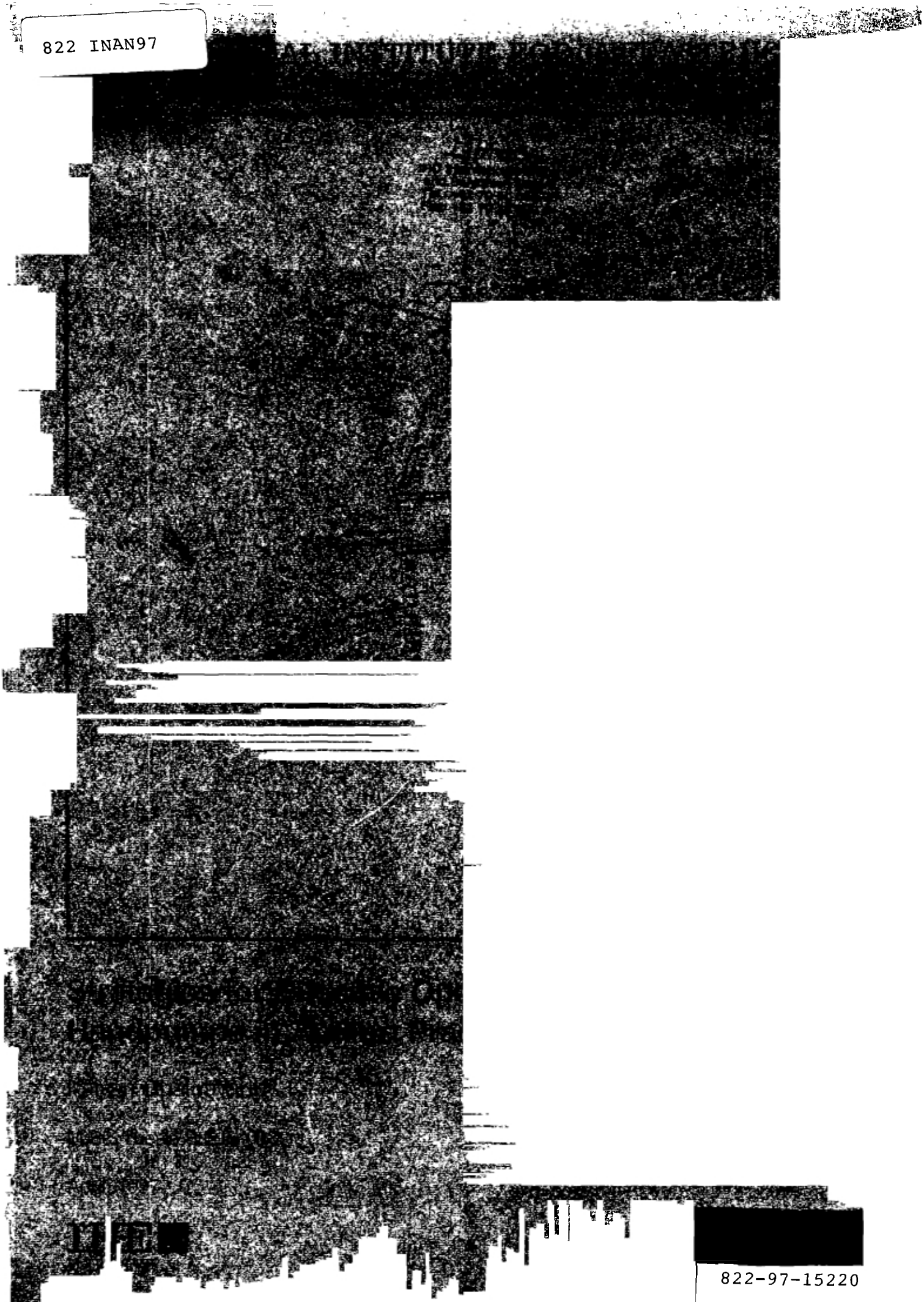

STRATEGIES FOR EFFECTIVE OPERATION AND MAINTENANCE OF HANDPUMPS IN ANDHRA PRADESH INDIA

Master of Science Thesis

By

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The findings, interpretations and conclusions expressed in this study do neither necessarily reflect the views of the International Institute for Infrastructural, Hydraulic and Environmental Engineering, nor of the individual members of the MSc-committee nor of their respective employers


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Boundary State/Union territory
Major city
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AFGHANISTAN
JAMMU AND KASHMIR
HIMACHAL PRADESH
PUNJAB
PAKISTAN
CHINA
CHANDIGARH
HARYANA
DELHI
TIBET
NEPAL
ARUNACHAL PRADES
SIKKIM
BHUTAN
RAJASTHAN
UTTAR PRADESH
ASSAM
MEGHALAYA
BIHAR
BANGLA DESH
WEST BENGAL
Calcutta
TRIPURA
GUJARAT
MADHYA PRADESH
DIU
DAMAN
D & N.H
MAHARASHTRA
Bombay
ORISSA
Hyderabad
ANDHRA PRADESH
GOA
KARNATAKA
Bangalore
Madras
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KERALA
LAKSHADWEEP
INDIA
ANDAMAN & NICOBAR ISLANDS
SRI LANKA
MALDIVE
1000 kilometres
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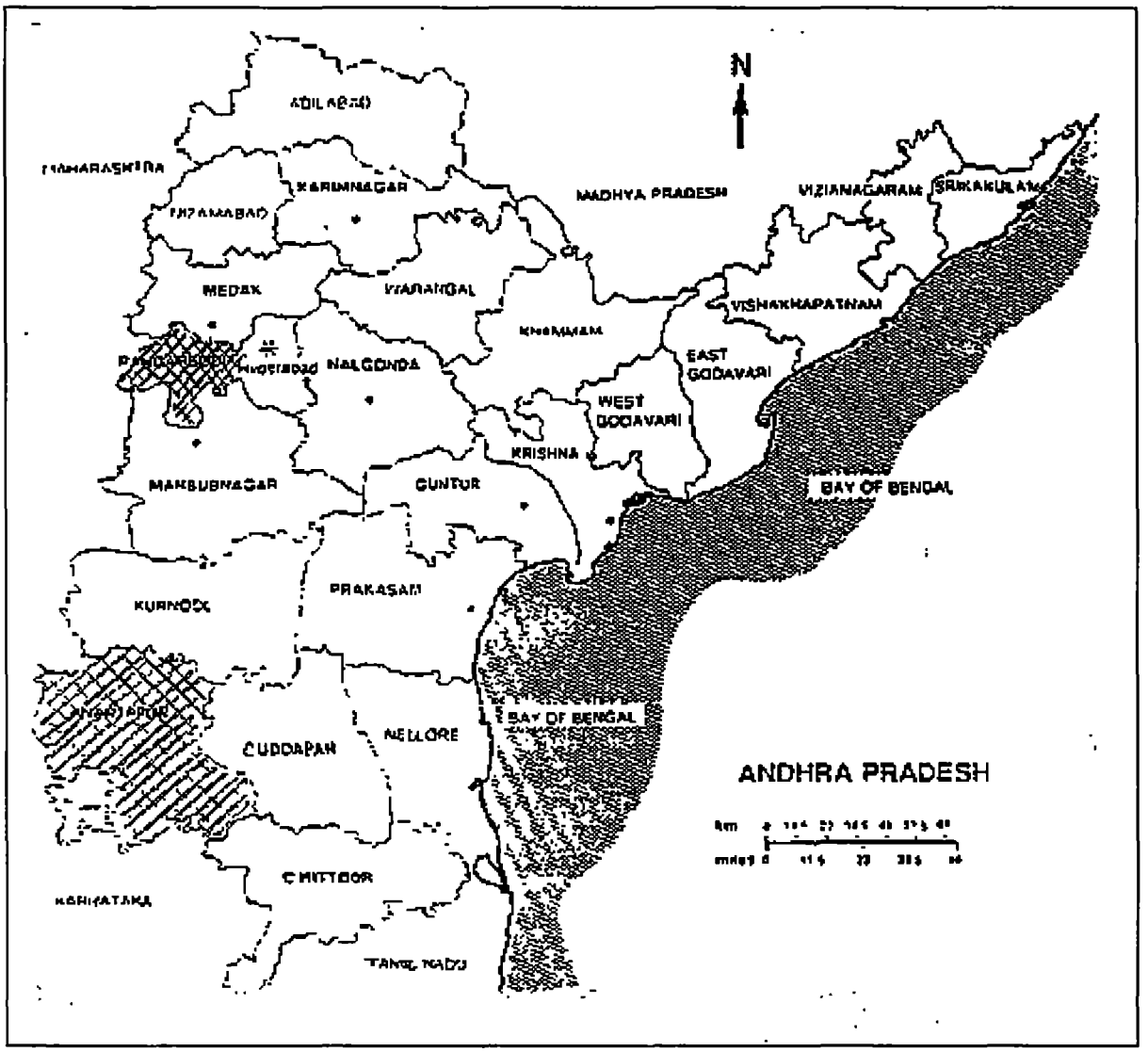
Map of India



Map of Andhra Pradesh showing the study areas

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Abstract

Handpumps are considered to be the most economical means for utilizing ground water for millions of people in rural areas of developing countries. In India, more than 300 million people depend on handpumps for their drinking water and this is taken to be as an appropriate method for providing drinking water to isolated communities and villages in rural India.In Andhra Pradesh (A.P) also a substantial part of rural population is covered with safe, potable drinking water through borewells fitted with handpumps which are being maintained under Panchayat Raj Engineering Department (PRED). It has the largest number of handpumps in India to the tune of 225000. In spite of the best efforts on the part of PRED, the handpump breakdown rate is still on higher side due to the absence of preventive maintenance, lack of proper monitoring and supervision. Due to enormous increase in the number of handpumps PRED is also facing difficulties with the shortage of staff and limited financial resources. The need for a viable maintenance system is very much essential. Hence at present the Govt. of AP is also in the view to handover the maintenance to the communities, i.e Gram Panchayats (GP), the only institutions available at the local level. At present in A.P, under PRED one-tier and two-tier systems are being implemented for maintenance of handpumps.

The objective of the study was to review the performance of the handpump maintenance system under PRED, and to suggest possible solutions to improve the performance. The methodology consists of literature work and two and half months field work in Andhra Pradesh. The literature work was carried at IRC, Hague and in IHE, Delft. Specific literature on handpump maintenance at AP were collected from the offices of PRED. Two districts where there is more use of handpumps and two-tier, one-tier maintenance systems are existing are selected for the present study. The study was carried out in totally in 8 Panchayats by choosing 4 Panchayats in the each district. 40 handpumps (30 India Mark II, 10 India Mark III) in these 8 Panchayats were studied. Opinion from 200 households living near the selected 40 handpump locations were obtained. A water resource mapping showing the existing water sources was prepared with the help of community members. Also the personnel involved in the O & M of handpumps were interviewed to know the present O & M procedures.

The study reveal that there is not much difference in the performance of one-tier and two-tier maintenance systems. Preventive maintenance and pump environment in both the systems is found to be poor. India Mark III handpumps are found to be efficient than India Mark II in all respects. There is a shortage of O & M of staff in the present system and there is no effective communication system for reporting failures of handpumps. No objective standards were set for Supervision and Monitoring processes. Also There is no feed back to the pump mechanics and caretakers. It is observed that users involvement is also less.

To improve the present system, the study recommends recruitment of adequate staff for O & M Setting out guidelines for supervision and monitoring processes and there should be feed back to improve the performance. Incentives should be given to the caretakers to improve the performance. India Mark III handpumps should be preferred for new installations. For future arrangements to handover the maintenance to the GPs, the study recommends the generation of community awareness, provision of adequate tools & spare parts and training required for maintenance at GP level, proper institutional set-up support system for community based development.Back-up support from PRED should be continued until the GP set-up is self-reliant.

Contents

List of Abbreviations

AD	-	Anno Domini.
AEE	-	Assistant Executive Engineer
AP	-	Andhra Pradesh
ARP	-	Accelerated Rural Programme.
ARWSP	-	Accelerated Rural Water Supply Programme.
BC	-	Before Christ.
BIS	-	Bureau of Indian Standards.
CGWB	-	Central Ground Water Board.
CPWS	-	Comprehensive Protected Water Supply Schemes
CWC	-	Central Water Commission.
CWRDM	-	Centre for Water Resources and Development
DTH	-	Down The Hole.
Dy.EE	-	Deputy Executive Engineer
GDP	-	Gross Domestic Product
GOI	-	Government of India.
GP	-	Gram Panchayats
Govt.	-	Government
IAS	-	Indian Administrative Services.
IRC	-	International Reference Centre
IS	-	Indian Standards
IDWSSD	-	International drinking Water Supply and Sanitation Decade.
MNP	-	Minimum Needs Programme.
NGO	-	Non Government Organisation.
O & M	-	Operation and Maintenance
P.C	-	Planning Commission
PHED	-	Public Health Engineering Department
PRED	-	Panchayat Raj Engineering Department
PWS	-	Protected Water supply Scheme
RD	-	Rural Development
RGNDWM	-	Rajiv Gandhi National Drinking Water Mission.
RR	-	Ranga Reddy
Rs	-	Indian Rupees
SC	-	Schedule Caste
ST	-	Schedule Tribe.
SEU	-	Socio Economic Unit
UNDP	-	United Nations Development Programme.
UNICEF	-	United Nations Children's Fund.
US	-	United States.
VLOM	-	Village Level Operation and Maintenance.
WHO	-	World Health Organisations.

Chapter 1
INTRODUCTION

Safe drinking water is a vital human need. Drinking water supplies in developing countries are receiving increased attention. Poor water supply and sanitation services continue to be critical problem in rural areas of developing countries despite considerable efforts to improve and expand access. Hand pumps are considered to be the most economical means for utilizing ground water for millions of people in rural areas in developing countries. Several hundred million people already depend on hand pumps for their drinking water. However, experience shows that many existing hand pump supplies are deficient or have been abandoned altogether because of inadequacies in design, manufacture, installation, and operation & maintenance.(IRC, 1983)

One prime conclusion of hand pump studies in recent years is that a predominant cause of breakdown and poor functioning has been inadequate provision for maintenance. Other contributing factors include poor well design and construction which allows sand to enter pumping elements causing premature ware of key components, choice of inappropriate pump technology, design of wrong service level, siting pumps in the wrong place or at the wrong depth and more fundamentally lack of community involvement in project selection and implementation.(IRC, 1988)

For effective operation and maintenance of water supply systems, motivation, good management, money and man power must be present. In other words operation and maintenance management should be sound in both technical and institutional aspects. The failure of a pump may render a well useless. Design criteria for hand pumps (depth, yield and dia of well, no. of users etc..and it's use) are needed particularly for developing countries, in meeting prevailing operational conditions as well as sanitary requirements.

Pumps which are more durable, trouble free, sanitary and inexpensive are needed. On the other hand pumps should require maintenance within the limitations of local capabilities, and should be easily operated and acceptable to users including women and children. For extra deep wells (when the static water level > 45 mts) less number of pumps are suitable which are more expensive and with less possibilities for village level operation and maintenance. Pumps should be suitable for local manufacture using local materials, equipment, and manpower. Ground water quality is also an important factor in the selection of hand pumps, aggressive ground water results the corrosion of below ground components like rising mains, pump rods, cylinder assemblies . Hence corrosion resistant materials like stainless steel which is more expensive than non-corrosion resistant material like galvanized iron should be used .(IRC, 1988)

Involvement of user community in maintenance is essential for successful drinking water supply projects. For this reason VLOM (village level operation and maintenance)has been coined. VLOM being an approach in which the user community is responsible for the management of the maintenance of it's hand pumps is widely recognized to be the only affordable maintenance strategy. The VLOM concept brings about guidelines, not only about hardware but also software (such as community education and organisational aspects about the implementation of hand pump projects). The design and selection criteria of the hardware are the main guidelines in the

concept. Traditionally women are involved in water collection and have a role in maintenance and management of community water supplies. Their potential in the hand pump maintenance, often is being under estimated. Their involvement may increase the economic efficiency of a project. (Albert Buiten huis, 1993; IRC, AJW2, 1992; AJW5, 1995)

Main subjects for monitoring in O&M by communities are management of water fund, preventive maintenance, participation of men/women in management of pump hygiene, conflict management and keeping of pump log books and users satisfaction. (IRC, AJW3, 1993; T. Bastemeyer, J.T. Visscher,)

Planned maintenance is essential to anticipate and to avoid interruptions of services. Breakdown maintenance restores the service in malfunctioning systems only after a system is collapsed, which makes long interruptions in the services. (Gavriel Salvendy, 1992).

1.1 Water supply scenario in India

1.1.1 General

India has a geographical area of about 3.3 million sq.km. It measures about 3200 km from North to South and about 3000 km from West to East. According to 1991 census, some 43% of its total area is agricultural land while 20% is forested. The country has varied climatic zones with considerable regional differences, including well irrigated areas in the North West, deserts in the West, the Himalayas in the North, the hill tracks in the East, the Gangetic plain, the semi-arid Deccan region and tropical coastal areas in the South. The country's economic and social conditions, languages and cultural and religious traditions also show some wide variations. While most Indians subscribe to the Hindu religion (83% approx), there are Muslims (11%), Christians (3%), Sikh (2%) and Buddhist (1%) minorities, in addition to other significant groupings such as Parsis and Jains.

In 1991, India's population numbered at 843.9 millions, the second largest in the world after China. The average annual population growth rate during the last decade was 2.1%. 75% of the population live in the rural areas, but much of the increase has been concentrated in urban areas. In many cities, the population increases by 3-5% per year, due to natural population growth and due to migration from rural to urban areas. India's urban population thus increased from 19% to 27% of the total population between 1965 to 1990.Urbanisation is reflected in the existence of more than 20 cities with over 1 million residents. Most prominent among these are : Bombay (12.6 million), Calcutta (10.9 million), Delhi (8.4 million), Madras (5.4 million), Hyderabad (4.3 million) and Bangalore (4.1 million) past.

The country consists of 25 states and 7 union territories. The state of Uttar Pradesh is by far the most populous state, with 138 million people. Madhya Pradesh is the largest state having an area of 443,400 sq.km.

According to world bank indicators, India should be considered a low income economy with GDP per capita of US$ 350 in 1990. The world bank estimated that at the end of the 1980s, about 40% of the population (about 340 million people) lived below the poverty line, defined during the 7th five year plan period 1985-1990 as a household income of Rs 6400/ yr or about US $ 460. This GDP per capita together with a life expectancy of 59 years , an average of 2-4 years of schooling and an adult literacy rate of 48%, classifies India as a ' low human development country', according to UNDP indicators.

Although India is a poor country, it is a major industrial power, ranking among the top 20 in the world (in 1990, manufacturing output was more than US$ 48000 million) . The shares of the three major economic sectors in GDP are roughly : agriculture 30%, industries 30% and services 40%. It is able to produce a vast range of industrial products, such as consumer goods, intermediate goods and capital goods and is largely self sufficient in those products(although at considerable cost).

India has large electronics and petrochemicals industries, whose products boost exports. Yet, in spite of such economic achievements, which brought prosperity to the roughly 150 million members of India's middle class, it has become painfully obvious that for many millions more poverty tends to increase. Due to population pressure and inequitable distribution of assets , the gap between the have's and have not's continues to grow.

1.1.2 Organisation of Govt and Planning

Govt structure:

India has a federal system of Govt., with two houses of parliament : the Lok Sabha (545 seats), elected directly and the Rajya Sabha (245 seats), indirectly elected by the state assemblies. The president is chosen by the electoral college of both houses of parliament and the state legislators. The constitution of India is having two tiers of govt, one at the centre and the other at the state level.

The constitution divides all the powers and control over public activities into three lists: the union, state and concurrent list. The first contains some 97 subjects of predominantly national importance. (foreign affairs, defence etc), the second enumerates 66 subjects (police, public health, education, agriculture, irrigation, rural water supply etc), where the state has full authority to legislate on application within the state; and the third evolves 47 items (eg marriage, divorce) over which the centre and state have concurrent jurisdiction (though central law will prevail incase of conflict)

1.1.3 Sector organisation

India is a country of 846.3 million population (as per 1991 census) living in around 3500 towns and about 600,000 villages. The federal constitution of India provides for water supply and sanitation as a state subject and therefore the states are vested with the constitutional right on the planning, implementation and cost recovery of water supply and sanitation projects. The central government formulates policy guidelines and provides technical assistance wherever needed. The central government provides considerable direct grant assistance for the water supply and sanitation in rural areas.

Public Health Engineering Department (PHED) is the principal agency at the state level for planning and implementation of water supply and sanitation programmes. In some states, Rural water supply and sanitation programmes are implemented by the Panchayat Raj Engineering Department (PRED) where as the Urban rural water supply and sanitation are looked after by the PHED only. In a number of states, statutory Water Supply and Sanitation Boards have taken over the functions of the PHEDs. The basic objectives for creation of WSSBs have been to bring in the concept of commercialization in the water supply and sanitation management and more accountability.

1.1.4 Water supply and Sanitation Coverage

At the beginning of the International Water Supply and Sanitation Decade 1981-1990 (IDWSSD) 72.31 percent and 30.8 percent of the population were covered with safe water supply, respectively in urban and rural areas. Sanitation coverage was only 25.14 percent and 0.5 percent in urban and rural areas respectively.

During the Decade, concerted efforts have resulted in large scale expansion in service coverage in the water sector in many developing countries including India. At the end of the Decade, 90% of rural population of India living in more than 574000 villages out of a total of 586174 villages were provided with safe water supply. In Andhra pradesh, about more than 21960 villages were provided with safe water supply system.(RGNDWM, 1993)

1.1.5 Mission Introduction

In the year 1977 the United Nations Water Conference separated the issue of drinking water and sanitation from other water issues to stress the seriousness and magnitude of the problem of drinking water. It suggested the decade approach to provide a realistic standard of quality and quantity to urban and rural areas by 1990.The conference recommended that each country should develop national plans and programmes for water supply and sanitation giving priority to the schemes of the population which require greatest attention. India was a signatory to the resolution seeking to achieve the target by 1991. The water decade programme in India was accordingly launched on 1st April, 1981 to achieve definite targets of coverage of entire population by 31st March , 1991.

In August 1985 the subject of rural water supply and sanitation was transferred from Ministry of Urban Development to Department of Rural Department with the objective of securing implementation of the programme and their integration with other rural development programmes.

The National Drinking Water Mission was launched as one of the 5 social mission in the year 1986. The mission has since been renamed as Rajiv Gandhi National Drinking Water Mission (RGNDWM). Government of India continues to give highest priority to rural water sector through the activities of the Mission.

1.2 Rural Water supply in Andhra Pradesh

1.2.1 General :

Andhra was originally the name of a tribe. The tribe was nomadic one and the hills and rivers adjacent to the habitat of this tribe were named after the tribe 'Andhra'. Gradually the area where this tribe settled was called "Andhra". It is impossible to confirm the date of its origin. Different tribes, classes and societies gradually combined over a period of time and a transformed society had evolved. This is the evolution of a society. Andhra society is one of the ancient societies of the India. One can encounter several tales about Andhras in epics like Mahabharatam and Ramayanam. A tribe called "Andhras" arrived at the banks of river Yamuna during the Mahabharata war (1500 B.C). This is clearly described in the epic. (Source : E.B. Murthy)

The then Prime Minister of India, Pandit Jawaharlal Nehru, on November 1,1956, inaugurating a new state Andhra Pradesh, appreciatively commented " The dreams of the people of Andhra Pradesh have come true and the cabinet of ministers is now engulfed with andhraism".

The political struggle for a separate state, claiming lives, property, and peace, started in 1903 and ended on the 1st of October, 1953. Statehood was achieved on November 1, 1956, and Andhra State was renamed as Andhra Pradesh. As the fifth largest state of India, Andhra Pradesh covers an area of 2,75,068 Sq.Kms. The capital is Hyderabad and Telugu is the official language.

The state is situated in the South-East of the Indian subcontinent, surrounded by Madhya Pradesh and Orissa in the North, TamilNadu in the South, Maharastra in the NorthWest, Karnataka in the West and Bay of Bengal in the East.

There are 23 districts spread over the Coastal, Rayalaseema and Telangana regions. Of these, Anantapur is the largest district, occupying 19,130 Sq.Kms and Hyderabad is the smallest one, with an area of 217 Sq.Kms.

Two kinds of climatic conditions prevail in all of Telengana and Coastal regions and Chittoor district except Nellore, Hyderabad, Ranga Reddy, Mahaboobnagar, Nalgonda and Guntur(west) districts receive heavy rainfall. In other areas and the excepted districts, hot steppe type prevails.

AP has an abundance of natural resources, such as minerals. Agriculture and Industries are the two wheels of the chariot, play a major role in the economy of the state. Agriculture is a gamble with the monsoons and the answer lies in irrigation projects as water constitutes the life-line of agriculture. Communications and technology symbolize the advancement of mankind and AP is proudly walking into this future.

About 77 % of the state population live in rural areas. As per 1991 census, the rural population is 48.62 millions spread over 27400 villages. In A.P urban and rural water supplies are managed by two different departments. The Panchayat Raj Engineering Department(PRED) and the Public Health Engineering Department (PHED) are the implementing bodies for rural and urban water supply schemes respectively. The PRED has the responsibility of providing water supply and appropriate low cost sanitation facilities in rural areas, in addition to other rural development works like construction of roads, schools buildings, minor irrigation schemes up to 100 acres ayacut, all works relating to Zilla Parishads, Mandal Parishads and Gram panchayats (village level local bodies).

The Government of India has formulated the following criteria for identification of problem villages to provide drinking water:

* those villages which do not have an assured source of water within a distance of 1.6 Kms or within a depth of 15 m., (in hilly areas, villages where water sources are available at an elevation difference of more than 100 m. from the habitations)

* those where the available water has excessive salinity, iron, fluoride or other toxic elements, or

* those where disease like Cholera, Guinea worm are endemic.

From the 4th five year plan (1969-74) onwards the problem villages are being taken up for provision of drinking water supply facilities. The Government of India introduced the Accelerated Rural Water Supply (ARWS) Programme in 1972-73 to accelerate the flow of funds to cover problem villages. The existing rural water supply programme was converted to the Minimum Needs Programme (MNP) from 1974-75 onwards. The Government of India revised the ARWS Programme from 1977-78 to supplement the Minimum Needs Programme. The GOI provides funds under the ARWS while the State Government releases funds under the Minimum Needs Programme.

1.2.2 Rural water supply programme in Andhra Pradesh

The PRED is dealing with the enormous task of providing safe drinking water to the rural areas of Andhra Pradesh. Based on the guidelines formulated by the Government of India, three surveys were conducted by the PRED during 1972, 1980 and 1985 to identify problem villages, and 22,960 problem villages were identified, out of a total of 27,379 villages in AP.

Drinking water is provided to the problem villages by the following means:

* Bore wells fitted with hand pumps (spot sources),

* Mini Protected Water Supply (MPWS) Schemes with a single point distribution,

* *Protected* Water Supply (PWS) Schemes for a single village with public stand posts in the village,

* Comprehensive Protected Water Supply (CPWS) Schemes covering number of -villages.

Norms of providing water supply facilities are as follows:

Bore well with a hand pump	for every 200 to 250 population
MPWS Schemes	for villages having 1, 000 to 1, 500 population
PWS Schemes	for villages having more than 1,500 population
Public stand posts	1 for every 200 people.

The coverage of water supply facilities in AP up to March 1996 is as follows:

Problem villages identified	: 22,960
Problem villages covered	: 20,427
Hand pumps provided	: 223,000
PWS and MPWS Schemes	: 12,300

Special care is taken to provide drinking water to all habitations of weaker sections, Scheduled Caste (SC) localities and Scheduled Tribe (ST) localities by making special allocations for SCs and STs. The allocation of funds for SCs and STs are 15 % and 6 % from MNP funds and 25 % and 1 0 % from the ARWS funds respectively.

1.2.3Maintenance of water supply schemes

The hand pumps are being maintained by the PRED with compulsory GP/Government contributions pooled with the PRED. The budget allocation per each hand pump is Rs: 600 per annum, of which 50% is recovered at source by deduction from grants payable to the GPs by the government. With regard to the PWS and MPWS schemes, no such systematic approach has been developed, despite the fact that piped water supply schemes call for greater attention and expertise to ensure their proper O&M. At present PWS Schemes are constructed by the PRED and handed over to the GPs for O&M. The GPs are maintaining the schemes and the cost of O & M is being met from the grants paid to the GPs by the Government.

