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 Malshiras Taluka of Solapur District

मध्य क्षेत्र, नागपुर
CENTRAL REGION, NAGPUR
जुलाई – 2016 / July – 2016

ARTIFICIAL RECHARGE PLAN AT A GLANCE

1.	Total Geographical Area of the Malshiras Block (Taluka)	1612.00 km^2
	❖ Area occupied by Hard Rock (Basalt)	1612.00 km^2
	❖ Area occupied by Soft Rock (Alluvium)	-
2.	Major land use pattern	Agriculture
3.	Average Annual Rainfall (mm)	524 mm
4.	Major Drainage	Nira & Bhima 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)*	170.67 km^2
6.	Overall quality of groundwater	Suitable for domestic, industrial and irrigation use
7.	Availability of Surplus surface runoff (MCM)	5.571 MCM
8.	Surplus runoff considered for planning (MCM) (Considering 85 % recharge efficiency)	1.165 MCM
9.	Runoff for RWH in Urban Household	0.222 MCM
10.	Sub-surface storage potential available (MCM)	0.99 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)	0.8155	0.291	0.058	0.222
❖ Feasible number of structures	4	10	4	9957
❖ Unit cost of structures (crores)	0.70	0.07	0.0025	0.0008
❖ Estimated Cost (Crores)	2.80	0.70	0.01	7.96
❖ Expected Recharge (MCM) (85 % recharge efficiency)	0.693	0.247	0.049	0.189

12.	Total estimated cost (Crores)	11.47 crores

Artificial Recharge Plan for the Over Exploited Malshiras Taluka of Solapur 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 Malshiras taluka of Solapur district which will form a base for the future strategy.

2. LOCATION

Malshiras taluka is situated in the western border of Solapur district and lies between North latitude 17° 35' to 18°01'45" and East longitude 74°36' 28" to 75°12'51". The Malshiras taluka covers geographical area of 1612 sq.km. (Fig 1a and 1b). There are total 117 villages in the taluka. The total population of Malshiras taluka is 485,645 persons as per the census 2011.

