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## Appendix 2

### Manual of Iron Removal Device

#### 1. Features

##### 1.1 General

The most common problem about ground water encountered in Cambodia is the high iron concentration which affect taste, smell and color to reduce villager's willingness to use the ground water.

This Iron Removal Device (IRD) is designed based on the design of "Iron Removal Plant by Water and Sanitation Section, UNICEF, Colombo, Sri Lanka in 1987". This device is designed for borehole wells with hand pumps to reduce iron from the groundwater by aeration, sedimentation, adsorption and filtration.

##### 1.2 Characteristics of IRD

Size	Compact Size Square: 80 cm x 80 cm, Height: 61 cm
Casing Material	Stainless Steel
Filter Material	Gravel, Sand and Charcoal
Portability	Movable and Light Weight
Operation	Water flows into the device directly from the outlet of hand pump through the pipe
Maintenance	It is easy to maintain for caretaker because of compact size and lightweight. Stainless steel is easy to wash and clean
Sanitation	Stainless steel is suitable for sanitation



## 2. Installation



1. Washing the filter materials



2. Setting and cleaning inside case



3. Filling charcoal into inlet pipe



4. Setting inlet pipe into A chamber

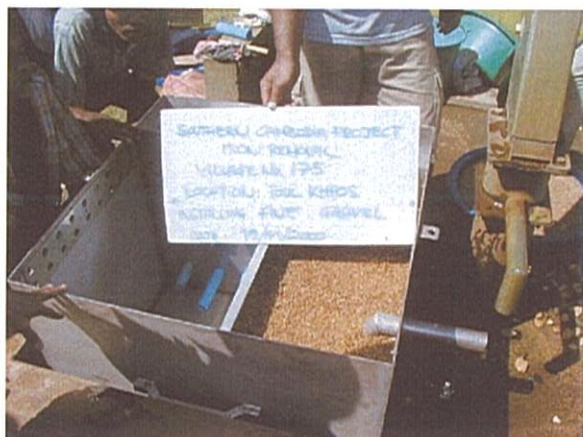


5. Filling coarse gravel into D chamber



6. Filling medium gravel into D chamber





7. Filling fine gravel into D Chamber



8. Filling coarse sand to D chamber



9. Filling medium gravel into C chamber



10. Filling charcoal into C chamber



11. Cover C & D chamber by perforated plate



12. Connect flexible pipe to hand pump





13. Put the cover with lock



14. Completion

### **3. Operation**

The water pumped out by the hand pump, flows through the aeration chamber A and sprays outwards through the slits. The water then passes throughout the charcoal bed thereby aerating it further. The water enters the sedimentation chamber B, where some sediment settles to the bottom. The water flows through connecting pipes to the bottom of adsorption chamber C. The water flows upwards along chamber C and will continue to do so as long as the water level in chamber B is higher than in C. The gravel and charcoal in chamber C absorb the gases dissolved in the water, filter the iron and other particles, and aerate the water while it flows upwards. The only solids which enter chamber D are extremely fine particles in the form of floating solids, all of which are filtered in this chamber thus emitting clean drinking water from the outlet.

### **4. Maintenance**

The IRD has to be cleaned and the charcoal and gravel replaced periodically. The life span of the filter depends on both the raw water quality and on the number of users. Community involvement is necessary to maintain the filter and ensure its performance. This manual describes the IRDs installation procedure and its maintenance, both at the community level. It is worth nothing however that the IRD is recommended for removing low iron content (i.e. less than 8mg/l).

#### **4.1 Procedure of Back-washing**

- (1) Disconnect flexible pipe from inlet pipe
- (2) Connect flexible pipe to outlet pipe
- (3) Remove cover
- (4) Remove charcoal of chamber A and chamber C.
- (5) Open drain valve of chamber B and chamber C.
- (6) Operate the hand pump continuously to flush out chamber B and chamber C until drained water becomes clean.
- (7) Close the drain valve of chamber B and chamber C.
- (8) Wash charcoal and put back to chamber A and chamber C.
- (9) Disconnect flexible pipe from outlet pipe of IRD.
- (10) Connect flexible pipe to inlet pipe of IRD.
- (11) Open drain valve of chamber D.
- (12) Operate the hand pump continuously to flush out chamber D until drained water becomes clean.
- (13) Close the drain valve of chamber D.
- (14) Put back cover.