Comprehensive schemes covering a number of villages and schemes provided under bilateral assistance are being maintained by the PRED for which the PRED prepares annual O&M estimates. The policy of the Government of Andhra Pradesh is to maintain the CPWS schemes by PRED. Regarding the O & M cost, 50% of the cost is recovered at source by deducting from

the grants payable to the concerned GPs by the government. The PRED was permitted to spend 10% of the capital budget on O&M. Since minor Gram Panchayats are not in a position to provide sufficient funds, the Government has exempted them from payment of electricity charges. (PRED study team, 1994).

1.2.4 Bilateral assistance programmes

Netherlands assisted projects (NAP) under rural water supply and sanitation sectors

The Royal Netherlands Government has been assisting the Government of Andhra Pradesh in providing safe drinking water facilities in fluoride affected and other problem villages since 1979. The details of the projects so far funded and completed are as follows.

Water supply AP - I

Under NAP, AP-I (1979-90) water supply and sanitation project, 201 fluoride affected villages were taken up in 6 districts at an estimated cost of Rs: 1825.51 lakhs (182.551 million rupees). There are 4 CPWS and 50 PWS schemes in this phase. In this phase only execution of water supply systems has been taken up.

Water supply AP - II

The NAP, AP-II (water supply and sanitation project) was taken up from 1988 and completed in 1994-95. Under this project 277 villages in 4 districts are being covered with 12 CPWS Schemes and 33 PWS Schemes in addition to 10,000 acres of land to be irrigated under Lift Irrigation.

In view of the integrated approach recommended by the International Drinking Water Supply and Sanitation Decade: support activities such as community education and participation, health awareness, sanitation, income generation activities and external water quality monitoring have also been taken up. The integrated approach of executing support activities along with water supply is carried out only in AP-II Parchur Project, Prakasam District.

Water supply AP - III

Four projects have been proposed under AP-III water supply and sanitation project, covering the villages in Nalgonda, Kanigiri, Ananthapur and Krishna Districts. Based on the expected fund flow from the Government of Andhra Pradesh in this sector, the Netherlands Government has agreed to support Nalgonda Project. The following components are proposed in the project.

* Water supply systems
  - Ground water supply
  - Surface water supply

* Community-based activities
  - Sanitation
  - Village planning
  - Integrated Child Development Scheme (ICDS)

* Institutional development
  - Management Information System (MIS)
  - Training

Further, based on the experiences of AP - I and AP - II schemes and problems facing with illegal connections, provision for 25 % house connections has been made in the design of the AP - III scheme.

1.2.5 Policies and strategies of Government of India

The Indian National Water Policy announced in 1987 gives the highest priority to drinking water supply. From the analysis of achievements during the 7 th five year plan (1985-90) and two annual plans (1990-92), it is evident that the operation and maintenance of water supply installations in the country were badly neglected.

Under the 8th five year plan, the approach to the water supply sector will take into account the following guidelines given in the New Delhi declaration, which was adopted by the U.N. General assembly in December 1990 (P.C. Report, GOI, 1992).

* Organizational reforms, promoting an integrated approach and including changes in procedures, attitudes and behaviour and the full participation of the women at all levels.

* Community management of services, backed by measures to strengthen local institutions in implementing and sustaining water supply and sanitation programmes.

The Indian Government Planning commission has summed up the situation well : Lack of involvement of the local communities in the maintenance arrangements, shortage of staff and inadequate funds are the main reasons why existing water supply schemes have failed to yield the expected results.(GOI Report, 1992)

Based on the experience gained in recent years and taking note of the issues which have emerged, the following aspects regarding operation and maintenance are emphasized:

* Private sector efforts for construction and maintenance of drinking water projects should be encouraged and mobilized to the maximum extent feasible.

* Local bodies should be made responsible for the operation and maintenance of the system installed, with technical guidance from Government agencies.

With the enactment of the Panchayat Raj bill, which is under consideration of the parliament of India, the local bodies should be actively involved in the maintenance of the drinking water schemes. This may be done by involving beneficiaries. The bill is aimed to delegate more powers to local bodies. This may lead to more decentralization and more chances for active involvement of local bodies in development programmes.

Human Resource Development of late is gaining a lot of importance in many areas of developmental activity. The concept received a boosting after a separate ministry was established with cabinet rank in the union Government. Recently under the aegis of RGNDWM a very ambitious HRD programme in the field of RWS & S was launched by Government of India with an ultimate objective of streamlining the sector by activating certain core components which are neglected from the past. They include

1. Training of 586,000 Grass Root Level Trainees (GRLTs) basically related to some preventive maintenance tasks in the entire country by 2000 A.D,.
2. Training of 12,500 sector professionals in corrective maintenance during the same period
3. Strengthening the training capabilities.
4. Developing manuals on RWS & S.

In consequence to the objectives, along with the other states the Government of Andhra Pradesh was entrusted to ground the mission by constituting the state level HRD cell on 16-11-95 with an officer of Chief Engineer cadre heading the cell as Executive Director. Subsequently, the state Executive committees and District level committees were constituted in all the districts by 9-1-96. The effective operationalisation of NHRDP in the state commenced with issual of detailed guidelines to all the Superintending Engineers who head the PRED set-up in the Districts on 12-1-96. The Govt of AP through a Govt. Order has delegated the task of implementing and monitoring the of HRD to the respective District collectors, who will act as Chairman and the Superintending Engineer as Convenor to co-ordinate at District level.

For selecting the GRLTs following criteria was adopted in the Andhra Pradesh.

1. The GRLT should be acceptable to the community
2. Preferred age of 18-35 years
3. He/She should have interest, motivation and a desire to do selfless service
4. GRLT should be a resident of the village.
5. Ladies should be given preference.
6. He/She should have preferably some exposure to mechanical skills, viz. Cycle mechanic, pump mechanic, etc.

The state HRD cell has an ambitious training plan to complete training 7500 GRLTs each year as against the 5500 set by the Govt. Of India to cover the backlog of each year by using the early released fund by the GOI. To transfer the maintenance of the handpumps to the community gradually, grass root level functionaries at the rate of one per revenue village are identified and trained for effective implementation of the handpump maintenance. In the AP the programme

is extensively implemented with the target of training 27,379 grass root level functionaries by the end of 2000 AD. So far 1806 GRLTS are imparted training in the state. (Note of ED, HRD cell PRED, 1996)

In Andhra Pradesh a substantial part of rural population are covered with safe, potable drinking water through borewells fitted with handpumps. It has the largest number of handpumps in India to the tune of 225,000, which are being maintained under PRED only. Most of the handpumps are India Mark II and in some areas India Mark III, which is also called village level operation and maintenance pump is being erected on trial basis.

Considering the enormous, number of handpumps in the state, the need for viable maintenance is very much essential. Though India Mark II is a well designed sturdy handpump, many factors influence its breakdown. The absence of preventive maintenance by the village level caretakers, lack of proper monitoring and supervision in the maintenance system are the main reasons for frequent failures resulting in uphill task of PRED, which is with limited financial resources and man power.

In the Initial stages when the number of handpumps are less, the maintenance was handled by the Rigs sub-division located at the District head quarters, with mobile vans and pump mechanics under the control of Sub-divisional officer. Sub sequently, three-tier and two-tier maintenance systems are being implemented due to increase in the number of pumps which will be discussed in detail in the coming chapters.

Depending on the availability of vehicles, these two types of maintenance systems for handpumps are being implemented in the state. In spite of the best efforts on the part of PRED the breakdown rate is still on the higher side. The village level voluntary handpump caretakers though trained to handle preventive maintenance aspect of the handpump are unable to deliver the required out put resulting in frequent failures of handpumps.This puts the pressure to transfer the maintenance to the communities in a different perspective. The Government of AP is also of the view that unless more active involvement of the user communities is effected, the maintenance of handpumps becomes extremely difficult. In the recent past Concrete measures are taken to transfer the maintenance to the communities. Government has given the instructions to transfer the maintenance of handpumps to the Gram Panchayats (GPs), which are village level local bodies. But the GPs are not willing to take the responsibility, as they are lacking in the financial resources, manpower and infrastructure required for the O & M of handpumps. So it appears that the current approach needs to be improved to make the transfer successful.

In the proposals of this study, it was intended to study the PRED and GP set-ups for O & M of handpumps and to review and compare the performances of these two set-ups. Although the GP set-up is being proposed already for two years back, the maintenance of handpumps in the Andhra Pradesh is being looked after by PRED only. Hence in the present study the areas where there is more use of handpumps are considered and two districts are selected. During the field observation, operation and maintenance systems of handpumps in these two districts were studied in detail and the performance was reviewed and discussed in the coming chapters.

1.3 Structure of the report :

The report consists of a total seven chapters. The second chapter discusses about the problem identification and about the study objectives. The third chapter reviews the literature about handpump technology, different handpump maintenance systems and the general indicators to assess the performance of the handpump maintenance system. The chapter four discusses the methodology adopted in the present study. The fifth chapter reviews the results obtained on the performance of the maintenance system and the sixth discusses the results with respect to the performance of the maintenance system based on the literature. Finally the seventh chapter presents the conclusions and recommendations of the study.

Chapter 2
PROBLEM IDENTIFICATION

2.1 Problem in general :

Experience in many developing countries during and since the International Drinking water supply and sanitation Decade (1981-1990) shows that even the best run water agencies can not successfully implement, operate and maintain water systems with out the full involvement and commitment of the users. Despite the best endeavour of central agencies, staff, and budgets become over stretched, leading to broken down systems, dissatisfied consumers and demoralised agency personnel.(IRC, 1983).

The handpump option is one of the options to improve the rural water supplies . Although attitudes have been different, handpumps are widely concerned to be the most affordable means for improving the rural water supplies nowadays. The reliability of handpump schemes has left much to be desired in the past. Publications mentioning that up to 80 % of the handpumps are out of order due to lack of maintenance, made clear that some thing had to be done on the issue of handpump maintenance. (Falken mark, 1982)

Even though the maintenance of rural water supply systems is increasingly being recognized a major problem, many systems are still being constructed due consideration to maintenance. This is strengthened by the fact that donor agencies are prepared to finance the construction of water supply systems but themselves not committed to long term support to the maintenance of these facilities (WHO, 1986).

2.2 Magnitude of problem in Andhra Pradesh :

The performance of handpumps and rural water supply schemes under Panchayat Raj Engineering Department (PRED) are found to be poor and problems like poor functioning of the handpumps; poor effluent quality and functioning with low efficiency in the case of RWS schemes are common. The main causes listed by Rao (1993) are defective operation and maintenance and its organization and also lack of knowledge of the plant operators and caretakers. Rectification of repairs is often delayed due to inadequate communication facilities. No proper quality monitoring and supervision exists. Most of the previously existing rural water supply projects are not functioning properly due to lack of skilled operation and maintenance personnel and paucity of funds for operation and maintenance.(Rao, 1993)

The National Environmental engineering research institute (NEERI) has also conducted an evaluation study of Rural water supply projects in the country to identify factors that are contributed for their success and those that have hampered their purpose. The findings of the survey show that systems managed by local bodies are generally entrusted to unskilled caretakers and often suffer for want of funds. The consumer often believes that water that is not supplied at his door step need not be paid for. (Reddy, 1995)

In 1996, the Government of Andhra Pradesh have appointed a staff review committee to study on the number of staff and their performance in the different Government departments and to give suggestions to improve their performance. The committee was appointed under chairmanship of a senior IAS (Indian Administrative Service) officer, Mr. Gangopadhyaya and named as "Gangopadhyaya committee. The committee has investigated the nature of jobs and performance of the work charged employees for operation and maintenance of handpumps under Panchayat Raj Engineering Department (PRED) and submitted it's report to the Government..

After the study the committee has reported that there are 218,000 handpumps in the state and for operation and maintenance of these handpumps, there are 1203 pump mechanics, 179 mobile teams each comprising of one driver, one mechanic, two helpers. Totally there are 1382 mechanics and 358 helpers and 179 drivers are working under PRED for O & M of handpumps. The committee has concluded that the O &M of handpumps under this system is poor and become a burden on the state Govt.'s expenditure and recommended that all the services of the work charged employees under PRED should be terminated and the present system should be removed. It is also suggested that the expenditure for O &M of each handpump costs about Rs. 600/- and this amount should be given to the Gram Panchayats as a grant. This expenditure totals to Rs. 13.44 Crores per anum, and if the O & M of handpumps transferred to GP there will be reduction in this total expenditure. The committee has also suggested that by transferring the O &M of handpumps to Panchayats the performance of the handpumps can be improved and by removing the pump mechanics system, the unemployed rural youth can be encouraged to open workshops for the repair of handpumps, by giving loans under self employment schemes. It is also suggested that there should be cost recovery for O & M of PWS schemes and Panchayats should be given power to collect tax from consumers . (committee report published in the local news paper dt 21-11-1996)

Every year a number of hand pumps are being installed by the PRED in the rural areas of AP. But after a few years of installation, hand pumps appear to be not working properly for the intended purpose due to one of the following reasons . A study in Karnataka (Nageshwara Rao, 1990), which to some extent also reveals the existence of similar situations.

(i) Failures of bore wells due to wrong locations during installation. There are about 8 % in the total handpumps in AP (i.e 18,000 out of 225,000) are not functioning due to drying up of borewells i.e, because of wrong location s during the installation.

(ii) Abandoning of hand pumps due to poor water quality (corrosion problem, when the water is aggressive)

(iii) Lack of proper monitoring and supervision in the maintenance system and also there is no monitoring feed-back to improve the performance.

(iv) Delay in reporting of failures / breakdowns due to lack of effective communication system.

(v) Delay in supply of spare parts

(vi) Absconding from the job by the hand pump care takers, when they find other lucrative jobs and there is no motivation and commitment among the care takers in performing their duties.

(vii) Shortage of O & M staff

(viii) Scarcity of maintenance funds and there is no cost recovery

(ix) Less or no community involvement in the preventive maintenance of the handpump and also in keeping the pump environment in good condition.

The problems mentioned under 'vii to ix ' were also identified by the Planning Commission of Government of India during the review of O & M of RWS projects (P.C. report GOI, 1992). The number of complaints received by PRED from the users are also more during the dry season. The main problem is due to lack of proper institutional management like inspection, supervision and reporting and there is less community involvement in the preventive maintenance of handpumps.

2.3 Study objectives :

The present study intends to examine the occurrence of such problems in the operation and maintenance of handpumps in Andhra Pradesh with the emphasis on the organizational set-up and procedures followed for operation and maintenance of handpumps.

Hand pump is one of the main technical option for providing rural water supply in A.P. At present there are about 218,000 hand pumps under PRED sanctioned under different grants and funded by external funding agencies like UNICEF. The present bore well programme in Andhra Pradesh is as follows.

Total number of Bore wells drilled	...	225,624
Total number of Bore wells condemned	...	18,000
Total number of hand pumps fixed	...	218,300
Total number of pump mechanics working (Under PRED)	...	1203
Total number of mobile teams working	...	179
Total number of community based hand pump care takers working in the state	...	58,883

The PRED is presently responsible for hand pump maintenance. In 1994 the Government of India has instructed the state Governments to transfer the Hand pump maintenance to village level local bodies.

The information about PRED suggests that initially it was implementing a three tier handpump maintenance system (Figure 1) where the first tier comprising of mobile teams at district / division level, each team is responsible for the maintenance of 500-750 hand pumps. The 2nd tier consists of a mechanic at Taluk level attending about 50-75 hand pumps. The third tier at village level is a hand pump care taker for each pump, responsible for the preventive maintenance of the hand pump in the village. But due to the enormous increase in the number of pumps, the two-tier system has been introduced in most of the districts where there is more use of handpumps. In the two-tier system the mobile team is shifted from division level to Sub-division level and attending the repairs of about 500- 750 pumps. The 2nd tier at village level consists of a hand pump care taker responsible for preventive maintenance and to inform the mobile team if there is a breakdown. In both the systems the handpump care taker job at village level is voluntary and not paid, hence in some of the districts no handpump caretakers are existing and the maintenance of the handpumps is being looked after by the first-tier (mobile teams at sub-division level) only. So at present in Andhra Pradesh, two types of systems are being implemented for maintenance of handpumps. They can be taken as one-tier and two-tier systems.

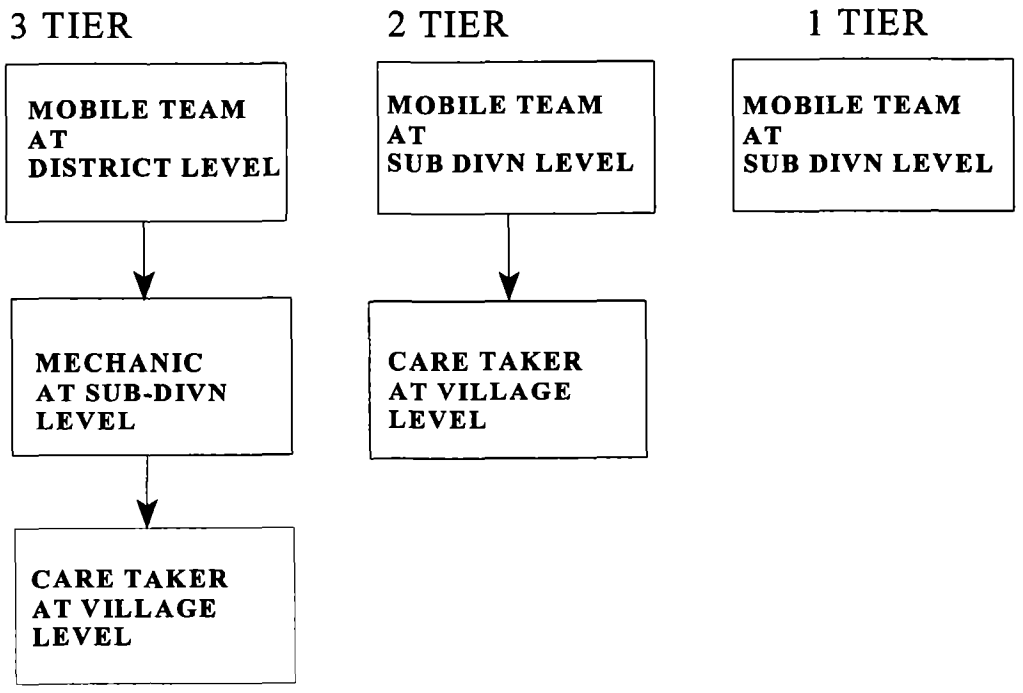


Fig.1 Handpump maintenance systems by PRED

As per the Government policy all the hand pumps after the construction by the PRED should be handed over to Gram Panchayats (GP) to look after operation and maintenance at village level. This appears to be similar to VLOM (village level operation and maintenance) launched by UNDP aimed to pass full responsibility of management of operation and maintenance to the community which should result in a reduction of government expenditure. The GP is expected to maintain hand pumps with its own resources and man power. The Government partially subsidises (about 50 %) the operation and maintenance cost. The balance cost will be borne by GP by levying taxes on the users. PRED is responsible only for breakdown maintenance and periodic corrective and preventive maintenance.

The present study is intended to describe the present organization set-ups for operation and maintenance of hand pumps exist in Andhra Pradesh and to assess their performances.

The main study objectives are :

* To learn about the Organizational set-up of Panchayat Raj Engineering Department (PRED) and the Gram Panchayat set-up regarding the operation and maintenance of hand pumps.

* To review the performance of the operation and maintenance system for handpumps under two-tier and one-tier system in Andhra Pradesh.

* To suggest possibilities to improve the performance

2.4 Relevance :

Most of the Rural water supply in Andhra Pradesh is covered by providing borewells fitted with handpumps which are being maintained under PRED. It has the largest number of handpumps in India. In spite the best efforts on the part of PRED, the handpump breakdown rate is still on higher side due to the absence of preventive maintenance, lack of proper monitoring and supervision. Due to enormous increase in the number of handpumps PRED is also facing difficulties with the shortage of staff and limited financial resources and the need for viable maintenance is very much essential. Hence at present the Govt. of AP is also in the view to handover the maintenance to the communities, i.e Gram Panchayats, the only institutions available at local level.

Hence to review and improve the performance of the present maintenance system and to suggest proper future arrangements a study on the present maintenance system and on its performance is important and may help the planners and decision makers to identify the lacunae in the present system and the alternate arrangements for the future set-up of handpump maintenance system in Andhra Pradesh.

Chapter 3
LITERATURE REVIEW

3.1. Introduction :

This chapter covers the literature on handpump technology, different handpump maintenance systems available in India in general. The chapter mainly consists of 3 sections . First section being with the history of handpumps and development of India Mark II and its recent modifications to India Mark III. Then it describes the different handpump maintenance systems available in India and also the variable factors which indicates the performance of the maintenance system based on the literature.

3.2. Hand pumps for Rural water supply

Hand pumps installed in wells where ground water is easily available provide one of the simplest and least expensive methods of supplying rural communities with water. They are considered to be the most economical means for utilizing ground water for millions of people in rural areas in developing countries. The history of handpumps goes back a long way. Mcjunkin (1977) reports the use of positive displacement reciprocating pumps in ancient Rome as early as 275 BC. One of the best documented early examples of a wooden pump using metal flap valves, from Saxony, was recorded by Agricola in 16 Th century.

Most of the reciprocating hand pumps in common use in developing countries today have their origins in designs developed during the late 19 Th and 20 Th centuries in Europe and United states. The industrial revolution brought mass production techniques for cast iron and meant that thousands of manufacturers were able to turn out handpumps to meet the huge demand for convenient water supplies at that time. It has been estimated that, by the end of second decade of Twentieth century about three thousand manufacturers will produce more than 40 million pumps in United States alone. (Arlosoroff. S; 1987)

The basic design of reciprocating handpump has not changed much in the twentieth century, but its use has. In normal cases, the most popular European backyard pump, was only used by an individual family or a farm for about 10 to 30 minutes a day. But when this pump has been introduced in the developing countries, it has to meet the demands of a large number of people with a continuous operation of 10 or more hours a day.

The extensive use of these pumps have resulted in frequent breakdowns in handpump water supplies. Also different pump types such as the diaphragm type and the progressive cavity pumps were also in use in developing countries. The non-uniformity of pump types, associated with it spare part problems resulted frequent breakdowns in handpump water supply systems. It was at this time, the UNICEF came up with the sponsorship programme on handpump research and development, with a view to improve the designs of the handpumps to suit the local conditions, particularly in the developing countries (Arlosoroff et al, 1987).

3.2.1 Hand pump water supply in India

As per 1991 census about 74 percent of the total population of India live in rural areas. Traditionally these villages have been depending on conventional water sources. Owing to the fast pace of development all over the country specially in rural areas since independence in 1947, there have been pressing demands on the available water sources.

The available water resources are increasingly becoming vulnerable to pollution from domestic and industrial effluent and these pose health hazards to the users. India being a tropical country, the summer season is very severe. In the hot season when the rural people need more water, it is found that sources get dried up or depleted. In that case villagers have not only to walk a considerable distance to fetch water but also have to cope up with meagre amount of water irrespective of the quality and other factors.

In those circumstances, an ambitious programme was taken up by the Government to provide safe and reliable drinking water supply to the rural people by tapping the ground water through the wells and hand pumps. In the initial stages of this ambitious rural water supply programme, the available type of hand pumps were fixed . Basically these were reciprocating hand pumps and meant for shallow tube wells and fetching water for small user groups.(Ghosh, 1995)

Reciprocating handpumps, for drawing water from below ground, have been in use for centuries. During 1960s these reciprocating type hand pump designs meant for small user groups were introduced to pump water from deeper bore wells with substantially larger groups. Several types of handpumps were in use. The following are some of them ; (UNICEF)

I) Dempster pump
ii) Double guide pump
iii) Double guide with conversion head
iv) Vadala pump
v) Sholapur pump
vi) Jalna pump

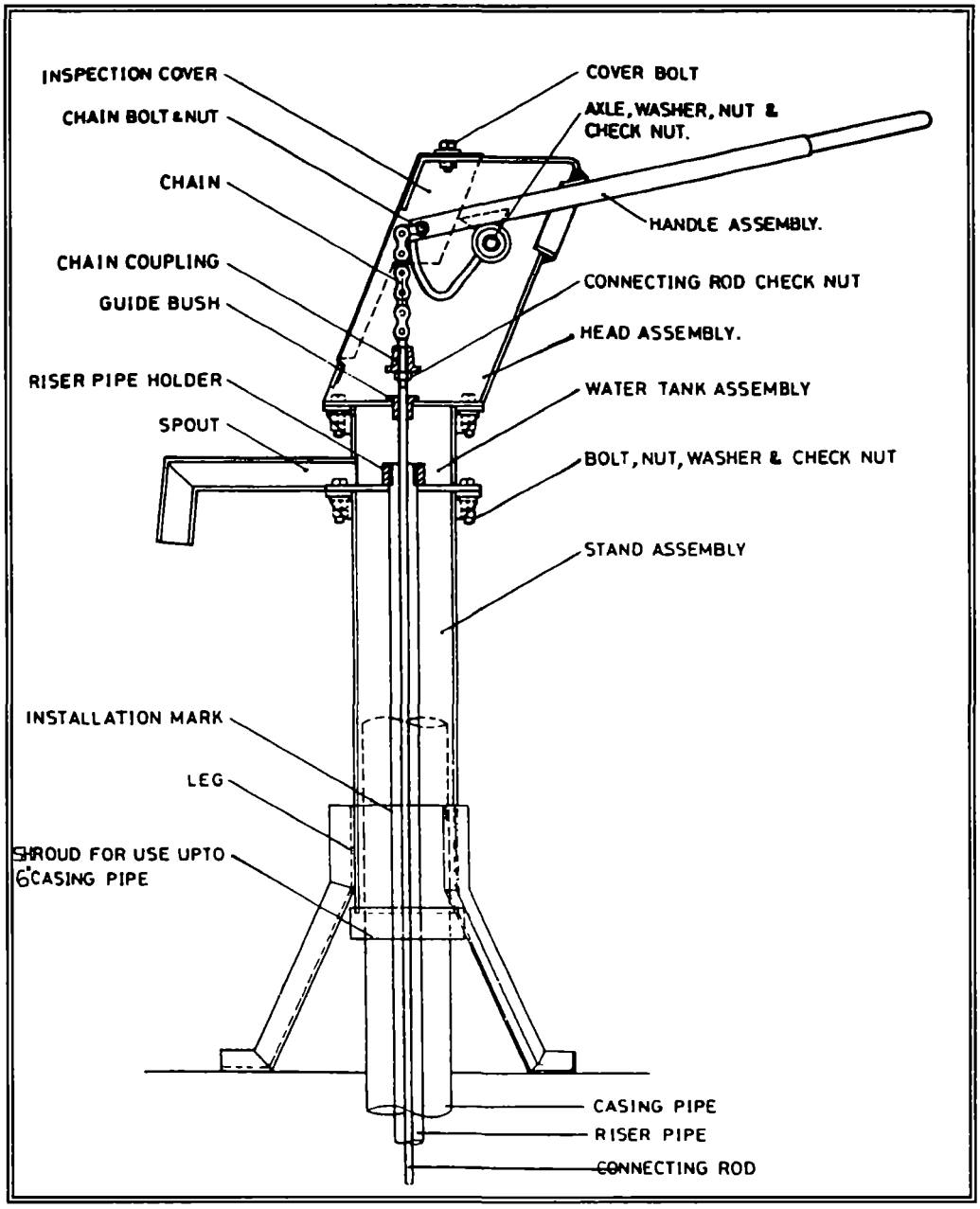
But these pumps could not cope up with deep tubewell and the breakdowns were common and frequent, which used to upset the regular availability of and forcing the villagers to resort to the polluted sources. The people started losing faith in this and the whole programme threatened to become counter productive. In this hour of despair, the new type of hand pump namely India Mark II was developed to suit Indian conditions.

3.2.2 India Mark II deepwell HandPump

In the early 1970s, the Government of India (GOI), concerned about the poor performance of the then deep well handpumps available for community use and its failure to provide sustained drinking water, initiated action in co-operation with the state Governments, World Health Organization (WHO), United Nations Children Fund (UNICEF), Mechanical Engineering Research and Development Organization (MIRADO) and Richardson and Cruddas (1972) Ltd.

