemented wherever economically feasible.
15. All pumping systems shall be examined for its operational efficiency. Necessary modifications may be implemented wherever economically feasible. .
16. Residential societies/communities may be involved effectively in implementation and maintenance of water supply systems in their area. These communities can even take up responsibilities like: augmentation of water supply, effective metering and revenue collection, usage of recycled water etc. They can even get the financial support from local bodies if necessary. Thus KWA can reduce its responsibility to supply desired

quantity of water to the above communities.

17. Energy Auditing similar to water audit has to be carried out in all the KWA plants and pump houses. In house Electro Mechanical Units have to be strengthened for this purpose.

5.4 Sustainable Financial Models

5.4.1 Cost of Production Vs Revenue

At present the average revenue collected per KL is only Rs.10.48, against an average cost of production per KL of Rs.23.89, i.e there is a considerable loss of Rs.13.41 per KL. This gap needs to be closed for the smooth functioning of KWA.

Income Vs Expenditure

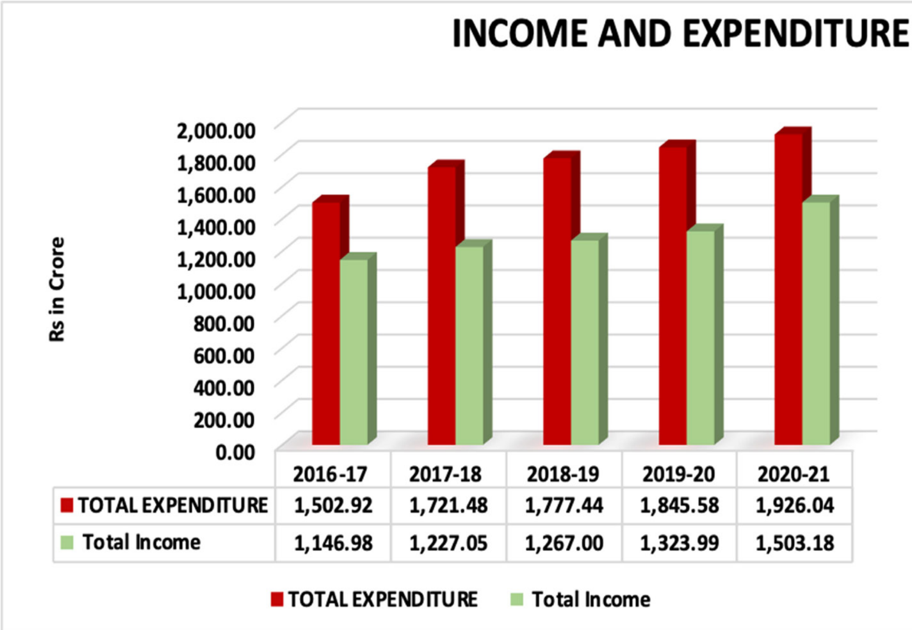
The comparative statement of income and expenditure of KWA for the last 5 years is presented below.

Table 5.5 Comparative statement of income and expenditure of KWA

		Pre-Audited				Provisional
		(Rs.in crore)				
INCOME		**2016-17**	**2017-18**	**2018-19**	**2019-20**	**2020-21**
1	Operating Income	585.40	625.53	662.47	716.87	840.33
2	Grants from GoI & GoK	307.02	284.63	359.02	273.53	347.44
3	Other Income	207.76	255.44	207.54	294.94	288.15
	Total Income	**1,100.18**	**1,165.60**	**1,229.03**	**1,285.34**	**1,475.92**
EXPENDITURE						
1	Operating & Maintenance Expenses	335.35	370.25	241.36	465.43	491.79
2	Payment & Provision to Employees	734.09	823.54	895.05	904.48	947.08
3	Office & administrative Expenses	27.89	118.37	47.28	31.36	32.54
4	Interest	286.06	281.89	289.07	298.70	298.09
5	Depreciation	119.53	127.43	137.55	145.61	156.54
Total Expenditure		**1,502.92**	**1,721.48**	**1,610.31**	**1,845.58**	**1,926.04**
6	Transferred to Capital Work-In-Progress	46.80	61.45	37.97	38.65	27.26
Actual Expenditure		1,456.12	1,660.03	1,572.34	1,806.93	1,898.78
Excess of Expenditure over Income		355.94	494.43	343.31	521.59	422.86
7	Prior Period Adjustments	-3.17	-2.46	-969.22	-4.64	-0.04
Excess of Expenditure over Income after prior period adjustments		**352.77**	**491.97**	**625.91**	**516.95**	**422.82**

Source: KWA

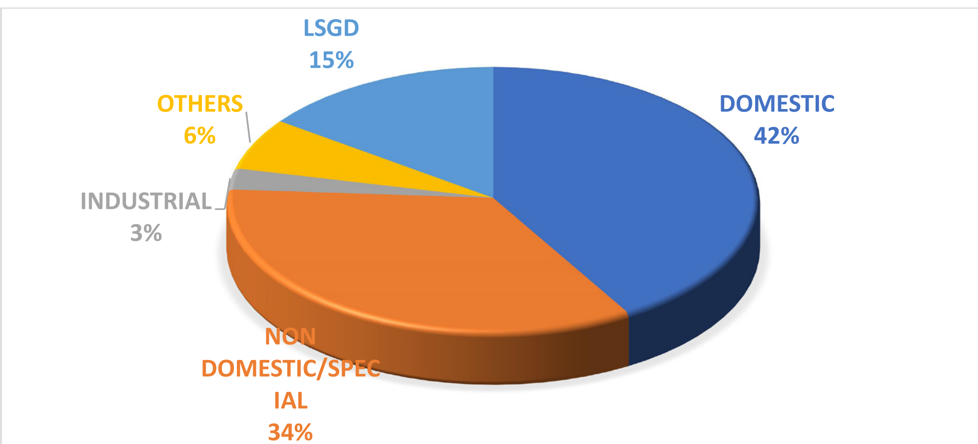
Fig. 5.1 Income and Expenditure of Kerala Water Authority (KWA)



Source: KWA

Contribution of each category of consumers towards the revenue of Kerala Water Authority is as follows.

Fig. 5.2 Revenue collection from different category of consumers



Source: KWA

As per the provisional annual report 2020-21, KWA is facing serious financial crisis. Income from consumers was Rs. 864.12 crore, whereas the total expenditure was Rs. 1840.29 crore. Operation & Maintenance cost alone was Rs. 440.77 crore. Payment and provision to employees alone was Rs. 923.88 crore. This shows that the income from consumers is not sufficient even for the salary of employees. This is not a sustainable situation. Immediate steps to reduce the gap between income and expenditure is necessary.

5.4.2 Tariff Rationalisation

The main source of Income of Kerala Water Authority is collection of water charges. From the formation of Kerala Water Authority, it has never earned any surplus income and is continuously running at deficit, which is made good to some extent by the non-plan grant received from Government of Kerala.

Though as per section 23 of the Kerala Water Supply and Sewerage Act, 1986,“ the Authority shall not, as far as practicable and after taking credit for any grants or subventions or capital contributions or loans from the Government under section 24, carry on its operations under this Act at a loss and shall so fix and adjust its rates of taxes and charges under this Act as to enable it to meet as soon as feasible the cost of its operations, maintenance and debt service and where practicable to achieve an economic return on its fixed assets”, year after year, the revenue deficit has been increasing. As the liabilities on the Authority are mounting on a large scale with expansion of services a reasonable upward revision in tariff cannot be postponed.

Kerala Water Authority meets its monthly commitments such as monthly salary and pension, HR Wages, Pensionary benefits, Earned Leave Surrender, Medical Expenses, Terminal surrender, etc. by collection of Water Charges from its consumers as well as the Non-plan grant received from Government of Kerala. GoK normally releases the entire Budget allocation of Non Plan Grant to Kerala Water Authority during the concerned year itself. Decreased revenue collection due to Covid-19 lock down adversely affected the financial position of the Authority. Due to shortage of funds, there are long pending commitments towards pensioners, employees as well as KSEB.

Kerala Water Authority collects its revenue from the consumers at a tariff fixed by the Government of Kerala from time to time. KWA has a consumer base of 27.87 lakh consumers, in which about 1.64 lakh consumers belonging to non-domestic & industrial category. In the remaining 26.23 lakh of domestic consumers, more than 75% of the consumers that is approximately 20 lakh consumers, fall in the consumption category of 15 KL or less.

Though Kerala Water Authority again submitted water tariff revision proposal during 2018 and 2020, the same has not considered yet. However, GoK has accorded tariff increase of 5% from 01-04-2021 to water charges along with other user fee charges as a part of the condition of GoI for the increase in overall borrowing limit to the State. The lowest tariff is Rs. 4.20 per KL and highest tariff is Rs. 52.50 per KL for domestic consumers. Revision in the water tariff is necessary for the smooth running of the Authority.

One Paisa Per Litre (OPPL) should be adapted urgently to tide over this financial crisis.

Energy Reforms: KWA is the largest consumer of the KSEBL, with main expenditure of KWA being Electrical charges. Electromechanical unit formed in KWA to be strengthened and more investment grade Energy Audit to be carried out in all the KWA plants and pumping stations. Also a preventive maintenance protocol is to be established and implemented so as to reduce the O&M charges.

Solar Energy and Mini Hydel projects: Projects for exploring the possibility of utilising the vast area available at plants and offices under Water Resources Department for garnering solar energy is to be implemented urgently. These are to be extended to all possible offices. Implementation of mini hydel projects through Irrigation Department for KWA WTP's by utilising the flow of water is to be explored.

Immediate measures are required to close all LT/HT connections of non-functioning pump houses/plants to reduce monetary loss through these redundant connections.

Revenue Reforms: All necessary measures to expanding the current coverage is to be made through new schemes to uncovered areas and thus increase the consumer base and revenue. Staff patterns be rearranged to strengthen field offices and training imparted to increase the service levels through consumer friendly interactions, time bound repairing works etc. Proper administrative checks and balances, reconciliation etc. are to be included in the upgradation of e-Abacus software or in a new billing software, to achieve proper revenue collection and accounting. Necessary measures to revise the water tariff in a regular and effective manner is required to ensure revenue growth.

5.4.3 Efficiency Improvement Programs

- Improving service levels in covered areas
- Improving water quality
- Improving customer services
- Improving operational efficiency

Regulatory/Legislative Changes

The following matters affecting the smooth functioning requires interaction and co-ordination with other departments and Government level decision/interaction are required to solve the issues.

Road Cutting & Utility Shifting: A MoU between LSGD/PWD/NHAI and KWA may be entered into, for ensuring road cutting sanction to rectify emergency leaks across the State. This shall avoid delay in leak rectification works thus reducing hardships to general public. Also road cutting sanction for new projects shall be issued in a time bound manner to avoid delay in project completion resulting in time and cost overrun.

Energy Charges: The total amount outstanding to KSEBL as on 31-03-2021 is Rs.634.92 crore (including interest and penal interest). KWA has about 264 HT connections which are charged by KSEBL at the maximum tariff i.e. HT 1 (A) Industrial. Even though KSEB is revising the power charges on a frequent manner, the same cannot be absorbed in water tariff since the revision of water tariff is not done regularly as in KSEB. Since there is reduced power tariff to Jalanidhi, Swajaladhara, Jaladhara schemes, same concession rate may made applicable to KWA also.

Leak Repair: A fixed charge may be incorporated in the water tariff to account for the leak repair works in the communication pipes & alteration of water connections. By introducing such a system the consumer will be relieved off procedures and financial liability associated with the above works.

5.5 Operation and Maintenance (O&M)

Operation and maintenance refers to all of the activities needed to run a water supply and sewerage scheme, except for the construction of new facilities. The overall aim of operation and maintenance is to ensure efficiency, effectiveness and sustainability of water supply and sewerage schemes. The two activities of "operation" and "maintenance" are very different in nature. Operation refers to the routine activities and procedures that are implemented to ensure that the water supply system is working efficiently. The activities that contribute to the operation of a water utility are undertaken by technicians and engineers who have responsibility for controlling the functions of the system .Maintenance, on the other hand, is to do with the technical activities, planned or reactive, which are needed to keep the system working.

