RAIN WATER HARVESTING

By:

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❑ GENESIS OF WATER SCARCITY:

- Population & Urban migration are uncontrollable

- Water Resources variable due to:
  - ✓ Global warming: 1 to 2°C rise
  - ✓ Rapid Environmental changes

    - Change of Rain Pattern – Intensity

    - Low pressure Zone – Timings – Distribution

❖ Days of Rainfall / years are decreasing:

SURAT
CLIMATOLOGICAL TABLE
PERIOD: 1951-1980

Month	Mean Temperature (^oC)		Mean Total Rainfall (mm)	Mean Number of Rainy Days
	Daily Minimum	Daily Maximum		
Jan	14.3	31.5	0.0	0.0
Feb	16.1	33.5	0.4	0.0
Mar	20.1	36.2	1.5	0.2
Apr	23.7	37.7	0.3	0.0
May	26.4	36.4	7.3	0.3
Jun	26.6	33.8	249.3	8.0
Jul	25.4	31.0	417.7	15.4
Aug	25.0	30.6	299.4	13.2
Sep	24.4	32.2	190.7	7.6
Oct	23.0	35.9	27.2	1.2
Nov	19.3	35.3	13.0	0.8
Dec	16.1	32.9	2.6	0.1
Annual	21.7	33.9	1209.4	46.8

Source: www.imd.gov.in

❖ Rain in Saurashtra doubled in 5 years:

Rains Recorded In Last Five Years

Year	North Gujarat	Saurashtra	Central-East Gujarat	South Gujarat	State average
2002	257.5	416.14	533.17	1379.5	646.58
2003	837	724.57	959.33	1616.8	1034
2004	517.5	605.57	864.67	1799.2	946.73
2005	903.17	873	1077.3	2362.5	1304
2006	1187.33	827	1277.5	1958.83	1311

all quantities recorded in mms

Source: www.expressindia.com

❖ INCREASED RUNOFF DUE TO URBANIZATION – CONSTRUCTION:

- ✓ Less recharging to Ground
- ✓ Storm Water Drains of hundreds of Crores drains Sweet Water to Sea.

❖ TAPTI SOURCE FOR SURAT NOW CATERS,

- ✓ South Gujarat, Atul to GNFC Bharuch
- ✓ Towns & Villages
- ✓ Power – Irrigation
- ✓ Multipurpose Industry - Water supply

- **UKAI STORAGE MAY DECREASE WITH UPSTREAM 4 DAMS & MANY CHECK DAMS IN NEXT DECADE.**

- **NO OWNED SOURCE FOR WATER IN CITY**
  - ✓ Need 2020 - 2000 MGD,
  - ✓ Source < 700 MGD, from Tapti.

❖ SURVIVAL OF CIVILIZATION & GROWTH:

- Not possible unless water is secured.
- Minimum need per person: WHO 2,000 cu.m / year
- Available at Surat in 2020, < 1,000 cu.m / year

WATER SCARCITY IS OBVIOUS

❑ CONSERVATION:

- Indian habits to save protected country against recession over world
- Save (not waste) rain water to keep Bank (ground water) flooded for 2020 – 2025

  - ✓ WE MUST EVERY DAY SAVE WATER & CONSERVE IT FOR OUR CHILDREN.

HOW ?

❖ WHAT WE CAN DO?

- Gods gifted rain should be stored, conserved and stopped from draining into tidal / sea water.

- How?

1) Reuse water for more than one use before draining to sewage drains.

Bath, washing m/c water can be use for flushing toilet, Garden

2) Every terrace say per 100 square meters generates 1 lakh liter / year (from rainy days)

- Store 20,000 liters in Under Ground tanks

  (5 m x 2 m x 2 m deep), drinking use.

- Harvest 80,000 liters by a 6” dia bore.

  10 to 20 m deep as per location of ground water.

This is enough for 2 - 3 persons minimum needs for year

Note in 2015 water can cost Rs. 10/- to 15/- per liter.

❖ WHY RAIN WATER HARVESTING ?

- Conserving Water
- Saves recurring maintenance of structures in expansive soils, e.g. Garden Industry, SVNIT Campus
- Traffic ability in low lying roads during rains – Sarjan Society, Sangana Society
- Wet the subsoil for plants / lawn e.g. Bombay Cricket Stadium, Sarjan Society Garden
- Gives recycled filtered water when crisis develops.
- Planned systems can desalinize soils & stop migration of salinity to urban areas.

❖ ECONOMICS IN 2009:

- Assume 100 sq.m. Terrace area for rain water collection.

- Average annual rainfall = 1000 mm = 1 m

  Total water available for harvesting = 100 cu.m

  = 1,00,000 liters

- Assuming 20 % loss say total water can be harvested

  = 80,000 liters

EXPENDITURE:

- The explained system requires one recharging bore & approximate cost for one recharge bore with the collection system = Rs 0.2 Million

EARNING / SAVING:

- Keeping the 50 % of total recharge water for Water Table rise, let's utilize the 40,000 liters for withdrawal.
- The cost of 40,000 liters water @ Rs 2/- per liter = Rs 0.08 Million
- The minimum working period will be 5 years
- Hence total earning / saving from harvested ground water = Rs 0.08 Million x 5 = 0.4 Million i.e. 200 % more than amount invested.

