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STATUS OF THE AID TYPE HANDPUMP IN THE DOMINICAN REPUBLIC

WASH FIELD REPORT NO. 98

AUGUST 1983

Prepared for:
USAID Mission to the Dominican Republic
Order of Technical Direction No. 143

WATER AND SANITATION FOR HEALTH PROJECT

COORDINATION AND INFORMATION CENTER

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August 4, 1983

Mr. Philip Schwab, Director
USAID Mission
Santo Domingo, Dominican Republic

Attention: Dr. Oscar Rivera-Rivera

Dear Mr. Schwab:

On behalf of the WASH Project I am pleased to provide you with 10 (ten) copies of a report on the Status of the AID Type Handpumps in the Dominican Republic.

This is the final report by Fernando Pareja-Gil and Henry Van and is based on their trip to the Dominican Republic from March 19 to May 9, 1983.

This assistance is the result of a request by the Mission on March 2, 1983. The work was undertaken by the WASH Project on March 7, 1983 by means of Order of Technical Direction No. 143, authorized by the USAID Office of Health in Washington.

If you have any questions or comments regarding the findings or recommendations contained in this report we will be happy to discuss them.

Sincerely,

David Donaldson
Acting Director
WASH Project

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

DBW:cdej

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FIELD REPORT NO. 98

STATUS OF AID TYPE HANDPUMP IN THE DOMINICAN REPUBLIC

Prepared for the USAID Mission to the Dominican Republic
under Order of Technical Direction No. 143

Prepared by:

Fernando Pareja-Gil
and
Henry Van, Ph.D.

July 1983

Water and Sanitation for Health Project
Contract No. AID/DSPE-C-0080, Project No. 931-1176
is sponsored by the Office of Health, Bureau for Science and Technology
U.S. Agency for International Development
Washington, DC 20523

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ACRONYMS

AID	U.S. Agency for International Development
GIT	Georgia Institute of Technology
GODR	Government of the Dominican Republic
PVC	Polyvinyl Chloride
SESPAS	State Secretariat for Public Health and Social Assistance, GODR
WASH	Water and Sanitation for Health

EXECUTIVE SUMMARY

The USAID/Washington through its Office of Health requested the Water and Sanitation for Health (WASH) Project to provide technical assistance for the USAID Mission to the Dominican Republic and the State Secretariate for Public Health and Social Assistance (SESPAS). This technical assistance consisted of a field survey and inspection and analysis of the current status of the locally manufactured "pull-through-the-base" type modified AID design handpump installed in the Dominican Republic under the Health Sector Loan II Project. AID/Washington issued Amendment Two of Order of Technical Direction (OTD) No. 143 to Camp Dresser and McKee, Inc. (CDM), an environmental engineering company that operates AID's centrally-funded WASH Project. The Engineering Experiment Station at the Georgia Institute of Technology, authorized by CDM, was assigned to conduct the field work.

The field inspection was conducted in two distinct parts: the surveillance mode and the detailed inspection mode. For the surveillance mode, the working status of 60 randomly selected modified AID handpumps was observed and noted. For the detailed inspection mode, 30 handpumps which were found to be inoperable either during the surveillance mode or had previously been identified by SESPAS were disassembled, and the causes of the malfunctions were identified.

Results of these efforts confirm that there are a series of problems with the modified version of the AID handpump (i.e. equipped with PVC drop pipe and PVC foot valve) which results in pumps failing to operate properly after only a few weeks of installation.

The most frequent causes of problems were: (1) a combination of design faults, manufacturing modifications, and/or installation flaws which allows the introduction of foreign matter into the pump that interferes with the normal operation of the piston (plunger) poppet valve and/or the foot valve poppet, (2) plunger poppet valve failure, (3) separation of the PVC pipe assembly, and (4) separation of the plunger rod.

Recommendations fall into three general categories: (1) new criteria for the selection of a manufacturer to produce pumps in the future, (2) changes in pump design and materials, and (3) concentrated technical assistance to the manufacturer, and to those responsible for implementing the pump program.

o *Selection criteria for a new handpump manufacturer*

- It is recommended that the price of the pumps should not be the only deciding factor or procurement of the approximately 640 pumps remaining to be manufacturer for the Health Sector Loan II Project. Technical and managerial conditions should be strongly considered. The manufacturer should be capable of maintaining rigid quality control measures throughout the life of the contract.

- It is recommended that the selected manufacturer be responsible for the overall quality of the complete pump, not just certain components.

o Changes in handpump design

- It is recommended that the modified "pull-through-the-base" type AID handpump design with a plastic drop pipe be discontinued and replaced by the conventional AID design.

- It is recommended that additional pump cylinders be manufactured for the modified AID pumps installed in the field. These pumps should be retrofitted with the new cylinders as they are taken out of service for repairs.

- It is recommended that additional cap assemblies be manufactured to replace those in the field that are found to have loose bushings.

- It is recommended that earlier installed AID handpumps (conventional design) have their leather flapper foot valves replaced with a metal popper/rubber seal foot valves. Such a valve can be manufactured or purchased locally.

- It is recommended that the plunger poppet valve failure be corrected by increasing the diameter of its top as well as making its shaft longer and of greater diameter to provide a better seal and to prevent its getting stuck between the cage legs.

o Concentrated technical assistance

- It is recommended that SESPAS, the USAID Mission and the handpump manufacturer be provided with in-depth and extended technical assistance in each of the above areas. Also, such assistance should extend to the following areas:

  1. Establishment of a training system for and train community organizers in proper long-term locally based handpump maintenance and repair procedures.

  2. Preparation of bid documents, gauge kits and specifications before a new manufacturer is selected.

  3. Assistance to the manufacturer in quality assurance procedures and to SESPAS in acceptance procedures.

  4. Determination of the reasons for the large amounts of foreign matter found in the plunger and foot valve assemblies.

At the request of SESPAS and the USAID Mission, WASH consultants looked into some of the financial concerns of the Health Sector Loan II handpump program. SESPAS has already purchase over $80,000 in materials for the installation of the remaining 640 handpumps. SESPAS expressed concern that these materials will have to be used. The consultants were informed that using the materials in other projects would be difficult. Therefore, although not necessarily recommended, the following alternatives should be considered.

- The remaining 640 handpumps yet to be manufactured could be of the modified AID design. The PVC foot valve could be replaced by a locally available brass foot valve.

- To prevent separation of the PVC pipe assembly at the handpump base, SESPAS could continue to use the 2-inch diameter by 12-inch long bell-ended PVC pipe section between the 2-inch PVC coupling and the PVC drop pipe assembly (Figure 3). This seemed to have reduced the frequency of pipe separation at this location. However, field data are not sufficient to guarantee the success of this approach, and it should not be expected to totally correct this problem (i.e. while it can be expected to reduce the number of early drop pipe failures it cannot be expected to eliminate them).

- For existing pumps retrofit of brass foot valves and 12-inch long bell-ended PVC pipe sections between the 2-inch PVC adaptor and the PVC drop pipe could be implemented as each pump is pulled for maintenance.

The above alternatives should be implemented only if the following steps are followed:

- SESPAS should carefully inspect the handpumps before accepting them from the manufacturer, thus drastically upgrading quality control.

- SESPAS should radically improve their handpump field installation procedures.

- SESPAS should carefully train handpump installation and maintenance crews and provide awareness of the consequences of an improperly installed handpump.

- Earlier installed AID handpumps (conventional design) should have their leather flapper foot valves replaced with metal popper/rubber seat foot valves (brass type) when the former wear out or fail to operate properly. To correct the problem of loose bushings in the cap assembly of existing pumps, any of the components (cap, fulcrum, rod end, and handle) which need a better fitting bushing can be taken to a general machine shop to have the hole(s) reamed to a diameter of approximately 0.874 inches which would provide a press fit with a bushing with an outside diameter of 0.875 inches.

Before a partial replacement of the bushings, SESPAS should carefully consider the logistical burden expected as a result of having handpump heads with bushings of two different sizes until all bushings have been replaced and all pumps have the same size bushings. Careful planning should be exercised.

Before implementing any of the alternative considerations, SESPAS should consider the possibly large cost of maintenance if they do not completely correct current problems. Such costs should be compared with the $80,000 already invested in materials.

SESPAS could contact private voluntary organizations in the country to investigate the possibility of using the purchased items, thus recuperating some of this investment to minimize the loss.

It is recommended that the conventional AID design handpump be used for future handpump programs in the Dominican Republic as the best technical alternative. This would reduce the numbers and types of spare parts and logistic problems.

ACKNOWLEDGEMENTS

The writers wish to thank Dr. Oscar Rivera, the Health Officer at the USAID Mission in Santo Domingo, for his valuable assistance and generous cooperation during the implementation of this assignment.

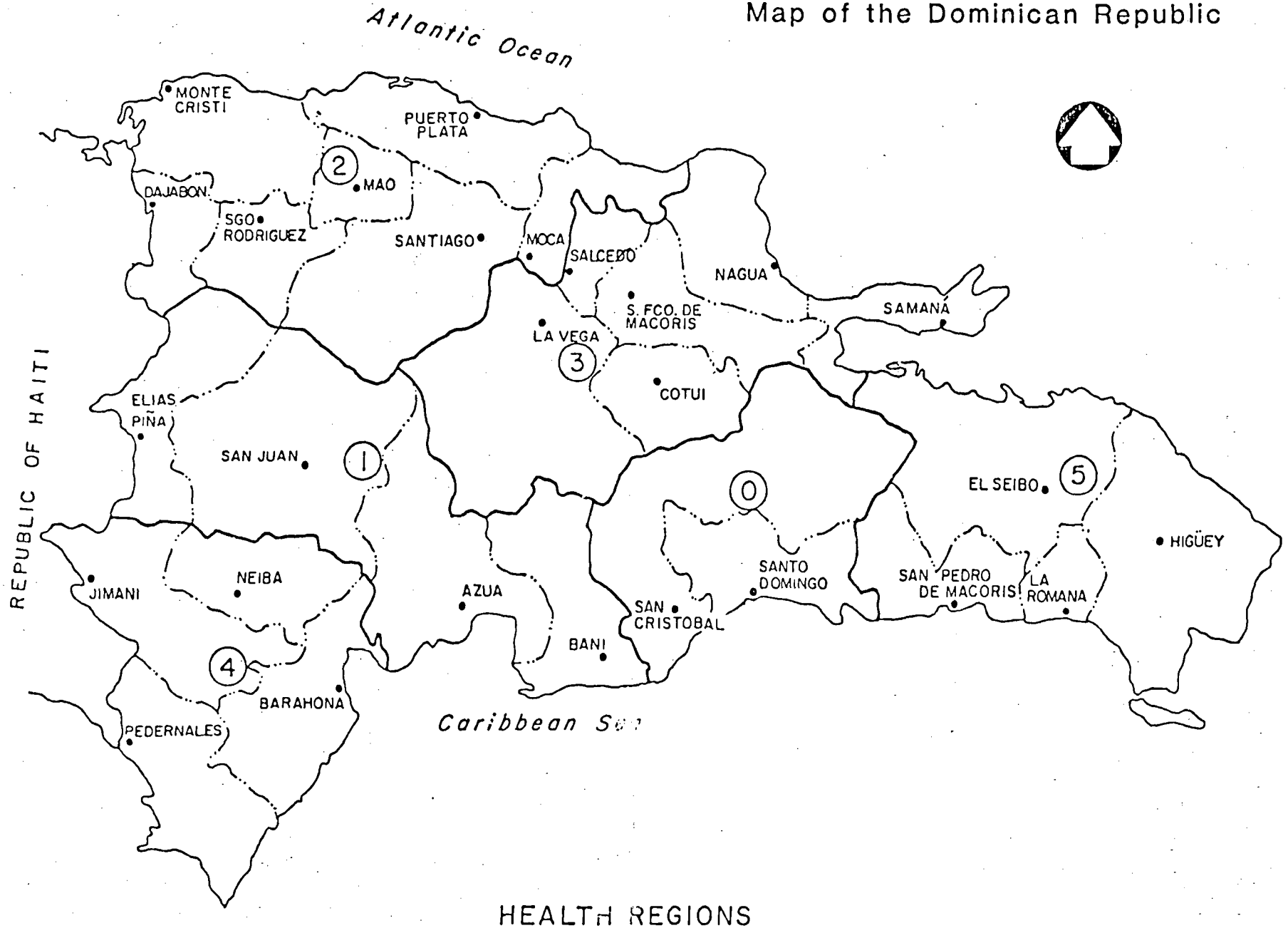
Appreciation is extended to Dr. Jose M. Herrera, Director of the Health Sector Loan II Project of SESPAS, his technical advisor Eng. Elpidio Caba, and SESPAS field personnel for providing important background information and extensive logistical support which was most valuable.

Mr. John H. Thomas of the USAID Mission was very helpful.

The enthusiastic support and ideas of Eng. Manuel Valdez of the USAID Mission are also gratefully acknowledged.

Finally, appreciation is expressed for the contributions of Mr. Eugene McJunkin and Mr. Victor Wehman, USAID/Office of Health in Washington, D.C., and Mr. David Donaldson of the WASH Project.

Map of the Dominican Republic



HEALTH REGIONS

STATE SECRETARIAT OF PUBLIC HEALTH AND SOCIAL ASSISTANCE

DOMINICAN REPUBLIC

Chapter 1

INTRODUCTION

The U.S. Agency for International Development (USAID), through its Office of Health, Bureau for Science and Technology in Washington, and its Mission in Santo Domingo, initiated a rural water supply project as part of a wider public health effort in the Dominican Republic (Health Sector Loan II). One component of the project is the local manufacture, installation, and maintenance of 2,300 handpumps in rural communities. One thousand of these pumps are of the conventional AID design. The others are of the modified version (Figure 1). At present, 1,000 conventional handpumps and 200 modified handpumps have been installed.

1.1 Events Leading to the OTD

In January 1983 a technical/management review team visited the Dominican Republic to look at its AID handpump program and found evidence that the program was experiencing problems with a modified version of the AID handpump that featured a 2-inch PVC drop pipe and a PVC foot valve. The modified pump differs from the conventional AID-design handpump in that the conventional one uses a 1.25-inch galvanized steel drop pipe and a 3-inch cylinder (see Figure 1). A substantial percentage of the pumps were failing to operate properly just a few weeks after installation. The review team suggested a field investigation be conducted to determine the cause of failure of the modified pump. Based on this investigation a corrective course of action could be recommended.

Based on the above findings, Admendment Two of Order of Technical Direction (OTD) No. 143 was issued by the AID office of Health in Washington in March 1983, requesting the Water and Sanitation for Health (WASH) Project to survey, inspect, and analyze the current status of the locally manufactured, "pull-through-the-base-type" modified AID-design handpumps that had been installed in rural communities under the Health Sector Loan II Project.

