

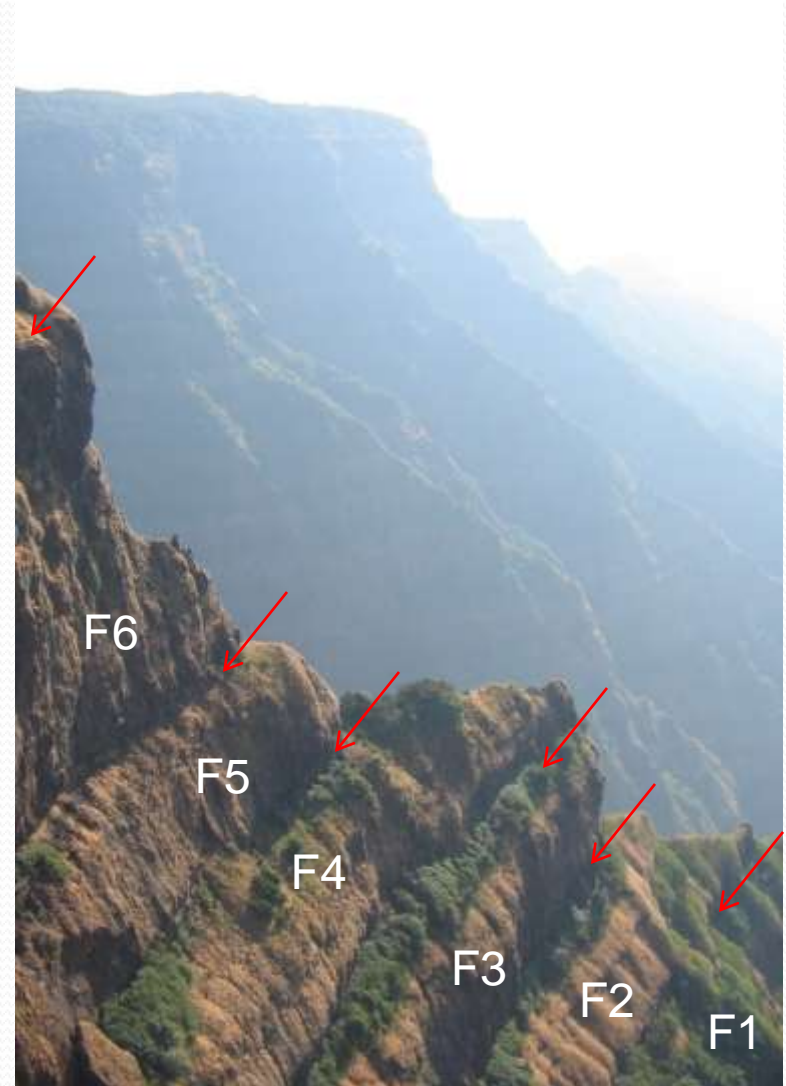


***Innovative Water Harvesting Techniques,  
its Implementation in  
Strengthening Drinking Water Sources  
in Hard Rock Terrain of Maharashtra***

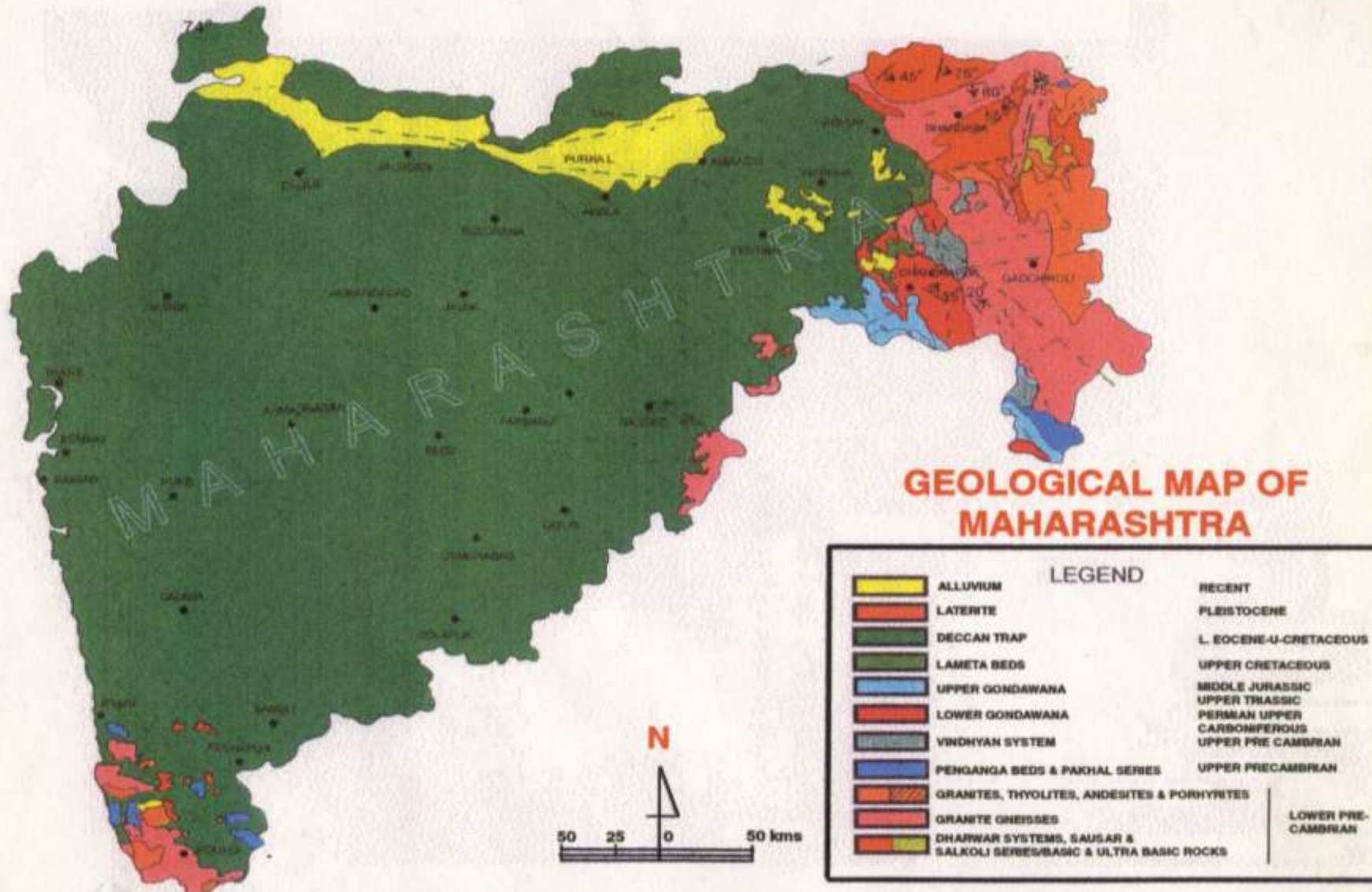
**Suresh Khandale  
Additional Director  
GSDA  
Maharashtra**