❖ THEORETICAL BASE:

- Manfred R. Hausmann (1990), "Engineering Principles of Ground Modifications", McGraw Hill Int. edition.
- The unconfined aquifer

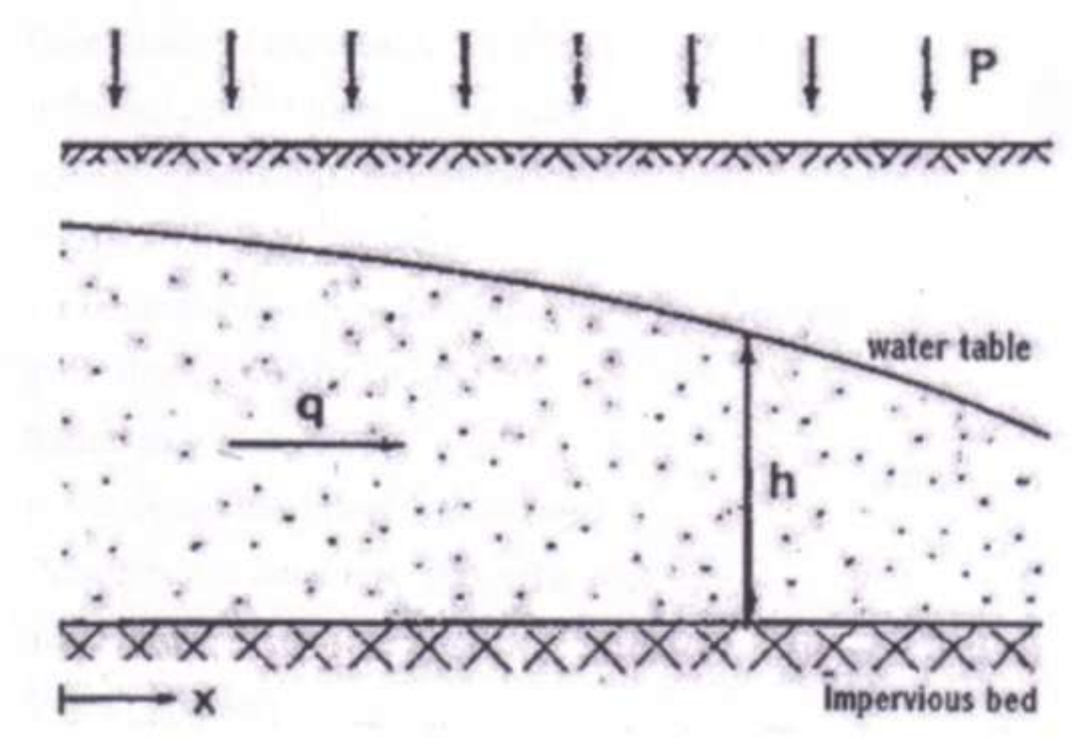


Figure - One-dimensional flow in an unconfined aquifer above an impervious base.

