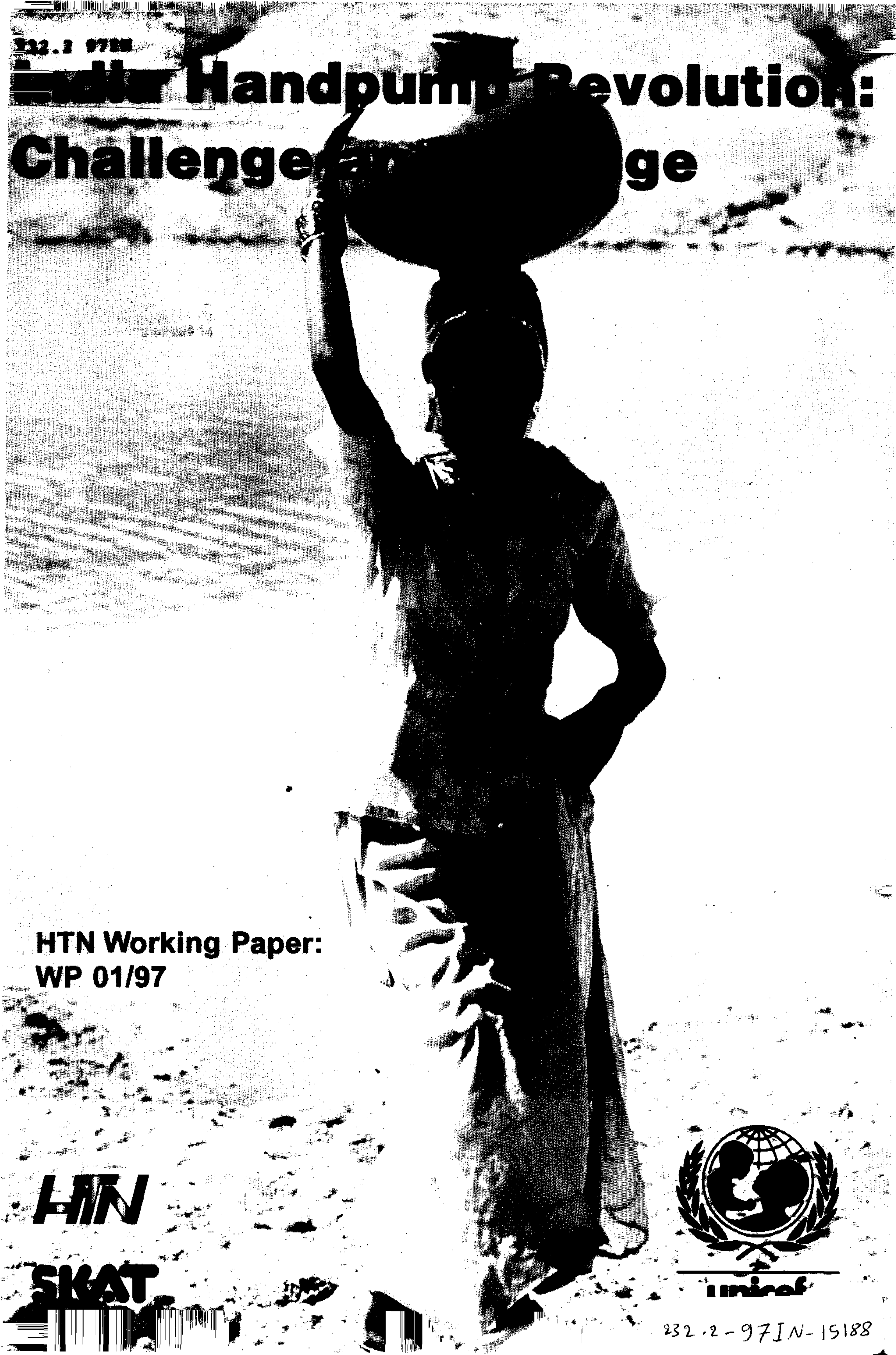
# India Handpump Revolution: Challenge [illegible]ge



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# India Handpump Revolution : Challenge and Change

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# FOREWORD

Appreciating the linkages between safe water and health and productivity of people in general and children in particular, the Government of India have accorded the highest priority in its planning for provision of safe drinking water in the rural areas in the country since the start of the planning process. Thanks to the political commitment, administrative support and the availability of appropriate technology, it has been possible to increase the coverage levels of safe water from mere 6% in 1971 to 85% in 1996.

The development of the India Mark II handpump and its standardisation on a national scale in the late 1970s and adoption of pragmatic implementation approaches by the Government had played an important role in achieving this impressive coverage.

The successful implementation of the Rural Water Supply (RWS) programme owes, to a great extent, the critical catalytic inputs provided by the UNICEF towards handpump standardisation, periodical revision of design through continuous R&D, quality control, capacity building and the excellent support as provided by the Bureau of Indian Standards (BIS), NGOs and the manufacturers of various equipment connected with water supply. This is an excellent example of a highly productive Government-Donor collaborative effort. Many lessons can be learnt from this experience.

I am happy to note that the Swiss Centre for Development in Technology and Management (SKAT) and the Handpump Technology Network (HTN) have recognised the merits of approaches adopted by the various agencies in the development and promotion of handpumps in India. The stage of development of the handpump, review of implementation approaches in the past that made the RWS programme a great success, gaps in the programme implementation and identification of the unresolved technical, institutional and social issues have been documented vividly in this case study.

Handpumps are now more reliable and much easier to maintain and technology challenges have been largely met. However, a larger and more complex challenge of motivating and empowering users to participate in the management of their maintenance still persists. The decentralisation of operations and maintenance of the systems at the community level will hopefully become a reality in the near future with the introduction of the Panchayati Raj system in the country.

I am sure, this case study will be useful to planners, implementing agencies, including the donors and the NGOs, involved in the design and implementation of large scale handpump based RWS programmes, elsewhere in the World.

**(Vinay Shankar)**

February 27, 1997

# Preface

This case study traces the deepwell handpump development in India from late 1960s to early 1990s and reviews the implementation approaches in research and development, standardisation, capacity building, quality assurance and procurement which have contributed to the success of the RWS programme. It also highlights the importance of proper technology selection, standardisation and quality control.

This is the story of rural water supply programme in India. It is a success story that has no parallel both in terms of magnitude (600,000 villages and over 2.5 million India Mark II deepwell handpumps) and its impact on rural communities.

It shows how the Coimbtore Handpump Field Testing Project, a collaborative handpump R&D project of the Government of India, UNICEF and UNDP/World Bank, responded to the VLOM (Village Level Operation and Maintenance) challenges of early 1980s through technology innovations including the development of an easier to maintain and repair handpump, the India Mark III.

It also discusses the impact of new technology developments on the maintenance structure, capital costs, maintenance costs, down time and community management of handpump maintenance.

It describes briefly the national rural water supply programme and role of the Rajiv Gandhi National Drinking Water Mission. It also highlights the importance of NGOs and emphasizes the need for a decentralized implementation with active community participation. It discusses the ways to enhance women's participation.

The study identifies the unresolved handpump design issues which need attention. Some of these issues are being addressed through a UNICEF sponsored handpump R&D project.

The hardware-software divide has been bridged to a substantial degree, and given the right policy environment and institutional capacity building, the management of most of the repairs should be possible at the village level itself. But a more difficult human and institutional challenge persists. The 'nuts and bolts' of community participation and management are infinitely more complex to handle. It needs a sustained and determined effort by government, donors, community leaders and most importantly, the users themselves.

Arun Kumar Mudgal

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# 1 Introduction

The availability of safe drinking water on a sustainable basis to communities throughout India has been a continuing focus of development programmes since the country's independence in 1947. The period from 1981 to 1990 witnessed more significant emphasis and takes its place in development history as the International Drinking Water Supply and Sanitation Decade (IDWSSD). The most visible sign of the country's involvement in the IDWSSD is without a doubt the handpump — more specifically the India Mark II handpump, in whose development UNICEF has played a crucial role.

When development historians pinpoint the date the Indian handpump revolution began in earnest, they invariably arrive at 1967. In that year, UNICEF responded to the drought conditions in the northern states of Uttar Pradesh and Bihar by airlifting eleven Halco borehole drilling rigs into the country. To water-deficient villagers, these were 'miracle' machines that bit deep into the parched earth to bring forth precious water. The arrival of these 'down-the-hole' (DTH) pneumatic drilling rigs signalled the beginning of a programme that was to become the largest of its kind in the world — in terms of both area covered and people served.

In the intervening decades, India's water supply programme (comprising largely rural handpump projects) has sought to blanket its approximately 600,000 villages. These population centres account for almost three-quarters of India's population, currently (1991 census) hovering around the 850 million mark. The impact of such coverage on the health and productivity of rural dwellers, while difficult to quantify accurately, is nevertheless deemed to be considerable. Indeed, the Government of India has made the provision of clean, safe drinking water a cornerstone of its rural development programme.

This case study traces the development of handpumps in India, including a review of the systems developed to ensure consistent, high quality production of the India Mark II. It investigates the pressures that led to the introduction of a new variant of the India Mark II — the India Mark III — a handpump designed for easy maintenance and repair. It highlights the primary issues of concern in the field that led to formulation of the concept of Village Level Operation and Maintenance (VLOM).

The case study follows the VLOM concept from its promotion in 1981 by a project for Laboratory and Field Testing and Technological Development of Community Water Supply Handpumps (a joint UNDP/World Bank response to the challenges presented by the IDWSSD agenda). It shows how technological innovations to the India Mark II resulted from the Coimbatore Handpump Field Testing Project, initiated in 1983. Funded by UNDP and UNICEF as part of the Global Field Testing Project and executed jointly by Government of Tamil Nadu, UNDP/World Bank Handpump Project and UNICEF with support from the Government of India — this project provided the field-level results that proved the validity of the VLOM concept.

The case study shows how the maintenance and repair of the India Mark III has been made simple both in terms of lifting out below-ground parts and in the kind of tools required to undertake this task. It explains how this ease of maintenance and repair has acted as a liberating factor at the village level. It shows that the evolution of handpump design in India has reaped many socio-economic benefits. In particular, it describes how the VLOM concept encouraged women — the traditional fetchers and carriers of water — to participate as handpump caretakers and mechanics. In developing a handpump that can be maintained and repaired for the most part by semi-skilled villagers and especially by women, the Indian handpump industry has been able to ensure widespread availability of safe drinking water in rural areas. By backing innovation that has responded to the needs of those most affected by water scarcity or absence, it has demonstrated a long-term commitment to the development of socially appropriate solutions.

It is believed that the information in the case study will help to explain how technological (hard) and systems (soft) improvements must be developed in combination if the resulting product is to meet user communities' needs. In India the idea of a pump that not merely permits, but actually encourages community responsibility for its operation and maintenance is beginning to take root. This case study not only addresses the technicalities associated with changes in handpump design but also implicitly suggests that with the India Mark III — a handpump that makes most of the repairs possible by a handpump caretaker with a few small tools — the hardware-software divide has been bridged to a substantial degree. The India Mark III — having learnt from the successes and travails of its predecessor — stands for the kind of people-oriented and integrated improvement methodology that is imperative for success. This approach to development is becoming increasingly vital for delivering safe water on a sustainable basis to the unserved and under-served millions.

# 2 Links in a chain

*"What happened to the Mark I?"* This is a question asked frequently by newcomers to the handpump scene in India. The answer is that there was a Jalna pump, a Jal-Vad pump, a Sholapur pump, and a short development (or Mark I) Phase, but there was no India Mark I. If one was to draw the India Mark II lineage as accurately as possible, the Sholapur pump of the early 1970s must be regarded as its closest preceding kin.

## Before the India Mark II

In 1969, Cyrus Gaikwad, working with the War on Want Project, Church of Scotland Mission at Jalna in Maharashtra designed a new pump. It was an alternative to the cast-iron 'family' pump that American and European homesteaders had been using for many years. In terms of meeting community, rather than family needs, the demands made on handpumps in the Indian context are considerable. The difference between individual family or farmer use for 10-30 minutes a day and the needs of 500 or more villagers puts into perspective the kind of design changes that were needed.

After considering that a community pump must operate almost continuously for more than 10 hours a day, Gaikwad, an Indian mechanic and driller, set about designing an all-steel handpump. Mechanics at the mission workshop produced several hundreds of these 'little yellow handpumps' over the next few years. The Jalna pump boasted the following improvements over the cast-iron handpump:

- The single pivot handle with a sealed ball bearing was a considerable improvement on the old multi-pivot handle;
- Connecting rod life was enhanced greatly by virtue of being kept aligned and in a state of constant tension through the device of a linked chain running over a quadrant.
- The pump base was not connected to the casing.

Another voluntary agency, the American Marathi Mission Project at Vadala, also in Maharashtra, soon produced an improved version of the Jalna. The Jal-Vad handpump, as it became known, was more accurately fabricated.

At the Coimbtore Water Development Project, the Jalna handpump underwent more modification, using a steel cable instead of a link chain on the handle, but this did not prove viable.

The main technology leap towards the India Mark II occurred with the advent of the Sholapur Handpump in the early 1970s. The Sholapur Well Service (SWS), funded by the Swedish Covenant Church, emerged with a better pivot design. The person behind this important development at SWS was Oscaar Carlsson. This pump was very professionally engineered — ensuring uniformity of the pump parts by manufacturing them on jigs and fixtures. The new pivot mechanism avoided lateral stretch on the bearings. It had a roller-chain operating over a quadrant. A pedestal fitting over the borewell casing pipe ensured a sanitary seal and the pump was set in concrete to eliminate movement.

By 1974, these pumps — the Jalna, Jalwad and Sholapur — had been shipped in their hundreds to user communities in Maharashtra. Witnessing the success of the mission-backed programmes, AFARM (Action for Agricultural Renewal in Maharashtra) which co-ordinated a number of non government organisations (NGOs) began to copy and install handpumps based on the Sholapur design. Consequently in the mid-1970s, one witnessed the spectacle of thousands of borewells capped by one or another of these handpumps. Basically, projects drilled their own borewells and installed their own favourite pump.

Despite growth in coverage, the work was virtually exclusive to one state — Maharashtra. As yet there was no move towards introducing these pumps on a significant scale elsewhere in India. When the pumps did find their way out of Maharashtra, each pump was invariably different from any other of the same design. The projects had not considered the need for standardised drawings. Therefore, inter-changeability of parts was, of course, impossible.

## The entry of UNICEF

Water supply and environmental sanitation were important components of UNICEF's Integrated Country Programme, which linked closely with India's Fifth Five-Year Plan (1974-1979). Since 1967, the agency's assistance to the water supply programme had largely taken the form of providing DTH hammer air percussion drill rigs. These were used to drill boreholes in the hard rock areas of India, which accounts for more than eighty per cent of the country's terrain.

### *A stimulus to action*

In 1974, UNICEF carried out a spot survey of handpumps fitted on the borewells drilled in Tamil Nadu using UNICEF-supplied rigs. The results were not encouraging and prompted a further survey in Maharashtra. In effect, the survey established that virtually seventy-five per cent of the cast iron handpumps were inoperative at any given point in time.

For UNICEF, the implication of the survey was clear — unless handpump quality, installation and maintenance were improved, a borewell would be a mere hole in the ground. It would have no utility value to the rural people it was designed to assist.

This was an unacceptable situation and marked the beginning of the India Mark II Handpump Project, which focused on:

- The development of a sturdy and reliable community handpump;
- The large-scale local production of these handpumps;
- Reducing pumping effort to minimize the burden on women;

**Handpumps Through the Ages**

Community water supply depends, for the most part, on the reciprocating, positive displacement, plunger pump. Mists of antiquity shroud the exact origins of this technology, but the starting point is sometimes located by historians[1] as early as 275 BC and linked to a certain Ctesibius. The pump in question seems to have been a twin cylinder lift type with external valves and without packing between the plunger and the cylinder wall. It was used for fire fighting. Apparently, Hero (2nd Century BC) and Vitruvius (1st Century BC) were familiar with this sort of pump. Archaeological digs in Europe occasionally threw up late Roman examples of this technology. Another historian[2] states that a reciprocating pump of wood was used as a ship's pump in the early Greek and Roman navies. In the 16th Century, Agricola (1556) recorded the use in Saxony of a wooden pump with metal flap valves.

In 17th century England, reciprocating pumps made of wood or lead and with the plunger packed in leather were commonly used. However, it was not until the middle of the 19th century that the Industrial Revolution facilitated mass production techniques for varying models of cast iron handpumps. Some 42 million handpumps are estimated to have been made in the USA alone[3], mainly up to 1920.

- Demonstrating that a better-designed handpump, standardisation and quality control could facilitate a more effective maintenance system;
- Demonstrating that a more reliable supply of potable water could reduce the incidence of water-borne and water-related diseases.

## *Taking a lead role*

In 1973, UNICEF had commissioned a WHO consultant to evaluate the handpumps installed in different parts of India with a view to coming up with an improved design. The improved design was discussed at a handpump workshop in Bangalore in 1975. Organised by the Government of India and WHO, the workshop was attended by Chief Engineers from various states and representatives

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1 F.E. Jenkins, Handpumps, IRC, The Hague, The Netherlands

2 B. Eabanks, *The story of the pump and its relatives, Salem, Oregon, USA, 1971 (private printing)*

3 Ibid

from the Mechanical Engineering and Research Organisation (MERADO) - a Government organisation that is a part of the Council of Scientific and Industrial Research (CSIR), Richardson and Cruddas (R&C) - a Government of India owned engineering company located at Madras in Tamil Nabu, and UNICEF. The consultant had suggested that a Jalna-type pump made of cast iron could be considered. The workshop deemed this version of the Jalna to be excessively heavy and no great improvement on its predecessor. A non-metallic deepwell cylinder (instead of the brass cylinder then in use) was also recommended. The proposal did not stand up to the rigors of field testing in Coimbtore.

