



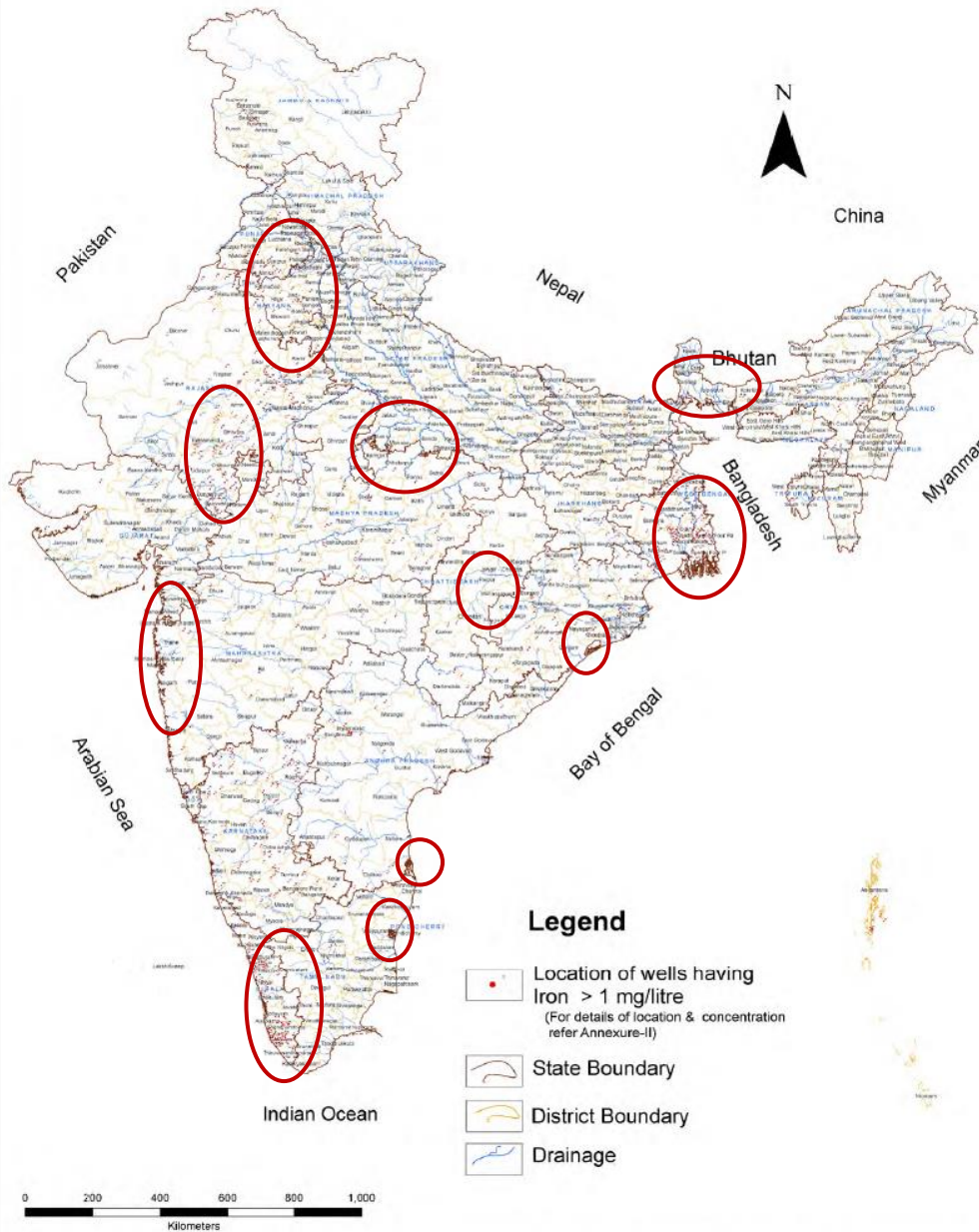
The 2013 University of Oklahoma International WaTER Conference

