Pre-monsoon and Post-monsoon Groundwater Table/Piezometric Surface Configuration in Kolkata

7.1 Introduction

Kolkata Megacity is highly endowed with ground water resources down to the depth of 400 m below ground level. In general the entire Kolkata Megacity consists of a thick clay/silty clay blanket of thickness 30-50 m below ground level containing thin sand bodies which form perched aquifers/ aquitards. The present study is aimed at understanding the precise configuration of groundwater level occurring within the 20 m depth throughout the year. Thus, it is felt necessary to map Pre-& Post-monsoon water level scenario in the shallow zone. The study area includes Kolkata and parts of Howrah bounded by 22°40′45″ N to 22°26′50″ N latitude and between 88°13′40″ E to 88°28′50″ E longitude. The area is mostly flat sloping from north to south and from west to east. The City is approximately 30 km from the Bay of Bengal and river tides at Kolkata range over 4 m. The region contains numerous low lying areas, marshes, wetlands, shallow lakes and jheels. The present investigation aims at mapping the groundwater table within the shallow 20 m depth range to assess the scope of liquefaction consequent upon seismic activity. The major objectives of the present study are as follows:

- a) Construction of 50 numbers of Piezometers tapping granular zones within 20 m depth spread all over the Kolkata city.
- b) Utilization of 20-30 Dug Wells already existing in parts of Kolkata and its neighborhood as observation wells.
- c) Analysis of the lithological variation of the selected sites with Piezometers log.
- d) Collection of the groundwater level data using Piezometers and Dug Wells.
- e) Mapping of Pre-monsoon and Post-monsoon water table for Kolkata and its neighborhood.
- f) To find out the groundwater table fluctuation during Pre-monsoon, Monsoon and Postmonsoon period of 2012, 2013 & 2014.
- g) To find out the general flow direction of the groundwater within the 20 m depth zone.
- h) Chemical analysis of water samples collected from the Piezometers.

7

7.2 Climate and Meteorology of the Study Region

Kolkata, the capital city of West Bengal is located in the Ganges Delta of eastern India. Its climate is highly influenced by the Bay of Bengal. Kolkata is dominated by tropical wet and dry type of climate as depicted in Figure 7.1(a).

The annual mean temperature of Kolkata is about 27°C whereas the monthly mean temperature ranges from 19°C to 30°C. Kolkata is dominated by three seasons' namely - Summer, Monsoon and Winter. The summer is hot and humid with a mean temperature of about 30°C but during dry spells the maximum temperature would often exceed 40°C during April-May with a frequent break by severe thunderstorm/thunder squall during afternoon/evening hour's results a relief from the humid heat. These thunderstorms often depicted elaborately by the Bengali nature poets are known as Kal-baisakhi, the Nor'westers. Figure 7.1(b) depicts the annual rainfall variation in India.





(a) Tropical wet and dry climatic zone of Kolkata (<u>http://www.indianetzone.com</u>), and (b) Variation of average annual rainfall (in centimeters) in India (<u>http://www.mapsofindia.com</u>).

The main seasonal influence upon the climate is the Monsoon where the rainfall is predominantly due to the South-West Monsoon. The Monsoon arrives in June and stay up to October. During the Monsoon season, maximum rainfall occurs in August with a measure of about 679.2 mm as illustrated in Table 7.1 and the total seasonal (Monsoon) rainfall varies from 1362.2 mm to 2268.4 mm. The overall rainfall pattern of Kolkata is given in Figure 7.2. The two month October and

November of Post-monsoon season is the transition period between the Monsoon and Winter. The Post-monsoon season also experiences severe cyclonic storm over Bay of Bengal that gives heavy rainfall in Kolkata.

Monthly rainfall during 2012 and 2013 in Kolkata (Source: http://www.imd.gov.in)

Table 7.1

Month	Rainfall (mm) 2012	Rainfall (mm) 2013
January	94.4	12.2
February	15	9.9
March	0	1.2
April	133.5	31.2
May	93.9	122.4
June	178.1	397.5
July	248.5	327.2
August	251.7	679.2
September	439.2	341.4
October	161.8	523.1
November	18.3	0
December	34.2	0



Figure 7.2

Monthly rainfall variation in Kolkata from 2010 to 2013.

During the month of January in the years of 2010, 2011, 2012 & 2013 the maximum rainfall has been observed during January 2012 with a measure of 94.4 mm and the lowest in January 2010 (no rainfall) as depicted in Figure 7.3. The average rainfall for January in the four years span is 26.7 mm. In the month of February in the years of 2010, 2011, 2012 & 2013 the rainfall is found to be the highest during February 2011 measuring 15.1 mm and

in January 2010 (no rainfall) as depicted in Figure 7.3. The average rainfall for January in the four years span is 26.7 mm. In the month of February in the years of 2010, 2011, 2012 & 2013 the rainfall is found to be the highest during February 2011 measuring 15.1 mm and the lowest in February 2010 (no rainfall). The average rainfall for February in the four years span is 10.0 mm. In the month of March in the years of 2010, 2011, 2012 & 2013 the rainfall is found to be the highest during March 2011 (26.5 mm) and the lowest in March 2012 (no rainfall). The average rainfall for March in the four years span is 9.475 mm. In the month of April in the years of 2010, 2011, 2012 & 2013 the rainfall is found to be the highest during April 2012 (133.5 mm) and the lowest in April 2010 (20.6 mm). The average rainfall for April in the four years span is 58.425 mm. In the month of May in the years of 2010, 2011, 2012 & 2013 the rainfall is found to be the highest during May 2010 (150.0 mm) and the lowest in May 2011 (89.3 mm) and the average rainfall for May in the four years span is 113.9 mm. In the month of June in the years of 2010, 2011, 2012 & 2013 the rainfall is found to be the highest during June 2013 (397.5 mm) and the lowest in June 2012 (178.1 mm) and the average rainfall for June in the four years span is 318.1 mm. In the month of July in the years of 2010, 2011, 2012 & 2013 the rainfall is found to be the highest during July 2013 (327.2 mm) and the lowest in July 2012 (207.9 mm) and the average rainfall for July in the four years span is 261.9 mm. In the month of August in the years of 2010, 2011, 2012 & 2013 the rainfall is found to be the highest during August 2013 (679.2 mm) and the lowest in August 2012 (251.7 mm) and the average rainfall for August during the four years span is 412.45 mm. In the month of September in the years of 2010, 2011, 2012 & 2013 the rainfall is found to be the highest during September 2012 (439.2 mm) and the lowest in September 2012 (332.8 mm) and the average rainfall for August in the four years span is 376.075 mm. In the month of October in the years of 2010, 2011, 2012 & 2013 the rainfall is found to be the highest during October 2012 (523.1 mm) and the lowest in September 2011 (23.5 mm) and the average rainfall for September in the four years span is 203.35 mm. In the month of November in the years of 2010, 2011, 2012 & 2013 the rainfall is found to be the highest during November 2012 (18.3 mm) and the lowest in November 2011 and November 2013 (no rainfall) and the average rainfall for November in the four years span is 4.6 mm. In the month of December in the years of 2010, 2011, 2012 & 2013 the rainfall is found to be the highest during December 2012 (34.2 mm) and the lowest in December 2011 and December 2013 (no rainfall) and the average rainfall for December in the four year span is 13.4 mm. The monthly rainfall variation for the period of 2010 to 2013 in Kolkata is depicted in Figure 7.3. Though, the monsoonal months are from late June to November, but most of the annual rainfall is observed during July and August.

It is observed that the maximum monthly rainfall varies in monsoonal season. Figure 7.4(a) shows the rainfall variation in the monsoon months for the period of 2010 to 2013. The maximum annual rainfall occurred in 2013 measuring 2268.4 mm and the lowest was observed in 2012 with 1279.3 mm. It is found that during the year 2013 the annual rainfall was maximum measuring 2268 mm as depicted in Figure 7.4(b).





Monthly rainfall variation from the period of 2010 to 2013 in Kolkata (http://www.imd.gov.in).



Figure 7.4

(a) Monsoon rainfall variation in Kolkata for the period of 2010 to 2013, and (b) Annual rainfall variation in Kolkata from 2010 to 2013.

Table 7.2 exhibits that the rainfall occurred in 2012 was less compared to 2013 and the heavy monsoonal rainfall occurred continuously upto October. In the months of June 2013 the rainfall was found to be more than double than that in 2012 along with high rainfall in May 2013 which made the water level fluctuation of Pre-monsoon and Post-monsoon 2013 less than the year of 2012. In August 2013 the rainfall was highest measuring 679.2 mm.

Table 7.2

Month wise rainfall variation during 2012 and 2013

Month	Rainfall (mm) 2012	Rainfall (mm) 2013
January	94.4	12.2
February	15	9.9
March	0	1.2
April	133.5	31.2
May	93.9	122.4
June	178.1	397.5
July	248.5	327.2
August	251.7	679.2
September	439.2	341.4
October	161.8	523.1
November	18.3	0
December	34.2	0

Source: IMD Data

7.3 Geological and Hydro-geological Characteristics

Kolkata is situated in the Bengal Basin, a huge pericratonic Tertiary basin with enormous thickness of fluvio-marine sediments. The Bengal Basin can be divided into three structural units *viz*. the westernmost shelf or platform, the central hinge or shelf/slope break and deep basinal part in the east and southeast that presently open in the Bay of Bengal (Alam *et al.*, 2003). Kolkata is located over the western part of the hinge zone across which sediment thickness and facies significantly varies from shelf area in the west to the deep basinal part in the east (Nath *et al.*, 2014). Kolkata-Mymensingh Eocene Hinge zone associated with a gravity high and magnetic

low possibly represents a zone of numerous en-echelon faults over the Eocene-Sylhet Limestone (Nandy, 2007; Nath *et al.*, 2014). The hinge is about 25 km wide that occurs at the depth of 4500 meters approximately below Kolkata. Total sedimentary thickness below Kolkata is of the order of 7500 meters above the crystalline basement; of this the top 350-450 meters is Quaternary, followed below by 4500-5500 meters of tertiary sediments, 500-700 meters of Cretaceous trap and 600-800 meters of Permo-Carboniferous Gondwana rocks (Nandy, 2007; Nath *et al.*, 2014). The detailed geology, geomorphology and subsurface lithostratigraphy of Kolkata have already being discussed in Chapter 2. Kolkata is located on the lower deltaic plain of the composite Ganga-Bhagirathi Delta and is covered by the sediments deposited by the river system flowing through the area during the Quaternary era. To recapitulate, the subsurface geology of the area is completely obscured by the blanket of recent sediments. The upper strata of 300 meters below the ground level belongs to the Quaternary era and is principally an alternation of clay, silt, sands of various grades, gravels with occasional pebble beds. The Formation belonging to the Quaternary era is the principle repository of groundwater in the area.

7.4 Field Investigation

Kolkata is one of the most populated metropolitan cities in India. For the last 300 years the City has experienced a huge population growth. Due to huge development and increase in population demand of water for domestic purposes has increased by many folds. Domestic water supply is done mainly from the Hooghly River through the Tala pumping station and the Garden Reach pumping station. In spite of this surface water sources a huge amount of water is drawn from the groundwater aquifers below Kolkata. This exploitation is so large that permanent depletion of water level has occurred in the groundwater of Kolkata.

Due to heavy exploitation of groundwater a major change has been occurred in the subsurface water level condition of Kolkata. Investigations conducted in Kolkata for the last four years reflect alarming depletion of Piezometric level. The statistical study on Pre- & Post-monsoon groundwater level variation has been done by collection and analysis of various information from the study area *viz*. location map, drainage map, rainfall data, Pre- and Post-monsoon depth of groundwater and water level fluctuation information from CGWS. The field investigation has been conducted in two stages. Firstly, we have undertaken reconnaissance investigation of the whole study region and thereafter, the entire study region has been divided into equal grid intervals. The Piezometer and Dug Well investigation sites have been selected based on the spatial distribution and geomorphology of the respective sites. Figure 7.5 depicts the spatial distribution of Bore Well/ Piezometer and Dug Well investigated in Kolkata.





Spatial distribution of Bore Well/Piezometer and Dug Well investigated sites.