In 1975, UNICEF began to take a lead role in handpump development in India. The UNICEF initiative was spearheaded by a dedicated team lead by Ken Mcleod, a no-nonsense and pragmatic Australian engineer with missionary zeal. It encouraged the activities of the AFARM affiliates and offered support to MERADO. It also purchased 6,500 Sholapur 'conversion heads' from the AFARM group and provided them to various state governments as part of the handpump rejuvenation programme. The 'conversion heads' (or top part of the Sholapur pump) replaced the multi-pivot handle of the cast iron handpump. The successful outcome of this hybridisation marked the turning point in the Government's attitude to the handpump industry. An improved handpump now seemed within reach.

## Accelerating change

UNICEF played the role of co-ordinator and facilitator in the development of the India Mark II. The other major players in this process were MERADO and Richardson & Cruddas. While Richardson & Cruddas was responsible for manufacturing the various prototypes and rationalising components (keeping in view mass production techniques), MERADO provided design support. Those who lead this important effort in partner organisations included T S Kannan and M A Krishnamurty from Richardson & Cruddas and M V Maheshwaran from MERADO.

### *The basis of design*

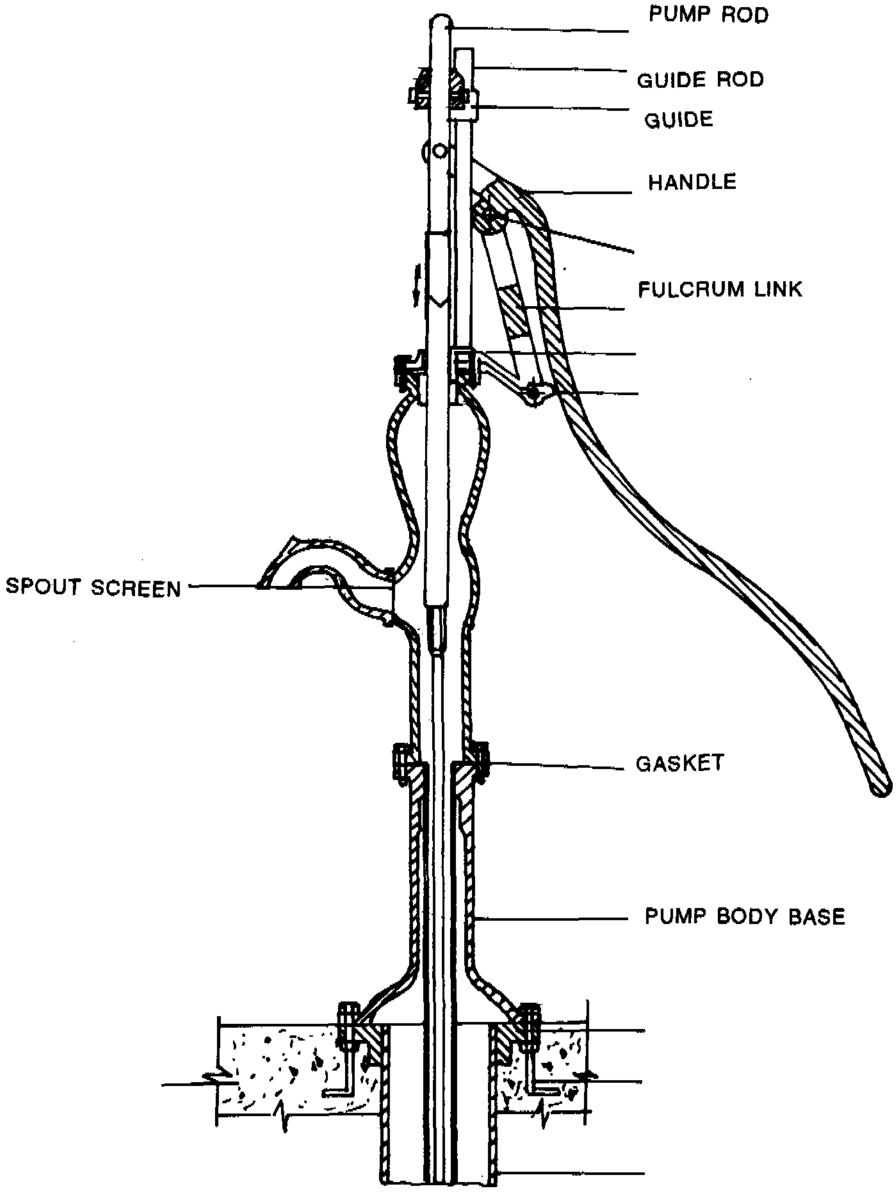
While the Sholapur pump was modified in many ways, it remained the point of reference during development of the India Mark II. In essence the development thrust was towards a piece of equipment that could be:

- easily mass produced in simply-equipped workshops;
- produced entirely with materials and components available in the country;
- made available at less than US$ 200 (1977-78 prices).

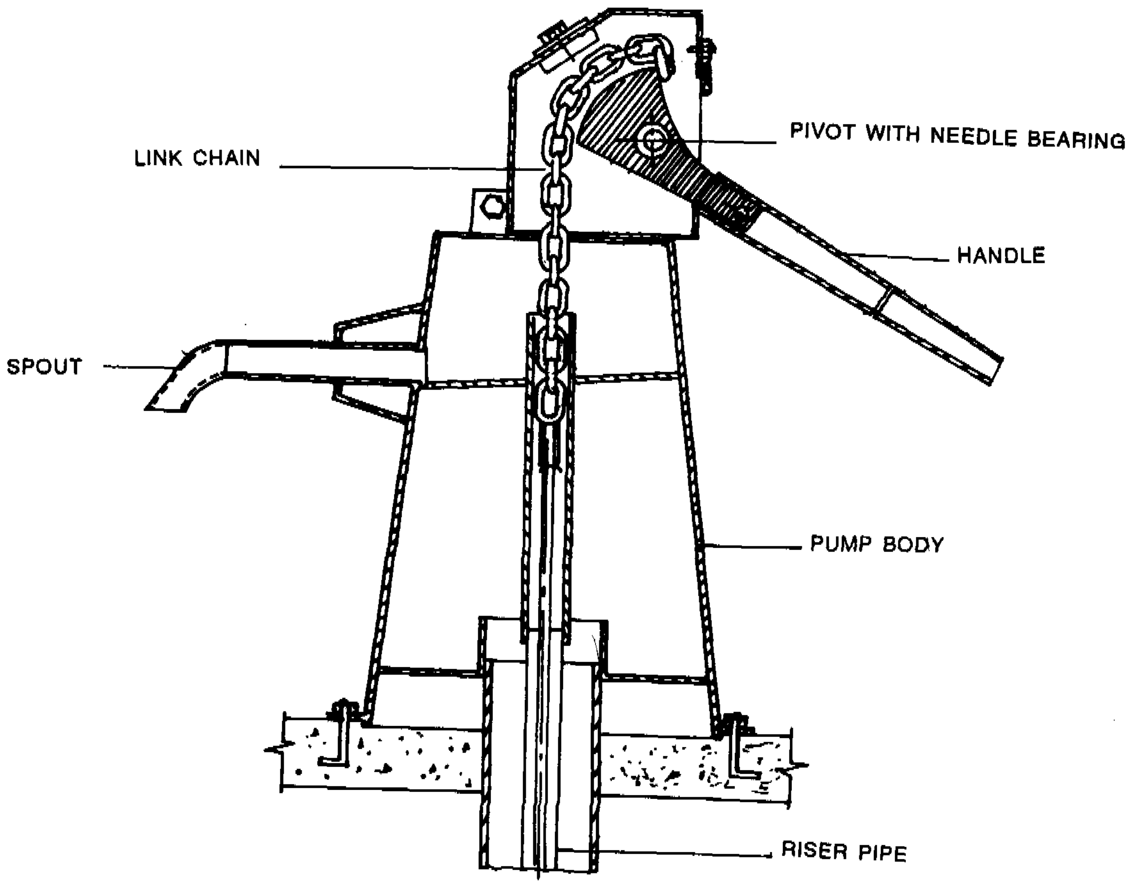
In addition, the pump was to be demonstrably sturdy, reliable and easy to operate. It was to function without breaking down for at least a year and be capable of drawing water from borewells with Static Water Level (SWL) up to 30 metres.

**Pumps leading to the India Mark II**

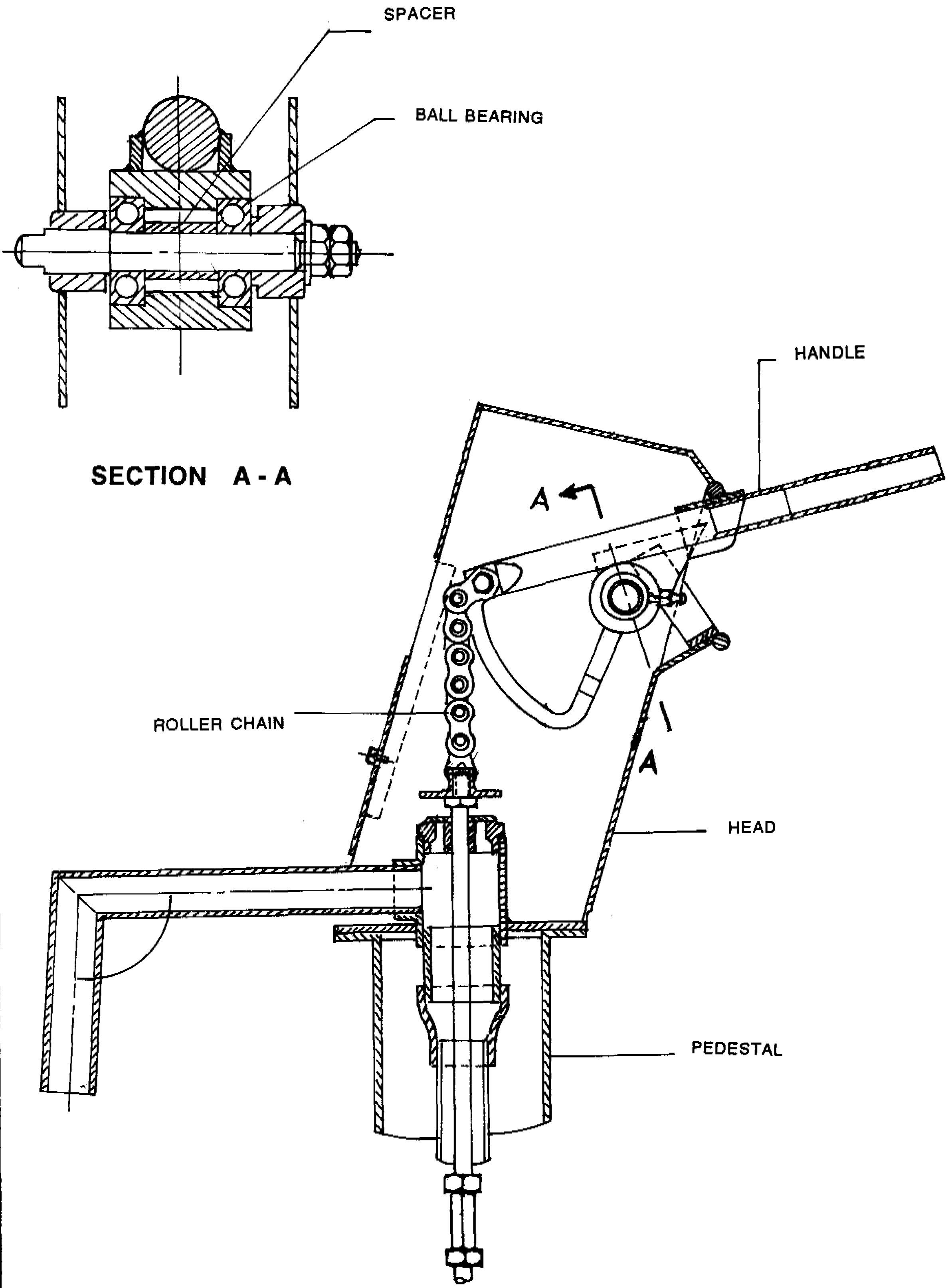
1. *"Slide and Guide" Handpump*
2. *Jalna Pump*
3. *Jal-Vad Handpump*
4. *Sholapur Handpump*