#### **4.2 Time for Back-wash**

To gain long lasting efficiency of this device, back-washing shall be done at least once a month. Wherever a large amount of excess iron content exists in well water, this device shall be cleaned once a week.

#### **4.3 Time for Changing Charcoal and Aggregate**

Half yearly or if the iron removal device is not functioning well even though the back-washing has been done, take out all materials from the tank, wash them thoroughly and replace them properly. If it is still not functioning well, change with new materials of charcoal and aggregate (sand and gravel in chamber D).

#### **4.4 Attention**

- (1) Be careful not to break the drain pipe when fastening or loosening the plug.
- (2) Prevent children from stepping on drain pipes, breaking PVC mesh, throwing debris into tank, sitting on tank and removing parts from tank.

## **Appendix 3**

### **Manual of Well Disinfections**

In rainy season in the study area, deep well may be infected by the flood which causes that the well water will become unclear and will be contaminated by bacteria, fecal coliform, etc.

In case the well water will be contaminated, disinfections shall be done in accordance with the following procedure in order to get safe water again.

Step 1: Pump up the well water by hand pump until the water becomes clear

Step 2: Remove hand pump head cover, handle, and connecting rods

Step 3: Pull out the check valve by fishing tools

Step 4: Mix 300 gram of bleaching powder thoroughly in 15 liters of water in a bucket.

Step 5: Pour the chlorine water into the well through riser pipe.

Step 6: Leave the hand pump free for at least 6 hours (if possible, it is better during the night time)

Step 7: Reassemble the hand pump then pumping the smell out until chlorine smell is completely remove from the water.



## **Appendix 4**

### **Text of Technical Training in Operation and Maintenance**

The Ministry of Rural Development and the JICA Study Team aim to fully support the operation and maintenance of hand pump installed in the 30 villages.

#### **1. Provision of spare parts & tools**

PDRD will provide with a minimum amount of spare parts. The tools will be provided with WPC.

#### **2. Method of requesting spare parts**

In accordance with the application form for replacement of spare parts enclosed in this manual, WPC will submit requests to PDRD. However, the cost of the spare parts will collect from water fund to be charged from all the users of water well.

For facilities judged by the caretakers to be immediately in need of major repair, a request for a mechanics will be sent to PDRD, using the repair order form enclosed herein. The spare parts for this kind of repair will be provided with PDRD. The cost for the repair and spare parts shall be taken from the water fund pooled by WPC by collecting water charges from the users.

#### **3. Maintenance tools to be provided to pump caretaker**

The pump caretaker will be provided with tools for maintenance works. This training manual provided by the JICA Study Team will enable caretakers to conduct effectively the operation and maintenance of handpump.

#### **4. Spare parts to be provided to PDRD**

Spare parts will be provided to PDRD. In case WPC needs spare parts, PDRD will supply spare parts to WPC.

