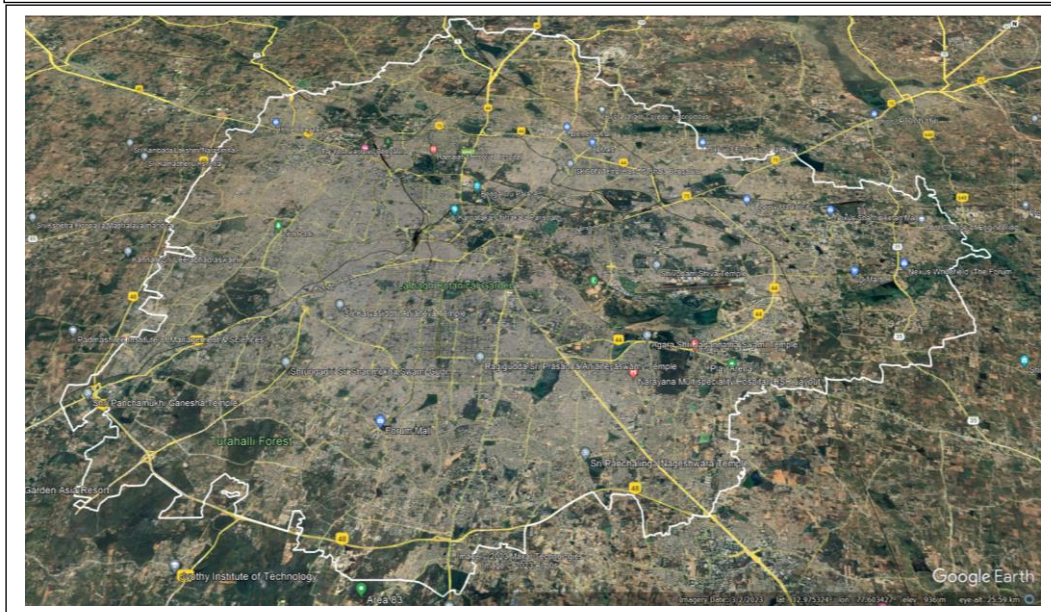




**INCEPTION REPORT ON
BANGALORE CITY IN URBAN AGGLOMERATE CATEGORY
UNDER NAQUIM 2.0
(AAP 2023-24)**



**South Western Region
Bengaluru**

May 2023

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BANGALORE CITY IN URBAN AGGLOMERATE CATEGORY
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CONTENTS

No.	Contents	Page No
1	Salient information	1-6
2	Priority types	6
3	Previous Studies	6-9
4	Objectives	9-11
5	Existing data	11
6	Data gap analysis	12
7	New Data generation plan	12
8	Month-wise activity plan	13
9	Composition of the team	13
10	Team-member-wise responsibilities and monthly targets	13-15
	ANNEXURE-I Location of CGWB monitored Dugwells and Piezometers	16
	ANNEXURE-II Tentative locations of dugwells to be established as keywells	17-18
	ANNEXURE-III Tentative locations of borewells to be established as keywells	19-20
	ANNEXURE-IV Tentative locations for bacteriological, COD,BOD sample analysis from borewells	21
	ANNEXURE-V Location of EW drilled by CGWB in study area	22
	ANNEXURE-VI Location of VES conducted by CGWB in study area	23-24

INCEPTION REPORT ON BANGALORE CITY IN URBAN AGGLOMERATE CATEGORY UNDER NAQUIM 2.0

1.0 Salient Information

- **State:** Karnataka
- **District:** Bangalore urban
- **Taluk:** Bangalore city area comprises of parts of 5 taluks namely-Bangalore North, Yelahanka, Bangalore East, Bangalore South and Anekal taluk.
- District Headquarter: Bangalore city
- Total no. of wards: 198
- Total area : 711 sq.km
- Toposheet No.:
- Administration: Bruhat Bengaluru Mahanagar Palike (BBMP)
- No. of Assembly constituencies: 29

Other demographic information:

Population as per 2011 census: 84,43,675 (Male: 43,91,723, Female: 40,51,952)

**Population in 2023: 1,36,08,000 (Male:52lakhs approx., Female:48 lakhs approx.)

Currently the city is experiencing a 3.15% growth rate .

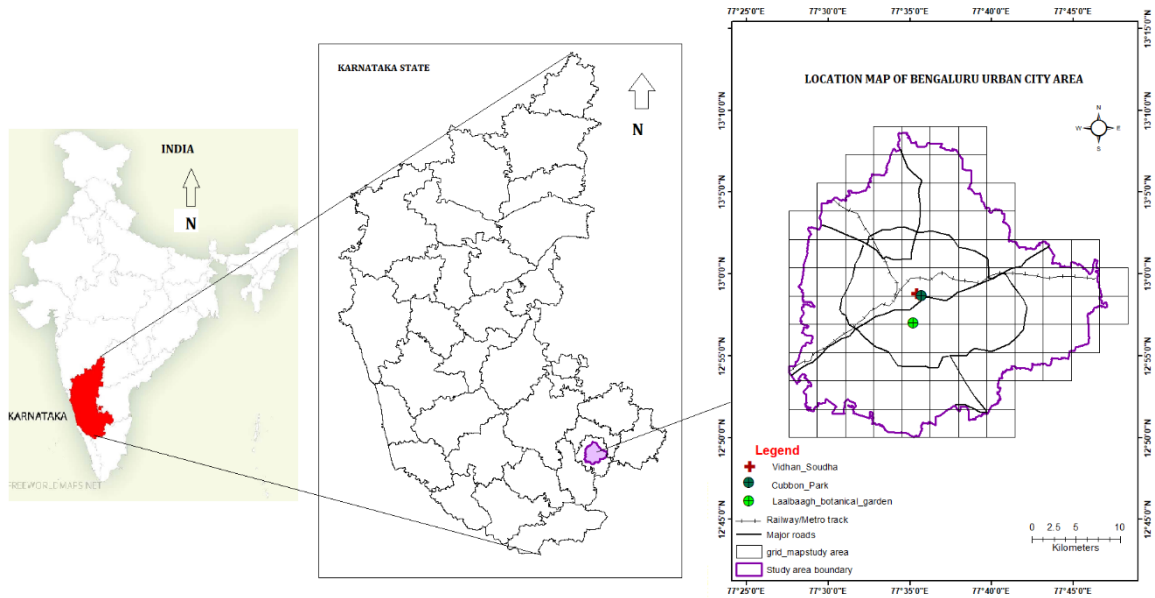
**Data Source: [United Nations - World Population Prospects](#) ,

** <https://www.macrotrends.net/cities/21176/bangalore/population>>Bangalore, India Metro Area Population 1950-2023. www.macrotrends.net. Retrieved 2023-05-01.

