For official use only
CGWB/SR/AR/2015-16/24

GOVERNMENT OF INDIA
MINISTRY OF WATER RESOURCES,
RIVER DEVELOPMENT & GANGA REJUVENATION
CENTRAL GROUND WATER BOARD

PLAN ON
ARTIFICIAL RECHARGE TO GROUNDWATER AND WATER CONSERVATION IN PENUMURU MANDAL, CHITTOOR DISTRICT, ANDHRA PRADESH

SOUTHERN REGION
HYDERABAD
AUGUST-2016

PLAN ON
ARTIFICIAL RECHARGE TO GROUNDWATER AND WATER CONSERVATION IN PENUMURU MANDAL, CHITTOOR DISTRICT, ANDHRA PRADESH

CONTENTS

AT A GLANCE

Name of the Mandal	PENUMURU
District	CHITTOOR
State	ANDHRA PRADESH
Total Area(sq. km)	135
Area suitable for Artificial Recharge (sq.km.)	130
Latitude and Longitude	13.260830 to 13.414120 and 79.093930 to 79.235300.
Average Annual Rainfall (mm)	843
Geology	BGC
Average Depth To Water Level (Decadal) (Pre Monsoon)	18.1
Average Depth To Water Level (Decadal) (Post Monsoon)	8.2
Ground Water Resources (2011)	
Annual Replenishable Ground Water Resources (MCM/yr)	18.42
Net Annual Ground Water Availability(MCM)/yr	16.58
Net Annual Ground Water Draft(MCM)/yr	19.18
Projected Demand for Domestic and Industrial Use(MCM)/yr	2.84
Stage of Ground Water Development (%)	116
Surface runoff available (MCM)/yr	24.55
Total Storage Created in the Mandal by Various Agencies (MCM)/yr	1.61
Artificial Recharge/Conservation Measures	
Recharge Structures Proposed (No.s)	Percolation Tanks: 0, Check Dams: 51 Farm ponds: 480, Recharge Shafts: 115
Improving Water use Efficiency	*Micro Irrigation System: 2400 ha*
Tentative Total Cost in Lakhs (Rs.)	2022.72
Expected Recharge/Savings (MCM)/yr	9.598

1. INTRODUCTION

Penumuru Mandal is one of over-exploited Mandal in Chittoor district, Andhra Pradesh State, which is economically backward and chronically drought affected. The Mandal has 16 inhabited villages, 1 uninhabited village and with 24 gram panchayats.

2. LOCATION

The Mandal lies between north latitudes 13.260830 to 13.414120 and between east longitudes 79.093930 to 79.235300.The Mandal occupies the Centre part of the Chittoor district and is bounded on the north by Chandragiri Mandal, on the east by Kuppam Mandal, on the south by Gangadhara Mandal and west by Puthalapattu Mandal. (Fig.1) The geographical area of the Mandal is 135 sq.km.

3. PHYSIOGRAPHY AND DRAINAGE:

The area is drained by streams which are tributaries of Palar River. The streams are mostly ephemeral in nature. The drainage pattern is dendritic, rectangular to sub rectangular due to the influence of geological structures. (Fig.2)

4. RAINFALL

The average rainfall in the Mandal is 843 mm. The rainfall during the South-west monsoon season i.e., June-September accounts for about 85% of the total rainfall.

5. LAND USE PATTERN

Out of the total geographical area of 135 sq.km, the area covered by forest is 12.95 sq.km and the net area sown is 48.23 sq.km. Barren and uncultivable land is 12.57 sq.km. The land for non agricultural use accounts for 17.01 sq.km. (Fig.3)

6. HYDROGEOLOGY

The area is underlain by granitic gneisses of Archaean age (Fig.4). Ground water occurs in weathered and fractured zones under water table and semi- confined conditions. The weathered zone thickness as per the GEC report is 9 m. The weathered zone has been extensively tapped by dug and dug cum bore wells upto 20 m depth, which are mostly dry now. Ground water occurs in the fractured granites up to 200 m bgl. However, the potential fractures are encountered between 50-100 m bgl. The cumulative yield varies from 2-5 lps.

7. GROUND WATER LEVEL SCENARIO

The depth to water level during the pre-monsoon and post-monsoon varies from 5 to 20 m. The average depth to water level (decadal) during pre and post monsoon is 18.1 and 8.2 m bgl respectively. The depth to water levels maps for pre and post monsoon period (2014) are shown in Fig 5 & 6 respectively. The decadal mean water level trend during post monsoon is depicted in the Fig.7.

8. DYNAMIC GROUND WATER RESOURCES

The Ground water availability, Utilization and stage of Development in Penumuru Mandal, Chittoor District is given in Table-1.

Table-1: Ground water resources of Penumuru Mandal, Chittoor district.

Annual Replenishable Ground water resources (MCM)	18.42
Net Annual Ground Water Availability(MCM)/yr	16.58
Net Annual Ground Water Draft(MCM)/yr	19.18
Projected Demand for Domestic and Industrial use up to 2025. (MCM)	2.84
Stage of Ground water development (%).	116
Whether notified or not with year of notification.	No

9. NEED FOR ARTIFICIAL RECHARGE AND CONSERVATION METHODS

The ground water withdrawal is more than the recharge with a stage of development above hundred percent. The long term water level trend mostly shows a declining trend and the water levels are very deep ranging upto20 m. The sustainability of bore wells has become questionable as many bore wells are either drying up or have recorded reduced yields. There is no surface water irrigation facility in the area. All these factors indicate that there is an urgent need for artificial recharge and water conservation in the Mandal.

10. JUSTIFICATION OF THE ARTIFICIAL RECHARGE PROJECT

Penumuru Mandal falls under high stage of ground water development i.e., 116 % and with sufficient amount of uncommitted surface runoff. The area is completely dependent on ground water for domestic, industrial and irrigation purposes. During the monsoons runoff quickly flows out of the area without natural recharge to ground water. It is necessary to apply artificial recharge techniques to allow more and more recharge through check dams, PTs, MPTs, farm ponds, recharge shafts to cope up with the withdrawal pattern and also to improve ground water situation through various interventions including on farm activities and micro irrigation systems (Sprinkler-Drip-HDPE).

11. AVAILABILITY OF SURPLUS, SURFACE WATER FOR ARTIFICIAL RECAHRGE OR CONSERVATION

The runoff was calculated by taking into account of normal rainfall of the mandal and corresponding runoff yield from Strangers table. The existing storage created by various artificial recharge structures constructed by the State Government, if any, was deducted for calculating the runoff yield to recommend new AR structures.

Total Geographical area (Sq.kms)	135
Hilly Area (Sq.kms)	5
Area suitable for Artificial Recharge (sq.km.)	130
Runoff Yield in MCM/yr.	24.55
Existing No. of Check Dams	71
Storage created MCM/yr.	0.503
Existing No. of Percolation Tanks	157
Storage created MCM/yr.	1.11
Total Existing Storage Created	1.61

12. FEASIBLE ARTIFICIAL RECHARGE STRUCTURES

Since the mandal is categorized as over exploited, there is an immediate need for improving ground water scenario and to ensure sustainability of ground water sources. It is also suggested to create additional storage capacity of surface water bodies which would result in supplementing irrigation thereby reducing the ground water draft. The run off available in the mandal has been assessed as 22.94 MCM/yr, which could be considered for further planning of artificial recharge. However, the number of artificial recharge structures feasible has been recommended in areas, by considering the utilizable yield, number of existing structures, land use, drainage pattern and also where the post monsoon water levels (decadal mean) are more than 5 m bgl., and or decadal trends are either falling or showing insignificant raising trend.

A) Check dams and Percolation Tanks

The area is covered by seasonal nalas – drains, which carry discharge during monsoon period debauched into the water bodies within a short duration. It is proposed to identify such nalas for construction of check dams/Percolation tank with recharge shafts, so as to harness ground water and to increase soil moisture content.

- The site selected for check dam/Percolation Tank should have sufficient thickness of permeable soils or weathered material to facilitate recharge of stored water within a short span of time. The water stored in these structures is mostly confined to the stream course and height is normally less than 2m.

- These are designed based on stream width and excess water is allowed to flow over the crest wall. In order to avoid scouring from excess runoff water cushions are provided on the downstream side. To harness maximum runoff in the stream, a series of such check dams can be constructed to have recharge on a regional scale.

- Considering the annual monsoon rainfall of 843 mm, sufficient rain water can be harnessed. This will improve ground water regime as well as delaying the instant flow into the main river.

- The flow in these seasonal rivers can be sustained up to about 2 to 3 months after monsoon.
- Recharge trenches can also be constructed along upstream side of the check dam/Percolation Tank in the impoundment area for enhancing the ground water recharge rate.

Thus, a total of 51 **Check dams** are recommended.