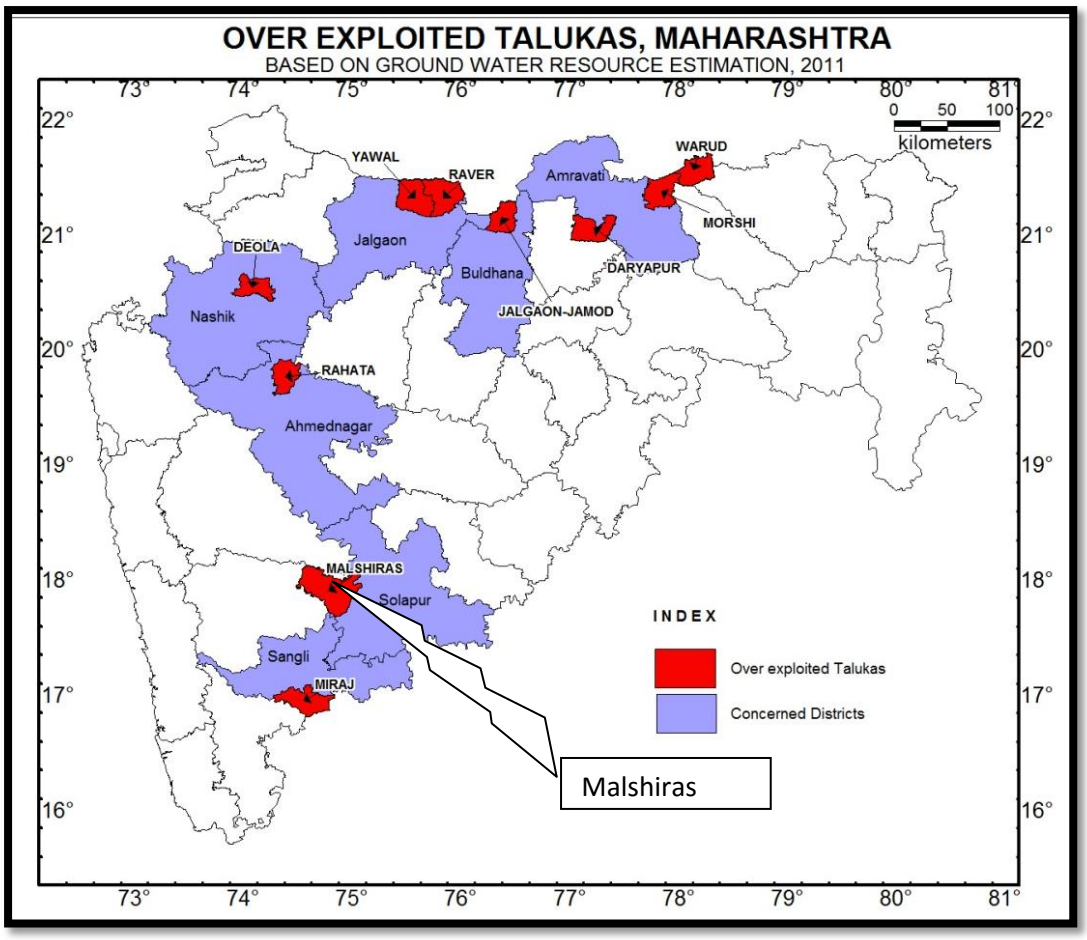


Figure1a: Location of Malshiras Taluka, Solapur District, Maharashtra

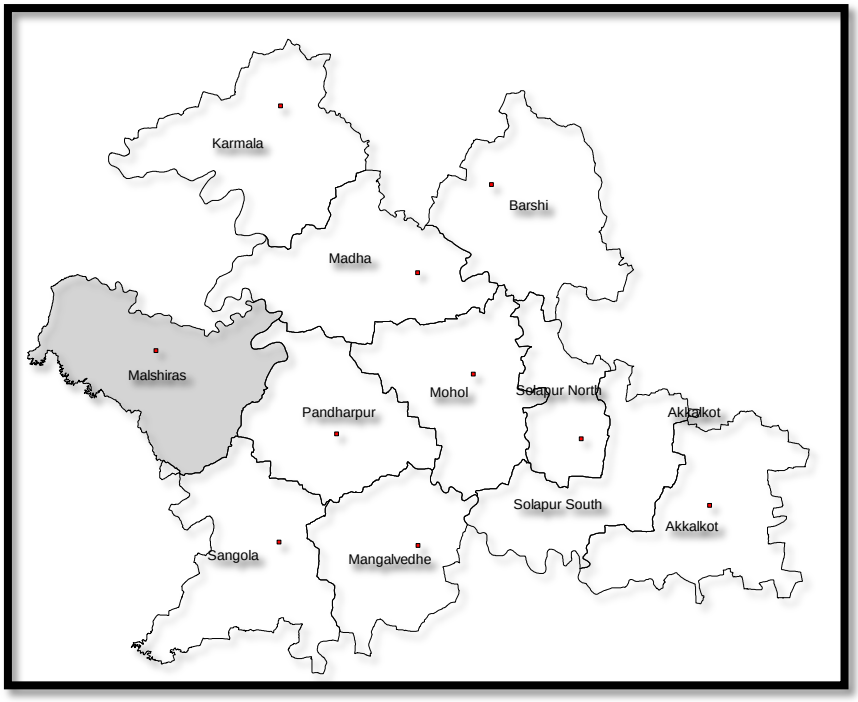


Figure1b: Location of Malshiras Taluka, Solapur District

3. PHYSIOGRAPHY & DRAINAGE

Physiographically, the Malshiras taluka is divided in to two divisions viz, hilly region and plain region. The western boundary of the Malshiras taluka forms hills known as the Phaltan range, overlooking the Malshiras plain which are drained both to the north and the east by the tributaries of the Nira and Bhima rivers (**Fig. 2a**).A digital elevation model of Malshiras taluka indicating village boundaries is shown in figure 2b.

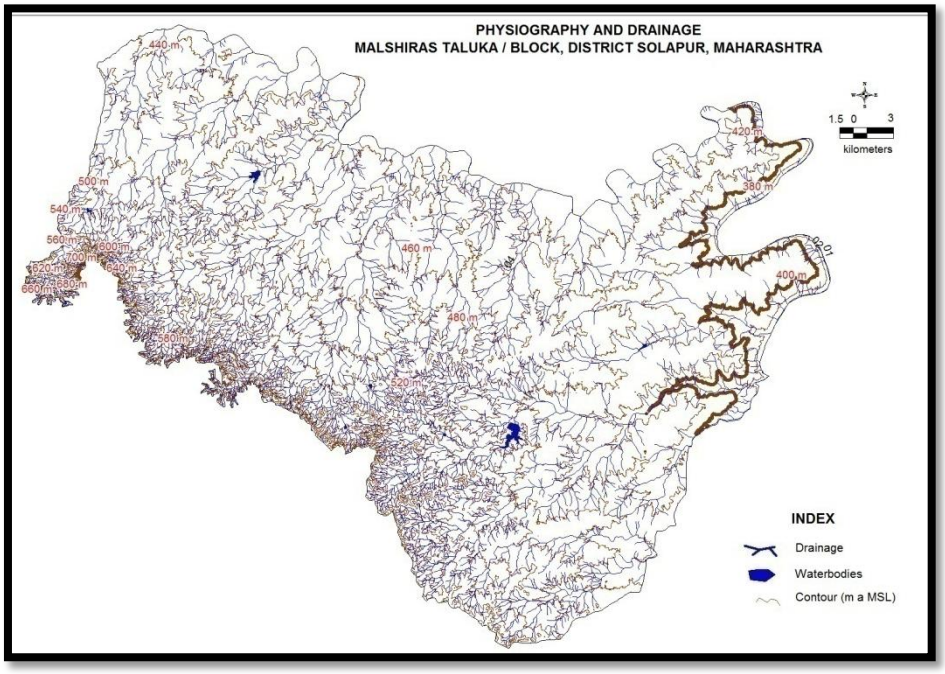


Figure2a: Physiography and Drainage, Malshiras Taluka

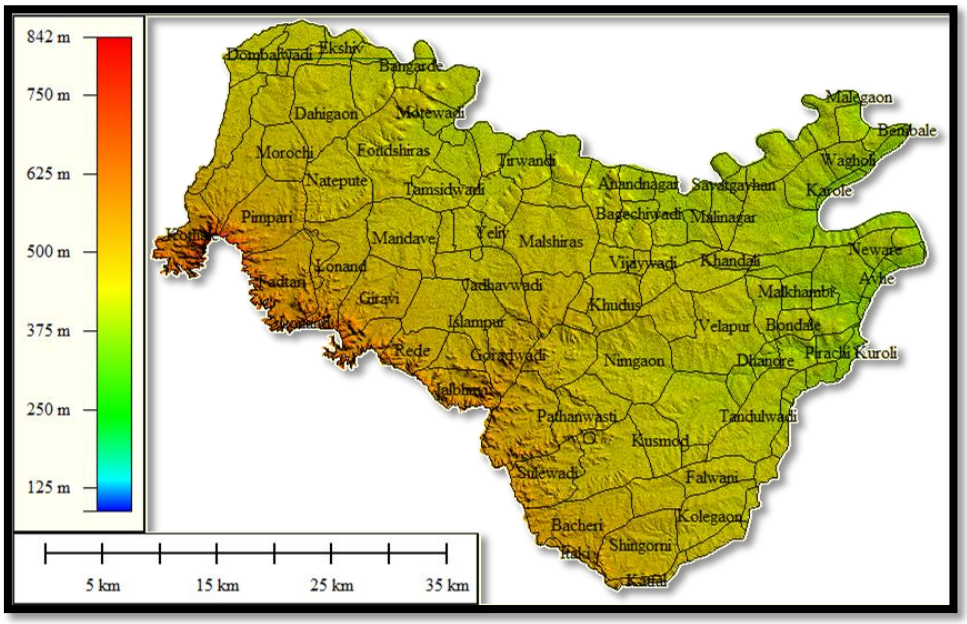


Figure2b: Digital Elevation Model, Malshiras Taluka

4. RAINFALL

The area receives rainfall due to the south-west monsoon and about 83% of the rainfall takes place during the months of June to September. About 17% of the normal annual rainfall is received in the post-monsoon months of October and November. The taluka receives scanty and uncertain rainfall and the average annual rainfall in the area is 524 mm.

5. LAND USE PATTERN

The land use pattern of the area prominently reflects agriculture activity and cultivation of sugarcane in particular with isolated scattered patches of notified 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 occurs in the entire taluka where the ground water potential is not uniformly distributed due to inherent heterogeneity of the formation. Ground water in Deccan Traps mostly occurs in the weathered and fractured parts down to 10-15m depth. At places potential zones are encountered at deeper levels in the form of fractures and inter-flow zones which are generally confined down to 60-80m in the taluka. The weathered portions of both vesicular and massive units have better porosity and permeability. Intensity of weathering is less in hilly region occurring in the western part of the taluka, while it is higher in plain area. It is noticed and reported that the yields of the wells drastically get reduced in summer months beginning form March up to June end **(Fig. 3)**.

