

Appendix H: Hand Pump Installations

Introduction

UWP installs hand pumps when a new borehole is drilled, when an AquaTrust borehole qualifies for an upgrade, or when an existing borehole needs rehabilitation after failure. UWP exclusively installs India Mark-II hardware (also known as “U2”), the standard pump hardware used in Uganda. India Mark-II pumps use a system of seals and valves to move water in a one-way direction when the pump handle is moved up and down. A series of rods enclosed within riser pipes connect the pump handle to the pump cylinder, which is located within the screened section of the casing. As the handle is pumped, rods move the plunger assembly within the cylinder up and down, which draws water up the riser pipe and eventually out the spout.

Figure 1 provides schematic diagrams of the complete India Mark-II pump assembly.

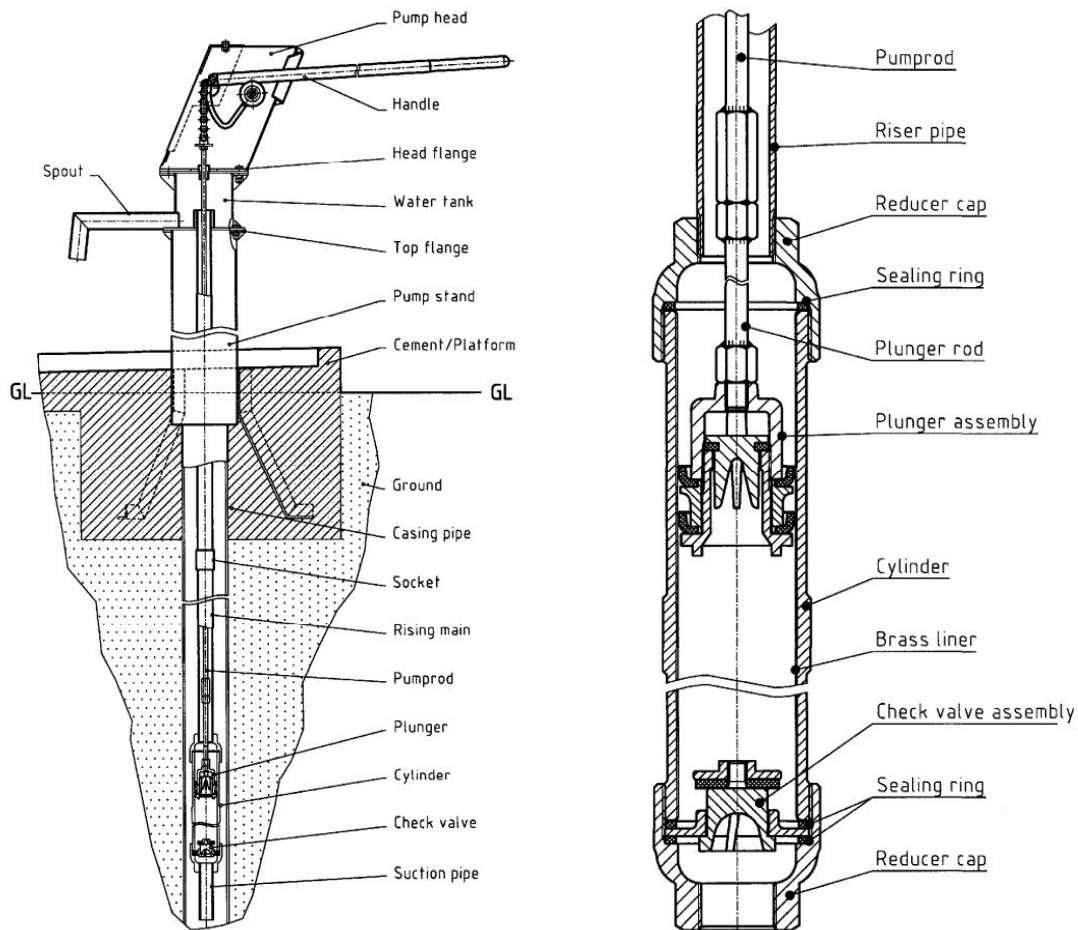


Figure 1: Schematic diagram of the India Mark-II pump assembly

Materials Used by UWP

The pipe and rod assemblies of India Mark-II pumps typically come in one of three material types: stainless steel, galvanized iron (GI), and PVC pipes with stainless steel or GI rods. UWP exclusively uses 304 stainless steel pipes and rods, which are the most robust of the available materials. UWP does not use GI or PVC parts because they are more prone to failure than stainless steel (GI materials are at risk of corrosion and PVC pipes can burst when used in deep wells). Though stainless steel cylinders are available, UWP opts to use cast-iron cylinders with a brass lining. Functionally, cast iron cylinders and stainless steel cylinders are comparable. The benefit of cast iron cylinders is that they are much less expensive than stainless steel and spare parts are more readily available. All above-ground components of the India Mark-II pump are made of galvanized steel.

