



RESEARCH PAPER

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Physico-Chemical analysis of bore water from different regions of Karachi, Pakistan

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Key words: Bore water, Physico-Chemical analysis, Heavy metal analysis, Pakistan Standard for Drinking Water (PSDW) and WHO.

Abstract

Pure water for drinking and domestic purpose is the basic requirement for healthy life. However, increase in water pollution decrease the pure water resources and become a challenge for pure water and besides contaminated water created health hazard problems. In this study, we collect bore water samples from different regions of Karachi including Jamshad Town, DHA and Korangi Industrial Area. These bore water used in homes for cleaning purpose, in some area for drinking purpose and in some industries for Reverse Osmosis feed water for producing drinking and portable water. This research investigates the physico-chemical and heavy metals analysis embraces; appearance, color, odor, taste, pH, TDS, total hardness of Chloride, Total Alkalinity, Sulfate, Turbidity, Phosphate, Iron, Chromium, Lead and Zinc in the water. Heavy metals of bore water observed within limit while TDS, Hardness, Chloride. Sulfate and turbidity of most of samples found very high and unacceptable for drinking purpose as per limits which are specified by WHO and PSDW. Physico-chemical parameters analyzed by titration method and Spectrophotometer method while Heavy metals determine by Atomic Absorption Spectrophotometer method. It is concluded that contamination in bore water due to Geological structure, internal damages of sewerages system and bed quality of industrial waste water system.

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Introduction

Bore water, depending upon the quality, may be used for human consumption, livestock watering and irrigation purposes. Pollutants are being added to the ground water system through human and natural processes. The usage of the contaminated bore water causes the diseases.

A lot of works have been reported in the literature on bore water analysis. Such works include, study of heavy metal contamination (Oyeku and Eludoyin, 2010); Evaluation of Ground Water Quality (Mosher and Ahmed, 2009); Physico-Chemical Analysis of bore water (Anima and Chandrakla, 2014); Surface Water Quality Monitoring and Assessment (Ansa-Asare and Darko, 2006); Ground Water Resource Evaluation (Walton, 1970); Water processing (McGowan, 2000). All these workers concluded that there is a need to monitor water quality on a regular basis.

The human body required water which have certain amount of minerals, if these minerals above and below the recommended limits than such water is not suitable for good health (WHO, 2006). A common aphorism is “without water no life”, this statement expressed that water is the one naturally occurring necessary requirement for all good health activities (Singanan *et al.*, 2008).

Water available beneath the earth surface in all places is not necessarily suitable for drinking purpose while it requires some treatment processes before drinking. Water which is available at very shallow depth might be few hours' old, water at moderate depth may be hundred years old and at great depth water may be several thousand years of age (Mosher, 2009).

The rapid increase in population and industrialization creates a huge shortage of water in Karachi that has forced people to use ground water (from bores, wells or hand pumps) for their basic requirement (Government of Pakistan, 1997). Due to the presence of sea water in sediments and related minerals as evaporate deposits, that responsible of the high concentration of sodium chloride in ground water (Walton, 1970). The aim of present work to analyze

the Bore water of some areas of Karachi and to check its Physico-Chemical parameters (including appearance, color, odor, taste, pH, TDS, total hardness of Chloride, Total Alkalinity, Sulfate, Turbidity, Phosphate, Iron, Chromium, Lead and Zinc) to determine its suitability for drinking purpose.

Materials and methods

Bore water samples were collected from thirty two points in between 09:00 a.m. to 12:00 a.m. in the duration from August 2016 to February 2017 for physico-chemical analysis and standard methods were adopted for bore water sampling. PET bottle of volume two liters was used for sampling of Bore water and before sampling bottle washed with demineralized water. At the time of sampling temperature of samples noted and then samples stored in refrigerator (Andrew *et al.*, 2005). Bore water samples were collected from Jamshad Town, DHA and Korangi Industrial Area. The reagents used for Bore water analysis were Analytical grade. The glass wares used for Analysis were also washed with demineralized water.

Physico-Chemical Analysis

Physico-chemical parameters and heavy metals analysis of Bore water were performed included: Appearance, color, odor, taste, temperature, pH, specific conductivity, total dissolve solid, total Hardness, Calcium hardness, Magnesium hardness, Phenolphthalein and Methyl orange Alkalinity, Chloride, Sulfate, Turbidity, total suspended solid, Phosphate, Residual Chlorine, Iron, Chromium, Lead and Zinc carried out. Temperature was measured by thermometer on site while other parameters were measured in laboratory. Appearance and color was physically compared with demineralized water, odor was measured by nose sensory response, tastes were measured by mouth feel, pH, specific conductivity and total dissolve solid were measured by Hanna and Ezdo pH/conductivity/Tds meters.

Total Hardness, Calcium hardness and Magnesium hardness were determined by EDTA titration method (complexometric titration), Chloride were determined by Silver Nitrate titration method (Precipitation titration), Phenolphthalein and Methyl Orange

Alkalinity were determined by Sulfuric Acid titration (Acid-Base titration), method of all these titrations obtained from textbook of quantitative analysis by Vogel's. Turbidity, total suspended solid, Sulfate, Phosphate, Residual Chlorine were determined by spectrophotometer. All chemicals (solvents and reagents) used in the physico-chemical analysis of Bore water from different regions of Karachi were analytical grade. Glass wares were used, washed and rinsed through deionized water.