1.2 Scope of Work

The scope of work Admendment Two of OTD 143 (see Appendix A) was the following:

A. Perform an initial survey of the "pull-through-the-base" handpumps already installed to determine field performance.

B. Document with instant black and white photographs all installed handpumps and handpump facilities surveyed.

C. Document persistent problem areas resulting in handpump system failure.

D. Bring back to Washington, D.C. appropriate samples of defective handpump system elements.

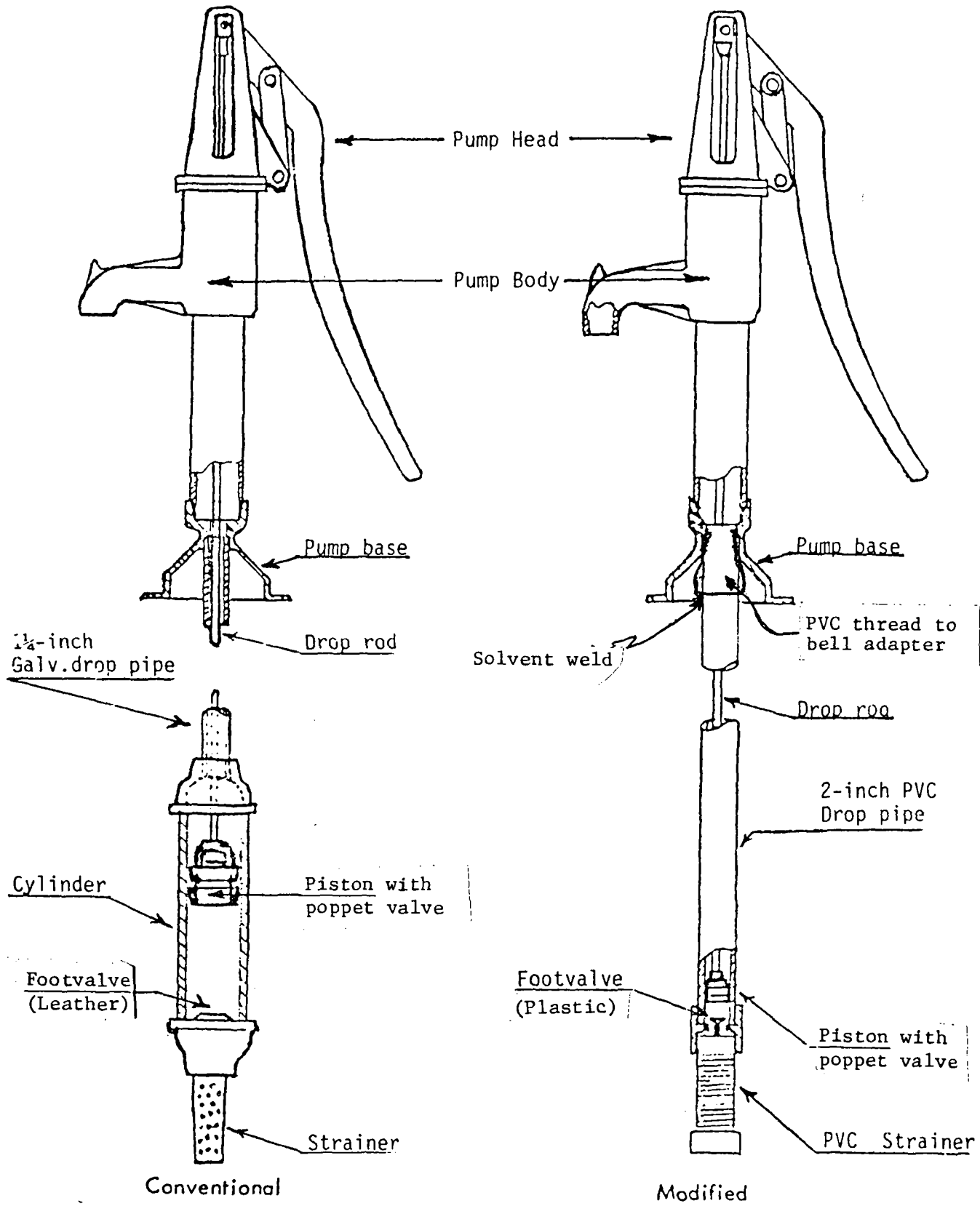


Figure 1

Source:WASH Field Report No.20
June,1981

AID HANDPUMP

E. For each site surveyed obtain the following information:

- o length of service
- o maintenance performed to date
- o depth of well
- o length of drop pipe
- o apparent quality of PVC joints and strainers
- o any foreign objects found in pipe components
- o condition of foot valve(s)
- o condition of connections of PVC drop pipe at pump stand base
- o current water level of well
- o description of problems with any part of handpump system
- o date of survey
- o date of notification of SESPAS maintenance crews for them to repair the broken handpump
- o average number of users of handpump system per day
- o estimate of average daily quantity of water taken per user per day if available.
- o any other pertinent information on particular sites.

Chapter 2

METHODS AND PROCEDURES

The field activities were conducted in two parts: the surveillance mode and the detailed inspection mode. For the surveillance mode, site visits were made to existing installations, and the working status of 60 randomly-selected modified AID handpumps was observed and noted. Additional information recorded was the exterior condition of the pump, the condition of the bushings, and the degree of lubrication. For the detailed inspection mode, 30 handpumps, which were found to be inoperable during the surveillance mode or previously reported by the Government of the Dominican Republic as inoperable, were disassembled and the causes of the malfunctions identified. The condition of the pump components was noted along with other information such as the date of pump installation, the approximate number of users, the exterior condition of the pump, the depth of the well, and the level of water in the well.

Appendix D contains the handpump field inspection procedures used while conducting the work required by OTD 143. Appendices E and F present the site data sheets filled out during the surveillance and detailed inspection modes, respectively.

Chapter 3

FINDINGS AND CONCLUSIONS

3.1 Summary of Data

The most frequent types of problems were : (1) A combination of design faults, manufacturing modifications, and/or installation which permitted the introduction of foreign matter into the drop pipe that interfered with the normal operation of the piston (plunger) poppet valve and/or the foot valve popper, (2) plunger popper valve failure, (3) separation of the PVC pipe assembly, and (4) the separation of the plunger rod.

3.2 General Findings

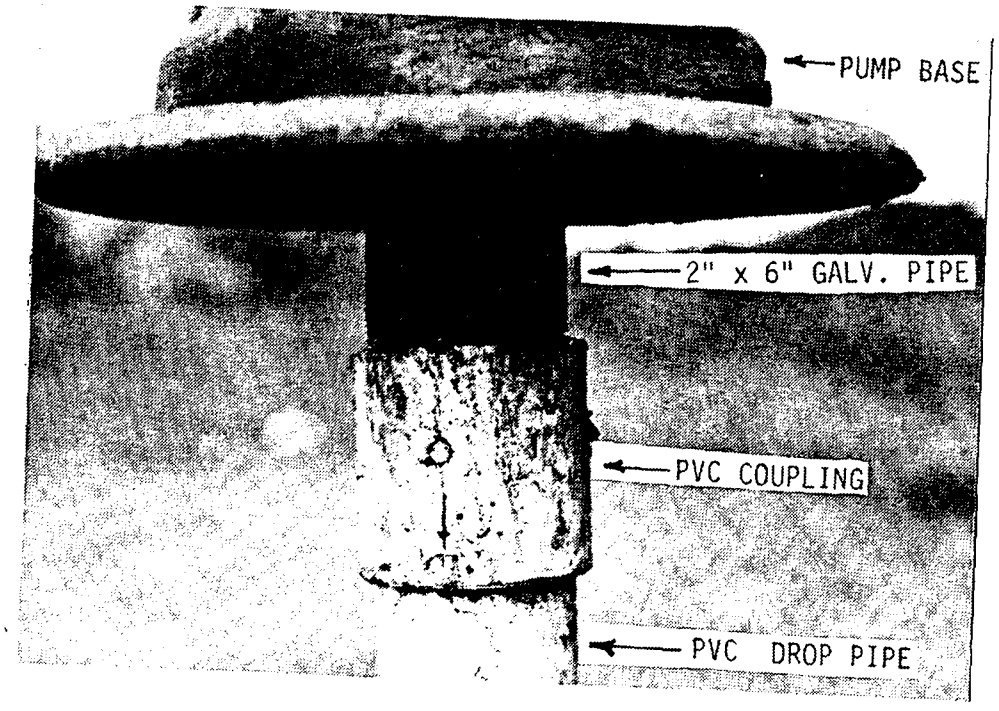
The above problems were due to the following:

- Problem Area 1 (42.5 percent) - Foreign materials such as pebbles, stones, sticks and even a "C" battery were found in the drop pipes as a result of an oversized drop rod opening on the pump head, improper installation techniques and/or deliberately inserting them through the spout (see Appendix G). The foreign matter became lodged between the plunger poppet valve or the foot valve poppet and seat, preventing the poppet from properly closing. Since no similar field investigation has conducted on the "conventional" pumps that are currently in the field it cannot be said that this is a problem unique to the "modified" pump. However, the frequency of failures and short length of time between installation and failure are unusual deviations from other experiences with handpump installations in the Dominican Republic and elsewhere.

- Problem Area 2 (15 percent) - Due to a defective plunger poppet valve, failures occurred when the valve got stuck between two legs of the cage or did not completely cover the valve seat. This is an apparent design problem.

- Problem Area 3 (15 percent) - Separation of the PVC occurred at the joint between the drop pipe and the PVC male-threaded adaptor in six cases. When inspected, little, if any, PVC solvent was found sticking to the internal surface of the PVC adaptor (Figure 2). In five cases the drop pipe had to be lifted out of the well by bonding another length of PVC pipe to it. The pipe ends became covered with new solvent in this process, so their surfaces could not be inspected. In one case it was possible to lift the PVC pipe out of the well with a rope. This allowed a better inspection since the pipe surface was not covered by new solvent.

- Problem Area 4 (15 percent) - Plunger rod separation was found in six cases. In two cases, the plunger rod had separated from the rod end. In three cases, the separation was at a coupling between rods. In one case, the separation was at the plunger assembly.



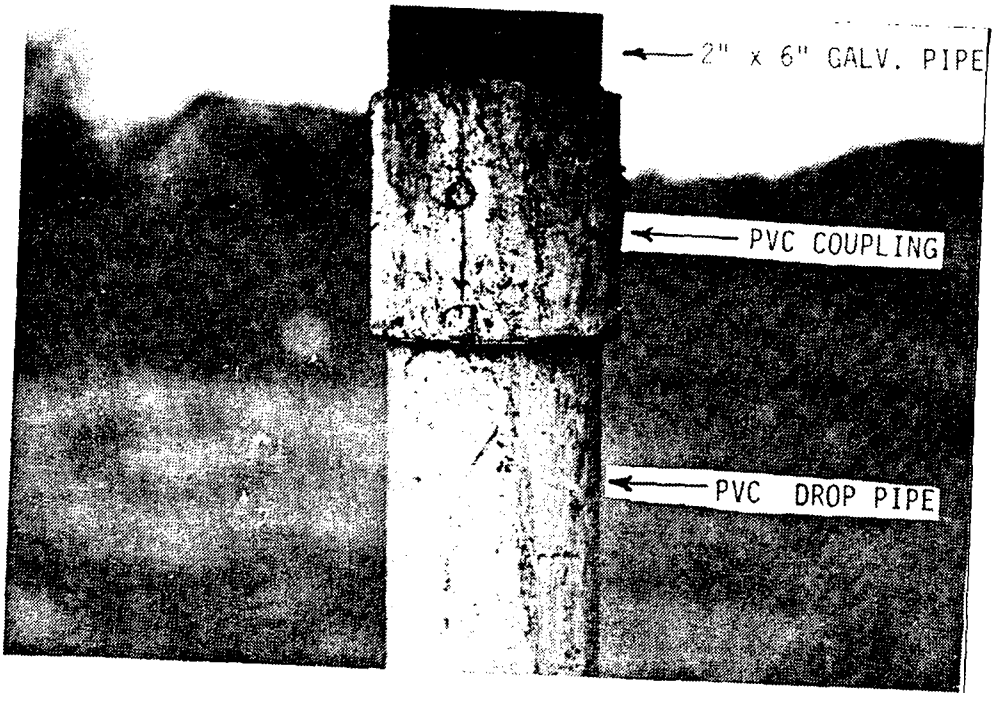


Figure 2

HAND PUMP BASE AND DROP PIPE
CONNECTION ASSEMBLY

- Problem Area 5 (12.5 percent) - See Table 1 for nine problems.

In addition to the above reported problems that resulted in pump failure, it was observed that most pumps had extremely loose bushings. However, this problem had not caused any pump malfunctions as of the time of inspection. In addition, it was observed that in general the handpumps were poorly lubricated and many did not have any lubrication at all.

Table 2 summarizes the surveillance mode inspection activities and Table 2 the detailed inspection mode. Table 3 is a matrix of each site where a detailed inspection was carried out and each site's associated problems. Appendix G shows representive pictures of the problems presented above.

3.3 Conclusions

Based on the findings, the following conclusions are drawn:

- The manufacturing quality of the handpumps is generally poor. Deficient quality controls in the factory were apparent and the methods and procedures used by SESPAS for pump acceptance from the manufacturer were not adequate in providing assurance of suitable pump quality or conformance to specifications. Appropriate handpump acceptance tests were not conducted, thus permitting defective handpumps to reach the field.

- Handpump installation techniques need to be improved. This is especially true with respect to PVC solvent application.

- There is a considerable lack of maintenance. Poor lubrication or none at all was the rule. It takes a long time for the limited number of maintenance crews to respond to a village's request for help in repairing a broken pump. During the inspection visits it was noted that villagers lack even the simplest information concerning the proper maintenance of a handpump. This makes it difficult, if not impossible, for the user to do simple maintenance locally.

Table 1

Summary of Detailed Inspection Mode
(Sample size was 30 pumps)*

Problems Identified During Detailed Inspection	Frequency of Problem	Problem Area	Percentage Problem
Foreign matter	17	1	42.5 %
Poppet valve stuck/worn out	6	2	15 %
Separation of PVC drop pipe	6	3	15 %
Separation of plunger rod	6	4	15 %
Separation of foot valve cage on non-reinforced foot valve**	2	5	5 %
Steel nipple unscrewed from pump base	1	5	2.5 %
Bottom 15 feet of drop pipe filled with mud	1	5	2.5 %
Water level in well below piston level	1	5	2.5 %
	40***		100 %

*Not all of these pumps were among those inspected in the surveillance mode. Some had previously been identified as inoperable by SESPAS.

** The first group of foot valves used in the project were not reinforced. At present, the foot valve used has been reinforced.

***The 30 pumps in the sample had 40 total problems, since some pumps had multiple problems.

Table 2

Summary of Surveillance Mode

Surveillance Mode

- size of random sample:	60 pumps
- pumps not working:	32 pumps (53 percent)
- pumps working:	28 pumps (47 percent)

Table 3

MATRIX OF INOPERABLE PUMPS BY SITE AND CAUSE OF FAILURE

	Plunger (Piston)			Separation of Pipe or Rod		Foot Valve and Bushings		
	Foreign Matter	Poppet Stuck Open	Poppet Disk Worn Out	PVC Drop Pipe	Plunger Rod	Footvalve Stuck Open with Trash	Bushings Loose or Missing	Other* Problems
1. Bogueron (T)	X	X					1	
2. Ranchito (T)					X		3	
3. Refugiados	X						3	
4. Tablas (Clinica)		X		X			2	
5. Arabelli Soto			X				4	
6. Martina Espequero				-See Note-			1	
7. La Cabria					X		6	
8. M. de Regla							5	X
9. M. Vargas		X					4	
10. V. Jimenez				X			2	
11. G. Estepan						X		
12. D. Solis						X	3	
13. J. Reyes			X	X				
14. R. Bello (T)	X						7	
15. V. Santo (T)	X							
16. O. Valdez							2	X
17. M. Contreras							4	X
18. A. Puello	X				X		3	X
19. M. Tapia (T)	X		X		X		5	
20. J. Diaz						X	5	
21. Sebana Larga Escuela	X				X	X	1	
22. J. Alta Gracia	X				X	X	0	
23. F. Pujols				X			0	
24. B. Franco				X			0	
25. M. Matos							1	X
26. A. Arias	X						0	
27. Vengan a ver Escuala	X						0	X
28. La Urea				X			4	
29. El Corbano	X						2	
30. Barranca (La Gallera)	X						1	X

T = Test Site: Installed by a consultant or by SESPAS between April and December 1981.

Notes: Tablas (martina Espeguero): Pump was working at time of inspection. However, community had previously reported it as inoperable and that it worked and failed alternatively. Failure condition was not present at inspection time.

