E-355
VOL. 2 REVISED

Environmental Analysis Report

for

Kerala Rural Water Supply and Sanitation (KRWSS) Project

30 th May, 2000

Prepared for

The World Bank, Washington D.C.

and

Kerala Rural Water Supply and Sanitation Agency

Prepared by
Dr. R. Paramasivam (Consultant)

CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF MAPS

LIST OF ACRONYMS USED

AIIH & PH	-	All India Institute of Hygiene and Public Health
BC	-	Beneficiary Committee
BIS	-	Bureau of Indian Standards
BOD	-	Biochemical Oxygen Demand
CGWB	-	Central Ground Water Board
CWC	-	Central Water Commission
CWRDM	-	Centre for Water Resources Development and Management
DPMU	-	District Project Management Unit
DSTE	-	Department of Science,Technology & Environment (Govt of Kerala)
EA	-	Environmental Analysis
EIA	-	Environmental Impact Assessment
EMP	-	Environmental Management Plan
GoK	-	Government of Kerala
GP	-	Gram Panchayat
GWD	-	Ground Water Department (Of Kerala)
ID	-	Irrigation Department
IEC	-	Information, Education and Communication
KAP	-	Knowledge, Attitude and Practices
KCIP	-	Kerala Community Irrigation Project
KRWSA	-	Kerala Rural Water Supply and Sanitation Agency
KRWSS	-	Kerala Rural Water Supply and Sanitation (Project)
KSPCB	-	Kerala State Pollution Control Board
KWA	-	Kerala Water Authority
lpd	-	litres per day
lpcd	-	litres per capita per day

MCM	-	Million Cubic Metre
MOEF	-	Ministry of Environment and Forests (Govt of India)
MPN	-	Most Probable Number
MSL	-	Mean Sea Level
NGO	-	Non-Governmental Organisation
O&M	-	Operation and Maintenance
PMU	-	Project Management Unit
RWSA	-	Rural Water Supply and Sanitation Agency
SC	-	Scheduled Caste
SEUF	-	Socio-Economic Unit Foundation
SLC	-	Scheme Level Committee
SO	-	Support Organisation
SPC	-	Standard Plate Count
ST	-	Scheduled Tribe
THSM	-	Total Health and Sanitation Mission
VWSC	-	Village Water and Sanitation Committee

LIST OF ANNEXURES

	Title
Annexure 1	Environmental Analysis' Study for Kerala RWSS Terms of Reference
Annexure 2	Public Consultation
Annexure 3	Sanitary Survey of Water Supply Sources
Annexure 4	Recuperation Test for Yield Estimation of an Open Well
Annexure 5	Roof Water Harvesting Systems
Annexure 6	Bleach Powder Solution Dosing Equipment for Disinfection of Small Pumped Water Suppliers
Annexure 7	Sanitary Protection of Wells through Cement Grouting

1. INTRODUCTION

1.1. Background

The Govt. of Kerala (GoK), encouraged by the people's demand for better quality of life through improved access to safe water supply and sanitation services, and their willingness to participate in all stages of development from planning to implementation including total responsibility for operation and maintenance (O & M) of the systems, proposes to launch, with World Bank assistance, a pilot water supply and sanitation project in four districts of the state, with scope for replication of the model in other parts of the state. The GoK, which has initiated the decentralised planning programme since 1997, will implement the project through its recently established Rural Water and Sanitation Agency (RWSA).

The project is in the preparation stage and is aimed at improving the quality of rural water supply and environmental sanitation service delivery to achieve sustainability of investment and generate health and income benefits. This will be realised through (a) phased implementation of appropriate policy and institutional reforms and (b) delivery of demand responsive and sustainable water and sanitation services to the beneficiary communities in the pilot districts.

The key components of the project include construction of new / augmentation/ rehabilitation of drinking water schemes, drainage schemes, household latrines, solid waste disposal systems, and environmental management and watershed development schemes. The health, hygiene and sanitation component of the project includes health and hygiene education programs for safe handling of drinking water, disposal of waste water (sullage), personal hygiene, household hygiene and community environmental sanitation. The integrated watershed management component of the project includes schemes for improving sustainability and perenniality of the water sources. The project also includes state-wide sector development studies including institutional capacity building and programs for improving

KWA's O&M cost recovery performance and preparing river basin plans for the project area. The proposed project, estimated to cost approximately US$ 80 million will be implemented in phases over a period of 6 years with financial assistance from the Bank.

1.2. Environmental Analysis Study

The proposed RWSS project has been classified by the Bank under category B requiring Environmental Analysis (EA) only, as the impacts of the project are expected to be positive; few, if any, of them may be negative for which the mitigatory measures can be designed easily. Accordingly, the terms of reference (ToR) for the EA study have been formulated as in Annexure I.

1.3. Methodology

Collection and Collation of Secondary Data

The methodology basically comprised collection and collation of secondary data on water resources availability, their utilisation, ambient and ground water quality, problems of water quantity and quality as relevant in the context of the proposed KRWSA project, demographic and socio-economic aspects , water supply and sanitation coverage and service levels and problems in O & M of existing water supply systems with focus on the four project districts. A review and analysis of this information resulted in the delineation of the baseline status of relevant environmental components in the project districts and provided the basis for identification and assessment of the potential environmental impacts due to the proposed project and preparation of environmental management plan (EMP) for enhancing beneficial impacts and mitigating adverse impacts. The agencies for the secondary sources of data included the KWA, KSPCB, CWRDM, state/central ground water departments, state irrigation, agriculture, industries, social welfare departments, SEUF and NGOs.

Site Visits to Project GPs

Existing rural water supply systems based on ground water / surface sources were inspected to obtain first hand information on existing systems, their performance,

including adequacy of source, water quality, potential sources of contamination, constraints / problems in O & M, and identification of issues, if any, that need to be addressed in the proposed project design. During these visits detail discussions were held with the consumers, the KWA, local GPs and NGOs.

Public Consultations

This constituted an important activity during the site visits, and were held at least in one pilot GP in each of the four project districts so as to assess the knowledge attitude and practices (KAP) of the communities w.r.t. water, health and sanitation including personal and environmental. hygiene, their awareness of, roles in and expectations from the proposed projects, their views/suggestions to enhance project performance and benefits as also any new other issues that need to be addressed in the project. The participants in these consultations comprised the beneficiaries, SOs, KWA, RWSA and NGOs. The salient points arising from the consultations were compiled for incorporation, as appropriate, in the project design and in the preparation of EMP.

The EA consultant interacted with fellow consultants engaged in studies on other components of the project viz., water quality survey, watershed management and social assessment including health, sanitation and hygiene component for exchanging information and findings of common interest. Their findings and recommendations were incorporated in the preparation of environmental mitigation and monitoring plan for the project.

Desk Study

The desk study included the following :

- A detailed review of available secondary data on water resources (surface and ground), their distribution, utilisation and problems related to water quality etc. in the state in general and with specific focus on the four project districts.

- An assessment of the adequacy of current water quality monitoring programmes and institutional capacity for the project area leading to recommendations for improving them

- A review of the existing state policies and legislations on water and its management in the light of similar acts/ legislations in force elsewhere, and suggestions to help achieve the project objective of safe water and sanitation to the target populations

- Identification of major environmental impacts, primary, secondary etc. due to the proposed project and delineation of EMP for enhancing beneficial impacts and mitigating adverse impacts

- Identification and preparation of appropriate environmental performance indicators which could form the basis for evaluation of the project.

In all the above activities, the consultant worked very closely with the staff of KRWSA and other partners for the proposed project.

1.4. Organisation of the Report

The report is presented in six chapters including the introductory chapter.

Chapter 2 provides information on the policy, legal and administrative framework for environmental assessment and requirements for appraisal of the proposed project by the Bank.

Chapter 3 presents the details of the proposed project, the project cost and financing plan, the institutional arrangements, the project implementation schedule as also the expected benefits from the project.

Chapter 4 presents the baseline data on relevant environmental components in the state in general and with specific reference to the four project districts. The baseline data formed the basis for identification and analysis of the potential impacts due to the proposed project.

Chapter 5 analyses the potential environmental impacts primary, secondary, beneficial, adverse etc. due to the proposed project activities.

Chapter 6 describes the environmental management plan (EMP) for enhancing the beneficial impacts of the project and mitigating the adverse impacts. Environmental performance indicators have been proposed which could be used as tools to assess the project performance.

2. POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK FOR ENVIRONMENTAL ANALYSIS

2.1. EA Requirements for Projects Proposed for IDA Funding

Considering the type, location, sensitivity and the scale of the project as well as the nature and magnitude of its potential impacts, the proposed KRWSS project has been classified by the Bank as Category 'B' requiring environmental analysis (EA) only. The overall impact of the project on human population is expected to be positive, and in most cases of potentially adverse impacts, if any, the mitigative measures can be designed easily so as to improve environmental performance.

As per OP 4.01 of the Bank, the EA process requires that the project affected groups and the local non-governmental organisations (NGOs) are consulted about the project's environmental aspects and their views are taken into account in the design of the project. Prior to the consultation, relevant information regarding the project's objectives, description and potential impacts is provided to the project affected groups and local NGOs. In the bottom-up planning process adopted in the formulation of the proposed KRWSS project, the above requirements have already been fulfilled. The report on the EA study, when completed, should be made accessible to the affected groups and local NGOs. Public availability in the borrowing country and official receipt of the EA report by the Bank are pre-requisites to Bank appraisal of the project.

2.2. Ministry of Environment and Forests (MoEF), Govt. of India Requirements

As per the Ministry's Notification of 1994 (as amended on May 4, 1994) under the Environmental (Protection) Act of 1986, environmental clearance from the Central Government is mandatory for expansion or modernisation of any activity, if pollution load is to exceed the existing one and also for new projects listed in Schedule –1 (Table 2.1) of the Notification. By another Notification dated April 10, 1997 the MoEF,

Table 2.1

Projects Requiring Environmental Clearance as per Schedule-I of Ministry of Environment & Forests Notification, 1994

1	Nuclear power and related projects such as heavy water plants, nuclear fuel complex, rare earths
2	River valley projects including hydel power, major irrigation and their combination including flood control
3	Ports, harbours, airports (except minor ports and harbours)
4	Petroleum refineries including crude and product pipelines
5	Chemical fertilizers (Nitrogenous and Phosphatic) other than single superphosphate
6	Pesticides (Technical)
7	Petrochemical complexes (both Olefinic and Aromatic and Petro-chemical intermediates such as DMT, Caprolactum LAB etc. and production of basic plastics such as LLPDE, HPDE, PP, PVC
8	Bulk drugs and pharmaceuticals
9	Exploration for oil and gas and their production, transportation and storage
10	Synthetic rubber
11	Asbestos and asbestos products
12	Hydrocyanic acid and its derivatives
13	Primary metallurgical industries (such as production of iron and steel, aluminium, copper, zinc, lead and ferro alloys) Electric arc furnaces (mini steel plants)
14	Chlor alkali industry
15	Integrated paint complex including manufacture of resins and basic raw materials required in the manufacture of paints
16	Viscose staple fibre and filament yarn
17	Storage batteries integrated with manufacture of oxides of lead and lead antimony alloy
18	All tourism projects between 200 m – 500 m of high water line and at locations with an elevation of more than 1000 m with investment of more than Rs. 5 crores
19	Thermal power plants
20	Mining projects (with leases more than 5 hectares)
21	Highways projects
22	Tarred roads in Himalayas and or Forest areas
23	Distilleries
24	Raw skins and hides
25	Pulp, paper and newsprint
26	Dyes
27	Cement
28	Foundries (individual)
29	Electroplating

Govt. of India has made 'Public Hearing' mandatory for environmental clearance of projects and has laid down the procedure for the same. The proposed KRWSS project does not fall under any of the project categories listed in Schedule – 1 of the aforementioned Notification and hence does not require any formal environmental clearance of the MoEF, Govt. of India.

2.3. Kerala State Water Policy

The Kerala state water policy (1992), in keeping with the fact that the per capita fresh water availability in the state is one of the lowest in the country (even lower than that of Rajasthan), has laid stress on the need to harness and manage the water resources in the state to the best advantage, maintaining at the same time an ecologically healthy environment. Nearly 3/4th of the 44 rivers and the major ground water basins in the state do not have any interstate implications due to which the state may be considered "hydrologically land locked".

The State's Water Policy, which is complementary to the National Water Policy, recognises the crucial importance of hydrometeorological data base in effective planning of water resources of the state, and proposes to establish a centralised facility for processing, evaluation and storage of hydrometeorological data. The data will be made available to any agency of the state government engaged in water development projects.

Stressing the need for basinwise integrated land and water resources development with due regard for environmental and socio-economic impacts, the policy provides for the establishment of a Water Resources Control Board (WRCB) which will be the apex body to advise the Government on interstate matters and approve river basin development plans in the state. In the area of water resources development in the state, drinking water schemes will get top most priority. In order to prevent adverse environmental impacts

such as bank instability and associated problems arising out of uncontrolled extraction of sand from river beds, the government proposes to regulate such extraction.

With a view to maximising water availability and reducing drought impact, the state proposes to formulate specific short term and long term water management strategies to arrest and conserve as much rain water as possible, at places wherever it is feasible. The long term water management strategy for the state, *inter alia*, includes (i) massive *in situ* soil and water conservation measures through contour trenching, check dams and other watershed management practices, (ii) linking up of irrigation and hydel reservoirs with urban and rural water supply schemes, (iii) selective and judicious ground water development through bore wells and tube wells without causing salinity incursion in coastal belt and drying up of neighbouring household wells, (iv) regulation of ground water extraction through legislation, etc. The short term water management strategies include (i) desilting of tanks and ponds, deepening of household and community wells and construction of contour trenches and check dams, (ii) encouraging drip irrigation and other water saving irrigation technology, (iii) repairing of non-functional pumps installed in bore wells and tube wells, and reduction of leakage in existing distribution pipes, (iv) awareness and training programmes for the public on upkeep and maintenance of household wells and pumps etc.

The State's Water Policy under scores the need for a regular programme of continuous monitoring of fresh water bodies for their health and ecology. The data so generated shall be processed and used in the design and development of water resources projects. Training of professionals on water management and related matters, and science and technology inputs in priority areas of activity are other important aspects of the policy.

The policy has also delineated the institutional arrangements for the implementation of the policy. A Water Resources Control Board (WRCB) to oversee and

co-ordinate all policy related activities at state level, a Centralised Hydrological Data Bank and Data Processing Centre and a separate cell in the Irrigation Department to organise and coordinate all programmes related to non-conventional fresh water resources in the state, viz., tanks, ponds, springs etc., would form essential ingredients of the proposed institutional arrangements.

Water supply and Sanitation Sector Policy:

The state is yet to formulate specific water supply and environmental sanitation sector policy. For rural water supply and sanitation, targets have been fixed by the Government of India for a total coverage of rural areas with safe drinking water supply and 25% coverage of rural households with sanitary latrines by the end of the 7th Plan period ended March 1997. The salient features of this policy are:

- Participation by Panchayati Raj Institutions and the community.
- Emphasis on the integration of water supply and environmental sanitation (inclusive of environmental, domestic and personal hygiene)
- Emphasis on the managerial, financial and environmental sustainability of facilities and systems.
- Emphasis on supporting software features of institutional strengthening, community development and hygiene promotion.
- Promotion and development of appropriate technologies for water treatment and distribution and production including the use of traditional systems and methods.

The Government of Kerala now follows this national policy through its adoption of the Panchayati Raj institutional process with the intended devolution of development and functional responsibilities to the Panchayat System. This is already underway in its initial stages supported by the Peoples Campaign initiated by the Government of Kerala in the second half of 1996. While this represents a change for both water supply and

environmental sanitation components of the sector, the intention of 'people' being responsible for the development of their own communities is clear. The Government of Kerala has already initiated the decentralized planning programme since 1997 in a phased manner. As a result, the community is even now involved in identification, selection and implementation and thereafter operation and maintenance of certain water supply schemes. For sanitation, the Government of Kerala have a programme of total sanitation and health in the state, integrating health education, sanitation and water supply, solid waste management, waste water disposal, personal hygiene etc. and developing a demand based approach to promote latrine use.

The objectives and scope of the proposed KRWSS project are in consonance with the state water policy outlined as above and would greatly promote the water supply and sanitation sector activities in the project districts consistent with environmental preservation.

2.4. Water Quality Monitoring

There are at least four agencies engaged in water quality monitoring in the state of Kerala. These are the KWA, the state PCB, the CGWB Thiruvananthapuram and the Kerala State Ground Water Department. In addition, the CWRDM, Kozhikode and the Central Water Commission are engaged in the generation of considerable water quality data in the state. The mandate, objective and scope of water quality monitoring by these agencies differ considerably.

The CGWB, Kerala Region is monitoring water level and quality in the state and the U.T. of Mahe through a network of National Hydrograph (NH) Stations, numbering 722 as on April 1997. The depth to water level measurements are made four times in a year in January, April, August and November while the water quality is monitored from the water samples collected from the NH stations during April. The number of NH stations in the four project districts are: Kozhikode-45, Malappuram-64, Palakkad-56 and

Thrissur-64. Likewise, State Ground Water Department is also engaged in depth to water level measurements and ground water quality assessment.

The Kerala SPCB, as part of its mandate, has been engaged in ambient water quality monitoring of all surface water bodies in the state including the coastal waters. In addition to its own programme of ambient water quality monitoring, it also participates in programmes sponsored by Government of India. The primary objective of these monitoring programmes is pollution control and accordingly the frequency of sample collection and the parameters of analysis are decided.

Under an Indo-Dutch project for institutional strengthening of the Board, the programme of ambient water quality monitoring was reviewed in order to make it more systematic and purpose oriented. Accordingly, the monitoring network of the river basins of Kerala such as Chaliyar, Chalakudy and Bharathapuzha has been redesigned to attain better correlation between locations of monitoring and sources of pollution so as to ensure inclusion of all relevant parameters and elimination of those with little significance. The trend in water quality of these rivers with reference to pollution parameters of public health significance can provide a valuable basis for identification of the best locations to tap the rivers for public water supplies as appropriate for the proposed KRWSS project.

The Central Water Commission, Ministry of Water Resources, GOI has established a network of gauging stations in most of the rivers in the state and generates data not only on flows but also on water quality including sediment load.

There exists a fairly well established water quality monitoring system by the Kerala Water Authority (KWA) for routine analysis and quality control of the KWA managed water supply systems. A district water quality laboratory is functioning in each one of the 14 districts in the state. Each laboratory is headed by an executive engineer /

assistant executive engineer / assistant engineer and has necessary facilities and equipment for routine physico-chemical and bacteriological analysis of water samples including a vehicle for sample collection. The lab staff comprises one AEE or AE, one sanitary chemist, two lab attendants, a bacteriological analyst and one sample taker. The frequency of sample collection and analysis is as follows.

Sl. No.	Population size	Frequency of sample collection	Parameters of analysis
1.	Towns with population more than 1,00,000	Twice a month	Physical, chemical and bacteriological tests from source to tap
2.	Population 50,000 – 10,000	Once in a month	-do-
3.	Towns/panchayats with population 20,000 – 50.000	Once in 3 months	-do-
4.	Panchayats with population 5,000 – 20,000	-do-	-do-
5.	Panchayats with population less than 5,000	Once in six months or on receipt of complaint of poor quality	-do-

The water quality laboratories also undertake testing of chemicals used in water treatment such as alum, lime and bleaching powder. A sizeable number of posts of laboratory staff are reported to be vacant. In the existing set up, an effective mechanism of feed back on the findings of the laboratory is lacking in order to implement necessary control measures at the source / treatment plant. There is also a need for effective linkages between the various agencies engaged in water quality monitoring for sharing of information for mutual benefit.

In most of the surface water treatment plants, bleaching powder is the most commonly used chemical for disinfection. In many of the remote installations bleaching powder is added directly at the source / intake well at a frequency which is not conducive

for continuously maintaining a residual chlorine of 0.5 mg/l. For open dug well schemes which are maintained by local bodies chlorination is done only once in 6 months.

In the proposed KRWSS project, majority of the water supply schemes will be based on ground water sources in the form of dug wells or bore wells. Water distribution will be through elevated service reservoirs piped to the individual households. A reliable, cost effective system of disinfection of pumped water supplies is through the use of differential pressure bleaching powder solution dosers. Necessary provision should be made in all the schemes for installation of such chemical dosers.

With the adoption of demand driven, decentralised planning process in the proposed project, the beneficiary community / panchayat will take on the total responsibility for routine operation and maintenance of the water supply facilities, which was hitherto the mandate of the KWA. For routine water quality testing for the new schemes the services of the existing district water quality laboratories established by the KWA or the laboratories of the GWD, CWRDM and state PCB could be utilised. If necessary, the laboratories could be further strengthened to take on the increased work load due to the new schemes. A mechanism has to be worked out by which water samples could be collected regularly by the BC/SO and delivered to the district lab for necessary testing. The mechanism should also provide for appropriate compensation for this service by the KWA as per mutually agreed terms. Designated persons from the panchayat should be initially trained by the district laboratory in the methods of sample collection, handling and preservation and testing for simple parameters such as residual chlorine.

Following the initial testing of the source water for compliance with the prescribed water quality standards, seasonal variations in quality should normally be expected. These variations, however, will not be very significant. Subsequent routine testing could therefore be restricted to residual chlorine only. This could be done every

day by the local operator at the service reservoir and at one of the farthest taps from the reservoir. The farthest tap could be rotated each time of the sampling. And once in 3 months, source water quality could be tested for complete physico-chemical and bacteriological analysis. Compilation of such data will be useful in assessing the long term trend in water quality at the source and in the design of future water supply schemes based on the same source.

The Kerala Water Authority, as part of its strategy for improving the existing institutional frame work for water quality monitoring and surveillance has proposed a community based 3 tier system which merits consideration. The 3 tier system comprises the panchayat , +2 level /technical institutions at the grass root level, satellite laboratories at the middle level and the KWA district laboratory at the apex level. Routine monitoring and control of water quality will be performed at the lower level using portable kits attached to the panchayat, analysis of more complex nature and training of water quality monitoring personnel will be taken up by the satellite laboratories with higher level support from the district laboratory with an appropriate system of cost sharing. In order to ensure accuracy and reliability of water quality data generated under the 3 tier system, an exercise in inter laboratory analytical quality control should be undertaken periodically. The water quality data generated should also be compiled periodically (at least once in 3 months) and made available for ready access to the public.

The above set up which will have the catchment area as its jurisdiction will also complement the Information, Education and Communication (IEC) activities of the panchayats/educational institutions. A pilot scheme of such an institutional set could be taken

up in each of the project districts and based on the experiences the system could be replicated on a larger scale.

2.5 State Ground Water Legislation

Realising the fact that the erratic development of ground water taking place in some areas of the State could create undesirable environmental impacts in those areas, the State of Kerala has formulated a draft legislation called the Kerala Groundwater (Control and Regulation) Act 1997 to regulate, control the extraction,use or transport of ground water and to conserve ground water in the State. The legislation is proposed to be administered by the creation of a Ground Water Authority which will function under the overall control and supervision of the Government. The proposed legislation (Annexture 10) is quite comprehensive in scope and comprises as its main features the following:

i) Powers to notify areas for control and regulation of groundwater development,

ii) Grant of permit to extract and use groundwater in the notified area,

iii) Registration of existing wells in the Notified Area,

iv) Power to alter, amend or vary the terms of the permit or certificate of registration including its cancellation.

v) Powers of the Groundwater Authority for operationalising the Act.

vi) Offences and penalties, and

vii) Power to make rules as appropriate for implementation of the Act.

In the context of the proposed KRWSA project, this enabling legislation, when enacted, will help ensure sustainability of groundwater sources for public water supplies and to prevent undesirable environmental impacts such as mining of ground water and salinity intrusion in coastal districts of the State. There is an urgent need for enacting this legislation.

2.6 Statutory Requirements of State Pollution Control Board

The Kerala State Pollution Control Board (KSPCB) formed in 1974 administers relevant Acts to prevent and control pollution, protect the environment and promote wholesomeness of water, land and air. As per the Water (Prevention and Control of Pollution) Act, 1974 (amended in 1978), the consent of the Board is required to bring into use a new outlet or to make discharge or to continue the existing discharge of trade effluent or sewage into any water body, sewer or on land in the State. Though not explicitly stated in the Act, discussions with the Board Officials indicate that a formal consent of the Board has to be obtained by KRWSA, if it proposes to let out into any water body, sewer or on land water treatment plant residues/effluents arising from a surface water treatment plant. In the proposed project such instances are expected to be very few, if any, as more than 90% of the schemes will be based on ground water sources.

2.7. Coastal Zone Management (CZM) Plan of Kerala

In pursuance of the Ministry of Environment & Forests (MOEF), Government of India (GOI) Notification of 19th February 1991 under the Environment (Protection) Act, 1986, directing the State Governments and the Union Territories to regulate various activities in their respective coastal areas, the Government of Kerala (GOK) has prepared

the Coastal Zone Management Plan (CZMP) for the entire Kerala coast. Within the framework of the approved plans, all developments and activities within the CRZ viz., the 500 metre distance from the high tide line shall be regulated by the State Government or the local authority appointed for this purpose. The coastal GPs, municipalities and corporations facing the sea are those influenced by the tidal action may come under the ambit of the coastal area. None of the GPs in the four districts of the proposed KRWSS Project comes within this category and hence the provisions of this Plan are not applicable.

The State Department of Science, Technology and Environment has a mandate to review all developmental projects of the state with an estimated cost of less than Rs. 50 million for its concurrence from environmental considerations. The Government, however, is considering to extend this limit to projects costing beyond Rs.50 million.

3. PROJECT DESCRIPTION

3.1. Project Development Objective

The primary development objective of the proposed Integrated Kerala Rural Water Supply and Environmental Sanitation (KRWSS) project is to assist the GoK in improving the quality of rural water supply and environmental sanitation service delivery to achieve sustainable health and hygiene benefits to the rural population through improvements in water supply and environmental sanitation services which will increase rural incomes through time savings and income opportunities for women and promote an all round improvement in quality of life of the rural population.

The secondary objective is to promote the long term sustainability of the rural water supply and sanitation sector by providing assistance to the GoK to identify and implement an appropriate policy frame work and a strategic plan.

The above objectives will be achieved through :

(i) Phased implementation of appropriate policy and institutional reforms.

(ii) Delivery of demand responsive and sustainable service to the target communities in selected districts in the state and

(iii) Sectoral development and special studies as required to improve the sector capability.

3.2. Project Scope and Area

The proposed KRWSS project is to be implemented in about 100 panchayats in the four northern contiguous districts of Kozhikode, Malappuram, Thrissur and Palakkad (Fig. 3.1). The total number of schemes will be about 2000. with an average of 20 schemes per panchayat.

Within the project districts, only those Gram Panchayats (GP) will be eligible for inclusion in the project who agree to : (a) follow the project's bottom-up planning approach; (b) provide 10% counterpart-financing from GP funds; (c) agree to take over existing KWA water supply schemes in their jurisdiction, initially by GPs and later by the respective beneficiary committees, once these are formally set up; (d) agree to collect proposed capital cost contribution for different schemes from beneficiaries; (e) agree to full responsibility for scheme operation and management by the beneficiary committees; and (f) agree to 100% O & M financing from user charges.

Within the selected Gram Panchayats, only those beneficiary committees will be eligible for inclusion in the project, who agree to the project rules, same as for the GP listed above, except for the GP share of counterpart funding.

The project would cover areas drained by the Bharathapuzha and the following smaller basins : Chaliyar, Kadalundi, Keecheri, Puzhakkal, Kuttiadi, Korapuzha, Kallai, Tirur and Karuvannur.

3.3. Project Components

The project would include three main components

A. Design and construction of water supply, sanitation, drainage, watershed development programme etc.

B. Institutional capacity building.

C. State sector development activities.

Part A : The first sub component would include : community mobilisation and development activities and post construction support to communities. The second sub component would include planning, design and construction of the following schemes :

- Water supply schemes will include (a) simple technologies (dug wells, hand pumps, rain water harvesting, small gravity piped systems) and (b) more complex technologies (single or multi village piped water systems based on ground water or surface water sources). These schemes involve engineering, construction and operation of more complex installations such as head works, pumping stations long pumping main, simple as well as sophisticated water treatment plants, reservoir filling operations, distribution management, private, domestic and commercial connections, water meters and other monitoring and control equipments.

- Drainage schemes will be simple open road side gutters with arrangements for safe disposal of sullage. Where the soil condition permits, simple household soak pits will be promoted. The design of sullage drainage schemes will require specialised engineering skills, but construction is relatively simple and can be done by the village communities with assistance from trained skilled masons.

- Household latrines will be based on a successful sanitary latrine model with leaching pits for onsite disposal of human wastes. The GOI has produced a manual recommending a range of options by varying the construction material and superstructure sophistication. Communities can choose the model which most reflect their need, preference and affordability.

- Environmental management schemes will cover : (a) water source protection, conservation and recharge measures : (b) water quality monitoring system : (c) household garbage and compost pits and (d) protection of village ponds.

Part B : The first sub-component would cover the institutional development comprising setting up, testing and scaling up of the new service delivery model to cover all the

eligible and willing villages in the project districts. It would include investment and operating costs of the state and district Project Management Units (PMUs), capacity building programmes for private sector, NGOs and PMUs, monitoring and evaluation (M&E). The second sub-component would support beneficiary capacity building and the third sub component will support information management.

Part C : This component will support sector development studies with the objective to help the state to identify issues affecting sector performance and formulate future policy and institutional reforms in a phased manner as also preparation of river basin plans for the project area.

3.4. Project Cost and Financing Plan

The cost summary for the various components of the project is presented in Table 3.1. The tentative financing plan will be as follows.

Agency	Financing share	
	U.S.$ (million)	%
Beneficiary	8	10
Gram Panchayat	8	10
Government of Kerala	4	5
World Bank	60	75
Total	**80**	**100**

Table 3.1
Kerala Rural Water Supply and Environmental Sanitation Project
Project Cost Summary

		Project Component	(Local Lakh) Local	Foreign	Total	% Foreign Exchange	% Total Base Costs	(US$ Million) Local	Foreign	Total	% Foreign Exchange	% Total Base Costs
A.		**Institutional Strengthening**										
	1.	Strengthening of Project Management	1767.8	1718.5	3486.3	49	11	3.9	3.8	7.7	49	11
	2.	Improving Health, Sanitation and Hygiene Education	271.0	-	271.0	-	1	0.6	-	0.6	-	1
	3.	Capacity Building	187.5	130.2	317.7	41	1	0.4	0.3	0.7	41	1
		Subtotal Institutional Strengthening	2226.3	1848.7	4075.0	45	12	4.9	4.1	9.0	45	12
B.		**Developing Water, Sanitation and Other Infrastructure**										
	1.	Community Development Support	3512.6	-	3512.6	-	11	7.8	-	7.8	-	11
	2.	Survey and Engineering Design Support	924.2	-	924.2	-	3	2.0	-	2.0	-	3
	3.	Construction of Schemes	3918.0	-	3918.0	-	12	8.7	-	8.7	-	12
	4.	Construction of Physical Schemes									-	
		Water Supply Schemes	12567.4	-	12567.4	-	38	27.8	-	27.8	-	38
		Environmental Sanitation	4600.0	-	4600.0	-	14	10.2	-	10.2	-	14
		Watershed Activities	900.0	-	900.0	-	3	2.0	-	2.0	-	3
		Subtotal Construction of Physical Schemes	18067.4	-	18067.4	-	55	40.0	-	40.0	-	55
	5.	Women Development Initiatives	1000.0	-	1000.0	-	3	2.2	-	2.2	-	3
		Subtotal Developing Water, Sanitation and other infrastructure	27422.2	-	27422.2	-	84	60.7	-	60.7	-	84
C.		**Statewide Sector Development**										
	1.	Water and Sanitation	199.6	174.9	374.5	47	1	0.4	0.4	0.8	47	1
	2.	River Basin Planning	237.1	655.4	892.5	73	3	0.5	1.5	2.0	73	3
		Subtotal Statewide Sector Development	436.7	830.3	1267.0	66	4	1.0	1.8	2.8	66	4
		Total BASELINE COSTS	**30085.2**	**2679.0**	**32764.2**	**8**	**100**	**66.6**	**5.9**	**72.5**	**8**	**100**
		Physical Contingencies	2217.2	6.8	2224.0	-	7	4.9	0.0	4.9	-	7
		Price Contingencies	5637.3	480.8	6118.1	8	19	2.3	0.3	2.7	13	4
		Total Project Costs	**37939.7**	**3166.6**	**41.106.2**	**8**	**125**	**73.8**	**6.3**	**80.1**	**8**	**110**

3.5. Institutional Arrangement

The Department of Irrigation and Water Supply, GoK has been identified as the nodal department for the proposed KRWSS project. The institutional model for the project depicted in Fig.3.2 comprises four main partners : The Project Management Unit (PMU), Support Organisations (SOs), Gram Panchayats (GPs) and Beneficiary Committees (BCs). The Project Management Unit (PMU) set up by the GoK has the mandate to plan and complete project preparation and implementation ensuring appropriate linkages with the existing sectoral institutions. The District Project Management Units (DPMUs) are responsible for the project management at the district level, with support from the state level PMU.