1.1 General description:

Bangalore is situated on a highland that forms a divide between the rivers Arkavathi on the west and South Pennar on the east. The city consists of two distinct entities namely area covered by the core city (erstwhile Bangalore City Corporation area) and the other, i.e., peripheral/ surrounding area (covered by erstwhile 7 CMCs and one Town Municipal Council). The area is predominantly underlain by granites and gneisses of Archaean age. The weathered thickness varied from 10 to 30 meters. Fractured, fissured and weathered granites and gneisses constitute the major aquifer system in Greater Bangalore. Groundwater occurs under phreatic condition in the shallow weathered rock and residuum, and under semi-confined condition in the deeper jointed and fractured granites and gneisses. Bangalore gets its major water supply from surface water sources, supplemented by borewell waters. The responsibility of supplying adequate quantity and quality of water to the BBMP is entrusted

to the Bangalore Water Supply and Sewerage Board (BWSSB). The inner zone of BBMP is fully covered by piped water supply from Cauvery river. The outer zone is partially covered by surface water source and partially by ground water with flourishing water markets based on borewells, which puts tremendous pressure on ground water leading to over-exploitation.



The study area forms parts of 5 taluks of Bengaluru Urban district namely-Bangalore North, Yelahanka, Bangalore East, Bangalore South and Anekal taluk. (Figure 1).

Figure 1: Location Map of the Study area

1.2 Drainage

Bangalore city is covered by Arkavathi and South Pennar basin. Bangalore is located on the water shed of two principal river basins, Arkavathi to the west and South Pennar to the East (Figure 2). The local topography is characterised by a series of well-defined valleys which radiate from a ridge of High Ground to the north of the city and fall in a gradual manner towards wide belt of flat land extending beyond the limits of the metropolitan area to the South. The three main watershed regions are Vrishabhavathi valley to the West, Koramangala and Chellaghatta valley to the East and Hebbala valley to the North. The three valleys run generally in a north to the south direction and divide the greater part of the metropolitan area which lies to the south of the ridge into three separate and distinct drainage zones.

1.3 Land use

Agricultural area is sparse and located at the fringes of the city. Agricultural land is fast diminishing and being taken up for real estate projects and industries. Major part of the city is covered by built up area. The city is dotted with several lakes and waterbodies. (Figure 3)

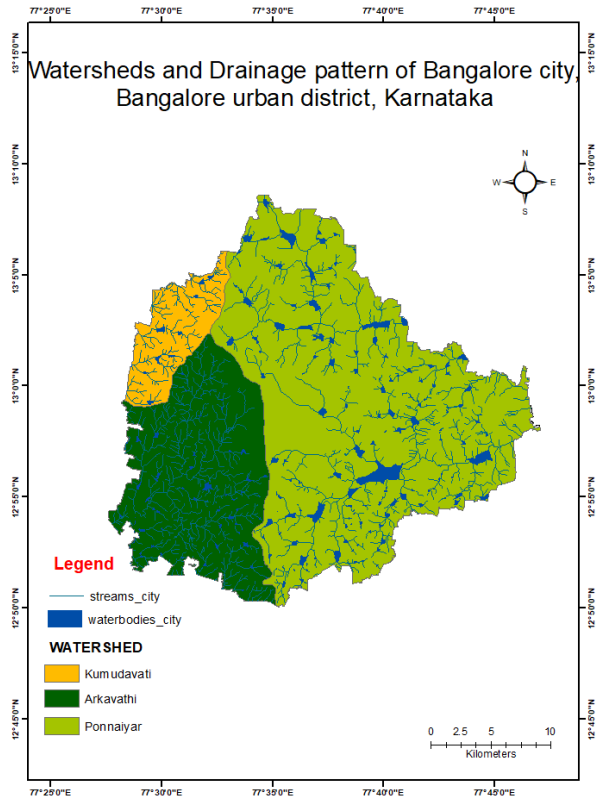


Figure 2: Drainage pattern map of the study area

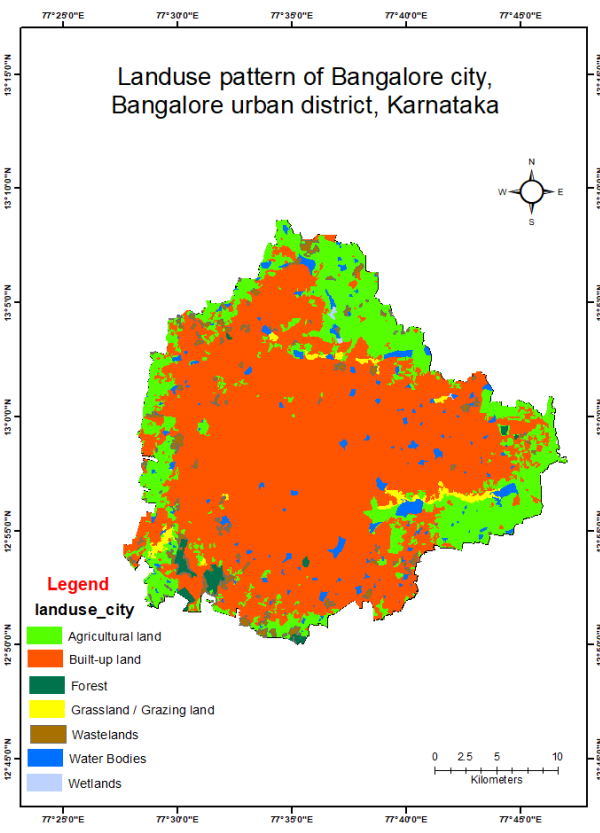


Figure 3: Land use pattern map of the study area

1.3 Hydrogeology:

Ground water occurs in phreatic conditions or unconfined conditions in the weathered zone and under semi confined to confined conditions in fractured and jointed rock formations. The occurrence of ground water movement and recharge to aquifers are controlled by various factors like fracture pattern, degree of weathering, geomorphological setup and amount of rainfall received. Generally, the depth of weathering varies, being more in the valley, and often extending up to 30 m in the dug wells. However, the yield in the bore well is dependent upon factors like degree of weathering, presence of joints and fractures and its connectivity and the presence of intrusive bodies. Granites and Gneisses of peninsular gneissic group constitute major aquifers in the urban district of Bangalore.

