भारत सरकार
जल संसाधन, नदी विकास और गंगा संरक्षण मंत्रालय
केन्द्रीय भूमि जल बोर्ड

GOVERNMENT OF INDIA

MINISTRY OF WATER RESOURCES, RIVER DEVELOPMENT & GANGA REJUVENATION

CENTRAL GROUND WATER BOARD

Artificial Recharge Plan for the Over Exploited Miraj Taluka of Sangli District

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CENTRAL REGION, NAGPUR

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ARTIFICIAL RECHARGE PLAN AT A GLANCE

1.	Total Geographical Area of the Miraj Block (Taluka)				928.70 km^2
	❖ Area occupied by Hard Rock (Basalt)				928.70 km^2
	❖ Area occupied by Soft Rock (Alluvium)				-
2.	Major land use pattern				Agriculture
3.	Average Annual Rainfall (mm)				600 mm
4.	Major Drainage				Krishna River
5.	Area identified for Artificial Recharge *(considering average decadal (2005-14) post-monsoon water level more than 5 m bgl, long term post-monsoon water level trend, depth of weathering and lineaments)*				63.00 km^2
6.	Overall quality of groundwater				Suitable for domestic, industrial and irrigation use
7.	Availability of Surplus surface runoff (MCM)				2.05 MCM
8.	Surplus surface runoff considered for planning (MCM) *(70% of surplus surface runoff)*				1.44 MCM
9.	Runoff for RWH in Urban Household				0.473 MCM
10.	Sub-surface storage potential available (MCM)				2.21 MCM
11.	Proposed Artificial Recharge & Water Conservation Plan				
	Item	**Percolation Tank**	**Check Dam**	**Water Conservation Structure**	**Roof Top Rain Water Harvesting (for 10% houses)**
	❖ Proportionate Allocation of surplus runoff MCM)	1.01	0.36	0.07	0.473
	❖ Feasible number of structures	5	12	5	18537
	❖ Unit cost of structures (crores)	0.70	0.07	0.0025	0.0008
	❖ Estimated Cost (Crores)	3.50	0.84	0.0125	14.82
	❖ Expected Recharge (MCM) (considering 85 % efficiency)	0.858	0.306	0.059	0.402
12.	Total estimated cost (Crores)	19.17 crores			

Artificial Recharge Plan for the Over Exploited Miraj Taluka of Sangli District

1. INTRODUCTION

Groundwater being most dependable source of water supply is under tremendous stress to meet the ever increasing demand of irrigation, industrial and domestic sector. The over exploitation of this resource has resulted in to decline in water levels in many part of the Country and many of the water assessment units are thus categorised as over-exploited blocks. The state of Maharashtra also faces the problem of groundwater over-development in some of the areas. Many talukas have been identified as Critical / Over-Exploited based on the ground water resources estimation based on GEC-97 Methodology. As per the latest groundwater resource assessment as on March 2011, 10 talukas have been identified as Over-Exploited.

Immediate remedial measures are therefore required to be taken up for converting these talukas into Critical / Semi-critical / Safe categories. The present artificial recharge plan has been prepared for the Miraj taluka of Sangli district which will form the base for the future strategy.

2. LOCATION

Miraj Taluka is situated in the southern part of Sangli district and lies between North latitude 16° 53' 01" to 16°54'10" and East longitude 74°41'34" to 74°44'53" and spread over an area of 954.06 sq.km. There are total 96 villages in the taluka and the population of the taluka is 1,85,372 persons as per 2011 census (Fig 1a and 1b).