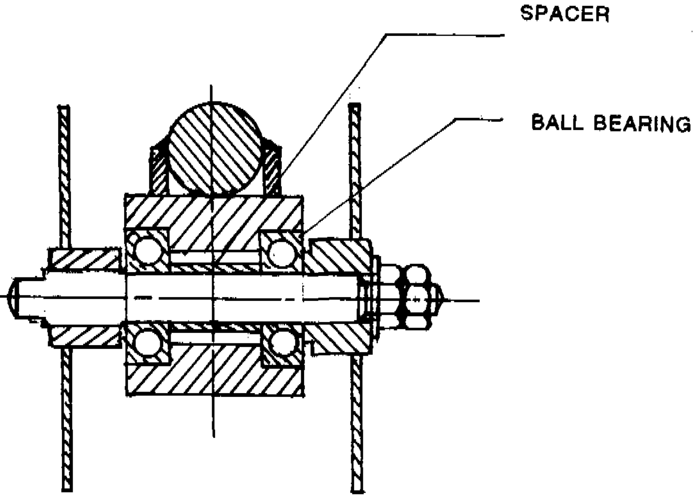

**SLIDE AND GUIDE CAST IRON PUMPHEAD**
**YEAR - $1960_s$**




**JALNA PUMPHEAD**
**YEAR - 1969**




**SHOLAPUR PUMPHEAD**
**YEAR - 1973**

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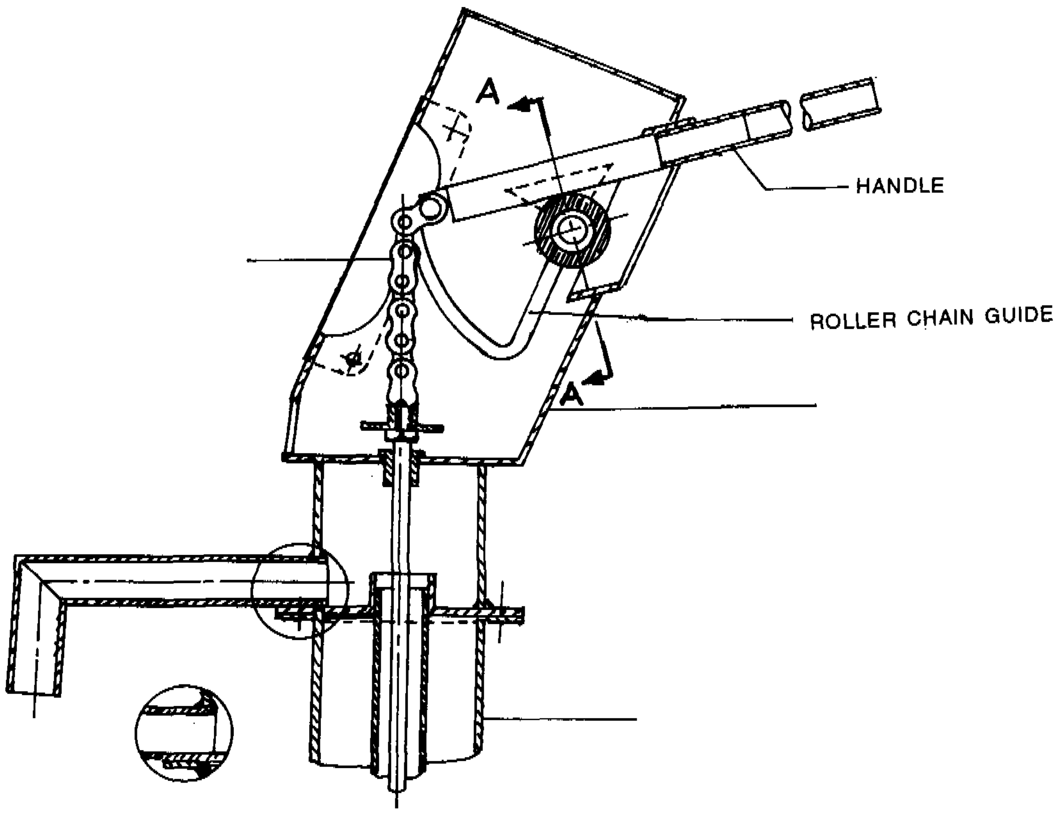
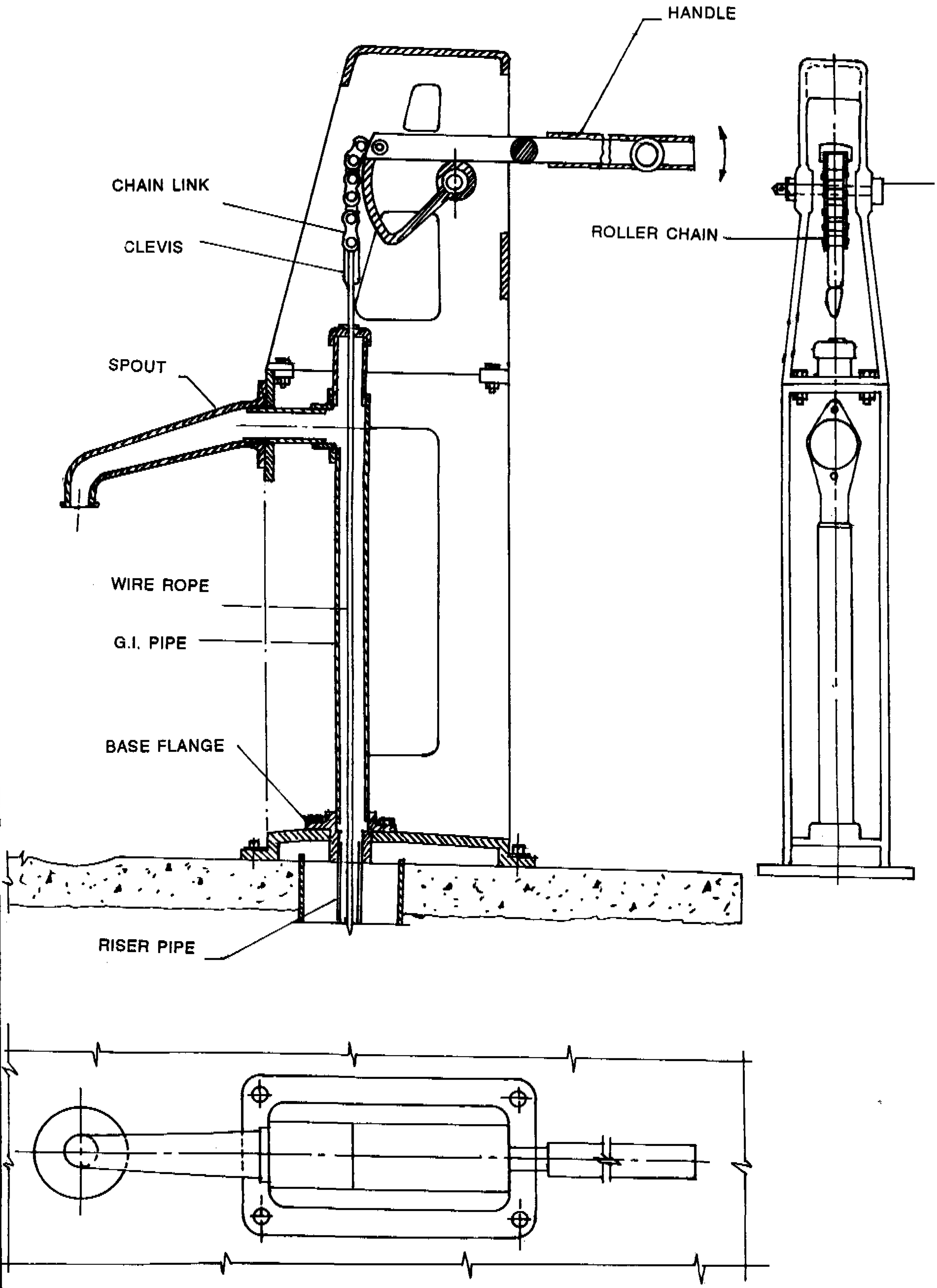
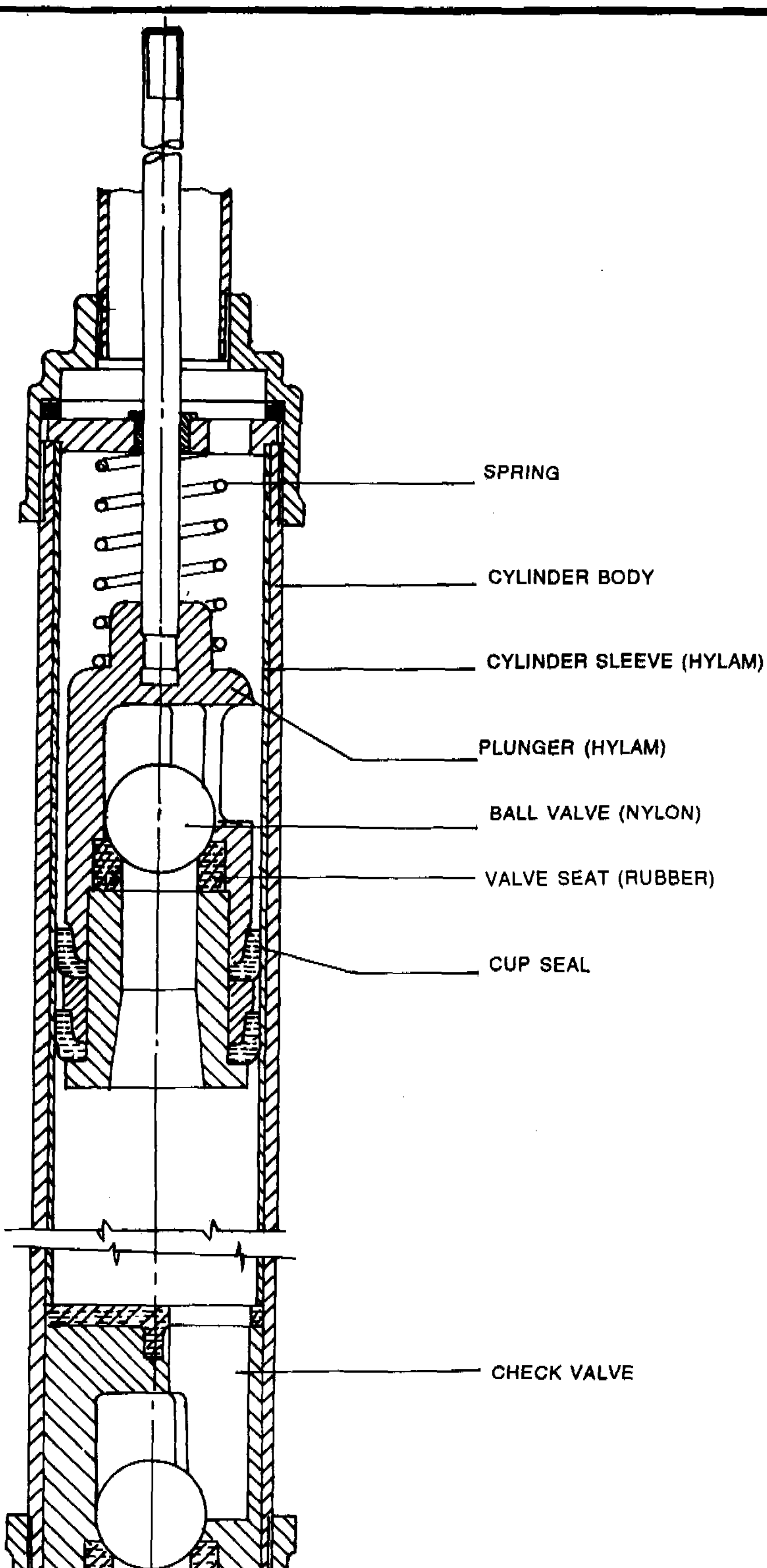


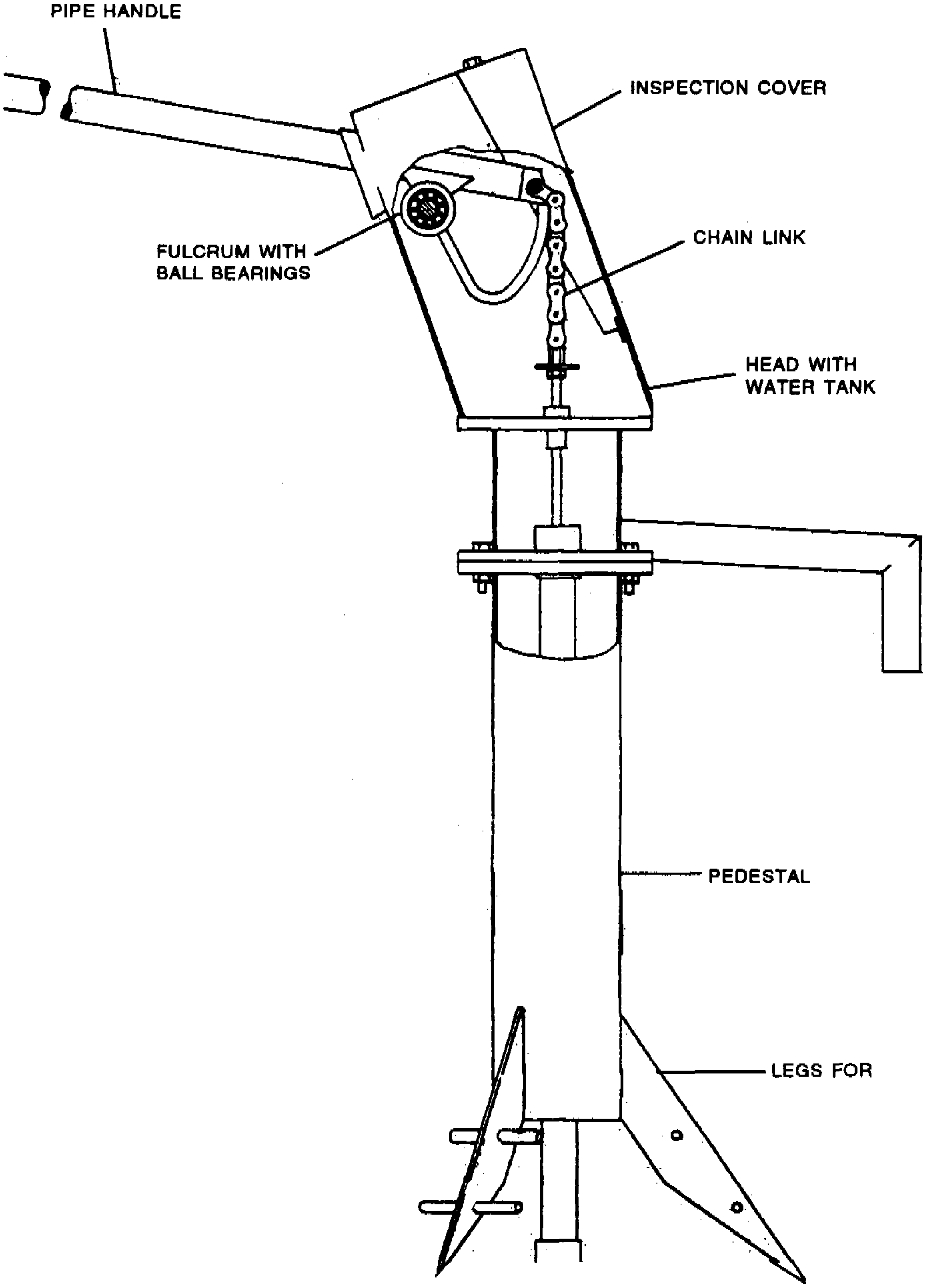

**SHOLAPUR PUMPHEAD**
**YEAR - 1974**



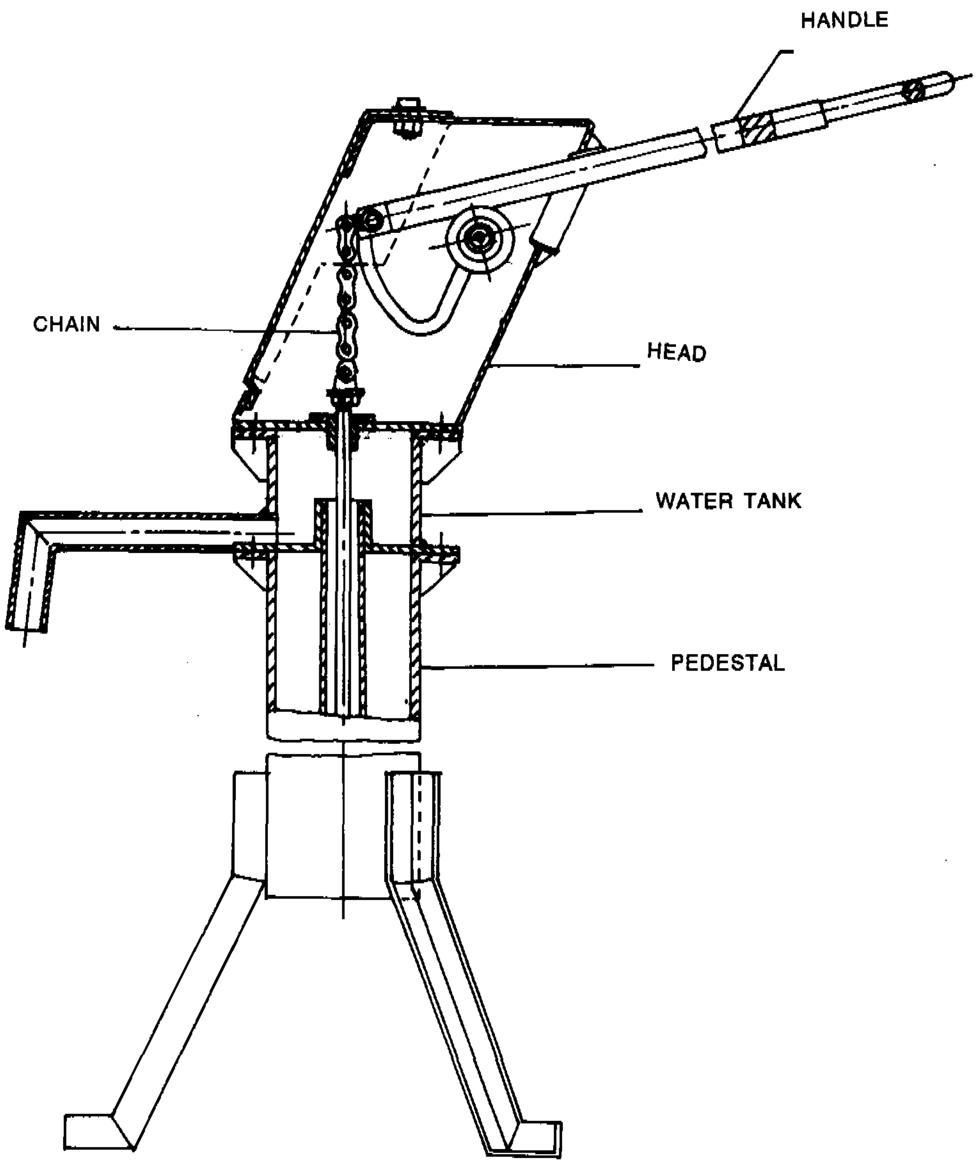

**BANGLORE PUMPHEAD CAST IRON**
**YEAR - 1975**




**BANGLORE PUMP CYLINDER**
**YEAR - 1975**




**SHOLAPUR PUMPHEAD - YEAR 1976**




**INDIA MARK II PUMPHEAD**
**YEAR - 1977**

To achieve these various objectives, the design team made certain design changes, including the following:

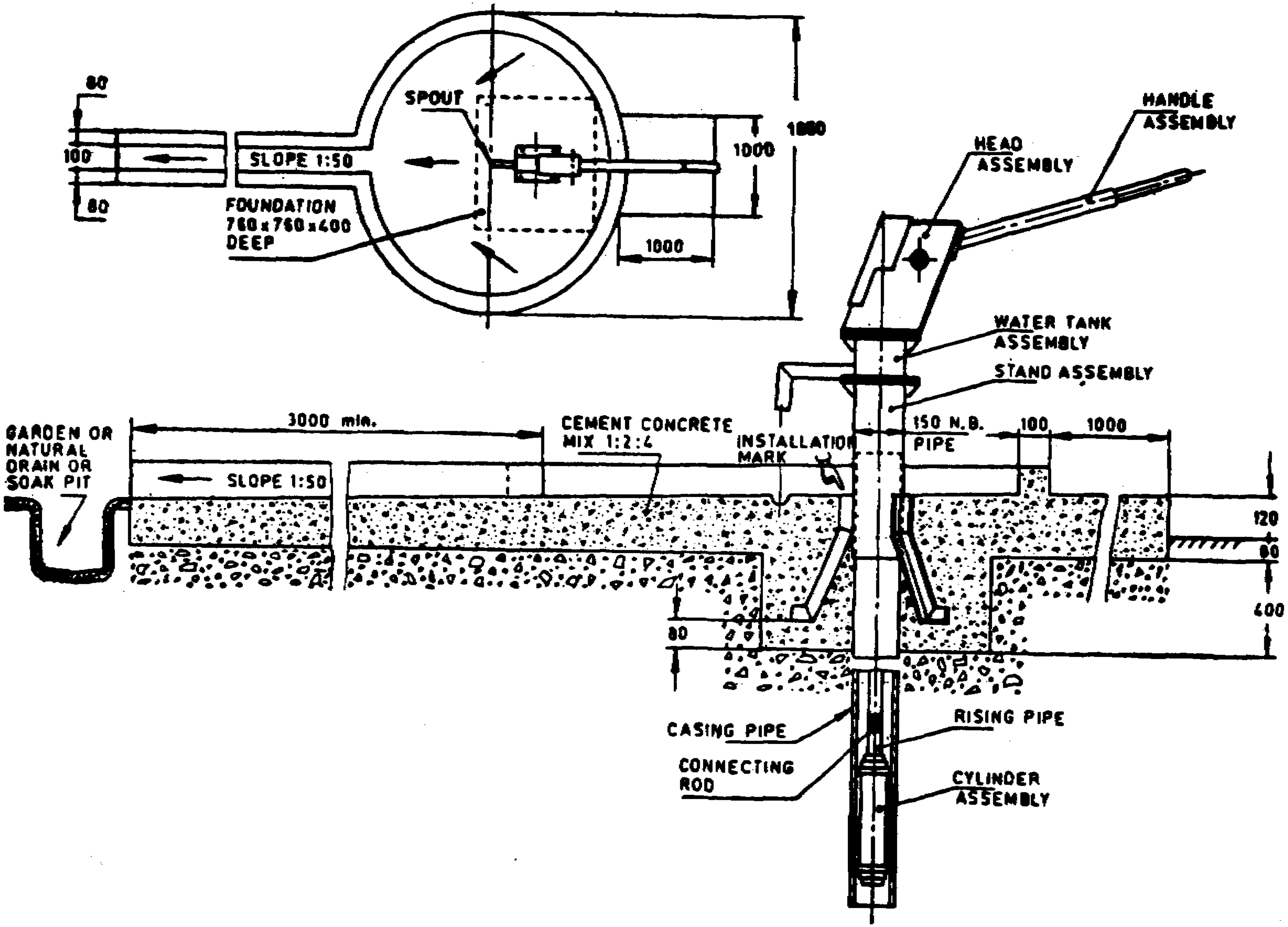
- Eliminating compound curves on the pumphead;
- Increasing the pedestal diameter from 5" to 6" (125-150 mm) to accommodate the 5" casing pipe that was in common use by 1976;
- Replacing the pipe handle with a solid bar. This counter-balanced the weight of the connecting rods, facilitated the use of the pump by young children and eliminated a point of failure in the Sholapur pump;
- Replacing the two-part Sholapur design (head with water tank and pedestal) with a three-part modular design (head, water tank and pedestal). This made for easier installation and repair.