In physico-chemical analysis, Eriochrome Black T, Ammonia buffer (for total hardness), Murexide indicator and Calcium buffer, Phenolphthalein and Methyl orange indicator, (0.02N) H₂SO₄ Solution, (0.014N) AgNO₃ and Potassium dichromate solution, Palintest 7100 and HACH DR-3900 reagents were used. Instruments used during the analysis were, atomic absorption spectrophotometer (ICE 3000, thermo scientific), UV spectrophotometer (HACH DR 3900), UV spectrophotometer (Palintest 7100), digital pH and TDS meter (EZDO PH-5011, TDS-5032). Complexometric titration used for determination of Total/Calcium Hardness. 0.02 M of EDTA used as titrant in burette and 50ml of sample taken in conical flask with addition of total hardness buffer solution and Erichrome Black-T as indicator from purple color to blue color end point.

$$\text{Total Hardness} = (\text{Volume of EDTA} * M * 1000) / \text{Volume of Sample (Where M is Molarity of EDTA)}$$

For Calcium Hardness determination, Calcium Buffer (KOH) and Murexide (Ammonium Purporate) used as indicator and 0.02M of EDTA used as titrant from red to purple color end point.

Precipitation titration used for determination of Chloride measurement. 0.014 N of AgNO₃ used as titrant in burette and 50ml of sample taken in conical flask with addition of Potassium Chromate as indicator from yellow color to red brick color end point.

$$\text{Chloride (Cl)} = (\text{Volume of AgNO}_3 * 0.014N * 35.5 * 1000) / \text{Volume of Sample.}$$

Acid-base titration used for determination of Alkalinity measurement. 0.02 N of H₂SO₄ used as titrant in burette and 50ml of sample taken in conical flask with addition of Phenolphthalein and Methyl orange as indicator from pink to colorless and from yellow color to orange color end point.

$$\text{Alkalinity} = (\text{Volume of H}_2\text{SO}_4 * 0.02N * 50 * 1000) / \text{Volume of Sample.}$$

Heavy Metals Analysis

Heavy metals such as Chromium and Lead were analyzed by Atomic Absorption method while Iron and Zinc were analyzed by HACH DR-3900 spectrophotometer and PALINTEST 7100 spectrophotometer.

For estimation of Lead and Chromium in Atomic Absorption, their respective electrodes used and firstly instrument is blank with deionized water then respective standard used for calibration curve and results were recorded. For determination of Iron and Zinc HACH and Palintest spectrophotometer with prepared reagent used, initially spectrophotometer blank with deionized water and then results was taken after putting sample in spectrophotometer containing respective reagents.

In Fig. 1, Map of Jamshed Town, Fig. 2, Map of Korangi Industrial Area and Fig. 3 Map of DHA are shown. However in Table-1 Sample Point at Korangi Industrial Area, Table-2 Sample Point at Jamshed Town, Table-3: Sample Point at DHA, Table-4: Drinking Water Standard Limits and Table-5: Physico-Chemical & Heavy Metal Analysis of Jamshed Town, DHA and Korangi Industrial Area are mention.

Table 1. Sample Point at Korangi Industrial Area.

S.N.	Korangi Industrial Area	Sample No.
1	Rempack Industries	K1
2	Denim Clothing	K2
3	National Refinery	K3
4	Nova Tannery	K4
5	Ghazi Tannery	K5
6	Gulf Leather	K6
7	Marfani Denim	K7
8	Shafi Tannery	K8
9	Young's Food	K9
10	Hafiz Tannery	K10

Table 2. Sample Point at Jamshed Town.

S.N.	Jamshed Town	Sample No.
1	Manzoor Colony	J1
2	Mehmoodabad	J2
3	Azam Basti	J3
4	Chaneser Goth	J4
5	Jamshed Quarter	J5
6	Garden East	J6
7	Soldier Bazar	J7
8	Pakistan Quarter	J8
9	Jut Line	J9
10	PECHS:1	J10
11	Akhter Colony	J11
12	PECHS:2	J12
13	Jacob Line	J13

Table 3. Sample Point at DHA.

S.N.	D.H.A	Sample No.
1	DHA Phase:1	D1
2	DHA Phase:2	D2
3	DHA Phase:7(Ext)	D3
4	DHA Phase:4	D4
5	DHA Phase:5	D5
6	DHA Phase:6	D6
7	DHA Phase:7	D7
8	DHA Phase:8	D8

Table 4. Drinking Water Standard Limits.

S.N.	Parameters	WHO	PSDW
1	Appearance	-	-
2	Color	15 TCU	15 TCU
3	Odor	Non Objectionable/	Acceptable
4	Taste	Non Objectionable/	Acceptable
5	Temperature	-	-
6	pH	6.5-8.5	7.0-8.5
7	Specific Conductivity	-	-
8	TDS	1000 mg/l	1000 mg/l
9	Total Hardness	No guideline	500 mg/l
10	Calcium	No guideline	200 mg/l
11	Magnesium	No guideline	100 mg/l
12	Chloride	250 mg/l	250 mg/l
13	Total Alkalinity	-	-
14	Sulfate	250 mg/l	400 mg/l
15	Turbidity	5 NTU	No guideline
16	TSS	-	-
17	Phosphate	-	-
18	Iron	0.3 mg/l	No guideline
19	Chromium	0.05 mg/l	0.05 mg/l
20	Lead	0.01 mg/l	0.01 mg/l
21	Zinc	3.0 mg/l	3.0 mg/l

PSDW: Pakistan Standard for drinking water.

WHO: World Health Organization.