*Other Problems:

- The 2" diameter by 6" long galvanized nipple became unscrewed from pump base. Drop pipe fell into the well.

- Water level below plunger.

- Silt on foot valve poppet and seat.

- Drop pipe filled with mud to a height of 15 feet.

- Separation on foot valve cage.

Chapter 4

RECOMMENDATIONS

In developing the recommendations of this report the writers take notice of the fact that over half (53 percent) of the pumps were not operational at the time of inspection and that the major problem was that of foreign matter in the drop pipe (42 percent of the cases.) In 15 percent of the pumps visited were there problems directly related to the plastic drop pipe and its solvent welds. In an additional 15 percent of the cases it was clear that the poppet valve of the plunger cylinder needed to be redesigned so that it was larger and heavier and had a longer tail. These redesigns would prevent the poppet from sticking in the cylinder cage while at the same time fully covering its seat. The recommendations that follow address these basic problems.

This chapter contains a set of recommendations and a set of alternative considerations. The former is based on OTD requirements and presents the most reliable way for the current project to be carried to a successful completion. The latter reflects various economic and political concerns of SESPAS and the Mission. However, due to the fact that the second set of recommendations would involve a technology that has not yet been proven through extensive field tests, it cannot be assured that they will be successful in resolving the problem with the modified pump.

SESPAS stopped production of the handpump due to a (a) problems being reported with the modified AID handpumps installed in the field, (b) general poor manufacturing quality of the modified handpumps, and (c) the present manufacturer requesting an increase in the handpump price. Based on the above, SESPAS has considered the selection of a new manufacturer. While the field problems are substantial they can probably be solved satisfactorily if the recommendations are implemented.

4.1 Recommendations Based on OTD Requirements

The following recommendations are based on the problems found during the field inspection and analysis of the handpump system component samples taken:

Recommendation No. 1

It is recommended that for approximately 640 pumps remaining to be manufactured for the Health Sector II Project, the price of the pumps not be the only deciding factor for procurement. The selection of a manufacturer should also be based on a technical evaluation of each bidder's managerial capabilities, foundry and machine shop facilities, plant capacity, and level of product quality as evidenced by observation of products being manufactured at the time of the technical evaluation. The manufacturers quality control procedures should be carefully evaluated.

Recommendation No. 2

It is recommended that the selected manufacturer be responsible for the overall quality of the complete pump, not just certain components. SESPAS should avoid a repetition of the past whereby items such as pins, bushings, and foot valves were purchased separately by SESPAS and then delivered to the manufacturer for assembly.

Recommendation No. 3

It is recommended that the modified "pull-through-the-base" type AID handpump design be replaced by the conventional design that uses a 3.0-inch cylinder and a 1.25-inch drop pipe (galvanized iron). The foot valve for the pump should be either a locally made metal poppet valve or a Clayton Mark (or equivalent) model which is available in Dominican Republic hardware stores for approximately $8.00.

Recommendation No. 4

For those pumps installed in the field with 2" PVC drop pipe and the locally made plastic foot valves it is recommended that additional 3-inch-diameter pump cylinders be manufactured and installed as needed.

Recommendation No. 5

Additional cap assemblies should be manufactured to replace those in the field with loose bushings. The leather flapper foot valves should be replaced with metal popper/rubber seat foot valves in the AID handpumps of conventional design that were installed before the modified pump.

Recommendation No. 6

It is recommended that the plunger poppet valve failure be corrected by increasing the diameter of the top of the poppet as well as increasing the diameter and length of its shaft, to provide a better seal and to prevent it from getting stuck between two legs of the plunger cage. Additional poppet valves should be manufactured to replace those in the field.

Recommendation No. 7

It is recommended that SESPAS, the USAID Mission, and the handpump manufacturer be provided with in-depth and extended technical assistance for each of the above recommendations. This should include assistance to the selected manufacturer in production and quality control and to SESPAS on acceptance testing. Also, such assistance should extend to the following areas:

- For assisting SESPAS to develop a long-term, locally based maintenance system for training community organizers (health educators) in techniques for increasing awareness of the need for proper maintenance and repair of

handpumps. This can be achieved by establishing a training system with field based workshops. After these workshops, community organizers would be capable of training villagers in maintaining and repairing their handpumps.

- o Preparation of bid documents, gauge kits and specifications before a new manufacturer is selected. This would insure proper inclusion of pertinent technical manufacturing requirements (for instance, one requirement should be the use of properly designed and fabricated jigs and fixtures).

- o Assistance to the manufacturer in quality assurance procedures and to SESPAS in acceptance procedures.

- o Determination of the reasons behind large amounts of foreign matter found in the plunger and foot valve assemblies. It is believed that the causes range from vandalism to improper installation procedures (for instance, laying the drop pipe on the ground and causing dirt, rocks, twigs, etc., to enter into the drop pipe without cleaning it out before installing it).

- o Capability of anticipating handpump operational problems.

4.2 Alternative Considerations

At the request of SESPAS and the USAID Mission, WASH consultants examined some economic and financial aspects of the handpump component of the Health Sector Loan II Project (i.e. SESPAS has purchased all the materials necessary for the installation of the remaining 640 modified AID design handpumps, which represents an investment of over $80,000).

SESPAS stated that it would be difficult to use the purchased materials in other projects or even transfer them to another government agency. Also, because various problems associated with the handpump program have cast a negative image, SESPAS would prefer to avoid the further adverse publicity which would result from wasting materials or transferring them to another project.

In light of this situation, the following alternatives though not necessarily recommend are suggested:

- o The remaining 640 handpumps yet to be manufactured could be of the modified AID design. However, the PVC foot valve should be replaced with a locally available 1.25-inch brass foot valve (a Clayton Mark or equal model which is available in Dominican Republic hardware stores for approximately $8.00). Implementation of this change would require purchasing the brass foot valve and a 2 by 1.25-inch reducer.

- o To prevent separation of the PVC drop pipe assembly at the handpump base, the SESPAS installation and maintenance crews have used a 2-inch diameter by 12-inch long bell-ended section of PVC pipe between the 2-inch PVC adaptor and the PVC drop pipe assembly (Figure 3). The 2-inch PVC adaptor and the 12-inch section of PVC pipe are glued 24 hours prior to handpump

installation. So far this has apparently eliminated separation of the PVC drop pipe assembly at the location where this problem most frequently occurred. This practice should be continued wherever the PVC drop pipe assembly is used. However, there is not sufficient field-test data to guarantee the success of this approach, and it should not be expected to totally correct the PVC drop pipe separation problem.

- For existing installations that used the modified pump, the foot valve and the connection of the drop pipe at the pump base could be replaced with the brass foot valve and the 12-inch section of pipe, as described above, at a time when regular maintenance or repair is conducted.

The above alternative considerations should be implemented if the following steps are followed. Otherwise, the likelihood of success will be extremely low.

- SESPAS should carefully inspect the handpumps before accepting them from the manufacturer, thus drastically upgrading quality control.

- SESPAS should radically improve handpump field installation procedures.

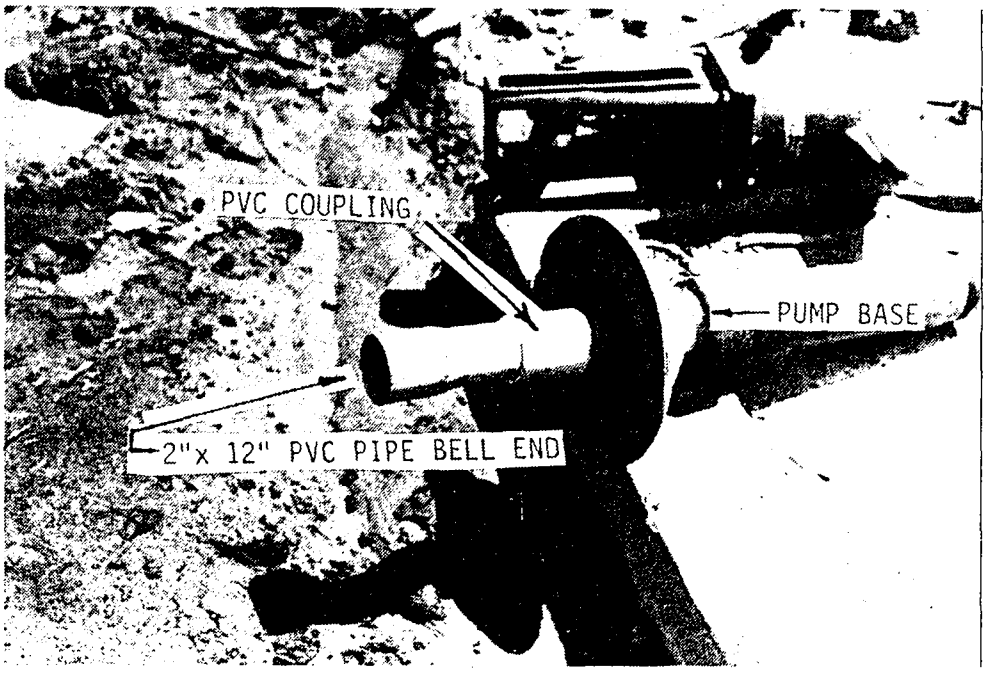
- SESPAS should carefully train handpump installation and maintenance crews and provide awareness of the consequences of an improperly installed handpump.

- To correct the problem of loose bushings in the cap assembly of existing pumps, any of the components (cap, fulcrum, rod end, and handle) that need better fitting bushings can be taken to a general machine shop by maintenance crews to have the hole(s) reamed to a diameter of approximately 0.874 inches, which would provide a press fit with a bushing with an outside diameter of 0.875 inches. While this is being done on a specific handpump, a new component can be replaced to avoid leaving the community without a working pump.

  SESPAS should carefully prepare for the logistical burden which will result from having handpump heads with two different size bushings until all pumps have the same size bushings. There should be extremely careful planning before making the decision to go ahead with the implementation of this alternative. Record keeping and a system for the clear identification of the pump installation sites are of utmost importance.

- Earlier installed AID handpumps (conventional design) should have their leather flapper foot valves replaced with metal poppet/rubber seal foot valves (brass type) when the former ones become worn out or fail to operate properly.

Before implementing the alternative considerations stated above, SESPAS should consider the high maintenance cost if the above considerations do not correct the problems completely and compare that cost with the $80,000 already invested in PVC pipe and other materials.



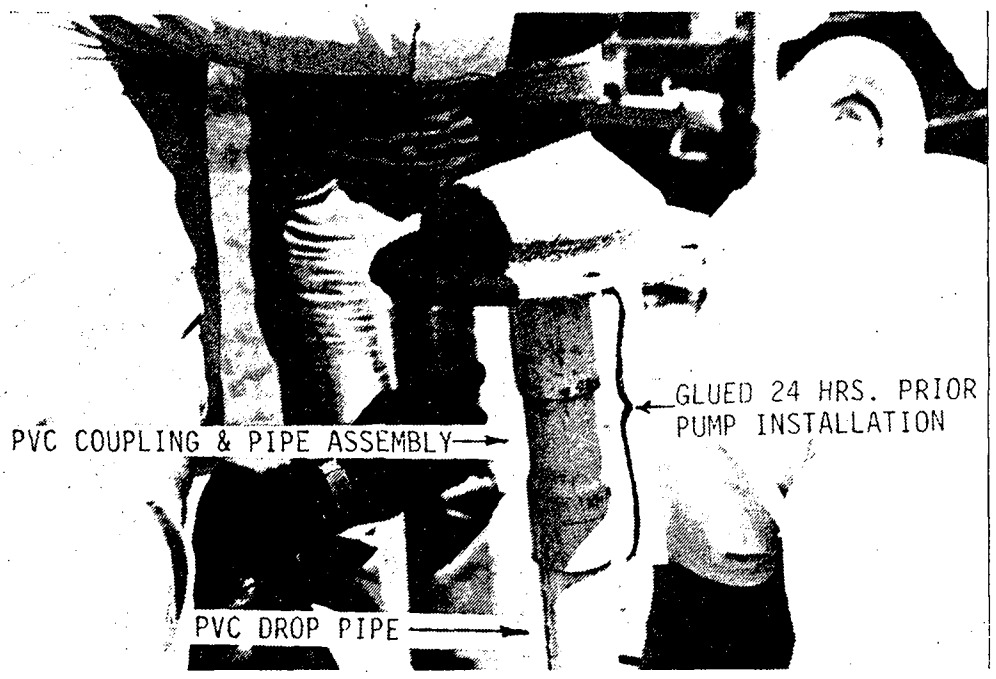


Figure 3

PVC DROP PIPE CONNECTION GLUED 24 HRS. PRIOR PUMP INSTALLATION
TO PREVENT PVC DROP PIPE SEPARATION

SESPAS should contact private voluntary organizations in the country to investigate the possibility of selling the PVC pipe purchased to them in order to minimize a loss to the project if the decision is made to use the conventional AID design handpump.

The conventional AID design handpump is recommended for future handpump programs in the Dominican Republic. This is the best technical solution and in addition it would reduce the number and types of spare parts and logistic problems.

APPENDIX A

WATER AND SANITATION FOR HEALTH (WASH) PROJECT
ORDER OF TECHNICAL DIRECTION (OTD) NUMBER 143
March 7, 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/Dominican Republic and Peace Corps/Dominican Republic

REFERENCES: A) Santo Domingo 01637, dated 2 March 1983
B) Description of Workshop

1. WASH contractor requested to provide technical assistance to USAID/Dominican Republic and PC/Dominican Republic as per Ref A, para 1-7 and Ref B.

2. WASH contractor/subcontractor/consultants authorized to expend up to 96 person days of effort over a five (5) month period to accomplish this technical assistance effort.

3. Contractor authorized to expend up to 95 person days of internatio and/or domestic per diem to accomplish this effort.

4. Contractor to coordinate with LAC/DR/HN (Linda Morse), LAC/DR/ENG (Rod MacDonald), Dominican Republic Desk Officer, PC Water and Sanitation Specialist (Jim Bell), PC/W Dominican Republic Desk Officer and others in Washington or USAID/Dominican Republic and should provide copies of this OTD along with any ETA information, or interim reports as may be requested by S&T/H/WS, LAC/DR or PC/W staff.

5. Contractor authorized to provide up to two (2) international round trips from consultants home base through Washington D.C. (for briefing and planning) to Dominican Republic and return to consultant's home base through Washington D.C. during life of this OTD. Contractor authorized to expend up to two (2) domestic round trips in additomon to the two (2) international round trips described above in this para for purposes of material preparation or planning.

6. Contractor authorized local travel for consultants in the Dominican Republic NTE $1100 without the written approval of the AID WASH Project Manager.

7. Contractor authorized to obtain secretarial, graphics or reproducti or piecework assistance (mason, carpenter, workmen, etc.) services in the Dominican Republic or WASH CIC as necessary and appropriate to accomplish tasks. These services are in addition to the level of effor specified in para 2 and 3 above and NTE $2600 without prior written approval of the AID WASH Project Manager.

8. Contractor authorized to provide for car or vehicle(s) rental if necessary and appropriate to facilitate effort. USAID/Dom. Rep., PC/Dom. Rep. and SESPAS strongly encouraged to provide vehicle support for workshop if at all possible and if available and appropria

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

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

11. Contractor report on overall progress of activity to be made in writing in the field after conclusion of effort. A draft coordinated report in English is to be left at USAID/Dom. Rep.. USAID and Peace Corps/Dom. Rep. are responsible to provide secretarial and translating services to produce Spanish versions of field draft coordinated report to support this effort if USAID and PC want Spanish tranlation of draft field report. Final report due to S&T/H within 30 days of return of consultants to the U.S. Final report to be in Spanish and English translated, edited and printed by WASH CIC.