## 5. Handpump maintenance by caretakers

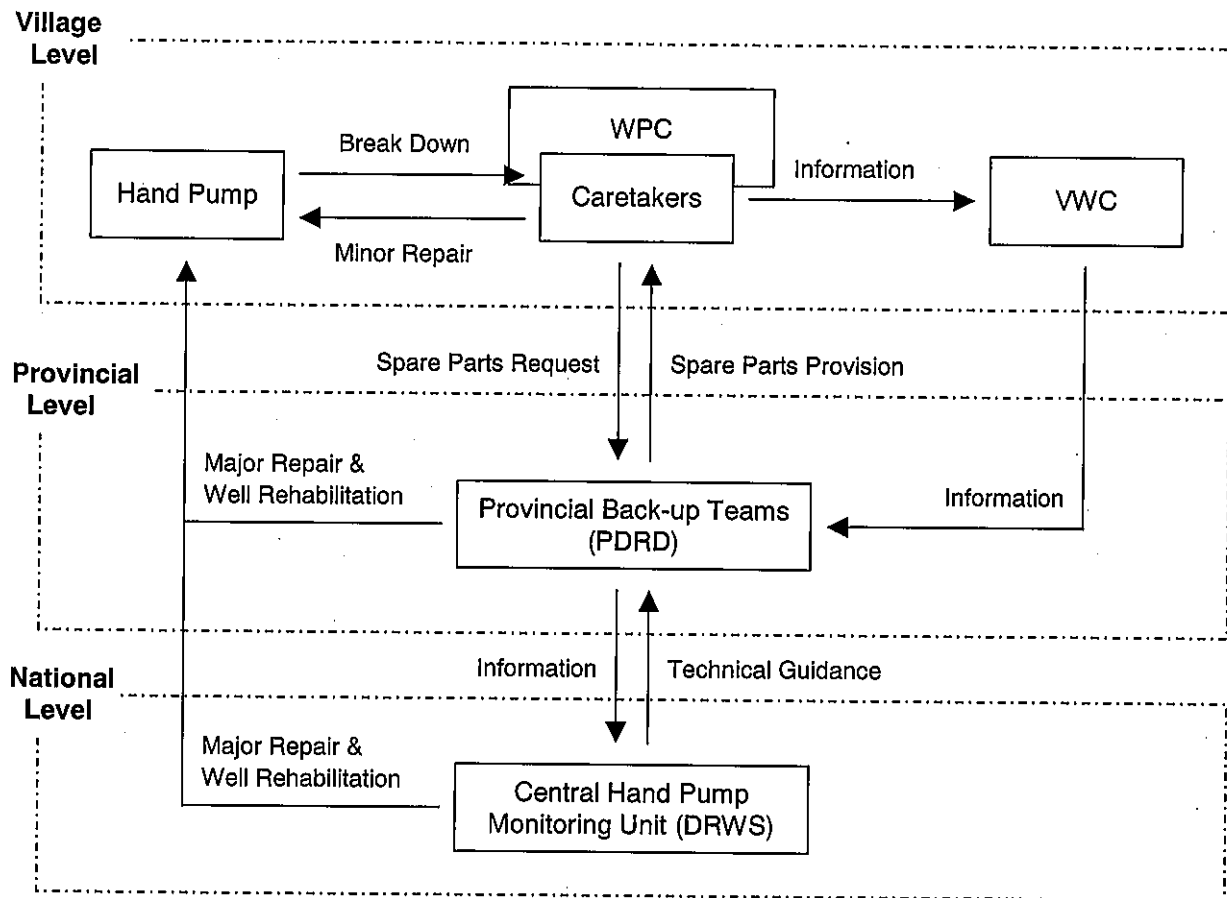
The responsibilities of caretakers are shown in the following table.

Inspection	Detail Work
1. Daily Inspection	<ul style="list-style-type: none"> <li>- To confirm hand pump conditions at sight.</li> <li>- To check platform and drainage conditions.</li> <li>- Lubrication and greasing fixtures</li> </ul>
2. Regular Inspection (every six months)	<ul style="list-style-type: none"> <li>- To inspect items specified in monitoring sheet.</li> <li>- To take quick action in case any damages in handpump are detected.</li> </ul>
3. Emergency Inspection	<ul style="list-style-type: none"> <li>- To conduct minor repairs, such as those required for platform and drainage canals, tightening of bolts and replacement of bolts, rings, seals and O-shaped rings, etc.,</li> <li>- Major repairs also require bigger tools. Hence, caretakers will get in touch with PDRD so that PDRD dispatch local handpump mechanics for repair (e.g. damage or breakdown in the foundation of handpump, replacement of spare parts etc.)</li> </ul>

## 6. Responsibilities of caretaker and PDRD mechanics

Minor Repairs (Responsibilities of Caretakers)	Major Repairs (Responsibilities of PDRD mechanics)
<ul style="list-style-type: none"> <li>- To repair damage or breakdown in platform and drainage canals</li> <li>- To tighten and replace bolts and nuts</li> <li>- To replace 'U' seal</li> <li>- To replace 'O' ring</li> <li>- To replace bobbin</li> <li>- To replace bush bearing</li> </ul>	<ul style="list-style-type: none"> <li>- To repair damage of handpump foundation</li> <li>- To replace riser pipes and cylinders</li> <li>- To replace handpump</li> <li>- To conduct 'Well Development'</li> </ul>