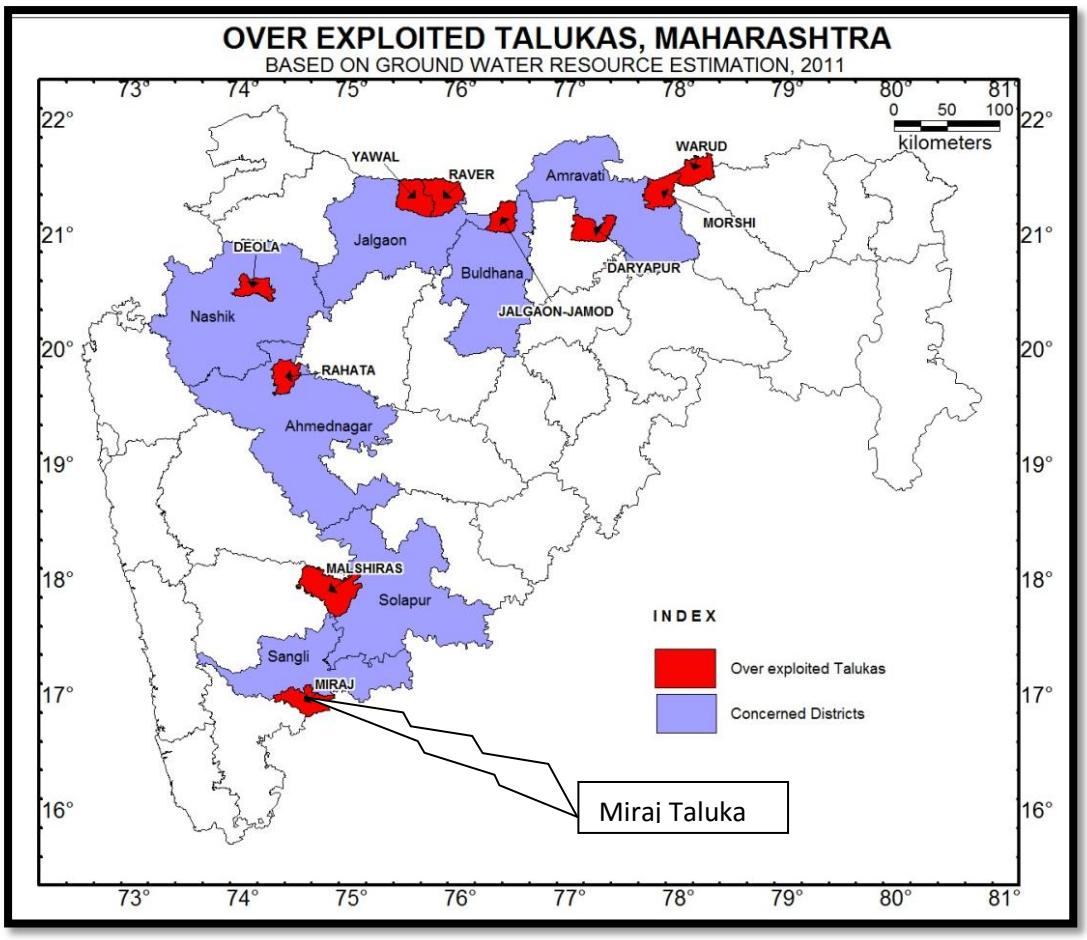


Fig1a: Location of Miraj Taluka, Sangli District, Maharashtra

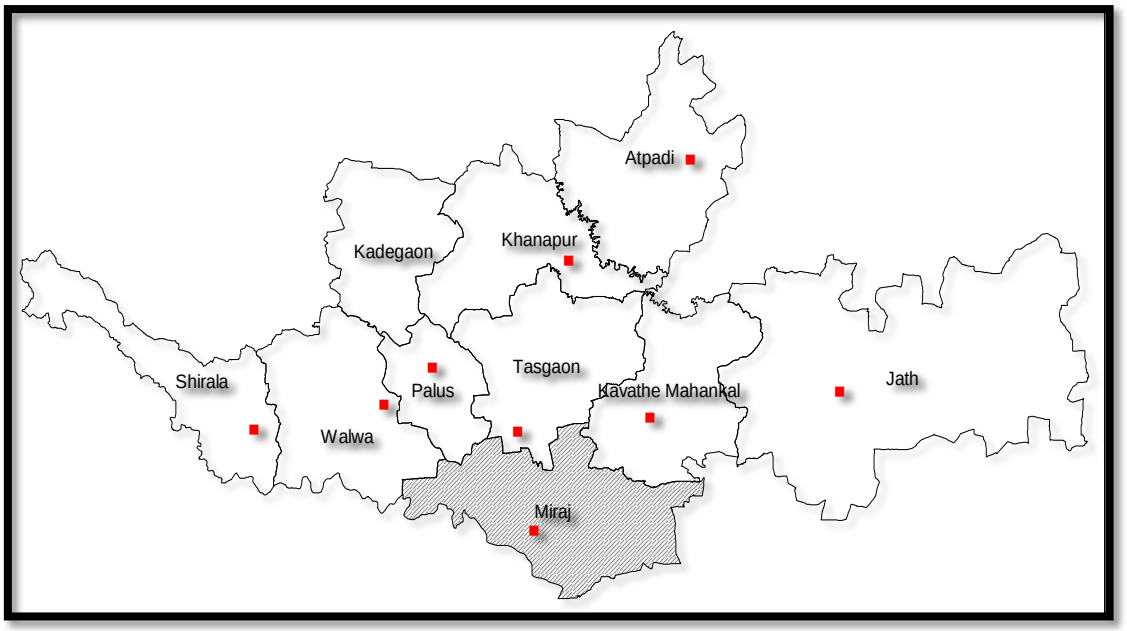


Fig1b: Location of Miraj Taluka, Sangli District

3. PHYSIOGRAPHY & DRAINAGE

The taluka is having plain to undulating topography and drained mainly by the Krishna river and its tributaries (**Fig 2a**).A digital elevation model of Miraj taluka indicating the village boundaries is shown in **figure 2b**.

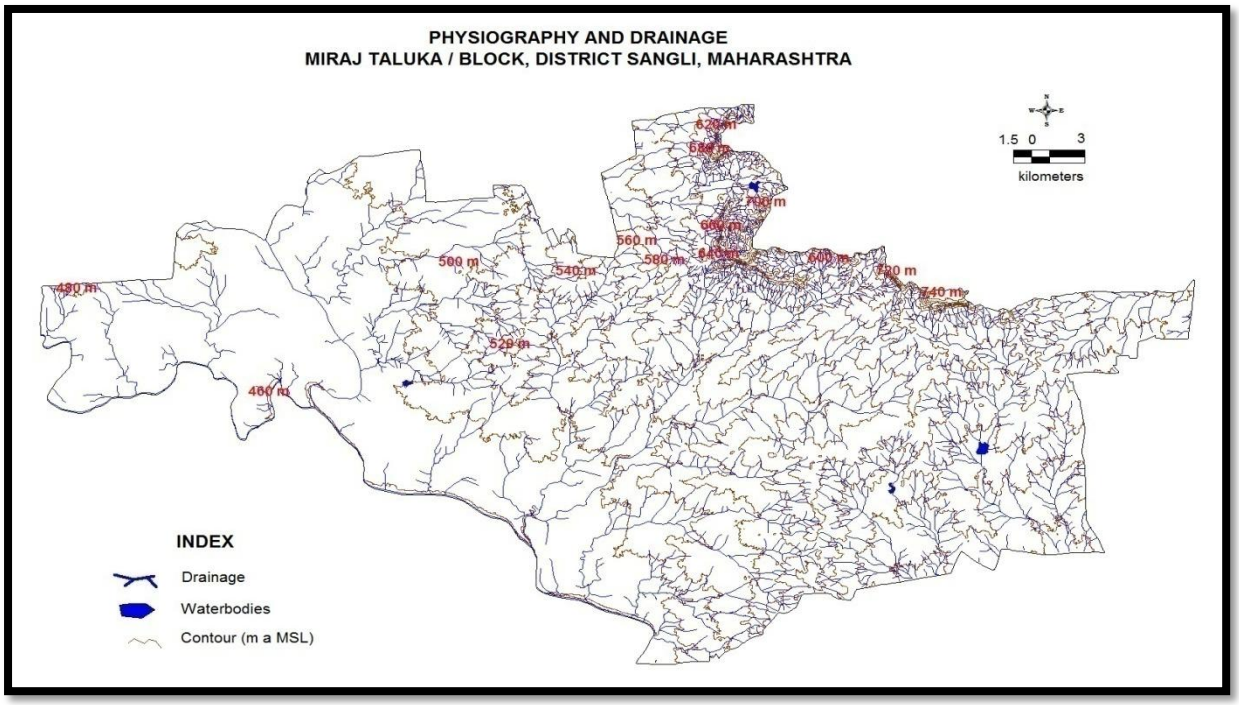


Figure 2a: Physiography and Drainage, Miraj Taluka

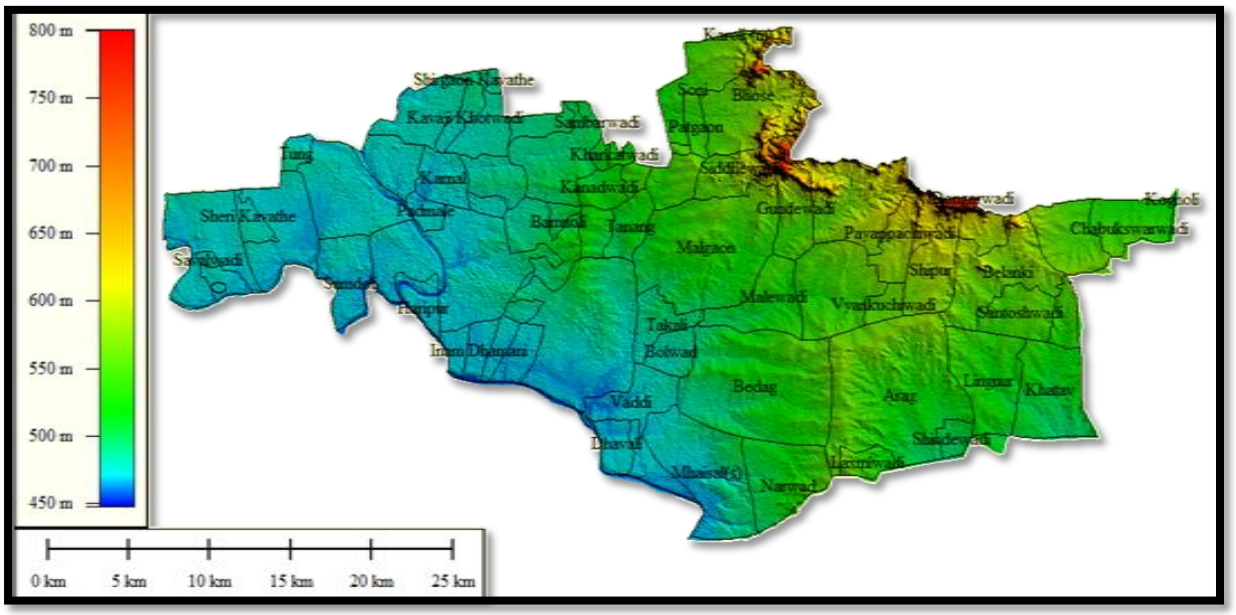


Figure 2b: Digital Elevation Model, Miraj Taluka

4. RAINFALL

The area receives rainfall due to the south-west monsoon and about 75% of the rainfall takes place during the months of June to September. About 19% of the annual rainfall is received in the post-monsoon season. The taluka receives erratic rainfall and the average annual rainfall in the taluka is about 600 mm.

5. LAND USE PATTERN

The land use pattern of the area prominently reflects significant agriculture activity, sugarcane cultivation, with isolated patches of forest area and unmodified hilly forest. The double-crop (Kharif and Rabi) area is evenly distributed in the entire taluka. Triple cropped (Kharif, Rabi and Summer) area is prominently observed along the major streams.

6. HYDROGEOLOGY

Deccan Trap Basalt belonging to upper Cretaceous to lower Eocene age comprising pahoehoe and aa lava flows of basaltic composition occurs in the entire taluka where the ground water potential is not uniformly distributed due to inherent heterogeneity of the formation. The ground water in basaltic lava flows of Deccan trap occurs under unconfined conditions in shallow/phreatic aquifer and in semi-confined to confined condition in deeper aquifers. The vesicular portion of different flows varies in thickness from 8 to 12 m and sometimes up to 20 m **(Fig 3)**.