(a GOI undertaking), for the development of a dependable deepwell hand pump. The reliable and sturdy deepwell handpump developed in the late 1970s was the India Mark II hand pump. In a decade the India Mark II hand pump became a house hold name in villages in India. By 1988, over a 1.3 million India Mark II hand pumps were installed in India to provide safe water to 260 million people in rural and peri- urban areas. Also India Mark II hand pump benefit an estimated 360 million people in Asian, African and Latin American countries. The first Indian national standard for India Mark II appeared in 1979, with IS 9301 Indian standard deep well handpump specifications. Later this has been revised thrice and the latest is in 1990 The following figure (Figure.1) gives the sectional details of India Mark II deepwell handpump (UP Jal Nigam, 1995).

Figure 3.1 . Sectional Details of Pump head assembly of India Mark II handpump



Description of India Mark II : The India Mark II deep well handpump contains four major assemblies. They are;

(I) Pump head assembly (above ground mechanism) :

Fully hot galvanized fabricated steel structure consists of head assembly, water tank and stand assembly(pedestal). The figure 1. gives the details of pumphead assembly.

(ii)Cylinder assembly :

Cast iron body fitted on the inside with a seamless brass liner having excellent inner surface finish. Plunger and foot valve are of gun metal as per IS 318-1981 with leather buckets and sealing rings.

(iii) Connecting rods :

12 m.m dia electro- galvanized mild steel bright bars of length 3.0 metres along with hexagonal couplings and locking nuts.

(iv) Riser pipe :

32 m.m. nominal bore galvanized iron medium class pipe in 3.0 mts standard length along with coupling sockets.

The development of the India Mark II was a major break through in terms of reliability and ease of operation. The number of handpumps operating at any point of time rose from a dismal 25 % to an impressive 85 %. How ever, this pump relies heavily on centralized maintenance. Though extensive field and laboratory tests have demonstrated that India Mark II deep well hand pump is very durable, it is not easy to maintain because of the high skills, special tools and a motorized van needed to service the below ground components. A mobile team, consisting of a van with special tools and a team of 4 or 5 semi - skilled workers is needed to provide specialized maintenance. This system is expensive and difficult to sustain. Alternative models of decentralized maintenance systems have been tried out with limited success. (Dept. of RD, GOI; 1990)

If a conservative estimate of hand pump maintenance costs of Rs 800 per handpump per year (conservative cost in comparison to the present provision of Rs 600 taken by the UNICEF,1995) is used, the all India cost of handpump maintenance totals Rs 200 crores per year. This real value of handpump maintenance costs would come to almost 15 % of total Government expenditure on Rural water supply in 1994-95. Another indication of scope of the handpump maintenance programme is the fact that, currently for every Rs 100 spent on new pumps by the state Governments, about an additional Rs 50 is spent on spares, i.e , one- third of value of the domestic production of handpumps in India is for spare parts (Data from BIS, UNICEF ; 1995).

This cost of maintenance is now, or will soon become, an unacceptable burden on Government resources. Accordingly several states have initiated some form of decentralized of community based hand pump maintenance system (also known as VLOM) with the objective of reducing the cost of maintenance while making it more efficient. (UNICEF ; 1995)

The Village Level Operation and Maintenance (VLOM) concept has been promoted by various agencies, including UNICEF and the UNDP/World Bank Water and Sanitation program since the early 1980s. The VLOM concept promotes the maintenance of handpump by users themselves with minimal out side support. It demonstrates that it is possible for pumps to be maintained by users themselves with minimum downtime and lowest financial and economical cost, provided it is technically easy and spare parts are made available. (Dept of RD, GOI ; 1990)

3.2.3 Conversion of India Mark II to Mark III :

To encourage the maintenance of hand pumps by the users themselves and to reduce dependence on centralised maintenance, it was necessary to introduce design changes in the existing India-Mark II handpump. These changes simplified the maintenance procedures substantially that is the changes make it easier to take apart and carry out repairs at simple standard tools that are locally available.

India Mark III deep well hand pump

The research and development efforts spread over four and half years in the Coimbotore project resulted in the development of a VLOM derivative of the India Mark II now known as the India Mark III deep well handpump. This pump has design features which have simplified the below-ground repairs substantially. There were two principle design criteria for the development of the India Mark III : improve ease of maintenance while maintaining the robustness and reliability of the India Mark II. These criteria were met with India Mark III. It is important to note, however, that the India Mark III is not a better pump than the India Mark II in any aspect except ease of maintenance. The reason that ease of maintenance was given such high importance was not to make the jobs of block mechanics and mobile teams easier. It was to make it possible to have the pumps maintained and repaired at village level under a community-based handpump maintenance programme.

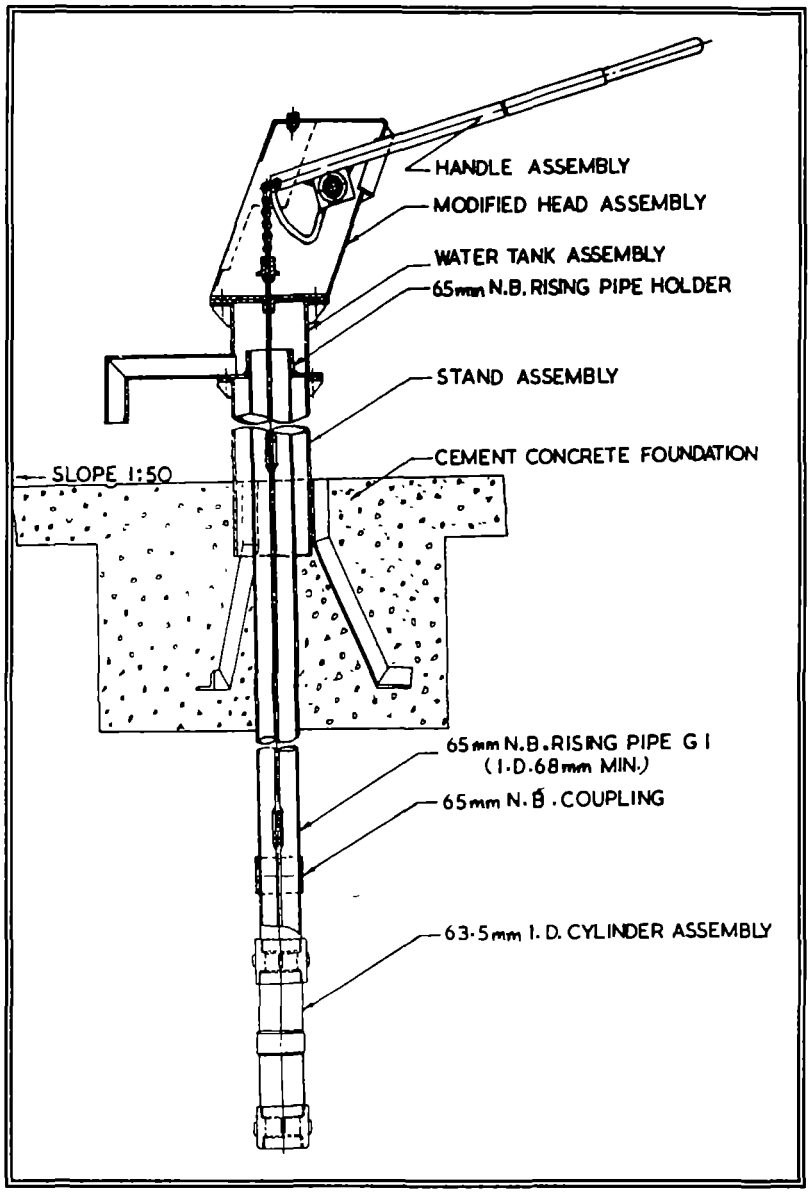


Figure 3.2. Sectional details of India Mark II deepwell handpump

Design features of India Mark III : This pump design enables the extraction of the piston and foot valve with out having to remove the rising main pipes and facilitates below - ground repairs (excepting the repairs in the rising main and cylinder body) by one mechanic with help of a pump user. The above (Figure.2) gives the sectional details of India Mark III deepwell handpump.(Dept of RD, GOI ; 1990)

The following are the important design features of India Mark III.

(i) The piston and foot valve can be extracted with out lifting the rising main.

(ii) When the piston assembly is screwed on to the foot valve body, the push rod lifts the upper valve guide. This helps in dumping the column of water soon after the foot valve is lifted up by a few millimetres. This makes the lifting of the foot valve, piston assembly and pump rods much easier.

(iii) The foot valve is placed in a conical receiver and sealing is provided by an O-ring

(iv) Nitrile rubber piston seals have been used which have much higher life than leather seals and the cylinder brass liner does not get scored as easily.

(v) The two piece upper valve eliminates failures due to disconnection of the threaded joint.

(vi) An additional flange known as the intermediate plate is placed between the head flange and the water tank top flange. This facilitates removal of the head assembly with out the removal of the handle assembly. This improves access to the chain assembly and simplifies the maintenance of above ground mechanism.

(vii) A square bearing housing instead of a round bearing housing ensures higher rigidity and less distortion of the housing due to welding. This improves the quality of the bearing housing and will enhance the life of the bearings and handle assembly.

(viii) The increased window opening reduces the hitting (banging) of the handle on the bracket bottom stop.

(ix) The height of water tank assembly was increased to eliminate the splash of water during fast pumping operations. The overall height of that stand assembly was reduced by 75 mm to bring the operating end of the handle close to the platform foot rest.

This reduces the banging of the handle on bracket bottom stop and makes repairs more convenient.

3.2.4 Comparison of India Mark II and Mark III

Coimbotore hand pump project was taken up in late 1983 by the Tamilnadu Water Supply and Drainage Board in collaboration with the UNDP and World Bank Hand pump Testing and development Project, UNICEF and Richardson & Cruddas Ltd. The National Drinking water mission, Department of Rural Development, GOI, co-ordinated the intensive development and testing project at the National level The project aimed at :

1. Verification of actual costs of operation of India Mark II deep well hand pumps and ;

2. Identification and testing of potential improvements to the standard India Mark II hand pump design to make maintenance easier and less expensive.

Approximately 80 handpumps were tested near Coimbatore over period of four and half years under conditions of heavy use and deep static water. A sample of 50 standard India Mark II handpumps provided the baseline information with which the performance of experimental variations were compared. Initially all test pumps were fitted with the standard India Mark II pump head and leather cup seals. How ever as the field testing and monitoring progressed, refinements were carried out in the standard India Mark II hand pump as well as the experimental hand pumps which are with open top cylinder and 65 mm dia galvanized iron riser pipe (referred as Mark III). The extensive field testing and monitoring was mainly confined to the following two types.

(a) India Mark II : In this pump the above ground mechanism was modified shortly to facilitate easier and quicker removal for access to the below ground parts. The changes include a nitrile cup seal instead of a leather cup seal and a two piece upper valve instead of a three piece upper valve and a modified spacer.

(b) India Mark III : This pump uses a 65 mm dia G.I riser pipe for the raising main to facilitate withdrawal of the extractable piston and foot valve with out having to remove the rising main. The pump's above ground mechanism was modified slightly to facilitate its easier and quicker removal for access to the below ground parts.

Two types of design were tested: first, the design improvement that will increase the Mean Time Before Failure (MTBF) ; second, the design improvements that would make the pump easier to take apart and reassemble, using fewer tools and less manpower. Radical design changes were avoided to ensure high degree of compatibility with the existing India Mark II deep well handpump.

Analysis of field data shows the following distinct improvements in the reliability and serviceability of the experimental pumps - India Mark II (modified) and India Mark III deep well handpump over the standard version India Mark II deepwell handpump. In the India Mark III deepwell handpump, the average frequency of service required (from a mobile maintenance team) was reduced by 89 % per year and the mean annual repair time was reduced by 67 %. In fact, 90 % of the total repairs for the India Mark III deepwell handpump can be carried out by a bicycle - mobile mechanic using few tools and with the assistance of the handpump care taker. (Coimbatore Project Report ; 1990)

The implications of these design improvements are as follows :
(Department of Rural Development, GOI ; 1990)

1. Minor modifications costing Rs 250 - which will be fully offset in less than two years - to the existing 1.3 million India Mark II deepwell handpumps will, due to increased MTBF, result in a substantial decrease in the maintenance cost and effort. This will increase the quality of service as mobile teams will be required to make fewer visits.

2. Adoption of India Mark III deepwell handpump will substantially reduce the dependence on a mobile team for most of the repairs. It will be possible for a village -based mechanic to move about on a two wheeler and carry 90% of the repairs with the help of a handpump caretaker/user. This will substantially reduce the downtime and also the maintenance cost.

3. The additional capital cost of Rs.1320 in the case of India Mark III deepwell handpump will be fully offset by the lower maintenance cost in less than three years time.

4. There is need for further improvement in the handpump design to make the maintenance of the handpumps simpler and easier so that the handpump caretakers are able to carry out most of the repairs at the village level itself.

The following are the recommendations of the Coimbatore Project ;
(Coimbatore Project Report ; 1990)

1. Design improvements to the India Mark II deepwell handpump be incorporated into the national standard specifications.

2. The existing 1.3 million India Mark II deepwell handpumps be modified to substantially increase the MTBF.

3. The India Mark III deepwell handpump be installed on a large scale in all the states presently using the India Mark II deepwell handpumps and a village-based maintenance system be developed which needs minimal support from a mobile team.

4. A national standard be prepared for the India Mark III deepwell handpump.

5. A study on a national level be conducted to evaluate the strengths and weaknesses of the various existing maintenance systems and to suggest ways to create village level capacity to repair deepwell handpumps.

6. Further research and development should be undertaken to simplify maintenance requirements which will encourage the users themselves to carry out maintenance.

Advantages of India Mark III over India Mark II :

India Mark III deepwell handpump offers the following substantial benefits over India Mark II deepwell handpump. (UNICEF; Dept of RD, GOI ; Coimbatore Project Report; 1990)

1. Improved serviceability : For the routine maintenance of India Mark III pumps, a set of fewer and lighter tools and less labour is needed to replace the parts which need frequent replacement, such as piston seals, valves, valve seats and above ground parts and occasionally pump rods. When compared the mean active repair time by component of India Mark II versus India Mark III, it is observed that 67 % less time was spent on the India Mark III when similar repairs carried out on both the pumps.

Another important feature is that for all below ground repairs a mobile van needed for India Mark II where as for India Mark III it can be carried out by a mechanic with help of a handpump caretaker. The dependence of mobile team is 0.16 times per pump per year in case of Mark III against 1.44 times in the case of Mark II.

2. Frequency and cost of replacements of parts : When compared the average frequency of the parts replacement such as Axle, handle assembly, chain assembly, piston seal, bolt and nuts etc, and the maintenance costs for consumption of spareparts based on the data collected during the Coimbatore project, it is observed that the mean annual frequency of parts replacement is 9.15 parts per India mark II pump as compared to 4.49 parts per India Mark III .And the annual cost of parts replaced was Rs 228 per India Mark III against Rs 423 per India Mark II i.e, the cost of replacement of parts was 46 % less in the case of the India Mark III

3. Maintenance costs : Maintenance costs for India Mark II and Mark III have been worked out based on the assumptions made on the density of pumps and travel distance and data collected during the Coimbatore project on consumption of spare parts, active repair time and man power needed for various types of repairs.

As shown in the table below , the total annual maintenance cost for India Mark III is Rs 381.11 against Rs 874.21 for India Mark II and the saving per annum in maintenance is Rs 493.10.

Maintenance cost	Mark II	Mark III
	Rs	Rs
Caretaker	40.00	40.00
Block mechanic	18.61	42.25
Mobile team	392.10	228.20
Spare parts	423.50	228.20
Total	874.21	381.11

Table.3.1. Comparison of maintenance cost per Pump per Year
(Source : Coimbatore project report, 1990)

As shown above, it is evident that there are substantial savings in the case of India Mark III and these savings can be further increased if village- level mechanics are trained to carry out most of the repairs at the village level itself and an efficient spare parts distribution system established.

4. Break-even point on cash basis : It is estimated that the extra expenditure of Rs.1350 on the capital cost in the case of the India Mark III will be offset in 3 to 5 years time due to lower maintenance time.

5. Lower downtime : In the case of India Mark III, over 90 % repairs can be carried out by a mechanic (using a two wheeler) with the help of a pump user. This mechanic will easily accessible and will therefore cut down communicate delays and reduce the response time. This will reduce the downtime. The financial and economical benefits accruing due to lower down time will be far in excess of savings in the maintenance cost.

Limitations of the India Mark III (UNICEF ; 1995)

While the advantages of converting to the India Mark III are clear, there are some disadvantages.

1. It is the fact that the India Mark III (including riser mains)is approximately 25 % more expensive than the India Mark II. While studies show that converting to the India Mark III over a long term results in large programme budget savings in O & M.

2. The other disadvantage is related to the heavy, 65 mm dia metre, GI riser main used with the pump. There have been reported cases from a couple of states where the riser mains have failed (broken off at the top) in deeper installations.

   It should be stressed that this has occurred only in a very small percentage of installed pumps, and that this type of failure is often due to improper installation or the use of sub standard pipes or couples, and is not necessarily be the design fault of the pump.

3. Due to non-verticality of bores, there have been some problems reported in installing the India Mark III pump in bores of less than 125 mm dia metre.

Use of PVC rising pipes and joints in the India Mark III handpump

To overcome some of the above disadvantages of India Mark III, PVC pipes are introduced and used in the Coimbatore project. The advantages of PVC pipes are low cost and corrosion proof and also easy to handle even by women as they are less weight.

The 75 mm outer diameter and 5 mm wall thickness PVC pipes with different types of joints are used as raising mains and tested in fifteen borewells and the following observations were made in the Coimbatore project.(Coimbatore Project Report , 1990)

1. The use of pump rod centralizer in pumps with PVC rising mains is essential. How ever, it's use, even in pumps with a Galvanized Iron (GI) rising main will reduce damage to the inner surface of GI pipe due to Abrasion. Further development is needed on this problem.

2. The rubber compression fitting used in experimental pumps to hold the PVC rising main in the water tank assembly performed extremely well. No failure was noticed during three years of field testing.

3. The PVC rising main is not found suitable for installation in unlined bore wells. The abrasion from outside causes premature failure of the PVC rising main. The threaded PVC joint in the PVC rising main worked satisfactorily for two years . Further development and field testing will be necessary to develop a system compatible with unlined bore wells

   How ever, it is noticed during the field survey of this author that some of the India Mark III deepwell handpumps (located in Shameerpet Mandal, Ranga Reddy District Andhra Pradesh)fitted with PVC rising mains , installed during 1994-1995 are working satisfactorily with out any complaints

3.3. Operation and Maintenance of Handpumps

Operation refers to the routine activities necessary to make the system function. A series of simple actions which collectively enables an assembly of inanimate pieces of technology to operate and provide the desired output.

Maintenance refers to periodic inspection, replacement or repair of damaged parts, lubrication, removal of unwanted waste etc. With in the field of maintenance there are two distinct types of activities, reflecting different types of maintenance and different strategies for providing satisfactory maintenance at minimum cost. The two types are preventive maintenance (planned maintenance) and corrective maintenance (breakdown maintenance) Preventive maintenance is that which is conducted to prevent or to minimize the breakdowns. Corrective maintenance is that which is done after a breakdown occurred and it tries to restore a service in malfunctioning the systems as quickly as possible.

Most operation and maintenance evaluations will be much more concerned with maintenance them with operation. Both planned and breakdown maintenance is needed for all systems but the aim is to minimize the breakdowns through planned maintenance. There is an obvious relation between proper maintenance of a system and its operation. Those which are well maintained are much more likely to operate with minimal difficulty. (Cairncross, 1980)

3.3.1 Importance of the proper maintenance of the hand pumps :
(Ghosh.G ; 1995)

Handpumps are basically mechanical appliances, requiring regular maintenance and care of avoid breakdown. since it is used by all sections of the rural community and as such it is subject to all sorts of handling, misuse and even abuse. The high rate of abandoned or defective handpump is not simply a reflection of poor quality pumps but also inadequate maintenance and repair. Frequent breakdown of handpump will force the villagers to go back to the old unreliable water sources with all handicaps. All the capital investment in that case go to waste.

The only answer to this is ensure proper and effective maintenance of the handpumps on a systematic and regular basis. Usually handpumps are located at very remote places all over the country and have to work in different conditions prevalent at different places.

In these circumstances, it is considered desirable to evolve some basic norms for the maintenance of the handpumps to achieve cost effective operation and maintenance.

3.3.2 Maintenance approaches :

From the review of the literature, three main approaches to maintenance are identified and developed in a logical sequence. (IRC ; Teun Bastemeyer; Jan Teun Visscher, 1987)

(i) The Technical approach

(ii) The Organizational approach

(iii) The Systematic approach

(i) Technical approach :

Attempts have been made to ensure the long-term functioning of rural water supply systems were based on the understanding that maintenance problems could be prevented by installing very sturdy or robust systems. For instance, many handpump programmes concentrated on the development of "maintenance-free" pumps (DHV,1978, Trietsch,1984, Blankwaardt,1984). The research carried out has contributed to improved pump design and pump reliability, but feedback from the field has shown that even the very sturdy and often costly pumps broke down and needed regular maintenance. In 1974, Farrar and pacey rejected the concept of maintenance -free pumps and have argued that the selected technology was too complicated and therefore not appropriate. In their view a technology needed to developed which allows village level maintenance , that is pumps which can be maintained and repaired by local care takers and with occasional support from agency staff.

This shift in emphasis can also be observed in the UNDP/World Bank Rural Water Supply Handpumps Project (Arlosoroff, 1986). This project was designed to test and evaluate handpumps, and to promote the development of a new generation of handpumps (World Bank,1985). While the initial objectives remained at the core of the project, the focus has widened considerably as it became clear that handpump technology was only one of the factors involved. The project has concentrated increasingly on the promotion of village level operation and maintenance (VLOM).

Intermediate results of the project indicate , that successful introduction of the VLOM pumps greatly depend s on higher level support, ongoing promotion activities and on the motivation of users to accept the main responsibility for their water supply facilities. For example, in the Malawi upper Livulezi project, timely maintenance carried out by (female) care takers has helped to prevent breakdown of the pumps.

These examples show that even technology, which can easily maintained at village level, needs to be properly introduced by involving the users from the beginning. The need to involve the users and give them some controls also stressed by Van Wijk- Sijbesma, (1983). A case is cited of the performance of local caretakers being very much improved after being put under the control of both the Government and village council. She also indicates that involving the community, particularly the women, in all stages of a project could be the key to improve operation and maintenance of water supply systems.

(ii) Organizational approach

The high failure rate of handpumps has forced implementing organizations to set up maintenance systems. At first, adhoc repairs were mostly carried out by installation teams. Later on, some organizations started to train maintenance teams and to establish maintenance systems. Often these systems were rather independent of existing structures or Governmental agencies, but several organizations have tried to develop a maintenance organization as apart of Governmental body, for example the three-tier handpump maintenance system developed in Tamilnadu in India (Water supply and Drainage Board, 1977), the two-tier system in the north and north-east of guinea Bissau (Stepanistchev,1981)

In this organizational approach, responsibilities are shared by local communities and relevant government agencies in a decentralized maintenance system. The success mainly depends on technical management of human and material resources. (Donaldson, 1984). Decentralization of certain responsibilities reduces maintenance costs (Hofkes, 1982), but requires technology which can be operated and maintained at community level. Further, back-up services for the village care taker, and supply of spareparts need to be ensured.

An analysis of existing or planned handpump maintenance systems as summarized by Hofkes (1982) indicates that most of the systems seem to have been set up with emphasis on repairs to be carried out, and to a lesser degree on preventive maintenance. In general, the central or regional Government is responsible for the overall management, including organizational set-up

and payment of staff, and users and local authorities do not have a say in or control over maintenance. Mostly maintenance is financed completely by the Government. In few cases there are revenue collection systems but mainly for the purchase of spareparts for minor repairs. In about half of the cases, no clear responsibility is set for manpower development and training, and for distribution and purchase of spareparts. In 75 % of cases, no formal provision have been made to monitor the functioning of the system, and this explains the limited data available on maintenance system performance.

Over the years the organizational approach to maintenance has developed and now includes a wide range of essential elements, but often too little emphasis has been placed on local environmental conditions, local resources for maintenance, and affordability of technology. The choice of technology should be related to these local conditions which determine the maintainability of rural water supply systems. Thus often the organizational approach has not been successful because of inappropriate technology, and insufficient user involvement.

(iii) Systematic approach :

This approach to maintenance combines both the technical and organizational concepts but also takes into account environmental conditions, affordability and users involvement. Pacey concluded in 1977 that experience of donor agencies in Bangladesh, India and East Africa showed that the greatest effort was put into technology development. Other aspects of the maintenance problem, such as the social and human aspects were often neglected. Many water projects are implemented as crash programmes, whereas they should be part of development approach which takes into account the local situation. In an attempt to apply systems theory to rural water supply, Pacey outlines maintenance systems for three situations distinguished mainly by the degree of the community involvement as follows .

* Total community self-reliance in the manufacture and maintenance of pumps;

* Partial self-reliance, with factory-made pumps and villagers partly responsible for maintenance ;

* No community involvement, sturdy pumps are provided and maintained by the Government.

For each of these situations he addresses technology choice and maintenance organization, the level of training, local production potential and quality control

Pacey's ideas form the basis for the systematic approach to maintenance, but do not sufficiently address aspects such as finance, spareparts supply and management organization. These aspects received more attention from Shawcross (1978), who stressed the relationship between the local conditions for maintenance, the organizational set-up of a maintenance system, technology selection and financial resources. He proposed a step-wise decision making process which includes two main stages :

* Selection of general maintenance strategy (comparable with the three 'typical' situations outlined by Pacey) ;

* Definition of the most suitable Organizational set-up on the basis of available governmental capacities and local resources for maintenance.

In the first stage, six key factors are considered: type of handpump feasible in view of prevailing geo hydrological conditions, population density, Government structure, technological level of local society, existing maintenance systems, and socio-economic conditions at community level. Shawcross does not show clearly how the results of this first stage in the process can be used to determine the most suitable organizational set-up, and how users can be involved in the decision-making process.

Field experiences show that local factors are best taken into account by involving users in decision-making. For example, the Yatenga-Comoe village water supply project in Burkina Faso, 24 % of the villages preferred open wells to bore wells with handpumps (BURGEAP, 1986). In some districts in Benin, 60 % of communities refused improvements to their water supply facilities, when their responsibilities were made clear to them. In other districts, where drinking water was scarce, almost 100 % of villages accepted fully these responsibilities and contributed towards maintenance. Experience in other African countries (Diluca,1983) indicate that early user involvement and clear agreement on responsibilities may lead to lower maintenance costs and more reliable functioning of facilities.

Considering the growing success of these, and similar efforts, the systematic approach seems to be the most viable approach to maintenance.

3.3.3 Different types of maintenance systems in India

Previously in India, the Govt. departments used to construct wells and install handpumps with out any special arrangements for maintenance and repair of pumps. The advantage of this approach is that the Govt. can standardise equipment and ensure a satisfactory well construction and the use of suitable handpumps. The great disadvantage was that the Govt. did not handle an organization or an agency to carry out routine maintenance. This maintenance system or rather the lack of it generally produced poor results. With the responsibility of the maintenance of the pumps completely left to the local bodies/Panchayats, as many as 80% of the pumps were inoperative within two years after installation.(Ghosh,1995)

(i) Three tier maintenance system

After a great deal of efforts and research a new system known as "Three-tier system" was developed and first used in the state of Tamilnadu. In Tamilnadu until August 1976, all handpumps whether installed by the state Govt. or by the Panchayat Unions were formally under the maintenance of the village Panchayat concerned. Due to the limited financial resources of the village panchayats and the non-availability of skilled mechanics in the rural areas, there was no

proper maintenance of the pumps. A very high portion was, in fact out of order. The Govt. by order dated 3rd August 1976, entrusted the responsibility for the maintenance of the handpumps to the Tamilnadu water supply Drainage Board. This system has been successful in reducing the number of inoperative handpumps. The three-tier maintenance system provides for maintenance attention at Village, Block and District level.

(a) Village level . With the general consent of the villagers, a person, who resides close to the handpump is selected for the job. He or She may either be an artisan, a literate farmer or a social worker. This caretaker will be given a two day orientation course on the importance of safe drinking water supply, the mechanism of the handpump and the failures that might occur to the pump. He will be trained and expected to attend to minor repairs and is supplied with the basic tools necessary. He is also provided with pre-stamped and addressed post cards, which list in the regional language, the possible problems that might arise. When such a breakdown occurs, the caretaker will indicate on two post cards the type of repairs needed and post one to the block level fitter and the other to the District mobile team of the Tamilnadu water supply and Drainage Board. The functions of the caretaker are

* attending to minor handpump repairs;

* educating the community on how to protect the water supply;

* sending information to the block level fitter and district mobile team whenever there is a breakdown in the handpump.