B). Recharge Shafts

The existing check dams and percolation tanks lose their storage capacity as well as recharge capacity due to siltation. Hence, Recharge shafts are recommended in the existing Check dams and Percolation tanks to enhance the ground water recharge. During the heavy downpours, there will be sufficient accumulation of runoff, which can also effectively be utilized for recharge by constructing recharge shafts. Hence, it is proposed to construct 36 and 79 recharge shafts of 165 mm dia with 30 m depth in the existing check dams and percolation tanks respectively.

C). Farm Ponds

A farm pond is a large dug out in the earth, usually square or rectangular in shape, which harvests rain water and stores it for future use. It has an inlet to regulate inflow and an outlet to discharge excess water. The pond is surrounded by a small bund, which prevents erosion on the banks of the pond. The size and depth depend on the amount of land available; the type of soil water from the farm pond is conveyed to the fields manually, by pumping, or by both methods.

Advantages of Farm Ponds

- They provide water to start growing crops, without waiting for rain to fall.
- They provide irrigation water during dry spells between rainfalls. This increases the yield, the number of crops in one year, and the diversity of crops that can be grown.
- Bunds can be used to raise vegetables and fruit trees, thus supplying the farm household with an additional source of income and of nutritious food.
- Farmers are able to apply adequate farm inputs and perform farming operations at the appropriate time, thus increasing their productivity and their confidence in farming.
- They check soil erosion and minimize siltation of waterways and reservoirs.
- They supplies water for domestic purposes and livestock.
- They promote fish rearing.
- They recharge the ground water.
- They improve drainage.

- The excavated earth has a very high value and can be used to enrich soil in the fields, levelling land, and constructing farm roads.

As per the Land use classification, majority of the area is covered by the agricultural field. Hence, it is proposed to construct480 farm ponds in 24 villages of the Mandal @ 20 farm ponds in each village.

D). Micro Irrigation System (Sprinkler /drip/HDPE pipes)

Micro irrigation is defined as the frequent application of small quantities of water directly above and below the soil surface; usually as discrete drops, continuous drops or tiny streams through emitters placed along a water delivery line. In flood/furrow irrigation method more than 50% of applied water is wasted through seepage to deeper level, localized inundation causes loss through evaporation and it leaches out the nutrients from the plant. While through drip & sprinkler irrigation wastages of irrigational water could be minimized. The studies on different crops, has revealed that irrigation water is saved drastically. The conveyance losses (mainly seepage & evaporation) can be saved up to 25 to 40% through utilization of HDPE pipes. Initially the scheme is proposed to be implemented in worst affected areas showing deepest water levels and significant declining trends. It is proposed to take up micro irrigation system in 2400 ha @ 100 ha per village.

13. TENTATIVE COST ESTIMATES (PENUMURU MANDAL)

S.No.	Feasible Artificial Recharge & Water Conservation structures/	No. of Structures/ Quantity	Total Volume (MCM)	Tentative unit cost (in Rs lakh)	Total tentative cost (in Rs Lakh)	Expected Annual GW recharge/savings (MCM)
1	Proposed Masonry Check dams Crest Length -10-15 m, Height-1-2 m) (0.007 MCM*4 fillings)	51	1.428	5	255	1.071
2	Recharge shaft in Check dam (50% of the existing Check dams)	36	0.396	0.5	18	0.396
3	Proposed Percolation Tanks (100*100*2.5)* 4 fillings)	0	0	15	0	0
4	Renovation Desilting, Repairs and installation of Recharge Shafts in existing PTS (50% of the existing PTS)	79	0.869	1	79	0.869
5	Proposed Farm Pond (6 filling) 5*5*1.5 dimension @ 20 farm ponds per each village	480	0.06912	0.25	120	0.062208
6	Proposed Sprinkler/drip/HDPE pipes for 100 ha in each village	2400	14.4	0.6	1440	7.2
7	Proposed Piezometers up to 50 mbgl @ one PZ per Village	24	0	0.6	14.4	0
8 (i)	Total (No. of AR Structures)	670	2.76		486.4	2.398
8 (ii)	Total (ha)	2400			1440	7.2
	Total (8(i) + 8 (ii))				**1926.4**	**9.598**
9	Impact Assessment & O & M -5 % of Total cost of the Scheme				**96.32**	
	Grand Total				**2022.72**	

*(Expected annual GW Recharge/Savings MCM - CDS& PTS: 75%, Farm ponds - 90%, Sprinklers-50%, Recharge shafts in existing CDS and PTS-100%)

Note: The type, number and cost of structure may vary according to site, after the ground truth verification.

14. TIME SCHEDULE

Steps	Quarters							
	1st	2nd	3rd	4th	5th	6th	7th	8th
Identification of line department/implementing agency and preparation of DPR								
Approval of Scheme and releases of sanction of funds								
Implementation of ARS								

Phase = one quarter or 3 months or equivalent to financial quarter

A). Operation and Maintenance

In all projects impact assessment has to be carried out to ensure that project is economically viable, socially equitable and environmentally sustainable by inter-related socio-economic, cultural and human-health impacts, both beneficial and adverse. Accordingly it is proposed to have impact assessment as well as operation & Maintenance at the rate of 5% of the total cost of the project for 5 years from the completion of artificial recharge project.

B). Expected Benefits

The benefits of the project are:

1. The implementation of the project would result in additional recharge/Ground water savings to the tune of 9.598 MCM.
2. Ground water recharge will help in arresting the rapid decline in ground water resources and will also ensure improvement in quality of ground water by dilution.
3. Proposed structures and measures will also enhance the ground water potential and would ensure sustainability of ground water resources. It is estimated that the stage of ground water development may likely to be reduced from the present 116% to 73% (43%)
4. It will also help in controlling soil erosion.

Acknowledgements

The data received from the Director Ground Water Department Andhra Pradesh in respect of the basic inputs is duly acknowledged. The information on existing Artificial Recharge Structures have been taken from the EMUSTER, Department of Rural Development, Government of AP.

EXISTING ARTIFICIAL RECHARGE STRUCTURES
PENUMURU MANDAL, CHITTOOR DISTRICT, AP.

S.no	Gram Panchayat	Habitation	Structure Type	Longitude	Latitude	Scheme
1	C.r.khandriga	C.R.Khandriga	Check Dam	79.1564	13.3423	NREGS
2	Mopireddipalle	KondamaAgraharam	Check Dam	79.1881	13.3303	NREGS
3	Mopireddipalle	KondamaAgraharam	Check Dam	79.1881	13.3269	NREGS
4	Nanjarapalle	Kondaiahgaripalle	Check Dam	79.1396	13.3169	NREGS
5	L.k.p.vuru	Lankipalle	Check Dam	79.1435	13.3217	NREGS
6	L.k.p.vuru	Lankipalle	Check Dam	79.1436	13.3205	NREGS
7	L.k.p.vuru	Lankipalle	Check Dam	79.1434	13.3188	NREGS
8	L.k.p.vuru	Lankipalle	Check Dam	79.1489	13.3214	NREGS
9	L.k.p.vuru	Parrasuramakhandriga	Check Dam	79.1413	13.3171	NREGS
10	Guthavandlavuru	K.P.Vaddagudisalu	Check Dam	79.1570	13.3010	NREGS
11	Guthavandlavuru	K.P.Vaddagudisalu	Check Dam	79.1536	13.2942	NREGS
12	Kathireddipalle	E.Gagammagaripalle	Check Dam	79.1691	13.3821	NREGS
13	Kathireddipalle	Kathireddipalle	Check Dam	79.1634	13.3545	NREGS
14	Kavurivaripalle	C.Kavurivaripalle	Check Dam	79.1909	13.3423	NREGS
15	Kavurivaripalle	Somanadhapuram	Check Dam	79.1914	13.3427	NREGS
16	Kavurivaripalle	Somanadhapuram	Check Dam	79.1906	13.3417	NREGS
17	Kaligiri	Gollapalle	Check Dam	79.1360	13.3188	NREGS
18	Kaligiri	Muravakandriga	Check Dam	79.1313	13.3135	NREGS
19	Kaligiri	Peddakaligiri	Check Dam	79.1253	13.3089	NREGS
20	Kalvagunta	Kalvagunta H.W	Check Dam	79.1336	13.2852	NREGS
21	Gangupalle	Sanyasipalle	Check Dam	79.1471	13.2795	NREGS
22	Thatimakulapalle	Erramatipalle	Check Dam	79.1966	13.3658	NREGS
23	Thatimakulapalle	Thatimakulapalle	Check Dam	79.2144	13.3536	NREGS
24	Chipparapalle	Chipparapalle	Check Dam	79.2043	13.3888	NREGS
25	Chipparapalle	Gunturvandlavuru	Check Dam	79.2017	13.3875	NREGS
26	Sathambakam	Chinnarajupalle	Check Dam	79.1705	13.2948	NREGS
27	Pulikallu	Cherlopalle	Check Dam	79.2021	13.3166	NREGS
28	Pulikallu	Cherlopalle	Check Dam	79.2002	13.3138	NREGS
29	Pulikallu	Cherlopalle	Check Dam	79.2063	13.3181	NREGS
30	Pulikallu	Cherlopalle	Check Dam	79.2019	13.3182	NREGS
31	Pulikallu	Cherlopalle	Check Dam	79.1988	13.3147	NREGS
32	K.c.palle	Ontillu	Check Dam	79.2436	13.3714	NREGS
33	Guntipalle	Kanikapuram	Check Dam	79.2029	13.3342	NREGS
34	Guntipalle	Ramanandapuram	Check Dam	79.2116	13.3356	NREGS
35	Samireddipalle	MonabotupalleAaw	Check Dam	79.1790	13.3284	NREGS
36	Samireddipalle	Yanadhicolony	Check Dam	79.1665	13.3168	NREGS
37	Samireddipalle	Yanadhicolony	Check Dam	79.1656	13.3122	NREGS
38	C.r.khandriga	C.R.Khandriga	Check Dam	79.1564	13.3423	IWMP
39	Mopireddipalle	KondamaAgraharam	Check Dam	79.1881	13.3303	IWMP
40	Mopireddipalle	KondamaAgraharam	Check Dam	79.1881	13.3269	IWMP
41	Guthavandlavuru	K.P.Vaddagudisalu	Check Dam	79.1570	13.3010	IWMP
42	Guthavandlavuru	K.P.Vaddagudisalu	Check Dam	79.1536	13.2942	IWMP