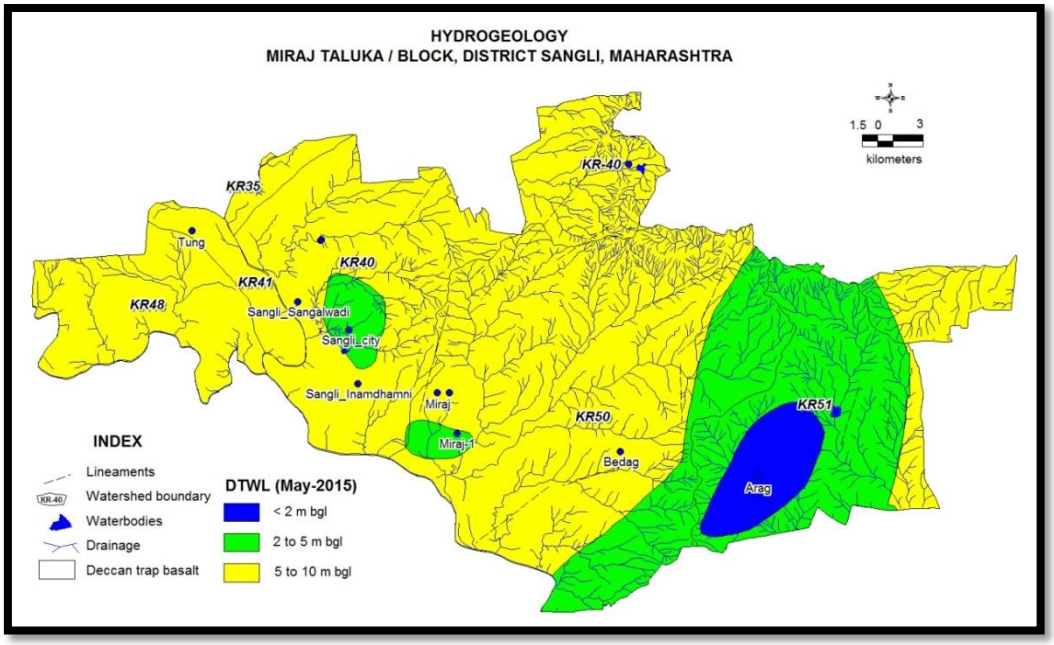


Fig 3: Hydrogeology, Miraj Taluka

7. GROUND WATER LEVEL SCENARIO

CGWB regularly monitors ground water levels in the taluka 4 times in a year during May, August, November and January through its network of Ground Water Monitoring Wells (GWMW). The water levels recorded during the pre-monsoon season in May (2014) mostly ranges from 3.4-12.3 m. bgl. **(Fig 4).** Water levels ranging from 10-20 m bgl are seen in major parts of the taluka. Water levels ranging from 5-10 m bgl are seen in northern parts of the taluka (**Fig 5**). The water levels recorded in post-monsoon season (Nov. 2014) are ranging from 0.7 to 8 m bgl. Water levels ranging from 5-10 m bgl are seen in major parts of the taluka. Shallow water levels up to 2 m bgl are also observed in SE parts of the taluka.

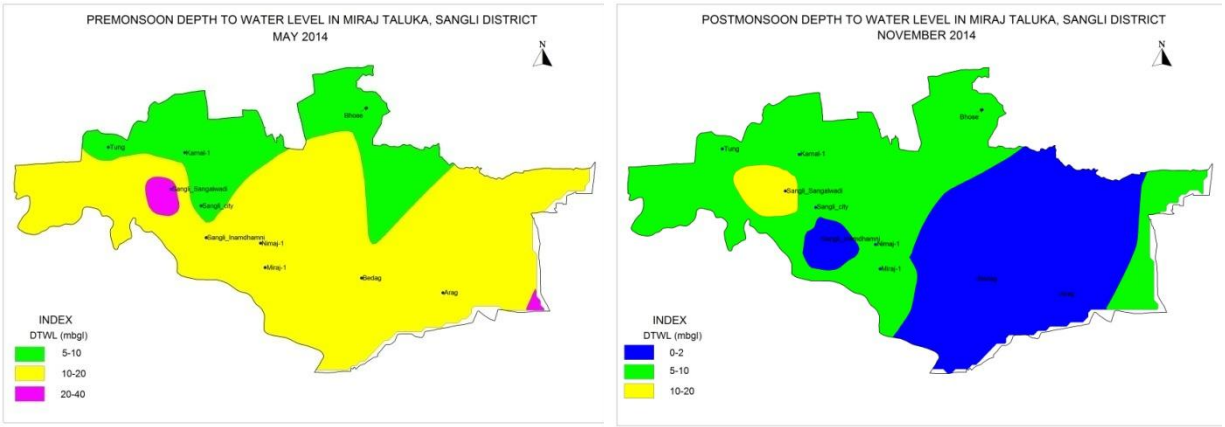


Fig 4 and 5: Pre and Post-monsoon (2014) Depth to Water Level Map, Miraj Taluka

8. DYNAMIC GROUND WATER RESOURCE

Ground Water Resources Assessment for the year 2011 indicates Net Annual Ground Water Availability of 10936.78ham, draft for all uses is 12058.28 ham with irrigation being the major consumer withdrawing 11814.82 ham and stage of ground water development is also high about 110.25% **(Table 1)**. The taluka is categorised as Over Exploited. The comparison of 2009 and 2011 ground water resource assessment indicates that the stage of ground water development has increased from 90.05% in 2009 to 110.25% in 2011. So far none of the taluka has been notified by CGWA/SGWA for ground water regulation.

Table 1: Dynamic Ground Water Resources of Miraj Taluka (As on March 2011)

S. No	Particulars	GW Resources (Ha.m)
1.	Net Annual Ground Water Availability	10936.78
2.	Existing Gross Ground Water Draft for irrigation	11814.82
3.	Existing Gross Ground Water Draft for domestic and industrial water supply	243.46
4.	Existing Gross Ground Water Draft for All uses	12058.28
5.	Provision for domestic and industrial requirement supply to 2025	401.78
6.	Net Ground Water Availability for future irrigation development	659.09
7.	Stage of Ground Water Development	110.25%
8.	Category of the Assessment Unit	Over Exploited

9. NEED FOR ARTIFICIAL RECHARGE AND CONSERVATION MEASURES

Miraj taluka is one of the major sugarcane growing area of Maharashtra. For cultivation of sugarcane, huge amount of groundwater is required. This has led to over-exploitation of groundwater resources from both the shallow and deeper aquifers in the taluka. These practices are being continued since last few decades and stage of groundwater development in the taluka even exceeded more than 100 % of its natural recharge which lead to heavy depletion of ground water level. The over development of ground water has brought the taluka in over exploited category. Therefore there is an urgent need for taking up various artificial recharge and water conservation measures in the area.

10. JUSTIFICATION OF THE ARTIFICIAL RECHARGE PROJECT

The various State Government Agencies like department of Agriculture, Irrigation, Forest have already taken up some water conservation / artificial recharge measures in Miraj taluka. However, a robust consolidated plan for artificial recharge measures are also required for converting the entire Over-Exploited Miraj taluka into Critical / Semi-critical / Safe category.

11. FEASIBLE AREA FOR ARTIFICIAL RECHARGE OR CONSERVATION

The feasible area for artificial recharge to groundwater in Miraj taluka has been identified based on the following criteria's.

1. Long term average decadal post-monsoon depth to water level (2005-2014)
2. Long term post-monsoon water level trend (2005-14)
3. Depth of weathering in the taluka
4. Lineaments in the area

Thematic layers are prepared for all the above mentioned four criteria's and are superimposed on one another to generate the integrated map for identification of the feasible area for artificial recharge.

The long term post-monsoon water level data for the period 2005-14 reveals the deepest water level of 17.00 m bgl. Water level contour map is prepared wherein 3 categories of observed water levels are made i.e. less than 2 m bgl, 2 to 5 m bgl and 5 to 10 m bgl **(Fig. 6)**. Area having depth to water level less than 5 m bgl is not recommended for artificial recharge to ground water since it may lead to water logging and leaching of salts problems.