The PMU has been constituted with an executive committee (apex body) headed by the Secretary Irrigation (Chairman) and a staff secretariat headed by a Director supported by higher level staff, support staff and consultants for various activities. The PMU will be assisted in its function at the district level by 2 District Project Management Units (DPMUs) one each at Kozhikode and Thrissur. The organisational set up of PMU is shown in Fig.3.3. Each DPMU will be staffed with higher level staff and support staff.

SOs and consultants will be employed to assist the PMU, GPs and BCs in planning and management of various project activities. The GPs will (a) be a focal point for project activities in the GP area, (b) ensure collection of beneficiary contributions in accordance with the project rules; (c) provide its share of counterpart funds; (d) receive project funds and pass them on to BCs for implementation and (e) ensure people's participation in the project, especially of the socially disadvantaged groups. The beneficiary committees will be responsible for upgrading their RWSS facilities,

providing their part of the capital cost contribution, managing the O & M of the improved facilities, and levying and collecting sufficient user charges.

Fig. 3.2. Proposed Institutional Setup for KRWSS Project

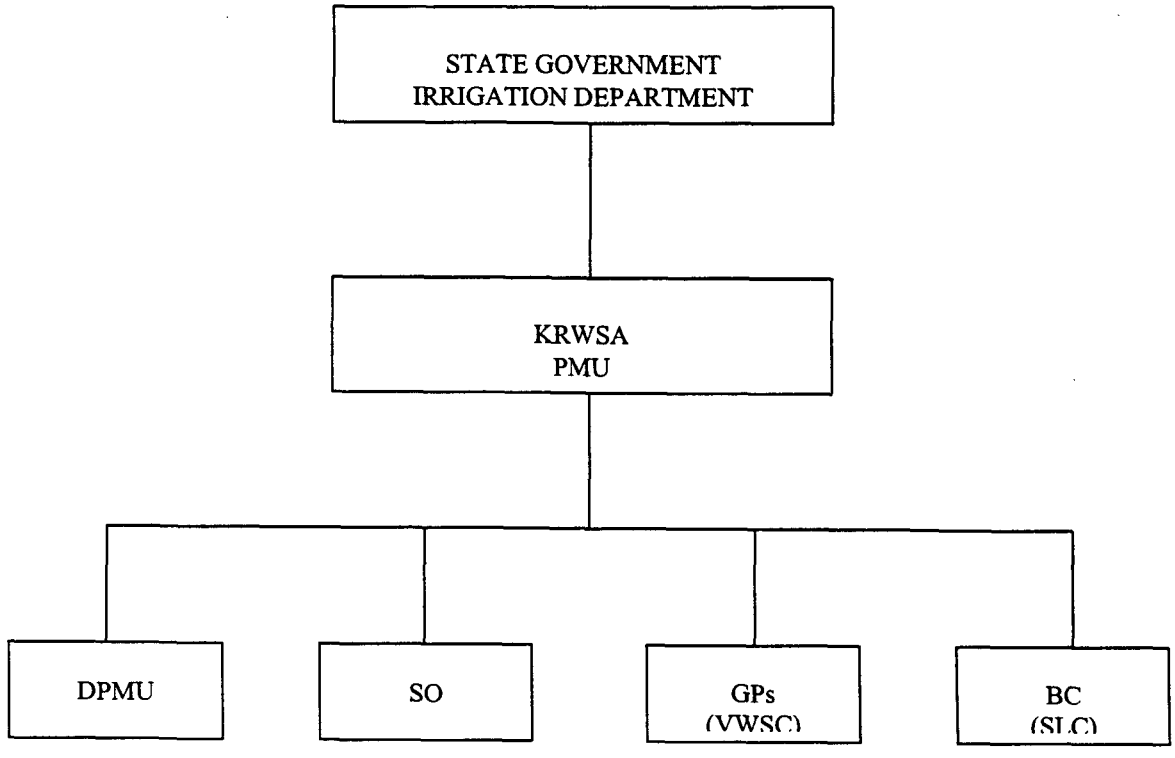
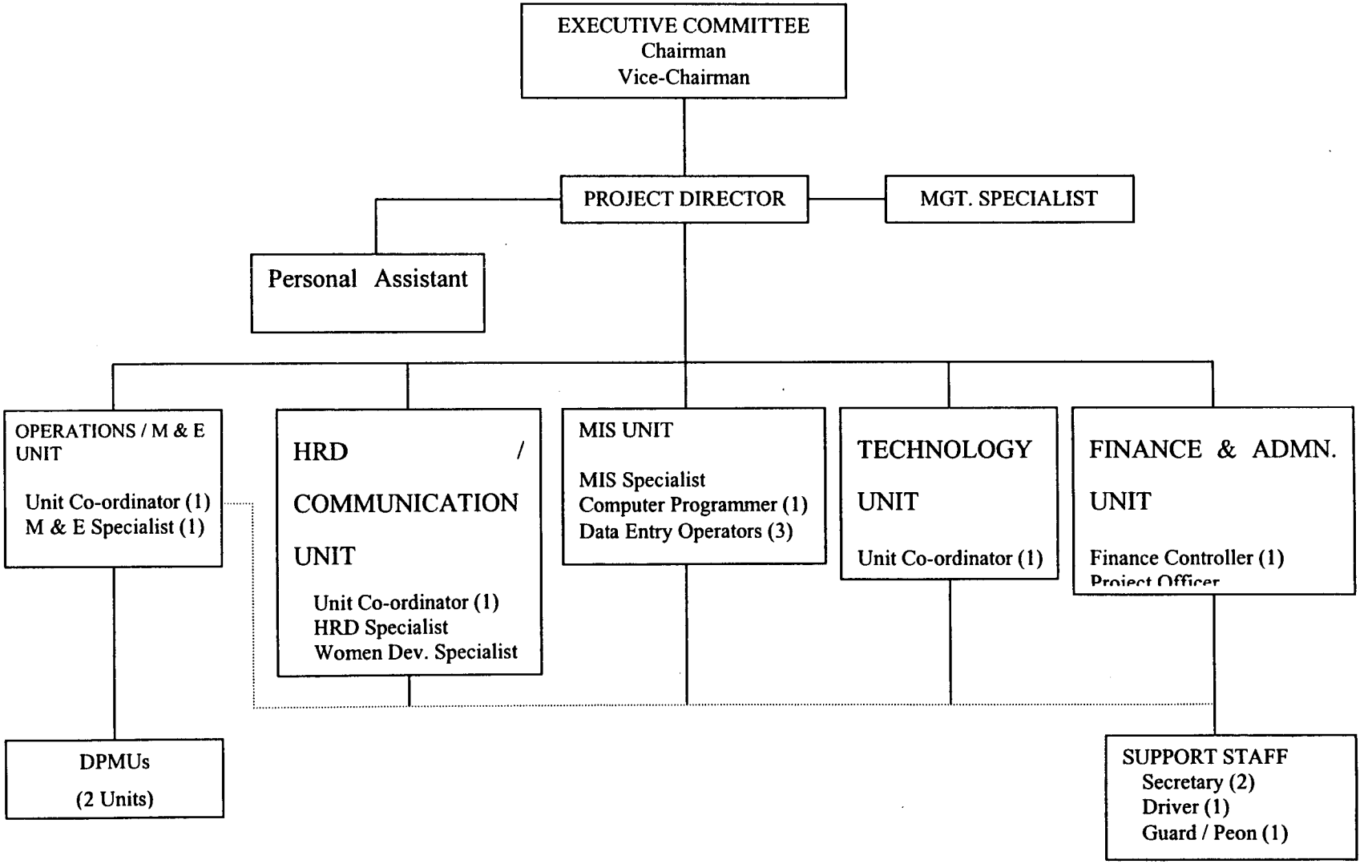


Fig. 3.3. Organogram for the KRWSS Project Management Unit (PMU)



3.6. Project Implementation Schedule and Scheme Cycle

The project is proposed to be implemented over a six year period (July, 2000 to June, 2006). It will be implemented in four batches (10, 20, 25 and 25 GPs in successive batches). Overall implementation schedule and phases of scheme cycle are given in Table 3.2. Scheme cycle for each batch will have four phases : pre-planning (5 months), planning (7 months), implementation (7 months) and post-implementation (3 months). Implementation phase for more complex water supply schemes will be 18 months, spanning two dry seasons. Thus, the scheme cycle for each batch will span over 21 or 33 months. Each batch is scheduled to begin in December of the first four years.

Each phase will have discrete activities, processes and outputs which are being further developed. The key outputs in each phase are : (a) pre-planning phase-selection of GPs and SOs, (b) planning phase formation of Beneficiary Committees and their capacity building, choice of technology, finalization of detailed project proposal; signing of implementation phase agreement among GP, BC and PMU; community contributions raised; (c) implementation phase – construction of schemes and capacity building in scheme operation; and (d) post-implementation – stabilizing beneficiary management of scheme operations. Scheme cycle will be the most important tool in effective planning and monitoring of project implementation.

3.7. Expected Benefits of the Project

Communities in 100 villages would directly benefit from improved water supply and environmental sanitation services through time savings in fetching water, better health from more and cleaner water, improved health knowledge and better hygiene practices. Women would be the primary beneficiaries. In addition to the direct benefits mentioned above, they would benefit through being full members of the Village Water and Sanitation Committees responsible for the project at the community level and through specific components designed to empower them and provide them with additional income opportunities.

Table 3.2

KRWSS Project - Percentage Implementation Plan of Schemes – 4 Batches

	Number of Panchayat	1999	2000	2001	2002	2003	2004	2005
With infiltration/WTP								
Batch I	20	5	45	30	20			
Batch II	30		5	50	20	25		
Batch III	30			5	35	25	35	
Batch IV	20				5	40	25	30
With Dug Well, Bore Well and Spring Protection								
Batch I	20	5	65	30				
Batch II	30		5	65	30			
Batch III	30			5	65	30		
Batch IV	20				5	40	25	30
Total yearly %		1.25	15	23.125	22.5	20	10.525	7.5
Drainage :								
Batch I	20		10	10	30	50		
Batch II	30			20	30	30	20	
Batch III	30				20	20	30	20
Batch IV	20				20	20	30	20
Total yearly %			2.5	7.5	25	30	20	15
Sanitation								
Batch I	20		25	25	25	25		
Batch II	30			25	25	25	25	
Batch III	30			20	20	20	20	20
Batch IV	20					30	30	10
Total yearly %			6.25	17.5	25	25	13.75	7.5
Water Conservation								
Batch I	20		10	10	30		50	
Batch II	30			20	30	30	20	
Batch III	30				20	20	30	30
Batch IV	20				20	20	30	20
Total yearly %			2.5	7.5	2.5	30	20	15

The private sector and NGOs would benefit from the opportunity the project provides them to implement their own mandate of sustainable service delivery to larger population and to become a partner in development with the government. Their participation would provide additional employment opportunities to the skilled technicians and professional personnel in the project area.

The Kerala Government would benefit from an increased institutional capacity to facilitate delivery of sustainable services due to promotion and development of additional partners in the communities, NGOs and private sector.

The Kerala Government's financial position would improve because of cost sharing by the beneficiaries, which would enable the Government to provide financial support to a larger number of communities in lesser time, because the community's assumption of full responsibility for operation and maintenance would reduce the state's recurring expenditure budget, and the presumption of the longer life of the investments due to better O&M would reduce the capital replacement interval.

The cost recovery and institutional reforms promoted under the project would eventually bring similar benefits to rural communities throughout the state.

4. BASLINE ENVIRONMENTAL STATUS

4.1. Physical Environment

Location and Physiography

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 74°52' and 77°22' E longitude. Flanked by Karnataka in the north and Tamil Nadu in the east, Kerala is an enchanting strip of land ensconced between the Arabian Sea and the Western Ghats. The state comprises 14 districts divided into 61 taluks (Fig.4.1). The largest among the 14 districts is Idukki (5019 sq.km) and the smallest is the coastal district of Alappuzha (1414 sq.km).

Based on its physical features, the state can be divided into three natural divisions, namely – the sandy coastal region (<7.6 m above MSL) with is extensive coconut groves, paddy fields, backwaters and the sea; the midland region (7.5 m – 75 m above MSL) made up of fertile reddish hills and valleys that grow most of Kerala's agricultural crops; peaks, extensive ridges and ravines of the Western Ghats (>75 m above MSL), where sandalwood, tea, coffee, rubber and most of Kerala's exotic spices are grown.

The Western Ghats which form a solid, contiguous mountain wall, seem to dominate the topography of Kerala. The 2.695 m high Anai Mudi peak here is the highest point in South India. The Ghats act as a natural barrier during the South West monsoon, thereby ensuring a steady rainfall. More than forty rivers spring from the mountains and taking a round about route, they either join the backwaters and lagoons or directly merge with the sea.

Kozhikode district lies between latitude 11°5' and 11°50' N longitude 75°30' and 76°15' E and is surrounded by the Arabian Sea in the West, Wayanad district in the East, Kannur district in the North and the Malappuram district in the South. Administratively it is divided into 3 taluks namely Kozhikode, Quilandy and Badagara and comprises. 12 blocks and 103 villages.

Topographically the district has 3 distinct regions : the sandy coastal belt with an area of 362.85 sq.km, the rocky highlands formed by the hilly portion of the western ghats having an area of 625.81 sq.km and lateritic midland of 1344.5 sq.km sandwiched between the coastal belt and the highlands.

Thrissur district of Kerala lies in the central part of the state between 10°0' and 10°45' N latitude and 76°0' and 76°52' E longitude with an aerial extent of 3032 sq.km. The district has five taluks viz., Chavakkad, Talappalli, Thrissur, Kodungallur and Mukundapuram comprising 7 municipalities and 99 panchayats under 18 community development blocks (including a small portion of Parakkadavu block of Eranakulam district).

Physiographically, the district is sub divided into three parallel zones viz., the coastal plains, the midland and the highlands. The coastal region has an area of 46544 ha and covers 51 revenue villages/towns. The low-lying tracts (0.5-1 m below MSL), the 'kol lands' are also located in this region. The midland region covering an area of 154860 ha comprises 171 revenue villages / towns. The region is characterised by numerous well defined small cultivated watersheds (elas). The highland region lies along the eastern part of the midland and covers a total area of 98157 ha. The region is characterised by rugged hill ranges of Western Ghats. The eastern highland exhibits a typical topography with steep hills dissected by deep `V' shaped valleys drained by youthful rivers. Most of the reservoirs are located in this region.

The land cover status of the area comprises fourteen classes which include coconut (495.48 sq. km), paddy (393.17 sq.km), mixed plantations (486.84 sq.km), rubber (693.16 sq.km), teak (160.9s sq.km) etc. With the diverse agroclimatic conditions brought about by the natural physiographic divisions, a wide variety of crops such as rice, coconut, arecanut, pulses, pepper, tapioca, rubber and fruits like banana and cashew are grown in the district.

Palakkad is the second largest district of Kerala state with an area of 4480 sq.km and lies between longitudes 76°02' and 76°55'E and latitudes 10°20' and 11°14'N. The district with an area of 4480 sq.km comprises five taluks, viz. Ottapalam, Mannarghat, Palakkad, Chithur and Alathur.

Geology

The state is mainly comprised of crystalline rocks such as charnockites, khondalites, gneisses, and Dharwar schists of precambrian age. The charnockites are exposed in all districts, khondalites and gneisses are concentrated in the southern part of the state and Dharwar schists and genisses are exposed in the northern part of the state whereas intrusive granites and dolemites occur in some parts of the state only. Pegmatite and quartz veins cut across all the rock formations all over the state.

Late Tertiary sedimentary formations, equivalent to the Rajahmundry sandstone form a linear coastal outcrop to the north of Kannur and from Kottayam to beyond Thiruvananthapuram in the south. These, together with alluvium, cover an area of about 6000 km^2. The sedimentaries are over 300 m thick in the widest part of the outcrop between Sherthalai and Karunagappally. The top of the beds is 70 m below MSL at Kochi and rises to 80 m above MSL south of Thiruvananthapuram. They are of riverine origin, and comprise, from bottom to top (i) Vaikom beds of over 100 m thickness of sandstone-clay with four lenticular granular horizons, (ii) Quilon beds of fossiliferous

limestone, marl, sand and clay of about 70 m thickness and (iii) Varkkallai beds of about 80 m thickness of two persistent interconnected gritty sandstone horizons with interbedded clay and lignite. The Quilon beds do not persist eastward, and thin out 7 km short of the eastern boundary of the sedimentaries.

Laterites cover wide areas in Kerala. All along the midland region it forms as a residual deposit due to weathering of either cystalline or sedimentary rocks. The thickness of the laterite generally varies from 5 to 8 m. Plateau laterite of greater thickness is seen in Malappuram, Kozhikode and Kannur districts. Lateritic soil is predominant in the midland regions.

Alluvium overlying laterite is 14 to 20 m thick. It extends all along the coast from Kasaragod to Thiruvananthapuram. It is essentially sand, clay and silt.

Rainfall

The average annual rainfall of the state is estimated at 3000 mm. However, the spatial and temporal distribution pattern is mainly responsible for the frequent floods and droughts in Kerala. The average annual rainfall in the lowland of Kerala ranges from 900 mm in the south to 3500 mm in the north. In the midland, annual rainfall ranges from 1400 mm in the south to 4000 mm in the north. In the highlands, annual rainfall varies from 2500 mm in the south to about 6000 mm in the north. About 60% of the annual rainfall in the state is received during the South-West monsoon (June-August), 25% during North-East monsoon (September – November) and the remaining during the summer months.

There are certain areas in the Attappady valley with only 600 mm annual average rainfall. Generally, the high ranges receive more rainfall than the other zones, mainly due to a phenomenon called orography-hills influencing rainfall. Areas on the eastern side of

the Western Ghats have less rainfall and are rightly called 'rain-shadow' areas; the rainfall in regions close to the gaps, such as Palakkad is also comparatively less due to the escape of moisture-laden clouds through the gaps. While the temporal distribution of rainfall depends on the monsoon winds to a great extent, the spatial distribution depends on the configuration of land, especially the undulating topography of the ghats.

Climate

Kerala enjoys a balmy weather almost all through the year. It is neither too cold in the winter months nor too hot in summer. The warmer (>32°C) months are March-May and September-October. Mid-May to August is the monsoon period, and one can expect a wet time. In addition, June is also a windy month.

4.2. Water Environment

Surface Water Resources

There are 44 rivers in Kerala state with a minimum length of 15 km. Of these, 41 originate in the Western Ghats, flow towards the west and join the Lakshadweep sea. The remaining three also originate in the Western Ghats within the state and drain into the Bay of Bengal.

The rivers of Kerala are monsoon-fed and fast-flowing. According to an estimate (PWD, 1974), the total runoff of the rivers of the state amounts to about 77,900 Mm^3, of which 70,200 Mm^3 is from Kerala catchments and the remaining 7700 Mm^3 is from Karnataka and Tamil Nadu catchments. The estimated water potential of the river basins of the state is given in Table 4.1. The available per capita fresh water resources in Kerala is less than the national average. It is even less than that of the dry states like Rajasthan, Karnataka, Gujarat and Maharashtra as can be seen from Table 4.2.

Table 4.1
Water Potential in the River Basins of Kerala

Name of Basin	Annual yield (MCM)			Annual utilisable yield (MCM)		
	Total	In Kerala	Outside	Total	In Kerala	Outside
Manjeswar-Uppala	698	309	389	379	106	273
Shiriya	1337	620	717	973	358	615
Chandragiri-Mogral	3964	1718	2246	3129	1218	1911
Nileswar – Karingode	1710	1356	354	1238	937	301
Kavvayi – Peruvamba Ramapuram	1143	1143	Nil	603	603	Nil
Kuppam	1516	1236	280	1024	786	238
Valapattanam	4092	2784	1308	2938	1823	1115
Anjarakandy	986	986	Nil	503	503	Nil
Tellicherry	251	251	Nil	122	122	Nil
Meha	803	803	Nil	445	445	Nil
Kuttiyadi	1626	1626	Nil	1015	1015	Nil
Chaliyar – Korappuzha – Kallayi – Kadalundi	7775	7135	640	3160	2616	544
Tirur	165	165	Nil	60	60	Nil
Bharathapuzha	7478	6540	938	4146	3394	797
Keecheri – Puzhakkal	1024	1024	Nil	345	345	Nil
Karuvannur	1887	1887	Nil	963	963	Nil
Chalakkudy	3121	2541	580	2033	1539	494
Periyar	11607	11341	266	8232	8004	228
Muvattupuzha	3814	3814	Nil	1812	1812	Nil
Meenachil	2349	2349	Nil	1110	1110	Nil
Manimala	1829	1829	Nil	1108	1108	Nil
Pamba	4641	4641	Nil	3164	3164	Nil
Achencovil	2383	2383	Nil	1249	1249	Nil
Kallada – Pallickal	2270	2270	Nil	1368	1368	Nil
Ithikkara	761	761	Nil	429	429	Nil
Vamanapuram – Ayroor Mamom	1324	1324	Nil	889	889	Nil
Karamana	836	836	Nil	462	462	Nil
Neyyar	433	433	Nil	229	229	Nil
Kabbini*	4333	4333	Nil	4333	4333	Nil
Bhavani*	1019	1019	Nil	1019	1019	Nil
Pambar*	708	708	Nil	709	708	Nil
Total	**77883**	**70165**	**Nil**	**49188**	**42672**	**6516**

MCM – Million Cubic Meter

Source : Water Resources of Kerala, PWD, 1974; * East flowing

Table 4.2

Per capita Water Resources in Litres / Head / Day

	Rain	Surface water	Ground water
India	15,600	2,612	1,280
Karnataka	19,100	2,103	810
Maharashtra	17,600	1,343	1,500
Rajasthan	16,000	32,807	790
Gujrat	13,100	2,291	910
Kerala	12,500	1,652	780
Tamilnadu	7,140	1,443	1,030

Source : Dr.P.Basak, Water Resources of Kerala – Myths and Realities, Water Scenario of Kerala, State Committee on Science, Technology and Environment, Government of Kerala.

The four project districts, viz., Kozhikode, Malappuram, Thrissur and Palakkad fall essentially under three river basins, the Chaliyar, the Chalakudy and the Bharathapuzha basins. Details on the water resources of these basins and their utilisation are briefly presented hereunder.

The **Chaliyar** river basin ranks 3rd largest in the annual water discharge and 4th largest in catchment area among the 44 rivers of Kerala. The basin mainly covering Kozhikode and Malappuram districts extends over a distance of 60 km from north to south and 90 km from east to west. Maximum flow in the river occurs at Areacode station

during the months of June to December (total 2047.87 Mm^3 in 1991 and 3593.52 Mm^3 in 1992). Minimum flow is generally observed from January to May at the same station (Total 1.46 Mm^3 in 1991 and 18.50 Mm^3 in 1992). The river is a major source of irrigation water to Malappuram and Kozhikode districts and serves as the source of Kozhikode city water supply. A regulator cum bridge across the river Chaliyar at Kavanakkal near Oorkadavu is nearing completion to prevent salinity intrusion into the Kozhikode water supply intake at Koolimadu. Investigations for 3 hydroelectric projects in river Chaliyar have been completed. A large number of major/medium irrigation schemes are proposed utilising 2239 Mm^3 of water from the Chaliyar river to provide irrigation to 87601 ha of land.

The **Chalakudy** river originating from the Anamalai hills of Western Ghats at an elevation of 1250 m above MSL, in its initial course passes through thick forests and after many falls reaches the plain at Kanjirappally and finally empties into the right arm of Periyar river in Ernakulam district. The river basin with a total area of 1704 sq.km is located in Thrissur, Palakkad and Ernakulam districts of Kerala. The river flows mainly through Thrissur district. The Chalakudy main irrigation project as also 27 minor irrigation projects are located in this river. The downstream of the river is extensively used as a source of a few rural and urban water supply schemes. There are two hydel power projects one each at Peringalkuthu and Sholayar. In the mid stretch of the river there are a few rural and urban water supply schemes in addition to a few major industrial establishments which discharge their effluents into the river.

The river basin has good ground water potential. While in the high ranges sub soil water is tapped through springs, in the mid region large diameter dug wells and high yielding tube wells are used.

The **Bharathapuzha** river originates in the Anamalai mountain ranges in Coimbatore district of Tamil Nadu, enters the Kerala state crossing the Palakkad gap and runs a distance of 250 km before draining into the Lakshadweep sea. The river basin, the largest in Kerala with a basin area of 6186 sq.km flows through Palakkad. Thrissur and Malappuram districts. More than 50% of the river basin lies in Palakkad district and 80% of the district is covered by the basin. Maximum flow in the river is found to occur during the months of June to December and minimum flow during January to May.

The river basin has good ground water potential which has not been fully utilised due to forest cover and hilly terrain. The limited extraction is through springs in highlands and dug wells and tube wells in the midland and coastal lands. The ground water potential of Malappuram, Palakkad and Thrissur districts are shown in Table 4.3.

Table 4.3

District - wise utilisable groundwater resources, draft and balance for Kerala State as on 31-03-1992[1]

S.No	District	Utilisable resources in MCM	Net Draft in MCM	Balance resources available for irrigation in MCM
1.	Trivandrum	209.7	51.3	158.4
2.	Quilon	327.0	70.9	301.1
3.	Pathanamthitta	317.8	32.4	285.4
4.	Alleppey	486.2	45.0	441.2
5.	Kottayam	402.9	40.7	362.2
6.	Idukki	389.3	19.2	370.1
7.	Eranakulam	638.0	134.1	503.9
8.	Trichur	709.9	153.6	536.3
9	Palaghat	752.7	78.6	674.1
10.	Malappuram	548.5	100.3	448.2
11.	Calicut	416.1	53.3	362.8
12.	Wyanad	360.9	17.8	343.1
13.	Cannanore	623.2	90.7	532.5
14.	Kasargod	359.6	118.3	241.3
	Total	6586.8	1006.2	5580.6

MCM – Million Cubic Meter

[1] District wise utilizable groundwater is the annual replenishable recharge of the district phreatic aquifer (including rainfall, topography, hydrogeology etc).

The highlands are mostly reserved and protected forest with tea and coffee as main cultivation. In the midland coconut, rubber and pepper are grown and in the lowland region paddy and coconut are cultivated.

Surface Water Quality

During the course of its travel, the Chaliyar river receives considerable amount of pollution load. M/s.Grasim Industries Ltd. situated at Mavoor, 25 km upstream from the river mouth depends solely on the river for its water needs and as a sink for its wastewater discharge with a BOD load of 1110 kg/day. A large number of small and medium scale industries are also located on the banks of the estuarine portion of the river. The river also receives domestic wastes and also fertiliser and pesticide run off from agricultural lands which it irrigates.

A number of polluting industries located in the Chalakudy river basin contribute a BOD load of 224 kg/day. Apart from these, there are a large number of small industries which also contribute to the pollution load in the river. However, the pollution load from these industries is not known. The details of major townships and the pollution load generated from these towns are shown in Table 4.4. It is estimated that 7696 kg of BOD is being discharged into the river every day from these townships. The pilgrim centre at Muringoor and the tourist spot Athirampalli water fall also contribute to the pollution load in the river.

A large number of industries – large, medium and small scale – have come up in the Bharathapuzha river basin especially in Palakkad district. The details of major townships/urban centres (none has waste water collection and treatment system) and the

Table 4.4

Details of Pollution due to Domestic Waste in the Chalakudi River Basin

Pan. . ayat	Area in sq. km	No. of households	Population	Qty. of sewage m^3 / day	BOD kg/day
Chalakudy	20.3	11862	60258	1200	950
Mala	28.35	10325	55481	1100	870
Koraty	23.42	8451	40257	821	812
Kodakara	21.29	7415	36951	870	719
Aloor	34.39	8526	45217	985	920
Kadukuty	17.63	5142	35214	520	620
Pariyaram	27.19	6352	25147	812	452
Vettilappara	489	3200	11458	420	312
Melur	23.06	725	26584	687	615
Kodassery	93.30	8200	32651	950	680
Total				**8365**	**6920**

BOD – Bio-chemical Oxygen Demand

Source : Ambient Water Quality Monitoring Network – Chalakudy River Basin (Sep. 1999). Indo-Dutch Project, Kerala State Pollution Control Board, Thiruvananthapuram

pollution load from these centres are given in Table 4.5. (Basis : per capita sewage contribution 20 lpd and BOD load 0.95 kg/m^3). A wide spectrum of pesticides are used in the three basin distrits (Table 4.6). Details of major industries along with the pollution load contributed by them are given in Table 4.7.

Sand extraction along the banks of the river is common in Parali, Shoranur and Pattambi Panchayats, and this activity contaminates the river water making it unfit for drinking and bathing without treatment.

The Periyar, one of the largest river systems of Kerala, is highly polluted with effluents discharged from major industries located on the banks. These industries discharge hazardous pollutants like phosphates, sulphides, ammonia N, fluorides, heavy metals, and insecticides into the downstream reaches of the river. Apart from major industries, coir retting by conventional methods also adds to the pollution in the Periyar estuary. A temporary barrage is constructed in summer at Pathalam in one of the branches of Periyar to prevent salinity intrusion into the upstream reaches. The enormous quantities of wastewater discharged daily into this branch of the river (around 10 million m^3) is not flushed out, leading to stagnation and pollution buildup to high toxic levels. This water is found to be highly acidic (pH 1.9), loaded with ammonia, fluorides and phosphates, resulting in massive fish kills.

The Vembanad wetland system is a receptacle of a large variety of industrial effluents, domestic sewage from Cochin and a string of small towns nearby. Cochin city alone generates 2550 million litres/day of waste water that directly enters into the backwater untreated. Total dissolved solid content of water in this zone is as high as

Table 4.5

Details of Major Townships Contributing Pollution Load in the Bharathapuzha River Basin

Sl.No.	Name of the block	Area, km^2	No. of household	Population	Discharge m^3/day	BOD load kg/day
1	Shoranur	32.28	7601	39500	791	752
2	Mannarkkad	63.38	7790	45422	908	863
3	Palakkad	26.6	22923	123289	2466	2343
4	Ottapalam	32.66	7938	44186	884	840
5	Pattambi	15.84	3521	22108	442	420
6	Pudussery	122.84	9090	41710	834	793
7	Chittur – Thathamangalam	14.71	6292	32048	641	609
8	Hemambikanagar	3	3306	15847	317	301
9	Puthupariyaram	19.93	4793	24808	496	471
10	Marutharoad	9.52	3100	16089	322	306
11	Koduvayur	10.53	3400	17647	535	335
12	Alathur	19.62	440	23498	470	447
13	Ponnani	9.32	6329	51770	1035	984
14	Kuttipuram	31.31	5654	371156	743	706
15	Tanur	19.49	6942	54243	1085	1031
16	Thrithala	22.78	3804	22312	446	424
17	Parli	30.27	5695	29640	593	563
18	Vadakkenchery	37.88	6030	31470	629	598
19	Malampuzha	183.42	2709	12860	257	244
	Total				**14652**	**13923**

BOD – Bio-chemical Oxygen Demand

Source : Ambient Water Quality Monitoring Network – Bharathapuzha River Basin (Sep. 1999). Indo-Dutch Project – Kerala State Pollution Control Board, Thiruvananthapuram.

Table 4.6

Average Yearly Consumption of Pesticides in kgs in the Project Districts for the Year 1998

Sl.No.	Name of pesticide	Thrissur	Palakkad	Malappuram
1.	Aldrin	0	0	0
2.	BHC – 10%	3700	3780	2560
3.	BHC – 50%	10490	3650.7	240
4.	Carbaryl	2420	4860	2870
5.	Carbofuran	126780	88140	59710
6.	Cypermethion	0	0	0
7.	Chloropyriphos	40	480	0
8.	Dichlorobos	1950	379	54.6
9.	Dimethoate	5760	4270	2210
10.	Endosulfan	1215	2510	1690
11.	Ethion	0	0	0
12.	Femithrothion	380	356	37
13.	Fenthion	0	460	0
14.	Fenvelerate	287.8	108.5	410
15.	Formothion	0	421	2.4
16.	Malathion	6460	6300	1840
17.	Methyl-parathion	410	632	460
18.	Monochlorofos	44357	6980	1730
19.	Phenthiote	580.4	51	160
20.	Permithrin	3200	1700	600
21.	Phorate	2670	7820	6910
22.	Phosolon	30	0	0
23.	Phosphamide	6887	1700	1200.5
24.	Pyrithron	3246	620	480
25.	Qunalphin	10224	6680	774
26.	Caplan	60	0	0

Table 4.6 Contd.,

Sl.No.	Name of pesticide	Thrissur	Palakkad	Malappuram
27.	Carbondizam	0	1620	8
28.	Copper oxy chloride	711	1320	1866
29.	Copper sulphate	8626	2000	170
30.	Ediphinphos	0	0	0
31.	Mancozeb	3129	1540	253
32.	Nickel chloride	16	0	0
33.	Sulphur	260	100	0
34.	Zineb	0	0	0
35.	Ziram	326	234	94
36.	Thiram	0	0	0
37.	Anilophos	0	0	0
38.	Beta chlor	540	0	600
39.	Benathiocarb	0	480	0
40.	Diuran	0	0	360
41.	2-4-D	3260	0	590
42.	Glyphosate	7.8	26	0
43.	Paraquart	0	0	560
44.	Propanil	17	46	3200
45.	Bromadiolene	265	0	0
46.	Ethylene di bromide	1500	0	0
47.	Methyl bromide	860	0	0
48.	Varfurin	550	0	0
49.	Zinc phosphide	2200	3705	0
50.	Ethipon	0	0	0

Source : Ambient Water Quality Monitoring Network – Bharathapuzha River Basin (Sep. 1999). Indo-Dutch Project – Kerala State Pollution Control Board, Thiruvananthapuram.