The 2nd stage includes the following aspects *viz*. (i) Drilling (2" diameter) has been conducted at every selected site followed by lithological and electrical logging, (ii) Based on the lithological and electrical logging data, design of Piezometer has been set up, (iii) Out of 48 numbers of drilled boreholes, in 28 boreholes lowering of tube well assembly has been done due to presence of near surface granular horizon. However in 20 numbers of drilled boreholes lowering of well assembly was rejected due to non-availability of granular zones within the target depth of 20 m, (iv) Design of the tube wells along with borehole logs for successful wells have been drawn, (v) Inventory of 16 numbers of Dug Wells has been done, and (vi) Seasonal groundwater level data has been collected by using Piezometers and Dug Wells. Figure 7.6 depicts the field photograph of the different stages of drilling conducted in Kolkata.



Initial Digging of the bore hole

Pool of water made for Drilling



The Set up for Drilling

The Drilling Process

Figure 7.6

Different stages of drilling conducted in Kolkata.

7.4.1 Piezometers and Dug Wells' to Measure Groundwater Table

In the study region, 48 numbers of Piezometers and 16 numbers of Dug Wells have been constructed for the assessment of Pre- and Post-monsoon water level fluctuations along with water sample analysis. The details of groundwater information based on Dug Wells and Piezometers are given in Tables 7.3 and 7.4 respectively.

Table 7.3

Detailed groundwater information based on 16 Dug Wells' survey

Well No.	Address	Spatial Location	Initial Water Level (m bgl)	Depth of Dug Wells (m)
1	4 no. Mahajati Nagar, 91 Maharaja Nandakumar Road, Kol-51	22°39′37.1″ 88°26′25.4″	1.05	9.1
2	Uday Sangha, 7 no. Uday palli, Kol-59	22°39′35.9″ 88°26′26.1″	0.35	9.5
3	289 M.B. Road, Kol-51	22°39′36.2″ 88°26′24.5″	0.57	10.7
4	17, Bonhoogli More, Kol-35	22°39'06.5″ 88°24'49.4″	1.38	7.6
5	New Noapara Colony, A. K. Mukherjee Road, Kol-90	22°38′20.4″ 88°23′32.4″	3.87	15.2
6	Gram Thakurani Chak. Paus Samabay Pally, Thana-Bally, Howrah	22°39′23.9″ 88°19′18.8″	3.58	12.2
7	Bally Ghoshpara, Howrah-711227	22°38′46.6″ 88°20′09.0″	0.99	9.14
8	Sahara Ghoshpara	22°40′50.3″ 88°26′56.0″	1.26	9.14
9	House no. 21/6, Gopalpur,Kol-136	22°37′58.6″ 88°26′34.2″	1.29	7.6
10	100/61, Jessore Road, Kol-74	22°37′01.0″ 88°24′51.5″	0.94	9.6
11	Santi Ranjan Bhowmik, Thakurpukur, Kalagachia, Kolkata	22°27′34.6″ 88°17′10.2″	2.12	12.2
12	Kadarhat Ramkrishna Palli, Kol- 150	22°27′23.1″ 88°24′54.7″	1.00	7.6
13	Besides china-mandir khalpar	22°31′29.9″ 88°24′51.0″	2.68	6.1
14	Bharat Traders Marbles & Granite Traders. 36, Topsia Road, Kol-39	22°31′57.4″ 88°23′48.1″	4.62	7.6
15	Besides Delhi Public School, Ruby Park	22°31′14.5″ 88°23′48.3″	4.49	6.1
16	Besides Gitanjali Stadium, Rajdanga Mail Road, Kolkata	22°30′57.3″ 88°23′40.9″	2.92	7.6

Table 7.4

Detailed groundwater information based on 48 Piezometers' survey

Sl. No.	Address	Spatial Location	Depth of Drilling (m)	Lowering of pipe	Initial Water Level (m bgl)
1	Rangan Primary school, Jatragachi RR side, Gouranganagar, PS-New Town	22° 35′13.3″ 88° 27′49.1″	18	Yes	
2	Uday Sangha, 7 No Udyan Palli, PO: Ashwini Nagar, Kolkata-700059	22° 36′ 17.7″ 88°25′ 46.5″	20	Yes	11.62
3	Lake Town Cultural Organization, Link Road, Lake Town, Kolkata	22° 36'15.3" 88°24'14.1"	20	Yes	8.81
4	Jyangra-Hatiara 2 no. Gram panchayat,P.OGhuni,P.S New Town, N24 Parganas	22° 35′ 57.5″ 88°27′ 20.2″	20	Yes	1.12
5	107 no. Ward Office,10 P. Mazumder Road, Kolkata	22° 35′57.5″ 88°27′20.2″	20	Yes	14.63
6	Burn Standard Company, 22B Raja Santosh Road, Kolkata	22° 31′02.0″ 88°19′40.9″	20	20 Yes	
7	P.W.D Sunderban Electrical Division 75, Diamond harbor Road, Kolkata-700023	22° 32′17.6″ 88°19′38.0″	20	No	
8	Kasba Samannaoy Samiti,115/1 B.B. Chatterjee Road, Kolkata-700042	22° 31′07.7″ 88°22′39.6″	20	No	
9	AIWC Buniadi Vidyapith Girls High School(H.S.), Beleghata Main Road, Kolkata-700010	22° 33′40.5″ 88° 24′28.8″	20	Yes	8.42
10	Shri Sambhu Sadan Vidyalaya, Block-17, Taratala, CPT colony, Kol-88	22° 33′51.2″ 88° 18′43.3″	20	Yes	11.63
11	Akra Saktigarh Rabindra Vidyapith, Rabindranagar, Kolkata-700018	22° 31′54.1″ 88° 15′23.4″	20	Yes	4.98
12	Maheshtala College, P.O. Chandannagar, Budge Budge Road, Kolkata-700142	22° 30′02.1″ 88°14′09.8″	20	Yes	6.67
13	Sri Sathya sai Bal Vihar, Balaka, Joka, Kolkata-700104	22° 27′34.6″ 88°19′26.3″	20	No	

SI. No.	Address	Spatial Location	Depth of Drilling (m)	Lowering of pipe	Initial Water Level (m bgl)
14	Kalagachia Kailash Kamini Ucchya Vidyalaya, Thakurpukur, Kolkata	22° 27′34.6″ 88°17′10.2″	20	No	
15	Vivekananda College, Barisha, Behala, Kolkata	22° 29′18.9″ 88°18′50.5″	20	Yes	11.43
16	ITI College, 24 Chandi Ghosh Road, Tollygunge, Kolkata-700049	22° 29′07.2″ 88°20′34.9″	20	Yes	6.965
17	Shantinagar Vidyamandir: Moore Avenue, Kolkata	22° 28′48.7″ 88°21′08.8″	20	Yes	6.78
18	Dilip Mukherjee Smriti Sangha, Picnic Garden, Kolkata	22° 31′42.9″ 88°23′12.5″	20	Yes	13.08
19	Jodhpur Park Boys School, Jodhpur Park, Kolkata	22° 30′16.6″ 88°21′54.8″	20	No	
20	Charankabi Mukundadas Primary School. 7 no. Mukundapur, Kolkata-700099	22° 29′28.1″ 88°24′19.5″	20	Yes	11.65
21	Kadarhat Gopalchandra Aboitonik Prathamik Vidyalaya, Kolkata-700150	22°27′23.1″ 88°24′54.7″	20	No	
22	Labanhrad Bidyapith for Girls, Salt Lake, Kolkata	22° 35′07.4″ 88°24′31.6″	20	Yes	7.36
23	Tramways Corporation Ltd. Lenin Sarani, Esplanade, Kolkata	22° 33′55.1″ 88°21′11.5″	20	No	
24	Taki House for Boys, APC Road, Sealdah, Kolkata	22° 34′23.4″ 88°22′21.5″	20	Yes	4.30
25	MCPT, Motilal Institution, 2, Motilal Colony, Dum Dum, Kolkata-700081	22°38′52.0″ 88°26′03.0″	20	No	
26	Paikpara Yubak Sangha, Paikpara, Kolkata	22°36′44.4″ 88°22′53.6″	20	Yes	12.20
27	Sarathi Seva Sangha, 40/60 Netaji Colony, B.T.Road Tobin Road junction, Kol-90	22°38′15.7″ 88°22′42.2″	20	No	
28	Ananda Society, Rabindra Sarani P.O. Nimta Durganagore, Kolkata- 700049	22° 39′14.6″ 88°24′45.0″	20	Yes	12.25

SI. No.	Address	Spatial Location	Depth of Drilling (m)	Lowering of pipe	Initial Water Level (m bgl)
29	Kendriya Vidyalaya Santragachi, Santragachi, Howrah	22° 35′32.9″ 88°17′04.1″	20	No	
30	Ganipur Sitala Abaitanik Primary School, Mahestala	22° 30'09.8" 88°16'20.4"	20	No	
31	Amrita Bihar Abasan, Kamagachi, Kolkata	22° 26′52.6″ 88°23′24.1″	20	Yes	11.71
32	Jadavpur N.K.Pal Sikshayatan. 43/5H, Jheel Road, Kol-31	22°30′04.4″ 88°22′27.9″	20	Yes	14.05
33	Howrah Siksha Sadan, 2 Troilokyonath Banerjee Lane, Howrah	22° 34′50.2″ 88°19′47.8″	20	No	
34	Botanic Garden Adarsha Bidyalaya, 61 Danesh Sekh Lane, Howrah-9	22° 31′39.1″ 88°17′55.4″	20	No	
35	Bally Jagacha Panchayet Samiti, Bally Jagacha Samiti Unnayan Daptar, Howrah	22° 37′26.5″ 88°17′ 37.1″	20	No	
36	Kona Agradyut Sangha, Benaras Road, Howrah- 711114	22° 36′50.1″ 88°18′26.2″	20	No	
37	Jagacha High school, Jagacha, Howrah	22° 35′ 18.0″ 88° 17′ 01.0″	20	Yes	10.38
38	Uttarayan Club, 145 Indra Biswas Road, Kolkata -700037	22° 36′33.2″ 88°22′39.4″	20	Yes	9.74
39	Dum Dum Tarun Samiti, 37 No Dum Dum Road, Kolkata- 700074	22° 37′15.3″ 88°23′52.0″	20	Yes	8.32
40	Bally Santiram Vidyalaya, 382, G.T. Road P.O. Bally, District- Howrah	22° 38′47.2″ 88°21′3.07″	20	Yes	10.81
41	Entally Hindu Balika Vidyamandir. 8, Middle Road, Kolkata-700014	22° 33′35.8″ 88°22′05.7″	20	No	
42	Baghbazar Multipurpose, Baghbazar, Kolkata	22° 36′15.2″ 88°22′15.3″	20	No	
43	Ganabhavan, Ward No-17, Kolkata-700005	22° 35′33.4″ 88°21′52.8″	20	Yes	9.23
44	Naktala Udayan Sangha, 1/250 Krishanu Dey Sarani, Kolkata- 700047	22° 28′27.5″ 88° 21′59.2″	20	Yes	4.22

SI. No.	Address	Spatial Location	Depth of Drilling (m)	Lowering of pipe	Initial Water Level (m bgl)
45	Basanti Devi College, Gariahat, Kolkata	22° 31′11.1″ 88° 21′43.6″	20	No	
46	Tarun Sangha, Motijeel, DumDum, Kolkata	22° 37′29.4″ 88° 24′38.7″	20	No	
47	Notunpara Kalyan Sangha Club, Behala, Kolkata-700061	22° 29′03.5″ 88° 18′24.6″	20	No	
48	Santoshpur Bidya Mandir for Boys (H.S.), Kolkata-700075	22° 29′25.7″ 88° 23′03.7″	20	Yes	4.65

7.4.2 Generalized Subsurface Geology/Lithology

In the present study, 48 numbers of Piezometers have been constructed in and around Kolkata and during drilling lithological samples have been collected at every 2.0 meter depth interval as depicted in Figure 7.7. The soil samples have been analyzed megascopically. The graphical representations of individual Piezometric lithological log along with the tube well design have been presented in Figure 7.8.