2.0 PRIORITY TYPE: Urban Agglomerate

3.0 PREVIOUS STUDY:

- Report on systematic hydrogeological surveys in Bangalore(South), Devanahally, Hosakote taluks, Bangalore district, Karnataka, CGWB,SWR(1983-84)
- Hydrogeology and groundwater potential of Bangalore urban and rural districts, Karnataka, CGWB, SWR, 1990
- Hydrogeological report on Bangalore Metropolitan Area, Karnataka, CGWB, SWR, 1998-99
- Groundwater Information Booklet, Bangalore Urban district, CGWB, SWR, Bangalore, 2008: enumerating the general details of the district, groundwater scenario, groundwater development and management strategies.
- NAQUIM study taken up in the taluks namely Bangalore North, Yelahanka, Bangalore East, Bangalore South and Anekal which make up parts of the study area during XII th Plan (2020-22): The studies highlighted the presence of 2 aquifers namely phreatic and fractured aquifer made up of granite gneiss. The taluks are overexploited in terms of groundwater resource with problems of fluoride and nitrate contamination. Suitable recharge structures, roof top rain water harvesting, desiltation and maintenance of lakes, point recharge structures, regulation on drilling of borewells were suggested.
- Bangalore Urban Report for CGWB, CHQ, Faridabad ,2017-18 explaining the groundwater scenario in the core part vs peripheral part of the city. From the point of

drinking water supply, the core area is fully covered by surface water supply from Cauvery river source and the outer peripheral area is partly by surface water source and partly by ground water source.

- As the core part of the city is covered by surface water supply, the dependence on ground water for drinking water is minimal in this area. Ground water source helps to augment the supply when there is shortage or disturbance during the regular supply. The BWSSB has projected that, the demand for water has increased from 1400 MLD in 2011 to 4100 MLD in 2051 and the supply is 950 MLD in 2011 to 2070 MLD upto 2031 and thereafter the supply is pegged to 2070 MLD only.
- Groundwater Impacts of Water Consumption Patterns in Bengaluru, India by Vishal K. Mehta, Muddu Sekhar and Deepak Malghan; JGWR (ISSN: 2321- 4783), Vol.2, Issue1, June 2013 Published by AGGS, India - In this paper, taking Bangalore as a case study, the authors have illustrated the possible impacts of domestic water supply and consumption through lumped and distributed simulations of net groundwater recharge. The lumped model results show that a severe lack of systematic data on actual groundwater extraction. The study concluded with recommendations for gaining a better understanding of Bangalore's groundwater status and dynamics, as well as the importance of systematic collection of water extraction data from all sectors, and from all sources.
- Groundwater Level Dynamics in BengaluruCity, India (2017) by M. Sekhar, Sat Kumar Tomer, S. Thiyaku, P. Giriraj, Sanjeeva Murthy and Vishal K. Mehta; Sustainability. 10. 26. 10.3390/su10010026- In this study the authors deployed a dense monitoring network in 154 locations in Bengaluru, India between 2015 and 2017. Groundwater levels collected at these locations were analyzed to understand the behavior of the city's groundwater system. At a local scale, groundwater behavior is non-classical, with valleys showing deeper groundwater than ridge-tops. In the drought year of 2016, groundwater depletion was estimated at 27 mm, or 19 Mm³ over the study area. The data showed that rainfall has the potential to replenish the aquifer. Sustainable groundwater management in Bengaluru must account for substantial spatial socio-hydrological heterogeneity. Continuous monitoring at high spatial density will be needed to inform evidence-based policy.
- Deep Drilling for Groundwater in Bengaluru, India: A Case Study on the City's Over-Exploited Hard-Rock Aquifer System by by Tejas Kulkarni, Matthias Gassmann, C. M. Kulkarni, Vijayalaxmi Khed and Andreas Buerkert; Sustainability 2021, 13(21), 12149; <https://doi.org/10.3390/su132112149> Using preliminary surveys, the study

looked at the spatio-temporal evolution of the wells on a city scale and found that catchments with deficient water infrastructure have deeper wells. To maintain yields, wells with depths >400 m were drilled, especially since 2000, leading to unsustainable groundwater extraction. Camera inspections in 54 wells at Electronic City in 2016 and 2017 revealed that water levels in the majority of the wells remained lower at depths <100 m, although some wells had deeper water levels at depths >250 m. Analysis of $\delta^{18}\text{O}$ and $\delta^2\text{H}$ signatures of groundwater samples at all depths followed the local meteoric water line indicating recent recharge, implying that drilling deeper only increased the borehole volume and does not tap into newer water sources. Water levels in deeper wells may stabilize at lower depths, are subject to high spatial variability, density of drilling, and high connectivity in upper zones. The study discusses the interconnectedness between shallow and deeper aquifers. The research shows that increasing borewell depths could be a good indicator for falling aquifer water levels. The study fills an important gap in peri-urban, intermediate-scale aquifer conceptualizations across different land uses and provides further evidence for the difficulties of reliable groundwater monitoring in the over-exploited hard-rock aquifers of Bengaluru city.