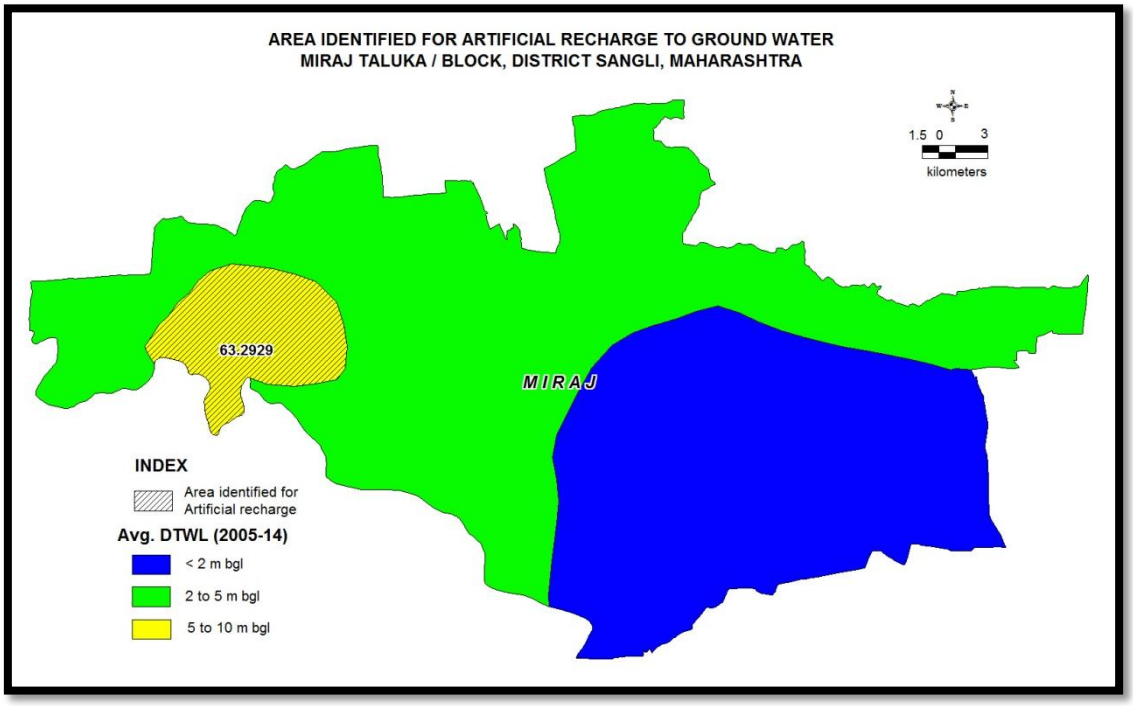


Fig 6: Average Decadal Post-monsoon depth to water level, Miraj Taluka

It has been observed from the Depth to Water level (DTWL) map of the Miraj taluka that 63.00 sq.km area has DTWL more than 5 m bgl which can be taken up for artificial recharge to groundwater based on water level scenario in the area.

The long term water level trend map for the period 2005-2014 has been prepared and is shown in **Figure 7**. Both the rising and falling water level trend from 0.0 to 0.2 m/year are observed. The area showing rising water trend has been excluded for taking up artificial recharge measures in the area and the area showing falling water level trend is only considered and recommended for artificial recharge to groundwater in Miraj taluka **(Fig 7).**

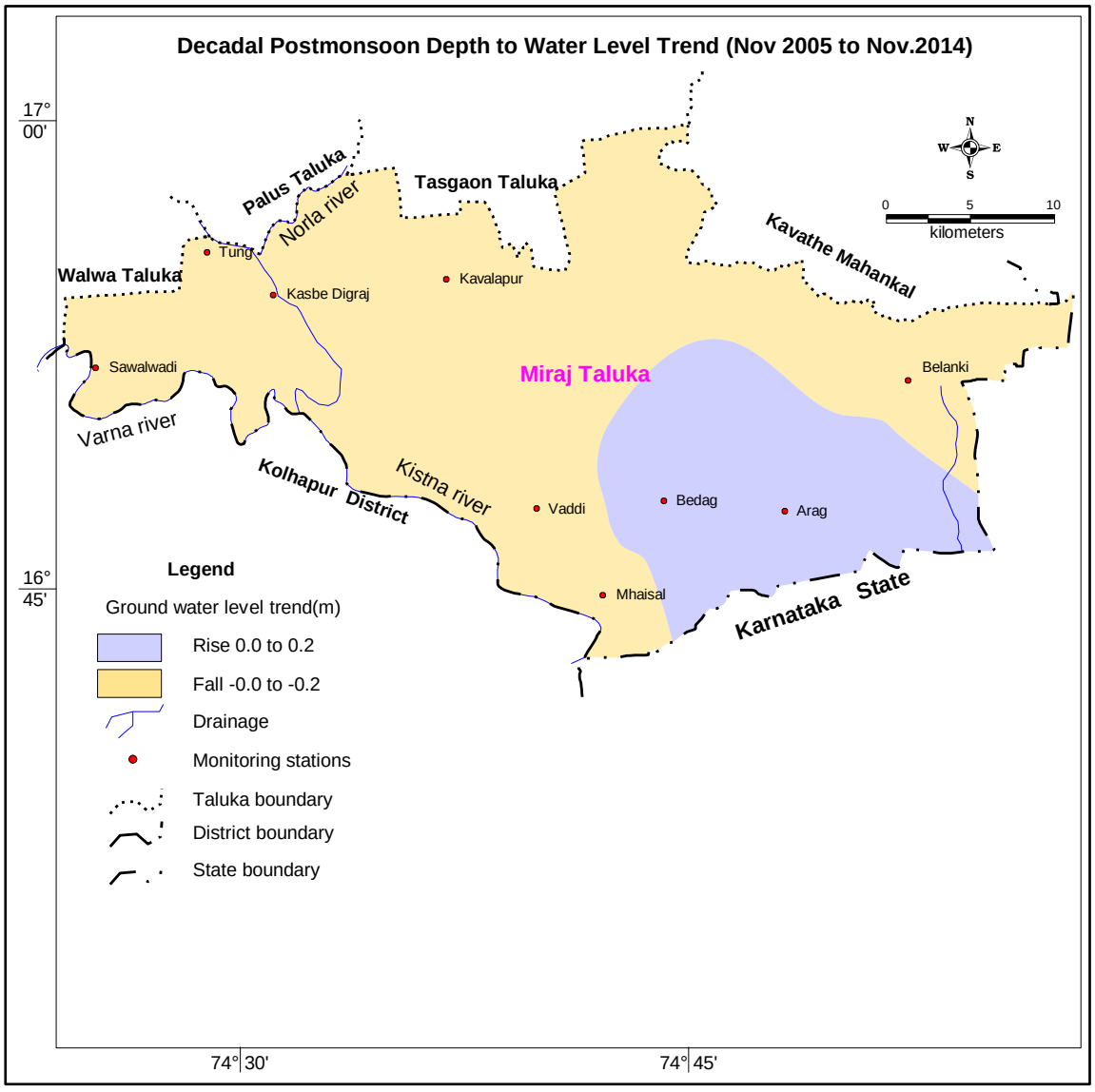


Figure 7: Map showing long term post monsoon water level trend (2005-14)

Based on the data available on depth of weathering form key wells established during the various hydrogeological studies in the area and also groundwater exploration data, a map showing area under various categories of depth of weathering has been prepared and considered for preparation of artificial recharge plan **(Fig. 8)**. The map reveals that most of the area of Miraj taluka is having sufficient thickness of weathered zone varying from 10 to 35 m and therefore found feasible for artificial recharge to groundwater. Some of the area of Miraj taluka is also traversed by few lineaments (**Figure 9)** indicating scope for artificial recharge in that area.

