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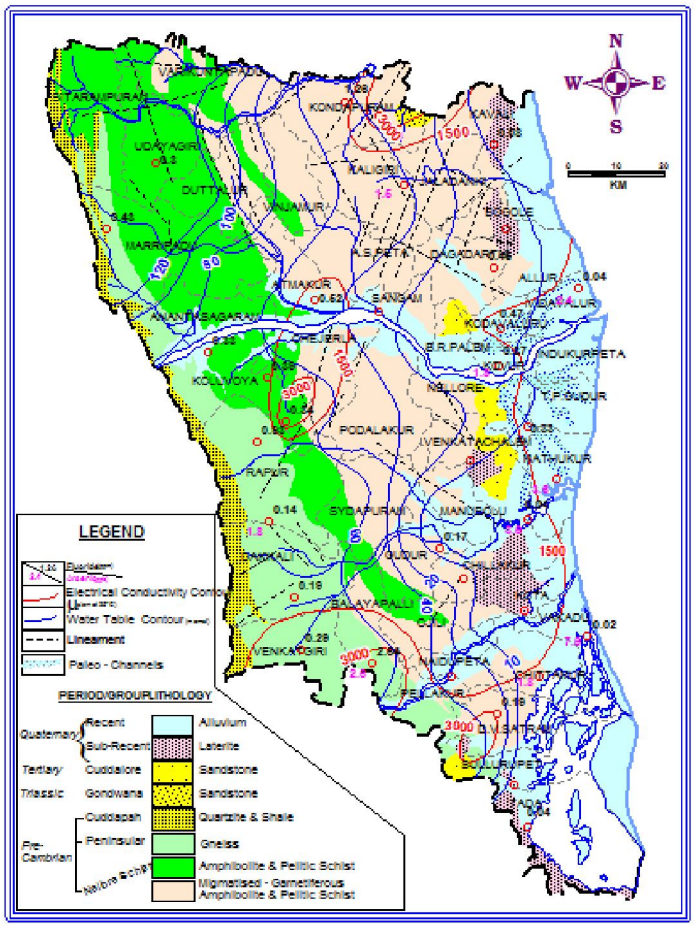
# CENTRAL GROUND WATER BOARD
## MINISTRY OF WATER RESOURCES
## GOVERNMENT OF INDIA

# GROUND WATER BROCHURE
## NELLORE DISTRICT, ANDHRA PRADESH




**SOUTHERN REGION**
**HYDERABAD**
**September 2013**

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**MINISTRY OF WATER RESOURCES**
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# GROUND WATER BROCHURE
**NELLORE DISTRICT, ANDHRA PRADESH**
**(AAP-2012-13)**

**BY**


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# GROUND WATER BROCHURE
## S.P.S. NELLORE DISTRICT, ANDHRA PRADESH

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# S.P.S. NELLORE DISTRICT AT A GLANCE

| | | |
|---|---|---|
| **1. GENERAL INFORMATION** | | |
| Geographical Area ($Km^2$) | : | 13,076 |
| Administrative Divisions | | |
| District HQ | : | Nellore |
| Mandals | : | 46 |
| Towns | : | 5 |
| Villages | : | 1201 |
| Population | : | 29,66,082 (2011 census) |
| Normal Annual Rainfall | : | 1,084 mm |
| Annual rainfall (2012) | : | 889 mm |
| | | |
| **2. GEOMORPHOLOGY** | | |
| Major Physiographic Units | : | Structural Hills |
| Pediplains, | | |
| Deltaic plains and | | |
| Coastal plains | | |
| Major Drainage | : | Pennar & Swarnamukhi |
| | | |
| **3. LAND USE (ha) (2012)** | | |
| Forest Area | : | 2,62,787 |
| Net Area Sown | : | 3,76,388 |
| Cultivable waste | : | 96,956 |
| | | |
| **4. SOIL TYPE** | | |
| Red loamy soils, Black cotton soils, Sandy soils, Lateritic soils and Alluvial soils | | |
| | | |
| **5. IRRIGATION BY DIFFERENT SOURCES (ha)** | | |
| Dug Wells | : | 12,494 |
| Tube wells/ Bore wells | : | 79,681 |
| Tanks/ Ponds | : | 70,783 |
| Canals | : | 96,889 |
| Other Sources | : | 5,124 |
| Net Irrigated Area | : | 2,64,971 |
| Gross Area Irrigated | : | 3,35,305 |
| | | |
| **6. GROUND WATER MONITORING WELLS** | | |
| Dug Wells | : | 39 |
| Piezometers | : | 3 |
| | | |
| **7. GEOLOGICAL FORMATIONS** | | |
| Quaternary | : | Alluvium & Laterites |
| Tertiary & Triassic | : | Sandstone |
| Pre-Cambrian | : | Quartzite & shale |
| | | Gneiss |
| | | Amphibolites & |
| | | Pelitic schists (migmatised) |
| | | |

| | | |
|---|---|---|
| **8. Hydrogeology** | | |
| Water Bearing Formations | : | |
| Hard Rock | : | Gneisses & Schists |
| Soft Rock | : | Laterites, Sandstones & Alluvium |
| | | |
| Pre-monsoon | : | 1.28 to 9.50 m bgl |
| Depth to Water Level (May, 2012) | | |
| Post-monsoon | : | 0.50 to 9.58 m bgl |
| Depth to Water Level (Nov., 2012) | | |
| | | |
| **9. GROUND WATER EXPLORATION** | | |
| Wells Drilled | : | 62 |
| Depth Range | : | 18 to 457 m |
| Discharge | : | < 1 to 38 lps |
| Transmissivity | : | 16 to 500 $m^2$/day |
| | | |
| **10. GROUND WATER QUALITY** | | |
| In general good and suitable for drinking and irrigation purposes, except in the coastal area. | | |
| | | |
| **11. DYNAMIC GROUND WATER RESOURCES** | | |
| Total Recharge | : | 2369.16 MCM |
| Total Draft | : | 791.64 MCM |
| Projected Demand (2025) | : | 109 MCM |
| for Domestic & Industrial Uses | | |
| Stage of GW development | : | 37 % |
| | | |
| **12. GROUND WATER CONTROL & REGULATION** | | |
| Over Exploited Mandals | : | Nil |
| Critical | : | Nil |
| Semi-Critical Mandals | : | Nil |
| Notified Mandals | : | Nil |
| | | |
| **13. GROUND WATER PROBLEMS AND ISSUES** | | |
| Coastal salinity is the major considerable problem. | | |

# GROUND WATER BROCHURE
## S.P.S. NELLORE DISTRICT, ANDHRA PRADESH

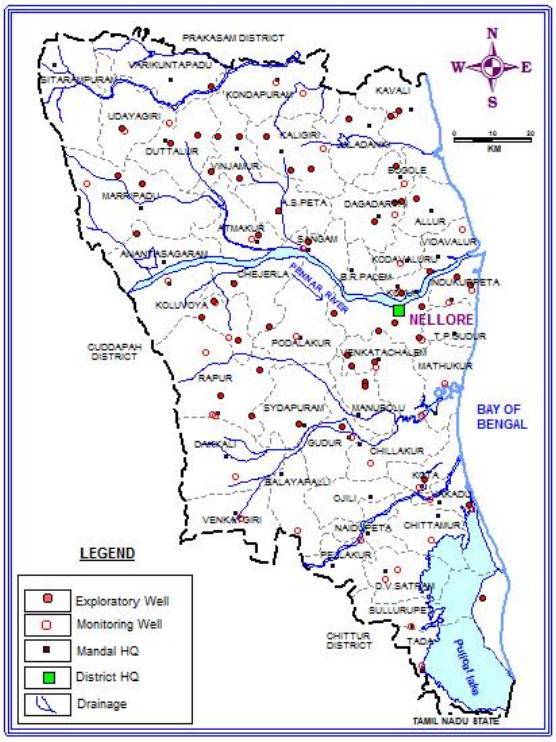
## 1.0 Introduction

Nellore district is one of the 9 coastal districts and it is situated in the south eastern part of Andhra Pradesh. Agriculturally it is an important district. The district has a coastline of 169 km. It is endowed by good rainfall and surface water.