Operation and maintenance has been neglected in the past, or been discussed and introduced only after a project was completed. Realizing the fact that this neglect or delay in applying proper operation and maintenance has affected the quality of service offered of the services to a great extent, a separate wing (Operations Unit) under KWA monitors the O&M of water supply and sewerage services and formulate appropriate policies and operating guidelines as and when required. Some of the main operation and maintenance activities are as follows

- Monitoring of Operations and Maintenance expenditure.
- Tracking utilization and wages of employees through software.
- Non-Revenue Water Management activities
- Emergency works related to Drought / Flood and special festivals.
- Monitoring of complaint redressal system
- Suggest remedial measures to be taken in case of emergency, quality issues etc
- Innovative and Pilot projects related to technological improvements in O&M of water supply and sewerage systems
- Optimised operational practices together with established preventive maintenance protocols are essential for maintaining health of the assets.

PPP Models

Public-Private Partnership is a key in the current globalized environment. In water sector innovation and technology infusion can be greatly achieved by incorporating private partners who are specialists in it. Both financial support, sustainable revenue model, better service delivery, quick response on complaints can be brought in PPP models.

Leverage private sector expertise: Private sector expertise can be leveraged by state and city departments to support efficient management of resources, given access to latest technologies and professional experience. Performance-linked remuneration models, along with adequate monitoring by authorities can help ensure financial sustainability of the project as well as satisfactory service delivery for end-users.

Validate concepts through a pilot-based approach: States can initially launch pilots before implementation of large-scale initiatives and innovative projects to test and validate concepts and project ideas with a small proportion of the total target audience. This can help in identifying and addressing potential implementation challenges and risks early in the project in a resource-efficient and timely manner.

CHAPTER-VI
WATER QUALITY MONITORING & SURVEILLANCE (WQM&S)

More than 600 000 people annually contract some form of gastrointestinal illness for which they seek medical help. The study conducted by CWRDM, IIT Chennai and other agencies indicate that 70 % of drinking water wells in Kerala have fecal contamination (CWRDM 2007).

Waterborne disease remains one of the major health concerns in the world. Diarrhoeal diseases, which are largely derived from contaminated water and inadequate sanitation, account for 2.4 million deaths each year and contribute over 73 million Disability Adjusted Life Years (a measure of disease burden, WHO 1999). On a global scale, this places diarrhoeal disease sixth in the list of causes of mortality and third in the list of morbidity. This health burden is primarily borne by the populations in developing countries and by children. Based on present estimates, one-sixth of humanity, lack access to any form of safe and improved water supply within 1 kilometre of their home and one-fifth of humanity lack access to any form of adequate and improved excreta disposal (WHO and UNICEF 2000). Endemic and epidemic disease derived from unsafe water supply affects all nations. Outbreaks of waterborne disease continue to occur in both developed and developing countries, leading to loss of life, disease and economic burden for individuals and communities. Strategies to improve water quality, in conjunction with improvements in excreta disposal and personal hygiene can be expected to deliver substantial health gains in the population. The Millennium Development Goals articulated by the General Assembly of the United Nations (2000), include a commitment to reduce by half the proportion of the World's population who are unable to reach or afford safe drinking-water by 2015.

There are two competing risks involved in the management of drinking water sources especially in State like Kerala. They are groundwater protection and better sanitation. . Therefore, one of the options is to study the defects in existing sanitation methods and it is also necessary to address the issue whether poor sanitation alone is responsible for the groundwater contamination. If so, it is appropriate to implement the corrective measures to improve the sanitation methods practiced in Kerala.

6.1 Water Quality Status of Kerala

Kerala is one of the smallest states in India (38.863 sq.km) covering merely 1.3 per cent of the total area of the country and is situated between 8°18' and 12°48'N latitude and 74052' and 77°22' E longitude.

Water and sanitation infrastructure in Kerala is extensive and valuable. According to a recent survey by CWRDM, there are 67 lakh open wells. A rough estimate indicates that 60% of the population relies on groundwater for many uses.

Policies and programs must appropriately invest in getting safe potable water, awareness to limit the exposure of people to faecal pathogens and chemical contamination. Conditions for water supply in the southern Indian state of Kerala are pretty much typical for (sub) urban-rural areas of developing countries. A large majority of rural households especially belonging to the poor and the vulnerable are without latrines or latrines which are not constructed scientifically. The morbidity rates are high, especially considering diseases related to water and sanitation.

The short, fast-flowing, monsoon-fed rivers of Kerala often encounter salinity intrusion into their lower stretches during the summer months. When the freshwater flow reduces, two major problems are encountered in these water bodies: (i) salinity propagates more into the interior of the river and (ii) the flushing of the system becomes less effective. The pollution problems are reported mainly from the downstream of the rivers. Biochemical Oxygen Demand is reported to be within 10 mg/l in the rivers. Bacteriological pollution is one of the major water quality problems of the Kerala Rivers. Lack of proper sewerage treatment system is one of the major reasons for the bacteriological contamination of the rivers. Kerala does not have a proper liquid waste management policy. Solid waste is also posing serious threats to the water bodies of Kerala.

The groundwater quality problems of Kerala are associated with mineralogical origin, human interference, industrial effluents, municipal solid waste, burial grounds etc. The location specific groundwater problems in Kerala are due to the presence of excess salinity, iron, fluoride, hardness, and coliforms. Seawater intrusion, domestic sewage, mineralogical origin, and agricultural and industrial activi¬ties are the major causes.

Open wells of Kerala have the problem of bacteriological contamination. The open character of the wells and inadequate maintenance habits and use of buckets and rope to draw the water, kitchen waste and pit latrines with average family load factor (5 members) at a distance of less than 5 m from wells are some of the factors which are found to be contributing to the bacteriological contamination.

The groundwater quality problems due to high fluoride content are reported from Palakkad and Alappuzha districts of Kerala. Fluoride content of 1.5 to 2.6mg/l is observed from the deeper aquifers tapping Varkala formations in the Alappuzha town. Some of the deep wells in Palakkad district in Chitoor taluk and a few wells in Kanjikode and Muthalamada area also reported to contain fluoride concentration greater than 1 mg/l.

Most of the latrines constructed in these areas are deep leach pit type, which, given the porous nature of soil accentuate biological contamination of these wells. Lack of adequate systems for solid and liquid waste management further adds to water contamination.

6.2 Water Quality Standards

Drinking water shall comply with the requirements given in the following table
Bacteriological Standards:

'able 6.1 BIS10500 STANDARD FOR DRINKING WATER (Amendments added)

Essential Characteristics			
Sl..No	Characteristics	Requirement. (desirable)	Permissible limit in the absence of an alternative source
1.	Color-Hazen units, maximum	5	15
2.	Odour	Agreeable	Agreeable
3.	Taste	Agreeable	Agreeable
4.	Turbidity,Ntu,Max	1	5
5.	pH value	6.5 to 8.5	No relaxation
6.	Total Hardness as CaCo3,max mg/l	200	600
7.	Iron as Fe,max mg/l	1	No relaxation
8.	Chlorides as Cl,max mg/l	250	1000
9.	Residual free Chlorine as Cl, min	0.2	1

Desirable Characteristics			
10.	Dissolved Solids, mg/l, max	500	2000
11.	Calcium as Ca, mg/l,max	75	200
12.	Copper as Cu, mg/l,max	0.05	1.5
13.	Manganese as Mn, mg/l,max	0.1	0.3
14.	Sulphate as So4,mg/l,max	200	400
15.	Nitrate as No3,mg/l,max	45	No relaxation
16.	Fluoride as F, mg/l,max	1	1.5
17.	Phenolic compounds, mg/lit, max	0.001	0.002
18.	Mercury as Hg, mg/lit max	0.001	No relaxation
19.	Cadmium as Cd, mg/lit , max	0.003	No relaxation
20.	Selenium as Se, mg/lit, max	0.01	No relaxation
21.	Arsenic as As, mg/lit, max	0.01	0.05
22.	Cyanide as Cn, mg/lit, max	0.05	No relaxation
23.	Lead as Pb, mg/lit, max	0.01	No relaxation
24.	Zinc as Zn, mg/lit, max	5.0	15
25.	Anionic detergents, mg/lit, max	0.2	1.0
26.	Chromium as Cr, mg/lit, max	0.05	No relaxation
27.	Polynuclear Hydro carbons	0.0001	No relaxation
28.	Mineral oil, mg/lit ,max	0.5	No relaxation
29.	Pesticides, mg/lit, max	Absent	No relaxation
30.	Alkalinity, mg/lit ,max	200	600
31.	Aluminum as Al, mg/lit, max	0.03	0.2
32.	Boron as B, mg/lit, max	0.5	1

Source: Indian Standard- Drinking Water – Specification (BIS)

i) All water intended for drinking:
a) E. coli or thermotolerant coliform bacteria- Shall not be detectable in any 100 ml sample

ii) Treated water entering 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

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

6.3 Common Contaminants

Water sources can get polluted because of a range of harmful contaminants. The common contaminants occurring in drinking water can be classified into:

- **Inorganic contaminants:** include metals such as fluoride, arsenic, lead, copper, chromium, mercury, antimony, cyanide that can get into drinking water (surface as well as groundwater) from natural sources, industrial processes, as well as from plumbing systems.
- **Organic contaminants:** include pesticides, untreated domestic and industrial wastes etc that can get into rivers, lakes, ponds and even groundwater. Contamination through organic materials can cause serious health problems like cancers, hormonal disruptions, and nervous system disorders.
- **Biological contaminants:** include the presence of living organisms, such as algae, bacteria, protozoa or viruses in the water. Each of these can lead to a range of health problems among humans.
- **Radiological contaminants:** include radioactive materials that are found naturally in the soil or rocks or generated through industrial wastes that can get mixed with drinking water (surface water as well as groundwater) at the source.

6.4 Emerging Contaminants

United States Geological Survey (USGS) defines an Emerging Contaminant (EC) as any synthetic or naturally occurring chemical or micro-organism that is not commonly monitored in the environment but has the potential to enter the environment and cause unknown or suspected adverse ecological and human health effects. Sources of ECs are compounds such as Pharmaceuticals and Personal Care Products (PPCPs), contrast media, plasticizers, food additives, wood preservatives, laundry detergents, surfactants, disinfectants, flame retardants, pesticides, natural and synthetic hormones, and a few Disinfection By-Products (DBPs) (La Farré et al. 2008) that enters through several pathways. The conventional treatment plant is not capable of removing the ECs and requires advanced treatment technologies.

In India, the contribution of emerging contaminants in aquatic environment comprises of 57% pesticides, 17% pharmaceuticals, 15% surfactants, 7% personal care products and 5% phthalates (Gani & Khazmi 2016).

Micro Plastics

Microplastics are microscopic fragments, fibres or particles of plastic less than 5mm in length and are a major source of aquatic pollution due to their toxic potential. Unlike other pollutants, there is no accepted safe limit of microplastics in drinking water with research yet to establish whether any amount of microplastics could be considered safe for drinking. But several other toxic chemicals get attached to the surface of the microplastic and add to the overall toxicity of the water. The potential threat of microplastics cannot therefore be ignored.

A recent study by the National Institute of Oceanography (NIO) and Toxics Link, an environmental group, has detected potentially hazardous levels of microplastics in tap water supplied to households in Goa. The study said although the water treatment process may reduce a portion of the microplastics, some still remain. "However, although there is no documented evidence till date that ingesting microplastics can directly harm human health."