Figure 7.7

Lithological samples collected during drilling.

Uday Sangha, 7 No Udyan Palli, PO: Ashwini Nagar, Kolkata-700059 Location: Contact Person: Mr. Arup Sarkar (09903106439), Cultural Secretary

Date of Drilling : 30/05/2012



Water level (measured by hold-cut method):

Hold (m)	Cut	Height of MP from	Pre-monsoon water
	(m)	ground level (m)	level from bgl (m)
14	2.18	0.20	11.62

Remarks:

Drilling was done up to 20m and Pre- monsoon water level data was taken.

SITE NO: 9

Location: AIWC Buniadi Vidyapith Girls High School (H.S.), P-1 CIT Scheme-IV, MS2 Beleghata Main Road, Kolkata-700010

Contact Person: Mrs S.Panigrahi 9432210322

Date of Drilling: 22/06/2012

GPS Location:	Latitude: N 22º33'40.5"	Longitude: E 88°24'28.8

Details of the Drilling:

	Lithology				Design of the well
Depth(m)	Sample Type	Colour	Texture	Diagram	
0-2	CLAY with bricks	Yellowish grey	Compact	0m Clay	0-12m length
2-4	CLAY with bricks	Yellowish grey	Compact	2m 4m	Blank Pipe 3" (75 mm)
4-6	CLAY	Blackish grey	Compact	6m Clay	Diameter
6-8	CLAY	Grey	Compact	8m	
8-10	CLAY with kankar	Grey	Compact	10m Clay	12-17m length
10-12	CLAY	Grey	Compact	12m Clay	2"(SOmm) Diameter
12-14	CLAY	Light Grey	Compact	Clay	
14-16	CLAY with little SILT	Light Yellow	Compact	16m 18m Clay	17-20 m length blank pipe 2" (50mm)
16-18	CLAY with little SILT	Light Yellow	Plastic	20m Clay	Diameter
18-20	CLAYEY SAND	Grey	Medium- fine		× ·

Water level (measured by hold-cut method):

Hold (m)	Cut	Height of MP from	Pre-monsoon water
	(m)	ground level (m)	level from bgl (m)
11	2.38	0.20	8.42

Remarks:

Drilling was done up to 20m and Pre- monsoon water level data was taken.

SITE NO: 5

Location: 107 no. Ward Office,10 P. Mazumder Road,Kolkata

Contact Person: Mr. Sankar Mandal (09804511247)

Date of Drilling: 13/06/2012

GPS Location: Latitude: N 22°35'57.5" Longitude: E 88°27'20.2"

Details of the Drilling:



Water level (measured by hold-cut method):

I	Hold (m)	Cut (m)	Height of MP from ground level (m)	Pre-monsoon water level from bgl (m)
2	20	5.17	0.20	14.63

Remarks:

Drilling was done up to 20m and Pre- monsoon water level data was taken.

SITE NO: 11

Longitude: E 88º15'23.4"

Location: Akra Saktigarh Rabindra Vidyapith, Rabindranagar, Kolkata-700018

Contact Person: Ratan Kapashi (09433435095), Head sir

Date of Drilling: 24/06/2012

GPS Location: Latitude: N 22°31'54.1"

Details of the Drilling:

	1	ithology		Lithology	Design of the wel
Depth(m)	Sample Type	Colour	Texture		
0-2	CLAY	Brown	Plastic	Om	0m
2-4	CLAY	Brownish grey	Plastic,	2m 4m	0-12mlength
4-6	CLAY	Grey	Plastic	Clay	Blank 12m 3" (25mm)
6-8	CLAY	Grey	Plastic	Clay	Diameter
8-10	CLAY	Grey	Plastic, with wood	10m Clay Clay	
10-12	CLAY	Grey	Plastic	12m	12-17m length
12-14	SANDY CLAY	Grey		14m Sand	Blank 5 m 2''' (50mm)
14-16	Clayey Sand	Grey	Fine with mica	18m Sand	17-20m length Strainer 3m 211 (Strainer 3m
16-18	Clayey Sand	Greyish Brown	Fine with mica	20m	Bell Cap
18-20	SAND	Brown	Fine with mica		

Water level (measured by hold-cut method):

Hold (m)	Cut	Height of MP from	Pre-monsoon water
	(m)	ground level (m)	level from bgl (m)
9	3.76	0.26	4.98

Remarks: Drilling was done upto 20m and Pre- monsoon water level data was taken.

GPS Location: Latitude: N 22°36'17.7" Longitude: E 88°25'46.5"

Details of the Drilling:

Location: Maheshtala College, P.O. Chandannagar, Budge Budge Road, Kolkata-700142

Contact Person: Soumendu Sengupta (09433097764), Principal.

Date of Drilling: 25/06/2012

GPS Location: Latitude: N 22°30'02.1" Longitude: E 88°14'09.8"

Details of the Drilling:

	Lithology				Design	of the well
Depth(m)	Sample Type	Colour	Texture	Diagram		
0-2	CLAY with Silt	Yellowish grey			0m	
2-4	CLAY with fine sand	Grey		0m 2m		0-12m length Blank 12m
4-6	CLAY with fine sand	Grey		4m Sandy Clay		Jiameter
6-8	CLAY with fine sand	Grey		6m Sandy Cay 8m		
8-10	CLAY with wood	Grey	Compact	10m		12.17m lanath
10-12	CLAY	Grey	Compact	12m Clay		Blank 5m 2" (50mm)
12-14	CLAY	Grey	Compact	14m		
14-16	Clayey sand	Grey	Fine sand	16m		17-20m length Strainer 3m 211 (50mm)
16-18	Clayey sand	Grey	Fine sand	18m Clavey sand		Bell Cap
18-20	Clayey sand	Yellowish	Fine to medium	20m	, in the second se	

<u>SITE NO: 15</u>

Location: Vivekananda College, Barisha, Behala, Kolkata

Contact Person: Dr. Soma Bhattacharya (9874220701), Principal.

Date of Drilling: 28/06/2012

GPS Location: Latitude: N 22°29'18.9" Longitude: E 88°18'50.5"

Details of the Drilling:



Water level (measured by hold-cut method):

Hold (m)	Cut	Height of MP from	Pre-monsoon water
	(m)	ground level (m)	level from bgl (m)
10	3.13	0.20	6.67

Remarks:

Drilling was done up to 20m and Pre- monsoon water level data was taken.

Water level (measured by hold-cut method):

Hold (m)	Cut	Height of MP from	Pre-monsoon water
	(m)	ground level (m)	level from bgl (m)
14	2.32	0.25	11.43

Remarks:

Drilling was done up to 20m and Pre- monsoon water level data was taken.

SITE NO: 26

Location: Paikpara Yubak Sangha, Paikpara, Kolkata

Contact Person: Gopal Sahoo (9088089203)

Date of Drilling: 10/07/2012

GPS Location: Latitude: N 22°36'44.4" Longitude: E 88°22'53.6"

Details of the Drilling:

		Litho	logy		Design of the	well
Depth(m)	Sample Type	Colour	Texture	Diagram		
0-2	Concrete	Grey			0m	
2-4	Clay with brick particles	Yellowish		Om 2m		0-12m length
4-6	CLAY	Grey	Compact, Plastic	4m		Blank 12m 3'' (75mm)
6-8	CLAY with wood	Grey	Compact, Plastic	6m Clay		Diameter
8-10	CLAY	Grey	Compact, Plastic	8m Clay		
10-12	CLAY	Grey	Compact, Plastic	10m Clay		12-18m length Blank 6 m
12-14	CLAY	Light grey	Compact, Plastic	12m Clay		2" (50mm)
14-16	CLAY	Light grey	Compact, Plastic	Clay		Strainer 2m
16-18	CLAY	Yellow	Compact, Plastic	18m		Bell Cap
18-20	CLAY	Yellow	Compact, Plastic	20m Sandy clay		

Water level (measured by hold-cut method):

Hold (m)	Cut	Height of MP from	Pre-monsoon water
	(m)	ground level (m)	level from bgl (m)
13	0.60	0.20	12.20

Remarks: Drilling was done up to 20m and Pre- monsoon water level data was taken.

SITE NO: 22

Location: Labanhrad Bidyapith for Girls, Salt Lake, Kolkata

Contact Person: Mrs. Chayanika Chatterjee (9804439367), Headmistress.

Date of Drilling: 07/07/2012

GPS Location:	Latitude: N 22°35'07.4"	Longitude: E 88°24'31.6"

Details of the Drilling:

		Design o	of the well			
Depth(m)	Sample Type	Colour	Texture	Diagram		
0-2	SAND	Grayish Yellow	Medium-fine		0m	
2-4	CLAY	Grey	Compact, plastic	0m Cay		
4-6	CLAY with kankar	Grey	Compact, plastic	2m 4m		0-12m length Blank 12m 3'' (75mm)
6-8	CLAY	Grey	Compact, plastic	6m Cav		Diameter
8-10	CLAY	Grey	Compact, plastic	8m Cay		12-18m length
10-12	CLAY	Grey	Compact, plastic	10m Clay		Blank 6m 2" (50mm)
12-14	CLAY	Light-grey	Compact, plastic	14m		18 20m lunath
14-16	CLAY	Yellow	Compact, plastic	16m		Strainer 2m 2" (50mm)
16-18	CLAY	Yellow	Compact, plastic	18m Clay Sand with		Bell Cap
18-20	Clay with Sand	Yellow	Fine	20m Clay		

Water level (measured by hold-cut method):

Hold (m)	Cut	Height of MP from	Pre-monsoon water
	(m)	ground level (m)	level from bgl (m)
12	4.47	0.17	7.36

Remarks:

Drilling was done up to 20m and Pre- monsoon water level data was taken.

Location: Amrita Bihar Abasan, Kamagachi, Kolka	Location:	Amrita Bihar Abasan,	Kamagachi,Kolkata
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Contact Person: Mr. Pulak Kr.Das (09903050492)

Date of Drilling: 14/07/2012

GPS Location: Latitude: N 22°26'52.6" Longitude: E 88°23'24.1"

Details of the Drilling:



Water level (measured by hold-cut method):

Hold (m)	Cut	Height of MP from	Pre-monsoon water
	(m)	ground level (m)	level from bgl (m)
16	4.19	0.10	11.71

Remarks: Drilling was done up to 20m and Pre- monsoon water level data was taken.

SITE NO: 36

Location: Kona Agradyut Sangha, Benaras Road, Kona Checkpost, Howrah- 711114

Contact Person: Mr. Nityananda Chakraborty (09836329480)

Date of Drilling: 17/07/2012

not encased and it was found abandoned.

GPS Location: Latitude: N 22°36'50.1" Longitude: E 88°18'26.2"

Details of the Drilling:

		Li	thology		Design of the well
Depth(m)	Sample Type	Colour	Texture	Diagram	
0-2	CLAY with filled materials	Yellow	Compact Plastic	Site 36	Lowering of pipes was not done due to presence of Clay from 0m to 20m.
2-4	CLAY	Yellowish Grey	Compact Plastic	0m Concrete	
4-6	CLAY	Greyish	Hard Compact Plastic	2m Clay 4m Clay	
6-8	CLAY with wooden residue	Greyish	Compact Plastic	6m Clay with wood 8m Clay	
8-10	CLAY	Greyish	Hard Compact Plastic	10m Clay	
10-12	CLAY	Greyish	Hard Compact Plastic	12m Clay	
12-14	CLAY	Greyish	Hard Compact Plastic	16m Clay	
14-16	CLAY	Yellow	Hard Compact Plastic	18m Clay	
16-18	CLAY	Yellow	Hard Compact Plastic		
18-20	CLAY	Yellow	Hard Compact Plastic		

SITE NO: 33

Location: Howrah Siksha Sadan, 2 Troilokvonath Baneriee Lane, Howrah Contact Person: S.P. Singh (09883209523)

Date of Drilling: 15/07/2012

GPS Location: Latitude: N 22º 34'50.2" Long: E 88º19'47.8" Details of the Drilling:



Remarks: The drilling was done up to a depth of 20 m bgl but the logging probe could not go beyond 10m bgl inspite of repeated attempts. Sand was found within the housing area and as no strainer could be placed in the housing area the bore hole was not encased by blank pipes and strainers. The area below 12m was blocked by the upper bore hole caving marterial and thus no pipes could be lowered. Bore hole has been declared abundoned. Due to heavy caving from the upper layers the e-logging probe could not on a bableware. go to the lower base.

