REPORT ON

THE GROUND WATER CONDITIONS IN AND AROUND COCA-COLA BEVERAGES PRIVATE LIMITED COMPANY, PLACHIMADA, PALAKKAD DISTRICT, KERALA

The Coca-Cola Beverages Pvt. Ltd. as shown in Fig.1 is located at Plachimada village in Chittur taluk, Palakkad district, Kerala State. It is situated about 30 km east of Palakkad town and 45 km south west of Coimbatore. The factory was established in March 2000. It is having about 140 regular employees and 250 casual labourers. Coca-Cola, Fanta, Sprite, Limca, Kingley Soda, Maaza and Thums-UP are produced in the factory.

The Plachimada (Moolathara) village is falling in Palakkad gap area of Kerala state shows generally undulating topography and is drained by Chitturpuzha stream, a major tributary of Bharatapuzha river. The lined main canal of Moolathara Canal from Kambalathara Dam runs close north of Coca-Cola plant and flow in the canal is maintained for about 9 months in a year from June to February. The location of factory building, factory premises, canal and wells are shown in Fig.2.

Agriculture is the most important occupation for the population in the area. Of the 1 sq km study area, about 75 acres of the land is cropped with coconut trees and 25 acres of land is used for vegetable cultivation. The coconut and vegetables are irrigated using ground water from dug wells. Groundnut ands pulses are cultivated during rainy season as rain fed crops.

Geologically the area us underlain in Achaean crystalline rocks and higher grade of metamorphism and weathered form as valley fills. Hornblende biotitic gneisses and calc granulites are the major rock types which are intruded by pegmatite and quartz veins. The lithological cross section of the dug wells shows the presence of kankar which is calcium rich weathered product.

Ground water occurs under phreatic conditions in the weathered and fractured crystallines at shallow depth and semi-confined condition in the deeper fractures. The shallow fractures having hydraulic connection with the weathered zone act as a good ground water reservoir along with the weathered zone act as a good ground water reservoir along with the weathered zone.

Water Requirement of Coca-Cola plant

The requirement of water for Coca-Cola plant is based on the seasonality and production volume. The average water consumption of the factory is 5 lakhs lit/day, out of which 1.5 lakh lit/day is being used for producing beverages. Around 5 lakh is used for cooling towers, boiler make up and domestic purposes. The remaining quantity of water is treated since it contains effluent discharge and is used for gardening of the premises. The water is treated and part is recycled to the plant for non process activities.

Ground Water use in study area

The following ground water structures being used in the study area for different purposes are given in Table –1

Table-1 Existing Ground Water Structures for various purposes

Type of well	Irrigation	Domestic	Industrial	Total
Dug well	21	18	2	41
Bore well	2	2	6	10

M/s Coca-Cola Beverages Pvt. Ltd is using water from 6 borewells and 2 dug wells to the following manner.

1. 2 dug wells (together) are pumped for 12 hours and 240 kilolitres/day is used
2. 6 bore wells are pumped for 12 hours and 270 kilolitres/day is used.

The total ground water pumped per day is 510 kilolitres. It may be mentioned that M/s Coca-Cola is not registered with CGWA so far.

Rainfall in the study area

Meenkara rain gauge station is located 4 km away from Coca-Cola plant. Year wise rainfall for 5 years is given in table-2. The average rainfall of the area is 1560 mm.

Table-2 Year wise rainfall at Meenkara

Year	**Rainfall (in mm)**
1988	2060
1999	1785
2000	2137
2001	1147
2002	670

Water Level Monitoring

Water level monitoring of dug wells was carried in the months of June September 2002 and February 2003. The water level for June, September 2002, February 2003 and fluctuation data are given in table 3.

A total number of 45 (41 DW + 4 BH) wells were inventoried (Fig.2) during June, 2002, September 2002 and February 2003 to know the behaviour of water level in and around the area as there is no historical water level data of the area. 43 wells are within a radius of ½ km of the factory and 2 wells are within the factory premises.