12. New procedures regarding subcontractor cost estimates and justification for subcontractor/consultants remain in effect.

13. USAID and PC and persons identified in para 4 above should be contacted immediately and technical assistance initiated before 20 March 1983 or at date convenient to USAID and PC.

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

WATER AND SANITATION FOR HEALTH (WASH) PROJECT
ORDER OF TECHNICAL DIRECTION (OTD) NUMBER 143
March 14, 1983
Amendment No. 1

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/Dominican Republic and Peace Corps/Dominican Republic

REFERENCE: A) OTD # 143, dated 7 March 1983

1. Para 2 to subject OTD # 143 (Ref A) is cancelled. New para 2 to subject OTD # 143 (Ref A) is now to read as follows:

"2. WASH contractor/subcontractor/consultants authorized to expend up to 107 person days of effort over a five (5) month period to accomplish this technical assistance."

2. Para 3 to subject OTD # 143 (Ref A) is cancelled. New para 3 to subject OTD # 143 (Ref A) is now to read as follows:

"3. Contractor authorized to expend up to 104 person days of international/domestic per diem to accomplish this effort."

3. Nothing follows.

WATER AND SANITATION FOR HEALTH (WASH) PROJECT
ORDER OF TECHNICAL DIRECTION (OTD) NUMBER 143
AMENDMENT NUMBER 2
March 17, 1983

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

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

SUBJECT: Provision of Technical Assistance Under WASH Project Scope of Work for USAID/Dominican Republic and Peace Corp/Dominican Republic

REFERENCE: A) OTD #143, dated 7 March 1983

1. Para. 2 to subject OTD #143 (Ref. A) is cancelled. New para. 2 to subject OTD #143 (Ref. A) is now to read as follows:

"2. WASH contractor/subcontractor/consultants authorized to expend up to 133 person days of effort over a five (5) month period to accomplish this technical assistance. Of the 133 person days authorized, 26 person days authorized to be expended on scope of work identified in new para. 1.A. described below in this amendment."

2. Para. 3 to subject OTD #143 (Ref. A) is cancelled. New para. 3 to subject OTD #143 (Ref. A) is now to read as follows:

"3. Contractor authorized to expend up to 121 person days of international and/or domestic per diem to accomplish this effort. Of the 121 person days authorized, 26 person days authorized to be expended on scope of work identified in new para. 1.A. described below in this amendment."

3. New para. 5.A. to subject OTD #143 (Ref. A) is now to read as follows:

"5.A. Contractor authorized to provide up to two (2) international round trips from consultants' home base to Dominican Republic and return to consultants' home base through Washington, D.C. for the purpose of carrying out the scope of work in para. 1.A. described below in this amendment."

4. New para. 6.A. to subject OTD #143 (Ref. A) is now to read as follows:

"6.A. Contractor authorized to provide for local travel for two consultants in the Dominican Republic NTE $1600 without the written approval of the AID WASH Project Manager for the scope of work identified in para. 1.A. described below in this amendment."

5. New para. 7.A. to subject OTD #143 (Ref. A) is now to read as follows:

"7.A. Contractor authorized to provide for local Dominican Republic piecework manpower assistance (masons, carpenters, workmen, etc.) services as necessary and appropriate to carry out scope of work identified in para. 1.A. below. These services are in addition to the level of effort specified in para. 2 and 3 above and NTE $850 without the prior written approval of the AID WASH Project Manager."

6. New para. 8.A. to subject OTD $143 (Ref. A) is now to read as follows:

"8.A. Contractor authorized to provide for car or vehicles rental if necessary and appropriate to facilitate effort in carrying out para. 1.A. scope of work described below. These costs NTE $1800 without the prior written approval of the AID WASH Project Manager."

7. New para. 1.A. to subject OTD #143 (Ref. A) is now to read as follows:

"1.A. Contractor to provide field survey, inspection, [illegible] reporting services to S&T/H/WS and USAID/Dominican Republic regarding current field installed status of locally manufactured, pull-through-the-base-type modified AID design hand pumps being implemented under the Health Sector II Project of USAID/Dominican Republic. Contractor to initially survey population of these type hand pumps already installed to determine field performance. Contractor should have consultants document with instant black and white photographs all installed hand pump and hand pump facilities surveyed. Examples of persistent problem areas resulting in hand pump system failure should be documented by bringing back to Washington, D.C. appropriate samples of defective hand pump system elements. Each site surveyed should have information developed for report relating to length of service, maintenance performed to date, depth of well, length of drop pipe, apparent quality of PVC joints and strainers, any foreign objects found in pipe components, conditions of footvalve(s), condition of connections of PVC drop pipes at pumpstand base, current water level of well, description of problems with any part of hand pump system, date of survey, date of notification of SESPAS maintenance crews for them to repair the hand pumps broken, average number of users of hand pump system per day, estimate of average daily quantity taken out per user per day if available, any other pertinent information necessary to be recorded on particular sites. Contractor to work closely with USAID/Dominican Republic and SESPAS personnel implementing project in carrying out survey. S&T/H/WS recommends that at least one SESPAS engineer accompany consultants on field survey operation. Contractor to report preliminary results of survey back to WASH CIO and S&T/H/WS by phone at 1100 hours on

Thursday, March 24, 1983. S&T/H/WS personnel will be at WASH CIC to participate with CIC personnel in phone call to determine whether or not future follow-up will take place and to what extent. Report to be developed in English and left with the USAID/Dominican Republic staff before consultants leave Dominican Republic. Final report to be developed only after approval of AID WASH Project Manager."

8. Nothing follows.

APPENDIX B

Itinerary

WASH Consultants (Pareja and Van)

19 March 1983	H. Van arrives Santo Domingo.
21 March 1983	H. Van met with USAID Mission and SESPAS.
22 March 1983	H. Van met with USAID Mission and SESPAS.
23-24 March 1983	H. Van conducted surveillance inspection of handpumps.
24 March 1983	F. Pareja arrived Santo Domingo.
25 March 1983	H. Van and F. Pareja meet with USAID Mission and SESPAS.
28-31 March 1983	H. Van traveled to San Juan and Las Matas de Farfan, DR. F. Pareja initiated detailed inspection of handpumps.
1 April 1983	H. Van met with USAID Mission. F. Pareja conducted detailed inspection of handpumps.
4-16 April 1983	H. Van conducted latrine Construction Workshop at Las Matas de Farfan, DR. F. Pareja conducted detailed inspection of handpumps.
18-22 April 1983	H. Van prepared materials for the second latrine construction workshop. F. Pareja conducted detailed inspection of handpumps.
23 Apirl 1983	F. Pareja and H. Van met to summarize handpump field inspection data.
25 April-6 May 1983	H. Van conducted second latrine construction workshop.
9 May 1983	H. Van met with USAID Mission and SESPAS for a debriefing.

APPENDIX C

Persons Contacted

Dr. Oscar Rivera-Rivera, M.D.	USAID Mission/Santo Domingo
Mr. John H. Thomas	USAID Mission/Santo Domingo
Mr. Manuel Valdez	USAID Mission/Santo Domingo
Dr. Jose M. Herrera, M.D.	SESPAS
Ing. Elpidio Caba	SESPAS
Mr. Ramon Castro Bello	SESPAS

APPENDIX D

Handpump Field Inspection Procedure
Dominican Republic - OTD 143

1. Obtain general information requested in the Handpump Performance Data Sheets, i.e. Community, Date Installed, Type of Survey, etc.

   NOTE: Observe crew's procedures and documents.

2. Inspect the handpump exterior and visible components. Take pictures of all damaged or abnormal components.

3. Inspect and observe wear in pins, bushings and bushing housing.

4. Disassemble steel pipe section of pump and inspect threads.

5. Inspect handpump body and base threads and look for porosity.

6. Inspect condition of the following:

   a) Drop rod section coulping ends.
   b) Drop rod section couplings and threads. Take pictures to document their conditions
   c) Piston components. Take pictures to document their condition.

7. Perform foot valve leakage test. The test is conducted by filling the drop pipe with water and measuring the loss of water.

8. Perform piston leakage test. The test is conducted by putting the piston at the bottom of a 3" PVC pipe, filling it with water and measuring the drop of the water column in 15 min.

9. Disconnect pump base and take out drop pipe. Inspect condition of pipe sections and joints. Take pictures to document their condition.

10. Inspect condition of the PVC strainer. Take pictures to document its condition.

11. Cut pipe section to inspect condition of PVC foot valve. Take pictures of foot valve assembly and its components to document their condition.

12. Install drop pipe.

13. Allow PVC solvent to weld for 24 hours.

14. Perform foot valve leakage test.

15. Install handpump.

NOTE: Observe and document crew's installation procedures.

APPENDIX E

SURVEILLANCE MODE

HAND PUMP PERFORMANCE REPORT
DOMINICAN REPUBLIC

DATE _____ COMMUNITY _____

INSPECTED BY _____ MUNICIPALITY _____

TYPE OF SURVEY: PRELIMINARY ☐ DETAILED ☐ STATE _____

TYPE OF HANDPUMP _____

TYPE OF WELL: ☐ DRILLED ☐ EXCAVATED ☐ DRIVEN

DATED INSTALLED _____ AVERAGE NUMBER OF USERS _____

GROUP RESPONSIBLE FOR INSTALLATION _____

MAINTENANCE PERFORMED TO DATE _____

_____

_____

_____

_____

_____

DEPTH OF WELL _____

DISTANCE TO THE WATER SURFACE _____

TYPE OF DROP PIPE _____

LENGTH OF DROP PIPE _____

DIAMETER OF DROP PIPE _____

APARENT QUALITY OF PVC JOINTS, EXPLAIN _____

_____

_____

_____

_____

_____

_____

HAND PUMP PERFORMANCE REPORT

DOMINICAN REPUBLIC

(CONT'D)

APARENT QUALITY OF THE STRAINER, EXPLAIN_____

CONDITION OF THE FOOTVALVE ASSEMBLY, EXPLAIN_____

CONDITION OF CONNECTIONS OF PVC DROP PIPE AT PUMSTAND BASE, EXPLAIN___

ANY FOREIGN OBJECTS FOUND IN PIPE COMPONENTS, ☐ YES, DESCRIBE_____

HAND PUMP PERFORMANCE REPORT

DOMINICAN REPUBLIC

(CONT'D)

HAS THERE BEEN ANY BREAKDOWN IN THE HAND PUMP ☐ YES ☐ NO, IF YES, WHEN _____

_____

_____

WHAT WAS THE SYMPTOM OF FAILURE _____

_____

_____

HOW LONG HAS THE HAND PUMP BEEN OUT OF ORDER _____

_____

_____

WHICH COMPONENT (S) FAILED _____

_____

_____

_____

DATE OF NOTIFICATION OT "SESPAS" MAINTENANCE CREWS FOR THEM TO REPAIR THE HAND PUMP BROKEN _____

_____

WHAT WENT WRONG FIRST THAT CAUSED THE CARETAKER TO REPORT THE BREAKDOWN

_____

_____

WHERE ANY PART (S) REPLACED ☐ YES ☐ NO, IF YES, EXPLAIN _____

_____

_____

_____

HAND PUMP PERFORMANCE REPORT

DOMINICAN REPUBLIC

(CONT'D)

WHY DID THE BREAKDOWN OCCUR: MECHANICAL FAILURE_____

DAMAGE_____ MISSING COMPONENTS_____

OTHER_____ EXPLAIN_____

ESTIMATE HOW MANY HOURS WERE SPENT ONLY IN REPAIRING THE PUMP_____

DESCRIBE REASONS FOR TIME TAKEN BETWEEN BREAKDOWN AND FINAL REPAIR_____

WHAT IS THE PRESENT MONITORING PROCEDURE FOR THIS PUMP_____

ESTIMATE OF AVERAGE DAILY QUANTITY OF WATER TAKEN OUT PER USER PER DAY, IF AVAILABLE_____

HAS THERE BEEN ANY VISIBLE CHANGE IN THE EXTERIOR OF THE HAND PUMP,

☐ YES, ☐ NO; IF YES, INDICATE ☐ WEAR, ☐ DAMAGE, ☐ MISSING COMPONENTS, ☐ OTHER, GIVE DETAILS_____

HAND PUMP PERFORMANCE REPORT

DOMINICAN REPUBLIC

(CONT'D)

HOW MANY FULL STROKES DOES IT TAKE TO GET WATER_____

_____

HOW MANY FULL STROKES DOES IT TAKE TO FILL A STANDARD CONTAINER OF X LITERS (USE A FULL STROKE, UP-DOWN ALL THE WAY)_____

_____

_____

HAVE THERE BEEN ANY OTHER DIFFICULTIES OR PROBLEMS WITH THE PUMP,

☐ YES, ☐ NO, IF YES, DESCRIBE_____

_____

_____

_____

_____

_____

SOURCE OF WATER BEFORE HAND PUMP WAS INSTALLED_____

_____

_____

DISTANCE OF ABOVE SOURCE OF WATER_____

_____

_____

APPENDIX F

INSPECTION MODE

HAND PUMP PERFORMANCE REPORT
DOMINICAN REPUBLIC

DATE _____ COMMUNITY _____

INSPECTED BY _____ MUNICIPALITY _____

TYPE OF SURVEY: PRELIMINARY DETAILED

DATE INSTALLED _____ APPOXIMATE NO. OF USERS _____

EXTERIOR CONDITION OF PUMP _____

LUBRICATION STATUS OF PUMP_____

HOW MANY TIMES HAS THE PUMP BEEN BROKEN?_____

WHICH COMPONENT(S) FAILED_____

DATE OF NOTIFICATION TO "SESPAS" MAINTENANCE CREWS FOR THEM TO REPAIR THE PUMP _____

WERE ANY PART(S) REPLACE YES NO
EXPLAIN_____

REASON FOR PREVIOUS BREAKDOWN(S): MECHANICAL FAILURE_____

DAMAGE_____ MISSING COMPONENTS_____

OTHER_____

EXPLAIN_____

STATE REASONS FOR TIME TAKEN BETWEEN BREAKDOWN AND FINAL REPAIR_____

CONDITION OF DROP ROD_____

CONDITION OF PUMP PISTON ASSEMBLY_____

CONDITION OF CONNECTIONS OF PVC DROP PIPE AT PUMP STAND BASE_____

RESULTS OF FOOT VALVE LEAKAGE TEST_____

CONDITION OF PVC DROP PIPE JOINTS_____

CONDITION OF THE PVC STRAINER _____

CONDITION OF THE FOOT VALVE ASSEMBLY_____

RESULTS OF PISTON LEAKAGE TEST _____

_____

_____

_____

ANY FOREIGN OBJECTS FOUND IN PIPE, PISTON OR FOOT VALVE COMPONENTS

YES NO, DESCRIBE _____

_____

_____

_____

DEPTH OF WELL _____

DISTANCE TO WATER SURFACE

LENGTH OF PVC DROP PIPE

HOW MANY FULL STROKES DOES IT TAKE TO FILL A STANDARD CONTAINER OF X LITERS

_____

_____

OTHER COMMENTS _____

_____

_____

_____

_____

_____

_____

_____

_____

Appendix G

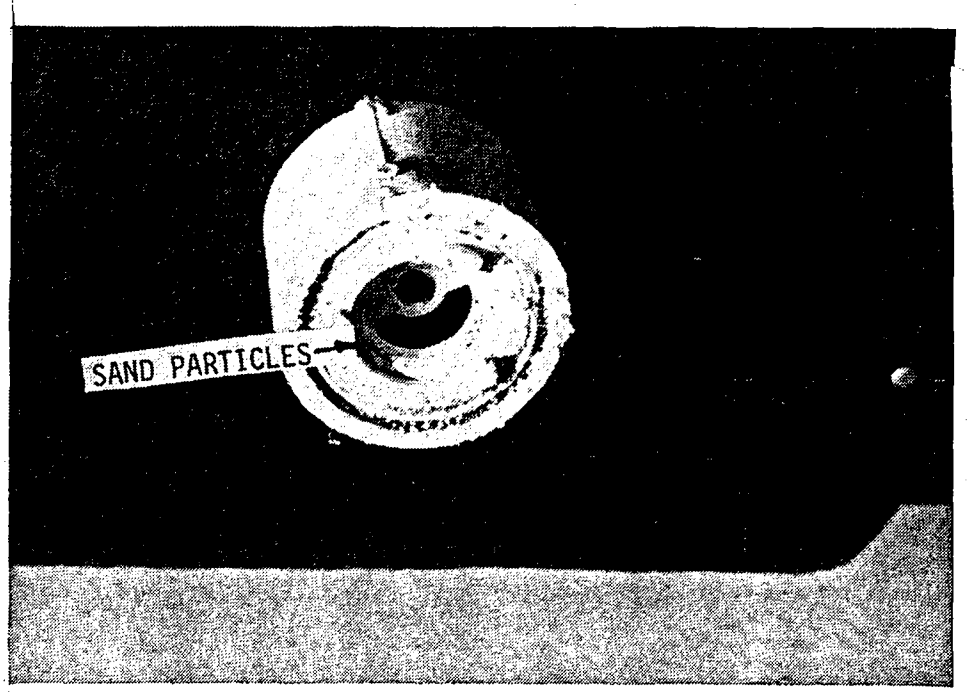
PHOTOGRAPHS OF PROBLEM AREAS

The following are representative pictures taken in the field during the detailed inspection of the modified AID hand pumps installed under the Dominican Republic Health Sector II Project. The purpose of these pictures is to provide a pictorial view of the different problems discussed in the body of the report. The pictures are presented by problem areas as follows:

- Foreign Matter
  - Plunger
  - PVC Foot Valve
- Plunger poppet valve failure
- Separation of PVC pipe or plunger rod

- FOREIGN MATTER -

Pebbles lodged between poppet valve and its seat causing leakage of the water column

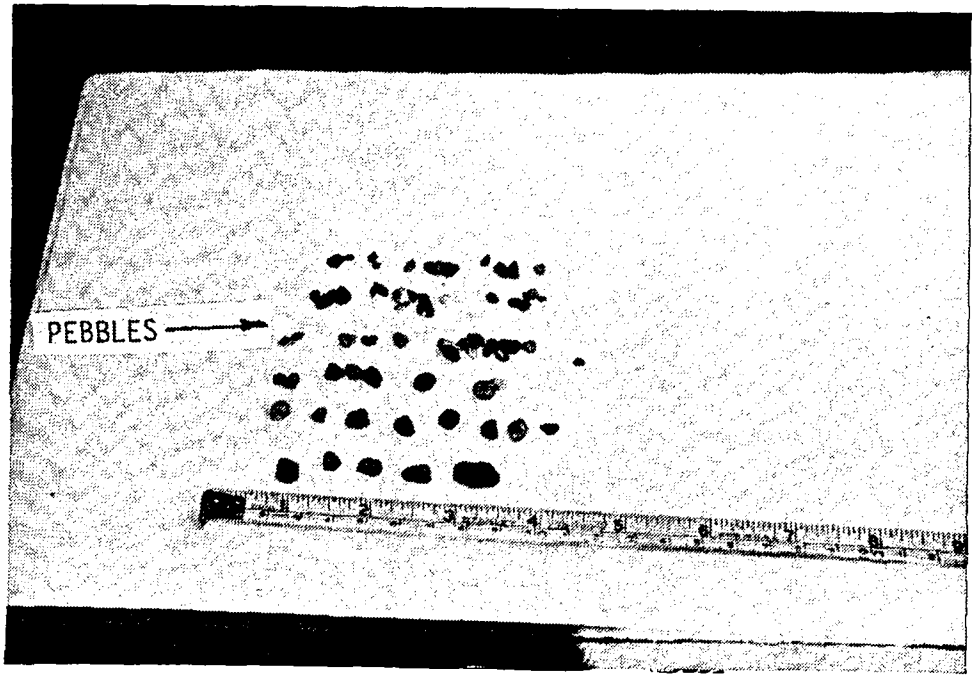


- FOREIGN MATTER -

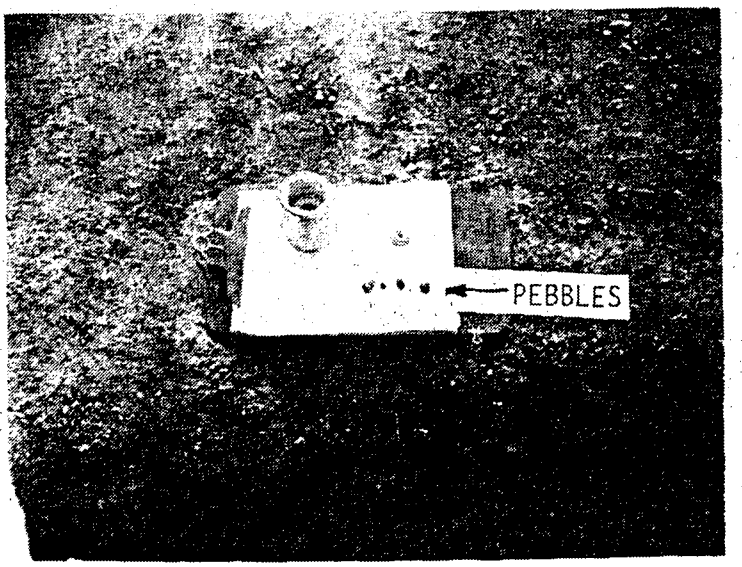
Sand particles interfering with the proper operation of the PVC foot valve causing leakage of the water column

- FOREIGN MATTER -

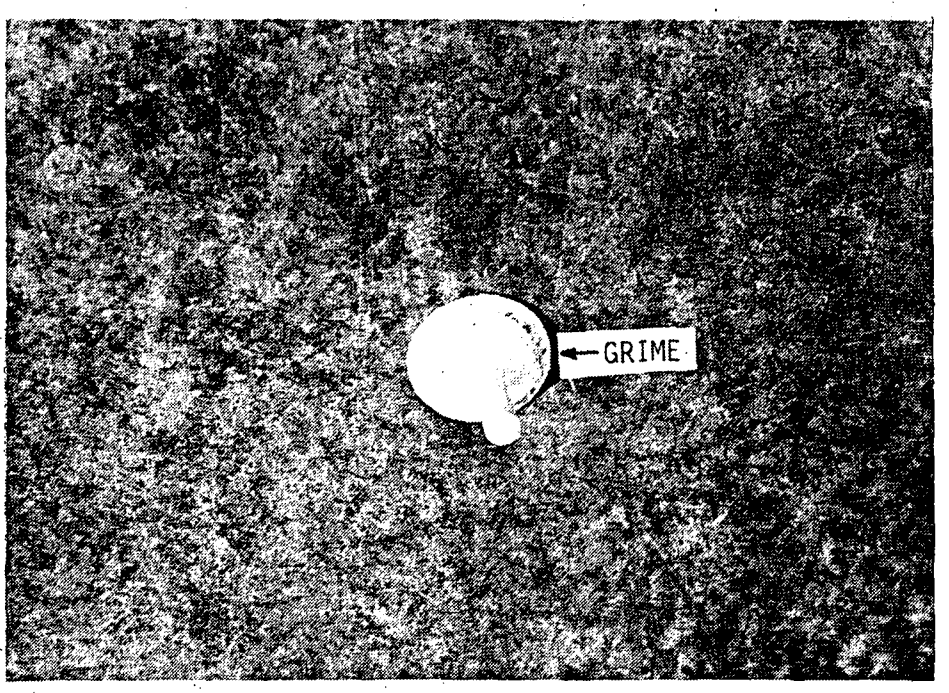
Pebbles lodged between poppet valve and its seat causing leakage of the water column



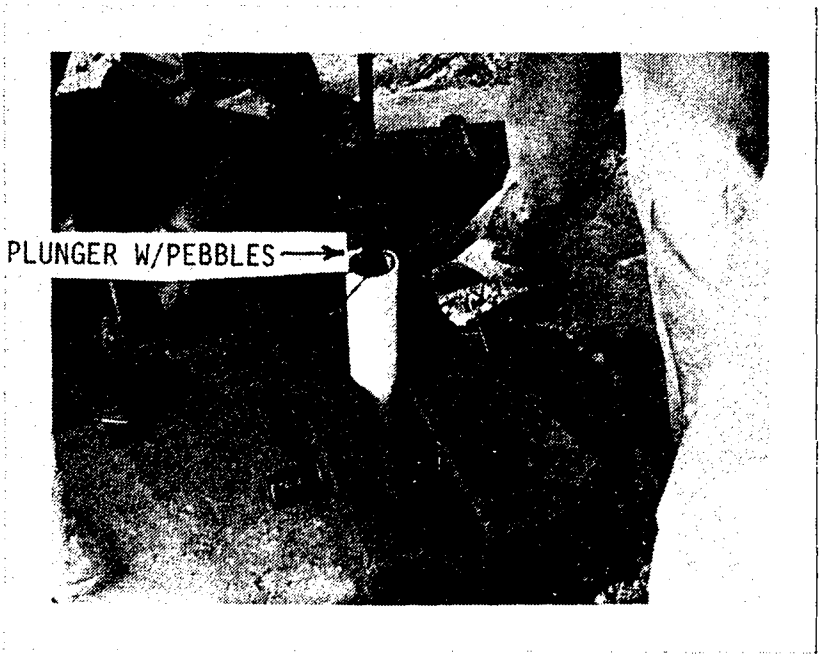
- FOREIGN MATTER -
Pebbles found in a PVC foot valve



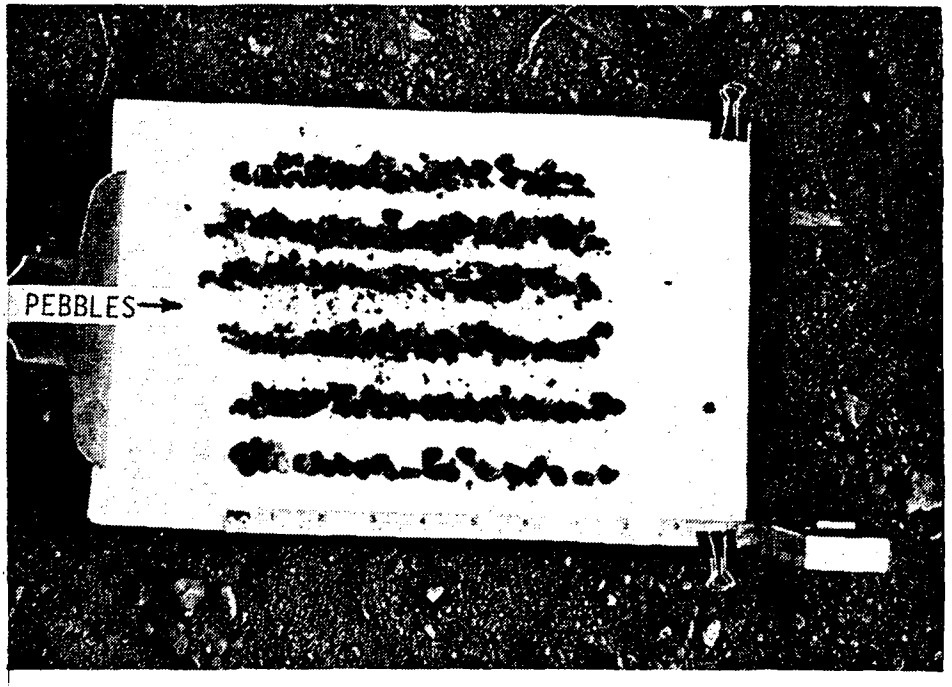
- FOREIGN MATTER -
Pebbles lodged between poppet valve and the seat of this PVC foot valve causing leakage of the water column



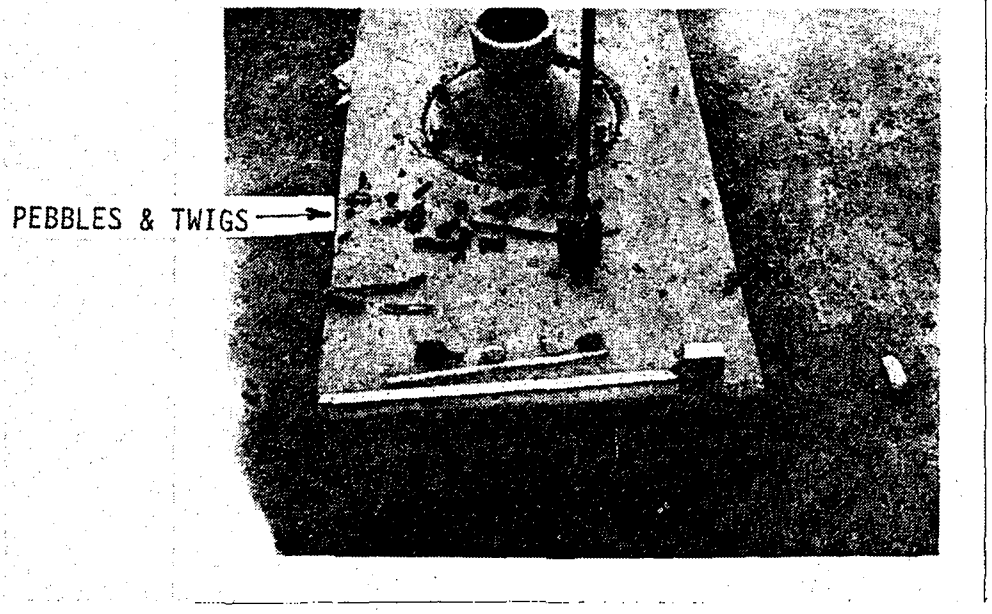
- FOREIGN MATTER -
Grime on the PVC poppet valve seal causing leakage of the column of water



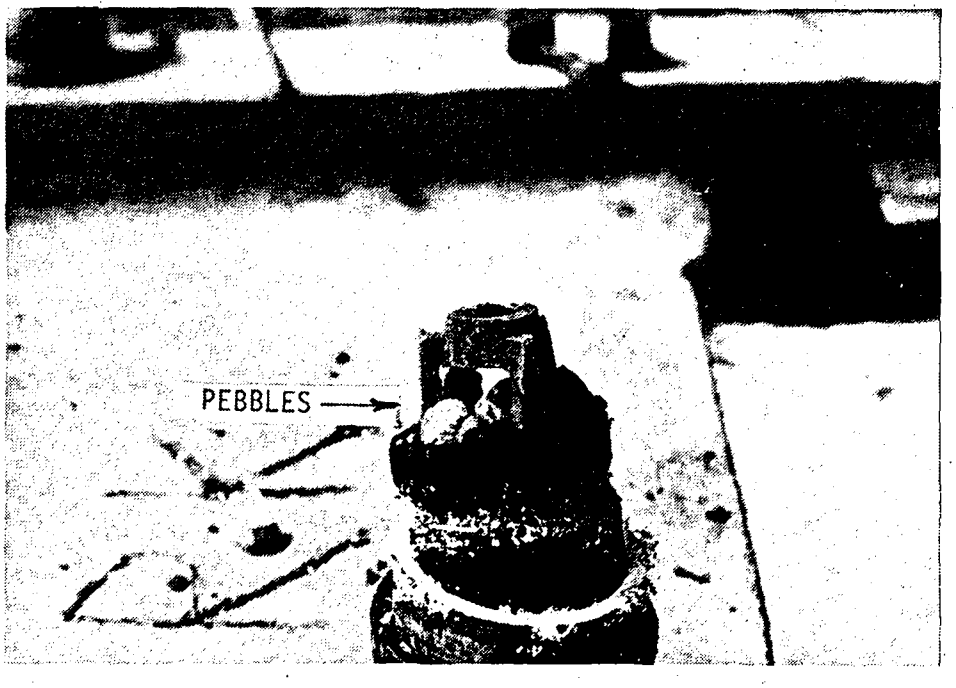
- FOREIGN MATTER -
Plunger being taken out with pebbles preventing functioning of the plunger poppet valve