6.5 Water Quality Testing Infrastructure

The following agencies have the facilities for water quality analysis in Kerala

a. State water quality laboratory of Kerala State Pollution Control Board, Regional Laboratories and district laboratories
b. Water Testing Laboratory of Centre for Water Resources Development and Management (CWRDM) Headquarters, Kozhikode, and Level I Laboratories in the CWRDM Sub Centres of Kottayam and Neyyattinkara
c. Water Quality Laboratory of State Ground Water Department at Thiruvananthapuram and district laboratories in District headquarters.
d. Water Quality lab facilities available with KWA. (District Level and State Laboratory)
e. Water quality lab available with Central Ground Water Board, Thiruvananthapuram.
f. Analytical facilities available CSIR – National Institute for Interdisciplinary Science and Technology (NIIST)
g. Analytical facilities available in CESS, Thiruvananthapuram, KFRI, Trichur & TBGRI, Palode.
h. Facilities available in CUSAT, Kerala University, MG University, Kannur University and Kerala Agricultural Universities.
i. State Public Health Laboratory in Thiruvananthapuram ,Regional Analytical Laboratories at Ernakulam and Calicut
j. Facilities available in CPCRI, selected Colleges, R&D institutes.
k. Facilities available in soil survey Department.
l. Facilities available in private sector.

It may be noted that though infrastructure facilities are available in many of the above centres, they are not completely capable of analyzing the water quality for public. NABL accreditation is available for 9 labs of KWA. In all these labs, testing for private samples is also conducted. Under JJM 70 labs are targeted to receive NABL accreditation. All Higher Secondary Schools, Engineering Colleges and other life science institutions should be equipped with water quality testing facilities available for public. Field Test Kits (FTKs) to be made available in all LSGs as well as ensuring atleast 5 Kudumbasree workers per ward are trained for doing field tests. Hence sufficient infrastructure facilities may be made available to cater to the needs of the public for testing their drinking water quality. Since providing safe drinking water is one of the major thrust areas of the Government, setting up of such facilities by the State Government shall in long way help in ensuring safe water for all.

6.6 Institutional Set up for WQM&S

To equip the state for providing facilities for water quality analysis a multipronged approach is recommended. It is suggested to launch a program on with an objective for developing infrastructure facilities for determining water quality analysis for the common man. The scheme may be launched in the state by identifying the following as nodal agencies.

1. Science and Technology Department, Government of Kerala
2. State Groundwater Department
3. Kerala Water Authority
4. Kerala State Pollution Control Board
5. Haritha Keralam Mission

We may set up a WQM&S model with the cooperation of LSGs, Educational Institutions and labs in public sector. A three tier system with level 1 addressing compulsory parameters, level 2 for optional parameters and level 3 for heavy metals and pesticides. The classifications of these parameters into three levels are based on the fact that First level parameters are those which lead to common water quality problems in Kerala and these parameters can be analyzed and monitored by the higher secondary school students with the help of trained teachers. The school labs with available facilities can perform compulsory water quality parameters (Level 1). The optional parameters are Fluoride, Nitrate and Iron, which are specific water quality problems of certain parts of Kerala. Hence it is considered as Level 2 or optional parameters that are to be analyzed in schools where these problems were reported and significant. The third level parameters are Heavy metals and Pesticides, which can be analyzed only in well-equipped labs with the help of specifically trained persons. These analyses also need sophisticated and costly equipment.

Level 1. Compulsory Parameters to be analyzed:

1. pH
2. Conductivity
3. Chloride
4. Hardness (Total)
5. Turbidity
6. Total coli form
7. Fecal coli form

Level 2. Optional Parameters to be analyzed depending on the local situation

1. Fluoride
2. Nitrate
3. Iron

Level 3. To be analyzed in referral labs only
1. Heavy metals
2. Pesticides

School/ college based program
The water quality problems of Kerala can be solved through the implementation of a proper water safety plan. In any water safety plan, water quality monitoring is an important component. The success of any monitoring program will depend on its sustainability. The chemistry and biology laboratories of High School and Higher Secondary Schools and the teachers therein can support the local community to assess the water quality status and enable them to correct the problems by themselves to a large extent. This may need the involvement of students who, in turn, will get trained in water quality analysis, as well as develop a feeling of social commitment and responsibility. The students may also take it up as a project as part of their curriculum.

High School/Higher Secondary Schools and colleges can undertake the analysis of the following water quality parameters after establishing a laboratory: Water quality analysis can be planned at 3 levels as compulsory water quality parameters, optional water quality parameters and water quality parameters which are to be analyzed in referred labs.

Establishment of a Mobile Laboratory
The mobile water analysis laboratory can be used for the field work and the analysis can be performed more conveniently and efficiently. Moreover, the importance of protecting the drinking water sources and simple methods of treatment will be popularizing among public.

The establishment of Mobile Water Analysis Laboratory will help the consumers especially in the rural areas to know the status of the drinking water quality of their source. The distribution of drinking water cards will help the people to get awareness on importance of the assurance of drinking water quality, methods of simple treatment and also the need to protect the drinking water resources.

The Mobile Laboratory will also be used to attend to assure the drinking water quality during any calamity especially during floods, drought and natural disasters.
Salient outputs are listed below:

1. Help to raise awareness within communities while carrying out their routine testing
2. Contribute to the establishment of a database for future work
3. A precautionary step taken to ensure the safety of water and its compliance with Bureau of Indian Standards drinking-water standards and WHO guidelines for drinking-water quality
4. Emergency Survey

The establishment of a mobile laboratory will cost Rs 35 lakhs.

Training and Information Education Communication (IEC) activities
The establishment of water analysis laboratory needs training of teachers and established NGOs on Hands on Training on Water Quality Monitoring .Along with water quality

monitoring, IEC activities will help in protecting the water resources and developing better sanitation practices. This activity can be carried out with the support of expertise available with Water Resources Department, Centre for Water resources Development and Management, various Academic Institutions, NGOs and other similar agencies.

Solutions: Protection/Conservation of Sources from Pollution

- Tighten decentralised Muncipal Solid Waste treatment systems
- Toilet systems with septic tank, etc. at household and community levels
- Public comfort stations with proper septic tanks at strategic locations
- Septage treatment systems at strategic locations, and measures for periodic desludging and treatment of septage
- Popularise and offer more incentives for organic farming
- Strict monitoring of industries and ensure discharge of water after necessary treatment- effluent generated and treatment by industries should be compulsorily made public.
- Regular monitoring of surface and groundwater sources
- Suitable water treatment measures to provide safe drinking water in coastal areas

Protection/Conservation of Sources

- Stop illegal sand mining from the rivers and ensure that approved quantity of sand is mined from the authorised 'kadavu'
- Water release schedules may be made for the withdrawal of water from Sasthamcotta and Vellayani lakes and withdrawal may be based on that.
- Mechanism for monitoring pumping from bore wells/tube wells may be evolved and enforced.
- Adopt soil and water conservation measures in an organized way, ie through watershed approach
- Rainwater harvesting may be given top priority, rooftop water harvesting in public buildings
- Restoring traditional water harvesting structures
- Wetland restoration
- Artificial recharge
- over exploitation of groundwater strictly prohibited in coastal areas
- land zoning

Conveyance

- Decentralize conveyance and distribution system and entrust user groups for management
- Timely leak detection, repair and replacement
- Monitoring for illegal connections

Misuse of Water

- Enforce strict monitoring and fine violators
- Awareness creation
- Dual line (long term)
- Effective pricing for both drinking water and sewage

Stakeholder Participation

- Decentralize conveyance and distribution of supply system
- Forums for participation may be created
- Incentives may be provided for water saving/conservation/water harvesting efforts

Integrated Water Resources Management

Plan and implement projects/programmes taking into consideration the principles of IWRM

Water Safety Plan

Water security and safety plan may be prepared and implemented on priority basis

Technological Options for Pollution Abatement and Water Conservation

- Pollution Abatement
- Those commonly used in Kerala for water treatment
- Those developed by CWRDM, BARC, CSIR, KWA, Jalanidhi etc. for water treatment
- Other
- Water Conservation
- Those commonly practiced in Kerala
- Other suitable to Kerala

Action Plan

The rejuvenation of rivers can be taken up by local bodies through various short term and long-term plans. The watershed-based conservation programmes will improve the quantity and quality of water that flows into streams and rivers. The action plans may differ from one river to another. But some of the general measures are described in the below sections:

CHAPTER-VII
SEWERAGE

The amount of water used in a country not only depends on minimum requirement and/or how much water is available, it also depends on the levels of economic development and urbanisation. People use water for a wide variety of activities. Different agencies and organizations have been proposed different amounts of water as the minimum standards. But the average water use of the countries varies from 10 to 575 lpcd, in which the highest water usage (575liters) reported for United States and lowest (10 liters) for Mozambique. In India, the average water usage for the domestic needs is 135 lpcd (UNDP, 2006). The water use and wastewater generation are interrelated. The volume of wastewater generated by domestic, industrial, and commercial sources has also increased with population, urbanization, improved living conditions, and economic development. It is the main cause of pollution of rivers, lakes and other natural water resources (Kamyotra & Bhardwaj, 2011). Central Public Health and Environmental Engineering Organization (CPHEEO) estimates, about 70-80% of total water supplied for domestic use gets generated as wastewater. According to WHO (2006) from the total water use, 80% is discharged as wastewater.

Wastewater disposal is a major challenge in the State. It was found that majorities (as much as 61%) of the families are disposing their wastewater directly to either the drainage channels/irrigation channels or to the open spaces.

7.1 Status

In Kerala, the coverage of sewerage facilities is extremely low. Around 30% in Thiruvananthapuram and 5% in Kochi Corporation areas have sewerage facilities, probably one of the lowest in the country. A new scheme for Guruvayur is under trial run. Thiruvananthapuram city has about 602.5 km sewerage coverage and for Ernakulam, it is 28 Kms. The Guruvayur sewerage scheme is technically commissioned. There is another septage treatment plant installed with the same capacity in Wellington Island, Kochi Corporation (Thiruvananthapuram Corporation, 2012; KSPCB,2010). The sewage treatment plant at Muttathara, Thiruvananthapuram has the facility to treat both the septage and sewage with the capacity of 107MLD. Independent septage treatment plant of Kerala is introduced in Brahmapuram by Kochi Municipal Corporation with the capacity of one lakh litres per day. The treatment plant proposed to collect the septage from homes and brought to the plant by tankers.

The collected wastes will be stored in separate tanks, and it will treat twice to achieve 90 percent purity. The treated water can be used for farming and other purposes. Rest of the urban and rural areas of Kerala does not have any septage treatment facilities. Currently, septage has been collected by private agencies and indiscriminately discharged into open spaces and natural water bodies of the State which is one of the major issues in Kerala.

Septage load of Kerala is estimated to be about 2.4million ton per year. Hence proper septage management system required prime attention and it should be incorporated into the sanitation scheme. Proper regulation or guidelines for safe handling transport and disposal

of septage is mandatory in Kerala to ensure the protection of natural resources and environmental hygiene.
The septic tanks are mostly faulty and need retrofitting. Further, it is highly necessary to convert the leach-pits to septic tanks considering that the groundwater table in Kerala is relatively high.

Details of STPs Functioning Under KWA:
a) 107 MLD STP in Thiruvananthapuram District at Muttathara (Activated Sludge with extended aeration process). The present sewerage system cover 43 out of 100 wards of Thiruvananthapuram corporation area either partly or fully. For convenience, the city area was divided into 5 blocks which were commissioned in different periods.
At present only 55MLD out of the 107 mld STP is used. Completion of ongoing works will enhance the utilization by 20%. Full utilization can be achieved only by expanding the sewer network. Considering the contamination of Karamana river and for providing sewerage systems for the 19 wards on the bank of this river, DPR prepared and submitted to GoK on 16.10.2021 for issuing AS under RKI. Sewer laying work of this 19 wards can be finished by 31/12/23, subject to the availability of funds. DPR for the remaining 81 wards for the full capacity utilisation of 107 mld STP is under preparation and expected to be completed by December 2021.

b) 4.5 MLD STP at Elamkulam, Ernakulam (Activated sludge process)
The existing Sewage Treatment Plant located at Elamkulam is having a capacity of 4.50 mld. The plant works in activated sludge treatment process. In Kochi existing sewerage system covers only 5% of Kochi Corporation. The Kochi Corporation is spread over 94.88 km2 and has been divided in to 74 wards with total population of 6,02,046 as per 2011 census. Considering 80% return, total sewage quantity in the year 2052 is estimated to be 147.80 MLD. .