The district lies between North latitude of 13° 30' and 15° 05' and East longitudes of 79° 05' and 80° 15' with an aerial extent of 13,076 $km^2$. It is bounded by the Bay of Bengal with a coastal length of 163 km on the East, Cuddapah district on the West, Prakasam district on the North, Chittur district on the southwest and Chengalpat district of Tamil Nadu state on the southeast. Chennai - Howrah broad gauge railway line and NH-5 runs across the district almost parallel to the coastline. India's prestigious and only satellite launch center known as SHAR is stationed at Sriharikota Island.

Nellore town is the district's headquarters. The district is divided into three revenue divisions viz., Nellore, Gudur and Kavali. Further these revenue divisions are divided into 46 revenue mandals (**Fig. 1**). There are 5 towns 1201 villages in the district. As per the 2001 census the population of the district is 26,68,564. The urban population of the district is 6,12,537 whereas rural population constitutes 20,56,027. The decennial growth rate from 1991 to 2001 is 11.55 percent. The density of population of the district is 204 persons per sq. km.

Fig. 1 ADMINISTRATIVE DIVISIONS - S.P.S. NELLORE DISTRICT



### 1.1 Drainage

The Pennar is the major river which drain in the middle of the district. The other important rivers flowing in the district are Swarnamukhi, Manneru and Upputeru. All the rivers are non-perennial, flowing in the eastern direction and joins the Bay of Bengal. The general drainage pattern is dendritic to sub-dendritic**.** The drainage density varies from less than 1 to 3 km/km$^2$. Pulicat lake is located in the south eastern part of the district. Pulicat Lake is the second largest lagoon of India and boasts of a rich biodiversity. Therefore, the lagoon has been preserved as a Wildlife Sanctuary. It straddles the border of Tamil Nadu and Andhra Pradesh states. The lake is separated from the Bay of Bengal, by an inland spit called the Sriharikota Island. The lake has a length of 60 km and a breadth of 0.2 to 17.5 km. It has a high water spread of 460 sq. km and low water spread area of 250 sq. km with an average depth of one metre. The lake is drained by three larger inflows (Swarnamukhi, Arani and Kalangi) and many minor inflows. It is connected with an estuary mouth with a width of 200 meters. Owing to its proximity to the sea, it has turned into a salt-water lagoon.

### 1.2 Irrigation

The district is served with both surface and ground water irrigation sources. Major and medium irrigation projects exist in the district. The total net area irrigated is 264971 ha (2012) by means of all sources of irrigation available in the district.

The district has one major (Pennar River Canal System) and five medium (Telugu Ganga, Somasila, Kanpur canal, Gandipalem project and Swarnamukhi Barrage) irrigation projects. The area irrigated through canals and tanks is 96889 ha and 70783 ha respectively, and irrigation through lift and other sources is 5124 ha. 92175 ha area is irrigated through tube wells and dug wells.

### 1.3 CGWB activities

The Central Ground Water Board took up long term hydrogeological studies since 1969 with the establishment of Network Hydrograph Stations in various hydrogeological environments as a part of the all India programme and presently there are 42 (39 dug wells and 3 piezometers) hydrograph stations in the district. The systematic hydrogeological surveys were carried out during 1959 – 1989. Ground water management surveys were carriedout in the entire district during 1994-1995. As a part of ground water exploration programme Geophysical surveys were carried out during 2000-04. Ground water exploratory drilling programme was taken up during 1970 – 2004 in the district in both hard rock and soft rock areas, and has drilled 62 exploratory wells to evaluate the aquifer properties of deeper aquifers. Under Hydrology Project 5 piezometers were constructed.

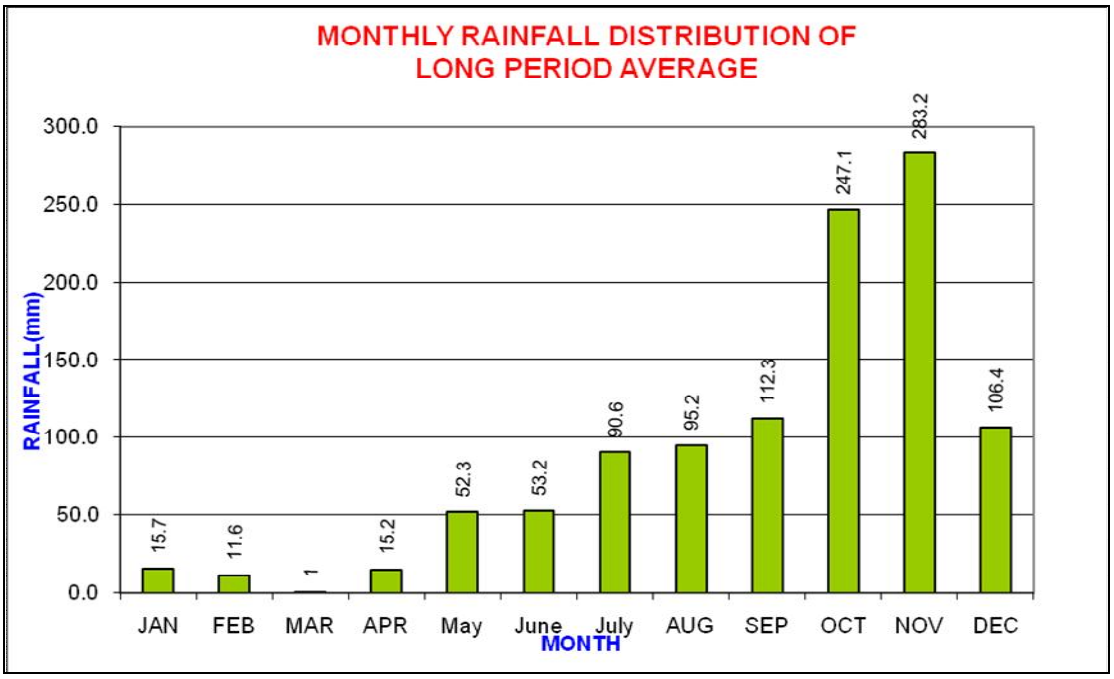
## 2.0 Rainfall & Climate

The climate of the district is moderate and characterized by sub-tropical climate. The period from December to middle of February is generally the season of fine weather. The summer season is from March to May. This is

followed by monsoon period from June to September, the post monsoon from October to December and the winter season from January to February.

The annual normal rainfall of the district is 1084 mm. The peculiarity of this district is that contribution of SW monsoon is far less than the contribution of NE monsoon rainfall. About 70% of the annual rainfall is contributed by the NE monsoon **(Fig. 2)**. In general the amount of rainfall is increases from west to east about 900 to 1300 mm in the district. The mean daily maximum temperature in the district is about 38°C in May and the mean daily minimum temperature is about 20°C in December/ January. Temperature in the district begins to rise from the middle of February till May. With the onset of southwest monsoon in June, the temperature decreases to about 20°C and is more or less uniform during the monsoon period. The relative humidity ranges from 60 to 80% in the mornings, whereas in the evenings it varies from about 45 to more than 70%. The annual rainfall during 2012 is 889 mm.

**Fig. 2 The mean monthly rainfall distribution**




## 3.0 Geomorphology & Soil Types

Geomorphologically the district can be broadly divided into 3 distinct units, viz., western hills, central pediplains and eastern deltaic & coastal plains. The higher relief is represented by hill ranges of Eastern Ghats, in the western border of the district. These hills are locally known as Veligonda hills, run in a northwesterly direction with an highest elevation of 1,105 m amsl at Penchalakonda. The pediplain area i.e., in the central part of the district extends in a north - south direction. The general altitude of this physiographic unit varies from 36 to 170 m amsl with isolated hillocks. The master slope of the area is from west to east towards the Bay of Bengal. The deltaic and coastal plain extends from north to south along the eastern margin of the district all along the coast. Pennar and Swarnamukhi rivers are the major contributors to the formation of the deltaic plains. The sandy coastal plain

extends upto a distance of 5 to 6 km from sea coast. The southern most fringe of the coastal plain is occupied by Pulicat lake.