## *Field testing phase*

After Richardson & Cruddas had manufactured twelve pre-production India Mark II handpumps, field testing was carried out over the period 1976-1977. Initial tests were conducted in Coimbatore district of Tamil Nadu State under the joint supervision of the Tamil Nadu Water Supply and Drainage Board (TWAD) and UNICEF. The combination of a deep SWL (around 40 metres) and a high handpump usage pattern made this district a suitable testing-ground.

The non-metallic cylinder developed by the WHO consultant failed in the initial period of testing and was replaced by the Sholapur cylinder, that also proved to be unsuitable due to inversion of the leather bucket and valve failures. The deep setting of the cylinder was apparently the cause of failures.

In order to test complete units, a spot decision was taken to continue the field testing using the cast iron Dempster-type cylinders introduced by UNICEF some years earlier. When, in October 1977, the twelve pumps completed their one-year intensive field testing with only one failure, a breakthrough was clearly apparent. Another 1,000 pumps manufactured by Richardson & Cruddas were put on trial in various states in December 1977. The results were very encouraging — the pumps had a very low breakdown rate and were easier to operate than the old cast iron models and were widely appreciated by communities and Government. With an extensive testing programme behind them, it was now time for the key players to introduce the new pump in large numbers.




INDIA MARK II INSTALLATION DETAILS

| Component | Feature |
|---|---|
| **Head Assembly** | • Sturdy mild steel box containing the handle pivot.<br>• Heavy duty handle stop.<br>• Simple inspection cover secured by a single bolt.<br>• Flange mounts to water tank. |
| **Handle Assembly** | • Solid bar handle to counter-balance connecting rods.<br>• Ball bearings.<br>• Chain linkage for gravity return of the piston.<br>• Quadrant and chain to ensure connecting rod alignment.<br>• Splash washer to help prevent wetting of chain. |
| **Water Tank Assembly** | • Angled spout makes ingress of debris to water tank difficult.<br>• Heavy duty riser pipe holder raised above the spout to prevent ingress of debris to cylinder.<br>• Flange mounts to pedestal. |
| **Pedestal (Stand) Assembly** | • 150 mm N.B. pipe pedestal fits over borewell 125 mm N.B. casing pipe.<br>• Angle iron legs to ensure firm bond to a concrete base.<br>• Sanitary seal created between OD of well casing and ID of pedestal to prevent infiltration of polluted water to well.<br>• Flange mounting provides for further head development or conversion to power pump. |
| **Connecting Rods** | • Mild steel bright bar, electro-galvanised for surface protection.<br>• Threaded rods with hexagonal coupling and check nut.<br>• 3 metre lengths for ease of handling. |
| **Rising Main Pipe** | • 32 mm NB medium grade galvanised pipe in 3 meter lengths to facilitate installation and repair using hand tools. |
| **Cylinder Assembly** | • Cast iron case for low cost and to protect brass liner.<br>• Brass liner with smooth finish to prolong leather bucket washer life.<br>• Rubber seated valve poppets for effective sealing. |

## *Large-scale production*

Because of the encouraging results emerging from the field, the improved pump design was finding acceptance by the Government of India and a number of state governments. Consequently, demand started to rise. By 1978, Richardson & Cruddas started manufacturing the India Mark II in volume (on average, some 600 handpumps per month) through a network of small-scale ancillaries employing about 800 workers to produce pump parts. These vendors were supplied jigs and fixtures and given technical assistance to establish mass production facilities to produce parts conforming to defined standards and acceptable to international inspecting agencies.

UNICEF again took the lead in identifying and developing new manufacturers. As part of the pre-qualification process, UNICEF engaged Crown Agents (an international inspection agency) to carry out works inspection and select potential manufacturers. Subsequently, UNICEF placed a trial purchase order with these manufacturers. Crown Agents also provided technical assistance to potential manufacturers to iron out production and quality related problems. This process enabled most of the manufacturers to establish effective production and in-house quality control systems. In the early 1980s, several private sector manufacturers qualified as UNICEF approved handpump suppliers. Largely through UNICEF's efforts, supply and demand coincided in 1982 with the production of approximately 100,000 handpumps per year. By 1984, more than 600,000 handpumps had been installed and, in 1995, some 2.3 million India Mark II handpumps were dispersed across India.

The private sector's response to meet demand for handpumps was excellent. Names such as INALSA, Meera & Ceiko Pumps and Ajay Industrial Corporation soon became familiar in the handpump industry — both within India and beyond. To date, the INALSA group has manufactured nearly a million handpumps and exported close to 60,000 pumps to more than fifty countries. As in the case of Richardson & Cruddas, this achievement has involved the active participation of many ancillary units, which has brought into sharp focus the vital aspect of quality assurance and control. Success in international markets has underscored the fact that a developing country manufacturer is capable of securing global tenders, in the face of stiff international competition, if it manufactures quality products on a consistent basis.

In 1984, there were thirty-six qualified suppliers of the India Mark II and its spare parts. By 1995, there were thirty-six manufacturers that had been awarded a license to manufacture by the Bureau of Indian Standards. All the qualified manufacturers had undergone a rigorous works inspection for assessment of their capacity and capability to manufacture handpumps conforming to stringent standards. These qualified manufacturers have a total annual production capacity of over 150,000 handpumps.

The early 1980s in the handpump development history are seen as the "Consolidation Phase". The pragmatic policies pursued and promoted by

Kenneth D Gray from UNICEF, on standardisation, local capacity building and quality assurance paid rich dividends and within a few years the handpump programme expanded phenomenally.

## Achieving quality

A concern for the quality of the product was intrinsic to UNICEF's involvement in the development of the India Mark II. The problems of non-standardisation had become apparent during the prototype testing of the India Mark II. A host of imitations, virtually all of a substandard quality, had proliferated and appeared in the market. A decision was taken in 1976 in concurrence with the Government of India to give the drawings and specifications relating to the handpumps to the Indian Standard Institution (ISI) - now the Bureau of Indian Standards (BIS) so that it could formulate a national standard on the deepwell handpump. The National Conference on Deepwell Handpumps, sponsored by the Central Public Health and Engineering Organisation (CPHEEO) and UNICEF, held in 1979 at Madurai in Tamil Nadu, endorsed the need for standardisation and strict quality control. Recognising the advantages of the India Mark II, it also recommended that the India Mark II should replace older types of handpumps as quickly as possible.

### *Standardisation*

In 1980, the first ISI specification (Specification for Deepwell Handpumps) or IS:9301-1979 appeared. The ISI reviewed and modified the standard in 1982, based on the feedback received during implementation. A subsequent review resulted in a second and third revision in 1984 and 1990. These revisions made some important changes that included the following:

- Stainless steel was specified as the material for the handle axle and plunger rod;
- Solid triangular gussets were to be provided at the top and bottom of the handle bracket to strengthen the stops;
- The connecting rods and plunger rod were to be provided with welded hexagonal couplers in place of lock nuts to simplify maintenance and enable greater reliability;
- The rear two stand legs were to be at $80^0$ rather than at $120^0$ in the interest of more stability;
- Hot dip galvanizing of the head assembly was specified to reduce problems with corrosion;
- A telescopic pedestal was added as an option to suit installation in borewells with 150 mm NB casing;

- A nitrile cup washer was to be used in place of leather cup washers - this improved the service life of the cup seal by almost 100%, perhaps the most significant development;
- A third plate was added for easy maintenance.

The process of national standards formulation was flexible enough to be responsive to the needs of the field and is evident from the periodic revision of BIS specifications. Any change in the standard was accepted only after it had proved its field worthiness. This was possible as UNICEF, government and manufacturers continued to work on refinement of the technology through R&D and field testing to improve reliability, durability and ease of maintenance.

These standards played a major role in ensuring that the handpumps made at different production centres would be of the same design and that subassemblies and parts would be interchangeable. The policy of standardisation coupled with the third party quality assurance was the mainstay of the RWS programme. This paid rich dividends such as full interchangeability, simplified procurement, better inventory control and economies of scale, resulting in very competitive prices and easier availability. The India Mark II was to rapidly become a household name all over India.

## *India Mark II Abroad*

Although the India Mark II was primarily designed for Indian rural conditions, it was soon found to be suitable for application outside the borders of the country.

Under the Handpump Project of the UNDP/World Bank, the Consumers Association Testing Laboratory in the UK conducted extensive trials in the early 1980s of twelve different deepwell handpumps from all over the world, including France, Holland, Canada, Sweden, UK, USA and India. The parameters used for testing included:

- Ease of manufacture, installation and use;
- Mechanical and volumetric efficiency;
- Frequency of breakdowns and maintenance needed;
- User acceptability;
- Resistance to corrosion, abuse and neglect.

From these tests, the India Mark II emerged along with the Consallen handpump as one of the top two handpumps. The Consallen, however, did not perform as well in the field and was not a serious contender. A comparison of prices showed that the India Mark II clearly led the pack. Following the Consumers Association testing programmes, the India Mark II soon went on to conquer export markets.

## *Quality Control*

The endorsement of the need for quality control in production by the National Handpump Workshop in Madurai was merely a recognition of the role that UNICEF has been playing from 1976 in collaboration with the Indian Standards Institution. The success of both the domestic handpump programme and the export-thrust of these handpumps is due, in great measure, to this effective partnership.

The strict quality control was introduced in order to ensure the longest possible pump life as well as inter-changeability of parts between pumps produced by the various manufacturers. Through a process of vendor questionnaires to potential manufacturers, works inspection to assess capacity and capability, placement of trial purchase orders and technical advisory services, UNICEF supported the development of local manufacturer of a new, public-domain handpump. On completion of trial-purchase orders, a manufacturer was included in the UNICEF list of "approved manufacturers". The technical support provided to potential manufacturers to improve production techniques and strengthen internal quality control systems was instrumental in creating a durable and quality conscious local production capacity in a short time.

The objectives of the quality control exercise were to:

- create awareness among implementing agencies about the need for the procurement of quality handpumps and spare parts;
- ensure control regarding the quality of handpumps and spare parts;
- monitor on a continuous basis the manufacturer's production capacity, consistency in quality control, level of approvals and rejections;
- monitor the effectiveness of the quality control mechanism through consignee end inspections on a random basis.

For this purpose UNICEF supported pre-delivery inspections of handpumps at the manufacturer's works and consignee end inspections by independent inspection agencies (Crown Agents and SGS) for over fifteen years. This responsibility has now been taken over by the Bureau of Indian Standards.

## *Quality Control System*

Quality control is carried out at two levels: at the manufacturer's level; and at the consignee level.

At the manufacturer's level, the quality control includes:

- Pre-qualification of the manufacturer to ensure that it has the necessary infrastructure, technical expertise, jigs and fixtures, measuring instruments and gauges, etc;
- Insistence on an effective internal quality control mechanism at the manufacturer's works. Internal quality control is the sole responsibility of the manu-

facturer and includes inspection by manufacturer's inspectors of raw material and bought out items, in-process inspection of components, sub-assemblies and assemblies, calibration of gauges and instruments and maintenance of verifiable records of internal quality control activities;

- Selection of suppliers from among pre-qualified manufacturers and their grading in order of merit and capacity;
- Insistence on registration of handpump manufacturers under BIS;
- Insistence on pre-delivery inspection of pumps and spare parts at the manufacturer's works by an independent inspection agency before dispatch to ensure conformance of handpumps and spare parts to relevant specifications;
- Continuous monitoring of performance of qualified manufacturers which includes a number of abortive visits by inspection agencies and delay in delivery time.

Inspections at the consignee level are carried out to:

- ensure that only inspected and accepted goods are received at the consignee end;
- ensure that materials are received as per the purchase order;
- collect data regarding damage during transportation, discrepancies, storage practices etc. and to give feedback to headquarters for taking up issues with manufacturers and consignees.

In the event of a consignee complaint, an inspection agency carries out the inspection of the consignment at the consignee end. In addition to this, UNICEF also assists state governments in the overall quality monitoring of handpumps and spare parts through quality audits by an independent inspection agency at divisional and sub-divisional stores. Such audits help in initiating macro-level corrective measures.

## *Procurement*

The most important factor in the success of the programme is the recognition by implementing agencies of the need for quality. Government departments (major purchasers of handpumps and spares) make handpump purchases only from the BIS approved manufacturers with pre-delivery inspection at the manufacturer's works. UNICEF, for nearly one and one half decades, arranged for pre-delivery inspection of handpumps and spares and contributed towards the payment of inspection fees for all government purchases. This strategy has paid rich dividends and now Government departments have started bearing handpump inspection costs. UNICEF, at present, bears the inspection costs of handpump spare parts procured by state governments. In the next few years it is expected that the state governments will take over this responsibility from UNICEF.

## *Government's Role*

The Government of India (GOI) played a crucial and decisive role in the implementation of the handpump programme strategy. This included: field testing and monitoring, evaluation of handpump performance, continual research and development to refine the handpump design in response to the field requirements, standardisation on a national scale, making inspection of handpump at the manufacturer's works an essential condition for government handpump procurement, local capacity building for production and quality control, establishment of a mechanism for periodical updating of national standards by the Bureau of Indian Standards and local capacity building for installation and maintenance. UNICEF support was catalatic in nature and mainly comprised of software inputs such as preparation of IEC materials, capacity building, training and R&D. But for the government's strong support to standardisation and quality control, the handpump programme in India would not have been successful.

# 3 Emerging limitations

By 1996, there were an estimated 2.6 million India Mark II and India Mark III handpumps operating in rural India, covering a population of approximately 500 million. If the most recent Government-stated norm of 150 persons to a handpump, 55 litres per capita per day and maximum distance of 500 metres in plains and 50 metres in hills is to be realised, it is obvious that considerable ground still needs to be covered. An encouraging sign in this respect is that, a study commissioned by UNICEF in 1985 found, on average, eighty-seven per cent of the pumps in four districts were working at any given point of time. This figure stands in stark contrast to a breakdown rate of seventy-five per cent in the 1970s.

## Maintenance

With extensive use, the most vulnerable parts of the India Mark II, such as the aboveground chain assembly and the below-ground cup washer, need maintenance and repair. Sustained usage and misuse also takes a toll on other aboveground and below ground components with varying degree of frequency. The below ground repairs necessitate bringing in mobile units of mechanics with heavy hand tools. Inefficient communication systems tend to extend the time lag between breakdown and repair.

### *System of Maintenance*

Virtually any mechanical device breaks down. One that is put under as much stress as the India Mark II is certainly no exception. Serving a minimum of 250 persons on a 10-11 hour basis per day, the fact that the pumps break down as infrequently as they do is indicative of their robustness. The India Mark II design process had paid attention to the question of maintenance and repair. However, the primary focus had tended to be on a device that would need occasional professional attention. The pump's designers had assumed that when necessary, competent professionals would be called in from the district headquarters or from the Public Health Engineering Department (PHED) to repair the pump. UNICEF had produced an installation and maintenance manual and training for PHED staff in installation and maintenance was an integral part of UNICEF's support to the handpump programme.

The National Conference on Deepwell Handpumps held at Madurai in 1979 (referred to earlier) was a significant milestone for handpump maintenance. This venue recommended the now much debated three-tier maintenance system as a workable solution for handpump maintenance. This system consisted of a village caretaker, a block-level mechanic to look after 100 pumps, and a mobile repair team at the District level for every 1,000 pumps. The concept of a village caretaker had developed from an experimental project in Salem District in Tamil Nadu, which sought to stress community education and participation as a means of reducing pump breakdown. The project was subsequently transferred to Tirunelveli District in the same state. The three-tier maintenance system was finalised in consultation with the Tamil Nadu Water Supply & Drainage Board and UNICEF, and approved by the Government of India in 1979.

## Community involvement

The intention was for the handpump caretaker to work on a purely voluntary basis and to:

- interact with villagers on how to keep pump surroundings clean;
- attend to preventive maintenance;
- report breakdowns;
- promote handpump water as "safe" water.

The three-tier approach was developed from NGO projects in Madurai, Coimbtore and Jalna. It sought to address the deficiencies of a weak reporting system. The pump caretaker would send off a pre-addressed postcard with a tick against the appropriate complaint so that the authorities were made aware of a handpump problem. A system in place at PHED would respond to the request for maintenance. UNICEF supported a systematic training programme for village handpump caretakers: first in Tamil Nadu, then in Andhra Pradesh, Orissa, Karnataka and other states. A two-day training camp for batches of 50-100 caretakers was intended to impart instruction on the pump's basic workings and on hygiene education. The three-tier system was an important beginning in stimulating community responsibility and in offering users an opportunity to participate in the handpump programme. These training programmes helped in familiarising many people with this new handpump.

## Practical experience

While the three-tier maintenance system was accepted in theory on a countrywide basis, attention was paid in practice to the two tiers on top (i.e. the block-level mechanic and the district mobile maintenance teams). Soon, a high dropout rate began to cut deep into the village caretaker level. By the early 1980s, most of the caretakers in Tamil Nadu had given up their responsibility. As in other sectors of development, the lack of institutional backing had put paid to a promising venture.