The existing Sewage Treatment Plant located at Elamkulam is having a capacity of 4.50 mld. Present utilisation capacity of this plant is only 3MLD. DER for utilizing unutilized capacity of Elamkulam plant is under preparation. The plant was commissioned as early in 1959 and maintenance of the sewage Treatment Plant is done by KWA. For the planning and implementation purposes the entire Municipal Corporation areas and Panchayaths was divided into four zones A, B, C, and D. Out of these zones, only a part of Zone B was commissioned. Zone B, which is further subdivided into five sewerage blocks (A, B, C, D and E) for planning purpose. Block A (fully) and Block B (partially) is functional at present and are connected to the existing STP of 4.5 MLD which is being rehabilitated to 5 mld under AMRUT and progressing to commission in 31.3.2022.

c) 3 mld STP at Guruvayur (Activated sludge process)
The Guruvayoor Sewerage Project is planned to provide an effective sewerage system for the thickly populated area under Guruvayoor Municipality. The main aim of the scheme is to collect the sewage from houses, flats, hotel etc. and to treat in sewage treatment plant

of capacity 3 mld at Chakkumkandam, Guruvayoor. The work completed and is functioning from September 2021. Length of network is approximately 7 km. Plant technically commissioned on 30.09.2021 and partially commissioned on 20.10.2021 with 85 % of network.

d) Thiruvananthapuram - Medical College 5MLD STP

Works of 5MLD STP under AMRUT for Medical College, Thiruvananthapuram completed and started functioning from September 2021.This STP is exclusively for Thiruvananthapuram Medical College campus.

Grey Water

Among the various greywater sources (shower, laundry, kitchen sink and mopping), laundry and kitchen sink were considerably more polluted than the other sources for the greywater generation. Greywater is much easier to treat and safer to recycle for water usages such as toilet flushing, urban landscaping, or road washing, gardening etc. From the study, it was found that only about 10% of the families, in one way or other, use recycled water for gardening, toilet flushing, etc.

7.2 Outlook and Priority

The state hitherto has been promoting on site sanitation. Though waste water collection treatment and disposal is a mandate of KWA, the sector did not so far get its due attention for various reasons. The absence of proper wastewater and municipal solid waste disposal systems have adversely affected the surface and groundwater quality in the state. Most of the water bodies in urban areas are carrying black water affecting aquatic life and also public health in general. Kerala being a prime tourist location needs to keep its water environment clean if it has to sustain its tourist industry.

The state and KWA is taking necessary initiative to provide 100% sewerage coverage for the urban areas. KWA is taking steps to implement and expand sewerage networks in Thiruvananthapuram, Kochi, Thrissur, Kollam and Kozhikode.

7.3 Technological Options

The sewerage sector has been witnessing new developments in both treatment and network technologies. The state has to adopt the state of the art technologies as conventional systems are not favoured by the people of Kerala for aesthetic reasons.

7.3.1 Piped Sewerage

Piped sewerage is the most prevalent system for wastewater collection. But, Kerala being thickly populated, narrow roads with heavy traffic, sewer laying natural gradients is a challenge. Also the NIMBY syndrome together with high land cost do not favour large network based systems. Appropriate choice of technology with robust and reliable designs are essential for building sewerage systems in the state.

7.3.2 Septage Management

Good sanitation system is a necessary requirement to ensure the betterment of community health and hygiene. The United Nations Millennium Development Goals (MDGs) targeted to halve the portion of population without access of basic sanitation between 1990 and 2015. During the MDGs period, it is estimated that, the use of improved sanitation facilities rose from 54% to 68% globally. The global MDG target of 77% has therefore been missed by 9% points and almost 700 million people. Sixty-eight percent of the global population now uses an improved sanitation facility. An improved sanitation facility hygienically separates human excreta from human contact (UNICEF & WHO, 2015). According to World Bank, access to improved sanitation facilities includes flush/pour flush (to the piped sewer system, pit latrine, and septic tank) latrines, ventilated improved pit (VIP) latrine, pit latrine with slab, and composting toilet.

Many programs and policies were formulated in India to improve the sanitation status of the country. According to the Indian Constitution, State governments (Panchayat Raj Institutions and Urban Local Bodies) are responsible for implementing the schemes and projects for water and sanitation. National Central Rural Sanitation Program, Total Sanitation Campaign, Valmiki Ambedkar Awas Yojana for slums, Jawahar Lal Nehru National Urban Renewal Mission, National Urban Sanitation Policy etc. are some of the necessary policies/programs targeted to raising the sanitation status of the country (WSP, 2011). Presently Prime Minister's ambitious program 'Swatch Bharat' was launched to have better sanitation for all Indians. Most sanitation programs are focused on the installation of on-site sanitation system and sewerage development. The on-site sanitation system comprising septic tanks and pit latrines gets filled up with septage and faecal sludge depending on its capacity and usage (Varmma, 2015). Safe management of faecal matter from on-site sanitation structures received limited attention (MoUD, 2013). Most of the septic tanks are not desludged properly; they tend to be too full to perform the intended primary treatment and serve as holding tanks. Highly contaminated septic effluent flowing out of septic tanks enters nearest waterways, which has resulted in the contamination of water bodies (USAID, 2010). Though, regular desludging is necessary to maintain the treatment efficiency of septic tanks (Graham & Polizzotto, 2015). The desludged materials with high pollution potential are disposed indiscriminately into the water bodies, farmlands and wasted lands due to the lack of septage treatment plants and inadequate enforcement. In the absence of any consolidated septage management practices, all these improved sanitation facilities will continue to degrade surface water bodies and groundwater resources. Therefore, septage management should be an integral part of sanitation scheme and it is essential to protect the natural ecosystem and environment sustainability.

Septage Management in Kerala

People of Kerala always have an adequate awareness about personal hygiene and sanitation. The availability of sanitary toilets has improved in most parts of the state except in backward regions like coastal areas, hilly regions, tribal areas and urban slums (Chakrapani, 2014). In Kerala 95.2% of households have latrine facilities within the premises; it is higher than the national average (46.9%). Maximum latrine availability is reported in the urban areas (97.4%) of the State. The use of septic tank (50.3%) is the most prevalent practices adopted in Kerala followed by pit latrine (with slab/ventilated improved pit) (27.6%). The remaining households depend, piped sewer system (12%), open pit (0.7%), night soil disposed to open drain (0.2%), public latrine (1%), an open defecation (3.8%) and other systems (4.4%) for disposing the human excreta (Census of India, 2011). The septic tanks and pit latrines get filled up with septage and faecal sludge depending on its capacity and usage. Periodic desludging of latrines does not properly practice in the State; however, it is carried out only when it overflows. In the absence of adequate public services, private agencies have emerged to empty the on-site sanitation system by hand or with vacuum trucks. Desludged septage from the low-income areas usually deposits the septage in the residential compound, nearby drains, open ground or waterways (USAID, 2010).

Presently there is no regulation or guidelines existing for safe handling, transport and disposal of septage in the State. Most of the current laws and policies deal with water, wastewater and sanitation services but the septage management is not covered in a holistic manner. This necessitates a well-defined regulation, guidelines and management strategy for septage in the State. In 2011, the High Court of Kerala directed the State Government to take effective steps to set up plants for treatment and disposal of human excreta or black water.

7.3.3 Waste Water Management / Recycling

Wastewater may be defined as, a combination of the liquid or water carried wastes removed from residences, institutions, commercial and industrial establishments together with groundwater, surface water and storm water as may be present (Metcalf & Eddy 2009). Wastewater is a combination of one or more of; domestic effluent consisting of black water & greywater; water from commercial establishments & institutions including hospitals; industrial effluent, storm water & other urban run-off: agricultural, horticultural and aquaculture effluents contaminated with either dissolved or as suspended matter (Corcoran, et al., 2010, UNWater.,2014). According to UN Water (2015), water is considered as wastewater, when it is contaminated with pathogenic material or inorganic or organic contaminants which can cause risk to human or animal health or damage natural ecosystems. Discharge of untreated wastewater is a great concern due to its impact on the environment. organic matter and nutrients (nitrogen, phosphorus and potassium), inorganic matter & toxic chemicals, dissolved minerals and pathogenic micro-organisms.

Domestic wastewater generally classified into grey water (kitchen and bathing wastewater) and black water (excreta, urine and faecal sludge) (Hanjra et al., 2012; UN-Water, 2015). Grey water is wastewater originating from showers, baths, bathroom sink kitchen sinks, wash basin and laundries and excludes wastewater from toilets.

Greywater usually receives the least attention compared to other environmental aspects like solid waste and black water, particularly in low- and middle-income counties. The untreated greywater often discharged into poorly developed earth drains, undeveloped plots of land or onto open surfaces. If the quantity of wastewater is more, the receiving water will become polluted or the land become sewage sick. Under such circumstances it becomes essential to treat the wastewater, so that the land or receiving water body can accept the treated water without any objections.

Separation of greywater from black water will dramatically reduce the danger posed by such pathogens (MoRD, 2006).

Sustainable wastewater management strategies are the key solutions to deal with the issues of available potable water shortage and water pollution.

7.3.4 Effluent Disposal

The proper disposal of treatment plant effluent or reuse requirements is an essential part of planning and designing wastewater treatment facilities. In order to remove our liquid waste out to sea, vast quantities of water are needed as a transporting agent in our river systems. Since the output of both domestic and industrial effluent is increasing more or less directly in relation to the growing abstractive demand, the pollution load becomes progressively harder for water resources to absorb. Thus effluent disposal and the subsequent deterioration in water quality influence both the use and conservation of water because, as the pressure on resources continues to build up, so the degree of pollution and the amount of feasible re-use of water will, in many respects, determine the real availability of supplies.

Effluent sewer systems, also called Septic Tank Effluent Gravity (STEG) or Solids-Free Sewer (SFS) systems, have septic tanks that collect sewage from residences and businesses, and the liquid fraction of sewage that comes out of the tank is conveyed to a downstream receiving body such as either a centralized sewage treatment plant or a distributed treatment system for further treatment or disposal away from the community generating the sewage. Most of the solids are removed by the interceptor tanks, so the treatment plant can be much smaller than a typical plant and any pumping for the supernatant can be simpler without grinders (sometimes water pumps are sufficient). An alternative effluent sewer which is similar to the STEG system is the STEP system. Because of the vast reduction of solid wastes and the capture of fats, oils and grease (FOG) within the interceptor tank, a pumping system can be used to move the wastewater under pressure rather than a gravity driven conveyance system.

Effluent pumping sewers have small diameter pipes that follow the contour of the land and are only buried a metre or two underground. While an effluent sewer can use gravity to move waste, the ability to move waste with a pressure system can be a big advantage in places where a gravity system is impractical. Compared to conventional sewer systems, effluent sewer systems can be installed at a shallow depth and do not require a minimum wastewater flow or slope to function. Effluent sewer systems, as well as all sewer systems, can use two methods to transport wastewater to a treatment facility. These methods are gravity and pumping, also called pressure systems. Gravity systems use pipes that are laid on a slight downhill slope to transport wastewater. Effluent pumping systems have pipes that are buried at a constant depth, such as a metre and a half, and rely on pumping stations that create pressure to move the waste to a treatment facility. An effluent sewer that uses gravity may be called a Septic Tank Effluent Gravity (STEG) system, while a pumping system may be called a Septic Tank Effluent Pumping (STEP) system. It is also possible to have a hybrid system that uses gravity and pumping. Gravity and pumping effluent sewer systems both have advantages and disadvantages. The best type of system to use depends on the area it will be serving. Factors such as population size, topography, groundwater level, as well as locations for pumping stations and the treatment plant, must be taken into account. STEG systems should not be confused with traditional sewer systems that use gravity to transport untreated sewage to a wastewater treatment plant, which are typically referred to as gravity sewer systems.