Table 4.7

Details of Major Industries Contributing Pollution in the Bharathapuzha River Basin

Sl.No.	Name of the Industry	Qty of effluent discharged, m^3/day	Total pollution load, BOD kg/day
1	M/S Premier Breweries	320	600
2	M/S Prima Industries	100	30
3	M/S Rubfila International (P) Ltd.,	170	51
4	M/S Co-Operative Sugars	280	287
5	M/S Palakkad Rubber Industries	70	70
6	M/S Co-operative Rubber Marketing Society	150	10045
7	M/S Kottakkal Arya Vaidya Sala	60	60
8	M/S Chaya Industries	500	150
9	M/S Teak Tex Processing Complex Ltd.	1500	450
10	M/S Super Star Distilleries	90	30
	Total	**3240**	**11773**

BOD – Bio-chemical Oxygen Demand

Source : Ambient Water Quality Monitoring Network – Bharathapuzha River Basin (Sep. 1999). Indo-Dutch Project – Kerala State Pollution Control Board, Thiruvananthapuram.

53750 mg/litre during summer and comes down to 160 mg/litre during the rainy season when the flushing is much better. The existing sewage treatment plant in Cochin covers only a small fraction of the population. The pollution load from Cochin corporation and Alappuzha town are 1,95,547 kg/day of BOD and 64,237 kg/day of BOD respectively. Annual fertilizer consumption in Kuttanad is : 8409 tonnes of N, 5044 tonnes of P and 6786 tonnes of K. Pesticides/fungicides/weedcides are applied to the tune of about 500 tonnes/year.

According to a study conducted under an Indo-Dutch programme on the Kuttanad water balance, about 25000 tonnes of fertilisers and 500 tonnes of highly toxic pesticides are used in Kuttanad's 55,000 ha of paddy fields annually. A major portion of these agrochemicals reaches the water bodies as runoff (Indo-Dutch Project report, 1989). The report indicated the presence of DDT in Pampa river (4000 ng/l). Lindane in Thanneemukkam (6000 ng/l) and Endosuphan in Vembanad lake (122 ng/l) and Manimala river (1114 ng/l).

Salinity Intrusion

The short, fast-flowing, monsoon-fed rivers of Kerala often encounter salinity intrusion into their lower stretches during the summer months. When the fresh water 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. Both these aspects have an impact on irrigation, drinking and industrial water supply schemes situated in the downstream reaches (James, 1996).

Based on the studies conducted with the help of mathematical models, it is found that the salinity in the Beypore estuary propagates to a distance of 24 km upstream, thereby creating problems to the water supply scheme to the Kozhikode corporation area

(James and Sreedharan, 1983); the flushing time in summer from a distance of 20 km from the mouth is 20 days and more, creating pollution concentration in the lower stretches. Problems of salinity intrusion are also encountered in the Periyar, Meenachi and Kuttiyadi rivers, which have been studied in detail (James, 1985).

The present measures for preventing salinity intrusion into the intake points of drinking water supply schemes is by the construction of temporary barrages, which prevent the flow and create ecological problems, especially concentration of pollutants upstream of the obstruction. Areas upstream of Thanneermukkom barrage in the Vembanad and Pathalam barrage in the Periyar are typical examples (James, 1996a).

Hydrogeology

Coastal Region

The groundwater in the coastal region predominantly occurs under water table conditions in the alluvial deposits of recent age, and these aquifers are normally a few metres in thickness. Open wells of diametres of about 2 m are the common groundwater extraction structures. In some places the sandy aquifer may extend to depths of a few tens of metres. In such places, it is suitable to construct filter point wells.

In some stretches, groundwater occurs in the upper tertiary sedimentary formations of Vaikom, Kollam and Varkkalai beds capped by laterites. In these areas, the groundwater occurs under artesian conditions. The piezometric surface of these confined aquifers has been found to vary from 0.5to 14.3 m above MSL. The wells with positive heads have a free flow of 270 – 360 lpm. The Vaikom aquifers having thickness of 25 to 79 m are the highest groundwater potential aquifers in the coastal region. The sedimentary tract between Kollam and Sherthalai is suitable for medium capacity tubewells.

Midland Region

In this region, groundwater is commonly encountered under water table conditions in the lateritic aquifers of about 10 to 20 m thickness. Dugwells of relatively large diameter of about 4 to 6 m are the common groundwater extraction structures in midland. The laterites are underlain by weathered rock and the two are usually separated by a lithomargic clay zone which is prone to caving and hence in such formation, laterite brick lining or concrete rings are necessary for open wells.

Highland Region

The jointed and highly weathered zone forms the aquifer in this region. Groundwater occurs under water table condition and the same can be exploited through dug wells. Deep seated fracture or fault zones in the hard rocks usually also hold groundwater and the same can be exploited through borewells.

Major Lineaments

There are a number of major faults and fractured zones in Wayanad, Palakkad, Kasaragod, Malappuram, Attapady etc. The most productive aquifers in the crystalline rocks are the fractured or faulted zones. The yield of wells located along these lineaments or at the intersection point of lineaments are likely to be high.

Groundwater Potential and Utilisation in Kerala

Reliable estimates of the total groundwater potential and its distribution over different regions of the State are basic information needed for formulating any plans for groundwater utilisation. Central Ground Water Board, State Ground Water Department, Central Water Commission and Centre for Water Resources Development and Management have estimated groundwater potential of the State. The CGWB estimates of ground water resource and irrigation potential of Kerala are given in Table 4.8.

Table 4.8

Ground Water Resource and Irrigation Potential of Kerala

Sl.No.	Districts	Total Replenishable Ground Water Resource (m.ha.m/Yr)	Provision for Domestic, industrial & Other-Uses (m.ha.m/Yr)	Available Ground Water Resource for Irrigation in Net Terms (m.ha.m/Yr)	Utilisable Ground Water Resource for Irrigation in Net Terms (m.ha.m/Yr)	Gross Draft Estimated on Prorata Basis (1992) (m.ha.m/Yr)	Net Draft (1992) (m.ha.m/Yr)	Balance Ground Water Resource for Future Use (m.ha.m/Yr)	Level of Ground Water Development (%)	Weighted Average Delta (m)	Utilisable Irrigation Potential for Development (m.ha)
1	2	3	4	5	6	7	8	9	10	11	12
1	Thiruvananthapuram	0.02996	0.00899	0.02097	0.01887	0.00733	0.00513	0.01584	24.26	0.73	0.02585
2	Kollam	0.04649	0.00929	0.03720	0.03348	0.01013	0.00709	0.03011	19.06	0.71	0.04715
3	Pathanamthitta	0.03739	0.00561	0.03178	0.02860	0.00463	0.00324	0.02854	10.20	0.72	0.03973
4	Alleppey	0.05720	0.00858	0.04862	0.04376	0.00643	0.00450	0.04412	9.26	0.65	0.06731
5	Kottayam	0.04740	0.0071	0.04029	0.03626	0.00581	0.00407	0.03622	10.10	0.69	0.05255
6	Idukki	0.04580	0.00687	0.03893	0.03504	0.00274	0.00192	0.03701	4.93	0.83	0.04221
7	Ernakulam	0.07506	0.01129	0.06380	0.05742	0.01916	0.01341	0.05039	21.00	0.65	0.08834
8	**Thrissur**	**0.08352**	**0.01253**	**0.07099**	**0.06389**	**0.02194**	**0.01536**	**0.05563**	**21.64**	**0.66**	**0.09680**
9	**Palakkad**	**0.08856**	**0.01328**	**0.07527**	**0.06774**	**0.01123**	**0.00786**	**0.06741**	**10.44**	**0.53**	**0.12782**
10	**Malappuram**	**0.06856**	**0.01371**	**0.05485**	**0.05211**	**0.01433**	**0.01003**	**0.04482**	**18.28**	**0.71**	**0.06952**
11	**Kozhikode**	**0.05201**	**0.01040**	**0.04161**	**0.03939**	**0.00761**	**0.00533**	**0.03628**	**12.81**	**0.75**	**0.04993**
12	Wayanad	0.04246	0.00637	0.03609	0.03249	0.00254	0.00178	0.03431	4.93	0.54	0.06015
13	Kannur	0.07331	0.01099	0.06232	0.05609	0.01296	0.00907	0.05325	14.55	0.78	0.07191
14	Kasaragod	0.04231	0.00635	0.03596	0.03236	0.01690	0.01183	0.02413	32.90	0.81	0.03996
	TOTAL	**0.79003**	**0.13135**	**0.65868**	**0.59281**	**0.14374**	**0.10062**	**0.55806**	**15.28**		**0.87925**

Source : Ground Water Resources of India, Central Ground Water Board, Ministry of Water Resources, Govt. of India (1995).

Springs in Kerala

As per a survey by CWRDM (1988), a total of 236 springs were identified in the state. About 80% of these springs are situated in the eastern side of the Western Ghat belt of the state. The districtwise distribution of springs is given in Table 4.9. The coastal districts like Alleppey and Ernakulam do not have any prominent springs. Most of the springs are formed in the highlands (more than 75 m from MSL) and above 800 m there is decreasing occurrence of springs due to lack of catchment area. The classification of springs based on Meinzer's classification is shown in Table 4.10. The springs which come under 3rd, 4th and 5th order can be considered for drinking water purposes for isolated villages.

Groundwater Quality

A sizeable rural population of Kerala, not yet covered by organised water supply schemes, depend upon ground water sources for their domestic use. The major ground water quality problems in the state are related to fecal contamination and presence of excessive concentrations of salinity, iron and fluoride. The causes of contamination can be attributed to sea water intrusion, domestic sewage, mineralogical origin and agricultural and industrial activities.

Groundwater Quality in the Coastal Area

The main water quality problem is the presence of chloride concentration in excess of 250 mg/l. As per CWRDM report (1997) well water samples from Azhikode, Kakkathuruthi, Edathinjil, Kadalundi, Anjengo, Chellanum, Nallalam, Monkombu and Harippad had chloride concentration in excess of 250 mg/l. The borewell samples in Kozhikode city had a high concentration of chloride (20200 mg/l), iron (0.40 – 0.90 mg/l), total hardness (9000 – 10600 mg/l) and sulphate (2200 – 2300 mg/l). The wells at Aiyur (near Mahe river), Payyoli and Chaliyam showed high concentrations of iron and TDS.

Table 4.9

District-Wise Distribution of Springs in Kerala

Sl.No.	Name of District	Number of Springs
1.	Kasaragod	8
2.	Kannur	34
3.	Wayanad	24
4.	**Kozhikode**	**46**
5.	**Malappuram**	**26**
6.	**Palakkad**	**18**
7.	**Thrissur**	**8**
8.	Kottayam	22
9.	Idukki	18
10.	Kollam	2
11.	Thiruvananthapuram	30
	Total	**236**

Source : Springs of Kerala – An Inventory, CWRDM (May 1988)

Table 4.10

Meinzer's Classification of Springs of Kerala

Order of magnitude	Discharge (1 sec^{-1})	No.of springs located
First	>2830.00	--
Second	283.00 - 2830.00	--
Third	28.30 - 283.00	3
Fourth	6.31 - 28.30	14
Fifth	0.631 - 6.31	34
Sixth	0.0631 - 0.0631	139
Seventh	0.0029 - 0.0631	46
Eighth	<0.0029	--

Source : Springs of Kerala – An Inventory, CWRDM (May 1988)

A study on ground water quality (CWRDM Report 1997) in Alappuzha reported that all the pumping wells of KWA in the town have a fluoride concentration higher than the permissible limit of 1 mg/l in drinking water and that 14% of the surveyed school children had dental fluorosis. The seasonal variation in fluoride concentration in different pumping wells of Alappuzha town is given in Table 4.11.

Groundwater quality of the midland region

The salient findings of a study on water quality characteristics of dug wells and bore wells of midland region of Thrissur have been reported (CWRDM Report, 1997).

With regard to ion concentrations, the concentration of fluoride, iron and chloride were found to be on the higher side in the case of a few bore well samples. The fluoride content was observed to be beyond the permissible limit (1 mg/l) in 12 bore wells located in Kadavallur, Cowannur, Killannur, Mullasserry, Venkitangu, Ollukkara, Pannancherry, Nadathara, Madakathara, Vilavattom and Kolazhi. The iron content of the target area was observed to be high and beyond the permissible limit in bore wells located in 15 panchayats namely Adat, Vellangallur, Velookara, Puthenchira, Aloor, Kuzhoor, Mala, Poyya, Karalam, Muriyad, Parapookara, Erumapetty, Mullukkara, Thekkumkara and Wadakkancherry. The chloride concentration was found to be well within the permissible limit except in one bore well sample at Paralam panchayat.

Microbiologically 52% of the wells were found to be contaminated. The details of the microbiologically contaminated wells are indicated in Table 4.12.

In the midlands of Thiruvananthapuram, Kottayam, Muvattupuzha, Kannur and Kasargode, the water quality problems are mainly associated with pH and iron. In the wells of Palakkad region fluoride is found to be a problem (CWRMD Report, 1997). The percentage of wells contaminated with various parameters in these places are indicated in Table 4.13.

Table 4.11

Fluoride Concentrations in the Wells of Alappuzha

Name of sampling station	Fluoride concentration (mg/l)	
	July 1995	March 1996
Alappuzha – Convent	1.0	1.2
Alappuzha – Vellakinar	1.01	1.4
Alappuzha – Alisserry	1.09	1.5
Alappuzha – Chudukkad-I	1.13	1.9
Alappuzha – Chudukkad-II	1.14	1.9
Alappuzha – Thookalam	1.02	1.4
Alappuzha – Pazhavangadi	1.08	1.4
Alappuzha – Vazhisserry	1.14	1.3
Alappuzha – Chandanakavu	1.15	2.6

Source : Water Quality Status of Kerala by K.N.Remani and PS Harikumar in Water Scenario of Kerala (1998) Published by State Committee on Science, Technology and Environment, Govt. of Kerala.

Table 4.12

Details of Microbiologically Contaminated Wells in Midlands of Thrissur[2]

Name of the Panchayat	Type of well	Total Coliforms (MPN/100 ml)	E. coli (MPN/100 ml)
Anthikad	DW	460	93
Cherpu	BW	240	5
Koorkancherry	DW	1100	46
Chiyyaram	BW	93	43
Kadavallur	DW	>2400	43
Porathisserry	DW	79	43
Aloor	DW	>2400	21
Aloor	BW	>2400	1600
Irinjalakuda	DW	140	--
Kolazhi	DW	>2400	17
Ollukkara	BW	>2400	12
Killanuur	BW	>2400	14
Kadangode	DW	540	--
Desamangalam	BW	1100	240
Vellangallur	BW	>2400	2

DW – dug well; BW – bore well; MPN – Most Probable Number

Source : Water Quality Status of Kerala by K.N.Remani and PS Harikumar in Water Scenario of Kerala (1998) Published by State Committee on Science, Technology and Environment, Govt. of Kerala.

[2] Please note : Coliforms / Ecoli should be absent in drinking water (Bureau of Indian Standards and WHO Guidelines).

Table 4.13

Percentage of Sampled Wells Contaminated with Iron, pH and Chloride in Various Districts of Kerala (K.N.Remani and P.S. Ravikumar)

Name of the Sampling Station	% of total contaminated samples	% of samples having the parameter exceeding the limit (BIS)		
		pH	Iron	Chloride
Kannur	67	67	13	NIL
Kottayam	68	68	11	NIL
Eranakulam	17	6	11	NIL
Palakkad	40	19	6	29
Kasargode	81	77	27	NIL
Thiruvananthapuram	72	40	68	NIL

BIS – Bureau of Indian Standards

Source : Water Quality Status of Kerala by K.N.Remani and PS Harikumar in Water Scenario of Kerala (1998) Published by State Committee on Science, Technology and Environment, Govt. of Kerala.

The major observations of the studies on the dispersion of domestic effluents on the groundwater quality of Palakkad district are reported below :

- With respect to fluoride, values ranging from 0.29 – 1.8 mg/l were noticed and highest concentration is reported in Olavakkode.
- Chloride concentration was found to be 650 mg/l in some of the wells of Chittoor taluk.
- High concentration of iron (>0.34 mg/l) and calcium (>300 mg/l) was found in areas of Kuzhalmannam, Kanjikode, Mundur, Paralam and Alathur.
- The coliform count was found to be beyond the permissible limit in areas of Karimba, Kannadi and Vadakkancheri.

Groundwater quality of Highlands

The water samples analysed from Myladumpara of Idukki district indicated a high concentration of iron and coliforms in the samples (0.84 – 1.15 mg/l Fe and 450 MPN-coliforms). The bore well samples from Chilavu of the same district is also contaminated with high concentration of iron and coliforms. The wells in Pudur panchayat (1.01 mg/l of iron), Sholayur (0.79 mg/l iron) and Agali (> 2400 MPN coliforms) are also contaminated.

7. A study on pollution of ground water due to domestic sewage has been undertaken by CWRDM in five taluks of Palakkad district, viz. Palakkad, Ottappalam, Chittoor, Alathur and Mannarghat. Data on water quality status of selected wells in the district is presented in Tables 4.14, 4.14a and 4.14b. The study has revealed that above 50% of the wells studied were bacteriologically contaminated. There has also been a high incidence of waterborne diseases in the district (Table 4.15 a). A comparison of water-borne diseases in Kerala with all India average is given in Table 4.15 b.

Table 4.14

Water Quality Status of Selected Wells in Palakkad District

Location	pH	EC	TH	Ca	Mg	NO_3N	K	PO_4	Cl	SO_4	F	Fe	SPC	MPN (C)	MPN (F)
Chittur Taluk															
Kozhinjanpara	8.0	3500	790	140	85	170	8	ND	660	97.5	ND	0.06	1320	220	220
Meenakshipuram	7.5	2500	602	124	75.3	90	9.5	ND	410	105	ND	0.1	440	≥2400	280
Chittur	8.2	1000	106	24	14.6	7.5	5.7	ND	100	65	ND	ND	1040	≥2400	≥2400
Kollenkode	8.1	700	228	40	24.2	17	4	ND	80	47.5	ND	ND	CR	≥2400	1600
Nemmara	8.5	600	162	24	14.6	2.7	9.1	ND	100	40	ND	ND	960	9	7
Ottapalam Taluk															
Pattambi	6.9	260	160	11.2	30.5	4.5	6	ND	60	ND	ND	0.28	CR	33	26
Vallapuzha	7.5	240	50	11.2	6.8	6	5.4	ND	40	ND	ND	0.27	320	≥2400	33
Lakkidi	7.2	70	22	1.1	0.7	2.7	4.2	ND	10	ND	ND	ND	1480	17	11
Sreekrishnapuram	7.3	50	18	2.4	1.5	3.2	4.5	ND	10	ND	ND	ND	580	4	4
Cherpulsassery	6.4	120	30	8.8	5.3	4.1	4.3	ND	20	ND	ND	0.41	CR	≥2400	≥2400
Palakkad Taluk															
Mundur	5.18	317.4	24	12	12	3	55	ND	40	ND	0.29	0.33	-	-	-
Parali	6.83	593.4	60	36	24	0.02	5.3	ND	98	ND	0.4	0.6	-	-	-
Kanjikode	7.73	3036	316	300	16	6.2	2.6	ND	44	ND	1.71	-	-	-	-
Olavakkode	7.51	900.9	182	84	98		3.5	ND	208	ND	1.80	-	54	14	2
Kannadi	7.95	831.6	144	104	40	0.5	5.2	ND	103	ND	0.8	ND		928	200
Alathur Taluk															
Kuzhalannam	7.86	485.1	96	44	52	1.8	1.4	0.01	80	ND	0.68	0.34		350	140
Alathur	7.31	554.4	102	60	42	0.25	20	ND	64	ND	0.79	0.3	7	140	140
Vadakencherry	7.73	152.46	12	4	8	0.2	15	ND	32	ND	0.58	0.004		350	170
Mangalam dam	7.51	384. 92	44	24	20	0.12	0.6	24		0.89	8.14	85	49	5	ND
Kazhani	7.96	831.6	188	124	64	4	1.9	ND	98	ND	1.20	0.12		2400	2400
Mannarkkad Taluk															
Alanallur	6.42	30.6	6.0	1.6	0.49	0.2	2.0	ND		ND	8.63	0.004	5	26	26
Mannarkkad	6.59	341.7	48	14.4	2.92	5.4	24	ND		ND	8.61	0.12	129	>2400	1600

Table 4.14 Contd.,

Kanjirapuzha	6.80	31.11	ND			0.86	2	ND		ND	0.61	0.12	1	22	22
Kariaba	6.85	168.3	36	12.8	0.97	5.4	5	ND		ND	0.67	0.18	76	358	350
Chengaleri	6.75	66.3	ND			3	2	ND		ND	0.47	0.12		26	21
Agali															
Jellippara	7.72	1017	20.0	6.4	0.94	-	0.9	ND	-	-	0.90	0.20	-	350	-
Pudur															
Elachivazhi	6.79	6448	116	24.0	13.61	-	3.0	-	-	-		1.0	-	<2	-
Sholoyur															
Anakkatty	7.22	1684.6	4968	101	58.81	-	17.5	-	-	-	0.626	0.79	-	9	-

MPN – Most Probable Number;

SPC – Standard Plate Count;

C – Coliforms ;

F – Fecal Coliforms

Note : EC is in micro mhos/cm, SPC in MPN/100 ml

Source : Pollution of Groundwater Due to Domestic Sewage – Final Report CWRDM. November 1997

Table 4.14a

Bacteriological Characteristics of Well Water Samples in Mannarkkad Taluk, Palakkad District[3]

Sample Code	SPC/ml	Total Coliforms MPN /100 ml	Fecal Coliform MPN / 100 ml	E-Coli MPN / 100 ml
1.	44	>2,400	>2,400	240
2.	173	23	23	<3
3.	6,500	>2,400	>2,400	150
4.	6,500	>2,400	>2,400	43
5.	6,500	>2,400	>2,400	240
6.	326	<3	-	-
7.	6,500	>2,400	>2,400	-
8.	6,500	>2,400	>2,400	>2,400
9.	2500	<3	-	-
10.	608	240	240	43
11.	6,500	>2,400	>2,400	240
12.	6,500	<3	-	-
13.	185	>2,400	>2,400	23
14.	208	>2,400	>2,400	93

MPN – Most Probable Number

Source: Pollution of Ground Water Due to Domestic Sewage (Final Report) CWRDM, Kozhikode, December, 1997.

[3] Please note : Coliforms / Ecoli should be absent in drinking water (Bureau of Indian Standards and WHO Guidelines).

Table 4.14b

Bacteriological Characteristics of Well Water Sample in Ottappalam Taluk, Palakkad District[4]

Sample Code	SPC/ml	Total Coliforms MPN/100 ml	Fecal Coliform MPN / 100 ml	E-Coli MPN / 100 ml
1.	6,500	>2,400	>2,400	1,100
2.	6,500	>2,400	>2,400	11
3.	444	1,100	1,100	9
4.	288	9	4	4
5.	134	1,100	1,100	150
6.	6,500	>2,400	>2,400	150
7.	944	>2,400	1,100	1,100
8.	228	>2,400	>2,400	>2,400
9.	296	43	23	23
10.	264	240	240	7
11.	576	>2,400	>2,400	9

SPC – Standard Plate Count; MPN – Most Probable Number;

Source: Pollution of Ground Water Due to Domestic Sewage (Final Report) CWRDM, Kozhikode, December, 1997.

[4] Please note : Coliforms / Ecoli should be absent in drinking water (Bureau of Indian Standards and WHO Guidelines).

Table 4.15 a

Statistics of Waterborne Diseases in Palakkad District of Kerala

Diseases	Number of cases	
	1992 – 93	1993 – 94
Acute Diarrhoea	65774	45131
Viral hepatitis	393	734
Cholera	1	--
Enteric fever	1080	433
Gastro enteritis	1608	661
Poliomyelitis	--	3

Source : Department of Health Services, Kerala.

Table 4.15 b

Statistics of Waterborne Diseases in Kerala as compared to All- India

Diseases	Number of cases (1993-94)	
	Kerala	All-India
Acute Diarrhoea	610,914	7,262,755
Viral hepatitis	10,387	117,789
Cholera	36	4958
Poliomyelitis	71	7,576

Source : CSE, The Citizen's Fifth Report (Part II Statistical Database)

The pollution sources identified were animal feedlots, septic tanks, garbage, kitchen waste and storm runoff. In 8% of the wells surveyed, nitrate concentration was above the permissible limit of 45 mg/l (as No_3) for drinking water. High nitrate concentrations were observed in biologically polluted wells. In about 16% of the wells studied, fluoride levels were high, above the permissible limit of 1.0 mg/l. High chloride concentration in dug well waters at Kozhinjanpara and Meenakshipuram in Chittur taluk, and high concentration of iron in groundwater at Mundur, Paralam and Alathur were also reported.

Over-exploitation of Groundwater in Certain Hydrogeological Zones

As per Ground Water Year Book of Kerala (1996-97), CGWB, Kerala Region, water level observations during August 1996 (Fig. 4.2) have indicated that 55% of NH stations showed a fall in water level less than 2m and are distributed throughout the state; the fall in water level of 2-4 m is observed in a few isolated pockets and that in Kozhinjampara of Palakkad district a fall of 4.3 m is observed. As per November 1996 observations (Fig. 4.3) a decline in water level of more than 2 m is confined to a few pockets in Pathanamthitta district and around Palakkad and southern tip of Thriruvananthapuram district. Groundwater level during April 97 (Fig. 4.4) 397 NH stations indicates that, in general, the change in water level ranges from +2 to –2 m as represented by 96% NH stations analysed. The fall in water level above 2 m in 3% of NH stations analysed occurred in isolated pockets in Kannur, Malapuram and Palakkad districts.

As per CGWB report `Ground water Resources of Kerala, (1997)', in 35 of the 151 blocks in the state the level of ground water development is more than 45%. Among them 4 blocks show higher development and as per present growth rate these blocks may become `dark' or `grey' after 5 years as per details in the following table.

Name of block	District	Present level Development (%)	Project stage of development at year five (%)	Category at year five
Chirayinkil	Thriruvanantha Puram	60.52	85.77	Dark (>85 but <100%)
Kottarakara	Kollam	52.09	66.44	Grey (>65 <85%)
Mala	Thrissur	58.67	66.77	Grey
Kasaragod	Kasaragod	56.16	72.71	Grey

Fecal contamination in ground water sources

An assessment of the bacterial quality of water with reference to fecal coliforms in open dug wells in Kearla has been undertaken by the Kerala State Pollution Control Board. It also attempted to determine the extent of contribution to fecal contamination by the factors influencing water quality such as soil type; depth of well, presence of latrine pit in relation to distance and slope from well, presence of cattle shed in relation to distance from well, water use pattern and user behavior.

In total 150 selected wells, fifty each from the south, central and northern zones of the Socio-Economic Units of the Kerala Water Authority, were monitored. Of these 150, 144 are open wells and 6 are closed with hand pumps. Among the 144 open wells, 103 have SEU latrines in the vicinity while another 30 wells have related pits or septic tanks of other types. 11 open wells without any pits in the vicinity were also monitored. Water samples from the wells were analysed four times, at an interval of approximately 2 weeks, during the period of December 1990 to April 1991. Along with fecal coliforms, three other parameters of water quality, namely pH, conductivity, total dissolved solids were also monitored.

The general conclusions from the study are:

1. Water in none of the open wells investigated is of drinking water quality standard as prescribed by the Bureau of Indian Standards.
2. The open character of the wells and the conventional maintenance habits are found to be responsible for fecal pollution in them.
3. Pit latrines with average family load factor (5 members) at a distance of 5 meter from wells are found to make no contribution to the pollution of well water.
4. Water analysed from covered wells with hand pumps as close as 5 meters to the SEU latrine were found to contain no fecal coliforms.

Though the operation is limited to the three areas of Kollam, Thrisoor and Kozhikode where the Socio-Economic Units of Kerala Water Authority operates, the observations can be generalised since the study has covered varied geological, social and cultural factors applicable to the State as a whole. With these conclusions in mind, it is suggested that there should be a system for monitoring the quality of well water, since habits of poor maintenance overtake the programmes for disinfection and protection of wells resulting in water quality deterioration.

Relevant information on water resources, their utilisation and problems of water quality with specific reference to the four project districts is presented as follows.

Surface Water Sources of Malappuram District

The Malappuram district has 4 major rivers all of which are west flowing and drain into the Arabian sea. The basic features of these rivers are as follows.

Sl. No.	Name of the river	Length km	Catchment area in km^2	Annual discharge in MCM
1.	Chaliyar river (only a portion falls in Malappuram district)	196 (105)	2535 (1570)	2350
2.	Kadalundi river	130	1122 (1033)	1550
3.	Tirur river	48	117	165
4.	Bharathapuzha or Ponnani river (only a portion falls in Malappuram district)	209 (70)	4400 (650)	970

* Figures in the brackets are the lengths and catchment areas falling in Malappuram district

The district has also a large area of back water body in which Biyyam Kayal is the biggest one. The total water stored in these back water bodies is estimated assuming an average depth of 3 m is 294 Mm^3.

Groundwater Quality Along Malappuram Coast

The groundwater quality in the coastal belt of Malappuram district can be divided into the following categories.

a. Places where groundwater remains unpotable throughout the year due to high pH, high TDS and high Cl_2 (Ottumpuaram and Ottumpuram beach) and. high pH alone (Kuttayi and Chamvaravattom)

b. Places where groundwater becomes unpotable during summer only due to
   i. high pH and TDS (Kadalundi Nagaram, Purathur and Munumbum)
   ii. low pH (Kolathambalam, Anangadi beach, Kattungal Parambu and Minadattur.
   iii. high pH during summer (Tripangode and Talakkad), and

iv. high iron content (Pachattiri, Vettam, Tirur, Cherupunna, Kanniramukku, Eramangalam and Palathingal). Barring the pockets referred above, ground water in the remaining places is found potable throughout the year.

Water Resources of Kozhikode district

The Kozhikode district has 4 major rivers (Kuttiadi, Kallai, Chaliyar and Kadalundi) all of which are west flowing and drain into the Arabian Sea. The largest river in the district is Kuttiadi. Data on water resources availability and utilisation in the district is presented in Table 4.16.

Coastal Groundwater Quality In Kozhikode District

The majority of the coastal wells produce potable water, the exceptions being at places like Kadalundi, Kallai and Kannankadav where a large percentage of wells get saline in summer. The spatial distribution of important water quality parameters during pre monsoon of 1982 of few wells along the coast is given below.

Parameters	**Well Location**		
	Kannankadav	East Kallai	Kadalundi
Date	3-5-1980	3-5-1980	5-5-1980
pH	6.8	7.1	8.3
TDS in ppm	1200	1200	870
C1 in ppm	167	244	295
Conductivity µ.mho/cm	2132	2026	1456

Ref: Water Scenario in Kerala. Vol. I Kozhikode District (1983)

Table 4.16

Water Resources Availability and Utilisation in Kozhikode District

Source	Estimated Annual Utilisable Amount in MCM	Annual Utilised Potential in MCM (1983)	Percentage of Utilisation (1983)
Surface Water			
Rivers	1581.12	320*	20.24
Backwaters	10.68	Nil	Nil
Tanks	8.392	5.438	65.06
Reservoirs	113.9	113.9	100
Total	**1714**	**440**	**25.67**
Ground Water			
Coastal Alluvium	108.8	27.2	25
Midlands	672	58.8	8.75
Highlands	37.5	0.91	2.42
Total	**818.3**	**86.91**	**10.6**
Grand Total			
Surface Water and Groundwater	**2532.3**	**527**	**20.81**

MCM – Million Cubic Meter

* As per Bureau of Economics and Statistics this figure is only 12.075 MCM. This large disparity is due to the fact that the Bureau of Economics and Statistics has taken care of only irrigated paddy cultivation.