The depth to water level during June 2002 (Pre-monsoon) ranges from 3.20 to 11.95 mbgl and during the month of September 2002, (post monsoon) it is between 1.60 and 10.75 mbgl. The water level observation made during the month of February 2003 reveals that the water level in the area ranged from 3.20 to 11. 83 mbgl.

In the absence of historical water level data of the area, the comparison of September 2002 (post monsoon) ind9cates a rise in the water level of all the wells ranging from 0.50 m to 7.05 (Average=2.2 m). Further the water level during February 2003 has declined in the range of 0.25 and 2.40 m (Average=1.34). A few wells have shown rise in water level during February 2003.

The rise in water level during September 2003 when compared with June 2002 level and decline of water level during February 2003 when compared with September 2002 is a normal behaviour of water level, which is coinciding with the rainfall pattern of the area.

Table-3 Water level for June, September 2002 and February 2003 and fluctuation data

Sl. No.	**Well No.**	**Well type**	**location**	**Water level (mbgl) June 2002**	**Water level (mbgl) Sept. 2002**	**Fluctuation of water level between June 02 and Sept. 02 (m)**	**Water level (mbgl) Feb. 2003**	**Fluctuation of water level between Sept.02 and Feb. 2003**
1.	F1	Dug well	In the premises of Coca-Cola plant	7.36	2.9	+4.46	1.5	+1.4
2.	F2	-do-	In the premises of Coca-Cola plant	6.63	2.45	+4.18	1.4	+1.05
3.	1	-do-	Well located near Mariamman temple at Vijayanagaram, Panchayat well	4.3	3.1	+1.83	5.5	-2.4
4.	2	-do-	In the house of Sri Palanisamy, near Anganvady	4.3	2.85	+1.58	5.2	-2.35
5.	3	-do-	In the house of Sri Muthusamy	6.27	2.9	+3.37	5.30	-2.4
6.	4	-do-	In the house of premises of Sri Subramanian	3.2	1.6	+1.6	3.2	-1.6
7.	5	-do-	In the house premises of Smt Mailathai	5.15	3.31	+1.84	5.95	-2.64
8.	6	-do-	In the house premises of Sri Arumugham	6.5	4.4	+2.1	6.3	-1.9
9.	7	-do-	In the house premises of Sri Marimuthu	6.55	4.75	+1.8	7.15	-2.4
10.	8	-do-	In the house premises of Sri Nataraj	7.2	5.25	+1.95	7.1	-1.75
11.	9	Bore well	In the Agri farm of Nataraj	7	NC	-	NC	-
12.	10	Dug well	In the house premises of Sri Nataraj	3.65	3.15	+0.5	3.9	-0.75
13.	11	-do-	In the Agri farm of Sri Radhakrishnan Vijayanagaram	6.15	5.9	+0.25	3.58	+2.32
14.	12	-do-	In the Agri. Farm of Sri.	9.6	6.8	+2.8	7.5	-0.7