7.3.5 Sludge Management

Sludge management is one of the most difficult and challenging tasks of wastewater treatment plants due to its high water content and poor dewater ability and strict regulation for sludge reuse or disposal. Sewage sludge is the solid, semisolid, or slurry residual material that is produced as a by-product of wastewater treatment processes. Many sludge are treated using a variety of digestion techniques, the purpose of which is to reduce the amount of organic matter and the number of disease-causing micro-organisms present in the solids. Digested sludge is passed through de watering step; the dried solids are disposed of, and the water is sent back to secondary treatment The most common treatment options include anaerobic digestion, aerobic digestion, and composting. Biological sludge can be disposed of by incineration; the carbon, nitrogen, and sulphur are removed as gaseous by-products, and the inorganic portion is removed as ash. Currently, sewage sludge management is a huge challenge in the field of environmental engineering.

New effective solutions for the treatment of wastewater led to an improvement of the quality of the final effluent but considerably increased the volume of produced sewage sludge, which increases each year and mountains. Faecal Sludge Management (FSM) is the collection, transport, and treatment of faecal sludge from pit latrines, septic tanks or other onsite sanitation systems. Faecal sludge is a mixture of human excreta, water and solid wastes (e.g. toilet paper or other anal cleansing materials, menstrual hygiene materials) that are disposed in pits, tanks or vaults of onsite sanitation systems. Faecal sludge that is removed from septic tanks is called septage. FSM is necessary in densely populated areas where a proportion of population is not connected to a sewerage network, and the covering and rebuilding pit latrines is not possible.

CHAPTER-VIII
WATER CONSERVATION

The main factors that determine the water availability of an area are mainly the topography of the area, the slope of the land, the type of soil, utilization of land, the availability of rainfall, the density of water resources and the presence of waterways. Kerala is a relatively a sloping narrow land between the Western Ghats in the east and the Arabian Sea in the west. Kerala is rich with 44 rivers, their tributaries and their chains of streams, creeks, and canals. However, compared to other states, the steeper slope and the short rivers accelerates the water flow during rain and the rain water quickly reaches the sea.

Water resources of Kerala
50445 pools
13 lakes
879 Rocks
44 rivers
84869 km Waterways
236 springs
55 reservoirs
4648 km Irrigation canals
About 150 barrier reservoirs
About 1000 tunnels
More than 50 lakh wells

Major problems faced by water resources in Kerala
Pollution
Pollution is a major problem for our water resources. This is due to city vulcanization and the habit of inadvertently disposing of waste. At the same time, depletion of summer water availability leads to an increase in wastewater concentrations. There are two main types of pollutants that reach our water sources: solid and liquid. In addition to being dumped or discharged directly into water sources, wastes discharged elsewhere also flow with rainwater and end up in them. In addition, in many places, sewage pipes and sewers that are open to canals, rivers and streams cause pollution. In many places, meat waste and even hospital waste are dumped in rivers. Our country has strong laws in place to prevent and control this pollution. But these are not seen utilized effectively.

Flooding
The greater the slope of the earth and the greater density of the network of canals caused faster flow of rainwater subsequently reaching the plains. Changes in land use and the increase in the area of land used for construction have significantly reduced the rate at which rainwater infiltrates into the soil. Decreased area of paddy fields and wetlands in the plains has reduced the water carrying capacity of the area. All this led to the flood.

In Kerala generally flood occurs at regular intervals. But the gap between the two floods can be seen to be narrowing in recent years. Extreme levels of rainfall over a short period of time also cause floods.

Encroachments
Common encroachments on water bodies, structures that have been lowered into water bodies, partially or completely filled sections, and unscientifically constructed culverts and bridges across the rivers reduces the width of the river. In addition to encroachment by private individuals, encroachments by government agencies are also observed as part of the construction of roads and buildings.

Networks Disruption
The integrity of a canal is important in ensuring water availability and flow. But as part of many human interventions, these networks have been broken in many places. In many places the streams have been closed, narrowed, or filled. This can cause waterlogging thereby creating flooding, landslides.

Decrease in catchment groundwater table
Changes in land use, population growth and increased population density have led to the conversion of most areas into urban areas, increasing the area of land used for residential purposes, the shift of many people from agriculture to other occupations, the depletion of agricultural land (especially paddy fields), and the filling of reservoirs, including ponds, with soil and other wastes. The depletion of agricultural land and the depletion of green cover have significantly reduced the groundwater table in the catchment area.

Salt water intrusion
As a result of activities such as excessive and unsustainable sand dredging, the lower reaches of the rivers and the lower summer runoff caused the inflow of salt water into the very hinterland.

Our rivers and canals have two main functions. One is to ensure summer water availability and two is to ensure safe drainage of excess water during monsoons. For this to be possible, the rivers need to be provided with the space they need to carry water and overflow. There has been a huge decrease in this in recent times. In addition, our ponds and fields played an important role in storing water during the monsoon and draining it very slowly after the rains. This enabled groundwater recharge to help control floods, increase water flow duration and ensure more water availability during the summer.

Rivers in Kerala depend on rainfall alone to maintain their flow. There is only a difference of days between our two monsoon seasons (South west and North east monsoons).

8.1 Rain Water Harvesting (RWH) and Ground Water Recharge
Rain water is considered the purest form of water. Impurities and salts present in water on earth are left behind during vaporization by the sun. In India rainwater harvesting has been in practice for more than 4000 years. It is basically a simple process of accumulating and storing of rainwater. Rainwater harvesting systems, since ancient times, has been applied as a supply for drinking water, water for irrigation, and water for livestock. The systems are easy to construct from locally sourced inexpensive materials, and it has proved to be a success in most areas. The prime advantage of rainwater is that the quality of water is usually good, and it does not necessitate any treatment before consumption.

Recharging Groundwater Aquifers

Groundwater aquifers can be recharged by various kinds of structures to ensure the percolation of rainwater in the ground instead of draining away from the surface. Commonly used recharging methods are: -

- Recharging of bore wells
- Recharging of dug wells.
- Recharge pits
- Recharge Trenches
- Soakaways or Recharge Shafts
- Percolation Tanks

Conservation of traditional water resources

It is estimated that there are 50445 large ponds in Kerala. Most of these were used to prepare irrigation for agriculture. The depletion of agricultural land and fields has led to the destruction of many of these. Due to the low carrying capacity and the contamination of the water without proper protection, the water in these cannot be used for various purposes. These ponds can be converted into additional water sources to ensure the availability of fresh water to more people. For that

- All ponds should be cleared of waste and water carrying capacity restored.
- Contamination should be avoided by making side protection possible.
- Summer water availability should be increased by enabling groundwater recharge in the catchment area.

  More than 60 per cent of households in Kerala also depend on wells for water. Considering their drinking water problem,
- It is advisable to encourage those who use wells with access to drinking water throughout the year to continue using the same
- Adequate recharging system should be set up in summer drying wells to increase water availability. Lack of safe septic tank system, high ground water level and high density of toilets pollute the well water. Interventions should be made to avoid these.
- There are 830 quarries in our state with access to water and there are many smaller rock formations. Many of these have large amounts of water available. It can be used as a local source. Water quality can be checked and suitable ones can be utilized as additional reservoirs.
- Locally used lakes and tunnels etc. can be kept clean and safe and used as a source of drinking water.

In a survey conducted by CWRDM there were 6.6 million wells in Kerala, perhaps more than the number of families in the State. Most of the families, who do not have piped water supply must be depending on these sources. The random surveys show that at least 50% of families partly or fully depend on these sources, all through the year or part of the year. The major problems faced by these wells are mainly due to lack of maintenance, recharge and sanitization. 40% of wells in the coastal belt can be rejuvenated and 90% of our wells sanitized and an attempt should be made to popularize recharging, which has not picked up so far.

"Vattatha Uravakayi" (വറ്റാത്ത ഉറവയ്ക്കായി): Jalasamrudhi –Kattakada

The 'Jalasamrudhi' project which made Kattakada a water-surplus constituency has attracted national attention when it was showcased by the Kerala State Land Use Board at the India Water Week being organised by the Union Water Resources Ministry at Vigyan Bhavan, New Delhi during September 2019.

The conservation methods included digging of farm ponds, making groundwater recharging pits in institutions, diversion of water from quarries to recharge pits and construction of check dams in streams. These have brought about a drastic change in the ground water situation in the region

The current Kattakada Assembly constituency has conducted water audit and is a water surplus unit. This model can be replicated throughout Kerala.

8.2 Watershed Management

Rivers are streams in the last row of a network of canals. Only by conducting scientific soil-water conservation activities in the micro-watersheds of the canals that flow into them and their tributaries can their water flow be stabilized, water availability increased and water quality improved.2

Intervention in micro-watersheds is possible only in small areas (100 to 1000 hectare). Therefore, appropriate interventions can be made to suit the nature of each small area. In addition, the soil type, biodiversity and water availability of the area will be similar.

Watershed Intervention -Three main factors

1. Water resource management
2. Land Use Management
3. Biomass Management

The scientific basis for watershed interventions is a diverse approach (Multidisciplinary) based on watersheds. In Kerala, various departments / agencies are functioning under the direct control of the Government in the field of water resources. The activities of such departments require precise goal setting and coordination.

To make this possible, priority should be given to activities from the top of the hill to the valley. Such activities can be mainly divided into watershed management and waterway intervention.

Watershed Management

Watershed management mainly involves interventions to safely drain rainwater under soil from an area. Extreme care is required in determining the appropriate catchment area management intervention in the event of continuous rainfall in Kerala. The type of soil in an area, the slope of the land and the thickness of the topsoil need to be considered when determining these actions.

Biological methods

Organic fencing, mulching, cover crop, mixed multi-cropping, crop rotation, afforestation etc.

Constructions

Stone laying, ditching, contour ditches and bunds, basing around trees, pool renovation, pool construction, etc.

Ponds are a major contributor to groundwater recharge. Therefore, the maintenance and construction of ponds is an essential task. Among this the protection of Head ponds are the most important. It is important to clean the ponds and take care of the side and find various uses for them as well as to ensure that the catchment area is maintained in such a way as to increase the water availability in them. There are 830 large stone masonries in our state with access to water. There are also several small rock formations. Many of these have large amounts of water available. It can be used as a local source. Water quality can be checked and suitable ones can be utilized as additional reservoirs

Intervention in waterways

Watershed management activities will enable summer runoff in the canals and increase the groundwater level in the area. At the same time, various interventions can be made in waterways.

- Restoration of lost networks
- Restoration of canals (depth, width, etc.)
- Lateral conservation activities in waterways (emphasis should be given to organic practices such as planting grass, bamboo and other suitable trees, and protection with coir geotextile).
- Removal of accumulated silt, waste and indoor vegetation to facilitate monsoon flow and restore water carrying capacity.
- Ensuring summer water flow and water availability. (Groundwater recharge activities in the catchment area, resumption of paddy cultivation and increase in paddy cultivation area will all contribute greatly to this)
- Construction of temporary and permanent dams to enable water storage, increase summer flow and ensure environmental flow. Barriers can also be constructed without preventing the flow of monsoon water.

Reduce salt water intrusion

Coastal areas are a major zone having drinking water shortage. This inflow of salt water is felt from the shore to the deep inside. Its rate is increasing. This intrusion is visible not only in surface water but also in groundwater. This can be prevented on a large scale by increasing the summer water flow in the canals as part of interventions in the catchment areas from the point of origin of the canals. Extensive ponding and storage of water in coastal areas can be done to prevent monsoon flooding and to prevent the intrusion of groundwater by the pressure of the water stored in these reservoirs.

Particular attention should be paid to the preparation of systems for the scientific management of wastewater and sewage in coastal areas where groundwater levels are very high.

Operational organization

Coordination of various departments and agencies is essential for organizing such activities at the local government level. The Mahatma Gandhi Rural Employment Guarantee

Scheme and the Ayyankali Employment Guarantee Scheme can play an important role in this. Interventions should be made for machine-assisted disinfection of water sources where manual operations are not possible. In addition, special funds (as budget allocations) should be made available to various departments for conservation of water resources that have been cleaned and rehabilitated. The Local Self Governments should take the lead in implementing the work in collaboration with the various departments by enabling such coordination.