- Assessing the role of groundwater recharge from tanks in crystalline bedrock aquifers in Karnataka, India, using hydrochemical tracers by Bentje Brauns, Somsubhra Chattopadhyay, Dan J. Lapworth, Sian E. Loveless, Alan M. MacDonald, Andrew A. McKenzie, Muddu Sekhar, Siva Naga Venkat Nara, Veena Srinivasan; Journal of Hydrology X, Volume 15, 1 May 2022, 100121; <https://doi.org/10.1016/j.hydroa.2022.100121> The study concluded that the importance of aquifer recharge from tanks is limited compared to other recharge sources and highly dependent on the specific setting. Additional studies to quantify tank recharge and revisions to the current guidelines for national groundwater recharge estimations, using a less generalised approach, are recommended to avoid over-estimating the role tanks play in groundwater recharge.
- Percolation pits push up Lalbagh groundwater by 20 feet | Deccan Herald <https://www.deccanherald.com/city/top-bengaluru-stories/percolation-pits-push-up-lalbagh-groundwater-by-20-feet-929042.html>
- Groundwater over-exploited in 4 taluks in Bengaluru Urban: study <https://www.thehindu.com/news/cities/bangalore/groundwater-over-exploited-in-4-taluks-in-bengaluru-urban-study/article35356902.ece>

- Drilling of PZ/EW/OW: The study area was taken up under drilling of EW/OW/PZ through In house and National Hydrology Project.

4.0 OBJECTIVES OF THE PRESENT STUDY:

- Monitor aquifer wise water level and quality in 10sq.km gridded areas to identify problematic areas
- Identify how the groundwater scenario of the city has changed over the last 3 decades
- Identify recharge areas and groundwater potential zones
- Identify drinking water source
- Plan for drinking water source sustainability
- Develop an implementable aquifer wise groundwater management plan
- Formulate artificial recharge plan and feasible water conservation measures
- Ensure sustainability of existing drinking water source for water security
- Inculcate participatory approach and awareness at community level

5.0 EXISTING DATA ANALYSIS:

The existing data is presented in **Table 1** and **Figures**.

Table 1: Existing Data in the study area

NHS	EW	VES	TEM	WQ	IT	Slug test/ PYT /PT
CGWB DW: 19 CGWB PZ: 23 GWD DW: nil GWD PZ: 18	23	85 Carried out under short term water supply investigation	Nil	18	Data not availab le	23 PYT/ slug test

NHS: National Hydrograph Station, EW: Exploratory Well, VES: Vertical Electrical Sounding,
TEM: Transient Electromagnetic, WQ: Water Quality, IT: Infiltration Test, PT: Pumping Tests