SITE NO: 37

Location: Jagacha High school, Jagacha, Howrah.

Contact Person: Mr. Amit Manna (09432895468)

Date of Drilling: 17/07/2012

GPS Location: Latitude: N 22°35'18.0" Longitude: E 88º17'01.0" Details of the Drilling:

	Lith	ology		Design of the well
Sample Type	Colour	Texture	Diagram	
CLAY	Yellow	Compact Plastic	Site 37	
CLAY	Yellowish Grey	Hard Compact Plastic	Om Clay	0-12m length
CLAY mixed with fine sand	Greyish	Fine	2m Clay 4m Clay 6m Sand	Blank Pipe 3'' (75 mm)
SAND	Greyish	Fine	Ren Sand	Diameter
SAND	Greyish	Fine	Sand	
SAND	Greyish	Fine	10m Sand	
SAND	Greyish	Fine	12m Sand	
SAND	Yellow	Fine	14m Sand	12-17m length
SAND	Yellow	Fine	10-	2."(50mm)
SAND	Yellow	Fine	16m Sand	Diameter
			20m	17-20 m length blank pipe 2" (S0mm) Diameter
				~
	Sample Type CLAY CLAY CLAY mixed with fine sand SAND SAND SAND SAND SAND SAND SAND SAND	CLAY Yellow CLAY Yellow CLAY Yellowich Grey CLAY Greyish with fine sand SAND Greyish SAND Greyish SAND Greyish SAND Greyish SAND Greyish SAND Yellow SAND Yellow	Lithology Sample Colur Texture Type Colur Texture CLAY Yellowish Hand period CLAY Yellowish Hand period CLAY Yellowish Hand period mixed Greyish Fine sand Yellow Fine SAND Yellow Fine	Lithology Lithology Colour Texture Diagram Type Colour Texture Bias CLAY Yellowih Hard Gene Grey Bias Grey Grey Villowih Fine Grey Grey SAND Greyish Fine Grey SAND Greyish Fine Ban SAND Greyish Fine Grey SAND Greyish Fine Grey SAND Greyish Fine Grey SAND Greyish Fine Grey SAND Yellow Fine Grey

Water level (measured by hold-cut method):

Hold (m)	Cut	Height of MP from	Pre-monsoon water
	(m)	ground level (m)	level from bgl (m)
16	5.47	0.15	10.38

Remarks : No aquifer was found in the zone of drilling. This is the reason for which the bore hole was Remarks: Drilling was done up to 20m and Pre- monsoon water level data was taken.

Location: Dum Dum Tarun Samiti, 37 No Dum Dum Road Kolkata- 700074

Contact Person: Mr. Mrinal Kanti Chakraborty (09748151477)

Date of Drilling: 18/07/2012

GPS Location: Latitude: N 22°37'15.3" Longitude: E 88°23'52.0" Details of the Drilling:



SITE NO: 43

Location: Ganabhavan, Ward No-17, Kolkata-700005 Contact Person: Mr. Pradip Mehra (09830170571)

Date of Drilling: 10/09/2012

GPS Location: Latitude: N 22°35'33.4" Longitude: E 88º21'52.8"

Details of the Drilling:



Water level (measured by hold-cut method):

Hold (m)	Cut	Height of MP from	Pre-monsoon water
	(m)	ground level (m)	level from bgl (m)
12	2.57	0.20	9.23

Remarks: Drilling was done up to 20m and Pre- monsoon water level data was taken.

Location: Naktala Udayan Sangha, 1/250 Krishanu Dey Sarani, Kolkata- 700047

Contact Person: Mr. Ranjan Samaddar (09163906365)

Colour

Gravish

Greyish Fine

Greyish

Grevish

Greyish

Greyish

Greyish

Greyish Fine

Greyish

Grevish

Lithology 'our Texture

Fine

Fine

Fine

Fine

Fine

Fine

Fine

Fine

Date of Drilling: 11/09/2012

Sample Type CLAY

CLAY

SAND

SAND

SAND

SAND

SAND

SAND

SAND

with sand SAND

Details of the Drilling:

Depth(m)

0-2

4-6 6-8 8-10

10-12

12-14 14-16

16-18

18-20

GPS Location: Latitude: N 22°28'27.5"

SITE NO: 44

SITE NO: 48

Location: Santoshpur Bidya Mandir for Boys (H.S.),

9C Privanath Ghosh Road, Kolkata- 700075

Contact Person: Mr. Prabir Paul (033-2416-7848)

Date of Drining: 15/09/201	of Drilling: 13/09/2012
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GPS Location: Latitude: N 22°29'25.7" Longitude: E 88°23'03.7"

Details of the Drilling:

	Lithology				Design of the well
Depth(m)	Sample Type	Colour	Texture	Diagram	
0-2	CLAY	Brownish Grey	Plastic		
2-4	CLAY	Greyish	Plastic	100.000	
4-6	CLAY	Greyish	Plastic	Site 48	0-12m length
6-8	CLAY	Greyish	Plastic	0m Clay	Blank Pipe
8-10	CLAY	Greyish	Plastic	2m Clay	3" (75 mm)
10-12	CLAY	Greyish	Plastic		
12-14	CLAY	Greyish	Hard, Compact	6m Clay	Diameter
14-16	CLAY with silt	Yellowish	Hard, Compact	8m Clay	L]
16-18	Clay with SAND	Yellowish	Fine	10m Clay	12-17m length blank pipe
18-20	Clay with SAND	Yellowish	Fine	12m Clay	2,"(50mm) Diameter
				14m Clay with Sit	
				16m Clay with Sand	17-20 m length
				18m Clay with Sand	blank pipe 2" (Somm) Diameter

Water level (measured by hold-cut method):

Hold (m)	Cut	Height of MP from	Pre-monsoon water
	(m)	ground level (m)	level from bgl (m)
12	7.73	0.05	4.22

Water level (measured by hold-cut method):

Hold (m)	Cut	Height of MP from	Pre-monsoon water
	(m)	ground level (m)	level from bgl (m)
7	2.2	0.15	4.65

Remarks: Drilling was done up to 20m and Pre- monsoon water level data was taken.

Remarks: Drilling was done up to 20m and Pre- monsoon water level data was taken

Representative lithologs of Piezometer survey in Kolkata.

(m) 7.58 ground level (m) level from bgl (m) 16 0.10 8 32

Remarks: Drilling was done up to 20m and Pre- monsoon water level data was taken

Diagram

Site 44

Om

2m

4m

6m

8m

10m

12m

14m

16m

18m 20m

Longitude: E 88°21°59.2"

ne san

ine san

ne sand

Fine san

ine sand

Fine sand

ine sand

Design of the well

0-12m length

Blank Pipe

3" (75 mm)

Diameter

12-17m length blank pipe 2."(50mm) Diameter

The subsurface litholog data collected from drilling has been used to make several panel diagrams. The first panel diagram consists of 0-20 m of clay as depicted in Figure 7.9(a). The clay is mainly compact, plastic and grayish or yellowish in colour. In many places like Balaka Joka (SH-13), Thakurpukur (SH-14) and B.T & O. Tobin Road junction (SH-27) the yellowish hard clay is found below a depth of 14.0 or 16.0 m respectively. In Satragachi (SH-29), Maheshtala Gonipur (SH-30), Bally Jagacha (SH-35), Kona (SH-36), Baghbazar (SH-42) and Tarun Sangha Motijheel (SH-46) the yellow sand is found followed by silty clay or fine sand.

The second category comprises of dark grayish compact clay which has been observed throughout with upper yellow to brown sticky clay in Jodhpur Park (SH-19), Kadarhat Garia (SH-21), Lenin Sarani (Esplanade, SH-23), Danesh Sekh Lane, (Howrah, SH-34) and Behala Notunpara (SH-47) as depicted in Figure 7.9(b). The lithology of these areas is predominantly associated with grey clay and brown clay.



Figure 7.9

(a) Areas with predominantly grey clay in Kolkata, and (b) Areas with predominantly grey clay and brown clay in Kolkata.

In the third category, silty clay or fine sand layers have been found amidst the clayey layers as depicted in Figure 7.10(a). In Jatragachi (SH-1, at depth 14-18 m) and Kestopur (Aswini Nagore, SH-2, at depth 4-16 m) fine grey sand have been observed. In Lake Town (SH-3) from 6-16 m depth brown sand and from 16-20 m depth brownish grey sand have been found. In Jyangra Hatiara Area (SH-4) at 16-20 m depth brown silty sand is present. Taratala Area (SH-10) shows a stretch of clay with silt at a depth of 2-4 m and at 16-20 m depth clay with silt and fine sand is observed. Akra Rabindra Nagar area (SH-11) is associated with grey sand at a depth of 14-16 m and brown sand at a depth of 16-20 m. Maheshtala Budge-Budge area (SH-12) shows yellowish clay with silt from 0-2 m depth, sandy clay from 2-10 m depth, grayish clay from 10-14 m depth, grayish clayey sand from14-18 m depth and yellowish clayey sand from 18-20 m depth grey sand is found. In Tollygunj area (SH-16) at a depth of 0-2 m reveals yellow clay with silt, at 2-6 m depth reveals grey sand, at 6-8 m depth grey clay is found while at long stretch of grayish sand

have been witnessed. In Moore Avenue (SH-17) at a depth of 0-4 m exhibits grayish clay, at 4-10 m depth reveals grayish clayey sand beyond which a large stretch of grayish medium to fine grain sand have been found.

In Picnic Garden area (SH-18) a long stretch of 0-16 m grayish clay and a short stretch of 16-20 m brownish sandy clay have been found. In Mukundapur area (SH-20) a long stretch of 0-12 m grey clay, 12-14 m yellow clay and the rest of the borehole depth consist of silty clay. In Sealdah (SH-24) and Saltlake Area (SH-22) the upper long stretch comprise of clay while below18 m depth sandy clay have been found. In Nimta & Paikpara area, the yellowish sand and grayish clay have been found with the presence of silt zone at a depth from 18-20 m.



Figure 7.10

(a) Areas with predominant clay with traces of Silt/Sand layers in Kolkata, and (b) Areas with predominantly sand layers in Kolkata.

In the fourth category, sand is found to be predominant in most of the layers within 20 m depth which includes Garia Kamalgazi (Pz-31), Naktala (Pz-44), and Howrah Troilokyonath Lane (Pz-33). In Howrah, most of the areas comprise predominantly of grey and yellow clay. However at 16-20 m depth zone silt with clay is seen to dominate as depicted in Figure 7.10(b).

Peat layers have been observed in some areas within the upper 20 m depth. Figure 7.11(a) shows the subsurface lithological strata which are predominantly associated with peat layer mixed with clay at a depth of 2-12 m. The peat layers have been observed in Kasba (SH-8) at a depth of 2-4 m, in Kadarhat Garia (SH-21) at a depth of 10-12 m, in Tobin Road Crossing (SH-27) area at a depth of 6-8 m, in Ganipur Behala (SH-30) area at a depth of 8-10 m, in Baghbazar (SH-42) area at a depth of 6-8 m, in Behala Notunpara (SH-47) area at a depth of 6-8 m, in Bally Jagacha (SH-35) area at a depth of 3-4 m and in Kona (SH-36) area at a depth of 6-8 m.

A panel diagram has been prepared to depict the overall extent of clay and sand/silt layers which reveals the presence of thick blanket of clay in Kolkata as depicted in Figure 7.11(b).



Figure 7.11

(a) Areas containing Peat layers in Kolkata, and (b) Panel diagram showing presence of clay and sand/silt throughout the study region.

7.4.3 Detailed Electro Logging of Piezometer

Details of electro logging of the drilled Piezometer

48 Nos. of Piezometers have been electrically logged to delineate the fresh/brackish water interface, granular and non granular boundary by deploying Sludge method. The Self Potential (SP) and the Resistivity measurements have been taken at 1 meter depth interval upto 20 m depth. Based on the results and interpretation of electrical logs the zones have been recommended for construction of wells. The electrical log results are summarized in Table 7.5. The representative electro logging graphs are presented in Figure 7.12.