(b) Block level : One fitter is appointed at the block level for every 100 handpumps under the administrative control of the Block Development officer and the technical supervision of the Tamilnadu Water Supply and Drainage Board.

Upon receipt of request from caretaker, the fitter will proceed to the village and attend the repairs

(c) District level : In the case of major repair, it is the district level team which will proceed to the village immediately upon receipt of the card. If there is a large number of repairs to be carried out, the help of the Assistant engineer at the Tamilnadu Water Board is sought.

From experience, it has been discovered that one mobile team can not effectively cover 1000 handpumps and the Tamilnadu water Supply and Drainage Board has, therefore, recommended one mobile team for every 500 handpumps. The objective of the maintenance system for the handpump is to attend to any repair with in seven days (known as "SEVEN DAY RULE").

The first tier of the three-tier maintenance system i.e. the village pump caretaker is essential to the success of the whole system. Unless the maintenance staff at the Block and District level is informed promptly when a handpump breaks down, repairs will be delayed and the maintenance system will not function as intended. Training courses for pump caretakers were , initially organized in one block of each district with UNICEF assistance. One follow-up camp was then

conducted per block by the district development officers concerned with the assistance of the Tamilnadu Water Board. After three months, were given a refresher course during which caretakers for newly installed handpumps and substitutes for any drop-outs were trained.

The village caretaker is a volunteer and receives no payment from the Govt, but his position carries some prestige. the maintenance duties are shared between the village caretakers, the block level mechanic and the mobile team at district level. The cost of maintenance is mainly borne by the Government but through the pump caretaker the community is involved in the care of its pump. As a part of his training, the handpump caretaker is informed of the importance of good hygiene and of safe drinking water supply. It is the intention that the caretaker will become a health education provider in the village. In some states, the mobile team will use an exchange system for pump servicing. It means that instead of carrying out repairs on the spot at the well site, they will fit anew reconditioned pump and take the old pump to the workshop for servicing and repair. This process speeds up the work of the mobile team, ensures that the handpump they leave is in good condition and it allows repair work to be carried out in the workshop. (Ghosh, 1995)

(ii) Two-tier System

In some of the states like Andhra Pradesh, Karnataka, two-tier system maintenance of handpumps is being followed which may be considered as an improvement over three tier system and advocated by the UNICEF after evaluating the working of three-tier system in some states. One of the reasons for adopting this system is the increase in number of handpumps at Block level which is beyond capabilities of the handpump mechanics since the major repairs require lifting of pump for which at least 2 or 3 persons more are required.

The system comprises of the usual caretaker being nominated in each village (at the rate of one per handpump) Who is to look after the minor repairs above ground level of the hand pump which includes the tightening the bolts and nuts and greasing. In addition, he will also take immediate action to inform the mobile unit at the Block level when ever a major repair has to be carried out for the pump. He will be provided with two spanners, grease and some postcards which will be useful for the purpose These caretakers are selected from among the people who are living close to the handpumps and who have bent of mind of carrying out social/voluntary work. A scheme has been evolved to train these caretakers for two days in the proper upkeep of the Handpump, and also to impart necessary health education to the people. He will also be responsible for the proper drainage of excess or split water around handpump and keep the environment clean.

The second stage of maintenance is the provision of having the mobile unit at Block/ Taluk level comprising of a mobile van with a driver, a mechanic three helpers (out of whom one is mason). It has been analysed by the UNICEF that one mobile van , comprising of these personnel can conveniently look after 500 handpumps in a Taluk and this system is being followed in some states for the timely repairs of handpumps

In addition to the above, Karnataka has evolved a novel method called as " Route map system " wherein, a taluk is divided conveniently into 6 or 8 segments depending on the area. The mobile van will start from the Headquarters on Monday and move on a specific route to cover one segment to return on Wednesday evening to headquarters. The van will then leave for the second segment on Thursday morning and return to headquarters on Saturday evening. Sunday will be utilised for the normal maintenances of the van and replenish necessary spares for the next tour. In this way, the complete Taluk is covered at least once in 3 weeks/month to visit all habitations in the Taluk for checking all handpumps for preventive maintenance and also repairing the handpumps requiring major repairs below ground level. The dates on which the mobile unit goes to a village is intimated in advance and the concerned caretaker and other villagers will be present while the mobile unit carries out the repair work. This has infused a sense of involvement by the villagers in the proper up keep of the handpump which is meant for them.

The repair work is carried out at the taluk level only, which is decentralised from the District level as contemplated in the three-tier system. It is expected that the maintenance cost on the mobile van will also be economical in this system compared to the van going in all directions in the Taluk whenever a report of failure is intimated.(Charless Kerr, 1989 ; Ghosh,1995)

(iii) One-tier maintenance system (Rajasthan System)

In this system, handpumps after their installation are handed over to the Gram panchayat or the representatives of the Panchayat samithis for their maintenance. These bodies carry out their maintenance through a fitter or a handpump mistry. The handpump mistries are identified selected by Panchayat samithis. These persons are selected from the list of beneficiaries eligible for financial help under the Integrated Rural Development Programme (IRDP). To be eligible for this training, a person should have completed school education up to standard VII and should be between 18-23 years of age. They are trained for this work either under the TRYSEM (Training of Rural Youth for Self Employment) Programme or at the Social welfare and Research centre, Tilonia or ITI certificate holders. The mistries usually local persons and part time employees of the Panchayats.

The decision to introduce this system was reported to have been taken to decentralise the maintenance system, reduce the cost and shorten the delay in repairing the pumps. The Public Health Engineering Department (PHED), however, it was envisaged, was to provide the necessary support in areas where such handpump mistries would not be available.

The mistries are also given Rs 200/- per handpump per year (Rs 150/- as their remuneration and Rs 50/- for replacement of minor parts), and they are responsible for the maintenance of 30 - 40 handpumps in the area. A sum of Rs. 3750/- is given to them initially (partly as loan and partly as subsidy) under the IRDP programme. With this the mistry purchases a cycle and toolkit for repair.

In addition two campaigns for major and minor repairs of handpumps are carried out by the state PHED, every year for a period of 15-20 days for repair and maintenance of handpumps. The mistries are also involved in these campaigns. Even though the handpumps remain under the administrative control of Panchayats, the provision for repairs of handpumps is made in the budget of PHED and the funds are then transferred directly to the Panchayat Samithis. In addition complaints regarding the handpumps as and when received by the Executive Engineer, PHED are also attended.(Charless Kerr, 1989 ; Ghosh,1995)

3.3.4 Organizational set-up

An effective hand pump system is not simply a technological object but a conglomerate of technology, institutions and people - individuals who must plan, design, manufacture, finance, purchase, install, operate, maintain, oversee and use the pumps. A large number of hand pump systems requires a central organization set - up for planning, funding, engineering, purchasing, construction, training, supervision and control. The central organization is also responsible for administering the national program and policy. To describe an organizational set-up the following parameters can be considered.

(i) Staffing

To keep the handpumps in a proper and reliable manner, certain physical activities are required. For performing these activities certain staff are needed. The pattern of staffing of handpump maintenance depends on choice of system chosen for maintenance. An important factor is the scope of hand pump programme, both in terms of number of handpumps as well as area covered. In deciding the staffing pattern, factors such as distance, accessibility and density of handpumps, frequency of inspections and repairs necessary are essential considerations.

The norm of one pump mechanic for 50 pumps and a mobile team consisting a van, driver, one pump mechanic and two helpers for 500 pumps is recommended. Alternatively the pump mechanic should be given a moped instead of a bicycle for quick movement, so that he can cover larger number of pumps. (In case of three-tier system) (Ghosh,1995)

(ii) Management system

Main areas of responsibility involved in maintenance include overall management, preventive maintenance, repairs, spareparts supply, revenue collection, training and monitoring. Prior to implementation a detailed analysis is required for realistic division of responsibilities, roles , powers and limitations to appoint required staff. The degree to which the user can assume certain responsibilities will vary accordingly to available resources and capacities. Devolving tasks, responsibilities and risks to local institutions needs to be authorised formally and reflected in the legislation (IRC ;1987).

The overall management of operation and maintenance of handpumps comprises of the following main activities.(RGNDWM, 1993)

* Defining the preventive maintenance schedule
* Identifying the agencies to carry out repairs as and when needed
* Employing the operation staff, ensuring training
* Setting up the procedures for procurement of spareparts
* Ensuring required manpower and training
* Establishing the backup support
* Supervision / inspection on the maintenance
* Monitoring of the performance and Feedback to evaluate the performance.
* Arranging for collection of revenue
* Preparing annual budget estimates for operation and maintenance and arranging the funds and responses.

In the overall management , attention will be paid as to how best these activities can be performed effectively. It includes the procedures adopted for receiving the complaints i.e the communication system between the users and caretaker / pump mechanic / mobile team and also to look after that how efficiently these complaints are being attended. It is also comprises the distribution system for spareparts and man power development, training of handpump care taker to perform the preventive maintenance effectively.(IRC, 1987)

(iii) Supervision

Supervision of maintenance system consists of the formulation of objective standards and inspection and reporting on the functioning ,use of the facilities and equipment. It is essential to set objective standards. Items on which standards are need to be set are

* number of visits of the care taker
* number of visits of the pump mechanic
* maintenance of registers in stock keeping and distribution of spareparts
* acceptable number of breakdowns
* acceptable breakdown period
* level of preventive maintenance
* quality of spareparts and repairs

The data reported during the supervision should be compared with the objective standards and the required action will be taken in case of sub standard functioning of the system. When ever possible the collected information should be used to check the performance of the system, agency staff and the caretakers with respect to the objective standards. A healthy competitive spirit should be initiated by instituting prizes and awards for the best annual performance by the field staff. On a state level three prizes should be awarded to the best three handpump mechanics / maintenance unit for outstanding performance (Ghosh.G, 1995)

(iv) Monitoring and control

Monitoring of a maintenance system involves the formulation of maintenance standards and the collection, processing and interpretation of data functioning and use of facilities and equipment. It is essential to set objective standards according to which a system could function. Items on which standards need to be set are shown below.

* Quality of installed facilities
* Water consumption / Provision per pump
* maximum number of users per water point
* acceptable water quality
* acceptable number of breakdowns
* acceptable breakdown period
* Quality of spareparts and repairs
* level of preventive maintenance
* cost of maintenance
* revenue collection
* users satisfaction

The data collected in the monitoring process need to be compared with standards and action needs to be taken in case of sub-standard functioning of the system. When ever possible the collected information should be used to improve the performance of the systems, the agency staff and the responsible community members. Careful monitoring will also enable timely modifications of the water supply or the maintenance system, in order to meet the agreed standards on a continuous basis (IRC ; 1987).

Monitoring and evaluation should focussing issues related to sustainability such as quality of the constructed water points, their usage, performance, maintenance, health awareness in the communities, the level of the community participation in the decision making, and the results of training of local people. The whole water supply system should, at all levels, be evaluated, to identify possible weak points and verify whether applied methods and systems were adequate. The kind of monitoring and evaluation activities depends on the maintenance system largely. It will be clear that data have to be gathered from all levels involved. In many cases an awakening will be needed, of those having responsibility for data recording and collection, of the importance of monitoring and evaluation.(Albert Buiten Huis ;1993)

Quality control is also important and should include regular checks on the technical equipment installed, which sometimes could be carried out at the factory. Manufacturers may be given a contract to provide equipment provided they are prepared to accept or carry out regular quality checks. Also the quality of the installation and repair of equipment needs to be monitored. When maintenance is left to the private sector a contract could be awarded to those prepared to provide quality service . Quality control is only possible when standards are agreed upon and linked to formal contracts indicating the rights and obligations of users, suppliers and responsible persons. (IRC ;1987).

3.3.5 Performance of the maintenance system

In the past, there have been serious problems with the poor performance and short working life of most handpumps used for community water supply. Some of these problems are associated with handpump design, selection and quality of manufacture. Others are rooted either in the behaviour of handpump users or in the Organization of handpump installation and maintenance programme. Review of a number of handpump projects indicates that handpump failure maybe attributed to one of the following (Arlosoroff, S. Et al., 1984)

(i) Lack of institutional infrastructure, proper maintenance, spareparts, trained personnel and appropriate budgets.
(ii) Pumps which are not designed for continuous use by entire communities nor for repair and maintenance by villagers.
(iii) Improper bore hole design and construction.

Hence to keep handpumps in well functioning, the performance of the maintenance system should be efficient. The performance of the maintenance system can be assessed from the following parameters.

1. Functioning of the handpumps

Functioning of handpump directly reflects the performance of the maintenance system. A normally functioning handpump should be able to supply adequate quantity of safe water for the domestic needs of the users. The normal parameters which may have an effect on the normal functioning of handpump systems are

(a) Pump discharge
(b) Leakage
(c) Breakdown frequency
(d) Average downtime
(e) Use of handpump
(f) Water use

(a) Pump Discharge .

Commonly used hand pumps in Andhra pradesh are India mark II Type. They are single acting reciprocating pumps. The theoretical rate of discharge of a single acting reciprocating pump is a function of cylinder volume (V) swept by the plunger during its upward, pumping stroke and the number of plunger pumping strokes per unit time(N). Hence the Discharge, Q = V * N

The actual discharge normally varies slightly from the theoretical discharge due to failure of valves to close instantly when the plunger changes direction and to back leakage between the plunger and the cylinder wall during pumping

(b) Leakage

A handpump is said to have leakage when no water is discharged from pump with in the first three strokes after approximately 5 minutes with out pumping (Arlosoroff, et al., 1984). Obviously leakage in a pump will increase the number of strokes required for the collection of a bucket of water and hence more physical strain and time consumption. Leakage lead to more wear and tear of the pump materials, which can result in frequent repairs and poor performance of the system.

Field tests conducted in Ghana reports "leakage mainly caused by loosened or defective couplings, in the rising main was a major poor performance for the India mark II pumps and particularly at the beginning of the monitoring. This appears to be due to poor installation (Arlosoroff et al, 1984).

(c) Break down frequency

This is the average time span between the consecutive repairs done to a hand pump. Poor performance are often due to problems related to the material from which the components are made, fabrication of components, pump installation and well construction.

The majority of pump failures are caused by material defects or poor workmanship in various pump components including pumping elements, rising mains, rods, bolts and couplings. The failures are

* breaking of rods, couplings ,etc.
* leakages due to defective couplings and corrosion
* hard pumping and rod breakage due to inaccurate tolerances

Many problems are related to lack of adequate care in the installations of hand pumps. They are,

* disconnected pump rods, rising mains, etc. due to improper tightening of couplings, nuts and bolts.
* loosening of pump stands because of bad quality
* hard pumping and extreme wear due to maladjustments or bad alignments of parts of the pumps, and
* entering of dirt and polluted water in to the well if pump stands are not sealed off, etc.

The following problems have been encountered due to poor well construction methods in the field and have an adverse impact on durability; they are,

* Sand, silt and clay in the water
* Pump cylinders that are not immersed, or only partly immersed

(Source : Arlosoroff et al, 1984)

(d) Average down time

Down time is defined as the period of time when the pump is not available for normal use. It consists of ;

* time taken to report a breakdown,
* time lag between the receipt of breakdown report and actually reaching the pump to commence the repair ,
* active repair time i.e, the actual time taken to carry out repairs

It is estimated that 85 % of the India Mark II handpumps remain operational at any point of time. This would mean that the India mark II handpump remains idle for a period approximately 50 days in a year. The ORG report notes that reporting breakdown varies from 4 to 13 days while the time taken to put the pump back in operation varies from 7 to 44 days after the receipt of report. This report points out that, on an average, a Mark II pump remains inoperative for 37 days per year. This not only causes hardship to the community, but also keep the investment idle (Dept of RD, GOI ; 1990).

Item	Cost in Rupees
1. Capital cost	24,950.00
2. Maintenance cost (From table)	874.21
3.Interest @ 12 % per anum on total cost	2994.00
4. Depreciation (15 years approximately)	1663.33
Total (of 2 + 3 + 4)	5531.54

Table 3.2. Cost of down time in India Mark II handpump per year.

Hence the cost of operation per day is Rs. 15.16

When India Mark II pump does not work, the loss is approximately Rs.15 per day. If a pump is inoperative for 37 days in one year, the loss of benefits to the community in indirect financial terms will be Rs.561 per year. Apart from this the loss of time involved in drawing water from

a more distant source and the potential adverse impact on the health community is also significant. (dept. Of RD, GOI ; 1990)

The high down time of the mark II is possibly due to the following factors.

* delay in reporting breakdown;
* communication delays;
* delay in taking action on receipt of breakdown report; and
* use of non-standard spares and faulty installations.

The higher the down time, the lesser will be the functioning of the system.

(e) Use of handpump :

This can effect the functioning of the handpump. As per the latest national guidelines, a basic service such as a hand pump / stand post has to serve a population 150. But there are habitations with population ranging from 400 - 500 people sharing a single hand pump / stand post. In such cases, the pump will not adequate to meet the demand in summer season which leads the people back to their un safe traditional sources.

(f) Water use (Volume of water collected per house hold)

Human body needs about 3 to 10 litres of water per day for normal functioning depending on climate and job conditions. Part of this water is obtained from food. The use of water for food preparation and cooking is relatively constant The amount of water used for different purposes varies and influenced by the type and availability of water supply. The factors influencing the collection of water are cultural habits, pattern and standard of living, cost and quality of water.

The use of water for domestic purposes can be classified in to various categories, such as for drinking, cooking, , personal hygiene, washing (dishes, clothes), garden watering (vegetables), cattle feeding. Water use and consumption rate are expressed in litres per capita per day. (lpcd). Although such data neglects the fact that in a house hold a considerable part of water use is shared by all members of family (e.g. for cooking, cleaning), per capita daily water usage data are useful for making rough estimates of a community water demand.

(ii) Visits of the mechanic :

The efficiency of the Organization depends mainly on the the maintenance system expenditure. This mainly depends on the type of the technology and the selected maintenance system. The efficiency of the organization system can be assessed by knowing the number of staff working for O & M of handpumps, number of staff per number of pumps (in different levels in the two-tier and three-tier systems). As per norms one pump mechanic has to look after the maintenance of the 50-75 pumps and visit each pump once in two weeks and the caretaker has to look after preventive maintenance once in a week Where as in the one -tier system where there is no

caretaker, the pump mechanic has to look after the preventive maintenance of the pump also. In this case he has to visit the pump at least once in 10 days. The number of the visits of mechanic per pump i.e, how often he checks the performance of the pump depends on the number of staff per number of pump.(Ghosh, 1995)

The following table gives the maintenance cost arrived for the centralized maintenance system (three-tier system) adopted in the Coimbatore project. The following assumptions are made for arriving at the maintenance costs . (Source : Dept. Of RD, GOI ; 1990)

(i) one caretaker for each handpump;
(ii) one block mechanic can repair 1500 pumps in one year;
(iii) one mobile team with a van can repair 300 pumps per year;
(iv) cost of spare parts have been calculated based on the frequency of replacement of each spareparts.

Item	Rupees
(a) Caretaker	40.00
(b) Block mechanic	18.610
(c) Mobile team	392.10
(d) Spareparts	423.50
Total	874.21

Table 3.3 Maintenance cost of centralized maintenance per pump per year for India Mark II hand pump

(iii) Condition of the pump and platform :

Badly constructed platforms leads to loosening of the foundation of the hand pump. The heavy use of bad quality materials and improper construction methods can result in broken platforms and drainage systems of handpumps This ultimately affect the stand assembly and loosening of which may develop more wear and tear of pump components. Wear and tear of these components will lead to more number of breakdowns finally affects the functioning of handpumps.

Broken plat form, broken drain and stagnant pools of water due to bad drainage conditions may force the people to abandon the handpump.

Poor pump conditions such as more play of handle, damaged bearings and leaking water tank may reduce the easiness of operation which may result a lower discharge from the handpump. Moreover the damaged bolts, signs of corrosion may result the lower interest of the people and may cause rejection of the source This indicates the poor performance of the maintenance system.

(iv) Pump environment

Poor pump environment such as source of pollution, stagnant pools of water near the periphery of the handpump site may infiltrate in to the ground and pollute the ground water, finally cause spreading of endemic diseases. This also result the lower interest of the people to use the handpump and may cause abandoning of the handpump. This indicates the users involvement in the upkeep of handpump and pump environment.

(v) Community / users involvement

Involvement of the users is seen as a way to obtain cheap "self-help" labour in a few cases. While creation of water committee suggest that users are involved in decision making, this practice is often limited to the organization of village labour and appointment of caretaker. In most cases both users and local authorities are involved only on adhoc basis and don't really influence decisions concerning technology choice, planning and organization.(T.Bastemeyer et al, 1987)

Community participation and users satisfaction is essential in recognizing the deficiencies of the traditional water supply, in the planning of safe drinking water system, in preparing a budget, in accepting external assistance in construction and operation and maintenance. All sections of the community may not be capable to participate in this process and hence there is a need to organize the community for participation. This participation is of full when the community is involving in the decision making process. (Reddy ; 1995)

Women's participation proved to be essential for maintenance facilities. Evaluation of two handpump projects in Malawi show that well committees formed to maintain site hygiene neglected their work in many cases. Another factor was found to be the absence of an arrangement on the duties and rights of the village committees. Therefore more attention is now being paid to community involvement, including the women, in local planning of well projects and in site management, and supervision of these arrangements by mixed village committees. One outcome of the discussions on management committees was that villages do not question whether women should be involved, but whether men should be involved. Another outcome was the good hygiene perceived during field-work in the area, for which the women members of the village committee are especially responsible. When women are involved in maintenance arrangements they should be consulted as a group rather than as individuals to find a joint solution. Although women's groups have been quite effective in carrying out tasks assigned to them, greater benefit would be derived by projects and users, if these groups were also involved in management decisions. This refers particularly to the organization of the work and the use of water at source.(Wijk-Sijbesma et al, 1985)

Chapter 4

RESEARCH METHODOLOGY

4.1 Introduction

Research is an inseparable part of human knowledge. Its role in human life is as precious as that of salt in a vegetable. Research is an important pre-requisite for a dynamic social order. Society has marched on to its present form with the help of constant research and investigation. Research should never be treated as a piece of compilation of work. By reading a number of books and compiling their material in yet another book is no research. Research must be based on facts. Observable data forms a sound basis for research. Inductive investigations lend greater support to research findings. For analysing facts a scientific methodology of analysis must be developed and results interpreted logically.

The modern concept of research is, therefore broad-based and provides for a meaningful investigation into any field of academics. Research these days is treated as advancement in knowledge acquired through scientific methods. According to P.V. Young, social research may be defined as a scientific undertaking which, by means of logical and systematized techniques seeks to ;

(i) Discover new facts or verify and test old facts;

(ii) Analyse their sequences, inter relationships and causal explanations which were derived within an appropriate theoretical frame of reference;

(iii) Develop new scientific tools, concepts and theories which would facilitate reliable and valid study.

According to John Best, research is a more systematic activity directed towards discovery and the development of an organised body of knowledge. (A.N.Sadhu and Amarjit Singh; 1985)

This chapter describes the methodology adopted for the present study. The chapter consists of five parts, in which the first part describes the key themes and corresponding indicators selected for the study and their relationship with functioning, use and maintenance of handpumps. The rest of four parts describe the various methods adopted for data collection i.e, selection of sample villages, Organizing field works, observation procedures adopted in the field, interview procedures and water resource mapping.

4.2 Description of Key issues and indicators

In the systematic approach to describe the organizational set-ups for operation and maintenance of hand pumps in Andhra pradesh and to compare their performance, some parameters which have a direct influence on the Organizational set-up and O & M of hand pumps are selected as

key themes for the present study. Their effect of influence can be measured and compared with reference to the guidelines set by the National Government, Design Parameters and Literatures for conclusions.

The following are the key issues

4.2.1 Organizational set-up.

In the present study to describe the existing organizational set-up for operation and maintenance of hand pumps in Andhra pradesh the following themes and corresponding indicators are selected. (McJunkin, 1977 ; Batemeyer, Visscher, 1987)

(i) Staffing

To keep the handpumps in a proper and reliable manner, certain physical activities are required. For Performing these activities certain staff are needed. The efficiency of the Organization system can be assessed by knowing the number of staff working for O & M of handpumps and the number of staff per number of pumps (in different levels in the two-tier and one-tier systems). Indicators selected for this theme are number of staff in the organization, number of staff per number of pumps and their roles and responsibilities. Source of information is office files, records and literature.

(ii) Management system

Main areas of responsibility involved in maintenance include overall management, preventive maintenance. repairs, spare parts supply, training and monitoring. Hence to know the management system, how does the overall management work and the procedures adopted for receiving and attending complaints should be known. Also data related to the training and spare parts supply has to be collected. Data regarding this theme was collected from the existing files, records in the office and during the interviews with the officials.

(iii) Supervision

Supervision of maintenance system consists of the formulation of objective standards and inspection and reporting on the functioning and use of handpumps. It is essential to set objective standards. Indicators selected for this theme are objective standards and procedures adopted for supervision in the existing system. Source of information is guidelines set for supervision, office records and interviews with officials involved in the supervision process.

(iv) Monitoring and *Feed back*

Monitoring of a maintenance system involves the formulation of maintenance standards and the collection, processing and interpretation of data functioning and use of facilities and equipment. For this process also, it is essential to set objective standards according to which a system could

function. Feedback is to evaluate the performance. Indicators selected are monitoring criteria and procedures adopted for monitoring and feedback and the source of information is guidelines for monitoring, interviews with the officials involved.

(v) Equipment

In countries with less developed infrastructure transport is difficult. Certain equipment and vehicles are required for an organisation to look after the maintenance of the handpumps which are located at far and remote places. Hence indicators selected for this theme are details of the equipment and vehicles for transport and the number of handpumps they maintain. Source of information is office files and records.

4.2.2 Performance of the maintenance system

The main issue to review the performance of maintenance system is the functioning record of the pumps and the frequency of the visits of the mechanics / caretakers. Furthermore users satisfaction is an important theme. Finally an impression of the condition of the pump and platform and pump environment was obtained.

(i) Functioning of the handpump

A normally functioning handpump should be able to supply adequate quantity of safe water for the domestic needs of the community. Four parameters have been selected to assess the performance.

① pump discharge : Poor pump discharge is an indication of the wearing of the pump and effectiveness of the repairs. In order to investigate this issue, discharge of each handpump is measured in the field tests. Indicator selected is volume of water produced per minute at 40 strokes.

② Leakage : This has been measured in the field for each handpump. Indicator for this theme is number of strokes before water is produced.

③ Breakdown frequency : The breakdown frequency reflects the performance of a maintenance system particularly in terms of quality of repairs. Data have been collected during the field interviews with the households, personnel involved in the O & M of handpumps. Indicator selected is number of breakdowns per year.

④ Average down time : This clearly indicates the performance of the maintenance system. The average downtime for each handpump was collected from field interviews with households, pump mechanics / caretakers. Indicator is time between breakdown and repair.

The fore mentioned indicators are also be affected by the frequency and the volume of the use. Therefore these two themes were also assessed as follows.

(a) Use of handpump : The average number of persons using the handpump has been collected during the field interviews with the households. Indicator for this theme is average number of users per handpump.

(b) Water use : This parameter combined with the number of users indicates the use of handpump. Indicator selected for this parameter is Volume of water collected per capita per day.

(ii) Visits of Pump mechanic / Caretaker

The average visits of pump mechanic / caretaker for each pump gives an idea about the inputs that is provided by the system. This has been collected from the field interviews with the households/users. Indicator selected is number of visits of mechanic per pump per month.

(iii) Condition of the pump, platform and drainage system

Condition of the pump, Platform and drainage conditions may indicate the quality of installation and effectiveness of the possible repairs. This was observed in the field visits with a preprepared observation sheet.

(iv) Pump environment

Bad Pump environment such as source of pollution near the pump, stagnant pools of water near by etc. gives an idea about user / community involvement in the upkeep of the pump and pump environment.

(V) Users satisfaction

This gives user views about the performance of the mechanic / caretaker which directly reflects the performance of the maintenance system. Data related to this theme was collected during the interviews with the households.

4.3 Methods of data collection

4.3.1 Preliminary investigation

To select the study area, a preliminary investigation regarding the hand pump schemes in the Andhra Pradesh state was done initially to get information regarding the areas where there is large number of hand pumps and extensive use of hand pumps and less availability of other water sources. Also noting the information about the geographical location and climatic conditions, two districts were chosen for selecting study areas where there is two-tier and one- tier maintenance systems are existing.. Out of these two districts four Mandals are taken. Due to time constraint, only eight Gram Panchayats out of these four mandals are selected for the study.