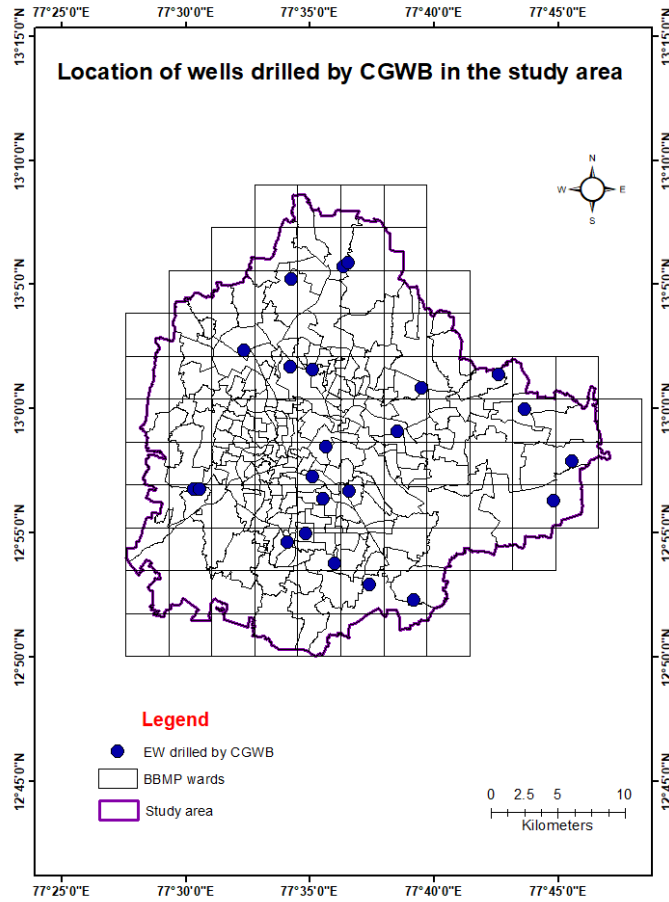


Figure 2: Existing EW drilled by CGWB in the study area

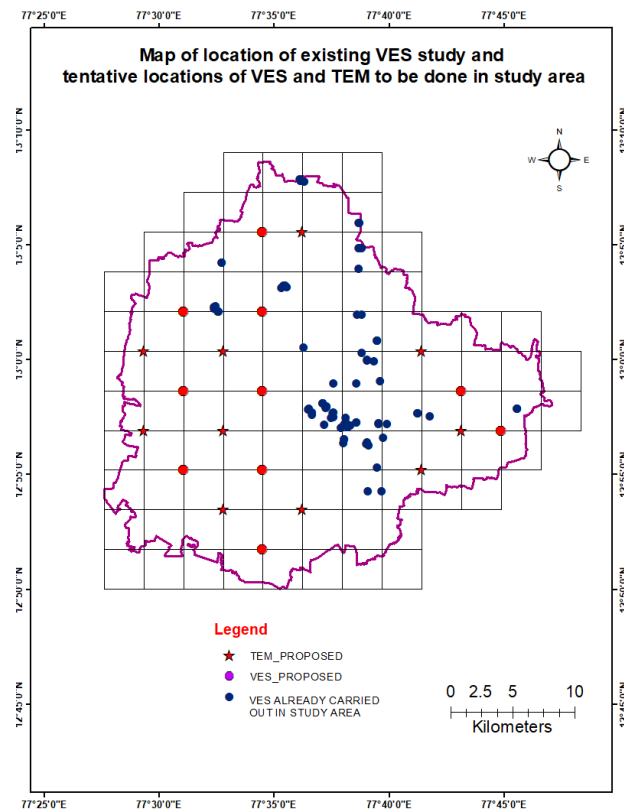


Figure 3: Map of proposed and existing VES locations in the study area

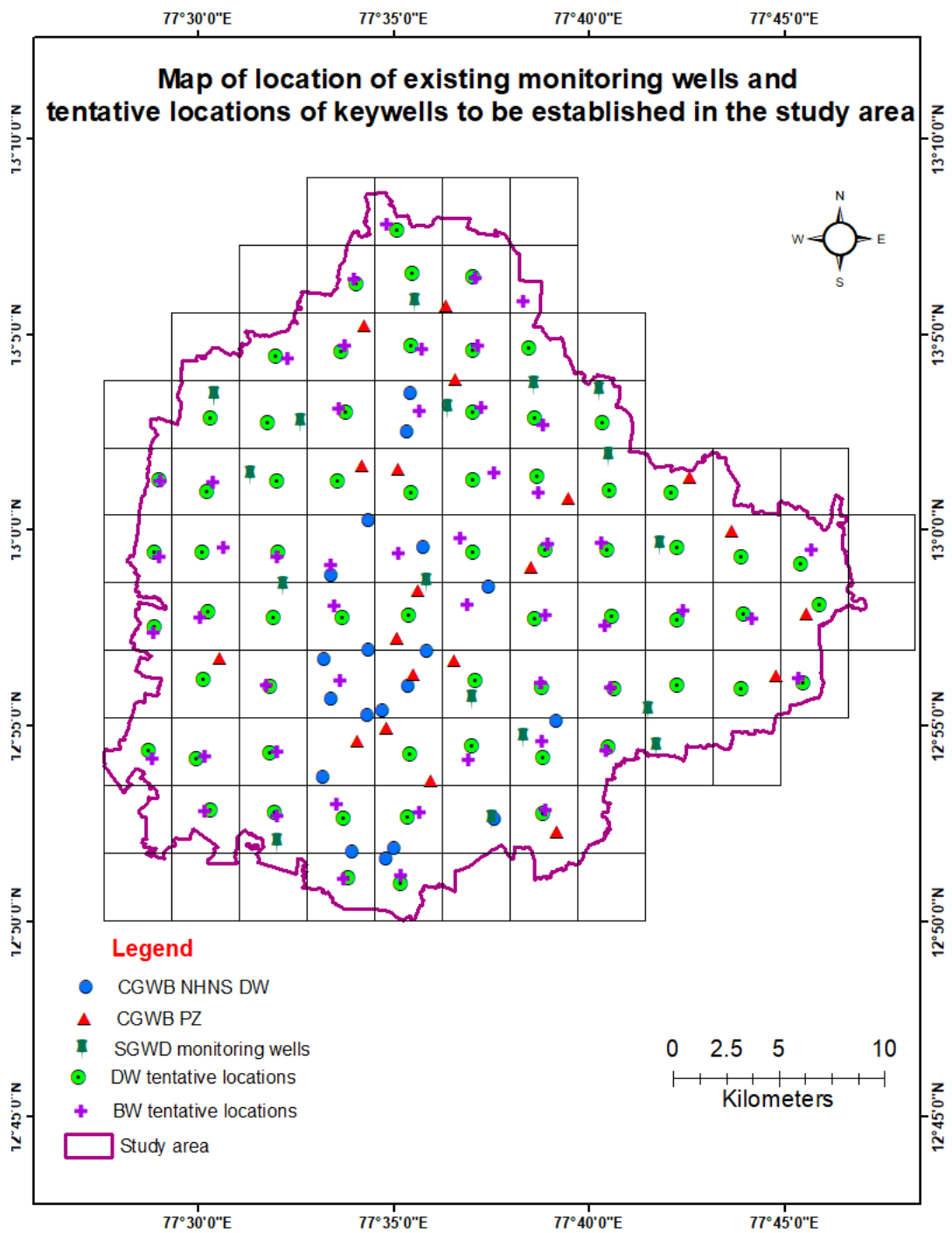


Figure 4: Location of existing monitoring wells and tentative location of wells to be established

6.0 DATA GAP ANALYSIS

The proposed data gap generation to be taken up in the study area is presented in **Table 2**. This is a tentative map prepared which may be modified or refined based on real field conditions like availability and accessibility due to forest cover.

Table 2: Proposed Data generation in the study area in 10sq.km grids

Water level monitoring	EW	VES	TEM	WQ	IT
DW: 65 BW: 51	No drilling activity proposed as per AAP	10 proposed as per AAP	No TEM proposed as per AAP 10 proposed for NAQ UIM study requirement	DW : 56 BW : 43	10

The numbers given above are tentative and may vary as per field situation

7.0 NEW DATA GENERATION PLAN

Activity wise monthly targets for new data generation and Plan for integration with other ongoing activities.

Activity	Deliverable
Exploratory Drilling	Not proposed.
Pumping Test	Not proposed. Will explored the possibility of pumping test in dug well.
Water Level	1 every 10 sq. km.
Water Quality	1 every 10 sq. km Bacteriological samples are also proposed to be collected .
VES/TEM/Imaging	10 nos. VES and 10 nos.TEM,As per space availability and datagap.
Feedback and Sample survey	At least 1 for each 10sq.km

8.0 MONTH-WISE ACTIVITY PLAN

May to 2nd Week of June - Pre-monsoon Field Work - 20 to 25 days depending on the area.

June-October - Data Analysis and interpretation, Chemical Analysis of Samples;

October 4th Week - Mid-term appraisal presentation.

15 October to 15 November- Post Monsoon Field Visit (20 to 25 days depending on the area),

15 November to 15 January - Field visit for verification and ground truthing (20 to 25 days) and Data Analysis and interpretation

15 January to 15 February - Ground water management plan preparation

15 February to 15 March - Report Finalisation

15 March to 31 March - Sharing the Report and findings

9.0 Composition of the Team

- **Team Lead:** Dr. Suchetana Biswas, Scientist- C
- **Hydrogeologist:** Ms. Caroline Louis, Sc-C
- **Hydrologist:** Dr. Lubna Kouser, Sc-C
- **Geophysicist:** Smt. Veena Achutha, Sc-D
- **Chemist:** Smt. Lalitha B.H., STA (Chemist)

10.0 Team-member-wise responsibilities and monthly targets for entering in the MIS

- **Team Lead: Dr. Suchetana Biswas, Scientist- C**
 - Planning, Supervision and Execution of the Project
 - Work distribution and monitoring of activities of other team members
 - Preparation of the inception report
 - Timely Delivery of the envisaged Outputs
 - Finalization of the management plan
 - Presentations at different forums, sharing of the outputs
 - Preparation of the draft report as per the approved Quality Standards and its Final Submission
 - Priority area wise deliverables and outputs for GMU wise implementable management Plan.