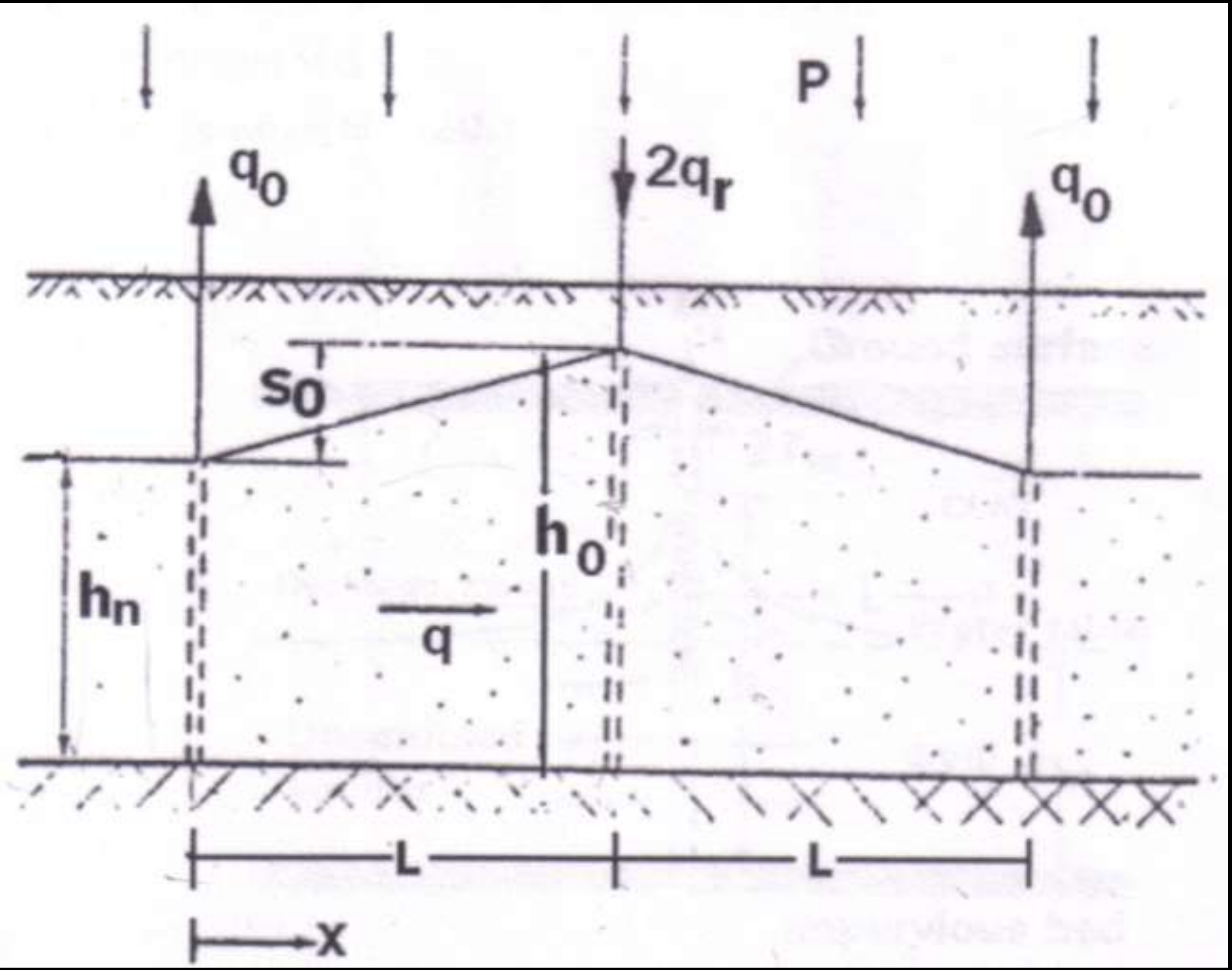


Figure - Artificial recharge by bore well in an unconfined aquifer above an impervious base