4.3.2 Sample selection

The primary purpose of the research is to discover principles that have universal application. Research therefore needs, adequate and accurate data for this purpose. In order to obtain these data, a researcher conducts investigations into a given population. Information, thus, can be often be derived quickly and cheaply and with sufficient accuracy from a sample of the total. Sampling refers to the investigation of part of the whole population. A sampling procedure is a technique of selecting a sample from a given population. A statistical sample according to, Calvin, is a miniature picture or cross-section of entire group or aggregate from which the sample is taken. In short, sample represents the whole population and by observing the sample , certain inferences may made about the population. For collecting representative data, samples are not selected haphazardly but a proper procedure is adopted, so that the influence of chance and probability can be estimated.

The important considerations in selecting a sample is to see that it is closely representative of the universe. The size of the sample may not be a guarantee of its being representative of the population. Some times a large sample poorly selected may not prove to be a true representation of universe while a small sample properly selected may be much more reliable. (Sadhu.A.N, Singh.A ; 1985)

The selection of Mandals was such that where there are few traditional sources and most of the water supply is provided by hand pumps. The Panchayats located in the selected Mandals differ in their traditional water sources, terrain, rainfall, population density, distribution pattern etc. Hence the following information on the number of handpumps, public dug wells, ponds, springs etc. in the selected Panchayats are collected from the related GP and Mandal offices. These have been obtained from official records of Panchayats and the sub-divisional offices of PRED and also by enquiring with the key-personnel in these Panchayats. The criteria for selection of Gram Panchayats included ;

(i) *should contain population less than 5000*
This is considered as the time available for data collection was limited

(ii) *operation and maintenance of handpumps by PRED under one-tier and two-tier maintenance systems.*
As all the handpumps in the state are being maintained by PRED, four panchayats, where there is two-tier system is existing and another four Panchayats where one-tier system is existing for O &M of handpumps are selected to review the performance.

(iii) *Availability of traditional water sources*
Panchayats are selected in consideration with similar local conditions i.e, confirming that in all the selected Panchayats there is more use of handpumps and less existence of traditional sources.

4.3.3 Selection of Panchayats :

To review the performance of the maintenance of handpumps under the PRED with one-tier and two-tier maintenance systems, two Districts are chosen for study. They are,(i) Ranga Reddy district where there is two-tier maintenance system for maintenance of handpumps is existing and;(ii) Ananthapur district where there is one-tier system is existing for maintenance. The Mandals and the related Panchayats in these districts vary widely according to their size, elevation, location, geography, water sources, climatic factors. Considering the above said selection criteria, two Mandals in Ananthapur district and one Mandal in Rangareddy district are selected for the study. They are Kalyandurg, Beluguppa, and Shameerpet respectively.

The Mandals Kalyandurg and Beluguppa (Ananthapur district) consists of 14 and 15 Gram Panchayats respectively and totally 4 Panchayats i.e, 2 Panchayats under each Mandal are selected for the study. Where as Shameerpet Mandal(Ranga Reddy district) consists of 20 Gram Panchayats, hence all the 4 Panchayats are selected in this Mandal only, as it consists of larger area. The details of the Panchayats are given below :

Table. 4.1 Details of the Panchayats selected for the study

S.No.	Name of the village	Name of the Mandal	Name of the District
1.	Shameerpet	Shameerpet	RangaReddy
2.	Lalgadi Malakpet	Shameerpet	RangaReddy
3.	Pothaya Pally	Shameerpet	RangaReddy
4.	Balajinagar	Shameerpet	RangaReddy
5.	Borampalli	Kalyandurg	Ananthapur
6.	Ontimidde	Kalyandurg	Ananthapur
7.	Doddikunta	Beluguppa	Ananthapur
8.	Gangavaram	Beluguppa	Ananthapur

These villages are visited by the author and some of the handpump sites located in these villages were visited and interviews with the surpanches about the use and maintenance of handpumps were held.

4.3.4 Collection of data from various sources :

(i) Literature review

The present system of operation and maintenance of handpumps in the state of Andhra Pradesh is studied in the terms of functioning and organizational aspects. The literature related to the different systems for O & M of handpumps was collected and the possible alternatives to improve the performance of the maintenance system were studied.

(ii) O &M of the scheme by the PRED :

At present the PRED is maintaining the handpumps in the state. All the routine and regular preventive maintenance and breakdown maintenance are being done by the PRED only. The handing over of maintenance of handpumps to the GPs is still at initial stage. To know the guidelines, operational procedures in the maintenance of handpumps by PRED, the offices are visited and the departmental personnel are interviewed. The following information is collected from the PRED.

* type of organization
* history of organization
* activities of PRED
* details of handpumps under PRED
* system followed for the O &M handpumps
* staffing pattern for O & M of handpumps
* O & M cost
* O & M procedures
* problems faced during O & M

The details regarding the policies, approaches and the steps taken by the department for effective and sustainable operation and maintenance of handpumps are collected from the office of Engineer-in-chief. The information about the Organizational set-up and the details of handpumps, staffing pattern required for maintenance were also collected from the office of Engineer-in-chief. The O &M cost details of handpumps in one sub division for the year 1995-96 is collected from office of Deputy Executive Engineer, Kalyandurg Sub-Division. I, Ananthapur Dist.

The information regarding the monitoring, supervision and inspection procedures followed in the operation and maintenance of handpumps was collected through interviews with the Deputy Executive Engineers and the Assistant Executive Engineers in the Sub- Divisions visited. Problems encountered during the maintenance of handpumps were collected from operational level staff such as pump mechanics, handpump caretakers. Also the pump mechanics were interviewed with a pre-prepared questionnaire The details regarding the training and procedures followed in receiving and attending the complaints, their limit in attending the complaints, frequency of the breakdowns, normal break down time for major and minor problems and the normal downtime are gathered during the interviews with pump mechanics.

4.3.5 Organizing field works

Organizing the field works with the limited time and available communications and travelling facilities in these districts is very difficult. As the Mandals in the Ranga Reddy district are located near by the Hyderabad and Secunderabad cities (Twin Cities), there are more transport facilities available The district Ananthapur is situated about 400 Kms away from Hyderabad and the Mandals located in Ananthapur district are in a scattered manner and with less transport facilities. Hence field visits to these areas are of time taking

The field study was designed to visit the handpump sites to collect the data regarding the performance of the handpump and to collect the data from villages regarding the existence of water committees, water related behaviour of the communities. It was planned to interview the users to know the user views. Full cooperation of key informants was necessary for the efficient data collection. Hence it was decided to get the cooperation of these key personnel from the selected Panchayats. Some of them are Sarpanches, some of them are school teachers and village leaders. Appointments were made in advance with these people and then, the purpose, relevance of the present study was made clear to them.

A field visit was arranged with the key personnel in the beginning. A location map of the handpumps in the panchayat is prepared with help of local people and the key personnel. The map includes the locations of handpumps and the near by traditional sources available. The basic idea was to locate the handpumps in the village and to know the location of other water sources. After the identification of the handpumps, the following observations are carried out.

Data collection methods and techniques

All the selected villages were visited during the data collection and about 3 to 4 days were spent in the each village. Each handpump has taken as a sample in the observation procedure. The details of samples collected from the selected Panchayats are shown in the table below.

Name of the **G.P.**	No. of samples collected
Shameerpet	5
Lalgadi Malakpet	5
Pothaya Palli	5
Balajinagar	5
Borampalli	5
Ontimidde	5
Doddikunta	5
Gangavaram	5

Table 4.2 . Number of samples collected from different Panchayats

4.3.6 Observation method:

In prior to the field visits, an observation sheet was prepared regarding the information on the number of households collecting the water from the handpump, condition of the pump and the condition of the platform and drainage facilities

A water resource mapping was for each handpump location under study was prepared with the help of local community and key personnel. The map includes location of the handpump and the locations of the existing water sources such as open well (perennial / seasonal), springs (perennial/seasonal), rivers, streams and ponds (perennial/seasonal)and any piped water supply. The location of near by traditional sources will indicate whether the use of handpump is regular or not and also to assess the similarity in the local conditions when comparing the two systems..

To assess the performance of the maintenance system and pump condition an observation sheet for handpump site conditions (based on the approach followed by Lloyd and Helmer, 1994) and pump condition are prepared prior to the field visits.

To assess the functioning of the pump, it is observed that whether the pump is giving standard volume of discharge for required number of strokes and. For measuring the pump discharge, a bucket of 15 litres capacity was used. Pumping rate was kept constantat 40 strokes per minute. The number of strokes required to fill this bucket are counted and noted in the observation sheet. This data can be compared with the actual number of strokes needed to give 15 litres discharge as given in the literature. To assess the leakage of the handpump the following procedure was adopted. Pumping was started after stopping the use of handpump for some time. If the pump was able to deliver water with in first three strokes of pumping, it was considered that there is no leakage. If it is not, the pump is leaky and the same was noted in the observation sheet.

The pump condition was assessed as follows. Five factors such as play of the handle more than 3 mm (As per IS: 9301, only 3 millimetres horizontal clearance for the handle was given in the approved design of India Mark II), clear signs of corrosion, whether the pump is noisy because of loose bolts or damaged bearings and lacking grease in chain were studied in detail and noted correspondingly in the observation sheet. 'Yes' or' No' option was given to these each of these items and one 'No' was considered as 'Good', two or three' No's considered as' Moderate' and the rest as' Bad'.

The same method was adopted for assessing the platform site conditions and drainage facilities. A total nine items were considered for the evaluation, one'No' out of nine was considered 'Good' and two or three 'No's are considered as 'Moderate and the rest are considered as 'Bad'. The nine items considered for evaluation of site conditions are given in the observation sheet and the observation sheets used are enclosed as annexure.

4.3.7 Interview procedure :

Selection of households :
According to the research proposal, an interview with the households residing with in the periphery of handpump location to be conducted. The proposal was to conduct interview with 8-10 households residing in the each handpump location within the stipulated time for data collection. The same was trailed during the first visit and found that it is more time consuming and not possible for the selected areas within the stipulated time. Hence the number of households to be interviewed is reduced to 5.

Five households in the periphery of the each handpump location are interviewed with a prepared questionnaire in all the villages. In some locations it was difficult to meet this requirement due to uneven spread of households in the location or as the households are locked their houses to attend their daily jobs. In such cases maximum number of households available with in the radial distance of 250 mts from the handpump and the rest from the households near the traditional sources were interviewed. A total of 200 households are interviewed and the panchayat wise details are given below.

Name of the **G.P.**	No. of house holds
Shameerpet	25
Lalgadi Malakpet	25
Pothayapally	25
Balajinagar	25
Borampalli	25
Ontimidde	25
Doddikunta	25
Gangavaram	25

Table.4.3 Details of the number of households interviewed in the Panchayats

Interviews :

The interview was carried out with a preset user's questionnaire with open and closed questions which is attached as appendix. A source- use matrix was also prepared to know about the use of handpump and other water sources. This user's questionnaire and the source-use matrix were filled for each household interviewed. The main objective was to collect information regarding the number of persons using the handpump, the volume of water collected per day per household, the number of visits of the pump mechanic/ caretaker, the average breakdown frequency of the handpump, the usual down time and about the site management near the handpump, existence of user's committee.

At the beginning of the interview the author introduced himself as one of the PRED employees, but now studying in the Netherlands. It was made very clear that for the time being the author did not represent the Government or PRED. It was also made very clear that the aim of the visit was not to establish any commitment or responsibility for the maintenance of the handpumps. Efforts have been made to get a true picture of the situation and the social life of the community by emphasizing the repeatedly the need to express their views freely and frankly.

The number of people using the handpump is obtained from the interviews. In the rural areas of Andhara Pradesh people use a standard 12.5 litre volume plastic pots or 10 litre volume metal buckets for the collection of water from handpumps. The households were asked about the number of pots/buckets they collect in a day and the same was recorded in the interview sheet. By knowing the number of persons in each household and the volume of water they collect, the consumption rate can be calculated.

The households were also asked about the breakdown frequency of handpumps and are recorded as usual (every month), regular (once in three months) or occasional (more than six months) and also about the number of visits of pump mechanic/caretaker and about their performance. They were also interviewed about the usual down time, the agency responsible for doing the maintenance. The community were asked about the handpump site management i.e about the cleanliness at the pump site, existence of user's committee and it's role. All the responses from the households are noted in the interview sheet.

The households were interviewed regarding the use of water sources for their domestic purposes such as cooking, washing, personal hygiene, gardening and cattle feeding etc. and the observations are marked on the source-use matrix sheet. The possible reasons for the non-use of handpump are also noted.

Also the handpump caretakers who were present at the time of field work in the villages were interviewed with the pre-prepared questionnaire The details about their training and number of visits to the handpump site, breakdown frequency, normal breakdown time procedures followed for preventive maintenance and to report the failures and supply of spare parts were noted. The handpump caretakers were also asked about their job conditions and job satisfaction and the responses were noted and recorded.

Chapter 5

RESULTS

Introduction :

For obtaining the desired information, a systematic and scientific analysis of the collected data is required. This can be done in different ways. Classification and tabulation are the two methods adopted in this study for presenting the data in an organised manner. Classification is the process of grouping the data according to their similarities of attributes and other features to present the data in a comparable fashion. (Sadhu and Singh ; 1985)

This chapter begins with the description of the administrative set-up of PRED and then describes the handpump maintenance system by PRED in the selected panchayats and the reflections from the field work done in the selected panchayats. Then it presents the performance of the pumps visited in these Panchayats. Then it gives the description of the communities visited regarding their water source situation and use of handpumps. Then it continues with the user views obtained during the interviews with the users.

5.1 Administrative set up of PRED

The Panchayat Raj Engineering Department (PRED) is vested with the responsibility of providing water supply and appropriate low cost sanitation facilities in the rural villages and about 150 major panchayat towns, in addition to execution of other rural development works like construction of rural roads, rural buildings, minor irrigation schemes up to 100 acres ayacut, all works relating to local bodies, i.e., Zilla Praja Parishad (district level), Mandal Praja Parishad (mandal level) and Gram Panchayats (village level).

The PRED is headed by an Engineer-in-Chief, who is in-charge of rural water supply and sanitation along with overall general administration and assisted by six Chief Engineers, for Rural Water Supply, Roads & Buildings, Minor Irrigation & Watershed, Projects & Designs, Jawahar Rozgar Yojana and Vigilance & Quality Control. The PRED consists of 22 circles headed by Superintending Engineers. At the office of the Engineer-in-Chief, the Chief Engineers are assisted by Deputy Chief Engineers of the rank of Superintending Engineer for RWS & Administration, Monitoring, Panchayat Raj and Jawahar Rozgar Yojana. At the district level, four to six Executive Engineers are in-charge of works. Separate middle and lower level staff look after water supply projects funded by external funding agencies under bilateral assistance. The organogram of the PRED is enclosed as appendix

The entire state of AP is divided into 23 districts and each district is further subdivided into 50 to 60 Mandals. Each mandal comprises 15 to 20 villages. The staffing pattern of the PRED is based on these geographical sub-divisions. The following three hierarchial levels of organization and management can be distinguished in the Panchayat Raj Engineering Department.

Top/Strategic level

One Engineer-in-chief and six Chief Engineers head the PRED wing at state level. The Engineer-in-Chief is responsible for RWS and general administration. They report directly to the Principal Secretary to the Government of AP, Panchayat Raj and Rural Development. This level frames strategies and policies.

Middle/Tactical level

Next in line are the Superintending Engineers. They are accountable to the Chief Engineers. Each Superintending Engineer supervised one district, called a circle. He is responsible for design, planning, analysis and evaluation of works in PRED.

Operational level

Each circle is subdivided into four to six Divisions, which are headed by an Executive Engineer, who is in-charge of approximately 10 mandals. The Executive Engineer reports both to the Superintending Engineer and to the District Collector. The Executive Engineers are assisted by Deputy Executive Engineers at subdivision level, covering 3 to 4 mandals. The Deputy Executive Engineer is the head of the Subdivision. Below this level are the Section Officers, Assistant Executive Engineers (Graduate) and Assistant Engineers (Diploma holder), who are in-charge of 10 to 15 villages. They are assisted by Draughtsmen and Work Inspectors.

This level reports to the middle level. This level is responsible for formulating various operational level work plans for construction, rehabilitation and operation and maintenance. It is responsible for direct administration, operation & maintenance and water supply.

5.1.1 Procedures

All levels from Chief Engineers to Assistant Executive Engineers are bound by the regulations laid down in the Departmental and Financial codes. Each Executive Engineer has a nontechnical office manager, a Divisional Accounts Officer, who assists the Executive Engineer in maintaining compliance with the departmental and financial codes. Only the Executive Engineers are cheque-drawing officers with the district treasury accounts. The Executive Engineer can delegate cheque drawing responsibilities to his Deputy Executive Engineer only. The Executive Engineers are the executive backbone of the department and are the pivotal agents for the whole of the public rural infrastructure.

The Executive Engineer is responsible for proper maintenance of records and is also responsible to his own superiors, to the District Collector, to the departmental officers and peoples representatives.

5.1.2 The mode of operation of Panchayat Raj Engineering Department

The Panchayat Raj Engineering Department estimates the volume of work and the financial implications for a period of five years into future, on the basis of 20 quarterly projections. The financial year runs from 1st April to 31st March.

The annual budget is prepared by the Engineer-in-Chief/ Chief Engineers and presented to the Government, which in turn presents it to the Assembly. The Assembly passes the budget. Based on the approved budget, the Engineer-in-Chief / Chief Engineer allocates funds to all the divisions and to areas of operations depending on the projected work load for the year. Funds are released quarterly.

At project level, there is an annual budget, and a tentative financial plan for subsequent years until project completion or 5 years into the future at a maximum. Financial progress monitoring is done on the basis of a comparison between quarterly budget releases and actual expenditure incurred during those periods. Physical progress monitoring is carried out at works level. Depending on the type and stage of work, different assessment methods are in use.

5.1.3 Operation and maintenance of the Handpumps :

At the beginning of the handpump programme (1967), the maintenance of the Handpumps was handed over to the Gram Panchayats. When this arrangement was found unsatisfactory, the Government took a decision to maintain the Handpumps departmentally. The Panchayat Raj Engineering Department (PRED) has been looking after the maintenance of the Handpumps in the state since 1979.Due to increase in the number of Handpumps at district level (Chapter 1), the mobile team at division level in the three-tier system was shifted to the sub-division level. The Mandal mechanic was dispensed with and accommodated in the mobile team in the two-tier system. The purpose is that the availability of a mobile team at sub-divisional level helps in improved mobility with full equipment and enables coverage of increased number of handpumps (1000-1500) at sub-division Usually one PRED sub-division exists for two mandals to execute Rural development activities including the O & M of Handpumps under the control of Sub-divisional head, Dy.EE. Each Mandal will be looked after by a separate section officer (AEE) with the supporting staff. At present as the requirement of the pump mechanics and the mobile teams has gone up due to increase in the number of pumps over the years, the 2-tier system is being implemented in most of the districts of Andhra Pradesh.

Two-tier maintenance system : This is similar to the two-tier maintenance system, which is described in the Chapter 3. This maintenance system consists of

(i) Voluntary handpump care taker at village level,

(ii) A mobile maintenance team at Sub-division officially to look after 500 Handpumps and also installation of new Handpumps, but in practice dealing with1000-1500 handpumps.

The caretaker (normally an unpaid literate youth who depends on some other job for living and who has been given two days training for this job) is normally responsible for site management around the handpump site, especially for seeing that the drainage system works properly to prevent the build-up of muddy areas and of stagnant water- pools that support mosquito-breeding. The caretakers training also includes some simple health education to make the people aware about the house keeping around the well. He is expected to perform minor mechanical operations. such as regularly tightening the bolts and nuts and applying lubricant (greasing the chain). His other main responsibility is to notify the mobile team when there is a failure or breakdown. He has to inform this by sending a pre-printed, pre-stamped, pre-addressed post card on which he has to make a tick against the appropriate cause of failure which are already listed on the post-card. But it is observed during the the field visits that the caretakers are not attending their duties properly.

The mobile-team at sub-division is a key element and consists of a diesel van and a crew of five members. The crew consists of a driver, one mechanic, one mason and with two helpers, also with a store for spare parts and aworkshop at Sub-division. Each team is supplied with three sets of tools, two for carrying on the van, one for the workshop. One of the set of vehicle tools consists of a special tools for installing the Handpumps and for pulling up the cylinders and rods and also for fishing activities. The team is responsible to the AEE in the Sub-divisional office. The team often looks after 1000-1500 Handpumps doing both preventive and corrective maintenance mainly the repairs of the below ground parts which need heavy tools and equipment. The mobile team has to eventually visit each handpump once in a month for preventive maintenance work where as it is observed from the interviews with the households during the field visits that the visit frequency of the mobile teams are not regular.

One-tier maintenance system : Though it is said to be two-tier system is existing all over the state, it is observed that in some of the districts the first tier i.e handpump caretaker is not existing . This can be taken as one-tier maintenance system. The one-tier system consists of only a mobile maintenance team at sub-division level to look after maintenance of 1000-1500 Handpumps. The tasks carried out by the mobile team are similar to as given in the two-tier system. The details of the Handpumps and staff working and the details of the mobile teams are enclosed as annexure

5.1.4 General provision for O & M

In the initial stage of the handpump programme , an amount of Rs.200 per pump per year was provided for maintenance of Handpumps. The provision was increased to Rs.360 during 1982. In 1992, the Government increased it to Rs.425 keeping in view of the increase in the cost of spares, fuel and salaries of the crew members. The maintenance grant is subsequently increased to Rs.600 per handpump per year, by the Government during 1994 (G.O Ms. No. 581, P.R.D & Relief Dept. (RWS. I) Dt.15-9-94), out of this amount 50 % of the cost is recovered from the Gram Panchayats from the grants payable to them by the Government and the other part also received directly to the PRED from the Government. The details of annual cost of maintenance for each handpump are shown in the figure below.

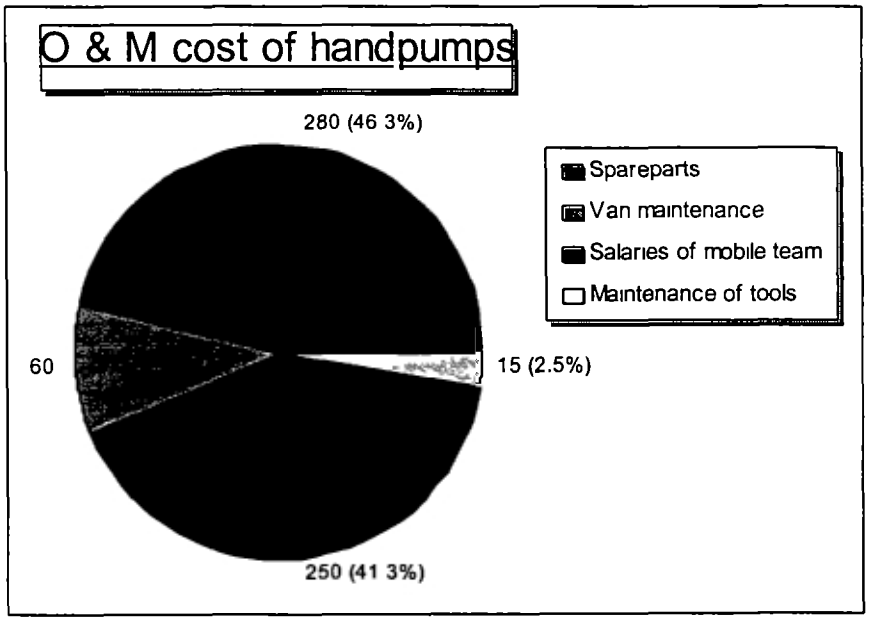


Fig . 5.1 Annual maintenance cost of each handpump

5.1.5 Spare parts supply :

Generally the requirement of spares is assessed once a year at the beginning of the financial year. The assessment of the spares is based on previous experience and suggestions of the section officers (AEEs) concerned. The spare parts are procured on an annual basis by open tendering, or either from the authorized dealers or from the rate contract holders of the PRED, depending upon the nature of material. All the spares are kept under the control of the stores supervisor concerned. The cost of the spares will be met from the O & M budget allocated for Handpumps by the state Government

5.2 Description of the handpump maintenance system in the selected area :

As mentioned in the earlier chapter the mandals and panchayats in the RangaReddy, Ananthapur districts vary widely according to their size, elevation, location and other water sources, climatic factors. As the present study is intended to review the performance of the handpump maintenance system in these two districts, the Mandals and the corresponding GPs were selected considering their size and similar local conditions such as presence of traditional water sources, climatic conditions which will effect the use of handpumps.

(I) RangaReddy District :

This district consists of 15 Mandals. Total handpumps in the district are 7711. Shameerpet mandal is one of the largest Mandals in the 15 Mandals of the Ranga Reddy district and consists of 20 GPs. Total number of handpumps in this mandal are 383. All the 4 GPs selected in this mandal are situated close to the Hyderabad city. These communities have good access to the city and also some of the community awareness programmes taken up by the organizations like UNICEF are taken place in these villages.

Earlier there was three-tier system for O & M of hand pumps with a regional workshop and stores at Hyderabad. Now two-tier system of maintenance is being implemented for the O & M of handpumps under these villages. Mobile team under the two-tier system working under the control of AEE and the overall control of DyEE at the Sub-divisional office located at Shameerpet which will look after the maintenance of 700 handpumps in the two mandals. It is observed during the field visits of the handpumps that only for 15 handpumps out of 20 handpumps, caretakers are appointed for the rest of the pumps there is no caretaker, so these are being served by a one-tier system. The 15 handpump caretakers are also newly appointed and are working since, 1 month before the field visit. All these caretakers include men and women with ages ranging 25 to 50 as against the norms, 18-35 range set by the Govt. These caretakers have been given training for two days for preventive maintenance of handpumps. It is also observed a woman with an age of 50 years, who is not able to do the required maintenance is working as a caretaker for one of the pumps visited The mobile team supposed to visit each handpump once in a month, but in practice they go only every 1.5 to 2 months.. It is observed that some of the staff are living at Hyderabad and the mechanic in the mobile team is living in the mandal head quarters of Shameerpet. They have a District level work shop and stores for spare parts supply at Hyderabad. Registers are being maintained in the stores for the issue of spare parts. Usually the mobile team gathers at the work shop at Hyderabad and start their daily visit.. Post card system is being maintained for reporting failures All the caretakers are given with preaddressed, printed post cards which has to be posted to the sub-divisional office whenever there is a breakdown. Mobile team will attend the repairs based on the priority given for the complaints which are received earlier. A register in the Sub-division is being maintained for complaints.

(II) Ananthapur District :

This is the largest district in the state consists of 63 Mandals and consists of 12479 handpumps. The selected two Mandals out of these 63 Mandals are remotely located. The Kalyandurg mandal consists of 15 GPs and the Beluguppa mandal consists of 14 GPs. The total number of handpumps in the Kalyandurg and Beluguppa Mandals are 294, 201 respectively. The communities selected in these Mandals are located far away from the District Head quarters.

Though it is said to be two-tier system, in practice one-tier system is being implemented here for the maintenance of the handpumps as there is no handpump caretaker in the system. There is a sub-divisional office located at Kalyandurg which looks after all the rural development activities both in the Kalyandurg and Beluguppa Mandals. The mobile team working under the control of

an AEE and under the overall control of DyEE at the Sub-divisional office at Kalyandurg will look after the all the preventive and corrective maintenance of handpumps under these two Mandals. The mechanic in the mobile team has 14 years experience in the handpump maintenance. All the team members live in the Kalyandurg mandal. For the supply of spare parts, there is a stores in the sub-division under the control of AEE with assistance of a work Inspector. Registers are being maintained for the issue of spare parts. The mobile team has to visit officially every two weeks but in practice found in the field survey, this to be once in every three weeks. Postcard system is being used for reporting failures. As there is no caretaker is existing, postcards will be given in the local GP office and whenever there is a failure, villagers will inform to the GP and consecutively GP will inform the failures to the Sub-division office. A register is being maintained at sub-division for receiving complaints and complaints will be attended by the mobile team at sub-division on first come and first serve basis.

5.3 Description of the villages

All villages except Shameerpet (with population of 6000) are small, the population (as per 1981 census) ranging from 2000 to 4,500. All the villages have good access to their Mandal head quarters. Public transport facilities are available for all the villages. All villages have a primary school. A primary health care centre exists only in the Mandal head quarters. The only regular market is held weekly in the Mandals, on Tuesdays. Most of the villages have a telephone connection. This can be utilized for communication between PRED and the community. The geographic details of the villages are given in the table below.