			Rajappan					
15.	13	-do-	In the Agri. Farm of Sri Sahul Hamid	7.15	5.0	+2.15	5.1	-0.1
16.	14	-do-	In the Agri. Farm of Sri. Krishnaswamy	6.15	3.8	+2.35	4.0	-0.2
17.	15	-do-	In the Agri. Farm of Sri. John	7.0	4.1	+2.9	5.9	-1.8
18.	16	-do-	In the Agri. Farm of Smt. Meenakshiamma	9	7.1	+1.9	8.16	-1.06
19.	17	-do-	In the Agri. Farm of Sri. Palanisamy	8.0	NC	NC	NC	NC
20.	18	-do-	Velur, located near Mariamman temple Panchayat well	7.8	4.6	+3.18	6.05	-1.45
21.	19	-do-	In the house premises of Sri.Aruchamy, Velur	8.1	6.3	+1.18	7.54	-1.24
22.	20	-do-	In the house premises of Sri. Sheik Mustafa	11.95	10.75	+1.2	11.83	-1.08
23.	21	-do-	In the Agri. Farm of Sri. Sheik Mustafa	9.25	7.75	+1.5	8.52	-0.77
24.	22	-do-	In the Agri. Farm of Mani	4.8	NC	-	NC	-
25.	23	-do-	Well located in the Agri. Farm of Sri. Rathansamy	6.0	6.0	-	NC	-
26.	24	Bore well	Well located in the Agri. Farm of Sri. Rathansamy	9.0	NC	-	-	-
27.	25	Dug well	In the Agri. Farm of Sri. Velusamy	8.3	6.5	+1.8	6.3	+0.20
28.	26	-do-	Well located in the Agri. Farm of Mayilchamy Gownder	7.5	6.5	+1.0	5.1	+1.4
29.	27	Bore well	Well located in the Agri. Farm of Mayilchamy Gownder	8	NC	-	NC	-
30.	28	Dug well	Well located in the Agri. Farm of Sri. Sreedhar	6.7	5.6	+1.1	7.1	-1.5
31.	29	-do-	Well located in the Agri. Farm of Sri. Palaniswamy	6.5	5.5	+1.0	6.1	-0.6
32.	30	-do-	Well located in the Agri. Farm of Appuchamy	8.3	7.3	+1.0	7.9	-0.6
33.	31	-do-	In the house premises of Sri. Mustafa, Plachimada	8.94	8.45	+0.49	8.7	-0.25
34.	32	-do-	In the house premises of Sri. Velayutham	10.58	9.3	+1.28	9.94	-0.64
35.	33	-do-	In the house premises of Sri. Devaraj	11.25	4.2	+7.05	7.51	-3.31
36.	34	Bore well	Well located in the western side of Coca-Cola factory	9.0	NC	_	NC	-
37.	35	Dug well	Well located in the Agri. Farm of Sri. Aruchamy	6.5	4.6	+1.9	4.3	+0.3
38.	36	-do-	In the Agri. Farm of Sri. Raghavan	6.58	NC	-	5.5	-
39.	37	-do-	Well located in the Agri. Farm of Aruchamy Gownder	4.8	1.71	+3.09	-	-
40.	38	-do-	In the house premises of Sri. Palanisamy	7.9	-	-	6.2	+1.7
41.	39	-do-	In the house premises of Sri. Sreedhar	5	-	-	2.03	-
42.	40	-do-	Well located in the Agri. Farm of Sri. Sudevan	5.9	3.0	+2.9	3.73	-0.73

43.	41	-do-	In the house premises of Sri. Sivakumar	5.85	2.9	+2.95	3.73	-0.83
44.	42	-do-	In the house premises of Gopi	7.87	3.6	+4.27	5.2	-1.6
45.	43	-do-	In the house premises of K.P Balan	-	-	-	1.45	-

NB:- Fluctuation of water level + indicates rise
- indicates fall
NC Not Collected

Ground Water Quality

For monitoring of ground water quality the field measurements were done for TDS and pH for 33 wells in and around Coca-Cola plant, Plachimada, Palghat district in the middle of February 2003. As per Bureau of Indian Standard (BIS) the permissible limit of total dissolved solids (TDS) is 2000 mg/l. Out of 37 wells, 29 wells i.e. 78.3% fall within permissible limits and 8 wells i.e. 21.6% falls above permissible limits and the pH of the above wells and treated effluent of plant shows within limit as shown in Table-4.