Source : Water Scenario in Kerala. Vol I – Kozhikode District (1983) P.Basak and G.Anil Kumar.

As per findings of Basak and Vasudev (1983) every centimeter drop of groundwater table along the Kozhikode Coastal belt is met with an increase of 1 to 20ppm of total dissolved solids (TDS) and an increase of 0.5 to 8 ppm of chloride. The present (1983) and future water demands for the district are given in Table 4.17. The following inferences have been drawn from the data given in Table 4.17.

1. 2014 A.D. to meet the water requirement of the district, every drop of available utilisable surface and groundwater resources (2532 MCM/year) have to be used.
2. By 2021 A.D. the district will face an annual water deficit of the order of 166 MCM which will be increased to 666 MCM by 2051 A.D. from the present (1983) surplus of 1281 MCM. This deficit has to be tackled by improved water management practices as well by transporting water from neighbouring districts if feasible.
3. By 2007 A.D. the entire groundwater resources of the district will be needed to meet the industrial and domestic water demand of the district. The present pace of groundwater development in the state has to be accelerated to meet the future demand.
4. By 2021 A.D. entire surface water resources (1714 MCM/year) of the district will not be sufficient even to meet the agricultural water demand (1730 MCM/year) of the district alone.

Water Resources of Thrissur District

The average annual rainfall in the highland, midland and lowland regions of the district are 2851 mm, 3011 mm and 2858 mm respectively. The major river basins falling within the Thrissur district are Karuvannur, Keecheri – Puzhakkal. Small portions of Bharathapurzha and Chalakudy also fall within the district. The Karuvannur basin has an area of 1054 sq.km and Keechari-Puzhakkal, 635 sq.km. The average monsoon flow (June-November) for Karuvannur is 994 Mm^3 and for Keecheri-Puzhakkal, 231 Mm^3.

Table 4.17

Present and Future Water Demand for Kozhikode District

Type of Demand	Taluks	Water Demand in MCM/year (rounded to the nearest whole number)							
		1983		2001		2021		2051	
		Paddy	Other crops	Paddy	Other crops	Paddy	Other crops	Paddy	Other crops
Agricultural water demand	Kozhikode	201	197	221	321	230	384	278	449
	Quilandy	143	238	210	341	245	393	280	448
	Badagara	111	231	156	200	172	306	200	333
	Total Agricultural demand	255	666	587	942	647	1083	758	1230
		921		1529		1730		1988	
Industrial water demand for Major & Minor Industries		Major	Minor	Major	Minor	Major	Minor	Major	Minor
	Kozhikode	26	167	31	422	38	550	44	677
	Quilandy	Nil	22	Nil	59	Nil	78	Nil	97
	Badagara	Nil	47	Nil	Nil	Nil	257	Nil	194
	Total industrial demand	26	236	31	602	38	785	44	968
		262		633		823		1012	
Domestic Water Demand		Urban	Rural	Urban	Rural	Urban	Rural	Urban	Rural
	Kozhikode	32	13	50	21	68	27	38	38
	Quilandy	0.6	12	1	19	1.2	26	1.7	35
	Badagara	1.5	9	2	15	3	20	4.3	27
		34	34	53	55	72	73	98	100
	Total Domestic demand	68		108		145		198	
Total Annual Demand		1251		2270		2968		3198	

MCM – Million Cubic Meter

Source : Water Scenario in Kerala. Vol I - Kozhikode District (1983). P.Basak and G.Anil Kumar.

The estimated average lean flow (December-May) for Karuvannur is 4 Mm^3 and Keecheri-Puzhakkal 5 Mm^3 at 75% dependability. Most of these rivers are practically dry during summer months.

Groundwater Occurrence and Availability

Groundwater occurs mostly under phreatic (water table) conditions in sandy alluvium in the coastal region, laterite in the midland region and weathered and fractured rocks in the midland and highland regions of the district. Yield from open wells in coastal sandy aquifers is 0.17-0.35 lps and in laterite formations it is 0.17-0.23 lps. Yield from borewells tapping the fractured aquifers is 0.5 lps and 24.5 lps. The groundwater potential in areas covered by crystalline rocks is 163.96 Mm^3/yr, in laterite is 540.00 Mm^3/yr and in alluvium is 152.40 Mm^3/yr. The blockwise groundwater potential in the district is presented in Table 4.18.

Groundwater Extraction Structures and Their Density

Large diameter dug wells are the most common groundwater extraction structures in the area. In places where the sandy aquifer is quite thick (10 m), filter point wells are also used. In places where the overburden is thick (10 to 20 m) and the water level is quite deep (especially in summer), dug-cum-bore wells are used. In some places bore wells are also used to extract groundwater from the fractured rocks There are 200 to 250 dug wells, 2 to 3 dug-cum-bore wells and 1 to 2 bore wells per sq.km in the study area.

Groundwater Utilization

An EIA study of Kerala Community Irrigation Project in 12 out of 17 development blocks of Thrissur district has shown that:

i. The present (1995) level of groundwater draft through dug wells per sq.km is 0.118 Mm^3. It is expected to increase to 0.183 Mm^3 per year by 2015 AD.

Table 4.18

Ground Water Potential of Thrissur District

Sl.No.	Name of block	Total GW Recharge MCM / year	Utilisable GW for irrigation MCM / year	Gross draft as on 31/03/92 in MCM / year	Net draft as on 31/03/92 in MCM / year	Ground water balance in MCM / year
1.	Kodungallor	26.55	22.57	6.88	4.82	17.75
2.	Ollukkara	87.42	74.31	17.21	12.05	62.26
3.	Thalikulam	31.57	26.83	12.34	8.64	18.19
4.	Mullasseri	14.08	11.97	5.60	3.92	8.05
5.	Chavakad	40.33	34.28	7.18	5.03	29.25
6.	Anthikkad	24.91	21.17	10.59	7.41	13.76
7.	Chalakudy	118.40	100.64	23.90	16.73	93.91
8.	Vellangullur	29.06	24.70	12.73	8.91	15.29
9.	Irinijalakuda	66.26	56.32	17.09	11.96	44.36
10.	Mathilakam	29.77	25.30	12.48	8.74	16.56
11.	Vadakkanchery	74.13	63.01	26.73	18.73	44.30
12.	Puzhakkal	48.64	41.34	11.73	8.21	33.13
13.	Mala	42.73	36.32	30.44	21.31	15.01
14.	Chovannur	28.27	24.03	5.31	3.72	20.31
15.	Cherpu	26.77	22.75	5.13	3.59	19.16
16.	Pazhayannur	72.15	61.13	6.09	4.26	57.07
17.	Kodakara	74.20	63.07	8.08	5.66	57.41
	Total	464.95	371.96	101.36	70.93	301.03

MCM – Million Cubic Meter

Source : Ambient Water Quality Monitoring Network – Chalakurdy River Basin (Sep. 1999). Indo-Dutch Project, Kerala State Pollution Control Board, Thiruvananthapuram.

ii. The present (1995) level of draft from bore wells per sq.km is 0.006 Mm^3/yr. It is expected to increase to 0.020 Mm^3/yr (without KCIP bore wells) by 2015 AD.

iii. As at present (1995), the stage of groundwater development in all the 12 blocks of the study area is `White' (<65%). The estimates show that by 2015, one block namely Chowannur can turn `dark' (>85%), 6 blocks namely Wadakkancherry, Pazhayannur, Cherpu, Chalakkudy, Kodakkara and Ollukkara can turn `Gray' (>65% but <100%) and the remaining 5 blocks namely Puzhakkal, Anthikkadu, Irinjalakkuda, Vellangallur and Mala will continue to be `White'.

Water level fluctuations in bore wells and nearby dug wells recorded by KCIP for two consecutive years have shown a falling trend of water level in places like Kuttanellur, Kuttenchira, Perumala, Achattupadi and Thekkumkara. The fall in water level varies between 0.2 and 4 m in bore wells and less than 0.5 m in dug wells.

Bacteriological Quality of Groundwater

Microbiological examination was done for 26 bore wells and 16 dug wells. 27% of the bore wells and 68% of the dug wells were found to be bacteriologically contaminated. The locations of contaminated bore wells are Cherpu, Chiiyyaram, Aloor, Ollukkara, Killanur, Desamangalam and Vellangallur.

Endemic Health Problems

As per the statistics on water borne diseases (1993-94) with respect to Thrissur district collected from the Department of Health Services, Kerala and Primary Health Centres of Thrissur district, the casualities due to diarrhoeal diseases were noted to be the maximum in the district at 78008. However, the district wise data and the figures for the diseases reported do not indicate the source of water – surface or ground.

Chemical Quality of Groundwater

With regard to chemical quality, the concentration of iron, chloride and fluoride was found to be on the higher side in the case of a few bore well samples. The fluoride concentration was beyond the permissible limit (1 mg/l, BIS) in 12 bore wells located at Kadavallur, Chowannur, Killannur, Mullasery, Venkitangu, Ollukara, Panancherry, Nadathara, Mandakkathara, Vilavattom and Kolazhi. The iron content was observed to be 0.3 mg/l in 15 panchayats, viz. Adat, Vellanagallur, Velookara, Puthenchira, Aloor, Kuzhoor, Mala, Poyya, Karalam, Muriad, Parapookara, Erumapetty, Mullukkara, Thekkumkara and Vadakkancerry. The chloride concentration was found to high in a bore well located at Paralam Panchayat.

Effect of Fertilizer and Pesticide on Groundwater Quality

In Thrissur district, three panchayats, viz., Paralam. Velangallur and Kaiparamba were taken up for a detailed study of the effect of fertilizers on groundwater quality. Kaiparamba was selected for the study on the effect of pesticides on groundwater. Water samples were collected from these areas and subjected to detailed analysis for agrochemicals. The results of the analysis revealed that there is no effect of agrochemicals on the groundwater quality of these regions.

Water Scenario of Palakkad District

The rainfall in Palakkad district varies from 700 mm to 4000 mm with an average rainfall of 1985 mm. The Palakkad gap, a natural opening of about 40 km wide in the Western Ghats, plays a significant role in the distribution of rainfall in the district. Major part of the rainfall occurs during the south-west monsoon season from June to Sept.

Ground water occurs under phreatic condition in the weathered formation – laterite and alluvium. The depth to water level in the phreatic aquifer of alluvium along the Bharathapuzha river varies from 3-8 m bgl and the depth of well ranges from 4 m to

10 m bgl. While in the western part of the district the depth of dug wells is 4-16 m bgl, in the eastern part, especially in parts of Chittoor taluk the dug wells are deep, >-32 m bgl. In the four eastern blocks of Palakkad, viz. Chittoor, Kollengode, Palakkad and Kuzalmannam, there has been a spurt in the number of irrigation bore wells since 1986.

Long term trend in water level for the period 1985-95, as observed from 33 dug wells tapping phreatic aquifer, indicates a decline in water level in some parts of the district due to increased ground water draft*. In such areas, recharge to ground water can be enhanced through artificial recharge and preservation of existing tanks and ponds in the area.

Diminishing and deteriorating traditional sources

Traditionally, Kerala had very sound systems of conservation and management of natural resources of which water conservation was an integral part. These systems not only ensured adequate water available for both irrigation and domestic needs, but also conserved rainwater to offset any deficiency in the monsoons. While shallow open dug wells met the drinking water needs, rivers, streams (Thodus) and ponds met the irrigation and other needs (washing, bathing etc.). The agricultural practice was also extremely conducive to water conservation, e.g., the paddy cultivation not only helped in crop production but also in retaining the excess surface water over the ground for a long duration, thus recharging the ponds and wells.

This situation has totally changed today. Paddy fields, ponds and even the 'Thodus' are being reclaimed either for constructing houses or for cash crop plantations. Heavy pumping from deep bore wells has caused significant lowering of groundwater

* A study on Declining of water level in Palghat District, Kerala State N. Vinayachandran and K.M. Najeeb
Workshop on Groundwater Regime Monitoring in Kerala, January 1998. CGWB, Kerala Region

table resulting in drying up of the shallower open dug wells. This drastic reversal of water development strategies (over-exploitation on one hand and neglect of conservation measures on the other) has resulted in large-scale water shortages.

4.3. Socio-economic Environment

Population

The population of Kerala as on March 1, 1991 was 29,098,518 persons (14,288,995 males and 14,809,523 females) and comprised 3.44% of the total population of India. The average population size of a district is 20.78 lakhs. The district-wise population profile is given in Table 4.19.

The density of population was 749 persons/sq.km, the second highest in the country and about 2.7 times the all India density of 274 persons/sq.km.As for the sex ratio, Kerala is unique with 1,036 females per 1000 males, as compared to the all India figure of 927. Since 1971 census, the population growth rate in the state has been declining and the present growth rate of 14.32% during 1981-1991 is the lowest in the country which has a growth rate of 23.85%.

As per 1991 census, the average size of a household in the state is 5.3 persons as against 5.6 for all India. The urban population in Kerala has been steadily increasing from 7.11% in 1901 to 26.39 in 1991. It is difficult to distinguish a village from a town in Kerala and in appearance villages resemble an urban continuum and this is a unique feature of the state.

Kerala with a literacy rate of 89.18% stands foremost among the states in India with an average of 52.21%. Literacy of women, who occupy a pivotal role in the society, is 86.17% as against 39.29% for the country.

As per the 1991 census, Kerala had 28.87 lakhs of SC and 3.21 lakhs of ST population constituting 9.29% and 1.10% respectively, of the total population. Salient socio-economic data of the state is presented in Table 4.20.

Table 4.19

District-wise Population Profile of Kerala– 1991 Census

	District	Area	Population	Sex ratio	Growth rate 1981-91	Density (per km^2)	Effective Literacy rate (per cent)		
							Total	Male	Female
	1	2	3	4	5	6	7	8	9
	KERALA	38,863	29,098,518	1,036	14.32	749	89.81	93.62	86.17
1.	Kasaragod	1,992	1,071,508	1,026	22.78	538	82.51	88.97	76.29
2.	Kannur	2,966	2,251,727	1,049	16.63	759	91.48	95.54	87.65
3.	Wayanad	2,131	672,128	966	21.32	315	82.73	87.59	77.69
4.	**Kozhikode**	**2,344**	**2,619,941**	**1,027**	**16.69**	**1,118**	**91.10**	**95.58**	**86.79**
5.	**Malappuram**	**3,550**	**3,096,330**	**1,053**	**28.87**	**872**	**87.94**	**92.08**	**84.09**
6.	**Palakkad**	**4,480**	**2,382,235**	**1,061**	**16.52**	**532**	**81.27**	**87.24**	**75.72**
7.	**Thrissur**	**3,032**	**2,737,311**	**1,085**	**12.20**	**903**	**90.18**	**93.77**	**86.94**
8.	Ernakulam	2,407	2,817,236	1,000	11.12	1,170	92.35	95.46	89.27
9.	Idukki	5,019	1,078,066	975	11.22	215	86.94	90.82	82.96
10.	Kottayam	2,203	1,828,271	1,003	7.71	830	95.72	97.46	94.00
11.	Alappuzha	1,414	2,001,217	1,051	7.28	1,415	93.87	96.79	91.12
12.	Pathanamthitta	2,642	1,188,332	1,062	5.60	450	94.86	96.55	93.29
13.	Kollam	2,491	2,407,566	1,035	10.68	967	90.47	94.99	87.00
14.	Thiruvananthapuram	2,192	2,946,650	1,036	13.50	1,344	89.22	92.84	85.76

Source : Census of India 1991. Series-12, Kerala

Table 4.20
Salient Socio-economic Data of Kerala (1991 Census)

Description		Kerala	India
Area (in sq.km)		38,863	30,65.027
No. of districts		14	452
No. of C.D. Blocks		151	5,774
No. of taluks		61	NA
No. of villages (inhabited)		1,384	5,80,702
No. of villages (uninhabited)		0	46,732
No. of U.A. and Towns		109	3,699
Total No. of Towns		197	4,615
No. of occupied residential houses		54,59,474	14,70,11,586
No. of households		55,13,200	15,20,09,467
Total population	P	2,90,98,518	84,63,02,688*
	M	1,42,88,995	43,92,30,458
	F	1,48,09,523	40,70,72,230
Population below age 7 years	P	38,36,900	15,04,21,175
	M	19,59,527	7,73,22,151
	F	18,77,373	7,30,99,024
Literates	P	2,26,86,461	35,92,84,417
	M	1,15,42,848	22,95,36,935
	F	1,11,43,613	12,97,47,482
SC Population	P	28,86,522	13,82,23,277
	M	14,22,614	7,19,28,960
	F	14,63,908	6,62,94,.317
ST Population	P	3,20,967	6,77,58,380
	M	1,60,812	3,43,63,271
	F	1,60,155	3,33,95,109
Main Workers	P	83,01,087	28,59,32,493
	M	64,04,458	22,16,58,584
	F	18,96,629	6,42,73,909
Marginal Workers	P	8,45,031	2,81,98,877
	M	3,94,392	27,05,223
	F	4,50,639	2,54,93,654
Non-workers	P	1,99,52,400	52,44,36,566
	M	74,90,145	21,08,44,351
	F	1,24,62,255	31,35,92,215

SC – Scheduled caste; ST- Scheduled Tribe; P – Population ; M – Male ; F- Female

* Including projected population of Jammu & Kashmir.

All other figures of India exclude Jammu & Kashmir where 1991 census was not conducted.

Source : Census of India 1991, Series – 12, Kerala.

Tribal Population

Out of 350 Gram Panchayats in the four project districts, some 9 GPs have tribal population (3 in Palakkad 4 in Malappuram and one each in Thrissur and Kozhikode district). The tribal GPs in Palakkad and Malappuram are distinctly different from others and are characterized by high incidence of poverty, illiteracy, low health status and weak GP management. With undulating topography, very few water sources in nearby viscinity and water quality problems, these GPs demand different technological options. Thus, the tribal GPs can not be treated on the same lines as that of non-tribal GPs and they demand a special dispensation.

Living and Habitation Patterns of People

A typical feature of Kerala is the habitation pattern of its people, who prefer to live in a dispersed pattern, independently and on their own property, rather than together in clusters as in the conventional concept of a "village". Hence, majority of households owned independent source of water. In water scarce areas, poor people shared either neighbour's well or a public well for drinking water. Ponds or streams were widely used for bathing and washing purposes. Increasing material prosperity and breaking up of the traditional joint family structures, led to households splitting physically, a consequent division of property along with need for more water sources. Due to increased pressures on the land, people not only started reclaiming old ponds and paddy fields for building construction but also started replacing open dug wells with bore wells. All these phenomena resulted in a gradual over-exploitation of groundwater on the one hand and a collapse of the traditions of conservation of water on the other, contributing to the current water crisis.

The peculiar dwelling pattern of people (right in the middle of their agricultural property) and the type of land allotted to poor people also compelled them to live in water scarce areas where no traditional sources are available.

Economy

Kerala's progressive economy is mainly agro-based. Extensive rubber plantations on the foothills of the Western Ghats and the cashew factories of Kollam are valuable foreign exchange earners. The coir products and handicrafts from Alappuzha are received well both in India and abroad. The land itself is believed to have derived its name from "Keram" the coconut palm.

Though industrially backward, Kerala is one of the most progressive states in terms of social welfare and physical quality of life. The matriarchal system here is a unique social heritage as the women of Kerala enjoy a better status than their counterparts elsewhere in India. The absence of the village system in Kerala is also a unique phenomenon. The people of Kerala enjoy a unique cosmopolitan outlook, which is reflected in their tolerance towards other races and religions.

The early settling of Jews, Syrians and Portuguese in Kerala, has resulted in a happy blending and enrichment of the Keralite's life and culture. This rich culture, together with the peculiar ecological pattern and beauty of the region have earned for Kerala the title – "God's own Country".

Water Supply and Sanitation

Despite the state's progress in health and social sectors, much remains to be achieved in the water supply sector. The state had targeted 100% coverage of rural areas with safe drinking water supply during the VII Plan period ended March 1977. As against this, the rural population covered till 1.4.99 is only 51% (Table 4.21), while the coverage for urban population is 77.66% (Table 4.22). As per the survey conducted by the Rajiv Gandhi National Drinking Water Mission, there are still 7091 partially covered (water supply less than 40 lpcd) habitations, 990 not covered habitations and 13 inaccessible and hence not covered habitations in the state (Table 4.23).

Table 4.21

Coverage and Status of Water Supply in the State of Kerala

Population covered by Rural Water Supply Schemes (District-wise)

Sl. No	Name of District	Total population based on 1991 census			Total population based on 1998-99 census			Total population covered till 1.4.99			Coverage status in %		
		Cumulative coverage											
		Total	SC	ST	Total	SC	ST	Total	SC	ST	Total	SC	ST
1.	Kasaragodu	895282	75208	28924	4975	245	390	571002	59675	13582	64	79	47
2.	Kannur	1106251	48202	17640	21265	0	0	464324	36003	8255	42	75	47
3.	Wayanadu	649179	26387	112543	300	300	0	341511	15245	53785	53	58	48
4.	**Kozhikkode**	**1615444**	**131859**	**4942**	**16063**	**665**	**0**	**441777**	**54885**	**3240**	**27**	**42**	**66**
5.	**Malappuram**	**2813876**	**237233**	**10514**	**47845**	**1768**	**23**	**1305655**	**134438**	**3419**	**46**	**57**	**33**
6.	**Palakkad**	**2007658**	**333881**	**34899**	**16679**	**2798**	**8**	**985359**	**156242**	**14214**	**49**	**47**	**41**
7.	**Thrissur**	**2017095**	**270712**	**3891**	**79706**	**12411**	**12**	**1305756**	**195540**	**2555**	**65**	**72**	**66**
8.	Ernakulam	1444059	150768	2202	9210	648	44	1097261	114125	1497	76	76	68
9.	Idukki	1027185	153860	49531	13314	2093	896	365192	49495	19733	36	32	40
10.	Kottayam	1507353	117689	17582	0	0	0	671404	53497	7010	45	45	40
11.	Alappuzha	1391607	154689	1732	43616	4409	211	781570	82702	928	56	53	54
12.	Pathanamthitta	1033298	139563	6590	0	0	0	520356	71607	1234	50	51	19
13.	Kollam	1961530	266810	3443	20280	14563	58	880941	126754	1796	45	48	52
14.	Thiruvananthapuram	1948407	245063	15331	21856	2672	7	1265704	148253	8397	65	60	55
	Total	21418224	2351924	309764	295109	29462	1649	10997812	1298461	139645	51	55	45
	Cumulative coverage Total				10997812	1298461	139645						
	Census population village total	21418224	2351924	309764	21418224	2351924	309764						
	Coverage Status in percentage(%)				51	55	45						

SC – Scheduled caste; ST- Scheduled Tribe

Source : Kerala Water Authority

Table 4.21

Coverage and Status of Water Supply in the State of Kerala

Population covered by Rural Water Supply Schemes (District-wise)

Sl. No	Name of District	Total population based on 1991 census			Total population based on 1998-99 census			Total population covered till 1.4.99			Coverage status in %		
		Cumulative coverage											
		Total	SC	ST	Total	SC	ST	Total	SC	ST	Total	SC	ST
1.	Kasaragodu	895282	75208	28924	4975	245	390	571002	59675	13582	64	79	47
2.	Kannur	1106251	48202	17640	21265	0	0	464324	36003	8255	42	75	47
3.	Wayanadu	649179	26387	112543	300	300	0	341511	15245	53785	53	58	48
4.	**Kozhikkode**	**1615444**	**131859**	**4942**	**16063**	**665**	**0**	**441777**	**54885**	**3240**	**27**	**42**	**66**
5.	**Malappuram**	**2813876**	**237233**	**10514**	**47845**	**1768**	**23**	**1305655**	**134438**	**3419**	**46**	**57**	**33**
6.	**Palakkad**	**2007658**	**333881**	**34899**	**16679**	**2798**	**8**	**985359**	**156242**	**14214**	**49**	**47**	**41**
7.	**Thrissur**	**2017095**	**270712**	**3891**	**79706**	**12411**	**12**	**1305756**	**195540**	**2555**	**65**	**72**	**66**
8.	Ernakulam	1444059	150768	2202	9210	648	44	1097261	114125	1497	76	76	68
9.	Idukki	1027185	153860	49531	13314	2093	896	365192	49495	19733	36	32	40
10.	Kottayam	1507353	117689	17582	0	0	0	671404	53497	7010	45	45	40
11.	Alappuzha	1391607	154689	1732	43616	4409	211	781570	82702	928	56	53	54
12.	Pathanamthitta	1033298	139563	6590	0	0	0	520356	71607	1234	50	51	19
13.	Kollam	1961530	266810	3443	20280	14563	58	880941	126754	1796	45	48	52
14.	Thiruvananthapuram	1948407	245063	15331	21856	2672	7	1265704	148253	8397	65	60	55
	Total	21418224	2351924	309764	295109	29462	1649	10997812	1298461	139645	51	55	45
	Cumulative coverage Total				10997812	1298461	139645						
	Census population village total	21418224	2351924	309764	21418224	2351924	309764						
	Coverage Status in percentage(%)				51	55	45						

SC – Scheduled caste; ST- Scheduled Tribe

Source : Kerala Water Authority

Table 4.22
Coverage and Status of Water Supply in the State of Kerala

Population Covered by Urban Water Supply Schemes (District-wise)

Sl. No.	Name of District	Upto 1980-81	1990-91	1991-92	1992-93	1993-94	1994-95	1995-96	1996-97	1997-98	1998-99
1.	Thiruvananthapuram	511250	562375	721140	728200	728700	728700	733000	733000	733000	742900
2.	Kollam	259000	306300	309000	312400	312850	333490	463490	463490	463490	463490
3.	Pathanamthitta	Nil	83520	84350	85200	85200	85200	85200	95700	105200	105200
4.	Alappuzha	261000	485000	489000	494700	494700	494700	494700	494700	494700	494700
5.	Kottayam	8300	244000	246000	248000	248250	363310	363310	363310	363310	363310
6.	Idukki	Nil	10000	10600	38900	38900	38900	38900	53900	53900	53900
7.	Ernakulam	671000	886800	895600	904500	905100	905295	1060996	1071496	1071486	1107586
8.	**Thrissur**	**405000**	**530100**	**535400**	**540700**	**541300**	**542270**	**542270**	**542270**	**542270**	**575270**
9.	**Palakkad**	**134000**	**228300**	**230600**	**232800**	**233100**	**233900**	**256750**	**256750**	**256750**	**256750**
10.	**Malappuram**	**115000**	**174300**	**176000**	**177700**	**178050**	**187234**	**238334**	**256334**	**265634**	**273634**
11.	**Kozhikkode**	**332000**	**548500**	**554000**	**559400**	**559866**	**560116**	**596850**	**602850**	**611250**	**659250**
12.	Wayanadu	Nil	10500	11000	11500	11500	11500	11500	11500	11500	11500
13.	Kannur	201000	480300	485100	489200	489550	504356	577503	577503	588103	628103
14.	Kasargodu	137000	221400	223600	225800	225800	228850	228850	228850	228850	228850
	Total	3034550	4771395	4971390	5049000	5052866	5217821	5691653	5751653	5789443	5964443
	Population based on 1991 census		7680294	7680294	7680294	7680294	7680294	7680294	7680294	7680294	7680294
	Percentage coverage		62.13	64.73	65.74	65.79	67.94	74.11	74.89	75.38	77.66

Source : Kerala Water Authority

Table 4.23

Rural Water Supply Coverage Status under the RGNDWM in Kerala State

Sl.No.	District	No. of NN habitations	No. of NC habitations	No. of PC habitations	No. of FC habitations	Total
1.	Kasaragod	--	3	336	79	418
2.	Kannur	--	4	419	76	499
3.	Wayanad	1	5	228	56	290
4.	**Kozhokkode**	**1**	**33**	**595**	**71**	**700**
5.	**Malappuram**	**1**	**109**	**757**	**169**	**1036**
6.	**Palakkad**	**--**	**37**	**758**	**143**	**938**
7.	**Thrissur**	**1**	**51**	**711**	**221**	**984**
8.	Ernakulam	4	43	554	134	735
9.	Idukki	--	177	289	83	549
10.	Kottayam	1	111	509	127	748
11.	Alappuzha	3	140	408	117	668
12.	Pathanamthitta	1	62	417	57	537
13.	Kollam	--	119	583	131	833
14.	Thiruvananthapuram	--	96	527	218	841

RGNDWM- Rajiv Gandhi National Drinking Water Mission
NN - Not accessible and Not covered habitations
NC - Not covered habitations
PC - Partially covered habitations with water supply level less than 40 lpcd
FC - Fully covered habitations with water supply level above 40 lpcd.

Source : Kerala Water Authority.

The total number of fully covered habitations (water supply more than 40 lpcd) are only 1682. Existing piped water supply schemes in the state account for only 1008 mld of which the loss due to leakages in distribution is about 30%.

A large proportion of the rural population of Kerala continues to depend for their daily water needs on open dug wells, the density of which is one of the highest in the country. The existing schemes implemented by the various agencies such as the Kerala Water Authority (KWA), Ground Water Department and the local bodies have proved inadequate to meet the growing demand of the population, and the gap between the demand and supply of drinking water is widening year after year. Lack of funds and inadequate infrastructure have remained as the major constraints in the coverage and timely implementation of water supply projects. The state's present water policy gives priority to drinking water supply, and the GoK is framing a legislation to regulate the extraction of ground water to enable efficient management of the ground water resources of the state.

Water Quality Assessment of Dug Wells in Selected Panchayats of Project Districts

In the backdrop of complaints from the public of poor quality of water supplies in rural areas of Kerala and as a part of the preparatory phase for the proposed KRWSS Project, a study – 'Water Quality Assessment of selected Panchayats' (in the project districts), on water quality of traditional sources in six Panchayats viz; Kunnummel (Kozhikkode District), Nediyiruppu and Pookottoor (Malappuram District), Mundathikode (Thrissur District), Erumayoor (Palakkad District and Orumanayoor, a very thickly populated panchayat in Thrissur District has been undertaken. The objective of the study was to determine the water quality of traditional sources in the project area and to suggest appropriate mitigative measures to minimise the contamination in the well waters.

One time water samples from 233 open dug wells and five bore wells serving as sources of rural water supplies in the study were collected and analysed for physico chemical and bacteriological parameters. The selection of the sources was preceded by a detailed reconnaissance survey of the Panchayath. The final selection of the sources was made keeping in view the local soil characteristics, distance from farm land/agricultural fields, distance from household leach pits and waste dumps, the ownership of the wells, the environmental conditions, the hydrogeological position and the density of the population in the area to ensure that the sources were truly representative. A detailed sanitary survey of the selected sources was also undertaken using standard format.

A summary of the results of physico-chemical and bacteriological analyses of water samples collected during the study is presented in Tables 4.24, 4.25 and 4.26. The study has shown that almost all the samples tested were bacteriologically contaminated, and therefore unfit for drinking (Table 4.26). A large number of distributed sources of contamination such as leach pits, compost yards, unsanitary surroundings of the wells, poor construction and maintenance of the wells, pollution from improper disposal of spill water, the method of water withdrawal from the wells and bird droppings seem to contribute to the bacteriological contamination. The main physical parameters of poor water quality relate to pH, turbidity, chlorides, hardness and iron. Fluoride and nitrate levels were well within the permissible limits for drinking water. Representative water samples were also analysed for the presence of pesticides. None of the samples, however, showed the presence of any pesticide residue.

Table 4.24
Range, Mean and Standard Deviation of various water quality Parameters of the pilot Panchayaths

Parameter	Kunnummal Panchayath			Nediyirippu Panchayath			Pookottoor Panchayath		
	Range	Mean	S.D.	Range	Mean	S.D.	Range	Mean	S.D.
Turbidity NTU	0.21-6.7	0.93	1.23	0.1-14.8	2.14	3.16	0.1-11.2	2.06	2.5
pH	5.11-7.6	5.953	0.59	5.19-6.64	5.9	0.374	5.55-7.36	6.29	0.45
Electrical Conductivity μ mho/cm	45-200	86.675	39.33	52-174	89.44	36.26	39-255	101.3	49.85
Alkalinity	4.0-56	25	13.74	8.0-64	21.28	10.78	8-184	27.5	29.42
TDS	40-110	59.25	20.5	40-140	65.97	26.32	20-180	75.63	38.65
Total Hardness	8-47	20.2	11.51	4.0-58	16.06	10.91	6-162	21.54	26.26
Calcium	0.8-16	5.51	3.93	0.6-13.6	3.56	2.55	1.6-25.6	4.1	3.41
Magnesium	0.48-5.3	1.51	1.03	0.27-6.4	2.08	1.5	0.48-23.8	3.35	4.55
Chloride	10-60	23.73	10.4	8-162	18.72	10.08	4.0-36	13.4	7.7
Fluoride	0.01-0.16	0.03	0.034	0.013-0.092	0.063	0.024	0.013-0.081	0.045	0.024
Iron	0.02-0.8	0.12	0.19	0.02-0.42	0.171	0.099	0.16-2.1	0.983	0.67
Nitrate	0.26-28	5.6	5.37	0.26-31.89	6.196	8.6	0.256-24.8	6.87	7.5
Sulphate	0.5-9	1.81	1.66	1-2.5	1.42	0.52	0.5-2	1.13	0.48

contd..

