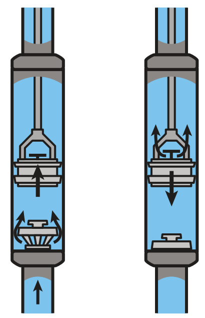
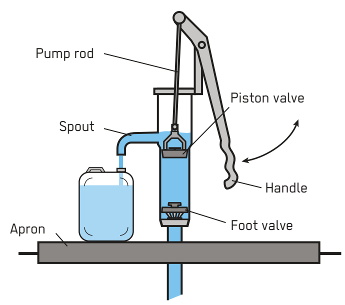
# Piston-Plunger Suction Pump

| Response Phase | Application Level | Management Level | Objectives / Key Features |
|---|---|---|---|
| Acute Response<br>* Stabilisation<br>* Recovery | ** Household<br>* Neighbourhood<br>City | ** Household<br>** Shared<br>Public | Positive displacement pump, all working parts above ground |
| **Local Availability** | **Technical Complexity** | **Maturity Level** | |
| ** Medium | * Low | *** High | |

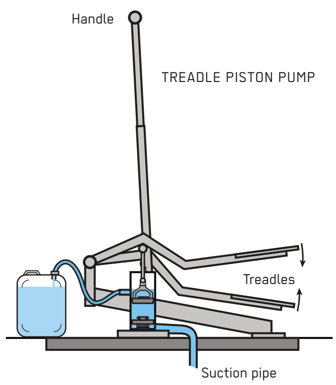
PISTON PUMP OPERATION



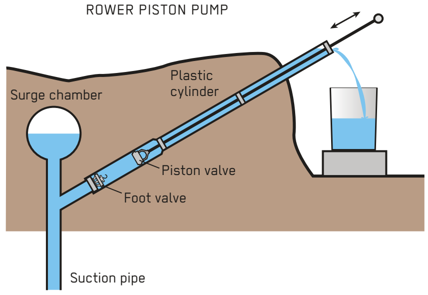
PISTON PUMP




TREADLE PISTON PUMP




ROWER PISTON PUMP




A Piston-Plunger Suction Pump is a positive displacement pump that displaces a fixed amount of water per cycle. All working parts are usually above ground. This type of pump can be quite common in some areas, and can be rehabilitated in emergencies to bring them back into use, though it tends to not be suitable in acute emergencies where infrastructure must be built. It is instead more suitable for long-term water supply in rural areas (or for irrigation purposes). Non-suction Deep Well Piston Pumps are described in A.4.

Piston-Plunger Suction Pumps can be both manually (by hand or foot) or mechanically operated. They function through a sliding seal within a cylinder, which moves up and down (reciprocating action) to force water through one of two non-return valves, usually located within the pump head itself. This action creates a vacuum in the suction pipe that pushes water up the pipe through atmospheric pressure.

**Design Considerations:** The maximum height to which water in the suction pipe can rise is limited and determined by atmospheric pressure. Theoretically, this is the point at which the atmospheric pressure pushing water up the pipe is equal to the weight of the water column in the pipe (i.e. 10.34 metres). In reality, however, imperfect suction conditions and friction losses in the pipe mean that at sea level, this maximum is more likely to be around 7 metres. At higher altitudes, this will be even lower (e.g. around 4.5 metres at an altitude of 2,400 metres) as there is less atmospheric pressure that can push the water. An advantage of this pump type is that a higher flow rate is possible (between 3,000–4,500 L/hour from 5 metres depth) compared to non-suction types (2,500–3,000 L/hour at the same depth), making it well suited for small-scale irrigation requiring larger volumes of water.
There are different varieties of the pump available both for irrigation or drinking water supply. Pumps used for irrigation generally serve a larger demand and are subsequently designed to be operated using stronger body parts

(such as the legs or back). For example, rower pumps can be operated sitting or standing using a rowing action performed by the arms and back, whereas treadle pumps are operated using a stepping action performed by the legs to activate pistons under each foot. Suction pumps usually need priming to create a vacuum, which involves pouring some water into the cylinder to create an airtight seal between the piston seals and cylinder. Additionally, it is essential that the intake pipe is airtight to facilitate efficient pump priming and operation. Having a non-return foot valve at the other end of the suction pipe helps to hold water in the pipe once it has entered. In this case, even though it may leak back into the well over time, less effort is required to bring water back between pumping intervals.

**Materials:** Materials needed include the pump mechanism, a suction pipe to the water source, potentially a non-return valve at the end of the pipe, and for some pumps, a discharge pipe to deliver water to a higher elevation than the pump. In many cases, this type of pump is produced locally. Availability will depend on country context.

**Applicability:** Manually operated Piston-Plunger Suction Pumps are most viable in emergencies when used at a household level. If they already exist in communities requiring an emergency response, they can be overhauled to be fully operative rather than being newly installed. Depending on the design, they can be used either for drinking water supply (e.g. cast-iron suction pump) or for small-scale irrigation (e.g. treadle or rower pump). As these pumps operate using suction lift, they are only suitable for shallow aquifers. However, within this context, they can be useful in situations where an offset pump is needed (e.g. withdrawing water from a riverbed well with the pump offset on the riverbank), or where higher volumes of water are needed (e.g. irrigation for small gardens).

**Operation and Maintenance:** The maintenance requirement for Piston-Plunger Suction Pumps is less onerous than for most other handpumps, as there are fewer working parts, and all the working parts are above ground which means that maintenance is more easily carried out. The parts that do need to be replaced are the piston seals and valves. These pumps can use plastic or metal for both the cylinder and suction pipe. From experience, if metal components are used in conjunction with groundwater with a pH of less than 6.5, corrosion is more likely to require a frequent replacement of the affected parts, particularly pump rods and pipes. Pumps used for irrigation tend to have a different ownership structure, and are often owned by individuals or groups for productive use (i.e. irrigation of crops), and because of this vested interest they may be better maintained compared to pumps used for non-productive use (i.e. drinking water) that may have been donated rather than purchased.

**Health and Safety:** The main health and safety issue is that microbiological water quality can be compromised if contaminated water is used to prime the pump. Additionally, these pumps withdraw water from shallow aquifers, which are by nature more prone to contamination, particularly in urban areas or where there is a source of pollution nearby. Chemical water quality can be an issue in some metal pumps if the groundwater has a pH of 6.5 or less, as solubility of iron from pipes is increasingly likely. If lead is used for the weighted non-return valve as part of soldering or if it is integrated into brass fittings, it may leach into water at pH values of 7 and below. Lead contamination poses a direct health risk, whilst iron leaching from pipes is a more indirect risk where it can cause or worsen the effect of iron-related bacteria, affecting taste and colour to the point where people may choose an alternative, unsafe source.

**Costs:** Costs are usually within a range of 100–200 USD. Ongoing costs are low, as there are fewer moving parts. For some pumps, parts can be fabricated locally.

**Social and Environmental Considerations:** Generally, these pumps are well accepted. As this pump is mainly operated manually it represents an environmentally friendly way of extracting water, with limited risk for over-exploiting the water source used for pumping.

**Strengths and Weaknesses:**

(+) Requires low O & M due to fewer working parts
(+) Easier O & M because working parts are accessible above ground
(+) Good for offset pumping situations

(−) Lifts only limited amounts of water
(−) Can be contaminated during priming

→ **References and further reading material for this technology can be found on page 216**