➤ **Expert (Hydrogeology): Ms. Caroline Louis, Sc-C**

- Field Data Collection (Water Level, Water Quality, Pumping Tests, demand/supply data, sample surveys and others)
- Sample collection for quality studies
- Secondary Data collection
- Entering data in database (WIMS) immediately after collection of data and returning to HQ.
- Integration of data, preparation of thematic maps, preparation of cross sections etc.
- Consultation with allied experts like agriculture, irrigation, agro- economics etc.
- Preparation of Management Plan
- Assisting the Team Lead in preparing maps and reports.
- Priority area wise deliverables and outputs for GMU wise implementable management Plan.

➤ **Expert (Geophysics): Smt. Veena Achutha, Sc-D**

- Field Geophysical Surveys
- Interpretation of field data
- Entering data in database (WIMS)
- Integration with existing geophysical and lithology data
- Preparation of inferred lithologs
- Suggesting potential sites for construction of water wells/artificial recharge
- Preparation of Tables, graphs and maps for reports
- Assisting the Team Lead in preparing the Report
- Priority area wise deliverables and outputs for GMU wise implementable management Plan.

➤ **Expert (Hydro chemistry): Smt. Lalitha B.H., STA (Chemist)**

- Analysis of samples.
- Integration with existing data
- Validation and interpretation of data
- Entering data in database (WIMS)
- Preparation of Tables, graphs and maps for reports
- Assisting the Team Lead in preparing the reports
- Priority area wise deliverables and outputs for GMU -wise implementable management Plan.

➤ **Expert (Hydrology): Dr. Lubna Kouser, Sc-C**

- Carrying out soil infiltration test wherever required
- Integration with existing data
- Validation and interpretation of data
- Entering data in database (WIMS)
- Preparation of Tables, graphs and maps for reports
- Assisting the Team Lead in preparing the reports
- Priority area wise deliverables and outputs for GMU -wise implementable management Plan.

ANNEXURE-I**Location of CGWB monitored Dugwells and Piezometers**

Sl_No	VILLAGE	LATITUDE	LONGITUDE	Well_Type
1	Gottigere(A)	12.860000000000	77.580000000000	DW
2	Bangalore (South)	12.915793000000	77.580392000000	PZ
3	B'lore University	12.945730000000	77.509455000000	PZ
4	Hebbal	13.025886000000	77.585320000000	PZ
5	Indiranagar	12.984464000000	77.641982000000	PZ
6	Lalbagh Garden	12.954163000000	77.585041000000	PZ
7	Singasandra	12.871648000000	77.653008000000	PZ
8	Varthur	12.937796000000	77.746457000000	PZ
9	Yelehanka	13.086884000000	77.571074000000	PZ
10	Basavanagudi	12.948745000000	77.572345000000	DW
11	Beguru	12.876958000000	77.626219000000	DW
12	Byrasandra	12.933616000000	77.589400000000	DW
13	Chennammanakere Achkattu	12.928336000000	77.556592000000	DW
14	Gollahalli	12.863103000000	77.565401000000	DW
15	Gottigere	12.864568000000	77.583709000000	DW
16	Hebbala	13.041889000000	77.589205000000	DW
17	Jayanagara	12.923373000000	77.578444000000	DW
18	Kodigehalli	13.057990000000	77.590401000000	DW
19	Malleswaram	13.004223000000	77.572610000000	DW
20	Rajajinagara	12.981003000000	77.556527000000	DW
21	Srinagara	12.944780000000	77.553892000000	DW
22	Ulsoor	12.975664000000	77.623610000000	DW
23	Vasanthanagar	12.992653000000	77.596145000000	DW
24	Vasanthpur	12.895065000000	77.553176000000	DW
25	Wilsongarden	12.948325000000	77.597344000000	DW
26	H.S.R Layout	12.918913000000	77.652664000000	DW
27	Seva Kshetra Hospital	12.921320000000	77.572198000000	DW
28	A dugodi(Pz)	12.944693000000	77.609455000000	PZ
29	Jayanagara(Pz)	12.915793000000	77.580392000000	PZ
30	Lalbhag(Pz)	12.954163000000	77.585041000000	PZ
31	Singasandra(Pz)	12.871648000000	77.653008000000	PZ
32	IISC(Pz)	13.027429000000	77.569886000000	PZ
33	Nimans(Pz)	12.938679000000	77.592141000000	PZ
34	GSI(Pz)	12.910473000000	77.568180000000	PZ
35	Cubbon Park(Pz)	12.974395000000	77.593965000000	PZ
36	IIM(Bannerughatta)	12.893578000000	77.599520000000	PZ
37	Immadahally	12.964577100000	77.759144700000	PZ
38	Sadaramangala	12.999420000000	77.727530000000	PZ
39	Bhattarahalli	13.022700000000	77.709600000000	PZ
40	Kalkere	13.013670000000	77.657890000000	PZ
41	Jakkur(Pz)	13.095277780000	77.606111110000	PZ
42	Rachanahalli(Pz)	13.064166670000	77.609722220000	PZ

ANNEXURE-II**Tentative locations of dugwells to be established as keywells**

Sl.no	Longitude	Latitude	Ward location
1	77.4819	12.9909	Herohalli
2	77.4791	12.9062	Hemmigepura
3	77.4838	13.0213	Dodda Bidarakallu
4	77.4819	12.9588	Ullalu
5	77.5054	13.0477	Bagalakunte
6	77.5041	13.0166	Peenya Industrial Area
7	77.5022	12.9909	Hegganahalli
8	77.5048	12.9652	Jnana Bharathi Ward
9	77.5025	12.9366	Jnana Bharathi Ward
10	77.4997	12.9027	Hemmigepura
11	77.5055	12.8811	Hemmigepura
12	77.5332	13.0742	Kuvempu Nagar
13	77.5298	13.0460	Jalahalli
14	77.5337	13.0212	Nandini Layout
15	77.5341	12.9905	Kamakshipalya
16	77.5324	12.9631	Attiguppe
17	77.5311	12.9336	Rajarajeshwari Nagar
18	77.5311	12.9054	Uttarahalli
19	77.5328	12.8798	Hemmigepura
20	77.5674	13.1050	Atturu
21	77.5610	13.0763	Vidyaranyapura
22	77.5632	13.0503	Dodda Bommasandra
23	77.5597	13.0208	Malleswaram
24	77.5621	12.8776	Vasanthpura
25	77.5640	12.8519	Anjanapura
26	77.5614	12.9629	Chalavadipalya
27	77.5914	13.1095	Chowdeshwari Ward
28	77.5909	13.0786	Yelahanka Satellite Town
29	77.5909	13.0163	Gangenahalli
30	77.5898	12.9641	Sampangiram Nagar
31	77.5903	12.9047	Puttenahalli
32	77.5866	12.8495	Gottigere
33	77.5895	12.8782	Gottigere
34	77.6172	13.1079	Jakkuru
35	77.6175	13.0765	Jakkuru
36	77.6175	13.0502	Thanisandra
37	77.6172	13.0213	Nagavara
38	77.6175	12.9905	Pulikeshi Nagar
39	77.6181	12.9360	Koramangala
40	77.6168	12.9080	Bilekhali
41	77.6470	12.8795	Singasandra