Parameter	Mundathikode Panchayath			Orumanayoor Panchayath			Erimayoor Panchayath		
	Range	Mean	S.D.	Range	Mean	S.D.	Range	Mean	S.D.
Turbidity NTU	1-20	2.85	3.61	1-57	6.8	10.76	1-56	5.9	12.04
pH	6.85-8.56	7.96	0.43	4.45-8.95	7.91	0.88	8.08-9.32	8.7	0.24
Electrical Conductivity μ mho/cm	54-362	132.75	77.07	136-4026	684.91	745.4	119-1888	452.89	380.34
Alkalinity	13-86	30.775	15.49	8-240	83.09	65.9	28-308	105.12	62.67
TDS	40-280	10.75	58.55	100-3020	521.69	564.74	90-1420	342.62	284.94
Total Hardness	22-102	44.5	22.33	48-904	184.59	176.86	40-438	143	82.79
Calcium	4-25.6	8.68	5.12	6.4-296	48.18	57.28	8-76.8	29.44	16.65
Magnesium	1.9-14.09	5.46	2.81	0.972-52.488	14.79	12.61	1.63-59.29	16.72	12.21
Chloride	8-78	21.95	15.34	30-2000	207.59	390.45	16-464	72.09	84.521
Fluoride	0.05-0.91	343	0.27	0.041-0.524	0.104	0.083	0.06-0.61	0.24	0.15
Iron	0.01-0.99	0.2	0.23	0.03-2.18	0.165	0.371	0.01-1.48	0.212	0.29
Nitrate	0.44-35.44	5.53	7.52	0.04-51.39	9.16	13.24	0.044-27.98	5.25	6.08
Sulphate	0.01-9	2.39	2.38	3-83	14.93	16.8	0.1-35	5.75	6.51

Note: All values except pH turbidity and electrical conductivity are expressed in mg / l

Table 4.25

Physical & Chemical analysis of water samples from selected bore wells of the pilot panchayaths

Sl No	Parameter	Unit	Limit	Source of sample/Date of collection					
				Bore well **Kunnummal** Panchayat 17.01.2000	Danida Kondotty-Cheekode WSS **Nediyiruppu** panchayat 07.02.2000	RWSS **Pookkoottor** Panchayat 25.01.2000	RWSS to Athani **Mundathikkode** panchayat 19.01.2000	TWSS **Erimayoor** Panchayat 22.10.1999	
1	pH		6.5-8.5	6.8	8.06	7.35	8.7	7.2	
2	Tur	NTU	5	69	0.60	0.20	13	8	
3	Alk	Mg/L	200	122	....	.....	60	116	
4	TDS	Mg/L	500	....	220	40	160	....	
5	EC μ mho/cm		....	240	319	77	205	446	
6	TH	Mg/L	300	98	208	86	86	230	
7	Ca 2+	Mg/L	75	36	43.28	8.02	15.2	17.64	
8	Mg2+	Mg/L	30	1.94	24.3	16.03	11.66	45.19	
9	Cl -	Mg/L	250	16	104	22	12	28	
10	F	Mg/L	1	0.04	....	Nil	0.86	0.90	
11	Fe 2+	Mg/L	0.30	1.4	Nil	Nil	0.40	0.54	
12	No 3-	Mg/L	45	0.35	....	....	....	....	
13	Res Cl2	ppm		Nil	0.20	Nil	Nil	Nil	

Table 4.26

Bacteriological Contamination in Drinking Water Sources (wells) in the Four Pilot Districts

S No	Name of panchayat/District	No of samples (Wells) Tested	No of samples +ve for			% Samples unfit for drinking
			Total Coliform	Fecal Coliform	Fecal Streptococci	
1.	Kunnummal (Kozhikode)	40	38	37	38	95
2.	Nediyeruppu (Malappuram)	36	36	34	35	100
3.	Pookkottur (Malappuram)	40	40	39	40	100
4.	Mundathikode (Thrissur)	40	40	35	40	100
5.	Orumanayoor (Thrissur)	35	28	27	26	80
6.	Erimayoor (Palakkad)	42	42	42	40	100

Based on the findings, the study has made the following recommendations/ mitigation measures.

- Effective disinfection of all water supplies based on open wells.
- A systematic and regular water quality monitoring and control should be in place to ensure safe drinking water.
- A manual of practice for sanitary construction and maintenance of wells should be brought out for the benefit of all the Panchayats.
- Covering of the wells to minimise contamination from bird droppings.
- Appropriate solid and liquid waste management to be encouraged in the rural areas to minimise the risk of ground water contamination.
- An effective awareness programme on environmental sanitation and personal hygiene should be implemented in the project districts.

Water Quality Improvement Programme of KWA

At present there are 1412 pucca rural water Supply schemes and 50urban water supply schemes in operation under the control of Kerala Water Authority. The conventional treatment process being followed in Kerala for treating raw water to drinking water standards are as follows

1. For schemes with ground water as source, only disinfection by chlorination is being practiced.
2. For schemes with ground water as source, which contains excess iron, aeration and excess lime treatment followed by sedimentation, filtration and disinfection are being practiced.
3. For small water schemes up to 2.5 mld capacity with surface water source where the turbidity is low, plain sedimentation followed by slow sand filtration and disinfection are the process adopted.
4. For high turbid surface water schemes with more than 2.5 mld capacity, the process

being adopted are aeration, coagulation and flocculation, sedimentation, filtration and disinfection

The urban water supply schemes are provided with conventional treatment units, whereas most of the rural water supply schemes have infiltration gallery at intake followed by disinfection (chlorination) process before the water is distributed through the distribution net work

Water quality monitoring set up:

Though the water supplied through the distribution network is subjected to various treatment processes, strict quality monitoring and surveillance at the treatment and distribution ends are required for ensuring water quality standards.

The quality control programme was commenced in the field of water supply under the Kerala Water Authority in 1990, with three Regional Laboratories, ie. at Aluva , Kozhikode and Thiruvananthapuram. A quality monitoring cell established under the Chief Engineer, IPD evaluated performance of the quality monitoring programme and evolved new programmes and proposals to ensure water quality standards and a new up for ensuring State wide implementation of satisfactory quality control activities was established in the year 1995.

At present, there are two quality control divisions, each headed by an Executive Engineer, one at Aluva and the other at Kozhikode. Also, there are four regional laboratories headed by the Assistant Executive Engineer at Thrissur, Kannur, Tiruvananthapuram and Thiruvalla. District laboratories headed by Assistant Engineers have been established at Kasaragod, Waynad, Malappuram, Palakicad, Alappuzha, and Kollam. Two more district laboratories, one at Iduicki, and Kottayam will be made functional. The basic water quality tests on a day to day

basis is done by the Operation & Maintenance (O&M) wing and periodical returns are sent them to the Quality Control Wing for monitoring and suggesting corrective measures.

The Quality Control Wing of the KWA undertakes the following surveillance activities:

i. Collection of raw water and treated water samples from water supply schemes.

ii. Subjecting the samples collected to physical, chemical and bacteriological tests at specified intervals and checking whether the water conforms to water quality standards.

iii. Furnishing the results of the tests to the concerned officers in charge of operation & maintenance of the water supply schemes to apply corrective measures, if any, required to ensure quality standards to the water supplied.

iv. Conducting quality tests on chemicals used in treatment plants.

Even with this available set up, strict water quality monitoring is not found effective and hence the system requires improvement. Adequate emphasis has to be given to the area of quality monitoring and surveillance programme.

Total Sanitation Program of Kerala Government

The Government of Kerala have a programme of total sanitation and health in the state. As per a study conducted by the Indian Market Survey, sanitation coverage in Kerala is only 51.3%, rural household coverage is 44% and only 32% of the households living below the poverty line have latrines. The objective of the total sanitation programme is to cover the entire state within a time frame of three years. The actual areas for coverage and funding source for the project are being finalised. The subsidy for latrines under this programme has been standardised at Rs. 2,000/- per latrine.

The planning, design and implementation of different components of environmental sanitation are to be carried out through an integrated activity of local

community, local body authority, departments / agencies and NGOs with total transparency. The same methodology of the on-going People's planning Campaign initiated by the Kerala Government is being adopted for identifying, planning and design of various programme components.

4.4. Summary Observations

The salient points arising from a review of the secondary data, and the limited primary data generated in connection with the proposed project could be summarised as follows.

1. Despite the high average annual rainfall in the state and in the project districts, its spatial and temporal distribution is not uniform within the state and within the same district. The highly undulating topography is not conducive for retention of precipitation which is drained off quickly. Thus, the per capita availability of water resources in the state is much less than in many other dry states in the country resulting in water scarcity during summer months.
2. Due to several constraints such as topography, distance, risk of salinity intrusion, and the need for treatment the scope for tapping economically river sources for the proposed rural water supply schemes is limited.
3. Surface waters in rivers especially in the lower reaches are polluted by municipal and industrial discharges and by salinity intrusion from the sea.
4. As per the estimates of ground water potential and its utilisation by various agencies, the level of ground water utilisation in the state and in the project districts has not exceeded 45% excepting in some isolated pockets thus leaving still a significant scope for utilisation.

5. Ground water in the state in general and in the project districts is, by and large, of potable physico-chemical quality except in certain areas which suffer from high concentrations of Cl, F and Fe.

   There is wide spread fecal contamination of open dug well waters and some bore well waters due to the existence of a large number of non-point sources of pollution such as pit latrines, septic tanks, barn yards and storm and agricultural run off.

6. Available limited data on public health indicates that the incidence of acute diarrhoeal diseases and worm infestation is high among the rural population, especially the poor sections of the people.

7. Extensive sand mining in almost all the rivers has also seriously affected the quantity and quality of river water in the state.

8. Excessive ground water withdrawal in certain parts of the project districts (Palakkad, Thrissur) has resulted in the lowering of the ground water table warranting regulatory measures to arrest the trend.

9. The changing life style of the people, their agricultural practices and land use pattern have a significant impact on the ground water resources in the state.

4.5. Public Consultations

A unique feature of the proposed KRWSS project is its bottom-up planning process. Following the 73rd and 74th Constitution Amendments, the GoK has taken major initiatives to decentralize all relevant functions to local institutions with adequate financial backing and infrastructure support. The felt needs of the people are discussed in the neighbourhood groups, locally known as 'ayalkootams' and the communities are mobilised from the ward level to the panchayat level culminating in the form of well

defined development proposals for implementation by the local institutions. Thus, the proposed project should be viewed as one primarily conceived, planned and developed by the beneficiary communities themselves with the full knowledge and understanding of their stakes in the project.

However, as part of the EA study and in keeping with the Bank's OP 4.01, public consultations were held in the pilot GPs in the four project districts. The purpose of these consultations was to identify new issues, if any, including alternatives to the project that need to be addressed in the project design. These consultations were held with not only the target groups at the grass root level but also with other partners in the development effort such as ward members, standing committee chairmen, panchayat presidents and members of support organisations.

The EA Consultant's programme of public consultations along with a record of the consultations held is at Annexure II. A summary of the main points that emerged from these consultations is given below.

Nediyeruppu Panchayat (Malappuram district)

- There exists a problem of water scarcity in summer as many dug well sources dry up.
- Water supply to the panchayat from the existing DANIDA assisted scheme based on bore wells is inadequate.
- People are dissatisfied with the quantity and quality of existing supplies and want surface water from river Chaliyar to be tapped to meet the requirements of the panchayat.
- People are willing to consider roof catchment of rain water if subsidy is made available to them.
- No problem is anticipated in acquiring privately owned sources of good yield for public water supply.

Pookkottur Panchayat (Malappuram district)

- Though source is not a problem for the 4 existing water supply schemes in the panchayat, there is inequity in distribution of water.
- As the yield from (existing) ground water sources is reliable, dug wells / bore wells will form the sources for the new schemes. Need for rain water harvesting is not envisaged.
- While the coverage of individual household sanitation is high (90%), there is no organised system of sanitary disposal of hospital and slaughter house wastes.

Kunnummal Panchayat (Kozhikode district)

- During summer months, many dug wells go dry and there is a potential risk of existing private dug wells going dry when new sources are fitted with high capacity pumps.
- No difficulty is envisaged in acquiring private lands/water sources for the new schemes.
- Watershed management programme should be implemented concurrently with the water supply schemes to ensure source sustainability.
- The potential risk of ground water contamination in the area will be minimal as the number of new latrines to be installed under the project is small.

Mundathikode Panchayat (Thrissur district)

- For the proposed schemes, the per capita water supply will be kept flexible depending on the yield of the source.
- Serious concerns were express regarding the poor quality of water supplies are public as well as private sources (dug wells)
- People are willing to donate land for locating new sources. The potential risk of hydraulic interference of new and existing sources is recognised.

- Local women will be able to find more time for productive work after the construction of piped water supply schemes.
- People already having deep pit latrines would like to retain them as such.

Erimayoor Panchayat (Palakkad district)

- Some issues / concerns, not identified now, may come up at the time of implementation of the proposed schemes.
- In view of the existing KWA schemes and the proposed WB assisted schemes two types of water tariffs may exist in the panchayat.
- To resolve the potential problem of hydraulic interference between the existing and new sources, there must be some directive / stipulation from the government.
- Acquisition of land for siting new sources has to be done through persuation.
- A few sections of the community want improved water supply and sanitation but are not yet willing to participate financially as they do not have to pay for the services from the existing KWA schemes. Some households having their own wells are also wary of participation in the project. (The project familiarisation campaign is in the initial stages).
- The local community is of the view that in discriminate sand mining in the nearby Gayathri river is the main cause of their water supply problem, which did not exist a few years ago. They complained of the poor quality of water supplied from the existing systems.

Summary of Main Issues

The public consultations with the target beneficiaries and other partners to the proposed water and sanitation project in the pilot GPs bring forth the following main issues which need to be addressed in the project design.

1. Sustainability of yield from the new sources for the proposed water supply schemes with minimal interference to the existing sources, and flexibility in the per capita water supply depending on source yield.
2. Ensuring bacteriologically safe, potable water supply to the public at all times.
3. To mitigate the potential risk of hydraulic interference between the existing and new sources, the government should enforce regulatory measures.
4. Watershed management programmes should be implemented concurrently with the water supply schemes to ensure source sustainability.
5. The problem of safe disposal of hospital and slaughter house wastes in Pookkottur panchayat.
6. Need for effective promotional campaigns and community awareness programmes to elicit the participation of people in the proposed project.

5. IMPACT IDENTIFICATION AND ANALYSIS

5.1 Preamble

The proposed KRWSS Project can be considered as comprising three phases: i) the planning phase, ii) the construction phase, and iii) the post construction or the operational phase with the component activities as under:

Planning phase:

- Health, Sanitation, Hygiene Education (HSHE) & environmental awareness campaigns
- Demonstration plants for solid waste, drainage and sullage disposal
- Identification of technology options for source, water treatment and distribution, and safe sanitation
- Site identification and selection for source location and service reservoir construction
- Taking possession/acquisition of land for the above

Construction phase:

- Rehabilitation of existing water supply schemes
- Construction of wells(sources), over head (OH) service reservoirs and laying of water distribution pipelines.
- Construction of water conservation structures
- Installation of on-site sanitation systems
- Drainage and sullage disposal systems
- Solid waste treatment systems for wastes from market sources, slaughter houses and hospitals

Operation phase:

- Ground water abstraction and use
- Use of on-site sanitation systems
- Awareness and HSHE Programmes
- Operation of drainage, sullage and solid waste disposal systems
- Institution capacity building

The potential environmental impacts arising from the activities of the proposed project have been identified, classified as positive/negative and presented in a matrix form in Table 5.1. These are discussed hereunder.

5.2 Pre-construction phase Impacts:

Land acquisition and monetary compensation:

Under the proposed project, about 2000 community water supply schemes are to be installed in about 100 GPs spread over the four project districts. For more than 90% of the schemes, the source will be ground water tapped through dug wells or bore wells. The sources could also be existing public/ private wells. While the sources established in public lands could be readily taken over, private lands have to be acquired through voluntary donation or outright purchase.

Preliminary assessment in the project districts indicates that land will have to be made available for 1360 (64%) sources. The total land requirement at the rate of two cents (100 cents = 1 acre) per scheme for the project as a whole will be a maximum of 27.2 acres. As the schemes will be planned, implemented, operated and maintained by the beneficiary communities, the lands, to a large extent, will be obtained from among them.

Table 5.1

Kerala Rural Water Supply and Environmental Sanitation Project
Environmental Impact Matrix

Sl.No.	Project Phase / Components	Potential Environmental Impacts	
		Positive	**Negative**
1.	Planning phase • Health, Sanitation, Hygiene Education (HSHE) & environmental awareness campaigns • Demonstration plants for solid waste drainage and sullage disposal • Technology options for source (wells) water distribution and safe sanitation • Site identification and selection for source location and service reservoir construction • Taking possession / acquisition of land for the above	Primary • Appreciation of environmental and sustainability issues of the proposed project by the beneficiary community. • Community's willingness for informed participation secured. • Collective decision by community regarding technology choice and service levels	Primary • Cash compensation, i f any, for land acquisition
2.	Construction Phase • Rehabilitation of existing water supply schemes • Construction of wells (sources), OH service reservoirs and laying of water distribution pipe lines • Construction of water conservation structures	Primary • Employment opportunities for local technicians / artisans, NGOs and private sector	

	• Installation of on-site sanitation systems • Drainage and sullage disposal systems • Solid waste treatment systems for waste from market sources, slaughter houses and hospital s		
3.	Operation phase • Ground water abstraction and use • Use of on-site sanitation systems • Awareness, and HSHE programmes • Operation of drainage, sullage and solid waste disposal systems	Primary • Availability of adequate supply of safe water on a sustainable basis including in summer months • Labour and time saving in fetching water • Employment opportunities for local technicians/artisans, NGOs and private sector • Reduction in soil and surface water contamination • Improved community awareness/knowledge on water health, sanitation and environment leading to behavioral changes • Reduction in surface runoff, increase in ground water recharge, halt to declining water table and improved sustainability and perenniallity of water supply sources • Reduction in soil erosion, turbidity and sediment load in stream / river flows and promotion of vegetation cover Secondary • Opportunities for income generation by women • Improved personal and environmental hygiene and health	Primary • Increased ground water abstraction • Risk of hydraulic interference between existing and new dug / bore well sources • Risk of ground water contamination • Cash compensation • Financial burden on community and local body (GP) Secondary • Risk of lowering of ground water table • Risk of saline water intrusion especially in coastal areas

The project does not envisage any involuntary land acquisition, and mechanisms are being developed to ensure voluntarism. Further, lands will not also be acquired from those with land holdings less than a stipulated size.

Likewise, the watershed management component of the project may involve construction of water and soil conservation structures on lands owned by individual households or on public land or both. The number and type of structures to be built and the land area required will be decided, case by case, depending on site specific considerations. A similar approach as above will be adopted with respect to land acquisition. Thus, the issue of land acquisition will not have any socio environmental impact.

5.3. Construction phase Impacts:

The major activity during this phase will consist of earth work/trench excavation, transportation of materials of construction and actual construction work. The individual schemes will be of small scale serving on an average 50-80 households with the participation of the beneficiary community in cash/kind. The construction phase of the project as such will not cause any adverse environmental impact but would provide significant employment opportunity for local technicians/artisans, NGOs and private sector.

5.4. Operation phase Impacts:

Positive impacts:

Access to adequate quantity of safe water on a sustainable basis:

The most significant positive impact of the project in the operation phase will be the availability of adequate quantity of safe water, piped to individual households on a

sustainable basis all through the year, thus meeting a basic need for a healthy, productive life. The water supply schemes will be designed to deliver 70 lpcd normally and a minimum of 40 lpcd even during summer.

Reduction in Drudgery in Water Collection and Generation of Income Opportunities:

The proposed water supply schemes will ensure a better service delivery which would enable and promote safe water at convenient points within the individual premises. This will largely eliminate/reduce the drudgery in fetching the daily water needs by women and children. The time and labour saved due to the better and more convenient service could provide opportunities for income generation, especially for women. For individual households with their own wells fitted with power pumps, the recurring expenditure on consumption of electricity and on O & M of pumps would be minimised. However, part of this benefit will be off set by the fact that the individual households have to pay their share towards the cost of O & M of the public facility.

Improved Personal and Environmental Hygiene

Availability of adequate quantity of safe water through the new schemes would promote personal and environmental hygiene which is presently of a low order among the community. This impact will be enhanced through a regular and continuing programme of health and hygiene education targeted on the beneficiary population.

The on-site sanitation schemes, sullage/drainage schemes and construction of solid waste/ garbage disposal systems under the proposed project would help minimise soil and surface water contamination. These activities will bring about a significant

reduction in the incidence of acute diarrhoeal and other water borne diseases which are widely prevalent in the project districts.

Employment opportunities

The proposed project involves operation and maintenance of large number of small water supply systems and watershed management structures. This will generate significant employment opportunities to the local technicians and NGOs which in turn will have a positive impact on the income levels of the wage earners and small entrepreneurs.

Water and Soil Conservation

The construction of large number of water conservation structures of various types to suit the local conditions will reduce surface run off, improve ground water recharge, minimise soil erosion, promote growth of vegetation and arrest/reverse the declining trend in ground water level observed in certain areas such as in Palakkad. These measures would also help in achieving the sustainability and perenniality of water supply sources.

Community Capacity Building and Self Reliance

The bottom-up planning and decision making which are essential ingredients of the proposed project would generate and promote among the beneficiary communities a sense of pride and self reliance, and enhance their capacity building in other sectors of community development.

Reduced Financial Burden on State

Due to active participation of the beneficiary community in all stages of planning and implementation of the project, including sharing of capital costs of the schemes and

meeting the total O & M expenditure, there will be reduced financial burden on the state. This would facilitate increased coverage of population by the state with the available government funds.

Potential Negative Impacts

Increased Groundwater Abstraction

Most of the community water supply schemes under the proposed project will be based on local groundwater sources tapped through dug wells/bore wells fitted with power pumps. The schemes also envisage supply of water to individual households through yard connections. Due to the higher service levels and the convenience the new systems will afford to the consumers, the per capita consumption of water is expected to increase than at present. This would lead to increased abstraction of ground water in the area. The projected water demand for domestic use in the year 2021 with a per capita consumption of 160 lpd for the entire state is 3230 Mm^3.* This constitutes only about 6.5% of the total projected demand. Considering the fact that the level of groundwater utilisation does not exceed 40% of the utilisable resources in any of the project districts except in isolated pockets, this would not cause any impact on the ground water regime. The proposed legislation on groundwater would also enable regulation of ground water abstraction to prevent any adverse environmental impact:

---

* Water Scenario of Kerala (January 1998): State Committee on Science, Technology and Environment, Govt. of Kerala.

Lowering of Ground Water Table

As per available data on long term trend in water level in the state, there has been a decline in the ground water level in certain parts of Palakkad, Kozhikkode and Thrissur indicating that mining of water is taking place (Fig. 4.3, 4.4 & 4.5). Creation of additional/new sources in such critical areas may increase the gravity of the situation unless proper siting of the new sources is ensured, compensatory water conservation measures are implemented concurrently, and ground water legislation is passed expeditiously.

Hydraulic Interference between existing and new sources

A majority of households in the GPs of the four project districts have their own wells which are also used to meet/supplement their domestic water supply needs. When a high yielding source is located for a new scheme in the area, there is a potential risk of hydraulic interference with the existing sources in the vicinity. In extreme cases, the nearby sources may dry up. This problem could be minimised/eliminated by siting of the new sources with recourse to scientific methods.

Risk of Ground Water Contamination

Studies on water quality of wells used as traditional drinking water sources in the state have been undertaken by several agencies such as CWRDM(in Palakkad, Thrissur and Thiruvananthapurm), Centre for Environment and Development (in five coastal panchayats in Thiruvananthapuram district), SEUF (in Thiruvananthapuram, Kollam, Thrissur, Kozhikkode, Palakkad, Pathanamthitta Districts). All these studies have shown widespread faecal contamination of the wells, the percentage of contaminated wells being

as high as 100%. A just concluded study undertaken as part of the preparation phase of the proposed project in six GPs in the four project districts has confirmed the widespread faecal contamination of the community wells. One time water samples collected from 233 open dug wells and 5 bore wells have shown that almost all the samples were bacteriologically contaminated. The study has also established that several distributed sources of pollution contribute to the ground water contamination. These include insanitary surroundings of the wells, poor construction and maintenance of wells, proximity of leach pits, manure pits, bird droppings, etc.

The construction of a large number of on-site sanitation systems under the proposed project may also pose the risk of ground water contamination unless safe sanitation technologies best suited to the local conditions are selected and installed and adequate preventive and corrective measures are implemented. The preventive measures would include sanitary protection of water supply sources and proper siting of new sources. The single most important corrective measure is to ensure continuous, effective chlorination of all water supplies.

Risk of Salinity Intrusion in Coastal Areas

In coastal areas, especially in some parts of Kozhikkode and Malappuram districts, where the fresh water resources are limited or saline water intrusion is already evident, tapping of ground water for the new schemes may aggravate the situation, unless due precautions are taken in siting of the new sources and abstraction of ground water is regulated. Alternatively, distant fresh water sources may have to be tapped, which would increase the capital cost of the scheme.

Financial Burden on Community

The proposed project incorporates a demand driven approach to water supply and sanitation service delivery with financial participation by the individual beneficiary households, the local GP and the GoK. Further, the total responsibility for O & M of the newly constructed water supply schemes will rest with the community. Thus, there will be an increase in financial burden on the community. However, part of this burden will be off set by the savings in recurrent cost of O & M of individually owned water supply systems currently in use. The mitigatory measures for the potentially negative impacts can be easily designed and implemented to eliminate/minimise the impacts.

Conclusion

In sum, the overall impact of the project on the beneficiary communities and the environment is expected to be positive resulting in an improvement in the quality of life of the people in the project area.

5.3. Analysis of Alternatives

No project scenario

The proposed KRWSS project is aimed at improving the quality of rural water supply and environmental sanitation service delivery to achieve sustainability of investment and generate health and income benefits. The felt need for the project has its genesis in the following key issues.

Despite the high rainfall (3000mm/annum) in the state the rivers tend to go dry after the north east monsoons and the drought is becoming increasingly severe year after year. Any significant deviations in the normal rainfall pattern lead to dry spells and acute drought conditions. In some cases, depletion of sources during summer season is also a problem.

The high density of population, higher per capita consumption in comparison with the national average and the increasing aspirations of the people lead to enhanced demand in the drinking water sector. The potable water sources available in the coastal belts of Kerala with a density of population 5-6 times the national average are being subjected to rapid environmental degradation including salinity intrusion in ground water.

The existing schemes implemented by water supply agency such as the KWA, Ground Water Department and the local bodies own their own and under the International Water Supply and Sanitation Decade (1981-1991) as also the Rajiv Gandhi National Drinking water Mission have proved inadequate. The percentage of rural population covered till 1/4/99 is only 51%. Which is much lower than the coverage in most other Indian states. The gap between demand and supply of drinking water is widening year after year given the fact that the water demand for the population is estimated to double every 21 yeas. The sanitation coverage in the state is only 51.3%, rural house hold coverage is 44% and only 32% of households below poverty line have latrines. Lack of funds and inadequate infrastructure have remained as the major constraints in the coverage and timely implementation of water supply and sanitation project in the state.

High incidence of water borne diseases continues to occur among the rural communities in the project districts. Lack of adequate safe water supply, safe sanitation and poor personal and community hygiene habits are the major causes for this situation. As per the statistics of the Department of Health Services of Kerala, there have been 78008 casualties during the year 193-94due to water borne diseases in the district of Thrissur alone. The corresponding figures for Palakkad District were 65774 and 45131 for the year 1992-93, 93-94 respectively.

It is quiet evident that if the present scenario continues in future, there would inevitably be a serious deterioration in this sector so vital for the health, well being and productivity of the people, and the social and economic development of the state as a whole. Thus, the proposed integrated rural water supply and environmental sanitation project is timely not only to halt the present trend but also to enhance the existing levels of service to meet the legitimate demand of the people on a sustainable basis.

6. ENVIRONMENTAL MANAGEMENT PLAN

6.1 Preamble

The proposed KRWSS project, as discussed earlier, will bring about positive health and environmental benefits through supply of safe drinking water, provision of safe on-site sanitation systems, sustained health and hygiene education programmes as also watershed management programmes aimed at sustainability and perenniality of community water supply sources. The project is also likely to cause some adverse environmental impacts depending upon site specific situations encountered in the project area. Appropriate environmental mitigation measures discussed in this chapter should be incorporated in the project design so as to eliminate / minimise the adverse impacts and enhance the net positive benefit due to the project.

6.2 Key Environmental Issues

A critical review of the base line data, observations during site visits and public consultations clearly bring out the following key environmental issues that need to be addressed in project design and implementation.

Water Quantity

- The availability of safe drinking water is a serious problem, especially in the summer months when most of the traditional private dug wells run dry and the public supply from various sources is inadequate. The problem is very acute for the coastal areas where traditional dug well sources are saline and the service level from the existing water supply schemes is meager.

- Declining water table is observed to be an emerging phenomenon in some parts of the state. The Central Ground Water Board reports decline in water table in the range of 1-3 m for the period 1981 – 1990 in the northern districts of Kasaragod, Kannur, Wayanad and in eastern parts of Palakkad district due to a spurt in ground water development (Long Term Water Level Trend in Kerala for 1981-1990). A recent study by CGWB (Workshop on Groundwater Regime Monitoring in Kerala, January, 1998) has also confirmed the decline in water level in some parts of Palakkad district. The study has

further concluded that increase in groundwater draft is the major cause for this phenomenon. It is generally observed in the project districts that competing demands for agricultural and domestic purposes are leading to an increasing use of 'pumps' for lifting water from traditional sources, in addition to bore wells. This increasing pressure of demand for water is not keeping in pace with the annual replenishable recharge of ground water reserves.

Water Quality

There is wide spread bacteriological contamination of fecal origin in sources of public drinking water supplies, viz. traditional open dug wells, bore wells and surface sources. This is confirmed by the findings of various studies including the one commissioned under this project and public concerns expressed during site visits. Theses concerns for ground and surface water contamination relate to

- Close proximity of increasing numbers of leach pit latrines under varying soil conditions, laterite (midland) and sandy soils (coastal area);
- Non point sources of pollution in the catchment area including possible agricultural and surface run off, especially during the rainy season;
- Washing, bathing and other domestic activities around the open dug well sources, especially among the low income communities;
- Inadequate and irregular disinfection of drinking water supplies, including chlorination under KWA schemes;
- Inadequate testing and irregular monitoring of drinking water quality.

Lack of sanitation and environmental health

The present level of sanitation coverage in the state is only 51.3 %, the rural household coverage is 44 % and only 32 % of households below poverty line have latrines. This implies that still a large percentage of rural population resorts to open field defecation with its associated risk to public health. Open field defecation also constitutes a major non-point source of pollution of surface and ground waters in addition to soil contamination. This problem is more acute in densely populated settlements, especially

in coastal areas. Poor environmental sanitation conditions and personal hygiene habits and lack of adequate supply of safe water are factors responsible for high incidence of water bone / water related diseases / deaths among the rural population. This situation could be remedied to a large extent by increasing the community coverage with sanitation facilities to achieve 100 % coverage in as short a time frame as possible.

6.3 Mitigation strategy

The mitigation strategy would include the following essential elements :

i) Formulation of appropriate policies, programmes and priorities as also enabling legislations.

ii) Creation / augmentation / restructuring of institutional infrastructure / framework for implementation.

iii) Forging effective linkages and ensuring co-ordination between various related agencies and departments.

iv) Active involvement and participation of the beneficiary communities through the panchayati raj institutions.