The predominant soils in the district are red loam, black cotton, lateritic sandy and alluvial soils. Red loam soils cover an area of more than 70% of the district except in the deltaic area. The black cotton soils constitute about 10% of the district and it is found in the southern part in isolated patches of Pennar river. Red lateritic soil occurs all along the eastern side of the district. The alluvial soil occurs along the Pennar and Swarnamukhi rivers, and also in the due north of the Pennar along the eastern margin of the district.

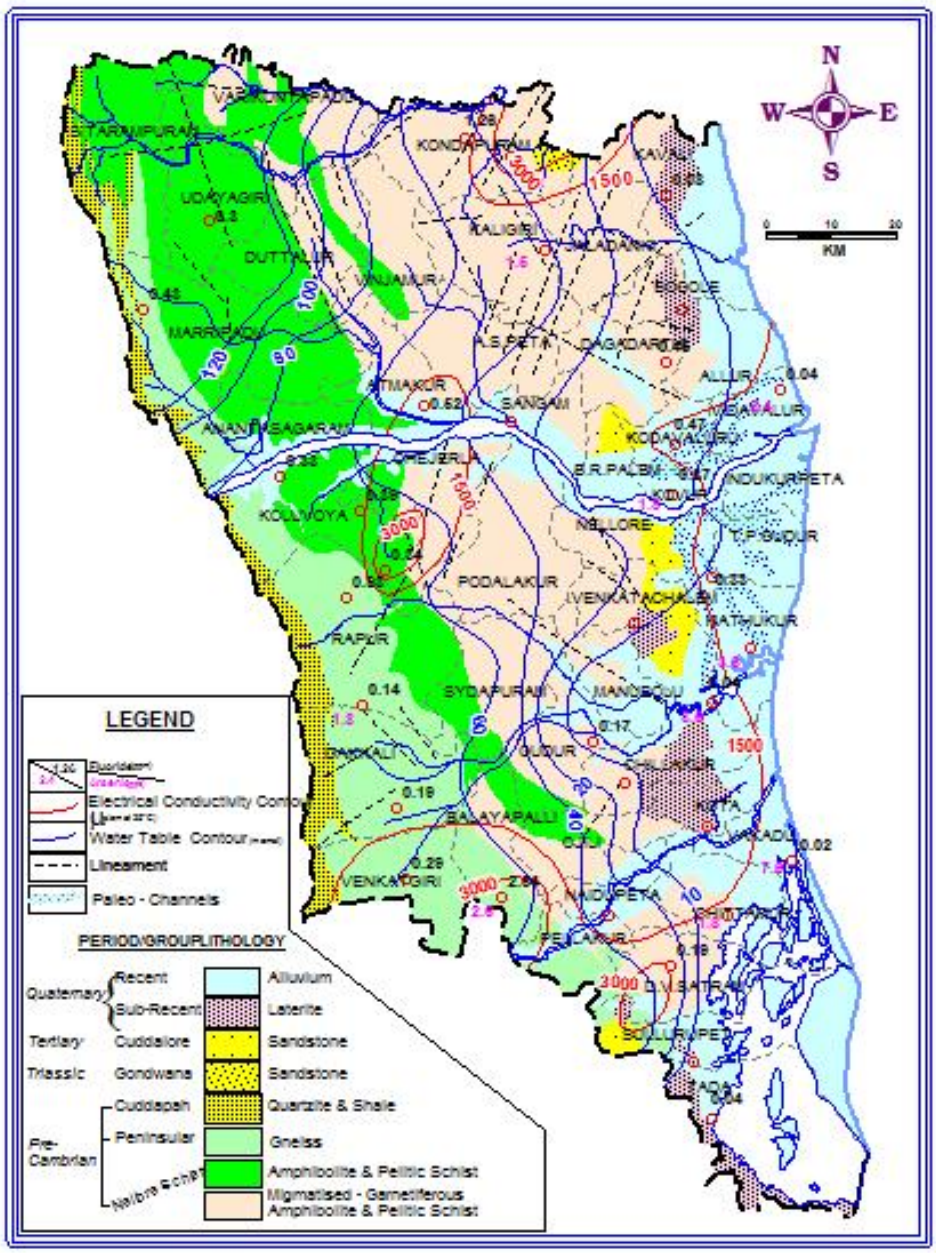
# 4.0 Ground Water Scenario

## 4.1 Hydrogeology

The district is underlain by variety of geological formations comprising from the oldest Archaeans to Recent Alluvium. Hydrogeologically these formations are classified as consolidated (Hard), semi-consolidated (Soft) and unconsolidated (Soft) formations. The consolidated formations include mainly migmatised high grade metamorphics (essentially garnetiferous amphibolites & pelitic schist), low grade metamorphics (essentially amphibolites & pelitic schists) of Nellore schist belt, granitic gneiss and Cuddapahs (Quartzites & Shales) of Pre-cambrian period. The schist and gneisses are intruded by granites, pegmatites and basic dykes. One of the high grade mica in the world is being mined around Gudur occurs in the pegmatites. Among these consolidated formations, schists (amphibolites and pelitic schists) and gneisses occupied the major area of the district, where as the quartzites and shales of Cuddapah group are restricted to the western margin of the district.

The semi consolidated formations occur as discrete patches and are represented by Gondwana sandstones, Cuddalore sandstones and laterites of Triassic, Tertiary and Quaternary periods respectively. Gondwana sandstones occur as a small patch in the northern part of the district. Cuddalore sandstones and Laterites occur as isolated patches in the eastern margin of the district. The unconsolidated formations comprise of river alluvium, coastal alluvium and wind-blown sand deposits of Quaternary period. The river alluvium occurs all along the banks of major rivers and the deltaic areas formed by Pennar and Swarnamukhi rivers. The Pennar and Swarnamukhi deltas cover an area of 1470 $Km^2$ and 415 $Km^2$ respectively. The thickness of alluvium increases from west to east, it ranges from few meters to 150 m and 60 m in Pennar and Swarnamukhi delta areas respectively and is followed by sand stones. The coastal alluvium covers an area of 900 $Km^2$ lie along the coast. The wind-blown sand deposits occur as narrow dunes in the coastal areas and the thickness varies from 5 to 7 m. These deposits extensively occur over Sriharikota island. Prominent lineaments in the district are trending in NE-SW and NW-SE directions **(Fig. 3)**.

Fig. 3 HYDROGEOLOGY - S.P.S. NELLORE DISTRICT




Ground water occurs in all most all geological formations and its potential depends upon the nature of geological formations, geographical set up, incidence of rainfall, recharge and other hydrogeological characters of the aquifer. Among the consolidated formations gneisses are relatively good aquifers. Schistose formations also form potential aquifers when the wells tapping contact zones with intrusives. Quartzites and shales of cuddapah group are of little significance from the ground water point of view as they are restricted to the hilly terrain in the western margin of the district. In the consolidated formations ground water occurs under unconfined to semiconfined conditions. Ground water is developed in these formations by dug wells, dug cum bore wells and bore wells tapping weathered and fractured zones. The yield of the dug wells are in the range of 15 to 35 $m^3$/day

and reduce considerably during peak summer periods. The occurrence of fractures in these formations is limited to 40 to 60 m bgl and occasionally extends down to 70 to 80 m bgl. The bore wells in these formations generally tap the weathered and fractured zones. The yields of the bore wells generally range between 80 and 350 $m^3$/day. The higher yields are limited to the available thickness of fractured zones.