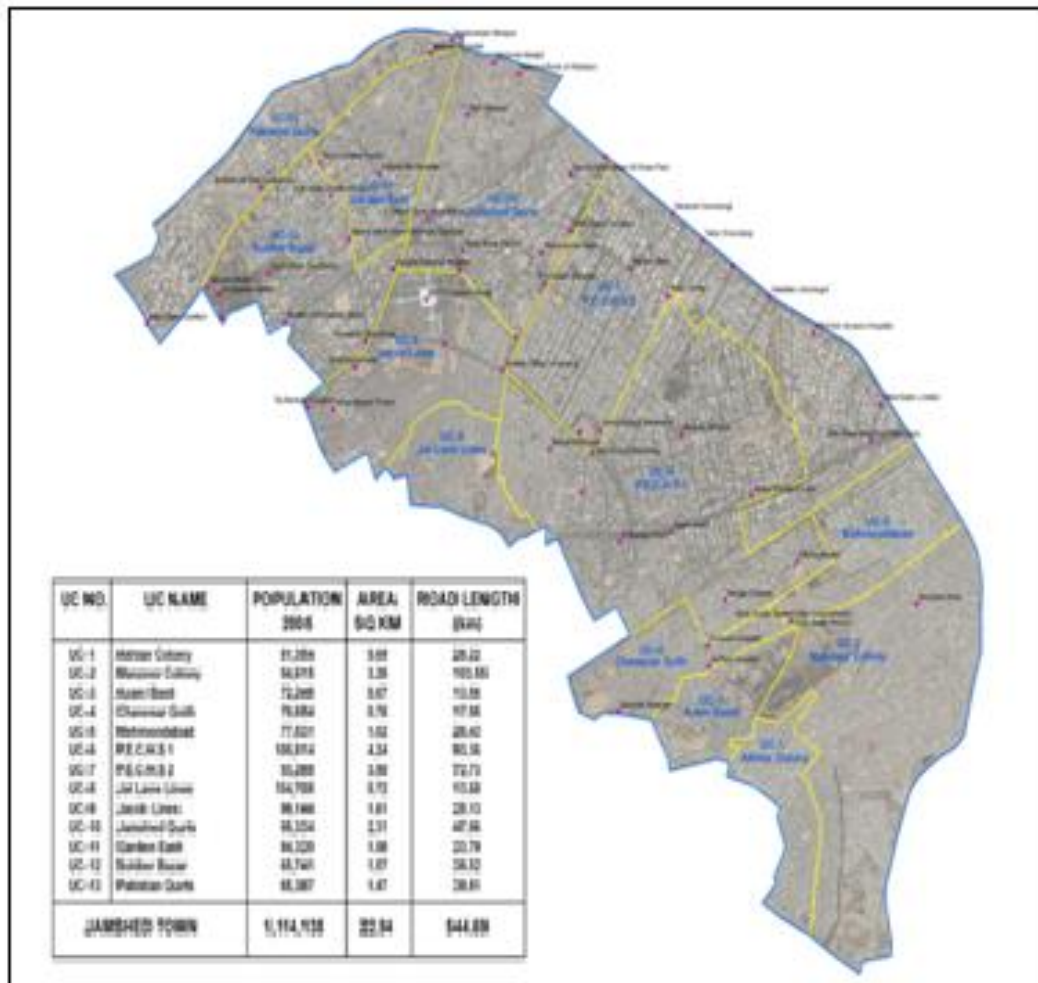


Fig. 1. Map of Jamshed Town Karachi including sampling locations.



Fig. 2. Map of Korangi Industrial Area Karachi including sampling locations.

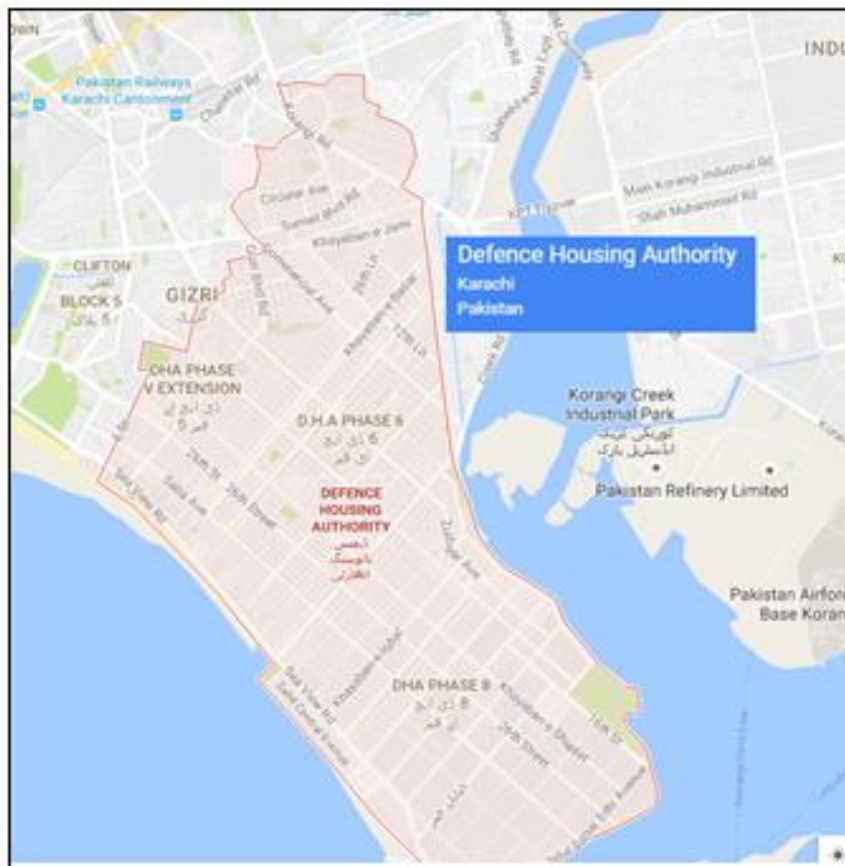


Fig. 3. Map of DHA Karachi including sampling locations.