## 7. Action flow chart for O&M





## 8. Trouble shooting chart

Problem	Operation	Cause	Counter-measure
1. No water	-Easy to operate	-Rods disconnected	-Pull out all rods and replace broken rods
	-Difficult to operate	-Pipes disengaged	-Join the pipes
		-Plunger seal defect	-Replace seal
	-Normal operation	-Water level gone below the cylinder	-Extend pipes and rods
2. Delayed flow	-Normal operations	-Leaky valves	-Replace valve bobbins
		-Complete stroke not available	-Adjust length of top rod
		-Leakage in pipe joints	-Replace riser pipe, if any defective pipes -Ensure proper seal at joint
		-Leaking foot valve 'O' ring	-Replace 'O' ring
3. Reduced discharge	-Difficult to operate	-'U'-seal tight	-Replace with proper 'U' seal
	-Normal operation	-Complete stroke not available	-Adjust rods length properly
		-'U' seal worn out	-Replace with new one
		-Valve bobbin worn out	-Replace with new one
		-Pump cylinder cracked	-Replace cylinder
4. Abnormal noise during operation	-Normal operation	-Rods bent	-Straighten bent rods
	-Inconvenient operation	-Centralizer worn out	-Replace centralizer
		-Rods abraded	-Replace with new rods
		-Bearing worn out	-Replace with new one
		-Handle fork touched pump head	-Adjust handle to proper position
5. Pump handle shaky	-Pump stand shaking	-Platform cracked	-Repair platform
		-Flange loose	-Tighten bolts and nuts
		-Bearing worn out	-Replace with new
		-Hanger pin loose	-Tighten bolts and nuts
		-Fulcrum pin worn out	-Tighten bolts and nuts

## 9. Communication List

### (1) DRWS and PDRD, Ministry of Rural Development

	Province	Name of Director	Person in Charge	Address	Phone
1	DRWS	Dr. Mao Saray	Mr. Sam Bonal	Kampuchea Krom Blvd. Rd #139, Phnom Penh	023-883272
2	PDRD, Peri-Urban	Mr. Sam Than	Mr. Phan Sarun	#271, Trapaing Chhuk Village, Tuek Thla Commune, Russei Keo District	011-864459
3	PDRD, Svay Rieng	Mr. Mey Lonnn	Mr. Sao Sam Ouern	Soun Thmei Village, Prey Chhlak Commune, Svay Rieng District	044-945717
4	PDRD, Ta Keo	Mr. Thor Sen	Mr. Pak Choun	Chak Village, Roka Krau Commune, Doun Keo District	016-872558
5	PDRD, Kandal	Mr. Chap Moch	Mr. Un Chann	Ta Khmau Village, Ta Khmau Commune, Ta Khmau District	016-823948
6	PDRD, Prey Veng	Mr. Tauch Setha	Mr. Ney Khon	Village No.3, Kampong Leav Commune, Kampong Leav District	043-944502 043-348026
7	PDRD, Kompong Speu	Mr. Im Sam An	Mr. Chhim Mony	Svay Krovanh Village, Chhbar Mon District	012-881874

### (2) Supplier of Spare Parts

	Company Name	Person in Charge	Address	Phone
1	PPS International Co., Ltd	Mr. Prasad	PO Box 2063, PP III, #32, Street352, Phnom Penh	023-213452 023-363125 023-722417(fax)

### (3) Water Point Committee

	Province	District	Commune	Village
1	Peri-urban	Dangkao	Sak Sampov	Khvet
2	Peri-urban	Mean Chey	Steung Mean Chey	Mean Chey
3	Svay Rieng	Svay Rieng	Koy Tra Bek	Koy Tra Bek
4	Svay Rieng	Rom Doul	Thnal Thnong	Trapaing Thmor
5	Svay Rieng	Ro Meas Hak	Chrey Thom	Dok Por
6	Svay Rieng	Chan Trei	Prey Koky	Cham Kar Leiv
7	Svay Rieng	Svay Chrom	Cham Bok	Toul Khpos
8	Ta Keo	Doun Keo	Roka Krau	Prech
9	Ta Keo	Tram Kak	Chroul Popel	Prey Maok
10	Ta Keo	Tram Kak	Kus	Trapaing Thmor
11	Ta Keo	Bati	Krang Leav	Ta Pen
12	Kandal	Kaoh Thum	Prek Thmei	Svay Kraom
13	Kandal	Mukh Kampul	Svay Ampear	Krang Svay
14	Kandal	Angsnuol	Snao	Angkor Chey
15	Prey Veng	Pea Reang	Prey Pnou	Ka Kou
16	Prey Veng	Me Sang	Prey Khnes	Russei Tvear
17	Prey Veng	Kampong Leav	Ta Kao	Kok Trom Kha
18	Prey Veng	Ba Phnum	Sdau Kaong	Prey Phdau
19	Kompong Speu	Somrong Tong	Rolaing Chak	Sre Kak
20	Kompong Speu	Phnom Srouch	Taing Sia	Kiri Raksmei