Public Participation - People's Committees

Public participation is very important for water resources recovery activities. Participants in the activities can be made aware that these water sources are theirs (it is important to form people's committees everywhere for these activities. In addition, these committees themselves, as a permanent monitoring mechanism, can intervene to prevent pollution and encroachment, and may periodically inform the relevant authorities about these matters, such as undertaking continuous maintenance of rehabilitated water resources and engaging them with agriculture and aquaculture using water available wherever possible).

Integration with other departments

The information available with the Irrigation Department and the Ground Water Department can be used for activities in this area. GIS of Ground Water Department lab can be expanded and used. Water resources can also be geo-referenced and utilized for planning, taking advantage of the feasibility of the Mappathon project prepared under the IT Department.

8.3 3R Concept

The 3R concept of waste management basically includes 4 key activities, viz. reduce, reuse, recycle and recover

A. Reduce: Only the most optimal amount of resources must be used in order to avoid wastage of any usable resources. This can be considered as a sort of a conservation effort which aims at reducing the needs to reduce the waste.

B. Reuse: Before trying to acquire newer resources, we must first analyse if the resources available with us can be used again.

C. Recycle: whatever material can be reused through some form of processing, must go through recycling. Recycling gives a new life to base material and makes it fit to be used in the same capacity as before.

8.4 Demand Management

Water budget and water security

Kerala receives so much rainfall but summer water availability is often insufficient. The water budget is prepared in such a way that we can scientifically identify the amount of water available to us each time and the total amount of water required for various purposes and adopt ways to address the shortage of availability. We get water for various purposes mainly from rain.

Soil specificity

The amount of surface vegetation and the type of soil determine how much water falls into the soil in each area. Then the amount of water required for each need is also calculated. Water is mainly used for agriculture, animal husbandry, industry, commerce, household, tourism and ecology. In this way the total water requirement is calculated by adding them all together. In this way, every ten days, the gap between water demand and water availability should be checked and measures should be taken to address the shortage and ensure water security.

Scales can be set up to determine water availability at water sources. It can be placed in pools as a first step. A board can be placed near the scales to record the total amount of water available in the pond according to the water level on the scale. This will enable the public to know the availability of water at all times. It will also help in gathering information required for preparing the water budget.

(As part of the activities of Haritha Keralam Mission, such scales have been installed in 100 ponds in Kattakada constituency and the water level in them has been determined with the participation of the people and used for planning).

CHAPTER-IX
RESEARCH & DEVELOPMENT

9.1 Technology Adaptation

In recent years the water and wastewater sector has been witnessing a flurry of technologies in the entire spectrum of water utility activities including in water treatment process engineering, smart water network etc. Traditionally the water industry is not a fast-moving early adopter of latest technologies. But KWA in its JICA assisted KWSP has introduced a variety of technologies like high-rate filters, pulsator clarifiers, lamella clarifiers, plant automation, SCADA and telemetry, latest leak detection methods, etc. KWA needs to internalize these technologies both in its design and implementation by providing training, capacity building, etc.

9.2 Smart Water Network

Smart water refers to a movement in the water industry involving emerging technology that includes hardware, software, and analytics to help water and wastewater utilities target to solve problems through automation, data gathering and data analysis.

A Smart Water Network is the collection of data-driven components helping to operate the data-less physical layer of pipes, pumps, reservoirs and valves. Water utilities are gradually deploying more data-enabled components. Initially smart meter network can be adapted in high utility, high density areas such as dense urban population, industrial parks/estates, Central Business Districts (CBD).

Collecting and using comprehensive data about water network operations offers the promise of better operations through better knowledge and tighter control of the network's extensive and complex assets. The concept has a significant contribution in the efforts towards affordable, sustainable and pure water for all.

9.3 Non-Revenue Water Management (NRW)

The difference between the total amount of water produced and the amount of water used to reach at the consumer level through the supply chain is considered as Non-Revenue Water. This is mainly calculated based on two factors - the actual loss (physical loss) due to leaks in the pipes and the commercial loss due to the inability to quantify the proper use of water due to meter failure and theft.

The daily production of drinking water by Kerala Water Authority is 2800 MLD. According to the current billing estimates, the non-revenue of the Kerala Water Authority is about 40% - 45%. This includes damage due to leaks through pipes (physical damage) and loss (commercial loss) due to inability to verify proper use of water due to meter malfunction and theft. This cannot be completely reduced. However, global figures suggest that the amount of non-revenue water can be reduced up to 20%.

In this way, the water loss in KWA is around 550 MLD to 700 MLD per day. Under the current tariff, the average daily loss would be Rs 60 lakh. As a result, the Water Authority loses about Rs 200 crore in revenue every year. Losses need to be accurately calculated as the first step in reducing the amount of non-revenue water. For this, bulk water meters need to be installed at production centers and main distribution lines. Steps are being taken to complete the project in stages. Leak detection equipment is being used to detect underground leaks in pipeline. In addition, a flowmeter is used on the main lines to determine the amount of water and to detect leaks. There are plans to form Leak Detection and Surveillance Squads in all regions to expand such activities. The Head Office has a 24-hour grievance redressal center for the public to register such complaints and monitor leaks until they are resolved. A meter policy has been formulated with the objective of minimizing rate of commercial losses.

To avoid water loss due to breakage of pipes, immediate rectification of the broken pipes by the running contractor and using the Blue Brigade system are in place.
To summarize, the following measures are being taken to control NRW:
- Bulk flow measurement to assess the quantity produced and distributed
- Meter policy aimed at reducing commercial losses
- Active leakage control measures using modern leak detection equipment
- Prompt rectification of pipe bursts
- Awareness creation on misuse of water
- Enforcement of penal provisions for misuse, unauthorized use and theft
- Replacement of old and damaged pipelines

Also an ADB assisted project for implementing 24X7 water supply in Thiruvananthapuram and Kochi cities is in its preliminary stages. This project is expected to bring down the NRW in these two cities to the national benchmark level of 20%.

9.4 Wastewater Recycling
Wastewater recycling is the process of converting sewage or industrial wastewater into water that can be reused for a variety of purposes. Types of reuse include urban, irrigation, environmental, industrial, direct and indirect potable reuse etc. For example, reuse may include
- irrigation of gardens
- irrigation of agricultural fields
- replenishing surface water and groundwater
- toilet flushing
- businesses and industry
- and could even be treated to reach drinking water standards.

Reusing wastewater as part of sustainable water management allows waste water to remain as an alternative water source for human activities. This can reduce scarcity and alleviate pressures on groundwater and other natural water bodies.

The Goreangab water treatment plant in Windhoek, Namibia opened in 1968 was the first waste water treatment plant in the world. NEWater is the brand name given to highly treated reclaimed wastewater produced by Singapore's Public Utilities Board.
The two types of recycling includes
- Indirect:

Uses an environmental buffer, such as a lake, river, or a groundwater aquifer, before the

water is treated at a drinking water treatment plant.
• Direct: Involves the treatment and distribution of water without an environmental buffer.
Technologies used to treat wastewater are:
• Ozonation
• ultrafiltration
• aerobic treatment (membrane bioreactor)
• forward osmosis
• reverse osmosis
• Advanced oxidation.

Some water demanding activities do not require high grade water. In this case, wastewater can be reused with little or no treatment. One example of this scenario is in the domestic environment where toilets can be flushed using grey water from baths and showers with little or no treatment.

In the case of municipal wastewater, the wastewater must pass through numerous sewage treatment process steps before it can be used. Steps might include screening, primary settling, biological treatment, tertiary treatment (for example reverse osmosis), and disinfection.

The cost of recycled water exceeds that of potable water in many regions of the world, where a fresh water supply is plentiful. However, reclaimed water is usually sold to citizens at a cheaper rate to encourage its use. As fresh water supplies become limited and climate changes affecting the sources, this technology may be used at its full so as to meet the demands in future.

According to the 2015 report of the Central Pollution Control Board, India has the capacity to treat approximately 37% of its wastewater, or 22,963 million litres per day (MLD), against a daily sewage generation of approximately 61,754 MLD.

In Kerala, the sewage treatment plants may be used as source for producing fresh water in future. The STP at Muttathara, Thiruvananthapuram, having a capacity of 107 MLD may be used a source for producing at least 50 MLD fresh water through tertiary treatment.

Global warming and increased demand resulted in scarcity of surface water sources thereby urging the need for producing fresh water through alternate technologies including waste water recycling which is one of the sustainable development methods.

9.5 Industry-Institution Linkage

Need for linking knowledge points is the need of the hour. The engineers in the departments need to service their knowledge for keeping abreast with the ever-changing technologies in their respective fields. Building linkages with academic institutions having highly qualified and experienced professionals in various engineering faculties is a step in this direction. Such linkages will be a cross cutting learning opportunity for both the sides. The vibrant student community can come up with out of the box ideas and solutions which can be tried and tested in the wide canvas of the departments. Their presentations and success stories can be shared with the officers across the sector so that both sides benefit.

This will ensure entrepreneurship and create new job opportunities for youngsters who can be readily accommodated in the ever expanding water sector. Research oriented implementation will take place leading to cost cutting, better service delivery, etc with the local populace.

9.6 Desalination

Desalination in water sector can be defined as a purification process that removes salts and mineral components from saline water so as to produce fresh water. Both waste water recycling and desalination techniques are vital considering the fact that both are rain-independent. Although both are costly techniques, these become inevitable as alternatives for other sources as the depletion of reserves is a critical problem worldwide. Desalination is an eco-friendly and long lasting technology. Most of the modern interest in desalination is focused on cost-effective provision of fresh water for human use.

This technology is in use world-wide, more common in Gulf countries. The world's largest desalination plant is located in Saudi Arabia (Ras Al-Khair Power and Desalination Plant) with a capacity of 1,401,000 cubic meters per day. Main desalination plants in India are located at Jodiya in Gujarath and Kattupally in Chennai.

The most common desalination technologies are

- **Membrane based reverse osmosis:**

The key technology in this desalination process is the Reverse Osmosis. In this process sea water is forced against semi-permeable membranes under pressure in a continuous flow condition. As the water permeates through the membrane, most of the dissolved impurities and 99.5% of the total salt is removed.

- **LTTD (Low Temperature Thermal Desalination):**

LTTD works on the principle of utilizing temperature gradient within a water body or between two water bodies to evaporate the warmer water at low pressure and condense the resultant vapor with the colder water to obtain freshwater.

LTTD was studied by India's National Institute of Ocean Technology (NIOT) from 2004. Their first LTTD plant was opened in 2005 at Kavarati in the Lakshadweep islands. The plant's capacity is 100,000 litres.

Kerala has a coastal line of 590 km. Kerala Water Authority in collaboration with Fisheries Department and National Institute of Ocean Technology (NIOT), is exploring the possibility of installing desalination plants along coastal belts (Fishing Harbour and Fishing Villages) to solve the problem of water shortage in these areas of Kerala. KWA is thus planning to create a chain of desalination plants connecting all coastal villages with a view of producing 1 lakh litres/hr of desalinated water so as to supply the additional water produced to Ports, Coastal Industries, Naval bases etc.

As decided in the joint meeting convened, the Fisheries department will identify fishing villages with acute water shortages, while KWA is to fine tune the selection in accordance with present coverage and scope, and NIOT is to provide appropriate technology. A list of the villages experiencing water shortage was provided by the Director of Fisheries. The list contains information about fishing villages in Thiruvananthapuram, Kollam, Malappuram, Kozhikode, Kannur, Ernakulam, Alappuzha and Thrissur where water is in short supply. As a first step towards assessing whether desalination plants can be installed at these sites, a preliminary survey for data collection and analysis of water that can serve as a source for the desalination plant is to be undertaken. After that the technology of desalination will be decided according to the data collection and analysis. As the depletion of reserves is a critical problem worldwide, Kerala should not hesitate to start a desalination plant, bottled water plant or even water from air plant wherever economically feasible. Kudumbasree units can operate these plants based on the income from consumers. Certain mobile units can be effectively used in places facing natural calamities.