43	Kathireddipalle	E.Gagammagaripalle	Check Dam	79.1691	13.3821	IWMP
44	Kathireddipalle	Kathireddipalle	Check Dam	79.1634	13.3545	IWMP
45	Kavurivaripalle	C.Kavurivaripalle	Check Dam	79.1909	13.3423	IWMP
46	Kavurivaripalle	Somanadhapuram	Check Dam	79.1914	13.3427	IWMP
47	Kavurivaripalle	Somanadhapuram	Check Dam	79.1906	13.3417	IWMP
48	Gangupalle	Sanyasipalle	Check Dam	79.1471	13.2795	IWMP
49	Thatimakulapalle	Thatimakulapalle	Check Dam	79.2144	13.3536	IWMP
50	Chipparapalle	Chipparapalle	Check Dam	79.2043	13.3888	IWMP
51	Chipparapalle	Gunturvandlavuru	Check Dam	79.2017	13.3875	IWMP
52	Sathambakam	Chinnarajupalle	Check Dam	79.1705	13.2948	IWMP
53	Pulikallu	Cherlopalle	Check Dam	79.2021	13.3166	IWMP
54	Pulikallu	Cherlopalle	Check Dam	79.2002	13.3138	IWMP
55	Pulikallu	Cherlopalle	Check Dam	79.2063	13.3181	IWMP
56	Pulikallu	Cherlopalle	Check Dam	79.2019	13.3182	IWMP
57	Pulikallu	Cherlopalle	Check Dam	79.1988	13.3147	IWMP
58	K.c.palle	Ontillu	Check Dam	79.2436	13.3714	IWMP
59	Guntipalle	Kanikapuram	Check Dam	79.2029	13.3342	IWMP
60	Guntipalle	Ramanandapuram	Check Dam	79.2116	13.3356	IWMP
61	Samireddipalle	MonabotupalleAaw	Check Dam	79.1790	13.3284	IWMP
62	Samireddipalle	Yanadhicolony	Check Dam	79.1665	13.3168	IWMP
63	Samireddipalle	Yanadhicolony	Check Dam	79.1656	13.3122	IWMP
64	Penumuru	Guttakinda H.W	Check Wall	79.1832	13.3584	NREGS
65	Pulikallu	Pulikallu	Check Wall	79.1906	13.3133	NREGS
66	Samireddipalle	Samireddipalle	Check Wall	79.1763	13.3236	NREGS
67	Samireddipalle	Samireddipalle	Check Wall	79.1772	13.3222	NREGS
68	Penumuru	Guttakinda H.W	Check Wall	79.1832	13.3584	IWMP
69	Pulikallu	Pulikallu	Check Wall	79.1906	13.3133	IWMP
70	Samireddipalle	Samireddipalle	Check Wall	79.1763	13.3236	IWMP
71	Samireddipalle	Samireddipalle	Check Wall	79.1772	13.3222	IWMP
72	C.r.khandriga	BandameedavuruAaw	MPT	79.1534	13.3259	NREGS
73	C.r.khandriga	C.R.Khandriga	MPT	79.1521	13.3239	NREGS
74	Gudyanampalle	Gudyanampalle	MPT	79.2228	13.3362	NREGS
75	Gudyanampalle	Gudyanampalle	MPT	79.2163	13.3378	NREGS
76	Gudyanampalle	Gudyanampalle H.W	MPT	79.2272	13.3417	NREGS
77	Gudyanampalle	Gudyanampalle H.W	MPT	79.2297	13.3431	NREGS
78	Gudyanampalle	Gudyanampalle H.W	MPT	79.2256	13.3406	NREGS
79	Gudyanampalle	Gudyanampalle H.W	MPT	79.2304	13.3425	NREGS
80	Gudyanampalle	KotarlaPalle	MPT	79.2227	13.3508	NREGS
81	Nanjarapalle	Kondaiahgaripalle	MPT	79.1393	13.3101	NREGS
82	Nanjarapalle	Matampalle Part	MPT	79.1410	13.3054	NREGS
83	Nanjarapalle	Matampalle Part	MPT	79.1400	13.3046	NREGS
84	Nanjarapalle	Nanjarapalle	MPT	79.1392	13.2967	NREGS
85	Penumuru	Guttakinda H.W	MPT	79.1912	13.3719	NREGS
86	Penumuru	Guttakinda H.W	MPT	79.1916	13.3716	NREGS
87	Penumuru	Guttakinda H.W	MPT	79.1825	13.3560	NREGS

88	L.k.p.vuru	Jangamaiahvuru	MPT	79.1439	13.3148	NREGS
89	L.k.p.vuru	Kalikirivandlavuru	MPT	79.1427	13.3386	NREGS
90	L.k.p.vuru	Kalikirivandlavuru	MPT	79.1415	13.3360	NREGS
91	L.k.p.vuru	Parrasuramakhandriga	MPT	79.1444	13.3155	NREGS
92	Thirivireddipalle	Thirivireddipalle	MPT	79.2137	13.3695	NREGS
93	Guthavandlavuru	Jalakantapuram	MPT	79.1518	13.3007	NREGS
94	Kathireddipalle	E.Gagammagaripalle	MPT	79.1712	13.3782	NREGS
95	Kathireddipalle	Kathireddipalle	MPT	79.1672	13.3516	NREGS
96	Kavurivaripalle	C.Kavurivaripalle	MPT	79.1985	13.3301	NREGS
97	Kavurivaripalle	C.Kavurivaripalle	MPT	79.2013	13.3310	NREGS
98	Kavurivaripalle	Sanyasipalle	MPT	79.1952	13.3341	NREGS
99	Kaligiri	Gollapalle	MPT	79.1333	13.3301	NREGS
100	Kaligiri	KaligiriThupalle	MPT	79.1319	13.3065	NREGS
101	Kaligiri	Muravakandriga	MPT	79.1302	13.3158	NREGS
102	Kalvagunta	DiguvaPunepalle H.W	MPT	79.1318	13.2759	NREGS
103	Gangupalle	Bhaskarapuram	MPT	79.1553	13.2773	NREGS
104	Gangupalle	Sanyasipalle	MPT	79.1405	13.2861	NREGS
105	Thatimakulapalle	Vididhipalle	MPT	79.2242	13.3596	NREGS
106	Sathambakam	Krishnapuram	MPT	79.1861	13.2873	NREGS
107	Sathambakam	Thokalachenu	MPT	79.1824	13.2920	NREGS
108	Pulikallu	Elumgundlapalle	MPT	79.2145	13.3200	NREGS
109	Pulikallu	Godugumanipalle H.W	MPT	79.2188	13.3341	NREGS
110	Pulikallu	YanadiIndlu	MPT	79.2039	13.3138	NREGS
111	K.c.palle	Gollapalle H.W	MPT	79.2220	13.3800	NREGS
112	K.c.palle	K.C.Palle H.W	MPT	79.2370	13.3750	NREGS
113	K.c.palle	KambaleChenu	MPT	79.2327	13.3869	NREGS
114	K.c.palle	Puttaganipalle	MPT	79.2291	13.3912	NREGS
115	K.c.palle	Puttaganipalle	MPT	79.2281	13.3924	NREGS
116	K.c.palle	Puttaganipalle	MPT	79.2273	13.3851	NREGS
117	Guntipalle	Guntipalle	MPT	79.2045	13.3418	NREGS
118	Guntipalle	Ramanandapuram	MPT	79.2108	13.3343	NREGS
119	Samireddipalle	Gollapalle	MPT	79.1792	13.3215	NREGS
120	C.r.khandriga	BandameedavuruAaw	MPT	79.1534	13.3259	IWMP
121	C.r.khandriga	C.R.Khandriga	MPT	79.1521	13.3239	IWMP
122	Gudyanampalle	Gudyanampalle	MPT	79.2228	13.3362	IWMP
123	Gudyanampalle	Gudyanampalle	MPT	79.2163	13.3378	IWMP
124	Gudyanampalle	Gudyanampalle H.W	MPT	79.2272	13.3417	IWMP
125	Gudyanampalle	Gudyanampalle H.W	MPT	79.2297	13.3431	IWMP
126	Gudyanampalle	Gudyanampalle H.W	MPT	79.2256	13.3406	IWMP
127	Gudyanampalle	Gudyanampalle H.W	MPT	79.2304	13.3425	IWMP
128	Gudyanampalle	KotarlaPalle	MPT	79.2227	13.3508	IWMP
129	Penumuru	Guttakinda H.W	MPT	79.1912	13.3719	IWMP
130	Penumuru	Guttakinda H.W	MPT	79.1916	13.3716	IWMP
131	Penumuru	Guttakinda H.W	MPT	79.1825	13.3560	IWMP
132	Thirivireddipalle	Thirivireddipalle	MPT	79.2137	13.3695	IWMP