These are broadly discussed as under :

i) There already exists a well formulated State Water Policy (1992) which has identified in a comprehensive manner the important issues to be addressed, the priorities, the short term and long term water management strategies as also the institutional framework for policy implementation. However, much remains to be done to make any visible impacts of the policy on the water sector. For instance, the establishment of Water Resources Control Board (WRCB) as the apex body to advise the Government on water sector and a centralised facility for processing, evaluation, storage and dissemination of hydrological data has not yet been effected. Likewise, concrete action to regulate uncontrolled extraction of sand from river beds is yet to be initiated. The state has formulated a legislation to regulate and control the ground water extraction, but the legislation is yet to be passed. In the context of the emerging trend of the decline in groundwater level in certain pockets of the state, there is an urgent need to pass this legislation and to notify these areas to be brought under the Act.

ii) The existing institutional infrastructure with strengthening / restructuring as necessary and those proposed / identified in the State Water Policy and the Kerala Groundwater (Control and Regulation) Act 1997 and that recommended in this report should be able to cope with the activities envisaged in the water and sanitation sector.

iii) The responsibility for implementation of most of the mitigatory measures for the proposed project will rest with the Beneficiary Committees and Support Organisations under the overall supervision and guidance of KRWSA. The DSTE could be assigned the task of preparing the water resources map for the entire state down to the village level with recourse to remote sensing and technical backup support from CWRDM, CGWB and the GWD. The data generated could be shared with all the interested agencies for a fee. There are a few measures such as bringing in a legislation for regulation and control of groundwater abstraction which, however, has to be taken up at the government level with technical backup support from institutions such as DSTE, CWRDM, CGWB, GWD etc in the enforcement of the Act.

iv) With the decentralisation process and bottom up planning already in place, the panchayati raj institutions have to play a lead role in all local development programmes related to water, sanitation and health. These institutions would need technical support and training to undertake activities such as measuring the depth to water level and test for residual chlorine in water supply. In this task the support organisations have a crucial role in identifying the information and training needs of the beneficiary committees as also the appropriate institutions which will provide these inputs. The initial cost for these inputs has to be met from the project funds.

In the light of the key issues identified and the associated environmental impacts, the mitigatory measures along with the agencies responsible for action are summarised in Table 6.1. These are briefly discussed as follows.

Table 6.1

Summary of Potential Adverse Impacts and Mitigatory Measures

Potential Adverse Impacts	Mitigatory measure(s)	Responsibility
➢ Water scarcity during summer and decline in ground water table due to over abstraction	➢ Instituting an organized survey with recourse to modern tools and techniques such as geophysical methods and remote sensing to locate potentially high yielding ground water sources	GWD, DSTE, CWRDM, CGWB
	➢ Scientific integrated watershed management at micro level so as to enhance ground water recharge, minimise soil erosion and promote green cover	BC, SO, KRWSA
	➢ Enacting and enforcing appropriate legislation to accord high priority to drinking water and to regulate ground water abstraction/prevent water mining	GOK
	➢ Providing a flexible per capita water supply (minimum 40 lpcd during summer) to match the source yield	SO, BC
	➢ Roof catchment of rain water in drought - prone and water scarcity areas to augment drinking water supply	SO, BC
➢ Hydraulic interference between existing and new dug/bore well sources	➢ Adoption of scientific tools & methods for siting of the new sources to eliminate / minimise interference	SO, GWD

Potential Adverse Impacts	Mitigatory measure(s)	Responsibility
➢ Risk of contamination of ground water sources of rural water supply due to large scale installation of leach pit type sanitation systems	➢ Selection of appropriate safe sanitation system to suit the local soil characteristics and hydrogeology	➢ SO, BC
	➢ Careful siting of the system, and adoption of best construction practices	➢ SO, BC
	➢ Revamping / rehabilitation, wherever economically feasible, of existing deep (3m & above) single leach pit latrines which penetrate the free ground water table	➢ SO, BC
	➢ Sanitary disposal of garbage from domestic and market sources and cattle wastes through composting	➢ SO, BC
	➢ Sanitary protection of existing and new dug wells by lining	➢ SO, BC
	➢ Effective disinfection of water supply from traditional sources to leave a minimum residual Cl_2 of 0.5 mg/l	➢ SO, BC
	➢ An effective and sustained programme of community awareness and education aimed at promoting personal and environmental hygiene	➢ SO, BC, THSM
➢ Salt water intrusion in rivers identified as water supply sources	➢ Construction of weirs / barrage / bunds across the river ensuring natural / artificial flow in summer to flush off pollutants	➢ ID
➢ Salt water intrusion in ground water in coastal / back water areas	➢ Regulation of ground water extraction and artificial ground water recharge	➢ GOK, SO, BC

GWD – Ground Water Department; DSTE – Department of Science, Technology and Environment; CGWB – Central Ground Water Board
CWRDM – Centre for Water Resources Development and Management; BC – Beneficiary Committee; SO – Support Organisation
KRWSA – Kerala Rural Water Supply and Sanitation Agency; GOK – Government of Kerala;
THSM – Total Health and Sanitation Mission

Water quantity aspects

The strategy for environmental mitigation would consist of both preventive and corrective measures. Such measures for water quantity aspects include

1. Proper siting of new sources with recourse to scientific methods to ensure sustainable yield throughout the year

The State and Central Ground Water Departments, CWRDM and the Dept. of Science, Technology and Environment of Government of Kerala should play a lead role in rendering technical assistance to the GPs (local bodies) in identifying and siting of aquifers of sustainable yield. In this task, recourse should be taken to modern scientific methods and tools to achieve maximum success rates. The SO/local body should seek the assistance of these Departments in siting the sources. Once the site is identified with recourse to scientific tools and techniques, a detailed sanitary survey (Annexure 3) of the surrounding area should be undertaken so as to identify potential sources of contamination. Appropriate measures should be taken to eliminate such sources from the vicinity of the site. Following the construction of a dug well/bore well, the safe yield of the source should be ascertained by performing a recuperation/pumping test as described in Annexure 4 during the most critical period ie., summer. Depending on the safe yield, the per capita water supply has to be decided upon. Complete physico chemical analysis of the source water has to be conducted and the source commissioned for supply only if the quality meets with the drinking water standards.

2. Construction of water conservation structures to enhance ground water recharge thereby improving the sustainability of the sources

Implementation of integrated water shed management programmes in the project districts should receive the highest priority to achieve sustainability and perenniality of the water supply sources. As an integral part of the proposed KRWSS Project, watershed management components are currently being planned. These schemes will be prepared jointly by the Agriculture and Ground Water Departments, CWRDM and the local NGOs. Programmes for these schemes include raised contour building, small check dams, reservoirs and rain water harvesting for improving sustainability and perenniality

of the water sources. It would be useful to extend these programmes for addressing sustainability of fresh water lenses in the coastal areas. The watershed component of the project is being addressed separately.

As per information from Central Ground Water Board (Ground Water Resources of Kerala, 1997) in some coastal areas of Thrissur, Malappuram and Calicut Districts, the coastal alluvium can sustain filter point wells, which are highly productive. Maximum efforts should be made to identify such locations which could serve as sustainable sources of fresh water supply to the coastal panchayats.

3. Installation of rain water-harvesting systems for individual house holds

The high rainfall in the state favours roof catchment of rain water especially in areas where there is acute scarcity of drinking water during summer months. While there are not many existing installations in the state, a good beginning has been made in certain areas such as in Kondotty in Malappuram District, where roof catchment of rain water is being practiced. The system designed and installed with the assistance of SEUF is being evaluated for further development and propagation in other areas. A brief description along with a typical design of the system is in Annexure 5

4. Providing flexibility in the level of service (per capita supply) in the proposed schemes

The proposed water supply schemes under the project are being designed for a per capita supply of 70 lpd with distribution through pipelines to individual household yards. The supply will be metered in order to ensure equity in distribution and to provide a basis for water consumption by the individual households. The actual level of service after the system comes into being will be decided to a large extent by the source yield. Hence, there needs to be a scope for flexibility so that the service level matches with the source yield subject to a minimum of 40 lpcd in summer months.

5. Preventing wasteful consumption of water and ensuring equitable distribution

In order to minimise wasteful consumption of water, the water tariff should be fixed so as to impose a penal rate on such consumers. This will discourage the wasteful consumption.

6. Enacting legislation to regulate and control groundwater abstraction.

The long term water level trend in Kerala for the period 1981-1990 (CGWB, February, 1993) indicates a falling trend in water levels in the range of 1-3 m for the period 1981-1990 in the northern districts of Kasaragod, Kannur, Wayanad and in eastern parts of Palakkad district.

A recent study (Workshop on Groundwater Regime Monitoring in Kerala, January, 1998) has also confirmed that a decline in groundwater level is observed in certain parts of Palakkad district. Analysis of dug well data has shown a decline in water level during post monsoon season in five isolated pockets. The rate of decline is not high except in Palakkad where it is 30 cm per year. The study has further concluded that increase in groundwater draft is the major cause for this phenomenon.

The Government of Kerala have already formulated a draft legislation for regulation of ground water abstraction in the state including the creation of a regulatory authority for administering the legislation. In the light of the signs of over exploitation in some parts of the State already evident, urgent action need to be taken to expedite the enactment.

Water quality aspects

1. Effective and continuous disinfection of all drinking water supplies so as to maintain a minimum residual chlorine of 0.5 mg/l

Available information on the quality of drinking water supplies in the state clearly indicates high level of bacterial contamination. This poses a serious risk to public health. This is confirmed by the high incidence of acute diarrhoeal diseases and other water borne infections among the people especially the poor sections of the community. This brings out the need for a system of continuous disinfection of the water supplies. The traditional wells used as a drinking water sources are reported to be disinfected only

occasionally, once or twice a year. This is highly inadequate to provide any safety against contamination.

In the proposed schemes water will be lifted from the source to an overhead reservoir before distribution. In such a system disinfection of the water being pumped could be readily achieved by installing a 'displacement type bleaching powder solution doser in the rising main. The Displacement Doser provides a simple and reliable means of adding bleaching powder solution to a pipeline under pressure, using differential pressure created by a venturi tube or orifice plate to impel the solution into the pipeline. In principle water from the higher pressure upstream side of the venturi tube or orifice is led to a closed vessel, which has been filled with the solution to be applied and from which a connection leads to the low pressure throat of the venturi tube on downstream side of the orifice plate. The difference of pressure causes the water to flow into a closed vessel, driving the solution in it into the pipeline. In order that the incoming water shall displace the solution instead of mixing with it, the vessel is divided into two by a flexible membrane in the form of a sac or a bag, into which the solution is originally placed, and from which it is expelled by the closing up of the bag by the incoming water. Since the quantity of solution leaving the bag is equal to the quantity of water entering the vessel, it is easy to regulate and measure the dose by controlling and measuring the flow of incoming water. A detailed description of such a system is given in Annexure 6. In the context of widespread contamination of ground water due to a variety of non-point sources, chlorination will provide an effective barrier against contamination and ensure safewater.

2. Sanitary protection of existing traditional open dug well sources and springs

One of the factors causing pollution in traditional wells serving as water supply sources is poor construction of the well. Hence, the sanitary protection of such wells and springs will practically eliminate contamination from the surface through leaching of spill water and storm and agricultural run off. The technical details of such protection measures are given in Annexure 7. To cut down the entry of pollution to a minimum in a well, the recommended interventions are good parapet, good lining, good adequate drain and at least a nylon net cover.

3. Establishment/strengthening of institutional arrangements for regular monitoring and control of water quality from source to distribution

Currently, there is no institution identified for systematic sampling, monitoring and control of drinking water supplies for schemes maintained by the panchayats. The GOK should identify an agency to take on this responsibility.

As part of the Indo-Dutch Project, the Kerala State Pollution Control Board is strengthening its ambient water quality monitoring net work for the various river basins in the State. A similar initiative should be taken up by other identified agencies such as the Ground Water Department for monitoring the quality of traditional and other drinking water sources. A programme for dissemination of water quality information to the local people should also be undertaken by these agencies.

With the adoption of demand driven, decentralised planning process in the proposed project, the beneficiary community/panchayat will take on the total responsibility for routine operation and maintenance of the water supply facilities, which was hitherto the mandate of the KWA. For routine water quality testing for the new schemes, the services of the existing district water quality laboratories of the KWA or the laboratories of the GWD, CWRDM and the state PCB could be utilised. If necessary, these laboratories could be strengthened to take on the increased work load due to the new schemes. A mechanism has to be worked out by which water samples could be collected regularly by the BC and delivered to the identified laboratory for necessary testing. The mechanism should also provide for appropriate compensation for the services rendered by the testing agency as per mutually agreed terms. Designated persons from the panchayat should be initially trained by the agency in methods of sample collection, handling and on spot testing for simple parameters such as residual chlorine.

Following the initial testing of the source water for compliance with the prescribed water quality standards, seasonal variations in the quality should normally be expected. These variations, however, will not be very significant. Subsequent routine testing could therefore, be restricted to residual chlorine only by the trained local operator. This should be done every day

at the service reservoir and at one of the farthest taps from the reservoir. The farthest tap could be rotated during each sampling. And once in 3 months, source water quality could be tested for complete physico-chemical and bacteriological analysis. Compilation of such data will be useful in assessing the long term trend in water quality at the source and in the design of future water supply schemes based on the same source.

The Kerala Water Authority, as part of its strategy for improving the existing institutional frame work for water quality monitoring and surveillance has proposed a community based 3 tier system which merits consideration. The 3 tier system comprises the panchayat , +2 level /technical institutions at the grass root level, satellite laboratories at the middle level and the KWA district laboratory at the apex level. Routine monitoring and control of water quality will be performed at the lower level using portable kits attached to the panchayat, analysis of more complex nature and training of water quality monitoring personnel will be taken up by the satellite laboratories with higher level support from the district laboratory with an appropriate system of cost sharing. In order to ensure accuracy and reliability of water quality data generated under the 3 tier system, an exercise in inter laboratory analytical quality control should be undertaken periodically. The water quality data generated should also be compiled periodically (at least once in 3 months) and made available for ready access to the public.

The above set up which will have the catchment area as its jurisdiction will also complement the Information, Education and Communication (IEC) activities of the panchayats/educational institutions. A pilot scheme of such an institutional set could be taken up in each of the project districts and based on the experiences the system could be replicated on a larger scale.

4. Selection and installation of safe sanitation technologies to suit the local soil characteristics and hydrogeology so as to minimise ground water contamination.

Extensive work has been done in India and outside on various designs of low cost on-site sanitation systems for use in areas not provided with conventional sewerage system. These include the most widely used (in India) pour flush single/two pit latrines, conventional septic tanks and its variations (eg. SUBO), the Dry Compost Latrine, VIP latrines, Aqua Privies etc.

Considerable published literature is available on many of these sanitation systems. A description of some of these is given in Annexure 8.

The selection of a sanitation system is governed by a variety of considerations. The most important ones are availability of water supply (for flushing and ablution), the local soil and hydrogeological conditions, the customs and habits of the local people and the cost. The SOs should play a crucial role in facilitating the choice of appropriate sanitation system for the site specific situation.

Lateritic soil is predominant in the midland and highland areas of the state while in the coastal areas the soil is alluvial/sandy. In coastal belts the water table is high and flooding and water logging are common. The population density is also very high. In such areas communal latrines connected to a bio-gas plant could be an appropriate sanitation system.

Pollution safeguards for twin pit pour flush latrines

To ensure that the risk of polluting ground water and drinking water sources is minimal, the following safeguards should be taken while locating the pits:

a. Drinking water should be obtained from another source or from the same aquifer but at a point beyond the reach of any fecal pollution from the leach pits.

b. If the soil is fine (effective size 0.2 mm or less), the pits can be located at a minimum distance of 3 m from the drinking water sources, provided the maximum ground water level throughout the year is 2 m or more below the pit bottom (low water table). If the water table is higher, ie., less than 2 m below the pit bottom, the safe distance should be increased to 10 m.

c. If the soil is coarse (effective size more than 0.2 mm), the same safe distances as specified above can be maintained by providing a 500 mm thick sand envelope, of fine sand of 0.2 mm effective size, all around the pit, and sealing the bottom of the pit with an impervious material such as puddle clay, a plastic sheet, lean cement concrete, or cement stabilised soil.

d. If the pits are located under a footpath or a road, or if a water supply main is within a distance of 3 m from the pits, the invert level of the pipes or drains connecting the leach pits should be kept below the level of the water main, or 1 m below the ground level. If this is not possible due to site considerations, the joints of the water main should be encased in concrete.

5. Revamping, wherever economically feasible, the existing deep pit latrines

Some of the older installations of pit latrines are deep (>3m) and often penetrating the free water table thereby providing a direct contact of human excreta with the ground water. Depending upon site specific conditions, such latrines could be a source of potential risk to public health. It may be necessary, under such situations, to revamp these latrines and to convert them into a safe sanitation system.

6. Increasing environmental awareness regarding water supply, sanitation and personal hygiene

The high bacteriological contamination of traditional drinking water sources is also related to personal and community hygiene practices. Programmes related to hygiene education and awareness are essential to keep the area around the traditional water sources clean. These will be taken up under the health, sanitation and hygiene education component of the project, including safe handling of drinking water, disposal of waste water (sullage), personal hygiene, household hygiene and community environmental sanitation.

3.3. Environmental monitoring and evaluation

In keeping with the identified environmental issues which need to be addressed in the project design and implementation, and the expected impacts, a list of environmental performance indicators has been identified along with the agencies responsible for monitoring (Table 6.2). These, along with the indicators for the other components of the project, could provide a basis for monitoring and evaluation of the project performance.

Table 6.2

Performance Indicators

Identified issues	Performance indicators	Monitoring agency
Water Quantity		
• Scarcity of drinking water supply during summer months	• Availability of at least 40 lpcd of drinking water during summer.	• BC
• Decline in ground water table due to over abstraction	• No. of wells drying up in summer.	• BC
	• Trend in falling ground water table arrested / reversed	• GWD, BC, CGWB
	• Reduction in surface run off / sediment load as measured at the existing gauging / sampling stations in the catchment area	• ID, CWC
	• Legislation to regulate ground water exploitation is in place	• GOK, KRWSA
Water Quality		•
• Bacterial/chemical contamination in drinking water supplies	• Daily residual chlorine test at the service reservoir & public taps	• BC
• High incidence of waterborne diseases and worm infestation	• Independent water quality surveillance once in 3-6 months.	• BC, Identified agency
	• No. of wells made sanitary by lining.	• BC
	• Decline in the number of ADD cases and if possible worm infestations.	• BC
	• No. of awareness programmes organised, attendees and simple pre & post evaluation to assess the efficiency of training.	• BC

Table 6.2 (Contd...)

Identified issues	Performance indicators	Monitoring agency
• Lack of sanitation and environmental health	• Percentage / Number of house holds with access to sanitation and environmental hygiene facilities	• THSM & BC
	• Cases of diarrhoea in children under five years of age	• THSM & BC
Solid waste management	• No. of BCs who have installed vermi composting plants.	• GP

BC - Beneficiary Committee; GWD - Ground Water Department

CGWB - Central Ground Water Board; ID - Irrigation Department
KRWSA - Kerala Rural Water Supply and Sanitation Agency
GOK - Govt of Kerala ; GP - Gram Panchayat.

A note on vermi composting as practiced by North Parur Municipality in Kerala is in Annexure 9.

LIST OF REFERENCES

1. Census of India 1991. Series-12 Kerala.
   Paper-3 of 1991. Final Population Totals.

2. Statistics Since Independence (1998).
   Department of Economics and Statistics, Govt. of Kerala.

3. Ground Water Resources of India (1995). Central Ground Water Board,
   Ministry of Water Resources, Govt. of India.

4. Draft Project Concept Document No.II (Sept. 1999).
   The Integrated Rural Water Supply and Environmental Sanitation Projects in Kerala State, India by Kerala Water Authority.

5. Water Atlas of Kerala (1995).
   Centre for Water Resources Development and Management, Kozhikode.

6. Ambient Water Quality Monitoring Network – Chaliyar River Basin (Sept. 1999).
   Indo-Dutch Project, Kerala State Pollution Control Board.

7. Ambient Water Quality Monitoring Network – Chalakudy River Basin (Sept. 1999).
   Indo-Dutch Project, Kerala State Pollution Control Board.

8. Ambient Water Quality Monitoring Network – Bharathapuzha River Basin (Sept. 1999). Indo-Dutch Project, Kerala State Pollution Control Board.

9. Environmental Impact Assessment of Kerala Community Irrigation Project (Sept.1996). Centre for Water Resources Development and Management, Kozhikode.

10. Water Resources Development of Bharathapuzha Basin – A Status Report (Nov.1991). Centre for Water Resources Development and Management, Kozhikode.

11. Manual of Individual Water Supply Systems (1973).
    Environmental Protection Agency, Water Supply Division, USEPA.

12. SUBO – The New Eco-Friendly Septic Tank (First Edition, Nov. 1999).
    Prof. V.A.Sudhakaran, COSTFORD.

13. Technical Guidelines on Twin Pit Pour Flush Latrines (1992).
    Ministry of Urban Development, Govt. of India.

14. P.Basak and G.Anil Kumar.
    Water Scenario in Kerala – Vol.I, Kozhikode District (1983), CWRDM, Kozhikode.

15. P.Basak and M.Nazimuddin. Ground Water in the Coastal Belt – Malappuram District, July 1984. CWRDM, Kozhikode.

16. Water Scenario of Kerala (1998).
Published by State Committee on Science, Technology and Environment, Govt. of Kerala.

17. Experience of a Pilot Programme on Decentralised Water Supply Systems. Malappuram District, Kerala.
Technical Support Unit (TSU), Socio-Economic Unit Foundation (SEUF),
Kondotty, Malappuram, Kerala.

18. Pollution of Ground Water Due to Domestic Sewage – Final Report (Dec. 1997), CWRDM, Kozhikode.

19. Investigations on the Bacterial Quality of Water of Selected Wells in Kerala (Aug. 1991), Kerala State Pollution Control Board.

20. Springs of Kerala – An Inventory (May 1988).
CWRDM, Kozhikode.

21. Deepa, G.D. Water Quality of Selected Open Wells in Cochin Corporation Area (1998). M.Sc. Dissertation, School of Environmental Studies, Cochin University of Science and Technology.

22. Long Term Water Level Trend in Kerala for the Period 1981-1990 (Feb. 1993). Govt. of India, Ministry of Water Resources, Central Ground Water Board, Kerala Region.

23. Ground Water Year Book of Kerala (1996-97). Dec. 1997. Govt. of India, Ministry of Water Resources, Central Ground Water Board, Kerala Region.

24. Workshop on Ground Water Monitoring in Kerala. 28 Jan, 1998. Central Ground Water Board, Kerala Region, Thiruvananthapuram.

25. An Investigation of Water Quality Problems Related to Excess Fluoride and Chloride in Alappuzha and Chertalla Regions. Final Project Report (1997), CWRDM, Kozhikode.

26. Effect of Industrial Effluents on the Productivity of Chithrapuzha River and Area Around FACT Cochin Division – Final Project Report (1997), CWRDM, Kozhikode.

27. Coastal Zone Management Plan of Kerala. December 1995 Government of Kerala, Department of Science Technology and Environment Centre for Earth Sciences Studies, Thiruvananthapuram

28. Final Report of the Committee on Provision of Drinking Water to All by 2000AD Vol I Main report 1988

29. Census of India 1991. Series 12 – Kerala
Part VII Tables on Houses and House hold Amenities

30. A Bill to Regulate and Control the Extraction, Use or Transport of Ground Water to Conserve Ground Water in the State of Kerala. (Draft) 1977.

31. IEC strategy for Sanitation and Health Programmes Task Force Report. Commissionerate of Rural Development, Thiruvananthapruam, Feb 1990.

32. James, E.J and Sreedharan KE (1983). 'Exchange of fresh and salt waters in the Beypore estuary on the Malabar coast', Journal of the Institution of Engineers (India), vol 64.

33. James, EJ (1985). 'Problems in estuarine management in the south-west coast of India', Vth World Congress on Water Resources, Brussels.

34. James, EJ (1996). 'Salinity intrusion into rivers and its impact on drinking water schemes - case studies from south west India', Proc. 3rd National Water Congress, New Delhi.

ANNEXURE - I

'Environmental Analysis' Study for Kerala RWSS Terms of Reference

Background

1. The primary development objective of the project is to assist the Government of Kerala in improving the quality of rural *water* supply and environmental sanitation service delivery to achieve sustainability of investments and generate health and income benefits. This will be done through: (a) phased implementation of appropriate policy and institutional reforms, and (b) delivery of demand responsive and sustainable water and sanitation services to beneficiary communities in some select Gram Panchayats from four districts in Kerala.

2. The specific objectives of the project are:

- to enhance health benefits by improving the delivery of 'safe' water supply and sanitation services;
- to demonstrate viability of institutional reforms and enhanced cost recovery by developing, testing and implementing a decentralized service delivery model; and
- to conduct sector development studies for eventual scaling up of the proposed service delivery model aimed at statewide implementation.

3. The key components of the project include construction of new / augmentation / rehabilitation of drinking water schemes, drainage schemes, household latrines, and environmental management and watershed development schemes. The Health, Hygiene and Sanitation component of the project includes

health and hygiene education programs for safe handling of drinking water, disposal of waste water -- sullage, personal hygiene, household hygiene and community environmental sanitation. The integrated watershed management component of the project includes schemes for improving sustainability and perenniality of the water sources. The project also includes state wide sector development studies and programs for improving KWA's O&M cost recovery performance and preparing river basin plans for the project area.

4. The project will bring about positive health and environmental benefits through supply of 'safe' drinking water and sanitation, improved water quality monitoring programs, health and hygiene education programs as well as watershed programs for source protection. Several environmental mitigation measures will be included in the project design, and the project is expected to have a net positive effect on the environment. The project itself will not cause any adverse environmental impacts. However, based on information gathered during site-visits, following are the key environmental concerns related to the Kerala RWSS project:

Water Quantity Issues:

- availability of 'safe' drinking water, especially in the summer months when most of the traditional private dug wells run dry' and the public supply is inadequate;
- declining water tables and competing demands for agricultural and domestic purposes;

Water Quality Issues:

- water quality of public drinking water supplies including bore-wells and surface sources, in addition to the traditional private dug wells;
- close proximity (to drinking water Sources) of increasing numbers of leach pit latrines under laterite soil conditions;
- non-point sources of pollution in the catchment area including possible agricultural and surface runoff; especially during the rainy season;
- inadequate monitoring of drinking water quality;
- inadequate and irregular disinfection of drinking water supplies, including chlorination under KWA schemes;
- washing/bathing and other domestic activities around the open dug well sources, especially among the low income communities.

5. To contribute to the environmental sustainability of the project, an Environmental Analysis[9] Study will collect and analyze information regarding the environmental issues related to the project and *prepare* an Environmental Management Plan (EMP), duly integrated in the project. The aim of the EA study is to analyse the existing environmental issues related to RWSS and ensure that these inadequacies are addressed or mitigated in the project design.

Objectives

6. The key objective of the Environmental Analysis Study is to recommend measures for enhancing the positive environmental benefits of the project. This will be done by integrating appropriate measures to mitigate any identified adverse environmental impacts, as part of the project design. Specifically, the EA would:

- identify and assess the existing environmental issues (with a focus on water quantity and quality related issues) and how they will be addressed through the various project Components including activities/tasks under the proposed Kerala RWS S.
- recommend an Environment Management Plan (EMP), including performance indicators for the identified issues.

7. The project components, including safe delivery of water supply and sanitation, watershed management, health, sanitation and hygiene education are all expected to contribute positive benefits. Recognizing these, the consultant should analyze whether the project activities/tasks are adequate to address the existing environmental issues or not. If not, appropriate mitigation plans should be prepared in the form of specific operational guidelines and recommendations should be made regarding suitable implementation arrangements and performance indicators. The Consultant should pay particular attention to identify' issues that need to get main streamed into different project activities.

Scope of Services

8. The study will be based on field visits to pilot GPs, supplemented with secondary sources of information from various Government Departments / Agencies, Institutions and Primary Health Centers, relating specifically to project area. The specific tasks of the study are to:

(i) assess the availability of safe drinking water from surface! groundwater sources, on the basis of secondary sources of information. Specific details should be collected regarding declining water tables in the project area;

(ii) examine the extent and possible causes of contamination of drinking water sources. The Consultant is expected to draw upon the findings of the study - *Water Quality Assessment of Selected Panchayats,* being commissioned to analyze water quality' parameters of representative dug well borewells/public sources, for establishing possible sources of pollution. In addition, the Consultant should collect information from secondary sources to examine possible non-point sources of contamination.

(iii) collect information and prepare simple implementation guidelines on 'safe' sanitation technologies as appropriate for the project area, on the basis of soil characteristics, hydrogeology, proximity of water sources etc.

(iv) assess adequacy of current water quality monitoring programs and institutional capacity for the project area, and provide recommendations for enhancing these as well as disseminating water quality information to the rural public;

(v) assess current programs for disinfection treatment of drinking water supplies and provide recommendations for enhancing as well as making these effective;

(vi) prepare environmental performance indicators (on the basis of key issues), which can be interfaced with the overall project indicators;

9. A review of existing legislations and policies should be undertaken, to help Kerala RWSS project attain the objective of safe water and sanitation.

10. The project has a specific watershed component which is being addressed separately. In addition the project is also addressing public health hygiene aspects, including beneficiary participation and awareness raising programs, as part of the Health, Sanitation and Hygiene component. The Consultant will interact with these

groups to have the benefit of the information, as necessary for the preparation of the EMP.

11. The major environmental issues should be presented in a descriptive, matrix form and classified as primary, secondary etc. The EA study should be *representative* of project district areas including lowlands, midlands and highlands, with Maps and Tables for clarity.

12. An analysis of alternate scenarios should clearly bring out the value addition by integrating environmental issues in the design of the project.

13. Views of the target groups and the local NGOs should be taken into account in the preparation of the EA. This should be done for the pilot GPs.

14. EA Report should provide the information as well as the required analysis, in accordance with the World Bank's OP/GP/BP 4.01 on Environmental Assessment and the Environmental Sourcebook Update on Water Resources and Sanitation.

Expertise and Consultant Input Required

15. Water Resources and Environmental Management Specialist with extensive experience in water supply and sanitation projects. Inputs required are 30 man days, over a period of maximum 60 days.

Outputs and Schedule

16. The Consultancy shall be completed within 60 days from the date of signing of contract and after approval of contract by the competent authorities. The following is the target period for submission of various reports by the Consultant:

(i) Inception Report: Within 10 days from the date of award of contract. It should contain detail methodology of the Consultant for preparation of the report,

identification of data requirements and the mode of collection of data.

(ii) Draft Final Report and Executive Summary: Within 45 days from the date of award of contract. It should provide baseline information and specify environmental issues related to the project, on the basis of collection, collation and analysis of data (primary and secondary) and public consultations. It should include an analysis of alternative scenarios and recommendations regarding mitigative measures, monitoring, evaluation strategies and institutional responsibilities. The Report should be supported by Annexes containing data, relevant to the consideration of environmental issues in the project area. The Report should not exceed 150 pages and the Executive Summary should not exceed 15 pages.

(iii) Final Report and Summary: Within 10 days after receiving the comments on draft Final Report and Executive Summary. 10 copies of the Final Report should be submitted.

17. The report, including data base attachments should also be submitted in electronic format.

Reporting

18. The Consultant will report to Executive Director, Rural Water and Sanitation Agency (RWSA), who is mainly responsible for carrying out the Environmental Analysis on behalf of GOK and for submitting the Environmental Analysis Report to the Bank.

ANNEXURE II

Public Consultations

As part of the EA study public consultations were held in the pilot GP in the project districts to identify environmental issues, if any, including alternatives to the project, that need to the addressed in the project. The following is a note on these consultations.

Public Consultation - 1

Date	:	Feb 28, 2000 FN
Location	:	Nediyeruppu Panchayat, Kondotty Block, Malappuram District
Nediyeruppu Panchayat at a glance	:	(Information furnished by SEUF, (SO), Nediyeruppu)
Panchayat Area	:	2009 Ha
Total number of wards	:	10
Population (1999)	:	26273
No. of families	:	4165
No. of privately owned wells	:	2626 (63%)
No. of families experiencing water scarcity	:	2646
No. of families having sanitary latrines	:	2544 (61%)
Persons met	:	Mr.K.M.Namboodri, Senior Technical Advisor, SEUF. Mr. Georgekutty Joseph - Technical Director, SEUF Mr. Isac John - Project Manager, Technical Support Unit, SEUF Mr. Radhakrishnan, Ms. Nisha - Programme Associates, SEUF

Mr.Chariapu - Ward Member

No. of participants in the public consultation held at Pantalamkunnu 'ayalkootam' – 32 (see list....)

Main points

1. Problem of water scarcity in summer, as many dug well sources dry up.
2. Water supply to the panchayat from the existing DANIDA assisted scheme based on borewells is highly inadequate, with supply even on alternate days.
3. People are dissatisfied with the quantity and quality of existing supplies and want surface water from Chaliyar river should be tapped for supply to the panchayat.
4. People willing to consider household rainwater harvesting (roof catchment) provided subsidy is made available to them.
5. If private sources with good yield need to be acquired for the project, no problem is anticipated, if compensated for.
6. Problem of recurring turbidity (colloidal) in some well waters during the period Jan – May.

Public Consultation – 2

Date February 28,2000

Location: Pookkottur Panchayat, Malappuram District.