The Social Work Research Centre in Tilonia, Rajasthan adopted a different stance towards the question of maintenance. With initial assistance from UNICEF, it pioneered the 'one-tier' approach. This system trained local school-leavers or dropouts as village 'mistris' as part of the Government-sponsored TRYSEM (Training Rural Youth for Self-Employment) Programme. This training and the promise of proper tools could, it was felt, eliminate to a substantial extent, the need to call in block-level or district-level mechanics. The interesting feature of this new system was that it made the mistris responsible to village panchayats — they were both appointed by, and answerable to these bodies. Although the mistris' pay, tools, equipment, etc. came from the Government, authority had been decentralised and devolved to a more familiar setting as far as communities were concerned.

Although the Public Health Engineering Department (PHED) and Rural Development Department of Rajasthan Government adopted this system, it had its own inherent problems and the mistris were often caught between their obligations to the panchayats and the PHED officials responsible for the provision of water supply. This maintenance system did not perform well and had to be supported by a six monthly PHED pump repair campaign.

However, as a practical response to the average density of handpumps per block in India (approximately 1,000 pumps), a two-tier approach gained wide currency. The first tier consists of the block mobile team and the second tier of one or two handpump caretakers. This cut out the district-level apparatus, as experience had proved that the lead-time needed to activate a district-level team and the lag-time in response was too great. The high drop out rate of voluntary handpump caretakers in the three-tier and two-tier systems adversely affected the reporting of handpump failure to district/block level officials.

## Further problems

The India Mark II was a good technical solution to the problems of providing water to large numbers of people situated in various terrains. It could draw water up from as deep as 50 metres and could deliver up to 900 litres an hour for an average of 10-11 hours a day. In use, it would untiringly absorb the careless and often very rough handling to which it was subjected. It was a tethering post for buffaloes and its spout a receptacle for twigs and stones. These vagaries it bore with a quiet and stoic fortitude and kept going. However, when it stopped — and it did on occasion — technical solutions became dependent on not-so-neat arrangements such as methods of communication between the pump users and a block-level mechanic. Solutions also depended on the availability of these mechanics, their ability to travel, availability of spare parts, and the interest on the part of relatively sluggish administrative machinery.

### *Eliminating the web*

It was perhaps on the basis of this apt assessment of the administrative 'web' that tended to ensnare the best technology, that the designers of the India Mark II had tried to create a veritably robust machine. They had deliberately tried to reduce the frequency of maintenance interventions rather than making the pump easy to repair. Consequently, the question of ease or difficulty of pump repair by relatively unskilled people — perhaps even the consumer — while not being totally ignored, was not an over-riding design consideration. Thus, for all its simplicity of design and ruggedness, the India Mark II was flawed. It did not offer the user an opportunity to interact with its internal functioning. It permitted only a 'handshake' relationship. The user would operate the pump handle, direct the water-container under the spout, fill it up and go on his or her way. The pump allowed, so to speak, no intimacies. It was a part of village life but remained a mystery — a thing apart to be dealt with, when needed, by people from outside the village area. This was not in keeping with the spirit of community involvement and participation that was in the vanguard of the development ethos of the early 1980s.

## Barriers to progress

A design deficiency stood in the way of a 'hands-on' approach by the community to handpump maintenance. Belowground components such as the leather piston seal tended to wear out relatively quickly. The India Mark II piston itself is housed within a cylinder and every time the pump handle is pushed downwards by a user, the piston is actinide to lift water. In all deepwell handpumps, this section is deep inside the borehole, well below the water table. Whenever the washer wears out, the piston has to be removed. In the India Mark II, in order to remove the piston, which had to be extracted jointly with the cylinder, the rising main had to be removed with special lifting tools.

The tools to facilitate this work are heavy and can be operated only by a specialised team of mobile mechanics that has been told about the breakdown. Furthermore, two to three mechanics are needed to carry out the work. The mobile team is normally located at a block or district headquarters and, on average, has to travel 20-40 km to repair a handpump. Besides, the van that carries them and their tools has to be available and roadworthy.

This centralised maintenance system was not only expensive, it also lacked responsiveness, in terms of time and occasionally inclination. Overall, a survey estimated that the period for repair averaged out at about 40-50 days of downtime (non-functioning) of the handpump. Clearly this level of service was unacceptable. The key to a better pump had to be in a model that retained the sturdiness and reliability of the India Mark II, but modified the maintenance needs so that communities could carry out most of the pump repairs themselves.

# 4 The VLOM concept

Village Level Operation and Maintenance (VLOM) appeared to be the most suitable approach to the maintenance impasse that had been reached. A sturdy handpump was certainly needed, but not one so sturdy that it did not permit the user to reach inside it and set it right when it stopped working. The global/inter-regional handpump project initiated in 1981 by UNDP/World Bank in support of the IDWSSD was the major promoter of the VLOM concept. It was seen as a means of resolving some of the main problems related to sustainable community water supply systems throughout the world.

## Understanding the issues

The project for Laboratory and Field Testing and Technological Development of Community Water Supply Handpumps (or more simply The Handpump Project), had as its main focus the development of a new generation of handpumps. Work progressed on resolving the technology problems. However, field trials indicated strongly that technology was not the panacea for solving problems related to handpump breakdowns. Often pumps remained inoperative due to a combination of circumstances. Mechanics were not available, or if they were, the tools and spare parts were not on hand. The non-availability of a vehicle or the lack of funds to fuel the vehicle could further complicate the situation.

A careful appraisal of the inter-linked obstacles surrounding handpump maintenance systems led the project team to the conclusion that handpump technology had to be demystified. People at the village level, with a minimum of training, should be able to work as handpump mechanics. In effect, the design of the pump had to be 'user-friendly'. The design philosophy that had yielded the India Mark II had to be modified. The concept of a pump that could operate for long periods but that resulted in substantial inoperative periods had to yield to the new vision — a pump that could be put back into service with little effort and minimal administrative overhead.

Initially, the VLOM idea restricted itself to the hardware aspect, with the intention of developing pumps that were:

- manufactured indigenously, thus ensuring the availability of spare parts;
- mostly maintainable by a village caretaker with minimal skills and a few light tools;
- sturdy under field conditions;
- cost effective.

## Village-level accountability

These objectives contained within them the inherent need for organising an enabling environment within which the people and their pump could interact. The software element became prominent and very important. The training course for pump caretakers and area mechanics, the selection of these caretakers and mechanics, the question of remuneration, the question of responsibility and management at the village level — became crucial issues to be discussed and resolved. This called for involvement not merely by district level administrators but by village functionaries. Community participation and management — terms often used loosely - took on a very sharp definition. The responsibility for operation and maintenance of the pumps was now a local responsibility, a village responsibility. The issues were clear, the approach to these had to be equally clear — responsibility had to be accompanied by accountability. One could no longer point to a block or district headquarters and blame faceless bureaucrats for a non working handpump — the pointing finger had the village area as its outer limit.

**Perception of reliability**

An interesting finding of the UNDP/World Bank global/inter-regional project[4] involved in developing community water supply handpumps is that the Mean Time Before Failure (MTBF) of the handpump is one of less importance to the villager than its downtime. In other words, a pump working continuously for 18 months and which breaks down and awaits repairs for two months is considered less reliable than one that works for eight months, breaks down, but is repaired within a week.

[4] Community Water Supply - The Handpump Option, The World Bank Publication

# 5 Changes in design

As part of the global/inter-regional project to improve and field test handpumps, the UNDP/World Bank's Handpump Project and UNICEF established a Handpump Field Testing Project near Coimbatore in Tamil Nadu. This project area was chosen because of the earlier work done by UNICEF on the India Mark II in the same area in 1976-1977.

The Coimbatore Project was developed in collaboration with the Central Public Health and Environmental Engineering Organisation (CPHEEO), National Drinking Water Mission, Department of Rural Development (Government of India), the Tamil Nadu Water Supply and Drainage Board (TWAD) and Richardson & Cruddas. The objective of this project was to carry out potential improvements to the India Mark II so as to increase the Mean Time Before Failure (MTBF) and simplify maintenance procedures. The project ran between the years 1983 and 1988 and was successful in meeting its objectives. Two optional handpump designs emerged from this period of extensive field testing. They were:

- the India Mark II (modified) Deepwell Handpump;
- the India Mark III (VLOM) Deepwell Handpump.

## Shifting emphasis

The two pumps represented a major philosophical shift in the perceived role of Government with respect to the provision of handpumps. Before going into the details of the testing procedures, it would be useful to emphasise that the former (i.e. the modified India Mark II) was intended to be more reliable, in the spirit of the original Mark II. The latter (i.e. the India Mark III (VLOM)) was to represent the second technology leap since the Sholapur handpump and emphasise local level maintenance. The India Mark III was to be representative of a technology that encouraged and promoted the devolution of technical capacity and development accountability to the basic unit in India — the village.

The concept of the handpump belonging to the Government and its functioning therefore remaining the sole responsibility of the Government was now untenable — the India Mark III being easy to maintain at village level encouraged the community to maintain the handpump. Certainly, the Government would be involved in arranging training and generally facilitating the conditions needed at village level to carry out basic repairs. However, it would be left to the community to implement these repairs. Naturally, extensive repairs would necessitate intervention by block-level or district-level mechanics. However, these were to be the exception rather than, as in the past, the rule. The India Mark III stood in the village and invited, perhaps challenged the community to participate, to maintain, and to manage.

## Into the field

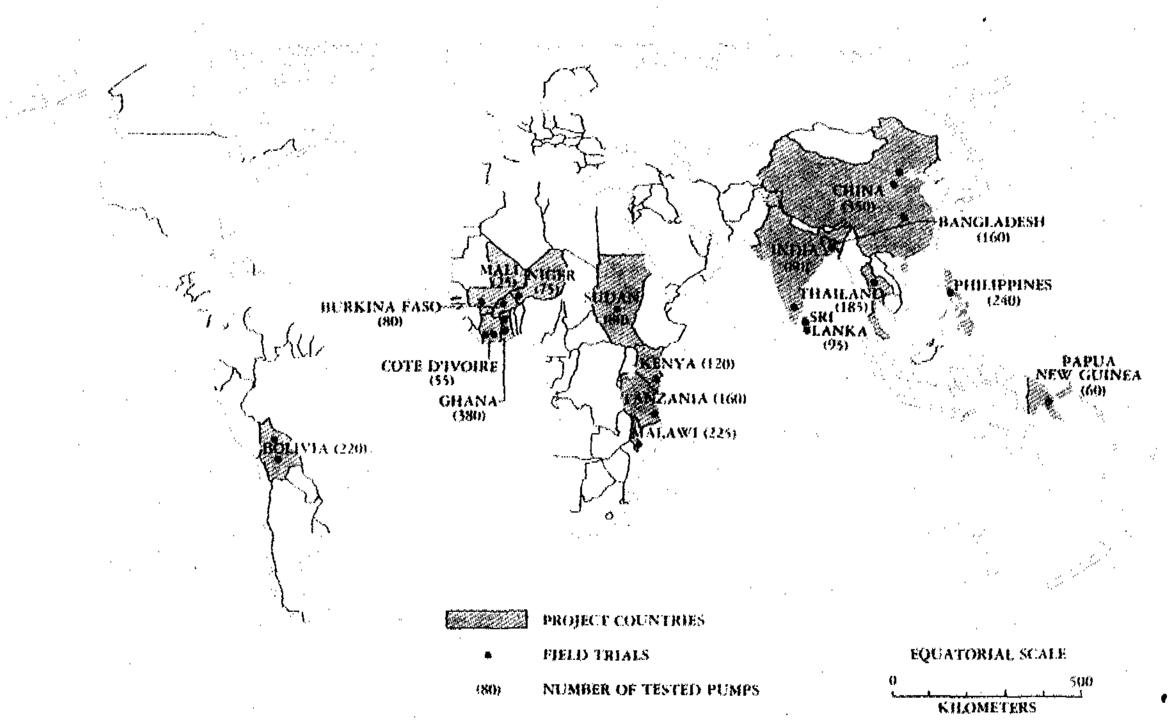
As part of the larger global/inter-regional handpump project of the UNDP/World Bank, the Consumers Association in the UK undertook laboratory tests. Various agencies field-tested handpumps in some seventeen countries (see map below) including Coimbtore in India. This enormous global exercise involved some 2,700 handpumps of seventy different models. While Saul Arlosoroff led the handpump project at the global level, W K Journey led the handpump project in South Asia.

The objectives of the Coimbatore project (1983-1887) were as follows:

- to document the working life of the standard India Mark II Deepwell Handpump components, its maintenance cost and spare parts requirement for two years of normal operation;
- to identify and test potential improvements to the standard India Mark II to reduce maintenance costs;
- to test experimental variations of certain handpump components to identify and evolve improvements to a basically sound design;
- to recommend a field-proven design for adoption on a national scale;
- to develop special tools for easy maintenance of the handpump.

An improvement to a basically sound design was the key theme of the Coimbatore Project. This was based on a situation reflecting the established reliability of the India Mark II, its standardisation and adoption on a national scale and the large number of pumps already in the field. Development work to improve serviceability had to be carried out without adversely affecting the interchangeability of the components.

FIELD TRIALS AND NUMBER OF PUMPS TESTED




## Data collection

The UNDP/World Bank handpump project tested approximately eighty pumps near Coimbatore over a period of 4½ years. Pumps were installed under conditions of heavy use and deep SWL. A sample of about fifty standard India Mark II handpumps provided the baseline information with which the performance of the experimental variations was compared. Each pump was assigned an identification number, visited by project staff on a regular basis and repaired whenever necessary. Project staff entered the data collected on performance, maintenance and repair into a database for analysis.

The monitored period of the test pumps varied. Standard India Mark II handpumps were monitored for 32 to 53 months; India Mark III handpumps were monitored for 10 to 48 months. The average monitored period for the standard India Mark II handpump tested was 3.83 years versus 2.26 years for the India Mark III handpump.

Initially, all test handpumps were fitted with the standard India Mark II pumphead and leather cup seals. However, as field testing progressed, refinements were carried out on the standard India Mark II handpump as well as the experimental handpumps. An open top cylinder and 2½" (65 mm NB) galvanised iron riser pipe (India Mark III) was fitted.

In the India Mark II, the aboveground mechanism was modified slightly to fácilitate easier and quicker removal for access to the belowground parts. In the India Mark III, the aboveground mechanism was modified to facilitate withdrawal of the extractable piston and foot valve without having to remove the rising main.

Variations of a number of pump components were also tested in the field. These included:

- different types of piston seals;
- connecting rods with different types of coatings/materials;
- a uPVC rising main with a different type of connector;
- a uPVC cylinder;
- a bottom intake pipe;
- a sand trap;
- plastic handle bearings;
- 50 mm ID brass-lined cast iron cylinder open top type;
- pump rod centraliser;
- rising main pipe centraliser;
- special tools;
- different platform designs.

As a result of the project's findings, the following design changes were made to the India Mark II:

- nitrile rubber piston seals instead of leather seals to ensure longer life;
- a modified spacer;
- a two-piece upper valve to eliminate failures due to disconnection of the threaded joint;
- an additional flange known as the intermediate plate placed between the head flange and the water tank top flange. This facilitates removal of the head assembly without the removal of the handle assembly. Access to the chain assembly is improved and the maintenance of the aboveground mechanism is simplified. The concept of the third plate was in fact introduced by a handpump mechanic in a DANIDA assisted RWS&S project in Madhya Pradesh;
- an increase in the stroke length from 100 mm to 125 mm;
- a square bearing housing instead of a round bearing housing, ensuring higher rigidity and less distortion of the housing as a result of welding. This improves the quality of the bearing housing and enhances the life of the bearings and handle assembly;
- an increased handle bracket opening to reduce hitting (banging) of the handle on the bracket bottom stop; and

- an increase by 25 mm in the height of the water tank assembly to eliminate water splashing during fast pumping. The overall height of the stand assembly was decreased by 75 mm, to bring the operating end of the handle close to the platform footrest to reduce the frequency of handle banging on the bracket bottom stop.