Sites	Location	Depth Logged (m bgl)	Zones recommended for screening (m bgl)	Remarks
1	Rangan Primary School, Jatragachi, Rajarhat	20	15-18	-
2	Uday Sangha, Kestopur	20	12-15	-
3	Lake Town Cultural Organization, Lake town	20	16-19	-
4	Jyangra Hatiara 2 no Gram Panchayet	20	16-19	-
5	107 no. Ward Office	20	16-19	-

Table 7.5

Sites	Location	Depth Logged (m bgl)	Zones recommended for screening (m bgl)	Remarks
6	Burn Standard Company	20	15-18	-
7	Office of Executive Engineer P.W.D Sunderban Electrical Division	20	-	No Significant granular zones encountered upto the target depth
8	Kasba Samannaoy Samiti B. B. Chatterjee Road	18	-	Logged upto 18m because the probe could not encounter due to hard formation
9	AIWC Buniadi Vidyapith Girls High School (H.S.), Beleghata	20	17-20	-
10	Shri Sambhu Sadan Vidyalaya, Taratala	20	18-20	-
11	Akra Saktigarh Rabindra Vidyapith, Akra, Mahestala	20	18-20	-
12	Maheshtala College Budge Budge Road, Mahestala	20	17-20	-
13	Sri Sathya sai Bal Vihar, Balaka, Joka	20	-	No Significant granular zones encountered upto the target depth
14	Kalagachia Kailash Kamini Ucchya Vidyalaya, Thakurpukur	20	-	No Significant granular zones encountered upto the target depth
15	Vivekanada College, Barisha	20	18-20	-
16	ITI College	20	17-20	-
17	Shantinagar Vidyamandir, Moore Avenue	20	14-17	-
18	Dilip Mukherjee Smriti Sangha, Picnic Garden	20	17-19	-
19	Jodhpur Park Boys School, Jodhpur Park	20	-	No Significant granular zones encountered upto the target depth
20	Charankobi Mukundadas, Mukundapur	20	18-20	_
21	Kadarhat Gopalchandra Aboitonik Prathamik Vidyalaya, Behala	20	-	No Significant granular zones encountered upto the target depth
22	Labanhrad Vidyapith for Girls, Saltlake	20	18-20	-

Sites	Location	Depth Logged (m bgl)	Zones recommended for screening (m bgl)	Remarks
23	Tramways Corporation Ltd. Lenin Sarani			Electrologging could not be done due to presence of very loose formation and continuous caving
24	Taki House for Boys, Sealdah	20	17-20	-
25	MCPT Motilal Institution, Dum Dum	20	-	No Significant granular zones encountered upto the target depth
26	Paikpara Yubak Sangha, Paikpara	20	18-20	-
27	Sarathi Seva Sangha, B.T. Road, Tobin Road junction	20	-	No Significant granular zones encountered upto the target depth
28	Ananda Society, Nimta	20	18-20	-
29	Kendriya Vidyalaya Santragachi, Santragachi	20	-	No Significant granular zones encountered upto the target depth
30	Mahestala, Gonipur, Dakshin 24 Paraganas, Gonipur Sitala Abaitanik Primary School	20	-	No Significant granular zones encountered upto the target depth
31	Amrita Bihar Abasan, Kamagazi	20	18-20	-
32	Jadavpur N. K. Pal Sikshayatan, Jadavpur	20	18-20	-
33	Howrah Siksha Sadan, Howrah	20	-	Electrologging could not be done due to presence of very loose formation and continuous caving
34	Botanic Garden Adarsha Bidyalaya, Howrah	20	-	No Significant granular zones encountered upto the target depth
35	Bally Jagacha Panchayet Samiti, Bally Jagacha, Howrah	20	-	No Significant granular zones encountered upto the target depth
36	Kona Agradyut Sangha, Howrah	20	-	No Significant granular zones encountered upto the target depth
37	Jagacha High school, Howrah	20	17-20	-
38	Uttarayan Club	20	18-20	-

Sites	Location	Depth Logged (m bgl)	Zones recommended for screening (m bgl)	Remarks
39	Dum Dum Tarun Samiti, Dum Dum, Kolkata	20	18-20	-
40	Bally Santiram Vidyalaya, Howrah	20	15-18	-
41	Entally Hindu Balika Vidyamandir, Entally, Kolkata	20	-	No Significant granular zones encountered upto the target depth
42	Baghbazar Multipurpose, Baghbazar	20	-	No Significant granular zones encountered upto the target depth
43	Ganabhavan	20	-	No Significant granular zones encountered upto the target depth
44	Naktala Udayan Sangha, Naktala	20	17-20	-
45	Basanti Devi College, Gariahat	20	-	No Significant granular zones encountered upto the target depth
46	Tarun Sangha, Motijeel, Dum Dum	20	18-20	-
47	Notunpara Kalyan Sangha, Behala	20	-	No Significant granular zones encountered upto the target depth
48	Santoshpur Bidya Mandir for Boys, Santoshpur	20	18-20	-

0m

Clay

18m











Site-17: Electrologging graph and logging details of Shantinagar Vidyamandir, Moore Avenue



Site-26: Electrologging graph and logging details of Paikpara Yubak Sangha, Paikpara



Site-29: Electrologging graph and logging details of Kendriya Vidyalaya Santragachi



Site-35: Electrologging graph and logging details of Bally Jagacha Panchayet Samiti, Bally, Howrah Site-37: Electrologging graph and logging details of Jagacha High School, Jagacha, Howrah









Site-41: Electrologging graph and logging details of Entally Hindu Balika Vidyamandir

Site-42: Electrologging graph and logging details of Baghbazar Multipurpose School





Site-44: Electrologging graph and logging details of Naktala Udayan Sangha

did e

Resistance in Ohm-M

SITE-44

0m Clay

4m

Sand

20m



Site-45: Electrologging graph and logging details of Basanti Devi College



Naktala Udayan Sangha Date: 11.09.12

Depth

SSP in mV 80 90 100 110 120 130



7.5 Water Level Variation in Kolkata

Groundwater level has been measured at a regular time interval. The water level has been subtracted from the Reduced Level (RL) to get the groundwater level from the Piezometers and the Dug Wells. Thereafter, the contour maps have been prepared based on the Piezometer and Dug Well information which are illustrated below.

7.5.1 Piezometric Groundwater Level

7.5.1.1 Piezometric Groundwater Surface Configuration in the year 2012

The water table contour map of Pre-monsoon period of 2012 is depicted in Figure 7.13(a) which exhibits one trough in the central part of the City where the water level ranges between 1.0 m bgl to -0.5 m bgl. A shallow trough with a gentle slope is found in the northeastern part where water level ranges between 0.5 m bgl to -0.5 m bgl. Groundwater flows to the trough from the two mounds located in the southwestern and eastern part of the study region. The water level in the mound region ranges from 7.5 m bgl to 5 m bgl. The general trend of flow is in the southeastern side of the study region.





(a) Piezometric Pre-monsoon groundwater surface configuration in the year 2012, and (b) Piezometric Postmonsoon groundwater surface configuration in the year 2012.

The water table contour map of Post-monsoon period of 2012 is depicted in Figure 7.13(b) that exhibits three troughs in the study region; one is located in the northeastern side and the other two in the southeastern side of the region. The water level ranges from -9.0 m bgl to -3.0 m bgl in the trough zones. Three mounds have been observed - one in the central region and the two in the southern part of the City. The water level observed in the mound zones ranges from 6.0 m bgl to -2.0 m bgl. The general trend of the water flow is in the southeastern side of the study region.

7.5.1.2 Piezometric Groundwater Surface Configuration in the year 2013

The groundwater depth scenario changes in the year 2013 as depicted in Figure 7.14(a) which shows one trough in the study region instead of two in the same time span of the previous year. The trough is observed in the northeastern part of the City. In the central part, a steep mound is found and two other mounds are observed in the southern part. The water level ranges between -12.0 m bgl to -5.0 m bgl in the trough region whereas the water level ranges from 6.0 m bgl to -2.0 m bgl in the mound region. A small gentle depression is witnessed in the south central region with no such water level variation.





(a) Piezometric Pre-monsoon groundwater surface configuration in the year 2013, and (b) Piezometric Postmonsoon groundwater surface configuration in the year 2013.

The water table contour of Post-monsoon period of 2013 shows one steep trough in the northern part where the water level ranges from -10.0 m bgl to -3.0 m bgl as depicted in Figure 7.14(b). Two gentle troughs are found in the south-central and central part of the study region. Three mounds are witnessed in the study region— in the north-central, southern and southwestern parts of the City. The water level ranges between 7.0 m bgl to -1.0 m bgl as observed in the mound zones. The general flow direction is in the southeastern part of the study region.

7.5.1.3 Piezometric Groundwater Surface Configuration in the year 2014

The trough which was found in the northern side of the study region in Pre-monsoon of 2013 have slightly shifted in the northern side in Pre-monsoon of 2014 as depicted in Figure 7.15(a). The water level ranges from -12.0 m bgl to -5.0 m bgl in the trough region. A mound has been observed in the central part of the study region where the water level ranges from 6.0 m bgl to -3.0 m bgl. A gentle mound with little variation is found in the southern part of the City.

In the Monsoon of 2014, a distinctive trend is found in the water table map as depicted in Figure 7.15(b). A gentle contour covering a wide area is found in the northeastern side while a large mound is found in the central part followed by a small mound in the southern part of the City. In adjacent to the trough in the northern side a steep mound is found in the northeastern part of the study region. The water level in the trough region ranges between -6.0 m bgl to - 0.5 m bgl while in the mound it ranges from 6.5 m bgl to 1.5 m bgl. The general flow direction is towards the southeastern side of the study region.



Figure 7.15

(a) Piezometric Pre-monsoon groundwater surface configuration in the year 2014, (b) Piezometric Monsoon groundwater surface configuration in the year 2014, and (c) Piezometric Post-monsoon groundwater surface configuration in the year 2014.

The water table contours of Post-monsoon period of 2014 shows a gentle trough in the northeastern part, where the water level ranges from -6.0 m bgl to -1.0 m bgl as depicted in Figure 7.15(c). Two mounds are found in the study region – one in the northeastern and the other in the southern region with the water level ranging between 6.5 m bgl to 1.0 m bgl. The general flow direction is in the southeastern part of the study region.

7.5.2 Dug Wells' Groundwater Level

7.5.2.1 Dug Well Groundwater Surface Configuration in the year 2012

In Pre-monsoon of 2012, the contour drawn from the Dug Well water level data exhibits a trough in the southwestern part of the study region and a mound in the northeastern region as depicted in Figure 7.16(a). The water level ranges from -0.5 m bgl to 2.5 m bgl in the trough region and in the mound region the water level varies between 7.5 m bgl to 3.0 m bgl. In Post-monsoon of 2012, a little change in the contour diagram is found from the previous time span though the basic pattern remains the same as shows in Figure 7.16(b).





(a) Groundwater table contours of Pre-monsoon Dug Well in the year 2012, and (b) Groundwater table contours of Post-monsoon Dug well in the year 2012.

7.5.2.2 Dug Well Groundwater Surface Configuration in the year 2013

In Pre-monsoon of 2013, the water table contours show a trough in the southeastern region where the water level ranges from 0.0 m bgl to 3 m bgl. Another trough is found in the northwestern part of the study region as depicted in Figure 7.17(a).





(a) Water level contours of Pre-monsoon Dug Well in the year 2013, and (b) Water level contours of Postmonsoon Dug Well in the year 2013.

A mound is present in the northern side of the study region where the water level ranges from 6.0 m bgl to 3.5 m bgl. In Post-monsoon of 2013, the pattern shows the same trend and the continuity of the two troughs are found in the western side of the study region as depicted in Figure 7.17(b). The mound at the northern part of the region is linked with the mound situated at the base in the southeastern part as depicted in Figure 7.17(b).