Name of the **G.P.**	Population	Rainfall (mm)	Soil type	Topography	GWT*
Shameerpet	6000	750	Granitic	Undulated	Shallow
Lalgadi Malakpet	4500	700	Granetic	Undulated	Shallow
Pothaya Palli	4000	680	Granetic	Plain	Deep
Balajinagar	4000	650	Basaltic	Undulated	Deep
Borampalli	3000	550	Entisols	Plain	Deep
Ontimidde	2500	600	Entisols	Plain	Deep
Doddikunta	2000	600	Entisols	Undulated	Deep
Gangavaram	2100	600	Vertisols	Undulated	Deep

Table 5.1 . Geographical details of the 8 Panchayats selected

* GWT - Ground Water Table

Socio-economic situation of the community

All villages comprise different social groups. The farmers are the leaders and constitute the richer groups in the villages. These are the influential people and the decision makers regarding their village development activities. Almost all the Scheduled Caste (SC) locality people (10 to 20% of the village population) are landless labourers working in the fields of the farmers. For their livelihood and financial needs, they depend on the farmers. These people are controlled by the richer groups of the community. There is no Scheduled Tribe (ST) population of mentionable size in any of the villages.

The houses in the villages are situated in two clusters. One is the main village and the other one is the SC locality. The SC locality is situated some distance away. The people living in this locality are economically backward. All the houses are constructed with mud walls with thatched roofs consisting of one or two rooms.

The rich people are living in pukka houses constructed with stone or brick masonry with tiled roofs. No factions exist in the villages based on the political parties, except in Kalyandurg Mandal. But even in this Mandal, the political factions are not affecting the water supply system.

Seventy to ninety percent of the habitants are landless labourers. All these people depend on their daily wages. They work in the fields of the farmers . The wages range from Rs: 30 to 40 per person per day. The labourers get work only during the agricultural season. In the remaining seasons, they are searching for work in the nearby areas, where development works are going on such as construction of roads and buildings. Sometimes the labourers are going to nearby towns and factories in search of work. Almost all the labourers own 2 to 5 cattle per household. The annual income of the labourers is about Rs: 2,000 to Rs: 3,000.

The remaining people are farmers. They depend mainly on agriculture. The agriculture is rain-fed. Some of them are marginal farmers, who have less than 5 acres of land. They depend on both agriculture and labour work. The remaining farmers whose farms range from 5 to 10 acres. All the farmers own livestock. The main crops grown are food grains and pulses for daily consumption. The farmers are depending on rain-fed crops only. They are following the traditional ways of agriculture. Availability of mechanised systems, such as tractors for ploughing, electrical pumps, etc., is limited. The usage of fertilizers is also limited, since all crops are food grains and rain-fed and no cash and commercial crops are grown, which require more fertilizers. The economic condition of the farmers is also not allowing them to use fertilizers. In some of the villages paddy fields exist under irrigation tanks. The income level of the farmers is rather higher than those of the labourers. Their average annual income being about Rs: 8,000 to Rs: 12,000. The income of the marginal farmers is less than that of the other farmers.

5.4 Review of the Performance of the maintenance system :

The sustainability of a handpump based water supply depends on condition of pump itself. The pump conditions as well as the pump environment may affect the long term functioning of the handpump systems. To review the performance of the maintenance system for handpumps under PRED, the study looked into the following parameters in all the Panchayats selected.

① Functioning of the handpump.

② Pump condition

③ Condition of the Pump and platform

④ Pump environment and drainage conditions

⑤ Visits of mechanic / caretaker

⑥ Users satisfaction

5.4.1 Review of the functioning of the handpump

To review the functioning of the handpump, indicators selected were pump discharge, leakage, breakdown frequency, Average downtime, Use of handpump and water use.

(i) Pump discharge

Pump discharge is one of the most important in the selection of the type of handpump. The observations obtained from the field tests in developing countries that when users are able to compare different pumps under the same operating conditions, they almost invariably favoured the pumps with highest discharge rate, even though the force required may be relatively high. In extreme cases, the community may reject pumps which produce low discharges, irrespective of the efforts applied (Arlosoroff et al, 1987).

In the present study there were 30 India mark II and 10 India Mark III type pumps out of 40 pumps visited. All these 40 pumps were tested for discharge rate. The field testing of the handpumps were done at 40 strokes per minute. As per Indian standard code Is 9301 for India Mark II specifies at a stroke rate of 40 strokes per minute, the pump should produce 14 litres discharge, where as for Indian mark III it should produce more than 14 litres at 40 strokes per minute, as it is having larger dia rising main. The discharge of the handpump at 40 strokes per minute were tested for all the 40 handpumps and are presented in the appendix. The tables below give the average discharges for India Mark II, India Mark III in the different panchayats in RR district, Ananthapur district respectively

Table.5.2 Discharge of handpumps in four panchayats in RR district. (2-tier)

Name of the Panchayat	Discharge in Litres @ 40 strokes per minute		Total pumps
	India Mark II	India Mark III	
Shameerpet	15,15,13,8#	17.2	5
Pothaipally	15,14, 13.3*, 10*#,-*#	No MarkII	5
Balajinagar	15, 14, 14	17, 16.5	5
L.Malkpet	15,14*, 13*	17, 16.5	5

Table.5.3 Discharge of handpumps in four panchayats in Ananthapur District (1-tier)

Name of the Panchayat	Discharge in Litres @ 40 strokes per minute		Total pumps
	India Mark II	India Mark III	
Ontimidde	15,14,14,14,-	17.2	5
Borampally	15,13,13	17	5
Doddikunta	15,13,8#	17,17	5
Gangavaram	15,14,14,11.5#	16.5	5

It can be seen from the above table that, pump discharge in the case of India mark II is below the standards set by the Bureau of Indian standard of 14 liters at 40 strokes per minute in 9 out of 30 pumps (30 %). Where as in the case of India mark III, all the pumps producing discharge more than 14 lit @ 40 strokes per min.In the one-tier system 8 pumps out of 25 (32 %) are producing below standards and in the two-tier system also 1 pump out of 15 (7 %) are below standards.

(ii) Leakage

Leakage mainly caused by defective or loosened couplings, due to rusted and perforated rising mains, or due to piston seal damages etc.. Can reduce the discharge of the pumpset. In the present study it is found that five out of 40 handpumps are found to be leaky and all poducing lower discharge as well. The details are shown in the tables 5.2 1nd 5.3 (with # mark for leaky pumps).

* Pumps with no caretaker in RR district,
# Leaky pumps
- pump is not functiong

In practice 4 out of 25 pumps in the one-tier system (16 %) are found to be leaky and in the two-tier system 1 out of 15 pumps (7%) are found to be leaky. It is interesting to note that the discharge of handpumps in Pothaipally (RR dist), Doddikunta (ATP dist) are less than the standards was due to excessive leakage of pumps.

(iii) Breakdown frequency

Data regarding breakdown frequency is obtained during the interviews with the households. A total of 200 households were interviewed during the field visits in the two districts. Bsaed on the responses obtained from the households, the number fo handpumnps with different breakdown frequency in the two districts selected are are shown in the following.

Table 5.4 No. of handpumps regarding Breakdown frequency in Ranga Reddy District (2-tier)

Name of the GP	Breakdown frequency (No. of Household responses)			Total
	Often (monthly)	Regular (3 months)	Occasional (> 6months)	
Shameerpet	-	1	4	5
Pothaipally	-	2*	2 (1*)	5
Balajinagar	-	1	4	5
L.Malakpet	-	1*	3 (1*)	5
Total	-	2 (3*)	12 (2*)	20

* handpumps with out caretakers

Table 5.5 No.of handpumps regarding Breakdown frequency in Ananthapur District(1-tier) (based on the household responses)

Name of the GP	Breakdown frequency (No. of Household responses)			Total
	Often (monthly)	Regular (3 months)	Occasional (>6months)	
Ontimidde	-	1	4	5
Borampally	-	-	5	5
Doddikunta	-	2	3	5
Gangavaram	-	1	4	5
Total	-	4	16	20

All the household responses obtained during the field visits regarding the brealdown frequency of each handpump are presented in the appendix. It can be noticed that in the Ranga Reddy District 16 % of households and in the Ananthapur 15 % of households responded that Breakdowns are regular. It is interesting to note that 30 % of households in Pothaipally (RR dist), 30 % in Doddikunta (ATP dist) residing near by the leaky handpumps with out caretakers have opined that breakdowns are regular. In practice 28 % of pumps out of 25 in one-tier system and 14 % of pumps out of 15 in the two-tier system are found with breakdown frequency of once in 6 months and in both the systems India Mark III pumps are found with less breakdown frequency. Details are shown in the Table 5.6

Table 5.6 Number of handpumps based on the breakdown frequency

O &M by	once in 6 months	>6months	> 1 year	Total
2 - tier system	2 (14%)	5 (34%)	3, 5[$] (52 %)	15
1 - tier system	7 (28%)	8 (32%)	5, 5[$] (40%)	25

The opinion obtained from all handpump users were shown in the appendix. Even though a slight variation in households responses is obtained, in general per pump the picture was reasonably uniform.

$ India Mark III pumps

(iv) Downtime

The average down time (the time between breakdown and repair) of each handpump is obtained by interviewing the beneficiary households All the 200 households of 40 handpumps are covered and the details are sown in the appendix. As seen from the appendix, it can be noticed that in RR district 24 % of users opined that down time is more than 3 weeks, and in the case of Ananthapur it is only 9% of households responded that downtime is more than 3weeks. In both the cases 40 % of households responded that downtime is less than 1 week. User responses were very close to each other, which give the impression that the time of repairing the estimate is reasonably accurate. The time taken for handpumps to be repaired, and the number of handpumps with different downtimes in the one-tier system and two-tier system are shown in the table 5.7

Table. 5.7 Number of handpumps based on the average down time.

O & M by	Downtime of handpumps			Total
	1week	2 weeks	3 weeks and above	
One-tier system	5,3[$] (32 %)	10,2[$] (48%)	5 (20%)	25
Two-tier system	1,4[$] (34%)	6,1[$] (45%)	3 (21 %)	15

In practice it is found that in the one-tier system 48 % out of 25 pumps are found with an average down time of 2 weeks where as in the two-tier system 45 % out of 15 pumps are found with 2 weeks average downtime. And in both the system about 20 % of pumps are found with average downtimes 3 weeks nad above In the one-tier system 3 out of 5 (60 %) India mark III pumps arefound with 1 week average downtime and the rest with two weeks downtime. In the two-tier system 4 out of 5 (80%)India Mark III pumps are found with 1 week average down time. An average down time of two to three weeks together with a breakdown frequency of once in six months may lead the handpump idle for one to two months in a year. On an average, the total downtime in RR district comes to about 2-3 weeks, where as in Ananthapur district it is about 2 weeks.

(v) Use of handpump

The number of users per handpump indicates its use. This is obtained as follows. During the interviews, an average five households were covered in each handpump location. The percentage of handpump users of the total five households is calculated based on the use of handpump for drinking and cooking purposes. In practice it was found that all the households used handpump water for drinking and cooking purposes except in case of two pumps that produce salty water. The number of households using the handpumps was then established by estimating the number of houses with in a radius of 25o m. from the each handpump site.. It is found that in all locations

all the households are using the handpumps. The average number of users in Ranga Reddy district are 280(min 220, max 350) and in the Ananthapur district are 255 (min 210, max 300) as against the norms fixed at 250 for each handpump.

(vi) Water use

The volume water used from the handpump gives the water use. During the interviews with the households, they were asked about the total collection of the water from the handpump. In the all locations people use to carry water with similar containers / buckets of 12, 15 litres volume. The total volume of water used per each house is calculated by multiplying the number of containers collected with the volume of container. Then the average volume of water use is calculated by dividing the total volume of water used by the number of households. The average volume of water collected in the Ranga Reddy district is 24 (max 29, min 19.6) litres per capita per day and in the Ananthapur district is 26.5 (max 28, min 18) litres per capita per day.

A water resource mapping was done for each panchayat visited showing locations of the handpump, piped water supply and other available near by traditional water sources which will affect the use of handpumps. Water resource map was drawn duly consulting with the local community members and key persons in the community.

All the villages have the access to the both piped water supply which is only for a few hours (2 or less than 2 hours) per day and handpumps. During the interviews with the households it is found that, 68 % of the respondents state that they use both piped water supply and handpumps in the dry season for all purposes. However, two pumps out of the 40 pumps visited are not used for drinking and cooking purposes as they provide salty water (brackish), which is used for other purposes such as washing the clothes and utensils , bathing and for personal hygiene. 32 % of respondents have stated that they exclusively use handpump and they don't make use of the piped water supply as they are living farther away from the centre of the village where usually the piped water supply is provided and also they stated that the timings of the Piped water supply are not regular and reliable, hence only the people who are living the near the Piped water supply, have the opportunity to collect the water whenever it is giving the supply.

About 40 % of the communities are having the access to the open dugwells during the wet seasons. 36 % of the respondents have stated that they are using these seasonal open wells next to piped water supply and handpumps during the wet seasons only for the purposes other than drinking and cooking.

5.4.2 Pump conditions :

A total of five factors were considered for reviewing pump conditions. The observations of each of the seven items were marked separately for each handpump visited and are shown in the appendix. As described in the methodology (Chapter 4), a rating was given for the overall condition of the handpump based on the observations.

Table 5.8 : Number of handpumps based on the pump condition in Ranga Reddy District (2-tier)

Sl.No	Parameters observed	Observation				Total
		India MarkII		India Mark III		
		Yes	No	Yes	No	
1	Play of the handle more than 3 mm	9, 4*	2	1*	4	20
2	Clear signs of corrosion	1	14	-	5	20
3	Loose bolts	-	15	-	5	20
4	Lacks grease	8, 5*	2	2,1*	2	20
5	Noisy	1,3*	11	-	5	20

Table 5.9 Number of handpumps based on the pump conditions in Ananthapur District (1-tier)

Sl.No	Parameters observed	Observation				Total
		India MarkII		India Mark III		
		Yes	No	Yes	No	
1	Play of the handle more than 3 mm	15	-	2	3	20
2	Clear signs of corrosion	2	13	-	5	20
3	Loose bolts	1	14	-	5	20
4	Lacks grease	15	-	5	-	20
5	Noisy	8	7	1	4	20

* Handpumps with out caretaker sin the RRdistrict

From the above tables, it can be seen that about 65 % of the handpumps in RR district and 75 % of handpumps in the Ananthapur District are having a handle play more than 3 mm, this may be more usage of handpumps. Also about 80 % in RRdistrict and all of the pumps in Ananthapur are lacking greasing of the handpump chain which was a very simple task in the preventive maintenance to be carried out in the India Mark II handpumps.

Based on the above factors given in the table 5.8 a rating has been arrived for the whole twenty handpumps in the study area as *'Good'*, *'Moderate'* or*'Bad'* as identified in chapter four. The table below gives the rating of handpumps based on the pump conditions.

Table 5.10 Rating of the handpump based on the pump conditions in the two districts (* Pumps with out caretaker in RR district)

Name of the District	Rating			Total
	Good	Moderate	Bad	
RangaReddy (2 tier)	9 (1*)	9 (3*)	2 (1*)	20
Ananthapur (1 tier)	5	14	1	20
Total	14	23	3	40

The percentage of *bad* handpumps in the in the both the systems are found to be less than 10 %. In practice 50 % of the pumps out of 15 handpumps in the two tier system are found to be *Good* and other 45 % are found to be moderate. Where as in the one-tier system, out of 25 handpumps 25 % are found to be *Good* and 70 % are found to be *Moderate.*

5.4.3 Platform conditions

The factors considered regarding the platform condition are

(i) Whether the platform is broken and the cement floor is less than 1 metre radius all round the pump.

(ii) Whether the drainage system is broken or faulty

(iii) Is the handpump loose at the point of attachment to base

The details of platform and pump environment conditions of each handpump location visited in the two districts are presented in the appendix. The abstract is given below.

Table 5.11 : Abstract of the observations on Platform and Pump environment conditions of handpumps in Ranga Reddy District (2-tier)

Sl.No	Parameters observed	Observation		Total
		Yes	No	
1	Source of pollution with in 10 mts of the handpump site	12 (4*)	8 (1*)	20
2	Broken plat form and drainage system	10 (4*)	10 (1*)	20
3	Attachment to base is loose	-	20 (5*)	20
4	Stagnant pools of water near by	18 (4*)	2 (1*)	20
5	Fencing around the installation	1	19 (5*)	20

Table 5.12: Abstract of the observations on Platform and Pump environment conditions of handpumps in Ananthapur district. (1-tier)

Sl.No	Parameters observed	Observation		Total
		Yes	No	
1	Source of pollution with in 10 mts of the handpump site	18	2	20
2	Broken plat form and drainage system	11	9	20
3	Attachment to base is loose	-	20	20
4	Stagnant pools of water near by	19	1	20
5	Fencing around the installation	-	20	20

* Handpumps with out caretaker in RR district

From the tables 5.11, 5.12 it can be noticed that, 30 % of handpumps in the two-tier system are found to be with broken platforms and drainage system. Where as in the one -tier system 60 % of handpumps are observed with broken platforms and drainage system. In 3 handpumps sites out of 20 in the Ananthapur district (1-tier), it is observed that there is no platform at all.

5.4.4 Pump Environment

The factors considered on the condition of pump environment covered in the study are
(i) Whether there is a source of pollution with in the 10 mts of handpump site
(ii) Whether there is a stagnant pool of water near by the handpump site.
(iii) Is there adequate fencing around the installation.

The details of each handpump location visited are shown in the appendix and the abstract of the observations in the two districts are shown in the tables 5.13 and 5.14. Pump Environment condition in RR District of one pump sponsored by UNICEF, and two pumps in Anathapur Districts are shown in the Photo Graphs in page 75 and 76.

From the tables 5.11, 5.12 it can be seen that 93 % of handpumps in the 2 tier system and 92 % of handpumps in the 1-tier system are having with stagnant pools of water near the handpump sites. Also 53 % of handpumps in the two-tier system and 88 % of handpumps in the one tier system are having source of pollution with in the 10 mts of handpump site.

Based on the observations on the pump and platform conditions and pump environment a rating has been arrived as defined in the chapter four. The table below gives the rating of the forty handpumps visited in the two districts.

Table 5.13 Rating of the Platforms based on the platform and pump environment conditions. (* Pumps with out caretakers in the RR district)

Name of the District	Rating			Total
	Good	Moderate	Bad	
RangaReddy (2-tier)	8	3 (2*)	9 (3*)	20
Ananthapur (1-tier)	3	6	11	20
Total	11	9	20	40

From the above table it can be observed that 53 % out of 15 handpump platforms in the two-tier system are found to be in *Good* condition, 7 % are in *Moderate* and 40 % are in *Bad* condition. In practice in the one-tier system only 12 % out of 24 platforms are in *Good* condition, 32 % are in *Moderate* and 56 % are in *Bad* condition.

Pump Environment condition (Sponsored by UNICEF) in RR District

Pump Environment conditions in the Ananthapur District.

5.4.5 Visits of the pump mechanic :

The data regarding the visit frequency of pump the pump mechanic is obtained during the interviews with the households. The data collected for each handpump is presented in the appendix. Average visits of pump mechanic for each handpump was obtained and rounded to full weeks and the abstract of the data was shown below.

Table 5.14 Number of handpumps regarding the Visits of the pump mechanic with respect to household responses in RangaReddy District (2-tier)

Name of the GP	Visits of the pump mechanic			Total
	2 weeks	3 weeks	1 month and above	
Shameerpet	1	3	1#	5
Pothaipally	-	2	3*(2#)	5
Balajinagar	2	3	-	5
L.Malakpet	-	3(1*)	2(1*)	5
Total	3	11	6	20

Table 5.15 Number of handpumps regarding the Visits of the pump mechanic with respect to household responses in Ananthapur District (1-tier)

Name of the GP	Visits of the pump mechanic (No. of Household responses)			Total
	2 weeks	3 weeks	1 month and above	
Ontimidde	1	4	-	5
Borampally	1	4	-	5
Doddikunta	3	2	-	5
Gangavaram	2	3 (1#)	-	5
Total	7	13	-	20

* Handpumps with out caretakers in the RRdistrict # Leaky pumps

From the tables above, it can be stated that in practice 75 % out of 15 pumps in the two-tier system in the RR district are being visited by the pump mechanic once every three weeks. But in the case of other 5 pumps in the RRdistrict where there is no caretaker Pumps are having a visit frequency of one month and above. In the Ananthapur district where there is one-tier system, the visit frequency of the mechanic of 35 % pumps out of 20 pumps is 2weeks and for the rest of the pumps (65%) is 3 weeks. It is interesting to note that the visits of the pump mechanic are not regular in the case of leaky handpumps and the responses of the households near these pumps also confirming the same

Though in the Ranga Reddy district II- tier system is existing, there is no handpump caretakers for the five pumps out of twenty visited. Data related to the weekly visits of caretaker is collected by interviewing the five households for each handpump and the average visits was obtained and rounded to one week / two weeks.

Dta related to each handpump which has a caretaker (15 handpumps) was presented in the appendix. From the data it can be noticed that, 40 % of households have responded that the visits of the caretakers are not regular.

Table 5.16 Handpumps based on the household responses regarding the visits of the caretaker in Ranga Reddy District

Name of the GP	Regular visits of the caretaker		Total
	Yes	No	
Shameerpet	3	2	5
Pothaipally	2	-	2
Balajinagar	3	2	5
L.Malakpet	2	1	3
Total	10	5	15

From the above table it can be observed that, for the 33 % out of 15 handpumps caretakers are not regular and 66 % of handpumps are being attended by the caretakers regularly.

5.4.6 Users satisfaction :

During the field visits households were asked about the performance of the pump mechanic and caretaker. From the responses of the households it was noticed that in the RR district 30 % of household responses are stating that performance of the pump mechanic is not satisfactory and other 30 % opined that his performance is satisfactory and the rest of (40 %) households did not give the clear response. In the case of caretakers performance 40 % of household responded that it is not satisfactory. In the Ananthapur district (1-tier) only 14 % of households opined that pump mechanic performance was not satisfactory and 45 % of them have responded that his performance is satisfactory and the rest (41%) of them have not given the clear answer. The same opinion was obtained from the responses of the households regarding the visit frequency of the mechanic and caretakers. During the field visits, it is observed that no users committee is existing in all the communities visited. This shows that there is less involvement of the users in the maintenance. Also the photographs shown in the page 76 confirm the same. Where as in the case of pump(RR District) shown in the page 75, pump environment conditions are good due to the awareness programme conducted by UNICEF.

Chapter 6

DISCUSSIONS ON THE RESULTS

This chapter provides an overview of the relationship with the indicators selected in the present study for the description of Organization set-up for maintenance of handpumps and to review the performance of the maintenance system. The chapter starts with the discussion on Organization set-up of PRED for handpump maintenance and the relationship of various parameters involved in the present study. Further it explains the relationship of various components with the performance of the handpump maintenance system in the selected areas.

6.1 Organization set-up

The literature reviewed earlier provide the information on the indicators to describe the organization set-up and main activities involved in the management system. In the chapter 3 the main activities involved in the overall management are listed and the possible relationship of selected indicators with the organizational set-up are explained. The following sub-sections explain the relation ship of the indicators selected with the PRED set-up for the maintenance of handpumps in A.P.

6.1.1 Staffing

As per norms set by the national Government a mobile team consisting a van, driver, one pump mechanic and two helpers has to look after the maintenance of 500 handpumps. At present there are 225,000 handpumps being maintained and 179 mobile teams are working under the maintenance system by PRED. Under each mobile van jurisdiction there are about 1000-1500 handpumps which is about 2 to 3 times higher than the norms specified. This shows that the system is understaffed and there is a requirement of additional staff to run the system properly.

If you take this aspect with the modification of India Mark II to Mark III, this gives an other picture. If most of the pumps modified to India Mark III which enables maintenance and repairs of pump at village level with trained caretakers reduce the jobs of block mechanics and mobile teams. In that case, the existing staff will be sufficient to look after the maintenance of the remaining India Mark II pumps and the back-up for the caretakers of the India Mark III handpumps.

6.1.2 Management system

The main tasks involved in the management system of maintenance of handpumps are mentioned in the chapter 3. One of the main activities is to develop a preventive maintenance schedule. In the present study it is observed that, though there are guidelines set for preventive maintenance and the caretakers have been given training for two days (in the two-tier system), the level of preventive maintenance is poor and it has to be improved a lot. Where as in the case of one-tier system, there is no caretaker at all to carry out the preventive maintenance which is lacking very much. This is also noticed that, as the job of caretaker is voluntary and not paid,

there is no commitment / motivation in the caretakers to perform their duties and there is no appreciation for preventive maintenance to encourage the caretakers to do the preventive maintenance. Regarding the agency to carry out the repairs as and when needed, in the present system PRED is the only available agency and the staff working under PRED are properly trained in the Regional training and development centres to look after the preventive and corrective maintenance, but as said earlier the maintenance system under PRED is under staffed. The procedures followed for the procurement and distribution of spare parts were mentioned in the previous chapter and this is similar to both two-tier and one-tier systems.

During the interviews with the departmental personnel involved in the O & M of handpumps, it is obtained that there is a high degree of centralization and inadequate delegation of powers. The table below shows that the delegation powers of the operational staff of the PRED is limited which causes certain delays in the operation and maintenance procedures.

Table 6.1: Delegation of powers of officers of PRED

Powers	Delegation of powers given to the various departmental personnel				
	Chief Engineer	Superintending Engineer	Executive Engineer	Deputy executive Engineer	Assistant Executive Engineer
Technical Sanction	No limit	Up to Rs:1,000,000	Up to Rs : 100,000	Up to Rs :5,000	No power
Tender acceptance	No limit	Up to Rs 1,000,000	Up to Rs:100,000	No power	No power
Excess tender percentage	Up to 40 %	Up to 25 %	Up to 5 %	–	–
Purchase of materials by calling quotations	–	–	Up to Rs 10,000	–	–

Hence permission may be given at Sub-division level (Dy.EE level) to purchase spare parts without calling tenders and quotations, when there is immediate requirement and also at AEE level permission may be given for permanent advance facilities to each Assistant Engineer/Assistant Executive Engineer for Rs: 2,000 as the amount required on maintenance will be immediate nature.

Supervision and monitoring processes and the related items on which objective standards should be set are discussed in the Chapter 3. During the study and interviews with the officials, it is observed that there is no effective monitoring system available in the organization system.

No objective standards are set for the Supervision and Monitoring processes. The Section officers (AEEs) and the Sub-divisional heads (DyEEs) , who are the key persons in the supervision and monitoring processes are over burden with the other Rural development activities such as construction of Roads, Buildings and M.I works and O & M of RWS and CRWS schemes. Less importance was given to the maintenance of the handpumps. There is no proper feedback of the system to the management levels for evaluation of performance of the maintenance system and to improve the performance of the caretakers and Mobile teams. mechanics.

Regarding the task of arrangement for collection of the revenue, there is no cost recovery in the present system and the entire O & M cost is provided by the Government only. The annual maintenance cost per each handpump is shown in the figure 5.1. As seen from the figure, it can be noticed that about 47 % of maintenance cost is for the salaries of the maintenance staff. If the maintenance of the handpumps handed over to the communities along with the modification of India mark II to Mark III, this can be reduced to some extent.

In the overall management attention should be paid, how best the above activities can be performed effectively. This includes the procedures adopted for attending and receiving complaints. The possible factors for high down time of India mark II are mentioned in the Literature review. During the field study it is noticed that Post card system which is described in the previous chapter is being used in the both one-tier and two-tier systems for reporting the breakdowns / failures. To reach the sub-division from the caretaker, the postcard takes at least 2-3 days (4 days in the weekends) and as the mobile team attends the complaints on the priority basis, this will extend another 3-4 days downtime of handpump. Hence due to the present communication system, even if all the procedures adopted properly, the downtime of handpump will go to more than a week. If this added to a breakdown frequency of once in 3 months, it will cause 4 weeks downtime of a handpump in a year. This has to be improved.

6.2 Performance of the maintenance system

In the Literature review, the information on the parameters and the corresponding indicators by which the performance of the handpump maintenance system can be assessed are given. It also explains the possible relation of those indicators with the performance of the system. The following sub sections will explain the relationship of the indicators selected with the performance of handpump maintenance system by PRED.