CHAPTER-X
POLICY AND GOVERNANCE

Policy is a framework by which governments undertake decisions that guide specific actions with the objective of achieving specific goals. Policy also acts as a tool that enhance accountability between government and citizens. With this objective in view the central and state governments have come out with policy documents.

10.1 National and State Water Policies

The present edition of national water policy (2012) and Kerala state water policy (2008) are being revised considering the emerging challenges especially the climate related ones. Dr.Mihir Shah, Chairman of the drafting committee of the new national water policy says " We need to take serious cognizance of the current context of climate change and the grave crisis of water facing the country". Recent estimates suggest that if the current pattern of demand continues, about half of the national water demand will remain unmet by 2030. With water tables falling and water quality deteriorating a radical change is needed in the approach to water management. Changing patterns and intensity of precipitation, as also rates of discharge of rivers, show that it can no longer be assumed that the water cycle operates within an invariant range of predictability. This requires greater emphasis on agility, resilience and flexibility in water management, so that there could be an adequate response to the heightened uncertainty and unpredictability of the future".

According to Dr.Mihir Shah, two major recommendations in the new policy would be,:
(i) Shift focus from endlessly increasing supply of water towards measures for demand management. This means diversifying cropping pattern to include less water intensive crops. It also needs lowering the industrial water footprint by reducing water use and shifting to recycled water.

(ii) Shift in focus within the supply side also because the country is running out of sites for further construction of large dams, while water tables and ground water quality are falling in many areas.

In terms of policy and governance mentioned in CWMI, Kerala state is positioned at 14 out of 17. It is based on the indicators 27, 28a and 28b. Indicator 27 mentions percentage of households being provided with water supply and charged for water in urban areas. This is mentioned as 26%. According to Kerala Water Authority, two-third household in urban area are provided with water supply through functional household tap connection. It is claiming that all water supply connections are fitted with water meter and charges accordingly. It shows that there is a huge difference between data from NITI Aayog and KWA. Indicators 28a and 28b are connected with Data Centre.

10.2 Water Pricing

The national and state water policy documents have recognized the economic value of water and emphasized the need for logical pricing of water. According to the state water policy 2008, water charges for various uses shall be fixed in such a way that they cover at least the

O&M charges for the service. However, the prevailing user fees for drinking water in the state does not even cover 50% of the O&M cost.

The state follows an increasing block tariff which is uniform across the state. The user fees in force (fixed in (2014 with a 5% increase allowed in 2021) is reasonably fixed for the non-domestic and industrial consumers, but it is extremely low for the domestic consumers, especially at the lower consumption brackets. The fee is as low as 0.42 paise per litre up to a consumption level of 10 kl while the cost of production is as high as 2.3 paise/kl. About 55% of KWA's consumers fall in the below 15 kl consumption bracket and the low fee at this consumption level punches a deep hole in the bottom line of KWA's finances. Even though the willingness to pay have been established as is evidenced in the Jalanidhi schemes, where the minimum charge is Rs.100/household for a lesser service level of 70 lpcd, the willingness to charge is missing.

By better management practices, there is enough scope for making significant improvement in revenue collection, operational efficiency and reliable services to the people by reducing NRW which is around 40%, improve energy efficiency, better design and procurement standards and all-round productivity improvement, there could be a turnaround probably with an immediate user fee revisit. This is possible under well-defined responsibility, accountability, operational freedom and SMART customer focused management practices. Kerala has proven similar experience to a great extent in power sector. Ringfenced divisions with more autonomy on operational management to achieve financial and operational sustainability and to improve services meeting national benchmarks.

10.3 Source Protection

Source protection is critical both from the water security and water safety angles. The available surface water sources are dwindling because of encroachment, dumping of solid waste and changing weather patterns. In most urban areas development is happening by encroaching floodplains and wetlands that would have otherwise helped the process of recharging groundwater.

There is mounting evidence across the globe in favour of nature-based solutions for water storage and supply. Thus, National Water Policy places major emphasis on supply of water through rejuvenation of catchment areas, which needs to be incentivized through compensation of ecosystem services, especially to vulnerable communities in the upstream, mountainous regions. There will be renewed thrust on RWH to catch the rain where it falls, when it falls, must be combined with demarcation, protection and revival of traditional local water bodies in both rural and urban areas.

There has to be enhanced integration and coordination through effective land and water zoning regulations that protect urban water bodies, groundwater sources, wetlands and green cover while simultaneously working to enhance wastewater recycling and water recharge activities targeting aquifers and wells through rainwater harvesting.

This would be for enhanced integration and coordination through effective land and water zoning regulations that protect urban water bodies, groundwater sources, wetlands and green cover while simultaneously working to enhance wastewater recycling and water recharge activities targeting aquifers and wells through rainwater harvesting.

At the sectoral level the ministries and departments of WR must coordinate with their counterparts in agriculture, environment, and rural development for greater convergence to achieve water and food security.

10.4 Data Management

There is an urgent need to setup an integrated Data Centre in the state and update data regularly. As per CWMI, 15 out of 26 reporting states have Data Centers, out of which 13 are updating regularly.

A transparent data generation and management systems amenable for intelligent/disaggregated analysis and capable of supporting informed decision making has to be set up. Currently the data generation in the state is in silos, fragmented, partial and flow vertically hampering transparency and informed decision making. The state sector information management system may be set up and anchored at the WRD/KWA with mandatory sharing of data by stakeholders/ networks. All as-laid maps may be digitized in GIS and mandatorily integrated with the SIMS. Application of SMART water practices and technologies like AI, sensors, IoT and SCADA can be integrated for better management and be seamless data sharing.

10.5 Water Regulator

The water sector in India has always been complex with multiple challenges such as inefficient use of water resources, conflicts between various categories of water users, inadequacy of funds to complete resource development projects, fiscal issues in meeting operational and maintenance costs from water tariff, lack of a uniform approach in water planning and development, etc. The huge amount of investment on infrastructure by the State also has not led to increasing efficiency in the maintenance and distribution of water resources. Water, being a vital resource, is widely recognized as a public good. Being a public good, water tariffs have not conventionally taken into account the operation and maintenance costs of infrastructure. This has often resulted in arbitrary and ad-hoc pricing mechanisms in the water sector.

A regulatory mechanism for overseeing the relationship between the service provider and water user entities and also within a water user entity, in terms of determination, enforcement and dispute resolution of entitlements and fixation of water charges will go a long way in streamlining and disciplining the chaotic sector.

The main functions of the authority can be:

1. Determine the criteria, regulate and enforce the distribution of entitlements for the various categories of use and the distribution of entitlements, within each category of use.
2. Specify or enforce standards with respect to quality, quantity, continuity and reliability of service
3. Promotion of competition, efficiency and economy in activities of the water sector
4. Establish a water tariff system for levying water charges on various categories of water

users with a view to establishing a stable and self sustainable management of service delivery to such users.

5. Review and clear water resources projects, with a view to ensuring that a project proposal is in conformity with the overall sectoral plan of the state.
6. Support and aid the enhancement and preservation of water quality and promote sound water conservation and management practices.
7. Ensure equitable distribution of water during periods of scarcity
8. Advise the State Government on all or any of the following matters, namely:
   - Promotion of investment in electricity industry.
   - Reorganization and restructuring of water sector institutions in the State
   - Any other matter referred to the State Commission by that Government.

An economic regulatory entity/function (which could range from a unit in WRD to a stand-alone entity) shall be established to provide transparent sector oversight through the assessment of the costs and performance of service providers. They may be empowered for tariff setting, cost recovery and cost efficiency parameters based on sound economic rationale, performance benchmarks, service delivery standards and welfare implications.

CHAPTER-XI
TARGETS FOR 14TH FIVE YEAR PLAN

This report identifies targets to be achieved during the 14th Five Year Plan period, major targets under different heads are abstracted below.

Drinking water supply

1. 100% household coverage with FHTCs by the year 2024 in rural areas with a service level of 100 lpcd
   It is proposed to cover all the rural households with functional tap connections under the Jal Jeevan Mission project which is a prestigious project of GoI implemented with the support of the state and local governments.
2. 100% household coverage with FHTCs by the year 2026 in the urban areas with a service level of 150 lpcd
   There is already coverage of 65% in the urban sector and it is intended to achieve 100% coverage by promoting service connections utilising the available installed capacity and new connections through the ongoing urban projects. The AMRUT 2.0 project announced by the GoI will also help in achieving the target by the year 2026.
3. Water Quality: All piped water systems ensuring IS:10500, 2012 standard (with latest amendments)
   It is the responsibility of the service provider to ensure that all drinking water supplied conforms to the Indian Standard on drinking water quality (IS:10500, 2012). It is expected that by providing water treatment plants in all water supply schemes, the targeted water quality can be achieved. Also, by creating a network of water quality testing labs with NABL accreditation, which is already underway as part of the JJM project together with a robust water quality monitoring and surveillance system, can ensure the desired quality standards.
4. Regularity – All cities to achieve 24x7 water supply by 2026
   Though we have adequate installed capacity and distribution infrastructure in most of the cities, 24X7 water supply is yet to be achieved. We will be able to convert our city water supply systems in to 24X7 systems by optimising the operation of the systems together with capacity additions, NRW management and use of technology in the distribution system management.
5. 20% of water produced shall be through desalination and recycling. Large consumers in coastal areas to have captive desalination systems.

The desalination technology is fast emerging as a viable option and many Indian states are adopting this technology to meet drinking water demands, especially in coastal areas. Kerala, though rich in rainfall, has been facing climate change induced vagaries and cannot rely entirely on fresh water resources for all its water supply needs in future. With a 540km coastline and plenty of brackish backwaters, we can slowly foray into desalination technology to augment drinking water supply capacity. To begin with, bulk users in the coastal areas can be persuaded to install captive systems.

6. Achieve 50% reduction in NRW

   The present level of NRW which is upwards of 40%, is unsustainable and it is proposed to reduce it by 50% so that Kerala can reach the benchmark figure of 20% in the next five years. Active leak detection program along with IoT based distribution system management will have to be introduced for achieving the targets.

7. Shift in source from Groundwater to surface water sources for public water supply systems

   Reliable source is a primary requirement for long term sustainability of public water supply schemes. It has been observed that the major reason for failure of Jalanidhi schemes which are comparatively small in capacity, has been failure of its groundwater-based sources. Besides quantity issues, there are emerging water quality issues as well. Also considering the urbanised nature of Kerala with high population density and high water demand, small groundwater-based schemes are not a choice with respect to technical and financial parameters. In future we have to focus on multi-GP schemes with reliable surface water sources for all public water supply schemes. Groundwater-based mini/micro schemes may be adopted in areas where surface water-based schemes are not feasible.

8. 10% of budget allocation in all heads of account shall be earmarked for adaptive research

   Water and wastewater sector is witnessing rapid changes in technology and management. Unfortunately there is tardiness and status quo mentality in the sector organisations in embracing and adapting latest developments in the field. There is an urgent need for Research and Development and the sector organisations have to evolve themselves as learning organisations. The sector organisations need to be given adequate freedom in identifying and promoting research and at same time supported with adequate finances.

9. Promote entrepreneurship among women and students in water sector, especially in O&M of water supply schemes

   The JJM guidelines envisage Operation and Maintenance of in-village infrastructure by the respective GPs/Village water and sanitation committees. This policy opens up huge possibility for rural entrepreneurship especially by women and young startups. The demand for system operation and maintenance, water meter repair, repair and maintenance of electrical equipment, billing, collection and revenue management, etc., will leapfrog when the 100% household tap connection target is achieved in the next four to five years.

10. Asset management through GIS based IT systems

    Most sector organisations do not have a reliable database of their assets and this is proving extremely costly for them. Assets designed for long life are either disused or end up as scrap much before their design life. GIS based asset management systems which is industry standard need to be introduced for effective asset management.

11. Establish network of educational institutions for WQM&S

    WQM&S is critical to ensure the desired water quality standards and it will be a Herculean task when the entire population is brought under public water supply systems. It is proposed to join hands with educational institutions having science labs and make them part of a three tier WQM&S system. The system will be designed in such a way that it will be a win-win for all stakeholders.