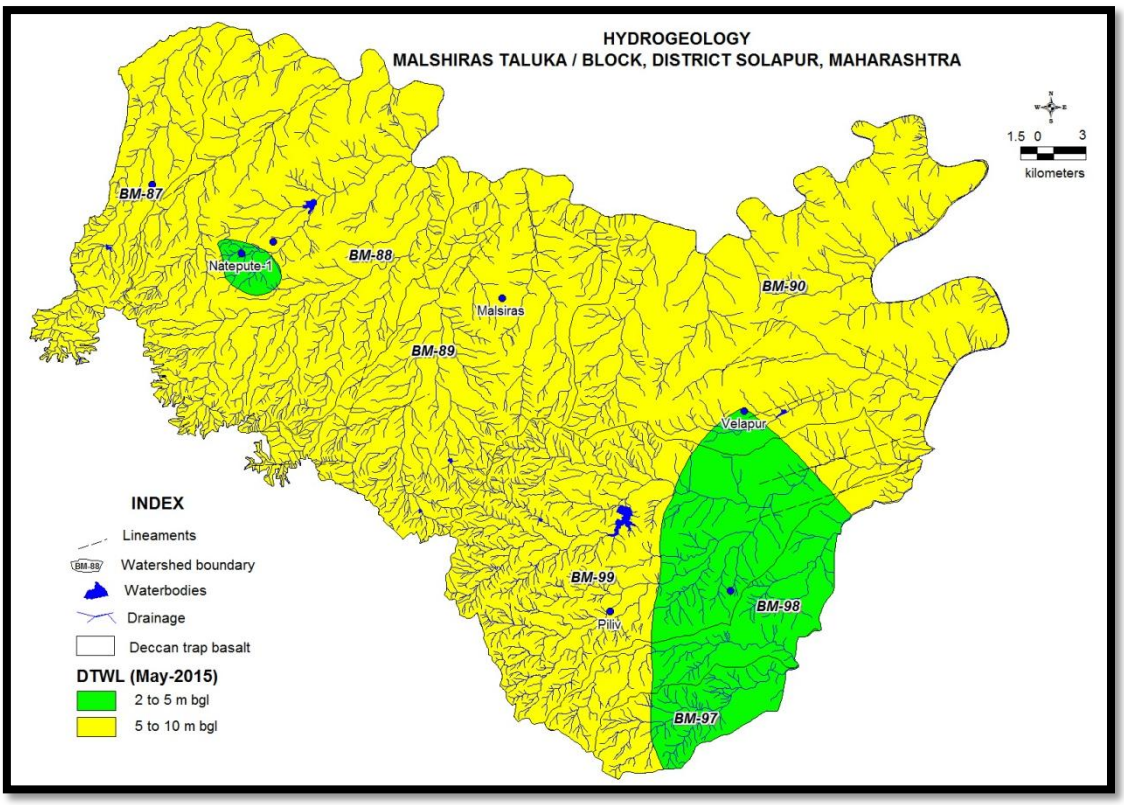
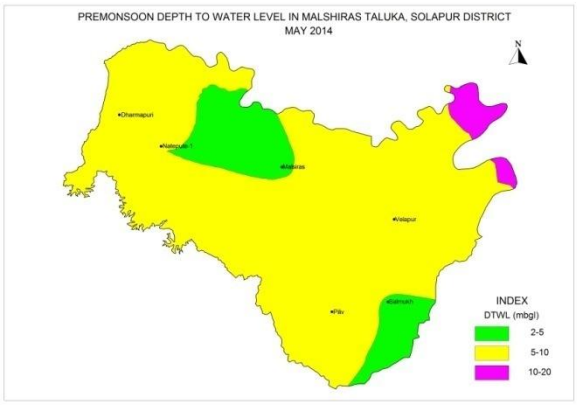


Figure 3: Hydrogeology, Malshiras Taluka

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). Depth to water levels recorded during the pre-monsoon season in May 2014 ranges from 4.8-7.4 m bgl. However, in major parts of the taluka depth to water level are in the range of 5-10 m bgl (Fig 4).

The water levels recorded in post-monsoon season (Nov. 2014) are ranging from 1.3-6.4 m bgl and in major parts of the taluka covering central and southern parts; the water levels are in the range of 2-5 m bgl. The water levels are ranging from 5-10 m bgl in northern parts of taluka area (Fig. 5).



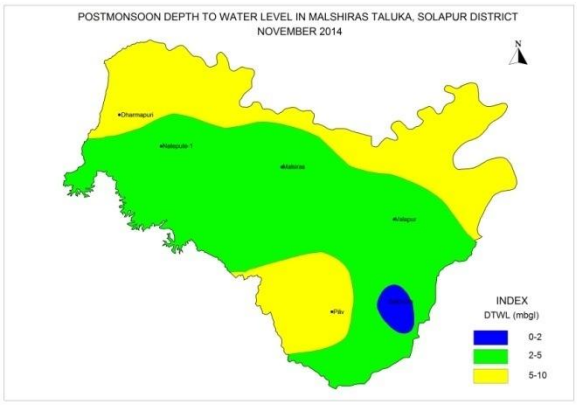


Fig 4 and 5: Pre and Post-monsoon (2014) Depth to Water Level, Malshiras Taluka

8. DYNAMIC GROUND WATER RESOURCE

Ground Water Resources Assessment for the year 2011 indicates Net Annual Ground Water Availability of 23100.74ham, draft for all uses is 23307.64 ham with irrigation being the major consumer withdrawing 22693.90 ham and stage of ground water development is also high about 100.90% **(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 decreased marginally from 101.53% in 2009 to 100.90% 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 Malshiras Taluka (As on March 2011)

S. No	Particulars	GW Resources (Ha.m)
1.	Net Annual Ground Water Availability	23100.74
2.	Existing Gross Ground Water Draft for irrigation	22693.90
3.	Existing Gross Ground Water Draft for domestic and industrial water supply	613.74
4.	Existing Gross Ground Water Draft for All uses	23307.64
5.	Provision for domestic and industrial requirement supply to 2025	890.63
6.	Net Ground Water Availability for future irrigation development	3024.77
7.	Stage of Ground Water Development	100.90%
8.	Category of the Assessment Unit	Over Exploited

9. NEED FOR ARTIFICIAL RECHARGE AND CONSERVATION MEASURES

Malshiras taluka is one of the major sugarcane growing area in 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 therefore the 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 the Malshiras taluka. However, a robust consolidated plan for artificial recharge measures are also required for converting the entire Over-Exploited Malshiras taluka into Critical / Semi-critical / Safe category.

