WATER AND SANITATION FOR HEALTH PROJECT

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EVALUATION OF THE FEASIBILITY OF MANUFACTURING AND MARKETING THE AID-DESIGN HANDPUMP AND ROBOSCREEN IN PERU

WASH FIELD REPORT NO. 89

JUNE 1983

Prepared For:
USAID Mission to the Republic of Peru
Order of Technical Direction No. 114

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WASH

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June 3, 1983

Mr. John Sanbrailo
Mission Director, USAID
Lima
Peru

Attention: Ms. Norma Parker

Dear Mr. Sanbrailo:

On behalf of the WASH Project I am pleased to provide you with ten (10) copies of the final report on a feasibility study of manufacturing and marketing the AID handpump and roboscreen in Peru. The study responded to a request by the Mission on August 18, 1982. On September 8, 1982 the WASH Project was authorized to start work by means of Order of Technical Direction (OTD) No. 114, which was issued by the USAID Office of Health in Washington. By the end of October the field work had been completed.

The attached report presents the WASH Project's recommendations, which include the need for a comprehensive marketing study before any final decision is made on a handpump pilot project. If you have any questions or comments regarding the findings or recommendations contained in this report, we will be happy to discuss them.

Very truly yours,
Camp Dresser & McKee, Inc.

Dennis B. Warner

Dennis B. Warner, Ph.D., P.E.
WASH Project Director

DBW:DD:PFH:pwr

cc: Victor W.R. Wehman, Jr., P.E., R.S.
AID WASH Project Manager

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Prepared by:

The WASH Project

June 1983

Water and Sanitation for Health Project
Contract No. AID/DSPE-C-0080, Project No. 931-1176
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U.S. Agency for International Development
Washington, DC 20523

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ACRONYMS

CARE	Cooperative for American Relief Everywhere
CDM	Camp Dresser and McKee, Inc.
DISAR	Directorate of Rural Sanitation
IRWRDL	International Rural Water Resources Development Laboratory
GOP	Government of Peru
MOH	Ministry of Health
PHC	Primary Health Care
RWSES	Rural Water Systems and Environmental Sanitation Program
UNICEF	United Nations Children's Fund
USAID	U.S. Agency for International Development
WASH	Water and Sanitation for Health Project

SUMMARY

One of the measures that the AID Mission to Peru is considering in its efforts to assist the Government of Peru (GOP) improve its rural water supplies is the use of handpumps mounted on existing or new dug wells or tube wells. At the Mission's request a study was conducted in October 1982 of the feasibility of manufacturing and marketing the AID-design handpump and roboscreen (a plastic well screen) in Peru. This report presents the findings of the evaluation and recommends further action for the Mission to consider.

While the available data concerning the need for water supply programs in Peru vary from source to source, it is recognized that Peru has serious health problems, particularly in rural areas where almost half of all Peruvian deaths occur among children under the age of five. It is estimated that 60 percent of these deaths are caused by water-related diseases spread by poor sanitary conditions. While health status is a function of a large number of variables such as rural versus urban setting, educational level, income and numerous other socio-economic factors (including the availability of health services), it is increasingly clear that adequate quantities of safe water, coupled with environmental sanitation are one of the health sector's major responses for improving and/or maintaining people's health.

Programs for improving water supply are being implemented or planned by the GOP as well as development agencies such as USAID/Peru, CARE, UNICEF, Accion Comunitaria, Catholic Relief Services and others. In procuring the hardware needed to carry out these programs it would seem reasonable to rely on local manufacture as much as possible rather than deal with the problems and delays of importing equipment and spare parts. Among the various hardware items needed for these programs will most likely be handpumps and well screen for wells in rural communities.

It was to find out if the capability existed in Peru to manufacture and market the AID-design handpump and roboscreen that the Mission requested assistance from AID/Washington in August 1982. AID/Washington responded to the request in September 1982 by issuing Order of Technical Direction (OTD) No. 114 to Camp Dresser and McKee, Inc. (CDM), an environmental engineering company that operates AID's centrally-funded Water and Sanitation for Health (WASH) Project. CDM, in turn, authorized its sub-contractor, the Engineering Experiment Station at the Georgia Institute of Technology, to undertake the field work. Georgia Tech has extensive experience in this work with the AID-design handpump in several developing countries. A WASH team from the Georgia Institute of Technology carried out the assignment in Peru in October 1982.

The WASH team found that the capability exists in Peru for high-quality manufacture of the AID-design handpump at rates in excess of 5,000 pumps per year. Excellent in-country capability also exists for producing roboscreen in reasonable quantities at acceptable prices. While no direct quotations were obtained from potential pump manufacturers, after analyzing local labor costs and costs of producing gray iron castings, it was estimated that the AID handpump could be purchased from manufacturers in Peru for an average cost of $207. Three-inch diameter roboscreen could be purchased from local manufacturers for about $3.50 to $4.00 per foot in lots of 3,000 feet.

The preliminary study that the team was able to conduct indicated that there was a potential handpump market in Peru, but in order to determine the actual need for the AID-design handpump and roboscreen, a cost-effective analysis should be made of various feasible alternatives to improve water supply in the needy areas. Based on this analysis an estimate can be made of the number of handpumps needed. It can then be decided whether or not it is cost-effective to manufacture the AID handpump in Peru.

This document is basically the report submitted to CDM-WASH by Georgia Tech in December 1982, a draft of which was left with the Mission in October after the Georgia Tech field visit. CDM-WASH developed additional chapters describing a handpump program and a marketing study and also edited the material submitted by Georgia Tech. The conclusions and recommendations of the present report were developed by CDM-WASH after discussions with Georgia Tech and AID/Washington.

The report is divided into eight chapters. The first discusses the background of the WASH assignment, the needs in Peru that it was intended to help address, and the scope of work. The second chapter discusses AID technology transfer programs involving handpumps. The third chapter discusses in-country institutional and other factors of importance in handpump programs. The fourth chapter presents a preliminary assessment of the need for handpumps in Peru, that is, how many would be needed and when. The fifth chapter presents a suggested approach for the market study that should be done before deciding to go ahead with a handpump program in Peru. The sixth chapter discusses the capability in Peru of installing and maintaining handpumps. The seventh chapter presents an in-depth assessment of the capability of several Peruvian companies to manufacture the AID-design handpump and roboscreen, and, finally, the eighth chapter presents conclusions and recommendations.

Chapter 1

BACKGROUND

1.1 Background for the WASH Assignment

Since 1980, AID/Peru has been assisting the Directorate of Rural Sanitation (DISAR) of the Ministry of Health (MOH) through a program entitled "Rural Water Systems and Environmental Sanitation" (RWSES) to address Peru's rural water and sanitation problems. A primary goal of the program is to achieve long-term improvements in water and sanitation for Peru's rural poor.

Among the various measures being considered to improve rural water supply in Peru is the use of handpumps mounted on existing or new dug wells or tube wells. In order to avoid problems with delivery schedules, supply of spare parts and use of limited foreign exchange capacity, it was thought best to use a handpump that was locally-manufactured in Peru. Because no handpump was locally available, in August 1982 AID/Peru requested assistance from AID/Washington in the assessment and evaluation of the feasibilty of locally manufacturing and marketing the AID-design, hand-operated, community-level water pump, and roboscreen (a PVC well screen) in Peru. This request resulted in the issuance of Order of Technical Direction (OTD) Number 114 (see Appendix A) by the AID/ Washington Office of Health, Science and Technology Bureau, to Camp Dresser and McKee's Water and Sanitation for Health (WASH) office in Arlington, Virginia. The assessment and evaluation activities were then subcontracted to the Georgia Institute of Technology's Engineering Experiment Station.

1.2 Purpose of the WASH Assignment

The evaluation of the feasibility of local manufacture and marketing of the AID handpump and roboscreen in Peru is directly linked to the RWSES program which is in the process of providing water supply systems, latrines, and health education in some 420 communities with populations of 500 or less. The communities are located in six health regions in the Sierras and high jungle zones of Peru (see Figure 1). Activities have begun in Cuzco, Junin, and Cajamarca, and expansion to an additional three provinces is planned over the life of the program. The program is integrated into the MOH's primary health care (PHC) activities. The integration will aid in strengthening the infrastructure of the regional health offices by creating an environmental sanitation team which will remain intact following the project's conclusion.

1.3 Goals of the WASH Assignment

The goals of the WASH assignment were to identify and, whenever possible, quantify factors which might affect the utilization of the AID handpump and roboscreen in the RWSES water, latrine, and health education program. Areas investigated were manufacturing capability, political/economic (in-country considerations), marketing, other organizational involvement, installation/maintenance/repair capability, and governmental (MOH) capability to implement a handpump program. Potential alternatives for improving water supply, such as gravity systems, were not investigated.

Due to considerations of time and availability of data, the WASH team concentrated on the manufacturing capability of the country. Preliminary estimates were made for the marketing potential of the two devices.

1.4 Need for Water Supply Programs in Peru

1.4.1 Country Setting*

Peru has the least arable land area per capita of any country in South America. Population density per arable square kilometer is 476.2. The Andean mountains cross the country from north to south, dividing it into three distinct regions with different ecological settings and socio-cultural characteristics. The regions are coast, mountain, and jungle. The coast represents 11.5 percent of the total area and has approximately 46 percent of the population. The mountain and jungle regions represent 26.83 percent and 61.63 percent of the area and 44.1 percent and 9.9 percent of the population, respectively. Peru has a rapidly growing population which totaled more than 17 million in 1979. Its annual growth rate is estimated to range between 2.5 percent and 2.9 percent.

Due to migration patterns, existing statistics describing the age pyramid difference among community nuclei of different sizes are not available, but it is estimated that 43 percent of Peru's population is under age 15. Experts believe, however, that the percentage of young people, including infants and children, in rural Sierra areas is higher.

1.4.2 The Problem*

Peru has serious health problems which are most critical in the rural areas. In general, 48.4 percent of deaths are among children under age five. Sixty percent of these deaths are thought to be caused by water-related diseases often spread by poor sanitary conditions. According to some reports, Peru has an infant mortality rate (under age one) of between 130 and 148 per thousand live births. In some rural areas of Peru's southern Sierra, however, these rates reach 200 per thousand. The main causes of death are infections and parasitic diseases which could be controlled by basic environmental sanitation. Poor nutritional status is an additional factor contributing to ill health because of inadequate diet and frequent gastro-intestinal diseases. Due to the present economic crisis affecting the world, health conditions have deteriorated even further, especially in the lower income strata.

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*The data in this section were taken from the Country Development Strategy Statement (CDSS) developed by AID/Peru for Fiscal Year 1981.

FIGURE 1
POLITICAL MAP OF PERU
WITH MOH HEALTH REGIONS

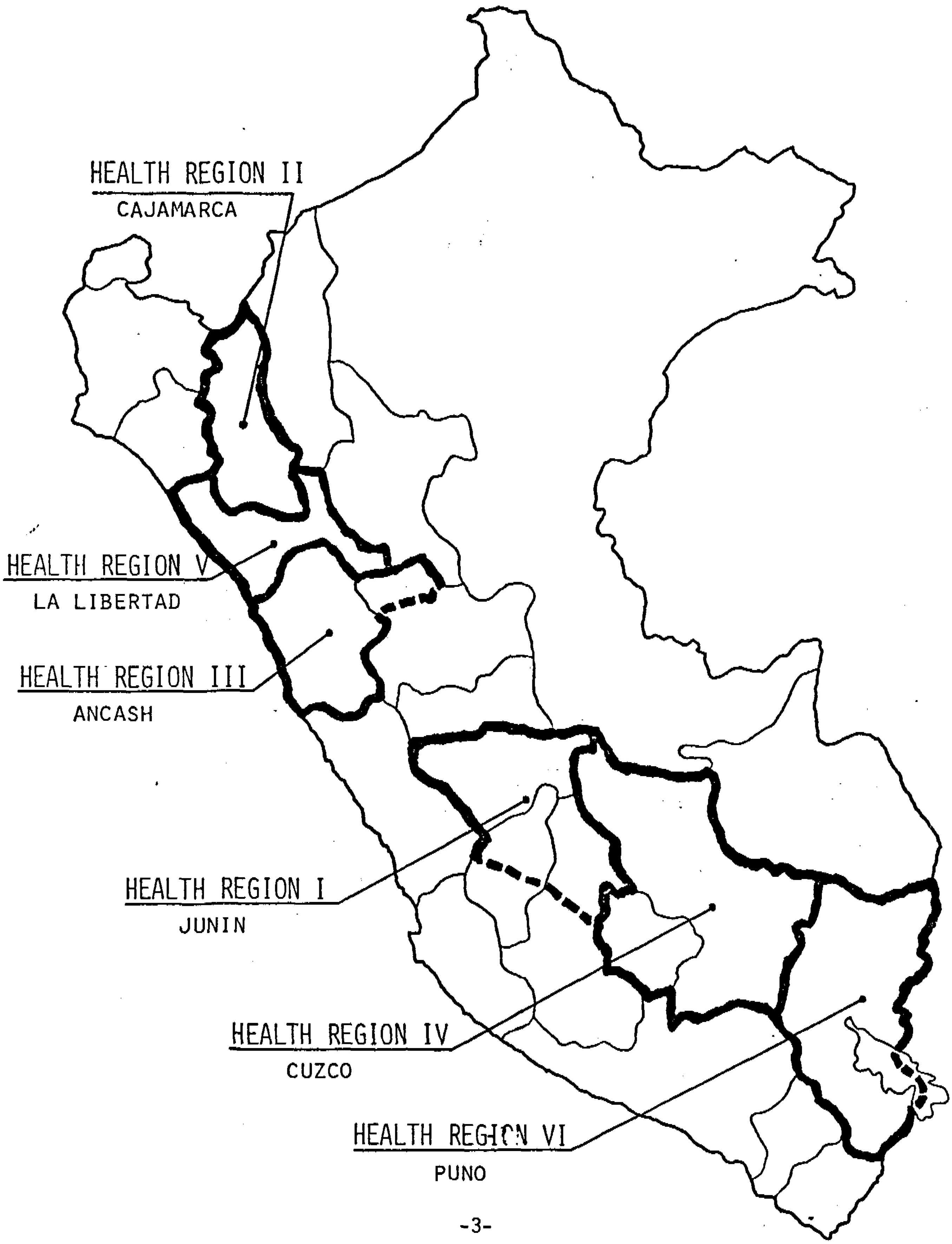


Table 1 presents demographic statistics for rural communities in Peru of fewer than 2,000 inhabitants according to the 1972 census. Use of 1972 figures was necessary because 1982 census results were not yet available.

According to the Government of Peru (GOP), communities of fewer than 500 inhabitants are widely dispersed. To provide these communities with other than basic services would be difficult. It is estimated that 69 percent of the rural population must be served by means of basic-level water supplies such as gravity-fed systems or wells with handpumps.

The MOH is responsible for providing potable water supplies to communities of fewer than 2,000 inhabitants. Due to insufficient funding, however, it has not been possible to serve all of these communities. From 1962 to 1981, approximately 1,150 communities with populations under 2,000 were provided with potable water. But this represents only one percent of the total number of communities, thus leaving 99 percent of communities of fewer than 2,000 inhabitants without government-provided potable water supplies.

Table 2 shows the percentage of population served in communities with fewer than 2,000 inhabitants. Note that only 15.4 percent of the population in such communities is provided with water through an MOH program and 84.6 percent is not.

1.5 Scope of Work

The scope of work requested by AID/Peru and authorized by OTD 114 was to study the feasibility of manufacturing and marketing the AID handpump and robo-devices in Peru.

In assigning this scope of work to the Georgia Institute of Technology (its subcontractor), CDM-WASH instructed them to:

1) Perform an assessment and evaluation of the feasibility of conducting a successful technology transfer program in Peru which would consist of developing or enhancing in-country capability for producing high quality AID handpumps and roboscreen at a reasonable price in acceptable quantities. The program would also include developing in-country capability for installing and maintaining the AID handpumps and roboscreen.

2) Evaluate the capacity of foundries, machine shops, and appropriate government agencies to manufacture, install and maintain handpumps at three rates: 1,000, 2,000, and 5,000 pumps per year.

1.6 Work Plan

In order to carry out the assignment under OTD 114 CDM-WASH considered that three questions would have to be investigated to determine if a technology transfer program involving the AID handpump was appropriate for Peru. The three questions were:

1) Is there a need to improve rural water supply?

Table 1. Communities in Peru of less than 2,000 Inhabitants.

POPULATION RANGE	COMMUNITIES	POPULATION	PERCENT DISTRIBUTION
1,999-1,000	699	1,116,847	13.5
999-500	1,810	1,433,432	17.3
499-200	6,631	2,366,583	28.6
199-100	8,381	1,375,404	16.6
99-50	10,550	875,406	10.6
Less than 49	77,899	1,106,822	13.4
TOTAL	105,970	8,274,494	100.0

Source: Ministry of Health, Directorate of Rural Sanitation, October 1982

Table 2. Population Served in Communities of Less Than 2,000 Inhabitants.

POPULATION RANGE	POPULATION SERVED	TOTAL POPULATION	% POPULATION SERVED
1-399	32,267	4,855,569	0.7
400-1,999	1,226,437	3,294,389	37.2
TOTAL	1,258,704	8,149,958	15.4

Source: Ministry of Health, Directorate of Rural Sanitation, October 1982.

2) Is it feasible to manufacture and utilize the AID-design handpump in Peru?

3) What is the potential market for a locally-manufactured handpump in Peru?

Within the authorized time and resources questions 1 and 2 were addressed, and the basic data for the marketing study of question 3 were gathered.

Following a general description of the AID-design handpump and its role in AID technology transfer programs, the remainder of the report presents the findings of the WASH team's investigation and CDM-WASH's recommendations of how to further address question 3.

Chapter 2

THE AID-DESIGN HANDPUMP AND AID TECHNOLOGY TRANSFER PROGRAMS

2.1 The AID-Design Handpump and Implementation Program

Before discussing the specific case of the potential for a handpump program in Peru, it will be helpful to describe the AID handpump and to give an idea of the range of concerns involved in a handpump program in general.

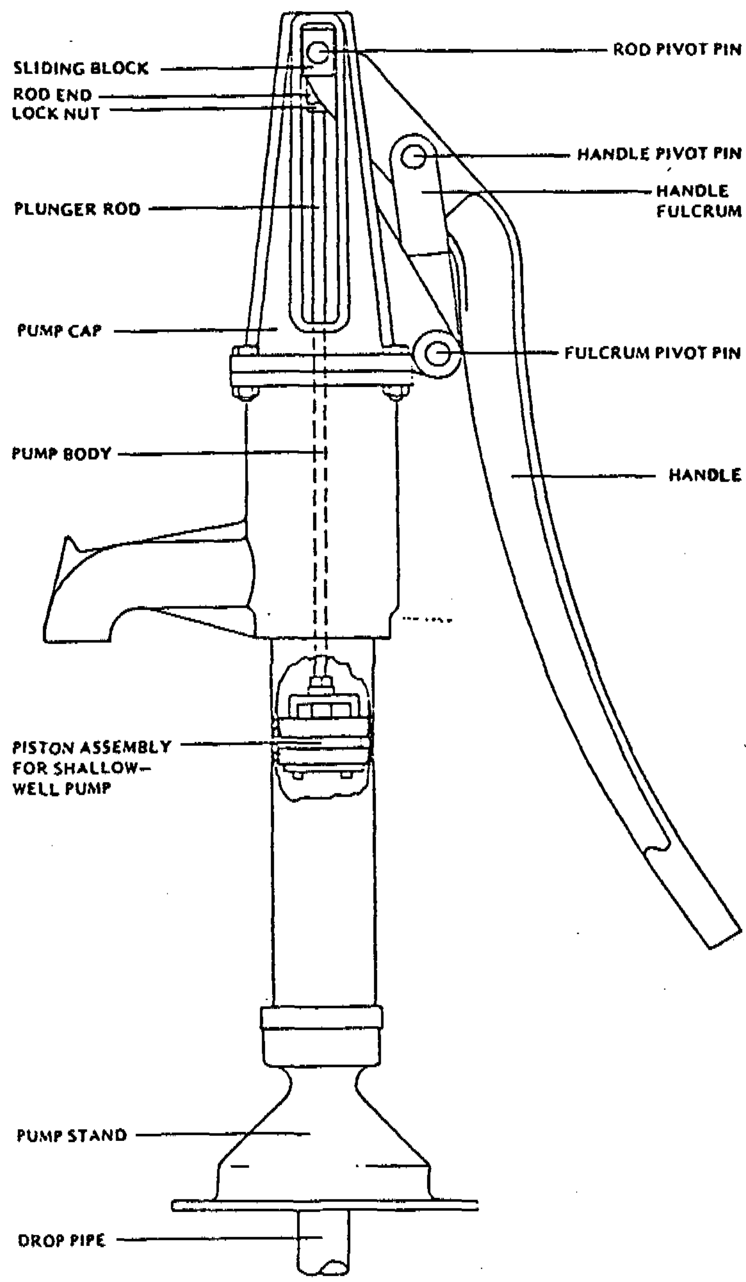
The AID-design handpump (see Figures 2 and 3) is a single-acting, positive-displacement piston pump for community or multi-family use consisting of an above-ground pump stand made of cast iron and galvanized steel, a drop pipe, and a PVC or PVC-lined pump cylinder containing a steel and brass piston or plunger assembly with leather cup seals. It can be mounted on tube wells or on a platform built over dug wells. The pump has been found to provide a reliable water supply for 50 to 100 families per pump. Its average pumping capacity is approximately five gallons per minute (gpm) and it can pump from depths of up to 100 feet. The pump produces approximately one half liter of water per stroke of the handle. The pump has not been in use long enough to determine its average useful life before replacement, but some have estimated its useful life to be 10 years. It is most likely that, rather than replacing an entire worn-out pump, its component parts would gradually be replaced as needed, and it may be that after 10 years of use the pump would no longer contain any of its original parts.