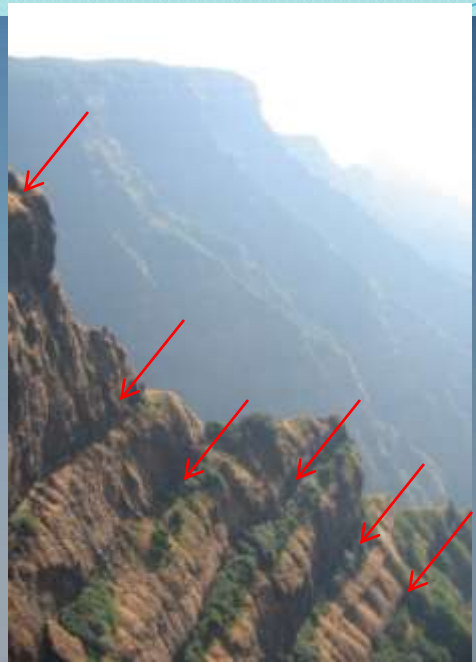


# Deccan trap



# Maharashtra: Geology





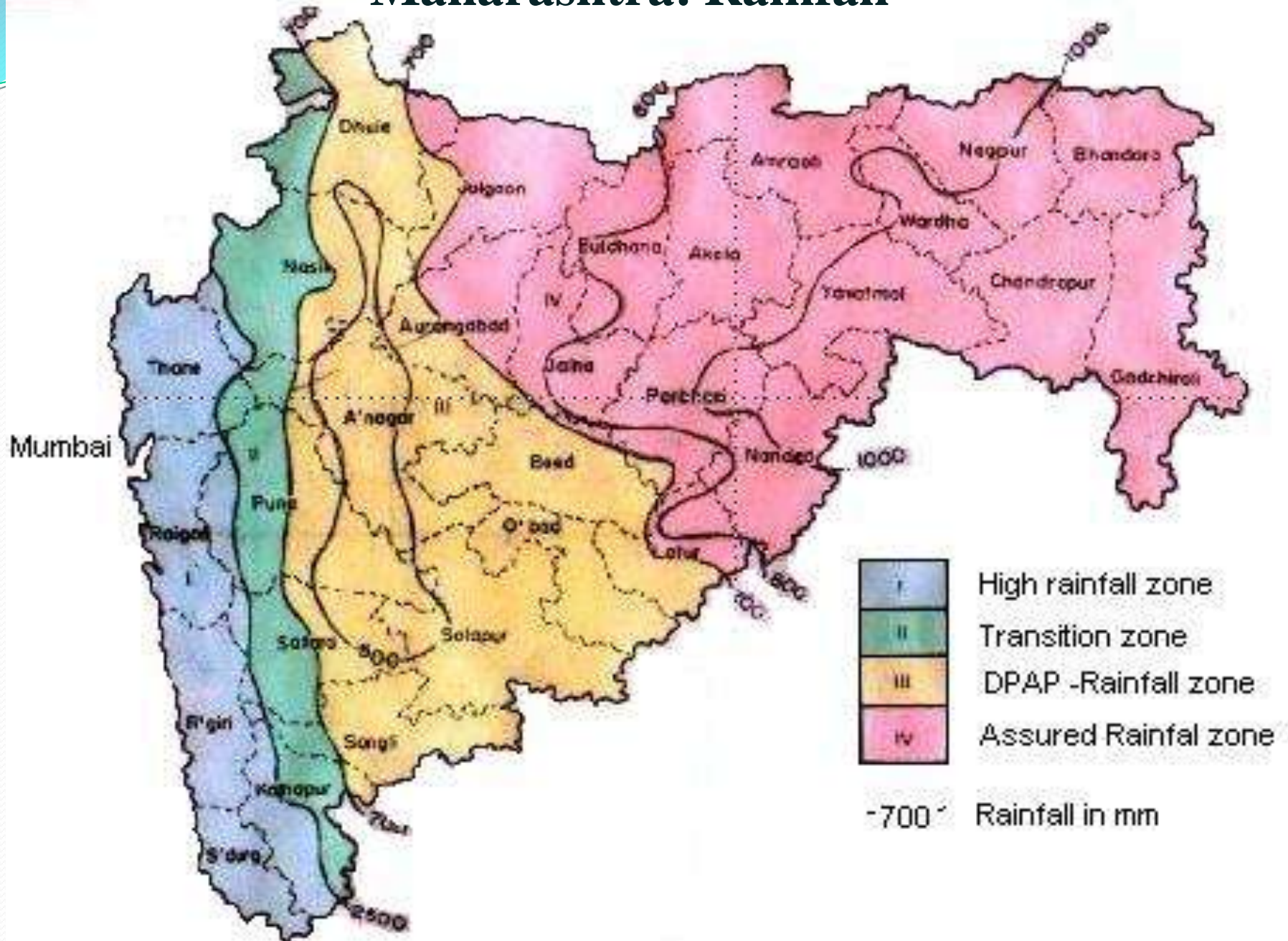








# Maharashtra: Rainfall



ये रे ये रे पावसा, तुला देतो पैसा.....

पैसे टाकून, पाऊस विकत घेता येत असता तर ?



राज्यात १२ महिन्यातले ४ महीने

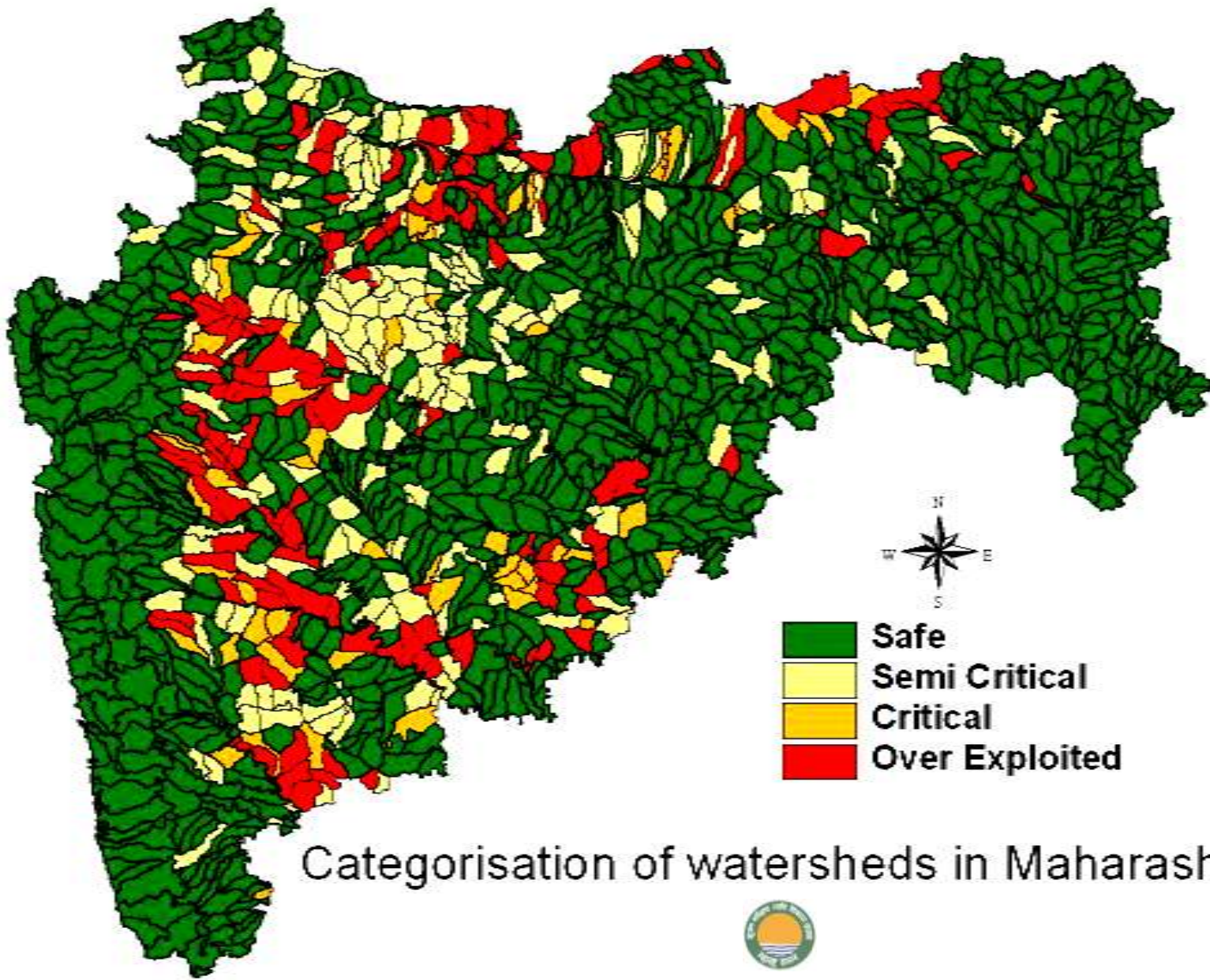
४ महिन्यातले ४० दिवस

४० दिवसातले १६ तास



म्हणजे फक्त ४ दिवसच पाऊस पडतो.