Hand pump attachable iron removal plant for field
implication in rural areas

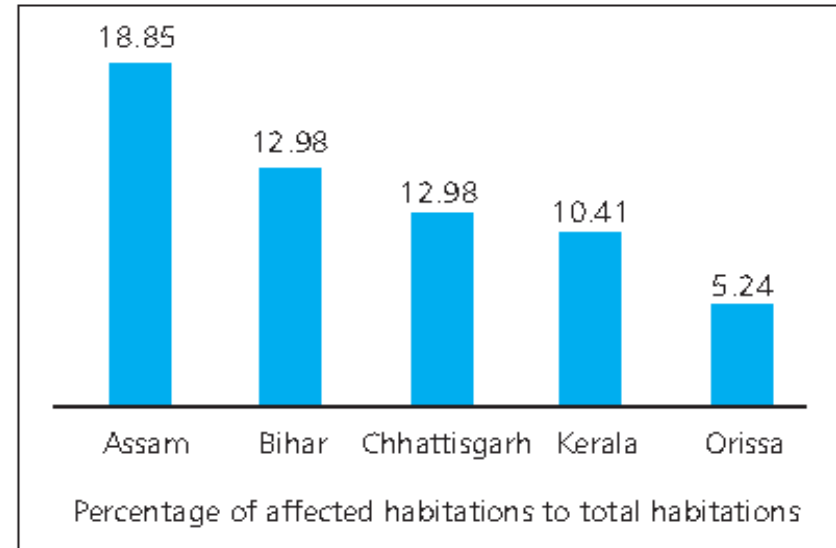
Poonam Gwala

Senior Research Fellow
CSIR- NEERI, Nagpur
INDIA

IRON IN GROUND WATER (>1 mg/litre)