Results and discussion

Bore Water results in which chemical parameters and heavy metals analysis are presented in Table-5. These values have been placed along with WHO and PSDW guidelines for drinking waters. pH of all samples appeared to range in between 6.80 to 8.20, while total dissolve solid of almost all samples are found to be high. Especially in DHA and Korangi industrial Area samples dissolve solid were found to be very high up to 39200 ppm from 720 ppm. Specific conductivity of DHA and Korangi industrial Area samples were found to be very high (56000 μ S/cm), Hardness of most of samples were observed higher sides (178 to 6840 ppm), Chloride content were noticed high (142.8 to 22749 ppm) and Alkalinity content were also discovered high (109.7 to 960.7 ppm), iron content in most of samples were found within limit (0.01 to 0.33 ppm) while in some samples were found exceed the WHO limits, Sulfate content in some samples were obtained to be high and in some cases in the limit (90 to 940 ppm), Phosphate content according to European Economic Community were discovered within the limit (0.2 to 1.72), and Turbidity of most of samples were attained within limit while in some samples were exceed the limit (0.1 to 38.5 NTU). Heavy Metals of Bore Water from Korangi Industrial area, Chromium and lead content were in traces while Zinc (0.23 to 1.46 ppm) and Iron (0.01 to 0.33 ppm) content were noticed within limit as per WHO and PSDW guideline.

Table-5 presents the mean pH values with standard deviation. pH of Jamshed Town, D.H.A and Korangi Industrial Area are observed within recommended limit of WHO and PSDW guidelines. pH of water is the important indication of corrosion tendency, but some other factor also contributes with pH like dissolve gases and minerals. In general, lower the pH wills higher the potential of corrosion (Nordberg *et al.*, 1985).

In Table-5 mean Conductivity values with standard deviation are presented. Conductivity of Jamshed Town, D.H.A and Korangi Industrial Area are found 961 to 52265 μ S/cm.

In Table-5 mean TDS values with standard deviation are calculated. TDS of Jamshed Town, D.H.A and Korangi Industrial Area are found 720 to 39200mg/l. Only sample results of Soldier Bazaar (J7: 780.6mg/l) and Jut Line (J9: 720mg/l) are analyzed within limit while all other samples are exceed the WHO and PSDW guidelines. TDS of water is measured by specific conductivity via conductivity meter/probe that determines the conductance of ions, the measure conductivity can be converted into TDS by multiplying with factor that depends on type of ions in water (McQuillan, 1976). High TDS concentration (greater than 500mg/L) results scaling in pipe line, boilers and household appliance. Scaling due to TDS can shorten the operating life of equipment and appliance (Singh *et al.*, 1975).

Table-5, also shows the mean Total Hardness values with standard deviation. T.H. of Jamshed Town, D.H.A and Korangi Industrial Area are found 178 to 6840mg/l. Only sample results of Manzoor Colony (J1: 300mg/l), Mahmoodbad (J2: 460mg/l), Soldier Bazar (J7: 210mg/l), Jut Line (J9: 178mg/l) and Jacob line (J13: 380mg/l) are found within limit while all other samples are exceed the PSDW guidelines. There is no guideline of T.H. as per WHO. Hardness is the property of water that reacts with soap and form lather. This lather formation is due to water contains variety of dissolved polyvalent metallic ions, mainly calcium and magnesium yet some other also have minor contributes like aluminum, iron, manganese, barium and strontium. Unit of Hardness expressed in mg of CaCO₃/ L (ISO, 1985; McGowan, 2000).

Table-5 exhibits the mean Calcium Hardness values with standard deviation. Ca H. of Jamshed Town, D.H.A and Korangi Industrial Area are found 86.7 to 3860mg/l. Only sample results of Manzoor Colony (J1: 160mg/l), Rempak (K1: 180mg/l), Soldier Bazar (J7: 110mg/l), Jut Line (J9: 86mg/l) and Jacob line (J13: 190mg/l) are found within limit while all other samples were transcending the PSDW guidelines.

There is no guideline of T.H. as per WHO. In Table-5, mean Magnesium Hardness values with standard deviation were imparted. Mg H. of Jamshed Town,

D.H.A and Korangi Industrial Area are noticed from 80 to 2980mg/l. Only sample results of Jamshed Quarter (J5: 80mg/l) and Jut Line (J9: 92mg/l) are found within limit while all other samples are exceed the PSDW guidelines.

There is no guideline of T.H. as per WHO. Inadequate level of magnesium in the body caused the risk of increase the vascular reactions, endothelial dysfunction, decreased the insulin sensitivity and hypertension coronary heart disease. Excess hardness in water will increase the soap consumption and precipitates that form due to hard water not easily rinse off from skin and causing irritation (Thomas *et al.*, 2008).

In Table-5 mean Total Alkalinity values with standard deviation are also given. Total Alkalinity of Jamshed Town, D.H.A and Korangi Industrial Area are found 109.7 to 960.7mg/l. There is no guideline of Total Alkalinity as per WHO and PSDW. Alkalinity is the acid neutralizing capacity of water. Alkalinity is due to the presence of carbonate ions, bicarbonate ions and hydroxyl ions. Moderate level of alkalinity in drinking water desirable in order to control the corrosion tendency while excess level may cause number of damages. WHO guideline for alkalinity only in term of total dissolve solid about 500mg/L (Mohsin *et al.*, 2013).

Table-5 also contains mean Chloride values with standard deviation. Chloride of Jamshed Town, D.H.A and Korangi Industrial Area are found 142 to 23750mg/l. Only sample results of Soldier Bazar (J7: 180mg/l) and Jut Line (J9: 142mg/l) are found within limit while all other samples are exceed the PSDW and WHO guidelines.

