ANNEXURE- V

The sample calculations for recharge of Vadodara taluka for the year 2003

I Monsoon Recharge:

a. Area

(i) Total Geographical area = 670.00 sq.kms.

(ii) Net suitable alluvial area for groundwater recharge 'A' = 502.50 sq. kms.

b. Specific yield S_y (fraction)

For alluvial = 0.09

(Computed from pumping tests in unconfined aquifer by GWRDC)

c. Rainfall

(i) Norma l monsoon Rainfall(IMD)years 1963to2007 = 894mm

(ii) Average monsoon rainfall years 2003to 2007 = 1361mm

(iii) Normalization factor NF= $\frac{(i)}{(ii)}$ =0.66

But as per norms of GWRDC range of NF is 0.9 to 1.10

So consider NF =0.90

d. Water table fluctuation (WTF) year 2003for alluvial area = 3.46m

e. Rainfall recharge by WTF= A * WTF * S_y =502.5* 3.46*0.09 = 156.48 MCM/year

II Recharge due to seepage from canals and tanks etc.

a. Recharge from canals.

Using wetted area of canal in Million sq. m., average running days of canal and seepage factor depending upon unlined or lined canal the seepage in MCM/year is calculated.

The monsoon recharge from canal seepage = 0.19 MCM/year

And the non monsoon recharge from canal seepage = 1.01 MCM/year

Total recharge from canals=0.19 + 1.01 = 1.21 MCM/year

b. Recharge from surface water bodies.

Considering average water spread area in sq. km. of number of village tanks, percolation tanks and check dams and respective seepage factors the seepage in MCM/year is calculated.

The monsoon recharge from tanks etc. due to seepage = 2.63 MCM/year

And the non-monsoon recharge from tanks etc. due to seepage = 0.0 MCM/year

Total recharge from surface water bodies = 2.63 MCM/year

So R_s =Recharge due to monsoon seepage from canals and tanks =0.19+2.

= 2.82 MCM/year

And non-monsoon recharge from canal seepage =1.01 MCM/year.

III Recharge due to seepage from surface water irrigation

The type of the crop, total area irrigated for respective crop in hectare, average depth of water applied to each type of crop and seepage factor are used to calculate seepage from surface water irrigation. Main crops are Bajari, Juvar, Pulses, Wheat, Castor, Vegetables and Fodder etc.

The recharge due to monsoon seepage from surface water irrigation (R_{is})

= 0.20 MCM/year

And the recharge due to non-monsoon seepage from surface water irrigation

= 2.24 MCM/year

Total recharge from surface water irrigation = 0.20+ 2.24 =2.44 MCM/year

IV Potential Recharge

Recharge from flood prone area:

The yearly flooded area (in sq. km), duration of flooding (in days) and seepage factor are used to estimate the recharge from flood prone area in MCM/year.

It is found as 1.48 MCM/year.

So potential recharge = 1.48 MCM/year

V Gross annual groundwater draft

Calculation of gross groundwater in MCM/year is done using type of wells, no. of wells, pump sets with electric motor having various horse powers, diesel pumps, number of running hours per day, no. of running days and average unit draft of groundwater structure. Gross draft for Vadodara taluka from hydrogeological data of Gujarat state (2002) is 104.12 MCM/year. This data is extrapolated considering development for year 2003 as 117.86 MCM/year.

Gross Kharif (monsoon) draft =20 % of gross annual groundwater draft =0.20 * 117.86

=23.57 MCM/year

And gross non-monsoon draft =80 % of gross annual groundwater draft=0.8 *117.86

=94.29 MCM/year

VI Recharge due to monsoon seepage from groundwater irrigation

(R_{igw}) =30 % of gross kharif draft= 0.30 *23.57 =7.07 MCM/year

VII Monsoon Recharge:

Rainfall recharge= = $A * WTF * S_y$ = 156.48MCM/year

Gross kharif draft = D_w =23.57 MCM/year

Recharge due to monsoon seepage from canals and tanks = R_s = 2.82 MCM/year

Recharge due to monsoon seepage from groundwater irrigation =R_{igw} =7.07 MCM/year

Recharge due to monsoon seepage from surface water irrigation = R_{is} = 0.20 MCM/year

Normalisation factor NF =0.90

Monsoon recharge (in MCM/year) =

$$[\{(A * WTF * S_y) + D_w - (R_s + R_{igw} + R_{is})\} * NF] + R_s + R_{is}$$

$$= [\{(156.48) + 23.57 - (2.82 + 7.07 + 0.20)\} * 0.90] + 2.82 + 0.20$$

$$= [\{(156.48) + 23.57 - (2.82 + 7.07 + 0.20)\} * 0.90] + 2.82 + 0.20$$

$$= [\{180.05 - (10.09)\} * 0.90] + 3.02$$

=152.964+3.02

=155.984 MCM/year

Potential recharge from flood prone area = 1.48 MCM/year

Total monsoon recharge =157.464 MCM/year

VIII Total non–monsoon recharge

(a) 15 % of the non monsoon draft considered as non monsoon recharge in MCM/year

=0.15* 94.29 = 14.1435 MCM/year

(b) Non-monsoon recharge from canal seepage and from surface water irrigation

= 1.01+ 2.24 = 3.25 MCM/year

SO total Non-monsoon recharge =17.3935 MCM/year

IX Monsoon recharge in m/day

Total monsoon recharge = 157.464 MCM/year

Gross kharif draft (D_w) = 23.57 MCM/year

Net monsoon recharge =157.464-23.57 =133.894 MCM/year

$$\text{Monsoon recharge in m/day} = \frac{\text{Net monsoon recharge in MCM/year}}{\text{Total geographical area in sq.km} * \text{Total no.of monsoon days}}$$

$$= \frac{133.894}{670 * 122}$$

= 0.001638 m/day

X Non- monsoon recharge in m/day

Total non- monsoon recharge = 17.3935 MCM/year

Gross non- monsoon draft = 94.29 MCM/year

Net non- monsoon recharge =17.3935-94.29 = (-) 76.896 MCM/year

$$\text{Non- monsoon recharge in m/day} = \frac{\text{Net non monsoon recharge in MCM/year}}{\text{Total geographical area in sq.km} * \text{Total no.of non monsoon days}}$$

$$= \frac{(-)76.896}{670 * 243}$$

$$= (-)\ 0.0004723 \text{ m/day}$$

Same procedure has been followed for all talukas and years 1997,1998,2003,2004, 2005 and 2006.