Categorisation of watersheds in Maharashtra



# GW Assessments as per GEC 1997

Information at a Glance of Groundwater Assessments as per GEC 1997			
Sr.No	Description	2004	2007
1	Total No.of Districts in the State	29	33
2	Total No.of watersheds in the State	1505	1531
3	Total No.of Talukas in the State (As per 2002 - 353)	318	348
4	Total No.of Assessment Sub Units	2316	2688
5	Annual Groundwater Recharge (BCM)	32.96	37.68
6	Net Groundwater Availability ( BCM)	31.21	35.66
7	Gross Annual Withdrawal (BCM)	15.09	17.74
8	Groundwater Irrigation Draft (BCM)	14.24	16.67
9	No.of Existing Irrigation Wells with Pumpsets	1511797	1665229
10	No.of Existing Irrigation Wells with Mhots	4745	4852
11	No.of Existing Irrigation Borewells with Powerpump	41936	154102
12	Total No.of Irrigation dug wells and bore wells	1558478	1824183
13	No.of Existing Domestic Wells with Pumpsets	38980	52086
14	No.of Existing Domestic Wells with Mhots	88004	108516
15	No.of Existing Domestic Borewells with Handpump	134214	141943
16	No.of Existing Domestic Borewells with Powerpump	11389	14697
17	Total No.of Domestic Wells ( 13+14+15+16 )	272587	317242
18	No.of Existing Industrial Wells with Pumpsets	641	623
19	No.of Over Exploited Assessment Watersheds	76/7	54 /7
20	No.of Critical Assessment Watersheds / Talukas	20/1	7 / 2
21	No.of Semi Critical Assessment Watersheds / Talukas	163/23	113 / 10
22	No.of Safe Assessment Watersheds / Talukas	1242/287	1353 / 329
23	Unclassified Assessment Watersheds due to entire Poor Quality	4/-	4/-

# Background

- Groundwater is the Major drinking water resource in Rural Areas
- 85% of Drinking Water Supply Schemes are based on Groundwater
- Annual Rainfall & Geology plays important role in Groundwater Occurrence
- Annual Rainfall is for the four Months; for rest Eight months we have to depend upon surface/subsurface storages

# Background

- Rise in No. of Groundwater Structures, Over Exploitation of GW resources has seriously affected GW levels
- The Scanty rainfall at times results into inadequate GW recharge and Water Table gets depleted; scarcity conditions
- To ensure sustainable availability of both surface and groundwater resources conventional and Unconventional measures are essential

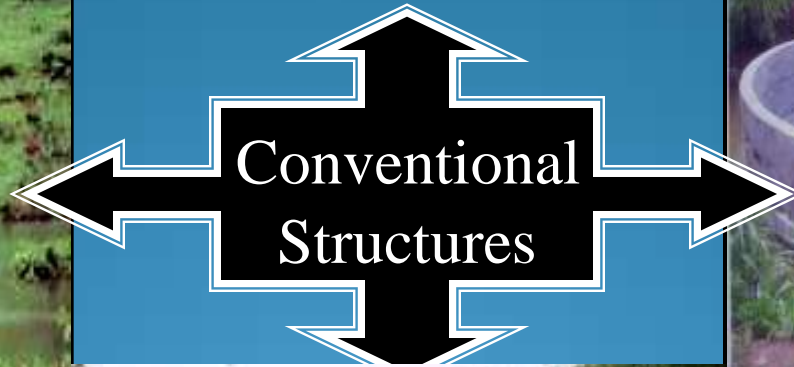
# Need for Water Conservation Measures

- Inadequate rainfall and inadequate GW recharge results into drying up of drinking water sources
- Tendency for alternative source; results into additional cost
- Original Source needs to be strengthened to reduce the cost
- Conventional Measures are the means of Strengthening

# Strengthening of Source



Check Dam



Percolation Tank

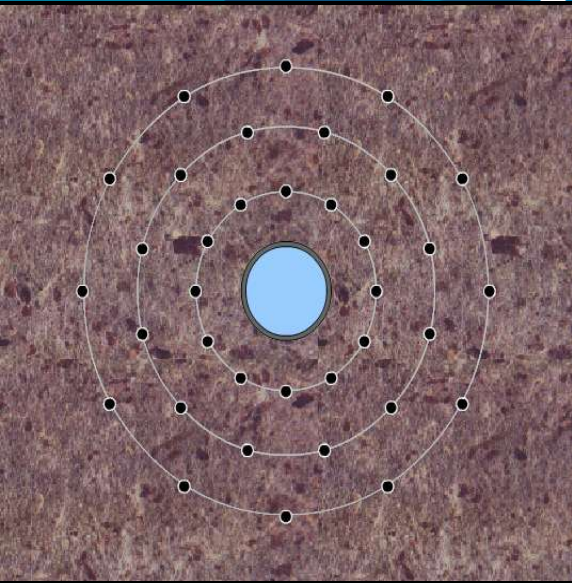
Village Pond



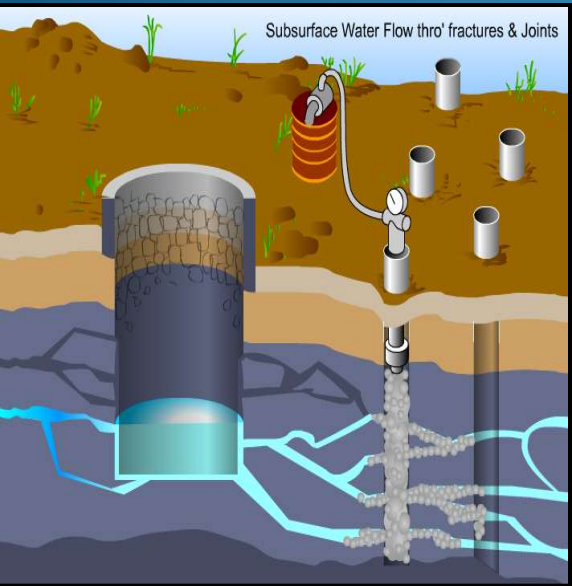
Deepening of well



# Strengthening the drinking water source

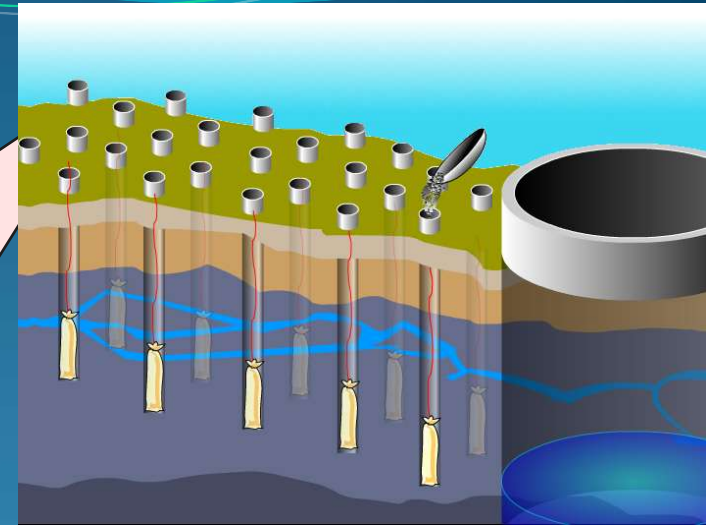


**Jacket Well**

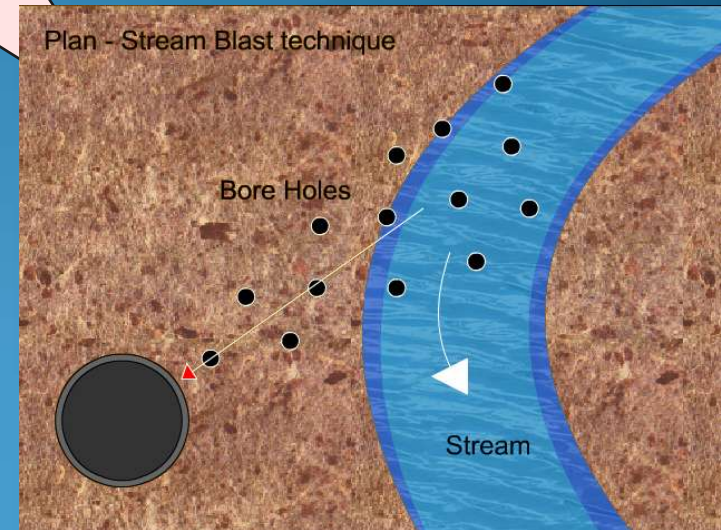
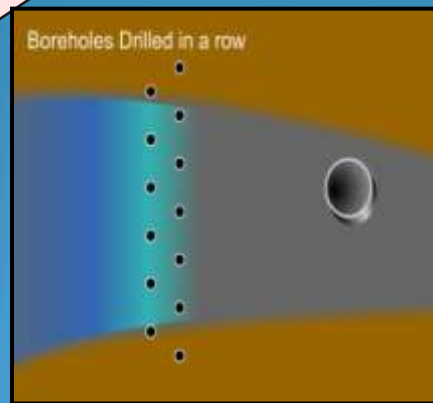


**Fracture Seal Cementation**

**Unconventional Structures**



**Bore Blast Technique**



**Stream Blasting**

# Unconventional Measures

- Developed and implemented by GSDA
- Initial implementation has given more scientific insight for further improvement in the techniques
- Rock formation and its physical characteristics plays important role
  - Hard Rock
  - Fractured/Jointed Rock
  - Moderately weathered rock