133	Guthavandlavuru	Jalakantapuram	MPT	79.1518	13.3007	IWMP
134	Kathireddipalle	E.Gagammagaripalle	MPT	79.1712	13.3782	IWMP
135	Kathireddipalle	Kathireddipalle	MPT	79.1672	13.3516	IWMP
136	Kavurivaripalle	C.Kavurivaripalle	MPT	79.1985	13.3301	IWMP
137	Kavurivaripalle	C.Kavurivaripalle	MPT	79.2013	13.3310	IWMP
138	Kavurivaripalle	Sanyasipalle	MPT	79.1952	13.3341	IWMP
139	Gangupalle	Bhaskarapuram	MPT	79.1553	13.2773	IWMP
140	Gangupalle	Sanyasipalle	MPT	79.1405	13.2861	IWMP
141	Thatimakulapalle	Vididhipalle	MPT	79.2242	13.3596	IWMP
142	Sathambakam	Krishnapuram	MPT	79.1861	13.2873	IWMP
143	Sathambakam	Thokalachenu	MPT	79.1824	13.2920	IWMP
144	Pulikallu	Elumgundlapalle	MPT	79.2145	13.3200	IWMP
145	Pulikallu	Godugumanipalle H.W	MPT	79.2188	13.3341	IWMP
146	Pulikallu	YanadiIndlu	MPT	79.2039	13.3138	IWMP
147	K.c.palle	Gollapalle H.W	MPT	79.2220	13.3800	IWMP
148	K.c.palle	K.C.Palle H.W	MPT	79.2370	13.3750	IWMP
149	K.c.palle	KambaleChenu	MPT	79.2327	13.3869	IWMP
150	K.c.palle	Puttaganipalle	MPT	79.2291	13.3912	IWMP
151	K.c.palle	Puttaganipalle	MPT	79.2281	13.3924	IWMP
152	K.c.palle	Puttaganipalle	MPT	79.2273	13.3851	IWMP
153	Guntipalle	Guntipalle	MPT	79.2045	13.3418	IWMP
154	Guntipalle	Ramanandapuram	MPT	79.2108	13.3343	IWMP
155	Samireddipalle	Gollapalle	MPT	79.1792	13.3215	IWMP
156	Gudyanampalle	Gudyanampalle	PT	79.2217	13.3415	NREGS
157	Gudyanampalle	K.Kandriga	PT	79.2266	13.3467	NREGS
158	Gudyanampalle	KotarlaPalle	PT	79.2221	13.3509	NREGS
159	Nanjarapalle	Kondaiahgaripalle	PT	79.1393	13.3121	NREGS
160	Nanjarapalle	Matampalle Part	PT	79.1377	13.2957	NREGS
161	Nanjarapalle	Matampalle Part	PT	79.1402	13.3005	NREGS
162	Nanjarapalle	Nanjarapalle	PT	79.1313	13.2989	NREGS
163	Penumuru	Guttakinda H.W	PT	79.1814	13.3605	NREGS
164	L.k.p.vuru	Lankipalle	PT	79.1459	13.3202	NREGS
165	L.k.p.vuru	Parrasuramakhandriga	PT	79.1458	13.3142	NREGS
166	L.k.p.vuru	Parrasuramakhandriga	PT	79.1464	13.3132	NREGS
167	Thirivireddipalle	Arivandlavuru	PT	79.2150	13.3752	NREGS
168	Thirivireddipalle	Sangeethagopannapall	PT	79.2045	13.3822	NREGS
169	Thirivireddipalle	Thirivireddipalle H.	PT	79.2074	13.3673	NREGS
170	Thirivireddipalle	Vadlavanimitta	PT	79.2099	13.3746	NREGS
171	Guthavandlavuru	Guthavandlavuru	PT	79.1450	13.2945	NREGS
172	Guthavandlavuru	Guthavandlavuru	PT	79.1463	13.3016	NREGS
173	Guthavandlavuru	Guthavandlavuru	PT	79.1463	13.3058	NREGS
174	Guthavandlavuru	K.P.Vaddagudisalu	PT	79.1630	13.3068	NREGS
175	Kaligiri	Ellampalle	PT	79.1253	13.3174	NREGS
176	Kaligiri	Ellampalle	PT	79.1267	13.3187	NREGS
177	Kaligiri	Ellampalle	PT	79.1231	13.3196	NREGS

178	Kaligiri	Gollapalle	PT	79.1312	13.3201	NREGS
179	Kaligiri	Obaiahgaripalle	PT	79.1334	13.3083	NREGS
180	Kalvagunta	Kalvagunta H.W	PT	79.1341	13.2767	NREGS
181	Gangupalle	Sanyasipalle	PT	79.1466	13.2784	NREGS
182	Chipparapalle	Gobbillamitta	PT	79.1945	13.3825	NREGS
183	Chipparapalle	Gunturvandlavuru	PT	79.2008	13.3923	NREGS
184	Chipparapalle	Palemkothuru	PT	79.1984	13.3908	NREGS
185	Sathambakam	Chinnarajupalle	PT	79.1736	13.2924	NREGS
186	Sathambakam	Chinnarajupalle	PT	79.1727	13.2953	NREGS
187	Pulikallu	YanadiIndlu	PT	79.2032	13.3104	NREGS
188	K.c.palle	Gollapalle H.W	PT	79.2186	13.3778	NREGS
189	K.c.palle	Gollapalle H.W	PT	79.2198	13.3795	NREGS
190	K.c.palle	Gollapalle H.W	PT	79.2181	13.3802	NREGS
191	K.c.palle	Guthavandlavuru	PT	79.2297	13.3830	NREGS
192	K.c.palle	Jettivanioddu	PT	79.2249	13.3986	NREGS
193	K.c.palle	Puttaganipalle	PT	79.2277	13.3849	NREGS
194	K.c.palle	Uppilepalle	PT	79.2410	13.3733	NREGS
195	Guntipalle	Guntipalle	PT	79.2105	13.3393	NREGS
196	Guntipalle	Kanikapuram	PT	79.2045	13.3325	NREGS
197	Samireddipalle	Battuvarripalle H.W	PT	79.1835	13.3215	NREGS
198	Samireddipalle	Yanadhicolony	PT	79.1654	13.3179	NREGS
199	Gudyanampalle	Gudyanampalle	PT	79.2217	13.3415	IWMP
200	Gudyanampalle	K.Kandriga	PT	79.2266	13.3467	IWMP
201	Gudyanampalle	KotarlaPalle	PT	79.2221	13.3509	IWMP
202	Penumuru	Guttakinda H.W	PT	79.1814	13.3605	IWMP
203	Thirivireddipalle	Arivandlavuru	PT	79.2150	13.3752	IWMP
204	Thirivireddipalle	Sangeethagopannapall	PT	79.2045	13.3822	IWMP
205	Thirivireddipalle	Thirivireddipalle H.	PT	79.2074	13.3673	IWMP
206	Thirivireddipalle	Vadlavanimitta	PT	79.2099	13.3746	IWMP
207	Guthavandlavuru	Guthavandlavuru	PT	79.1450	13.2945	IWMP
208	Guthavandlavuru	Guthavandlavuru	PT	79.1463	13.3016	IWMP
209	Guthavandlavuru	Guthavandlavuru	PT	79.1463	13.3058	IWMP
210	Guthavandlavuru	K.P.Vaddagudisalu	PT	79.1630	13.3068	IWMP
211	Gangupalle	Sanyasipalle	PT	79.1466	13.2784	IWMP
212	Chipparapalle	Gobbillamitta	PT	79.1945	13.3825	IWMP
213	Chipparapalle	Gunturvandlavuru	PT	79.2008	13.3923	IWMP
214	Chipparapalle	Palemkothuru	PT	79.1984	13.3908	IWMP
215	Sathambakam	Chinnarajupalle	PT	79.1736	13.2924	IWMP
216	Sathambakam	Chinnarajupalle	PT	79.1727	13.2953	IWMP
217	Pulikallu	YanadiIndlu	PT	79.2032	13.3104	IWMP
218	K.c.palle	Gollapalle H.W	PT	79.2186	13.3778	IWMP
219	K.c.palle	Gollapalle H.W	PT	79.2198	13.3795	IWMP
220	K.c.palle	Gollapalle H.W	PT	79.2181	13.3802	IWMP
221	K.c.palle	Guthavandlavuru	PT	79.2297	13.3830	IWMP
222	K.c.palle	Jettivanioddu	PT	79.2249	13.3986	IWMP