7.5.2.3 Dug Well Groundwater Surface Configuration in the year 2014

In Pre-monsoon of 2014, the water table contour exhibits a gentle trough in the southern part and a mound at the northern part of the region. The general flow of water is towards the southern part of the study region as depicted in Figure 7.18(a). The water level varies from 7.5 m bgl to -1.0 m bgl in Pre-monsoon season. During the Monsoon of 2014, the previous water trough shifted towards the eastern part although the flow pattern is same as in the previous time span. The trough located in the southern part has been found to be steeper than the earlier time span as shown in Figure 7.18(b). The water level ranges from 7.0 to 7.5 m bgl in the Monsoon season. Figure 7.18 (a-b) exhibits the low water table *i.e.* ~7.0 m bgl in the northeastern part of the study region while the southeastern part of the region is associated with high water table depth *i.e.* ~2 m bgl at both Pre-monsoon and Monsoon season. The western part of the study region exhibits an average water table depth of 3.5 to 4.5 m bgl.

In the Post-monsoon of 2014, a trough is found in the southeastern part and a mound is found in the northern part of the study region. The general flow of water is in the southeastern part of the region as depicted in Figure 7.18(c).





Figure 7.18

Groundwater level contours of (a) Pre-monsoon, (b) Monsoon, and (c) Post-monsoon Dug Wells in the year 2014.

7.6 Groundwater Level Fluctuation

7.6.1 Piezometric Groundwater Table Fluctuation

The Piezometric groundwater level shows a seasonal as well as spatial variation of groundwater depth as the aquifer tapped is a phreatic surface which receives maximum rainwater through percolation. The average groundwater level fluctuations during Pre- and Post-monsoon of 2012, 2013 and 2014 are given in Table 7.6. It has been observed that the water level rises during the Post-monsoon seasons as compared to the Pre-monsoon season. The average fluctuation in 2012 is 1.40 m which is the maximum amongst 2012, 2013 and 2014 (*i.e.* Table 7.6). In 2013 the fluctuation of water level is minimum being at 0.34 m (*i.e.* Table 7.6). Average fluctuation of water level during 2012, 2013 and 2014 is 0.917 m. However, the annual rainfall of 2013 was higher nearly double as compared to 2012, so the fluctuation of Pre-monsoon and Post-monsoon was observed to be maximum in 2012 and minimum in 2013. The groundwater level fluctuations during the time span of 2012 to 2014 for each Piezometer sites are shown in Figure 7.19.

Table 7.6

Groundwater level fluctuations of Piezometers during the period of 2012 to 2014

Season	on Groundwater Table (m bgl)			
Pre-monsoon 2012 9.04 m		1.40 m		
Post-monsoon 2012	7.64 m	1.40 III		
Pre-monsoon 2013	8.70 m	0.24 m		
Post-monsoon 2013	8.36 m	0.34 111		
Pre-monsoon 2014	7.61 m	1.01 m		
Post-monsoon 2014	6.60 m	1.01 III		







Figure 7.19

Piezometric groundwater level fluctuation during the span of 2012 to 2014 in Kolkata.

The detailed Piezometric groundwater level of shallow aquifers in Kolkata is discussed below:

- Rangan Primary School: The data collected from this site during 2012 to 2014 have been plotted in Figure 7.19(a). During Pre-monsoon of 2013 and 2014 the water level is found to be going down and during Post-monsoon of 2012 and 2013 the level of water rose. The highest rise of water level was during Post-monsoon of 2013 (5.79 m bgl) and highest fall was during Pre-monsoon of 2013 (7.24 m bgl).
- Uday Sangha: Groundwater level data collected from this site during 2012 to 2014 have been plotted in Figure 7.19(b). The highest rise of water level was during Pre-monsoon of 2013 (9.65 m bgl) and highest fall was during Post-monsoon of 2012 (13.92 m bgl).
- 3) Lake Town Cultural Organization: Water level data at this site collected during 2012 to 2014 have been plotted in Figure 7.19(c). During Pre-monsoon of 2013 and 2014 the water level is found to be going down and during Post-monsoon of 2012 and 2013 the level of water rose. The highest rise of water level was during Post-monsoon of 2012 (8.18 m bgl) and highest fall was during Pre-monsoon of 2013 (9.78 m bgl).

- 4) Jyangra Hatiara 2 no. Gram Panchayet: Water level data collected at this site during 2012 to 2014 have been plotted in Figure 7.19(d). The highest rise of water level was during Postmonsoon of 2013 (8.59 m bgl) and highest fall was during Pre-monsoon of 2013 (9.98 m bgl). The water level in Pre-monsoon was found to be 1.12 m bgl.
- 5) 107 no. Ward Office: Water level data collected at this site during 2012 to 2014 have been plotted in Figure 7.19(e). The highest rise of water level was during Monsoon period of 2014 (0.66 m bgl) and highest fall was during Post-monsoon of 2013 (1.06 m bgl).
- 6) Burn Standard Company: The water level data collected at this site during 2012 to 2014 have been plotted in Figure 7.19(f).
- 7) AIWC Buniadi Vidyapith Girls High School: At this site the variation of water level in Premonsoon and Post-monsoon is given in Figure 7.19(g). The Post-monsoon water level has been always found to be rising than the Pre-monsoon water level. The highest rise was found during the Monsoon of 2014 (7.39 m bgl) and the lowest rise was during Pre-monsoon of 2013 (9.23 m bgl).
- 8) Akra Shaktigarh Rabindra Vidyapith: Water level data collected at this site during 2012 to 2014 have been plotted in Figure 7.19(h). The highest rise of water level was during the Monsoon of 2014 (4.14 m bgl) and highest fall was during Pre-monsoon of 2013 (5.96 m bgl). The Pre-monsoon water level has been found to be lower than the Post-monsoon water level.
- 9) Maheshtala College: The graph of water level variation for this site is given in Figure 7.19(i). The water level rise was highest during Post-monsoon of 2013 (5.88 m bgl) and lowest in Pre-monsoon of 2014 (6.95 m bgl).
- 10) Vivekananda College: This site in Behala shows an overall steady state of water level fluctuation with the highest fall has been found in the Pre-monsoon time span. Water level was found to be rising highest during Post-monsoon of 2014 (7.15 m bgl) and lowest in Pre-monsoon of 2012 (11.43 m bgl) as depicted in Figure 7.19(j).
- 11) ITI College: At this site water level was found to be rising in the Post-monsoon season compared to the Pre-monsoon months. The highest rise of water level was during Post-monsoon of 2013 (5.45 m bgl) and lowest was in Pre-monsoon of 2013 (7.51 m bgl). The Pre-monsoon water level has been found to be higher than Post-monsoon water levels as shown in Figure 7.19(k).
- 12) Shantinagar Vidyamandir: This site in Moore Avenue focused a distinct variation in water level in Pre-monsoon and Post-monsoon time frame. The highest rise of water level was found in Post-monsoon of 2013 (3.28 m bgl) and lowest was found in Pre-monsoon of 2013 (7.13 m bgl) as depicted in Figure 7.19(l).
- 13) Dilip Mukherjee Smriti Sangha: This site in Picnic Garden shows water level rise in Postmonsoon season of 2012 (8.61 m bgl). In Pre-monsoon the water level has been found to be low in 2012 as shown in Figure 7.19(m).
- 14) Charankobi Mukunda Das Primary School: The water level variation at this site shows rise in Post-monsoon period than Pre-monsoon seasons. The highest rise of water level was during Post-monsoon of 2013 (9.14 m bgl) and lowest in Pre-monsoon of 2012 (11.65 m bgl) as depicted in Figure 7.19(n).

- 15) Laban Hrad Bidyapith for Girls: The graph of water level variation for this site is given in Figure 7.19(o). The water level rise was highest during Post-monsoon of 2012 (6.33 m bgl) and lowest in Pre-monsoon of 2012 (7.36 m bgl) while the Pre-monsoon water level is lower than the Post-monsoon water level.
- 16) Taki House for Boys: This site is located near Sealdah area and at this site Post-monsoon water level is found to be rising than the Pre-monsoon seasons. The water level rise was highest during Post-monsoon of 2012 (3.90 m bgl) and lowest in Pre-monsoon of 2014 (4.33 m bgl) as depicted in Figure 7.19(p).
- 17) Paikpara Yubak Sangha: The highest rise is in the Monsoon of 2014 (12.01 m bgl) and lowest is in Pre-monsoon of 2014 (14.46 m bgl) as shown in Figure 7.19(q).
- 18) Uttarayan Club: The water level variation at this site is given in Figure 7.19(r). The water level rise was highest during the Monsoon of 2014 (8.28 m bgl) and lowest in Pre-monsoon of 2013 (13.05 m bgl).
- 19) Dum Dum Tarun Samiti: The variation of water level for this site is given in Figure 7.19(s). The water level was lowest in Pre-monsoon of 2013 (15.83 m bgl).
- 20) Bally Shantiram Vidyalaya: The rise in water level was very high in Post-monsoon of 2012 (5.28 m bgl) and minimum rise is found in Pre-monsoon of 2012 as depicted in Figure 7.19(t).
- 21) Ananda Society: Water level was found to be rising in Post-monsoon seasons than the Pre monsoon time as shown in Figure 7.19(u). The water level was very high in Post-monsoon of 2012 (10.87 m bgl) and lowest in Pre-monsoon of 2012 (12.25 m bgl).
- 22) Amrita Bihar Abasan: The water level rise was very high in Post-monsoon of 2012 (10.53 m bgl) and lowest in Pre-monsoon of 2012 (11.71 m bgl) as depicted in Figure 7.19(v).
- 23) Jadavpur N.K. Pal Sikshayatan: The water level rise was very high in Post-monsoon of 2012 (13.03 m bgl) and minimum in Pre-monsoon of 2012 (14.05 m bgl) as shown in Figure 7.19(w).

7.6.2 Dug Well Groundwater Table Fluctuation

Similarly, the groundwater level has been collected from Dug Wells at 16 different locations in and around Kolkata. The average water level fluctuations of Pre- and Post-monsoon of 2012, 2013 and 2014 are given in Table 7.7. It is found that the groundwater level is rising in the Post-monsoon seasons than the Pre-monsoon time span. The average fluctuation in 2012 is 0.61 m which is the maximum amongst 2012, 2013 and 2014. In 2013 the fluctuation of water level is the minimum that of 0.16 m. Average fluctuation of water level during 2012, 2013 and 2014 is 0.33 m. Annual rainfall of 2013 was nearly double as compared to 2012, so the fluctuation of Pre-monsoon and Post-monsoon water level was maximum in 2012 and minimum in 2013. The groundwater level fluctuations during the span of 2012 to 2014 for each Dug Well site is shown in Figure 7.20.

Table 7.7

Groundwater level fluctuations in Dug Wells during the period of 2012 to 2014

Season	Fluctuation (m)	
Pre-monsoon 2012	2.63 m	0.61 m
Post-monsoon 2012	2.02 m	0.01 III
Pre-monsoon 2013	2.17 m	0.16
Post-monsoon 2013	2.01 m	0.10 III
Pre-monsoon 2014	1.24 m	0.22 m
Post-monsoon 2014	1.01 m	0.25 III







(f)







Figure 7.20

Dug Well groundwater level fluctuation during the span of 2012 to 2014 in Kolkata.