42	77.6473	12.9033	Mangammanapalya
43	77.6467	12.9331	Agara
44	77.6438	12.9623	Jeevanbhima Nagar
45	77.6483	12.9915	Benniganahalli
46	77.6444	13.0229	Banasavadi
47	77.6438	13.0480	Horamavu
48	77.6413	13.0778	Jakkuru
49	77.6724	13.0460	Ramamurthy Nagar
50	77.6752	13.0169	Horamavu
51	77.6743	12.9918	A Narayanapura
52	77.6765	12.9632	HAL Airport
53	77.6774	12.9325	Bellanduru
54	77.6749	12.9077	Bellanduru
55	77.7041	12.9341	Varthuru
56	77.7044	12.9620	Dodda Nekkundi
57	77.7044	12.9924	Garudachar Palya
58	77.7019	13.0159	K R Pura
59	77.7314	12.9886	Hudi
60	77.7326	12.9642	Hagadur
61	77.7317	12.9328	Varthuru
62	77.7580	12.9350	Varthuru
63	77.7647	12.9683	Hagadur
64	77.5848	13.1279	Chowdeshwari Ward
65	77.7571	12.9858	Kadugodi

ANNEXURE-III**Tentative locations of borewells to be established as keywells**

Sl.no.	Longitude	Latitude	Ward location
1	77.4842	13.0210	Dodda Bidarakallu
2	77.4834	12.9889	Herohalli
3	77.4811	12.9564	Ullalu
4	77.4807	12.9029	Hemmigepura
5	77.5064	13.0206	Peenya Industrial Area
6	77.5112	12.9929	Kottegepalya
7	77.5009	12.9627	Jnana Bharathi Ward
8	77.5033	12.9036	Hemmigepura
9	77.5029	12.8803	Hemmigepura
10	77.5382	13.0730	Kuvempu Nagar
11	77.5337	12.9888	Kamakshipalya
12	77.5292	12.9343	Rajarajeshwari Nagar
13	77.5337	12.9057	Uttarahalli
14	77.5338	12.8784	Hemmigepura
15	77.5667	13.1068	Atturu
16	77.5600	13.0517	Dodda Bommasandra
17	77.5567	12.9851	Srirammandir
18	77.5583	12.9677	Binnipete
19	77.5605	12.9361	Vidyapeeta Ward
20	77.5591	12.8835	Vasanthpura
21	77.5619	12.8517	Anjanapura
22	77.5864	12.8530	Gottigere
23	77.5946	12.8800	Arakere
24	77.5854	12.9901	Vasanth Nagar
25	77.5943	13.0510	Byatarayanapura
26	77.5952	13.0770	Byatarayanapura
27	77.5803	13.1303	Chowdeshwari Ward
28	77.6184	13.1074	Jakkuru
29	77.6190	13.0786	Jakkuru
30	77.6206	13.0522	Thanisandra
31	77.5629	13.0786	Vidyaranyapura
32	77.6260	13.0246	HBR Layout
33	77.6121	12.9967	Pulikeshi Nagar
34	77.6149	12.9685	Shantala Nagar
35	77.6155	12.9022	Bilekhali
36	77.6466	12.9104	HSR Layout
37	77.6463	12.9352	Agara
38	77.6482	12.9637	Jeevanbhima Nagar
39	77.6492	12.9942	Benniganahalli
40	77.6451	13.0161	Banasavadi
41	77.6473	13.0446	Horamavu
42	77.6387	13.0976	Jakkuru
43	77.6758	12.9333	Bellanduru

44	77.6739	12.9063	Bellanduru
45	77.6736	12.9593	HAL Airport
46	77.6720	12.9945	A Narayanapura
47	77.7612	12.9916	Kadugodi
48	77.7358	12.9621	Hagadur
49	77.7069	12.9659	Dodda Nekkundi
50	77.7561	12.9368	Varthuru
51	77.6483	12.8807	Singasandra

ANNEXURE-IV**Tentative locations for bacteriological, COD,BOD sample analysis from borewells**

Sl.no.	Longitude	Latitude	Ward name
1	77.5593	12.8824	Vasanthpura
2	77.5038	12.9033	Hemmigepura
3	77.6473	12.9362	Agara
4	77.5597	12.9366	Vidyapeeta Ward
5	77.7554	12.9366	Varthuru
6	77.5922	12.9375	Jayanagara
7	77.6747	12.9588	HAL Airport
8	77.4837	12.9883	Herohalli
9	77.5341	12.9883	Kamakshipalya
10	77.5837	12.9905	Vasanth Nagar
11	77.7610	12.9917	Kadugodi
12	77.6490	12.9947	Benniganahalli
13	77.6973	12.9952	Devasandra
14	77.5064	13.0205	Peenya Industrial Area
15	77.6255	13.0251	HBR Layout
16	77.6486	13.0434	Horamavu
17	77.5948	13.0516	Byatarayanapura
18	77.5597	13.0520	Dodda Bommasandra
19	77.6183	13.1075	Jakkuru
20	77.5811	13.1306	Chowdeshwari Ward