223	K.c.palle	Puttaganipalle	PT	79.2277	13.3849	IWMP
224	K.c.palle	Uppilepalle	PT	79.2410	13.3733	IWMP
225	Guntipalle	Guntipalle	PT	79.2105	13.3393	IWMP
226	Guntipalle	Kanikapuram	PT	79.2045	13.3325	IWMP
227	Samireddipalle	Battuvarripalle H.W	PT	79.1835	13.3215	IWMP
228	Samireddipalle	Yanadhicolony	PT	79.1654	13.3179	IWMP

PROPOSED ARTIFICIAL RECHARGE STRUCTURES
PENUMURU MANDAL, CHITTOOR DISTRICT, AP.

S.No.	Mandal	Lattitude	Longitude	Structure_Type
1	Penumuru	13.3293	79.1388	Check Dam
2	Penumuru	13.3127	79.1225	Check Dam
3	Penumuru	13.2986	79.1235	Check Dam
4	Penumuru	13.3074	79.1274	Check Dam
5	Penumuru	13.3100	79.1570	Check Dam
6	Penumuru	13.3128	79.1712	Check Dam
7	Penumuru	13.2984	79.1760	Check Dam
8	Penumuru	13.3241	79.1898	Check Dam
9	Penumuru	13.3228	79.1995	Check Dam
10	Penumuru	13.3368	79.1459	Check Dam
11	Penumuru	13.3412	79.1384	Check Dam
12	Penumuru	13.3401	79.1574	Check Dam
13	Penumuru	13.3423	79.1647	Check Dam
14	Penumuru	13.3251	79.1413	Check Dam
15	Penumuru	13.3297	79.1303	Check Dam
16	Penumuru	13.3715	79.1582	Check Dam
17	Penumuru	13.3674	79.1545	Check Dam
18	Penumuru	13.3573	79.1532	Check Dam
19	Penumuru	13.3498	79.1659	Check Dam
20	Penumuru	13.3582	79.1674	Check Dam
21	Penumuru	13.3603	79.1662	Check Dam
22	Penumuru	13.3445	79.1796	Check Dam
23	Penumuru	13.3353	79.1806	Check Dam
24	Penumuru	13.3322	79.1817	Check Dam
25	Penumuru	13.3272	79.1839	Check Dam
26	Penumuru	13.3335	79.1860	Check Dam
27	Penumuru	13.3336	79.1904	Check Dam
28	Penumuru	13.3457	79.1849	Check Dam
29	Penumuru	13.3392	79.1529	Check Dam
30	Penumuru	13.3541	79.1817	Check Dam
31	Penumuru	13.3597	79.1742	Check Dam
32	Penumuru	13.3545	79.1769	Check Dam
33	Penumuru	13.3482	79.2055	Check Dam
34	Penumuru	13.3472	79.1948	Check Dam
35	Penumuru	13.3236	79.2154	Check Dam
36	Penumuru	13.3623	79.2426	Check Dam
37	Penumuru	13.3626	79.2197	Check Dam
38	Penumuru	13.3920	79.1931	Check Dam
39	Penumuru	13.3704	79.2482	Check Dam
40	Penumuru	13.3739	79.2467	Check Dam
41	Penumuru	13.3435	79.1655	Check Dam
42	Penumuru	13.3602	79.2104	Check Dam

43	Penumuru	13.3478	79.2088	Check Dam
44	Penumuru	13.3721	79.1734	Check Dam
45	Penumuru	13.3721	79.1832	Check Dam
46	Penumuru	13.3540	79.2378	Check Dam
47	Penumuru	13.3606	79.2392	Check Dam
48	Penumuru	13.3511	79.1571	Check Dam
49	Penumuru	13.3857	79.1729	Check Dam
50	Penumuru	13.3893	79.1697	Check Dam
51	Penumuru	13.3547	79.1834	Check Dam

Fig.1

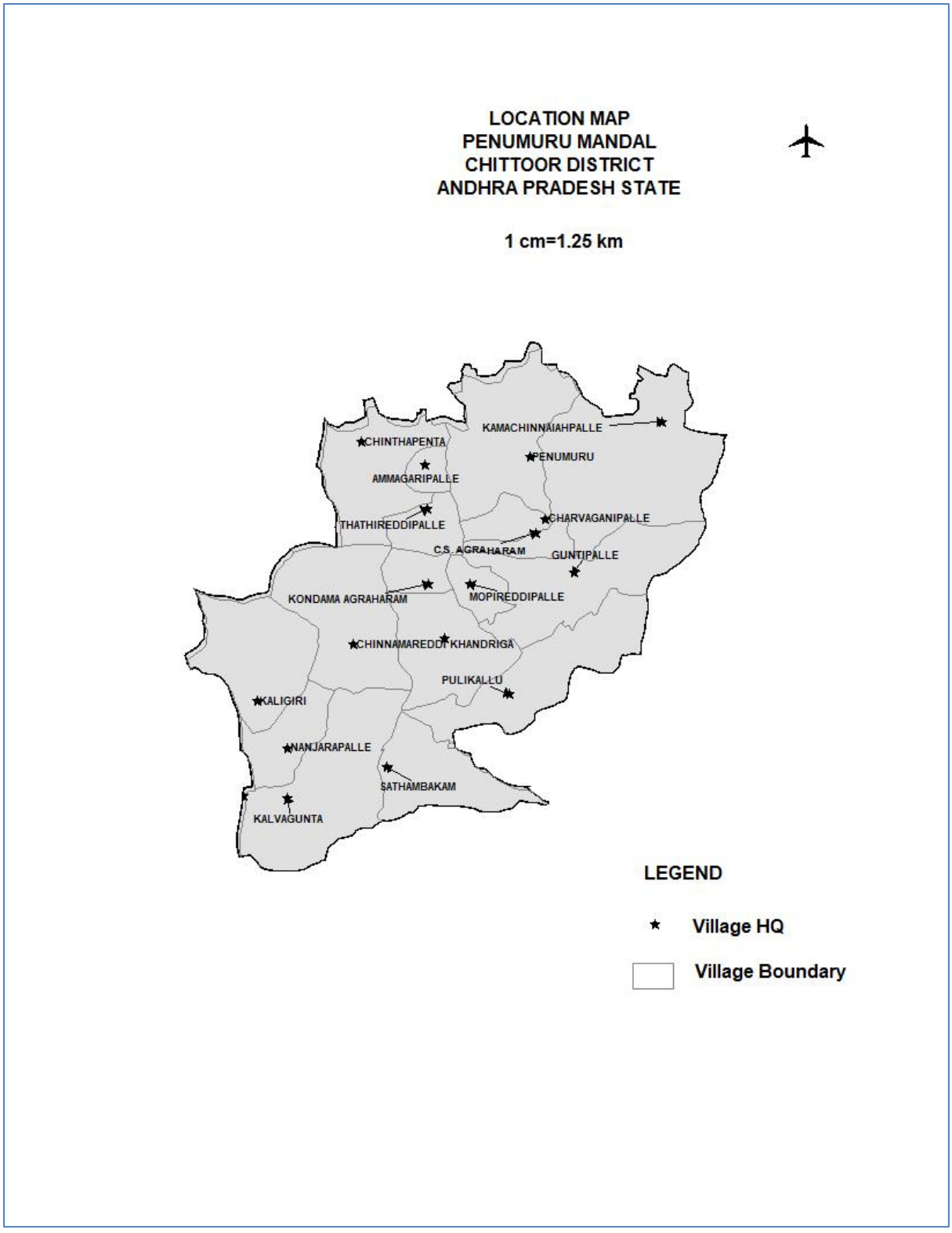

LOCATION MAP
PENUMURU MANDAL
CHITTOOR DISTRICT
ANDHRA PRADESH STATE
1 cm=1.25 km
KAMACHINNAIAHPALLE
CHINTHAPENTA
PENUMURU
AMMAGARIPALLE
THATHIREDDIPALLE
CHARVAGANIPALLE
C.S. AGRAHARAM
GUNTIPALLE
KONDAMA AGRAHARAM
MOPIREDDIPALLE
CHINNAMAREDDI KHANDRIGA
PULIKALLU
KALIGIRI
NANJARAPALLE
SATHAMBAKAM
KALVAGUNTA
LEGEND
Village HQ
Village Boundary