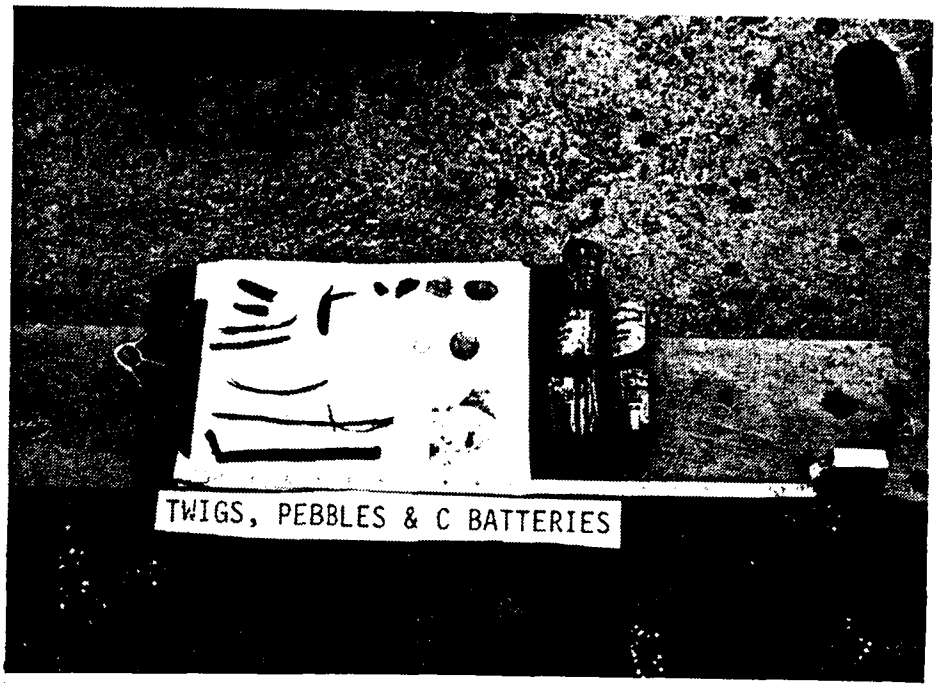
- FOREIGN MATTER -
Pebbles found in the above plunger



- FOREIGN MATTER -
Pebbles and twigs lodged between poppet valve and its seat causing leakage of the water column



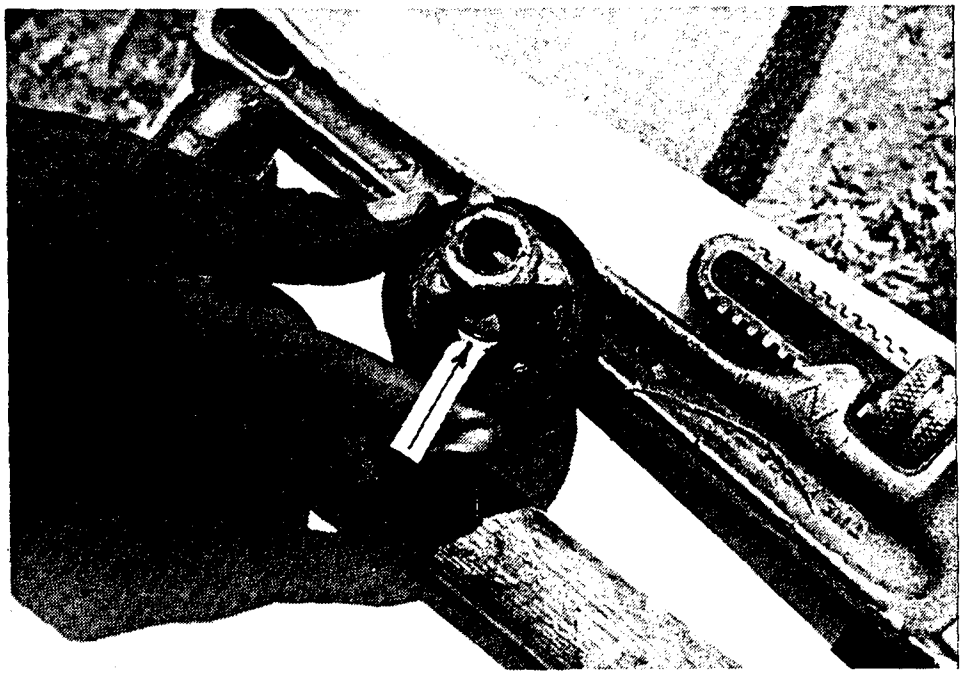
- FOREIGN MATTER -
Closer view of the above plunger



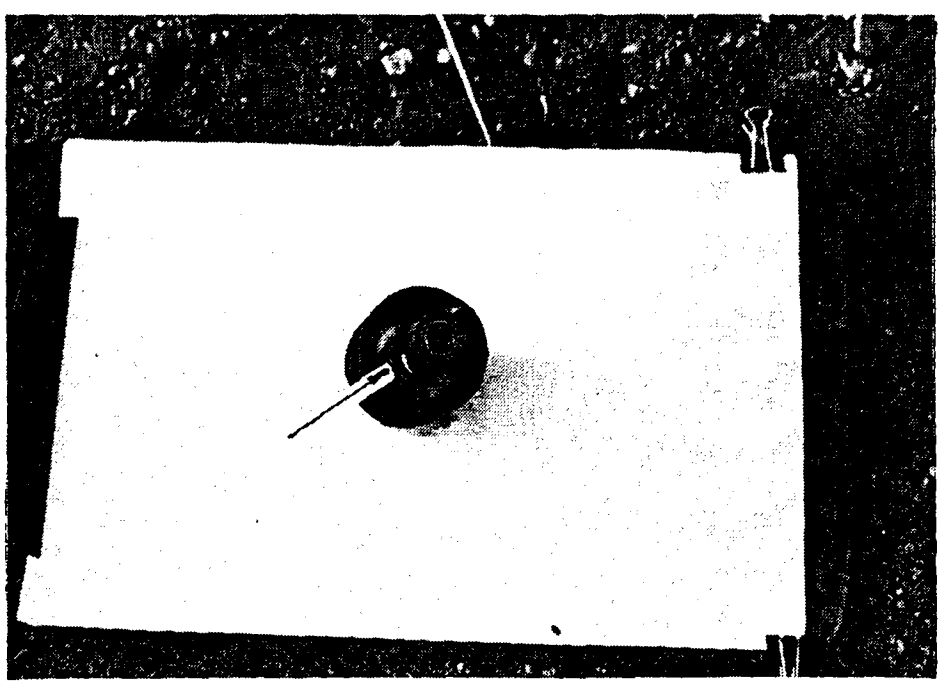
- FOREIGN MATTER -
The above items were found in the plunger,
"C" batteries were resting on the plunger

- PLUNGER POPPET VALVE FAILURE -
Plunger poppet valve not covering the valve seat thus causing loss of pumping efficiency

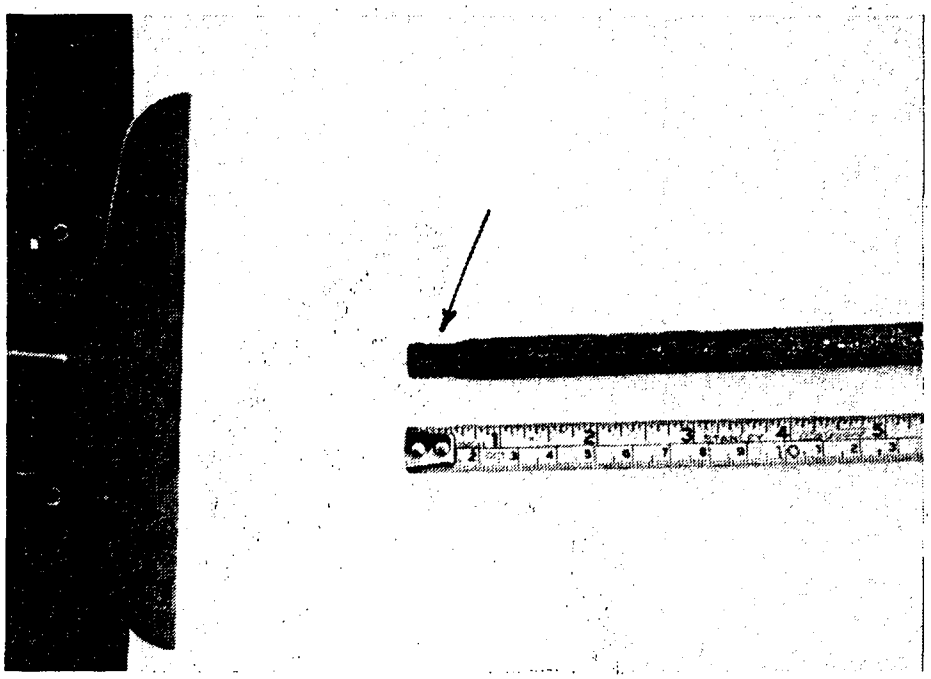
- PLUNGER POPPET VALVE FAILURE -
Plunger poppet got stuck between two cage legs preventing lifting of the water column



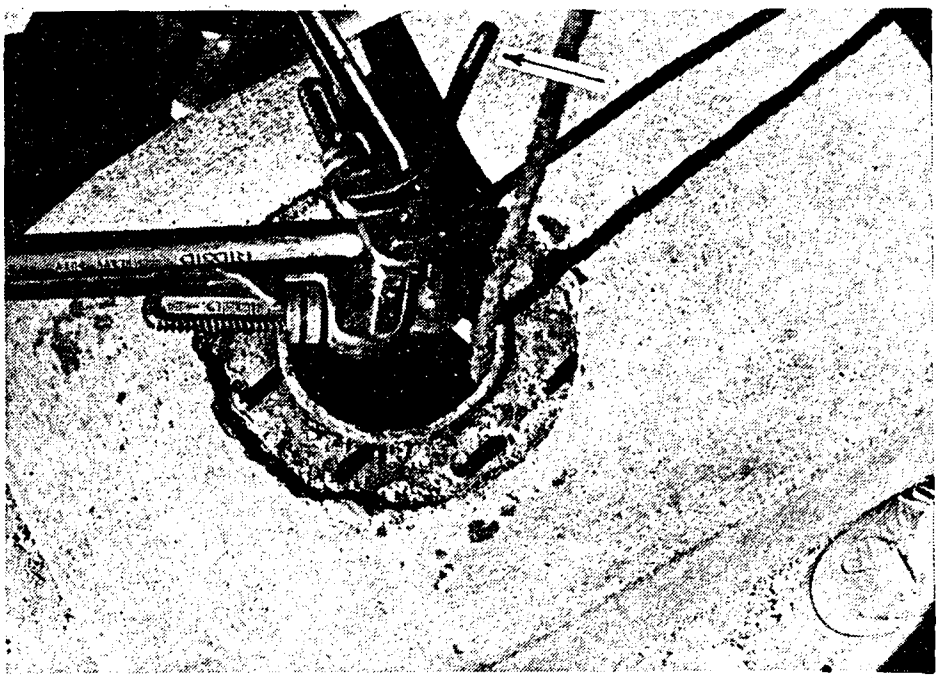
- PLUNGER POPPET VALVE FAILURE -
Plunger poppet valve not covering the valve seat thus causing loss of efficiency



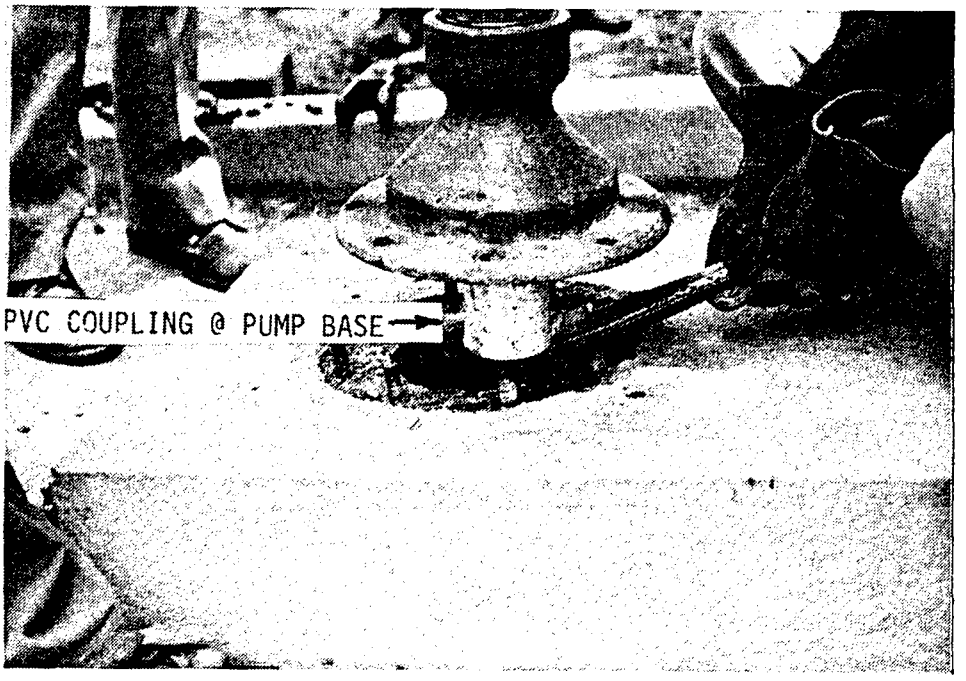
- PLUNGER POPPET VALVE FAILURE -
Another site with the above problem



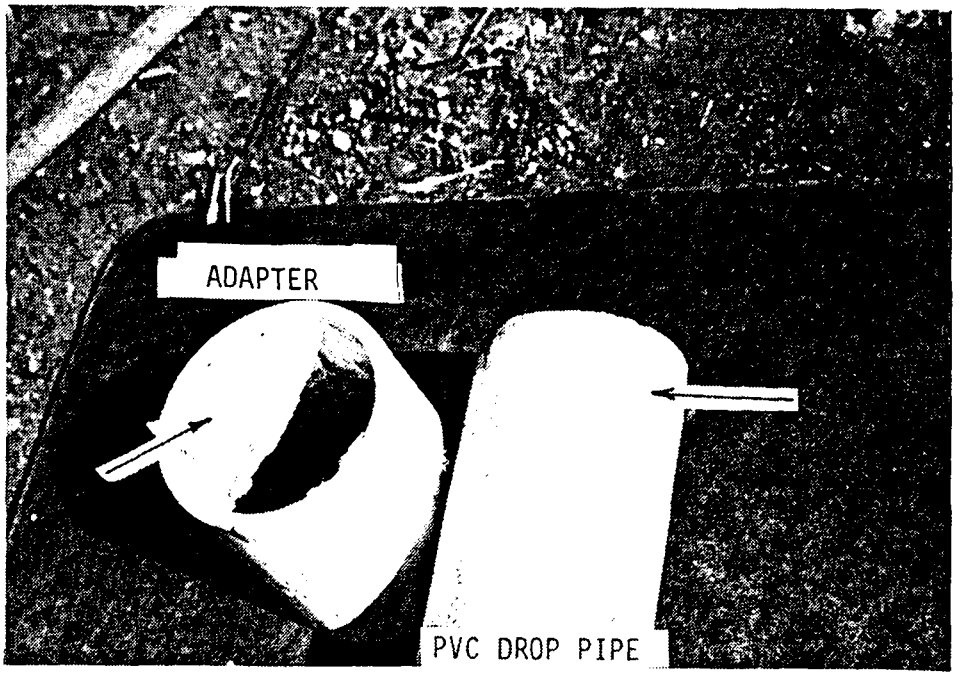
- SEPARATION OF DROP ROD FROM "T" COUPLING -
Defective drop rod section end threads caused separation of plunger rod