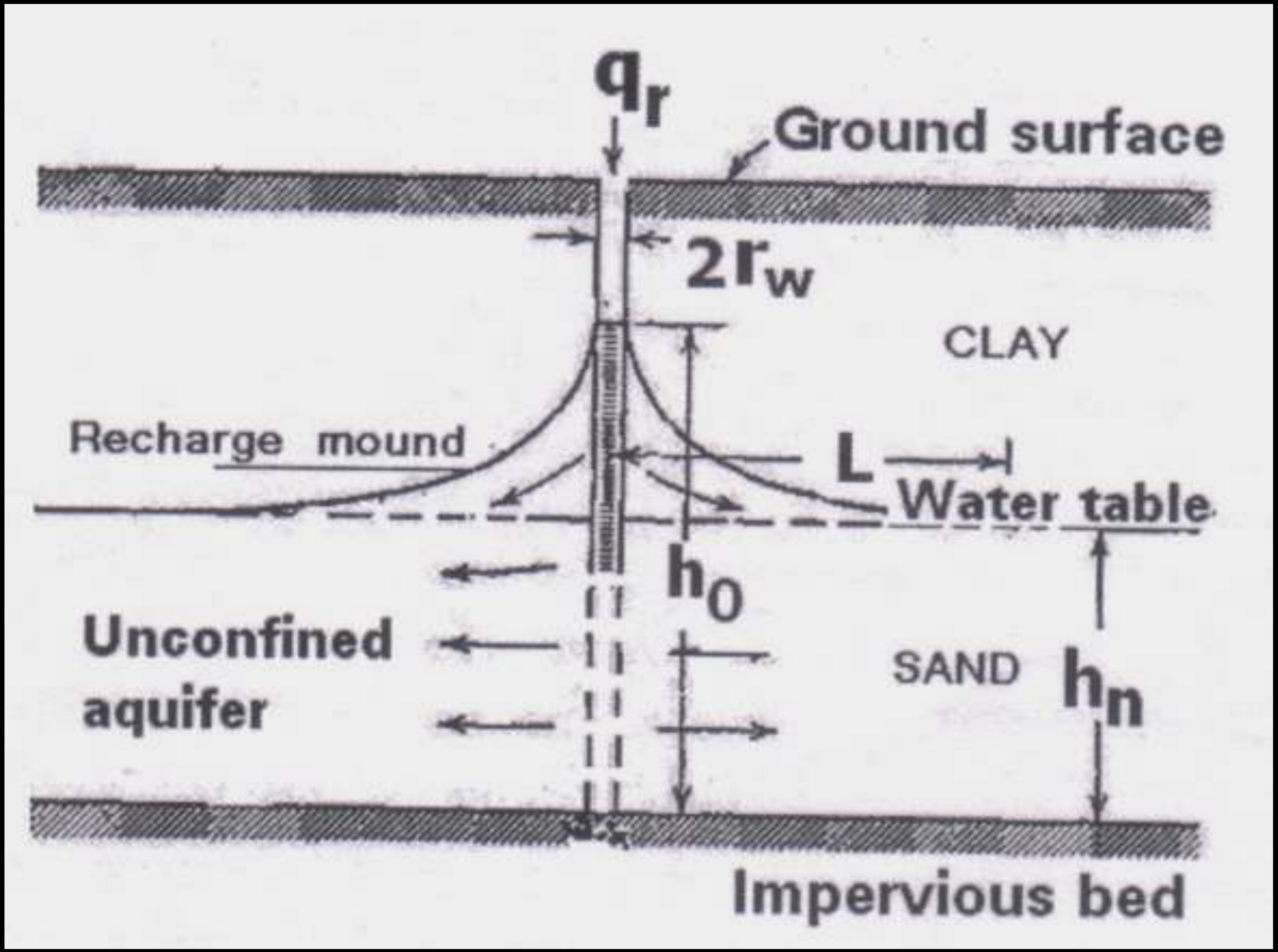


Figure - Radial flow from recharge well penetrating in unconfined aquifer

- Empirical Formula:

$$q_r = \frac{h_0^2 - h_n^2}{2L} \times k$$

Where

- q_r = Recharge rate in m^3/sec
- h_0 = Height of water above aquifer base in m
- h_n = Height of G.W.L. above base of aquifer in m
- L = Radius of spread in m
- k = Permeability Coefficient in m/sec

- q_r can be estimated from

$$h_0^2 = -\frac{P}{k}L^2 + \frac{2q_0}{k}L + h_n^2$$

Where

- P = Precipitation rainfall (m/sec)
- q_0 = under ground flow per unit aquifer width $m^3/m/sec$

- For k varies for different soils. The cone of recharged water level above G.W.L. is shown in Table below.

Table - Variable Permeability (k)

K (m/sec)	h_0 (m)	S_0 (m)	T (days)
Sandy silt (1.16×10^{-6})	34.85	14.85	109
Silty sand (5.36×10^{-5})	11.16	1.162	51
Fine sand (5.78×10^{-4})	10.11	0.11	48.88
Coarse sand (1.74×10^{-3})	10.03	0.03	48.68
Sandy Gravel (1.1×10^{-2})	10.006	0.006	48.60

Note:

Increase of permeability, drawdown (S_0) decreases, decreases detention time T.

- Detention Time T,

$$T = \frac{P \times H \times L}{q_0}$$

Where

- P = Porosity = 0.3
- H = Sat. Thickness of aquifer in m

- For given unconfined aquifer,
- Aquifer 20 m, $k = 1 \times 10^{-3}$ m/sec, $q_r = 15 \times r \times h$

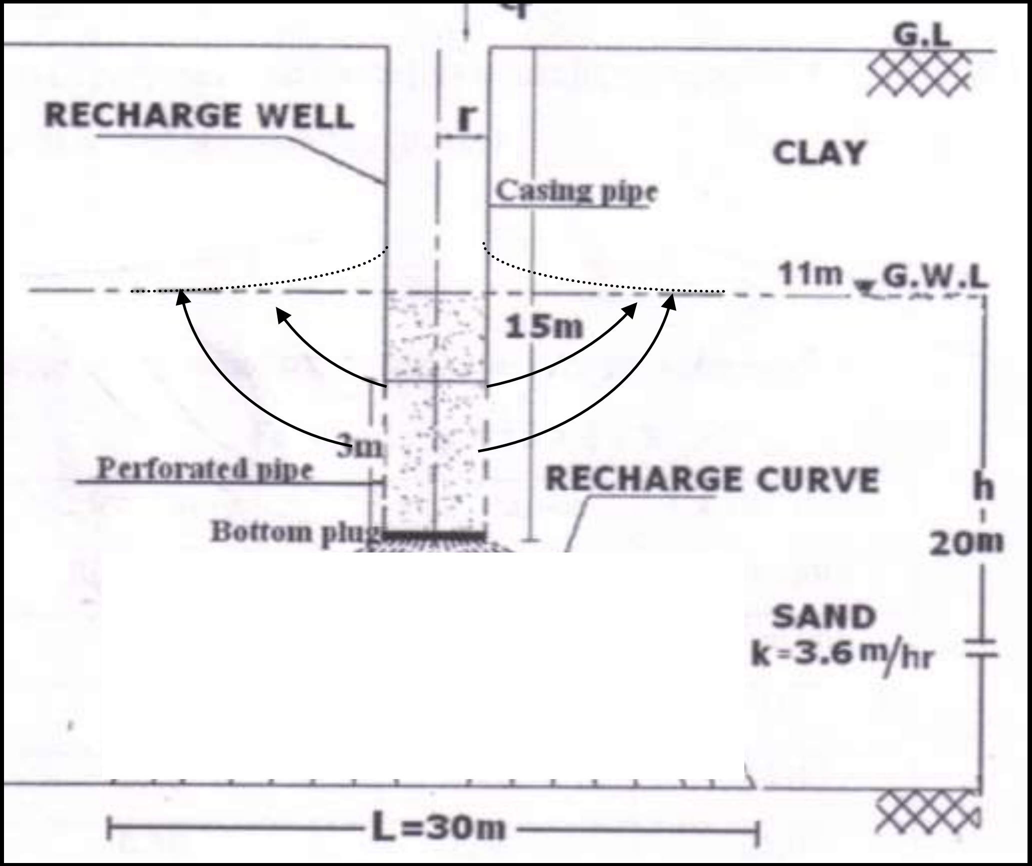


Figure - RECHARGE BORE WELL

- Recharge capacity

  = f (radius of bore m, h = G.W.L. height above bottom of aquifer)