11. FEASIBLE AREA FOR ARTIFICIAL RECHARGE OR CONSERVATION

The feasible area for artificial recharge to groundwater in Malshiras 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.

For identification of feasible area for artificial recharge to groundwater, the long term average decadal post-monsoon depth to water level of 2005 to 2014 has been considered. 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.

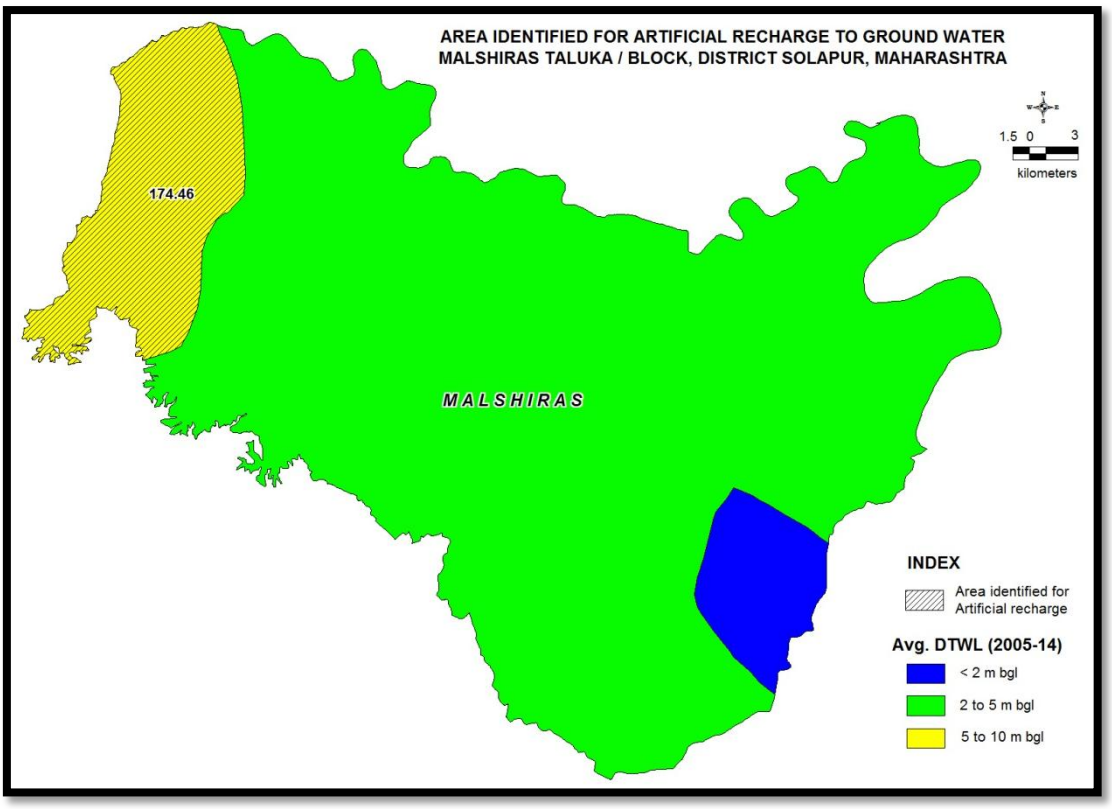


Fig 6: Average Decadal Post-monsoon depth to water level, Malshiras Taluka

It has been observed from the Depth to Water level (DTWL) map of the Malshiras taluka that 174.00 sq.km area has DTWL more than 5 m bgl. Therefore an area of 174.0 sq.km out of the total geographical area of 1612.00 sq.km of Malshiras taluka can be taken up for artificial recharge to groundwater.

The long term water level trend map for the period 2005-2014 has been prepared and is shown in **Figure 7**. Both the rising water level trend from 0.0 to 0.2 m/year and falling water level trend between 0.0 to 0.4 m/year. 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 Malshiras taluka **(Fig 7).**

