4. RESULTS AND DISCUSSION

The mean and standard deviation (SD) of the studied physic-chemical characteristics, heavy metals and bacteriological parameters in water samples are presented in Tables (4.1 to 4.75) and Figures (4.1 to 4.50).

4.1 Physico-chemical characteristics and Heavy metals of water samples:

4.1. 1. Electrical Conductivity

EC values for water samples in Mahmoudia canal results were ranged between 368 µS/cm in sample site H05 in Table 4.5 to 811 µS/cm in sample site H01 in Table 4.1, and in Nubaria canal results were ranged between 291 µS/cm in sample site N04 in Table 4.15 to 2986 µS/cm in sample site N10 in Table 4.21.

The results of both canals showed that the higher the EC, the higher the total dissolved solids and these results in agreement with the equation

TDS (ppm) = Conductivity (µS/cm) * 0.67 [77]

4.1. 2. Chloride Cl^-

The chlorination of water supplies and polluted water serves primarily to destroy or deactivate disease- producing microorganisms. A secondary benefit, particularly in treating drinking water, is the overall improvement in water quality resulting from the reaction of chlorine with ammonia, iron, manganese, sulfide, and some organic substances [77].

When chloride combined with sodium, chloride gives a salty taste to drinking water and may increase the corrosiveness of water. Chlorides may also result in blackening or pitting of stainless steel [57].

Chloride results were ranged between 22.9 mg/l in sample site H04 in Table 4.4 to 100.5 mg/l in sample site H03 in Table 4.3 in Mahmoudia canal and were ranged between 12.9 mg/l in sample site N01 in Table 4.12 to 699 mg/l in sample site N10 in Table 4.21 in Nubaria canal.

In raw water, chloride not recommended in the Egyptian standards.

4.1. 3. Total Dissolved Solids (TDS)

Total dissolved solids in raw water put as ≤ 500 mg/l for FDA [87] and Egyptian limits.

Total dissolved solids (TDS) are the term used to describe the inorganic salts and small amounts of organic matter present in solution in water. The principal constituents are usually calcium, magnesium, sodium, and potassium cations and carbonate, hydrogen carbonate, chloride, sulfate and nitrate anions.

TDS in all water samples were ranged between 220.8 mg/l in sample site H05 in Table 5.5 to 486 mg/l in sample site H01 in table 5.1 in Mahmoudia canal. That means all results in the studied canal below the Egyptian limits and FDA.

In Nubaria canal TDS not detected in some sample sites and recorded high result in sample site N10 in Table 5.21 which 1792 mg/l.

No health-based guideline value for TDS has been proposed by WHO [88].

4.1. 4. pH

Acidity in all water sample were ranged between 7.31 in sample site H03 in Table 4.3 to 7.95 in sample site H05 at Table 4.5 in Mahmoudia canal and were ranged between 7.38 in sample site N03 in Table 4.14 to 8.38 in sample site N05 in Table 4.16 in Nubaria canal.

pH of water are within the permitted standard range (pH 6.5-8.4) according to FAO[89], Egyptian limits and EPA.

4.1. 5. Alkalinity

Alkalinity is the water's capacity to resist changes in pH that would make the water more acidic. The main sources for natural alkalinity are rocks which contain carbonate, bicarbonate, and hydroxide compounds. Borates, silicates, and phosphates also may contribute to alkalinity. Limestone is rich in carbonates, so waters flowing through limestone regions or bedrock containing carbonates generally have high alkalinity – hence good buffering capacity. Conversely, areas rich in granites and some conglomerates and sandstones may have low alkalinity and therefore poor buffering capacity.

Alkalinity results were ranged between 133 mg/l in sample site H04 in Table 4.4 to 262.2 mg/l in sample site H01 in Table 4.1 in Mahmoudia canal and were ranged between 110 mg/l in sample site N03 in Table 4.14 to 326 mg/l in sample site N11 in Table 4.22 in Nubaria canal.

4.1. 6. Ammonia

Ammonia of water samples were ranged between 0.05 mg/l in sample site H05 in Table 4.5 to 9.84 mg/l in sample site H02 in Table 4.2 in Mahmoudia canal and were ranged between 0.01 mg/l in sample site N01 in Table 4.12 to 4.8 mg/l in sample site N10 in Table 4.21 in Nubaria canal.

Ammonia increases naturally in winter and these results are in agreement with results obtained by Elewa (2012) [31] and Marwa (2013) [90].

Ammonia concentration s in surface water affected by hydrogeology, weather conditions and human activities, also changing seasonally in different drinking water sources and varying in various regions due to geological permeability and the natural features of regions.

4.1. 7. Dissolved Oxygen (DO)

A dissolved oxygen test measures the amount of oxygen dissolved in the water. A dissolved oxygen measurement, however, does not measure the amount of dissolved oxygen the water is capable of holding at the temperature at which it was tested. Warmer water is capable of holding less dissolved oxygen than colder water. When water holds the entire DO it can hold at a given temperature, it is said to be 100 percent saturated with oxygen. If water holds half as much oxygen as it can hold at a given temperature, it is 50 percent saturated. Appendix 2 shows the solubility of oxygen at various water temperatures[91].

Dissolved oxygen value attained its maximum in sample site H01 in Table 4.1 in Mahmoudia canal. On the other hand, DO reach its minimum in sample site N07 in Table 4.18 in Nubaria canal.

4.1. 8. Chemical Oxygen Demand (COD)

The chemical oxygen demand (COD) test is commonly used to in directly measure the amount of organic compounds in water.

COD is the measurement of the amount of oxygen in water consumed for oxidation of pollutants.

The concentration of COD in water samples varied from 6.2 mg/l in sample site H01 in Table 4.1 to 61.7 mg/l in sample site H04 in Table 4.4 in Mahmoudia canal and varied from 3.2 mg/l in sample siteN03 in Table 4.16 to 470 mg/l in sample site N10 in Table 4.21 in Nubaria canal.

COD is an indicator of organics in the water, usually used in conjunction with BOD.

4.1. 9. Biological Oxygen Demand (BOD)

High BOD is an indication of poor water quality. The discharge of wastes with high levels of BOD can cause water quality problems such as severe dissolved oxygen depletion and Fishkill in receiving water bodies [36].

The concentration of BOD in water samples varied from 0.09 mg/l in sample site H01 in Table 4.1 to 3.4 mg/l in sample sites H08 and H11 in Tables 4.8 and 4.11 in Mahmoudia canal and not detected in sample site N04 in Table 4.15 in Nubaria canal. On the other hand BOD recorded high result (8.3 mg/l) in sample site N14 in Table 4.25.

The values of COD and BOD reflecting the high organic load in water of both canals.

4.1. 10. Fluoride (F^-)

A fluoride concentration is approximately 1.0 mg/l in drinking water effectively reduces dental caries without harmful effects on health. Fluoride may occur naturally in water or it may be added in controlled amounts. Some fluorosis may occur when the fluoride level exceeds the recommended limits. In rare instances the naturally occurring fluoride concentration may approach 10 mg/l; such water should be defuoridated. Traces of

fluorides are present in much water. Fluoride concentrations vary with the type of rock that the water flows through but do not usually exceed 10 mg/l [77].

Fluoride (F^-) concentration in raw water samples not detected in some sample sites and recorded 0.83 mg /l (high concentration) in sample site H06 in Table 4.6 in Mahmoudia canal.

In Nubaria canal fluoride concentration not detected in some sample sites and recoded high concentration 1.89 mg/l in sample site N10 in Table 4.21.

These results complies with Ismail and Radwan (1995) [43], and these results are in agreement with Marwa (2013) [90].

4.1. 11. Nitrate (NO^{-3}) and Nitrite (NO^{-2})

Total oxidized nitrogen is the sum of nitrate and nitrite nitrogen but the major total oxidized nitrogen was nitrate [77]. The maximum contaminant level (MCL) for nitrate in water is 45 mg/l as nitrate (NO^{-3}) or 10 mg/l as nitrogen (N) or 1 mg/l as nitrite to protect their risk [92].

Nitrite results of water samples were ranged between 0.049 mg/l in sample site H04 Table 4.4 to 2.8 mg/l in sample site H03 in Table 4.3 in Mahmoudia canal and were ranged between 0.002 mg/l in sample site N04 in Table 4.15 to 1.5 mg/l in sample site N11 in Table 4.22in Nubaria canal.

The concentration level of nitrite (NO^{-2}) in all analyzed samples was much lower than the permissible values of 10 mg/l (3 mg/l as nitrogen). All these results are in acceptable range for EMCL for raw water.

Nitrate were ranged from 0.62 mg/l in sample site H04 in Table 4.4 to 12.4 mg/l in sample site H10 in Table 4.10 in Mahmoudia canal and were ranged between 0.75 mg/l in sample site N04 in Table 4.15 to 32.4 mg/l in sample site N02 in Table 4.13 in Nubaria canal.

These results are in agreement with the results obtained by Elewa (2012) [31] and Marwa (2013) [90].

4.1. 12. Total Suspended Solids (TSS)

TSS can include a wide variety of material, such as silt, decaying plant and animal matter, industrial wastes, and sewage. High concentrations of suspended solids can cause many problems for stream health and aquatic life.

Total suspended solids concentration varied from 0.5 mg/l in sample site H02 in Table 4.2 to 40.2 mg/l in sample site H10 in Table 4.10 in Mahmoudia canal and varied from 0.4 mg/l in sample site N06 in Table 4.17 to 43 mg/l in sample site N14 in Table 4.25 in Nubaria canal.

In Mahmoudia canal parameters pH, TDS, TSS, DO, BOD, COD, NO^{-3}, NH4, Total and Fecal coliform are in agreement with Abukila (2012) [3].

4.1. 13. Turbidity

Turbidity values of water samples were ranged between 1.31 NTU in sample site H02 in Table 4.2 to 83.2 NTU in sample site H10 in Table 4.10 in Mahmoudia canal and were ranged between 1.4 NTU in sample site N06 in Table 4.17 to 88.9 NTU in sample site N14in Table 4.25 in Nubaria canal.

The results of both canals showed that increasing in turbidity in spring due to low water levels in canals.

Turbidity in water is caused by presence of suspended and colloidal matter such as clay, silt, finely divided organic and inorganic matter, and plankton and other microscopic organisms [(77)].

4.1. 14. Iron

Iron is necessary for your health. The most well-known role that iron plays in human nutrition is in the formation of protein hemoglobin, which transports oxygen to all cells of the body. Iron is also used in cellular metabolism and is found in many of the body's enzymes [(93)].

Concentrations of iron in all water samples were not detected in some sample sides and were recorded 1.778 mg/l in sample site N01 in Table 4.37 in Nubaria canal and were not detected in some sample sites and were recorded 6.6 mg/l in sample site H01 in Table 4.26 in Mahmoudia canal.

4.1. 15. Color

Color in water typically indicates a presence of natural metallic ions, and presence of suspended mater.

In all water samples the variation range of color is narrow which ranged between (10 to 40 Hazen unit) but some sample sites recorded high color during the study such as sample site H01.

4.1. 16. Temperature

The temperature of water samples were increased during the year according to season. This could be due to increase in rate of chemical reaction and nature of biological activity, since temperature is one of the factors that govern the assimilative capacity of the aquatic system.

Temperature for raw water in Mahmoudia canal during all seasons were ranged between 16.8 ºC in sample site H08 in Table 4.8 to 28.9 ºC in sample site H01 in Table 4.1 and were ranged between 16.9 ºC in sample site N09 in Table 4.20 to 28.7 ºC in sample site N06 in Table 4.17 in Nubaria canal.

4.1. 17. Silica

Silicon does not occur free in nature, but rather as free silica (SiO_2) in coarsely crystalline (quartz, rock crystal, amethy, etc) and microcrystalline (flint, chert, jasper, etc)

varieties of quartz, the major component of sand and sandstone. Silicon is found in combination with other elements in silicates, represented by feldspar, hornblende, mica, asbestos, and other clay minerals. Silicates also occur in rocks such as granite, basalt, and shale. Silicon therefore is usually reported as silica (SiO_2) when rocks, sediments, soils, and water are analyzed. It is considered a nonessential trace element for most plants, but essential for most animals. Chronic exposure to silica dust can be toxic [77].

There is no USEPA drinking water standard MCL for silica [77].

In all water samples silica were ranged between 0.292 mg/l in sample site H04 in Table 4.4 to 8.86 mg/l in sample site H01 in table 4.1 in Mahmoudia canal and were ranged between 0.15 mg/l in sample site N04 in Table 4.15 to 18.45 mg/l in sample site N02 in Table 4.13 in Nubaria canal.

4.1. 18. Total Hardness

Hardness is mainly caused by calcium and magnesium salts. These salts are dissolved from geologic deposits through which water travels.

Calcium and magnesium bicarbonates predominate in water that are associated with chalk or limestone and comprise the temporary hardness of water where the alkalinity is less than the total hardness; the excess hardness is termed permanent hardness. Conversely, where the alkalinity is greater than the total hardness, the excess alkalinity is usually due to the presence of sodium bicarbonate, which does not affect the hardness of the water [94].

Results of hardness in water samples were ranged between 128 mg/l in sample site H05 in Table 4.5 to 278.4 mg/l in sample site H01 in Table 4.1 in Mahmoudia canal and were ranged between 117.8 mg/l in sample site N04 in table 4.15 in Nubaria canal to 1962 mg/l in sample site N10 in Table 4.21.

These results of hardness analysis showed that all results of water samples in Nubaria canal are higher than that in Mahmoudia canal.

Limits of hardness in raw water are not recommended in EMCL in Egypt.

4.1. 19. Sulphate

Sulphate $(SO_4)^{-2}$ is widely distributed in nature and may be present in natural waters in concentrations ranged from a few to several thousand milligrams per liter [77].

Sulphate $(SO_4)^{-2}$ in all water samples were ranged between 27.18 mg/l in sample site H04 in Table 4.4 to 100.9 mg/l in sample site H03 in Table 4.3 in Mahmoudia canal and were ranged between 20.26 mg/l in sample site N10 in Table 4.21 to 481 mg/l in sample site N06 in Table 4.17 in Nubaria canal.

These results in agreement with the described limits by the Egyptian standards but there were 4 samples sites (N02, N06, N10 and N11) out of guidelines.

4.1. 20. Phosphate

Phosphorus occurs in natural water and in wastewater almost solely as phosphates. Phosphorus is essential to the growth of organisms and can be the nutrient that limits the

primary productivity of a body of water. Phosphates also occur in bottom sediments and in biological sludge, both as precipitated inorganic forms and incorporated into organic compounds [77].

Phosphate in some sample sites were not detected and high concentration 5.23 mg/l were recorded in sample site H08 in Table 4.8 in Mahmoudia canal.

In Nubaria canal phosphate were not detected in some samples sites but high concentration 1.04 mg/l were recorded in sample site N11 in Table 4.22.

4.1. 21. Copper

Copper is sometimes caused by contamination from mining operations, acid water and corrosion in copper plumbing.

Concentrations of copper were not detected in some sample site in Nubaria and Mahmoudia canal usually in summer and were recorded high concentration 0.174 mg/l in sample site H08 in Table 4.33 and 0.0288 mg/l in sample site N10 in Table 4.46 in Mahmoudia and Nubaria canal.

4.1. 22. Cadmium

In drinking water Cd limits are 0.003 mg/l for Egyptian limits and WHO [95] and 0.005 mg/l for EPA [96].

Cadmium is primarily found in surface water as a pollutant from industries such as electroplating [57].

Concentrations of cadmium were not detected in some sample site in Nubaria and Mahmoudia canal and were recorded high concentration 0.006 mg/l in almost water samples and 0.009 mg/l in sample sites N12, N13 and N14 in Mahmoudia and Nubaria canals.

4.1. 23. Cobalt

Concentrations of cobalt were not detected in some samples sites in Nubaria canal. On the other hand cobalt was recorded high concentration 0.009 mg/l in sample site N10 in Table 4.46.

In Mahmoudia canal concentrations of cobalt were not detected in sample site H08 in Table 4.33 and were recorded high concentration 0.007 mg/l in sample sites H01 and H03 in Tables 4.26 and 4.28.

4.1. 24. Manganese

Manganese is a contaminant in drinking water resources that does not pose a direct health risk, but can cause chronic aesthetic problems for drinking water. In which it is important that drinking water plants produce aesthetically pleasing water [97].

In all water samples manganese concentrations were varied between 0.0025 mg/l in sample site N04 in Table 4.40 to 0.099 mg/l in sample site N06 in Table 4.42 in Nubaria canal and were varied between 0.001mg/l in sample site H09 in Table 4.34 to 0.092 mg/l in sample site H07 in Table 4.32 in Mahmoudia canal.

4.1. 25. Nickle

Concentrations of nickle were not detected in some samples sites in Nubaria canal. On the other hand nickle was recorded high concentration 0.1248 mg/l in sample site N11 in Table 4.47.

In Mahmoudia canal concentrations of nickle were not detected in some sample sites in and were recorded high concentration 0.1248 mg/l in sample site H01 in Table 4.26.