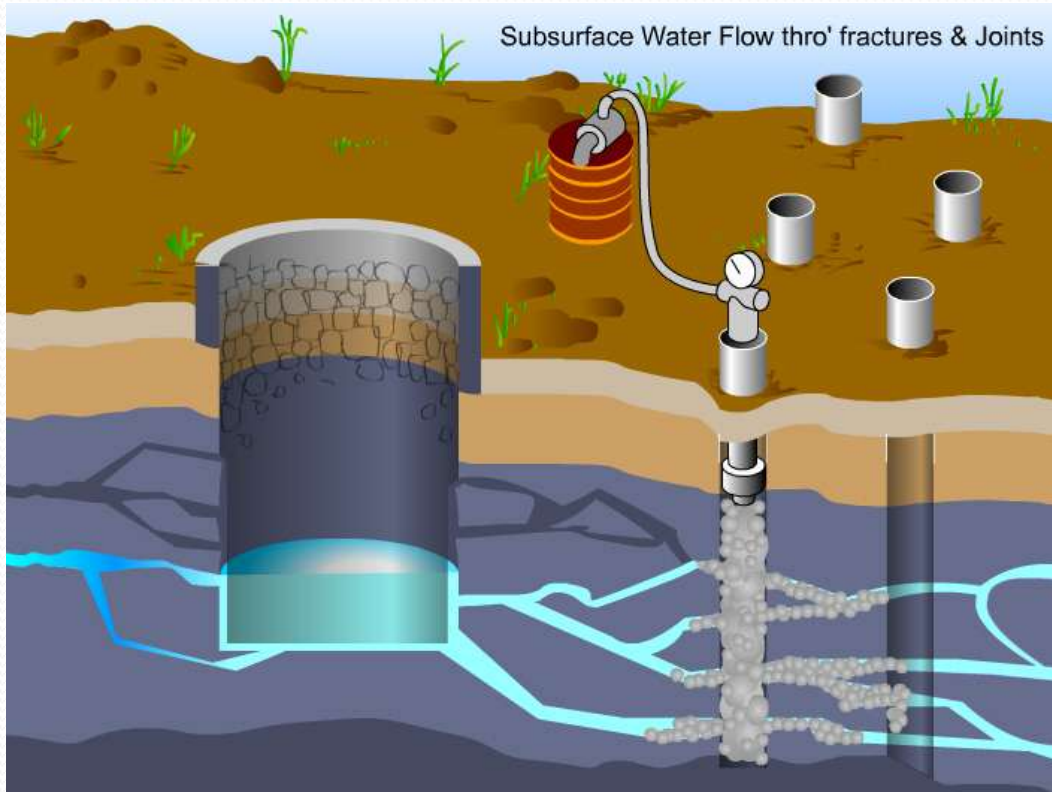
# Unconventional Measures

- Unconventional Measures needs to be decided on the basis of nature of rock. In broad sense –
  - Hard Rock – Bore Blast Technique
  - Fractured/Jointed Rock – Fracture Seal Cementation
  - Moderately Weathered – Stream Blasting, Hydrofracturing
- Geological Formation must be studied carefully prior to undertaking unconventional measures

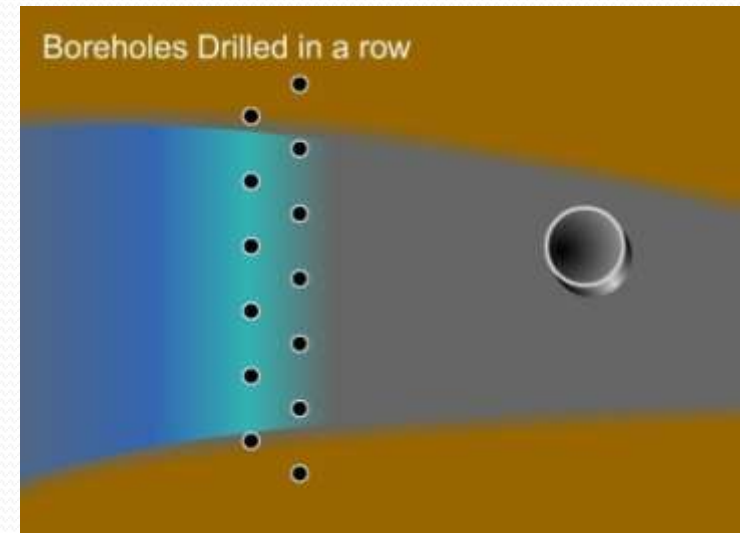
# Unconventional Measures

- Needs monitoring of Groundwater levels in pre & post experimental period
- The techniques needs much attention at district level and needs efficient implementation
- This ensures strengthening of drinking water sources

# 1. Fracture seal Cementation



FSC-2.EXE



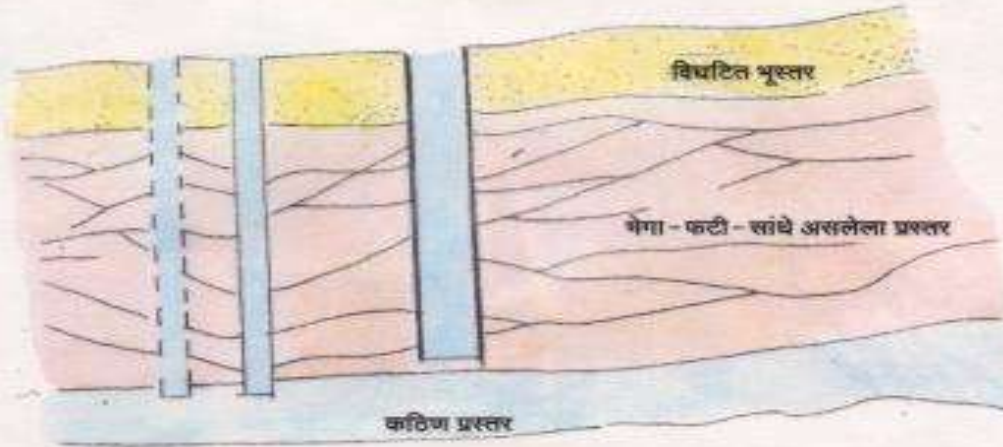
FSC.EXE

फ्रॅक्चर सील सिमेंटेशन



घरून दिसणारा देखावा

जमीन पातळी



फ्रॅक्चर सील सिमेंटेशन (जलरोध भिंत)

आकृती क्र. १२

# Fracture Seal Cementation (FSC)

- Fracture seal Cementation (FSC) is a technique to arrest the sub-surface groundwater movement through fracture network
- It is thereby suitable to strengthen the existing drinking water sources located in the upstream direction within hard rocks
- To stop or control, the interference of adjoining private wells, if any
- Technique needs to be adopted on the basis of field observations regarding the movement of groundwater through fractures

# FSC continued

- Under this process, normally one or two rows of boreholes are drilled to a depth of little more than the depth of dug well in the surrounding area.
- Through these bores cement slurry is injected under desirable pressure so as to seal the existing fractures, resulting in formation of diaphragm across the discharge point .