6.2.1 Comparison between the Performance of I-tier and II-tier systems :

All the indicators selected to assess the performance of the maintenance system are discussed based on the national standards as discussed in the previous chapter. Review on the functioning of the handpumps, pump condition of platform and drainage conditions, pump environment, visits of pump mechanic and User's satisfaction and on the corresponding indicators selected for the both two-tier and one-tier system is given in the chapter 5. Results obtained are compared between the two-tier and one- tier maintenance systems as well as India Mark II and India Mark III and tabulated as follows.

Table 6.2 Comparison of the performance of the **one-tier** and **two-tier** maintenance systems

Sl.No	Indicator	One-tier system	Two-tier system
1.	Functioning of handpump		
(i)	Pump discharge below the standards.	32 % of pumps out of 24 pumps	5 % of pumps out of 14 pumps
(ii)	Leakage	16 % of pumps	7 % of pumps
(iii)	Breakdown frequency		
	once in 6 months	28 % of pumps	14 % of pumps
	> 6 months	32 % of pumps	34 % of pumps
(iv)	Average downtime		
	2 weeks	48 % of pumps	45 % of pumps
	3 weeks and above	20 % of pumps	21 % of pumps
(v)	Average number of users	255	280
(vi)	Average volume of water collected per capita per day	26.5 litres	24 litres
2.	Pump conditions		
(i)	Play of the handle more than 3 mm	76 %	60 %
(ii)	Lacks grease	100 %	77 %
(iii)	Rating of the pumps (Bad)	8 % of pumps	7 % of pumps
3.	Platform conditions		
(i)	Broken platforms	60 %	36 %
(ii)	Broken drainage systems	60 %	36 %
(iii)	Rating of Platforms (Bad)	56 % of platforms	40 % of platforms
4.	Pump environment		
(i)	Source of pollution near by	88 % of platforms	53 % of platforms
(ii)	Stagnant water pools near by	92 % of platforms	93 % of platforms
5.	Visit frequency of Pump mechanic		
	3 weeks	56 % of pumps	66 % of pumps
	above one month	16 % (RR Dist)	13 % of pumps
6.	Users satisfaction on caretakers and mechanic performance	14 % of HH (not satisfactory)	30 % of HH (not satisfactory)

From the table 6.2, it can be seen that there is not much difference between the performances of the one-tier and two-tier systems except in the pump discharge and leakage in the case of functioning of handpumps and platform, drainage conditions and pump environment which indicates the preventive maintenance. 32 % of pumps in the one-tier system are producing less discharge than the standards and in the two-tier system it is only 5 % of pumps and there are 16 % of leaky handpumps out of 25 pumps in the one-tier system and it is 7 % out of 15 pumps in the two-tier system.

As there is no handpump caretaker in the one-tier system, one can expect that the preventive maintenance level will be lower than two-tier system, resulting in poorer condition of platforms and drainage system and also in the pump environment. But it is interesting to note that though there is a caretaker in the two-tier system to carry out the preventive maintenance, 77 % of pumps are found to be lacking grease, 60 % are having play in the handle and 93 % of platforms are with stagnant water pools near by, showing poor drainage conditions. Although there is some difference in the preventive maintenance of handpumps in the one-tier and two-tier systems, this has to be improved a lot in the both the systems.

Table 6.2 shows that in the one-tier system, the percentage of pumps with average downtime of 2 weeks are more than in the two-tier system. This is because of the visit frequency of the pump mechanic. Though it is showing in the table that 16 % of pumps have a visit frequency of pump mechanic of one month and above. Actually it is for the pumps where there is no caretaker in the RR district. In the figure below (figure 6.1) it can be seen that for the pumps which are producing the less discharge , the visit frequency of the mechanic is less than once in 4-5 weeks (not regular). And it is interesting to note that for these pumps there is also no caretaker to inform about the pump condition to the mechanic.

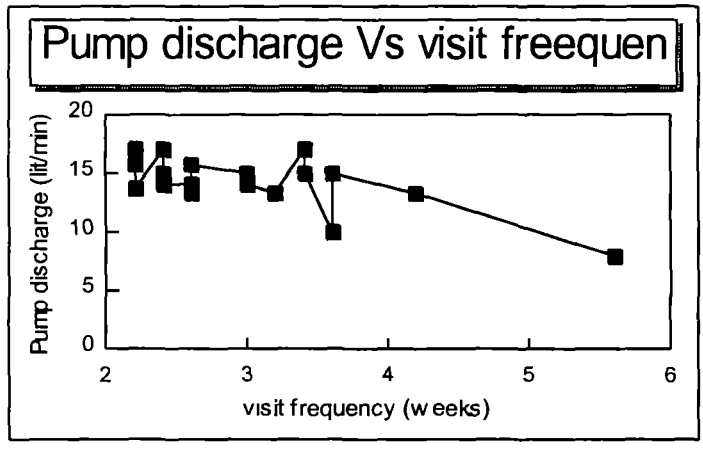


Figure 6.1: Pump discharge VS visit frequency of the pump mechanic for the 20 pumps in the RR district

In the one-tier system, for all the pumps, the average visit frequency of the mechanic per each pump is found to be once in every 3 weeks. As there is no caretaker to look after the preventive maintenance of the pump, the pump mechanic is also responsible for the preventive maintenance. Hence the visit frequency in the one-tier system needs to be more than two-tier system. Due to this the average down time of pumps in the one-tier system is also less than in two-tier system.

6.2.2 Comparison between the performance of India Mark II and III handpumps

The following table shows the comparison between performance of India mark II and India Mark III handpumps with respect to the results obtained in the study.

Table 6.3 : Comparison between the performance of India Mark II and Mark III handpumps

Sl.No.	Indicator	India MarkII	India MarkIII
1.	Pump discharge below the standards	33 % of pumps out of 30 pumps	None.
2.	Leaky pumps	17 % out of 30	None
3.	Breakdown frequency		
	< once in 6 months	20 % out of 30	None
	> once in 6 months	42 % out of 30	None
	> once in a year	38 % out of 30	100 % out of 10
4.	Average down time		
	one week	26 % out of 30 pumps	50 % out of 10
	2 weeks	64 % out of 30 pumps	50 % out of 10
	3 weeks and above	10 % out of 30	None.
5.	Play of handle more than 3mm	90 % out of 30 pumps	20 % out of 10 pumps
6.	Noisy pumps	40 % out of 30 pumps	None.

From the above table it can be observed that India Mark III pumps are look to be more efficient with more pump production and less breakdown frequency and average downtime. But it is observed that all the India Mark III pumps are recently installed i.e about 2-3 years back. Whereas the India Mark II pumps are working perhaps from 8 to 10 years. On the other hand it is obtained from the literature review and during the field study, there is less breakdown frequency in the case of India Mark III and the maintenance of the pump can be possible at the village level. The following figures also confirm the same fact.

Figure 6.2 Pump production Vs Breakdown frequency of India mark II and Mark III in the RR district.

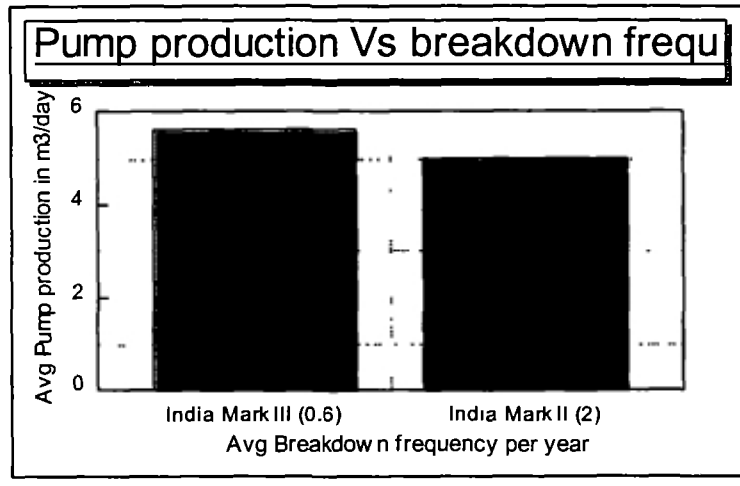
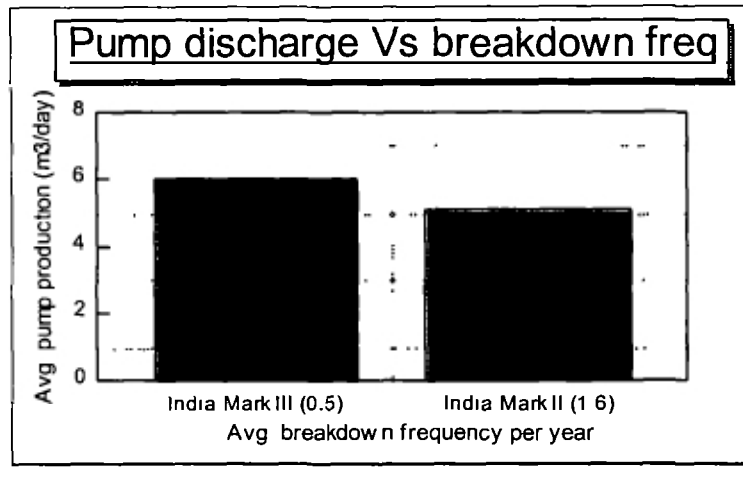


Figure 6.3 Pump production Vs Breakdown frequency of India mark II and Mark III in the Ananthapur district.



It can be noticed from the above figures, in both the one-tier and two-tier systems India mark III pumps are producing more (or equal) discharge with less Break down frequency than the India Mark II pumps.

In the figures 6.4 and 6.5, it can be observed that India Mark III pumps are serving equal number of people with less down times than India Mark II handpumps both in the one-tier and two-tier systems.

Figure 6.4 Average downtime Vs Number of users of India Mark II and mark III pumps in the one-tier system (Ananthapur District)

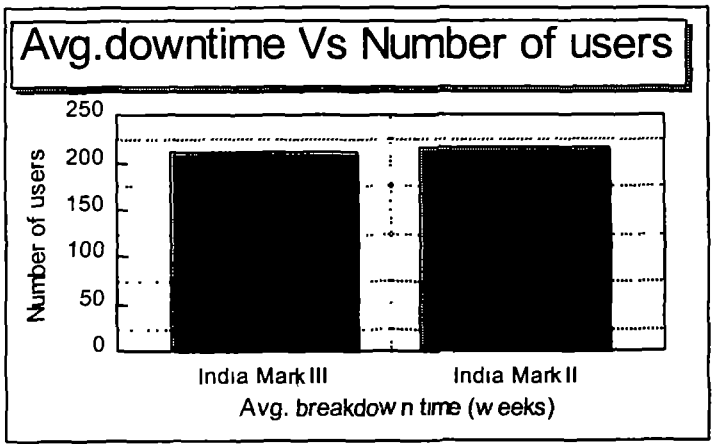
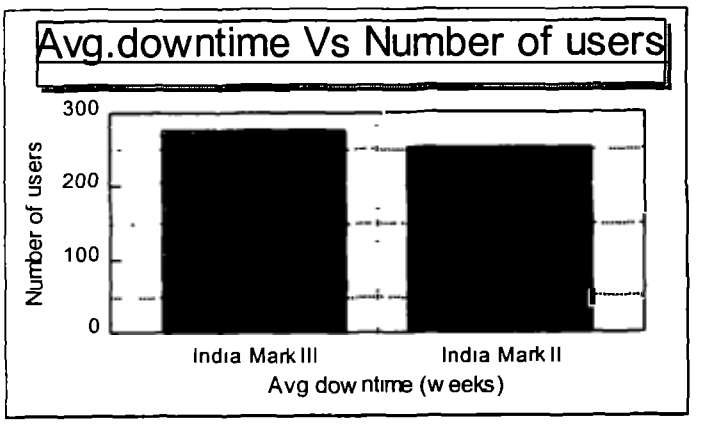


Figure 6.5 Average downtime Vs Number of users of India Mark II and mark III pumps in the two-tier system (RR district)



Chapter 7

CONCLUSIONS AND RECOMMENDATIONS

In the beginning of this chapter the topic and the objectives are discussed. Then it provides the general findings obtained in the present study in two sections, one under the Organizational set-up of PRED and the second under the performance of maintenance system. It then gives a few recommendations of the study to improve the performance of the present maintenance system also some suggestions are given for the future arrangements, if the maintenance of the handpumps transferred to the communities. An action plan to implement the recommendations is suggested in the last section.

7.1 Topic and objectives of the study

Most of the Rural water supply in Andhra Pradesh is covered by providing borewells fitted with handpumps which are being maintained under PRED. It has the largest number of handpumps in India and the number of handpumps is up to 225,000.

In spite of the best efforts on the part of PRED, the handpump breakdown rate is still on higher side due to the absence of preventive maintenance by handpump caretakers, lack of proper monitoring and supervision. Due to enormous increase in the number of handpumps PRED is also facing difficulties with the shortage of staff and limited financial resources and the need for viable maintenance is very much essential. At present the Govt. of AP is in the view to handover the maintenance to the communities, i.e Gram Panchayats, the only institutions available at local level.

Hence the present study was intended to describe the Organizational set-up of PRED for O & M of handpumps in Andhra Pradesh and to review the performance of handpump maintenance system under PRED. The objectives of the study are ;

1. To learn about the Organizational set-up of Panchayat Raj Engineering Department (PRED) regarding the operation and maintenance of hand pumps.

2. To review the performance of the operation and maintenance system for handpumps under two-tier and one-tier systems in Andhra Pradesh.

3. To suggest possibilities to improve the performance of the maintenance system

7.2 Conclusions

The conclusions drawn on the organizational set-up of PRED and on the performance of maintenance system regarding O & M of handpumps are given as follow.

7.2.1. Organizational set-up

1. At present there are 179 mobile teams are working under PRED to look after the O & M of 225,000 handpumps and under each mobile team there are about 1000-1500 handpumps which is about 2 to 3 times higher than the norms specified. This shows that the present maintenance system under PRED is under staffed and there is a requirement of additional staff to run the system properly. This is confirmed by the fact that pumps are not functioning sufficiently well showing long downtimes.

2. There is a high degree of centralization and inadequate delegation of powers to the Sub-divisional and Section officers. Permission may be given at Sub-division level with out calling tenders and quotations when there is a immediate requirement and also at Section officer level permission may be given for permanent advance facilities for Rs 2000 as the amount needed on maintenance will be immediate nature.

3. There are no objective standards set for supervision and monitoring processes and there si no effective monitoring system in the present organization. Also there is no proper feedback of the system to the management levels for evaluation of performance of the maintenance system and to improve the performance of the pump mechanics and caretakers.

4. Though there are guidelines for preventive maintenance, the level of preventive maintenance is found to be poor and also there is no appreciation for preventive maintenance to encourage the caretakers to perform their duties. Also there is no commitment / motivation among the caretakers as the job of handpump caretaker is voluntary and not paid.

5. There is no effective communication system available for the caretakers to report the failures / breakdowns of the handpumps to the Sub-divisions, more important that they do not monitor pump performance using the pump test to be able to report expected future failures. This would help to overcome the present available communication system (post card system) causing long down times of handpumps.

6. The Organization set-up for two- tier and one-tier are similar at PRED level and the pump mechanic visit frequency is also rather similar for both India Mark II and Mark III handpumps where as India Mark III pumps normally would require a lower staff input at PRED level.

7. For the selection of caretakers, guidelines set by the Government are not being followed. One complication in the present guidelines is that a caretakers should have a desire to do selfless service, which is creating lack of motivation and commitment among the caretakers to perform their duties.

7.2.2 Performance of the maintenance system

The following conclusions were obtained in the present study regarding the performance of the maintenance system.

1. There is not much difference in the performances of the one-tier and two-tier handpump maintenance systems. When it comes to discharge, the pumps in the two-tier system have a better track record. 32 % of pumps in the one -tier system are producing less discharge than the standards and in the two-tier system it is only 5 % of pumps. There are 16 % of leaky pumps out of 25 pumps in the one-tier system and it is 7 % out of 15 pumps in the two-tier system.

   There is not much difference between the breakdown frequency and down times of handpumps in the two systems. The average down time of 48 % of pumps in the one-tier system is 2 weeks where as in the two-tier system 45 %of pumps are having 2 weeks down time. The breakdown frequency and the downtime of the leaky handpumps in both the systems are more and there is no caretaker near the leaky pumps in the two-tier system. Regarding the platform and drainage conditions and pump environment which indicate the preventive maintenance, it is observed that the level of preventive maintenance in the one-tier system is lower than two-tier system and the real input of caretakers in the two-tier system is also not much.

2. Though there is a handpump caretaker in the two-tier system, to carry out preventive maintenance, 77 % of pumps are lacking grease, 60 % of pumps have play in the handle more than 3 mm, 53 % of platforms with a source of pollution near by the handpump and 90 % of platforms are with stagnant water pools near by, showing the bad drainage conditions. Where as in the one-tier system, the condition is still poor. With regard to breakdown frequency and down times of handpumps also, there is no difference between one-tier and two-tier systems. Hence having a caretaker does not seem to have a positive impact on preventive maintenance. It is clear from the above findings.

3. The percentage of broken platforms and drainage systems in the both system are fund to be high. This shows the use of poor materials and construction methods in the platform construction.

4. In both the systems, the percentage of pumps having play of handle more than 3 mm and the pumps lacking the grease is found to be high. Also the household responses in the two-tier system regarding the caretakers performance are showing that caretakers are not attending the duties regularly.

5. The average number of users in the both the systems are ranging from 200-280 and the average volume of use is ranging from 24-26.5 litres. 90 % of pumps are effectively used and 10 % pumps which are producing salty water are not used fro drinking and cooking purposes. 32 % of respondents use exclusively handpumps and about 40 % of communities are having access to the seasonal open wells. 14 % of households in the one-tier system and 30 % of households in the two-tier system are responded that performance of the pump mechanic is not satisfactory.

6. India Mark III handpumps are found to be more efficient than India Mark II in all respects such as pump discharge, breakdown frequency, average downtime, leakage and pump conditions.

7. The average visit frequency of the mechanic per pump of once in every 3 weeks in the one-tier system is for 56 % of pumps and in the two-tier system is 66 %. And 16 % of pumps in the one-tier system and 13 % of pumps in the two-tier system are having visit frequency more than once in 4 to 5 weeks.

7.3 Recommendations :

As the present trend of the Government of the AP is to transfer the responsibility of handpump maintenance to Village level local bodies (GPs), Recommendations are suggested for improvement of the present system and also for future arrangements.

7.3.1 To improve the performance of the present maintenance system :

The following recommendations are suggested for improving the performance of the present maintenance system under PRED.

1. As in the present system there is a shortage of pump mechanics and mobile teams, recruitment of additional O& M staff is required. If the modification of India Mark II to India Mark III is taken up, the present staff can be sufficient to look after the maintenance of the remaining India Mark II handpumps and back up for the caretakers of India Mark III pumps.

2. In emergencies, because there is no effective communication system, there is a delay in taking-up of remedial measures. Monitoring by local caretakers using pump test for discharge will give early warnings about the future failures. Hence this has to be introduced in the schedule of the caretakers for regular preventive maintenance. Also for effective & better communications, improved communications systems should be explored and it should be accessible to the village handpump caretakers to report the breakdowns as the present post card system takes long time in reporting the failures.

3. Setting out guidelines for supervision and monitoring processes and training the caretakers and supervision feed back should be used to improve the performance of the pump mechanics and caretakers.

4. Preventive maintenance should be appreciated and rewards should be introduced to encourage the performance of the caretakers. Also Caretakers should be given some monitory benefits like government subsidies to generate the motivation among them.

5. As the India Mark III handpump is found to be more efficient in all respects than India Mark II, it should be preferred for new installations and gradual modification of India Mark II to Mark III should be taken up for better performance.

7.3.2 For future arrangements

The following recommendations were suggested for the future arrangements, before transferring the responsibility of the handpump maintenance to the Gram Panchayats.

1. Proper co-ordination between sector agencies like Health, Education and Social welfare departments at local level to generate community awareness through mass medias about the health education and importance of the safe drinking water..

2 .Much needs to be done like organization of committees, training and making the communities about the importance of maintenance to prepare the GPs to take up the responsibility.

3. All the descriptions and responsibilities to be taken up by the GPs have to be formed and explained to them before handing over the responsibilities.

4. Proper institutional set-up and support system for community based maintenance i.e, formation of water committees at village level as well as inter village level and district level to support GP system institutionally.

5. Provision of adequate tools and spare parts, manpower and training required for maintenance of at GP level. This include the formation of training centres at regional level, District level training experts and proper guidelines to select the trainees etc. should be developed.

6. Gram Panchayats should be encouraged to levy taxes for raising funds by involving functional water committees.

7. Gram Panchayats should be supported technically by PRED in case of breakdown of handpumps due to major failures and financially by Government until it becomes self reliant.

7.4 Action Plan

An action plan is prepared to implement the recommendations suggested. The plan is proposed in such a way as to implement immediate measures, short term and long term measures.

7.4.1 Immediate measures

This measures are proposed to implement with in six months. In the both one-tier two-tier systems, preventive maintenance by caretakers is in poor condition. Caretakers should be given orientation and proper training in the O & M of handpumps. Introduction of pump test by giving emphasis on introduction of pump performance inventory by caretakers to enhance preventive maintenance if the pump discharge drops below 12 litres per minute at 40 strokes per minute. Incentives either in terms of monitory or Govt. subsidies to the caretakers should be introduced to generate motivation among them to attend their duties. A reward system can also be introduced to generate motivation.

For Supervision and Monitoring processes, objective standards should be set and staff should be appointed under PRED at District level exclusively for monitoring the O & M of handpumps and different schedules for staff should be developed for the maintenance of India mark II and Mark III pumps which needs lower staff input. Guidelines should be set to check the performance of the mechanics and caretakers. GPs have to clarify their capacity and need to transfer the handpump maintenance to them

7.4.2 Short term measures

This is proposed to complete with in one to two years mainly focussing on the potential of the GPs to take the responsibility of maintenance. It is proposed to transfer the monitoring of the first tier i.e, caretakers to the GPs to have a better check on the performance of caretakers at local level. Explore the possibilities to modify the India Mark II to India Mark III to facilitate the VLOM design after one year. This will be given second priority as it needs further investigation and experiments. Pilot studies should be carried out by selecting the villages with more use of handpumps and with more number of India Mark III handpumps and the maintenance has to be handed over to the GPs. The possibilities of maintenance (preventive and corrective) under the Gram Panchayats can be studied. Financial sanction and budget allocation has to be obtained before taking up the programme. GP shave to be given more power to levy taxes and possibility of contribution from the GPs and related communities may also explored.

7.4.3 Long term measure

This is proposed to implement after three years. To transfer the complete maintenance this may require further investigation and study. Based on the pilot studies carried out, gradual modification of India Mark II to Mark III can be taken up. Rural youth can be trained under NHRDP (National Human Resources Development Programme). A cash incentive scheme has to be evolved for the trained youth. GPs are required with provision of sufficient institutional set-

up for community based maintenance, man power, training and provision of adequate tools and spare parts at GP level. One set of tools should be procured GP wise for use by the local mechanic and similar facility to purchase fast moving spares at GP level should be worked out. Major parts can be supplied by the PRED. In addition a reward system on the overall performance of the local mechanics Mandal wise may be evolved. Back-up support from PRED for major breakdowns should be continued until the GPs have become self reliant.

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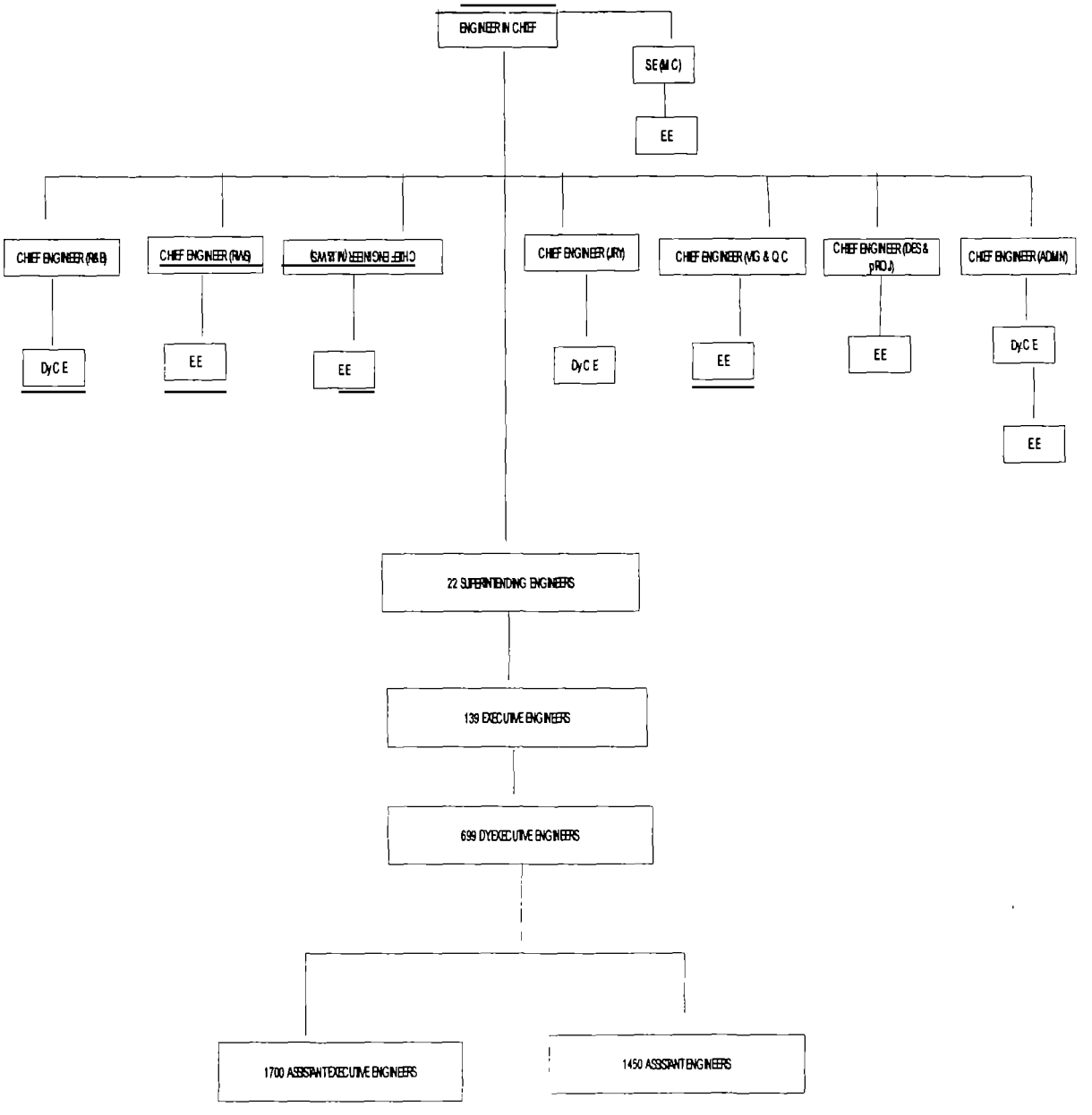
ANNEXURES

ANNEXURE - 1

ORGANISATION OF PRED



ANNEXURE - 2

Details of the Handpumps, Pump mechanics and the Mobile teams in Andhra Pradesh Under PRED. (as on January 1997)

Sl.No	District	No. of pumps	No .of Mechanics	No. of Mobile teams
1.	Srikakulam	6002	94	1
2.	Vizianagaram	6246	105	2
3.	Vishakapatnam	8675	48	2
4.	East Godavari	3882	11	3
5.	West Godavari	2782	24	2
6.	Krishna	5069	26	5
7.	Guntur	10190	64	2
8.	Prakasam	12227	55	7
9.	Nellore	9248	51	6
10.	Chittoor	18243	74	16
11.	Cuddapah	13288	70	11
12.	Ananthapur	12479	113	18
13.	Kurnool	9397	75	13
14.	Mahabub nagar	12246	81	13
15.	Medak	9639	46	4
16.	Nizamabad	9622	50	5
17.	RangaReddy	7711	35	14
18.	Nalgonda	14444	113	14
19.	Warangal	10636	55	12
20.	Khammam	14640	87	12
21.	Karim nagar	10259	52	8
22.	Adilabad	10666	53	9
Total		217591	1382	179

Annexure-3

Concept page for community description

Name of the District :

Name of the Taluk :

Name of the Village :

Area of the village :

Population :

No. of houses :

Coverage of water supply by : Piped supply & hand pumps / only hand pumps

No. of hand pumps :

Maintained under : PRED / GP

Other water sources : open wells/ river / spring

Village map showing the locations of the hand pumps and the near by traditional sources.
(This will be drawn for the each village visited)

Annexure -4

Observation sheet

Village : Panchayat/ Taluk :

Location of hand pump : Hand pump no. :

(a) Hand pump site conditions
(Based on Bely lloyd)

1. Is there any source of pollution with in 10m of hand pump? (e.gs. latrine on the higher ground) Yes / No

2. Is there any ponding of stagnant water with in 2 mts of the Platform Yes / No

3. Is the hand pump drainage channel faulty and permitting ponding ? Yes / No

4. Does the drainage channel need cleaning ? Yes / No

5. Is the cement floor less than 1m radius all round the pump? Yes / No

6. Is there any ponding on the cement floor around the hand pump? Yes / No

7. Are there any cracks on the cement floor around the pump? Yes / No

8. Is there adequate fencing around the installation? Yes / No

9. Is the hand pump loose at the point of attachment to base? (which could permit water to enter the casing) Yes / No

Annexure - 5

Observation sheet

Village :	Panchayat/ Taluk	:
Location of hand pump :	Hand pump no.	:

(b) Hand pump condition

1. Is there any play in the handle ? Yes / No
   (This will be checked in c.ms by keeping standards of new pump)

2. is the pump noisy ? Yes / No
   (e.gs. Bearings or other working parts are loose)

3. Whether there are any cracks at the basement ? Yes / No

4. are there any corroded parts ? Yes / No

5. Whether the hand pump lacks in greasing ? (lubrication) Yes / No

6. Is there any leakage ?

7. What are the number of strokes required to fill a standard volume of the container ?
(No. of strokes will be measured by keeping standard speed and length of stroke)

8.What are the number of breakdowns during the past three months ?