The pump comes in two models, one for shallow wells and another for deep wells. The shallow well pump (Figure 2) lifts water by suction from wells in which the lowest water level is no more than eight meters (approximately 26 feet) below the ground. The pump cylinder in this model is in the pump stand above the ground.

The pump cylinder in the deep-well pump (Figure 3) is located down the well. It either pushes water up to the surface from below the water level or, if the pump cylinder is set above the water level in the well, it lifts water by suction just as the shallow-well model does. In the latter case the cylinder must be no more than eight meters above the static water level.

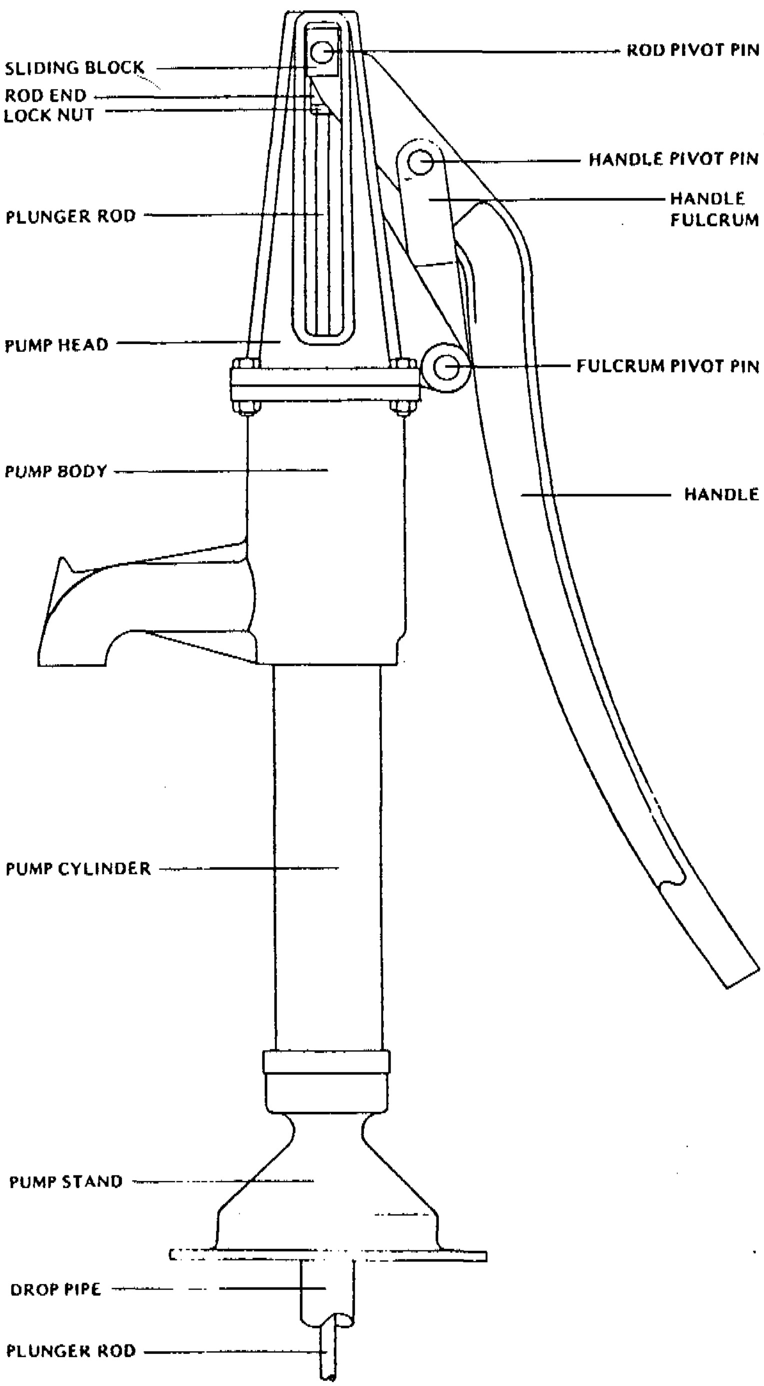
The pump is operated by moving the handle manually. If the pump is to lift water by suction, it must be primed initially. If it is to push water up from below the surface of the water it does not require priming. When the handle is lifted, the piston or plunger moves down and water pushes up through a poppet valve in its assembly. A foot valve at the bottom of the pump cylinder is closed during this action and prevents the column of water from draining out the bottom of the cylinder. When the pump handle is lowered, the piston or plunger moves up. The poppet valve closes and the piston or plunger assembly pushes water upward. The upward motion sucks open the foot valve and water passes up into the pump cylinder below the piston or plunger. Repeated operation of the handle brings water to the pump spout.

FIGURE 2
AID-DESIGN SHALLOW-WELL PUMP

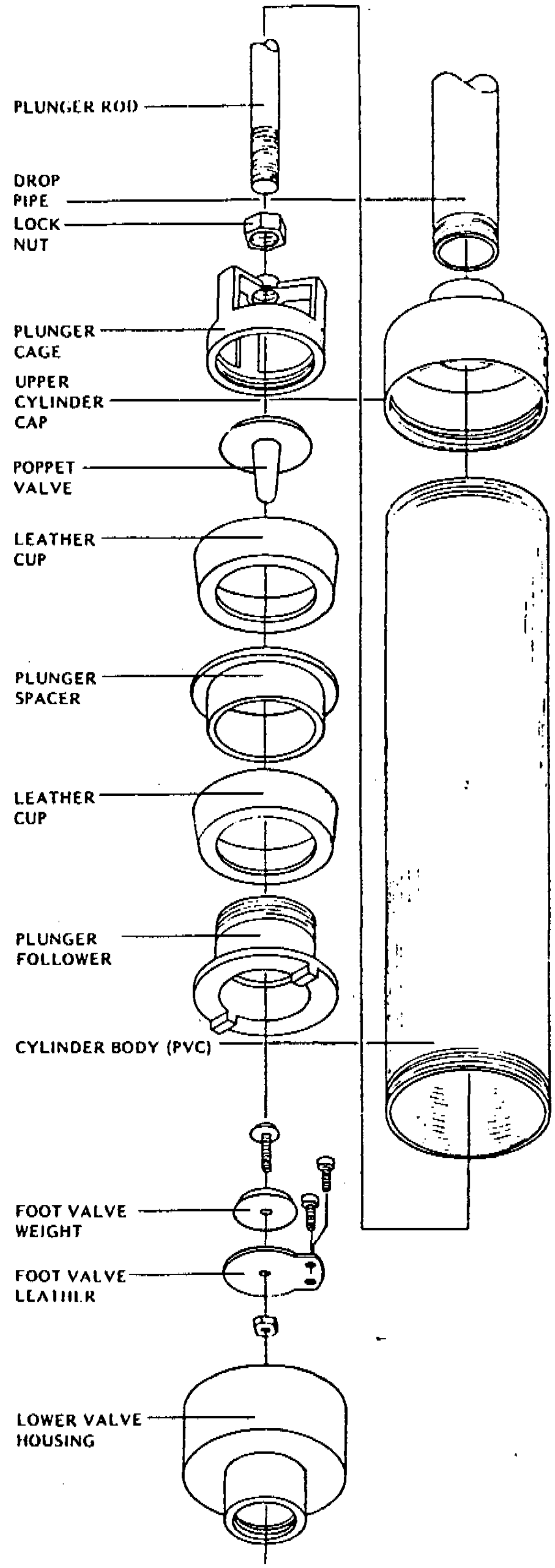


PUMP STAND

FIGURE 3
AID-DESIGN DEEP-WELL PUMP



PUMP STAND



COMPONENTS OF PUMP CYLINDER

Like all mechanical devices, the AID pump requires maintenance and repair. The most frequent maintenance item is lubricating the pins at the three mechanical linkages in the pump cap and the guides for the sliding blocks. This should be done once a week. It is expected that persons from the community where the pump is located could be trained to do this. The next most frequent maintenance item is replacing worn leather cups. This may have to be done as often as every six months or as infrequently as every two years. This is a relatively simple task for the shallow-well pump but is very laborious for the deep-well pump because it requires removing the pump cylinder from down in the well. In the latter case, therefore, a regional maintenance crew may have to do this work.

In any case, regional crews would have to be established to do more difficult maintenance and repair work. These crews would have to be supported by a national infrastructure capable of managing this operation. The principal management concerns would include the logistics of providing spare parts, tools, materials, fuel, and supplies, maintaining vehicles, scheduling work, personnel administration and training, and budgeting and financing. Experience in many countries has shown that, if such an infrastructure does not exist or cannot be developed, a handpump program will not remain viable for very long.

In order to be effective in reducing water-related diseases, a program involving handpumps should include an element of user education so that people will use clean containers to obtain water at the pump, will store it in clean containers in the home, and will be careful to use water in a sanitary manner. The well site should be drained to prevent water from pooling, and the users should keep the site clean and free from mud.

2.2. Components of a Handpump Program

Figure 4 shows the major components of a technology transfer program involving handpumps. The principal elements are planning and design, procurement, manufacture, field installation and maintenance and repair. It is important to note that this schematic assumes that either wells exist or there is a program to install wells, an aspect of a water-supply program that itself is quite complicated and demands considerable time and human and financial resources. Under each major component are listed the specific tasks which must be performed. Figure 4 also shows the type of skills needed to carry out the work under each component. It may well be that one individual may have several of the needed skills, so the program may not need as many persons as there are skills indicated. A most important feature is the need for a program coordinator (team leader) whose principal task is to orchestrate the activities of all of the individuals working in the program. This person should be an experienced manager who will serve the needs of and cooperate with those who carry out the work. His principal role would be to anticipate the needs of the project and facilitate its implementation.

A striking feature of Figure 4 is that the handpump itself is seen as a physical device in a social, cultural, institutional setting. Although it is obviously a key element in a handpump program, it is quite useless if many other aspects of the program do not function properly. Being a physical device, the pump can be manipulated and shaped in several ways. It is a tangible object that can be measured, tested, and rejected if it does not

Figure 4

Components of a Handpump Program

Well Construction Program (linked to Installation)

Phase	Planning and Design	Procurement	Manufacturing	Installation[1]	Maintenance[2]
Tasks	Marketing Study Assess Technical Feasibility Institutional Assessment Data Collection Evaluation of Alternatives Cost Analysis	Plans Specifications Bid Documents Contracts Qualification and Selection of Bidders	Management Training Managers, Technicians, Laborers Production Quality Control Quality Assurance Inspection Acceptance by Purchaser	Management Training Managers, Technicians, Laborers, Promoters Community Participation Organize Crews Logistics Warehousing Transport and Distribution of Materials	Management Training Managers, Technicians, Laborers, Promoters User Education and Motivation Spare Parts & Supplies Community Lubrication Community Maintenance Troubleshooting and Feedback
Skills	TEAM LEADER				
	Marketing Industrial/Mechanical Engineering Sanitary Engineering Planning	Contracting Project Engineering Sanitary Engineering (rural water supply) Mechanical Engineering	Management HRD[3] Foundry Operation Machine Shop Operation Quality Assurance/Control	Management Community Participation Promotion HRD[3] Sanitary Engineering	Management Community Participation HRD[3] Operation and Maintenance
Distribution of Technical Assistance	8%	24%	20%	20%	28%

1. Installation starts before manufacturing process is complete.
2. Maintenance starts before installation process is complete.
3. HRD = Human Resource Development

work, or it can be repaired so that it does work. The institutional and social infrastructure and the behavioral change necessary to make a handpump program successful, however, are problems that require attention all the way from the community to the national level, for human behavior is not so easy to anticipate or control. Consequently, the areas of institutional and infrastructure development, training, and user education and motivation are usually much more demanding in terms of time, people, and finances that must be devoted to them. Work in this area should begin well in advance of the handpump manufacture itself and may well continue long after pump manufacture has been completed. It is clear that this so-called "software" aspect of the program demands a lot of attention. It is also important to note that the consequences of such work can be very far reaching in that they can lead to progress in many other aspects of a country's development and help stimulate self-reliance so that little by little the country will be able to do more and more of its development work without outside help.

2.3 AID Technology Transfer Programs Involving Local Manufacture of Handpumps

Local manufacture of handpumps under AID's technology transfer program is usually a two-step process. The first step is usually a pilot program in that a relatively small number of pumps is involved and its purpose is as much for demonstration and data collection as it is for developing local manufacturing capability. The second step is to help AID, the host country government, and the local manufacturers not only with the same problems as those dealt with in the pilot program but also with problems associated with the increased size and complexity of large-scale, full-production programs that involve thousands of pumps.

The following outline presents the activities required to carry out a pilot handpump program.

1. Assessment of pump production capability of several manufacturers and the recommendation of one or more of these manufacturers to AID to furnish this pump for host country use.

2. Provision of mechanical drawings and a prototype pump to the selected manufacturer(s), and detailes discussion with the manufacturer(s) of the manufacturing of each pump component and the assembly and finishing of the pump.

   It appears to be common that foundries in developing countries have greater ability to duplicate already-manufactured items than to fabricate items using mechanical drawings and written specifications. The latter approach requires a higher literacy level and more formal, sophisticated training than is commonly found among foundry workers in developing countries. This is the principal reason that it has been necessary to rely so heavily on direct technical assistance to obtain a pump that conforms to the drawings.

   There is no question that the long-term interest of technology transfer would be better served if foundry workers could be trained to read drawings and specifications, because they would then be able to fabricate original products. Such training, however, could only be accomplished over a period of several years because it requires not only literacy training, which itself takes a lot of time, but also the development of skills for interpreting drawings which require a long period of supervised practice and repetition.

In light of these limitations, planners and managers of water supply programs must decide whether or not they want to set aside enough time up front so that in-country manufacturers can be trained to read drawings and specifications and thus be able to supply the program with whatever manufactured items are required without relying on outside technical assistance. If a decision is made not to undertake such a training effort, for example, because of the pressure to get a program started, then provision should be made for outside technical assistance to help the manufacturers produce the items needed for the program.

Other important factors in technology transfer involve the language barrier and the gap between highly-trained engineers and practical foundry men.

3. The manufacturer manufactures his production tooling (jigs and fixtures) and then manufactures the pump. This process involves casting and machining iron and brass components and procurement or fabrication of other materials and parts. The machining involves cutting, grinding, turning on a lathe, milling, drilling, and threading. The fabrication process also involves hardening and tempering steel pins and bushings for the pump's mechanical linkages.

   As the manufacturer completes some initial pumps, they are inspected very carefully, and this opportunity is used to orient and train the manufacturer in quality control, product inspection, and testing.

4. Based on inspection of the initial pumps, the principal difficulties encountered by the manufacturer are identified, the reasons for the difficulties are determined, and a mutually-acceptable program of intensive technical assistance is developed. This technical assistance is the major component of AID's technology transfer program and is the most time consuming.

5. The manufacturer completes the order of pumps, and final inspection and acceptance testing are conducted. Again, this opportunity is used to train the manufacturer in these last but critical steps in the pump production process.

6. If a host-country agency is purchasing the pumps, the agency's personnel are trained in the pump acceptance procedure so that they will be able to carry out this first step in ensuring that only reliable pumps reach the field. The agency's personnel will be the ones responsible for accepting or rejecting the pumps and approving or holding back payment to the manufacturer.

   If it is not the host country agency that is purchasing the pumps, technical assistance will probably be needed at a later date to train agency personnel when the host-country agency places its own order for pumps.

7. In order to obtain information on the performance of the locally manufactured pump and the acceptance and use of the pump by the local people, host country personnel are assisted in selecting field-test sites and in installing the pumps. This involves a sanitary survey, site selection and characterization, constructing a slab (for dug wells) or an apron (for tube wells), installing the pump and disinfecting the well. The occasion of carrying out these activities is also used as an opportunity to train host country personnel.

   There are five principal steps involved in field testing the handpumps. They presuppose the existence of wells or a program to install them. If this presupposition is not valid, then a well-construction step would have to be added. In each of the steps, host country personnel are involved not only to facilitate the work in rural communities but also for training so that they can eventually carry out the work on their own. The steps are:

   1. Site selection
   2. Site characterization
   3. Pump installation
   4. Monitoring and maintenance
   5. Data processing and feedback

   Site selection involves surveying existing well sites to investigate both technical and socio-cultural conditions that determine the suitability of the site for field testing. Based on this procedure a certain number of potential test sites are selected.

   Site characterization involves a detailed examination of each of the selected sites in order to determine the resources of time, money, personnel, materials, and equipment needed to prepare each site for testing. The characteristics investigated include well type, condition of existing superstructure, reported seasonal water levels, number of users, and location of possible sources of contamination.

   Pump installation involves preparing the well, constructing an apron or slab, mounting the pump, disinfecting the well and finishing the site (including provisions for drainage to avoid mud around the site).

   Monitoring involves determining the number of users, recording the community's likes and dislikes about the pump, and noting significant aspects of the community's use of it. Maintenance involves lubricating the pump once a week with grease, changing leather cups, and keeping the pump site clean.

   Data processing and feedback involve the system of collecting the records of the monitoring and maintenance activities, filing and cataloging them, and supplying key information to those responsible for addressing the various aspects of the pump program.

   It is especially important during field testing that activities be closely coordinated among all of the parties involved--from the community-level workers to the program managers in the host-country agency, the AID Mission, AID/Washington, and the technical assistance personnel.

Political, social, and cultural issues are most critical at this stage, and continual information exchange is vital to its success. At the beginning of the work a plan of action should be prepared by the host-country personnel responsible for the program in conjunction with their staff at all levels who will be involved in implementing the program. Non-host-country personnel who will be involved in the program should assist in developing the plan. It is important that all parties know their responsibilities, what they can expect from others and where they should go for help.

8. Together with host-country personnel, the field test sites are maintained and monitored and feedback is provided on the pump's performance, acceptability and maintainability to the AID Mission, the host-country agency, and the pump manufacturer.

9. If necessary, additional technical assistance is provided to the manufacturer or in-country personnel based on any difficulties revealed by the field testing.

10. Finally, a report is prepared documenting the activities and, based on the experience, conclusions are formulated which are either specific to the activity and/or are applicable to AID's overall handpump technology transfer program. Recommendations are made concerning both the specific country's water supply programs and future activities under AID's technology transfer program.

The ten-step procedure outlined above is for a pilot program. In large-scale, full-production programs AID may provide similar technical assistance in manufacturing, field installation, and maintenance but from a different position from that of the pilot program. Here the assistance would be provided to the AID and host-country personnel who are responsible for the implementation of the full-scale program rather than directly to the manufacturer or field crews, although it may be that such direct assistance may sometimes be authorized by those responsible. Perhaps the most critical needs for technical assistance in full-scale programs are in preparing contracts (drawings, specifications, proposal, contract), evaluating bids, and periodic technical and administrative evaluations of the program.