UWP hand pump installations can be broken down into four phases:

1. Stockyard Preparation
2. Pump Disassembly
3. Well Development and Depth Measurements
4. Pump Assembly

Each phase can be broken down into smaller steps, which are described below. The second phase, *Disassembly*, is not required when a new borehole is installed.

Phase 1: Stockyard Preparation

In the days preceding a hand pump installation, key preparations are made in the UWP stockyard. Most notably, pump heads, cylinders, pipes, and rods are prepared for installation. By preparing these materials in advance, on-site workload is reduced and installation processes are streamlined.

Key Steps

- **Preparing Pump Heads and Cylinders** - UWP installs both new and refurbished pump heads and cylinders. All reclaimed parts are refurbished in the stockyard prior to re-installation. As required, pump heads and cylinders are modified for extra-deep boreholes. All pump heads are painted red, branding them as Red Rhino Development pumps. Each cylinder is tested for leaks and reassembled if a leak is observed.
- **Testing and Ordering Pipe and Rods** - Due to manufacturing defects, pipes and rods are not always suitable for installation. For example, pipe socket welds may have small holes and rods may have defects in their threads. Each pipe and rod is inspected, tested, and modified, if required. For example, it is common for the tip of the male rod coupling to be trimmed to ensure good engagement. Once tested, pipes and rods are numbered in the order which they are to be installed.

Phase 2: Pump Disassembly

Boreholes being rehabilitated or upgraded by UWP typically come equipped with existing hardware. Once on site, this hardware must be extracted before the new hardware can be installed. All hardware removed from boreholes is brought back to the UWP stockyard where it is refurbished, repurposed, or sold as scrap.

Key Steps

- **Dismantling Above Ground Components** - The pump head cover is removed and the chain detached from the handle. The head and handle are detached from the water tank. The flange is used to lift the connecting rod, and the rod vice is inserted. The chain is removed, then the flange. The top rod lifter is attached and the vice removed. The pump-rod assembly is lowered until it sits atop the check valve, then the rod lifter is unscrewed. The water tank is detached from the pedestal, lifted, and the pipe vice fastened below. The water tank is unscrewed and removed.
- **Dismantling Below Ground Components** - The UWP crew and volunteer labor work together to lift the below ground components out of the borehole. Lifting spanners are positioned just above the pipe vice and used to brace the rising main pipe. The pipe vice is loosened and the rising main is lifted using the spanners. Once lifted, the vice is reattached and the spanners repositioned. This process repeats until the next pipe socket is elevated above the pipe vice. At this point, the pipe vice is reattached. The pipe is unscrewed, followed by the rod, then both are removed. This process continues one pipe at a time, until the whole rising main, all rods, and the cylinder are retrieved.
- **“Fishing”** - On rare occasions, assembly components become detached and sink to the bottom of the borehole. These components are retrieved through a process called fishing. To fish parts from a borehole, custom tools attached to pipes or rods are lowered into the borehole. Once lowered, these tools are manipulated to secure the lost part, which is subsequently pulled to the surface.

Phase 3: Well Development and Depth Measurements

Over time, borehole yield can reduce because silt and debris accumulate in the borehole, blocking the screen and restricting water flow into the water column. To maximize yield, UWP re-develops boreholes before installing new hardware. To re-develop a borehole, compressed air is blown into the hole to remove any build-up, hence the colloquial phrase “blowing out” the borehole. To inform cylinder installation depth, water level and borehole depth measurements are taken both before and after development.