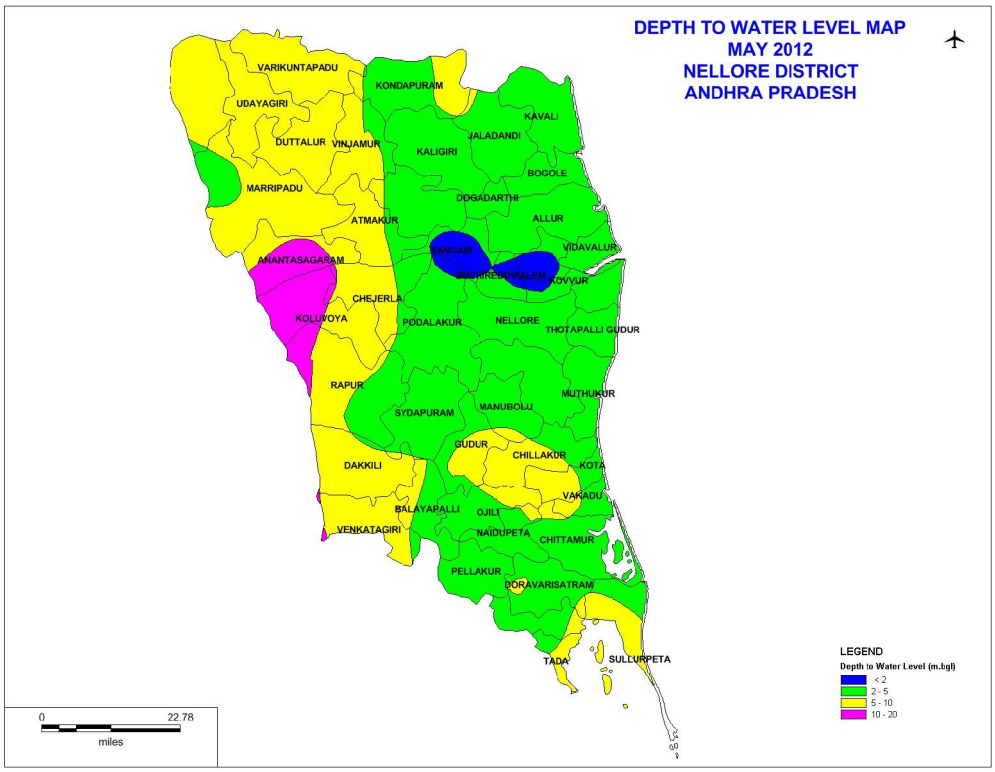
Among the semi-consolidated formations, laterites only form potential aquifers when their thickness is more than 8 m and without any overburden, whereas sandstones do not form potential aquifers, as these are very thin. In laterites ground water occurs under unconfined conditions. Ground water is developed in these formations by dug wells. The yield of these wells varies from < 1 to 2 $m^3$/hr. Among the un-consolidated formations river alluvium i.e., in deltaic area form potential aquifers. In deltaic area ground water occurrence is controlled by landforms and also in this area a lot of heterogeneity in hydrogeological conditions exist both spatially and vertically. In the lower Pennar delta area fresh water is generally limited to a depth of 40 m, whereas in Swarnamukhi delta it is limited to 15 m. Most of the coastal alluvium aquifers are saline. Palaeochannels are favourable locations for fresh water aquifers. Wind-blown sand/ sand dunes are fresh water aquifers. Ground water occurs under phreatic to confined conditions and is developed through shallow dug wells, filter point wells and tube wells. The depth of dug wells ranges from 5 to 12 m, while the depth of filter point wells generally varies from 6 to 11 m. The yields generally range in this aquifer between 500 to 1000 $m^3$/day. Occasionally high yields also occur in the palaeochannels.

The transmissivity value of the aquifers in the consolidated formations, semi-consolidated formations and unconsolidated formations generally vary from 15 to 75 $m^2$/day, 20 to 60 $m^2$/day and 200 to 500 $m^2$/day respectively, whereas specific capacity ranges from 10 to 290 lpm/mdd, 140 to 270 lpm/mdd and 35 to 1000 $m^3$/day/mdd respectively.

**Water Level Scenario**

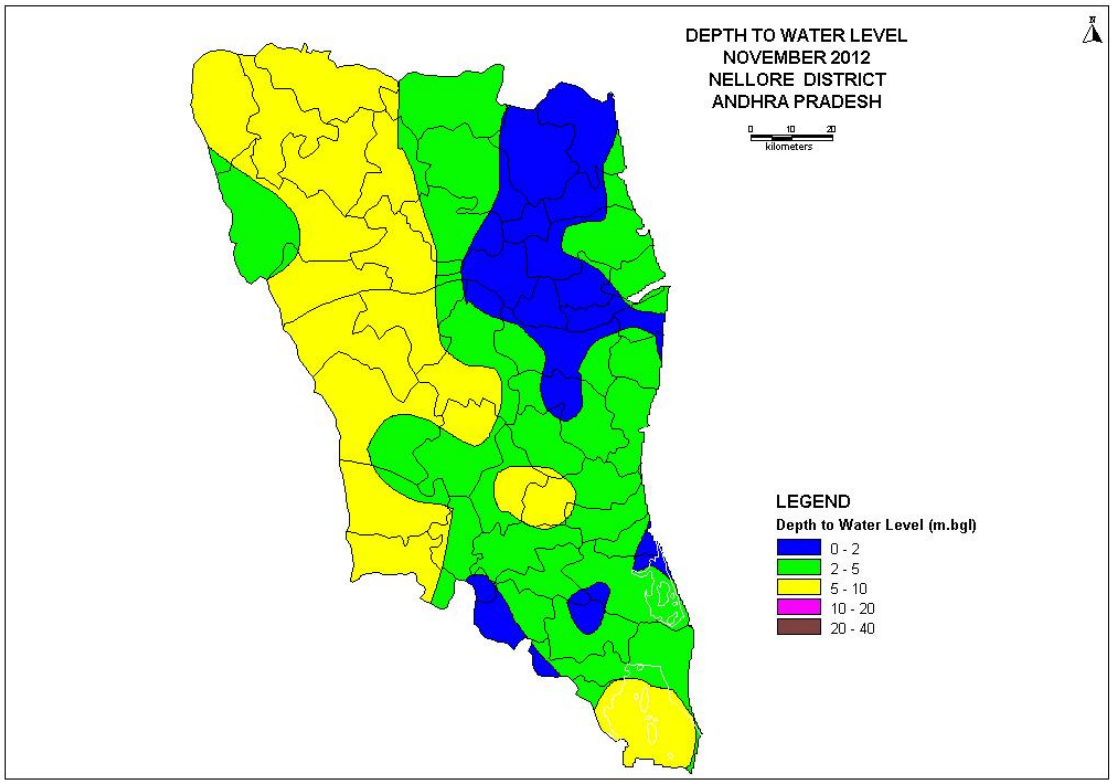
The depth to water level during pre-monsoon season (May, 2012) in the district generally ranges between 2 and 5 m bgl (**Fig. 4**). Water levels more than 5 m bgl occur in the north western and a small area in south eastern parts of the district i.e., in the parts of Sitarampuram, Varikuntapadu, Udayagiri, Duttalur, Marripadu, Ananthasagaram, Chillakur and Kota mandals. The shallow water levels i.e., < 2 m bgl occur in parts of Sangam, Buchireddipalem and Kovvur mandals.

**Fig 4. DEPTH TO WATER LEVEL PRE-MONSOON (MAY,2012)**




The depth to water level ranges between 5 and 10 m bgl in the north western area and a limited area in the west central part of the district during post monsoon season (Nov, 2012). The shallow water levels i.e., < 2 m bgl occur in the North eastern part of the area. In the rest of the district, the water levels range between 2 to 5 m bgl (**Fig. 5**).