Chapter 3

IN-COUNTRY CONSIDERATIONS

3.1 DISAR Organization

DISAR is the government entity under the Directorate of Environment of the MOH responsible for the design and construction of rural potable water systems in communities of less than 2,000 inhabitants. Figure 5 shows DISAR's organizational structure. The optimal staffing pattern as earlier planned by DISAR to implement its RWSES program is shown in Figure 6. DISAR management has stated that the staffing pattern still applies and is now beginning to be implemented.

Staffing has begun in the following areas where the RWSES program will be active:

- Cuzco
- Puno
- Ica
- Chiclayo
- Ayacucho
- Piura
- Cajamarca
- Trujillo
- Ancash
- Junin

Each of these areas will have a resident engineer with two or three assistants. While DISAR does not yet have an active handpump program, the need for one was expressed by MOH personnel and is being planned. If a handpump program is implemented, it would be under DISAR, and sites for installing the handpumps would be selected in areas where DISAR is currently operating. However, because DISAR does not have an active handpump program at the present time, technical assistance would be needed to train MOH personnel in the installation, operation, and maintenance of the pumps at the beginning of the program.

One of the reasons given for Peru's not developing a handpump program up to now is the lack of a satisfactory, heavy-duty, community-level handpump that is manufactured in-country. Health and sanitation authorities do not think it would be appropriate to use an imported pump because of the problems involved in obtaining spare parts and the additional burden it would impose on Peru's balance of payments.

If a handpump program was to be implemented, DISAR thinks that the additional staffing required would not be a major problem especially since a program of this type would be carried out in stages. DISAR would enlarge its present staff as necessary to handle the number of handpump installations planned each year. According to DISAR management the capability exists for funding additional personnel. Before it is decided to undertake such a program, however, careful assessment of DISAR's capability, organizational structure, and needs for training personnel would have to be assessed.

FIGURE 5

PERU'S RURAL SANITATION DIRECTORATE ORGANIZATION

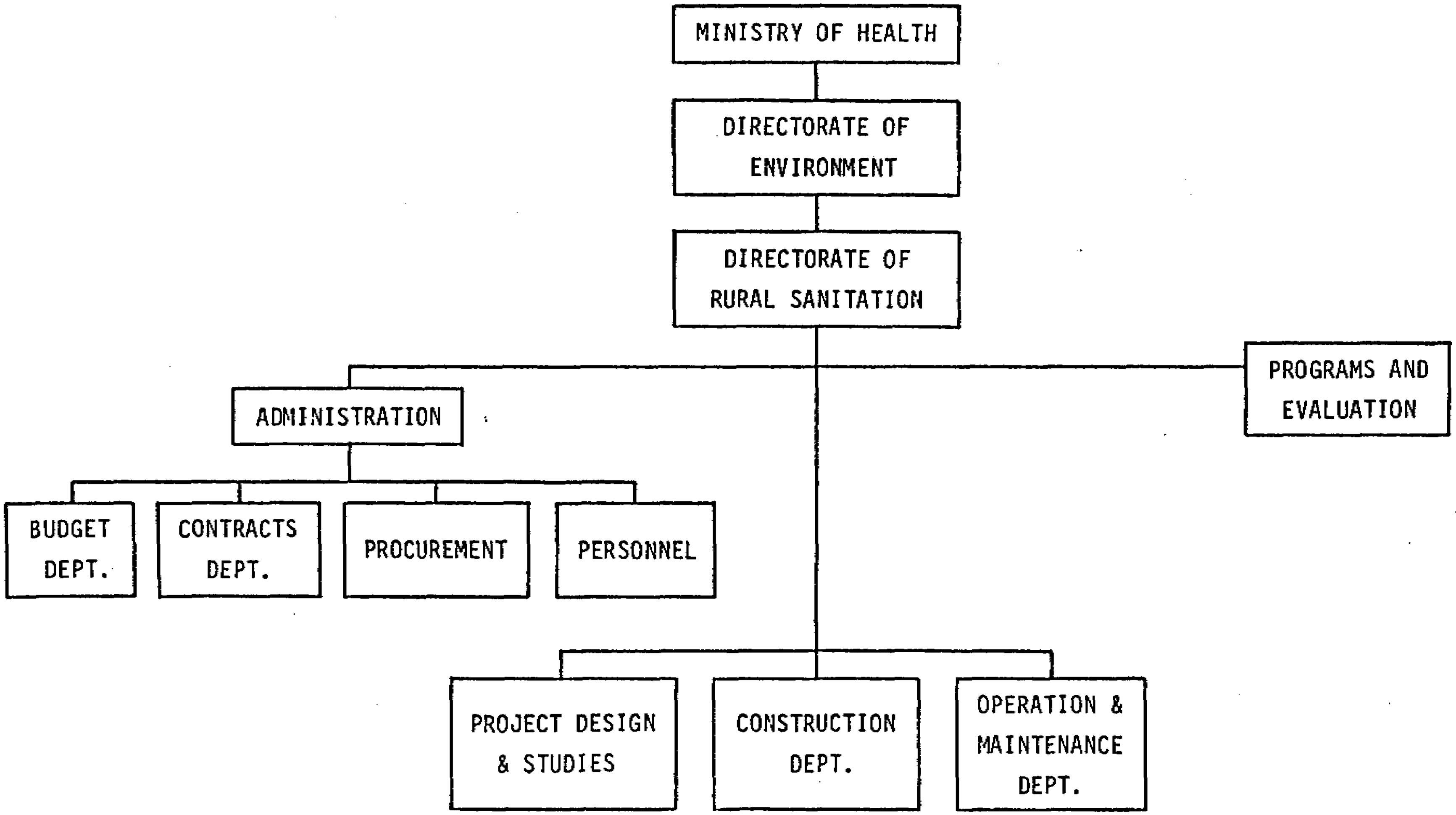
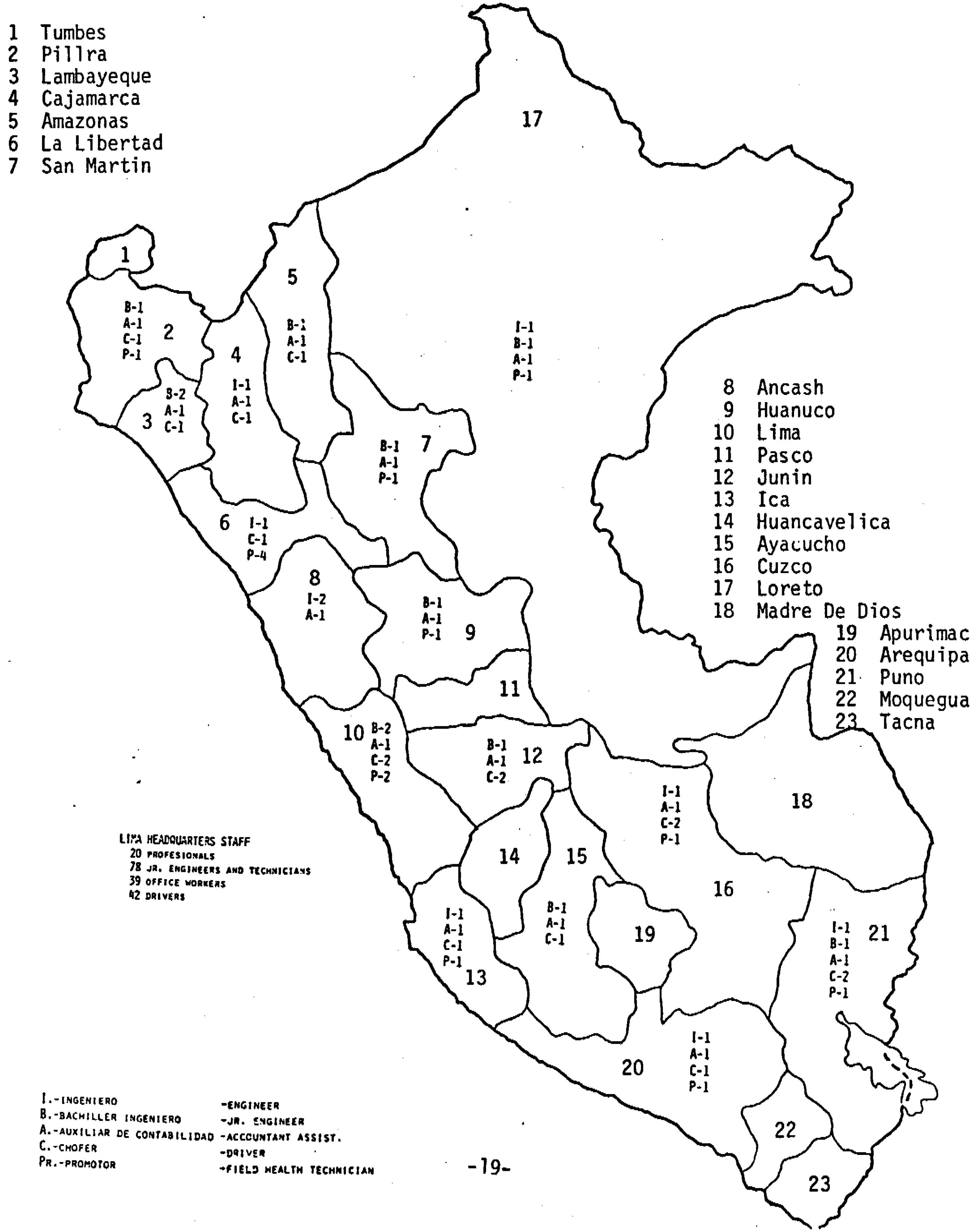


FIGURE 6

HUMAN RESOURCES FOR THE NATIONAL RURAL POTABLE WATER PROGRAM IN PERU



3.2 Social and Cultural Factors

Social and cultural factors have a significant influence on community development and should be considered when planning water supply projects. Among the factors to be considered are behavioral characteristics, physical needs and the mix of public and private sector involvement in the projects. The MOH rural water and sanitation department stated that acceptance of handpumps in rural communities would depend on location and the problems the local people have had in procuring water. Rural communities appear to be greatly influenced by what neighboring communities are using for water supply. If a neighboring community has a more sophisticated means of supply, such as a gravity-fed system, acceptance of the handpump would probably be limited. The community must also believe that it has a voice in the selection of its water supply system.

Rural communities receiving water from the MOH usually pay 10 percent of the initial cost in cash and also contribute unskilled labor and materials for construction. They also collect a user's fee which is used for operation and maintenance. DISAR engineers said that communities would be willing to pay for water supply systems when they recognize the need for them. Money collected by community representatives would be used to operate and maintain the systems.

The social and cultural characteristics of rural Peruvians were assessed indirectly by interviewing MOH personnel working with these communities through DISAR. They stated that in their opinion the majority of the rural communities in Peru would accept handpumps. If a handpump program is to be carried out, the community involvement factor would have to be assessed more carefully.

3.3 Other Factors

At present the RWSES program does not have specific funds allocated for handpumps. However, it appears that the original budget could be revised to cover handpump expenditures. Of course, this would have to be assessed more carefully if a handpump program is to be carried out. Program managers in the MOH and AID expressed interest in implementing a pilot handpump program under which 50 to 100 handpumps would be installed initially during 1983. They would like to use a locally-manufactured pump if the manufacturing capability can be established in the near future. The only locally-manufactured handpump they know of is a community-level pump being sponsored by UNICEF in Puno. Transporting materials and equipment in the rural mountain areas, however, poses major logistic problems in Peru, so the RWSES managers wanted a pump manufactured nearer the present areas of project activity. They suggested that foundries be assessed in Lima, Trujillo, and Cuzco for manufacturing an AID-design handpump.

Chapter 4

POTENTIAL USE FOR HANDPUMPS

4.1 General

The following information by no means represents the total current or potential use for handpumps in Peru. Due to the limited time (one week) allowed to assess the potential for using handpumps and the limited data available, only a rough preliminary estimate could be made.

Personal and telephone interviews with twelve national and international organizations were conducted (see Appendix B). All of these organizations were invited to see an AID handpump model at the AID Mission office in Lima. Nine of the organizations visited the Mission and saw the pump. In general, these groups expressed interest in having a locally-manufactured handpump in Peru. However, only two organizations, AID and UNICEF, expressed an immediate need for handpumps, and the latter is sponsoring handpump development in Puno. All organizations which saw the AID handpump were favorably impressed with it even though they were not able to see the pump installed and operating. Appendix B summarizes the discussions with these groups.

4.2 Organizations Active in Peruvian Water Supply Programs

Local government institutions and private associations and organizations involved in water supply programs in Peru include the following:

Urban Environment

- o Ministry of Housing and Construction, General Directorate of Sanitary Works (DGOS)
- o Development Corporations (DC)
- o Sanitation Enterprises for the Cities

Rural Environment

- o Ministry of Health, Directorate of Rural Sanitation

Other Organizations

- o USAID/Peru-Health, Rural Development and Special Projects Offices
- o Centro Panamericano de Ingenieria Sanitaria (CEPIS) as advisors
- o Pan American Health Organization (PAHO) as advisors
- o SEDAPAL/Subgerencia de Pueblos Jovenes
- o Instituto de Investigacion Tecnologica Industrial y Normas Tecnicas (ITINTEC)

- o UNICEF/Peru
- o Obra Filantropica de Asistencia Social Adventista (OFASA)
- o Accion Comunitaria del Peru (ACP)
- o Catholic Relief Services (CRS)
- o CARE
- o Convenio Rural Melgar (Dutch Assistance)

This survey was not intended to be exhaustive but to provide a representative sample of the present use of handpumps and the interest in expanding their use in Peru. If a handpump program is to be carried out, it would be beneficial to include representatives of these organizations in the planning and, where their capability exists or can be developed, in the implementation of the program.

4.3 Demand for Handpumps

4.3.1 Potential Demand

Due to the lack of other sources of data, information listed in Table 2 was used to make a preliminary estimate of the potential use for handpumps in rural Peru. The total population in communities of less than 2,000 inhabitants is 8,150,000. It is estimated that only 1,260,000 have been provided potable water service by the GOP. This means that some 6,900,000 inhabitants do not have potable water service provided by the GOP through the MOH.

If each family is assumed to have five members, the number of unserved families would be approximately 1,380,000. If it was assumed also that one community-level handpump could serve 60 families adequately and that one third of the families would have other acceptable sources of potable water (capped springs, cisterns, etc.), some 15,000 handpumps would be needed. If two thirds of the families would have other acceptable supplies, some 7,500 pumps would be needed. The number of pumps required would probably increase as population increases and as replacement units are needed.

In order to determine more accurately the future need for handpumps, the alternative measures for improving rural water supply should be studied and the most cost-effective alternative should be identified. From this study the Mission and the GOP will be able to determine the number of handpumps that will be needed per year. If the number is large enough (e.g. more than 1,000 per year), consideration should be given to allocating funds to develop local manufacturing for the AID-design handpump in Peru. It would cost between $100,000 and $200,000 to develop the manufacturing capability and field test the locally-manufactured pump. In studying alternative water supply schemes it is important to consider the difficulties of well siting (due to often-scarce hydrogeological data), well drilling (due to the limitation on drill rigs and the cost of transporting them, especially in hilly terrain), equipment and material supply in rural mountainous areas (a difficulty for both well and gravity-fed systems), and the limitations of logistic and financial support for maintenance (a need at the local, regional and national levels that requires careful planning and constant monitoring).

4.3.2 Immediate Demand

- AID and MOH program managers have requested at least 50 to 100 handpumps for 1983 for the RWSES project.

- AID/Peru estimates that the Tingo Maria and Alto Huallaga rural development projects which it is sponsoring need about 100 handpumps for the next three years, with the possibility of expanding this number to about 300.

- UNICEF said it needs 140 handpumps, and there is a good possibility of expanding this number in 1983.

From the above, it can be seen that at least 275 handpumps appear to be needed for on-going programs according to AID, MOH and UNICEF program managers. This does not appear to be a sufficiently high number of pumps (which should be at least 1,000 per year) to justify the large expense of developing local capability to manufacture and market the AID handpump in Peru at the present time. Given the high cost of developing manufacturing capability and field testing the pump, it would require an expenditure of $350 to $750 per pump to satisfy this apparent need of 275 pumps with a locally-manufactured AID-design handpump. If a large number of pumps was needed, however, the initial investment of developing the manufacturing capability and field testing may end up representing from $5 to $30 per pump, assuming 7,500 to 15,000 pumps are needed.

There is a potential problem, however, in basing a decision to proceed with development of local manufacturing capability on these figures. The manufacturers selected for initial development would be chosen on the basis of their technical ability to produce the pump. The selection would not be based on open competition involving bids. A subsequent large order of pumps for a major program, however, would require that the manufacturer be selected by evaluation of bids. Although it may be possible to stipulate that only the manufacturers who had already demonstrated their ability to manufacture an acceptable AID design handpump would be qualified to bid, there may well be legal or political pressure exerted by other manufacturers for the GOP to forego such a stipulation. The other manufacturers may challenge it in court because of the closed procedure by which the "qualified" manufacturers were originally selected. Again, this points out the need for great care in the planning process before either a pilot or a full-scale handpump program is undertaken.

Chapter 5

MARKETING STUDY

5.1 Initial Study

In order to help guide the GOP in its decision as to the size and feasibility of the handpump market in Peru, the WASH team carried out a preliminary survey (see Chapter 4).

Although the results of the preliminary survey indicated a potential market in the RWSES program for about 1,000 handpumps per year, the market for the AID-design handpump can only be determined through a more detailed market study.

5.2 Proposed Scope of Work for Further Study

The following six areas should be investigated as part of a feasibility study of local marketing of the AID handpump:

1. The need (or demand) for the handpump.
2. The in-country manufacturing capability.
3. The institutional capability to carry out handpump programs.
4. The human resource capabilities for handpump programs.
5. The level of acceptance for handpumps in rural communities.
6. The capital and recurrent costs of handpump programs.

Each of the six areas is described in greater detail below.

5.2.1 Need

- o Determine areas where groundwater conditions are suitable for handpumps.
- o Determine number of villages in above areas which do not have handpumps now.
- o. Estimate number of villages and overall population of villages that would be candidates for future handpumps.

5.2.2 Local Manufacturing Capability

- o Determine cost of local manufacture of handpump.
- o Determine number of local companies with manufacturing capability at present.

- Estimate number of companies that could develop capability for local manufacture.

5.2.3 Institutional Capability

- Determine GOP agencies which currently have handpump programs.
- Determine past experience with handpumps in Peru.
- Assess GOP capabilities for new handpump programs in the following areas:
  - procurement
  - field promotion
  - construction/installation
  - operation and maintenance
  - training
- Indicate inputs necessary to strength GOP capabilities listed above.

5.2.4 Human Resource Capabilities

- Determine availability of skilled personnel for handpump programs, including technicians, supervisors, and administrators.
- Identify areas requiring more skilled personnel.
- Indicate inputs necessary to develop needed trained personnel.

5.2.5 Social Acceptance

- Determine the role of community organizations in past handpump programs.
- Determine capabilities of community organizations to carry out future programs.
- Assess acceptability of handpumps to communities, and to individual families.
- Assess degree of commitment of community organizations and individuals towards maintaining proper handpump usage.

5.2.6 Cost

- Estimate overall capital and recurrent costs of handpump program.
- Determine cost per handpump, showing proportion borne by GOP, by community, by AID (both capital and recurrent).
- Determine possible methods of financing handpump programs after completion of an AID assisted program.

- Identify likely importation requirements for local manufacturing.
- Estimate "willingness to pay" for handpumps in rural communities.

5.2.7 Recommendations

- Determine overall feasibility of successfully marketing the AID handpump and robo devices, with particular reference to above.
- Prepare recommendations for AID consideration regarding the manufacturing and marketing of AID handpumps and robo devices.
- Prepare a detailed scope of work for all above recommendations requiring action by AID.
- Develop a methodology for carrying out future manufacturing and marketing feasibility studies in other countries.

It is estimated that the above market study would require three weeks of an economist's time and two weeks of a sanitary engineer's.

The WASH team was able to thoroughly investigate the manufacturing aspects of a handpump program (Section 5.2.2). Therefore no further work is needed in this area. (See Chapter 7.) They were also able to estimate the cost of the handpump if it were to be manufactured in Peru.