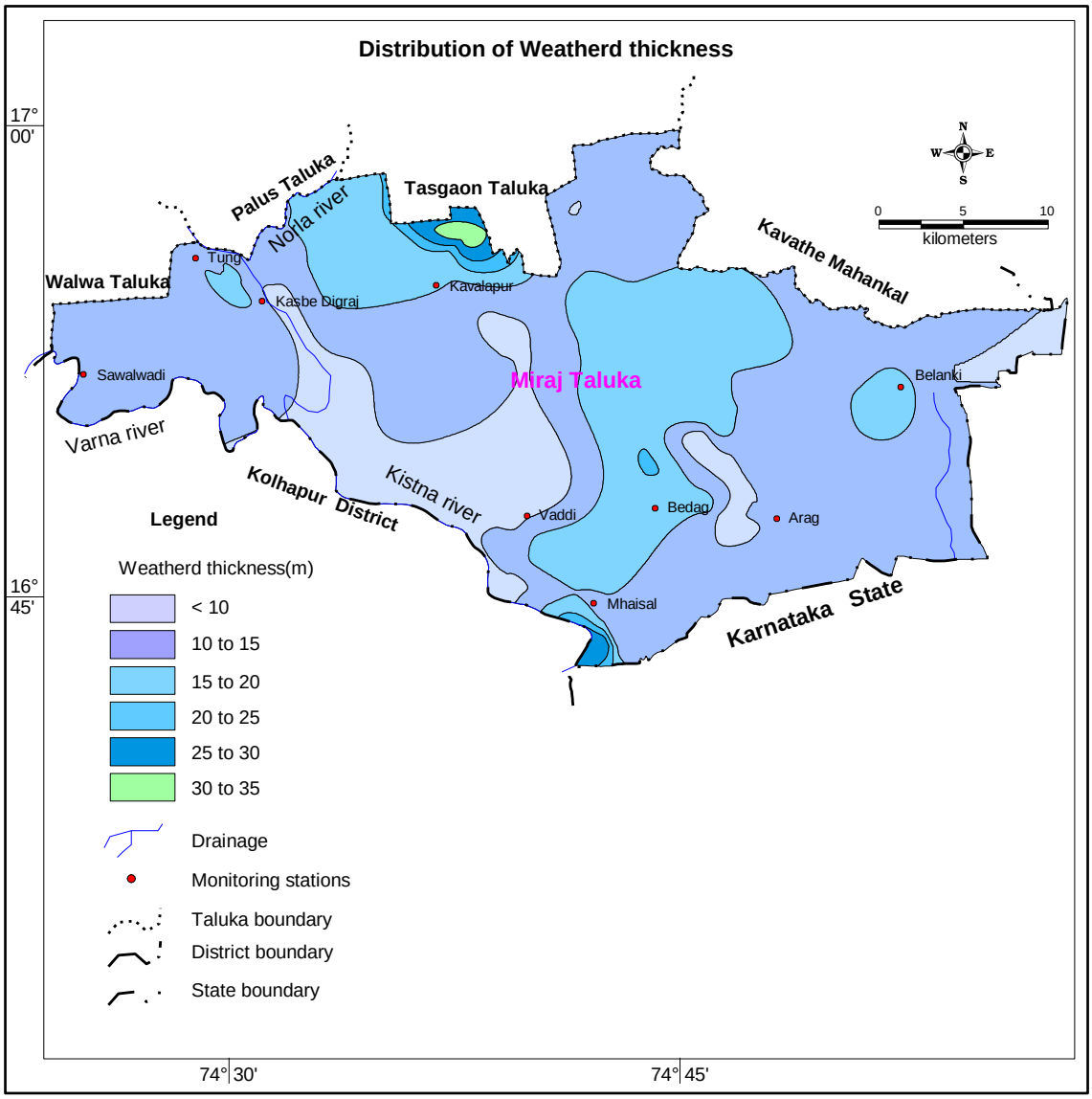


Figure 8: Map showing weathered thickness in Miraj taluka

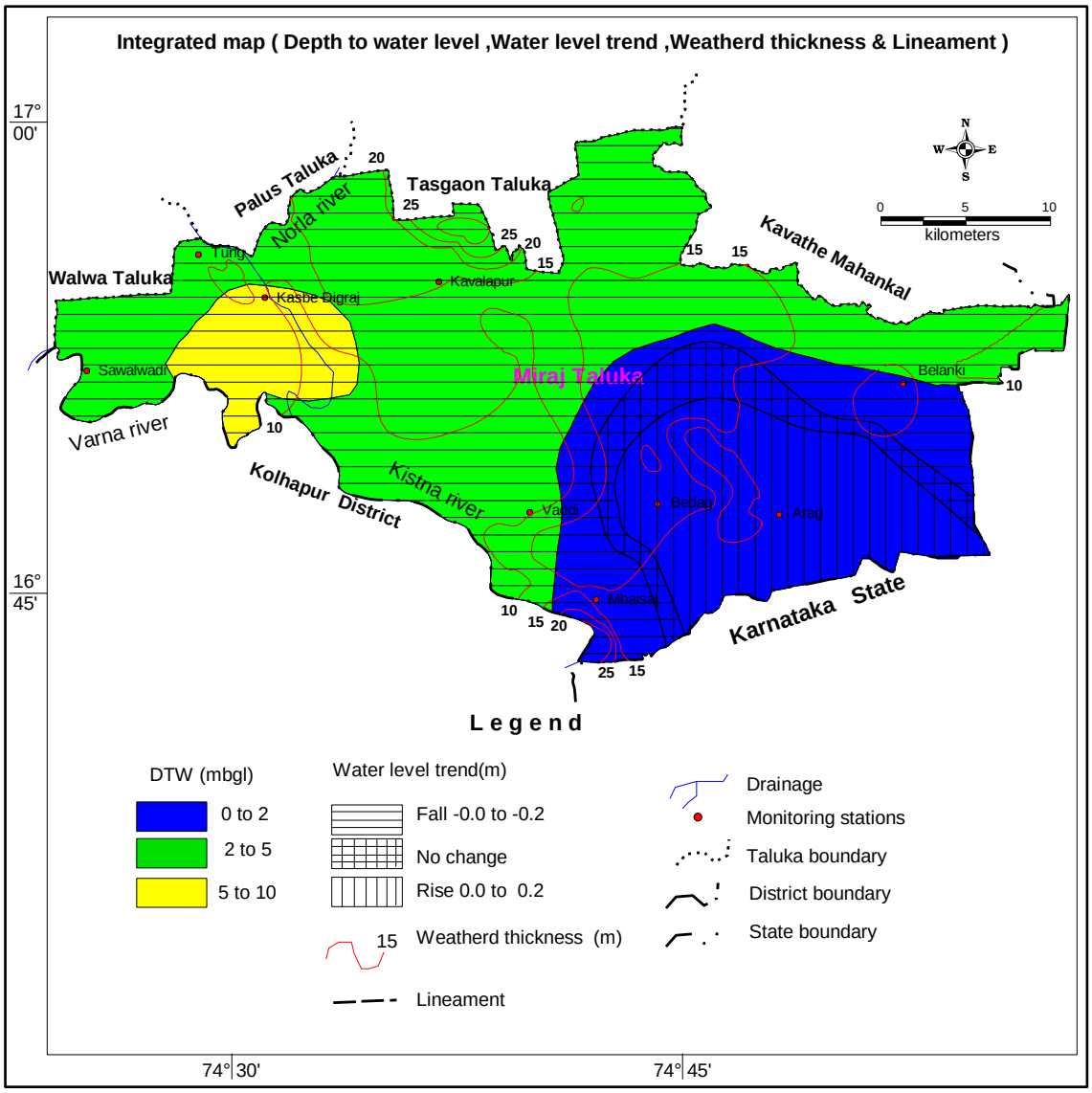


Figure 9: Integrated Map showing feasible area for artificial recharge to groundwater in Miraj taluka

An integrated map containing all the layers i.e. depth to water level, water level trend and weathered thickness, lineaments is prepared and is shown in **Figure 9**. Based on the map, an area of 63.0 sq.km is identified for artificial recharge to groundwater.