The taste in water through chloride anion is dependent on attached cation. Taste in water generate when sodium chloride and calcium chloride are in between 200 to 300mg/L (Zoeteman *et al.*, 1980). Chloride ion determine by silver nitrate titration method with potassium chromate indicator, other method are mercuric (III) nitrate titrate with indicator diphenylcarbazone (ISO, 1989).

Furthermore, Table-5 expresses the mean Iron values with standard deviation. Iron of Jamshed Town, D.H.A and Korangi Industrial Area are found 80 to 2980mg/l. Only sample results of Azam Basti (J3: 0.33mg/l) are found exceed limit while all other samples are within the WHO guidelines. There is no guideline of Iron as per PSDW.

In Table-5 mean Sulfate values with standard deviation are also presented. Sulfate of Jamshed Town, D.H.A and Korangi Industrial Area are found 80 to 540mg/l. Only sample results of Mahmoodabad (J2), Garden East (J6), Pakistan Quarter (J8), DHA Phase: 3,4,5 & 6, Denim Clothing (K2), National Refinery (K3), Nova Tannery (K4), Gazi Tannery(K5), Gulf Leather (K6), Marfani Denim (K7), Shafi Tannery (K8) and Young's Food (K9) are found exceed limit while all other samples are within the WHO and PSDW guidelines. Sulfate can be measured by gravimetrically, in aqueous acidic solution, sulfate treated with barium chloride so barium sulfate precipitate form. People consuming drinking water containing high sulfate content about 600 ppm will survive Cathartic effects and dehydration also reported in some cases. WHO and USEPA guideline for sulfate in drinking water about 250 ppm (ISO, 1990; Singanan *et al.*, 2008).

Moreover, Table-5 also shows the mean Turbidity values with standard deviation. Turbidity of Jamshed Town, D.H.A and Korangi Industrial Area are found 0.1 to 87 NTU. Only sample results of Manzoor Colony (J1), Azam Basti (J3), Chaneser Goth (J4), PECHS: 1(J10), Akhter Colony (J11) DHA Phase:7, Ghazi Tannery (K5), Gulf Leather (K6), Young's Food (K9) and Hafiz Tannery (K10) were noted beyond the limit while all other samples are within the WHO and PSDW guidelines (US DHEW, 1962).

Table-5 also analyzed the mean TSS values with standard deviation. TSS of Jamshed Town, D.H.A and Korangi Industrial Area are found 0.25 to 96.2mg/l. There is no guideline of Total Alkalinity as per WHO and PSDW.

Table 5. Physico- Chemical and Heavy Metal Analysis of Jamshed Town.

S.n.	Parameters	Who limits	Psdw limits	Sample points						
				J1	J2	J3	J4	J5	J6	J7
1	Appearance	-	-	Clear	Clear	Turbid	Turbid	Clear	Clear	Clear
2	Color	15 TCU	15 TCU	9.8 ± 0.447	7.8±0.44	12.20±0.447	8.8±0.447	10±0.707	12.80±0.447	16±0.0
3	Odor	Unobjectionable	Unobjectionable	Odorless	Odorless	Odor	Odorless	Odorless	Odorless	Odorless
4	Taste	Unobjectionable	-	Tasteless	Light Salty	Light Salty	Light Salty	Light Salty	Salty	Tasteless
5	Temperature	-	-	27± 0.0	26± 0.0	28± 0.0	26±0.0	27±0.0	26±0.0	24±0.0
6	pH	6.5-8.5	6.5-8.5	7.50 ± 0.007	7.90±0.007	7.10±0.008	7.71±0.007	7.40±0.007	7.50±0.007	7.61±0.014
7	Specific Conductivity	-	-	2180 ± 0.70	3500±0.707	4200±0.707	3814±0.707	5485±0.707	10900±0.707	1040.8±0.837
8	TDS	1000 mg/l	1000 mg/l	1524.2±0.83	2649.8±0.837	2940.64±0.089	2670±0.707	3840.2±1.095	7630.06±0.089	780.6±0.894
9	Total Hardness	No guideline	500 mg/	300.42±0.08	460.5±0.122	620.08±0.130	530.06±0.114	620.4±0.071	1429.98±0.11	210.4±0.249
10	Calcium Hardness	No guideline	200 mg/l	160.66±0.11	240.04±0.152	440.54±0.089	390.44±0.114d	540.1±0.141	760.12±0.084	110.22±0.179
11	Magnesium Hardness	No guideline	100 mg/l	140.34±0.43	220.70±0.122	180.78±0.130	139.98±0.110	80.54±0.089	670.54±0.114	100.2±0.110
12	Chloride	250 mg/l	250 mg/l	480.66±0.11	960.4±0.071	1220.28±0.13	1190.70±0.071	1989.18±0.130	3860±0.707	180.48±0.249
12	Total Alkalinity	-	-	280.52±0.08	245.10±0.122	236±0.122	220.48±0.110	360.1±0.122	590.88±0.110	120.78±0.179
14	Sulfate	250 mg/l	400 mg/l	136±0.70	309.8±0.447	195.2±0.447	150.22±0.110	194.8±0.447	272±0.707	80.2±0.447
15	Turbidity	5 NTU	No guideline	6.0±0.70	3.0 ±0.071	37.9±0.54	10.06±0.089	2.02±0.045	2.06±0.089	1.68±0.045
16	TSS	-	-	15±1.76	7.50±0.177	94.75±1.36	25.15±0.224	5.05±0.112	5.15±0.224	4.24±0.022
17	Phosphate	-	-	0.71±0.007	1.41±0.007	0.86±0.007	1.7 ±0.011	0.76±0.007	0.54±0.011	0.31±0.018
18	Iron	0.3 mg/l	No guideline	0.188±0.004	0.078±0.004	0.33±0.004	0.11±0.004	0.042±0.004	0.038±0.004	0.058±0.004
19	Chromium	0.05 mg/l	0.05 mg/l	-	-	-	-	-	-	-
20	Lead	0.01 mg/l	0.01 mg/l	-	-	-	-	-	-	-
21	Zinc	3.0 mg/l	3.0 mg/l	-	-	-	-	-	-	-

Continued...