**Fig 5. DEPTH TO WATER LEVEL POST- MONSOON (NOV, 2012)**



Ground water levels fluctuate considerably in response to the recharge and draft conditions of ground water reservoir. Overall rise in water levels from pre-monsoon to post-monsoon in the range of 0.03 to 3.52 m exist in the district, where as fall is in the range of 0.05 to 3.00 exist mainly in the western margin of the district i.e., in the parts of Udayagiri, Atmakuru, Dattaluru, Gudur, Manubolu, Rapur, Podalakur and Venkatagiri mandals. Long-term trend of water level (1997 to 2011) indicates that during pre-monsoon a raise in the range of 0.0123 to 0.1700 m/yr in Kondapuram, Dagadarthi, Podalakuru, Venkatachalam, Mathukuru and DV Satram areas, whereas in the majority of the district a fall in the range of 0.0062 to 0.3638 m/yr is observed. During post monsoon period both raise and fall is observed in the range of 0.0103 to 0.2940 m/yr and 0.0064 to 0.6192 m/yr respectively. The water table elevation ranges between <10 m amsl in coastal areas and 166 m amsl in the northwestern part of the district (Udayagiri mandal). The water table contours are almost parallel to the topographic contours and the general ground water flow direction is towards east i.e., towards the sea.

## 4.2 Ground Water Resources

The ground water recharge worthy area in the district is 1253284 ha. Which is subdivided in to 377133 ha of command, 836503 ha of non-command area and the remaining 39647ha is Poor Ground Water Quality area The ground water recharge due to rainfall in the command area is 312.19 MCM whereas the recharge due to other sources is 995.10 MCM with a total annual ground water resources of 1307.38 MCM. In the non-command area the recharge due to rainfall is 815.77 MCM and recharge due to other sources is 246.01 MCM with a total annual resource of 1061.78 MCM. Net annual ground water availability is 1183.48 MCM in the command and 972.16 MCM in non-command area with a total of 2155.64 MCM in the entire district.

The gross ground water draft for all uses in the command area is in the order of 301.63 MCM whereas it is 490.01MCM in non-command area and the total gross ground water draft for all uses in the district is 791.64 MCM. Out of this resource 61.96 MCM in Command area and 47.04 MCM in non-command area with the total of 109.00 MCM in the entire district is allocated to cater the domestic and industrial needs of the population in the district as on 2025. Net ground water availability for future irrigation use is 846.22 MCM in the command, 463.25 MCM in non-command area and 1309.47 MCM in the entire district. The details are as below:

| | | |
|---|---|---|
| *Total Ground Water Recharge Worthy Area* | *:* | 153284 ha |
| Command Area | : | 377133 ha |
| Non Command Area | : | 836503 ha |
| Poor Ground Water Quality Area | : | 39647 ha |

*(in MCM)*

| | **Command area** | **Non command area** | **Total** |
|---|---|---|---|
| Recharge from Rainfall | 312.19 | 815.77 | 1127.96 |
| Recharge from other sources | 885.10 | 246.01 | 1241.20 |
| Total Recharge | 1307.38 | 1061.78 | 2369.16 |
| Gross draft for all uses | 301.63 | 490.01 | 791.64 |
| Stage of Ground Water development | 25% | 50% | 37% |
| Category | Safe | Safe | Safe |
| Allocation for future domestic & Industrial uses | 61.96 | 47.04 | 109.00 |
| Net ground water available for future irrigation uses | 846,22 | 463.25 | 1309.47 |

Ground water resources for each mandal are presented in **Table - 1** for the consideration of future development. The net availability of ground water in the district varies from 10.11 MCM in S.R.Puram mandal to 136.52 MCM in Vidavalur mandal. Whereas gross ground water draft for all uses varies from 4.93 MCM in Kodavalur Mandal to 45.65 MCM in Nellore Rural mandal. The stage of ground water development is as low as 9% in Alluru and Bogole mandals and as high as 72% in Pellakur Mandal. All 46 mandals in the district are categorized as 'safe'. (**Fig. 6**).