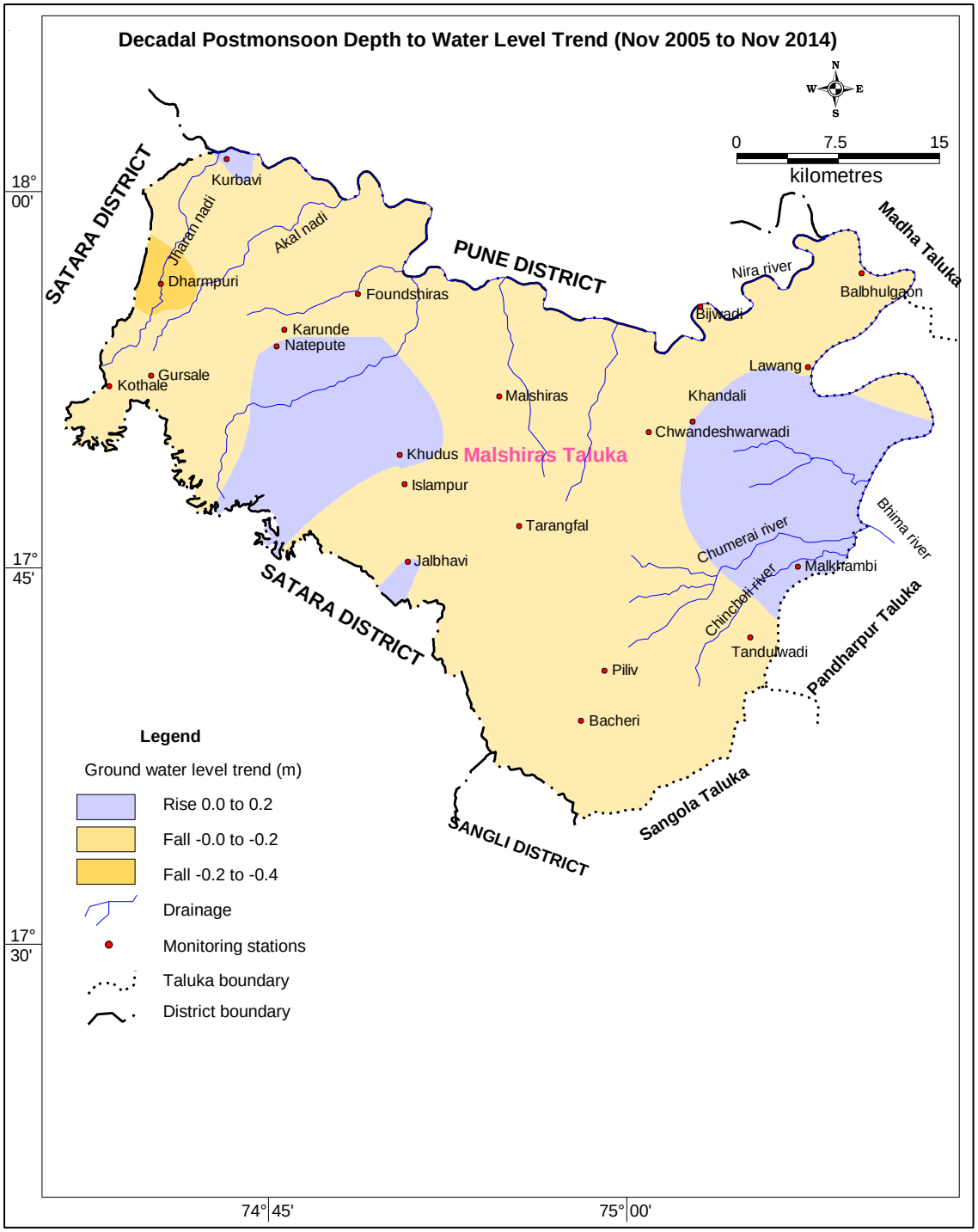


Figure 7: Map showing long term post monsoon water level trend (2005-14)

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 Malshiras 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 Malshiras taluka is also traversed by few lineaments (**Figure 9)** indicating promising scope for artificial recharge in that area.