## **Appendix 5**

### **Forms for Operation and Maintenance**

- 1. Form of Spare Parts and Tools Receipt**
- 2. Form of Spare Parts Request**
- 3. Form of Repair / Maintenance Request**
- 4. Form of Repair / Maintenance Record**

**Form of Spare Parts and Tools Receipt**

JICA PILOT WELL NO.: \_\_\_\_\_

Province: \_\_\_\_\_

District: \_\_\_\_\_

Commune: \_\_\_\_\_

Village: \_\_\_\_\_

Item	Description	Quantity	Remarks
Standard Spare Parts Set		1 set	
	Rod Centralizer	10	
	Bush Bearing	4	
	Valve Bobbing	2	
	'U' Seal	2	
Standard Tool Set	'O' Ring	2	
		1 set	
	Fishing Tool	1	
	Socket Spanner	1	
	Open Ended Spanner	2	

**Supplier**

**Witness**

**Receiver**

\_\_\_\_\_  
Date

\_\_\_\_\_  
Date

\_\_\_\_\_  
Date

\_\_\_\_\_  
PDRD Staff

\_\_\_\_\_  
WPC Chairman

\_\_\_\_\_  
WPC Caretaker

\_\_\_\_\_  
Signature

\_\_\_\_\_  
Signature

\_\_\_\_\_  
Signature

**Form of Spare Parts Request**

JICA PILOT WELL NO.: \_\_\_\_\_

Province: \_\_\_\_\_

District: \_\_\_\_\_

Commune: \_\_\_\_\_

Village: \_\_\_\_\_

Date: \_\_\_\_\_

To: Rural Water Supply Bureau, Provincial Department of Rural Development (PDRD)

**Subject: Request of Hand Pump Spare Parts**

We would like to request you the following hand pump spare parts.

Item	Quantity	Remark

Name of VWC Chairman: \_\_\_\_\_

Name of WPC Chairman: \_\_\_\_\_

Name of WPC Caretaker: \_\_\_\_\_



**Form of Repair / Maintenance Request**

JICA PILOT WELL NO.: \_\_\_\_\_

Province: \_\_\_\_\_

District: \_\_\_\_\_

Commune: \_\_\_\_\_

Village: \_\_\_\_\_

Date: \_\_\_\_\_

To: Rural Water Supply Bureau, Provincial Department of Rural Development (PDRD)

**Subject: Request for Immediate Arrangement for Hand Pump Repair**

We would like to request you that the provincial Office will sent your mechanical engineer for our hand pump maintenance as it has been out of order since \_\_\_\_\_ days ago.

Our WPC's caretaker reports WPC chairman that the matter of problem is major repairing require.

Given the following is the relevant information concerning the hand pump problem.

1. \_\_\_\_\_

2. \_\_\_\_\_

3. \_\_\_\_\_

4. \_\_\_\_\_

Name of VWC Chairman: \_\_\_\_\_

Name of WPC Chairman: \_\_\_\_\_

Name of WPC Caretaker: \_\_\_\_\_

**Form of Repair / Maintenance Record**

**JICA PILOT WELL NO.:** \_\_\_\_\_

**Province:** \_\_\_\_\_

**District:** \_\_\_\_\_

**Commune:** \_\_\_\_\_

**Village:** \_\_\_\_\_

Date of Occurrences	Date of Repair	Cost of Repair	Problem	Replaced Spare Parts	By whom repaired

**Name of VWC Chairman:** \_\_\_\_\_

**Name of WPC Chairman:** \_\_\_\_\_

**Name of WPC Caretaker:** \_\_\_\_\_