Some of the important considerations in the other items were also investigated as time permitted, but additional study and analysis are needed before a sound decision can be made regarding the initiation of a pilot or a full-scale AID handpump program in Peru.

Chapter 6

INSTALLATION AND MAINTENANCE CAPABILITY

6.1 General

Generally, the objective of the design of handpump installations is to achieve the best possible combination of performance, useful life, and reasonable cost. Because of the striking differences in Peru's ecologic zones, however, optimum installation involves a variety of compromises, requiring a flexible approach in each zone.

6.2 Installation of Handpumps

Although DISAR is responsible for the design and construction of rural potable water systems, its experience in the installation of handpumps is minimal. Due to the population distribution in Peru, the installation of handpumps would present various challenges. Some of these challenges are discussed below for each ecologic or geographic region.

6.2.1 The Coast

The coast represents 11.2 percent of the country's land surface and is an extremely arid region where surface water resources are very limited in quantity and quality. In this region are found 74 percent of the urban population, 25 percent of the cultivated land and most of the country's industrial potential.

6.2.2 The Sierra

The Sierra represents 26 percent of the country's land surface. Topography is rough and presents complex technical problems for the development of water resources since hydrologic resources in the mountain ranges are neither permanent nor abundant. This region's mountainous terrain has 21 percent of Peru's urban population and 60 percent of its rural population, 56 percent of Peru's agricultural land, and most of the mining industry. The economic capacity of the Sierra's population is limited.

6.2.3 The Jungle

The jungle represents 62 percent of the country's land surface. Climatic conditions are harsh, accompanied by abundant vegetation and excessive amounts of water. Serious erosion problems occur throughout the area, and floods occur in the lowlands. This region contains five percent of Peru's urban population, 19 percent of its cultivated land, and all of its forestry industry. The problem in this area is not the lack of water but its quality, which is characterized by high concentrations of organic matter and color.

6.2.4 Technical Constraints

Obviously, each area presents unique constraints which should be carefully evaluated when selecting sites for the installation of handpumps. Hydrogeologic data for these sites should be gathered from the various government agencies to properly select those areas where handpumps should be installed (see Appendix D).

6.2.5 Responsibility

DISAR has a construction department which would be responsible for preparing the wells and installing handpumps with community participation. Currently, this department has limited manpower resources, but DISAR management stated that the resources can be increased as required. As stated earlier, this is an aspect of a potential handpump program that requires closer scrutiny. It usually is necessary to plan for staff, budget, and training well in advance of initiating a handpump program.

6.2.6 Installation Cost

The estimated cost of installing the AID handpump would be approximately US$600 per site exclusive of drilling costs ($200 for labor and $400 for materials).

Appendix C lists suppliers and prices of materials, and Appendix D discusses well drilling costs. At this time, DISAR is considering using only dug wells, however, so the well drilling costs are presented for background information only. While no information was available on the cost of dug wells, it is expected that they will be less expensive than drilled wells because of community participation. As experience has shown in other countries, however, it is important to carefully assess these costs before deciding to carry out a handpump program. As Appendix D indicates, drilled wells will be very expensive in the mountainous areas.

6.3 Maintenance of the Handpump

Proper installation of handpumps is important to ensure that the water supply is safe for human consumption. Proper maintenance, however, is equally important if the handpumps are to continue providing safe and sufficient water for an extended period of time. Since even the most rugged handpump needs maintenance, proper estimation of the cost of a maintenance program is advisable. Each well varies according to its depth, water quality, type of construction and hydrogeology. The greater the geographical area a handpump program covers, the greater will be the variety of problems to be overcome in implementing the program, especially if the handpump is to be used by several families.

The National Plan for Rural Potable Water in Peru was adopted for the purpose of designing and constructing potable water systems for rural communities. Operation and maintenance of these systems are the responsibility of the water committees in each community with back-up from the national authority as needed. However, reports indicate that a high percentage of the water systems built prior to 1980 are not operating because of inadequate maintenance. This is largely due to the GOP not having allocated sufficient funds for the maintenance of water and sanitation systems prior to 1979. In 1979 some funds began to be allocated. With the assistance of CEPIS, the MOH has now designed a maintenance program which includes training sessions in proper maintenance procedures for its engineers and technicians. Because of these more recent activities, DISAR management now thinks that it has a viable maintenance program, but it is still in the developmental stage with much remaining to be done to serve the entire country.

As there are no on-going, large-scale handpump programs, the team was not able to obtain actual costs for this important element of a handpump program.

In light of these past problems in maintaining rural water systems, it is important to monitor the success of the new CEPIS/MOH maintenance program and find out if it will be adequate to maintain handpumps as well as the systems now under its charge. An objective monitoring and evaluation program should be carried out for at least one year. The results of the evaluation should be used to decide whether there is a sufficiently high probability that handpumps would be maintained before a decision is made to carry out a handpump program. It has been said that the rural third world is a "graveyard for handpumps," because maintenance programs have not been up to the demanding task of keeping them operating. Careful initial planning could prevent Peru from being added to the list of failures.

Chapter 7

PUMP MANUFACTURING CAPABILITY

7.1 Initial Considerations

In order to determine potential in-country handpump manufacturing capabilities, several basic criteria were established. The first criterion was that, to be considered as a potential supplier of handpumps, a manufacturer would need both foundry and machine shop facilities. Experience has shown that foundries which have other machine shops do their machining or machine shops which have other foundries supply their castings do not have enough control over the complete product to assure consistent high quality.

The second criterion was that the rated manufacturing capacity of each company would be based on the existing facilities of land, buildings and machinery with the assumption that the factory operated on one eight-hour shift per day, five days per week. However, expansion potential was to be taken into consideration as part of the overall rating.

At the beginning of the WASH assignment AID/Peru indicated that the assessment should be limited to the three geographic areas where the AID-sponsored water program was being implemented. These were Trujillo in the north coastal area, Lima in the central coastal area and Cuzco in the southern mountain area. These three cities by no means contain the total manufacturing capability in Peru. If desired, other cities could be investigated at a later date.

As part of this study, suppliers were located and cost estimates obtained for special hardenable steel for pins and bushings, PVC pipe for pump cylinders, and specialty heat-treating services for hardening the pins and bushings. In addition to the iron castings these are some of the more important materials or services needed to manufacture the AID handpump.

7.2 Production Parameters

Production of the AID handpump involves two distinct phases. The first is the production of metal castings. The second is the machining of the castings and other purchased parts and subsequently assembling and testing them for proper performance.

Because of the high cost of developing local manufacturing capability, it would be worthwhile to embark on such a development effort only if a large number of pumps were to be produced. For the purpose of this study, therefore, production capability was evaluated for three levels of production:

- 1,000 handpumps per year
- 2,000 handpumps per year
- 5,000 handpumps per year

In order to compare the capability of the companies being investigated with the capability necessary to produce handpumps at these three rates certain production parameters were used. These parameters were based on the design of the AID handpump program and on extensive analysis of AID handpump manufacturing operations in other developing countries. Details of these production parameters are provided below.

7.2.1 Foundry

Normal production practice for small and medium sized foundries is to produce molten metal only one day per week. Usually from Monday through Thursday foundry activity consists of preparing the interior of the cupola (melting furnace) by cleaning out slag and debris and replacing any needed refractory lining. Sand molds are also prepared during this period. The sand molds are made by compacting moist sand around a pattern of the object to be cast. The molds are then separated into halves, the pattern is removed (leaving a cavity in its exact image) and then the halves are reunited. On Friday, scrap metal, limestone and coke are layered into the cupola, and the coke is ignited. Powerful blowers direct an air blast into the cupola, and the temperature rises to more than 2,500^{o}F, at which point both scrap metal and limestone melt. The limestone smelt acts as a fluxing (cleansing) agent and is discarded. The molten metal is then tapped and collected in crucibles and poured into the prepared sand molds. The metal solidifies into a replica of the pattern. During the melting process additional scrap metal, limestone and coke are added to the open top of the cupola in order to establish a continuous process of melting, tapping and pouring.

Production limitations in a foundry are primarily a function of cupola size (in kilograms of metal melted per hour) and floor space available in the mold pouring area.

Table 3 indicates some general foundry requirements based on the three levels of production that were considered.

7.2.2 Machine Shop

Most small and medium-sized machine shops have machine tools for cutting and removing metal such as the following:

- Power saws (band or power hack)
- Grinders (pedestal and hand-type)
- Milling machines (horizontal or vertical)
- Lathes (engine lathes with thread-cutting ability)
- Drills (pedestal-type)

The size of these machine tools varies considerably, depending upon the types of items produced. For purposes of this study the tools were categorized as small, medium, and large. Machine tools too small to be used on any of the pump components were omitted. For this study, machine shop capacity was

Table 3. Foundry Requirements

REQUIREMENTS	PRODUCTION LEVELS		
	1,000 pumps/yr	2,000 pumps/yr	5,000 pumps/yr
1. Total metal/year	60,000 kg/yr	120,000 kg/yr	3000,000 kg/yr
2. Metal/week	1,200 kg/wk	2,400 kg/wk	6,000 kg/wk
Metal/hr	120 kg/hr	240 kg/hr	600 kg/hr
(Based on 1 pour/week with a 10-hour work day).			
3. Equivalent Pumps/week	20 pumps/wk	40 pumps/wk	100 pumps/wk
(Based on 50/5-day work weeks with one pour/week).			
4. Molds/pour	120 molds/pour	240 molds/pour	600 molds/pour
Floor space required	720 ft^2	1,440 ft^2	3,600 ft^2
(Based on 6 molds/ equivalent pump and 6 ft^2 floor space/mold.			

determined using only three types of machine tools (lathes, milling machines, and drills) since these tools are critical for producing a quality AID hand-pump.

Production limitations in a machine shop depend primarily on size and number of these three types of machine tools. Based on analyses performed on pump component machining in a Honduran machine shop (see Appendix E) and on the three levels of production that were considered, Table 4 indicates minimum machine tool capacity. The table also assumes one eight-hour shift per day, a five-day work week, and a fifty-week work year which is equivalent to 2,000 person hours per machine per year.

7.3 Facility Evaluation

7.3.1 Methodology

Evaluation of the selected manufacturing facilities was based upon objective measurements of production ability and subjective observations of management effectiveness. The latter included an estimate of the ability to produce pumps of the desired quality and for a reasonable cost and each company's ability to manage effectively an operation which could meet all commitments of price, quality, and delivery schedules.

Four general categories were measured as follows:

1. Managerial and financial considerations
2. Foundry capabilities
3. Machine shop capabilities
4. Overall impressions

Each of these categories had several sub-categories which were given a weight factor of 1, 2 or 3 depending upon their relative importance to production and delivery of a quality pump at a reasonable cost within schedule constraints.

Each sub-category was scored on a scale of 0 to 10, with 10 being the highest possible score. This scoring was performed after thorough facility examination and discussions with each company's management. Scoring of production facilities was a composite of adequate production capacity and ability to produce a quality product, while managerial and financial scores were based on a subjective estimation of relative excellence. Appendix F presents the analysis format used for this study, including weight factors.

7.3.2 Scoring Criteria

Generally, the scoring scale of 0 to 10 indicated the following:

0	1	2	3	4	5	6	7	8	9	10
Unacceptable					Average					Excellent

Table 4. MACHINE TOOL REQUIREMENTS

Process	Production Levels		
	1,000 pumps/yr	2,000 pumps/yr	5,000 pumps/yr
1. Lathe Turning	3 1/2 lathes	7 lathes	17 1/2 lathes
7 man-hours/pump	7,000 man-hrs/yr	14,000 man-hrs/yr	35,000 man-hrs/yr
2. Lathe Threading	1 lathe	2 lathes	5 lathes
2 man-hours/pump	2,000 man-hrs/yr	4,000 man-hrs/yr	10,000 man-hrs/yr
3. Milling	1/2 mill	1 mill	2 1/2 mill
1 man-hour/pump	1,000 man-hrs/yr	2,000 man-hrs/yr	5,000 man-hrs/yr
4. Drilling	1 drill	2 drills	5 drills
2 man-hour/pump	2,000 man-hrs/yr	4,000 man-hrs/yr	10,000 man-hrs/yr

In assessing managerial and financial ability, all elements were scored subjectively.

In evaluating each company's foundry, most elements were scored subjectively. However, the lack of a cupola, lack of in-house pattern-making capability or lack of sand treatment facilities automatically produced a score of less than five.

Machine shop evaluations were based on objective criteria, with the lack of any machine tool listed resulting in a score of zero. The scoring in Table 5 was established for assessing machine shop capability.

Overall impressions of each company were also recorded, with all elements scored subjectively.

Table 5: Scoring Criteria

	Unacceptable					Average					Excellent
	0	1	2	3	4	5	6	7	8	9	10
Number of Saws	0					1		2			3
Number of Grinders	0		1			3			5		7
Number of Milling Machines	0					1		2			3
Number of Lathes	0		1			3		5		7	10
Number of Drills	0					1		3		5	7

7.4 Company Visits

7.4.1 Methodology

Six companies were selected for evaluation after 20 companies were initially contacted by telephone (see Appendix G). These six were selected because they expressed strong interest in making the AID handpump, they had both a foundry and a machine shop, and they were located in the geographical areas of interest to AID. These six companies were:

Fundicion Ventanilla	Lima
Fundicion Industrial S.R.L.	Lima
Fundicion Moreno	Lima
Fundicion Americana S.A.	Lima
Fundicion de Alejandro Rodriguez	Trujillo
Factoria Echegaray	Cuzco

During the company visits, information was obtained in the areas of management, foundry and machine shop. The format used for the Manufacturers' Data Sheet is presented in Appendix H.

Completed Manufacturers' Data Sheets formed the basis for each individual company's facility analysis and can be found in Appendix I.

7.5 Comparative Evaluation

7.5.1 Company Ranking

Table 6 compares the ratings for the six companies visited, and Table 7 shows the ranking of the companies according to their ability to produce the AID handpump at rates of 1,000, 2,000 and 5,000 per year.

Table 6: Company Rating

Company Name	Managerial Financial Rating A	Foundry Rating B	Machine Shop Rating C	Overall Impression Rating D	TOTAL (A+B+C+D)
Fundicion Ventanilla	71	163	191	49	474
Fundicion Industrial S.R.L.	75	187	119	40	421
Fundicion Moreno	90	181	190	52	513
Fundicion Americana S.A.	83	106	147	43	379
Fundicion Rodriguez	19	74	83	18	194
Factoria Echegaray	36	71	76	32	215

Table 7: Company Ranking

Companies in Descending Order of Rank	Ability to Produce 1,000 pumps/yr	2,000 pumps/yr	5,000 pumps/yr
1. Fundicion Moreno	Yes	Yes	Yes
2. Fundicion Ventanilla	Yes	Yes	No
3. Fundicion Industrial S.R.L.	No	No	No
4. Fundicion Americana S.A.	No	No	No
5. Factoria Echegaray	No	No	No
6. Fundicion Rodriguez	No	No	No

The evaluation was based on existing conditions and gives only slight consideration to each company's potential for expansion. By noting the apparent financial condition and the potential for expansion, a better idea can be obtained of the long range capability of each company. These items are presented in each company's facility analysis (see Appendix I).

Completed facility analyses formed the basis of the comparative evaluation and can be found in Appendix J.

7.6 Suppliers of Critical Components

Based on experience in other countries, small and medium-sized businesses often encounter difficulty trying to obtain special materials, special services or special components needed for the AID handpump. As part of this study, efforts were made to find suppliers and obtain prices for:

1) Medium carbon steel rod for pump pins and bushings which was capable of being direct hardened to ranges of Rockwell "C" 40 and Rockwell "C" 60, respectively;

2) Specialty heat treating for machined pins and bushings to the hardness ranges mentioned in (1);

3) Special-dimension PVC pipe for the pump cylinder liner;

4) Specially-extruded PVC tubing for producing roboscreen (a PVC well screen) from 2-inch to 6-inch diameter.

7.6.1 Medium Carbon Steel Rod

Several steel suppliers were contacted and two indicated a ready availability of AISI 1040 medium carbon, direct-hardenable steel rod. Information from the suppliers is presented in Table 8.

Table 8: Steel Suppliers

Company	Rod Size Available	Price
1. Aceros Especiales Boehler L. Castro Ron Ceros No. 777 (Cdra. 20 Av. Argentina) Telfs. 24-3687; 24-9306 Lima, Peru	5/8," 7/8," 1" O.D.	1,320 Soles/kg. ($.75/lb.)
2. Aceros Especiales ASSAB Arnaldo Marquez No. 539 Telfs. 23-9774; 23-3711 Lima, Peru	5/8," 7/8," 1" O.D.	1,500 Soles/kg. ($.85/lb.)

Note: Calculations based on exchange rate of S/. 800 = US$1.00

7.6.2 Specialty Heat Treating Service

Two specialty heat treating facilities were contacted with respect to direct hardening pins and bushings to Rockwell "C" 40 and Rockwell "C" 60. Information on these facilities is presented in Table 9.

Table 9: Heat Treating Facilities

Company	Weight Range	Price
1. Pernos Nacionales Av. Argentina No. 1630 Telf. 29-9109 Lima, Peru		120 Soles/kg. ($.07/lb.)
2. Pulvimetal S.A. Av. Arequipa No. 330 Telf. 31-6723 Lima, Peru	11-50 kg. 51-100 kg. 101-250 kg.	2,400 Soles/kg. ($1.36/lb.) 1,200 Soles/kg. ($.68/lb.) 1,000 Soles/kg. ($.57/lb.)

Note: Calculations based on an exchange rate of S/. 800 = US$1.00

7.6.3 PVC Tubing for Pump Cylinders and Roboscreen

Roboscreen is a helically-slotted, internally-ribbed PVC well screen (strainer) developed at the International Rural Water Resources Development Laboratory (IRWRDL) at the University of Maryland under World Bank sponsorship. It was developed by Professor Ron Sternberg and Mr. Bob Knight, hence its name. Its principal advantage over other plastic well screens is its larger proportion of open area which permits more free movement of water and less clogging of the screen.

Several PVC tubing suppliers were contacted for producing non-standard PVC tubing. Non-standard PVC tubing for cylinder liners must have an inside diameter of 2.75 inches to accomodate a standard AID handpump piston. The PVC tubing must have an outside diameter of 3.068 inches in order for it to be forced into a standard 3-inch Schedule 40 steel pipe. Non-standard PVC tubing for roboscreen conforms to standard 3-inch Schedule 40 PVC tubing, except for eight internal ribs equally spaced on the internal surface of the tube and parallel with its axis. See Appendix K for further details on roboscreen specifications. Two manufacturers indicated they could supply the tubing, and discussions were conducted with them concerning their capability to produce these items and the estimated cost of doing so. The information obtained is presented in Table 10.

Special plastic tubing for roboscreen is further machined to produce the helical slots around its circumference. This machining can be performed by any quality machine shop equipped with a thread-cutting engine lathe with 6-inch swing over center and a 60-inch bed. Special machining fixtures and techniques have been developed in Honduras which make this possible. See Appendix L for further details.

Table 10: PVC Manufacturers

Company Name	Price Estimates
1. Tuboplast S.A. Esq. Calles B y D Urb. Industrial Sta. Rosa, Ate Telf. 24-2442 Lima, Peru	3" Slotted PVC Roboscreen Tooling Charge S/. 500,000 ($0.21/ft) Product S/. 9,000/m ($3.43/ft) Total Cost (3,000' lots) $3.65/ft. PVC Cylinder Liner Tooling Charge S/. 2,000,000 ($.83/ft) Production S/. 2,300/m ($.88/ft) Total Cost (3,000' lots) $1.63/ft.
2. Plasticos Fort. S.A. Los Claveles No. 155 Urb. Valdivieso, Ate Telf. 31-3005 Lima, Peru	3" Ribbed PVC Tube for Roboscreen Unslotted S/. 5,000/m ($1.91/ft) Slotted S/. 15,000/m ($5.72/ft) Total Cost (3,000' lots) $5.72/ft. PVC Cylinder Liner 3.068" O.D. 2.75" I.D. - S/. 3,000/m ($1.14/ft) Total Cost (3,000' lots) $1.14/ft.

Note: Calculations based on exchange rate of S/. 800 = US$1.00

7.7 Estimating Pump Cost

7.7.1 Background

Each company has its own methods for determining the manufacturing costs of its products and arriving at a reasonable selling price. Generally, the following elements of cost are common to almost all manufacturing companies.