ANNEXURE-V**Location of EW drilled by CGWB in study area**

Sl.no.	Longitude	Latitude	Location name
1	77.5680	12.9100	GSI Office PZ
2	77.5390	13.0390	CWC Office PZ
4	77.5700	13.0280	IISc, Sadashivnagara PZ
5	77.5920	12.9390	Nimhans PZ
6	77.5940	12.9740	Cubbon Park PZ
7	77.6060	13.0950	BWSSB Yelhanka, Jakkur PZ
8	77.6090	13.0980	Rachnehalli , Jakkur PZ
9	77.6000	12.8960	IIM, Bannerghatta PZ
11	77.5055	12.9458	Bangalore University
12	77.6234	12.8815	Begur Govt. Primary School
16	77.6095	12.9447	Adegudi
18	77.5804	12.9158	Bangalore (South)
20	77.5095	12.9457	B'lore University
24	77.5853	13.0259	Hebbal
26	77.6420	12.9845	Indiranagar
31	77.5850	12.9542	Lalbagh Garden
33	77.6530	12.8716	Singasandra
36	77.7465	12.9378	Varthur
37	77.5711	13.0869	Yelehanka
38	77.7591	12.9646	Immadihally
41	77.7275	12.9994	Sadaramangala
43	77.7096	13.0227	Bhattarahalli
44	77.6579	13.0137	Kalkere

ANNEXURE-VI**Location of VES conducted by CGWB in study area**

Sl.no.	Longitude	Latitude	Location name
1	77.5453	13.0702	Airforce Jalahalli East
2	77.5453	13.0702	Airforce Jalahalli East
3	77.6335	12.9397	ASC Butchery
4	77.6086	12.9639	RMS campus
5	77.6108	12.9618	RMS campus
6	77.6107	12.9603	RMS campus
7	77.6468	13.0051	MEG & Centre TBIII
8	77.6555	12.9991	MEG & Centre TBIII
9	77.6510	12.9050	Defence Trng Centre, Iblur
10	77.6610	12.9050	Defence Trng Centre, Iblur
11	77.6580	12.9220	Defence Trng Centre, Iblur
12	77.6185	12.9687	MEG&Centre, TB-III(New)
13	77.6185	12.9687	MEG&Centre, TB-III(New)
14	77.6185	12.9687	MEG&Centre, TB-III(New)
15	77.6185	12.9687	MEG&Centre, TB-III(New)
16	77.6185	12.9687	MEG&Centre, TB-III(New)
17	77.6340	12.9530	ASC centre, Agram
18	77.6082	12.9643	RMS campus
19	77.6083	12.9645	RMS campus
20	77.5401	13.0383	ALISDA
21	77.5410	13.0386	ALISDA
22	77.5399	13.0372	ALISDA
23	77.5912	13.0537	OTM/Army, Hebbal
24	77.5902	13.0540	OTM/Army, Hebbal
25	77.5897	13.0531	OTM/Army, Hebbal
26	77.5924	13.0526	OTM/Army, Hebbal
27	77.5887	13.0519	OTM/Army, Hebbal
28	77.6339	12.9425	ASC Centre, North,Ejipura
29	77.6429	12.9546	ASC Centre, North,Ejipura
30	77.6449	13.0994	AIFD,Kothanur
31	77.6447	13.0994	AIFD,Kothanur
32	77.6469	13.0328	MEG&Centre
33	77.6436	13.0328	MEG&Centre
34	77.6444	13.0661	MEG&Centre
35	77.6265	12.9828	65JCO,ASC South
36	77.6428	12.9828	65JCO,ASC South
37	77.6047	13.0091	Paramilitary traning centre
38	77.6449	13.0811	MEG & Centre
39	77.6447	13.0809	MEG & Centre
40	77.6467	13.0811	MEG & Centre
41	77.6339	12.9425	Ejipura
42	77.6429	12.9546	Ejipura
43	77.6265	12.9616	ASC Centre

44	77.6258	12.9613	ASC Centre
45	77.6600	12.9844	DRDO,Bangalore
46	77.6623	12.9435	DRDO,Bangalore
47	77.6653	12.9533	DRDO,Bangalore
48	77.6383	12.9526	Army campus, AT COY
49	77.6370	12.9511	Army campus, AT COY
50	77.6508	12.9995	MEG Centre
51	77.6505	12.9998	MEG Centre
52	77.6261	12.9585	ASC, Agram
53	77.6350	12.9544	ASC Centre & College (North)
54	77.6361	12.9528	ASC Centre & College (North)
55	77.6317	12.9508	ASC Centre & College (North)
56	77.6210	12.9659	ASC Centre & College (South)
57	77.6350	12.9544	ASC Centre & College (South)
58	77.6194	12.9528	ASC Centre & College (South)
59	77.6317	12.9508	ASC Centre & College (South)
60	77.6874	12.9614	CEMILAC,DRDO ,Marthahalli
61	77.6874	12.9614	CEMILAC,DRDO ,Marthahalli
62	77.6874	12.9614	CEMILAC,DRDO ,Marthahalli
63	77.6963	12.9593	Akash vihar, Marthahalli
64	77.6211	12.9661	Akash vihar
65	77.6211	12.9656	ASC CENTER and COLLEGE- Bangalore
66	77.6208	12.9657	ASC CENTER and COLLEGE- Bangalore
67	77.6210	12.9653	ASC CENTER and COLLEGE- Bangalore
68	77.6589	12.9539	CABS, DRDO ,BELUR, BANGALORE .
69	77.6588	12.9538	CABS, DRDO ,BELUR, BANGALORE .
70	77.7591	12.9645	Imandahalli
71	77.7591	12.9645	Imandahalli
72	77.7591	12.9645	Imandahalli
73	77.6579	13.0137	Kalkere
74	77.6579	13.0137	Kalkere
75	77.6579	13.0137	Kalkere
76	77.5433	13.0350	CQAE, Jalahalli, Bangalore
77	77.5427	13.0350	CQAE, Jalahalli, Bangalore
78	77.6247	12.9580	ASC College
79	77.6354	12.9580	ASC College
80	77.6503	12.9390	ASC College
81	77.6506	12.9400	ASC College
82	77.6520	12.9380	ASC College
83	77.6024	13.1300	BSF, Yelahanka
84	77.6021	13.1310	BSF, Yelahanka
85	77.6054	13.1290	BSF, Yelahanka