Table 4: Field, measurement of TDS and pH in and around Coca-Cola plant, Palghat district

Sl No.	Well No.	Location	pH	TDS mg/l
1.	F1	In the premises of Coca-Cola plant	7.3	987
2.	F2	In the premises of Coca-Cola plant	7.4	948
3.	1	Treated effluent of the plant	7.9	869
4.	2	Well located near Mariamman temple at Vijayanagaram, Panchayat well	7.0	1730
5.	3	In the house of Sri. Palanisamy near Anganwady	7.6	2179
6.	4	In the house of Sri. Muthusamy	7.8	2115
7.	5	In the house premises of Sri. Subramaniam	7.4	2564
8.	6	In the house premises of Sri. Mylathal	6.7	2044
9.	7	In the house premises of Sri. Arumugam	6.9	1666
10.	8	In the house premises of Sri. Marimuthu	6.9	2628
11.	9	In the house premises of Sri. Nataraj	6.9	2756
12.	10	In the house premises of Sri. Nataraj	7.2	2750
13.	11	In the Agri. Farm of Sri. Radhakrishnan Vijayanagaram	7.5	480
14.	12	In the Agri. Farm of Sri Rajappan	7.2	326
15.	13	In the Agri. Farm of Sri Shahul Hameed	7.1	410
16.	14	In the Agri. Farm of Sri. Krishnaswamy	6.9	708
17.	15	In the Agri. Farm of Sri. John	7.4	211
18.	18	Velur, located near Mariamman temple	7.3	438

		Panchayat well		
19.	19	In the house premises of Sri. Aruchamy, Velur	7.1	192
20.	20	In the house premises of Sri. Sheik Mustafa	6.9	344
21.	21	In the Agri. Farm of Sri. Sheik Mustafa	7.4	490
22.	24	Well located in the Agri. Farm of Sri. Rathansamy	8.0	628
23.	25	In the Agri. Farm of Velusamy	7.7	474
24.	26	Well located in the Agri. Farm of Sri. Mayilchamy, Gownder	8.5	628
25.	28	Well located in the Agri. Farm of Sri. Sreedhar	7.7	589
26.	29	Well located in the Agri. Farm of Sri. Palaniswamy, Gownder	7.3	653
27.	31	In the house premises of Sri. Mustafa Plachimada	8.7	1615
28.	32	In the house premises of Sri. Velayuthan	6.7	1121
29.	33	In the house premises of Sri. Devaraj	6.8	1127
30.	35	Well located in t4h Agri. Farm of Sri. Aruchamy	6.9	1147
31.	36	In the Agri. Farm of Sri. Raghavan	6.7	1153
32.	38	In the house premises of Sri. Palanisamy	6.9	506
33.	39	In the house premises of Sri. Sreedhar	7.	269
34.	40	Well located in the house premises of Sri. Sivakumar	7.2	519
35.	41	In the house premises of Sri. Sivakumar	6.9	608
36.	42	In the house premises of Gopi	73	358
37.	43	In the house premises of K.P Balan	7.4	492

Results of heavy metal analysis show the samples within limit as shown in Table-5

Table 5: Results of heavy metal analysis of water sample collected in and around Coca-Cola plant, Plachimada, Palakkad District

S. No	Lab. No	Location	Cu mg/l	Pb mg/l	Zn mg/l	Mn mg/l	Cr mg/l	Cd mg/l	As mg/l	Hg mg/l
	Permissible limit as per (BIS)		1.50	0.05	15.0	0.3	0.05	0.01	0.05	0.001
1.	5370 A	Treated effluent of the plant	0.029	0.002	5.720	Nil	0.009	BDL	BDL	BDL
2.	5371 A	Premises of Coca Coal plant D/W-II	0.039	0.005	0.013	0.296	0.012	“	“	“
3.	5372 A	Premises of Coca-Cola plant B/w-I	0.009	0.002	0.110	0.004	0.005	“	“	“

4.	5373 A	In the house premises of Sri. Devaraj	0.018	Nil	0.040	0.014	0.011	"	"	"
5.	5374 A	In the house premises of Sri. Subramaniam	0.012	0.016	0.054	0.016	Nil	"	"	"

BDL – below Detection Limit

10 samples from in and around the plant and treated effluent from the plant have been collected for chemical analysis and analysed for 13 parameters including Pollution Parameters – Fluoride and Nitrate (Table-6).