- Direct material costs
- Indirect material costs
- Direct labor costs
- Indirect labor costs
- Managerial and technical salaries
- Fringe benefits
- Governmental programs
- Energy costs
- Land, building, and equipment depreciation costs
- Financing costs

Some of these items, such as management salaries and fringe benefits, are often lumped together and called overhead. Once an appropriate ratio has been determined, overhead is often charged as a percentage of either direct labor, direct material, or some other cost element which the company has found gives a good correlation. After the company has accounted for all costs, it adds what it considers to be a reasonable profit.

The sum of manufacturing cost, overhead, and profit is the selling price. A potential customer for handpumps should avoid a commitment to a manufacturer with a price which is unrealistically low just as much as he or she should avoid a manufacturer whose price is too high.

7.7.2 Handpump Pricing in Peru

It is impossible for an outsider to determine a pump manufacturer's selling price without the confidential information known only to the manufacturer. However, an estimated price range can be determined prior to bid submission. An estimate was made based on a gray iron casting cost of $0.40/lb.,[1] a direct labor cost of $1.10/hr.[2] and a cost of materials and accessories (including nuts, bolts, pump leathers, pins and bushings) of approximately $55.00.[3] From a labor analysis of pump manufacturing in Honduras, it was found that approximately 18 man-hours were required in direct labor to produce an AID handpump. See Appendix E.

The estimate is itemized as follows:

Castings - Approx. 125 lb @ $.40/lb.	$ 50.00
Direct Labor - Approx. 18 man-hr @ $1.10/hr	$ 20.00
Other Materials and Accessories	$ 55.00
Manufacturing Cost	$125.00
Overhead (50 Percent Manufacturing Cost)	$ 63.00
Manufacturing Cost Plus Overhead	$188.00
Profit (10 Percent of Total Cost)	$ 19.00
Total Cost per Pump	$207.00

If a 10 percent margin of error is assumed, then the anticipated range of prices for the AID handpump manufactured in Peru would be $185.00 to $225.00 per pump. The average cost per pump would be approximately $207.00.

The average estimated cost of $207.00 compares favorably with the price of AID handpumps manufactured in some other countries ($250 in Honduras, $240 in Tunisia and $257 in Ecuador). It is in the same approximate price range as the AID handpump in Sri Lanka ($180) and the Dominican Republic ($210). It also compares favorably with the U.S.-made Dempster 210F handpump ($250 F.O.B. Nebraska, U.S.A.) and the U.S.-made Moyno rotary handpump ($575). Price, however, is not the only advantage of local manufacture of the AID handpump. Other advantages are shortened delivery time, elimination of the time and expense of clearing imported pumps through customs, ready availability of spare parts, development of local manufacturing capability, creation of local jobs, and avoidance of an additional burden of foreign debt.

1 Average cost of gray iron castings obtained during company visits.
2 Average direct labor wages obtained during company visits.
3 Cost estimate based on cost of tool steel, heat treating, etc.

Chapter 8

CONCLUSIONS AND RECOMMENDATIONS

8.1 Conclusions

The high incidence of water-related morbidity and mortality in rural areas makes it necessary to improve rural water supplies in Peru.

From information gathered during interviews with various organizations in Peru, it is evident that there is widespread interest in having a locally-manufactured handpump in Peru. Lack of time and resources, however, did not allow the WASH team to quantify the need for a handpump.

Extensive interviews with members of the DISAR indicated that the planned infrastructure would be capable of supporting the installation and maintenance of handpumps throughout most of Peru. Experience has shown, however, that rural water systems in Peru have not been maintained in the past.

An intensive investigation of a small portion of Peru's foundries, it was determined that there is in-country manufacturing capability to produce at least 5,000 high quality AID handpumps per year at an estimated price of US$207 apiece.

The investigations of the WASH team clearly showed that there is both a need to improve rural water supplies in Peru and a capability and willingness to establish a handpump manufacturing program in the country. Further investigations are required, however, to determine the commercial feasibility of establishing such a program in Peru.

8.2 Recommendations

8.2.1 In-Depth Marketing Study Background

Before deciding whether to initiate a handpump program in Peru, the GOP and AID need to make a careful study of rural water supply needs in order to determine the number of handpumps that will be required to satisfy the needs. The WASH team was able to carry out a preliminary effort, but a more in-depth effort is needed to decide how best to improve rural water supplies and how the AID handpump would figure in these improvements.

Recommendation

The AID Mission in Peru should carry out the marketing study outlined in Chapter 4 in order to complete the data required to evaluate the need for an AID-design handpump.

8.2.2 Pilot Program Background

Experience in several developing countries has shown that considerable time, energy and money can be wasted by building handpumps that are not needed or wanted or which have little or no role to play in on-going or future programs. Careful preliminary study and planning usually save resources and result in more efficient and effective programs because problems are defined, obstacles are identified, and solutions are tailored to the real situation. Too often in the past, familiar solutions have been implemented and attempts have been made to describe reality to fit them. Hardware often ends up being proposed to solve what are basically software problems.

If the marketing study recommended above indicates that a large enough number of handpumps is needed (e.g. 1,000 or more per year) and that there is no other handpump in Peru that would satisfy this need, a pilot AID handpump program should be considered. Such a pilot program would help identify the problems that may exist with the locally-manufactured AID handpump, its acceptance, its maintenance or its manufacture that could not have been, or were not, foreseen during the preliminary study. The pilot program would consist of the selection of one or more manufacturer(s) for AID handpumps and roboscreen, the placing of a relatively small production order for 100-200 handpumps and 300 feet of roboscreen, and technical assistance to the manufacturer(s) in manufacturing and quality control techniques. The manufactured handpumps and roboscreen would then be installed in one or more rural areas where they could be field tested to discover manufacturing defects, where performance data could be gathered and fed back to the manufacturer(s) and program managers for tightening of quality control, and where the appropriateness and user acceptance of handpumps could be determined more definitely. The pilot program would also provide an opportunity for training government engineers and technicians in proper well development, water disinfection, water quality analysis, and handpump installation, maintenance, and repair. At the conclusion of the pilot program the overall feasibility and advisability of using the AID handpump in a large-scale rural water supply program could be decided.

Recommendation

If the study proposed in Section 8.2.1 demonstrates the feasibility of marketing a large enough number of AID-design handpumps (e.g., about 1,000 per year), it is suggested that AID/Peru consider a 12- to 18-month field test of a small number (100 to 200) of locally-manufactured AID-design handpumps.

APPENDIX A

WATER AND SANITATION FOR HEALTH (WASH) PROJECT
ORDER OF TECHNICAL DIRECTION (OTD) NUMBER 114
September 8, 1982

TO: Dr. Dennis Warner, Ph.D., P.E.
WASH Contract Project Director

FROM: Mr. Victor W. R. Wehman Jr., P.E., R.S. VWW
AID WASH Project Manager
AID/S&T/H/WS

SUBJECT: Provision of Technical Assistance Under WASH Project Scope of Work for USAID/Peru for Assessment and Evaluation of the Feasibility of Local Manufacture of the AID Handpump in Peru

REFERENCES: A) Lima 8852, dated 31 Aug 82
B) State 239651, dated 26 Aug 82
C) Lima 8482, dated 18 Aug 82

1. WASH contractor requested to provide technical assistance to USAID/PERU as per Ref. C, para 2.

2. WASH contractor/subcontractor/consultants authorized to expend up to 42 person days of effort over a 3 month period to accomplish this technical assistance effort.

3. Contractor authorized up to 34 person days of international/domestic per diem to accomplish this effort.

4. Contractor to coordinate with LAC/DR/HN (P. Feeney), LAC/DR/ENGR (R. MacDonald), and Peru Desk Officer and should provide copies of this OTD along with any periodic progress reports and ETAs as requested by S&T/H or LAC Bureau.

5. Contractor authorized to provide up to two(2) international round trips from consultants home-base through Washington D.C. to Lima Peru and return to Washington D.C. for debriefing to consultants home base.

6. Contractor authorized local travel within Peru NTE $600 without the prior written approval of the AID WASH Project Manager.

7. Contractor authorized to obtain secretarial, graphics or reproduction services in Peru as necessary and appropriate to accomplish scope of work NTE $400 without the prior written approval of the AID WASH Project Manager.

8. Contractor/subcontractor authorized to purchase up to two deep well AID handpumps locally manufactured in Honduras and ship them by air to the USAID in Peru for use as cost estimating prototypes in obtaining cost estimates in a timely fashion from Peruvian local manufacturers. These handpumps would be left with the USAID in Peru for further reference in regard to technical specifications. These handpumps should not be installed in any field sites without the written permission of the AID WASH project manager. Contractor authorized NTE $950 for this paragraph activity without the prior written approval of the AID WASH Project Manager.

9. Contractor authorized to provide for car/vehicle rental if necessary to facilitate effort. Mission is encouraged to provide mission vehicles, if available and appropriate.

10. WASH contractor will adhere to normal established administrative and financial controls as established for WASH mechanism in WASH contract.

11. WASH contractor should definitely be prepared to administratively or technically backstop field consultants and subcontractors.

12. Contractor/subcontractor should definitely provide USAID/PERU with a coordinated draft final report before leaving country. Report to be provided to Mr. Paul White--contact for contractor in USAID/PERU. Final report due S&T/H/WS within 30 days of return of consultants to the U.S.

13. New procedures concerning subcontractor cost estimates and consultant justification remain in effect.

14. Mission should be contacted immediately and technical assistance initiated as soon as possible or convenient to USAID/Peru. Note: team has country clearance for Peru for period 4-19 Oct 82. S&T/H/WS (Wehman) will be in country on other activities during period 12-18 Oct 82. Can coordinate with this team and mission on this technical assistance effort.

15. Appreciate your prompt attention to this matter. Good luck.

ACTION COPY

Department of State

INCOMING TELEGRAM

PAGE 01 LIMA 08852 311628Z 3506 030275 AID132

ACTION AID-00

ACTION OFFICE STHE-01

INFO LAEM-02 LASA-03 LADP-03 LADR-03 SAST-01 RELO-01 MAST-01
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FM AMEMBASSY LIMA
TO SECSTATE WASHDC 4348

UNCLAS LIMA 8852

AIDAC

EO 12356: N/A

SUBJ: CONSULTATION OF RURAL WATER SYSTEMS AND ENVIRONMENTAL SANITATION PROJECT (527-U-074)

REF: LIMA 8482, STATE 239650, SSTATE 239651

1. CONCUR WEHMAN CONSULTATION VISIT O/A 12 OCTOBER. LOCAL PERU TRAVEL COSTS WILL BE PROVIDED BY MISSION.

2. ALSO CONCUR 4-~~14~~ 19 OCTOBER VISIT OF HANDPUMP ASSESSMENT TEAM.

3. REQUEST TWO-THREE WASH HANDBOOK FEASIBILITY STUDY REPORTS FOR REVIEW PRIOR TO ARRIVAL OF TEAM.
ORTIZ

UNCLASSIFIED

Department of State

OUTGOING TELEGRAM

WASH Proj. DIR

PAGE 01 STATE 239651 3540 025024 AID6734
ORIGIN AID-00

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INFO LAEM-02 LASA-03 LADP-03 LADR-03 SAST-01 RELO-01 MAST-01
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DRAFTED BY AID/ST/H: VWEHMAN: GT
APPROVED BY AID/ST/H: CAPEASE
AID/ST/H: F. MCJUNKIN--DRAFT
AID/LAC/DR: P. FEENEY--INFO
AID/LAC/DR: R. MACDONALD--INFO
AID/LAC/SA: W. RHODES--PHONE
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P 260115Z AUG 82
FM SECSTATE WASHDC
TO AMEMBASSY LIMA PRIORITY

VIC

UNCLAS STATE 239651

ADM AID PASS TO P. WHITE

E.O. 12356: N/A
TAGS:
SUBJECT: EVALUATION OF FEASIBILITY OF LOCALLY MANUFACTURED AID HANDPUMPS IN PERU

REF: LIMA 8482, DTD 18 AUG 82

1. ST/H/WS PLEASED TO PROVIDE SERVICE REQUESTEDPER REFTEL SUGGEST TIME PERIOD FORASSESSMENT TEAM TO BE 4-19 OCT 82.

2. REFERENCE PARA 3 OF REFTEL, THIS TDY SERVICE WILL BE PROVIDED TO USAID AT NO COST TO MISSION USING ST/H/WS RESOURCES. THE TEAM DOING THE ASSESSMENT AND EVALUATION HAVE DONE SIMILAR WORK IN 12 COUNTRIES DURING THE PAST 5 YEARS, INCLUDING ECUADOR (CONTACT KEN FARR, USAID/QUITO FOR INFO).

3. ST/H/WS APPRECIATES INTEREST OF USAID/LIMA IN THIS PUBLIC HEALTH, TECHNOLOGY TRANSFER AND PRIVATE SECTOR INITIATIVE. CONTACT INST/H/WS IS VIC WEHMAN (703-235-9823) FOR ANY FURTHER QUESTIONS. SHULTZ

Received ST/H (Wehman) 8-30-82
Passed to WASH 8-30-82

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Department of State
INCOMING TELEGRAM

PAGE 01 ...MA 08482 182244Z 6679 020044 AID1040
ACTION AID-00

ACTION OFFICE LASA-03
INFO PPCE-01 PDPR-01 PPPB-03 STHE-01 SAST-01 HHS-09 RELO-01
MAST-01 /021 A5 1219

INFO OCT-00 INR-10 EB-08 ARA-16 AMAD-01 /070 W
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R 182040Z AUG 82
FM AMEMBASSY LIMA
TO SECSTATE WASHDC 4182

UNCLAS LIMA 8482

AIDAC

EO 12356: NA
SUBJ: EVALUATION OF FEASIBILITY OF LOCALLY MANUFACTURED HANDPUMPS IN PERU

1. COUNTERPARTS IN MINISTRY OF HEALTH HAVE EXPRESSED INTEREST IN AN ON-GOING PROGRAM IN ECUADOR AND HONDURAS FOR LOCAL MANUFACTURE OF HANDPUMPS.

2. MISSION UNDERSTANDS THAT ASSISTANCE AND EVALUATION INTO THE FEASIBLITY OF LOCAL MANUFACTURE AND MARKETING OF AID HANDPUMP AND ROBO-DEVICES CAN BE OBTAINED THROUGH WASH PROJECT.

3. PLEASE ADVISE IF THIS SERVICE IS AVAILABLE AT NO COST TO MISSION AND IF SO, WHEN A TEAM COULD BE SENT TO DONCUT THE STUDY. ESTIMATE THAT SUCH A STUDY COULD BE CARRIED OUT IN PERU BY TWO TECHNICIANS IN FIFTEEN DAYS.

4. PLEASE ADVISE.
ORTIZ

WASH Proj Dir.

McJunkin
Austin
~~Wehman~~

Pass to P. Potts (677)

Received ST/H (Wehman) 8-19-82
Passed to WASH 8-19-82

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WATER AND SANITATION FOR HEALTH (WASH) PROJECT
ORDER OF TECHNICAL DIRECTION (OTD) NUMBER 114
Amendment No 1
14 October 1982

TO: Dr. Dennis Warner, PhD, PE
WASH Contract Project Director

FROM: Mr. Victor W R Wehman Jr, PE, RS
AID WASH Project Manager
AID/S&T/WS

SUBJECT: Provision of Technical Assistance Under WASH Project Scope of Work for USAID/Peru for Assessment and Evaluation of the Feasibility of Local Manufacture of the AID Handpump and Roboscreen in Peru

REFERENCES: A) OTD # 114 dated 8 Sept 1982

1. Paragraph 2 of subject OTD # 114 (Ref A) is cancelled. New paragraph 2 of subject OTD # 114 is now to read as follows:

"2. WASH contractor/subcontractor/consultants authorized to expend up to 50 person days of effort over a three (3) month period to accomplish this technical assistance effort."

2. Paragraph 3 of subject OTD # 114 (Ref A) is cancelled. New paragraph 3 of subject OTD # 114 is now to read as follows:

"3. Contractor authorized up to 42 person days of international/domestic per diem to accomplish this effort."

3. New paragraph 16 to OTD # 114 (Ref A) is authorized as follows:

"16. Contractor/subcontractor/consultants authorized to investigate feasibility of local manufacture of Roboscreen in Peru as per request from mission in Lima 8482 dated 18 Aug 1982 in addition to assessment described in para 8 of Ref A."

4. Nothing follows:

WATER AND SANITATION HEALTH (WASH) PROJECT
ORDER OF TECHNICAL DIRECTION (OTD) NUMBER 114
AMENDMENT NUMBER 2
November 29, 1982

Camp, Dresser & McKee, Inc.
WASH PROJECT

DEC 01 1982

TO: Dr. Dennis Warner, Ph.D., P.E.
WASH Contract Project Director

FROM: Victor W.R. Wehman, Jr., P.E., R.S. VWW
AID WASH Project Manager
AID/S&T/H/WS

SUBJECT: Provision of Technical Assistance Under WASH Project Scope of Work for USAID/Peru for Assessment and Evaluation of the Feasibility of Local Manufacture of the AID Handpump and Roboscreen in Peru.

REFERENCE: A) OTD #114, dated 8 Sept 1982

1. Para. 2 of subject OTD #114 (Ref. A) is cancelled. New para. 2 of subject OTD #114 is now to read as follows:

"2. WASH contractor/subcontractor/consultants authorized to expend up to 78 person days of effort over a four (4) month period to accomplish this technical assistance effort."

2. Para. 3 of subject OTD #114 (Ref. A) is cancelled. New para. 3 of subject OTD #114 is now to read as follows:

"3. Contractor authorized up to 47 person days of international/domestic per diem to accomplish this effort."

3. Note: USAID/Lima Representative (Mr. Paul White) indicated to S&T/H/WS (V. Wehman) that a draft and final report in both English and Spanish would be required because so few of the DISAR and MOH personnel read technical English. Both field draft and final report are to be prepared in English and Spanish.

4. Nothing follows.

WATER AND SANITATION FOR HEALTH (WASH) PROJECT
ORDER OF TECHNICAL DIRECTION (OTD) NUMBER 114
AMENDMENT NO. 3
23 January 1983

TO: Dr. Dennis Warner, Ph.D., P.E.
WASH Contract Project Director

FROM: Mr. Victor W.R. Wehman Jr., P.E., R.S.
AID WASH Project Manager
AID/S&T/H/WS

SUBJECT: Provision of Technical Assistance Under WASH Project Scope of Work for USAID/Peru for Assessment and Evaluation of the feasibility of Local Manufacture of the AID Handpump and Roboscreen in Peru

Reference: A) OTD # 114, dated 8 Sept 1982

1. Para 2 of subject OTD # 114 (Ref A) is cancelled. New para 2 of subject OTD # 114 (Ref A) is now to read as follows:

"2. WASH contractor/subcontractor/consultants authorized to expend up to 80 person days of effort over a eight (8) month period to accomplish this technical assistance effort."

2. Nothing follows.

APPENDIX B

Summary of the Interviews of Organizations Involved in Public Assistance

INTERVIEW

ORGANIZATION	:	ACCION COMUNITARIA DEL PERU
ADDRESS	:	Av. Republica de Chile N° Lima, Peru
DATE OF INTERVIEW	:	October, 1982
TELEPHONE	:	28-1950 & 32-8630
PERSON INTERVIEWED	:	Mr. Manuel Montoya Larios, Director

Mr. Montoya stated that his organization has a great deal of interest in hand pumps. They have their own technical staff, which designs their systems. The organization conducts training programs, promotion activities and health education to small communities. They could use the AID hand pump in at least 30% of their projects. However, they are interested in knowing how high the hand pump can pump. One of the applications they would be interested in is pumping to elevated tanks between 30 to 40 meters high from the ground level. If this is possible, they would have many locations where they could use the AID hand pump. However, he stated that there were also ground-level sites where his organization could use this hand pump.

INTERVIEW

ORGANIZATION	:	SEDAPAL SUBGERENCIA DE PUEBLOS JOVENES
ADDRESS	:	Ave. Monterrey N° 281, 2° Piso, Chacarilla Lima, Peru
DATE OF INTERVIEW	:	October, 1982
TELEPHONE	:	36-8783
PERSON INTERVIEWED	:	Engr. Marcela Vasquez de Salazar

This organization is in charge of providing technical assistance to "Pueblos Jovenes" (Squatters). They do not finance any projects. Any equipment is procured by the inhabitants of these communities. However, she will pass the word about the AID hand pumps. At present, she was not aware of any current project that would need hand pumps.