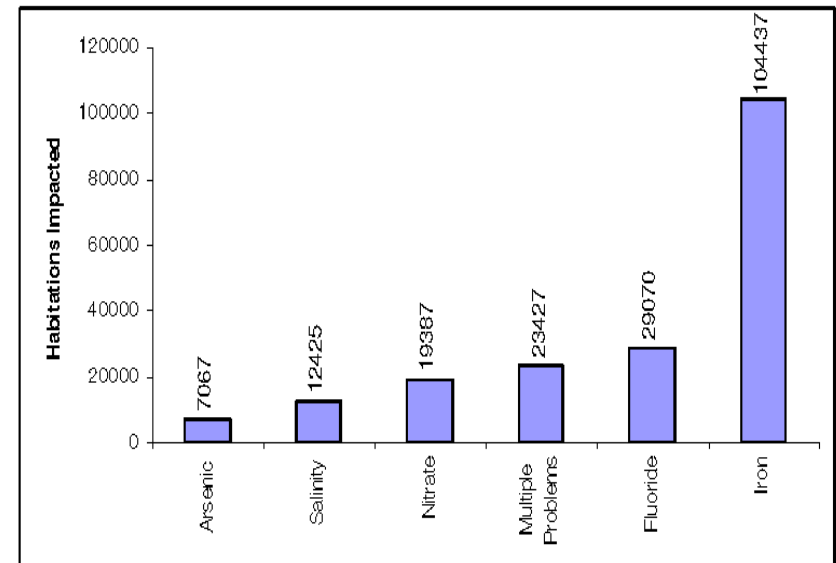


Top Five Iron affected States in India

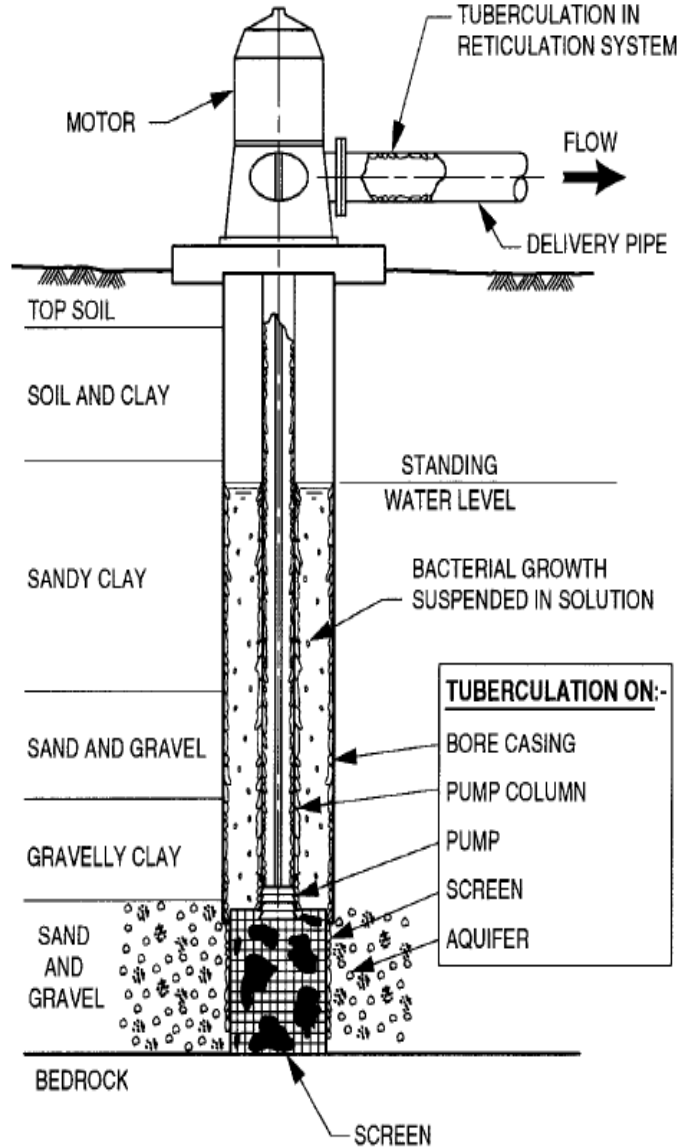


Source: Data from DDWS (2011)

Highest Habitation covered by Iron Contamination



Occurrence



- Iron is common constituent in Soil and Ground Water
- It is contributed in Ground water mainly through weathering of ferroginous minerals such as hematite, magnetite, sulphide ores
- During rainfall, water seeps through the soil which absorbs the org. matter and iron, ultimately through layer of soils and percolates into the ground.
- It is present either as soluble Ferrous ion (Fe^{2+}) or insoluble Ferric ion (Fe^{3+})
- Iron bacteria utilise ferrous iron as energy source & precipitate ferric hydroxide
- Energy utilized promotes growth of thread like slimes, which forms voluminous mass



Significance

- **Iron is an essential element in human nutrition, minimum daily requirement range from about 10 to 50 mg/day**
- **Taste is not usually noticeable at iron concentrations below 0.3 mg/litre**
- **Turbidity and colour may develop in piped systems at levels above 0.05–0.1 mg/litre**
- **Laundry and sanitary ware stain at iron concentrations above 0.3 mg/litre.**
- **The average lethal dose of iron is 200–250 mg/kg of body weight**
- **Long term consumption of drinking water with high conc. of iron can lead to liver disease (hemosiderosis).**
- **Hemochromatosis symptoms include chronic fatigue, arthritis, heart disease, cirrosis, cancer, diabetes, thyroid, impotency, sterility etc.**

Impacts of high iron content in groundwater

- **Unpalatable metallic taste**
- **Yellowish color of water**
- **Stains laundry, plumbing fixtures and utensils**
- **Growth of iron bacteria leads to slimy deposition in distribution system**
- **Concentrations greater than 1.0 mg/L may lead to deposits in pipes**
- **Not much health impacts**
- **The guideline for iron**
 - **USEPA and Canada : 0.3 mg/L**
 - **BIS : 10500-2012 : 0.3 mg/L**



Methods of Iron Removal

- **Aeration**
- **Chemical addition**
 - **Chlorine**
 - **pH adjustment with lime**
 - **Potassium permanganate**
- **Catalysis**
- **Heterogeneous phase separation**
 - **Ion exchange**
 - **Manganese dioxide**