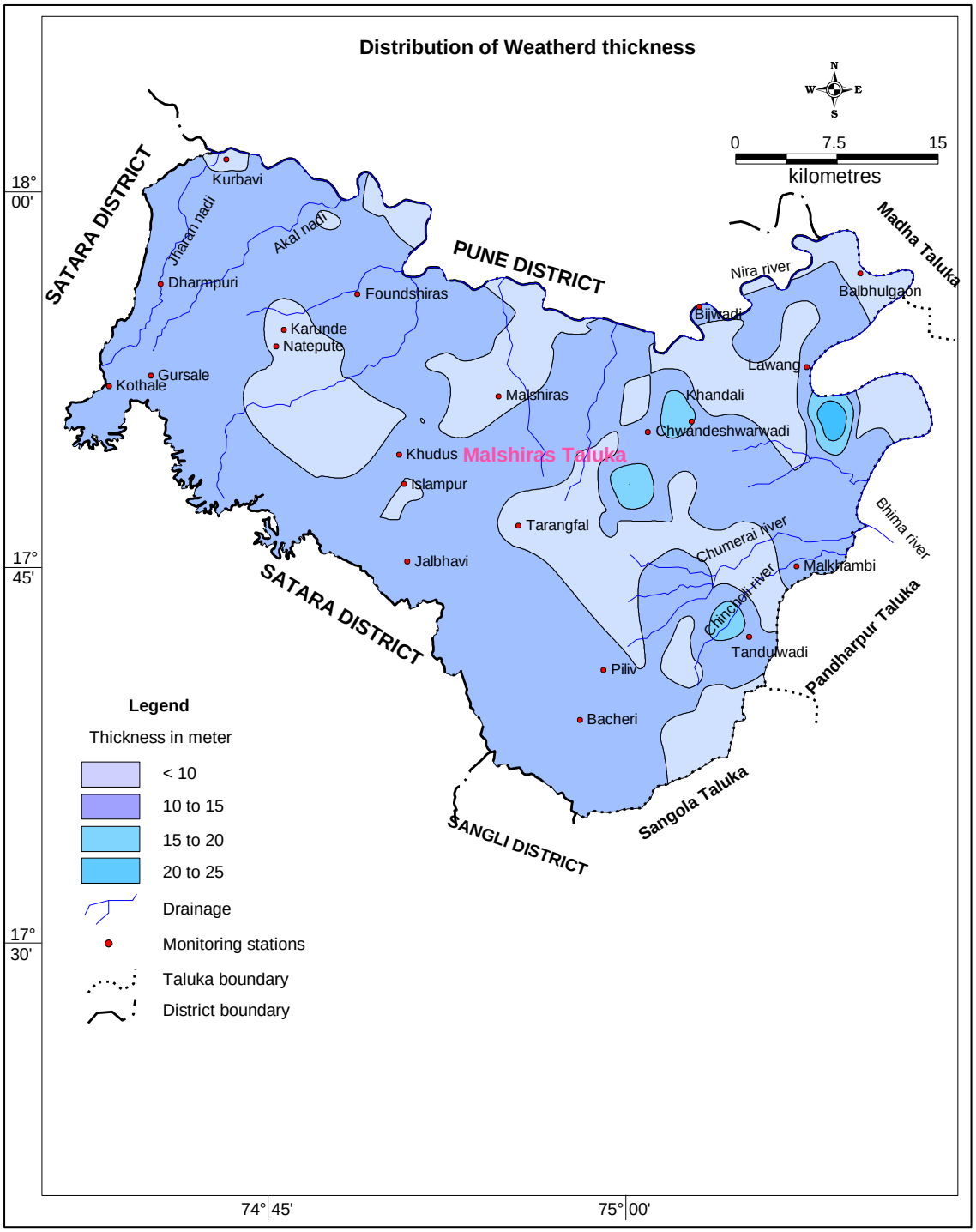


Figure 8: Map showing weathered thickness in Malshiras taluka

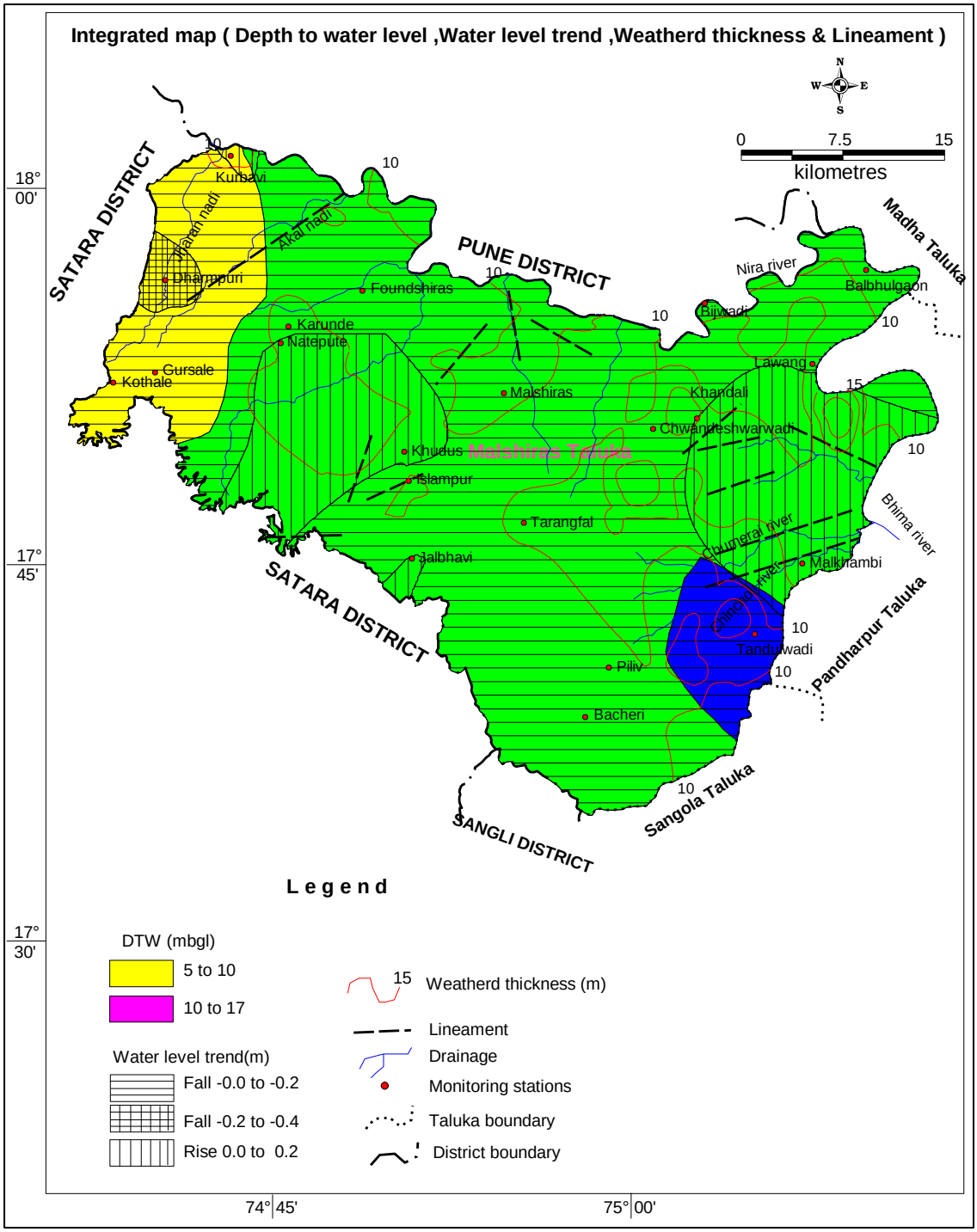


Figure 9: Integrated Map showing feasible area for artificial recharge to groundwater in Malshiras taluka

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 170.67 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.

Malshiras taluka of Solapur 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. The total surplus surface water availability for entire Malshiras taluka is estimated to be 5.571 MCM. To create the sub surface storage potential of 0.99 MCM, 1.165 MCM of surface water will be required for artificial recharge by considering 85% recharge efficiency. Thus 1.165 MCM surplus surface water can be considered for preparation and implementation of master plan for artificial recharge in the over-exploited Malshiras 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 Malshiras 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 and 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 in urban areas as most of the nala / river carries domestic sewage and non-availability of land for submergence.

Various artificial recharge studies carried out by CGWB so far in the State of Maharashtra and the findings of the various artificial recharges schemes implemented under Central Sector Scheme of GOI 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 about 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 numbers 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%.

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.