- SEPARATION OF DROP ROD FROM "T" COUPLING -
Another site where the above problem occurred



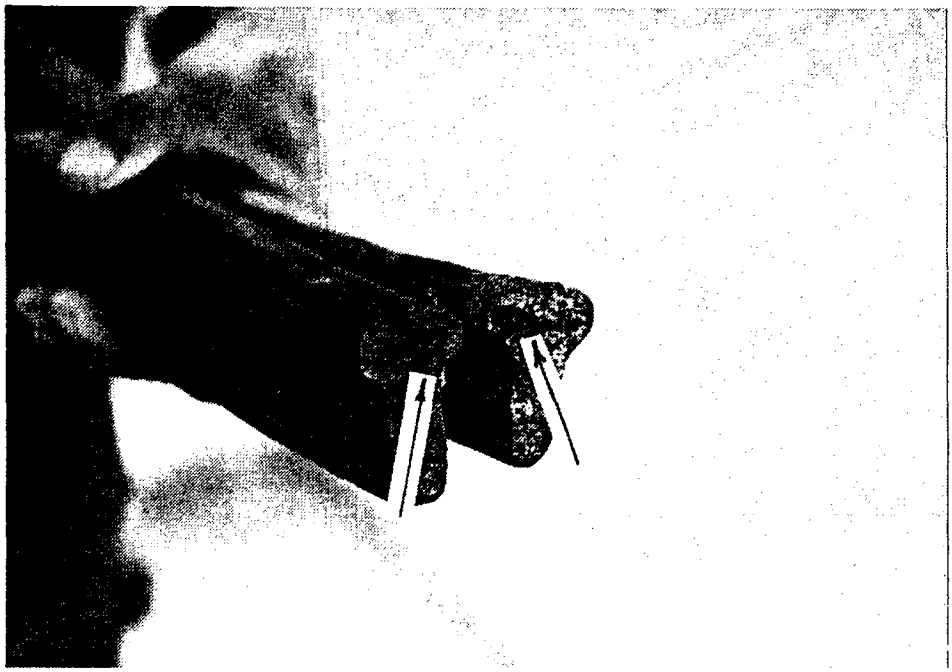
- PVC DROP PIPE SEPARATION -
PVC drop pipe separated from the PVC adapter



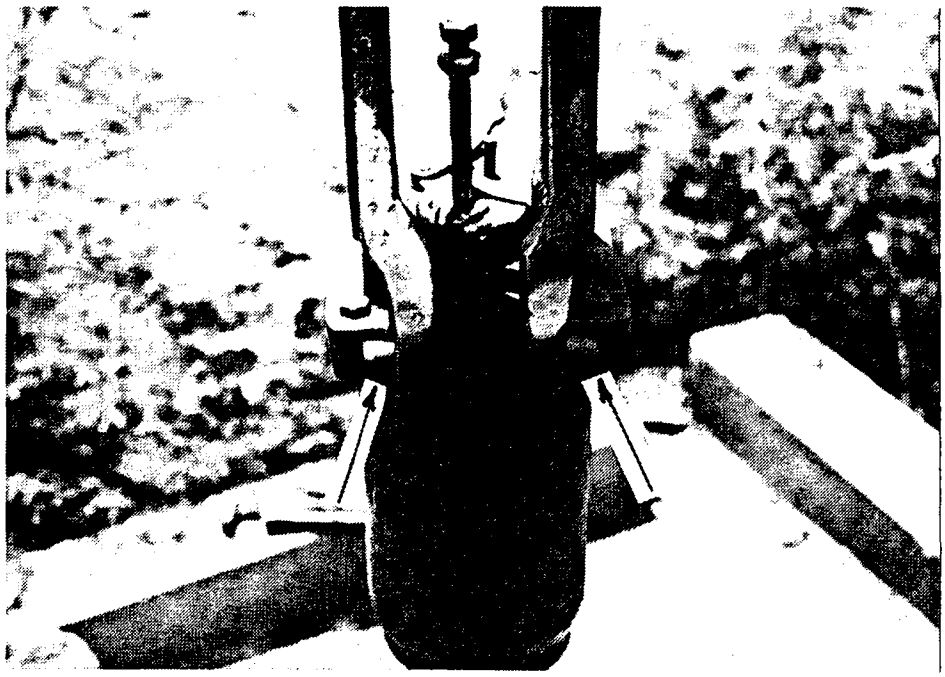
- PVC DROP PIPE SEPARATION -
These samples show little if any PVC solvent action on the surfaces

APPENDIX H

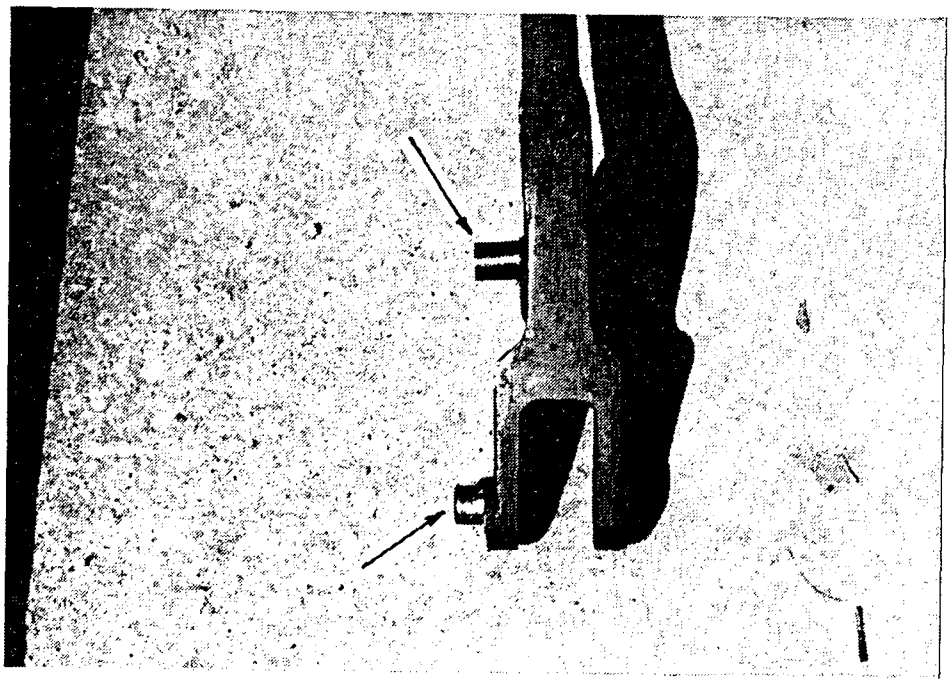
Photographs of Poor
Manufacturing
Quality Control of Handpumps



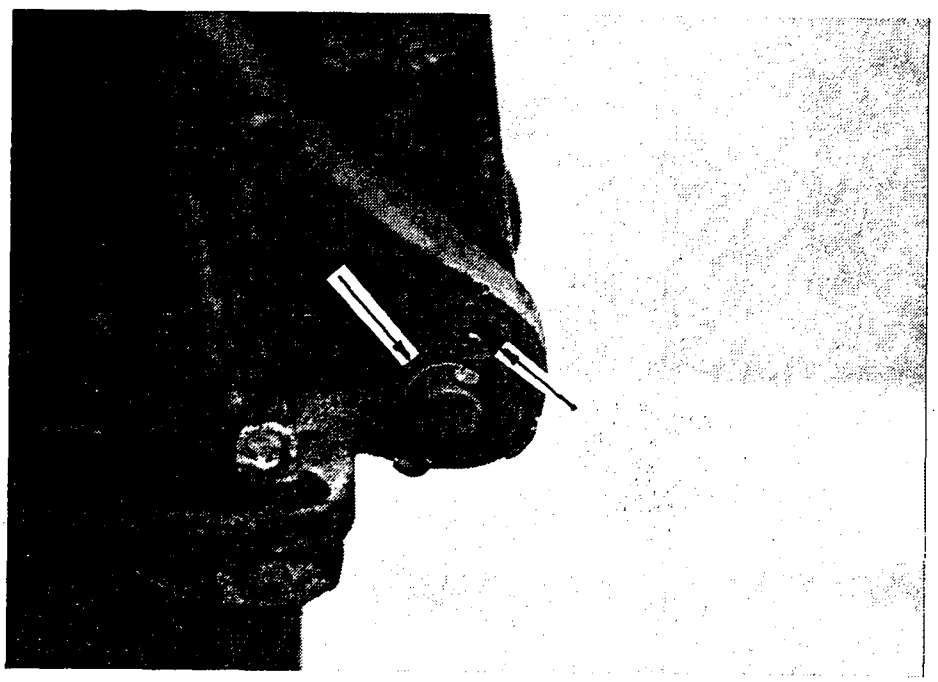
Hand pump handles have been breaking as a result of porosity as shown by arrows. These voids weaken the handle.



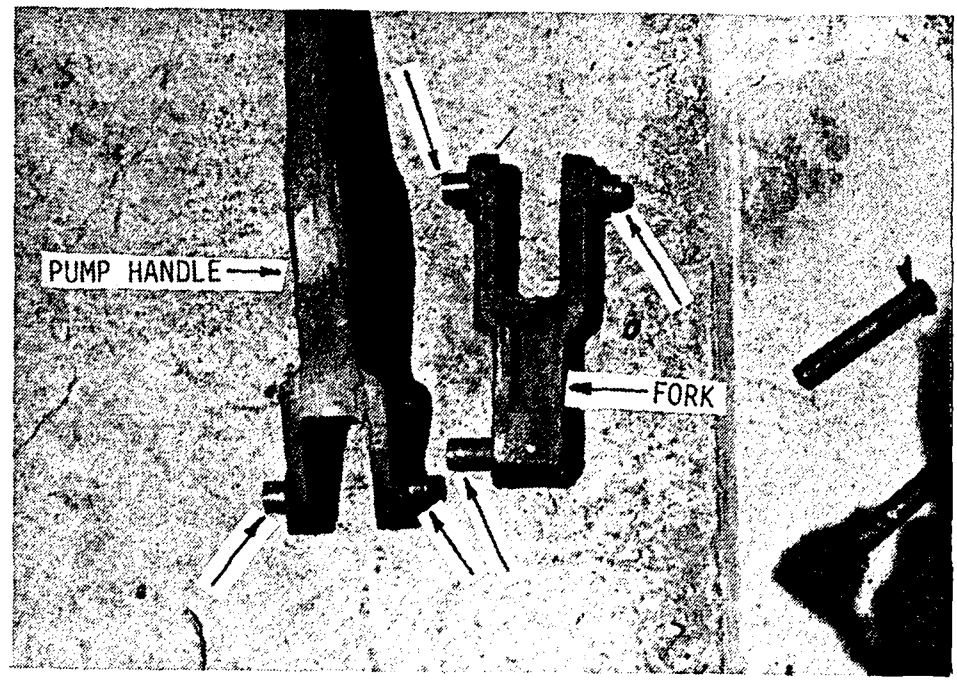
Arrows indicate the loose bushings. These should be press-fit and should not fall out as shown above



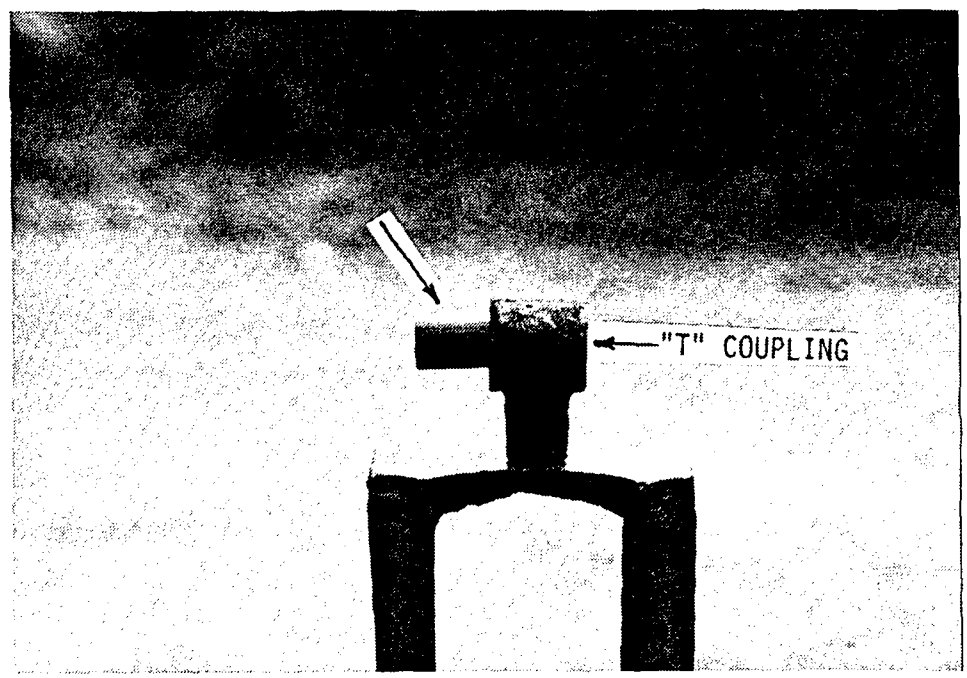
Arrows show loose bushings



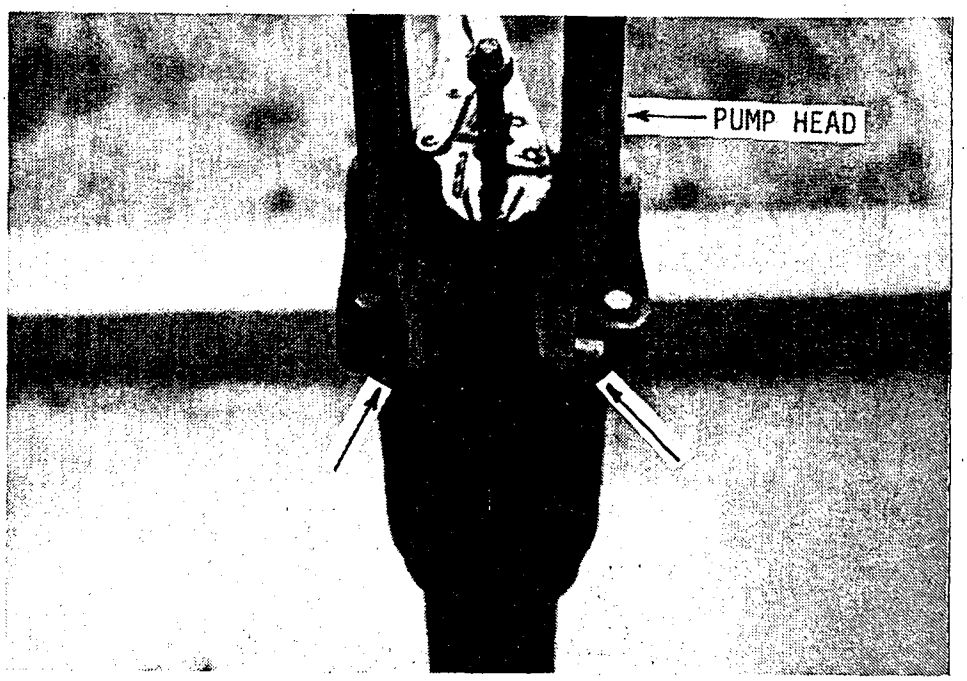
Arrows indicate oversized bushing hole and porosity