In addition to the modifications mentioned above, the India Mark III had three additional significant features:

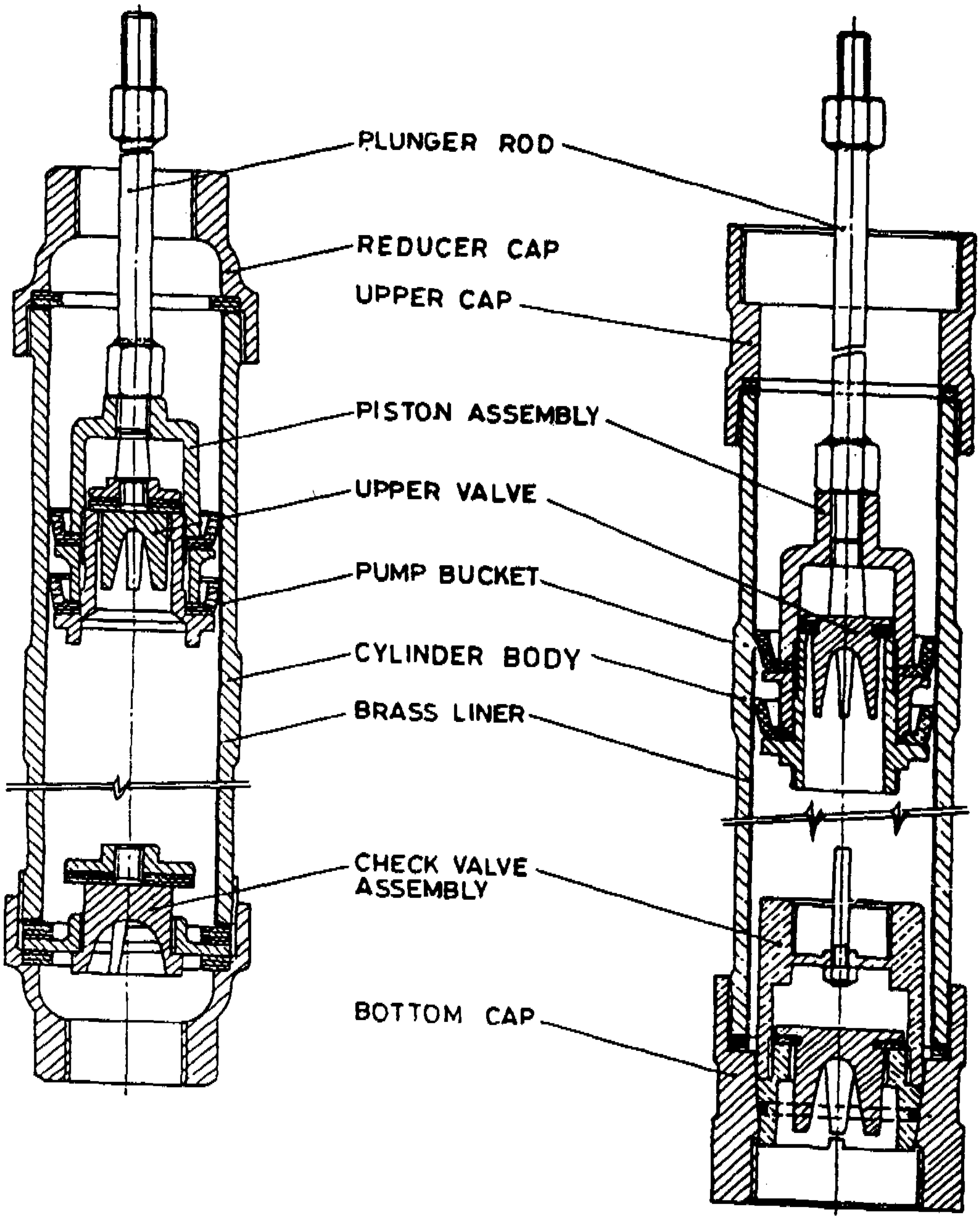
- the piston and footvalve can be extracted without lifting the rising main;
- the pushrod in the footvalve assembly lifts the upper valve guide when the piston assembly is screwed onto the foot valve body. This helps in dumping the column of water soon after the foot valve is lifted up by a few millimetres. The lifting of the footvalve, piston assembly and pump rods becomes much easier as a result;
- the foot valve is placed in a conical receiver and sealing is provided by a nitrile rubber O-ring.

Besides these changes, three special tools were developed for the installation and maintenance of the India Mark III. These were:

- a self-locking clamp for 65 mm G.I. riser pipe to facilitate the installation and dismantling of the rising main;
- a rod-holding vice for the easier maintenance of the pump, which enables a single person to disengage the threaded connection with an open ended spanner;
- pipe lifters to lift the 65 mm rising main.

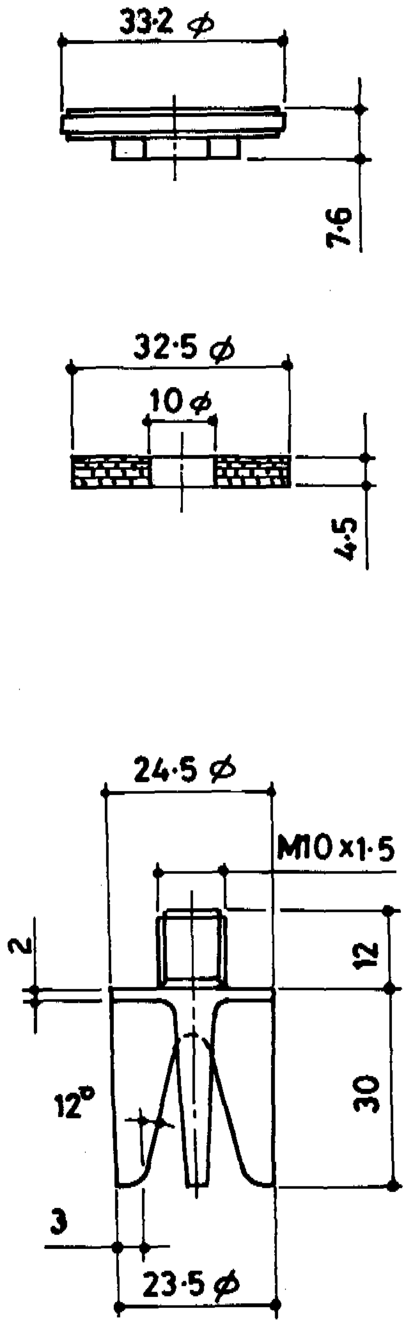
**Improvements and Costs**

As far as the India Mark II was concerned, the changes to improve the pump's reliability involved a total cost of Rs 250 (US$ 10 approximately at 1991 prices) for the materials. The savings in the annual recurring maintenance costs per pump was expected to be at least Rs 150 as a result of reduction in the frequency of breakdowns. The investment of Rs 250 therefore is expected to be more than recovered in two years. On a national level, the savings in maintenance costs were estimated at Rs 185 million (approximately US$ 7 million at 1991 prices). The capital cost of a complete India Mark III installation (with cylinder setting of 24 metres) is approximately Rs 1,320 (US$ 55) higher than that of the India Mark II. This, however, does not include the increased cost of borewell construction - 125 mm NB borewell is needed for the India Mark III as against 100 mm NB for the India Mark II. The increase of US$ 55 is mainly due to the use of a larger rising main which is necessary to facilitate extraction of the plunger and foot valve assemblies without lifting the rising main. However, a saving of Rs 493 approximately per pump in terms of annual maintenance costs will offset the Rs. 1,320 increase in capital cost a matter of 3-4 years. If increased borewell cost is also taken in to account it may take 7-8 years to offset the increased capital cost.

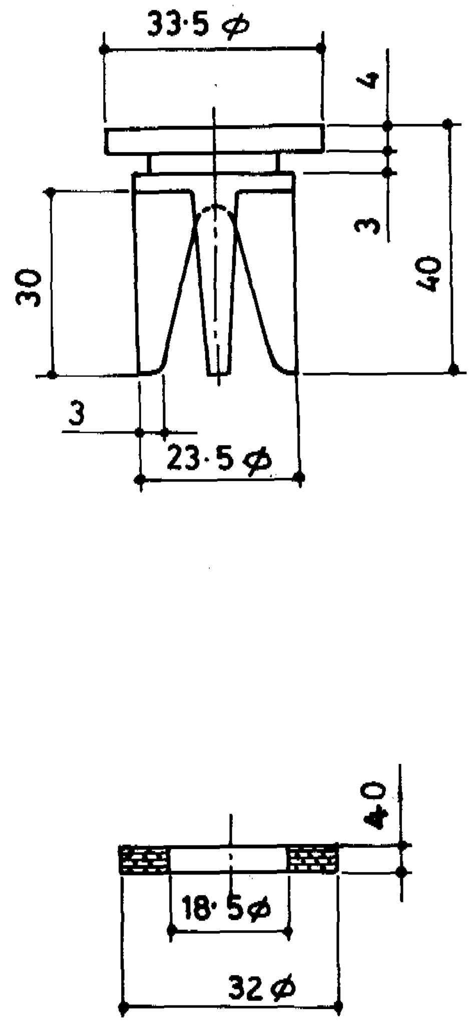



**INDIA MARK II**
**CYLINDER - YEAR 1979**

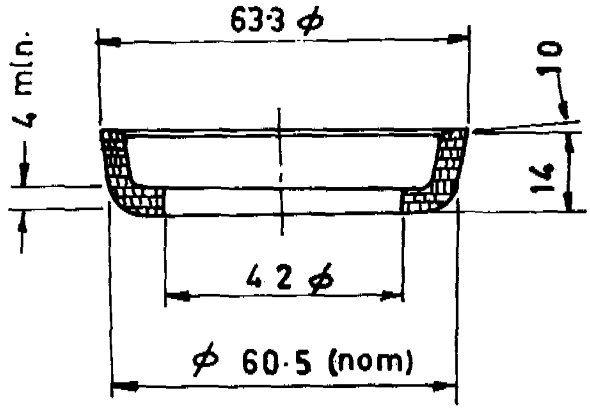
**INDIA MARK III**
**CYLINDER - YEAR 1990**



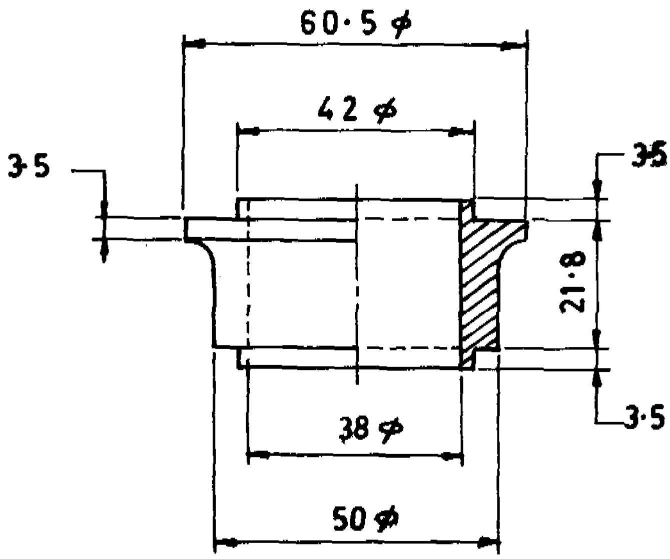

THREE PIECE UPPER VALVE




TWO PIECE UPPER VALVE




NITRILE RUBBER CUP SEAL




MODIFIED SPACER

# 6 Confirming results

The Coimbatore Project represented a major landmark in the collection of extensive data on the performance of both the modified India Mark II and the India Mark III (VLOM). The validity of the project's findings are reflected in the specifications issued by the BIS in this regard; IS:9301:1990 and IS:13056:1991 for the modified India Mark II and the India Mark III VLOM respectively. More importantly, for the first time in the history of handpumps operating in India, a wealth of data was available to make comparisons between two kinds of pumps along a variety of parameters. The more technical aspects of the comparison are available in the "*Report on Field Testing in Coimbatore of the Standard India Mark II and Open Top Cylinder India Mark III Pumps*[5].

## Initial findings

The data indicated that repairs to the India Mark III took 67 per cent less time than for the India Mark II. Furthermore, the tools (weighing approximately 7 kg in total) required for 90 per cent of the repairs to the India Mark III could be transported on a two wheeler (bicycle or motorcycle), unlike the 60 kg tool kit required for the India Mark II. The data also led to the conclusion that the assistance of the mobile team required for the India Mark III is 86 per cent less than for the India Mark II. More significantly — especially for the Government which placed considerable importance on the costs linked to technology improvement — an operating cost analysis was now available in a transparent format.

## Capital costs

The capital cost of a complete India Mark III installation is Rs 1,320 (US$55 at 1991 prices) or 5.3 per cent more than the India Mark II installation. A comparison of the costs of the pumps, excluding the cost of borewell and platform, indicates that the cost of the India Mark III pump is 36.3 per cent higher than that of the India Mark II pump. Only 7.6 per cent of the increase is because of any increase in the cost of the pump itself. The remaining 28.7 per cent is attributed to the bigger sized rising main — from 1¼" to 2½" (32 mm to 65 mm) — which is necessary to facilitate the easy removal of the plunger assembly, check valve and pump rods. Invariably, the initial cost is an important consideration in the selection of equipment. Higher capital expenditure can be justified only if it can be offset by lower recurring maintenance costs and other advantages.

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5 Jointly published by the National Drinking Water Mission, Department of Rural Development, Government of India, UNICEF and the UNDP/World Bank Water and Sanitation Programme, Regional Water and Sanitation Group, South Asia.

## Maintenance costs

The maintenance costs depend on the type of maintenance structure, the number of pumps a maintenance structure can look after, the number of interventions per year, and the cost of parts replaced. The maintenance costs can be categorised as:

- fixed expenses;
- variable expenses.

The maintenance structure available with minor variations in many states in India is as follows:

- a mobile team of three or four semi-skilled workers with a mobile van, tools and spares, capable of handling all repairs;
- block-level mechanics capable of handling essentially above-ground repairs — the pump design will decide the scope of repairs that can be carried out by a block-level mechanic;
- caretakers who are volunteers from the village who motivate users and inform the appropriate authorities about the breakdown of the pump, tighten nuts and bolts, lubricate the chain and help keep the pump surroundings clean.

It is estimated that a mobile van can provide a desired level of service to a maximum of 290 India Mark II pumps or 1,940 India Mark III pumps per annum subject to certain assumptions on pump density, travel time and types of repairs expected to be carried out by a mobile van team (see Appendix 1). The remaining repairs are expected to be carried out by a block mechanic. It is estimated that a block mechanic with a motorcycle can service 1,480 India Mark II pumps and 600 India Mark III pumps. The experience from several projects indicates that the block level mechanic duties can be easily performed by a trained village handpump caretaker/mechanic in the case of the India Mark III. This will further reduce the maintenance costs.

Fixed expenses include costs incurred in establishing and maintaining a basic maintenance structure. These expenses are independent of the level of maintenance effort, the number of breakdowns and the number of pumps repaired. However, the fixed expenses per pump will reduce when more pumps are serviced by the same maintenance structure. Unlike fixed expenses, including variable expenses (maintenance and running expenses motorised transport) are proportionately linked to the level of maintenance and number of interventions. These costs remain consistent over a period of time, unless other extraneous and unforeseen factors influence a change.

From the analysis, it can be concluded that the expenses per pump per year, in the case of a mobile team maintaining an India Mark II pump, are relatively high. They are reduced by 66 per cent in the case of the India Mark III pump. The total fixed and variable expenditure of the maintenance structure is Rs 451 per India Mark II pump per year and Rs 153 per India Mark III pump per year.

The average cost of spare parts used for the maintenance of India Mark II and India Mark III pumps has been calculated based on the frequency of replacement of parts. Tables in Appendix 1 give details of cost of parts[6] replaced per pump per year and also the level of maintenance structure required for the replacement of each part. Of interest here are the facts that:

- the rising main and handle assembly represent major shares in the total cost for the replacement parts for both pumps.
- the cost of parts replaced is 46 per cent lower in the case of the India Mark III pump.

The total maintenance cost of a pump is obviously a major determining factor in the selection of a pump. The table below compares the total' maintenance costs of both types of handpumps. The table makes it evident that the requirement for funds for maintenance of the India Mark III will be Rs 493 less per pump per year than for maintenance of the India Mark II.

* Note: The above estimates are based on the field data of a small number of the India Mark II and the India Mark III handpumps installed in a project area not known for aggressive water conditions. In aggressive water conditions, spare part replacement cost can be much higher due to frequent replacement of the G.I. riser pipe. The maintenance costs are area specific and can vary significantly due to changing field conditions.

***Total Maintenance Costs per Pump per Year for India Mark II and India Mark III Pumps***

| No | Item | Mark II($) | Mark III($) |
|---|---|---|---|
| 1 | Maintenance Costs | | |
| | (a) Caretaker | 1.90 | 1.90 |
| | (b) Block mechanic | 0.89 | 2.01 |
| | (c) Mobile team | 18.67 | 3.37 |
| | (d) Spare parts | 20.17 | 18.87 |
| | Total | 41.63 | 18.15 |
| 2 | Saving per year in maintenance | | 23.48 |

[6] The replacement of riser pipes in a corrosive water can be higher

## Downtime

Downtime is defined as the period of time when the pump is not available for use due to breakdown. Downtime consists of:

- the time taken to report a breakdown;
- the time lag between the receipt of the breakdown report and mechanics actually reaching the pump to commence repair;
- active repair time - the time actually taken to carry out repairs.

It is estimated that 85[7] per cent of the India Mark II deepwell handpumps remain operational at any point in time. This would mean that the India Mark II handpump remains idle for approximately 50 days in a year. A survey commissioned by UNICEF[8] noted that the time taken to report a breakdown varied from 4 to 13 days. The time taken to put the pump back in operation varied from 7 to 44 days after the receipt of the report.

When an India Mark II or India Mark III pump does not work, the indirect financial loss is approximately Rs 15 per day. The detailed calculations for this estimate are given in the table below.

***Costs of Downtime for India Mark II and India Mark III Pumps***

| No | Item | Mark II($) | Mark III($) |
|---|---|---|---|
| 1 | Capital cost | 1188.10 | 1250.67 |
| 2 | Maintenance cost | 41.63 | 18.15 |
| 3 | Interest @12 per cent per annum | 142.57 | 150.08 |
| 4 | Depreciation (15 years approx.) | 79.21 | 83.38 |
| 5 | Total (2+3+4) | 263.41 | 251.61 |
| 6 | Maximum number of days in year | 365 | 365 |
| 7 | Operational costs/day (5/6) | 0.72 | 0.69 |

Note: One U.S.$ = Rs 21.00 (1990 exchange rate)

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7 Some states have reported lower percentage of working handpump at any point in time.

8 Survey on the Functioning of Handpumps and Water uses in Selected Rural Areas, Operations Research Group for UNICEF, 1984

**_Cost Recovery for India Mark II and India Mark III Pumps_**

| Heads of recovery | Amount to be recovered per year ($) | Recovery per person per year ($) | Total annual recovery per person ($) |
|---|---|---|---|
| **India Mark II** | | | |
| Annual maintenance | 41.63 | 0.21 | 0.21 |
| Annual depreciation | 79.21 | 0.40 | 0.61 |
| Annual interest cost | 142.57 | 0.71 | 1.32 |
| **India Mark III** | | | |
| Annual maintenance | 18.15 | 0.10 | 0.10 |
| Annual depreciation | 83.38 | 0.42 | 0.52 |
| Annual interest cost | 150.08 | 0.75 | 1.27 |

Note: One US $ = Rs 21.00 (1990 exchange rate)

If a pump is inoperative for 37 days (estimated average downtime in India Mark II) 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 and productivity of the community is also likely to be significant. However, no study has been carried out to quantify the actual impact of these losses in financial terms.