Fig.2

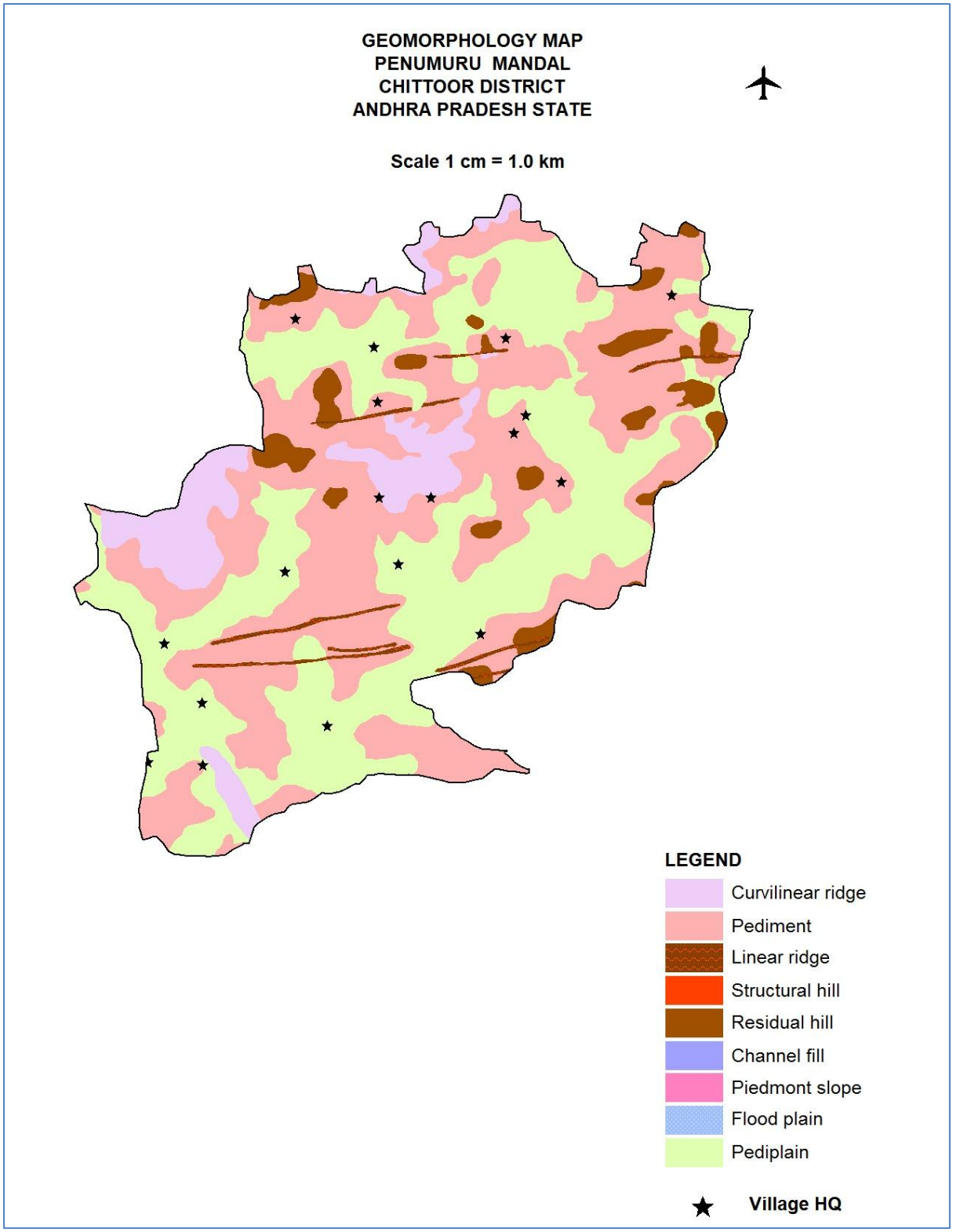

GEOMORPHOLOGY MAP
PENUMURU MANDAL
CHITTOOR DISTRICT
ANDHRA PRADESH STATE
Scale 1 cm = 1.0 km
LEGEND
Curvilinear ridge
Pediment
Linear ridge
Structural hill
Residual hill
Channel fill
Piedmont slope
Flood plain
Pediplain
Village HQ

Fig.3

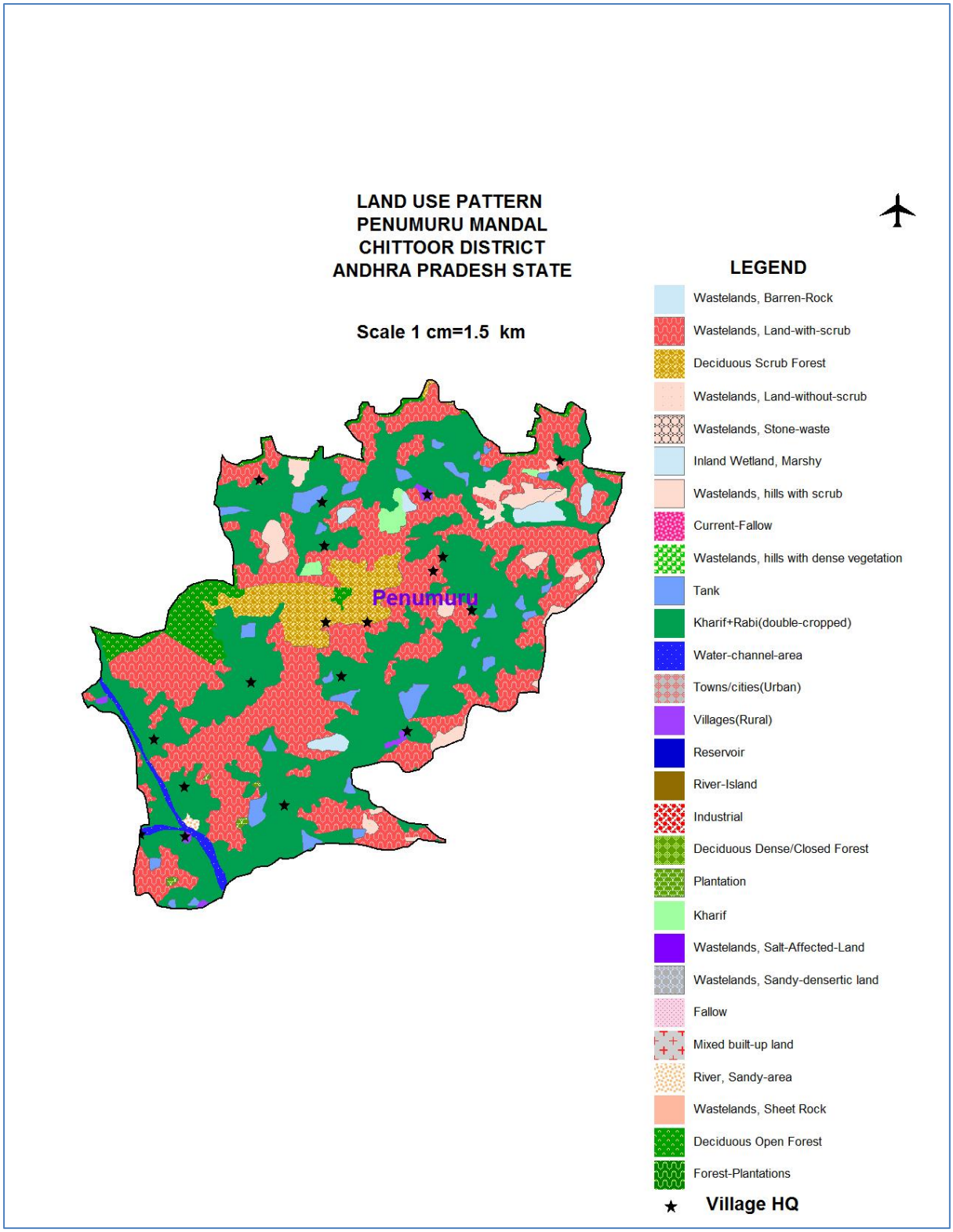

LAND USE PATTERN
PENUMURU MANDAL
CHITTOOR DISTRICT
ANDHRA PRADESH STATE
Scale 1 cm=1.5 km
Penumuru
LEGEND
Wastelands, Barren-Rock
Wastelands, Land-with-scrub
Deciduous Scrub Forest
Wastelands, Land-without-scrub
Wastelands, Stone-waste
Inland Wetland, Marshy
Wastelands, hills with scrub
Current-Fallow
Wastelands, hills with dense vegetation
Tank
Kharif+Rabi(double-cropped)
Water-channel-area
Towns/cities(Urban)
Villages(Rural)
Reservoir
River-Island
Industrial
Deciduous Dense/Closed Forest
Plantation
Kharif
Wastelands, Salt-Affected-Land
Wastelands, Sandy-densertic land
Fallow
Mixed built-up land
River, Sandy-area
Wastelands, Sheet Rock
Deciduous Open Forest
Forest-Plantations
Village HQ