12. AVAILABILITY OF SURPLUS SURFCE WATER FOR ARTIFICIAL RECHARGE OR CONSERVATION

The availability of non-committed surplus runoff as source water is one of the main requirements for any artificial recharge scheme. In India in general and Maharashtra in particular, the monsoon rainfall is the chief source of water which can be utilized for artificial

recharge. Normally the surplus / non-committed monsoon runoff can be utilized as source water for artificial recharge scheme.

The rainfall received during northwest monsoon between June and September is the principal source of water in the state of Maharashtra. The actual availability of surface water in the area depends upon the rainfall incidences, climate, Physiography, land use and hydrogeology. These components vary drastically in space and time and is not uniform in the state of Maharashtra. Therefore basin and sub-basin wise availability of water and its utilization status is considered to depict the realistic scenario of source water availability. For this purpose the hydrological data available with the state government was collected and compiled basin wise for Godavari, Krishna and Tapi basins.

Miraj taluka of Sangli district falls in Krishna river basin. The data available on the website of Water Resources Department, Government of Maharashtra reveals that geographical area of Krishna basin is 258948.00 sq.km. The basin has surplus runoff availability of 8452.48 MCM. Thus the proportionate surplus surface water availability per sq. km. comes out to be 0.03263 MCM and the total water availability to the tune of 2.05 for Miraj taluka. For estimation of volume of water to be utilised for recharge, 70% of surplus water availability has been considered. Thus about 1.44 MCM surplus surface water can be considered for preparation and implementation of master plan for artificial recharge in the over-exploited Miraj taluka and for estimation of number of structures required for augmentation of groundwater resource in the area. The estimated availability on surplus surface runoff in Morshi taluka is finalised in consultation with the State Government and hence confirmed for taking up artificial recharge measures in the taluka.

13. FEASIBLE ARTIFICIAL RECHARGE / CONSERVATION STRUCTURES

Hydrogeology, Physiography, climatic conditions and source water availability are the major factors which affect the selection of site, dimension of the artificial recharge scheme. The surface spreading techniques consisting of percolation tanks and cement plug/bund/check dam are most appropriate techniques in areas occupied by hard rocks. In alluvial areas i.e. alluvial part of Tapi and Purna basin, the percolation tanks in mountain fronts and recharge shaft in alluvial/bazada zone are the most feasible structures. Accordingly these structures have been recommended for artificial recharge to groundwater. Other

structures like continuous contour trenches, gabion structures, nala bunds, village ponds etc. may also be taken up side by side which would be more appropriate for soil and moisture conservation. The underground bandharas or sub surface dykes are ground water conservation structures and hence can be taken up a site specific location to conserve the ground water. Beside this roof top rain water harvesting and storm water harvesting in public parks, play grounds are the most appropriate techniques as in urban areas most of the nala / river carries domestic sewage and non-availability of land for submergence.

Various artificial recharge studies on carried out by CGWB so far in the State of Maharashtra and the findings of the artificial recharges schemes implemented under Central Sector Scheme are highly helpful is preparation of plan for artificial recharge for any given area. The findings of these studies / schemes are considered in formulating the artificial recharge plan and are mentioned below.

- A percolation tank of 100 Thousand Cubic Metre (TCM) capacity (single filling) will actually store 200% more due to multiple fillings during monsoon. This will have gross storage capacity of 200 TCM. However, desilting of percolation tank on regular basis in 1-2 year before the onset of monsoon should be carried out for effective infiltration of stored water into the sub-surface.
- A check dam / cement plug of 10 TCM capacity (single filling) will actually store 300 % more due to multiple fillings in monsoon. This will provide gross storage of 30 TCM for check dam. However, it is also required to be desilted to maintain the storage capacity and recharge efficiency.
- Unlike various water conservation schemes, percolation tank and check dam provide 85% recharge to ground water out of total storage.
- With regard to the amount of surface water considered for planning the artificial recharge, it can be considered that 70 % storage would be through percolation tank and remaining by check dam and other structures.

The number of recharge structures required to store and recharge the ground water reservoir have been worked out as follows.

$$\text{No. Of structures} = \frac{\text{Total surface water considered}}{\text{Average gross capacity of Percolation Tank/Check Dam (considering multiple fillings)}}$$

Based on the above field findings, it is proposed to allocate about 70 % of the surplus water for construction of percolation tanks, about 25 % surplus water for construction of check dam. The remaining 5 % surplus available water is proposed for allocation for construction of various water conservation structures like loose boulder structures, gabbion structures etc. The average recharge efficiency of artificial recharge structure is considered as 85% on safer side.

The tentative locations of proposed artificial recharge structures are shown in **Figure 10** and the location of sites are listed in **Annexure – I**. The design of percolation tank and check dam are presented as **Annexure-II**. However, the final design of the individual structures will be site specific and will be prepared based on the hydrogeological survey in consultation with the implementing agency.