As per Bureau of Indian Standard (BIS) the permissible limit is 600 mg/l for total hardness as CaCO3, 200 mg/l for Calcium and 1000 mg/l for Chloride. Total hardness and Calcium except two wells (Ref-well 5, 10 from Table-6) all samples fall within permissible limit and for Chloride except one well (No. 10 from Table-6) all samples fall within permissible limit as shown in the Table-6.

The Results of chemical analysis of the same 10 samples were compared with the results of earlier collection of the same wells, i.e. pre-monsoon June 2002 and post monsoon September 2002 is shown in Table-6 and it is observed that the EC value decreased from 3700 to 987 (Ref. Well no.1 from Table-6). It shows that water quality of the wells within the premises of plant improved. This may be probably due to the effect of rainfall and the artificial recharge scheme implemented by the company. The EC of treated effluent of plant has decreased from 2660 to 1352 which shows an improvement in quality of the treated effluent and it is within permissible limit. However the chemical constituent and EC of two wells (Well no.10 from Table-6) have increased from 2890 to 4290 which are located in Vijayanagaram close vicinity of the plant.

Chemical Quality of effluents

Treated effluent samples were collected and analysed. The results are given table 4,5 & 6. the E.C of treated effluent of Plant has decreased from 2660 in June 2002 to 1342 in February 2003 which shows an improvement in quality of the treated effluent is within permissible limit. The treated water passes through pond having fishes to validate its suitability for aquatic life. The treated effluent is used for irrigation of the lawns and coconut garden inside the factory premises.

Rainwater Harvesting and Ground Water Recharge

The Coca-Cola Company has already implemented rain water harvesting system in the factory premises. The company has constructed percolation tanks, percolation pits and dug cum bore wells. In addition to this the company is practicing in situ roof top rain water harvesting from main buildings of the factory for directly using for preparation of beverages after suitable treatment and surplus goes to recharge tanks.

								PPM										
Sl. No	**Well No.**	**Location**	**Source**		**Date of collection**	**pH**	**EC µs/cm at 25˚C**	**TH as $CaCO_3$**	**Ca**	**Mg**	**Na**	**K**	**CO_3**	**HCO_3**	**SO_4**	**Cl**	**F**	**NO_3**
1.	F1	In premises of Coca-Cola factory	D/W-I	Pre	14-6-02	7.18	3700	1170	370	60	363	6.0	0	573	38	965	0.96	6.20
				Post	14-9-02	7.24	1384	580	150	50	46	4.7	0	341	88	254	0.64	4.6
					14-2-03	6.96	987	410	118	28	37	2.5	0	268	19	178	0.82	2.0
2.	F2	“	D/W-II	Pre	15-6.02	7.40	1900	710	192	56	168	3.0	0	451	18	433	0.91	3.10
				Post	14-9-02	7.80	1735	545	128	55	190	4.8	0	366	42	405	1.26	3.8
					14-2-03	7.48	948	310	82	25	73	3.4	0	262	40	153	1.27	1.0
3.	F5	“	B/W-V	Pre	15-6-02	7.66	380	200	56	14	36	0	0	219	0	49	0.81	3.30
				Post	14-9-03	7.80	440	205	56	16	16	1.8	0	256	11	21	0.40	2.08
					14-2-03	7.7	303	120	34	8.5	11	1.2	0	154	3.7	14	0.12	0.9
4.		“	Treated effluent	Pre	15-6-02	7.90	2660	900	260	60	222	3.0	0	512	556	596	0.0	3.10
				Post	14-9-02	8.10	1690	570	116	38	136	3.9	0	378	58	405	0.81	5.34
					14-2-03	7.89	1352	440	120	34	109	4.8	0	342	62	256	1.24	1.3
5.	33	House of Devaraj	D/W	Pre	14-6-02	6.95	2600	980	148	148	265	5.0	0	244	21	695	0.96	13.0
				Post	15-9-02	7.06	1920	670	154	69	214	2.8	0	244	53	604	0.33	69.6
					15-2-03	7.29	1759	550	112	66	182	4.5	0	232	40	497	0.86	40
6.	35	House of Aruchamy	D/W		14-6-02	7.08	2320	880	204	90	138	0		451	20			