Fig.4

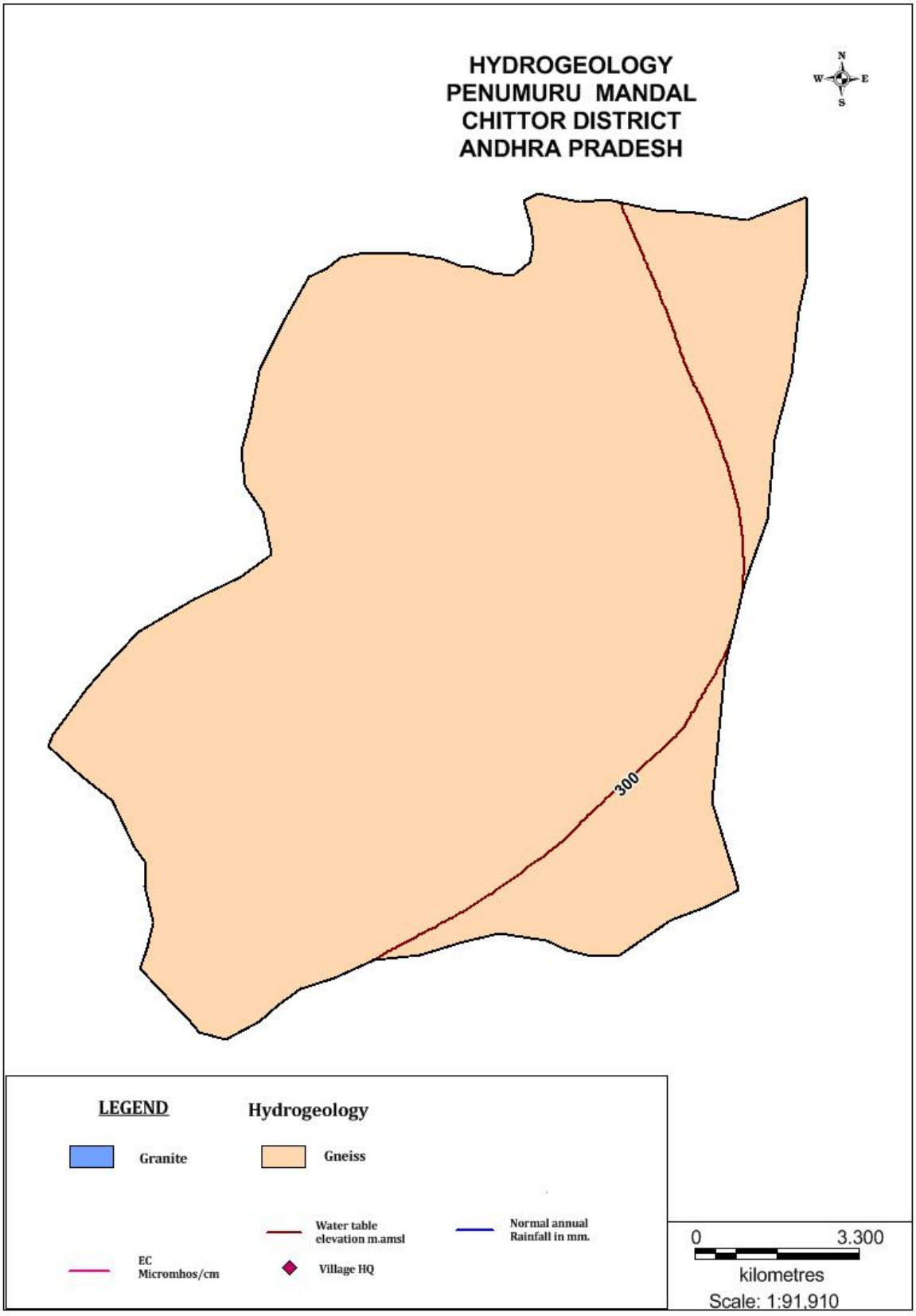

HYDROGEOLOGY
PENUMURU MANDAL
CHITTOR DISTRICT
ANDHRA PRADESH
N
W
E
S
300
LEGEND
Hydrogeology
Granite
Gneiss
Water table elevation m.amsl
Normal annual Rainfall in mm.
EC Micromhos/cm
Village HQ
0
3.300
kilometres
Scale: 1:91,910

Fig.5

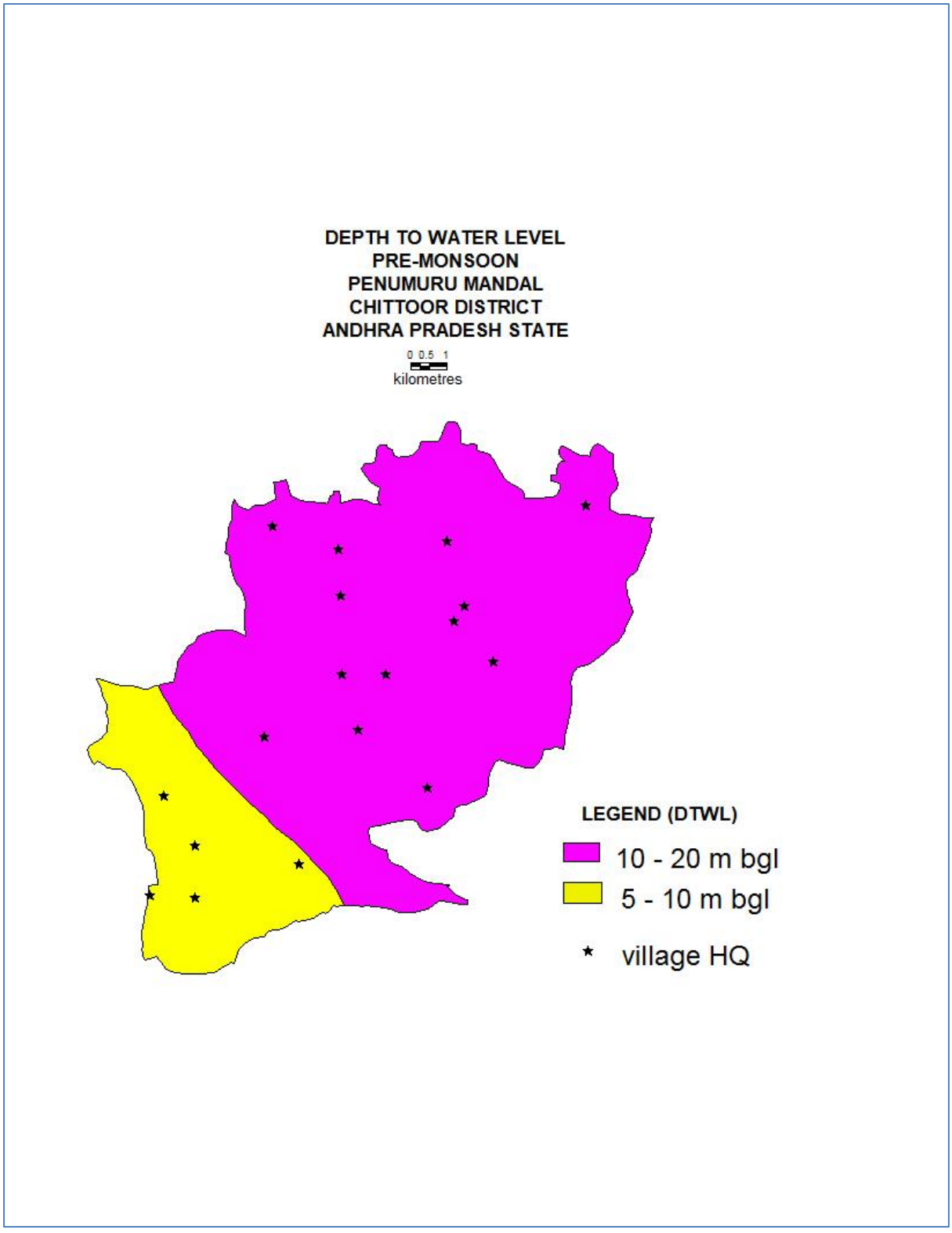

DEPTH TO WATER LEVEL
PRE-MONSOON
PENUMURU MANDAL
CHITTOOR DISTRICT
ANDHRA PRADESH STATE
0 0.5 1
kilometres
LEGEND (DTWL)
10 - 20 m bgl
5 - 10 m bgl
village HQ