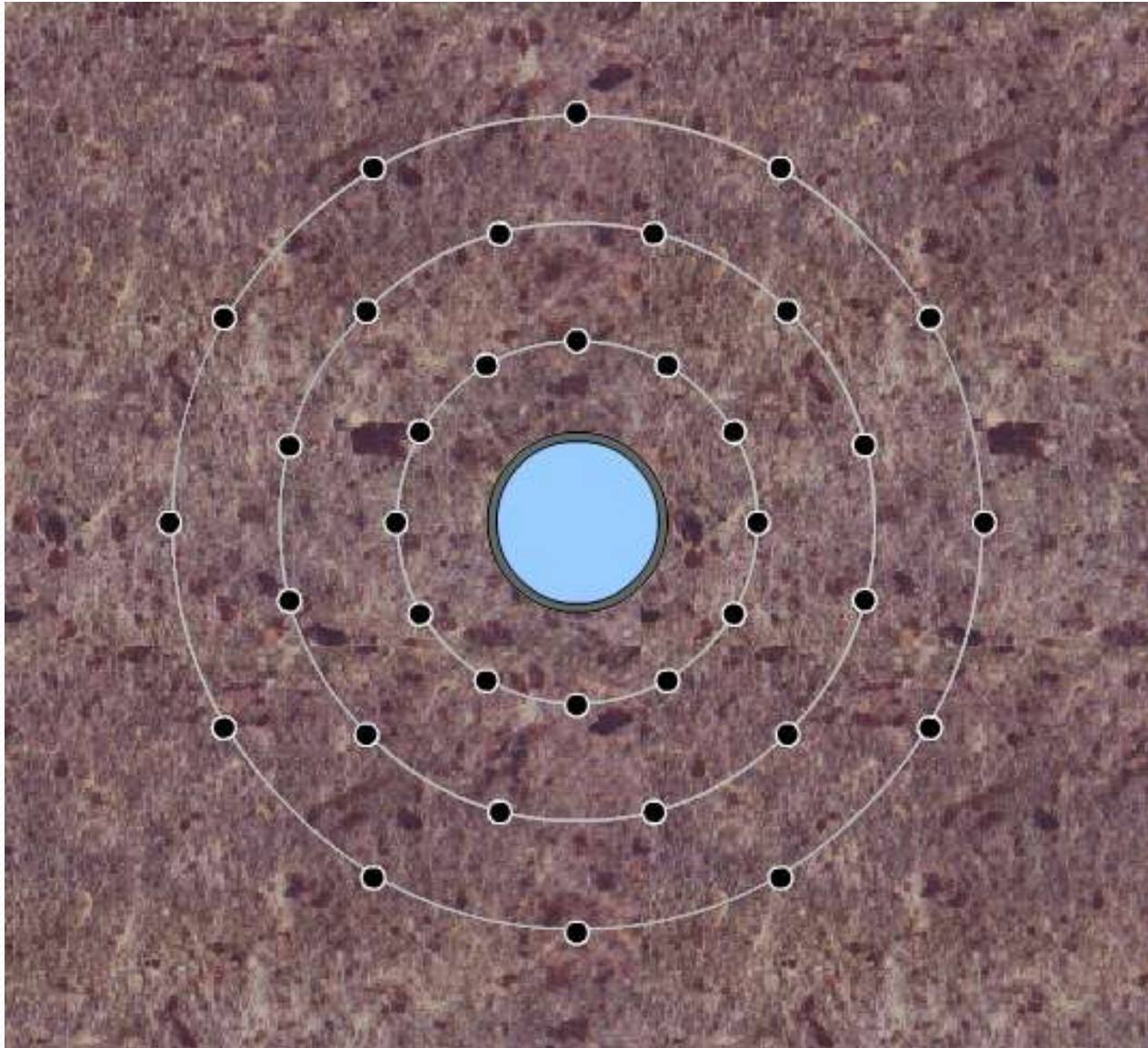
# FSC continued

- This technique creates an effect of '*Cut-off-Wall*' or '*Underground Bandhara*' in hard formation
- Geophysical Survey needs to be conducted before identification of site to know the intensity and extension of joints and fractures.

# FSC continued

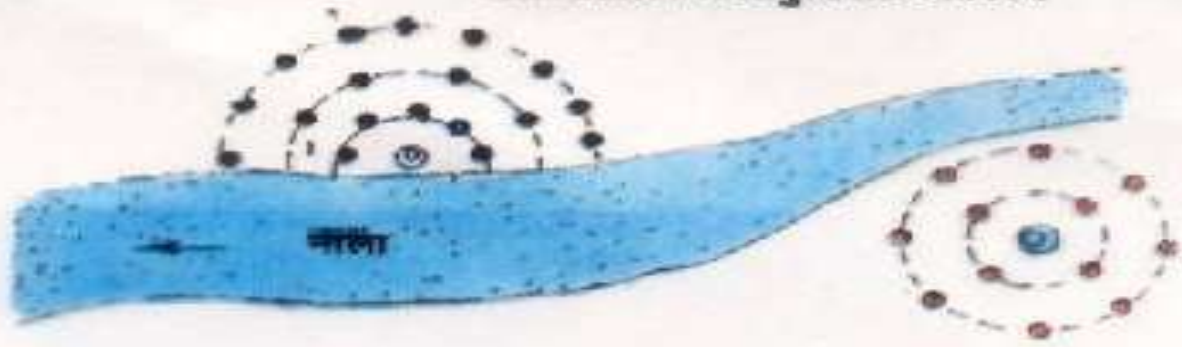
- Geophysical data will provide information to decide spacing between bore holes and also number of rows to be taken for effective sealing.

# 2. Well Jacketing Technique



JW.EXE

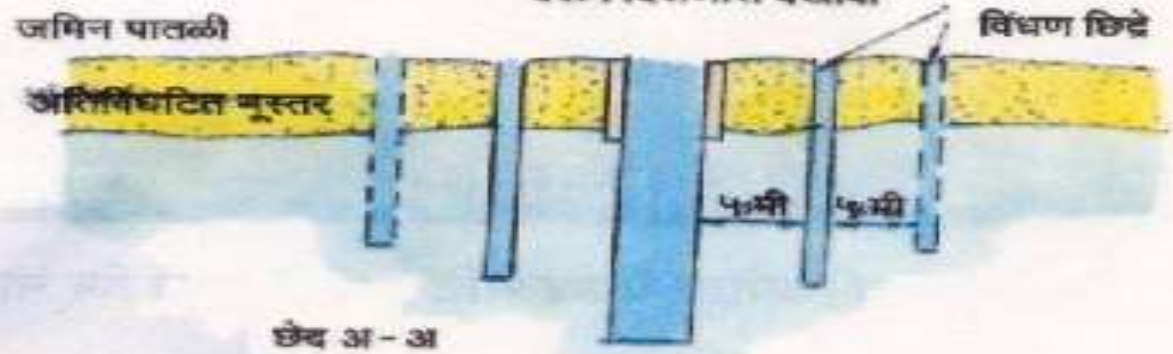
बेल जॉकेटिंग अर्धवर्तुळाकार जॉकेटिंग



वर्तुळाकार जॉकेटिंग



वरून दिसणारा वेश्रावा



छेद अ-अ

उदभव विहिर

आ. क्र. १३



**Well Jacketing Technique**

## 2. Well Jacketing Technique (JW)

- The Construction of Jacket around the dug well in hard rock areas increases effective diameter of the well artificially, thereby increases the storativity and improves transmissivity of the aquifer.

# JW continued

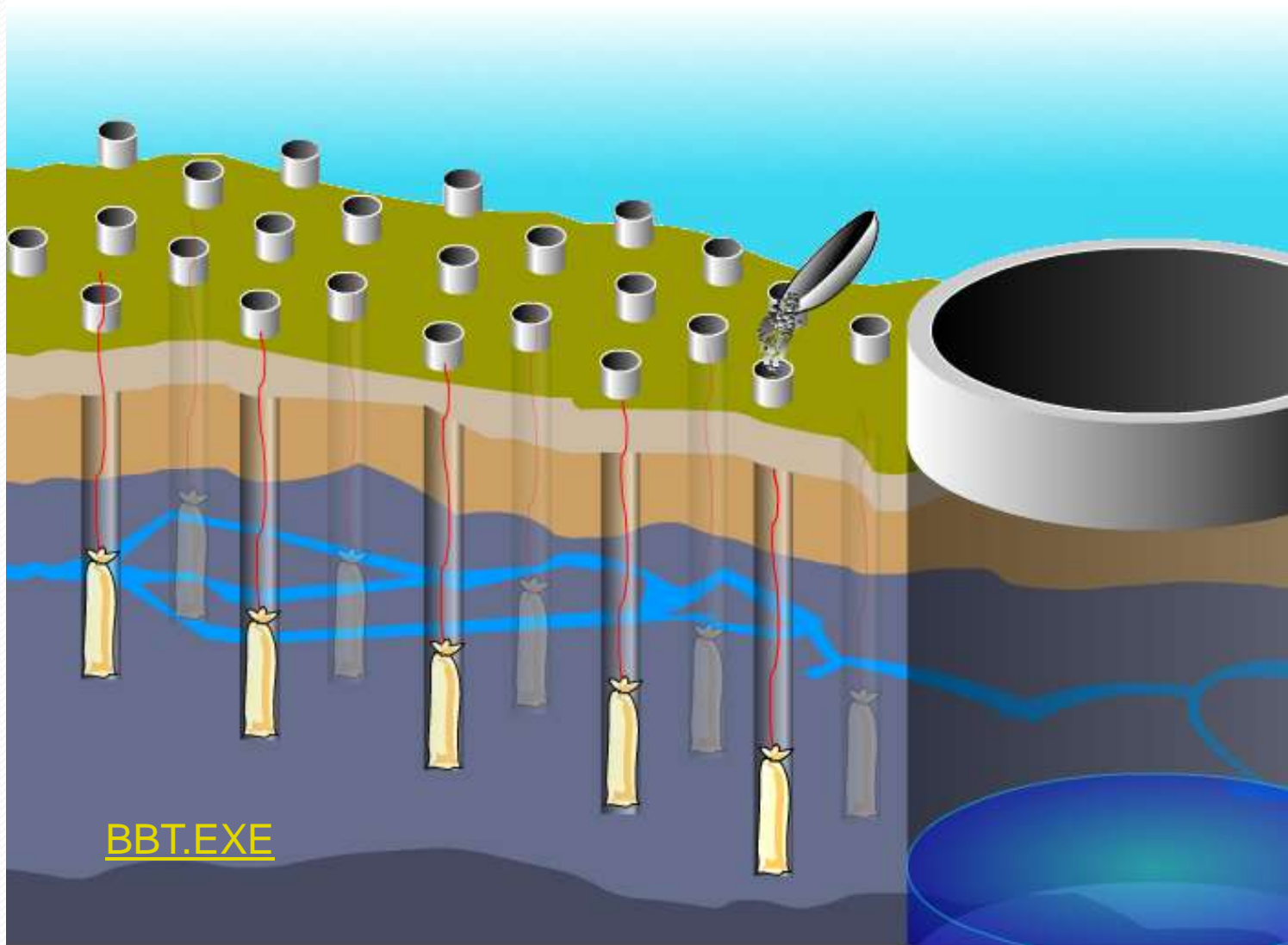
- Boreholes to a depth little less than of open dug well are drilled in a circular /semi-circular pattern around the targeted well.
- Subsequently blasting is carried out so as to create artificial fractures in the compact rocks, which ultimately gets connected to the drinking water source well