4.1. 26. Lead

In Nubaria canal lead not detected in some samples sides and recorded high concentration (0.014 mg/l) in sample site N14 in Table 4.50. On the other hand lead concentrations were ranged between 0.0015 mg/l in sample site H05 in Table 4.30 to 0.262 mg/l in sample site H06 in Table 4.31 in Mahmoudia canal.

Table 4.1: Seasonal variation of the physico-chemical characteristics in water samples of the sample site H01 in Mahmoudia canal:

Point	Parameters	Unit	Autumn[(a)]		winter		Spring		Summer		EMCL[(d)]
			Range	Mean ±SD[(b)]	Range	Mean ±SD	Range	Mean ±SD	Range	Mean ±SD	
Mahmoudia Canal	Temperature	°C	20.1-23.1	21.6±2.12	17.2-18.6	18.13±0.81	21.9-24.5	23.1±1.31	25.5-28.9	27.6±1.8	**3^0above usual**
	Turbidity	NTU	2.96-7.34	5.15±3.09	5.75-9.44	7.5±1.85	7.47-10.4	9.29±1.59	4.29-4.58	4.43±0.15	**NR[(e)]**
	pH		7.33-8.01	7.67±0.48	7.69-8.08	7.8±0.21	7.56-7.8	7.66±0.12	7.36-7.43	7.4±0.04	**7-8.5**
	EC	µS / cm	573-619	596±32.5	761-811	792±27.07	511-652	581±70.5	481-509	483.3±24.6	**NR**
	Total hardness	mg/l as $CaCO_3$	185-188	186.6±1.91	210-278.4	238.1±35.8	151.6-182	164.5±15.7	145.2-160.6	153.1±7.71	**NR**
	Alkalinity,total	mg/l as $CaCO_3$	170-171	170.6±0.85	216-262.2	236.9±23.4	166-176	171.8±5.58	148-162	157.2±7.6	**≤150**
	Chloride	mg/l as Cl^-	56-62	59±4.24	74-94.5	85±10.3	45.7-63	54.7±8.5	33.2-45.9	37.9±6.99	**NR**
	color	Hazen unit	20-25	22.5±3.54	20-50	33.3±15.28	30-60	43.3±15.3	20-30	23.3±5.77	**NR**
	TDS at 105 °C	mg/L	345-374	359.5±20.51	456.6-486	475.2±16.2	307-391.2	348.7±42.1	276-305	290±14.5	**≤500**
	TSS	mg/L	1.48-2.9	2.19±1	2.2-4.2	3.23±1	3.5-5	4.37±0.78	1.6-1.8	1.73±0.12	**NR**
	sulphate	mg/l as SO_4^{2-}	51-85	68.01±24	64.5-98.2	78.48±17.6	40.29-55.4	47.8±7.55	40.5-43.49	42.18±1.55	**≤200**
	phosphate	mg/l as PO_4^{3-}	ND-0.13	0.07±0.09	0.047-0.185	0.095±0.08	0.18-0.398	0.29±0.11	ND-0.24	0.12±0.12	**≤0.02**
	nitrate	mg/l as NO_3-	1.5-1.89	1.69±0.28	5.63-7.27	6.4±0.82	1.22-6.3	4.44±2.81	5.91-9.21	7.55±1.65	**≤45**
	nitrite	mg/l as NO_2-	0.297-0.31	0.3±0.007	0.461-0.64	0.52±0.11	0.173-0.56	0.41±0.21	0.16-2.52	1.09±1.26	**≤10**
	silica	mg/l as SiO_2	2.35-4.4	3.37±1.44	2.87-8.86	5.75±3	0.394-3.23	2.07±1.49	1.86-2.52	2.23±0.33	**NR**
	Amm.free	mg/l as NH_3	0.58-2.85	1.71±1.61	2.64-3.72	3.12±0.55	0.84-2.01	1.6±0.66	0.13-0.84	0.52±0.36	**≤0.5**
	Fluoride	mg/l as F^-	0.36-2	1.18±1.16	0.469-0.55	0.5±0.04	0.17-1.02	0.65±0.43	NA	NA	**≤0.5**
	DO	mg/l as O_2	5.86-7.9	6.9±1.44	6.3-9.01	7.5±1.38	6.21-7.23	7.01±0.72	6.5-6.88	6.73±0.2	**≥5**
	COD	mg/l as O_2	12-39.5	25.8±19.45	9.12-46.3	31.1±19.5	6.2-13.06	8.59±3.87	6.5-28	13.8±12.27	**≤10**
	BOD	mg/l as O_2	2.4-2.5	2.45±0.071	2-2.2	2.1±0.1	0.09-2	1.03±0.95	2	2±0	**≤6**

(a):Autumn (Oct to Dec2012),Winter (Jan to March 2013), Spring (Apr to Jun2013), Summer (Jul to Sep2013)
(b): Mean ± Standard Deviation , (C):NA:Not Analyzed , (f):ND:Not Detected
(d): EMCL: Egyptian Maximum Contaminant Limit For Raw Water, MWRI Decree 402 for 2009 , (e):NR : Not Recommended

Table 4.2: Seasonal variation of the physico-chemical characteristics in water samples of the sample site H02 in Mahmoudia canal:

Point	Parameters	Unit	Autumn[(a)]		winter		Spring		Summer		EMCL[(d)]
			Range	Mean±SD[(b)]	Range	Mean ±SD	Range	Mean ±SD	Range	Mean ±SD	
Zarkon Drain	Temperature	°C	20.3-23.2	21.75±2.05	17-18.6	17.9±0.83	21.6-24.4	22.9±1.41	26-28.6	27.7±1.45	**3^0above usual**
	Turbidity	NTU	2.3-6.39	4.35±2.89	6.58-14	9.18±4.18	4.56-12.2	8.06±3.86	1.31-5.48	3.43±2.09	**NR[(e)]**
	pH		7.55-7.81	7.68±0.18	7.76-8	7.88±0.12	7.65-7.87	7.74±0.113	7.48-7.66	7.58±0.09	**7-8.5**
	EC	µS / cm	567-620	593.5±37.5	772-808	794±19.29	514-651	578.7±68.8	465-505	482.3±20.5	**NR**
	Total hardness	mg/l as $CaCO_3$	177-192	184.4±10.4	192.2-334	245.7±76.9	156-214	177.7±31.7	145.4-158.8	152.07±6.7	**NR**
	Alkalinity,total	mg/l as $CaCO_3$	153-161	156.9±5.23	220-259.5	236.5±20.5	158-192	178.5±18.4	151-163	185.4±6.29	**≤150**
	Chloride	mg/l as Cl^-	59-60	59.5±0.71	65-95.3	80.9±15.2	46.2-62	53.9±7.65	32.5-39.8	35.6±3.8	**NR**
	color	Hazen unit	10-20	15±7.07	20-40	33.3±11.6	30-60	43.3±15.3	30-35	31.7±2.89	**NR**
	TDS at 105 °C	mg/L	341-374	357.5±23.3	463.2-484.8	476.4±11.6	308-390.6	347.1±41.5	279-303	289.3±12.3	**≤500**
	TSS	mg/L	1.15-2.4	1.78±0.88	3.1-6.4	4.57±1.68	2-5.8	3.7±1.94	0.5-2.2	1.4±0.85	**NR**
	sulphate	mg/l asSO_4^{2-}	49.9-55.1	52.5±3.7	59.3-94.5	75.87±17.7	39.08-55.9	47.29±8.43	35.03-42.5	39.3±3.8	**≤200**
	phosphate	mg/l asPO_4^{3-}	ND-0.23	0.114±0.16	0.045-0.112	0.086±0.04	0.18-0.483	0.32±0.15	0-0.07	0.045±0.04	**≤0.02**
	nitrate	mg/l asNO_3-	1.4-1.86	1.63±0.32	5.69-7.84	6.99±1.15	1.3-6.01	4.42±2.7	6.59-7.68	7.29±0.61	**≤45**
	nitrite	mg/l asNO_2-	0.29-0.31	0.3±0.008	0.412-0.655	0.53±0.12	0.173-0.53	0.35±0.18	0.12-1.39	0.61±0.68	**≤10**
	silica	mg/l as SiO_2	2.34-3.5	2.9±0.82	4.81-8.47	6.28±2.15	0.582-2.21	1.52±0.84	2.21-2.34	2.27±0.06	**NR**
	Amm.free	mg/l as NH_3	0.2-0.96	0.6±0.51	2.44-9.84	6.09±3.7	1.32-4.28	2.77±1.48	0.24-0.5	0.38±0.13	**≤0.5**
	Fluoride	mg/l as F^-	0.24-0.57	0.408±0.23	0.264-0.525	0.42±0.14	0.359-0.74	0.57±0.19	NA	NA	**≤0.5**
	DO	mg/l as O_2	6.24-7.1	6.67±0.61	7.1-8.73	7.81±0.84	6.9-7.46	7.19±0.28	6.5-6.98	6.66±0.28	**≥5**
	COD	mg/l as O_2	28-40.5	34.24±8.8	9.12-32	18.84±11.8	6.53-18	13.6±6.19	18-30	22.67±6.43	**≤10**
	BOD	mg/l as O_2	2-2.4	2.2±0.28	1.87-1.89	1.89±0.01	1.12-1.13	1.13±0.006	1.78-2.3	2.04±0.26	**≤6**

(a):Autumn (Oct to Dec2012),Winter (Jan to March 2013), Spring (Apr to Jun2013), Summer (Jul to Sep2013)
(b): Mean ± Standard Deviation , (C):NA:Not Analyzed , (f):ND:Not Detected
(d): EMCL: Egyptian Maximum Contaminant Limit For Raw Water, MWRI Decree 402 for 2009 , (e):NR : Not Recommended

Table 4.3: Seasonal variation of the physico-chemical characteristics in water samples of the sample site H03 in Mahmoudia canal:

Point	Parameters	Unit	Autumn[(a)]		winter		Spring		Summer		EMCL[(d)]
			Range	Mean ±SD[(b)]	Range	Mean ±SD	Range	Mean ±SD	Range	Mean ±SD	
Zarkon	Temperature	°C	20.2-23.1	21.7±2.05	17.1-18.7	18.07±0.85	21.6-24.5	22.97±1.46	25.7-28.4	27.4±1.5	**3^0above usual**
	Turbidity	NTU	4.58-15.8	10.19±7.9	7.71-15.6	10.35±4.55	5.5-8.23	7±1.39	2.5-4.94	3.99±1.3	**NR[(e)]**
	pH		7.49-7.8	7.65±0.22	7.69-8.03	7.82±0.18	7.53-7.8	7.64±0.14	7.31-7.47	7.41±0.09	**7-8.5**
	EC	µS / cm	571-618	594.5±33.2	767-807	792±21.8	510-654	579.3±72.2	463-502	484.3±19.8	**NR**
	Total hardness	mg/l as $CaCO_3$	187-190	188.2±2.33	222.6-271.2	242.6±25.4	152.4-184	168.1±15.8	145-169.6	154.8±13	**NR**
	Alkalinity,total	mg/l as $CaCO_3$	166-172	168.9±4.1	212.2-256.8	227.7±25.2	146-190	171.2±22.9	148-161	155.5±6.8	**≤150**
	Chloride	mg/l as Cl^-	36-59	47.4±16.4	81-100.5	87.9±10.88	46.3-65	55.3±9.1	33.1-42.7	36.8±5.8	**NR**
	color	Hazen unit	20-30	25±7.07	20-50	30±17.3	30-50	36.7±11.6	20-30	26.7±5.19	**NR**
	TDS at 105 °C	mg/L	351-373	362±15.56	460.2-484.2	475.2±13.1	344.4-392.4	347.6±43.3	278-301	290.7±11.7	**≤500**
	TSS	mg/L	1.8-7.9	4.85±4.31	3.5-7.2	4.75±2.12	2.6-3.8	3.2±0.6	0.8-2	1.57±0.67	**NR**
	sulphate	mg/l asSO_4^{2-}	50-63	56.7±9.42	71.6-100.9	81.6±16.73	39.04-56.7	47.8±8.83	37.97-42.03	39.7±2.08	**≤200**
	phosphate	mg/l asPO_4^{3-}	ND-0.1	0.05±0.07	ND-0.13	0.1±0.04	0.19-0.5	0.34±0.16	0-0.32	0.15±0.16	**≤0.02**
	nitrate	mg/l asNO_3-	1.38-1.77	1.57±0.28	6.12-7.02	6.7±0.51	1.26-7.34	4.86±3.19	5.85-9.4	7.63±1.8	**≤45**
	nitrite	mg/l asNO_2-	0.206-0.33	0.27±0.09	0.399-0.87	0.64±0.23	0.18-0.95	0.48±3.19	0.16-2.8	1.24±1.39	**≤10**
	silica	mg/l as SiO_2	2.06-2.82	2.44±0.53	3.3-9.7	6.3±3.23	0.001-2.78	1.63±1.45	1.3-1.88	1.63±0.3	**NR**
	Amm.free	mg/l as NH_3	0.6-3	1.81±1.68	2.88-4.87	3.78±1	0.72-3.42	2.23±1.38	0.1-1.2	0.69±0.56	**≤0.5**
	Fluoride	mg/l as F^-	0.42-0.5	0.46±0.06	0.37-0.53	0.45±0.08	0.25-1.04	0.68±0.39	NA	NA	**≤0.5**
	DO	mg/l as O_2	6.72-7.7	7.21±0.69	6.6-8.6	7.4±1.06	5.6-7.2	6.53±0.83	5.33-7.1	6.24±0.89	**≥5**
	COD	mg/l as O_2	32-39.5	32.8±5.3	12.16-53.9	30.7±21.3	6.4-32.6	15.2±15.1	7-31.4	15.5±13.8	**≤10**
	BOD	mg/l as O_2	2.2-2.6	2.4±0.28	1.99-2	1.99±0.006	1.4-1.6	1.5±0.1	1.78-2.35	2.04±0.29	**≤6**

(a):Autumn (Oct to Dec2012),Winter (Jan to March 2013), Spring (Apr to Jun2013), Summer (Jul to Sep2013)
(b): Mean ± Standard Deviation , (C):NA:Not Analyzed , (f):ND:Not Detected
(d): EMCL: Egyptian Maximum Contaminant Limit For Raw Water, MWRI Decree 402 for 2009 , (e):NR : Not Recommended

Table 4.4: Seasonal variation of the physico-chemical characteristics in water samples of the sample site H04 in Mahmoudia canal:

Point	Parameters	Unit	Autumn[(a)]		winter		Spring		Summer		EMCL[(d)]
			Range	Mean±SD[(b)]	Range	Mean ±SD	Range	Mean ±SD	Range	Mean ±SD	
End of Khandak	Temperature	°C	20.2-23.2	21.7±2.12	17-18.5	17.97±0.84	21.6-24.6	22.6±1.73	23.3-28.5	26.73±2.97	**3^0above usual**
	Turbidity	NTU	3.65-8.97	6.31±3.76	7.38-8.35	7.84±0.49	6.56-20	11.2±7.62	3.35-6.7	5.04±1.67	**NR[(e)]**
	pH		7.68-7.81	7.75±0.092	7.75-7.99	7.88±0.12	7.65-7.76	7.69±0.06	7.42-7.61	7.54±0.12	**7-8.5**
	EC	µS / cm	391-435	413±31.11	412-498	463.7±45.5	377-655	512±13.2	375-447	403±38.6	**NR**
	Total hardness	mg/l as $CaCO_3$	157-187	171.6±21.14	130-176.8	156.5±23.9	128.6-188	155.5±30.1	130.4-143.4	138.7±7.23	**NR**
	Alkalinity,total	mg/l as $CaCO_3$	149-160	154.7±7.49	162-173.1	166.2±5.98	133-188	161.8±27.4	133-161	144.2±14.5	**≤150**
	Chloride	mg/l as Cl^-	47-59	52.8±8.13	40-45.1	42.5±2.55	22.9-64	44.1±20.4	27-32.1	30.07±2.7	**NR**
	color	Hazen unit	20	20±0	10-40	23.3±15.28	10-40	28.3±16.07	20-30	23.3±5.77	**NR**
	TDS at 105 °C	mg/L	236-265	250.5±20.5	247-298.8	278.2±27.3	226-393	307.13±83.6	232-268	241.7±23.1	**≤500**
	TSS	mg/L	1.83-3.6	2.72±1.25	3.4-3.7	3.57±0.15	3-9.8	5.33±3.9	1.4-3	2.13±0.81	**NR**
	sulphate	mg/l as SO_4^{2-}	39.3-46.9	43.1±5.3	40.5-61.5	48.6±11.27	28.96-56.8	42.35±13.9	27.18-37.35	31.5±5.36	**≤200**
	phosphate	mg/l as PO_4^{3-}	ND-0.1	0.052±0.07	0.058-0.09	0.07±0.017	0.05-0.241	0.17±0.11	ND-0.11	0.04±0.06	**≤0.02**
	nitrate	mg/l as NO_3-	0.62-1.06	0.84±0.31	4.57-5.27	4.99±0.37	1.33-7.88	4.86±3.3	3.42-3.99	5.07±2.04	**≤45**
	nitrite	mg/l as NO_2-	0.049-0.11	0.08±0.04	0.23-0.73	0.46±0.25	0.17-0.41	0.27±0.12	0.12-0.21	0.15±0.05	**≤10**
	silica	mg/l as SiO_2	2.04-2.16	2.1±0.09	0.64-3.01	1.72±1.2	0.292-3.17	2.04±1.5	1.92-4.77	2.98±1.56	**NR**
	Amm.free	mg/l as NH_3	0.26-0.31	0.29±0.03	0.27-0.66	0.44±0.199	0.24-3.42	1.84±1.59	0.05-0.78	0.35±0.38	**≤0.5**
	Fluoride	mg/l as F^-	0.34-0.49	0.42±0.1	0.37-0.65	0.49±0.15	0.29-0.71	0.508±0.21	NA	NA	**≤0.5**
	DO	mg/l as O_2	6.9-7.11	7±0.15	7-8.92	7.81±0.99	6.69-7.5	7.19±0.44	6.3-7.2	6.86±0.45	**≥5**
	COD	mg/l as O_2	12-15.8	13.9±2.69	12.2-61.7	31.95±26.2	12.8-32.8	19.6±11.5	12.2-32	18.9±11.3	**≤10**
	BOD	mg/l as O_2	2.2-3	2.6±0.57	1.78-2.85	2.21±0.57	2	2±0	1.77-2.2	1.98±0.22	**≤6**