Fig.6

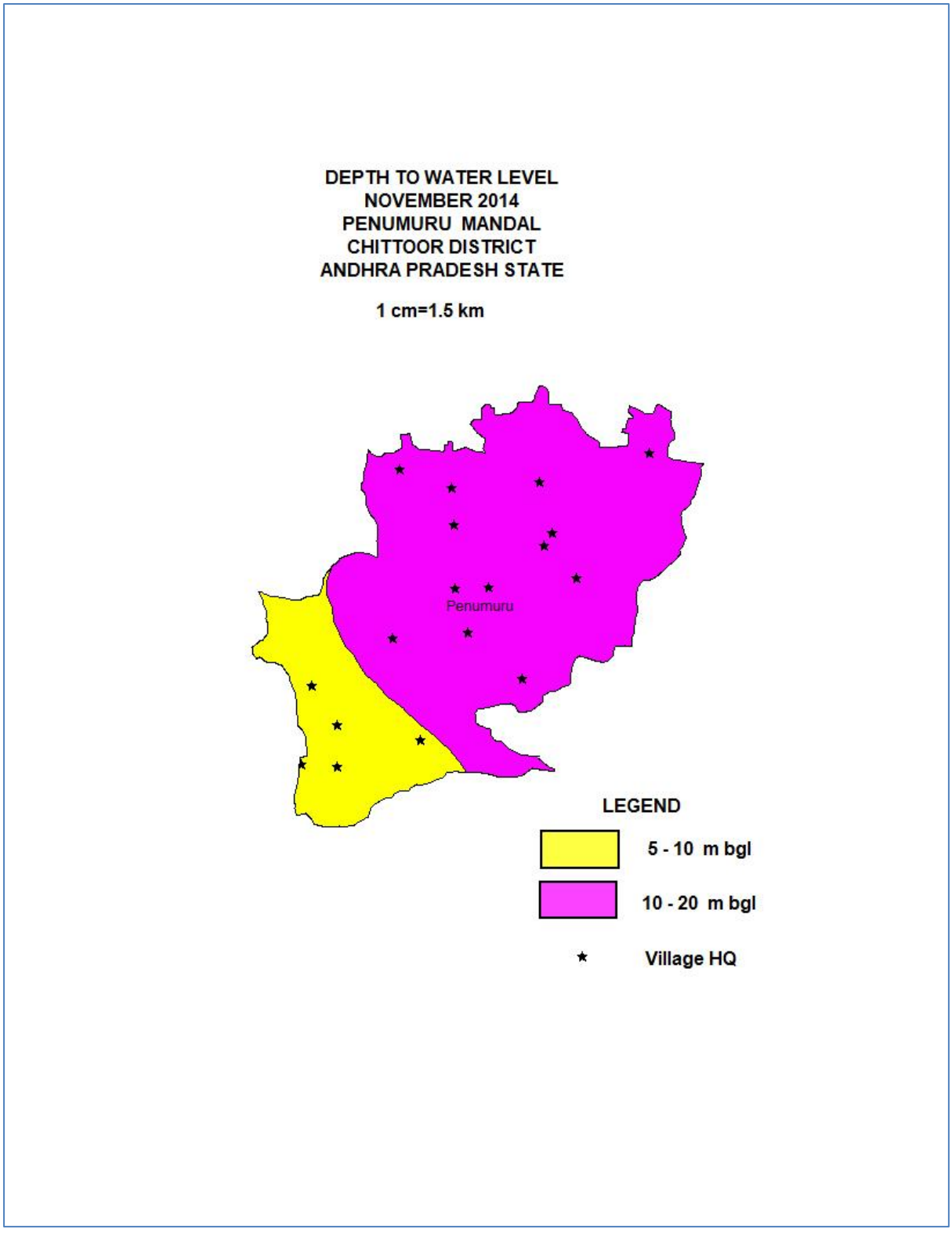
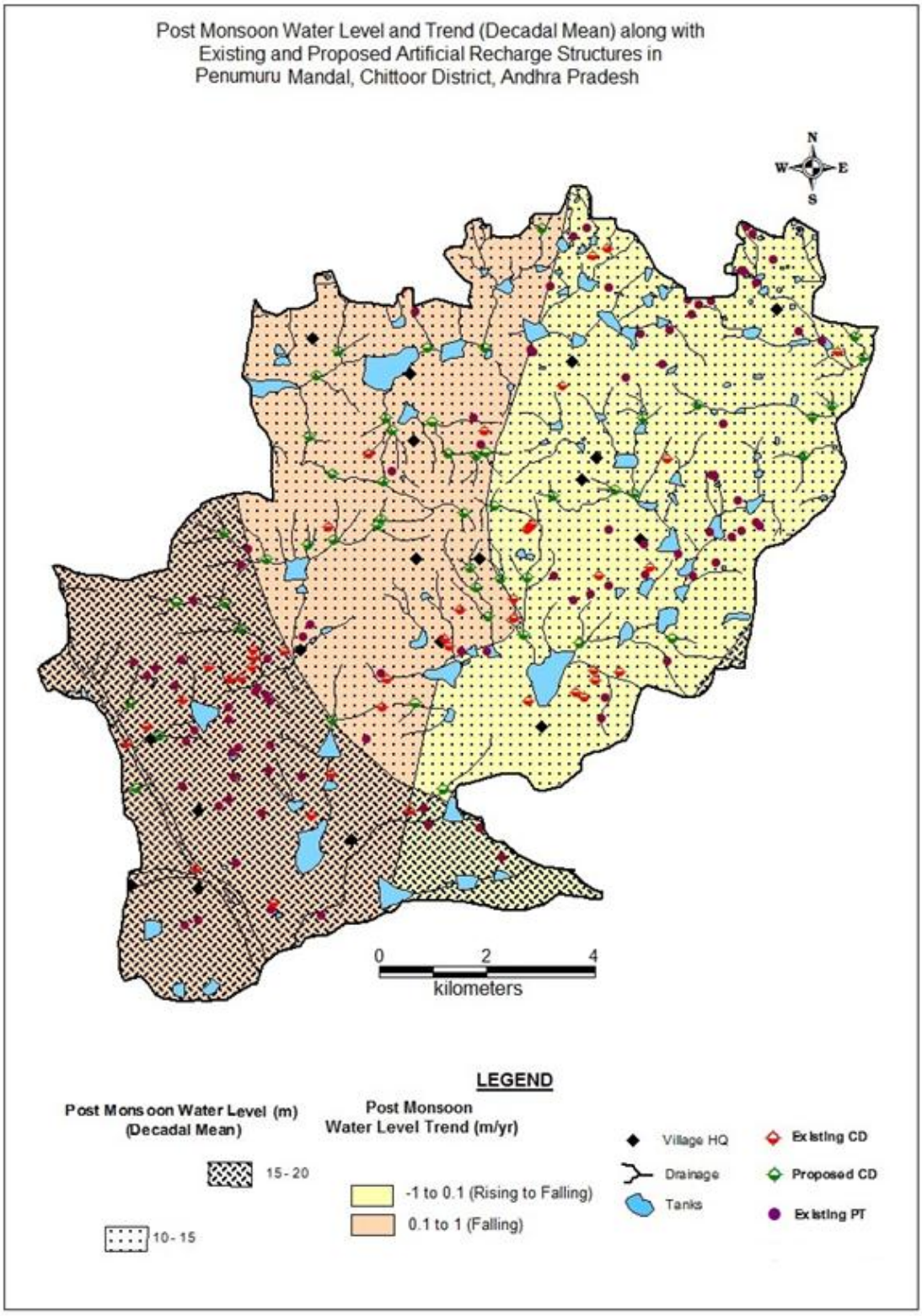

DEPTH TO WATER LEVEL
NOVEMBER 2014
PENUMURU MANDAL
CHITTOOR DISTRICT
ANDHRA PRADESH STATE
1 cm=1.5 km
Penumuru
LEGEND
5 - 10 m bgl
10 - 20 m bgl
Village HQ

Fig.7


Post Monsoon Water Level and Trend (Decadal Mean) along with
Existing and Proposed Artificial Recharge Structures in
Penumuru Mandal, Chittoor District, Andhra Pradesh
N
W
E
S
0
2
4
kilometers
LEGEND
Post Monsoon Water Level (m)
(Decadal Mean)
15 - 20
10 - 15
Post Monsoon
Water Level Trend (m/yr)
-1 to 0.1 (Rising to Falling)
0.1 to 1 (Falling)
Village HQ
Drainage
Tanks
Existing CD
Proposed CD
Existing PT