Persons met : Mr.A. Mohammad, Panchayat Vice President

Mr.P.C.Velayudhan Kutty – Secretary, Panchayat

Staff of Support Organisation – Kutumbashri

Kutumbashri

Staff List

(1)	Deepthi. R.	-	Team Leader
(2)	Harikumar	-	Project Engineer
(3)	Abdul Hameed	-	Junior Engineer
(4)	Babu. M.S.	-	Junior Engineer

(5)	Jazeera. T.	-	Accountant
(6)	Sajid. M.	-	Community arganiser
(7)	Noorjahan. V.	-	Community arganiser
(8)	Padmavathy. K.	-	Community Facilitator
(9)	Sulaikha. J.	-	Community Facilitator
(10)	Mini Mumtas. N.K.	-	Community Facilitator
(11)	Abdul Lateef. P.	-	Community Facilitator
(12)	Farisha. K.	-	Community Facilitator

Main Points :

1. 33 schemes were considered, 21 have been selected based on source yield considerations.
2. For the 4 existing water supply schemes in the panchayat, source is no problem but there is inequity in distribution of water.
3. As the reliability of yield from open dug wells is high, the sources for the proposed schemes will be open dug wells, excepting for one scheme for which the source will be a borewell subject to confirmation by the GW department for which the necessary fee has been deposited.
4. In view of good availability of ground water, rainwater harvesting is not being contemplated.
5. Sanitation coverage in the panchayat is 90%
6. A large number of hospitals have come up in the area and the problem of sanitary disposal of hospital wastes needs to be addressed.
7. Lack of organised system of slaughter house wastes which are presently dumped into unused wells.

Public Consultation – 3

Date	:	**Feb 29, 2000 FN**
Location	:	Kunnummal Panchayat, Kozhikode district
Presons met	:	Ms.K.K.Latika – Panchayat Presiden Vice President
		Mr.George Mathew – Programme Officer, NASRAD (SO)
		Mr. Jayaraj – Co-ordinator
		Mr. Manikandan – Accountant

Number of participants in the public consultation: 24 (see list)

Salient Features of Kunnummal Panchayat : (as furnished by NASRAD)

Area	:	10.58 km^2
Total population	:	16,870
Female	:	8568
Male	:	8302
No. of households	:	3484
No. of privately owned wells	:	2773 (937 – perennial)
No. of public wells	:	227
No. of borewells	:	4
Ponds	:	61
No. of taps	:	163
No. of schemes proposed	:	42

Main Points

1. During summer months many dug wells dry up.
2. Likely problem of drying up of private dug wells in the viscinity of the new source when fitted with high capacity pumps.
3. Schemes will be designed to serve a maximum number of 40 families who will be provided with 24 hr metered supply.
4. No problem is envisaged in acquiring land for location of new source/over head service reservoir (OHSR) or for taking over private sources of good yield. Formal consent of the land owner will be obtained by the panchayat for locating the OHSR. An agreement will be signed with the land owner when a new source is to be located on a private land. If the source is found successful, the land will be formally handed over to the panchayat for a mutually agreed price. A concern was expressed regarding the loss of investment if the identified source fails.
5. Watershed management programme should be taken up concurrently with the water supply scheme to ensure sustainability of sources.
6. No real risk of contamination of ground water, as the number of new latrines to be installed is small and the individual plot sizes are large.
7. Most of the beneficiary committees have registered their societies, opened their bank accounts, are ready with their contribution and are eager to start the work on the schemes.

Field Visit to Koduvally Water Supply Scheme of KWA based on surface source

Date : 1-3-2000 FN

Person met : Mr P. Jamal, Asst. Engineer, PH Section, KWA, Koduvally, Kozhikode dt.,

RWSS to Koduvally, Kizhakkoth and Madavoor Villages

Name of source - Cherupuzha River at Nadammal Kadavu

Well dia and depth - 8.00 m and 14.00 m

Gallery length - 72.00 m

Collecting well dia and depth - 3.00 m and 5.00 m

Pumping main size and length - 250 mm C-I class B, 1920 m

Levels

River bed	-	+ 14.00	Tank capacity
Well	-	+ 10.00	
Koduvally Tank		+ 101.00 + 3.00	3.5 lakh litres
Madavoor Tank		+ 68.00 + 3.00	3.5 lakh litres
Kishakkoth Tank		+ 73.00 + 3.00	2.5 lakh litres

Population Benifitted - 70,125

Gravity main 300 mm AC pipe 4275

250 mm AC pipe 2180

200 mm AC pipe 3024

150 mm AC pipe 1450

Distribution system 90.468 m (32 to 300 mm) subsequently laid approx 30 km (PVC pipes).

Key observations :

Sand mining at the intake site, upstream and downstream is extensive resulting in the lowering of the river bed by a few meters; change of the river regime near the intake, necessitating bunding D/S with sand bags so as to ensure adequate flow to the infiltration gallery; collapse of the retaining walls near the pump house, cultivation of river bed with seasonal crops (tapioca, sugarcane etc), generation of turbidity in the river water due to sand mining and other activities contributing to pollution at the intake; bleaching powder added directly to the intake well, signs of corrosion of metal surfaces in the pump house.

Visit to KWA and CWRDM, Kozhikkode

Date: 1/3/2000

Meetings with the following persons for discussion and collection of secondary data

Mr. C. Reghu, CE Northern Zone, KWA, Kozhikode

Dr.P. Basak, Executive Director, CWRDM, Kozhikode

Dr.E.J. James, Head Surface Water Division, CWRDM, Kozhikode

K. Damodaran, O/O District Officer, Economics and statistics Dept., GoK, Kozhikode

Public consultation - 4

Date	:	March 2, 2000
Location	:	Mundathikode Panchayat, Thrissur District
Persons met	:	Mr , Panchayat President
		Mr. Biju, Convenor
		Mr.M.L.George, Senior Engineer,COSTFORD(SO)
		Prof. V.A.Sundhakaran

Present status of Water Supply and Sanitation in the Panchayat

- KWA schemes cater to only 3 wards in the panchayat.
- Another ward has recently commissioned its own water supply scheme with 1 hr supply twice a day, people want more water.
- Existing borewells put up by KWA supply 50,000 lpd (16-18 hr pumping); population benefited is only about 3000, there is considerable misuse of water by the people.
- During rainy season, people use their individual wells to a large extent and the pumping from the public sources is kept to the minimum
- Sanitation coverage is high (95%).
- 45 locations have been identified for siting the new sources (dug wells and borewells).
- Five sites already selected, ground water department to confirm the sites.
- Some of the sites are privately owned and some belong to GP.
- All land required for the schemes will be made available by the people.

Public consultation in ward no.2. Mundathikode Panchayat

No. of participants - 42 (see list)

Main points :

1. For the proposed (new) schemes, the per capita supply will be kept flexible depending on the yield of the source.
2. People are willing to donate the land for locating the sources.
3. High yielding new sources (open dug wells) may cause the existing wells in the vicinity go dry; likewise a high yielding bore put up by private parties may interfere with the public source.
4. Serious concerns were expressed regarding the poor quality of water supplies for public as well as private sources (dug wells).
5. Women will be able to find more time for productive work after the introduction of the piped water supply scheme.
6. The remaining 5% of the population will be provided with sanitation system (leach pit latrines) in the coming year – people with old deep pit latrines would like to retain them.

2.3.2000 AN

Visit to State Ground Water Dept. Thrissur and discussion with Mr.S.Radhakrishnan, District Officer.

- Out of 36 wells studied by the Dept. in Mundathikode Panchayat, ony 2 are perennial.
- Good scope for bore well sources; potential sources could be located in paddy fields and in low lying areas.
- Problem of excessive fluoride in groundwater in Arthad Panchayat.
- As per water quality analysis reports obtained from WQ Testing Wing Thrissur, all the 9 samples (8 open wells and 1 pond) collected from Mundathikode Panchayat area on Jan 11, 2000 had shown the presence of fecal contamination (MPN range 460 to 1100^{+}/100 ml).

Public Consultation - 5

Date	:	March 3, 2000
Location	:	Erimayoor Panchayat (Palakkad Dist)

Persons met :	Mr.C.S.Sulaiman	-	Panchayat President
	Mr.K.M.Mathan	-	Standing Committee Chairman
	Mr.P.Vinod Kumar		'Maithri' Support Organisation
	Dr.K.K.Preetha		
	Mr.S.P.Ravi		
	Ms. Joti		
	Ms. K.B.Pushpa	-	Ward Member
	Mr.Unnikrishnan		
	Ms. Valsala	-	Ward Member
	Mr. Ratesh, KWA		
	Mr.Ramachandran, AE, KWA		

Present status of WSS schemes

1. Existing schemes in the Panchayat with 11 wards comprise
   (i) KWA schemes including multipanchayat schemes and
   (ii) Panchayat owned schems.
2. 85 new schemes were proposed of which 50 schemes have been decided.
3. Active preparatory stage

Some points raised by the above group

President :

1. Some issues/concerns may come up at the implementation stage of the schemes.

S.C. Chairman :

- Two types of tariffs may exist in the Panchayat – Existing KWA schemes and WB aided schemes.

President :

- In the event of new sources (wells) affecting the existing ones and vice versa, there must be some stipulation/directive from the government to control such incidents.
- Acquisition of land for siting new sources has to be done through peaceful persuasion.

Valsamma W.M. :

- The aspect of O&M costs needs more elaboration and explanation.
- There are certain areas where people are needy but are not willing to participate.
- On a question raised by Mr.Mathan reg per capita water supply from the proposed schemes, Mr.Unnikrishnan, Ward Member responded by saying that the quantity will be divided according to the availability at the source.

Unnikrishnan W.M. :

Narrated some points raised by SC community such as

(i) SC population has to pay for water in respect of WB schemes while they do not pay for KWA schemes.

(ii) What is the role of the government, if the existing KWA schemes are to be transferred to 'ayalkootams'?

Public consultation- 6

Date: March 3, 2000

Location Chullimada, Erumayoor panchayat Palakkad

- Some participants sought clarification from the SO regarding idnividual family contribution to the proposed project.
- A few people owning wells are wary of participation in the project.
- One participant : When the area served by KWA gets free water supply why should we pay for the project?

  Another participant : We will be assured of a realibale supply from the proposed project.

* Some questions : What is the guarantee that the new project will solve our problem?

  What if the government changes?

- In this area with 53 households, only 24 have their latrines while the rest resort to open field defecation.
- Some people would like to contribute to the project through labour.
- Because of extensive sand mining in the nearby Gayathri river, the people are experiencing the water supply problem, which did not exist a few years ago. They complained of the poor quality of water supplied from the existing systems.

ANNEXURE III

Sanitary Survey of Water Supply Sources

The importance of a sanitary survey of water sources cannot be overemphasized. With a new supply, the sanitary survey should be made in conjunction with the collection of initial engineering data covering the development of a given source and its capacity to meet existing and future needs. The sanitary survey should include the detection of all health hazards and the assessment of their present and future importance. Persons trained and competent in public health engineering and the epidemiology of waterborne disease should conduct the sanitary survey. In the case of an existing supply, the sanitary survey should be made at a frequency compatible with the control of the health hazards and the maintenance of a good sanitary quality.

The information furnished by the sanitary survey is essential to complete interpretation of bacteriological and frequently the chemical data. This information should always accompany the laboratory findings. The following outline covers the essential factors which should be investigated or considered in a sanitary survey. Not all of the items are pertinent to any one supply and in some cases, items not in the list would be important additions to the survey list.

Ground Water Supplies

a. Character of local geology; slope of ground surface.

b. Nature of soil and underlying porous strata; whether clay, sand, gravel, rock (especially porous limestone); coarseness of sand or gravel; thickness of water-bearing stratum, depth to water table; location, log and construction details of local wells in use and abandoned.

Source : Manual of Individual Water Supply Systems (1973)
U.S. EPA. Water Supply Division

c. Slope of water table, preferably as determined from observational wells or as indicated, presumptively but not certainly, by slope of ground surface.

d. Extent of drainage area likely to contribute water to the supply.

e. Nature, distance and direction of local sources of pollution.

f. Possibility of surface-drainage water entering the supply and of wells becoming flooded; methods of protection.

g. Methods used for protecting the supply against pollution by means of sewage treatment, waste disposal, and the like.

h. Well construction :

1. Total depth of well.

2. Casing : diameter, wall thickness, material and length from surface.

3. Screen or perforations : diameter, material, construction, locations and lengths.

4. Formation seal : Material (cement, sand, bentonite, etc.), depth intervals, annular thickness and method of placement.

i. Protection of well at top : presence of sanitary well seal, casing height above ground, floor, or flood level, protection of well vent, protection of well from erosion and animals.

j. Pumphouse construction (floors, drains, etc.), capacity of pumps, drawdown when pumps are in operation.

k. Availability of an unsafe supply, usable in place of normal supply, hence involving danger to the public health.

l. Disinfection : equipment, supervision, test kits, or other types of laboratory control.

Surface-Water Supplies

a. Nature of surface geology : character of soils and rocks.

b. Character of vegetation, forests, cultivated and irrigated land, including salinity, effect on irrigation water, etc.

c. Population and sewered population per sq Km of catchment area.

d. Methods of sewage disposal, whether by diversion from watershed or by treatment.

e. Character and efficiency of sewage-treatment works on watershed.

f. Proximity of sources of fecal pollution to intake of water supply.

g. Proximity, sources and character of industrial wastes, acid mine waters, etc.

h. Adequacy of supply as to quantity.

i. For lake or reservoir supplies : wind direction and velocity data, drift of pollution, sunshine data (algae).

j. Character and quality of raw water : coliform organisms (MPN), algae, turbidity, color, objectionable mineral constituents.

k. Nominal period of detention in reservoir or storage basin.

l. Probable minimum time required for water to flow from sources of pollution to reservoir and through reservoir intake.

m. Shape of reservoir, with reference to possible currents of water, induced by wind or reservoir discharge from inlet to water-supply intake.

n. Protective measures in connection with the use of watershed to control fishing, boating, swimming, wading, permitting animals on marginal shore areas and in or upon the water etc.

o. Efficiency and constancy of policing.

p. Treatment of water : kind and adequacy of equipment; duplication of parts; effectiveness of treatment; adequacy of supervision and testing; contact period after disinfection; free chlorine residuals carried.

q. Pumping facilities : pumphouse, pump capacity and standby units, storage facilities.

Distances to sources of contamination

All ground water sources should be located a safe distance from sources of contamination. In cases where sources are severely limited, however, a ground water

aquifer that might become contaminated may be considered for a water supply if treatment is provided. After a decision has been made to locate a water source in an area, it is necessary to determine the distance the source should be placed from the origin of contamination and the direction of water movement. A determination of a safe distance is based on specific local factors described under "Sanitary Survey".

Because many factors affect the determination of "safe" distances between ground water supplies and sources of pollution, it is impractical to set fixed distances. Where insufficient information is available to determine the 'safe' distance, the distance should be the maximum that economics, land ownership, geology and topography will permit. It should be noted that the direction of ground water flow does not always follow the slope of the land surface. Each installation should be inspected by a person with sufficient training and experience to evaluate all of the factors involved.

Since safety of a ground water source depends primarily on considerations of good well construction and geology, these factors should be the guides in determining safe distances for different situations. The following criteria apply only to properly constructed wells. There is no safe distance for a poorly constructed well.

When a properly constructed well penetrates an unconsolidated formation with good filtering properties and when the aquifer itself is separated from sources of contamination by similar materials, research and experience have demonstrated that 50 feet is an adequate distance separating the two. Lesser distances should be accepted only after a comprehensive sanitary survey, conducted by qualified state or local health agency officials, has satisfied the officials that such lesser distances are both necessary and safe.

If it is proposed to install a properly constructed well in formations of unknown character, the state or Geological Survey and the state or local health agency should be consulted.

When wells must be constructed in consolidated formations, extra care should always be taken in the location of the well and in setting "safe" distances, since pollutants have been known to travel great distances in such formations.

The following table is offered as a guide in determining distances

Formations	Minimum acceptable distance from
Favorable (unconsolidated)	50 feet. Lesser distances only on health department approval following comprehensive sanitary survey of proposed site and immediate surroundings
Unknown	50 feet only after comprehensive geological survey of the site and its surroundings has established, to the satisfaction of the health agency, that favourable formations do exist.
Poor (consolidated)	Safe distances can be established only following both the comprehensive geological and comprehensive sanitary surveys. These surveys also permit determining the direction in which a well may be located with respect to sources of contamination. In no case should the acceptable distance be less than 50 feet.

ANNEXURE IV

Recuperation Test for Yield Estimation of an Open Well

Source failure is becoming increasingly common in small pumping schemes. This is because no or little steps are taken to actually measure the "safe yield" of the source.

How much water can your well give? You must have a clear answer to this question in order to decide how much water each household can get or how many households can the well be used for especially in peak summer.

You can do this by some simple measurements, but it must be done in the peak summer. You also nee to pump your well nearly dry and make some observations of time and water levels, as described later.

The basic idea is to estimate the time required for the well to refill after it has been fully or partially emptied. If a well refills to almost its original level, within 12 to 16 hours, then this refilled volume of water is safely available, every day, for your scheme. This is the Daily Safe Yield your well can provide. It is the amount of water that the well can supply daily when pumping is done twice 3 to 4 hours each time, leaving 12 to 16 hours for the well to refill.

Steps for Safe Yield Estimation

1. Using a measuring tape, note down the diameter of the well in meters.
2. Using a thin rope or string with a stone tied on one end, measure the depth of the water level from the ground or the parapet wall of the well. Convert this into meters using the measuring tape.

Source : Experience of a Pilot Programme on Decentralised Water Supply Systems Malappuram District, Kerala,
Technical Support Unit (TSU)
Socio Economic Unit Foundation (SEUF)
Kondotty, Malappuram, Kerala

3. Use the rope again, and from the same place on the well wall (or ground), this time to measure the total depth of the well.
4. Install a pump to dewater the well making sure that the foot valve is close to the bottom of the well.
5. Start the pump and note the time.
6. Stop the dewatering when the water level has dropped very close to the foot valve. Note the time and the depth to the water level, using the string and the measuring tape.
7. Wait until the water level in the well rises to nearly (within 10 cm, use the tape to verify this) its original level before you started pumping. Initially, the water level will rise quickly. Later this rise will be much slower and may take 8 hours or more. Therefore, visit the well initially every half hour and later every one hour and judge the rate of recovery to decide when recovery is nearly completed.
8. Note down the time and depth to water level when recovery is nearly complete.
9. As mentioned earlier, the safe yield per day can be estimated as the quantity of water that flows back into the well within 12 to 16 hours time. It is assumed that the difference between the initial water level and the water level at the time of recovery is negligible.

Precautions

1. Measurements in Steps 1, 2, 3, 6 and 7 must be from an identifiable and fixed point at the ground level or the well wall. You may need to make measurements again from this point later.
2. If your well has recovered to its original level within 4 to 6 hours then, its yield is very good. However, if the water level has not come to half its original column height, within 6 to 8 hours, then your well is not very high yielding. In such a

situation let your well rest without pumping for two days. Then repeat dewatering, this time pumping till only.

3. It is also possible that when pumping from your well, it affects the neighbouring wells. Check if this happens by two measurements of water levels in your closest neighbouring well while your well is dewatering. If a drop in the water level in an adjoining well is observed, then your well is not suited for sustainable use.

Complete the calculations as illustrated below,

If :

Diameter of Well	=	d (m)
Depth of Well	=	D (m)
Depth of Initial Water level	=	SWL (m)
Time of starting dewatering	=	T1 (Hr./min.)
Depth of water level at end of dewatering	=	DW (m)
Time at the end of dewatering	=	T2 (Hr./min.)
Depth to Water level at end of recovery	=	DR (m)
Time at the end of recovery	=	T3 (Hr./min.)

Then :

Safe yield = Volume of recovered water

$$= \frac{22}{7} \times \frac{(d \times D)}{4} \times \frac{(DR - DW)}{} \text{ cu.m}$$

$$= 0.786\ (d \times D)\ (DR - DW) \times 1000 \text{ litres}$$

= Quantity of water available every day from your well

ANNEXURE V

Roof Water Harvesting Systems

The uplands and mid lands of Kerala are characterised by several isolated and scattered habitations facing acute water scarcity where no conventional water supply systems are feasible. Rain Water Harvesting (RWH) is found to be the most, if not the only, appropriate solution in such areas. RWII systems are designed to store and collect rain water to meet the drinking and cooking needs (10 lpcd) of households for about 180 days of non rainy period. Another requirement is hard roof that gets cleaned with the first two or three showers.

1. Suitability

Roof Water Harvesting systems are ideally suited to the following situations.

1. At localities where the rainy days in a year are spread in such a way that the storage requirements are reduced to the minimum. In most parts of Kerala, the tank starts filling in May and gets constantly replenished until end of October. This means the maximum storage required is for about 200 days in a year. However, there ar many localities where the water scarcity is felt only for two to three months in a year. At such locations, the storage is required only for three months (say 100 days).
2. The roof is of a hard surface and thatched roofs should be avoided.
3. At localities where all the other cheaper and sustainable alternative water supply systems such as decentralised piped water supply schemes (springs, wells, bore wells, rivers, ponds) either by gravity or small head pumping are infeasible.

Source : Experience of a Pilot Programme on Decentralised Water Supply Systems Malappuram District, Kerala,
Technical Support Unit (TSU)
Socio Economic Unit Foundation (SEUF)
Kondotty, Malappuram, Kerala

The remote and hilly tracts with scattered population and coastal areas with saline water problems are ideally suited for RWH in Kerala.

2. Advantages

1. Simple design and easy to construct and maintain
2. Assured water supply
3. Cost-effective compared to piped water supply systems with long lead pipe lines.
4. Negligible maintenance cost
5. Owned and managed by the beneficiary and as such maximum care will be taken to maintain and avoid wastage of water.

3. Limitations

1. Initial cost (Rs/litre) is high.
2. Can supply only the minimum requirement (for drinking and cooking).

Design assumptions for a standard unit

1.	Minimum roof area	=	15 sq.m
2.	Type of roof	=	RCC/Tiled
3.	Average rainfall	=	2500 mm
4.	Run off coefficient	=	80%
5.	No. of family members	=	5
6.	Per capita supply (drinking)	=	10 litres
7.	Storage requirements for	=	200 days (Ignoring refilling due to summer showers)
8.	Water collection method	=	The drainage pipe from the roof feeding a tank through a sand filter

4. Technical Specifications

4.1. Individual Houses (200 days storage)

1. Storage required (200 x 5 x 10) = 10000 litres

2. Type of storage tank = Ferro-cement tanks (20 mm thick walls) kept outside the house close to the external wall.

3. Number of tanks = 1

4. Size of tank = 2.7 m dia and 1.80 m high.

5. Foundation = Laterite masonry, 30 cm AGL and 25 cm BGL with 5 cm thick concrete floor.

6. Cost per litre = Rs. 1.2 – 1.8

4.2. Converting Abandoned Open Wells into Rain Water Storage Tanks

Like any other regions of rural Kerala, people have invested massively on open wells in lateritic areas. Many of the wells dry immediately after the rainy season and as such are abandoned by the owners.

The high ranfall notwithstanding, the highest water table in the high lateritic regions is about 5 m below ground during the monsoon, whereas the water table drops as deep as 10 to 15 m below ground during summer. For this reason, the wells in the lateritic regions are quite deep. Many wells end in massive rock. On the hilly areas, the bed rock slopes steeply causing rapid drainage of ground water. These are the wells that remain dry for three to four months in a year.

There are two basic features of wells in lateritic regions ending in rock that remains dry during summer.

1. The wells are neatly cut in laterites offering smooth but stable inner surfaces.
2. Good impermeable and stable foundation.

Both the above features bring in good scope for converting these wells into subsurface tanks to store rain water. The rain water falling over the roof can be diverted to fill the wells. By pouring concrete over the bottom and cement plastering the inner surface, seepage loss can be prevented. Providing a concrete slab on top of the wells will prevent contamination and evaporation loss.

Some calculations indicating the feasibility of this proposition are given below :

1.	Average volume of a lateritic well (3 m. dia, 8 m. deep)	:	21 cu.m
2.	Average roof area of rural houses	:	30 sq.m
3.	Average run off (80% of 2500 mm annual rainfall)	:	2000 mm
4.	Average annual run off volume (30 x 2)	:	60 cu.m

Since the run off is more than the volume of the well, the proposition to fill the wells with the runoff water is feasible. If the volume of the well is more, more houses can be tapped.

Although the above proposition seems to be promising, there are many unknown areas involved in the technology because this has never been done before. Following factors need to be studied :

1. Effectiveness of various plastering and water proofing materials
2. Structural stability of side plastering and bottom concrete.
3. Water quality changes if any, during one year.

4.3. Underground Sumps (Water Supply for Schools)

Many schools are located on lateritic hills. The school wells tend to dry up during summer and the children have to fetch water from far off places. The hard laterite exposed on the surface in such areas offers the possibility of underground tanks, by digging a rectangular sumps, concreting the floor, plastering the sides, and covering the same with RCC slab. Collecting the rain water from the school roof and storing the same in these underground sumps is feasible. The water can be pumped into a small supply tank using solar/kerosene/electric pumps and supplied through a set of taps. The pump is to be installed in such a way that pumping from underground sump or school well is possible as and when required.

The following calculations may be interesting

Average strength of a school	=	700 students
Daily requirement @ 2.5 lpcd	=	1750 litres (1.75 cum)
Number of working days to be supplied (summer)	=	60 days
Total storage required	=	105 cu.m
Average roof area	=	100 sq.m
Run off @ 2 cum/sq.m	=	200 cu.m
Size of underground sump	=	10 m x 3 m x 3.5 m (3 m BGL and 0.5 m AGL)
Cost per litre	=	Rs. 1.25 (Including sump, pump and pumphouse, supply tank and pipelines)

ANNEXURE VI

Bleach Powder Solution Dosing Equipment for Disinfection of Small Pumped Water Supplies

Bleaching Powder also known as Chloride of Lime, Calcium Hypochlorite and Chlorinated Lime has the chemical formula $Ca(OC1)_2$ and is commonly used in India as a disinfecting agent instead of gaseous chlorine. It is a white, dry powder, hygroscopic containing 25% to 33% of its weight as chlorine. For calculating the quantity of bleaching powder for a given dose of chlorine expressed in parts per million parts, it is safer to assume chlorine content at 25%. The quantity of water required for preparing solution of bleaching powder is 3 to 4 gallons of water per pound of bleaching powder. Chalk precipitates as a result of the chemical reaction and therefore the supernatant liquid is only used for feeding to the water to be chlorinated. The solution is therefore prepared in a separate bucket of non-corrodible construction and the supernatant liquid poured or decanted into another holding tank, or the solution is prepared in a tank of non-corrodible construction or in a suitably lined tank, whose outlet is kept about 15 – 30 cm feet above the bottom to avoid entry of chalk in the feed system; the chalk being then removed periodically through the drain at the bottom of the tank. Where the water used for solutionizing is hard, the lime in bleaching powder reacts to soften the water and impairs the release of oxy-chlorate of lime, which contributes towards chlorination of water to be treated. It is therefore, usual to add soda ash to the solutionizing water 750 gm kg of bleaching powder. The soda-ash should be allowed to dissolve completely before adding bleaching powder. This will form sodium hypochlorite, a more stable form than calcium hypochlorite. In either case the sludge at the bottom of the dissolving container should be

thrown away, or else if fed into the water supply system it will cause trouble by clogging valves and orifices and cause deposition in pipes. Bleaching powder is packed in non-returnable thin guage steel drums, usually about 50 kg weight.

Bleaching Powder solution can be fed by gravity from dosing boxes employing a "floating arm take-off" or constant head gravity feed device. When bleaching powder solution is fed by gravity, the constant head box must be of non-corrodible construction and so also all its components. Concrete tanks or boxes should not be used. When feeding to pressure systems, such as water flowing through a pressure filter or flowing in a pipeline under pressure, the popular unit called the "Displacement Doser" is used.

The Displacement Doser as shown in accompanying sketch provides a simple and reliable means of adding bleaching powder solution to a pipeline under pressure, using differential pressure created by a venturi tube or orifice plate to impel the solution into the pipeline. In principle water from the higher pressure upstream side of the venturi tube or orifice is led to a closed vessel, which has been filled with the solution to be applied and from which a connection leads to the low pressure throat of the venturi tube or downstream side of the orifice plate. The difference of pressure causes the water to flow into a closed vessel, driving the solution in it into the pipeline. In order that the incoming water shall displace the solution instead of mixing with it, the vessel is divided into two by a flexible membrane in the form of a sac or a bag, into which the solution is originally placed, and from which it is expelled by the closing up of the bag by the incoming water. Since the quantity of solution leaving the bag is equal to the quantity of water entering the vessel, it is easy to regulate and measure the dose by controlling and measuring the flow of incoming water, and so to avoid the difficulties inherent in attempts to measure or

adjust small flows of solutions that are usually corrosive and may frequently contain minute particles of insoluble matter. Small orifices and fine clearances are obviously inadvisable in conjunction with such solutions.

The Displacement Doser assembly consists of :

1. A Solution Preparing Tank, in which the correct quantity of solution of desired strength can be prepared, with necessary valves, to enable the solution when prepared to flow by gravity. Usually, we use a plastic bucket with wooden plunger and a lid to prepare the solution, and the solution is decanted leaving the thick chalk deposit below.
2. The Pressure Vessel, consisting of welded steel cylinder, with a removable flanged cover, drain and outlet valves, and flexible plastic sac or rubber bag, into which prepared solution is allowed to flow and from which it is discharged to the water to be disinfected.
3. The Withdrawable Injection Fitting, with isolating valve for insertion in the pipeline with the necessary PVC tubing between it and the pressure vessel.
4. The Orifice Plate or Venture Tube, with the necessary tubing to connect it to the inlet of the pressure vessel.

A charge of the required solution at the correct strength is first made in the preparing tank, the pressure vessel is then isolated from the main on the upstream side, the filling valve and the drain valves opened, so that the prepared solution runs in and fills the bag, displacing the water in the pressure vessel which escapes through the drain valve. The filling valve is then turned to its running position, connecting the interior of

the bag to the downstream tapping in the pipeline through the injection fitting, the valve on the upstream connection to the pressure vessel reopened and dosing will take place.

Displacement Dosers are available in sizes which define the bag capacity. The sizes are expressed in gallons and are in the range of 8, 16, 24, 32 and 48. The pressure vessel is designed for working pressure of 25 p.s.i., and is tested to 50 p.s.i. Venturi tubes and Orifice plates can be designed for any flow and to suit all normal type of water main. The differential pressure normally employed is of the order of 2 m head of water at the maximum flow, but can be varied somewhat if necessary to suit special circumstances.

ANNEXURE VII

Sanitary Protection of wells through Cement Grouting

The annular open space on the outside of the well casing is one of the principal avenues through which undesirable water and contamination may gain access to a well. The most satisfactory way of eliminating this hazard is to fill the annular space with neat cement grout. To accomplish this satisfactorily, careful attention should be given to see that

1. The grout mixture is properly prepared.
2. The grout material is placed in one continuous mass.
3. The grout material is placed upward from the bottom of the space to be grouted.

Neat cement grout should be a mixture of cement and water in the proportion of 1 bag of cement and 20 – 25 liters of clean water. Whenever possible, the water content should be kept near the lower limit given. Hydrated lime to the extent of 10 per cent of the volume of cement may be added to make the grout mix more fluid and thereby facilitate placement by the pumping equipment. Mixing of cement or cement and hydrated lime with the water must be thorough. Up to 5 per cent by weight of bentonite clay may be added to reduce shrinkage.

Grouting Procedure

The grout mixture must be placed in one continuous mass; hence, before starting the operation, sufficient materials should be on hand and other facilities available to accomplish its placement without interruption.

Source : Manual of Individual Water Supply Systems (1973)
U.S. EPA. Water Supply Division

Restricted passages will result in clogging and failure to complete the grouting operation. The minimum clearance at any point, including couplings, should not be less than 4 cm. When grouting through the annular space, the grout pipe should not be less than 2.5 cm nominal diameter. As the grout moves upward, it picks up much loose material such as results from caving. Accordingly, it is desirable to waste a suitable quantity of the grout which first emerges from the drill hole.

In grouting a well so that the material will move upward, there are two general procedures that may be followed. The grout pipe may be installed within the well casing or in the annular space between the casing and drill hole if there is sufficient clearance to permit this. In the latter case, the grout pipe is installed in the annular space to within a few cm of the bottom. The grout is pumped through this pipe, discharging into the annular space, and moving upward around the casing, finally overflowing at the land surface. In 3 to 7 days the grout will be set, and the well can be completed and pumping started. A waiting period of only 24 to 36 hours is required if quick-setting cement is used.

When the grout pipe is installed within the well casing, the casing should be supported a few cm above the bottom during grouting to permit grout to flow into the annular space. The well casing is fitted at the bottom with an adapter threaded to receive the grout pipe and a check valve to prevent return of grout inside of the casing. After grout appears at the surface, the casing is lowered to the bottom and the grout pipe is unscrewed immediately and raised a few cm. A suitable quantity of water should then be pumped through it, thereby flushing any remaining grout from it and the casing. The grout pipe is then removed from the well and 3 to 7 days are allowed for setting of the grout. The well is then cleared by drilling out the adapter, check valve, plug, and grout remaining within the well.