(a):Autumn (Oct to Dec2012),Winter (Jan to March 2013), Spring (Apr to Jun2013), Summer (Jul to Sep2013)
(b): Mean ± Standard Deviation , (C):NA:Not Analyzed , (f):ND:Not Detected
(d): EMCL: Egyptian Maximum Contaminant Limit For Raw Water, MWRI Decree 402 for 2009 , (e):NR : Not Recommended

Table 4.5: Seasonal variation of the physico-chemical characteristics in water samples of the sample site H05 in Mahmoudia canal:

Point	Parameters	Unit	Autumn[(a)]		winter		Spring		Summer		EMCL[(d)]
			Range	Mean±SD[(b)]	Range	Mean ±SD	Range	Mean ±SD	Range	Mean ±SD	
Zawyat Ghazal	Temperature	°C	20.2-23.2	21.7±2.12	17.1-18.5	18±0.78	21.5-24.6	22.9±1.56	23-28.3	26.5±3.06	**3^0above usual**
	Turbidity	NTU	11.1-16.8	13.95±4.03	4.3-12.7	9.83±4.79	7.65-10.3	8.74±1.39	4.57-6.59	5.35±1.09	**NR[(e)]**
	pH		7.74-7.95	7.85±0.15	7.73-7.91	7.8±0.096	7.66-7.92	7.77±0.13	7.38-7.56	7.5±0.09	**7-8.5**
	EC	µS / cm	435-566	500.5±92.6	445-641	568±107.14	368-585	478.7±108.6	433-456	447.7±12.7	**NR**
	Total hardness	mg/l as $CaCO_3$	160-161	160.4±3.54	156-220.2	187.5±32.12	128-188	153.87±30.8	138.6-154.2	147.7±8.13	**NR**
	Alkalinity,total	mg/l as $CaCO_3$	162-167	164.7±3.54	150-211.9	187.6±33.04	135-176	155.13±20.3	144-158	151.9±7.4	**≤150**
	Chloride	mg/l as Cl^-	30-47	38.3±12.3	39-74.3	57.7±17.7	24-56	40.4±15.8	28.6-34.6	31.3±3.06	**NR**
	color	Hazen unit	20-30	25±7.07	20-50	33.3±15.3	30-40	35±5	10-25	15±8.66	**NR**
	TDS at 105 °C	mg/L	269-345	307±53.7	267-389.6	340.8±64.3	220.8-351	287.3±65.1	260-274	268.7±7.57	**≤500**
	TSS	mg/L	4.9-8.4	6.65±2.47	1.7-5.9	4.47±17.75	3.5-4.6	3.97±0.57	1.8-3	2.2±0.69	**NR**
	sulphate	mg/l asSO_4^{2-}	43.5-47.7	45.6±2.95	46.6-81.1	61.24±17.9	28.9-50.2	39.03±10.7	34.14-38.7	35.7±2.6	**≤200**
	phosphate	mg/l asPO_4^{3-}	ND-0.15	0.08±0.11	0.061-0.13	0.09±0.04	0.08-0.33	0.18±0.13	ND-0.11	0.06±0.05	**≤0.02**
	nitrate	mg/l asNO_3-	0.9-1.48	1.19±0.41	4.87-6.06	5.47±0.59	1.36-6.53	4.75±2.94	6.35-7.34	6.77±0.51	**≤45**
	nitrite	mg/l asNO_2-	0.115-0.19	0.16±0.06	0.33-0.63	0.498±0.16	0.085-0.48	0.25±0.2	0.11-1.55	0.69±0.76	**≤10**
	silica	mg/l as SiO_2	1.54-1.55	1.54±0.004	1.8-4.58	2.95±1.45	0.64-1.96	1.5±0.75	1.98-2.79	2.49±0.45	**NR**
	Amm.free	mg/l as NH_3	0.3-1.2	0.768±0.61	1.08-2.28	1.68±0.6	0.84-2.28	1.6±0.72	0.05-0.63	0.39±0.3	**≤0.5**
	Fluoride	mg/l as F^-	0.31-0.41	0.36±0.07	0.392-0.69	0.56±0.15	0.21-0.703	0.51±0.26	NA	NA	**≤0.5**
	DO	mg/l as O_2	7.7-8.26	7.98±0.39	7-8.92	7.67±1.08	7.1-7.45	7.28±0.18	6.4-6.8	6.63±0.21	**≥5**
	COD	mg/l as O_2	14-23.7	18.9±6.86	15.2-38.6	25.9±11.82	6.2-19.58	10.77±7.6	6.8-12	8.67±2.89	**≤10**
	BOD	mg/l as O_2	2-2.8	2.4±0.57	1.5-2.8	2.1±0.66	NA	NA	0.98	0.98±0	**≤6**

(a):Autumn (Oct to Dec2012),Winter (Jan to March 2013), Spring (Apr to Jun2013), Summer (Jul to Sep2013)
(b): Mean ± Standard Deviation , (C):NA:Not Analyzed , (f):ND:Not Detected
(d): EMCL: Egyptian Maximum Contaminant Limit For Raw Water, MWRI Decree 402 for 2009 , (e):NR : Not Recommended

Table 4.6: Seasonal variation of the physico-chemical characteristics in water samples of the sample site H06 in Mahmoudia canal:

Point	Parameters	Unit	Autumn[(a)]		winter		Spring		Summer		EMCL[(d)]
			Range	Mean±SD[(b)]	Range	Mean ±SD	Range	Mean ±SD	Range	Mean ±SD	
Abou Hommos	Temperature	°C	20.2-23.2	21.7±2.12	17-18.6	17.9±0.83	21.6-24.6	22.97±1.52	23.6-28.4	26.77±2.74	**3^0above usual**
	Turbidity	NTU	1.46-6.9	4.18±3.85	3.79-30.7	13.07±15.27	5.65-10	8.27±2.31	2.62-5.51	3.98±1.45	**NR[(e)]**
	pH		7.67-7.92	7.79±0.18	7.61-7.96	7.8±0.18	7.62-7.89	7.75±0.14	7.48-7.58	7.54±0.07	**7-8.5**
	EC	µS / cm	437-578	507.5±99.7	573-665	627.7±48.39	479-588	531.7±54.6	443-471	455.3±14.29	**NR**
	Total hardness	mg/l as $CaCO_3$	166-167	166.2±0.85	158-214.6	186.5±28.3	143.8-192	163.3±25.4	138.8-156.4	148.7±8.99	**NR**
	Alkalinity,total	mg/l as $CaCO_3$	159-164	161.6±3.96	186.2-218.6	194.27±21.5	160-184	172.6±12.16	145-160	154.2±8.2	**≤150**
	Chloride	mg/l as Cl^-	36-53	44.65±11.8	39-74.2	58.47±17.89	46.6-53	49.37±2.97	30.5-37.3	32.9±3.82	**NR**
	color	Hazen unit	20-30	25±7.07	20-40	30±10	20-40	30±10	20	20±0	**NR**
	TDS at 105 °C	mg/L	263-350	306.5±61.52	343.8-399	376.6±29.03	287-352.8	318.9±32.95	266-283	273.3±8.74	**≤500**
	TSS	mg/L	0.73-2.8	1.77±1.46	1.4-15	6.13±7.68	2.4-4.7	3.7±1.18	1.1-2.2	1.67±0.55	**NR**
	sulphate	mg/l asSO_4^{2-}	46.3-48	47.13±1.17	56.3-83.5	68.14±13.93	36.3-50.4	43.01±7.03	37.5-39.98	38.97±1.27	**≤200**
	phosphate	mg/l asPO_4^{3-}	ND-0.09	0.04±0.06	0.05-0.1	0.07±0.03	0.17-0.31	0.24±0.07	0.11-0.14	0.12±0.015	**≤0.02**
	nitrate	mg/l asNO_3-	1.16-1.81	1.48±0.46	5.64-6.3	5.94±0.33	1.46-7.28	4.95±3.08	6.55-8.06	7.55±0.87	**≤45**
	nitrite	mg/l asNO_2-	0.093-0.52	0.17±0.11	0.39-0.71	0.56±0.16	0.311-0.5	0.43±0.1	0.11-1.06	0.512±0.49	**≤10**
	silica	mg/l as SiO_2	1.63-5.03	3.33±2.41	2.27-5.66	3.75±1.74	0.39-2.15	1.53±0.99	1.83-2.92	2.53±0.6	**NR**
	Amm.free	mg/l as NH_3	0.36-1.02	0.69±0.47	2.1-2.52	2.26±0.23	1.32-4.95	2.79±1.9	0.07-0.78	0.404±0.36	**≤0.5**
	Fluoride	mg/l as F^-	ND-0.83	0.41±0.59	0.421-0.63	0.503±0.11	0.13-0.75	0.42±0.31	NA	NA	**≤0.5**
	DO	mg/l as O_2	7.39-7.6	7.49±0.15	6.7-8.35	7.27±0.94	7.4-7.7	7.58±0.16	6.6-6.9	6.73±0.15	**≥5**
	COD	mg/l as O_2	16.2-36	26.59±14	21.28-38.6	29.29±8.73	9.79-22.8	14.21±7.47	8.6-10	9.13±0.76	**≤10**
	BOD	mg/l as O_2	2.4-2.5	2.45±0.07	1.66-2.2	2±0.27	0.98-2.1	1.34±0.64	1.4-1.6	1.5±0.1	**≤6**

(a):Autumn (Oct to Dec2012),Winter (Jan to March 2013), Spring (Apr to Jun2013), Summer (Jul to Sep2013)
(b): Mean ± Standard Deviation , (C):NA:Not Analyzed , (f):ND:Not Detected
(d): EMCL: Egyptian Maximum Contaminant Limit For Raw Water, MWRI Decree 402 for 2009 , (e):NR : Not Recommended

Table 4.7: Seasonal variation of the physico-chemical characteristics in water samples of the sample site H07 in Mahmoudia canal:

Point	Parameters	Unit	Autumn[(a)]		winter		Spring		Summer		EMCL[(d)]
			Range	Mean±SD[(b)]	Range	Mean ±SD	Range	Mean ±SD	Range	Mean ±SD	
Kafr El-Dawar	Temperature	°C	20.3-23.2	21.8±2.05	17-18.8	18±0.92	21.6-24.5	22.9±1.47	23-28.4	26.6±3.09	**3^0above usual**
	Turbidity	NTU	3.67-5.04	4.36±0.97	7.59-13.5	10.63±2.96	7.53-9.49	8.6±0.99	3.57-5.51	4.79±1.06	**NR[(e)]**
	pH		7.62-7.67	7.65±0.04	7.65-7.89	7.75±0.123	7.66-7.79	7.72±0.07	3.35-7.53	7.5±0.1	**7-8.5**
	EC	µS / cm	455-580	517.5±88.4	570-664	626.3±49.7	489-587	532.7±49.9	448-486	464.3±19.6	**NR**
	Total hardness	mg/l as $CaCO_3$	163-176	169.5±8.63	182-214	195.7±16.5	154-188	168±17.8	133-151.4	142.5±9.22	**NR**
	Alkalinity,total	mg/l as $CaCO_3$	162-168	164.9±4.67	156-213.4	189.8±30.03	156-178	170.6±12.8	145-158	151.6±6.61	**≤150**
	Chloride	mg/l as Cl^-	39-53	45.8±10.18	39-71.9	57.3±16.77	41.8-56	48.8±6.85	28.6-39.4	33.3±5.52	**NR**
	color	Hazen unit	10-20	15±7.07	10-40	23.3±15.28	20-40	30±10	25-30	28.3±2.89	**NR**
	TDS at 105 °C	mg/L	275-350	312.4±52.9	342-398.4	375.8±29.8	293-352.2	319.5±30.59	269-292	278.67±11.9	**≤500**
	TSS	mg/L	1.8-1.84	1.82±0.03	3.2-6.4	4.93±1.62	3.2-4.2	3.77±0.51	1.2-2.3	1.67±0.57	**NR**
	sulphate	mg/l asSO_4^{2-}	47.1-50.4	48.76±2.4	49.5-86.5	63.6±19.99	43.3-51.6	43.77±7.58	37.29-39.39	38.26±1.06	**≤200**
	phosphate	mg/l asPO_4^{3-}	ND-0.11	0.05±0.08	0.03-0.09	0.06±0.03	0.19-0.33	0.27±0.07	0.05-0.13	0.083±0.04	**≤0.02**
	nitrate	mg/l asNO_3-	1.24-1.85	1.54±0.43	6.02-7.75	6.73±0.09	1.62-7.58	5.1±3.1	6.88-9.14	8.34±1.27	**≤45**
	nitrite	mg/l asNO_2-	0.18-0.25	0.21±0.05	0.49-0.85	0.69±0.18	0.313-0.72	0.57±0.23	0.23-0.49	0.32±0.14	**≤10**
	silica	mg/l as SiO_2	2.09-2.32	2.2±0.16	1.78-6.14	3.58±2.28	0.263-2.22	1.38±1.01	1.95-2.6	2.22±0.33	**NR**
	Amm.free	mg/l as NH_3	0.3-1	0.65±0.44	0.6-2.4	1.77±0.99	0.96-2.58	1.71±0.82	0.07-0.52	0.46±0.23	**≤0.5**
	Fluoride	mg/l as F^-	0.3-0.4	0.37±0.09	0.37-0.57	0.45±0.103	0.131-0.647	0.31±0.29	NA	NA	**≤0.5**
	DO	mg/l as O_2	5.1-7.97	6.54±2.03	7-8.6	7.63±0.85	7.4-7.8	7.55±0.22	6.69-6.7	6.76±0.12	**≥5**
	COD	mg/l as O_2	34-56.7	45.33±16.03	9.12-46.3	27.14±18.6	12.8-13.06	12.97±0.15	12-12.6	12.33±0.31	**≤10**
	BOD	mg/l as O_2	3-3.2	3.1±0.14	1.98-2.1	2.02±0.06	1.09	1.09±0	1.44-1.71	1.56±0.14	**≤6**

(a):Autumn (Oct to Dec2012),Winter (Jan to March 2013), Spring (Apr to Jun2013), Summer (Jul to Sep2013)
(b): Mean ± Standard Deviation , (C):NA:Not Analyzed , (f):ND:Not Detected
(d): EMCL: Egyptian Maximum Contaminant Limit For Raw Water, MWRI Decree 402 for 2009 , (e):NR : Not Recommended

Table 4.8: Seasonal variation of the physico-chemical characteristics in water samples of the sample site H08 in Mahmoudia canal:

Point	Parameters	Unit	Autumn[(a)]		winter		Spring		Summer		EMCL[(d)]
			Range	Mean±SD[(b)]	Range	Mean ±SD	Range	Mean ±SD	Range	Mean ±SD	
Khorshid	Temperature	°C	20.1-23.2	21.65±2.19	17-18.6	17.97±0.85	21.6-24.6	22.9±1.55	23.1-28.5	26.6±3.03	**3^0above usual**
	Turbidity	NTU	4.14-5.51	4.83±0.97	7.75-10.9	9.78±1.76	6.11-15	9.84±4.6	5.46-9	7.61±1.89	**NR[(e)]**
	pH		7.58-7.67	7.63±0.06	7.55-7.9	7.7±0.18	7.48-7.76	7.61±0.14	7.55-7.62	7.59±0.04	**7-8.5**
	EC	µS / cm	455-571	513±82.02	457-671	595.7±120.2	485-588	535±51.6	449-486	463.3±19.9	**NR**
	Total hardness	mg/l as $CaCO_3$	163-169	166.3±4.38	152-219.8	188.3±34.2	154-182	166±14.4	143.6-153	148.5±4.72	**NR**
	Alkalinity,total	mg/l as $CaCO_3$	163-169	165.9±4.67	152-219.3	190.4±34.6	154-172	165.3±9.87	148-158	153.5±5.3	**≤150**
	Chloride	mg/l as Cl^-	38-52	44.75±10.25	40-70.4	58.6±16.3	42.1-56	48.2±6.8	29.6-38.3	33.73±4.4	**NR**
	color	Hazen unit	25-30	27.5±3.54	20-30	23.3±5.77	25-40	31.7±7.64	20-30	26.7±5.77	**NR**
	TDS at 105 °C	mg/L	275-345	310±49.5	274-402.6	357.4±47.14	291-352.8	321±30.94	269-292	277.7±12.5	**≤500**
	TSS	mg/L	1.9-2.07	1.99±0.12	3.4-5	4.47±0.92	2.4-7	4.43±2.35	2.8-4.3	3.57±0.75	**NR**
	sulphate	mg/l asSO_4^{2-}	46.2-46.4	46.33±0.15	50.7-85	65.17±17.8	36.92-51.5	43.81±7.32	37.3-44.6	41.12±3.69	**≤200**
	phosphate	mg/l asPO_4^{3-}	ND-0.13	0.07±0.095	0.031-0.14	0.092±0.06	0.21-0.35	0.27±0.07	5.1-5.23	0.16±0.06	**≤0.02**
	nitrate	mg/l asNO_3-	1.36-1.96	1.66±0.42	6.98-8.85	7.73±0.99	2.01-6.65	4.99±2.59	7.93-8.73	8.46±0.46	**≤45**
	nitrite	mg/l asNO_2-	0.157-0.17	0.16±0.007	0.48-0.88	0.72±0.21	0.36-0.65	0.54±0.15	0.09-0.39	0.24±0.15	**≤10**
	silica	mg/l as SiO_2	1.98-7.67	4.83±4.02	1.77-6.07	3.49±2.27	0.55-2.4	1.57±0.94	2.03-2.83	2.35±0.42	**NR**
	Amm.free	mg/l as NH_3	0.3-0.54	0.402±0.195	0.34-2.22	1.41±0.97	1.08-2.04	1.44±0.52	0.07-0.4	0.29±0.19	**≤0.5**
	Fluoride	mg/l as F^-	0.28-0.49	0.39±0.15	0.35-0.495	0.44±0.076	0.31-0.78	0.52±0.24	NA	NA	**≤0.5**
	DO	mg/l as O_2	6.1-6.53	6.32±0.3	6.4-8.35	7.31±0.98	7-7.46	7.25±0.23	6.7-7	6.87±0.15	**≥5**
	COD	mg/l as O_2	16.2-28	22.59±8.35	22-46.3	31.89±12.77	12.9-13.6	13.19±0.37	12-14.6	13.07±1.36	**≤10**
	BOD	mg/l as O_2	3.2-3.4	3.3±0.14	2.01-2.35	2.2±0.17	0.97-1	0.98±0.02	1.83-2.21	1.97±0.2	**≤6**

(a):Autumn (Oct to Dec2012),Winter (Jan to March 2013), Spring (Apr to Jun2013), Summer (Jul to Sep2013)
(b): Mean ± Standard Deviation , (C):NA:Not Analyzed , (f):ND:Not Detected
(d): EMCL: Egyptian Maximum Contaminant Limit For Raw Water, MWRI Decree 402 for 2009 , (e):NR : Not Recommended

Table 4.9: Seasonal variation of the physico-chemical characteristics in water samples of the sample site H09 in Mahmoudia canal:

Point	Parameters	Unit	Autumn[(a)]		winter		Spring		Summer		EMCL[(d)]
			Range	Mean±SD[(b)]	Range	Mean ±SD	Range	Mean ±SD	Range	Mean ±SD	
Seiouf WTP Intake	Temperature	°C	20.2-23.3	21.75±2.19	16.9-18.7	17.93±0.93	21.7-24.5	22.9±1.4	23.1-28.2	25.7±3.61	**3^0above usual**
	Turbidity	NTU	3.43-10.4	6.92±4.93	5.19-6.06	5.5±0.48	3.4-8.32	5.49±2.54	6.89-6.97	6.93±0.06	**NR[(e)]**
	pH		7.57-7.79	7.68±0.16	7.62-7.9	7.72±0.16	7.53-7.71	7.63±0.09	7.52-7.64	7.58±0.08	**7-8.5**
	EC	µS / cm	446-582	514±96.2	501-685	615±99.6	489-592	542±51.6	453-482	467.5±20.51	**NR**
	Total hardness	mg/l as $CaCO_3$	164-168	166±2.55	166-220	191.7±27.1	152-180	162.3±15.4	143.6-170.2	156.9±18.8	**NR**
	Alkalinity,total	mg/l as $CaCO_3$	162-163	162.4±1.13	156-211.8	190.99±30.5	157-176	166.5±9.31	147-152	149.4±3.68	**≤150**
	Chloride	mg/l as Cl^-	37-53	44.8±11.6	38-71.8	59.7±18.8	41.4-56	48.6±7.06	30.4-39.3	34.9±6.29	**NR**
	color	Hazen unit	20-30	25±7.07	20-40	26.6±11.5	25-40	31.7±7.64	20-30	25±7.07	**NR**
	TDS at 105 °C	mg/L	269-345	307±53.7	300.6-411	369±59.7	293-355.2	325.1±31.15	272-289	280.5±12.02	**≤500**
	TSS	mg/L	1.72-4.6	3.16±2.04	2.2-2.5	2.4±0.17	1.4-3.8	2.4±1.25	2.8-3	2.9±0.14	**NR**
	sulphate	mg/l asSO_4^{2-}	47.2-54.7	50.98±5.28	54.4-81.6	65.6±14.2	37.5-51.9	44.11±7.25	39.08-41.5	40.29±1.7	**≤200**
	phosphate	mg/l asPO_4^{3-}	ND-0.12	0.058±0.08	0.077-0.14	0.1±0.03	0.2-0.295	0.25±0.049	0.06-0.08	0.07±0.014	**≤0.02**
	nitrate	mg/l asNO_3-	1.37-1.98	1.67±0.43	7.38-8.6	8.03±0.6	1.77-6.76	3.95±2.56	7.93-8.19	8.06±0.19	**≤45**
	nitrite	mg/l asNO_2-	0.073-0.09	0.08±0.01	0.67-0.79	0.74±0.06	0.26-0.5	0.41±0.13	0.24-0.56	0.39±0.22	**≤10**
	silica	mg/l as SiO_2	2.09-2.76	2.42±0.48	2.04-5.8	3.55±2.02	0.61-3.74	2.28±1.58	2.19-2.83	2.51±0.45	**NR**
	Amm.free	mg/l as NH_3	0.2-0.48	0.35±0.19	0.96-3	1.88±1.03	1.32-2.76	1.96±0.7	0.07-0.4	0.24±0.23	**≤0.5**
	Fluoride	mg/l as F^-	0.3-0.48	0.39±0.13	0.51-0.592	0.55±0.04	0.094-0.71	0.4±0.31	NA	NA	**≤0.5**
	DO	mg/l as O_2	6.15-7.3	6.73±0.81	6-8.25	7.2±1.13	6.1-7.5	6.97±0.76	6.7-6.98	6.84±0.2	**≥5**
	COD	mg/l as O_2	25-56.7	40.84±22.4	9.12-28	19.51±9.58	9.79-13.06	11.01±1.78	12-14.8	13.4±1.98	**≤10**
	BOD	mg/l as O_2	2.6-3	2.8±0.28	1.89-2.21	1.99±0.18	1.03-1.52	1.21±0.28	1.31-2	1.66±0.35	**≤6**

(a):Autumn (Oct to Dec2012),Winter (Jan to March 2013), Spring (Apr to Jun2013), Summer (Jul to Sep2013)
(b): Mean ± Standard Deviation , (C):NA:Not Analyzed , (f):ND:Not Detected
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Table 4.10: Seasonal variation of the physico-chemical characteristics in water samples of the sample site H10 in Mahmoudia canal:

Point	Parameters	Unit	Autumn[(a)]		winter		Spring		Summer		EMCL[(d)]
			Range	Mean±SD[(b)]	Range	Mean ±SD	Range	Mean ±SD	Range	Mean ±SD	
Nozha WTP Intake	Temperature	°C	20.1-24.4	22.3±3.04	16.8-18.6	17.87±0.95	21.6-24.6	22.9±1.53	22.9-28.4	26.7±3.89	**3^0above usual**
	Turbidity	NTU	2.74-8.09	5.42±3.78	3.87-7.05	5.49±1.59	2.75-83.2	31.3±4.5	10.3-13.1	11.7±1.98	**NR[(e)]**
	pH		7.61-7.73	7.67±0.08	7.49-7.9	7.65±0.22	7.45-7.62	7.55±0.09	7.72-7.84	7.78±0.08	**7-8.5**
	EC	µS / cm	446-567	506.5±85.6	513-669	608.7±83.8	487-591	540.3±52.05	454-482	468±19.8	**NR**
	Total hardness	mg/l as $CaCO_3$	159-175	167±11.88	162-207.4	184.9±22.7	152-186	164.3±18.8	145-160.6	152.8±11.03	**NR**
	Alkalinity,total	mg/l as $CaCO_3$	161-170	165.4±5.94	160-204.4	184.9±22.7	151-172	164.3±11.6	146-154	150.1±5.52	**≤150**
	Chloride	mg/l as Cl^-	39-52	45.5±9.19	37-69.2	57.83±18.07	41.4-56	48.63±7.06	30.2-39.6	34.9±6.65	**NR**
	color	Hazen unit	10-20	15±7.07	30-40	33.3±5.77	20-40	28.3±10.4	25-30	27.5±3.54	**NR**
	TDS at 105 °C	mg/L	269-343	306±52.33	308-401.4	365.2±50.3	292-356.6	324.8±32.3	272-286	280.5±12.02	**≤500**
	TSS	mg/L	1.37-3	2.19±1.15	1.6-3.4	2.5±0.9	1.2-40.2	15.03±21.8	4.5-6	5.25±1.06	**NR**
	sulphate	mg/l asSO_4^{2-}	47-48	47.8±0.96	54.5-79.6	64.7±13.17	40.56-52.3	45.62±6.01	41.64-42.1	41.87±0.33	**≤200**
	phosphate	mg/l asPO_4^{3-}	0.15-0.22	0.19±0.05	0.039-0.09	0.07±0.03	0.21-0.35	0.27±0.07	0.09-0.11	0.099±0.013	**≤0.02**
	nitrate	mg/l asNO_3-	1.55-2.06	1.8±0.36	10.16-12.4	10.96±1.22	2.23-6.23	4.03±2.03	7.94-8.25	8.09±0.22	**≤45**
	nitrite	mg/l asNO_2-	0.139-0.14	0.14±0.003	0.68-0.97	0.83±0.14	0.32-0.42	0.38±0.05	0.22-0.6	0.41±0.27	**≤10**
	silica	mg/l as SiO_2	1.73-2.36	2.04±0.45	1.98-5.64	3.32±2.02	0.58-2.7	1.78±1.09	2.3-2.9	2.6±0.43	**NR**
	Amm.free	mg/l as NH_3	0.2-0.45	0.321±0.18	0.34-2.94	1.57±1.31	0.06-2.28	1.22±1.11	0.08-0.24	0.16±0.11	**≤0.5**
	Fluoride	mg/l as F^-	0.33-0.38	0.36±0.04	0.32±0.66	0.5±0.17	0.27-0.67	0.52±0.22	NA	NA	**≤0.5**
	DO	mg/l as O_2	6.1-6.6	6.35±0.35	7-8.35	7.51±0.74	5.35-6.9	6.05±0.79	7-7.46	7.23±0.33	**≥5**
	COD	mg/l as O_2	26-32.4	29.19±4.5	15.4±30	21.21±7.74	6.53-18	13.62±6.19	15-16.5	15.75±1.06	**≤10**
	BOD	mg/l as O_2	3-3.2	3.1±0.14	1.59-2	1.87±0.23	1	1±0	1.59-1.99	1.73±0.23	**≤6**

(a):Autumn (Oct to Dec2012),Winter (Jan to March 2013), Spring (Apr to Jun2013), Summer (Jul to Sep2013)
(b): Mean ± Standard Deviation , (C):NA:Not Analyzed , (f):ND:Not Detected
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Table 4.11: Seasonal variation of the physico-chemical characteristics in water samples of the sample site H11 in Mahmoudia canal:

Point	Parameters	Unit	Autumn[(a)]		winter		Spring		Summer		EMCL[(d)]
			Range	Mean±SD[(b)]	Range	Mean ±SD	Range	Mean ±SD	Range	Mean ±SD	
Manshia WTP Intake	Temperature	°C	20.3-23.2	21.75±2.05	16.9-18.2	17.55±0.92	21.5-24.4	22.9±1.46	22.8-28.5	25.7±4.03	**3^0above usual**
	Turbidity	NTU	7-11.3	9.15±3.04	5.27-7.03	6.15±1.24	2.6-15.4	9.2±6.4	8.39-9.11	8.75±0.51	**NR[(e)]**
	pH		7.54-7.79	7.67±0.18	7.55-7.76	7.66±0.15	7.5-7.63	7.56±0.07	7.66-7.79	7.73±0.092	**7-8.5**
	EC	µS / cm	448-574	511±89.09	504-674	589±120.21	489-591	540.3±51	475-482	478.5±4.95	**NR**
	Total hardness	mg/l as $CaCO_3$	162-166	164±3.11	164-208.4	186.2±31.39	150-178	161±14.9	152-167	159.5±10.6	**NR**
	Alkalinity,total	mg/l as $CaCO_3$	162-164	162.6±1.41	180-196.4	188.2±11.6	152-170	161.9±9.38	145-152	148.4±5.09	**≤150**
	Chloride	mg/l as Cl^-	39-54	46.5±10.6	37-67.3	52.15±21.4	40.7-54	48.4±6.78	30.7-39.3	35±6.08	**NR**
	color	Hazen unit	10-30	20±14	20	20±0	20-40	28.3±10.4	25-30	27.5±3.54	**NR**
	TDS at 105 °C	mg/L	272-349	310.5±54.4	302.4-404.4	353.4±72.1	293-354.6	324.07±30.8	285-289	287±2.83	**≤500**
	TSS	mg/L	3.5-4.8	4.15±0.92	2.3-3.1	2.7±0.57	1.2-7.2	4.3±3	3.6-4	3.8±0.28	**NR**
	sulphate	mg/l asSO_4^{2-}	45.9-47.9	49.92±1.37	54.4-62.2	58.32±5.48	38.6-53.2	45.18±7.39	37.2-41.98	39.59±3.38	**≤200**
	phosphate	mg/l asPO_4^{3-}	0.15-0.18	0.17±0.02	0.058-0.08	0.07±0.02	0.24-0.311	0.29±0.04	0.08-0.1	0.09±0.02	**≤0.02**
	nitrate	mg/l asNO_3-	1.98-2.06	2.02±0.05	9.94-12.05	10.99±1.49	2.31-10.04	5.96±3.89	7.89-7.95	7.92±0.04	**≤45**
	nitrite	mg/l asNO_2-	0.136-0.14	0.14±0.004	0.67-0.68	0.67±0.012	0.319-0.53	0.42±0.1	0.21-0.55	0.38±0.244	**≤10**
	silica	mg/l as SiO_2	2.13-5.43	3.78±2.34	2.21-2.23	2.22±0.012	0.69-3.6	2.099±1.47	2.22-2.8	2.51±0.41	**NR**
	Amm.free	mg/l as NH_3	0.2-0.51	0.35±0.22	0.96-2.46	1.71±1.06	0.19-2.52	1.22±1.19	0.11-0.16	0.132±0.03	**≤0.5**
	Fluoride	mg/l as F^-	0.28-0.37	0.33±0.06	0.016-0.645	0.33±0.44	0.018-0.71	0.36±0.35	NA	NA	**≤0.5**
	DO	mg/l as O_2	5.47-7	6.24±1.08	7.3-8	7.65±0.49	5.8-7.07	6.56±0.67	6.9-7.37	7.14±0.33	**≥5**
	COD	mg/l as O_2	28-48.6	38.29±14.5	9.12-38.6	23.86±20.85	6.64-22.9	16.56±8.69	14-18	16±2.83	**≤10**
	BOD	mg/l as O_2	3.2-3.4	3.3±0.14	2	2±0	0.97-1.29	1.09±0.18	1.03-1.31	1.13±0.16	**≤6**

(a):Autumn (Oct to Dec2012),Winter (Jan to March 2013), Spring (Apr to Jun2013), Summer (Jul to Sep2013)
(b): Mean ± Standard Deviation , (C):NA:Not Analyzed , (f):ND:Not Detected
(d): EMCL: Egyptian Maximum Contaminant Limit For Raw Water, MWRI Decree 402 for 2009 , (e):NR : Not Recommended