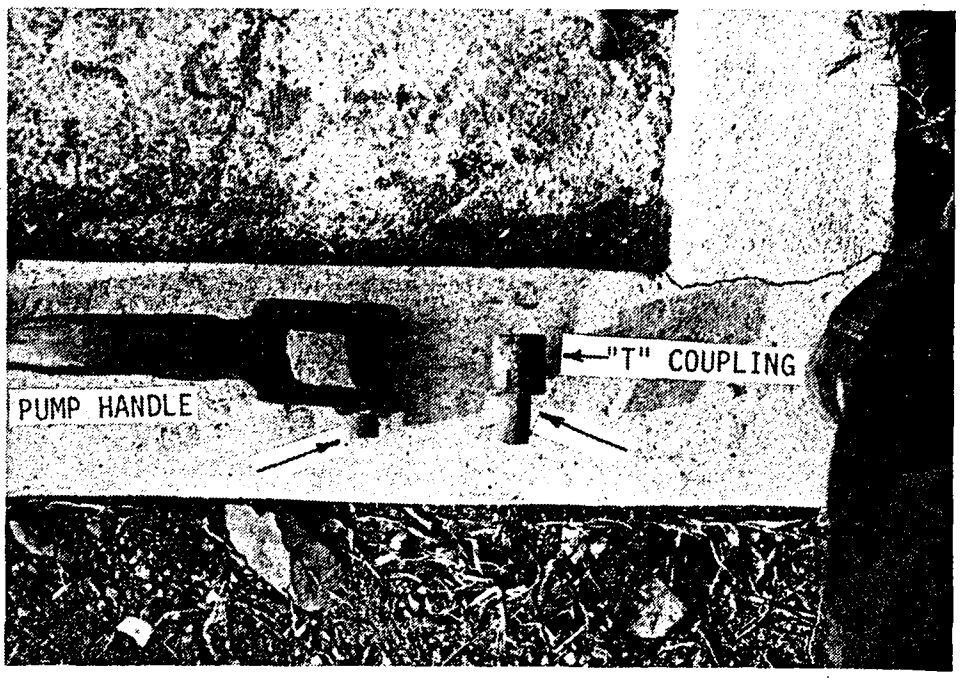
Loose bushings on handle and fork



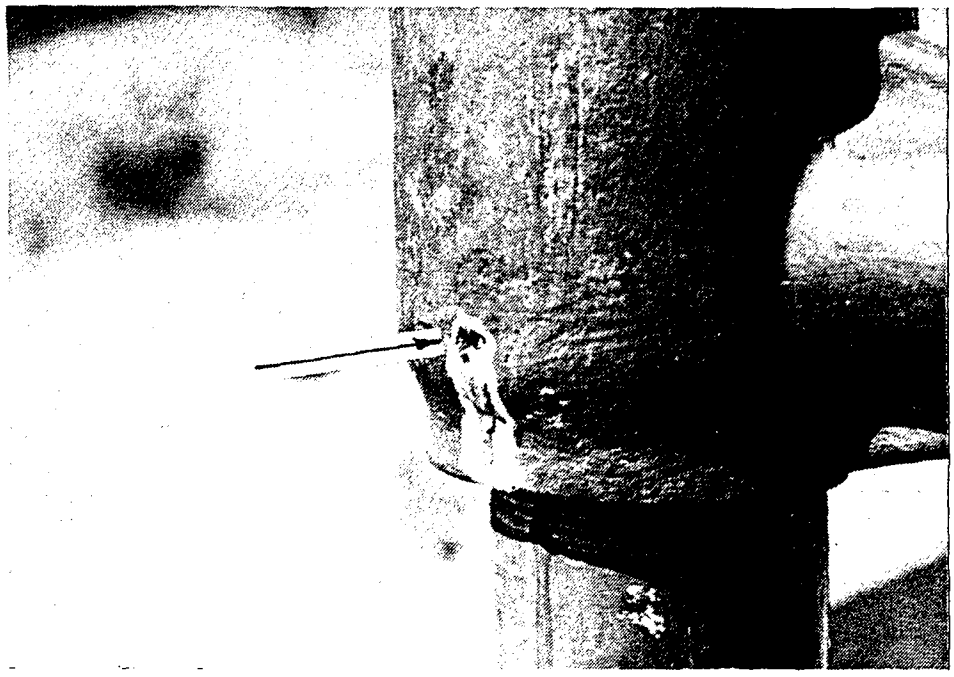
Loose bushing on "T" coupling



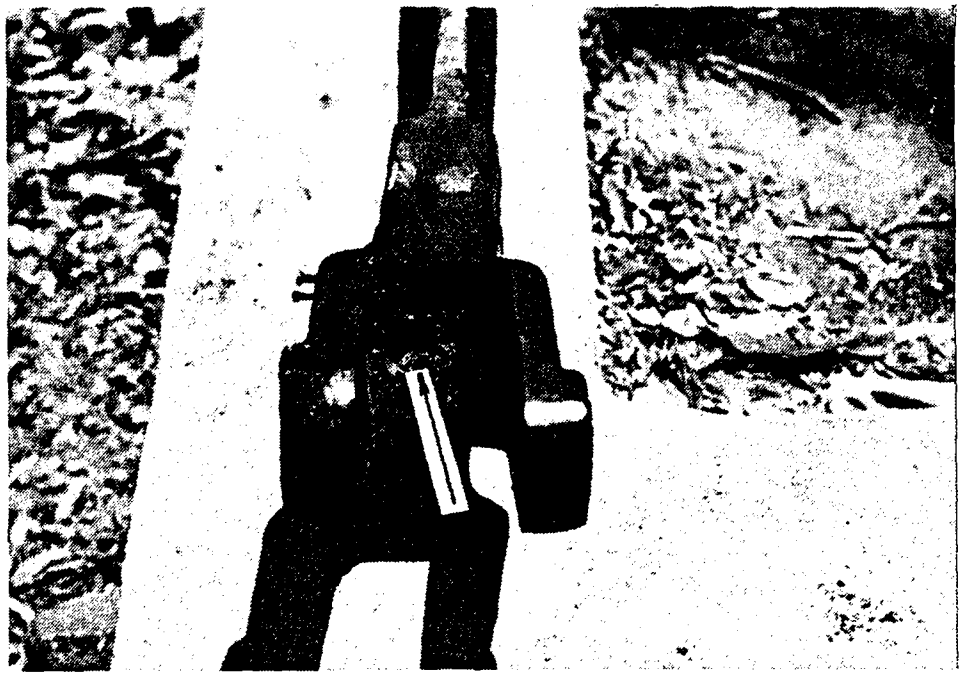
Another site with loose bushings on the pump head



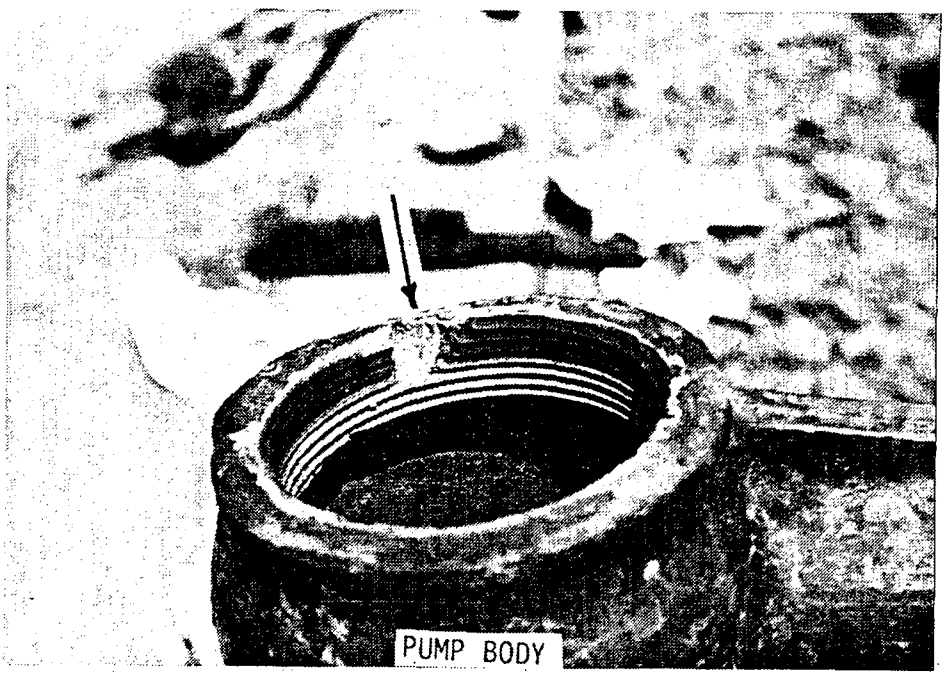
Another site with loose bushings on pump handle and "T" coupling



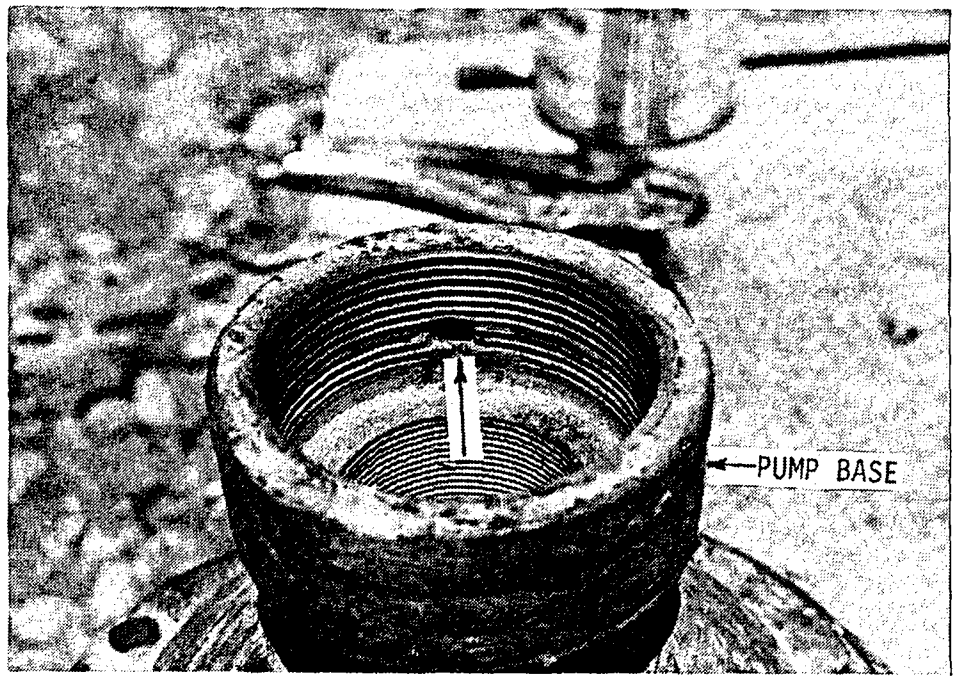
Several hand pumps had porosity in the pump body which allowed leakage of water



Arrow shows porosity

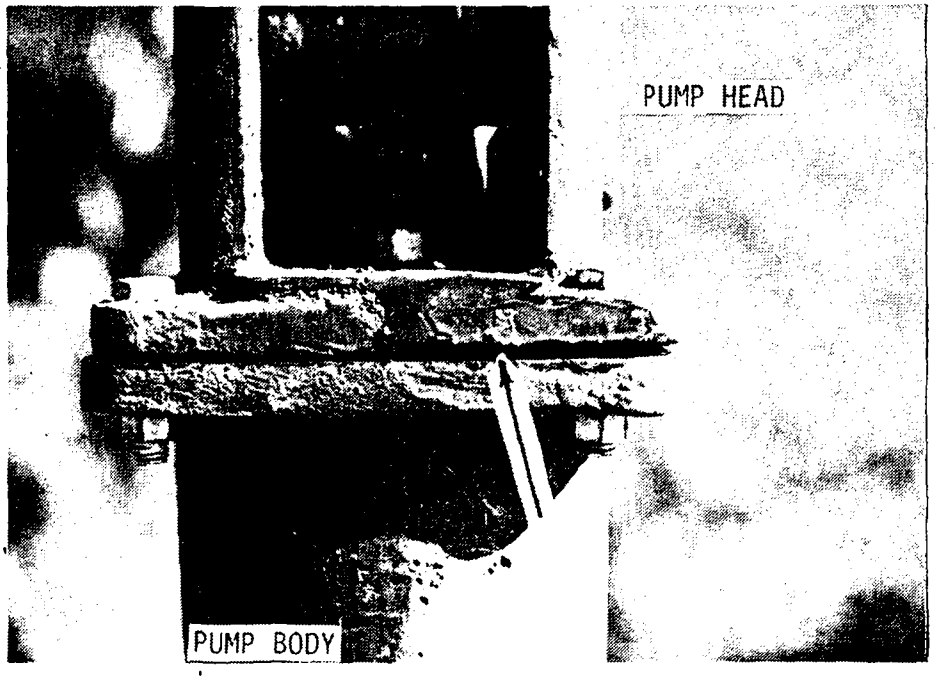


Defective threads on hand pump body causing water leakage

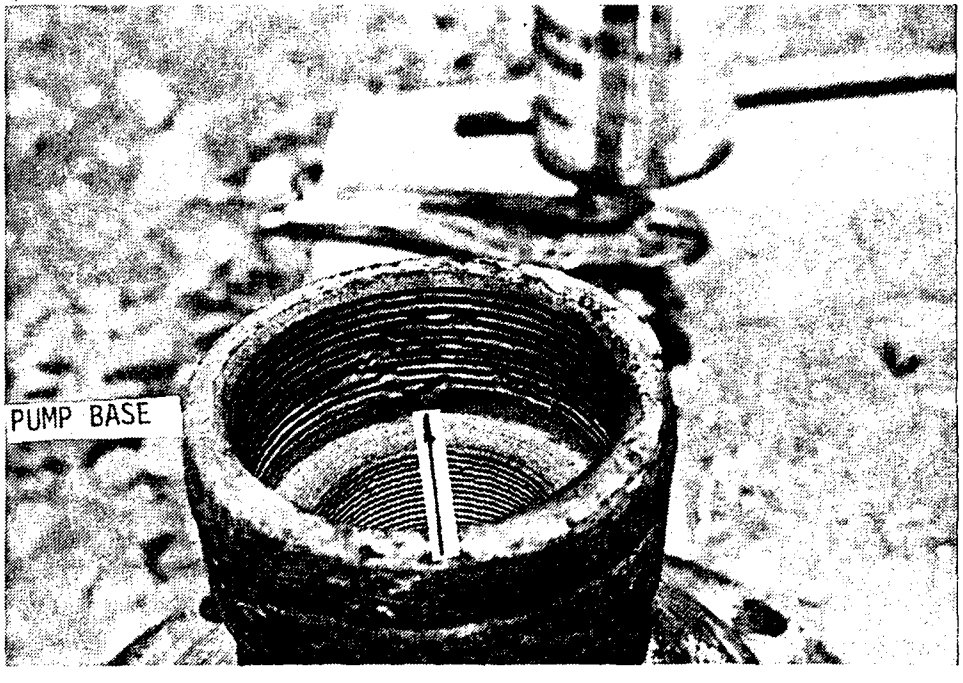


Porosity on interior pump base upper threads causing water leakage

Arrow shows plaster placed by manufacturer to cover porosity. Pump was accepted and installed as shown.



Plaster placed by manufacturer to cover severe porosity



Another site with the porosity problem on the upper threads of the pump base. This causes excessive water leakage.