Fig. 6 GROUND WATER RESOURCES - STAGE OF GW DEVELOPMENT

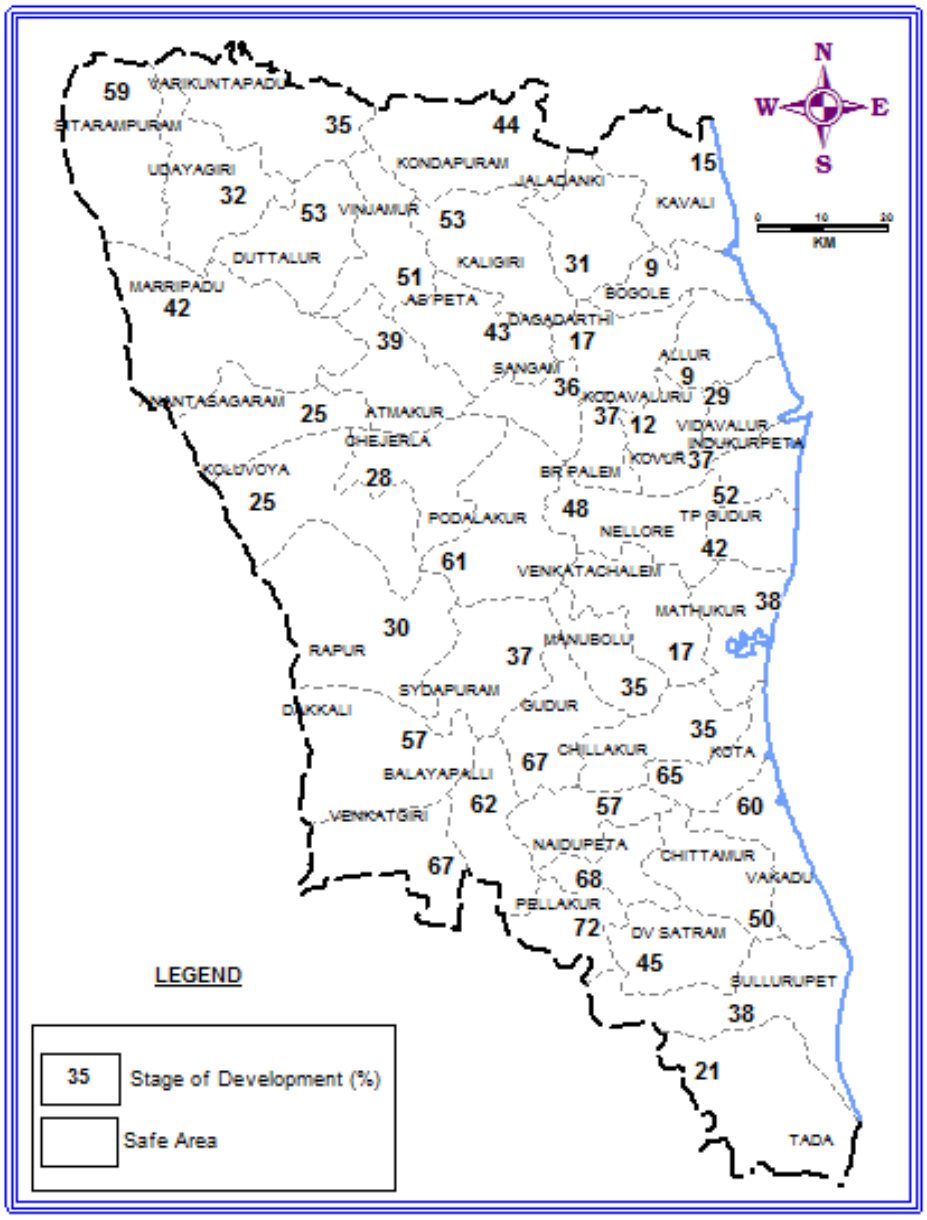


**Table : 1 DYNAMIC GROUND WATER RESOURCES - NELLORE DISTRICT**

*(ham)*

| Sl. No. | Mandal | Sub-Unit | Total Annual Ground Water Re-charge | Provision for Natural Discharges | Net Annual Ground Water Availability | Existing gross ground water draft for all uses | Provision for domestic and industrial requirement supply to | Net ground water availability for future irrigation development | Stage of ground water development | Category |
|---|---|---|---|---|---|---|---|---|---|---|
| **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | 11 |
| 1 | Allur | C | 7678 | 768 | 6910 | 494 | 171 | 6285 | 7 | Safe |
| | | N.C | 293 | 21 | 272 | 127 | 11 | 144 | 47 | Safe |
| | | Total | 7971 | 789 | 7182 | 621 | 182 | 6429 | 9 | Safe |
| 2 | Anantasagaram | C | 7513 | 751 | 6762 | 1542 | 122 | 5192 | 23 | Safe |
| | | N.C | 760 | 38 | 722 | 337 | 23 | 383 | 47 | Safe |
| | | Total | 8273 | 789 | 7484 | 1879 | 145 | 5575 | 25 | Safe |
| 3 | Anumasamudrampeta | C | 914 | 91 | 823 | 147 | 10 | 674 | 18 | Safe |
| | | N.C | 2760 | 153 | 2607 | 1323 | 161 | 1252 | 51 | Safe |
| | | Total | 3674 | 244 | 3430 | 1470 | 171 | 1926 | 43 | Safe |
| 4 | Atmakur | C | 1705 | 171 | 1534 | 241 | 22 | 1287 | 16 | Safe |
| | | N.C | 2781 | 226 | 2555 | 1361 | 116 | 1165 | 53 | Safe |
| | | Total | 4486 | 397 | 4089 | 1602 | 138 | 2452 | 39 | Safe |
| 5 | Balayapalle | C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | N.C | 3294 | 277 | 3017 | 1859 | 159 | 1132 | 62 | Safe |
| | | Total | 3294 | 277 | 3017 | 1859 | 159 | 1132 | 62 | Safe |
| 6 | Bogole | C | 7658 | 766 | 6892 | 606 | 175 | 6143 | 9 | Safe |
| | | N.C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | Total | 7658 | 766 | 6892 | 606 | 175 | 6143 | 9 | Safe |
| 7 | Buchireddipalem | C | 4375 | 438 | 3937 | 1459 | 141 | 2375 | 37 | Safe |
| | | N.C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | Total | 4375 | 438 | 3937 | 1459 | 141 | 2375 | 37 | Safe |

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|
| 8 | Chejarla | C | 6960 | 696 | 6264 | 990 | 88 | 5251 | 16 | Safe |
| | | N.C | 1907 | 132 | 1775 | 1265 | 64 | 490 | 71 | Safe |
| | | Total | 8867 | 828 | 8039 | 2255 | 152 | 5741 | 28 | Safe |
| 9 | Chillakur | C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | N.C | 4334 | 433 | 3901 | 1355 | 174 | 2458 | 35 | Safe |
| | | Total | 4334 | 433 | 3901 | 1355 | 174 | 2458 | 35 | Safe |
| 10 | Chittamur | C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | N.C | 4042 | 404 | 3638 | 1813 | 173 | 1716 | 50 | Safe |
| | | Total | 4042 | 404 | 3638 | 1813 | 173 | 1716 | 50 | Safe |
| 11 | D.V.Satram | C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | N.C | 4174 | 417 | 3757 | 1709 | 235 | 1893 | 45 | Safe |
| | | Total | 4174 | 417 | 3757 | 1709 | 235 | 1893 | 45 | Safe |
| 12 | Dagadarti | C | 4840 | 484 | 4356 | 330 | 98 | 3979 | 8 | Safe |
| | | N.C | 1578 | 119 | 1459 | 686 | 64 | 766 | 47 | Safe |
| | | Total | 6418 | 603 | 5815 | 1016 | 162 | 4745 | 17 | Safe |
| 13 | Dakkili | C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | N.C | 3483 | 305 | 3178 | 1807 | 157 | 1336 | 57 | Safe |
| | | Total | 3483 | 305 | 3178 | 1807 | 157 | 1336 | 57 | Safe |
| 14 | Duttalur | C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | N.C | 2805 | 265 | 2540 | 1342 | 95 | 1178 | 53 | Safe |
| | | Total | 2805 | 265 | 2540 | 1342 | 95 | 1178 | 53 | Safe |
| 15 | Gudur | C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | N.C | 2770 | 277 | 2493 | 1658 | 164 | 786 | 67 | Safe |
| | | Total | 2770 | 277 | 2493 | 1658 | 164 | 786 | 67 | Safe |
| 16 | Indukurupeta | C | 5256 | 263 | 4993 | 2611 | 1221 | 1652 | 52 | Safe |
| | | N.C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | Total | 5256 | 263 | 4993 | 2611 | 1221 | 1652 | 52 | Safe |
| 17 | Jaladanki | C | 4923 | 492 | 4431 | 1134 | 115 | 3227 | 26 | Safe |
| | | N.C | 1193 | 112 | 1081 | 562 | 41 | 497 | 52 | Safe |
| | | Total | 6116 | 604 | 5512 | 1696 | 156 | 3724 | 31 | Safe |

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|
| 18 | Kaligiri | C | 1013 | 101 | 912 | 256 | 24 | 640 | 28 | Safe |
| | | N.C | 3854 | 258 | 3596 | 2124 | 145 | 1416 | 59 | Safe |
| | | Total | 4867 | 359 | 4508 | 2380 | 169 | 2056 | 53 | Safe |
| 19 | Kaluvoya | C | 3193 | 319 | 2874 | 194 | 65 | 2658 | 7 | Safe |
| | | N.C | 2816 | 282 | 2534 | 1169 | 76 | 1351 | 46 | Safe |
| | | Total | 6009 | 601 | 5408 | 1363 | 141 | 4009 | 25 | Safe |
| 20 | Kavali | C | 3291 | 329 | 2962 | 287 | 320 | 2574 | 10 | Safe |
| | | N.C | 2828 | 283 | 2545 | 526 | 175 | 1893 | 21 | Safe |
| | | Total | 6119 | 612 | 5507 | 813 | 495 | 4467 | 15 | Safe |
| 21 | Kodavalur | C | 4754 | 475 | 4279 | 493 | 107 | 3729 | 12 | Safe |
| | | N.C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | Total | 4754 | 475 | 4279 | 493 | 107 | 3729 | 12 | Safe |
| 22 | Kondapuram | C | 844 | 84 | 760 | 159 | 44 | 575 | 21 | Safe |
| | | N.C | 2966 | 242 | 2724 | 1365 | 97 | 1319 | 50 | Safe |
| | | Total | 3810 | 326 | 3484 | 1524 | 141 | 1894 | 44 | Safe |
| 23 | Kota | C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | N.C | 3098 | 310 | 2788 | 1826 | 181 | 832 | 65 | Safe |
| | | Total | 3098 | 310 | 2788 | 1826 | 181 | 832 | 65 | Safe |
| 24 | Kovur | C | 3303 | 330 | 2973 | 1101 | 106 | 1795 | 37 | Safe |
| | | N.C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | Total | 3303 | 330 | 2973 | 1101 | 106 | 1795 | 37 | Safe |
| 25 | Manubolu | C | 412 | 41 | 371 | 16 | 6 | 352 | 4 | Safe |
| | | N.C | 3373 | 184 | 3189 | 1224 | 128 | 1910 | 38 | Safe |
| | | Total | 3785 | 225 | 3560 | 1240 | 134 | 2262 | 35 | Safe |
| 26 | Marripadu | C | 864 | 86 | 778 | 109 | 12 | 664 | 14 | Safe |
| | | N.C | 4919 | 265 | 4654 | 2154 | 152 | 2457 | 46 | Safe |
| | | Total | 5783 | 351 | 5432 | 2263 | 164 | 3121 | 42 | Safe |
| 27 | Muttukur | C | 4961 | 496 | 4465 | 1699 | 158 | 2695 | 38 | Safe |
| | | N.C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | Total | 4961 | 496 | 4465 | 1699 | 158 | 2695 | 38 | Safe |
| 28 | Naidupeta | C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | N.C | 2563 | 251 | 2312 | 1562 | 143 | 656 | 68 | Safe |
| | | Total | 2563 | 251 | 2312 | 1562 | 143 | 656 | 68 | Safe |
| 29 | Nellore rural | C | 8979 | 550 | 8429 | 4072 | 1670 | 3367 | 48 | Safe |
| | | N.C | 1099 | 60 | 1039 | 493 | 97 | 533 | 47 | Safe |
| | | Total | 10078 | 610 | 9468 | 4565 | 1767 | 3900 | 48 | Safe |