Table 4.12: Seasonal variation of the physico-chemical characteristics in water samples of the sample site N01 in Nubaria canal:

Point	Parameters	Unit	Autumn[(a)]		winter		Spring		Summer		EMCL[(d)]
			Range	Mean±SD[(b)]	Range	Mean ±SD	Range	Mean ±SD	Range	Mean ±SD	
Boline Bridge	Temperature	°C	22.3-23.6	22.95±0.92	17.1-17.8	17.4±0.36	21.6-25.1	23.33±1.75	23.4-28.1	25.73±2.35	**3^0above usual**
	Turbidity	NTU	4.3-29.4	16.85±17.75	7.23-14	10.78±3.39	11.9-14.8	13.3±1.45	3.38-5.48	4.69±1.14	**NR[(e)]**
	pH		7.71-8.02	7.87±0.219	8.09-8.42	8.25±0.17	8.03-8.3	8.13±0.15	8.03-8.1	8.06±0.04	**7-8.5**
	EC	µS / cm	401-416	408.5±10.61	388-441	421.33±29.1	332-517	411±95.41	294-332	310.33±19.6	**NR**
	Total hardness	mg/l as $CaCO_3$	139-146	142.5±4.95	142.8-182	157.87±21.1	131.4-153.6	141±11.4	118.2-126.2	122.27±4	**NR**
	Alkalinity,total	mg/l as $CaCO_3$	156-158	157±1.41	146-163	154.33±8.6	136-156	142.93±11.3	129-137	133.47±4.15	**≤150**
	Chloride	mg/l as Cl^-	25.3-27.1	26.2±1.27	24-34.6	29.77±5.36	17.6-22	20.2±2.31	12.9-19	16.3±3.11	**NR**
	color	Hazen unit	20	20±0	15-40	25±13.23	10-35	25±13.23	18-30	22.67±6.43	**NR**
	TDS at 105 °C	mg/L	251-254	252.3±2.12	238-271	258±17.58	0-7	4.4±3.83	NA[(c)]	NA	**≤500**
	TSS	mg/L	1.6-13.8	7.7±8.63	3.5-6.8	5.1±1.65	5.5-7	6.23±0.75	1.2-2.4	1.93±6.43	**NR**
	sulphate	mg/l asSO_4^{2-}	32.38-43.5	37.95±7.88	32.47-45.7	38.86±6.48	27.33-34.63	32.17±4.20	23.86-32.71	28.87±4.54	**≤200**
	phosphate	mg/l asPO_4^{3-}	ND-0.08	0.04±0	ND[(f)]-0.1	0.069±0.04	0.05-0.09	0.072±0.02	0-0.04	0.041±0	**≤0.02**
	nitrate	mg/l asNO_3-	0.6-0.7	0.65±0.07	3.8-4.6	4.33±0.43	3.3-6.4	4.47±1.72	2.6-3.6	2.99±0.55	**≤45**
	nitrite	mg/l asNO_2-	0.01	0.001±0	0.07-0.16	0.13±0.056	0.04-0.09	0.072±0.03	0.03-0.08	0.051±0.03	**≤10**
	silica	mg/l as SiO_2	0.84-0.95	0.895±0.09	0.18-0.99	0.46±0.46	0.32-2.37	1.51±1.07	3.42-10.39	5.83±3.95	**NR**
	Amm.free	mg/l as NH_3	0.07-0.26	0.165±0.13	0.06-0.14	0.11±0.043	0.13-0.17	0.15±0.02	0.01-0.16	0.071±0.08	**≤0.5**
	Fluoride	mg/l as F^-	0.47-0.52	0.495±0.04	0.27-0.56	0.39±0.15	0.07-0.53	0.32±0.24	NA	NA	**≤0.5**
	DO	mg/l as O_2	7.31-8.7	8.005±0.99	7.2-8.1	7.63±0.45	7.1-7.3	7.15±0.13	6.9-7.2	7.06±0.15	**≥5**
	COD	mg/l as O_2	18-54	36±25.46	18-93.8	43.67±43.42	9.6-72.86	30.89±36.35	10.5-62.72	28±30.06	**≤10**
	BOD	mg/l as O2	4-4.67	4.3±0.34	1.98-3.5	2.4±0.87	1.98-3.5	2.5±0.87	1.98-3.5	2.5±0.87	**≤6**

(a):Autumn (Oct to Dec2012),Winter (Jan to March 2013), Spring (Apr to Jun2013), Summer (Jul to Sep2013)
(b): Mean ± Standard Deviation , (C):NA:Not Analyzed , (f):ND:Not Detected
(d): EMCL: Egyptian Maximum Contaminant Limit For Raw Water, MWRI Decree 402 for 2009 , (e):NR : Not Recommended

Table 4.13: Seasonal variation of the physico-chemical characteristics in water samples of the sample site N02 in Nubaria canal:

Point	Parameters	Unit	Autumn[(a)]		winter		Spring		Summer		EMCL[(d)]
			Range	Mean±SD[(b)]	Range	Mean ±SD	Range	Mean ±SD	Range	Mean ±SD	
Delingat Drain	Temperature	°C	22.3-24.1	23.2±1.27	17.1-17.5	17.3±0.2	21.5-24.6	22.9±1.57	25.6-28.1	26.85±1.8	**3^0above usual**
	Turbidity	NTU	4.3-36.8	20.55±22.98	4.78-12.3	8.58±3.76	5-11.1	8.67±3.23	3.57-6.32	4.95±1.94	**NR[(e)]**
	pH		7.51-7.77	7.64±0.18	7.84-8.12	7.97±0.14	7.56-7.86	7.72±0.15	7.58-7.62	7.6±0.03	**7-8.5**
	EC	µS / cm	1062-1128	1095±46.67	1091-1183	1132.33±46.7	960-1240	1061.7±155	810-1028	919±154.2	**NR**
	Total hardness	mg/l as $CaCO_3$	276.8-293.8	285.3±12.02	303.2-348.4	330.53±24.04	299.6-366	324.2±36.39	300.4-335.6	318±24.89	**NR**
	Alkalinity,total	mg/l as $CaCO_3$	238-266	251.8±20.08	254-272	262.67±9.02	126-243	202.47±66.3	262-301	281±27.72	**≤150**
	Chloride	mg/l as Cl^-	82.8-100.1	91.45±12.23	92-105.5	100.37±7.31	74-98	89.37±13.34	71.2-78.9	75.05±5.4	**NR**
	color	Hazen unit	10-30	20±14.14	20-40	30±10	20-40	31.33±10.26	40	40±0	**NR**
	TDS at 105 °C	mg/L	2-18	9.8±11.46	2-5	3.58±1.42	0-5	2.23±2.25	NA	NA	**≤500**
	TSS	mg/L	1.7-17.9	9.8±11.46	2-4.75	3.58±1.42	2.5-5	3.9±1.49	1.2-2.8	2±1.13	**NR**
	sulphate	mg/l as SO_4^{2-}	45.3-167.88	106.59±86.7	153.99-212.83	189.03±30.99	33.6-128.8	94.31±52.76	53.4-150.8	102±68.8	**≤200**
	phosphate	mg/l as PO_4^{3-}	0.03-0.21	0.12±0.13	0.03-0.09	0.056±0.03	0.08-0.22	0.17±0.08	0.04-0.15	0.1±0.08	**≤0.02**
	nitrate	mg/l as NO_3^-	5.7-6.32	6±0.44	29.44-32.40	30.74±1.51	21.5-26.44	23.76±2.5	12.5-20.1	16.3±10.7	**≤45**
	nitrite	mg/l as NO_2^-	0.21-0.25	0.23±0.03	1.36-1.48	1.42±0.06	0.96-253	1.54±0.87	0.39-0.61	0.5±0.16	**≤10**
	silica	mg/l as SiO_2	11.07-14.64	12.86±2.52	5.94-14.09	9.09±4.38	9.89-10.39	10.13±0.25	3.39-18.45	10.9±10.7	**NR**
	Amm.free	mg/l as NH_3	0.42-0.57	0.49±0.11	0.67-3	1.58±1.24	0.54-0.9	0.72±0.18	0.32-0.52	0.42±0.14	**≤0.5**
	Fluoride	mg/l as F^-	0.62-0.7	0.66±0.06	0.45-0.61	0.54±0.08	0.28-0.68	0.53±0.22	NA	NA	**≤0.5**
	DO	mg/l as O_2	7.7-8.7	8.2±0.71	6.7-8.1	7.3±0.72	6.2-6.9	6.41±0.43	6-7.1	6.56±0.77	**≥5**
	COD	mg/l as O_2	32-296	164±186.68	22.174.2	75±85.98	6.4-192.3	68.4±107.3	12-94	53±57.98	**≤10**
	BOD	mg/l as O2	7.66-8.2	8±0.27	2.3-2.6	2.45±0.15	3-3.2	3.1±0.1	3-3.2	3.1±0.1	**≤6**

(a):Autumn (Oct to Dec2012),Winter (Jan to March 2013), Spring (Apr to Jun2013), Summer (Jul to Sep2013)
(b): Mean ± Standard Deviation , (C):NA:Not Analyzed , (f:)ND:Not Detected
(d): EMCL: Egyptian Maximum Contaminant Limit For Raw Water, MWRI Decree 402 for 2009 , (e):NR : Not Recommended

Table 4.14: Seasonal variation of the physico-chemical characteristics in water samples of the sample site N03 in Nubaria canal:

Point	Parameters	Unit	Autumn[(a)]		winter		Spring		Summer		EMCL[(d)]
			Range	Mean±SD[(b)]	Range	Mean ±SD	Range	Mean±SD	Range	Mean ±SD	
Kheneza Bridge	Temperature	°C	22.9-23.8	23.35±0.64	17.1-17.5	17.33±0.21	21.4-24.1	22.7±1.35	25.6-28.1	27.3±1.44	**3^0above usual**
	Turbidity	NTU	4.48-24.7	14.59±14.3	6.04-10.6	8.18±2.29	2.73-12.5	7.02±4.99	3.8-6.58	5.37±1.43	**NR[(e)]**
	pH		7.38-7.98	7.68±0.42	8.13-8.21	8.16±0.04	8-8.37	8.16±0.19	7.94-8.08	7.99±0.08	**7-8.5**
	EC	µS / cm	412-422	417±7.1	389-441	422±28.69	336-379	354.7±22.1	292-328	308±18.33	**NR**
	Total hardness	mg/l as $CaCO_3$	142.1-155.6	148.9±9.5	149.4-187.4	162.3±21.8	122-153.6	139.9±16.2	126.4-134.6	130.33±4.1	**NR**
	Alkalinity,total	mg/l as $CaCO_3$	152-176	164±16.97	148-160	154.27±6.1	110-180	138.7±36.7	125-139	133.2±6.97	**≤150**
	Chloride	mg/l as Cl^-	21.7-24.5	23.1±1.98	28-35	31.5±35	16.3-40	25.77±12.6	17.4-28.1	21.37±5.86	**NR**
	color	Hazen unit	20-30	25±7.1	20-40	30±10	20-40	30±10	10-30	20±10	**NR**
	TDS at 105 °C	mg/L	2-265	133.4±186.1	4-264	90.85±150	202-233	215.3±16	175-197	184.7±11.2	**≤500**
	TSS	mg/L	1.85-11.8	6.8±7.04	2.6-4.9	3.71±1.15	1.2-5.8	3.2±2.36	1.5-2.8	2.3±0.7	**NR**
	sulphate	mg/l as SO_4^{2-}	35.9-63.96	49.9±19.9	30.6-44.31	37.82±6.9	24.71-48.67	35.32±12.2	22.98-28.43	25.7±2.7	**≤200**
	phosphate	mg/l as PO_4^{3-}	0.03-0.05	0.04±0.02	0.04-0.09	0.05±0.03	0.02-0.08	0.05±0.03	0.01-0.15	0.08±0.099	**≤0.02**
	nitrate	mg/l as NO_3-	0.76-0.79	0.78±0.02	3.59-5.53	4.5±0.97	3.38-8.95	5.44±3.1	2.48-3.56	2.92±0.57	**≤45**
	nitrite	mg/l as NO_2-	0.003-0.03	0.015±0.02	0.08-0.2	0.13±0.07	0.05-0.062	0.06±0.008	0.025-0.049	0.04±0.01	**≤10**
	silica	mg/l as SiO_2	0.95-3.61	2.28±1.89	0.22-1.39	0.68±0.62	0.32-3.86	2.34±1.82	4.11-12.77	7.11±4.9	**NR**
	Amm.free	mg/l as NH_3	0.17-0.22	0.19±0.03	0.07-0.14	0.11±0.036	0.12-0.22	0.16±0.05	0.02-0.1	0.07±0.04	**≤0.5**
	Fluoride	mg/l as F^-	0.41-0.56	0.48±0.11	0.14-0.5	0.3±0.18	0.39-0.66	0.54±0.14	NA	NA	**≤0.5**
	DO	mg/l as O_2	7-8.40	7.7±0.99	7.1-8	7.53±0.45	0.6-7.4	5.13±3.9	6.9-7.1	7.17±0.3	**≥5**
	COD	mg/l as O_2	50-442	246±277.2	12.8-62.46	31.75±26.8	3.2-24.28	10.29±12.1	3.6-62.72	23.7±33.8	**≤10**
	BOD	mg/l as O2	5.5-6.7	6±0.61	2.5-4	3±0.83	1.23-1.6	1.43±0.19	1.89-2.25	2.04±0.18	**≤6**

(a):Autumn (Oct to Dec2012),Winter (Jan to March 2013), Spring (Apr to Jun2013), Summer (Jul to Sep2013)
(b): Mean ± Standard Deviation , (C):NA:Not Analyzed , (f):ND:Not Detected
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Table 4.15: Seasonal variation of the physico-chemical characteristics in water samples of the sample site N04 in Nubaria canal:

Point	Parameters	Unit	Autumn[(a)]		winter		Spring		Summer		EMCL[(d)]
			Range	Mean±SD[(b)]	Range	Mean ±SD	Range	Mean ±SD	Range	Mean ±SD	
Rayyah El-Nasery	Temperature	°C	22.8-23.8	23.3±0.71	17.1-17.3	17.2±0.1	21.4-25.5	23.13±2.12	25.1-28.1	27.07±1.7	**3^0above usual**
	Turbidity	NTU	2.46-9.19	5.83±4.76	3.81-9.49	6±3.05	3.48-7.18	5.6±1.9	1.9-8.09	4.92±3.1	**NR[(e)]**
	pH		7.51-8	7.8±0.35	7.97-8.24	8.11±0.14	7.97-8.2	8.1±0.13	7.85-7.98	7.92±0.07	**7-8.5**
	EC	µS / cm	401-418	409.5±12	390-443	424.7±30.04	348-534	420.3±99.7	291-329	309±19.1	**NR**
	Total hardness	mg/l as $CaCO_3$	141.8-150.9	146.4±6.4	148-154.4	150.13±3.7	121.6-152	139.6±16	117.8-120.4	118.9±1.4	**NR**
	Alkalinity,total	mg/l as $CaCO_3$	154-156	154.8±1.13	148-161	155±6.56	113-152	136.9±21.1	129-143	135.4±7.01	**≤150**
	Chloride	mg/l as Cl^-	23.8-24.7	24.3±0.64	25-33	30.1±4.4	16.2-24	21.1±4.24	14.6-19.6	17.1±2.5	**NR**
	color	Hazen unit	10-20	15±7.1	10-30	20±10	20-30	25±5	15-30	21.7±7.64	**NR**
	TDS at 105 °C	mg/L	4-252	128±175.4	238-268	257.7±17.03	212-320	254±58	175-197	185.3±11.1	**≤500**
	TSS	mg/L	1-4	2.5±2.12	1.7-4.42	2.7±1.5	1.3-3.2	2.43±1	0.8-3.6	2.1±1.4	**NR**
	sulphate	mg/l asSO_4^{2-}	34.06-34.64	34.35±0.4	29.63-41.39	36.15±6	27-31.49	28.77±2.4	23.08-27.34	25.89±2.43	**≤200**
	phosphate	mg/l asPO_4^{3-}	ND[(f)]-0.05	0.05±0	0.04-0.05	0.046±0.008	0.03-0.09	0.06±0.03	ND-0.2	0.204±0	**≤0.02**
	nitrate	mg/l asNO_3-	0.75-0.76	0.752±0.006	3.99-4.12	4.05±0.06	2.75-3.19	2.98±0.22	2.53-4.52	3.42±1.01	**≤45**
	nitrite	mg/l asNO_2-	0.002-0.009	0.005±0.004	0.066-0.177	0.11±0.06	0.05-0.089	0.07±0.02	0.04-0.06	0.044±0.01	**≤10**
	silica	mg/l as SiO_2	0.85-0.93	0.89±0.05	0.15-0.65	0.34±0.28	0.4-2.58	1.32±1.12	3.55-4.56	3.95±0.54	**NR**
	Amm.free	mg/l as NH_3	0.16-0.26	0.21±0.08	0.1-0.12	0.11±0.01	0.11-0.19	0.14±0.04	0.04-0.2	0.09±0.098	**≤0.5**
	Fluoride	mg/l as F^-	0.53-0.85	0.69±0.23	0.29-0.52	0.41±0.11	0.32-0.48	0.37±0.096	NA[(c)]	NA	**≤0.5**
	DO	mg/l as O_2	7.8-8.7	8.3±0.64	7.3-8.13	7.7±0.4	0.4-7.9	5.15±4.15	6.9-7.4	7.09±0.3	**≥5**
	COD	mg/l as O_2	32-46	39±9.9	19.2-46.9	30.7±14.4	6.4-12.14	8.44±3.2	5.8-94	35.3±50.8	**≤10**
	BOD	mg/l as O2	3.8-5	4.4±0.61	2.3-3.45	2.8±0.75	ND	ND	2-3	2.45±0.5	**≤6**