Table - $q_r = 15 \times r \times h$

h (m) / r (m)	4m	6m	8m	10m	20m
0.05m	$3 m^3/hr$	$4.5 m^3/hr$	$6 m^3/hr$	$7.5 m^3/hr$	$15 m^3/hr$
0.075	4.5	6.7	9	11.25	**22.5**
0.1	6	9	12	15	30
0.15	9	13.5	18	22.5	45
0.45	27	40.5	54	67.5	135

Remark : Recharge capacity of borehole is directly varies with radius of bore well (r) and thickness of pervious strata (h)

- For a given k aquifer at site, select diameter

$$q_r = 2.75 \times (2\ r) \times h \times k$$

- For h = 25 m i.e. depth of pervious strata 25 m from G.W.L., $qr = 65 \times (2\ r) \times k$

Table - $q_r = 65 \times (2\ r) \times k$

k (m/sec) / d(m)	1×10^{-3} m/sec Coarse sand	1×10^{-4} m/sec Fine sand
0.15	35 m^3/hr	3.5 m^3/hr
0.30	70	7.0
0.60	140	14.0
0.90	210	21.0
1.20	280	28.0

Remark : Constant value of bore diameter, with decrease in permeability recharge capacity reduce to 10 times.

- Select diameter for k, h and evolve q_r

e.g. $k = 1 \times 10^{-4}$ m/sec

$h = 25$ m

$d = 2r = 0.6$ m

$q_r = 14\ m^3/hr$

If roof top to be drained has flow 30 m^3/hr, 2 bores as above or 1.2 m dia. bore 1 no. can be proposed.

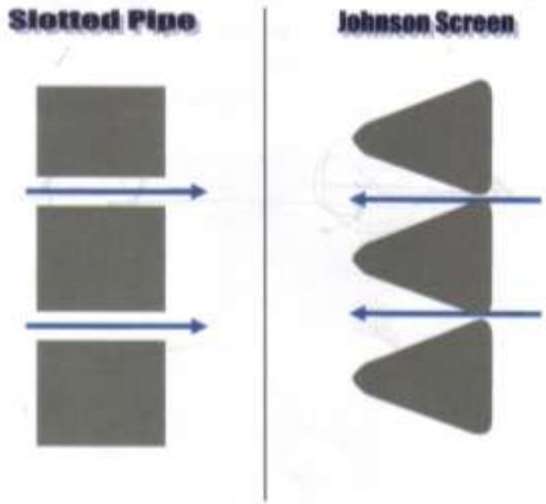
DESIGN PROCEDURE:

- Site Topography Study, Water Collection Points, Detention Reservoir (detention Tank / Pond) for given site.
- Ascertain soil stratification, Depth of G.W.L., Depth of aquifer
- Estimate co-efficient of permeability, k directly or by d_{10}
- Select expression for pumping in test from handbook
- Given inputs for site convert expression as function of (diameter of bore), normally 6” to12”dia bore, drilling 8” to 14”, no bentonite drilling
- Assess house top – clean flow to point of recharge in cumec (say rainfall 30 mm / hour)

- Select Diameter or numbers of bores or well of big dia. 1.5 to 3.0 m
- Strom intensity for local data, Surat 25 mm/hr - 4 hr maximum. Extra water will spread / drain to storm water, provide overflow outlet. Revised by experience - filed test for a site.
- Check G.W.L. rise, flow by meter & actual capacity by using 10,000 liters tankers. Open valve & control till overflow is stopped. Inflow = Q capacity m^3/min confirm.
- Choose Jonshon Strainer V shape net – no silting – no head loss, may give 40 % more yield.
- Improve design based on trial bore
- Compute recharge / season rains & rise of water table (structural safety)

What is a Johnson V-Wire Screen?