Table 5. Physico- Chemical and Heavy Metal Analysis of Jamshed Town.

S.n.	Parameters	Who limits	Psdw limits	Sample points						
				J8	J9	J10	J11	J12	J13	
1	Appearance	-	-	Clear	Clear	Turbid	Turbid	Clear	Clear	
2	Color	15 TCU	15 TCU	7±0.0	3±0.0	8±0.0	30±0.0	6±0.0	5±0.0	
3	Odor	Unobjectionable	Unobjectionable	Odorless	Odorless	Odorless	Odorless	Odorless	Odorless	
4	Taste	Unobjectionable	-	Salty	Tasteless	Light Salty	Salty	Light Salty	Tasteless	
5	Temperature	-	-	24±0.0	26±0.0	27±0.0	28±0.0	25±0.0	24±0.0	
6	pH	6.5-8.5	6.5-8.5	7.30±0.018	7.4±0.014	7.20±0.007	6.90±0.014	7.51±0.021	7.19±0.015	
7	Specific Conductivity	-	-	5666±0.707	960±0.707	6680±0.707	7493±0.707	3640±0.707	2186±0.707	
8	TDS	1000 mg/l	1000 mg/l	4250±0.707	720±0.707	5010±0.707	5620±0.707	2730±0.707	1640±0.707	
9	Total Hardness	No guideline	500 mg/	730.8±0.152	178.2±0.141	795.42±0.179	875.42±0.110	580.16±0.219	380.2±0.110	
10	Calcium Hardness	No guideline	200 mg/l	455.4±0.239	86.7±0.141	455.4±0.134	530.6±0.179	310.62±0.219	190.66±0.195	
11	Magnesium Hardness	No guideline	100 mg/l	275.3±0.179	92.5±0.211	340.78±0.110	355.3±0.179	270.6±0.219	110.68±0.179	
12	Chloride	250 mg/l	250 mg/l	2048.32±0.179	142.5±0.179	2765.68±0.179	3110.6±0.219	1150.5±0.212	580.5±0.283	
12	Total Alkalinity	-	-	460.76±0.152	109.4±0.212	445.4±0.212	525.6±0.179	28034±0.219	270.44±0.288	
14	Sulfate	250 mg/l	400 mg/l	280.4±0.894	110.4±0.894	210.4±0.894	222.4±0.894	140.2±0.447	113.8±0.447	
15	Turbidity	5 NTU	No guideline	1.33±0.045	0.5±0.0	87.98±0.110	8.52±0.045	4.14±0.089	0.12±0.045	
16	TSS	-	-	3.3±0.0122	1.25±0.0	19.94±0.261	21.26±0.134	10.3±0.224	0.3±0.112	
17	Phosphate	-	-	0.93±0.013	0.18±0.004	0.15±0.007	0.20±0.014	0.19±0.017	0.1±0.004	
18	Iron	0.3 mg/l	No guideline	0.094±0.009	0.032±0.004	0.08±0.007	0.11±0.004	0.07±0.014	0.106±0.009	
19	Chromium	0.05 mg/l	0.05 mg/l	-	-	-	-	-	-	
20	Lead	0.01 mg/l	0.01 mg/l	-	-	-	-	-	-	
21	Zinc	3.0 mg/l	3.0 mg/l	-	-	-	-	-	-	

Continued...

Table 5. Physico- Chemical and Heavy Metal Analysis of DHA.

S.n.	Name	Who limits	Psdw limits	Sample points			
				D1	D2	D3	D4
1	Appearance	-	-	Clear	Clear	Clear	Turbid
2	Color	15 TCU	15 TCU	8±0.0	12.8±0.447	15±0.0	16±0.0
3	Odor	Unobjectionable	Unobjectionable	Odorless	Odorless	Odorless	Odorless
4	Taste	Unobjectionable	-	Salty	Light Salty	Light Salty	Light Salty
5	Temperature	-	-	29±0.0	27±0.0	26±0.0	28±0.0
6	pH	6.5-8.5	6.5-8.5	7.89±0.005	8.006±0.009	7.91±0.007	8.18±0.045
7	Specific Conductivity	-	-	18743±0.707	4600.8±1.304	6771±0.707	7400±0.707
8	TDS	1000 mg/l	1000 mg/l	13120±0.707	3221.2±1.78	4740±0.707	5180.6±0.894
9	Total Hardness	No guideline	500 mg/	2740.48±0.148	690.36±0.230	740.54±0.089	820.9±0.141
10	Calcium Hardness	No guideline	200 mg/l	1360.26±0.089	430.5±0.141	510.15±0.1	490.28±0.110
11	Magnesium Hardness	No guideline	100 mg/l	1380.76±0.114	260±0.122	230.4±0.0141	380.58±0.110
12	Chloride	250 mg/l	250 mg/l	6580.38±0.130	1345.7±0.141	2480.24±0.230	2670.56±0.195
12	Total Alkalinity	-	-	460.1±0.071	285.28±0.11	380.76±0.152	460.76±0.152
14	Sulfate	250 mg/l	400 mg/l	190.2±0.447	194.6±0.984	290.4±0.894	380.4±0.894
15	Turbidity	5 NTU	No guideline	4.1±0.224	2.06±0.089	2.06±0.089	5.06±0.089
16	TSS	-	-	10.25±0.559	5.1±0.224	5.15±0.224	12.64±0.219