Hand Pump Attachable Iron Removal Plant



Three Chambered Unit

Aeration Chamber

Oxygenation of water

Removal of carbon dioxide

Removal of sulphur dioxide

Sedimentation Tank

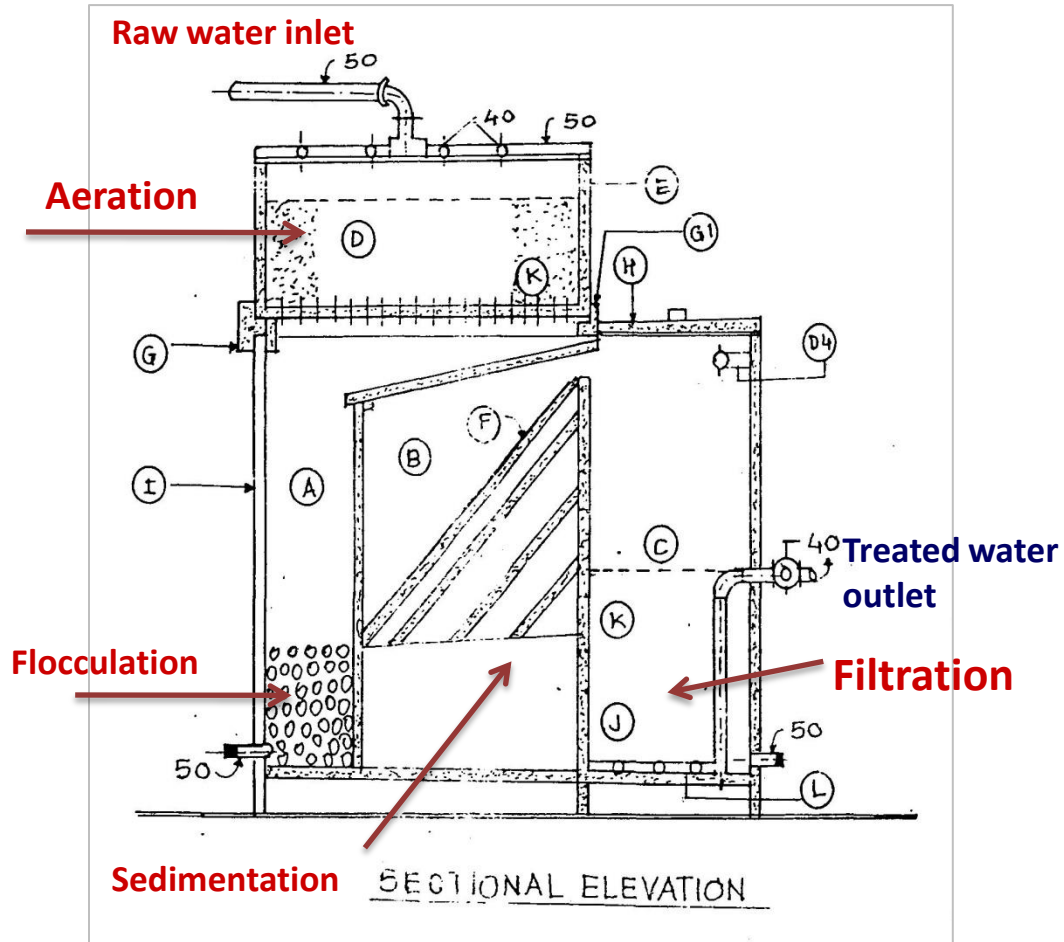
Precipitation

Sand Filter

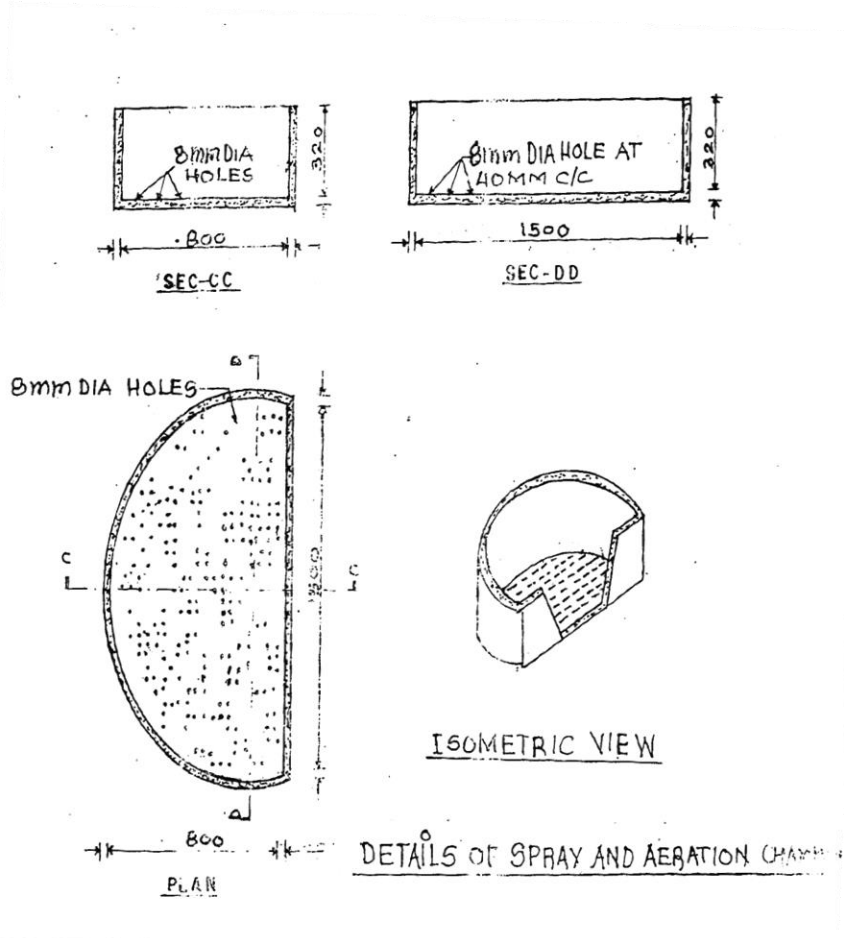
Transportation of unsettled particles

Adsorption of particles

Hand Pump Attachable Iron Removal System

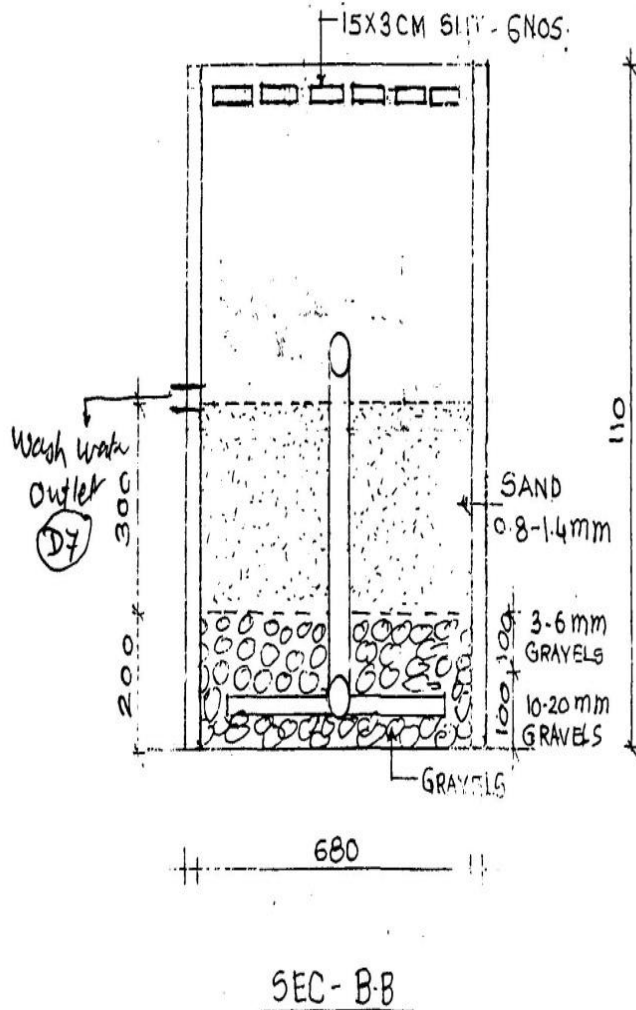


Aeration Chamber



- Semi-circular body with perforated bottom plate holding 20 cm aeration media, gravel/stone of size 20-40 mm
- Fitted with a slotted PVC header and lateral pipes embedded firmly to the periphery of the chamber
- Carbon dioxide escapes and ferrous iron is oxidized and precipitates.
- The precipitated hydrated iron oxide forms a coat over the gravel/stone and accelerates subsequent conversion of ferrous iron.

Filter Chamber