# JW continued

- Explosives of required strength and quantity are used to create maximum fractures and to inter-connect them. Sand is generally filled in the boreholes for effective blasting and to keep the cracks open even after blasting.
- In some cases jacket well technique is supported by F.S.C. Technique.



# 3. Bore Blast Technique



# **3. Bore Blast Technique (BBT)**

- Bore blast technique is adopted to create & increase the fracture intensity and thereby increasing the transmissivity and storativity
- Hydrogeological and Geophysical surveys are carried out to locate such area where the rock can be blasted to develop cracks below the zone of weathering.



20.07.2007 10:36

**Bore well Blast Technique (B.B.T.)**

विंधण विहीर विस्फोट तंत्र

स्फोटासाठी विंधण छिद्रे

उदभव विहिर

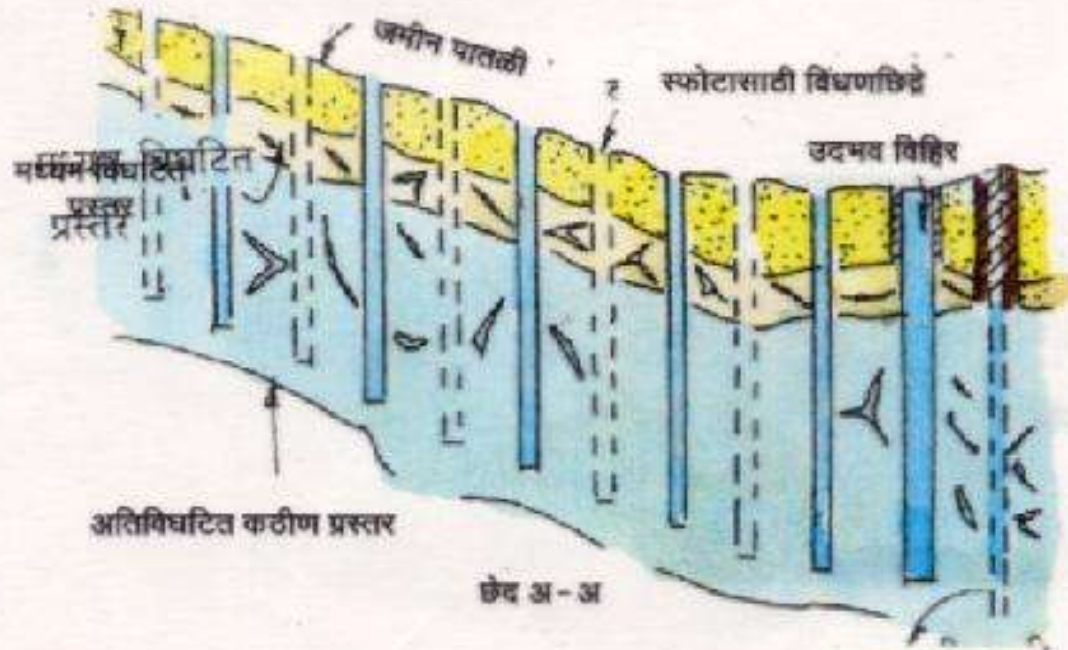
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भूमिगत बंधारा

अतिविघटित प्रस्तर  
माती

वरून दिसणारा देखावा



अतिविघटित प्रस्तर  
माती

जमीन घातळी

स्फोटासाठी विंधण छिद्रे

उदभव विहिर

अतिविघटित कठीण प्रस्तर

छेद अ-अ

एक एस सी साठी  
विंधण छिद्रे

# BBT continued

- Bores are drilled in staggered pattern & suitable types of explosives lowered in 2 to 3 sections in these boreholes for effective blasting.

# Bore Blast Technique



▲ DRILLING BORE HOLES FOR BBT APPLICATION



▲ SAND STEMMING & EXPLOSIVE PLACEMENT

# Bore Blast Technique



**A OK. SIGNAL (RED FLAG) BEFORE BLAST**



**A BORE HOLE BLAST (BBT)**

# Effect Of Blasting



**▲ WELL WATER BEFORE JW TECHNIQUE APPLICATION**



**▲ AFTER JW BORE HOLE BLASTING (NOTE RISE IN WATER LEVEL)**



## 4. Stream Blast Technique (SBT)

- Generally, drinking water wells are situated on nala banks.
- At some places, the groundwater flowing below the nala bed has no hydraulic connectivity with the well, and the well becomes dry or partially dry during summer months. Such well can be rejuvenated by this technique, known as stream blasting.

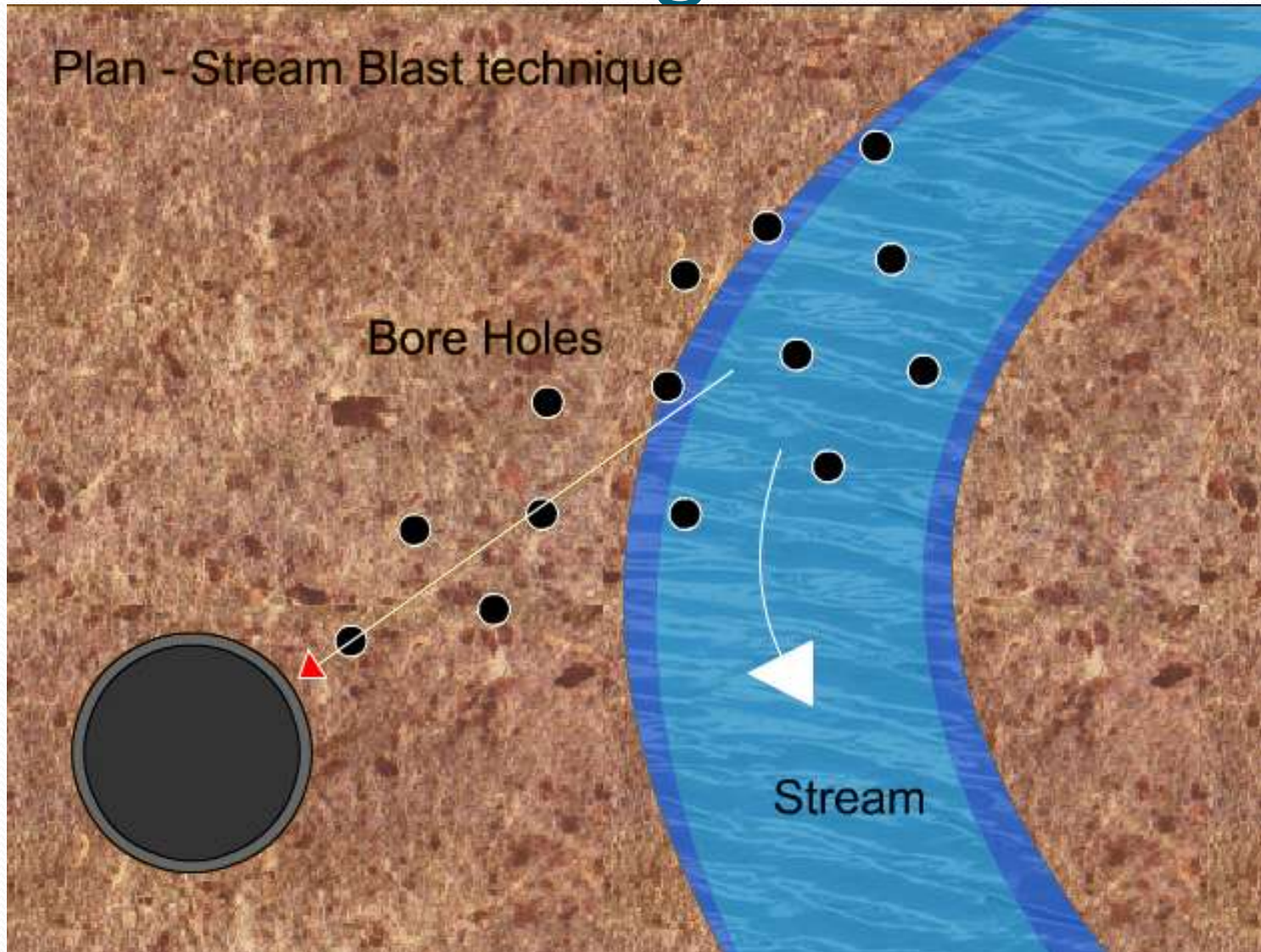
# SBT continued

- In this technique, the area of nala bed within the vicinity of well is investigated geophysically and geohydrologically.
- Then bores are drilled in the nala bed to a depth of open dugwell. These bores are in staggering pattern to get maximum blasting effect in minimum number of bores.