INTERVIEW

ORGANIZATION	:	OBRA FILANTROPICA DE ASISTENCIA SOCIAL ADVENTISTA (OFASA)
ADDRESS	:	Av. Angamos Oeste N° 770-Miraflores Lima, Peru
DATE OF INTERVIEW	:	October, 1982
TELEPHONE	:	46-9032
PERSON INTERVIEWED	:	Mr. Dwight Taylor, Director

Mr. Taylor conducts a project in Arequipa, Peru, where he may use several AID hand pumps. He did not know the exact number. However, he looked at the pump and liked it. He feels that manufacturing the pump in Peru would be great. Presently, his organization is involved in gravity water supply systems for small communities. In the past, they have prepared open dug wells and therefore have the experience in water well development.

His organization does not have its own technical staff. Technical expertise is usually obtained from Universities and volunteers. However, they do have their own technicians. Funding comes both from governments and private donations. Mr. Taylor would like to see AID publish a small brochure about the AID hand pump that can be distributed to other interested groups.

INTERVIEW

ORGANIZATION	:	COOPERACION POPULAR
ADDRESS	:	Lima, Peru
DATE OF INTERVIEW	:	October, 1982
TELEPHONE	:	24-6493
PERSON INTERVIEWED	:	Ing. Rafael Martinelli

The organization handles primarily food for poor areas. It does not engage in water supply programs.

INTERVIEW

ORGANIZATION	: INSTITUTO DE INVESTIGACION TECNOLOGICA INDUSTRIAL Y NORMAS TECNICAS (ITINTEC)
ADDRESS	: S/n Morelli y Av. Las Artes Dpto de Energia Lima, Peru
DATE OF INTERVIEW	: October, 1982
TELEPHONE	: 40-1040
PERSONS INTERVIEWED	: Ing. Alejandro Vega & Ing. Alfredo Oliveros

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Engr. Alfredo Oliveros is the Energy Division Director. He said that they already knew about the AID hand pump. ITINTEC is a Peru federal government institution involved in technical development of non-conventional sources of energy in rural areas. They are interested in a locally-manufactured hand pump but did not know the exact need for hand pumps in rural Peru. He stated that there is a need for a good reliable locally-manufactured hand pump in Peru.

Engr. Oliveros said that he knew of two groups which have had experience with hand pumps in Puno. One group, called "Convenios Rural Melgar," is sponsored by a Dutch Mission headed by Mr. Witt Hansen. This group has developed a hand pump for their program. The pump is made of plastic and is supposed to be very simple. The price of this pump is about S/.80,000 ($100.00) and apparently can pump to a depth of 30 meters. Mr. Hansen's tel. No. is 115 in Ayaviri, Puno; and his address is: Convenios Rurales Melgar, Apartado 5, Ayauiri, Puno, Peru. ITINTEC has not tested this pump.

INTERVIEW

ORGANIZATION : CARE

ADDRESS : Lima, Peru

DATE OF INTERVIEW : October, 1982

TELEPHONE : 40-0589 & 40-0591

PERSON INTERVIEWED : Mr. Timothy Labelle & Engr. Marco Campos

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Mr. Labelle had seen the AID hand pump in Nicaragua and was familiar with it. At present, all their water supply projects are piped systems using gravity-feed methods. They do not have an immediate need for hand pumps. However, they are interested in considering hand pumps, especially if the AID hand pump is manufactured in Peru.

Mr. Labelle and Mr. Campos visited the AID/Peru office and looked at the AID pump. They were interested in considering it for their future water supply programs.

INTERVIEW

ORGANIZATION	:	AID/Peru-Special Projects
ADDRESS	:	Av. Espana N° 386 Lima, Peru
DATE OF INTERVIEW	:	October, 1982
TELEPHONE	:	28-6200, Ext. 446, 439
PERSON INTERVIEWED	:	Ms. Veronica de Ferrero Director

This AID Division has a very limited budget. It can only fund projects up to $5,000. The request for a project must come from local people or groups, which generally provide all the labor. The money obtained from AID is usually used for equipment or materials.

Ms. De Ferrero said there is a great need for hand pumps which are locally manufactured. The basis for this statement is her experience in working extensively with rural communities. She said that frequently rural communities send representatives to her office requesting technical and financial assistance in developing their water supply. Most of these communities are in remote areas. She will notify other groups about the AID hand pump.

While currently none of her projects require hand pumps, Ms. De Ferrero related that a community in Piura had purchased two hand pumps, a Bane and a Ucelli from Holland two years ago and is still trying to get them out of customs. For this reason and others, Ms. De Ferrero stated strongly that locally manufactured hand pumps are badly needed in Peru.

Based on her knowledge of the need for water supply, she believes that once the small communities begin to know about a locally manufactured water hand pump, a good demand will develop.

INTERVIEW

ORGANIZATION	:	CENTRO PANAMERICANO DE INGENIERIA SANITARIA
ADDRESS	:	Los Pinos N° 259 Detras del Colegio Rooseveltt, pasando la Universidad de Lima Lima, Peru (Camacho)
DATE OF INTERVIEW	:	October, 1982
TELEPHONE	:	35-4135, Anexo 33
PERSON INTERVIEWED	:	Dr. Carl Bartone, Programs Coordinator

At present CEPIS is not involved in projects which could use hand pumps. However, based on Dr. Bartone's experience and knowledge of the needs for water supply in rural Peru, he believes that a locally manufactured hand pump is badly needed. They hope to become involved in hand pump projects in the future.

INTERVIEW

ORGANIZATION	:	CATHOLIC RELIEF SERVICES
ADDRESS	:	Esquina Gamma y Omicron N° 492 Lima, Peru
DATE OF INTERVIEW	:	October, 1982
TELEPHONE	:	51-0765
PERSON INTERVIEWED	:	Mr. Lynn Renner, Director

Mr. Renner examined the AID hand pump and is very interested in using it. He has two projects where he may use the AID hand pump, if it is locally manufactured. However, at this time, he does not know how many pumps would be needed. He stated that he knows of communities where people may be very interested in this type of hand pump. His organization will notify as many groups as it can reach about the AID hand pump. He believes, based on his experience and knowledge of Peru's rural poor need for water supply, that the AID hand pump, once manufactured in Peru, will have an excellent demand.

INTERVIEW

ORGANIZATION	:	AID/Peru-Rural Development
ADDRESS	:	Av. Espana N° 386 Lima, Peru
DATE OF INTERVIEW	:	October, 1982
TELEPHONE	:	28-2600, Ext. 407
PERSON INTERVIEWED	:	Mr. Jack Rosholt and Mr. Bill Sugru

Mr. Rosholt has two projects, one in Tingo Maria and the other in Alto Huallage, which have an immediate need for 85-100 pumps over the next two years with a good possibility of extending the demand to about 300. However, the projects would require technical assistance to install the first 15-20 hand pumps in dug wells prepared by the community.

INTERVIEW

ORGANIZATION	:	UNICEF
ADDRESS	:	Parque Meliton Porras N° 350 - Miraflores
DATE OF INTERVIEW	:	October, 1982
TELEPHONE	:	45-7046
PERSON INTERVIEWED	:	Dr. Javier Toro, Ms. Nora Padilla and Mr. Pedro Nunez

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Dr. Toro is the Director in Peru. UNICEF is extremely interested in the AID hand pump because it has an immediate need for hand pumps in Peru, Paraguay, and Bolivia.

UNICEF is sponsoring a manufacturing/training center in Chucuito, Puno, Peru, which Dr. Toro said could get involved in training of personnel in installation of the hand pump or even manufacturing. Their immediate need for hand pumps is about 150-200 pumps initially for Puno, Ancash, Cuzco and the Altiplano Boliviano.

They believe that the manufacturing of the AID hand pump in Peru would be an excellent idea. They also think this hand pump is very simple, but the technology transfer package accompanying the AID hand pump program is the feature UNICEF likes best. By technology transfer package Dr. Toro refers to training local nationals to manufacture, install, operate and maintain this pump.

INTERVIEW

ORGANIZATION	:	UNDP
ADDRESS	:	Av. Central N° 643 Lima, Peru
DATE OF INTERVIEW	:	October, 1982
TELEPHONE	:	41-8735 & 41-9135
PERSON INTERVIEWED	:	Sr. Isaia Gomez, Information Representative

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UNDP does not have water projects in Peru. However, Mr. Gomez said that based on their experience in Peru with water supply organizations a good local hand pump is badly needed and he was glad USAID and Peru Ministry of Health were doing something about it.

APPENDIX C

Selected List
of Suppliers and Materials

SELECTED LIST OF SUPPLIERS

Galvanized Drop Pipe (1-1/4")

- SAPCO
  Av. Elmer Faucet N° 444
  Lima, Peru
  Telf. 51-8777

  Price: S/. 16,250 ($20.31) + 16% tax (Pieces of 6.4 meters)

- JORGE MERE, S.A.
  Av. Colonial N° 2475
  Lima, Peru
  Telf. 52-270
  Price: S/. 21,527 ($26.91) + 16% tax (Pieces of 6.4 meters)

Steel Rod (9/16" or 1/2")

- ACEROS ESPECIALES ASSAB
  Av. Arnaldo Marquez N° 539
  Lima, Peru
  Telf. 23-9774
  23-3711

  Prices: 9/16" Steel Rod S/. 8,250 ($10.31) + 16% tax (Pieces of 6 meters)
  1/2" Steel Rod S/. 6,400 ($8.00) + 16% tax (Pieces of 6 meters)

- ACERO PERUANO S.A.
  Av. Victor Reynel N° 150-198
  Cdra. 20 Av. Argentina
  Lima, Peru
  Telf. 52-1874
  52-1999

  Price: 9/16" Steel Rod (Do not have)
  1/2" Steel Rod S/. 6,700 ($8.38) + 16% tax (Pieces of 6 meters)

Cement

Price: S/. 2,800/sac, $3.50/sac (FOB Lima w/taxes included)

Sand

Price: S/. 4,500/cubic meter, $5.63/m^3 (FOB Lima w/taxes included)

Gravel

Price: S/. 7,500/cubic meter, $9.38/m^3 (FOB Lima w/taxes included)

APPENDIX D

Selected List
of Drillers and Drilling Costs

DRILLERS

PERFORADORA ANDINA
Av. Jiron Jose Diaz N° 258, Of. 502
Lima, Peru
Telf. 31-3886
Engr. Augusto Torres

PERFORADORA PERUANA DE POZOS S.A.
Av. Nueva Tomas Marsano N° 2813, Of. 406
Edificio Cnetro Ejecutivo
Lima, Peru
Telfs. 47-9772 & 47-8860
Engrs. Romulo Vasquez Correa & Julio Haro

CAVERAT S.A.
Pablo Bermudez N° 285, Of. 501
Lima, Peru
Telf. 23-3039
Engr. Manuel Cevallos

DRILLING COST

The following is a summary of discussions were held with two drilling companies in Lima concerning the general hydrogeologic conditions in the area of the USAID/RWSES. Also discussed were the general drilling costs for wells with a diameter of 3" and 4". At this point, the number of wells which will be drilled during the project is not known. This information, however, should provide an idea of the possible cost of such an undertaking.

PERFORADORA PERUANA DE POZOS S.A.

Dr. Julio Haro is a hydrogeologist and associate of the firm. He said that hydrogeologic conditions in Loreto, Cuzco, Junin, Arequipa, Cajamarca and Piura vary considerably. Due to the striking differences in Peru's geologic conditions one should be careful when selecting well sites. Water quality in the Sierra is generally good, but yield is not optimum. For example, hydrogeologic conditions between Cuzco, Arequipa, and Loreto differ considerably. Dr. Haro suggested that before selecting hand pump sites concerned parties obtain specific hydrogeologic information from the Ministry of Agriculture. However, this type of information is not generally available for every region in Peru. At times the best source of information will be local drilling companies.

Dr. Haro quoted their price for drilling as S/.150,000 ($188.00) per meter, which includes drilling, casing, and grouting. This price applies to Lima and does not include equipment moving expenses. (Mobilization of equipment outside Lima is a critical factor when estimating drilling costs.)

PERFORADORA ANDINA

Engineeer Augusto Torre is president of the firm. The minimum diameter well his company drills is 9-inch, which is larger than necessary for the AID hand pump. However, he was very informative and wanted to give us an idea of the drilling prices in Lima. For a 9-inch diameter hole, the cost for the drilling only would be between S/.80,000-90,000 ($100-$113) per meter. Eight inch galvanized casing costs about S/.120,000 ($150) per meter. The cost for grouting is about S/.30,000 per cubic meter. Cost for developing the well (normally a 29-hour pumping test) is between S/.30,000 ($38) and S/.40,000 ($50) per hour. These prices do not include any transportation outside Lima. To give an idea of the transportation cost, Engineer Torres said the expense of transporting equipment to Cuzco would be about 2 to 3 million Soles by land. By plane, the cost would be 7 or 8 times more.

Engineer Torres said that hydrogeologic information exists only for some areas of Peru. However, the Ministry of Agriculture would be able to provide information on which zones have adequate hydrogeologic information.

The Ministry of Agriculture (Directorate of Water, Soils, and Irrigation) is the governmental organization that keeps national hydrogeologic records and information. Contact person in this Directorate is Engineer Sergio Veda.

APPENDIX E

Pump Machining Time

ESTIMATED TIMES IN MINUTES FOR HAND PUMP MACHINING OPERATIONS

PUMP COMPONENT	SAW CUT	GRIND	LATHE TURN	LATHE THREAD	HAND THREAD	MILL	DRILL	TOTAL TIME
PUMP STAND	-	15	45	25	-	-	10	95
PUMP BODY	-	15	60	15	-	-	10	100
PUMP CAP	-	15	-	-	-	60	10	85
FULCRUM	-	15	-	-	-	-	10	25
HANDLE	-	15	-	-	-	-	10	25
UPPER CYL. CAP	-	15	-	-	-	-	-	60
LOWER CYL. CAP	-	15	20	25	30	-	10	100
SLIDER BLOCKS (2)	10	5	10	25	-	-	10	35
ROD END	-	5	10	-	30	-	10	55
FOOT VALVE WEIGHT	5	5	-	-	-	-	10	20
PLUNGER CAGE	-	5	30	20	-	-	-	55
PLUNGER SPACER	-	5	30	-	-	-	-	35
PLUNGER FOLLOWER	-	5	30	10	-	-	-	45
POPPET VALVE	-	5	30	-	-	-	-	35
3" GALV. PIPE	10	-	-	20	-	-	-	30
SHORT BUSHINGS (6)	-	-	75	-	-	-	-	75
LONG BUSHINGS (3)	-	-	45	-	-	-	-	45
SHORT PIN	-	-	5	-	-	-	10	20
LONG PINS (2)	10	-	10	-	-	-	20	40
PLUNGER ROD	5	-	-	-	-	-	-	65
PVC CYL. LINGER	5	-	-	-	-	-	-	5

1050 MIN (17.5 hr)

APPENDIX F

Format of Manufacturers' Facility Analysis

FACILITY ANALYSIS

Factory Name

Owner/Manager

Location

Date Visited

	Weight Factor	Score	Rating*
A. Managerial and Financial Considerations			
1. Management Structure	2		
2. Technical Competency	3		
3. Apparent Business Activity	2		
4. Apparent Financial Condition	3		
B. Foundry			
1. Pattern Shop	3		
2. Melting	3		
3. Sand Treatment	2		
4. Core Making	3		
5. Molding	3		
6. % Total Production Capacity Available	3		
7. Quality Control	3		
8. Work from Drawings	3		

*Rating = Weight Factor x Score

FACILITY ANALYSIS (Continued)

	Weight Factor	Score	Rating*
C. Machine Shop			
1. Machine Tools			
A. Saws	2		
B. Grinders	2		
C. Milling Machines	3		
D. Lathes	3		
E. Drills	3		
F. Other Major Machine Tools	1		
G. Work from Drawings	3		
2. Heat Treating	2		
3. Layout and Space	2		
4. Assembly Paint Test	2		
5. % Total Production Capacity Available	3		
6. Quality Control	3		
D. Overall Impressions			
1. Managerial Ability	3		
2. Production Capability	3		
3. Potential for Expansion	1		
E. Total Rating			

*Rating = Weight Factor x Score

APPENDIX G

List of Peruvian Foundries

FOUNDRIES CONTACTED

LIMA, PERU

- FUNDICION MORENO

Ing. Carlos Moreno

Mr. Guillermo Moreno

Ing. Otto Moreno

Av. Venezuela Nº 1620

Lima, Peru

Telfs. 24-2877

24-2870

FUNDICION AMERICANA S.A.

Ing. Gonzalo Rosello

Ing. Jorge Chau Chau

Ing. Marco Sanchez

Jr. Maynas Nº 298

Lima, Peru

Telf. 27-2328

FUNDICION QUINBER S.A.

Av. Argentina Nº 4294 - Callao

Lima, Peru

Telf. 52-1517

FOUNDRIES CONTACTED

LIMA, PERU Cont'd

FUNDICION INDUSTRIAL S.R.L.

Ing. Enrique Torres

Av. Cajamarquilla Nº 601 - Zarate

Lima, Peru

Telf. 81-8118

FUNDICION VENTANILLA S.A.

Sr. Jose Cavero

Ing. Ronald Zamata

Office: Av. La Marina Nº 1353 - San Miguel

Lima, Peru

Telf. 62-6492

Plant : Av. Los Precursores Nº 880

Zona Industrial Ventanilla - Callao

Lima, Peru

Telf. 51-8942 or 51-6632

SALVADOR & VALDIVIA S.A.

Gral. Vidal Nº 906 - Breña

Lima, Peru

Telf. 24-4222

FOUNDRIES CONTACTED

LIMA, PERU Cont'd

- MAPIME MANUFACTURAS DE PIEZAS METALICAS

  3519 A, Mendiola

  Lima, Peru

  Telf. 31-5269

- MEPSA (Metalurgica Peruana S.A.)

  1051 P. Jimenez

  Lima, Peru

  Telf. 28-3285

- FUNDICION RIVER S.A.

  3013 Av. Materiales

  Lima, Peru

  Telf. 52-7416

FOUNDRIES CONTACTED

TRUJILLO, PERU

- DEPOSITO GENERAL Y FUNDICION

  Av. Moche Nº 963

  Trujillo, Peru

  Telf. 24-3691

- FUNDICION ANDINA DEL PERU

  Ing. Arlequin

  S/n Parque Industrial

  Trujillo, Peru

  Telf. 23-1832

FUNDICION ALEJANDRO RODRIGUEZ

Ave. Puma Cahua

Trujillo, Peru

Telf. 24-1705

FUNDICION WILFREDO SEVILLANO

Av. 3 de Octubre Nº 808

Trujillo, Peru

Telf. 24-2604

FOUNDRIES CONTACTED

TRUJILLO, PERU Cont'd

- FABRICANTES METALICAS

  Sr. Julio Nakamine

  Ave. J. Gutierrez Nº 300

  Trujillo, Peru

  Telf. 24-4453

FOUNDRIES CONTACTED

CUZCO, PERU

- FACTORIA ECHEGARAY

  Sr. Emilio Echegaray

  Pasaje America Nº 660

  Cuzco, Peru

  Telf. 2991 or 4468

- FACTORIA ELECTROMECANICA

  Av. Manco Capac Nº 1301

  Cuzco, Peru

  Telf. 4329

- ABC PRODEIN

  Av. San Andres Nº 321

  Cuzco, Peru

  Telf. 3098

MANUFACTURAS ELECTROMECANICAS DEL PERU

J-8 Mariscal Sucre Huancara

Cuzco, Peru

Telf. 2133

FOUNDRIES CONTACTED

CUZCO, PERU Cont'd

- MANUFACTURAS METALICAS HUAMAN

  Av. Garcilazo Nº 198

  Cuzco, Peru

  Telf. 3584

- MANUFACTURAS METALICAS MORVELY S.C.