A modification of this procedure is the use of the well casing itself to convey the grout to the annular space. The casing is suspended in the drill hole and held a few meters

off the bottom. A spacer is inserted in the casing. The casing is then capped and connection made from it to grout pump. The estimated quantity of grout, including a suitable allowance for filling of crevices and other voids, is then pumped into the casing. The spacer moves before the grout, in turn forcing the water in the well ahead of it. Arriving at the lower casing terminal, the spacer is forced to the bottom of the drill hole, leaving sufficient clearance to permit flow of grout into the annular space and upward through it.

After the desired amount of grout has been pumped into the casing, the cap is removed and a second spacer is inserted in the casing. The cap is then replaced and a measured volume of water sufficient to fill all but a few feet of the casing is pumped into it. Thus all but a small quantity of the grout is forced from the casing into the annular space. From 3 to 7 days are allowed for setting of the grout. The spacers and grout remaining in the casing and drill hole are then drilled out and the well completed.

If the annular space is to be grouted for only part of the total depth of the well, the grouting can be carried out as directed above when the well reaches the desired depth and the well can then be drilled deeper by lowering the tools inside of the first casing. In this type of construction, where casings of various sizes telescope within each other, a seal should be placed at the level where the telescoping begins, that is, in the annular space between the two casings. The annular space for grouting between two casings should provide a clearance of at least 4 cm and the depth of the seal should be not less than 3 m.

Spring Protection and Development

A majority of people living in the hilly tracts all over Kerala are still dependant on natural springs, although many of them are at the verge of drying up. If well protected, springs can provide safe, potable and palatable drinking water to a small community on a sustainable basis.

1. Suitability

Developing springs as a source for rural water supply is ideally suited for the following situations :

1. The springs are perennial (at least discharge at the rate of 20 lpcd during peak summer) and of good water quality (to be tested for chemical and bacteriological contamination).
2. Chance of polluting the catchment is minimum.
3. The beneficiary population lives within close proximity of the springs preferably in the down stream areas of the springs.

The spring water collected in the chamber can be supplied to the consumers through gravity pipe where the community is living in the downstream areas.

2. Advantages

1. The cost of source development is significantly low.
2. easy to construct and maintain by the local communities
3. The maintenance cost is negligible.

Source : Experience of a Pilot Programme on Decentralised Water Supply Systems
Malappuram District, Kerala,
Technical Support Unit (TSU)
Socio Economic Unit Foundation (SEUF)
Kondotty, Malappuram, Kerala

4. As long as proper catchment protection measures are ensured, the source is sustainable because only the naturally flowing water is extracted.
5. Traditionally used system and local community has good knowledge about protecting, developing and using the spring sources.

3. Disadvantages

1. Usage is limited to hilly tracts with perennial springs.

2. If the spring catchment is not properly protected, the springs may either dry up or become unsafe for drinking.

In view of the above, the hilly tracts of both the mid lands and western ghats of Kerala are suitable for spring development.

4. Design Assumptions

1. The spring is perennial with minimum discharge rate of 20 lpcd.
2. The benefitted population lives within 1 km from the source.
3. water quality is acceptable as per test results and peoples taste preference. Turbidity level is below 5 NTU even during the monsoon period.
4. Demand is about 20 to 50 lpcd.
5. Benefitted population is about 250 (50 households).
6. Catchment area is about 100 Ha
7. Community lives more than 10 m below the spring level.

5. Technical Specifications of a Typical Scheme

1.	Discharge of the spring	=	500 lph
2.	Benefitted population	=	200 (35 households)
3.	Supply rate	=	50 lpcd
4.	Spring protection chamber	=	4.25 m x 2.5 m x 1 m
5.	Gravity Main (40 mm PVC, 6 kg/cm^2)	=	484 m
6.	Supply Tank (18 hours storage) (Standard Ferrocement Tank)	=	10,000 Lt (10 Cum)
7.	Distribution Lines (20 mm to 75 mm PVC)	=	1047 m
8.	Outlets	=	House connection

ANNEXURE VIII

Safe Sanitation Technologies

"SUBO" Septic Tank - A modified version of Conventional septic tank.

"SUBO" septic tank is a modified version of the conventional septic tank with all its defects rectified. SUBO is a circular tank with a "separator" and "gas deflector" fitted to it as shown in Fig. . There are three distinct zones in the tank :

1. Active digestion zone.
2. Digested sludge zone, and
3. Outlet zone.

The first two zones and the treatments going on there are similar to those in conventional septic tanks. But a specially designed quiescent outlet zone is a remarkable new feature of the SUBO septic tank. The gas deflector prevents the entry of gas bubbles and particles attached to them into the outlet zone. The expanding cross section of the zone gradually reduces the effluent velocity enabling gravitational settling of finer particles. Also, a "Sludge Blanket" created by the settling particles, almost completely, blocks the upward movement of other particles and their subsequent escape from the tank.

An optional "Biofill Pack" placed above the sludge blanket will further improve the effluent quality. The microbial film developed on the biofills enables the decomposition of finely divided and dissolved organic materials in the effluent.

All these modifications contribute to the better performance of SUBO septic tank whose BOD removal efficiency (80-85) was observed to be 30 per cent higher than that of conventional septic tanks. The exceptional quality of the new tank, however, is the stable nature of its effluent BOD. SUBO septic tank can, therefore, be accepted, as a dependable sewage treatment facility for areas not provided with sewerage systems.

Source : SUBO - The New Eco-friendly Septic Tank, November 1999, Prof.V.A.Sudhakaran, COSTFORD, Thrissur – 680 003.

As the effluent quality of SUBO tank is high, a large soil absorption system is not essential. A simpler arrangement for the easy absorption of the cleaner effluent by the soil will serve the purpose. The effluent may, even, be discharged into open drains, (after disinfection in special cases).

SUBO tank will perform better in flood-prone areas also. The escape of undigested faecal-matters into the outlet zone with the rise of water table could be prevented by extending the vertical portion of the separator to the cover slab as shown in Fig. 3. This will reduce the chance of ground water contamination.

SUBO tank being circular in cross section could be constructed by a 10-12 cm, thick brick wall or 5 cm thick pre-cast concrete rings, thereby reducing its construction cost substantially. It can also be made of ferrocement. PVC, or fibre glass. Bigger tanks should have thicker walls made of brick or RCC. Moulded PVC tanks also could be used for larger systems.

The separator and gas deflector could be made of ferrocement or FRP (Fibre Reinforced Plastic). They should be inserted into grooves made in the side wall or attached to suitable fixtures provided on it. The inclination of the separators should be more than 45 degrees to enable particles deposited on them slip down easily. While smaller tanks need only one separator, it is better to provide two separators for larger units.

"Biofill Pack"

"Biofill Pack"is another speciality of SUBO septic tank which enables the removal of dissolved and finely divided organic materials from the effluent. It may be a pack of plane, corrugated, or meshed plastic sheets kept vertical or at 60 degree inclination and 5 to 10 cm spacing. They should be suitably held in position by fixing them to the wall or to a pre-fabricated frame made to size according to its position in the outlet zone. Patented biofills available in the market may be cut to size and used as the pack.

Alternately, a pre-fabricated tray netted on all sides and loosely packed with small pieces of PVC pipes or other packings may be used as the biofill pack. Yet another arrangement may be a pre-fabricated frame with rods on top and bottom and plastic ribbons wound on them. Fig. 3. shows the details of different types of biofill packs.

In the case of larger systems, a separate Biofill unit outside the tank proper will be more convenient for operation and maintenance. The bottom of this unit should be sloping towards the septic tank to enable the collection of detached slimy substances from the biofills.

Modification Of Conventional Septic Tanks To Subo Style

The better performance of the SUBO septic tank could be attributed to its quiescent outlet zone. So, if such an outlet zone could be created in a conventional septic tank, its efficiency could be increased to the same level as that of the SUBO tank. This could be easily achieved by fixing the seperator on the outlet side of the conventional septic tank as shown in Fig. . The biofill pack also may be placed in position if better effluent quality is required.

The arrangement for taking out the effluent from the septic tank should be modified. A channel in the shape of a half-pipe and placed across the tank as shown in Fig. will collect the effluent and discharge it into the existing soil absorption system.

Depending on the depth of the existing tank, one or two separators may have to be used. This is necessary to keep the slope of the separators above 45 degrees and to maintain the surface loading rate at 1.2 to 1.5 ml/hr for the new outlet zone created.

The Dry Composting Latrine

In water logged and high water table areas pit latrines and septic tanks can, and often do, contaminate well water with human feaces . This is very common in coastal

fishing communities. In such places, where open defecation on the sea shore and defecation areas is normal practice, many families want to have their own latrine, or at least a community latrine. But in a crowded village the wells and latrines would be forced to lie close together. If septic tanks, soak aways and pit latrines are used, the well water will be contaminated. Water contaminated with human faeces puts people at a high risk of cholera, dysentery, diarrhoea, jaundice, polio and a variety of intestinal worms.

In such cases a Dry Composing Latrine can provide a solution. It consists of two chambers covered with a slab having three holes in it with covers – defecation hole, the urine hole and the wash hole and a flower bed. The user squats and defecates in the defecation hole, and urinates in the urine hole. Then turns and washes over the washing place. The feaces will fall onto a bed of straw in the chamber. Instead of flushing, a little cooking ash or lime is simply sprinkled into the hold and the cover is replaced. The urine and wash water join together and flow to the flower bed (diluted urine is a good fertilizer so the plants will grow well).

The chambers are used for six months each and can be opened at the back to remove the non – smelling compost. The urine and wash water come to the flower bed. Because the urine is diluted with wash water it does not smell.

Before returning to use the first chamber it is opened at the back and emptied. The contents are pleasant, earthy, garden soil-like compost with no objectionable smell or appearance, it can be put around coconut trees, bananas or flowers etc.

Source

Programme for community Organisation and
Shrina Shakthi at
PCO Centre

Spencer Junction
MG Road,
Thiruvananthapuram- 695 039

TeL 0471-330408.

Recommended Construction Practice and Pollution Safeguards for

Twin Pit Pour Flush Latrines

1. Pits in Water Logged, Flood Prone and High Sub-soil Water Areas

In high sub-soil, water logged or flood prone areas, the pits should be raised above the ground level to a height such that the invert of the incoming drains/pipes is just above the likely flood water or sub-soil water level. Raising the pipes will necessitate raising the latrine floor also.

In pits located in water logged or flood prone areas, earth should be filled and well compacted all around the pits in 1000 mm width and up to the top. It is not necessary to raise the pits by more than 300 mm above the plinth of the house because if water rises above the plinth, the residents will anyway vacate the house. In high sub-soil water areas, about 300 mm filling all around the pits may be done depending on site conditions.

In these situations, the pits should be designed as wet pits, taking into consideration the infiltration rate of the type of soil.

2. Pits in Rocky Strata

In rocky strata with soil layers in between, leach pits are designed on the same principles as those for low sub-soil water level taking the long term infiltration capacity of the soil as 20 litres per sq.m per day. However, in rocks with fissures, chalk formations, or

old root channels, pollution can flow over a very long distance; hence these conditions demand careful investigation and adoption of pollution safeguards.

Source : Technical Guidelines on Twin Pit Pour Flush Latrines (1992)

Ministry of Urban Development, GoI

Regional Water and Sanitation Group – South Asia.
UNDP/World Bank Water and Sanitation Programme

In impervious rocky strata, since there will be no infiltration of liquid, the pits will function as holding tanks. In such situations, a PF latrine with leaching pits is not a suitable system.

3. Pits in Soils with Low Infiltration Capacity

Leaching capacity tends to be the limiting factor when the infiltrative capacity of soil is low. In these circumstances, there are two options : construct a larger pit, or increase the critical leaching area. The former option is costly, while the latter can be accomplished by backfilling and compacting with brick ballast, gravel, sand etc., in the required width all around the pit, since the leaching area is the vertical surface of the excavation of the pit rather than the external wall of the pit.

Pits in Black Cotton Soil are designed on the basis of whether the pit is wet or dry, taking the infiltration rate as 10 litres per sq. metre per day. However, a minimum 300 mm* vertical fill (envelope all around the pit) of sand, gravel or ballast of small sizes should be provided all round the pit, outside the pit lining, to separate the soil and the pit lining as well as to increase the infiltrative surface area.

4. Pits Where Space is a Constraint

Where circular pits of standard sizes cannot be constructed due to space constraint, deeper pits with smaller diameter (not less then 750 mm), or combined oval, square or

rectangular pits divided into two equal compartments by a partition wall, may be provided. In case of combined pits, the partition wall, as well as the adjoining side walls up to 225 mm width, should not have any holes. The partition wall should be 225 mm deeper than the pit lining. Both faces of the partition wall should be plastered in cement mortar 1:6.

5. Pollution Safeguards

Proper information and investigation of both geological/ hydrogeological conditions of sites where pits are to be located, and the location of drinking water sources, size, all are pre-requisites in planning, designing and construction of on-site low cost sanitation systems to ensure that pollution risk to ground water and water distribution mains is minimal. Faulty construction and wrong data/ information regarding hydrogeological conditions may lead to pollution of drinking water sources.

To ensure that the risk of polluting ground water and drinking water sources is minimal, the following safeguards should be taken while locating the pits :

a. Drinking water should be obtained from another source or from the same aquifer but at a point beyond the reach of any faecal pollution from the leach pits.

b. If the soil is fine (effective size 0.2 mm or less), the pits can be located at a minimum distance of 3 m from the drinking water sources, provided the maximum ground water level throughout the year is 2 m or more below the pit bottom (low water table). If the water table is higher, i.e. less than 2 m below the pit bottom, the safe distance should be increased to 10 m.

c. If the soil is coarse (effective size more than 0.2 mm), the same safe distances as specified above can be maintained by providing a 500 mm thick sand envelope, of fine sand of 0.2 mm effective size, all around the pit, and sealing the bottom of the pit with an impervious material such as puddle clay, a plastic sheet, lean cement concrete, or cement stabilised soil.

d. If the pits are located under a footpath or a road, or if a water supply main is within a distance of 3 m from the pits, the invert level of the pipes or drains connecting the leach pits should be kept below the level of the water main, or 1 m below the ground level. If this is not possible due to site considerations, the joints of the water main should be encased in concrete.

ANNEXURE IX

VERMI COMPOSTING

(SOLID WASTE DISPOSAL SYSTEMS IN NORTH PARUR MUNICIPAIITY)

Solid waste collected from different parts of the municipality is taken to the 2.5 acres of dumping yard in the outskirts. The method used to decompose the biodegradable waste is Wormicompost. For this purpose , 15 beds with 7.5 m length, 1.2 m breadth and 15 cm depth are dug. Coconut fiber and pith mixture is put into these pits and earth worms are set free into it The collected garbage is then sorted for bio- degradable wastes which is further shredded. This will be dumped into the beds, soaked with cow dung upto a height of 4 ft from the ground and covered with wet gunny bags. Certain solid wastes not suitable for vermicompost are sorted and dumped into another 7 compost pits (1O m length, 3 m width and one m depth) for decomposing. These are watered twice a day. Within 50 to 60 days, Vermicompost is ready When the decomposition is complete the worms will move down to the ground This compost is an odorless material, easy to handle and is sold out to the public There is heavy demand for this product now.

Non-biodegradable materials such as glass pieces, plastic wastes, iron pieces etc are sorted and handled separately in this process. Women groups are engaged to do the sorting and other related activities For this they are paid Rs 60 each per day.

ANNEXURE X

A BILL
TO REGULATE AND CONTROL THE EXTRACTION, USE OR TRANSPORT OF GROUNDWATER AND TO CONSERVE GROUNDWATER IN THE STATE OF KERALA

Preamble

WHEREAS it is expedient to regulate and control the extraction use or transport of groundwater and conserve groundwater in the State of Kerala.

AND WHEREAS it is observed that the trend of development of groundwater in some parts of the State is going on ignoring the actual groundwater re-charge of the those areas;

AND WHEREAS it has been realised that erratic development of groundwater in time and space that takes place in some areas could create undesired effects to the environment of those areas;

AND WHEREAS it has been realised by the Government of Kerala that groundwater is a critical resource of the state;

AND WHEREAS the Govt. of Kerala have; after careful examination of all aspects related to groundwater development, decided that it is necessary in the public interest to regulate and control the groundwater development in any form in the State of Kerala;

BE it enacted in the forty-eighth year of the Republic of India as follows-

1. **Short title, extent and commencement**:-

   (1). This Act may be called the Kerala Groundwater (Control and Regulation) Act 1997.
   (2). It extents to the whole State of Kerala in a manner as specified.
   (3) The act will operate fully in the area so notified by the Government. In the remaining part of the State, assigned as non-notified area, only those sections/sub sections of the Act will operate wherein it has been so specified.
   (4). It shall come into force on such date as the Government, by notification in the official Gazette, appoint for different areas of the State.

2. **Definitions**:- In this Act, unless the context otherwise requires:
   (a). "Act" means the Groundwater control and Regulation Act 1987;

(b). "Authority" means Groundwater Authority, established in accordance with section 3 Sub-section (1) of this Act;
(c). "Government" means the Government of Kerala;
(d). "Groundwater" means the water which exists below the surface of ground in an Earth formation or in a group of Earth formations at any particular location;
(e). "Notified area" means the area notified under section 4 subsection (2)of the Act;
(f). "prescribed" means prescribed by Rules made under this Act;
(g). "Pumping well" means a well fitted with a pump driven by an electric motor or oil engine of more than 1 HP or its equivalent capacity to draw water from the well.
(h). "Sink" with all its grammatical variation and cognate expressions includes, digging, drilling, boring, driving in or tunneling of new wells or deepening carried out to the existing wells.
(i). "User of groundwater" means the person or persons of an institution including a company or an establishment, whether Government or not who or which own or use groundwater from a well for any purpose including domestic use made either on a personnel or community basis.

Provided that it will exclude the person or persons who use groundwater drawn from a well using a pump driven by an electric motor or oil engine having capacity of 1 HP or less or its equivalent capacity or using manual devices like a hand pump, rope and bucket and similar devices,
j). "Well" means any structure constructed on the Earth's surface to tap groundwater by a person or persons except by the authorised officials of the State or Central Government for carrying out investigations, development and use or management of groundwater resources and includes open well, dug well, bore well, dug cum bore well, tube well, collector well and infiltration gallery;

Provided that it will exclude open wells and dug wells used for household purposes (domestic) by the owner/occupants of the premises within which it is situated.

3. Competent Authority

(1). The government shall by notification in the official gazette, establish with effect from such date as may be specified in the notification, an Authority to be known as Groundwater Authority.

(2). The structure and strength of the Authority and matters related to the terms of appointment and service conditions of its members shall be in such a manner as may be presented.

(3). In order to enable the Authority to properly function or exercise the power under the Act Government may appoint such number of technical personnel and other staff as it may consider necessary.

(4). The function and the terms and conditions of service of such employees shall be such as may be prescribed.

4. Powers to notify areas for control and regulation of groundwater development

(1). Ground water Authority shall function under the overall control and supervision of the government.

(2). If the Government on a report received from the Authority is of opinion that it is necessary or expedient in the public interest to regulate the extraction or use or both of ground water in any form in any area other than the notified areas the Government may by notification in the official Gazette, declare any such area to be notified area for the purpose of this Act with effect from such date as may be specified therein;

Provided that the date so specified in the notification shall not be earlier than three months from the date of publication of the said notification.

(3).Every such notification shall in addition to their publication in official Gazette, be published in not less than one daily news paper having circulation in the State and by affixing a copy of the same to some conspicuous part of the offices of the Grama Panchayat of the said area.

(4).If in the opinion of the Authority, the availability of the groundwater has improved in a notified area, it may advise the Government to denotify such area and the Government may do so according to the procedure, prescribed in sub section (2) of section 4 for notifying the area.

5. Grant of permit to Extract and use ground water in the notified area

(1). Any user of groundwater (as defined under section 2 subsection (j) desiring to sink a well in the notified area for any purpose either on personal or community basis, or to convert an existing well to that of a pumping well, shall apply to the Authority for grant of a permit for this purpose, and shall not proceed with any activity connected with such sinking or conversion unless a Permit has been granted by the Authority.

(2). Receipt of every application by the Authority shall be acknowledged in the manner may be prescribed.

(3). Every application under sub section (1) of section 5 shall be made in such form, shall contain such particulars and in such manner as may be prescribed.

(4). On receipt of an application under sub-section (1) above if the Authority is satisfied that it shall not be against public interest to do so, it may be grant, subject to such conditions and restrictions as may be specified or refuse to grant a Permit authorising the extraction and use of groundwater.

Provided that no person shall be refused a permit unless he has been given an opportunity of being heard.

(5). The decision regarding the grant or refusal of the permit shall be intimated by the Authority to the applicant within a period of 60 days from the receipt of the application.

(6). Where the Authority to whom the application is made under sub-section (1) fails to inform the applicant of its decision on the application within a period of ninety days from the date of receipt of such application, the permit shall be deemed to have been granted to the applicant and such person shall, for this purpose of this Act deemed to be a holder of a permit.

Provided that the applicant is in receipt of any communication from the competent Authority admitting the receipt of application by it in the prescribed time.

(7). In granting or refusing the permit under subsection (4) the Authority shall consider the following matters:-

a). the purpose or purposes for which water is to be used.

b). the existence of other users in the area.

c). the availability of groundwater.

d). quality of groundwater with reference to its users.

e). distance with adjoining wells and number of wells in the area and possible interference of the well with existing wells.

(f). long-term behavior of groundwater level in the area.

(g). any other factor relevant thereto.

6. Registration of existing wells in the Notified area

(1). Every owner of existing wells in the notified area in the State shall within a period of one hundred and twenty days from the date of establishment of the Authority will apply to the Authority for the grant of a Certificate or Registration recognising the existing use in such form and in such manner as may be prescribed.

Provided that the Authority may entertain any such application after the expiry of the aid period of One Hundred and Twenty days if it is satisfied that the applicant was prevented by sufficient causes from filling of application in time:

(2). The details to be furnished in an application under sub-section (1) shall include such particulars and in such manner as may be prescribed.

(3). On receipt of an application under sub section (1) if the Authority is satisfied, that it shall not be against the public interest to do so, it may grant subject to such conditions and restrictions as may be specified or refuse to grant a Certificate of Registration.

Provided that no applicant shall be refused a Certificate of Registration unless the applicant has been given an opportunity of being heard.

(4). The decision regarding the grant or refusal of the Certificate of Registration shall be intimated by the Authority to the applicant within a period of 90 days from the receipt of the application.

(5). In granting or refusing of the Certificate of Registration under sub-section (3) the Authority shall have regard to:

(a). the purpose or purposes for which water is to be used;

(b). the existence of other eligible users;

(c). the rate of re-change to the area of influences of the well;

(d). the quality of groundwater in the area;

(e). the long-term behavior of water level of wells.

(f). any other factor relevant thereto.

(6). The Certificate of Registration shall be in such form as may be prescribed.

(7). Pending communication by the Authority of the decision on the grant or refusal of the Registration under Sub-section (1) every existing well owner in the notified area shall be entitled to the continued use of groundwater in the same manner prior to the date of application.

(8). If a Registered well becomes defunct the fact should immediately be brought to the notice of the Authority in writing by the owner.

7. Registration of user of groundwater in non-notified areas.

(1). All users of groundwater as defined under section (2) sub section (j) in the State within a period of 120 days from the date of establish of the Authority shall apply to the Authority for the grant of a certificate of Registration for recognising the user as a Registered user of groundwater in the State.

(2). On receipt of an application for registration under sub-section (1) if the Authority is satisfied that it shall not be against the public interest to do so, it may grant, subject to such conditions and restrictions as may be prescribed or refuse to grant a Certificate of Registration.

Provided that no applicant shall be refused a Certificate of Registration unless he has been given an opportunity of being heard

(3).The sub clause (8) of clause (6) shall also be applicable.

(8). Prior to Alter, Amend or Vary the terms or the permit of Certificate of Registration.

At any time after a permit or Certificate of Registration, as the case may be, provided the owner has been given an opportunity of being heard;

Provided that before taking such action, the Authority shall ensure that the standing crop(s) are not damaged by the decision.

9. Cancellation of Permit of Certificate of Registration

If the Authority is satisfied either on a reference made to it in this behalf or on the basis of its own studies that;

(a). the permit or Certificate of Registration under the Act is not based on facts.

(b). the holder of the permit or Certificate of Registration has without reasonable cause failed to comply with the conditions subject to which the permit or Certificate of Registration has been granted or has contravened any of the provisions.of this Act or the rules made thereunder, or

(c) a situation has arisen which warrants limiting of the use or extraction of groundwater in the area around the well,

then without prejudice to any other penalty to which the holder of the permit or of the Certificate of Registration as the case may be.

10. Powers of the Ground Water Authority

(1). The Authority or any person authorised by it in this behalf shall have power-

(a). to enter on any property (private or Government owned) with the right to investigate and make any measurements concerning the land or the water located on the surface or the underground.

(b). to inspect the well which has been or is being sunk and the soils and other materials excavated therefrom;

(c) to take specimens of such soils or other materials or of water extracted from such wells.

(d) to require by order in writing, the persons sinking a well to keep and preserve in the prescribed manner specimens of soils or any materials excavated therefrom for such period not

exceeding three months from the date of completion or abandonment of the work as may be specified by the Authority and thereupon such person shall comply with such requisition.

(e) to inspect and take copies of the relevant record or documents and ask any question necessary for obtaining any information (including diameter or depth of the well which is being or has been sunk; the level at which the water is or was struck and subsequently restored/rested, the types of strata encountered in the sinking of the well and the quality of the water struck) required for carrying out the purposes of this Act;

(f) to require the user of groundwater to install water measuring device on any water supplies when necessary to properly administer the water or where there is reason to believe that the user does not comply with the provisions contained in this Act or any other sufficient reason for defending the public interest.

> Provided that where the user of ground water does not comply with the requisition issued to him within a period of thirty days, the Authority itself may install such water measuring device and recover the cost from the defaulting user of groundwater;

(g) to seize any equipment/device for illegal sinking and destroy the work executed fully or partly;

(h) to require any user of groundwater, who does not comply with the provisions of this Act and rules framed thereunder, to close down any water supply or destroy any hydraulic

work found to be illegal according to the provisions of this Act and the rules framed thereunder:

> Provided that where the user of groundwater does not comply with the requisition issued to him within a period of sixty days, the Authority itself may carry out the necessary work and recover the cost from the illegal user of ground water.

(i) to enter and search with such assistance, if any as it considers necessary, any place in which it has reason to believe that offence under this Act has been or is being committed and order in writing the person who has been or is committing the offence not to use the groundwater for a specified period not exceeding thirty days.

(j). to exercise such other powers as the case may be necessary for carrying out the purposes of this Act or any rules made thereunder;

(2). The power conferred by this section includes the power to break open the door of any premise where sinking, extraction and use of groundwater is going on;

Provided that (i) the power to break open the door shall be exercised only after the owner or any other person in occupation of the premises, if he is present therein, refuse to open the door on being called to do so;

(ii) No such entry shall be made after sunset and before sunrise.

(iii)Due regard shall, so far as feasible, be paid to social and religion customs and usage's of the occupant of the premises entered into.

(3). The provisions of the code of Criminal Procedure 1973 (2 of 1974), shall so far as may be, apply to any search or seizure made under this Act.

(4) Where the Authority seizes any mechanical equipment/device under clause (g) of sub section (1), it shall as soon as may be within ten days, inform a Magistrate and take his orders as to the custody thereof.

11.Service or orders, etc.

(1) Every order under clause (d) or (f) of sub-section (1) of section 10 shall be served

(a) by giving or tendering the order of notice or by sending it by post to the user for whom it is intended, or
(b) if such user cannot be found, by affixing the order of on some conspicuous part of his last known abode or place of business or by giving or tendering the order of notice to some adult male member or servant or his family or by causing it to be affixed on some conspicuous part of the land or building in which the well is being sunk.

(2). Where the person on whom the order of a notice is to be served is a minor, service upon his guardian in the manner provided in sub-section (1) shall be deemed to be served upon the minor.

12. Delegation of powers and duties

The Authority may, by general or special order in writing, direct that all or any of the powers or duties which may be exercised or discharged by it shall, in such circumstances and under such conditions, if any, as may be specified in its order be exercised or discharged also by any employee of the Authority specified in this behalf in the order.

13. Members and Employees of the Ground Water Authority to be public servants

All members and employees of the Authority shall when acting or purporting to act in pursuance of the provisions of this Act or of any rules made thereunder be deemed to be public servants within the meaning of section 21 of the Penal Code.

14. Protection Against Action Taken in Good faith

No prosecution, suit or other legal proceeding shall be instituted against the Government, the Authority or any other officer of the Government or any member or other

employees of the Authority for anything done or intended to be done in good faith under this Act, or the rules made thereunder.

15. Cognizance and Trial of Offences

(1). No prosecution for an offence under this Act shall be instituted except or by or with the written consent of the Authority or a person authorised in this behalf by the Authority.

(2). No court interior to that of a Magistrate of the first class shall try any offence under this Act.

16. Offences and Penalties

A. For Non receipt of Information.

If any user/owner of well contravenes or fails to comply with any of the provisions of this Act or any rule made thereunder in supplying information as prescribed, the person or group of persons shall be punishable-

(i) for the first offence with fine which may extend to Rs. One Hundred and
(ii) For the second and subsequent offences, with fine which may extend to Rs. Two hundred.

B. For Illegal Sinking/Construction and/or Use of Wells.

If any user of groundwater or well owner
(a). contravenes or fails to comply with any of the provisions of this Act or any rules made thereunder, or
(b). obstructs the Authority or any other persons authorised by it to exercise any of the powers under this Act.
The persons or group of persons shall be punishable-
(1) For the first offence with fine which may extend to Rs. One Thousand and
(2) For the second and subsequent offence, with imprisonment for a term which may extend to six months, or with fine which may extend to Rs.Five Thousand.

17. Compounding of Offences

Any offence under this Act the punishment of which does not exceed a fine of Rs. One thousand may be compounded by the Authority in a manner as may be prescribed.

18. Offences by Companies

(1) Whenever an offence under this Act has been committed by a company, every persons who at the time of offence is committed was in charge of or was responsible to the company for the conduct of the business of the company, shall be deemed to be guilty of the offence and shall be liable to be proceeded against and punished accordingly:

(2) Not withstanding anything contained in subsection (1), where an offence under this Act has been committed with the consent or connivance of, or is attributable to any neglect on the part of any director, manager, secretary or other officer shall also be deemed to be guilty of that offence and shall be liable to be proceeded against and punished accordingly.

Provided that nothing contained in this sub-section shall render any such persons liable to any punishment under this Act if he proves that offence was committed without his knowledge or that he exercised all due to diligence to prevent the commission of such offence.

EXPLANATION:- For the purpose of this section-

(a) "Company" means any body corporate and includes a firm or other association or individuals, and
(b) "Director", in relation to a firm, means a partner in the firm.

19. Appeals

(1). Any person aggrieved by a decision or action of the Authority under this Act may, within a period thirty days from the date on which the action is taken or the-

Decision is communicated to him and on payment of such fees as may be prescribed, prefer such an appeal to such authority as may be specified by the Government.

Provided that appellate authority may entertain an appeal after the expiry of the set period of thirty days, if it is satisfied that the applicant was prevented by sufficient cause from filing the appeal in time.

(2). On receipt of an appeal under sub-section (1), the appellate authority shall, after giving the appellant an opportunity of being heard, dispose of the appeal as expeditiously as possible.

20. Power to Make Rules

(1). The State Government may, by notification in the official Gazette, make rules to carryout the purpose of this Act.

(2). In particular and without prejudice to the generality of the foregoing power, such rules may provide for:-

(a). the term of office and manner of filling vacancies and other conditions of service among the Members and Chairman of the Authority.

(b). the functions and the terms and conditions of the service of the employees of the Authority;

(c). any other manner of affecting service of the notification under sub-section (3) of section 4;

(d).the form of application and Permit Certificate of Registration under various section (3) of section 4;

(e). the manner in which the specimens of soils or other materials shall be kept and preserved under clause (d) of subsection (1)m of section 10;

(f). specifying the appellate authority under sub-section (1)of section 20 and the fees to accompany the applicant for appeal;

(g). any other matter which is to be or may be prescribed.

(3). Every rule may under this section shall be laid, as soon as may be after it is made before the Legislative Assembly while it is in session for a total period of fifteen days which may be comprised in one session or in two successive sessions, and if before the expiry of the session in which it is so laid or the session immediately following, Assembly agrees in making in any modification in the rules or Assembly agrees that the rule should not be made, the rule thereafter shall have effect only in such modified form or be of no effect, as the case may be. However that any such modification on annulment shall be without prejudice to the validity of anything done earlier under that rule.