Sewerage

1. Sewerage network with Sewage treatment plant for all towns with population density greater than 1500/Sq.km.
   The second-generation sanitation issues can be addressed only by providing suitable systems for collection of wastewater, its treatment and safe disposal of the effluent. Kerala is far behind among Indian states in the provision of organised sewerage. It is proposed to build appropriate sewerage systems in all towns with a population density of 1500/sq.km on priority.
2. Septage systems for all areas with population density less than 1500/Sq.km
   Though on-site sanitation systems are in vogue, septage management is still in nascent stage. As piped sewerage is not practical everywhere, septage collection and treatment is critical and it is proposed to build septage treatment systems in all areas with population density less than 1500/Sq.km.
3. Recycled sewage effluent for industrial use and non-domestic use
   Water being a finite resource and demand for which is spiralling, it is imperative that we use water in the most judicious way. Sewage effluent, treated to the desired quality is being utilised for all purposes including drinking, elsewhere in the world. We must at least promote the use of treated effluent for industrial and non-domestic purposes.
4. Dual pipe systems for industries
   The water quality requirements of industries are specific and most industries do not require water treated up to drinking water quality standards. Treated effluent from sewage treatment plants may be good enough for certain industrial uses, certain other industries may need water with minimum treatment. The feasibility of providing dual pipe system, one for drinking water and another for industrial use, especially for industries/clusters with bulk demand may be studied and introduced.
5. Promote zero discharge systems in high water consumption industries
   The concept of Reduce, Re-use and Recycle, the widely adopted conservation technique has to be promoted to achieve zero discharge in major industries. Appropriate strategies may be designed to incentivise zero discharge.
6. Meter wastewater discharge and introduce volumetric user fees
   The cost of providing sewerage services is at least three to four times that of water supply. It is therefore essential to introduce reasonable charges on a volumetric basis.

Water Conservation

1. Minimum 5 RWH structures in Government buildings in each GP/ Municipality/ Corporation every year
   Though there are regulations in the building rules to provide RWH systems, it is not adhered to in letter and spirit; may be because of the illusion that Kerala is water rich.

RWH and groundwater recharge is the only solution to meet the ill effects of climate change, and to lead the way, it is proposed to build minimum 5 RWH structures in Government buildings in each GP/ Municipality/Corporation every year.

2. Promote dug wells as backup source through Recharge and sanitary protection
   Dug wells has been the hallmark of Kerala and still it is the preferred source of drinking water in the rural areas. By recharging through RWH, protecting and sanitising it, dug wells can be permanent backup source and at the same time excellent groundwater recharge system.
3. Replication of Kattakkada model Jalasmruddhi and Malappuram model watershed management in all districts
   Kerala, though rain rich, is water short in reality. The escape route for Kerala is water conservation and groundwater recharge. The successful model of Kattakkada and Malappuram has to be replicated to ensure water security of the state.

Revenue Models

1. Tariff rationalization to achieve breakeven levels
   The user fees prevailing in Kerala is extremely low and is not enough to cover even half of the cost of providing the services. With not enough funds for proper operation and maintenance of the costly infrastructure, the water supply systems are bound to collapse, which is not in the interest of the state and its people. It is therefore imperative to rationally revise the tariff to at least make it adequate to meet the O&M cost.
2. Promote non water revenue to enhance income: Solar power, packaged water, monetizing assets
   The KWA shall explore the possibility of generating non-water income by monetising its assets, diversifying into industrial water supply, packaged water production, solar energy, consultancy services, etc.
3. Sewerage service to be charged at par with water supply
   Till 2014, sewerage service was not charged and from 2014 onwards, 10% of water supply tariff was charged towards sewerage wherever the services are available. The cost of providing sewerage services is at least three to four times that of water supply and so the charges must be made at least at par with water supply.
4. Optimize revenue expenditure
   The KWA while expanding its revenue streams has to adopt a disciplined approach to reduce its revenue expenditure. Energy audits, use of energy efficient equipment, insistence on build quality, preventive maintenance and timely breakdown maintenance, etc can result in substantial savings in expenditure.
5. Ring fenced accounting for all Strategic Business Units (SBUs)
   Each of KWA's maintenance divisions may be identified as SBUs with ringfenced accounting system so that the performance of each of the units can be monitored and measured. Benchmarks on performance parameters can be established and the performance of the SBUs can be compared in a transparent manner. This will instil and promote healthy competition among the divisions which in turn will result in better performance.

APPENDIX I

REVISED PROCEEDINGS OF THE MEMBER SECRETARY

STATE PLANNING BOARD

(Present: Sri. Teeka Ram Meena IAS)

Sub: - Formulation of Fourteenth Five Year Plan (2022-27) – Constitution of Working Group on **Drinking Water and Sewerage** –-reg.

Read: 1. Note No. 297/2021/PCD/SPB dated: 27/08/2021
2. Guidelines on Working Groups

ORDER No. 448/2021/SS (WS)/SPB Dated: 13.09.2021

As part of the formulation of Fourteenth Five Year Plan, it has been decided to constitute various Working Groups under the priority sectors. Accordingly, the Working Group on **Drinking Water and Sewerage** is here by constituted with the following members. The Working Group shall also take into consideration the guidelines read 2nd above in fulfilling the tasks outlined in the ToR for the Group.

Co - Chairperson

1. Sri. T. K. Jose IAS, Addl. Chief Secretary, Department of Water Resources, Government Secretariat, Thiruvananthapuram, Mob:9446375216/ 0471-2333174, Email id:acs.home@kerala.gov.in
2. Prof. K.P Sudheer, Principal Secretary and Executive Vice President, KSCSTE, Mob: 9444256675, Email id:-evp.kscste@kerala.gov.in

Members

1. Sri. Pranabjyoti Nath IAS, Secretary to Government, Department of Water Resources, Government Secretariat, Thiruvananthapuram,
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2. Dr. Vijayakumar. K, Retired Prof. & HoD, Community Medicine, Medical College, Thiruvananthapuram, Honorary Secretary, Self-Action by People, Trivandrum Mob:9447563000, Email id: communitymedicine@gmail.com

3. Sri. S.Venkatespathy IAS, Managing Director, Kerala Water Authority, Jalabhavan, Vellayambalam, Thiruvananthapuram, Mob: 9447798383,
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4. Dr. P.S Harikumar, Head & Senior Principal Scientist, Ecology &Environment Research Group, Centre for Water Resources Development and Management, Kozhikode, Mob: 9847781444 , Email id: hps@cwrdm.org

5. Dr. E J James, Pro -Vice Chancellor, Karunya Deemed University, Coimbatore and Former Executive Director of the Centre for Water Resources Development and Management (CWRDM), Calicut. Mob: 9487846504,
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6. Dr. Ajayakumar Varma, Retd. Chief Scientist, National Centre for Earth Science Studies, GoI and Former Executive Director, Suchitwa Mission
Mob: 9447048526 /7907489435 Email id:- akvarmadr@gmail.com

7. Dr. Jacob Chandapillai, (Former Director, Fluid Control Research Institute), Professor, Jyothi Engineering College, Cheruthuruthy. Mob:9446495803, Email id:-jacobchandapillai@jecc.ac.in

8. Sri.S Haris, (Former Chief Engineer, Kerala Water Authority), Director, Technical & Operations, Jalanidhi, Mob: 9447294911, Email id:-haris.kwa@gmail.com

9. Sri Solomon Fernandez, Chief Engineer (Retd.), Kerala Water Authority, Mob: 9447044727, Email id: solomonkwa@gmail.com

10. Sri. Mohan Kumar.V.L, Director (Operations) in Kerala Rural Water Supply and Sanitation Agency (KRWSA), Mob: 9400592836, Email id:- vlmkumar1955@gmail.com

11. Dr. Resmi T.R, Senior Scientist, Ecology & Environment Research Group,Centre for Water Resources Development and Management, Kozhikode, Mob: 9495248238

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12. Dr. Abhilash Babu, Associate Professor & Director, School of Social Sciences, M G University. Mob: 6238852247 Email id: abhilashbabu3700@mgu.ac.in, abhijnu@gmail.com

13. Sri Rajendran.C, Jilla Panchayat Member (Devikulam Division),Swamiyaralakudi Kottakomboor PO,Vattavada ,Idukki Pin- 685615, Mob: 8547834290
    Email id:- rajendrancmnr@gmail.com

14. Sri.RV Satheesh, Technical Consultant, Haritha Kerala Mission, Mob: 9495244544, Email id:- satheeshkcni@gmail.com

Convener

Dr.Bindu.P.Verghese, Chief, Social Services Division, State Planning Board, Thiruvananthapuram Ph: 0471-2540609, 9495098606, Email: ssdnklaspb@gmail.com

Co- Convener

Smt.Roopa.R.V, Research Officer, Social Services Division, State Planning Board, Thiruvananthapuram. Mob: 9446043713, Email:ssdnklaspb@gmail.com

Terms of Reference

1. To formulate a time-bound plan to ensure that every resident of the State has access to clean, safe drinking water in their place of residence.
2. To suggest a time-bound plan to ensure that every residence, commercial establishment, or other institution in the State that produces sewage is equipped with the means of disposal of that sewerage.
3. To suggest effective interventions to improve the position of Kerala in the Composite Water Management Index (CWMI).
4. To suggest methods for regular monitoring of drinking water supply schemes in Kerala (this point may be subsumed by (1) above).

Terms of Reference (General)

1. The non-official members (and invitees) of the Working Group will be entitled to travelling allowances as per existing government norms. The Class I Officers of GoI will be entitled to travelling allowances as per rules if reimbursement is not allowed from Departments.

2. The expenditure towards TA, DA and Honorarium will be met from the following Head of Account of the State Planning Board "3451-00-101-93"- Preparation of Plans and Conduct of Surveys and Studies.

(Sd/-)
Member Secretary

To

The Members concerned

Copy to

PS to VC
PA to MS
CA to Member (Dr. P.K Jameela, Mob:9447737579, email:drjameelabalan@gmail.com)
Sr. A.O, SPB
The Accountant General, Kerala
Finance Officer, SPB
Publication Officer, SPB
Sub Treasury, Vellayambalam
Accounts Section
File/Stock File

Forwarded/By Order
(Sd-)
Joint Director (T.E Santhi)

APPENDIX II
PROCEEDINGS OF THE MEMBER SECRETARY
STATE PLANNING BOARD

(Present: Sri. Teeka Ram Meena IAS)

Sub: - Formulation of Fourteenth Five Year Plan (2022-27) – Constitution of Working Group on **Drinking Water and Sewerage** –Additional Members -co-opted - reg.

Read: Order No. 448/2021/SS (WS)/SPB Dated: 13.09.2021

ORDER No. 448/2021/SS (WS)/SPB Dated: 29.09.2021

As part of the formulation of Fourteenth Five Year Plan, it has been decided to constitute various Working Groups under the priority sectors. Accordingly, the Working Group on **Drinking Water and Sewerage** was constituted as per reference cited.

In the first meeting of the Working Group held on 16/9/2021, it was decided to Co-opt the following members in the Working Group. In the circumstances, the following persons are hereby included in the Working Group on **Drinking Water and Sewerage.**

Members

1. Dr. G. Bindu, Senior Hydrogeologist, Directorate of Ground Water Department, Jalavijnana Bhavan, Kowdiar. P.O, Ambalamukku, Thiruvananthapuram
2. Sri. Abraham Koshy, Consultant (Water Resources), Harithakeralam Mission, Pattom, Thiruvananthapuram.

Order under reference cited is modified to this extend.

(Sd/-)
Member Secretary

To

The Members concerned

Copy to

PS to VC
PA to MS
CA to Member (Dr. P.K Jameela, Mob: 9447737579, email:drjameelabalan@gmail.com)
Sr. A.O, SPB
The Accountant General, Kerala
Finance Officer, SPB
Publication Officer, SPB
Sub Treasury, Vellayambalam
Accounts Section
File/Stock File

Forwarded /By Order

(Sd/-)

Chief Social Services Division