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|
| 30 | Ozili | C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | N.C | 4991 | 487 | 4504 | 2585 | 170 | 1851 | 57 | Safe |
| | | Total | 4991 | 487 | 4504 | 2585 | 170 | 1851 | 57 | Safe |
| 31 | Pellakur | C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | N.C | 2545 | 172 | 2373 | 1717 | 137 | 581 | 72 | Safe |
| | | Total | 2545 | 172 | 2373 | 1717 | 137 | 581 | 72 | Safe |
| 32 | Podalakur | C | 469 | 47 | 422 | 89 | 5 | 332 | 21 | Safe |
| | | N.C | 5782 | 373 | 5409 | 3482 | 288 | 1865 | 64 | Safe |
| | | Total | 6251 | 420 | 5831 | 3571 | 293 | 2197 | 61 | Safe |
| 33 | Rapur | C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | N.C | 6286 | 547 | 5739 | 1697 | 175 | 3996 | 30 | Safe |
| | | Total | 6286 | 547 | 5739 | 1697 | 175 | 3996 | 30 | Safe |
| 34 | Sangam | C | 7770 | 777 | 6993 | 2434 | 231 | 4396 | 35 | Safe |
| | | N.C | 448 | 32 | 416 | 213 | 30 | 200 | 51 | Safe |
| | | Total | 8218 | 809 | 7409 | 2647 | 261 | 4596 | 36 | Safe |
| 35 | Seetarampuram | C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | N.C | 1123 | 112 | 1011 | 601 | 68 | 406 | 59 | Safe |
| | | Total | 1123 | 112 | 1011 | 601 | 68 | 406 | 59 | Safe |
| 36 | Sullurupeta | C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | N.C | 3315 | 322 | 2993 | 1130 | 181 | 1745 | 38 | Safe |
| | | Total | 3315 | 322 | 2993 | 1130 | 181 | 1745 | 38 | Safe |
| 37 | Sydapuram | C | 1235 | 127 | 1108 | 37 | 5 | 1069 | 3 | Safe |
| | | N.C | 3653 | 317 | 3336 | 1589 | 158 | 1696 | 48 | Safe |
| | | Total | 4888 | 444 | 4444 | 1626 | 163 | 2765 | 37 | Safe |
| 38 | T.P.Gudur | C | 5592 | 485 | 5107 | 2142 | 476 | 2699 | 42 | Safe |
| | | N.C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | Total | 5592 | 485 | 5107 | 2142 | 476 | 2699 | 42 | Safe |
| 39 | Tada | C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | N.C | 3837 | 365 | 3472 | 713 | 125 | 2674 | 21 | Safe |
| | | Poor Quality | 13447 | 1335 | 12112 | 0 | 0 | 12112 | 0 | |
| | | Total | 3837 | 365 | 3472 | 713 | 125 | 2674 | 21 | Safe |
| 40 | Udayagiri | C | 2765 | 276 | 2489 | 724 | 86 | 1720 | 29 | Safe |
| | | N.C | 606 | 35 | 571 | 262 | 18 | 303 | 46 | Safe |
| | | Total | 3371 | 311 | 3060 | 986 | 104 | 2023 | 32 | Safe |

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|
| 41 | Vakadu | C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | N.C | 3270 | 327 | 2943 | 1769 | 126 | 1089 | 60 | Safe |
| | | Total | 3270 | 327 | 2943 | 1769 | 126 | 1089 | 60 | Safe |
| 42 | Varikuntapadu m | C | 4093 | 409 | 3684 | 1283 | 66 | 2367 | 35 | Safe |
| | | N.C | 960 | 96 | 864 | 567 | 45 | 304 | 66 | Safe |
| | | Total | 5053 | 505 | 4548 | 1850 | 111 | 2671 | 41 | Safe |
| 43 | Venkatachalam | C | 10209 | 1021 | 9188 | 1497 | 207 | 7595 | 16 | Safe |
| | | N.C | 268 | 21 | 247 | 110 | 16 | 128 | 45 | Safe |
| | | Total | 10477 | 1042 | 9435 | 1607 | 223 | 7723 | 17 | Safe |
| 44 | Venkatagiri | C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | N.C | 2504 | 197 | 2307 | 1551 | 226 | 658 | 67 | Safe |
| | | Total | 2504 | 197 | 2307 | 1551 | 226 | 658 | 67 | Safe |
| 45 | Vidavalur | C | 15169 | 1517 | 13652 | 4017 | 445 | 9330 | 29 | Safe |
| | | N.C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | Total | 15169 | 1517 | 13652 | 4017 | 445 | 9330 | 29 | Safe |
| 46 | Vinjamur | C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | N.C | 2900 | 245 | 2655 | 1368 | 110 | 1266 | 51 | Safe |
| | | Total | 2900 | 245 | 2655 | 1368 | 110 | 1266 | 51 | Safe |
| Total | | C | 130738 | 12390 | 118348 | 30163 | 6196 | 84622 | 25 | |
| | | N.C | 106178 | 8962 | 97216 | 49001 | 4704 | 46325 | 50 | |
| | | Poor Quality | 13447 | 1335 | 12112 | 0 | 0 | 12112 | 0 | |
| Total (excluding Poor Quality) | | | 236916 | 21352 | 215564 | 79164 | 10900 | 130947 | 37 | |
| C: Command, N.C: Non-Command | | | | | | | | | | |

## 4.3 Ground Water Quality

The quality of ground water is as important as quantity. Ground water from shallow as well as deeper aquifers of consolidated formations of the district is generally good. In general ground water is suitable for domestic, industrial and irrigation purposes, except in Kondapuram and kaluvoya areas, where EC values are more than permissible limit exist.

In the alluvial formations, the quality of ground water is found to deteriorates from west to east i.e., towards coast. All along the coast both shallow and deeper aquifers are saline. However, along the coast limited potable ground water zones do exist at shallow levels but they may not sustain for heavy withdrawals. Away from the coast fresh water in the aquifers is limited to shallow to moderate depths. Deeper aquifers are invariably saline. Quality of water in the palaeochannels is comparatively good. Overall the ground water from shallow aquifers is suitable for domestic and irrigation purposes, except in Kondapuram, DV Satram and Koluvoya areas in North, South and western part of the district respectively where values of EC are more than permissible limit exist.

Arsenic and Fluoride contents in the ground water of the district are within the permissible limits. Nitrate enrichment (more than permissible limit) is high at isolated places in the coastal and in Venkatagiri, Rapur, and Atmakur areas due to localised pollution. Ground water from these areas can be used for other than drinking purposes.

## 4.4 Status of Ground Water Development

The assessment of ground water resources in the district has brought to light the wide scope for utilising the ground water resources to boost the irrigation. Ground water is one of the most important and essential commodities for agricultural development, thus the judicious and scientific management of the resource is essential. It is therefore, imperative that wells have to be designed and spaced properly for meeting the irrigation water requirements of the district. In the consolidated formations at present dug wells of 7 x 7 m to 10 x 10 m size with depths of 7 to 10 m exists. In these formations ground water is also developed through dug cum bore wells as the dug wells are not getting sufficient yields. The depth of the in-wells in these structures ranges from 20 to 30 m. The depth of dug wells in laterites varies from 4 to 18 m and generally they are of rectangular shape. Whereas, in the unconsolidated formations the dug wells with 6 to 8 m diameter are in the depth range of 6 to 9 m.

Ground water in the district is also developed through bore wells of 250 to 380 mm diameter, which are drilled down to 40 to 70 m depth in consolidated formations. Similarly filter point wells/tube wells in unconsolidated formations with 380 mm diameter are drilled down to depths of about 6 to 20 m. And also filter point wells are driven down to a depth ranging between 5 and 8 m in the coastal alluvium wherever the potential zones are available.