Annexure - 6

Users questionnaire

---

1. How many persons are there in a household ?

2. Where do you collect water for drinking?

3. Is the hand pump your only source ? if not What are the other sources ?

4. How many buckets do you collect ?

5. Who is doing the maintenance work ?

6. How often the caretaker / pump mechanic visits the pump ? Is he regular ?

7. How do you feel about the caretakers performance ?

8. What kind of breakdowns/failures occurred during the last three months ?

9. Do you remember when the pump broke down last ?

10. How do you report failures?

11. How long does it take usually before pump is repaired ?
(3 days, 1 week, 1 month etc..)

12. Who takes care of cleanliness at the pump site ?

13. Who pays for maintenance cost ?

14. Is there any users committee ? Yes / No

15. What the users committee do ?

Annexure - 7

SOURCE-USE MATRIX

Purpose	Source of water						Reasons for use and non-use
	Hand pump		Open well		River / stream		
Season	wet	dry	wet	dry	wet	dry	
Drinking							
Cooking							
Washing							
Personal hygiene							
Gardening							
Cattle feeding							

Annexure - 8

Caretakers questionnaire

Name :

Qualification : Experience :

---

1. What kind of training undergone ? When was it conducted ? and what is the training period ?

2. How often you visit each hand pump site?

3. How do you receive complaints ?

4. How many complaints are received during the last 2 months ?

5.. How do you attend the complaints ?

6.What is your limit in attending failures ?

7. If the failure exceeds your limit, what will you do ?

8. How long does it take to rectify a failure ? What is the normal breakdown time for major/minor problems ?

9. Where do you get the spareparts ?

10. What are the problems in the supply of spare parts ?

11. Are the job conditions are satisfactory ?

Breakdown time matrix

Type of failure	Repair time	Reasons / remarks

Abstract of the observations

Name of the GP	HP No	TYPE OF HP	Discharge in liters /min	Leakage	Average no of strokes @40 str/min	Total number of users	Avg Volume of use Lpcd	Condition of the Handpump								Condition of the platform					
								PH	CP	LB	LG	N	Rating			SP	BP	SW	Rating		
													G	M	B				G	M	B
Shameer pet	(R R Dist)																				
	HP1	Mark II	15	NO	40	350	19 6	-	-	-	+	-	*			+	+	+			*
	HP2	Mark II	15	NO	40	300	22	+	+	-	+	+			*	+	+	+			*
	HP3	Mark II	15	YES	75	300	24	+	-	-	+	+		*		+	+	+			*
	HP4	Mark III	15	NO	35	300	27	-	-	-	-	-	*			-	-	+	*		
	HP5	Mark II	15	NO	45	250	29	+	-	-	+	-		*		-	-	+	*		
Pothaya pally	(R R Dist)																				
	HP6	Mark II	15	NO	40	250	23	+	-	-	+	-		*		-	-	+	*		
	HP7	Mark II	15	NO	45	300	23	+	-	-	+	-		*		+	+	+			*
	HP8	Mark II	NO Dischrge	YES	—	240	22 6	+	-	-	+	+			*	+	-	+		*	
	HP9	Mark II	15	YES	60	300	24 2	+	-	-	-	+		*		+	+	+			*
	HP10	Mark II	15	NO	42	300	24	+	-	-	-	-	*			-	-	+	*		
Balaji Nagar	(R R Dist)																				
	HP11	Mark III	15	NO	35	300	27	-	-	-	+	-	*			-	-	+	*		
	HP12	Mark II	15	NO	40	250	23	+	-	-	+	-		*		+	+	+			*
	HP13	Mark II	15	NO	43	260	23	-	-	-	+	-	*			-	-	+	*		
	HP14	Mark III	15	NO	38	320	23	+	-	-	-	-	*			+	-	-	*		
	HP15	Mark II	15	NO	42	220	27 5	+	-	-	+	-		*		+	+	+			*
L Malakpet	(R R Dist)																				
	HP16	Mark II	15	NO	42	270	22	-	-	-	+	-	*			-	-	+	*		
	HP17	Mark II	15	NO	45	250	24 5	+	-	-	+	-		*		+	+	+			*
	HP18	Mark III	15	NO	38	320	24 8	-	-	-	+	-	*			-	+	-		*	
	HP19	Mark III	15	NO	35	240	23 6	-	-	-	+	-	*			+	+	+			*
	HP20	Mark II	15	NO	40	270	26	+	-	-	+	+		*		+	-	+		*	
Ontimidde	(Ananthapur Dist)																				
	HP21	Mark II	15	NO	43	250	27 5	+	-	-	+	+		*		+	+	+			*
	HP22	Mark II	NOT FUNCTI	NING	-	220	28	+	-	+	+	+			*	+	+	+			*
	HP 23	Mark II	15	NO	40	230	28	-	-	-	+	-	*			+	-	+		*	
	HP24	Mark II	15	NO	42	240	28	+	-	-	+	+		*		+	+	+			*
	HP25	Mark II	15	NO	43	280	17 5	+	+	-	+	-		*		+	+	+			*
Boram Pally	(Ananthapur Dist)											-									
	HP26	Mark III	15	NO	35	280	28	-	-	-	+	+	*			+	+	+			*
	HP27	Mark II	15	NO	45	240	24 5	+	-	-	+	+		*		+	+	+			*
	HP28	Mark III	15	NO	35	250	28	+	-	-	+	-		*		+	+	+			*
	HP29	Mark II	15	NO	40	300	27	+	-	-	+	+		*		+	+	+			*
	HP30	Mark II	15	NO	45	250	28	+	-	-	+	-		*		-	-	+	*		
Doddikunta	(Ananthapur Dist)																				
	HP31	Mark II	15	NO	40	250	25	+	-	-	+	+		*		+	-	+		*	
	HP32	Mark III	15	NO	35	210	30	-	-	-	+	-	*			-	-	+	*		
	HP33	Mark II	15	NO	44	300	27	-	-	-	+	-	*			+	+	+			*
	HP34	Mark II	15	YES	75	240	18	+	+	-	+	-		*		+	-	+		*	
	HP35	Mark III	15	NO	35	210	29	+	-	-	+	-		*		+	-	+		*	
Gangavaram	(Ananthapur Dist)																				
	HP36	Mark II	15	NO	40	300	27	+	-	-	+	-		*		+	+	+			*
	HP37	Mark II	15	LITTLE	52	300	25	+	-	-	+	+		*		+	+	+			*
	HP38	Mark III	15	NO	38	250	27	-	-	-	+	+	*			+	-	-	*		
	HP39	Mark II	15	NO	43	250	30	+	-	-	+	-		*		+	-	+		*	
	HP40	Mark II	15	NO	42	250	26	+	-	-	+	-		*		+	-	+		*	

CODES USED

Condition of the handpump :

PH Play of the handle more than 3 mm
CP Correded parts
LB Loose bolts
LG Lacks greasing
N Noisy

Condition of the PLatform .

SP Source of pollution with In the 10 rnts of the handpump
BP Broken platform and drainage system
SW Ponding of stagnant water with in the 2rnts of the handpump

Rating

G Good
M Moderate
B Bad

DATA COLLECTED DURING THE HOUSEHOLD INTERVIEWS

Name of GP	CODE	H H No	PERFORMANCE OF THE MAINTENANCE					USE OF THE HANDPUMP				
			Visits of the Mechanic	Visits of the Caretaker	Breakdown Freequency	Down time	Vol of water collected (Lpcd)	Use of different sources: Drinking	Cooking	Washing	P hygiene	Other uses
	1	2	3	4	5	6	7	8	9	10	11	12
Shameer pet		1	M	W	Occassion	1-2 W	18	HP,PS	HP,PS	HP	HP	HP
		2	M	W	O	2W	20	HP,PS	HP,PS	HP	HP	HP
	HP1	3	M	W	O	2W	20	HP,PS	HP,PS	HP	HP	HP
		4	3W	NO	O	3W	18	HP,PS	HP	HP	HP	HP
		5	M	W	O	2W	22	HP,PS	HP	HP	HP	HP
		6	M	NO	O	2W	23	HP,PS	HP,PS	HP,SOW	HP,SOW	HP,SOW
		7	M	W	O	2W	25	HP	HP,PS	HP,SOW	HP,SOW	HP,SOW
	HP2	8	3W	NO	O	1W	22	HP,PS	HP,PS	HP,SOW	HP,SOW	HP,SOW
		9	2W	NO	O	1M	21	HP,PS	HP	HP	HP	HP
		10	M	W	O	2W	20	HP,PS	HP	HP,SOW	HP,SOW	HP,SOW
		11	2M	NO	Regular	2M	25	HP,PS	HP	HP,SOW	HP,SOW	Other HPs
		12	M	NO	R	2M	24	HP,PS	HP	HP,SOW	HP,SOW	Other HPs
	HP3	13	2M	NO	R	1M	23	HP,PS	HP,PS	HP,SOW	HP,SOW	Other HPs
		14	M	NO	R	2M	20	HP,PS	HP,PS	HP,SOW	HP,SOW	Other HPs
		15	M	NO	O	3M	25	HP	HP,PS	HP	HP	HP
		16	2W	W	O	1W	25	HP,PS	HP	HP	HP	HP
		17	2W	W	O	1W	28	HP,PS	HP	HP	HP	HP
	HP4	18	2W	W	O	1W	30	HP,PS	HP,PS	HP	HP	HP
		19	3W	NO	O	1W	28	HP,PS	HP,PS	HP	HP	HP
		20	3W	W	O	2W	27	HP,PS	HP	HP	HP	HP
		21	3W	W	O	2W	30	HP	HP	HP	HP	HP
		22	3W	W	O	2W	25	HP,PS	HP	HP	HP	HP
	HP5	23	3W	NO	O	2W	30	HP	HP	HP	HP	HP
		24	M	W	O	1W	32	HP	HP	HP	HP	HP
		25	3W	W	O	2W	28	HP,PS	HP	HP	HP	HP
Pothaya pally		26	3W	NO	O	2W	27	HP	HP	HP,SOW	HP,SOW	HP,SOW
		27	2W	W	O	2W	25	HP	HP	HP,SOW	HP,SOW	HP,SOW
	HP6	28	3W	NO	O	2W	20	HP,PS	HP,PS	HP,SOW	HP,SOW	HP,SOW
		29	3W	W	O	1W	23	HP,PS	HP	HP,SOW	HP,SOW	HP,SOW
		30	M	W	O	1W	20	HP,PS	HP,PP	HP,SOW	HP,SOW	HP,SOW
		31	M	NO	O	2W	20	HP,PS	HP,PS	HP OHP	HP,OHP	Other HPs
		32	M	NO	R	2W	24	HP,PS	HP,PS	HP.OHP	HP,OHP	Other HPs
	HP7	33	3W	NO	-	1W	27	HP,PS	HP	HP.OHP	HP,OHP	Other HPs
		34	M	NO	R	2W	25	HP,PS	HP	HP OHP	HP,OHP	Other HPs
		35	M	NO	R	2W	20	HP,PS	HP	HP	HP	HP

1	2	3	4	5	6	7	8	9	10	11	12
	36	M	NO	R	1M	18	HP,PS	HP,PS	HP OHP	HP,OHP	Other HPs
	37	M	NO	R	1M	25	HP	HP	HP.OHP	HP,OHP	Other HPs
HP8	38	M	NO	O	2M	22	HP	HP	HP.OHP	HP,OHP	Other HPs
	39	3W	NO	R	2M	28	HP	HP	HP	HP	Other HPs
	40	M	NO	R	2M	20	HP,PS	HP	HP,OHP	HP,OHP	HP,OHP
	41	M	NO	O	3W	28	HP	HP	HP	HP	HP
	42	M	NO	O	3W	25	HP	HP	HP	HP	HP
HP9	43	3W	NO	O	2W	28	HP	HP	HP	HP	HP
	44	M	NO	O	1W	20	HP,PS	HP,PS	HP	HP	HP
	45	3W	NO	O	2W	20	HP,PS	HP,PS	HP	HP	HP
	46	3W	NO	O	1W	25	HP	HP	HP,SOW	HP,SOW	HP,SOW
	47	2W	W	O	1W	25	HP,PS	HP	HP,SOW	HP,SOW	HP,SOW
HP10	48	3W	W	O	2W	25	HP	HP	HP,SOW	HP,SOW	HP,SOW
	49	3W	NO	O	1W	25	HP	HP	HP,SOW	HP,SOW	HP,SOW
	50	M	W	O	2W	20	HP,PS	HP,PS	HP,SOW	HP,SOW	HP,SOW
Balajinagar	51	2W	W	O	1W	25	HP,PS	HP,PS	HP	HP	HP
	52	2W	W	O	1W	25	HP,PS	HP	HP	HP	HP
HP11	53	2W	NO	O	2W	28	HP	HP	HP	HP	HP
	54	3W	W	O	2W	28	HP	HP	HP	HP	HP
	55	2W	W	O	1W	30	HP	HP	HP	HP	HP
	56	2W	W	O	1W	25	HP	HP	HP	HP	HP
	57	2W	W	R	1W	25	HP	HP	HP	HP	HP
HP12	58	2W	NO	R	2W	20	HP,PS	HP	HP	HP	HP
	59	3W	NO	R	1W	20	HP,PS	HP	HP	HP	HP
	60	3W	W	O	2W	25	HP	HP	HP	HP	HP
	61	2W	W	O	1W	20	HP,PS	HP	HP,SOW	HP,SOW	HP,SOW
	62	2W	W	O	1W	18	HP,PS	HP	HP,SOW	HP,SOW	HP,SOW
HP13	63	2W	W	O	1W	25	HP,PS	HP	HP	HP	HP
	64	2W	W	O	2W	28	HP	HP,PS	HP	HP	HP
	65	3W	W	O	1W	25	HP,PS	HP,PS	HP	HP	HP
	66	2W	W	O	2W	20	HP,PS	HP,PS	HP	HP	HP
	67	2W	W	O	2W	25	HP,PS	HP,PS	HP	HP	HP
HP14	68	3W	NO	O	2W	25	HP	HP,PS	HP	HP	HP
	69	M	NO	O	1W	20	HP,PS	HP,PS	HP	HP	HP
	70	2W	W	O	1W	25	HP	HP	HP	HP	HP
	71	2W	W	O	2W	30	HP	HP	HP	HP	HP
	72	2W	NO	O	2W	30	HP	HP	HP	HP	HP
HP15	73	2W	NO	O	2W	25	HP	HP	HP	HP	HP
	74	3W	NO	O	3W	24	HP	HP	HP	HP	HP
	75	3W	NO	O	1W	28	HP	HP	HP	HP	HP

	1	2	3	4	5	6	7	8	9	10	11	12
L Malakpet		76	2W	W	O	1M	23	HP,PS	HP,PS	HP	HP	HP
		77	2W	W	O	3W	24	HP,PS	HP	HP	HP	HP
	HP16	78	3W	NO	O	2W	20	HP,PS	HP,PS	HP	HP	HP
		79	1M	W	O	3W	20	HP,PS	HP,PS	HP	HP	HP
		80	2W	NO	O	3W	25	HP	HP	HP	HP	HP
		81	2W	W	O	1M	25	HP,PS	HP,PS	HP	HP	HP
		82	3W	W	O	3W	25	HP,PS	HP	HP	HP	HP
	HP17	83	3W	NO	O	3W	20	HP,PS	HP,PS	HP	HP	HP
		84	3W	NO	O	3W	28	HP	HP	HP	HP	HP
		85	2W	W	O	2W	25	HP	HP	HP	HP	HP
		86	2W	NO	O	2W	21	HP,PS	HP	HP,SOW	HP,SOW	HP,SOW
		87	2W	NO	R	1W	23	HP,PS	HP	HP,SOW	HP,SOW	HP,SOW
	HP18	88	2W	NO	R	1W	25	HP,PS	HP	HP,SOW	HP,SOW	HP
		89	3W	NO	O	2W	30	HP	HP,PS	HP	HP,SOW	HP,SOW
		90	2W	NO	R	1W	25	HP,PS	HP	HP	HP,SOW	HP
		91	3W	W	O	1W	20	HP,PS	HP	HP,SOW	HP,SOW	HP,SOW
		92	3W	NO	O	1W	25	HP,PS	HP	HP,SOW	HP,SOW	HP,SOW
	HP19	93	M	W	O	1W	25	HP	HP	HP,SOW	HP,SOW	HP,SOW
		94	3W	W	O	2W	30	HP	HP	HP	HP,SOW	HP,SOW
		95	M	W	O	2W	20	HP,PS	HP	HP,SOW	HP,SOW	HP
		96	M	NO	O	1W	25	HP,PS	HP	HP	HP	HP
		97	M	NO	O	2W	25	HP,PS	HP	HP	HP	HP
	HP20	98	3W	NO	O	3W	24	HP,PS	HP	HP	HP	HP
		99	3W	NO	O	3W	28	HP	HP	HP	HP	HP
		100	M	NO	O	2W	30	HP	HP	HP	HP	HP
Onti midde		101	M	NO	O	1W	25	HP,PS	HP	HP	HP	HP
		102	2W	NO	O	1W	30	HP	HP	HP	HP	HP
	HP21	103	2W	NO	O	1W	25	HP,PS	HP,PS	HP	HP	HP
		104	3W	NO	O	2W	28	HP,PS	HP,PS	HP	HP	HP
		105	M	NO	O	2W	30	HP	HP	HP	HP	HP
		106	2W	NO	R	1W	25	HP,PS	HP,PS	HP,SOW	HP,SOW	HP,SOW
		107	2W	NO	O	1W	28	HP,PS	HP	HP	HP	HP,SOW
	HP22	108	3W	NO	R	2W	25	HP,PS	HP,PS	HP	HP,SOW	HP,SOW
		109	2W	NO	R	2W	28	HP	HP	HP	HP,SOW	HP,SOW
		110	M	NO	R	1W	30	HP	HP	HP	HP	HP,SOW
		111	3W	NO	O	1W	25	HP,PS	HP,PS	HP	HP	HP
		112	3W	NO	O	2W	25	HP,PS	HP,PS	HP	HP	HP
	HP23	113	2W	NO	O	2W	35	HP	HP	HP	HP	HP
		114	3W	NO	O	1W	25	HP,PS	HP,PS	HP	HP	HP
		115	2W	NO	O	1W	30	HP	HP	HP	HP	HP
		116	2W	NO	O	2W	30	HP PS	HP	HP	HP	HP
		117	2W	NO	O	1W	25	HP,PS	HP,PS	HP	HP	HP
	HP24	118	3W	NO	O	2W	30	HP,PS	HP	HP	HP	HP
		119	2W	NO	O	1W	25	HP,PS	HP	HP	HP	HP
		120	2W	NO	O	1W	32	HP	HP	HP	HP	HP
		121	3W	NO	O	2W	15	PS,OHP	PS	HP,SOW	HP,SOW	OHP,SOW
		122	1M	NO	O	2W	18	PS,OHP	PS,OHP	HP,SOW	HP,SOW	OHP,SOW
(Salty water)	HP25	123	3W	NO	O	3W	15	PS	PS	HP,SOW	HP,SOW	OHP,SOW
		124	2W	NO	O	2W	20	PS,OHP	PS,OHP	HP,SOW	HP,SOW	OHP,SOW
		125	3W	NO	O	1W	18	PS	PS	HP,SOW	HP,SOW	HP SOW

1	2	3	4	5	6	7	8	9	10	11	12
Boram pally	126	3W	NO	O	2W	24	HP,PS	HP,PS	HP,SOW	HP,SOW	HP,SOW
	127	3W	NO	O	2W	28	HP,PS	HP,PS	HP	HP,SOW	HP,SOW
HP26	128	2W	NO	O	3W	30	HP,PS	HP	HP	HP	HP,SOW
	129	3W	NO	O	1W	35	HP	HP	HP	HP	HP,SOW
	130	1M	NO	O	1W	25	HP,PS	HP	HP	HP,SOW	HP,SOW
	131	M	NO	O	2W	25	HP,PS	HP,PS	HP,SOW	HP,SOW	HP,SOW
	132	3W	NO	O	3W	28	HP,PS	HP	HP	HP,SOW	HP,SOW
HP27	133	3W	NO	O	3W	30	HP,PS	HP	HP	HP	HP,SOW
	134	2W	NO	O	2W	32	HP	HP	HP	HP	HP
	135	2W	NO	O	1W	27	HP	HP	HP,SOW	HP,SOW	HP,SOW
	136	2W	NO	O	2W	25	HP,PS	HP	HP	HP	HP
	137	3W	NO	O	2W	30	HP	HP	HP	HP	HP
HP28	138	2W	NO	O	2W	30	HP	HP	HP	HP	HP
	139	3W	NO	O	1W	25	HP	HP	HP	HP	HP
	140	3W	NO	O	2W	25	HP,PS	HP,PS	HP	HP	HP
	141	M	NO	O	1W	25	HP,PS	HP,PS	HP,SOW	HP,SOW	HP,SOW
	142	2W	NO	O	2W	25	HP,PS	HP,PS	HP	HP,SOW	HP,SOW
HP29	143	2W	NO	O	2W	30	HP	HP	HP	HP,SOW	HP,SOW
	144	2W	NO	O	1W	25	HP,PS	HP	HP,SOW	HP,SOW	HP,SOW
	145	3W	NO	O	2W	30	HP	HP	HP	HP,SOW	HP,SOW
	146	M	NO	O	1W	27	HP,PS	HP,PS	HP	HP	HP
	147	3W	NO	O	2W	25	HP,PS	HP	HP	HP	HP
HP30	148	3W	NO	O	1W	27	HP,PS	HP,PS	HP	HP	HP
	149	2W	NO	O	3W	30	HP	HP	HP	HP	HP
	150	2W	NO	O	2W	25	HP,PS	HP	HP	HP	HP
Doddikunta	151	2W	NO	O	1W	25	HP,PS	HP	HP	HP	HP
	152	3W	NO	O	2W	25	HP,PS	HP,PS	HP	HP	HP
HP31	153	2W	NO	O	2W	30	HP	HP	HP	HP	HP
	154	3W	NO	O	1W	20	HP,PS	HP,PS	HP	HP	HP
	155	2W	NO	O	1W	28	HP	HP	HP	HP	HP
	156	2W	NO	O	1W	28	HP,PS	HP	HP	HP	HP
	157	3W	NO	R	2W	28	HP,PS	HP	HP	HP	HP
HP32	158	2W	NO	R	2W	25	HP,PS	HP,PS	HP	HP	HP
	159	3W	NO	R	1W	35	HP	HP	HP	HP	HP
	160	1M	NO	O	2W	30	HP	HP	HP	HP	HP
	161	2W	NO	O	1W	25	HP,PS	HP,PS	HP	HP,SOW	HP,SOW
	162	2W	NO	O	2W	25	HP,PS	HP,PS	HP	HP,SOW	HP,SOW
HP33	163	2W	NO	O	1W	28	HP,PS	HP	HP	HP	HP,SOW
	164	3W	NO	O	1W	32	HP	HP	HP	HP,SOW	HP,SOW
	165	2W	NO	O	2W	28	HP,PS	HP	HP	HP	HP,SOW
	166	2W	NO	R	1W	18	PS,OHP	OHP,PS	OHP	HP	HP
	167	3W	NO	R	2W	20	PS,OHP	OHP	OHP	HP	HP
(Salty water) HP34	168	1M	NO	O	3W	25	PS	OHP	OHP	HP	HP
	169	2W	NO	R	2W	20	PS	PS	OHP	HP	HP
	170	3W	NO	R	1W	20	PS,OHP	PS	OHP	HP	HP
	171	2W	NO	O	1W	27	HP,PS	HP,PS	HP	HP	HP
	172	3W	NO	O	2W	25	HP,PS	HP	HP	HP	HP
HP35	173	3W	NO	O	2W	35	HP	HP	HP	HP	HP
	174	2W	NO	O	2W	25	HP,PS	HP,PS	HP	HP	HP
	175	2W	NO	O	1W	30	HP	HP	HP	HP	HP

	1	2	3	4	5	6	7	8	9	10	11	12
Gangavaram		176	3W	NO	O	2W	25	HP,PS	HP,PS	HP	HP	HP
		177	M	NO	O	2W	35	HP	HP	HP	HP	HP
	HP36	178	3W	NO	O	3W	30	HP,PS	HP	HP	HP	HP
		179	2W	NO	O	1W	25	HP,PS	HP,PS	HP	HP	HP
		180	M	NO	O	2W	20	PS	HP	HP	HP	HP
		181	2W	NO	O	2W	24	HP,PS	HP,PS	HP	HP,SOW	HP,SOW
		182	2W	NO	R	2W	25	HP,PS	HP	HP	HP,SOW	HP,SOW
	HP37	183	3W	NO	R	2W	30	HP	HP	HP	HP,SOW	HP,SOW
		184	2W	NO	R	1W	20	HP,PS	HP,PS	HP,SOW	HP,SOW	HP,SOW
		185	3W	NO	R	2W	27	HP	HP	HP,SOW	HP,SOW	HP,SOW
		186	1M	NO	O	3W	25	HP,PS	HP,PS	HP	HP,SOW	HP,SOW
		187	3W	NO	O	2W	35	HP	HP	HP	HP,SOW	HP,SOW
	HP38	188	2W	NO	O	2W	30	HP,PS	HP,PS	HP	HP	HP,SOW
		189	3W	NO	O	1W	28	HP,PS	HP	HP	HP	HP,SOW
		190	3W	NO	O	2W	20	HP,PS	HP	HP,SOW	HP,SOW	HP,SOW
		191	3W	NO	O	2W	30	HP,PS	HP	HP	HP	HP
		192	3W	NO	O	2W	25	HP,PS	HP,PS	HP	HP	HP
	HP39	193	2W	NO	O	1W	35	HP	HP	HP	HP	HP
		194	2W	NO	O	1W	25	HP,PS	HP,PS	HP	HP	HP
		195	3W	NO	O	2W	35	HP	HP	HP	HP	HP
		196	3W	NO	O	3W	30	HP	HP	HP	HP,SOW	HP,SOW
		197	M	NO	O	2W	20	HP,PS	HP,PS	HP	HP,SOW	HP,SOW
	HP40	198	2W	NO	O	1W	30	HP	HP	HP	HP,SOW	HP,SOW
		199	3W	NO	O	1W	25	HP,PS	HP	HP	HP,SOW	HP,SOW
		200	2W	NO	O	2W	25	HP,PS	HP	HP	HP,SOW	HP,SOW

Codes used :

PERFORMANCE
O : Occassional - more than three months
R : Reguler - once in three months
W : Week
M : Month

USE
HP : Handpump
PS : Piped supply
SOW : Seasonal open well