- Semi-circular, partitioned out of sedimentation tank with a width of 50 cm.
- The filter has a 20 cm gravel column of 10-20 mm size (10 cm) and 3-6 mm size (10 cm) and 30 cm of 0.8 – 1.4 mm sand column.
- A nylobolt cloth is placed in the filter 5 cm below the top layer of sand.
- When the filter is choked due to iron precipitate water above the sand bed is drained out and top 5 cm sand layer along with the nylobolt cloth is removed.
- Sand and cloth is washed with water and again placed on the filter bed and filtration is continued.
- This arrangement avoids the operation of filter backwashing, thereby reducing additional units like backwash water chamber and operation of additional valves.

Hand Pump Attachable IRP salient features

- ✓ Iron content reduced below 1 mg/L from 3.0 - 6.8 mg/L of iron in raw water
- ✓ Continuous operation system with 1 cu m/hour hydraulic loading
- ✓ 40 lpcd and 10 hours daily operation assumption
- ✓ Suitable for approx. 250 people population
- ✓ Based on contact bed aeration system in aeration chamber
- ✓ Cylindrical body easy for maintenance
- ✓ Collection / flocculation chamber
- ✓ Plant Dimensions
 - Diameter : 135 cm
 - Height : 150 cm
- ✓ 240 plants were installed at Assam during water Mission in 1992
- ✓ Construction cost about Rs. 50,000

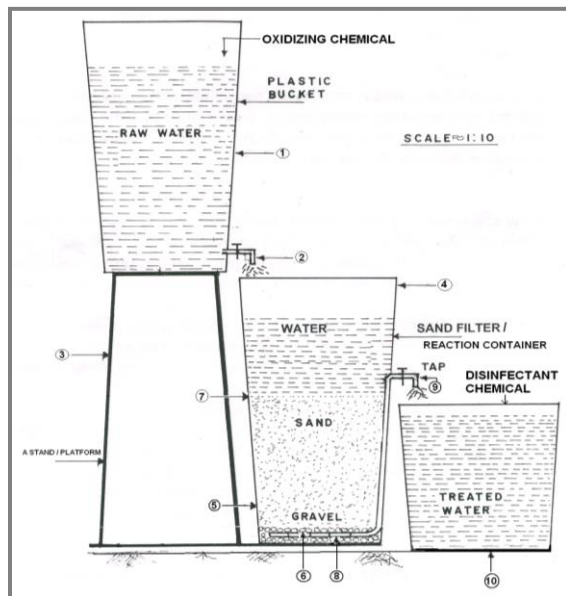
Hand Pump Attachable IRPs installed in different states in INDIA



"NEERI-Zar" - Domestic Iron Removal Unit



- NEERI-ZAR can also work as Domestic Iron Removal Unit
- KMnO_4 is used as oxidizing agent to precipitate out iron in groundwater (0.5 mg per mg of iron)
- KMnO_4 also works as disinfectant
- Suitable for iron affected remote places
- 20 units installed in Tadoba Reserve Forest, Chandrapur Dist. (M.S.) for supply of potable water to forest guards



Healthy Living



Thank you

email id: poonam.gwala28@gmail.com