Ground water irrigation in the district is not extensive and it accounts only for 29% of the gross irrigation of the district. A total number of 35,239 dug wells and 30,416 bore/tube wells are functioning in the district. A total area of 938 sq.km is irrigated through ground water, of which 127 sq.kms with dug well sources and 811 sq.kms by bore/tube wells.

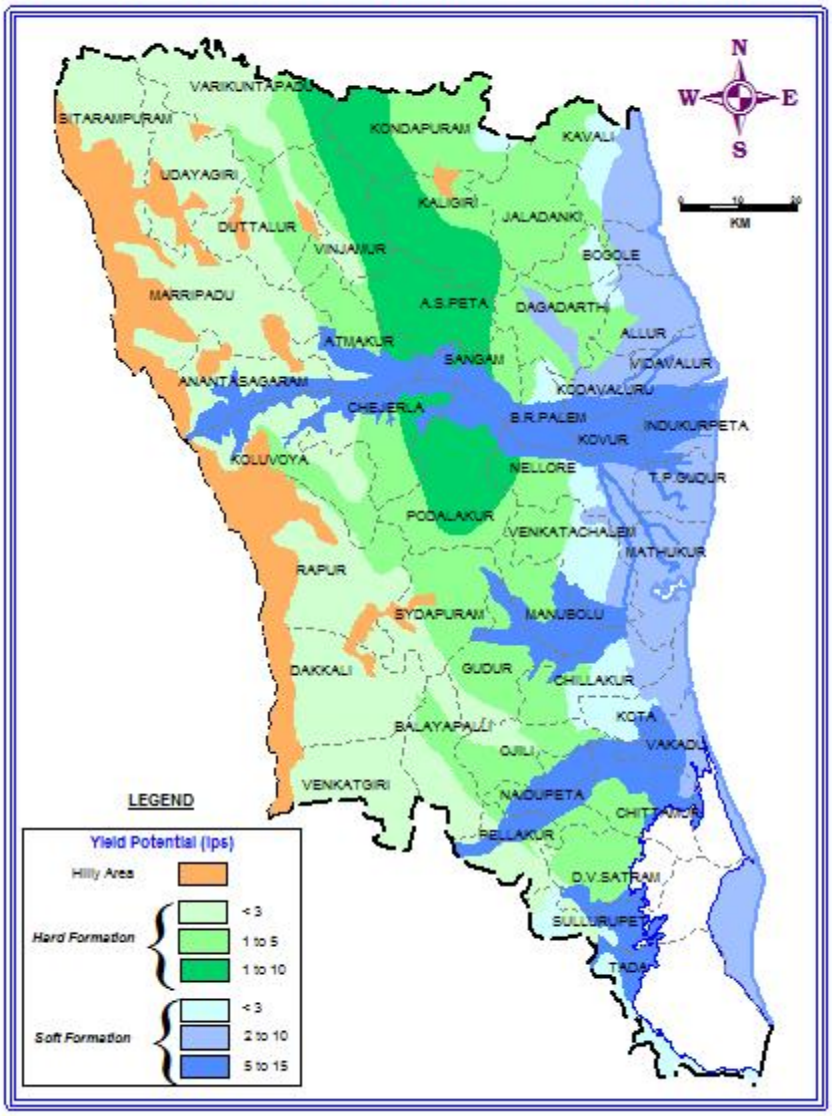
Urban water supply to Nellore town is from both Pennar river and ground water. The requirement for Kavali and Gudur towns is being met mostly by ground water. The rural water supply in the district is through both surface and ground water. A total number of 240 open wells, 16698 bore/tube wells and 2425 protected water schemes are meeting the drinking water requirements of the rural population.

# 5.0 Ground Water Management Strategy

## 5.1 Ground Water Development

The scope for further development of ground water in the district varies widely from place to place and from mandal to mandal. Hence scientific and judicious development and management of available water resource will contribute to the overall planned development and is important of the economy of the district. There is a huge scope for further development of ground water resources which will bring more areas under irrigation in the district. Present irrigation is confined to 72% of the net sown area. Hence a balance of 28% area is devoid of irrigation facilities. Though surface water is abundant but during summer season its availability is very scares due to swift nature of streams and rivers. The district is underlained by hard (consolidated) and soft (semi-consolidated & unconsolidated) formations, therefore DTH rigs and DR rigs respectively are most suitable for deployment. In the deltaic areas the ground water is supplementary source for irrigation requirements in few mandals. The ground water development in the coastal area is to be carried out judiciously by installing low capacity pumps as the fresh water zones are limited and also to minimise salinity problems. In order to monitor the advancement of fresh water/saline water interface towards inland in due course of time with rapid ground water development, it is necessary for construction of piezometers perpendicular to the coast line for monitoring the water level and chemical quality of the water. Based on the yield potential the aquifers of the hard (consolidated) formations of the district are classified as low (<3 lps), Low to Moderate (1 to 5 lps) and High (1 to 10 lps), and the soft (semi & Un consolidated) formations as Low (<3 lps), Moderate (2 to 10 lps) & High (5 to 15 lps) yield potential areas (**Fig. 7**).

Fig. 7 GROUND WATER YIELD POTENTIAL - S.P.S. NELLORE DISTRICT




## 5.2 Water Conservation and Artificial Recharge

Construction of artificial recharge structures like check-dams, contour trenches, percolation tanks and water conservation structures like sub-surface dykes are feasible in the areas where water levels are declining and considerable exploitation of ground water resources is taking place viz. Indukurupeta, Kovur, Gudur, A.S.Peta, Buchireddypalem, Dakkili, Naidupeta, Podalakuru, T.P.Gudur, Venkatagiri and Vinjamur mandals. In the deltaic area artificial recharge schemes have to be implemented to avoid further deterioration of quality of ground water. Roof top Rainwater Harvesting is to be implemented in the urban areas wherever deepening of water levels is taking place.

## 6.0 Ground Water Related Issues and Problems

Coastal salinity is the major problems in the deltaic area of the district. In the deltaic area the fresh to brackish/ saline ground water occur in hydraulic contact with fresh ground water. The quality of ground water varies widely from place to place even within short distances and the deeper aquifers are invariably saline. The salinity of ground water is caused mainly due to depositional environment and other factors like geomorphic landform, excess use of fertilizers and unregulated growth of aquaculture in the coastal area which also play an important role. In the northeastern part of the district seasonal water logging conditions exist. In the northwestern part of the district concentration of fluoride higher than permissible is also a considerable problem. Localised Nitrate pollution is another problem in the district, which is due to excess use of fertilizers, urban sewerage disposal and improper drainage system.

## 7.0 Awareness and Training Activity

Mass awareness programme and training activities will be planned in forth coming annual action plans.

## 8.0 Areas Notified by CGWA/ SGWA

Based on the stage of ground water development all mandals in the district are categorised as safe. So far no area/mandal has been notified by CGWA. Whereas.

## 9.0 Recommendations

- Ground water should be judiciously exploited in the shallow fresh water aquifers of coastal area without disturbing the fresh/saline water interface.

- In the limited fresh ground water potential areas and in the critical and over-exploited areas, modern irrigation methods like drip and sprinkler irrigation should be adopted to increase the command area of the wells.

- The aqua culture development should be restricted to areas close to the coast line only. The practice of converting agricultural lands in the inland areas should be stopped to avoid the pollution of fresh water aquifers.

- Conjunctive use of surface and ground water needs to be planned in the command area, particularly in the deltaic region, to prevent the water logging conditions and to improve or to avoid further deterioration of quality of ground water.

- Artificial recharge measures should be adopted in the urban areas, in the deltaic area and in areas with considerable exploitation of ground water particularly in semi-critical, critical and over-exploited mandals for improving the ground water situation.

- A multi-sectoral approach is needed to study the ground water development, augmentation and management perspective. Therefore, all the aspects related to ground water, involvement of NGOs and mass awareness campaigns will play an important role in conserving and developing the precious fresh ground water resources.

## ACKNOWLEDGEMENTS

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