S.n.	Name	Who limits	Psdw limits	Sample points			
17	Phosphate	-	-	0.924±0.009	0.202±0.004	1.342±0.004	1.455±0.01
18	Iron	0.3 mg/l	No guideline	0.058±0.004	0.062±0.004	0.038±0.004	0.058±0.004
19	Chromium	0.05 mg/l	0.05 mg/l	-	-	-	-
20	Lead	0.01 mg/l	0.01 mg/l	-	-	-	-
21	Zinc	3.0 mg/l	3.0 mg/l	-	-	-	-

Continued...

Table 5. Physico- Chemical and Heavy Metal Analysis of DHA.

S.n.	Name	Who limits	Psdw limits	Sample points			
				D5	D6	D7	D8
1	Appearance	-	-	Clear	Clear	Turbid	Turbid
2	Color	15 TCU	15 TCU	8±0.0	10±0.0	22±0.0	16±0.0
3	Odor	Unobjectionable	Unobjectionable	Odorless	Odorless	Odorless	Odor
4	Taste	Unobjectionable	-	Salty	Salty	Salty	Salty
5	Temperature	-	-	26±0.0	23±0.0	24±0.0	26±0.0
6	pH	6.5-8.5	6.5-8.5	7.0±0.071	7.2±0.09	6.81±0.011	7.31±0.018
7	Specific Conductivity	-	-	20973±0.707	17305±0.894	21653±0.707	8586±0.707
8	TDS	1000 mg/l	1000 mg/l	15730±0.707	12980±0.707	16240±0.707	6440.6±0.894
9	Total Hardness	No guideline	500 mg/l	3120.4±0.249	2460.68±0.179	3260.68±0.179	1650.5±0.0212
10	Calcium Hardness	No guideline	200 mg/l	1580.6±0.179	1250.16±0.219	1640.3±0.141	880.3±0.141
11	Magnesium Hardness	No guideline	100 mg/l	1540.6±0.195	1210.8±0.212	1620.68±0.179	760.42±0.249
12	Chloride	250 mg/l	250 mg/l	8630.76±0.152	6120.4±0.212	8870.5±0.212	2420.7±0.283
12	Total Alkalinity	-	-	580.4±0.212	1640.62±0.130	620.44±0.288	580.48±0.179
14	Sulfate	250 mg/l	400 mg/l	285.8±0.447	380.4±0.894	227.6±0.894	190.4±0.894
15	Turbidity	5 NTU	No guideline	2.04±0.089	3.48±0.045	8.02±0.045	5.06±0.089
16	TSS	-	-	5.1±0.224	8.75±0.112	20.05±0.112	12.64±0.219
17	Phosphate	-	-	0.824±0.009	1.42±0.009	0.67±0.018	0.824±0.009
18	Iron	0.3 mg/l	No guideline	0.116±0.009	0.136±0.009	0.17±0.009	0.114±0.009
19	Chromium	0.05 mg/l	0.05 mg/l	-	-	-	-
20	Lead	0.01 mg/l	0.01 mg/l	-	-	-	-
21	Zinc	3.0 mg/l	3.0 mg/l	-	-	-	-

Continued...

Table 5. Physico- Chemical and Heavy Metal Analysis of Korangi Industrial Area.

S.n.	Name	Who limits	Psdw limits	Sample points				
				K1	K2	K3	K4	K5
1	Appearance	-	-	Clear	Clear	Clear	Clear	Clear
2	Color	15 TCU	15 TCU	8±0.0	10±0.0	13±0.0	8±0.0	15±0.0
3	Odor	Unobjectionable	Unobjectionable	Odorless	Odorless	Odorless	Odorless	Odorless
4	Taste	Unobjectionable	-	Tasteless	Salty	Salty	Salty	Salty
5	Temperature	-	-	26±0.0	25±0.0	27±0.0	28±0.0	25±0.0
6	pH	6.5-8.5	6.5-8.5	7.30±0.011	7.70±0.007	7.0±0.071	7.20±0.007	6.8±0.007
7	Specific Conductivity	-	-	1906±0.707	19706±0.707	37866±0.707	24480±0.707	52266±0.707
8	TDS	1000 mg/l	1000 mg/l	1430±0.707	14780±0.707	28400±0.707	18360±0.707	39200±0.707
9	Total Hardness	No guideline	500 mg/l	340.68±0.179	3180.4±0.152	5280.52±0.179	3680.34±0.219	6840.32±0.179
10	Calcium Hardness	No guideline	200 mg/l	180.34±0.219	1660.58±0.179	3120.66±0.219	2130.68±0.179	3860.46±0.152
11	Magnesium Hardness	No guideline	100 mg/l	160.58±0.249	1520.48±0.177	2160.4±0.212	1550.38±0.179	2980.42±0.179
12	Chloride	250 mg/l	250 mg/l	450.76±0.152	7430.62±0.179	16630±0.707	9860±0.707	23750±0.707
12	Total Alkalinity	-	-	220.5±0.212	660.34±0.219	810.48±0.179	720.38±0.179	960.42±0.179
14	Sulfate	250 mg/l	400 mg/l	90.2±0.447	320.2±0.447	870.5±0.219	670.2±0.447	940.2±0.447
15	Turbidity	5 NTU	No guideline	2.02±0.045	4.04±0.089	4.02±0.045	2.04±0.089	8.52±0.045
16	TSS	-	-	5.05±0.112	10.1±0.224	10.05±0.112	5.1±0.224	21.26±0.134
17	Phosphate	-	-	0.20.4±0.009	0.364±0.009	0.478±0.011	0.298±0.004	0.864±0.009
18	Iron	0.3 mg/l	No guideline	0.02±0.004	0.01±0.004	0.042±0.004	0.074±0.009	0.042±0.004
19	Chromium	0.05 mg/l	0.05 mg/l	NIL	NIL	NIL	NIL	NIL
20	Lead	0.01 mg/l	0.01 mg/l	NIL	NIL	NIL	NIL	NIL
21	Zinc	3.0 mg/l	3.0 mg/l	0.842±0.004	1.468±0.004	1.20±0.004	0.972±0.004	0.23±0.004

Continued...