# SBT continued

- Pattern and number of bores is decided considering the hardness of the strata to be fractured or shattered.
- These boreholes are further charged with explosives and blasted to artificially create fractures and joints.
- These artificially created fractures gets connected to the well and divert groundwater movement below the nala bed into the well.

# Stream Blasting



[SBT.EXE](#)

# Conclusions

- Unconventional Measures have its own importance in strengthening of groundwater sources
- Along with natural GW recharge the induced recharge is possible with additional fracture network created
- Since Geology plays a important role in these techniques, GSDA plays a vital part in rendering technical advise
- In fact, for every drinking water supply scheme provision of suitable unconventional measure is essential

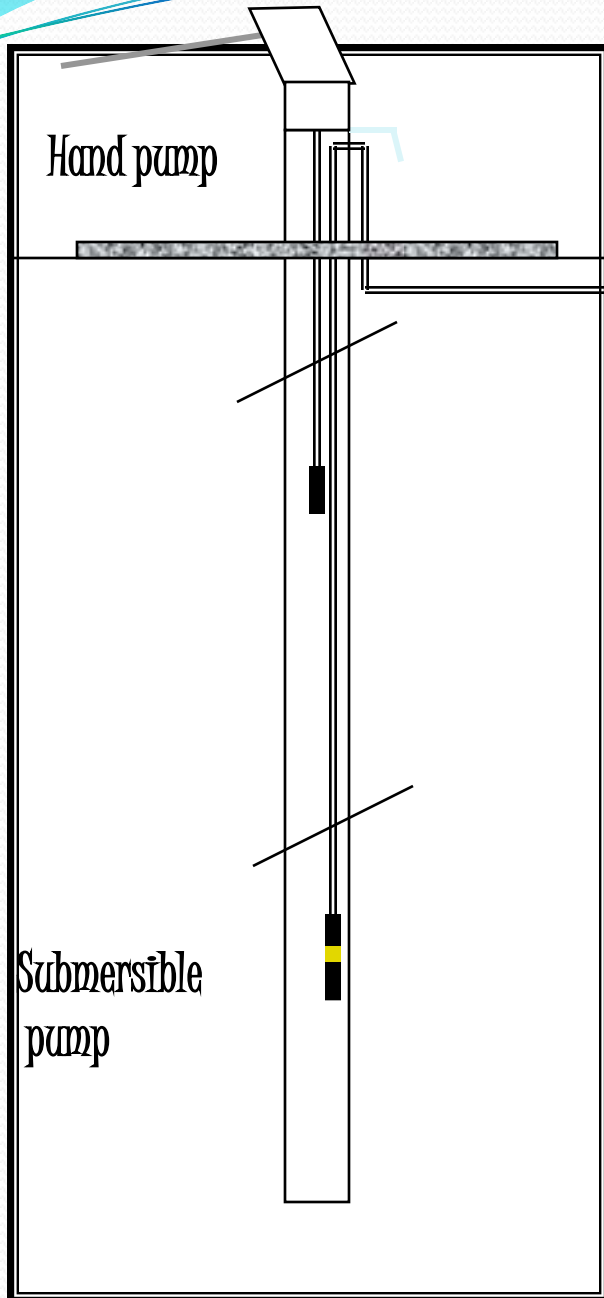
# Conclusions

continued

- For each Monsoon Cycle the post monsoon results in terms of rise in water table, pumping hours needs to be monitored
- This will ensure success of the scheme or necessity of additional measures required, if any
- Village community must be more educated in this regard to have the expected results with their active participation
- Local knowledge of the community must be considered so as to have the possibility of modified unconventional technique