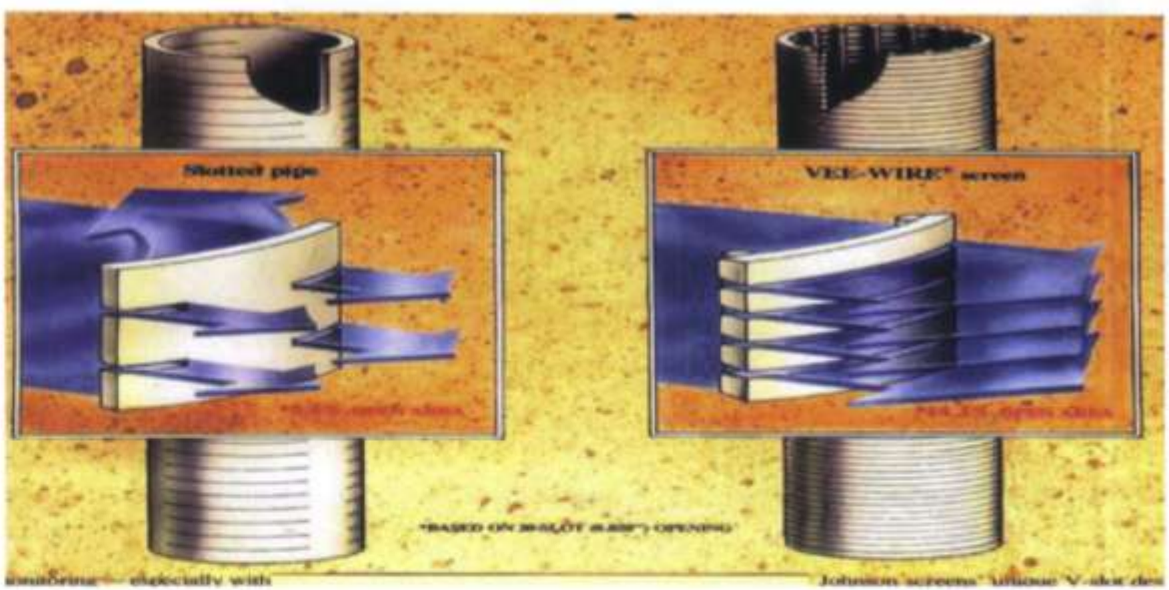
3) Non-clogging Slots



***Inwardly widening slots** do not allow any particle to get stuck inside the slot and cause clogging. Thus the slots are **non-clogging**. This ensures no reduction in discharge over a period of time due to clogged slots. This means* **Longer Effective Life of Tube Well.**

Moreover, due to reduced entrance velocity the formation of incrustants is also very slow.

4) Improved tube well development



❖ Ground Water Recharge Scheme at AMD, SVNIT, Surat


KRANTI

3) EDUCATE PEOPLE, WOMEN, ELECTED REPRESENTATIVE TO LEGISLATE:

a) Reservation of 5 – 6 % of land (low lying) for water body & recharge well in each T.P. Schemes of city.

b) Prevention of legal / illegal occupancy of existing water bodies for other uses.

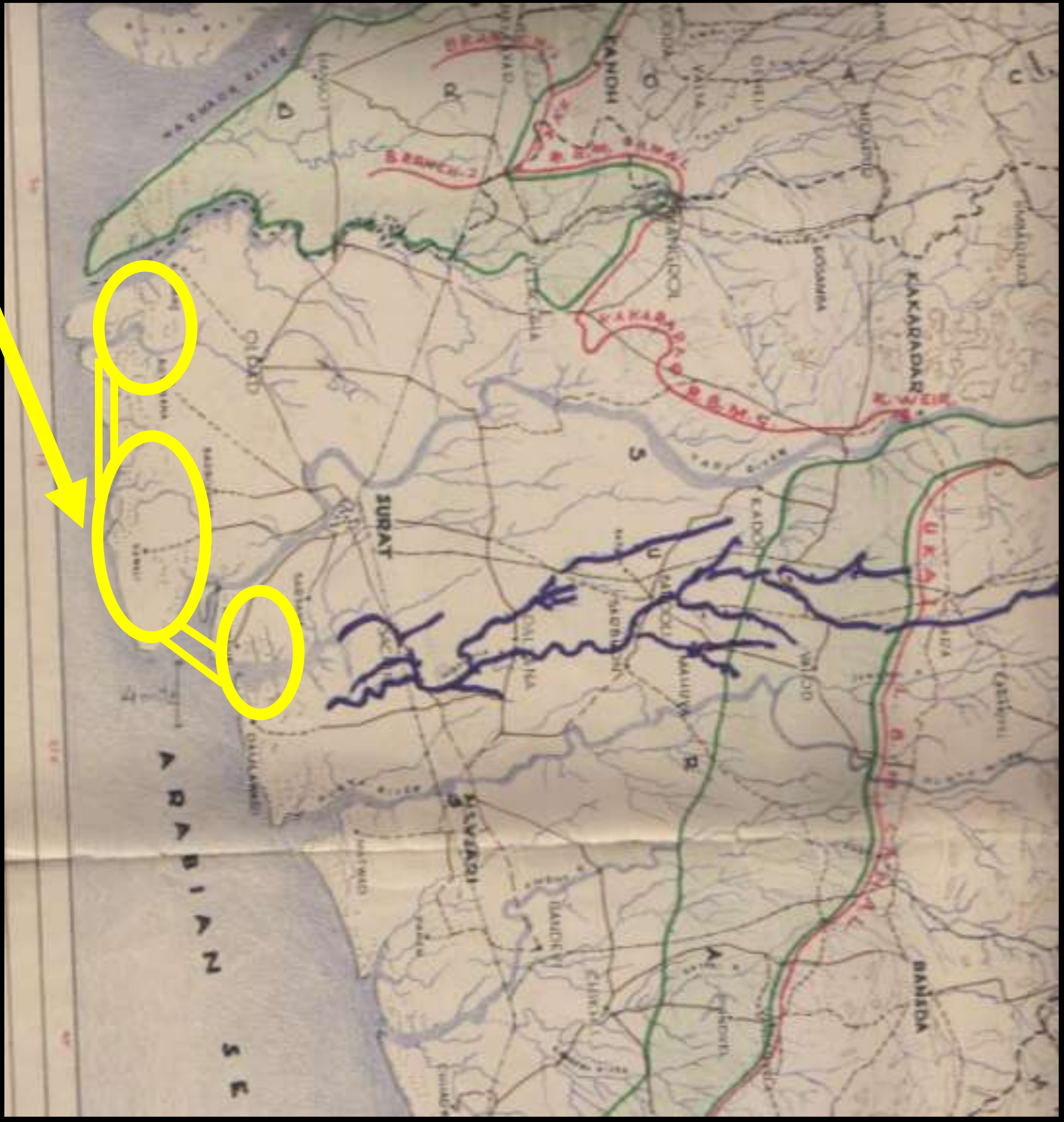
c) Conserve flood spills by drains to large flood detention reservoirs along coastal area.