Key Steps

- **Initial Depth Measurements** - A rope with a weight attached is lowered into the borehole until it reaches the static water level. This point is marked on the rope. The weight is lowered again until it reaches the bottom of the borehole. This point is also marked. The rope and weight are subsequently removed from the borehole. The length between the weight and the marks is measured to determine water level and borehole depth.
- **Borehole Development (“Blowing Out the Borehole”)** - 100ft lengths of hose are attached to the compressor and lowered into the borehole until the head of the hose is below the water level. The compressor is turned on and compressed air is forced into the water column, displacing water, silt, and debris that have accumulated over time.
- **Determining Cylinder Depth** - Approximately 20 minutes after borehole development is finished, the water level is measured again using the same methods described above. If the recovery is good (i.e., the water level is approximately equal to the static water level) the cylinder is installed approximately four pipes below the static water level. If poor recovery is observed (i.e., the water level considerably below the static water level), the cylinder is installed more than four pipes below the static water level. The number of pipes installed is determined by the foreman.

Note: The methods currently used by UWP to inform cylinder depth are sufficient, but not the gold standard. The best way to determine cylinder depth is by test pumping ([Appendix I](#)). UWP has been trained on test pumping procedures and plans to begin test pumping as soon as the equipment required to complete the test pumping is procured.

Phase 4: Pump Assembly

UWP installs the new hand pump assembly with assistance from volunteer community labor. A series of pump performance tests are completed throughout the assembly process. If leaks are documented at any point, the crew will disassemble the hardware, resolve the problem, and re-test the pump. This process repeats until the hand pump is fully installed and all UWP performance standards are met.

Key Steps

- **Preparing Pipes and Rods** - All pipes and rods are laid out (off the ground) in the order in which they are to be installed. Each rod is placed inside its respective pipe, with the end with the male coupler protruding from the socket end of the pipe.
- **Preliminary Leak Testing** - Prior to installation, a cylinder leak test is completed outside of the borehole. When the cylinder passes the leak test, it is ready for installation.
- **Installing the First Rod and Pipe** - Thread tape is applied to the cylinder pump rod, which is subsequently screwed into the first rod and tightened using two wrenches. Next, thread tape is applied to the riser pipe threads, screwed into the cylinder, and tightened with two pipe wrenches. The first pipe, rod, and cylinder are lowered into the borehole, then secured with the pipe vice when approximately 50cm of pipe is protruding from the pump stand.
- **Secondary Leak Testing** - Another leak test is completed by filling the entire first pipe with water and checking for water loss. This leak test is more robust than the initial test completed outside the borehole because of the excess water the cylinder is required to support. When the cylinder passes the leak test, the installation proceeds.
- **Installing Remaining Rods and Pipes** - The UWP crew and volunteer labor work together to install the remaining pipes and rods. Thread tape is applied to the second rod, which is screwed into the first rod and tightened using two wrenches. Thread tape is also applied to the second riser pipe, which is screwed into the first riser pipe and tightened with hands, not pipe wrenches. Lifting spanners are positioned as high as possible on the second pipe to brace the rising main. The pipe vice is loosened and the rising main is lowered using the spanners. Once lowered, the vice is tightened and the spanners repositioned. This process repeats until approximately 50cm of the riser pipe remains above the vice. The pipe vice is tightened and the next pipe and rod are attached. This process continues, one pipe at a time, until the cylinder is lowered to the appropriate depth.
- **Installing the Water Tank** - The water tank is screwed onto the top riser pipe and tightened by hand. While bracing the water tank with spanners, the vice is removed. The water tank is lowered to rest atop the pump stand and positioned such that the spout points in the required direction. The water tank is then secured using bolts and nuts.
- **Preparing the Top Rod** - For the cylinder to function properly, the protruding top rod must be cut to align with the top of the water tank. First, the location of the cut is marked using a hacksaw. Next, the rod lifter is attached, the rod lifted, and the rod vice secured. The rod is cut at the mark using a

hacksaw and any sharp edges are filed away. Threads are cut into the top of the rod using a thread cutter, allowing the chain to be attached.

- **Installing the Pump Head** - The middle flange is positioned and allowed to rest atop the rod vice. The chain and coupler are screwed onto the newly cut rod threads. The rod assembly is lifted using the middle flange, allowing the rod vice to be removed. The middle flange is then lowered to rest atop the water tank and the pump head is installed. The chain is attached to the handle, greased, and the head cover is installed.
- **Tertiary Leak Testing:** After the pump is assembled, a pump test is completed to ensure the assembly meets UWP performance standards. Protocols for pump testing are described in detail in [Appendix J](#).