The unusually high downtime of India Mark II handpumps in the field seems to be linked to the following factors:

- delays in reporting breakdowns;
- delays in communications;
- delays in taking action on receipt of breakdown reports;
- use of non-standard spares and faulty installations;
- non-availability of spare parts.

These problems could be mitigated to a great extent if users could repair their own pumps. This shift, however, as noted earlier in the text, also changes the emphasis from the need for a reliable technology to the need for a reliable administrative and institutional apparatus — in effect, a shift from hardware to software.

## Cost recovery

The "willingness-to-pay" by the consumer is now a matter of great concern to the Government of India. This thinking stems from the fact that the costs involved in the operation and maintenance of water supply systems — particularly those in the rural areas of the country — cannot continue to be borne by the state. Current development thinking also indicates that a consumer with a financial stake in the handpump he or she uses is more likely to be concerned with its proper functioning. The Coimbatore project came up with another set of interesting figures. The project assumed that, on average, 200 persons would use a pump. This is a midway figure between the previous and present norms set by the Government of 250 and 150 persons per pump. While the rates of recovery indicated in the accompanying tables are approximate, they do provide an idea of the scale of contribution required.

## Large-scale demonstration

While the Coimbatore Project resulted in significant findings, the field testing had been restricted to a relatively confined area. The Government of India sought to further examine the working of the modified India Mark II and India Mark III VLOM. Through the National Drinking Water Mission, it initiated four large-scale Demonstration Projects — in Ranchi District in Bihar, Rangareddy District in Andhra Pradesh, Betul District in Madhya Pradesh and four districts in the state of Maharashtra. The work was undertaken with technical and hardware support from the UNDP/World Bank Water and Sanitation Programme and UNICEF.

These projects were initiated in late 1987 and early 1988 and involved a total of 174 modified India Mark II pumps and 155 India Mark III pumps. The projects demonstrated that the reliability of both versions of the handpump had improved compared to the standard India Mark II. In general, other technical findings followed the trend of the data generated by the Coimbatore Project. It was noted that 90 per cent of the repairs (above ground and below ground) in the India Mark III could be carried out by a block mechanic with the help of a pump user.

While the majority of the objectives of these projects were technical and related to evaluating performance (such as MTBF), one 'soft' objective stood out — development of a village based handpump maintenance system. In this regard, reports from the field were very encouraging. Some spoke of an increased interest on the part of the villagers in Betul District in operating and maintaining the India Mark III. Users in this district found repair procedures simpler and less time consuming. From Maharashtra, reports spoke of the alacrity with which repairs to the Mark III were carried out at the village level. They also indicated greater community interest in maintaining the pump and the surrounding environment now that local people were involved. These were encouraging signs. Similarly, the UNICEF supported Banda Community Based Handpump Maintenance Project (1992-1994), involving maintenance of 657 Nos. India Mark III by women showed that the India Mark III could be maintained at the village level by women entrepreneurs. Even so, the projects had, as yet, only touched on the opportunities for increased community involvement across the entire country. The Government now sought to address the issue of how to replicate these attitudes across the nation and what mechanisms to use to facilitate and sustain such replication.

# 7 National Rural Water Supply Programme

The progress made over the past decade in handpump technology would have not been possible without the active participation of the Government of India. As mentioned earlier, it was a Government undertaking, Richardson & Cruddas, that played a major role in helping to develop and manufacture the India Mark II. The various recommendations emanating from meetings — such as the National Conference on Deepwell Handpumps in 1979 and the National Workshop on Potential Improvements in India Mark II Deepwell Design in 1990— also helped. They have served to emphasise the need to facilitate the establishment, operation and maintenance of a water supply system to all of India's population — especially in the rural sector — as soon as possible.

## National Drinking Water Mission

The Government placed a special focus on safe drinking water by setting up the National Drinking Water Mission (NDWM) in 1986. The Seventh Five-Year Plan (1985 - 1990), in line with the objectives of the IDWSSD, aimed to provide safe water facilities to the entire rural population. Forty litres of potable drinking water supply per capita per day (lpcd) and an additional 30 lpcd for livestock (eg. camels, cattle, goats etc) cattle in desert areas was the target of the plan. Its larger aims were to:

- impart to the Indian Rural Water Supply Programme a sense of urgency and ensure delivery within a stipulated time frame;
- effectively pool science and technology inputs to tackle problems of water availability and water quality;
- bring in a sharp management focus;

create a model of co-ordinated action to promote an integrated approach to water management.

Some of the strategies emphasised and developed by the NDWM on the basis of past experience were as follows:

- community involvement is vital at all stages of a project — formulation, execution and maintenance — to ensure equitable development;
- rural beneficiaries must share the costs of water supply, or at least the maintenance costs of assets provided;
- organisational and administrative procedures must follow a uniform approach;
- monitoring and evaluation systems need to be more efficient and effective at the central, state and district levels.

The NDWM's methodology for implementation included:

- promoting decentralisation of activities of operation and maintenance;
- establishing standards on quality in design and materials;
- effecting co-ordinated action between Government Departments to tackle issues relating to water supply;
- evolving a participate model of action through the involvement of village level bodies, NGOs, voluntary agencies, women's groups and youth organisations.

Of the new initiatives that have been taken up by the NDWM, some of the more important ones are:

- promoting low cost technologies, especially the handpump;
- standardising rural water supply activities and inputs through national standards prepared by the BIS;
- promoting community participation through the greater involvement of panchayats and water user committees, increased participation by NGOs and implementation of a community-based operation and maintenance model in selected areas;
- attempting to enhance the role of women in the management of water supply, by recognising the critical role they play as catalysts converting water supply investment into improved health;
- creating a role for communication and social mobilisation in the water supply programme to bridge the software gap.

At the end of the Seventh Five-Year Plan (1990), the number of 'problem'[6] villages to be tackled stood at 8,439 in mid-1990. The target for the year 1990-91 was set at 5,295 'problem' villages to be reached. However, it must be kept in mind that this 'coverage' refers to the provision of at least one safe water source per village — this in no way implies an adequate supply of such water to all of rural India. Thus the more specific criterion of adequate coverage would possibly increase the number of 'uncovered' villages manifold. A rural habitation survey validated in 1994 by the Government of India indicates that 140,975 habitations are not covered.

The cornerstone of NDWM's commitment to the provision of safe drinking water to all of India is the belief that handpumps represent the most viable channel of delivery. It has therefore recommended that whenever substantial repairs are to be made to existing India Mark II pumps, modifications should be made along the lines of the Modified India Mark II. In addition, it has recommended that whenever new borewells are drilled, they should be capped with the India Mark III VLOM.

## NGO support role

The IDWSSD has helped to highlight the fact that the Government must seek and, in fact, actively depend on NGOs for support. NGOs are vital in helping communities to establish and work the strategies that will facilitate the operation and maintenance of the rural water supply exemplified by the handpump. At the last count in 1990, the Government had listed 144 NGOs with which it was working in the rural water supply sector.

The most important role that NGOs can play in India is to work as effective intermediaries between the Government and the community. By and large, the fact that the staffs of such NGOs are persons who have joined out of a sense of duty, engenders them with a more motivated attitude than the average government official. This helps to make the organisations more flexible in approach and dynamic in purpose. NGOs, by working with target communities, can:

- create awareness regarding the Government's water and sanitation programmes;
- emphasise, through health education, the crucial need for better health which can be more assured through safe water use and good hygienic practices;
- help to create a sense of ownership of rural water supply facilities through participation (in the form of cash and/or labour) in construction and maintenance;
- devise, in consultation with the communities, appropriate training programmes emphasising the participatory approach;
- help to carry out training programmes for Government staff, on the basis of an understanding of the communities' needs and aspirations;
- serve to establish a closer and more effective working relationship between themselves, the Government and communities — a three-way partnership;
- reduce financial and administrative dependence on the Government through creating a sense of ownership;
- emphasise the positive role that women can play in resolving water and sanitation problems and, therefore, the practical need for them to be actively involved in all stages of water and sanitation projects;
- help to create, as intermediaries, an effective network between the various rural development programmes operating in the rural areas.

Most of the NGOs try to achieve the above objectives through interaction with communities on a day-to-day basis and through close contact with the concerned government officials. The possibility of developing sustainable water and sanitation projects and programmes becomes more real when, through mutual consultation, the Government, NGOs and communities co-operate in formulating and implementing strategies.

## Decentralised approach

If safe water and adequate sanitation in rural areas is to become a reality, policy-makers in India (and the rest of the world) will necessarily have to focus on certain primary issues. Perhaps the most important of these is the question of effective decentralisation (administrative, technical, institutional and financial) in order to properly assess and respond to rural communities' needs and aspirations.

### *Community participation*

The process of decentralisation is based on the premise that the people concerned will be encouraged to participate as individuals and through representative institutions. Their participation should be encouraged at all stages of a project from the formulation and planning stages, through monitoring and evaluation. When such a process is effective, the human resources involved — government, non-governmental, private sector, the community — undergo a fundamental change in their mutual attitudes and perceptions of their roles and responsibilities. Thus, the role of government changes from implementor to facilitator. Likewise, communities change from being perceived and perceiving themselves as beneficiaries, to regarding themselves as capable of understanding, and taking decisions to resolve problems. NGOs become intermediaries who suggest approaches to the community and occasionally help in implementing them, but only at the community's request, and guided more by the community than the reverse.

Implicit in this decentralisation process are other issues such as the use of NGOs to educate and motivate a community towards self-reliance and management of its water and sanitation facilities. Thus, training at all levels of the sector becomes another vital issue — whether it is in the development of skills at the village level, or reorientation of engineers and bureaucrats regarding the importance of software (information, education and communication strategies, for example), for the creation of demand and minimising the use of installed assets.

Decentralisation creates an enabling environment for the community, government and the concerned intermediaries, to establish adequate service levels with regard to water and sanitation and to ensure the proper use of these facilities. This in turn leads to the sustainability of the facilities and the better health and productivity of the community.

### *Emerging guidelines*

Within the larger context of creating this enabling environment by focusing on decentralisation and related issues, certain guidelines have evolved over the past decades of development experience in the water and sanitation sector. These guidelines represent a practical framework within which more detailed sub-guidelines and norms can be evolved. The guidelines — many of them tested on the

Coimbatore Project — provide a basis for effective management of rural water supply programmes:

The need for an *integrated approach* to rural water and environmental sanitation problems. This approach regards water and sanitation as fundamentally related issues, both conceptually and in practice, in that their objective is the better health of the community.

**Integrated Approach**

The availability of safe water without good hygienic practices is, at best, an unsatisfactory step towards the goal of health and productivity for the individual, the family and the community. If little or no regard is placed on safe collection, transport, storage and use of water, as well as other hygienic practices, both at the individual and community level, scant progress will be made. In this respect, it is useful to keep in mind that nearly 80 per cent of diseases in rural areas are water-borne.

There has been a tendency on the part of government planners to regard water and sanitation issues as two distinct entities. This approach ignores the vital influence both have over good health, which is best served by an integration of these two related areas. Furthermore, there seems to have been much more emphasis on the installation of the hardware components of projects such as handpumps, latrines etc. with limited concern for community involvement which are the factors crucial to any sustainable use of hardware.

Consequently, an integrated approach to safe water supply and sanitation as representing two sides of the same coin is necessary. In this respect, there is a strong need for effective hygiene education initiatives within the larger context of health education programmes at the rural community level. Hygiene education refers to personal hygiene (washing of hands after defecation, for example) as well as public hygiene such as the proper disposal of night soil, the collection and disposal of wastewater and disposal of solid waste. In effect, the availability of safe water, its proper use at different levels of activity and good environmental sanitation practices lessen the chances of disease and depletion, both physical and economic.

The need for effective *community participation* leading on to *community management* of water and sanitation facilities. This is proving to be the only viable strategy to create sustainable water and sanitation assets that are effectively used. NGOs could be particularly effective here.

The need to create an appropriate environment for dialogue with the community and within and between institutions through *a well-developed information, education and communication (IEC) strategy.*

The need to develop realistic *financing strategies*, which focus on *cost recovery* from the community for services established. The objective here is to create a sense of ownership within the community that will motivate it to look after its assets rather than depending completely on external agencies to do so.

The need to strengthen existing institutions and to facilitate intersectoral linkages at all levels of operation. Human resource development is an essential element of an effective decentralisation process, as is the need for effective communication between the various sectoral agencies, in order to achieve the common objective of improved health and productivity.

## Women, water and health

Even the most casual study of Indian village life indicates that it is the woman *and girl child* of the household who has the most to do with water - its availability, collection, transportation, storage and use. It is she who sets the example in matters regarding personal hygiene and good sanitation; matters that have a vital impact on the effect that safe water has on the individual and the community. For the women and girls, a handpump is often a higher priority than for the rest of the household.

### *Priority needs*

The most apparent benefits that result from a conveniently located and working handpump are a positive impact on a woman's health and the release of time that could be used for more productive activities. In terms of health, the incidence of water-carried or water-related diseases such as diarrhoea, dysentery, typhoid, giardiasis, dracunsuliasis, shigellosis, etc. is mitigated. Since it is normally a woman who bears the brunt of taking care of family illnesses, a woman has a good reason to try to reduce the incidence of these illnesses. Thus, not merely the availability of potable water, but also the need to keep the handpump's immediate environment clean and free from stagnant water, makes more sense to a woman than to a man.

Other areas where the handpump could make a difference is, for example, safe pregnancies, minimising the incidence of low birth weight babies and perhaps even lowering maternal mortality rates. The energy that a pregnant woman uses to carry water over long distances is energy diverted away from the growing foetus, perhaps leading to the birth of a lower weight baby, with a consequently lower chance of survival.

### *Management role*

The Government is concerned that women must play a bigger role in rural water management and suggests that this is possible through their involvement as:

- caretakers of handpumps;
- part of a handpump maintenance team;

- handpump mechanics;
- health education and orientation.

It is precisely this conviction that poses and articulates a challenge for the Government as it now shifts the focus from the handpump to the more complex needs of establishing and maintaining relationships and structures around the handpump. The relationship between the Government and the people it serves now becomes a subject for discussion, for criticism, for suggestion. Some of the ways in which women's participation could be enhanced are as follows:

- Women's role as manager and decision makers in PHEDs and in WES committees needs to be strengthened. More women professionals need to be brought in to the sector.
- By arriving at a better understanding (through participatory knowledge, attitude, and practice (KAP) studies, for example) of women's perceptions and needs. Here, there is also a need to differentiate between different categories of women (upper-caste/lower caste, wealthy/poor, etc.);
- By devising appropriate educational and training programmes for women and thus giving them access to information and knowledge;
- Through specific efforts at developing technology oriented towards women (the VLOM handpump is an example);
- Through emphasising that technology is not necessarily male-oriented (the training of women as handpump mechanics and as masons is an example);
- Through the process of certification by women regarding handpump installation and maintenance;
- Through setting-up, perhaps, exclusively women's panchayats or ensuring at least 50 per cent representation in the Pani Panchayat or Village Water and Sanitation Committee;
- By recognising the fact that if sanitation is to become a recognised 'felt need', leading to demand, it is the women who are best placed to articulate this need and influence the community towards their continued use and proper maintenance;
- By appreciating the reality that most rural committees are still male-oriented. If women are to play a crucial part, projects and programmes in the water and sanitation sector must recognise this reality.

## Forward progress

The issue then is not one of a lack of ideas — more a need for their effective implementation. An evolved handpump technology represented by the India Mark III needs to be matched with an evolved sense of community. The latter seems infinitely harder to achieve. Community involvement and women's participation as concepts have largely remained skeletal structures; little flesh has been added to them in terms of significant positive experiences. However, there are some signs that forward progress is being made.

A survey carried out by the Indian Market Research Bureau for UNICEF over the period 1988-89 and covering 22 districts in 8 major states provided some interesting findings. In particular, it addressed the area of willingness to pay towards handpump maintenance. Two out of three respondents indicated their readiness to pay various amounts ranging from Rs 4.30 (approximately US$ 0.20) to Rs 20.40 (approximately US$ 0.80) per month. Also, 41 per cent of the people interviewed said that they were ready to contribute if new handpump installations were conditional on their contributions. Significantly, more women expressed this last commitment than men did.

The indications, therefore, seem unambiguous about the commitment of the Indian people, and women specifically, to participate in setting-up and maintaining their own safe water supply. This commitment needs to be channelled into action by addressing practical issues such as adequate training for women, their remuneration as mechanics and caretakers and the degree to which they have control over their income. Viable institutional mechanisms must be created to sustain this interaction, with the handpump in particular and water supply in general.

# 8 Towards 2000

Based on the results of India's handpump revolution, two components can be considered key to the success of a large-scale handpump based rural water supply programme: Standardisation and Quality Control.

Standardisation on a public domain handpump offers benefits, which are difficult to ignore. It helps in lowering production costs and establishing a viable local manufacturing base, as the demand is not fragmented. As the handpump design is available to any manufacturer, it fosters intense competition resulting in improved delivery times and reduced prices. Training of caretakers and pump mechanics can have a sharper focus, which is not possible, if a wide variety of handpumps is used in a country. Lastly, the procurement and inventory control of spare parts becomes far simpler.

Quality of handpumps and spare parts is equally important. Poor quality can create serious problems during installation as well as maintenance, which can result in frequent breakdowns undermining users' confidence.

The above benefits were clearly visible in the India Handpump Programme, which scrupulously followed a policy of standardisation and quality control. The percentage of non-functional pumps dropped from 75% in 1974 to less than 15% in the 1980s. The price, in dollar terms, did not increase over the last 20 years in spite of a sharp increase in input costs - in fact it decreased marginally while quality improved.