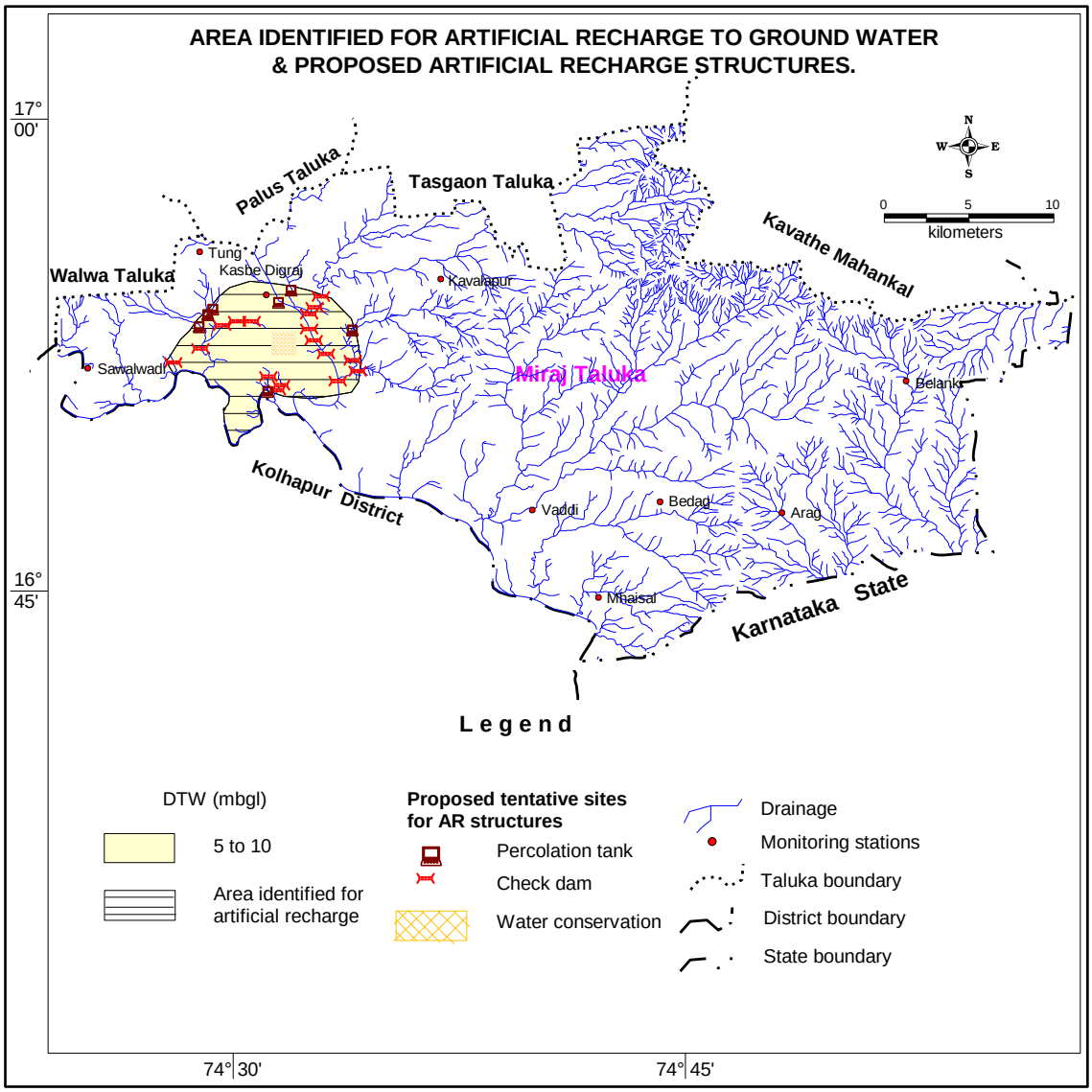


Figure 10: Tentative sites of percolation tanks and check dam, Miraj Taluka

14. TENTATIVE COST ESTIMATES

For estimating the tentative cost for construction of various types of artificial recharge and water conservation structures, schedule of rates **(**SOR) of Government of Maharashtra available for the year 2011 have been considered. In the state of Maharashtra, SOR of each district vary marginally from each other. It is estimated that the total expenditure to be incurred for construction of various water conservation and recharge structures will be Rs. 19.17 crores (As per 2011 SOR). However, it is likely that the actual cost will vary depending upon the actual period of construction and location of sites which will be finalised after detailed hydrogeological consultation and survey by the implementing agencies.

Percolation Tanks

It is estimated that in Miraj taluka, about 1.01 MCM of surplus was can be made available for construction of percolation tanks. To recharge the above quantum, about 5 percolation tanks shall be required to be constructed in Miraj taluka. Considering the recharge efficiency of 85%, it is expected that about 0.858 MCM of surface water shall be recharged. As per the SOR available for the year 2011, it is estimated that for construction of one percolation tank with average gross capacity of 200 TCM, Rs. 70 lakh will be required. Therefore the total expenditure involved for construction of 5 percolation tanks will be Rs. 3.50 crores. For enhancing the ground water recharge, it is proposed to utilise the stored water of the percolation tanks for irrigation of the surrounding areas.

Check Dams

A quantum of about 0.36 MCM of surplus was can be made available for construction of check dams. It is estimated that about 12 check dams can be constructed to recharge the proportionate allocated surplus water of 0.36 MCM. Considering the recharge efficiency of 85%, it is expected that about 0.306 MCM of surface water shall be recharged into sub-surface. The SOR available for the year 2011 indicate that for construction of one check dam with average gross capacity of 30 TCM, Rs. 7 lakh will be required. Therefore the total expenditure involved for construction of 12 check dams will be Rs. 0.84 crores.

Water Conservation Structures

After the allocation of surplus runoff water for the major structures like percolation tanks and check dams, the remaining quantum of surplus water can be taped by means of feasible water conservation structures for soil and water conservation. Thus about 0.07 MCM of surplus water can be made available for water conservation structures. The feasible water conservation structures in the area are loose boulder structure and gabbion structures. It is estimated that about 5 number water conservation structures will be required to conserve the 0.07 MCM of surplus runoff water. Considering the efficiency of 85%, about 0.059 MCM runoff water can be conserved and recharged. These structures can be constructed on lower order streams i.e. streams of 1^{st} and 2^{nd} order. As per the SOR 2011, an approximate expenditure of Rs. 25000 will be required for construction of one water conservation structure. Therefore the total expenditure involved for construction of 5 water conservation structures will be Rs. 0.0125 crores.

Roof Top Rain Water Harvesting

In this first phase, it is proposed to take up roof top rain water harvesting measures in the Urban households of Miraj Taluka. As per census 2011, there are about 185372 households in Miraj taluka. It is assumed that about 10% of the households i.e. 18537 households may have the average roof area of about 50 sq.m. Therefore, considering the average annual rainfall of 708 mm, average roof area of 50 sq.m and runoff coefficient of 0.85, the total rainwater harvesting potential generated in the urban households of Miraj taluka is about 0.473 MCM.

For taking up roof top rain water harvesting and artificial recharge through individual household, it is proposed to recharge roof top runoff through a recharge pit having dimension of size 1m X 1m and having a depth of 1.50 m. The top 0.6 m portion of the pit will be open for pouring the harvested rainwater whereas the bottom portion of 0.90 m depth shall be filled with boulder, gravel and sand each having a thickness of about 0.30 m.

It is anticipated that about 85% of the harvested water shall be recharged. Thus about 0.402 MCM shall be recharged through adoption of rainwater harvesting in the urban households.

15. TIME SCHEDULE

After the release of funds, the proposed plan can be implemented within a stipulated time of 2-3 years by the implementing agency of concerned State Department, Government of Maharashtra.

Time schedule	Activity to be carried out
0 To 3 months	Finalization of sites for construction of artificial recharge / water conservation structures by the Implementing Agency
4 To 6 months	Finalization of designs / specifications and budget Estimation as per the Schedule of Rates by the Implementing Agency
7 To 20 months	Implementation of the project by the Implementing Agency
20 To 24 months	Preparation of report and report submission by the Implementing Agency
25 To 36 months	Impact Assessment by the Implementing Agency

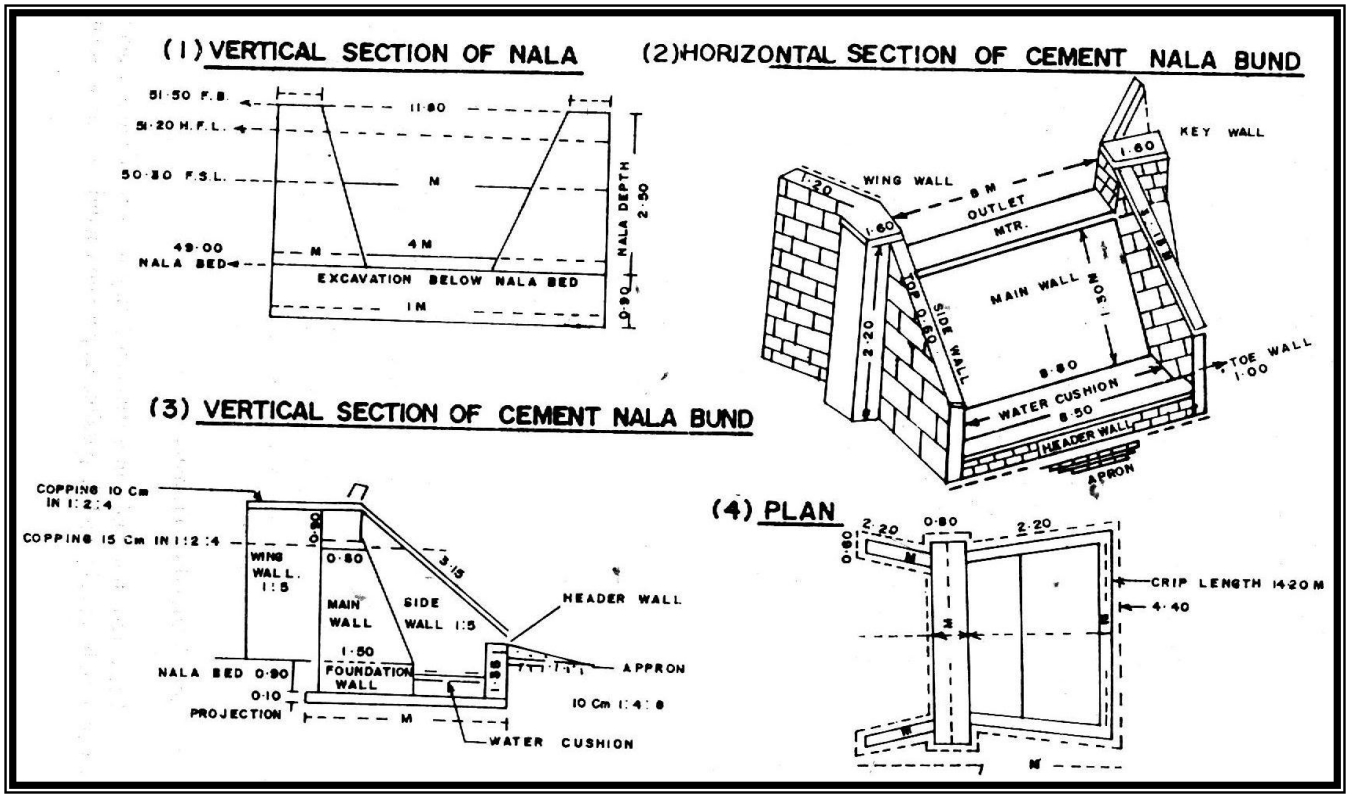
Annexure – I

Tentative Locations of Proposed Artificial Recharge Structure in Miraj Taluka, Sangli District