																530	0.93	4.16
					15-9-02	7.20	1790	695	162	71	124	6.0	0	488	30	462	0.74	8.58
7.	14	Agri farm of Krishnaswamy	D/W	Pre	13-6-02	7.14	635	340	88	29	21	0	0	366	0	42	0.74	2.48
				Post	15-9-02	7.50	850	345	88	30	32	1.8	0	220	19	135	1.08	8.32
					15-2-03	7.33	1106	470	136	32	46	1.9	0	354	23	170	0.59	6.6
8.	28	Agri farm of Sreedhar	D/W	Pre	15-6-02	7.60	750	360	80	38	36	0	0	439	17	35	1.05	10.40
				Post	15-9-03	7.84	760	345	72	40	30	3.3	0	451	29	43	.059	13.1
					15-2-003	7.6	920	380	94	35	27	3.3	0	433	35	32	0.89	16
9.	10	House of Nataraj	D/W	Pre	13-6-02	7.12	2890	970	280	65	243	3.0	0	524	17	724	0.78	1.96
				Post	15-9-02	7.30	3836	1390	298	157	205	4.4	0	403	71	1100	0.22	44.1
					14-2-03	7.4	4290	1540	408	126	268	28	0	403	69	1235	0.5	12
10	5	House of Subramanian	D/W	Pre	13-6-02	7.10	2750	1150	336	75	78	3.0	0	451	0	710	1.57	1.92
				Post	15-9-02	7.39	3250	1065	342	51	122	5.0	0	134	32	887	0.73	7.01
					15-2-03	7.43	3190	1280	376	83	155	6	0	451	20	852	0.6	3.7

D/W=Dug Well
B/W=Bore Well

Pre=Pre-monsoon
Post=Post-monsoon

Conclusion

1. The depth to water level of the dug wells (41 numbers) located in and around the factory ranging between 3.20 and 11.95 mbgl in June 2002 (premonsoon) and it is ranging between 1.60 and 10.75 mbgl in September 2002 (post monsoon). The water level fluctuation between June 2002 and Sept. 2002 is ranging between 0.50 and 7.05 m with an average rise of 2.2 m and again declined in the range of 0.25 and 2.40 m with an average fall of 1.34 m. No cases of complete drying up and abnormal changes in water level were observed in and around the factory.

2. The quality of water samples collected from the dug wells located in and around the factory during Feb. 2003 has been analysed. It is indicating that the TDS in 78.3% of wells are within the permissible limit of drinking water standard (BIS). No cases of abnormally high TDS has been found in the area and the water is suitable for all purposes.

3. The heavy metal analysis (Cu, AS, Hg, MN etc) of the five samples taken from 4 dug wells and a bore well have shown concentration below the permissible limit.

4. The chemical analysis of the 10 samples were compared with the results of earlier collection of the same wells i.e. premonsoon (June – 2002) and post (September 2002). The chemical analysis data revealing good improvement in quality after monsoon. It is observed that the EC value of pumping well located in the premises of the plant decreased from 3700 to 987. This may be probably due to rainfall as well as the effect of artificial recharge schemes as implemented by the company. However the chemical constituent of 2 wells located in the upstream (Vijayanagaram) are showing increase in EC.

5. The EC of treated effluent of plant has decreased from 2660 in June 2002 to 1352 in February 2003 which shows an improvement in quality of the treated effluent and is within permissible limit. The TDS and pH of treated effluent is also within permissible limit.

6. The rain water harvesting by constructing percolation tanks, percolation pits, dug cum well, collection of roof water is implemented by the Company.

7. Presently historical water level data is not available in study area. As such monthly monitoring of water level is done by Ground Water Department, Govt. of Kerala to evaluate the ground water change and its management in and around the study area.