Table 5. Physico- Chemical and Heavy Metal Analysis of Korangi Industrial Area.

S.n.	Name	Who limits	Psdw limits	Sample points				
				K6	K7	K8	K9	K10
1	Appearance	-	-	Clear	Clear	Clear	Turbid	Turbid
2	Color	15 TCU	15 TCU	5±0.0	7±0.0	5±0.0	7±0.0	30±0.0
3	Odor	Unobjectionable	Unobjectionable	Odorless	Odorless	Odorless	Odorless	Odorless
4	Taste	Unobjectionable	-	Salty	Salty	Salty	Salty	Salty
5	Temperature	-	-	26±0.0	28±0.0	26±0.0	27±0.0	26±0.0
6	pH	6.5-8.5	6.5-8.5	7.162±0.011	7.30±0.007	7.0±0.011	7.40±0.007	8.20±0.007
7	Specific Conductivity	-	-	44800±0.0	16853±0.0	25600±0.0	13146±0.0	3586±0.0
8	TDS	1000 mg/l	1000 mg/l	33600±0.0	12640±0.0	19200±0.0	9860±0.0	2690±0.0
9	Total Hardness	No guideline	500 mg/l	5940.36±0.261	2380.36±0.261	3850.6±0.219	2120.32±0.249	530.44±0.288
10	Calcium Hardness	No guideline	200 mg/l	3510.6±0.249	1210.64±0.261	2430.4±0.249	1160.5±0.283	310.58±0.249
11	Magnesium Hardness	No guideline	100 mg/l	2430.2±0.3707	1170.5±0.283	1420.5±0.283	960.44±0.288	220.34±0.288
12	Chloride	250 mg/l	250 mg/l	19630±0.707	6520.4±0.319	10220.4±0.319	4760.3±0.329	1160.5±0.283
12	Total Alkalinity	-	-	840.5±0.0283	950.2±0.219	830.28±0.303	720.1±0.288	280.42±0.249
14	Sulfate	250 mg/l	400 mg/l	590.2±0.447	240.2±0.447	2989.8±0.447	460.2±0.447	180.2±0.447
15	Turbidity	5 NTU	No guideline	8±0.0	4.04±0.089	3.04±0.089	40.4±0.089	10.06±0.134
16	TSS	-	-	20±0.0	10.1±0.224	7.6±0.224	10.1±0.224	25.15±0.335

S.n.	Name	Who limits	Psdw limits	Sample points				
17	Phosphate	-	-	1.242±0.004	0.416±0.009	0.288±0.004	0.784±0.004	0.202±0.004
18	Iron	0.3 mg/l	No guideline	0.012±0.004	0.04±0.00	0.088±0.004	0.032±0.004	0.022±0.004
19	Chromium	0.05 mg/l	0.05 mg/l	NIL	NIL	NIL	NIL	NIL
20	Lead	0.01 mg/l	0.01 mg/l	NIL	NIL	NIL	NIL	NIL
21	Zinc	3.0 mg/l	3.0 mg/l	0.674±0.004	0.468±0.004	1.134±0.009	1.062±0.004	0.524±0.009

Additionally Table-5 earns the mean Phosphate values with standard deviation. Phosphate of Jamshed Town, D.H.A and Korangi Industrial Area are observed 0.2 to 1.72mg/l. There is no guideline of Total Phosphate as per WHO and PSDW. Phosphate concentrations are not toxic to human or animal even a high concentration but in an extremely high level they possess problems in digestive system. Study conducted in the ground water of Ketu District, where phosphate level obtained in range of 0.001 to 0.6mg/l (Ansa-Asare *et al.*, 2006).

In the last Table-5 also analyzed mean values of Zn, Fe, Cr and Pb (Heavy metals) with standard deviation. In this analysis Zn, Fe, Cr and Pb of Korangi Industrial Area were discovered within the WHO and PSDW guideline.

Conclusion

The bore water analysis indicates that physic-chemical parameters of 77% samples of region Jamshed Town are found to be exceed the WHO and PSDW guideline. Bore water analysis signifies that physic-chemical parameters of 100% samples of DHA all phases are exceeding the WHO and PSDW guidelines and salinity of DHA phases were found very high.

This analysis also concluded that physico-chemical parameters of 90% samples of Korangi Industrial area were observed to be surpassing the WHO guidelines and PSDW limits, furthermore some samples had salinity equal to sea water and overall samples expressed very high salinity.

The Heavy metal analysis of Bore water from Korangi Industrial area indicates that Chromium and Lead content are in traces and within limit, while Iron and Zinc content are noticed within WHO and PSDW guideline. After the physico-chemical analysis of bore water, results show that bore water is not suitable for drinking purpose, however due to shortage and unavailability of fresh water, people of some areas in Karachi using bore water for drinking

purpose which creates bad impact on health of that segment of population.

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