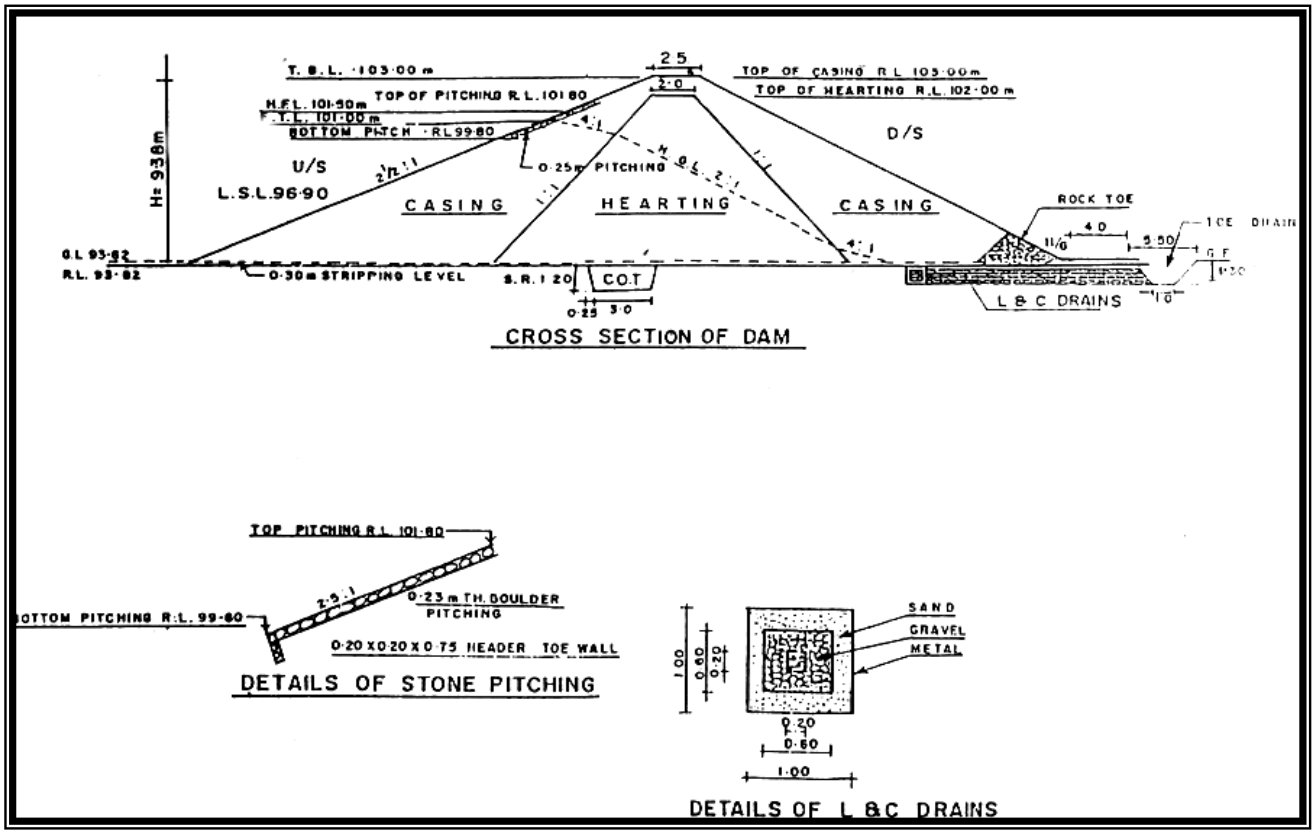
Sl. No.	District	Taluka	Structure	Village name	Long	Lat
1070	Sangli	Miraj	CD	Kasabe Digraj	74.4941	16.8904
1071	Sangli	Miraj	CD	Kavathe Piran	74.4821	16.8781
1072	Sangli	Miraj	CD	SANGLI	74.5196	16.8633
1073	Sangli	Miraj	CD	SANGLI	74.5664	16.8719
1074	Sangli	Miraj	CD	SANGLI	74.5244	16.856
1075	Sangli	Miraj	CD	SANGLI	74.5516	16.8752
1076	Sangli	Miraj	CD	SANGLI	74.5422	16.8885
1077	Sangli	Miraj	CD	SANGLI	74.5449	16.8825
1078	Sangli	Miraj	CD	Padmale	74.5423	16.8964
1079	Sangli	Miraj	CD	Kavathe Piran	74.467	16.8707
1080	Sangli	Miraj	CD	SANGLI	74.5691	16.8662
1081	Sangli	Miraj	CD	SANGLI	74.5581	16.8608
1082	Sangli	Miraj	PT	Kavathe Piran	74.481	16.891
1083	Sangli	Miraj	PT	Kasabe Digraj	74.4859	16.8976
1084	Sangli	Miraj	PT	Kasabe Digraj	74.5249	16.9041
1085	Sangli	Miraj	PT	Mouje Digraj	74.532	16.9106
1086	Sangli	Miraj	PT	SANGLI	74.5659	16.8895

Annexure-II

Design of Check Dam

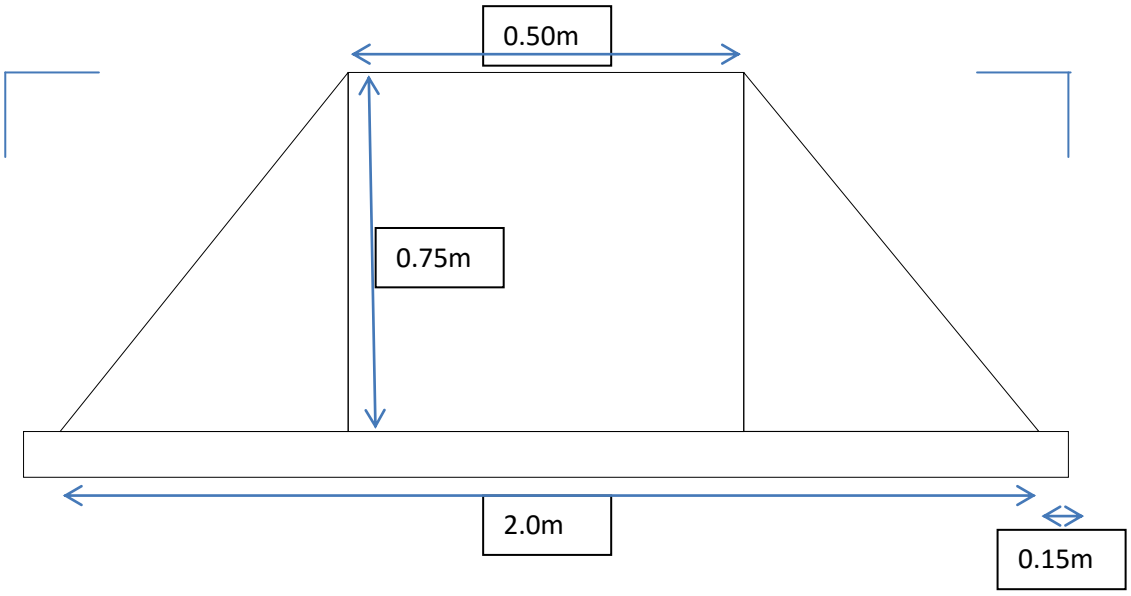


Design of Percolation Tank



DESIGN OF WATER CONSERVATION STRUCTURES

Cross Section of Loose Boulder Structure



Cross Section of Gabbion Structure