  Av. Huayna Capac Nº 162

  Cuzco, Peru

  Telf. 3740

APPENDIX H

Format of Manufacturers' Data Sheet

MANUFACTURERS' DATA SHEET

Company Name

Date Visited

Location

Number of Employees

Owner

Staff & Titles

Management

Product Lines

Comments

Foundry

Melting

Sand Treatment

Pattern Shop

Patterns

Molding Method

MANUFACTURERS' DATA SHEET (Continued)

Casting Area

Comments

Machine Shop

Saws

Grinders

Milling Machines

Lathes

Drills

Shapers

Arbor Press

Heat Treat Facilities

Work From Drawings

Machine Shop Area

Comments

Overall Observations

APPENDIX I

Individual Company Manufacturers' Data Sheets

MANUFACTURERS' DATA SHEET

Company Name	Fundicion Ventanilla S.A.
Date Visited	October 6, 1982.
Location	Office-Av. La Marina 1353, San Miguel Factory-Av. Precursores 880, Zona Industrie, Ventanilla.
Number of Employees	60.
Owner	Corporation.
Staff & Titles	Sr. Jose Cavero Carbajal, General Manager Ing. Ronald Zamata, Factory Manager.
Management	Top manager is non-technical but seems to be a competent manager, who shows definite interest in producing pumps.
Product Lines	General foundry and machine shop. They have no special product line of their own at present. They cast machine components for other companies.
Comments	Much of this company's work is done for the mining industry. The company is definitely interested in developing their own product line. They have been in business for 20 years.

Foundry

Melting	No cupolas, 2 induction furnaces, 1 large "blow type" furnace.
Sand Treatment	Excellent. Good mullers (sand crushers) and screeners.
Pattern Shop	Work from drawings. Good equipment. 3 people. Ability to make complicated patterns.
Patterns	Uses wood "match plate" production patterns.
Molding Method	No jolt-squeeze. Pneumatic hand ram only. Use CO_2 Sodium Silicate as well as resin cores.

Fundicion Ventanilla S.A (Continued)

Casting Method	Hand pour. No holding crucible.
Capacity	325 kg/hr. from each induction furnace. Only use one furnace at a time. No figures available on blow furnace. Now operating at about 25% total capacity.
Casting Area	Approximately 5,000 ft^2.
Comments	Good quality control. Regular use of standard wedge test for white iron. Uses university for special testing. Could operate second shift in foundry.

Machine Shop

Saws	1 small power hacksaw.
Grinders	Hand only.
Milling Machines	1 small Bridge-port type, 1 old horizontal.
Lathes	1 extra-large, 2 small (new), 4 medium engine-type.
Drills	3 medium pedestal, 1 large radial.
Shapers	None.
Arbor Press	None.
Heat Treat Facilities	Yes, but primitive.
Work From Drawings	Yes.
Machine Shop Area	Approximately 3,500 ft^2.
Comments	Machine shop has large open storage immediately adjacent. Machines look old and not too well kept. Have large, old horizontal boring mill. Presently working at around 40% total capacity.

Overall Observations

Excellent casting quality. Machine shop seems only adequate. Layout is only fair. Housekeeping is poor. Worker activity seems good.

MANUFACTURERS' DATA SHEET

Company Name	Fundicion Industrial S.R.L.
Date Visited	October 6, 1982.
Location	Av. Cajamarquilla 601 - Zarate-San Juan de Lurigancho Lima, Peru
Number of Employees	Approximately 50.
Owner	Four partners, all engineers.
Staff & Titles	Ing. Enrique Torres Galdos, General Manager. Other partners serve as head of quality control, head of machining, and head of marketing.
Management	Management seems to function well. This is a small informally managed company.
Product Lines	Custom castings and vises.
Comments	This company has been in business for 20 years. Financial condition seems to be only "fair."

Foundry

Melting	1 cupola.
Sand Treatment	Very basic screening, small muller, generally good.
Pattern Shop	Works from drawings. Small, 1 lathe, 2 people.
Patterns	Excellent - Wood "match plate" production patterns.
Molding Method	No jolt squeeze or pneumatic ram. Hand ram only CO^2 sodium silicate cores only. Excellent quality.
Casting Method	Hand pour. Metal comes from cupola directly from cupola into pouring cubicle. No holding crucible for gray iron. Holding crucible for injecting ductile iron.
Capacity	1,000 kg/hr. Now operating at about 50% total capacity.

Casting Area	Approximately 3,000 ft^2.
Comments	Good quality control. Good instrumentation, such as direct-read pyrometer and hardness tester. Casting cost approximately $1.00/kg.

<u>Machine Shop</u>

Saws	None.
Grinders	Hand only.
Milling Machines	1 horizontal, medium size.
Lathes	1 large, 1 small.
Drills	1 medium pedestal.
Shapers	None.
Arbor Press	None.
Heat Treat Facilities	Marginal.
Work From Drawings	Yes.
Machine Shop Area	Approximately 1,000 ft^2.
Comments	Machine shop is small and crowded. Presently working near full capacity. Average salary of machinists is around $6.00/day.

<u>Overall Observations</u>

Casting quality is good in both gray iron and ductile iron. Machine shop is inadequate to handle large order of pumps. Foundry area is crowded. Good worker activity.

MANUFACTURERS' DATA SHEET

Company Name	Fundicion Americana S.A.
Date Visited	October 7, 1982.
Location	Jiron Maynas 298 (Barrios Altos) Lima, Peru
Number of Employees	Approximately 30.
Owner	Corporation.
Staff & Titles	Ing. Gonzalo Rosello, General Manager. Ing. Jorge Chau, Production Manager. Ing. Marco Sanchez, Foundry Manager.
Management	Management team is young, enthusiastic, impressive.
Product Lines	Specialty casting and machining.
Comments	This company has been in business since 1939 but was acquired by the current owners in 1979. Parent corporation is multi-million dollar mining company. Much of the output of this company is for the parent company. However, the general manager wants to diversify.

<u>Foundry</u>

Melting	No cupola, 1 large blow-type furnace.
Sand Treatment	Marginal, barely adequate.
Pattern Shop	No work from drawings. Uses outside source.
Patterns	Only very old, obsolete patterns were observed.
Molding Method	No jolt squeeze or pneumatic ram. Hand ram only. CO_2 sodium silicate cores only.
Casting Method	Hand pour. No holding crucible.
Capacity	125 kg/hr. Now working at 15% total capacity.
Casting Area	Approximately 3,500 ft^2.

Comments	Entire foundry is marginal. Very doubtful that they would be able to produce quality castings in any great number.

<u>Machine Shop</u>

Saws	1 small power hacksaw.
Grinders	1 small pedestal.
Milling Machines	None.
Lathes	6 medium, 1 small.
Drills	3 medium, 1 large radial.
Shapers	Several (old).
Arbor Press	No.
Heat Treat Facilities	No.
Work From Drawings	Yes.
Machine Shop Area	About 2,000 ft^2.
Comments	All of the equipment in this machine shop is ancient. All machines are powered from central source via line shaft belt and pulley system. Machine shop is now working at about 80% total capacity. Average wage is around $6/day.

<u>Overall Observations</u>

The foundry equipment and methods are inadequate for volume production work. The machine shop equipment is more suited for large heavy work. The young management team and the good financial backing would indicate that this company has good expansion potential.

MANUFACTURERS' DATA SHEET

Company Name	Fundicion Moreno
Date Visited	October 7, 1982
Location	Av. Venezuela 1620 Lima, Peru
Number of Employees	Approximately 90
Owner	Ing. Carlos Moreno with 2 sons, Guillermo and Otto
Staff & Titles	Sr. Guillermo Moreno, President
Management	Ing. Moreno is the father of a family business. Sr. Guillermo Moreno has an economics degree and handles the financial concerns. Sr. Otto Moreno is getting his Metallurgical Engineering degree in U.S.A.
Product Lines	Large gate valves and fittings (Ells, tees, etc.) for water systems. Custom foundry and machine shop work.
Comments	This is a well managed company which has been in business for 20 years.

Foundry

Melting	2 cupolas, induction furnace purchased but not yet installed.
Sand Treatment	Excellent. Good mullers and screeners.
Pattern Shop	Works from drawings. Good equipment. 2 people.
Patterns	Aluminum and wood match patterns. Excellent quality.
Molding Method	No jolt squeeze. Pneumatic ram. Pneumatic vibrators used for pattern withdrawal.
Casting Method	Hand pour. Holding crucibles.
Capacity	3,000 kg/hr. Now operating at around 50% total capacity.
Casting Area	Approximately 20,000 ft^2.

Comments	Good quality control procedures. Castings cost about $.25/lb.

Machine Shop

Saws	2 power hacksaws.
Grinders	6 pedestal, many hand-type.
Milling Machines	None.
Lathes	40 medium engine-type.
Drills	6 medium, 1 large radial.
Shapers	None.
Arbor Press	1 hydraulic.
Heat Treat Facilities	Minimal.
Works From Drawings	Yes.
Machine Shop Area	Approximately 4,000 ft^2.
Comments	Has power pipe threading machine with 4" capacity. Present layout crowded with poor housekeeping. Output from machine shop is very high quality. Average machine shop wage is about $9.00/day. Machine shop presently working at about 50% total capacity.

Overall Observations

This is an excellent, well managed operation. The quality level of their products is very high. Good worker activity observed. Extremely large new building which will house their entire operation will be ready for operation within 6 months. The owner has planned this new building so that the transition from his present facilities into the new facilities will have minimal effect on his production.

MANUFACTURERS' DATA SHEET

Company Name	Fundicion de Alejandro Rodriguez.
Date Visited	October 8, 1982.
Location	Trujillo, Peru.
Number of Employees	6.
Owner	Sr. Alejandro Rodriguez.
Staff & Titles	Sr. Alejandro Rodriguez and 2 sons.
Management	This is a family business with Sr. Rodriguez handling both business and technical matters.
Product Lines	General foundry and machine shop. Specializes somewhat in water pipe fittings and simple valves.
Comments	This is a very marginal operation. The business is not on firm financial ground. Sales are also decreasing.

Foundry

Melting	2 cupolas (very small, crudely built).
Sand Treatment	None apparent.
Pattern Shop	No work from drawings. No pattern shop was in evidence, even though owner said he made his own patterns.
Patterns	Simple wood patterns but they looked good. Good workmanship.
Molding Method	Hand ram only. Used CO_2 sodium silicate cores.
Casting Method	Hand pour. No holding crucible.
Capacity	100 kg/hr. from each cupola. Only uses one cupola at a time. Now operating at about 10% total capacity.

Fundicion de Alejandro Rodriguez (Continued)

Casting Area	Approximately 1,000 ft^2. Very poor layout. Dangerous conditions.
Comments	Quality control was not evident. This foundry could not be depended on to meet quality standards or production schedules.

Machine Shop

Saws	1 power hacksaw.
Grinders	2 pedestal.
Milling Machines	None.
Lathes	1 medium.
Drills	1 pedestal.
Shapers	None.
Arbor Press	None.
Heat Treat Facilities	None.
Works From Drawings	No.
Machine Shop Area	Approximately 750 ft^2.
Comments	Not enough basic equipment to make pump components. This company would have to subcontract machining work.

Overall Observations

This foundry and machine shop should not be considered for manufacturing the AID hand water pump.

MANUFACTURERS' DATA SHEET

Company Name	Factoria Echegaray.
Date Visited	October 11, 1982.
Location	Pasaje America 660 Cuzco, Peru
Number of Employees	3.
Owner	Sr. Emilio Echegaray.
Staff & Titles	Sr. Echegaray, President.
Management	This is a family business with Sr. Echegaray handling both business and technical matters.
Product Lines	General foundry and machine shop.
Comments	This is a very small operation that is no longer modern. Even though the owner is interested in producing pumps, his other financial interests are such that this foundry is not critical to the owner's well being.

Foundry

Melting	1 cupola.
Sand Treatment	None apparent.
Pattern Shop	Works from drawings. All patterns are made by another company.
Patterns	Somewhat primitive and crude in appearance.
Molding Method	Hand ram only. Uses sand, flour and molasses for cores.
Casting Method	Hand pour. No holding crucible.
Capacity	325 kg/hr. Owner states that he is now operating at 10% of total capacity. However, it appears that this is an optimistic estimate.

Casting Area	Approximately 1,250 ft^2.
Comments	Products appear to be relatively low quality. This foundry does not have the technical capability or equipment to produce quality hand pump components.

Machine Shop

Saws	None.
Grinders	2 pedestal.
Milling Machines	None.
Lathes	1 small.
Drills	2 pedestal.
Shapers	None.
Arbor Press	Small screw-type.
Heat Treat Facilities	None.
Work From Drawings	Owner says yes, but it is doubtful.
Machine Shop Area	Approximately 800 ft^2.
Comments	Machine shop is very marginal. It has neither the space nor the equipment to produce quality hand pumps. It is now operating at about 10% of the total capacity.

Overall Observations

This is a marginal operation at best. The skill level seems very low with poor machine shop and foundry practices.

APPENDIX J

Analysis Sheets for Individual Company Manufacturers' Capability

FACILITY ANALYSIS

Factory Name	FUNDICION VENTANILLA
Owner/Manager	Sr. Jose Cavero
Location	Lima, Peru
Date Visited	October 6, 1982

	Weight Factor	Score	Rating*
A. Managerial and Financial Considerations			
1. Management Structure	2	8	16
2. Technical Competency	3	8	24
3. Apparent Business Activity	2	8	16
4. Apparent Financial Condition	3	5	15
			71
B. Foundry			
1. Pattern Shop	3	7	21
2. Melting	3	4	12
3. Sand Treatment	2	8	16
4. Core Making	3	8	24
5. Molding	3	5	15
6. % Total Production Capacity Available	3	8	24
7. Quality Control	3	9	27
8. Work from Drawings	3	8	24
			163

*Rating = Weight Factor x Score

FACILITY VENTANILLA (Continued)

	Weight Factor	Score	Rating*
C. Machine Shop			
1. Machine Tools			
A. Saws	2	5	10
B. Grinders	2	2	4
C. Milling Machines	3	7	21
D. Lathes	3	9	27
E. Drills	3	7	21
F. Other Major Machine Tools	1	4	4
G. Work from Drawings	3	7	21
2. Heat Treating	2	5	10
3. Layout and Space	2	7	14
4. Assembly Paint Test	2	7	14
5. % Total Production Capacity Available	3	8	24
6. Quality Control	3	7	21
			191
D. Overall Impressions			
1. Managerial Ability	3	7	21
2. Production Capability	3	7	21
3. Potential for Expansion	1	7	7
			49
E. Total Rating			474

*Rating = Weight Factor x Score

FACILITY ANALYSIS

Factory Name	FUNDICION INDUSTRIAL S.R.L.
Owner/Manager	Ing. Enrique Torres
Location	Lima, Peru
Date Visited	October 6, 1982

	Weight Factor	Score	Rating*
A. Managerial and Financial Considerations			
1. Management Structure	2	7	14
2. Technical Competency	3	10	30
3. Apparent Business Activity	2	8	16
4. Apparent Financial Condition	3	5	15
			75
B. Foundry			
1. Pattern Shop	3	8	24
2. Melting	3	8	24
3. Sand Treatment	2	8	16
4. Core Making	3	9	27
5. Molding	3	8	24
6. % Total Production Capacity Available	3	6	18
7. Quality Control	3	9	27
8. Work from Drawings	3	9	27
			187

*Rating = Weight Factor x Score

FUNDICION INDUSTRIAL S.R.L. (Continued)

	Weight Factor	Score	Rating*
C. Machine Shop			
1. Machine Tools			
A. Saws	2	0	0
B. Grinders	2	2	4
C. Milling Machines	3	5	15
D. Lathes	3	1	3
E. Drills	3	5	15
F. Other Major Machine Tools	1	0	0
G. Work from Drawings	3	9	27
2. Heat Treating	2	5	10
3. Layout and Space	2	2	4
4. Assembly Paint Test	2	4	8
5. % Total Production Capacity Available	3	3	9
6. Quality Control	3	8	24
			119
D. Overall Impressions			
1. Managerial Ability	3	8	24
2. Production Capability	3	4	12
3. Potential for Expansion	1	4	4
			40
E. Total Rating			421

*Rating = Weight Factor x Score

FACILITY ANALYSIS

Factory Name	FUNDICION AMERICANA S.A.
Owner/Manager	Ing. Gonzalo Rosello
Location	Lima, Peru
Date Visited	October 7, 1982

	Weight Factor	Score	Rating*
A. Managerial and Financial Considerations			
1. Management Structure	2	8	16
2. Technical Competency	3	9	27
3. Apparent Business Activity	2	5	10
4. Apparent Financial Condition	3	10	30
			83
B. Foundry			
1. Pattern Shop	3	0	0
2. Melting	3	3	9
3. Sand Treatment	2	2	4
4. Core Making	3	3	9
5. Molding	3	5	15
6. % Total Production Capacity Available	3	9	27
7. Quality Control	3	5	15
8. Work from Drawings	3	9	27
			106

*Rating = Weight Factor x Score

FUNDICION AMERICANA S.A (Continued)

	Weight Factor	Score	Rating*
C. Machine Shop			
1. Machine Tools			
A. Saws	2	5	10
B. Grinders	2	3	6
C. Milling Machines	3	0	0
D. Lathes	3	9	27
E. Drills	3	7	21
F. Other Major Machine Tools	1	8	8
G. Work from Drawings	3	9	27
2. Heat Treating	2	0	0
3. Layout and Space	2	4	8
4. Assembly Paint Test	2	5	10
5. % Total Production Capacity Available	3	4	12
6. Quality Control	3	6	18
			147
D. Overall Impressions			
1. Managerial Ability	3	8	24
2. Production Capability	3	3	9
3. Potential for Expansion	1	10	10
			43
E. Total Rating			379

*Rating = Weight Factor x Score

FACILITY ANALYSIS

Factory Name FUNDICION MORENO

Owner/Manager Ing. Carlos Moreno

Location Lima, Peru

Date Visited October 7, 1982

	Weight Factor	Score	Rating*
A. Managerial and Financial Considerations			
1. Management Structure	2	8	16
2. Technical Competency	3	9	27
3. Apparent Business Activity	2	10	20
4. Apparent Financial Condition	3	9	27
			90
B. Foundry			
1. Pattern Shop	3	8	24
2. Melting	3	9	27
3. Sand Treatment	2	8	16
4. Core Making	3	8	24
5. Molding	3	8	24
6. % Total Production Capacity Available	3	6	18
7. Quality Control	3	8	24
8. Work from Drawings	3	8	24
			181

*Rating = Weight Factor x Score

FUNDICION MORENO (Continued)

	Weight Factor	Score	Rating*
C. Machine Shop			
1. Machine Tools			
A. Saws	2	7	14
B. Grinders	2	7	14
C. Milling Machines	3	0	0
D. Lathes	3	10	30
E. Drills	3	10	30
F. Other Major Machine Tools	1	8	8
G. Work from Drawings	3	8	24
2. Heat Treating	2	5	10
3. Layout and Space	2	4	8
4. Assembly Paint Test	2	5	10
5. % Total Production Capacity Available	3	6	18
6. Quality Control	3	8	24
			190
D. Overall Impressions			
1. Managerial Ability	3	8	24
2. Production Capability	3	6	18
3. Potential for Expansion	1	10	10
			52
E. Total Rating			513

*Rating = Weight Factor x Score

FACILITY ANALYSIS

Factory Name	FUNDICION DE ALEJANDRO RODRIGUEZ
Owner/Manager	Sr. Alejandro Rodriguez
Location	Lima, Peru
Date Visited	October 8, 1982

	Weight Factor	Score	Rating*
A. Managerial and Financial Considerations			
1. Management Structure	2	4	8
2. Technical Competency	3	3	9
3. Apparent Business Activity	2	1	2
4. Apparent Financial Condition	3	0	0
			19
B. Foundry			
1. Pattern Shop	3	1	3
2. Melting	3	4	12
3. Sand Treatment	2	1	2
4. Core Making	3	2	6
5. Molding	3	4	12
6. % Total Production Capacity Available	3	8	24
7. Quality Control	3	4	12
8. Work from Drawings	3	1	3
			74

*Rating = Weight Factor x Score

FUNDICION DE ALEJANDRO RODRIGUEZ (Continued)