The details of Dug Well groundwater depth variation of shallow aquifers in Kolkata is discussed below:

- 4 no. Mahajati Nagar: The Dug Well is located in north Kolkata and shows a variation of water level in Pre-monsoon and Post-monsoon seasons. The high rise of water level is in Postmonsoon of 2013 (0.9 m bgl) and lowest is in Pre-monsoon of 2014 (1.5 m bgl) as depicted in Figure 7.20(a).
- 289 M.B. Road: The dug well is located in north Kolkata that shows a high water level rise in Post-monsoon of 2012 (0.47 m bgl) and low rise in Pre-monsoon of 2014 (1.66 m bgl) as shown in Figure 7.20(b).
- 17 Bonhoogli More: The highest water level is observed in Post-monsoon of 2012 (1.35 m bgl) and lowest in Pre-monsoon of 2012 (1.38 m bgl) as depicted in Figure 7.20(c).
- 4) New Noapara Colony: The details of groundwater level fluctuation of the dug well are given in Figure 7.20(d). The highest water level is in the Monsoon of 2014 (1.01 m bgl) and lowest in Pre-monsoon of 2012.
- Gram Thakurani Chak, Paus Samabay Pally: The highest water level is in Post-monsoon of 2012 (3.55 m bgl) and lowest is in Pre-monsoon of 2013 (4.98 m bgl) as shown in Figure 7.20(e).
- 6) Bally Ghoshpara: The Dug Well is located in Howrah depicting a high water level in Monsoon of 2014 (0.45 m bgl) and a low in Pre-monsoon of 2013 (1.16 m bgl) as depicted in Figure 7.20(f).
- 7) Sahara Ghoshpara: The highest water level is observed in Post-monsoon of 2012 (1.27 m bgl) and the lowest in Pre-monsoon of 2012 (1.26 m bgl) as shown in Figure 7.20(g).
- 8) 21/6 Gopalpur: The details of the Dug Well are given in Figure 7.20(h). The highest water level rise is in the Monsoon of 2014 (1.04 m bgl) and the lowest water level is in Pre-monsoon of 2013 (3.02 m bgl).
- 9) 100/61 Jessore Road: The highest water level observed is in the Monsoon of 2014 (0.9 m bgl) and the lowest in Post-monsoon of 2013 (1.83 m bgl) as depicted in Figure 7.20(i).
- 10) Thakurpukur, Kalagachia: The details of water level fluctuation in the Dug Well are given in Figure 7.20(j). The highest water level rise is in Post-monsoon of 2013 (0.65 m bgl) and the lowest in Pre-monsoon of 2013 (2.64 m bgl).
- 11) Kadarhat Ramkrishna Palli: The detail of the water levels for the Dug Well is given in Figure 7.20(k).
- 12) Dug Well beside China Mandir: The Dug Well is located in Chowbaga area near Basanti Highway. The highest water level is observed in Post-monsoon of 2013 (1.3 m bgl) and the lowest in Pre-monsoon of 2013 (3.65 m bgl) as depicted in Figure 7.20(l).
- 13) Bharat Traders (Marbles and Granites): The highest water level is observed in the Monsoon of 2014 (0.83 m bgl) as depicted in Figure 7.20(m).

- 14) Dug Well beside Delhi Public School, Ruby Park: The details of water level fluctuation of the Dug Well are given in Figure 7.20(n). The highest water level is observed in Post-monsoon of 2014 (1.06 m bgl).
- 15) Dug Well beside Gitanjali Stadium: The details of water level fluctuation of the Dug Well are given in Figure 7.20(o). The highest water level is observed in the Monsoon of 2014 (0.24 m bgl).

7.7 Chemical Analysis of Water Sample

The water quality analysis of water samples collected from Piezometers and Dug Wells shows a trend where contaminants are found mostly in the Pre-monsoon period than the Post-monsoon and Monsoon seasons. The contaminants are found to be minimal in the Monsoon seasons due to the dilution factors of the rain water with the contaminants of pH. Total Dissolved Solids (TDS) and Electrical Conductivity of several water samples collected during the study period is presented in Table 7.8 and Table 7.9 for Piezometers and Dug Wells respectively.

Sample Number	Sample Location	pH Monsoon 2014	pH Post- monsoon 2014	TDS (ppm) Monsoon 2014	TDS (ppm) Post-monsoon 2014	Electrical Conductivity (μs) Monsoon 2014	Electrical Conductivity (μs) Post-monsoon 2014
Pz-2	Uday Sangha, 7 no. Udayan Palli	7.10	-	494	-	900	-
Pz-3	Lake Town Cultural Organization	7.09	7.43	410	430	763	850
Pz-4	Jyangra Hatiara 2 no. Gram Panchayet	6.93	-	840	-	1395	-
Pz-5	107 Ward Office	6.98	-	390	-	632	635
Pz-9	AIWC Buniadi Vidyapith Girls High School	7.40	7.28	2120	1926	3900	4500
Pz-11	Akra Shaktigarh Rabindra Vidyapith	7.30	7.29	180	800	300	1505
Pz-12	Mahestala College	7.42	7.60	430	345	782	840
Pz-15	Vivekananda College	7.48	7.12	1153	1080	1852	1426

Table 7.8 Water quality analysis of the water samples collected from Piezometers

Sample Number	Sample Location	pH Monsoon 2014	pH Post- monsoon 2014	TDS (ppm) Monsoon 2014	TDS (ppm) Post-monsoon 2014	Electrical Conductivity (μs) Monsoon 2014	Electrical Conductivity (μs) Post-monsoon 2014
Pz-16	ITI College	7.18	7.50	490	455	896	871
Pz-17	Shantinagar Vidyamandir	7.23	7.16	657	714	1120	1211
Pz-22	Labanhrad Vidyapith for Girls	7.33	7.40	607	561	700	1020
Pz-24	Taki House for Boys	7.62	7.38	452	521	540	700
Pz-26	Paikpara Yubak Sangha	7.40	7.50	484	430	652	836

Table 7.9

Water Quality analysis of the water samples collected from Dug Wells

Sample Number	Sample Location	pH Monsoon 2014	pH Post -monsoon 2014	TDS (ppm) Monsoon 2014	TDS (ppm) Post -monsoon 2014	Electronic Conductivity (µs) Monsoon 2014	Electronic Conductivity (µs) Post-monsoon 2014
Dw-1	4 no. Mahajati Nagar, 91 Maharaja Nandakumar Road, Kol-51	7.09	7.45	626	653	962	1210
Dw-5	New Noapara Colony, A.K.Mukherjee Road, Kol-90	7.70	7.25	810	778	1420	1480
Dw-7	Bally Ghoshpara, Howrah-711227	7.39	7.14	617	780	965	1320
Dw-9	House no. 21/6, Gopalpur, Kol-136	7.31	7.21	652	530	1010	1060
Dw-10	100/61, Jessore Road, Kol-74	7.20	7.43	230	352	555	650
Dw-11	Santi Ranjan Bhowmik, Thakurpukur, Kalagachia, Kolkata	7.27	7.30	940	778	1650	1480
Dw-13	Besides china-mandir khalpar	7.13	7.20	295	1428	404	2750
Dw-14	Bharat Traders Marbles & Granite Traders. 36, Topsia Road, Kol-39	7.01	7.15	885	1006	1100	1910

Sample Number	Sample Location	pH Monsoon 2014	pH Post -monsoon 2014	TDS (ppm) Monsoon 2014	TDS (ppm) Post -monsoon 2014	Electronic Conductivity (µs) Monsoon 2014	Electronic Conductivity (µs) Post-monsoon 2014
Dw-15	Besides Delhi Public School, Ruby Park	7.23	7.20	1491	1230	230 2426 1930	
Dw-16	Besides Gitanjali Stadium, Rajdanga Mail Road, Kolkata	7.20	7.46	1538	1432	2856	2520

Concentration of Chloride is of immense importance for the determination of potability of water as well as using the water for other domestic purposes. The concentration of chloride in the water samples collected at different times and from different places is given in Table 7.10 and Table 7.11 for both the Piezometers and Dug Wells respectively. The concentration of Chloride has been found to be higher in Pre-monsoon than in Post-monsoon period. The concentration of Chloride has been found to be as high as 538.84 mg/l in Pre-monsoon period of 2013 at Dilip Mukherjee Club, Picnic Garden and Labanhrad Bidyapith for Girls at Saltlake. The lowest concentration of Chloride is found to be 28.36 mg/l in the Pre-monsoon period of 2013 at Maheshtala College.

Table 7.10

Concentration of Chloride in the water samples collected from Piezometers

Sample Number	Sample Location	Concentration of Chloride as Cl ⁻ mg/l on Pre-monsoon 2013	Concentration of Chloride as Cl ⁻ mg/l on Post-monsoon 2013	Concentration of Chloride as Cl ⁻ mg/l on Monsoon 2014	Concentration of Chloride as Cl ⁻ mg/l on Post-monsoon 2014
Pz-1	Rangan Primary School	184.34	170.16	-	-
Pz-2	Uday Sangha, 7 no. Udayan Palli	-	240.72	127.62	-
Pz-3	Lake Town Cultural Organisation	120.53	106.35	113.44	106.35
Pz-4	Jyangra Hatiara 2 no. Gram Panchayet	616.83	333.23	241.06	-
Pz-5	107 Ward Office	304.87	283.6	282.45	-
Pz-6	Burn Standard Company	106.35	Destroyed	Destroyed	-

Sample Number	Sample Location	Concentration of Chloride as Cl ⁻ mg/l on Pre-monsoon 2013	Concentration of Chloride as Cl ⁻ mg/l on Post-monsoon 2013	Concentration of Chloride as Cl ⁻ mg/l on Monsoon 2014	Concentration of Chloride as Cl ⁻ mg/l on Post-monsoon 2014
Pz-9	AIWC Buniadi Vidyapith Girls High School	850.80	857.87	935.88	856.52
Pz-11	Akra Shaktigarh Rabindra Vidyapith	241.06	233.97	283.6	270.80
Pz-12	Mahestala College	28.36	35.45	68.81	42.54
Pz-15	Vivekananda College	240.72	248.15	297.78	290.69
Pz-16	ITI College	170.16	120.53	156.87	140.25
Pz-17	Shantinagar Vidyamandir	255.24	269.42	262.33	248.15
Pz-18	Dilip Mukherjee	538.84	Destroyed	Destroyed	-
Pz-22	Labanhrad Vidyapith for Girls	538.84	GWT Not found	134.71	120.90
Pz-24	Taki House for Boys	127.62	148	964.24	170.16
Pz-26	Paikpara Yubak Sangha	49.63	28.36	56.72	49.63
Pz-31	Amrita Bihar Abasan	-	GWT Not found	GWT Not found	-
Pz-39	Dum Dum Tarun Samiti	297.78	255.24	GWT Not found	-
Pz-40	Bally Santiram Vidyalaya	255.24	Destroyed	Destroyed	-

Table 7.11

Concentration of Chloride in the water samples collected from Dug Wells

Sample Number	Sample Location	Concentration of Chloride as Cl ⁻ mg/l on Pre-monsoon 2013	Concentration of Chloride as Cl ⁻ mg/l on Post-monsoon 2013	Concentration of Chloride as Cl ⁻ mg/l on Monsoon 2014	Concentration of Chloride as Cl ⁻ mg/l on Post-monsoon 2014
Dw-1	4 no. Mahajati Nagar, 91 Maharaja Nandakumar Road, Kol-51	177.25	153.25	Destroyed	-

Sample Number	Sample Location	Concentration of Chloride as Cl ⁻ mg/l on Pre-monsoon 2013	Concentration of Chloride as Cl ⁻ mg/l on Post-monsoon 2013	Concentration of Chloride as Cl ⁻ mg/l on Monsoon 2014	Concentration of Chloride as Cl ⁻ mg/l on Post-monsoon 2014
Dw-3	289 M.B. Road, Kol-51	106.35	86.23	134.71	-
Dw-5	New Noapara Colony, A.K.Mukherjee Road, Kol-90	311.96	250.36	248.15	233.23
Dw-7	Bally Ghoshpara, Howrah-711227	538.84	403.89	219.79	553.02
Dw-9	House no. 21/6, Gopalpur, Kol-136	49.63	37.56	70.90	67.99
Dw-10	100/61, Jessore Road, Kolkata-74	42.54	33.25	49.63	453.08
Dw-11	Santi Ranjan Bhowmik, Thakurpukur, Kalagachia, Kolkata	389.95	296.42	311.96	248.15
Dw-13	Besides china-mandir khalpar	730.27	620.56	632.92	601.17
Dw-14	Bharat Traders Marbles & Granite Traders. 36, Topsia Road, Kol-39	177.25	112.28	113.44	101.80
Dw-15	Besides Delhi Public School, Ruby Park	496.30	368.56	545.93	406.85
Dw-16	Besides Gitanjali Stadium, Rajdanga Mail Road, Kolkata	538.84	435.73	751.54	581.38

The chemical analysis has been performed to determine the arsenic concentration also in the water samples collected from Piezometers. The Arsenic concentration of the water samples are given in Table 7.12. Maximum arsenic concentration has been found in pre-monsoon of 2013 at Vivekananda College (0.045 mg/l). In some places it has been observed that the arsenic concentration is above the desirable limit in the City. The areas are Rangan Primary School (Jatragachi, New Town) in Pre-monsoon of 2013 (0.03 mg/l), 2 Number Gram Panchayet (Jyangra Hatiara) in Pre-monsoon of 2013 (0.023 mg/l), 107 Number Ward Office (Near Haltu) in Post-monsoon of 2013 & Pre-monsoon of 2014 (0.016 mg/l & 0.014 mg/l), Burn Standard Company (Near Chetla) in Pre-monsoon of 2013 (0.02 mg/l), Akra Shaktigarh Rabindranagar Vidyapith (Akra) during Pre-monsoon of 2013 (0.02 mg/l), Vivekanada College (Behala) in Pre- & Post-monsoon of 2013 and Pre-monsoon of 2014 (0.045 mg/l, 0.030 mg/l & 0.030 mg/l). Arsenic concentration has also been

recorded beyond desirable limit in Shantinagar Vidyamandir (Moore Avenue) in Pre-monsoon of 2013 (0.018 mg/l), Paikpara Yubak Sangha (Paikpara) in Pre-monsoon of 2013 (0.016 mg/l), Dum Dum Tarun Samiti (Dum Dum) in Pre-monsoon of 2013 (0.04 mg/l) and at many places it has been found <0.01 mg/l in different span of time.