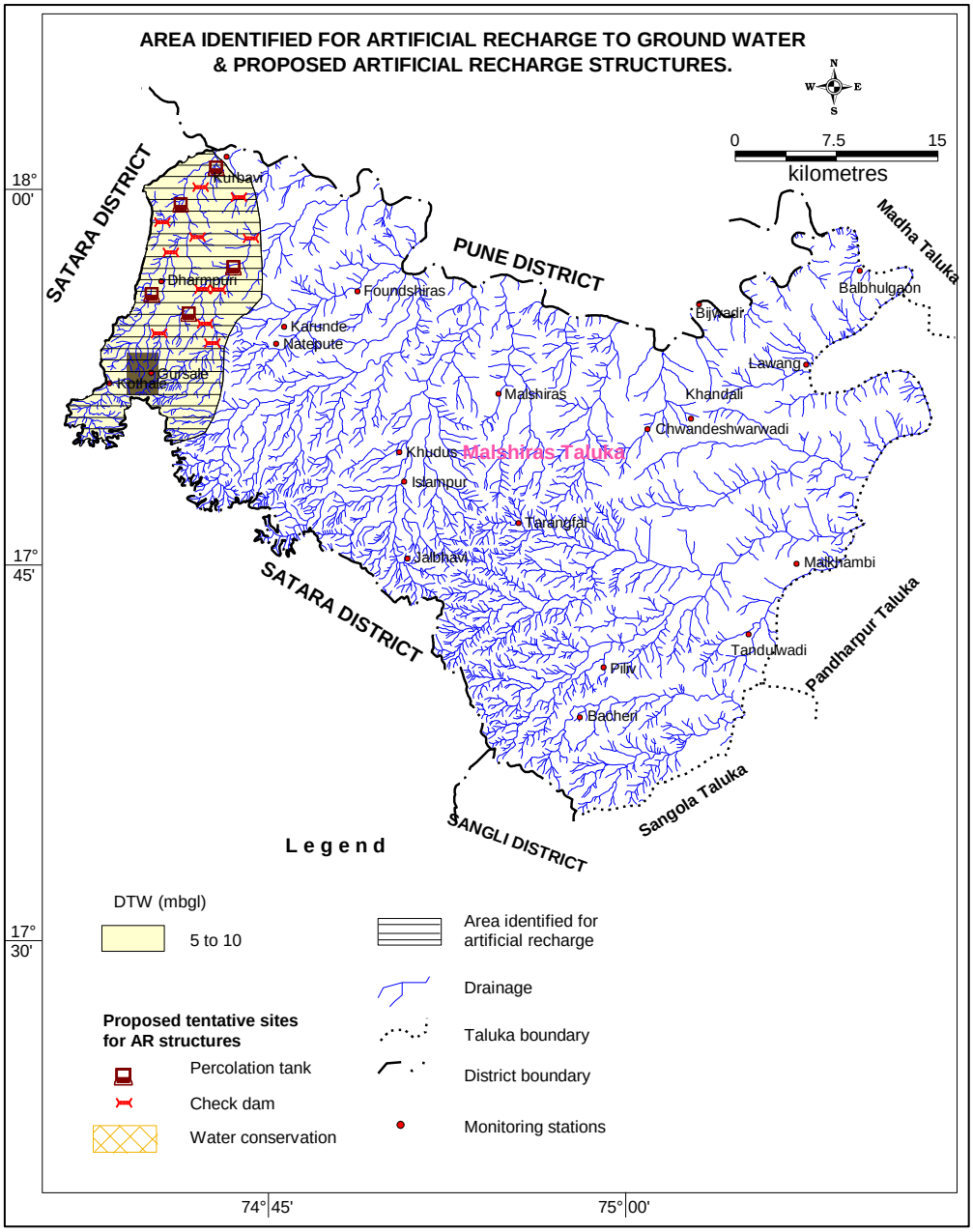


Figure 10: Tentative sites of Percolation Tank, Check Dam and Water Conservation Structure, Malshiras Taluka

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. 11.47 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 Malshiras taluka, about 0.815 MCM of surplus water can be made available for recharge through percolation tanks. To recharge the above quantum about 4 percolation tanks will be required to be constructed in Malshiras taluka. Considering the recharge efficiency of 85%, it is expected that about 0.693 MCM of surface water shall be recharged. As per the SOR available for the year 2011, 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 4 percolation tanks will be Rs. 2.80 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

It is estimated that about 0.291 MCM of surplus was can be made available for construction of check dams. Thus 10 check dams will be required to be constructed to recharge the proportionate allocated surplus water of 0.291 MCM. Considering the recharge efficiency of 85%, it is expected that about 0.247 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 10 check dams will be Rs. 0.70 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 0.058 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 4 water conservation structure will be required to tap the 0.058 MCM of surplus runoff water. Considering the efficiency of 85%, about 0.049 MCM runoff water will 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 4 water conservation structure will be Rs. 0.01 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 Malshiras Taluka. As per census 2011, there are about 99572 households in Malshiras taluka. It is assumed that about 10 % of the households i.e. 9957 households may have the average roof area of about 50 sq.m. Therefore, considering the average annual rainfall of 524 mm, average roof area of 50 sq.m and runoff coefficient of 0.85, total rainwater harvesting potential generated in the urban households of Malshiras taluka is about 0.222 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 1 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 0.189 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

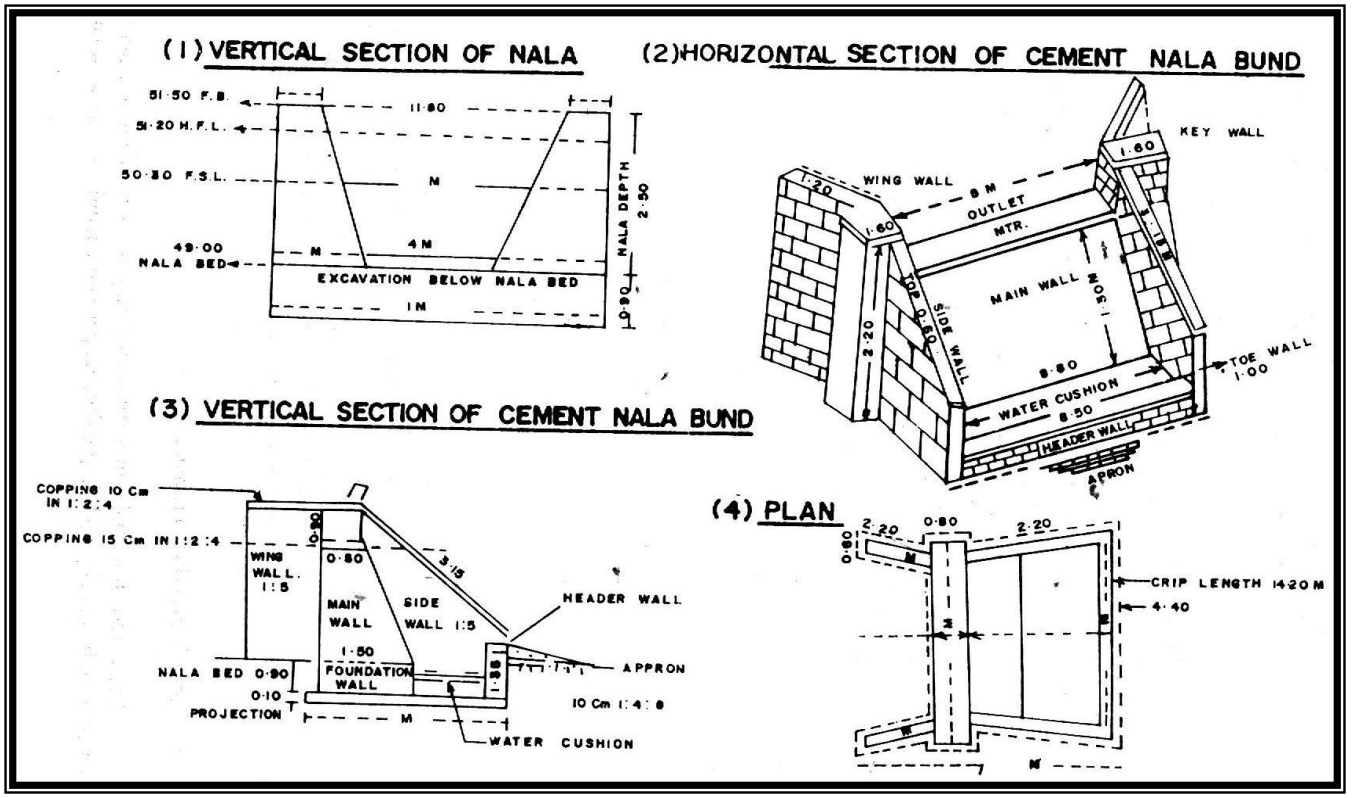
Annexure – I

Tentative Locations of Proposed Artificial Recharge Structure in Malshiras Taluka, Solapur District