The process for technology selection, standardisation and quality control, developed and followed during the implementation of the handpump programme in India, is very relevant for all developing countries. It also shows that there are no short cuts to the introduction of a technology and its adoption on a national scale.

Despite impressive progress, India*s handpump revolution is not yet complete. However, the challenge of developing a pump that allows maintenance to be carried out largely at the community level has been met. The VLOM concept has taken firm root — not only in India, but also across the world. It is now well established as a way of ensuring that scarce government resources allocated to the installation and maintenance of rural water supplies can be used to effect maximum benefit to user communities.

The Coimbatore Project successfully tested the technical aspects of the VLOM concept. Handpump manufacturers, initially hesitant about this new technology, have now taken to it liberally, and started to export it widely. The findings of the Coimbatore Project indicated some specific areas where changes could make maintenance even easier. These included:

- elimination of threaded joints in plunger and foot valve;
- hook and eye connectors or a similar design to replace threaded joints in connecting rods;

- simplified replacement procedures for piston seals and valves;
- Cost effective alternatives for corrosion-resistant connecting rods;
- development of connecting rods centralisers for uPVC riser pipes suitable for unlined borewells;
- development of improved joints for uPVC rising mains;
- development of pipe centralisers for uPVC rising mains suitable for installation in unlined borewells;
- improvements in tools used in handpump maintenance.

Both the modified Mark II and the India Mark III VLOM have also been found unsuitable for areas with corrosive water. The hot-dip galvanised steel rising main in both pumps is susceptible to corrosion. This would have been a matter for concern, but fortunately, the 10-15 per cent of India's land area that has such water corresponds to shallow-well zones, where corrosion-resistant pumps have to be used.

To address the above-mentioned opportunities for technology refinement, UNICEF, in 1993, sponsored a handpump research and development project, again in Coimbatore with the critical support of the TWAD Board. Under this project, the India Mark III handpump with 50 mm ID cylinder (both cast iron with brass liner as well as PVC brass lined cylinders) is under field testing on a small scale. This pump will have the option of a 50 mm. GI or uPVC riser main with threaded pipe couplers. It will eliminate some threaded joints in plunger and check valve, incorporate slip-on cups seals and include an option for threaded or eye joint connecting rods. It may be noted that some of the changes in the improved India Mark III handpump are conceptually based on the Afridev cylinder components design and a plunger design developed by the GTZ RWS&S project in Sri Lanka.

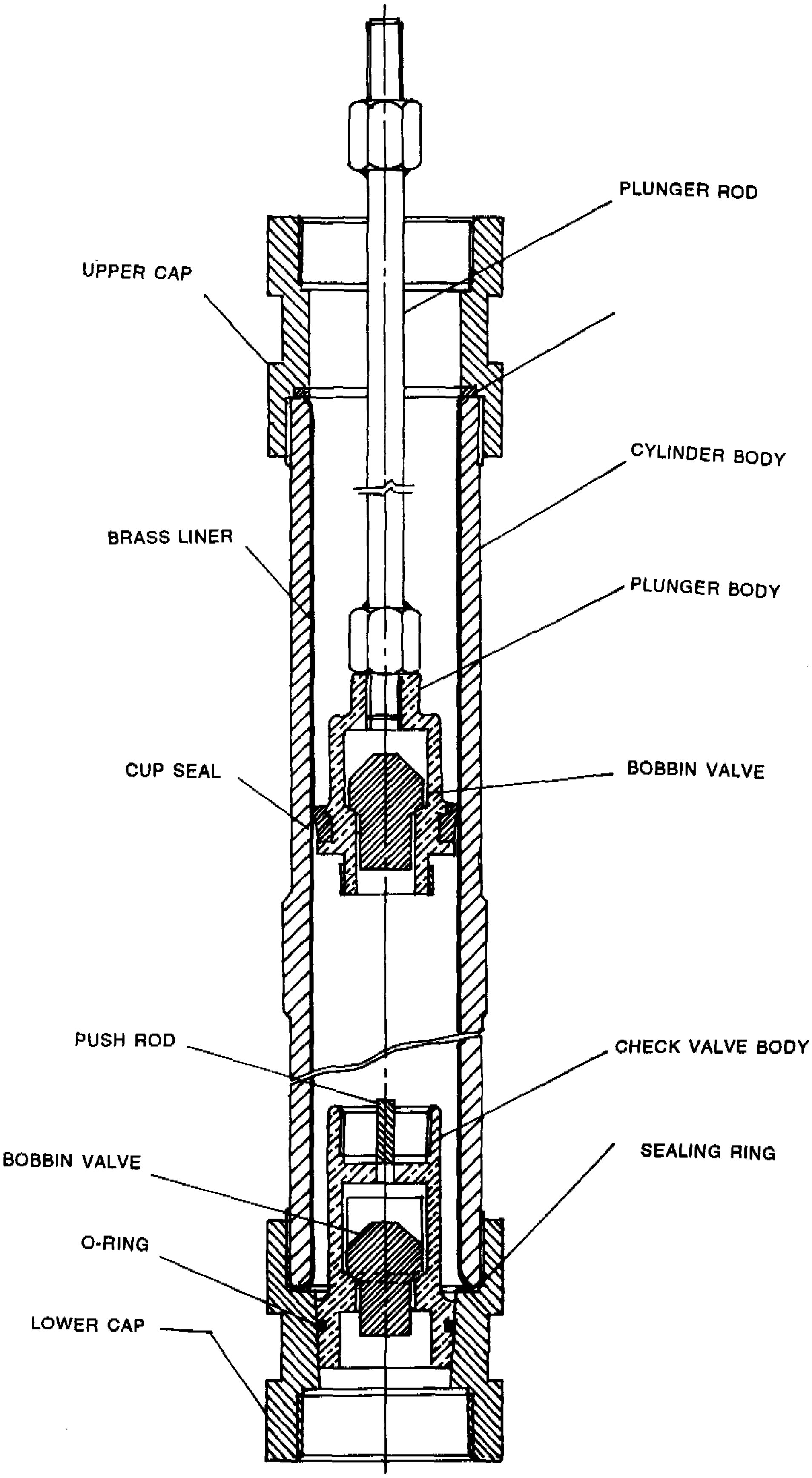
As things stand, the modified India Mark II is more reliable than the India Mark II. In comparison to the modified India Mark II, the India Mark III VLOM is as reliable and certainly much easier to maintain. However much technology progresses, though, it seems difficult to envisage a 'perma-pump' which will not require maintenance —at least during this century. Therefore, the focus of handpump programmes has necessarily shifted away from the pump and towards the people who are to operate and maintain it. In the case of the India Mark II, technology seemed to lag behind the push for community involvement in handpump maintenance. The village mistri could not afford the tools needed. Likewise, a single mistri did not have the strength to lift out the belowground parts of the thirty-or-so pumps assigned to him or her and there was a distinct possibility of errors or even an accident.

Technology has now succeeded in crafting a handpump that symbolises the process of decentralisation. However, the mechanical process of product creation cannot alone create the decentralised environment that can use this technology optimally. In other words, the 'nuts and bolts' of community participation are infinitely more complex and less amenable to being machined to fit into a preordained system. Thus, challenges still exist; and change must still occur.

While the mechanical system may have been rendered technologically more simple, the societal "web" needed to sustain it has become much more sophisticated. In order to make this support system strong, a variety of actions must be taken. The users and potential managers have to be trained — both as technicians and as managers. A programme of infrastructure needs to be developed. This must ensure adequate maintenance on a continuing basis, which is a different proposition from a one-shot installation exercise. The logistics of spare parts availability and accessibility have to be examined thoroughly. Unless availability and accessibility of quality spare parts improves substantially, the decentralisation of handpump maintenance will not be feasible. For this to happen, the government agencies should consider gradually discontinuing centralised procurement of spare parts. This will create market demand for spare parts which can easily be met by the private sector.

A process of setting up effective intersectoral linkages has to be initiated. This may take the form of committees at various levels — village, block and district — in order to establish a process of consultation. Programmes need to ensure that weaker groups, such as the scheduled castes and scheduled tribes, and especially the women within them, are not further marginalised. These WATSAN committees or 'Pani Panchayats' could be responsible for hiring and supervising handpump caretakers and mechanics. They could also be the focal liaison channel between the community and a local NGO. If safe water and sanitation are to be integrated, thus securing the improved health and productivity of the family and community, health educators have to be trained at the village level.

Finally, a proper monitoring system involving the community will have to be set in place. The designing of appropriate and lasting forward-backward linkages with the active involvement of the community is now the major challenge associated with the VLOM concept. The debate on the sturdiness of a pump versus its simplicity of repair has in a sense been overtaken — a VLOM handpump has to be both reliable and easily maintainable (as indeed the India Mark III is). Much to its credit, the Government of India has solved the technical challenge. It now faces a larger and more complex challenge. It must ensure that the community can be motivated and empowered to participate in this 'user-friendly' technology. In effect, the desired change in technology has been made, but the human and institutional challenge persists.




**INDIA MARK III MODIFIED CYLINDER (UNDER FIELD TRIALS)**
**YEAR - 1996**

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# Appendix: Maintenance System Capacity

The Coimbatore Project resulted in significant data, that allowed a transparent appraisal of the maintenance system capacity requirements for each type of pump. It found that travel time, active repair time, mode of transport and number of pumps per square kilometre have a significant influence on the cost and maintenance and the number of pumps that can be serviced by each crew. The following tables show the results of the project's findings for India Mark II and India Mark III handpumps.

## Travel time

Travel time depends mainly on the density of handpumps and the mode of transport. The number of pumps that can be serviced by a mobile van are given in the table below.

***Travel Time and Number of Pumps that can be Serviced by a Mobile Team***

| No | Item | Mark II | Mark III |
|---|---|---|---|
| 1 | Interventions needing a mobile team per year | 1.44 | 0.16 |
| 2 | Travel time per trip | 60 min | 150 min |
| 3 | Estimated travel time (1x2) per pump per year | 86.4 min | 24.0 min |
| 4 | Active repair time per pump per year | 250.8 min | 26.0 min |
| 5 | Total time mobile van is engaged per pump per year (3+4) | 337.2 min | 50.0 min |
| 6 | Total time van available per year (288 days x 8 hours) | 2304 hr | 2304 hr |
| 7 | Pumps that can be serviced at 100 per cent efficiency (6/5) | 410 | 2,765 |
| 8 | De-rate number of pumps that can be serviced by 30 per cent | 290 | 1,940 |

It is assumed that mobile teams and block mechanics will be provided with a 1.5 ton four-wheel motorised van and a motorcycle respectively. The average speed at which these modes of transport can travel has been assumed as 40 kilometres per hour. The density of pumps has been taken as 0.238 per square kilometre, i.e. 300 handpumps in an area with a radius of 20 kilometres. The distance travelled per visit has been assumed as twice the radius. Note that these assumptions may not be applicable in all regions as field conditions vary substantially from region to region.

The following table provides details of travel time, mean active repair time and the number of India Mark II and India Mark III pumps that can be serviced by a block mechanic.

***Travel Time and Number of Pumps that can be Serviced by a Block Mechanic***

| No | Item | Mark II | Mark III |
|---|---|---|---|
| 1 | Interventions needing a block mechanic per year | 0.40 | 1.19 |
| 2 | Travel time per trip | 130 min | 85 min |
| 3 | Estimated travel time per pump per year (1x2) | 52.0 min | 101.2 min |
| 4 | Active repair time per pump per year | 250.8 min | 26.0 min |
| 5 | Total time block mechanic is engaged per pump per year (3+4) | 65.4 min | 161.7 min |
| 6 | Total time block mechanic available per year (288 days x 8 hours) | 2304 hr | 2304 hr |
| 7 | Pumps that can be serviced at 100 per cent efficiency (6/5) | 2,100 | 860 |
| 8 | De-rate number of pumps that can be serviced by 30 per cent | 1,480 | 600 |

# Fixed expenses

The fixed expenses of maintaining a mobile maintenance team, a block mechanic with motorcycle and a caretaker are given in the following three tables.

***Annual Fixed Expenses of Mobile Team with Van***

| No | Expenses | $ |
|---|---|---|
| 1 | Salaries (5 persons @1000/mth) including benefits | 2,857.14 |
| 2 | Tool cost (life assumed _ three years) | 63.48 |
| 3 | Training expenses (spread over five years) | 28.57 |
| 4 | Interest charges @ 12 per cent per annum | 742.86 |
| 5 | Depreciation (over ten years) | 619.05 |
| | Total | 4,311.10 |

***Annual Fixed Expenses of Block Mechanic with Motorcycle***

| No | Expenses | $ |
|---|---|---|
| 1 | Salary (one person) | 571.43 |
| 2 | Tool cost (life assumed _ three years) | 23.81 |
| 3 | Training expenses (spread over five years) | 4.76 |
| 4 | Interest charges @ 12 per cent per annum | 114.29 |
| 5 | Depreciation (over ten years) | 95.24 |
| | Total | 809.53 |

***Annual Fixed Expenses for Caretaker***

| No | Expenses | $ |
|---|---|---|
| 1 | Tools (spread over three years) | 0.71 |
| 2 | Training (spread over five years) | 0.95 |
| | Total | 1.66 |

## Variable expenses

The variable costs of maintenance for the mobile van, motorcycle and caretaker are given in the following table.

***Annual Variable Expenses of Handpump Maintenance System***

| Item | Mobile Van ($) | Block Mechanic ($) | Caretaker ($) |
|---|---|---|---|
| India Mark II | | | |
| Running Expenses | 822.86 | 377.14 | |
| Maintenance Expenses | 467.43 | 142.86 | 0.24 |
| Total | 1,290.29 | 520.00 | 0.24 |
| India Mark III | | | |
| Running Expenses | 1,513.57 | 288 | |
| Maintenance Expenses | 736.43 | 109.52 | 0.24 |
| Total | 2,250.00 | 397.52 | 0.24 |

## Summary of maintenance expenses

The following three tables indicate the fixed and variable expenses of different types of maintenance systems.

***Mobile Van: Fixed and Variable Expenses per Pump per Year***

| No | Item | Mark II($) | Mark III($) |
|---|---|---|---|
| 1 | Fixed expenses | 4,311.10 | 4,311.10 |
| 2 | Variable expenses | 1,290.29 | 2,250.00 |
| 3 | Total fixed and variable expenses per mobile van | 5,601.39 | 6561.10 |
| 4 | Number of pumps serviced | 300 No | 1950 No |
| 5 | Total fixed and variable expenses per pump | 18.67 | 3.36 |

***Block Mechanic*: Fixed and Variable Expenses per Pump per Year***

| No | Item | Mark II($) | Mark III($) |
|---|---|---|---|
| 1 | Fixed expenses | 809.53 | 809.53 |
| 2 | Variable expenses | 520.00 | 397.52 |
| 3 | Total fixed and variable expenses per mechanic | 1,329.53 | 1,207.05 |
| 4 | Number of pumps serviced | 1500 No | 600 No |
| 5 | Total fixed and variable expenses per pump | 0.89 | 2.01 |

* Experience from several projects shows that maintenance interventions intended to be performed by a block level mechanic can be easily performed by a village level mechanic.

***Caretaker: Fixed and Variable Expenses per Pump per Year***

| No | Item | Mark II($) | Mark III($) |
|---|---|---|---|
| 1 | Fixed expenses | 1.66 | 1.66 |
| 2 | Variable expenses | 0.24 | 0.24 |
| 3 | Total fixed and variable expenses per pump | 1.90 | 1.90 |

## Cost of parts replaced

The two tables below give details of the cost of parts replaced per pump per year and also the level of maintenance structure required for replacement of each part.

***India Mark II Pump: Cost of Parts Replaced per Pump per Year***

| Component/Maintained by | Cost per Pump($) | Percentage of total cost (%) |
|---|---|---|
| **Block Mechanic:** | | |
| Handle assembly | 81.70 | 19.29 |
| Handle bearing | 8.10 | 1.91 |
| Chain | 10.80 | 2.55 |
| Bolt | 0.90 | 0.21 |
| Nut | 1.50 | 0.36 |
| Other | 4.40 | 1.04 |
| Sub-total | 107.40 | 25.36 |
| **Mobile Van:** | | |
| Pump rod | 29.80 | 7.04 |
| Rising main pipe | 194.70 | 45.97 |
| Rising main coupler | 37.90 | 8.95 |
| Piston seal | 9.60 | 2.27 |
| Cylinder body | 13.90 | 3.28 |
| Cylinder cap | 4.20 | 0.99 |
| Cylinder assembly | 9.40 | 2.22 |
| Piston valve | 4.90 | 1.16 |
| Foot valve | 11.70 | 2.76 |
| Sub-total | 316.10 | 4.64 |
| Total | 423.50 | 100.00 |

***India Mark III Pump: Cost of Parts Replaced per Pump per Year***

| Component/Maintained by | Cost per Pump($) | Percentage of total cost (%) |
|---|---|---|
| **Block Mechanic:** | | |
| Handle assembly | 52.70 | 16.56 |
| Handle bearing | 6.90 | 2.17 |
| Chain | 5.60 | 1.76 |
| Pump rod | 8.80 | 2.77 |
| Piston seal | 10.00 | 3.14 |
| Piston valve | 5.30 | 1.67 |
| Foot valve | 4.20 | 1.32 |
| Bolt | 0.20 | 0.06 |
| Nut | 1.10 | 0.35 |
| Other | 1.80 | 0.57 |
| Sub-total | 96.60 | 30.36 |
| **Mobile Van:** | | |
| Rising main pipe | 83.70 | 26.30 |
| Rising main coupler | 18.50 | 5.81 |
| Cylinder assembly | 29.40 | 37.52 |
| Sub-total | 221.60 | 69.64 |
| Total | 228.20 | 100.00 |