# achievements

- FSC = 1048
- BBT = 654
- JW = 321
- SBT = 150

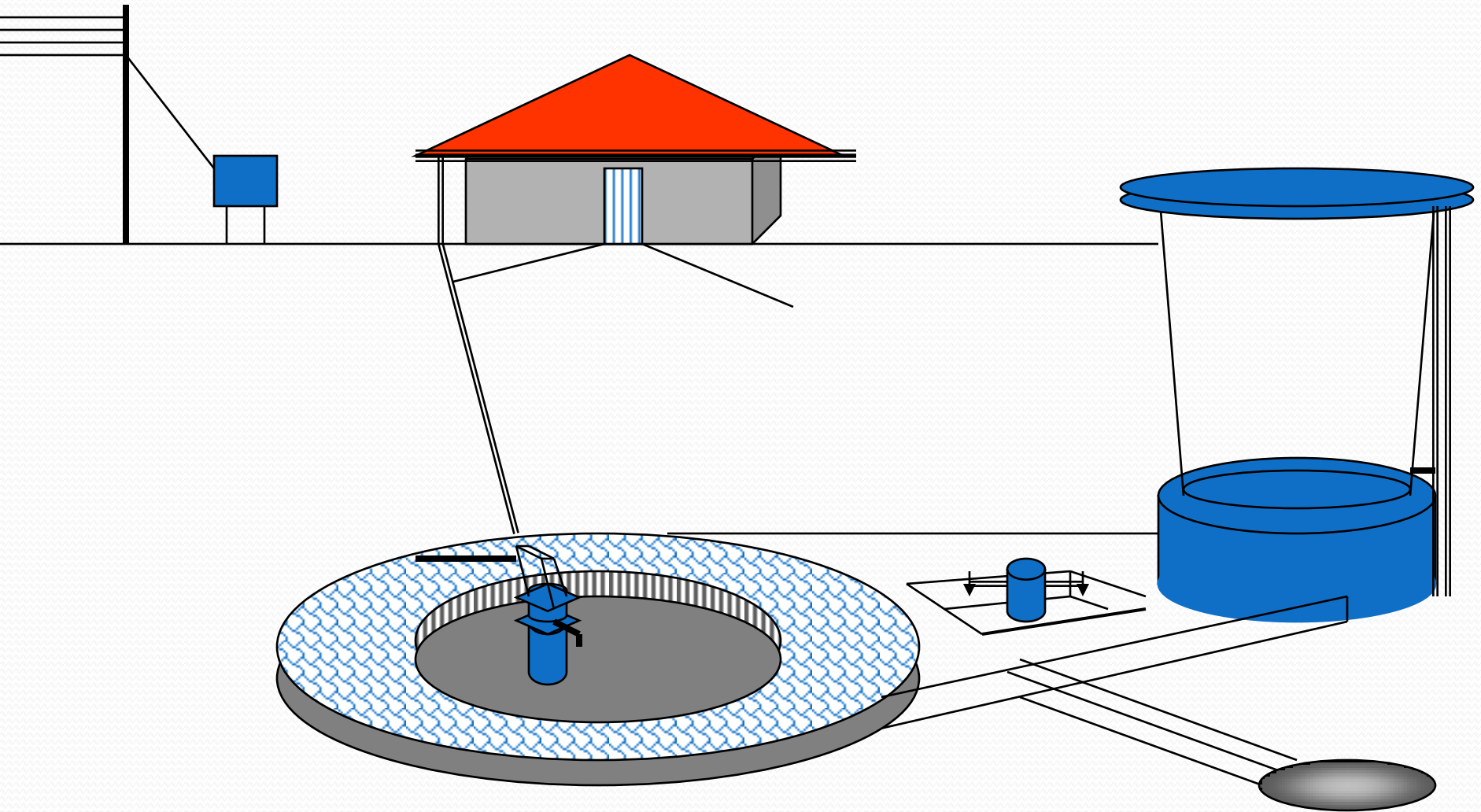


## Dual pump based Mini Rural water supply scheme

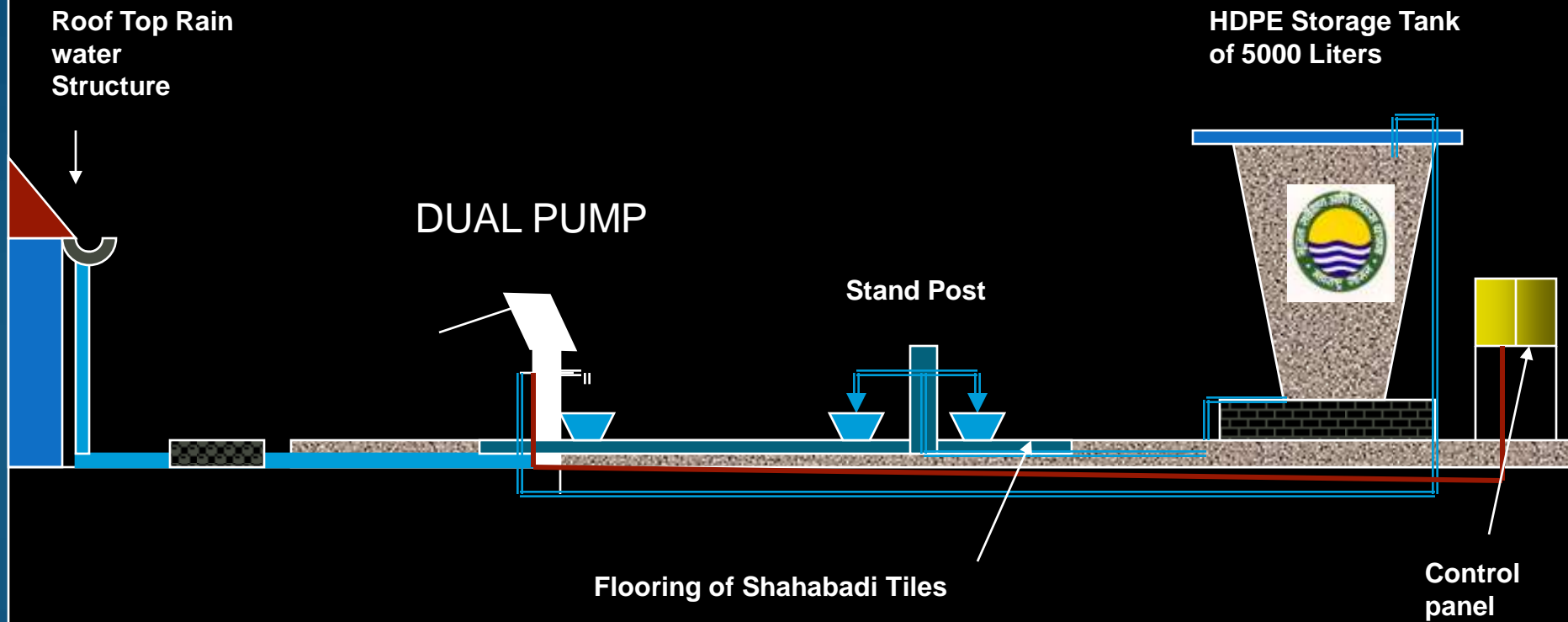
***concept***



# Dual pump based Mini Rural Water supply Scheme



Thematic Sketch of :  
Type Design of Mini Water supply Scheme based on Bore well /Tube well with  
Dual Pump & Roof Top Rain water Harvesting Structure.





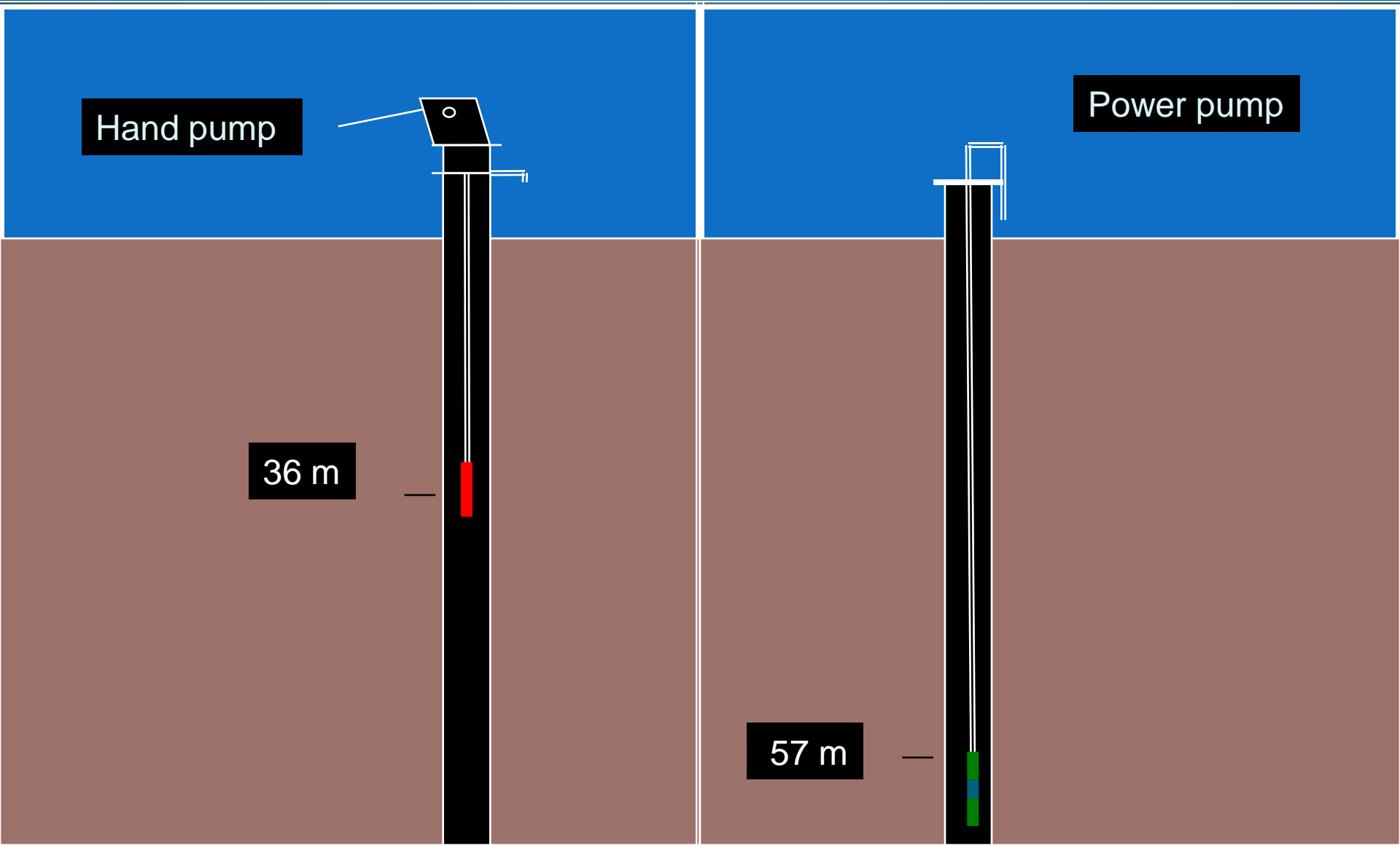


Hand pump

36 m

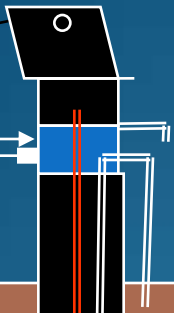
Power pump

57 m





Special  
water  
chamber



RTRWH

32 mm GI pipe 36 m depth  
with cylinder



25 mm dia HDPE pipe 57 m  
depth



1 HP single phase pump







## Verul . Taluka Aurangabad









उच्च इमतेच्या विद्यत विहीरीवर  
दुहेरी पंप उभारणी करणं  
कामणे तत्व- सी.बी. हाफळ  
क्षमता- ५००० लिटर  
दुकान क्र. ८६२१६/१  
जिल्हा इंजिनिअर व उपअडिटर (सोनीपी)  
इ.प्र.वि. कल्याण रोडपूर.

# achievements

- 150 habitations covered
- Proposed in 2009 -10

3300 habitations

( 100 each district, total 33 districts)

**The frog . . .**

**does not drink up...**

**the pond in which...**

**lives**





**Thank You**



MUNICIPAL WATER WORKS

THE RESERVOIR BENEATH  
THE GARDENS WERE  
CONSTRUCTED BY 1880  
AND EXTENDED TO HOLD  
30 MILLION GALLONS  
IN 1911.

THE GARDENS WERE DESIGNED  
BY THE CORPORATION AFTER THE  
LATE SIR FRANCIS BURNHAM GENTA.