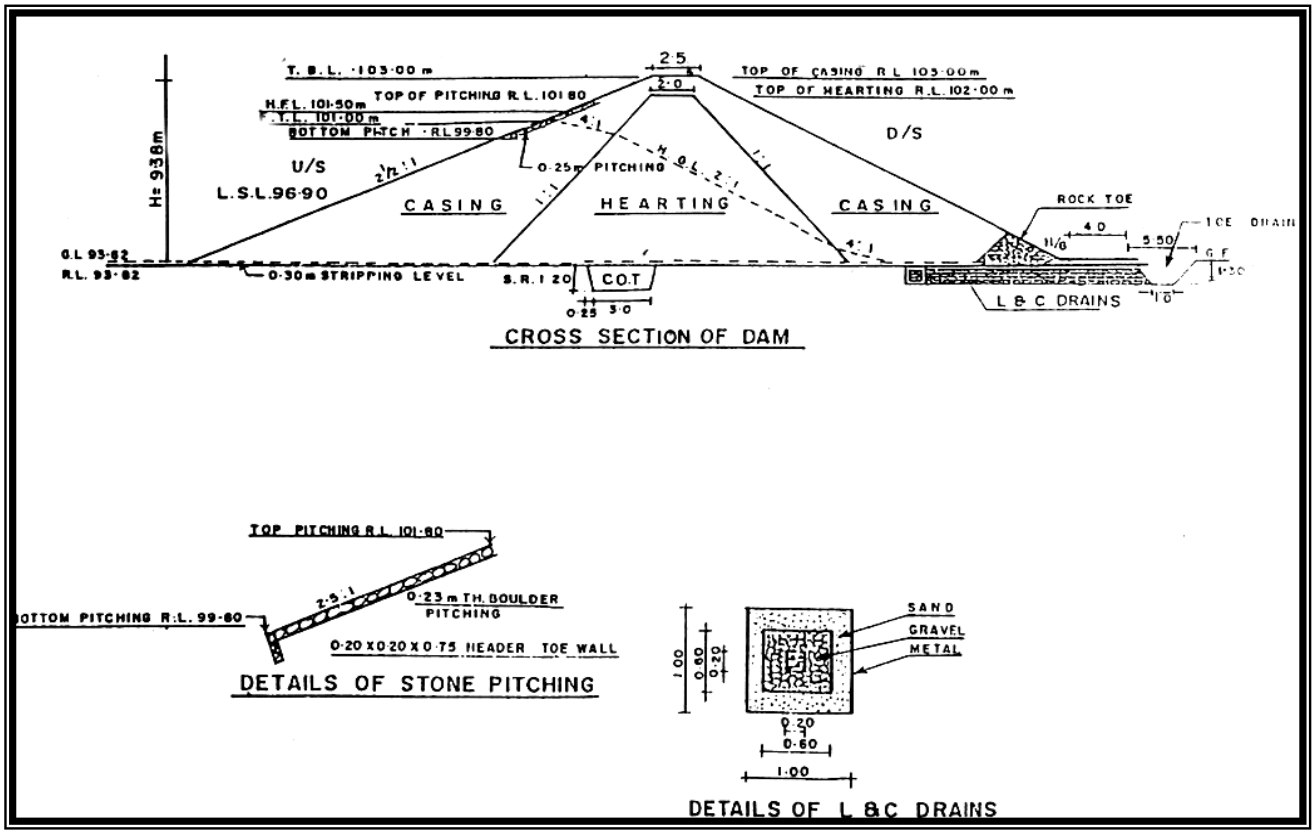
S. No.	Village	Longitude	Latitude	Type of structure
1	Karunde	74.6739	17.9038	Check dam
2	Morochi	74.7151	17.9328	Check dam
3	Dharmpuri	74.6762	17.9777	Check dam
4	Dombalwadi	74.703	18.0009	Check dam
5	Gursale	74.7007	17.9678	Check dam
6	Pimpari	74.7113	17.8971	Check dam
7	Dharmpuri	74.6821	17.9576	Check dam
8	Morochi	74.7043	17.933	Check dam
9	Dahigaon	74.7383	17.9668	Check dam
10	Dahigaon	74.7298	17.9943	Check dam
11	Dahigaon	74.7254	17.9505	Percolation tank
12	Dharmpuri	74.6682	17.9325	Percolation tank
13	Shindewadi	74.6884	17.9923	Percolation tank
14	Morochi	74.6941	17.9197	Percolation tank

Annexure-II

Design of Check Dam

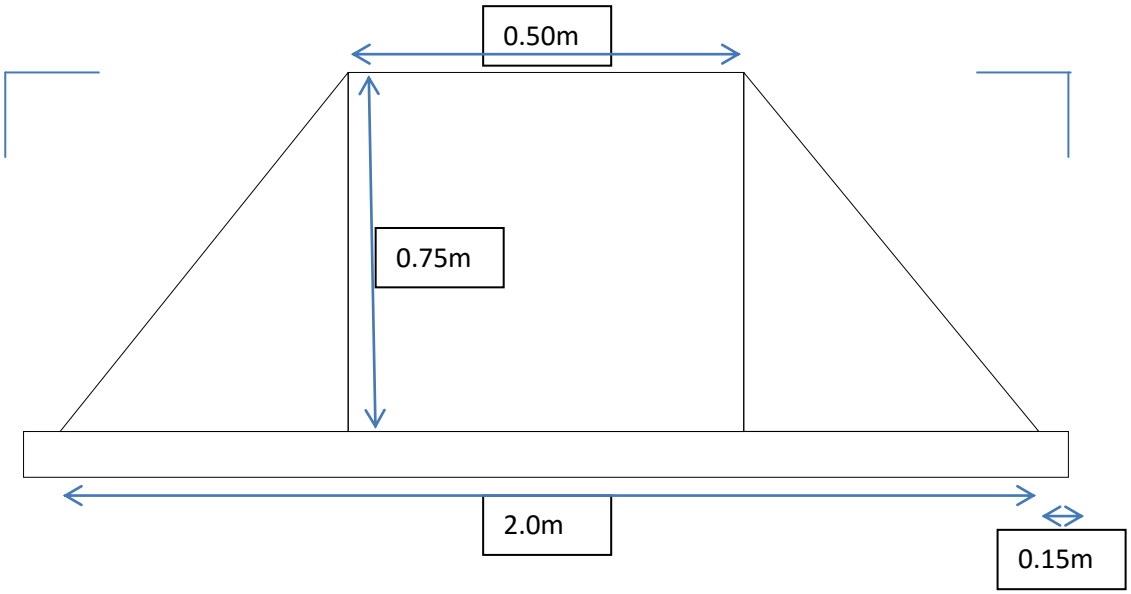


Design of Percolation Tank



DESIGN OF WATER CONSERVATION STRUCTURES

Cross Section of Loose Boulder Structure



Cross Section of Gabbion Structure