Table 7.12

Arsenic analysis of the water samples collected from Piezometers

Sample Number	Sample Location	Concentration of Arsenic as As mg/l on Pre- monsoon 2013	Concentration of Arsenic as As mg/l on Post- monsoon 2013	Concentration of Arsenic as As mg/l on Pre- monsoon 2014
Pz-1	Rangan Primary School	0.039	.003	0.002
Pz-2	Uday Sangha, 7 no. Udayan Palli	0.011	< 0.01	-
Pz-3	Lake Town Cultural Organisation	0.01	< 0.01	< 0.01
Pz-4	Jyangra Hatiara 2 no. Gram Panchayet	0.023	0.003	0.003
Pz-5	107 Ward Office	< 0.01	0.016	0.014
Pz-6	Burn Standard Company	0.02	Destroyed	-
Pz-9	AIWC Buniadi Vidyapith Girls High School	<0.01	0.003	0.003
Pz-11	Akra Shaktigarh Rabindra Vidyapith	0.02	0.002	0.002
Pz-12	Mahestala College	0.01	0.009	0.011
Pz-15	Vivekananda College	0.045	0.030	0.030
Pz-16	ITI College	< 0.01	< 0.01	< 0.01
Pz-17	Shantinagar Vidyamandir	0.018	< 0.01	< 0.01
Pz-18	Dilip Mukherjee	0.011	Destroyed	-
Pz-22	Labanhrad Vidyapith for Girls	0.011	GWT Not found	<0.01
Pz-24	Taki House for Boys	< 0.01	0.001	0.001
Pz-26	Paikpara Yubak Sangha	0.016	< 0.01	-
Pz-31	Amrita Bihar Abasan	0.011	GWT Not	
		0.011	found	-
Pz-39	Dum Dum Tarun Samiti	0.04	< 0.01	-
Pz-40	Bally Santiram Vidyalaya	< 0.01	Destroyed	_

From the results of chemical analysis of water samples it has been revealed that the quality of water samples in the aquifers within 20 m below ground level is not potable due to concentration of chloride and the Total Dissolved Solids (TDS) is also in the higher side above the desirable limit of BIS. The concentration of TDS ranges from 2140 ppm to 180 ppm during Monsoon period of 2014 and 1926 ppm to 345 ppm during Post-monsoon period of 2014.

7.8 Detailed Subsurface Study of South Kolkata

In the southern part of Kolkata in an around Tollygunge area the arsenic concentration has been currently in news. Therefore, a part of our present investigation was aimed at understanding the actual scenario of peat formation present in this location and the role of Calcutta peat in the mobilization of Arsenic in the adjoining Aquitards/Aquifers. Therefore, we have selected four locations *viz*. Bijoygarh Balika Vidyalaya (BBV), Film Services (FS), Katjunagar Sishu Udyan (KSU) and Azadgarh Vidyapithfor Boys (AVB) for detailed analysis of chemical quality of water samples as depicted in Figure 7.21. The details of the lithological logging for all the bore holes along with the design for the construction of the Piezometers are presented in Figure 7.22. The water level has also been recorded after the construction process was complete and the value is presented with the lithological details.





Sites considered for detailed subsurface study through Piezometers in South Kolkata (Red Points).

LOCATION: Bijoygarh Balika Vidyalaya, Bijoygarh, Kolkata.

Date of drilling: 15/01/2015

GPS LOCATION: Lat: N 22° 29'16.6" Long: E 88° 21' 43.2''

Lithology				Design of the well		
Depth(m)	Sample Type	Colour	Texture	Diagram		
0-2	CLAY	Brownish Grey	Compact			
2-4	CLAY	Brownish Grey	Compact			
4-6	CLAY	Grey	Compact with organic matter	2m Brownish Grey Compact Clay	0m 0-12m length Black 12m	
6-8	CLAY	Grey	Compact	Gravish Compact	Diameter 3"	
8-10	SAND	Grey	Fine with mica	6m Clay containing Sm Organic Materials	()3880)	
10-12	SAND	Grey	Fine with mica	10m Gravich Fine		
12-14	SAND mixed with Clay	Grey	Very fine with mica	12m Sand	12-15mlength Strainer 7m 2" (Stram)	
14-16	SAND mixed with Clay	Grey	Very fine with mica	16m Grayish very Fine Sand with Clay	12-JUNI Hearth Blank 5m 2 ¹¹ (50mm)	
16-18	SAND mixed with Clay	Grey	Very fine with mica	20m Grayish Clay	Bell Cap	
18-20	CLAY	Grey	Compact			



npact with / little

kes mpact with v little

compact with ry little

of mica

Clay w

0-9 m length Blank 9 m Diameter 3'' (25mm)

9-12m length Strainer 3m 2'' (50mm)

12-20m length Blank 8m 2" (50mm)

Bell Cap

er level (measured by hold-cut method):									
Hold (m)	Cut (m)	Height of MP from ground level (m)	Pre-monsoon water level from bgl (m)						
7.0	3.04	0.22	3.74						

Remarks: Drilling was done up to 20m and Pre- monsoon water level data was taken

Water level (measured by hold-cut method):

16-18 CLAY

18-20 CLAY

20-22 CLAY

LOCATION Film Services, Golf Club Road

Hold (m)	Cut	Height of MP from	Pre-monsoon water	
	(m)	ground level (m)	level from bgl (m)	
8.0	0.88	0.18	6.94	

Remarks: Drilling was done up to 20m and Pre- monsoon water level data was taken





Detailed lithologs & Piezometer design conducted in south Kolkata.

7.8.1 Chemical Quality of the Water Samples Collected from the Piezometers of South Kolkata

The pH value of the water samples are well within BIS drinking water standards. The range of pH in the water samples varies from 7.67 to 7.86 as given in Table 7.13. Turbidity of the water samples is very high. High amount of Turbidity make the water samples unsuitable for drinking. Conductivity of the water samples is high as compared to normal drinking water.

The most important finding from the chemical analysis is the concentration of Arsenic. Arsenic concentration is found to be above the desirable limit of 0.01 mg/l as denoted by BIS. The highest concentration is recorded at Film Services near Golf Club Road (0.019 mg/l) and the lowest in Azadgarh Vidyapith for Boys, Kolkata (0.01 mg/l) as given in Table 7.13. In Katjunagar Sishu Udyan (Jadavpur) the concentration of Arsenic is 0.014 mg/l.

A peat layer was encountered during the drilling activity. The clay layers mostly grayish in colour are observed. The additional study would always pave the way to link between the role of Calcutta peat in the mobilization of arsenic in the water of aquitards/ aquifers in this area.

Characteristics		Res	ults		Desirable	Permissible	Test Method			
	BBV	FS	KSU	AVB	limit	limit	Specification			
рН	7.67	7.86	7.68	7.83	6.5-8.5	No Relaxation	APHA 21 st Edition, 4500- H ⁺ B			
Turbidity (NTU)	896.0	281.0	516.0	487.0	5	10	APHA 21 st Edition, 2130-B			
Conductivity µmhos/cm	346.7	340.8	3048.0	3874.0			APHA 21 st Edition, 2510-B			
Parameters concerning Toxic Substances										
Total Arsenic (as As) mg/l	0.014	0.019	0.014	0.01	0.01	0.01	APHA 21 st Edition, 3500- As B			

Table 7.13 Chemical analysis of water Samples in South Kolkata

7.9 Concluding Remarks

The main water-bearing formation of the region is Quaternary alluvium consisting of sands of various grades inter-bedded with silt and clay. From the available records of the Piezometers and Dug Wells at different locations throughout the study region, it is evident that the groundwater

table is generally very shallow. The groundwater level is closely associated with the amount of precipitation and may be quite high when the monthly precipitation is high (Yilmaz and Yavuzer, 2005). Due to heavy exploitation of groundwater a major change has been observed in the water level condition in Kolkata. Investigations conducted in Kolkata for the last four years reflect alarming depletion of piezometric level. At present, the piezometric level is 11 to 16 m below ground level in Dum Dum, Paikpara, Jadavpur, Mukundapur, Picnic Garden, Kestopur area whereas in Santoshpur and the surrounding region water level is 5 to 10 m deep. The average piezometric level observed in Kolkata is at a depth between 4 to 10 m below sea level. Groundwater levels are especially shallow in the eastern part of the City. The major findings of the present investigation are highlighted below:

- a) The general flow of water in this region is towards the southeastern part.
- b) The ground water withdrawal for drinking water and other domestic purposes has immense effects on the water level fluctuation.
- c) Rainfall data available from India Meteorological Department shows that the annual rainfall for 2010, 2011, 2012 and 2013 is 1362.2 mm, 1377.6 mm, 1279.3 mm and 2268.4 mm respectively.
- d) The monsoonal rainfall occurred more in 2012 than in 2013 which may have influenced the water level fluctuation during Pre- and Post-monsoon of 2012 compared to 2013 though the annual average rainfall of 2013 is greater than 2012.
- e) Peizometeric water level fluctuation in Pre- and Post-monsoon period of 2012 is 1.40 m whereas in 2013 it is 0.34 m and in 2014 it is 1.01 m.
- f) Average water level fluctuation of Piezometers during 2012, 2013 and 2014 is 0.917 m bgl.
- g) Water level fluctuation in Dug Wells in Pre- and Post-monsoon in the year 2012 is 0.61 m, in 2013 is 0.16 m and in 2014 is 0.23 m.
- h) Chemical quality of water samples collected from the Piezometers and Dug Wells are not favorable for drinking.
- i) The ground water in south Kolkata possess high concentration of turbidity and conductivity while pH of the water is well within the desirable range.
- j) The most important finding is the high concentration of Arsenic in the water samples.
- k) A peat layer has also been found in the adjoining areas of Tollygunge at south Kolkata.

Soil properties are altered by moisture content (Yilmaz and Bagci, 2006). The shallow groundwater may contribute favorable conditions for the occurrence of swelling of clays (Yilmaz, 2008). On the other hand, liquefaction potential of the soil is also controlled by the groundwater level at a particular site. The high groundwater levels create favorable conditions for the occurrences of liquefaction during an earthquake (Yilmaz and Bagci, 2006; Nath *et al.*, 2014). Ground water level is, therefore, one of the important parameters considered for evaluating different soil properties and their effect on various attributes of Seismic Hazard Microzonation

especially liquefaction potential of a region. Although, depth-to-groundwater (DTW) is an important attribute in the simplified procedure for liquefaction evaluation for the calculation of effective normal stress. Thus, in the present investigation, the groundwater table has been used for soil liquefaction susceptibility analysis and as a thematic attributes of geohazard regime which is ultimately integrated on GIS for the preparation of Seismic Hazard Microzonation map of an earthquake prone region.