d) 10 km long x 1 km wide x 6 m deep or so at Tena, Sena, Kakra khadi, Kim & Mindhola (Conserve 60 to 100 MCM as source of water for industry, ponds in no source villages)

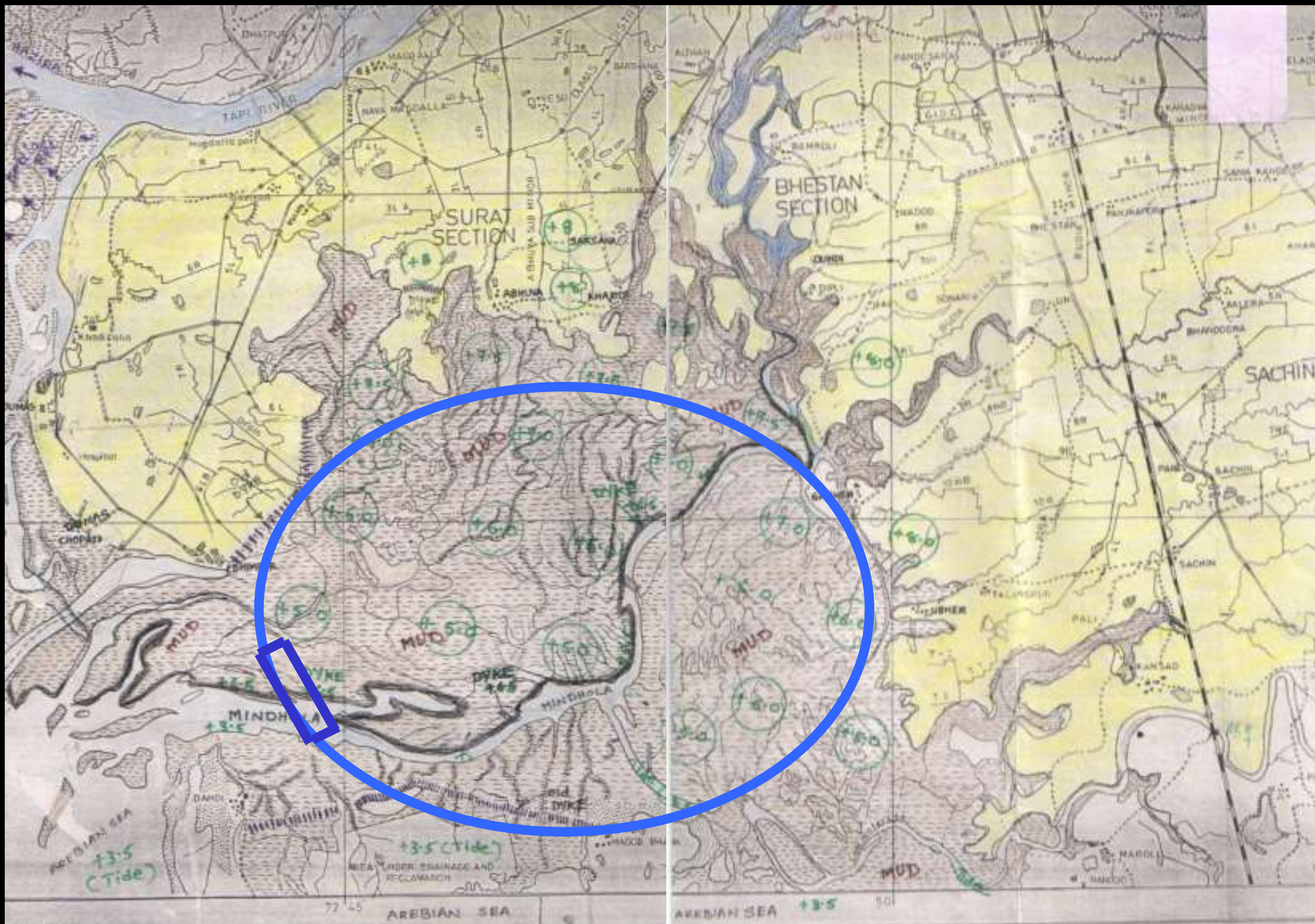
Flood Detention Reservoir with Ballon dam spillway:

Coastal Area of Hajira, Olpad.
- Tena Sena Creek & Kim River

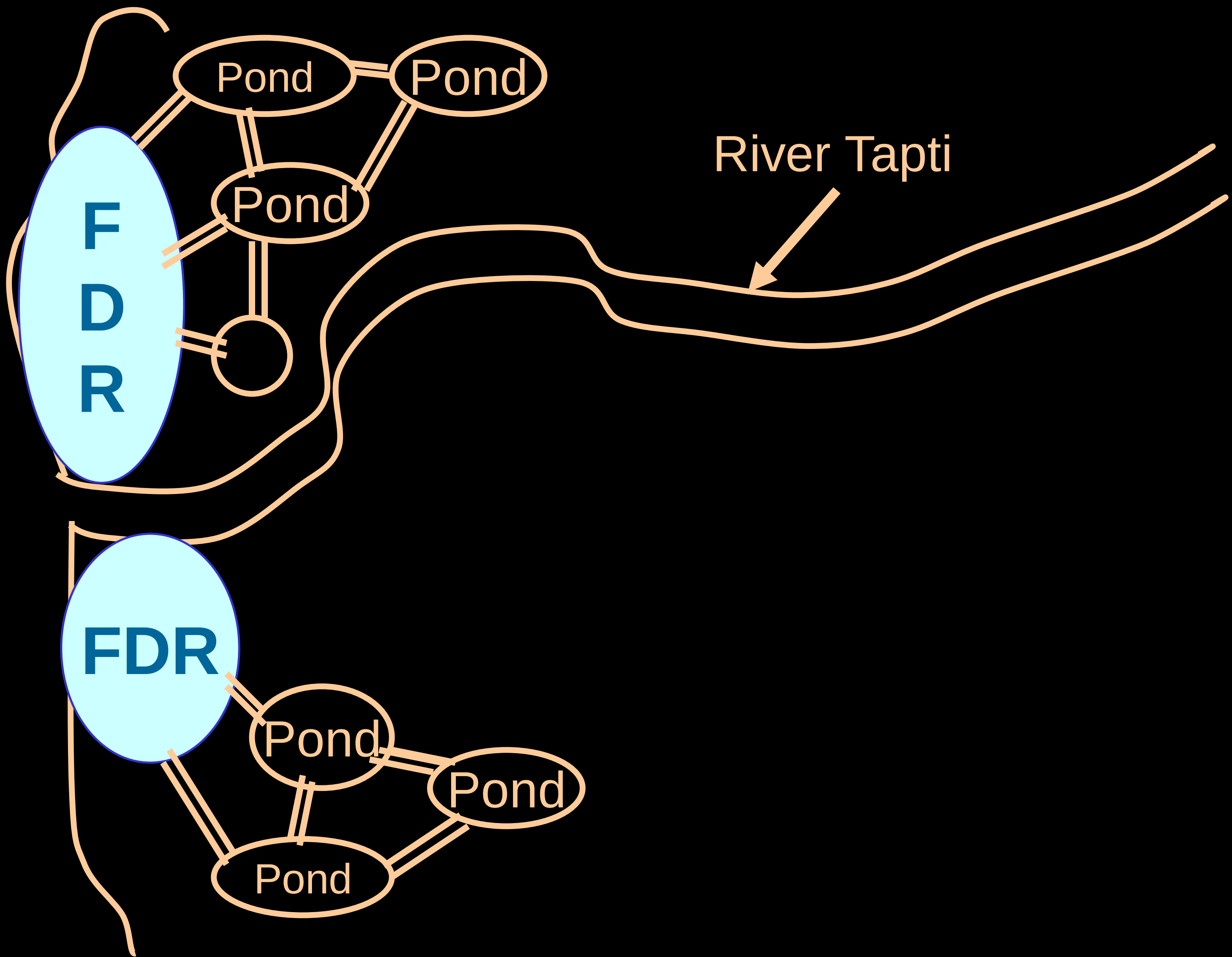
Coastal Area at Mouth of
- Mindhola River



Flood Detention Reservoir - Mindhola River



Linking of Village Ponds (reserved) for no source villages



Proposed Coastal Highway with Flood Detention Reservoir

NH-8.

Proposed Coastal Highway Evacuation for Hajira in Disaster

MAY GOD BLESS US WITH COURAGE, DEVOTION

AND SUCCESS TO PRESERVE RAIN WATER FOR

OUR FUTURE GENERATIONS’ - PLANETS SURVIVAL.


Proposed Barrage - Umra (Surat)

THANK YOU