	Weight Factor	Score	Rating*
C. Machine Shop			
1. Machine Tools			
A. Saws	2	5	10
B. Grinders	2	5	10
C. Milling Machines	3	0	3
D. Lathes	3	2	6
E. Drills	3	5	15
F. Other Major Machine Tools	1	0	0
G. Work from Drawings	3	1	3
2. Heat Treating	2	0	0
3. Layout and Space	2	2	4
4. Assembly Paint Test	2	4	8
5. % Total Production Capacity Available	3	5	15
6. Quality Control	3	3	9
			83
D. Overall Impressions			
1. Managerial Ability	3	2	6
2. Production Capability	3	4	12
3. Potential for Expansion	1	0	0
			18
E. Total Rating			191

*Rating = Weight Factor x Score

FACILITY ANALYSIS

Factory Name	FUNDICION ECHAGARAY
Owner/Manager	Sr. Emilio Echegaray
Location	Cuzco, Peru
Date Visited	October 11, 1982

	Weight Factor	Score	Rating*
A. Managerial and Financial Considerations			
1. Management Structure	2	4	8
2. Technical Competency	3	3	9
3. Apparent Business Activity	2	2	4
4. Apparent Financial Condition	3	5	15
			36
B. Foundry			
1. Pattern Shop	3	0	0
2. Melting	3	5	15
3. Sand Treatment	2	1	2
4. Core Making	3	1	3
5. Molding	3	4	12
6. % Total Production Capacity Available	3	7	21
7. Quality Control	3	3	9
8. Work from Drawings	3	3	9
			71

*Rating = Weight Factor x Score

FUNDICION ECHEGARAY (Continued)

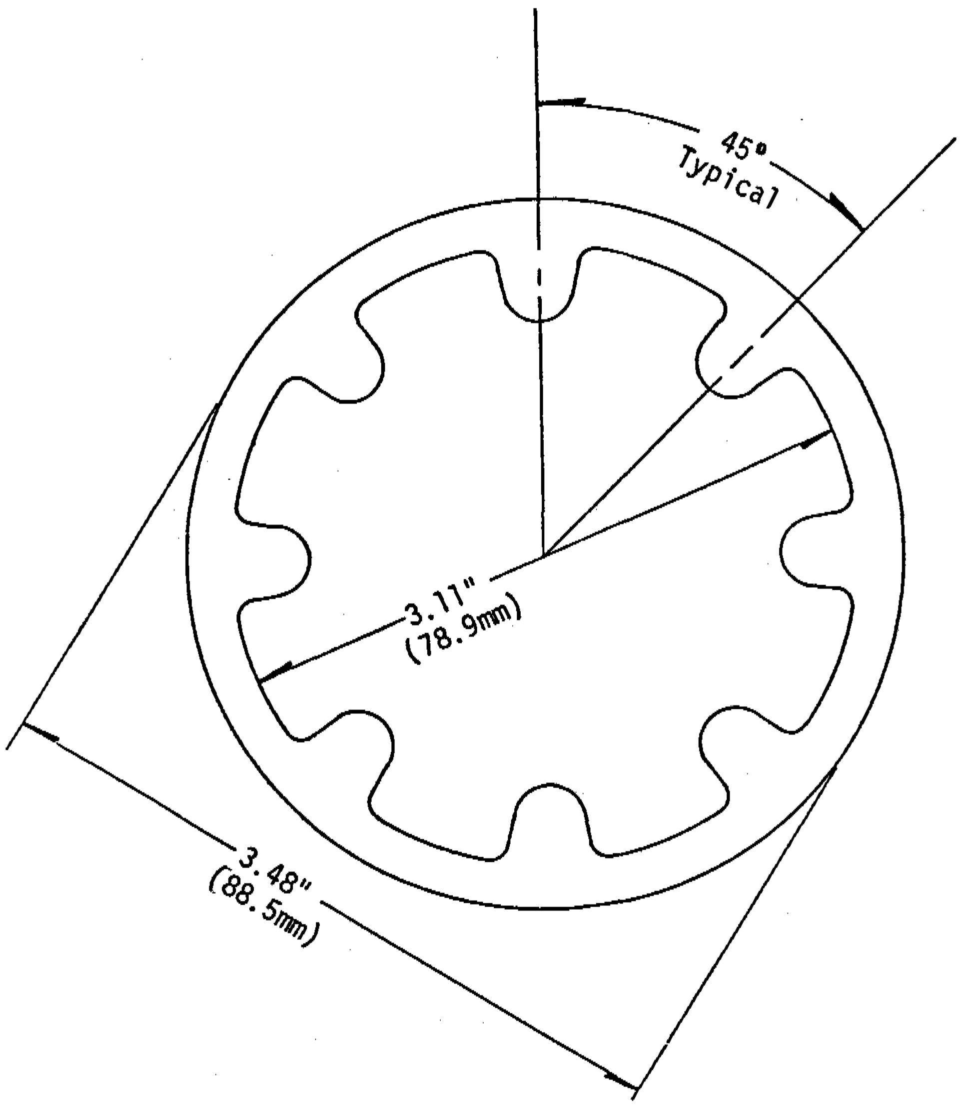
	Weight Factor	Score	Rating*
C. Machine Shop			
1. Machine Tools			
A. Saws	2	0	0
B. Grinders	2	5	10
C. Milling Machines	3	0	0
D. Lathes	3	2	6
E. Drills	3	5	15
F. Other Major Machine Tools	1	4	4
G. Work from Drawings	3	3	9
2. Heat Treating	2	0	0
3. Layout and Space	2	3	6
4. Assembly Paint Test	2	3	6
5. % Total Production Capacity Available	3	7	21
6. Quality Control	3	3	9
			76
D. Overall Impressions			
1. Managerial Ability	3	5	15
2. Production Capability	3	4	12
3. Potential for Expansion	1	5	5
			32
E. Total Rating			215

*Rating = Weight Factor x Score

APPENDIX K

Roboscreen and Cylinder Liner Specifications

CROSS SECTION OF
3" ROBOSCREEN PIPE

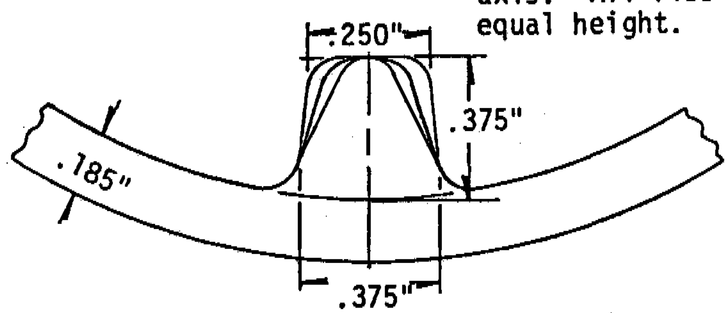


3" Nominal PVC Pipe (150 psi)
(Peruvian standard class 10)

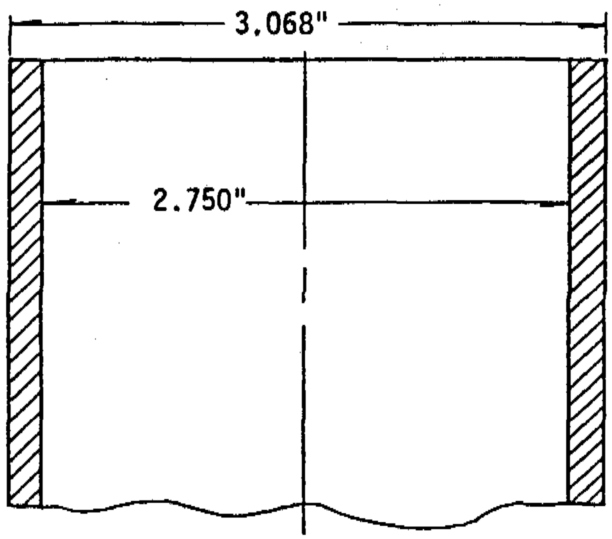
ROBOSCREEN
INTERNAL RIB PROFILES

—Typical—

Typical rib profiles must be symmetrical about radial axis. All ribs must be of equal height.



SPECIAL DIMENSION
CYLINDER LINER



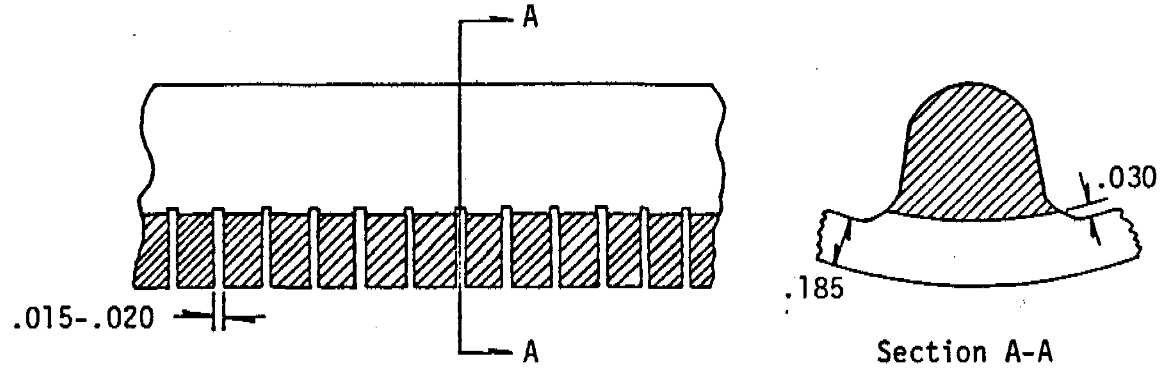
PVC Pipe

Same tolerances as
standard class 10 PVC tubing

APPENDIX L

Roboscreen Manufacturing Data

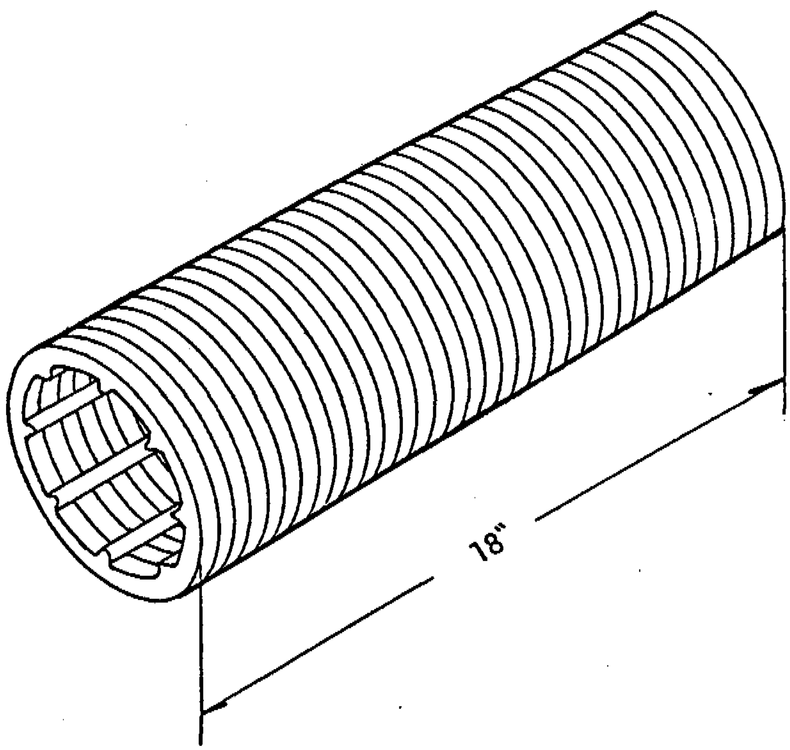
ROBOSCREEN

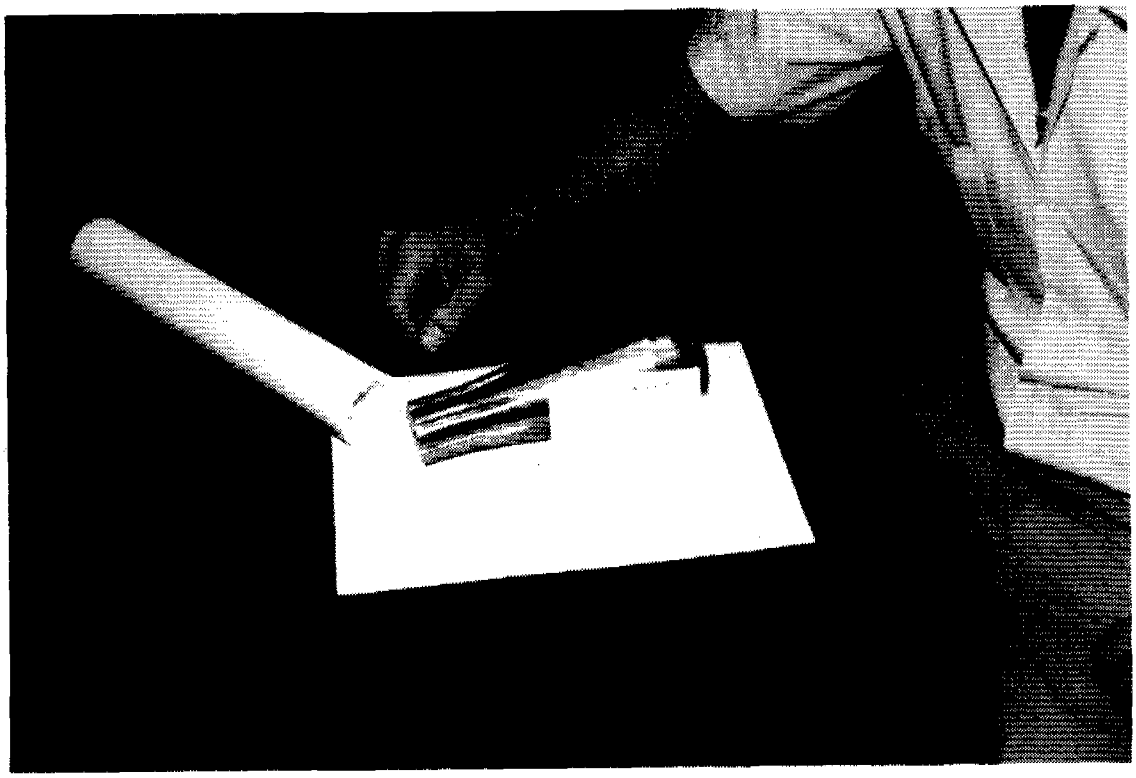


Note: All dimensions are in inches.

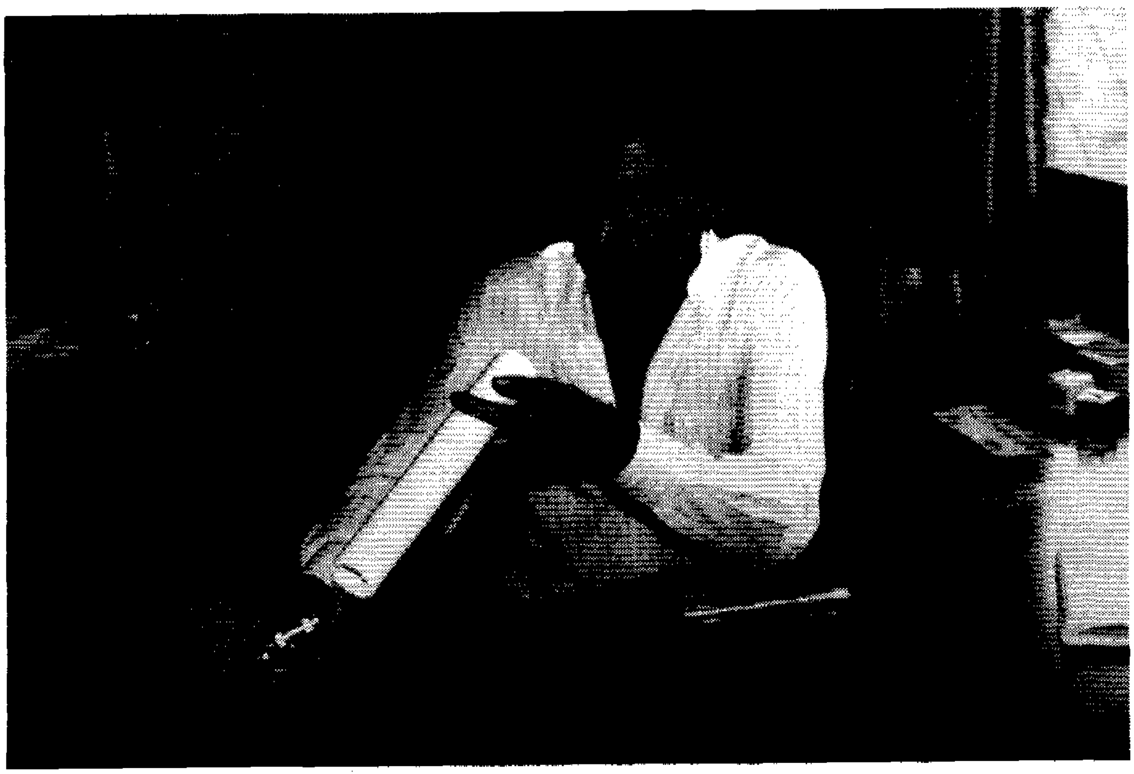
Section A-A

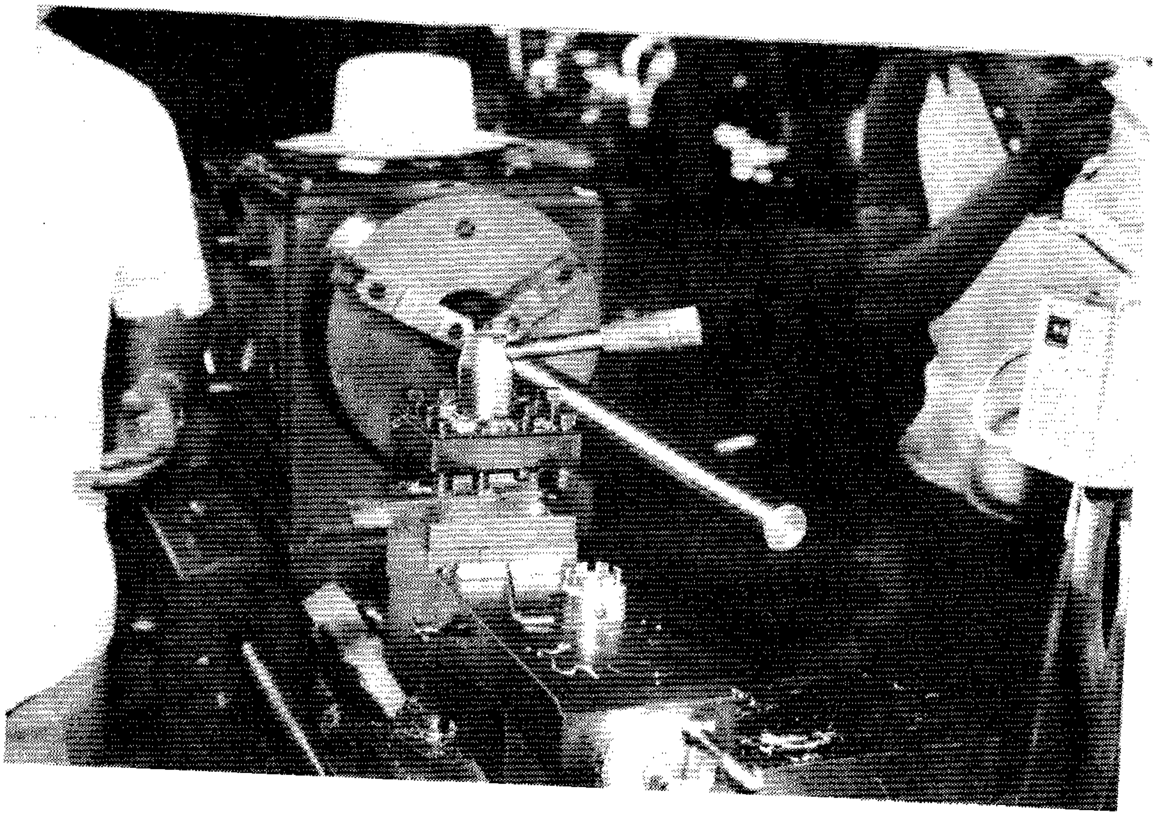
Lathe cut is made to cut entirely through 0.185" wall of PVC tubing and not more than 0.030 into the internal rib.





MODIFIED PVC EXTRUSION DIE
FOR PRODUCING ROBOSCREEN TUBE





ROBOSCREEN GROOVING METHOD