(a):Autumn (Oct to Dec2012),Winter (Jan to March 2013), Spring (Apr to Jun2013), Summer (Jul to Sep2013)
(b): Mean ± Standard Deviation , (C):NA:Not Analyzed , (f):ND:Not Detected
(d): EMCL: Egyptian Maximum Contaminant Limit For Raw Water, MWRI Decree 402 for 2009 , (e):NR : Not Recommended

Table 4.16: Seasonal variation of the physico-chemical characteristics in water samples of the sample site N05 in Nubaria canal:

Point	Parameters	Unit	Autumn[(a)]		winter		Spring		Summer		EMCL[(d)]
			Range	Mean±SD[(b)]	Range	Mean ±SD	Range	Mean ±SD	Range	Mean ±SD	
Boustan Bridge	Temperature	°C	22.9-23.7	23.3 ±0.6	17.1-17.4	17.27±0.15	21.3-25.2	23.03±1.99	25.6-28.2	27.23±1.4	**3^0above usual**
	Turbidity	NTU	7.74-7.98	7.86 ±0.17	5.69-17.6	10.97±6.1	2.66-11.7	7.6±4.58	2.12-4.63	3.31±1.26	**NR[(e)]**
	pH		7.58-7.89	7.74 ±0.22	8.01-8.18	8.1±0.09	7.83-8.36	8.09±0.27	7.91-8.03	7.96±0.06	**7-8.5**
	EC	µS / cm	410-437	423.5 ±19.1	402-458	435±29.31	356-1482	740±642.7	298-337	319.3±19.8	**NR**
	Total hardness	mg/l as $CaCO_3$	137.08-141	139.04 ±3.1	151-198	167.4±26.5	127-394.8	223±149.13	118-125.4	121±3.89	**NR**
	Alkalinity,total	mg/l as $CaCO_3$	153-157	155 ±2.83	144-162	154.9±9.6	130-226	169.3±50.3	130-144	136.5±7.16	**≤150**
	Chloride	mg/l as Cl^-	24.5-24.7	24.6 ±0.14	29-35	31.9±3.01	20-117.5	53.5±55.45	14.1-18.5	16.47±2.22	**NR**
	color	Hazen unit	20	20 ±0	15-30	21.67±7.6	30	30±1	20-30	25±5	**NR**
	TDS at 105 °C	mg/L	3-265	134 ±185.3	4.5-283.4	186±157.22	214.8-889	446.2±384	179-202	191.7±11.7	**≤500**
	TSS	mg/L	3	3 ±0	2.7-8.6	5.27±3	1.2-5.5	3.5±2.2	0.9-2	1.27±0.64	**NR**
	sulphate	mg/l as SO_4^{2-}	33.4-33.5	33.4 ±0.09	32.6-49.23	40.18±8.4	25.3-33.56	29.02±4.19	24.93-29.19	27.37±2.2	**≤200**
	phosphate	mg/l as PO_4^{3-}	ND[(f)]-0.04	0.04 ±0	0.03-0.08	0.054±0.03	0.04-0.09	0.07±0.024	ND-0.08	0.08±0	**≤0.02**
	nitrate	mg/l as NO_3-	0.75-1.08	0.9 ±0.23	4.04-5.63	4.7±0.8	3.67-13.36	7.19±5.36	2.25-3.23	2.73±0.49	**≤45**
	nitrite	mg/l as NO_2-	0.005-0.03	0.016±0.015	0.08-0.239	0.13±0.09	0.052-0.216	0.11±0.09	0.035-0.47	0.18±0.25	**≤10**
	silica	mg/l as SiO_2	0.51-0.95	0.7 ±0.3	0.39-0.83	0.58±0.23	0.72-17.81	6.9±9.4	2.63-4.38	3.76±0.98	**NR**
	Amm.free	mg/l as NH_3	0.1-0.12	0.11 ±0.02	0.12-0.17	0.14±0.03	0.06-0.1	0.08±0.02	0.04-0.12	0.092±0.04	**≤0.5**
	Fluoride	mg/l as F^-	0.5-0.6	0.55 ±0.08	0.02-0.39	0.21±0.18	0.22-0.58	0.46±0.21	NA[(c)]	NA	**≤0.5**
	DO	mg/l as O_2	7.20-8.6	7.9 ±0.99	7.2-7.8	7.5±0.3	1-7.5	5.1±3.57	6.9-7.4	7.13±0.26	**≥5**
	COD	mg/l as O_2	41-56	48.5 ±10.6	12.8-31.23	22.68±9.3	9.6-39.17	19.66±16.9	10.5-94	38.4±48.18	**≤10**
	BOD	mg/l as O2	4.3-5.59	5±0.65	3-3.1	3.1±0.06	0.23-2.17	0.99±1.04	1.55-3.21	2.5±0.84	**≤6**

(a):Autumn (Oct to Dec2012),Winter (Jan to March 2013), Spring (Apr to Jun2013), Summer (Jul to Sep2013)
(b): Mean ± Standard Deviation , (C):NA:Not Analyzed , (f:)ND:Not Detected
(d): EMCL: Egyptian Maximum Contaminant Limit For Raw Water, MWRI Decree 402 for 2009 , (e):NR : Not Recommended

Table 4.17: Seasonal variation of the physico-chemical characteristics in water samples of the sample site N06 in Nubaria canal:

Point	Parameters	Unit	Autumn[(a)]		winter		Spring		Summer		EMCL[(d)]
			Range	Mean ±SD[(b)]	Range	Mean ±SD	Range	Mean ±SD	Range	Mean ±SD	
Boustan Drain	Temperature	°C	22.9-23.5	23.2±0.42	17.1-17.4	17.37±0.15	21.4-24.2	22.8±1.98	25.6-28.7	27.47±1.64	**3^0above usual**
	Turbidity	NTU	1.57-2.03	1.8±0.33	2.74-4.29	3.42±0.79	3.15-11	7.08±5.55	1.4-2.73	1.81±0.8	**NR[(e)]**
	pH		7.74-7.85	7.79±0.078	7.92-8.13	8.03±0.105	8.02-8.07	8.05±0.035	7.65	7.65±1	**7-8.5**
	EC	µS / cm	1310-1531	1420.5±156.3	1161-1800	1503.7±322	336-1623	979.5±910	1231-1596	1395±185.3	**NR**
	Total hardness	mg/l as $CaCO_3$	244-258.6	251.3±10.32	300.4-680	467.2±193.94	122.2-515.5	318.8±278	390.4-414.8	405.7±13.4	**NR**
	Alkalinity,total	mg/l as $CaCO_3$	250.5-251	250.8±0.35	196-250	222.8±27	136-250	193.1±80.5	246-263	253.6±8.65	**≤150**
	Chloride	mg/l as Cl^-	100.2-110	105.06±6.85	86.2-135	113.73±25	17.1-110	63.55±65.7	95.6-267.5	159.7±93.9	**NR**
	color	Hazen unit	20	20±0	15-30	21.67±7.63	20-27	23.5±4.95	21-30	27±5.19	**NR**
	TDS at 105 °C	mg/L	265-919.28	592.14±462.6	264-1081	758.8±434.95	202-979	590.5±549	739-958	837.3±111	**≤500**
	TSS	mg/L	0.68-0.75	0.72±0.049	0.9-2.6	1.63±0.87	1.2-5.2	3.2±2.82	0.4-0.8	0.6±0.2	**NR**
	sulphate	mg/l as SO_4^{2-}	155.32-372	263.7±163.22	38.6-481	333.3±255.25	156.4-204	180.4±34	60.82-357.7	161.3±170	**≤200**
	phosphate	mg/l as PO_4^{3-}	ND[(f)]	ND	0.03-0.04	0.04±0.007	0.09-0.1	0.09±0.008	ND-0.07	0.067±0	**≤0.02**
	nitrate	mg/l as NO_3-	2.699-3.08	2.89±0.27	5.53-16.5	12.097±5.798	2.7-17	9.85±10.11	11.37-13.6	12.2±1.22	**≤45**
	nitrite	mg/l as NO_2-	0.046-0.05	0.049±0.004	0.097-0.42	0.25±0.16	0.35-0.53	0.44±0.12	0.183-0.313	0.23±0.072	**≤10**
	silica	mg/l as SiO_2	15-16.52	15.76±1.08	0.22-17.38	9.29±8.6	0.59-11.49	6.04±7.7	15.66-16.45	16.1±0.395	**NR**
	Amm.free	mg/l as NH_3	0.24	0.24±0	0.07-0.31	0.201±0.121	0.24-0.38	0.31±0.1	0.22-0.42	0.29±0.12	**≤0.5**
	Fluoride	mg/l as F^-	1.3-1.5	1.41±0.13	0.29-1.4	0.76±0.55	0.58-1.07	0.82±0.35	NA[(c)]	NA	**≤0.5**
	DO	mg/l as O_2	7.9-8.7	8.3±0.57	7.4-8.2	7.7±0.44	0.3-7.6	3.93±5.18	6.7-7.3	6.99±0.31	**≥5**
	COD	mg/l as O_2	16.45-59.2	37.83±30.23	32-62.46	46.82±15.25	6.8-195	100.9±133	5.9-156.8	56.23±87.1	**≤10**
	BOD	mg/l as O2	3.98-5	4.32±0.58	2.36-4.6	3.3±1.16	2.36-4.6	3.3±1.16	2.36-4.6	3.3±1.16	**≤6**

(a):Autumn (Oct to Dec2012),Winter (Jan to March 2013), Spring (Apr to Jun2013), Summer (Jul to Sep2013)
(b): Mean ± Standard Deviation , (C):NA:Not Analyzed , (f):ND:Not Detected
(d): EMCL: Egyptian Maximum Contaminant Limit For Raw Water, MWRI Decree 402 for 2009 , (e):NR : Not Recommended

Table 4.18: Seasonal variation of the physico-chemical characteristics in water samples of the sample site N07 in Nubaria canal:

Point	Parameters	Unit	Autumn[(a)]		winter		Spring		Summer		EMCL[(d)]
			Range	Mean±SD[(b)]	Range	Mean ±SD	Range	Mean ±SD	Range	Mean ±SD	
EL-Abd Bridge	Temperature	°C	22.6-23.7	23.15±0.78	17.2-17.4	17.3±0.1	21.5-24.9	22.97±1.75	25.6-28.4	26.97±1.4	**3^0above usual**
	Turbidity	NTU	4.36-8.33	6.35±2.81	6.41-15.6	9.8±5.04	8.12-11.5	9.63±1.72	4.01-9.73	7.3±2.9	**NR[(e)]**
	pH		7.44-7.99	7.7±0.34	8.1-8.22	8.15±0.06	8-8.19	8.07±0.1	7.89-8.09	8.02±0.12	**7-8.5**
	EC	µS / cm	428-433	430.5±3.54	429-479	458.7±26.3	357-388	370.7±15.8	325-371	351.7±23.9	**NR**
	Total hardness	mg/l as $CaCO_3$	147.4-157	152.3±6.93	151.4-214	184.4±31.4	127-143	136.3±8.3	129.8-181	148.1±25.6	**NR**
	Alkalinity,total	mg/l as $CaCO_3$	151-156	153.6±3.68	148-162	155.9±7.25	134-154	141.8±10.7	131-144	135.7±7.51	**≤150**
	Chloride	mg/l as Cl^-	26-44.2	35.1±12.87	29.5-40.3	35.6±5.53	18-42	28±12.5	14.8-31.3	21.83±8.51	**NR**
	color	Hazen unit	20-30	25±7.1	15-40	25±13.23	23-30	27.7±4.04	20-36	28.7±8.08	**NR**
	TDS at 105 °C	mg/L	3.62-262	132.8±182.7	260-294.9	279.6±17.9	214-237	225±11.5	195-223	211±14.4	**≤500**
	TSS	mg/L	1.9-3.2	2.55±0.92	2.7-7.5	4.6±2.55	3.8-5.3	4.43±0.78	1.7-4.2	3.2±1.34	**NR**
	sulphate	mg/l asSO_4^{2-}	39-42	40.41±2.22	45-56	49.6±5.75	33-54	41±11.32	31-46	37.05±7.6	**≤200**
	phosphate	mg/l asPO_4^{3-}	0.052-0.12	0.09±0.05	ND-0.09	0.08±0.015	0.07-0.11	0.095±0.02	0.05-0.1	0.07±0.03	**≤0.02**
	nitrate	mg/l asNO_3-	0.92-1.18	1.05±0.18	4.01-5.19	4.77±0.66	3.41-8.38	5.08±2.86	2.73-4.22	3.39±0.76	**≤45**
	nitrite	mg/l asNO_2-	0.02-0.03	0.024±0.13	0.08-0.19	0.12±0.06	0.04-0.1	0.08±0.04	0.03-0.07	0.05±0.02	**≤10**
	silica	mg/l as SiO_2	0.55-5.27	2.91±3.34	0.84-1.31	1.1±0.24	0.41-4.22	1.96±2	4.34-4.86	4.5±0.3	**NR**
	Amm.free	mg/l as NH_3	0.1-0.17	0.132±0.05	0.06-0.12	0.097±0.032	0.07-0.14	0.094±0.04	0.12-0.16	0.15±0.02	**≤0.5**
	Fluoride	mg/l as F^-	0.51-0.66	0.58±0.103	ND-0.52	0.35±0.25	0.4-0.76	0.64±0.21	NA[(c)]	NA	**≤0.5**
	DO	mg/l as O_2	7.6-8.6	8.1±0.71	7.2-7.9	7.57±0.35	0.25-7.6	5.1±4.2	6.98-7.39	7.13±0.23	**≥5**
	COD	mg/l as O_2	48-57	52.5±6.36	12.16-62.5	38.87±25.3	6.4-52.26	21.82±26.4	7-62.7	25.9±31.9	**≤10**
	BOD	mg/l as O2	7.28-7.9	7.6±0.31	1.98-3	2.3±0.58	0.78-2	1.5±0.69	1.98-2.99	2.32±0.58	**≤6**

(a):Autumn (Oct to Dec2012),Winter (Jan to March 2013), Spring (Apr to Jun2013), Summer (Jul to Sep2013)
(b): Mean ± Standard Deviation , (C):NA:Not Analyzed , (f):ND:Not Detected
(d): EMCL: Egyptian Maximum Contaminant Limit For Raw Water, MWRI Decree 402 for 2009 , (e):NR : Not Recommended

Table 4.19: Seasonal variation of the physico-chemical characteristics in water samples of the sample site N08 in Nubaria canal:

Point	Parameters	Unit	Autumn[(a)]		winter		Spring		Summer		EMCL[(d)]
			Range	Mean±SD[(b)]	Range	Mean ±SD	Range	Mean ±SD	Range	Mean ±SD	
El-Umum Drain	Temperature	°C	22.6-23.8	23.2±0.85	17-17.4	17.23±0.21	21.3-24.8	22.8±1.79	26-28.5	27.17±1.26	**3^0above usual**
	Turbidity	NTU	6.44-10	8.22±2.5	2.87-29	13.15±13.9	5.99-33.5	19.06±13.8	4.39-7.87	6.17±1.7	**NR[(e)]**
	pH		7.6-8.01	7.8±0.29	8.02-8.15	8.1±0.07	7.85-8.27	8.09±0.22	7.94-8.1	8.04±0.09	**7-8.5**
	EC	µS / cm	441-494	467.5±37.5	430-468	454.3±21.13	365-403	375.7±23.9	323-365	350.7±23.9	**NR**
	Total hardness	mg/l as $CaCO_3$	146-148.3	147.2±1.63	157.2-172	162.4±8.32	123.4-201	154.4±41.1	123.6-135.8	129.7±6.1	**NR**
	Alkalinity,total	mg/l as $CaCO_3$	154-159	156.6±3.7	146-162	155.2±8.27	127-156	140.3±14.7	129-145	139.5±8.7	**≤150**
	Chloride	mg/l as Cl^-	25.7-33.4	29.6±5.44	30.5-35.4	32.9±2.45	20.4-25	23.13±2.42	14.1-29.8	20.86±8.07	**NR**
	color	Hazen unit	20	20±0	15-30	21.67±7.64	21-40	30.3±9.5	20-30	24.67±5.03	**NR**
	TDS at 105 °C	mg/L	4-8	5.9±2.41	271.5-282	278.7±6.22	215-316	258.5±52	183-219	206.7±20.5	**≤500**
	TSS	mg/L	2.8-4.2	3.5±0.99	1.35-13.9	6.22±6.73	2.6-16.5	9.1±6.98	1.8-3.6	2.63±0.91	**NR**
	sulphate	mg/l as SO_4^{2-}	46.56-70.2	58.38±16.7	43-49	45.39±3.18	36-36.24	36.1±0.12	32.54-48.83	39.4±8.44	**≤200**
	phosphate	mg/l as PO_4^{3-}	ND[(f)]-0.06	0.03±0.043	0.04-0.08	0.063±0.02	0.03-0.51	0.22±0.26	ND-0.04	0.012±0.02	**≤0.02**
	nitrate	mg/l as NO_3-	1	0.91±0.13	4.48-4.79	4.64±0.15	2.75-8.73	4.98±3.27	2.66-4.56	3.37±1.04	**≤45**
	nitrite	mg/l as NO_2-	0.002-0.03	0.02±0.019	0.08-0.13	0.112±0.03	0.02-0.43	0.18±0.22	0.04-0.08	0.05±0.025	**≤10**
	silica	mg/l as SiO_2	1.16-1.87	1.51±0.5	0.29-1.17	0.82±0.47	0.47-2.98	1.56±1.28	2.35-4.42	3.69±1.17	**NR**
	Amm.free	mg/l as NH_3	0.12-0.14	0.132±0.017	0.04-0.14	0.104±0.056	0.08-0.11	0.094±0.01	0.06-0.16	0.095±0.06	**≤0.5**
	Fluoride	mg/l as F^-	0.53-0.56	0.55±0.018	0.24-0.56	0.38±0.16	0.29-0.44	0.38±0.08	NA[(c)]	NA	**≤0.5**
	DO	mg/l as O_2	7.6-8.6	8.1±0.71	7-8	7.57±0.51	7-8	7.47±0.57	6.49-7.29	6.99±0.44	**≥5**
	COD	mg/l as O_2	40-56	48±11.3	12.2-39.04	29.067±14.72	6.2-24.28	12.29±10.4	6.6-31.36	14.92±14.2	**≤10**
	BOD	mg/l as O2	4.3-5.59	5±0.65	2.3-3.45	2.8±0.58	0.23-2.17	0.98±1.03	1.23-3.5	2±1.23	**≤6**

(a):Autumn (Oct to Dec2012),Winter (Jan to March 2013), Spring (Apr to Jun2013), Summer (Jul to Sep2013)
(b): Mean ± Standard Deviation , (C):NA:Not Analyzed , (f):ND:Not Detected
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Table 4.20: Seasonal variation of the physico-chemical characteristics in water samples of the sample site N09 in Nubaria canal:

Point	Parameters	Unit	Autumn[(a)]		winter		Spring		Summer		EMCL[(d)]
			Range	Mean±SD[(b)]	Range	Mean ±SD	Range	Mean ±SD	Range	Mean ±SD	
El-Moudir Bridge	Temperature	°C	22.7-23.6	23.15±0.64	16.9-17.4	17.2±0.26	21.4-24.7	22.87±1.68	25.5-28.5	27±1.5	**3^0above usual**
	Turbidity	NTU	4.63-19.8	12.22±10.73	7.39-14.1	11.83±3.85	4.34-14.9	9.44±5.29	4.74-5.27	5.03±0.27	**NR[(e)]**
	pH		7.54-7.98	7.76±0.31	8.08-8.13	8.1±0.026	7.97-8.13	8.04±0.083	7.9-8.13	7.98±0.13	**7-8.5**
	EC	µS / cm	429-446	437.5±12.02	454-463	457.3±4.93	358-410	376±29.46	309-357	330±24.56	**NR**
	Total hardness	mg/l as $CaCO_3$	147.2-149	147.95±1.06	149.2-180	160.3±17.1	129-153.6	138.4±13.3	121.4-129.8	125.2±4.26	**NR**
	Alkalinity,total	mg/l as $CaCO_3$	150-163	156.6±9.33	140-163	152.7±11.44	125-154	139.7±14.4	130-140	136.1±5.03	**≤150**
	Chloride	mg/l as Cl^-	25.5-25.8	25.65±0.21	31-35.4	33.2±2.2	17.4-24	21.47±3.56	13.9-20.1	17.7±3.33	**NR**
	color	Hazen unit	20	20±0	15-40	28.3±12.58	24-40	31.33±8.08	17-30	25.7±7.51	**NR**
	TDS at 105 °C	mg/L	257-268	262.5±7.78	272-278	274.3±3.21	215-246	225.7±17.6	185-214	197.7±14.8	**≤500**
	TSS	mg/L	1.8-9	5.4±5.09	3.46-7.05	5.74±1.98	1.8-6.9	4.3±2.55	1.8-2.5	2.1±0.36	**NR**
	sulphate	mg/l as SO_4^{2-}	42.5-47.05	44.79±3.19	48.84-93.42	64.31±25.2	31.25-37.94	33.48±3.86	32.3-37.62	34.6±2.73	**≤200**
	phosphate	mg/l as PO_4^{3-}	ND-0.06	0.029±0.04	0.06-0.09	0.07±0.018	0.05-0.09	0.071±0.02	ND-0.06	0.018±0.03	**≤0.02**
	nitrate	mg/l as NO_3-	0.92-1.09	1±0.123	4.04-4.84	4.5±0.41	3.48-3.75	3.59±0.14	2.73-3.13	2.98±0.22	**≤45**
	nitrite	mg/l as NO_2-	0.01-0.02	0.014±0.004	0.06-0.18	0.105±0.07	0.03-0.08	0.055±0.03	0.04-0.08	0.06±0.024	**≤10**
	silica	mg/l as SiO_2	1.08-3.46	2.27±1.68	0.27-1.03	0.525±0.44	1.77-13.62	6.01±6.6	2.49-4.24	3.43±0.88	**NR**
	Amm.free	mg/l as NH_3	0.07-1.92	0.996±1.31	0.06-0.18	0.12±0.06	0.12-0.16	0.134±0.02	0.06-0.42	0.18±0.2	**≤0.5**
	Fluoride	mg/l as F^-	0.4-0.82	0.61±0.298	0.1-0.39	0.205±0.16	0.19-0.62	0.44±0.22	NA[(c)]	NA	**≤0.5**
	DO	mg/l as O_2	7.9-8.6	8.25±0.49	7-8	7.5±0.5	7.6-7.17	7.5±0.32	6.2-7.48	6.93±0.66	**≥5**
	COD	mg/l as O_2	16.2-96	56.1±65.43	15.2-20	16.94±2.66	12.8-89.05	38.35±43.9	12.6-62.72	29.37±28.9	**≤10**
	BOD	mg/l as O2	7.28-8	7.61±0.37	1.98-3	2.3±0.58	2.36-2.75	2.52±0.2	2.36-2.75	2.51±0.2	**≤6**

(a):Autumn (Oct to Dec2012),Winter (Jan to March 2013), Spring (Apr to Jun2013), Summer (Jul to Sep2013)
(b): Mean ± Standard Deviation , (C):NA:Not Analyzed , (f):ND:Not Detected
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Table 4.21: Seasonal variation of the physico-chemical characteristics in water samples of the sample site N10 in Nubaria canal:

Point	Parameters	Unit	Autumn[(a)]		winter		Spring		Summer		EMCL[(d)]
			Range	Mean±SD[(b)]	Range	Mean ±SD	Range	Mean ±SD	Range	Mean ±SD	
Drain No.3	Temperature	°C	22.8-23.2	23±0.28	16.9-17.3	17.1±0.28	21.4-24.7	22.9±1.68	25.5-28	26.8±1.25	**3^0above usual**
	Turbidity	NTU	6.78-12.1	9.44±3.76	11.4-14.5	12.95±2.19	2.67-12.9	8.69±5.35	5.59-10.1	7.29±2.5	**NR[(e)]**
	pH		7.46-7.75	7.61±0.21	7.83-7.94	7.89±0.08	7.76-7.92	7.8±0.08	7.87-7.99	7.9±0.06	**7-8.5**
	EC	µS / cm	2050-2056	2053±4.2	1977-2320	2148.5±242.5	2160-2986	2657.7±438	594-2043	1512±798.3	**NR**
	Total hardness	mg/l as $CaCO_3$	318.6-432	375.4±80.26	284-302	293±12.73	467-1962	1006±830.1	125.2-347	269.07±125	**NR**
	Alkalinity,total	mg/l as $CaCO_3$	269-280	274.5±7.78	245-251	247.9±4.17	172-284	235.9±57.6	142-287	221.5±73.6	**≤150**
	Chloride	mg/l as Cl^-	311.5-337	324.1±17.82	32.5-350	191.3±224.5	324.8-510	419.9±92.7	58.4-699	377.5±320	**NR**
	color	Hazen unit	20-60	40±28.28	30	30±0	40-95	58.3±31.8	25-30	25±5.03	**NR**
	TDS at 105 °C	mg/L	1230-1234	1232±2.8	1186-1392	1289±145.7	1296-1792	1594.7±263	356-1226	907±479.16	**≤500**
	TSS	mg/L	2.9-5.2	4.05±1.63	5.5-7.25	6.38±1.24	1.2-6	4.03±2.5	2.2-2.8	3.07±1.03	**NR**
	sulphate	mg/l as SO_4^{2-}	36.5-382.7	209.6±244.8	365-423.8	394.4±41.6	20.26-453.7	238.5±217	61.83-253.4	131.8±106	**≤200**
	phosphate	mg/l as PO_4^{3-}	0.04-0.98	0.51±0.67	0.09	0.088±0.003	0.22-0.8	0.52±0.29	0.21-0.26	0.16±0.14	**≤0.02**
	nitrate	mg/l as NO_3-	2.28-4.58	3.43±1.6	23.12-23.4	23.24±0.17	11.58-17.9	14.6±3.16	4.46-23.4	15.24±9.7	**≤45**
	nitrite	mg/l as NO_2-	0.13-0.45	0.29±0.22	0.76-0.8	0.78±0.03	0.15-0.53	0.35±0.19	0.14-1.44	0.84±0.65	**≤10**
	silica	mg/l as SiO_2	10.63-13.4	12.02±1.97	5.57-10.4	7.98±3.4	2.31-7.04	5.14±2.5	5.64-12.85	8.5±3.8	**NR**
	Amm.free	mg/l as NH_3	0.3-4.8	2.5±3.21	1.08-2.55	1.82±1.04	0.22-2.58	1.7±1.3	0.18-1.8	1.02±0.81	**≤0.5**
	Fluoride	mg/l as F^-	1.28-1.89	1.59±0.42	1.52	1.52±0.002	1.18-1.63	1.4±0.23	NA[(c)]	NA	**≤0.5**
	DO	mg/l as O_2	6.1-7.8	6.95±1.2	6.8-6.9	6.85±0.07	3.6-7.8	5.8±2.11	6.69-7.31	7±0.31	**≥5**
	COD	mg/l as O_2	82-336	209±179.6	24.3-154.2	89.3±91.9	38-161.92	80±70.97	32-470	178.7±252	**≤10**
	BOD	mg/l as O2	4.9-6	5.5±0.64	1.98-3.5	2.5±0.87	2.56-3.9	3.15±0.68	3.56-4.9	4.1±0.69	**≤6**

(a):Autumn (Oct to Dec2012),Winter (Jan to March 2013), Spring (Apr to Jun2013), Summer (Jul to Sep2013)
(b): Mean ± Standard Deviation , (C):NA:Not Analyzed , (f):ND:Not Detected
(d): EMCL: Egyptian Maximum Contaminant Limit For Raw Water, MWRI Decree 402 for 2009 , (e):NR : Not Recommended

Table 4.22: Seasonal variation of the physico-chemical characteristics in water samples of the sample site N11 in Nubaria canal:

Point	Parameters	Unit	Autumn[(a)]		winter		Spring		Summer		EMCL[(d)]
			Range	Mean±SD[(b)]	Range	Mean ±SD	Range	Mean ±SD	Range	Mean ±SD	
Drain No.1	Temperature	°C	22.9-23.5	23.2±0.42	16.9-17.4	17.15±0.35	21.5-25.1	23.03±1.86	25.1-28	26.4±1.46	**3^0above usual**
	Turbidity	NTU	3.8-8.93	6.37±3.63	5.44-9.3	7.37±2.73	6.23-12.3	8.81±3.14	4.03-10.8	7.7±3.4	**NR[(e)]**
	pH		7.56-7.8	7.68±0.17	7.99-8.14	8.07±0.11	7.76-7.99	7.91±0.13	7.99-8.15	8.05±0.09	**7-8.5**
	EC	µS / cm	933-950	941.5±12.02	1849-2280	2064.5±304.8	447-2850	1401±1275	472-2800	1273±1323	**NR**
	Total hardness	mg/l as $CaCO_3$	196.2-378	287.1±128.6	369-560	464.5±135.06	145-352	237.3±105	139-142.8	141.2±2.12	**NR**
	Alkalinity,total	mg/l as $CaCO_3$	181-210	195.6±20.65	217-235	226.2±12.45	166-326	220.1±249	150-266	189.2±66.2	**≤150**
	Chloride	mg/l as Cl^-	99.6-171.2	135.4±50.63	32.3-245	138.7±150.4	36-491	205.7±248.6	49.8-451	185.9±229.6	**NR**
	color	Hazen unit	20-40	30±14.14	20-40	30±14.14	30-40	36.7±5.77	30-40	33.3±5.77	**NR**
	TDS at 105 °C	mg/L	560-570	565±7.07	1109-1368	1238.5±183.1	544-1710	946.7±661.4	283-1680	763.7±793.9	**≤500**
	TSS	mg/L	1-4	2.5±2.12	2.72-4.4	3.56±1.19	1.6-3.4	2.6±0.92	1.6-5	3.4±1.71	**NR**
	sulphate	mg/l asSO_4^{2-}	37.6-162.3	99.98±88.18	268.3-374	320.9±74.51	39.6-144.7	97.8±53.45	55.89-70.6	63.87±7.42	**≤200**
	phosphate	mg/l asPO_4^{3-}	0.05-0.29	0.17±0.17	0.03-0.05	0.038±0.01	0.09-1.04	0.429±0.5	ND-0.1	0.033±0.06	**≤0.02**
	nitrate	mg/l asNO_3-	1.58-1.91	1.75±0.23	18.5-227.8	123.14±147.9	7.15-14.1	9.78±3.77	3.15-18.51	8.6±8.59	**≤45**
	nitrite	mg/l asNO_2-	0.01-0.11	0.06±0.07	0.16-0.22	0.19±0.04	0.06-0.18	0.11±0.06	0.1-1.5	0.59±0.79	**≤10**
	silica	mg/l as SiO_2	4.5-5.82	5.16±0.94	5.1-6.89	5.99±1.27	1.37-10.69	4.79±5.1	1.77-10.88	6.64±4.59	**NR**
	Amm.free	mg/l as NH_3	0.48-0.51	0.49±0.02	0.12-0.17	0.144±0.03	0.34-4.2	1.71±2.16	0.16-0.72	0.35±0.32	**≤0.5**
	Fluoride	mg/l as F^-	0.88-1.36	1.12±0.34	1.58-1.59	1.58±0.004	0.9-1.08	0.97±0.1	NA[(c)]	NA	**≤0.5**
	DO	mg/l as O_2	6.3-8	7.15±1.2	7.4-7.6	7.5±0.14	6.7-7.17	7.19±0.5	6.49-7.48	7.03±0.5	**≥5**
	COD	mg/l as O_2	49-144	96.5±67.18	27.4-115.7	71.5±62.5	3.2-40.48	25.23±19.54	28-94.08	50.69±37.59	**≤10**
	BOD	mg/l as O2	4.2-4.5	4.39±0.15	1.98-3	2.3±0.58	0.99-2.1	1.7±0.61	2.99-3.23	3±0.12	**≤6**

(a):Autumn (Oct to Dec2012),Winter (Jan to March 2013), Spring (Apr to Jun2013), Summer (Jul to Sep2013)
(b): Mean ± Standard Deviation , (C):NA:Not Analyzed , (f):ND:Not Detected
(d): EMCL: Egyptian Maximum Contaminant Limit For Raw Water, MWRI Decree 402 for 2009 , (e):NR : Not Recommended

Table 4.23: Seasonal variation of the physico-chemical characteristics in water samples of the sample site N12 in Nubaria canal:

Point	Parameters	Unit	Autumn[(a)]		winter		Spring		Summer		EMCL[(d)]
			Range	Mean±SD[(b)]	Range	Mean ±SD	Range	Mean ±SD	Range	Mean ±SD	
Janaclis Bridge	Temperature	°C	22.7-23.1	22.9±0.28	16.9-17.4	17.2±0.29	21.3-25.2	23±1.99	25.4-28	26.7±1.3	**3^0above usual**
	Turbidity	NTU	4.13-7.72	5.9±2.54	3.96-13.4	9.65±5.01	9.11-12.3	10.5±1.63	2.03-24.8	10.46±12.5	**NR[(e)]**
	pH		7.67-8.03	7.85±0.25	7.96-8.11	8.03±0.08	7.98-8.12	8.06±0.07	7.84-8.22	8.01±0.19	**7-8.5**
	EC	µS / cm	522-525	523.5±2.12	559-577	565.3±10.12	441-506	464.7±35.9	371-414	390±21.9	**NR**
	Total hardness	mg/l as $CaCO_3$	153.4-160	156.5±4.31	156.6-172	163.3±7.88	133.2-150	142.7±8.63	124-326	194.3±114	**NR**
	Alkalinity,total	mg/l as $CaCO_3$	157-169	162.8±8.49	156-168	164±6.61	142-168	153.3±13.3	136-146	142.3±5.56	**≤150**
	Chloride	mg/l as Cl^-	41.3-45.3	43.3±2.83	47-52.8	49.9±2.9	32.8-38	35.6±2.6	24.4-28.6	28.4±3.9	**NR**
	color	Hazen unit	20-30	25±7.07	30-40	33.3±5.77	30-35	31.7±2.89	25-50	35±13.23	**NR**
	TDS at 105 °C	mg/L	313-315	314±1.4	335-346	339±6.08	265-304	279±21.7	223-248	234±12.77	**≤500**
	TSS	mg/L	1.6-2.9	2.25±0.92	1.8-6.7	4.67±2.55	4.2-5.8	4.9±0.82	0.8-12	4.9±6.19	**NR**
	sulphate	mg/l asSO_4^{2-}	64.5-66.6	65.5±1.49	65.02-72.7	69.98±4.3	46.51-59.02	51.4±6.7	46.6-57.01	50.26±5.9	**≤200**
	phosphate	mg/l asPO_4^{3-}	ND[(f)]-0.06	0.06±0	0.05-0.07	0.06±0.01	0.03-0.12	0.08±0.04	0.13-0.19	0.16±0.03	**≤0.02**
	nitrate	mg/l asNO_3-	1.16-1.21	1.18±0.04	6.06-6.42	6.21±0.19	4.27-8.37	6.23±2.06	4.58-5.3	5.06±0.41	**≤45**
	nitrite	mg/l asNO_2-	0.02-0.04	0.028±0.014	0.14-0.26	0.21±0.07	0.04-0.16	0.12±0.07	0.05-0.11	0.075±0.04	**≤10**
	silica	mg/l as SiO_2	1.4-2.5	1.95±0.78	0.47-1.54	0.9±0.565	0.78-2.9	1.86±1.06	2.94-5.29	4.44±1.31	**NR**
	Amm.free	mg/l as NH_3	0.17-0.24	0.204±0.05	0.16-0.42	0.26±0.14	0.19-1.68	0.69±0.86	0.04-0.88	0.36±0.45	**≤0.5**
	Fluoride	mg/l as F^-	0.19-0.86	0.53±0.48	0.35-0.5	0.39±0.09	0.36-0.74	0.51±0.203	NA[(c)]	NA	**≤0.5**
	DO	mg/l as O_2	7.5-8.5	8±0.71	6.9-8.1	7.4±0.6	7.08-7.7	7.43±0.32	7.08-7.58	7.26±0.28	**≥5**
	COD	mg/l as O_2	24-32	28±5.66	12.2-23.14	19.48±6.3	6.5-13.2	10.8±3.76	14-94.08	41.36±45.7	**≤10**
	BOD	mg/l as O2	4.5-4.7	4.5±0.12	1.57-2.4	1.95±0.42	0.59-1.7	1.02±0.59	2.99-3.2	3.09±0.11	**≤6**

(a):Autumn (Oct to Dec2012),Winter (Jan to March 2013), Spring (Apr to Jun2013), Summer (Jul to Sep2013)
(b): Mean ± Standard Deviation , (C):NA:Not Analyzed , (f):ND:Not Detected
(d): EMCL: Egyptian Maximum Contaminant Limit For Raw Water, MWRI Decree 402 for 2009 , (e):NR : Not Recommended

Table 4.24: Seasonal variation of the physico-chemical characteristics in water samples of the sample site N13 in Nubaria canal:

Point	Parameters	Unit	Autumn[(a)]		winter		Spring		Summer		EMCL[(d)]
			Range	Mean±SD[(b)]	Range	Mean ±SD	Range	Mean ±SD	Range	Mean ±SD	
Nubaria WTP Intake	Temperature	°C	22.6-23.4	23±0.57	17-17.4	17.3±0.23	21.4-25.3	23.9±2.17	25.4-28.1	36.8±1.36	**3^0above usual**
	Turbidity	NTU	3.46-13.3	8.38±6.96	7.67-39.5	18.75±17.97	8.98-10.6	9.99±0.88	3.47-12.1	7.67±4.31	**NR[(e)]**
	pH		7.53-8	7.77±0.33	8.03-8.13	8.07±0.05	7.96-8.26	8.14±0.16	8.04-8.28	8.16±0.12	**7-8.5**
	EC	µS / cm	553-578	565.7±17.68	590-722	634.7±75.64	460-592	516.7±67.9	389-451	419±31.05	**NR**
	Total hardness	mg/l as $CaCO_3$	156.3-159	157.5±1.63	158.8-224	182.6±35.99	134.8-178.8	154.9±22.3	130.6-141.6	135.4±5.63	**NR**
	Alkalinity,total	mg/l as $CaCO_3$	158-162	160.1±2.97	160-170	164.7±5.19	146-282	196.7±74.5	134-147	140.4±6.3	**≤150**
	Chloride	mg/l as Cl^-	41.2-46.5	43.85±3.75	52.1-74	59.6±12.47	32.8-51	41.3±9.17	27.4-39.9	33.8±6.26	**NR**
	color	Hazen unit	20	20±0	30-40	33.3±5.77	30-35	31.7±2.89	25-30	28.3±2.89	**NR**
	TDS at 105 °C	mg/L	332-347	339.5±10.6	433-455	380.7±45.3	276-355	310±40.6	233-271	251.3±19	**≤500**
	TSS	mg/L	1.2-5.4	3.3±2.97	3.8-19.4	9.13±8.89	4-5	4.67±0.58	1.4-5.8	3.47±2.21	**NR**
	sulphate	mg/l asSO_4^{2-}	64.4-70.3	67.32±4.18	70.8-120.5	91.3±25.92	59.19-75.7	65.12±9.15	52.8-79.7	63.9±14.03	**≤200**
	phosphate	mg/l asPO_4^{3-}	ND[(f)]-0.1	0.048±0.068	0.05-0.13	0.08±0.04	0.04-0.22	0.103±0.1	ND-0.05	0.02±0.03	**≤0.02**
	nitrate	mg/l asNO_3-	1.08-1.23	1.15±0.11	6.55-7.34	7.03±0.42	4.09-8.58	6.12±2.28	3.55-4.11	3.84±0.28	**≤45**
	nitrite	mg/l asNO_2-	0.02-0.04	0.028±0.01	0.13-0.35	0.21±0.12	0.06-0.14	0.1±0.04	0.06-0.07	0.06±0.008	**≤10**
	silica	mg/l as SiO_2	0.89-1.07	0.98±0.13	0.51-1.62	0.99±0.57	0.64-2.57	1.57±0.96	1.77-4.01	3.23±1.26	**NR**
	Amm.free	mg/l as NH_3	0.13-0.22	0.17±0.059	0.12-0.19	0.16±0.04	0.05-0.24	0.14±0.096	0.04-0.28	0.16±0.12	**≤0.5**
	Fluoride	mg/l as F^-	0.47-0.53	0.49±0.04	0.41-0.87	0.57±0.26	0.45-1.06	0.71±0.32	NA[(c)]	NA	**≤0.5**
	DO	mg/l as O_2	7.7-8.6	8.15±0.64	7.1-7.9	7.5±0.4	7.1-7.6	7.35±0.25	7.01-7.48	7.23±0.24	**≥5**
	COD	mg/l as O_2	24-54	39±21.21	9.12-26	16.85±8.53	8.4-64.8	27.72±32.1	12-31.36	19.12±10.7	**≤10**
	BOD	mg/l as O2	1.89-3.94	2.95±1.03	1-2.3	1.8±0.75	1.2-2.3	1.89±0.64	2.4-2.6	2.5±0.1	**≤6**

(a):Autumn (Oct to Dec2012),Winter (Jan to March 2013), Spring (Apr to Jun2013), Summer (Jul to Sep2013)
(b): Mean ± Standard Deviation , (C):NA:Not Analyzed , (f):ND:Not Detected
(d): EMCL: Egyptian Maximum Contaminant Limit For Raw Water, MWRI Decree 402 for 2009 , (e):NR : Not Recommended

Table 4.25: Seasonal variation of the physico-chemical characteristics in water samples of the sample site N14 in Nubaria canal:

Point	Parameters	Unit	Autumn[(a)]		winter		Spring		Summer		EMCL[(d)]
			Range	Mean±SD[(b)]	Range	Mean ±SD	Range	Mean ±SD	Range	Mean ±SD	
K40 WTP Intake	Temperature	°C	22.8-23.1	22.95±0.21	17-17.4	17.27±0.23	21.4-25.1	22.97±1.9	25.3-28.1	26.8±1.4	**3^0above usual**
	Turbidity	NTU	12.1-25.9	19±9.76	17.1-20.4	18.77±1.65	14.6-88.9	40.67±41.8	5.04-23.8	13.6±9.48	**NR[(e)]**
	pH		7.95-7.96	7.96±0.007	8-8.1	8.06±0.06	7.97-8.14	8.07±0.09	8.1-8.18	8.14±0.04	**7-8.5**
	EC	µS / cm	639-673	656±24.04	673-686	679±6.51	574-628	592.7±30.6	414-504	469±48.22	**NR**
	Total hardness	mg/l as $CaCO_3$	163.4-172	167.9±6.36	167.6-208	184.4±21.04	155.8-180.9	164.2±14.5	137.6-145.6	142.4±4.2	**NR**
	Alkalinity,total	mg/l as $CaCO_3$	158-166	161.8±5.37	146-172	163.07±14.78	146-160	151.3±7.6	138-148	143.2±5.2	**≤150**
	Chloride	mg/l as Cl^-	53.2-63.1	58.2±7	64-68.3	66.37±2.18	53.3-58	55.1±2.54	36.9-41.6	39.47±2.38	**NR**
	color	Hazen unit	30	30±0	15-50	31.67±17.56	30-40	36.7±5.77	30-40	33.3±5.77	**NR**
	TDS at 105 °C	mg/L	384-404	394±14.14	404-412	407.7±4.04	344-377	355.7±18.5	248-302	281±28.9	**≤500**
	TSS	mg/L	5.6-12	8.8±4.53	8.55-10	9.22±0.73	6.8-43	19.6±20.3	2-11.4	6.2±4.78	**NR**
	sulphate	mg/l as SO_4^{2-}	93.5-99.7	96.59±4.4	89.8-123	103.7±17.28	66.7-84.6	77.84±9.7	50.08-74.08	59.9±12.57	**≤200**
	phosphate	mg/l as PO_4^{3-}	ND[(f)]-0.08	0.04±0.059	0.05-0.1	0.07±0.027	0.08-0.17	0.11±0.05	0-0.05	0.026±0.03	**≤0.02**
	nitrate	mg/l as NO_3-	1.3-1.35	1.32±0.04	6.15-7.24	6.65±0.55	7.83-7.59	6.58±1.5	4.14-5.51	4.77±0.69	**≤45**
	nitrite	mg/l as NO_2-	0.02-0.1	0.06±0.054	0.17-0.24	0.19±0.039	0.11-0.17	0.14±0.03	0.08-0.1	0.09±0.006	**≤10**
	silica	mg/l as SiO_2	1.1-1.3	1.2±0.16	0.5-1.1	0.82±0.31	0.4-3.4	1.55±1.66	1.7-11.7	5.49±5.38	**NR**
	Amm.free	mg/l as NH_3	0.12-0.16	0.14±0.025	0.22-0.28	0.24±0.035	0.12-0.19	0.16±0.036	0.08-0.32	0.19±0.12	**≤0.5**
	Fluoride	mg/l as F^-	0.4-0.46	0.43±0.04	0.25-0.6	0.43±0.17	0.52-1.27	0.92±0.38	NA[(c)]	NA	**≤0.5**
	DO	mg/l as O_2	7.5-8.8	8.15±0.92	7.2-7.8	7.4±0.32	6.9-7.6	7.2±0.35	6.69-7.58	7.46±0.45	**≥5**
	COD	mg/l as O_2	48-58	53±7.07	12.16-40	30.24±15.67	9.6-64.8	28.2±31.7	10.2-94.08	38.3±48.31	**≤10**
	BOD	mg/l as O_2	7-8.3	7.7±0.68	2.3-3.45	2.8±0.58	1.8-2.1	1.99±0.17	2.4-2.6	2.5±0.1	**≤6**

(a):Autumn (Oct to Dec2012),Winter (Jan to March 2013), Spring (Apr to Jun2013), Summer (Jul to Sep2013)
(b): Mean ± Standard Deviation , (C):NA:Not Analyzed , (f):ND:Not Detected
(d): EMCL: Egyptian Maximum Contaminant Limit For Raw Water, MWRI Decree 402 for 2009 , (e):NR : Not Recommended

Table 4.26: Seasonal variation of heavy metals concentrations in water samples of the sample site H01 Mahmoudia Canal:

Point	Element	Symbol	Autumn[a]		winter		Spring		Summer		EMCL[d]
			Range	Mean±SD[b]	Range	Mean±SD	Range	Mean±SD	Range	Mean±SD	
Mahmoudia Canal	Aluminium	Al	0.292-0.39	0.341±0.0693	0.1499-0.1573	0.1536±0.0052	0.033-0.043	0.038±0.0071	0.047-0.056	0.0515±0.0064	**NR[e]**
	Cadmium	Cd	ND-0.006	0.003±0.0042	0.0023-0.0027	0.0025±0.0003	0.004-0.005	0.0045±0.0007	0.001-0.003	0.002±0.0014	**≤0.003**
	Cobalt	Co	0.0012-0.005	0.0031±0.0027	0.0025-0.0028	0.0027±0.0002	0.003	0.003±0	0.003-0.007	0.005±0.0028	**NR**
	Copper	Cu	0.0073-0.011	0.0092±0.0026	0.0054-0.0056	0.0055±0.0001	0.001-0.003	0.002±0.0014	ND[f]	ND	**≤1**
	Iron	Fe	0.4176-6.6	3.5088±4.372	0.2435-0.2654	0.2545±0.0155	0.068-0.073	0.0705±0.0035	0.022-0.034	0.028±0.0085	**≤0.05**
	Manganese	Mn	0.038-0.088	0.063±0.0354	0.0543-0.0693	0.0618±0.0106	0.086-0.087	0.0865±0.0007	0.021-0.033	0.027±0.0085	**NR**
	Nickel	Ni	0.079-0.1248	0.1019±0.0324	0.0336-0.0421	0.0379±0.006	0.003-0.016	0.0095±0.0092	ND-0.003	0.0015±0.0021	**≤0.02**
	Lead	Pb	0.0041-0.006	0.0051±0.0013	0.0039-0.0042	0.0041±0.0002	0.002-0.003	0.0023±0.0011	0.004-0.005	0.0045±0.0007	**≤0.001**
	Zinc	Zn	0.0248-0.997	0.5109±0.6875	ND-0.0006	0.0003±0.0004	0.011-0.025	0.018±0.0099	0.006-0.012	0.009±0.0042	**≤1**

(a):Autumn (Oct to Dec2012),Winter (Jan to March 2013), Spring (Apr to Jun2013), Summer (Jul to Sep2013)
(b): Mean ± Standard Deviation, (C): NA: Not Analyzed, (f): ND: Not Detected
(d): EMCL: Egyptian Maximum Contaminant Limit for Raw Water, MWRI Decree 402 for 2009, (e): NR: Not Recommended

Table 4.27: Seasonal variation of heavy metals concentrations in water samples of the sample site H02 Mahmoudia Canal:

Point	Element	Symbol	Autumn[a]		winter		Spring		Summer		EMCL[d]
			Range	Mean±SD[b]	Range	Mean±SD	Range	Mean±SD	Range	Mean±SD	
Zarkon Drain	Aluminium	Al	0.2961-0.415	0.3556±0.0841	0.1984-0.2113	0.2049±0.0091	0.013-0.052	0.0325±0.0276	0.063-0.093	0.078±0.0212	**NR[e]**
	Cadmium	Cd	ND-0.006	0.003±0.0042	0.0028-0.0035	0.0032±0.0005	0.004-0.005	0.0045±0.0007	0.001-0.003	0.002±0.0014	**≤0.003**
	Cobalt	Co	0.0011-0.004	0.0026±0.0021	0.0028-0.0291	0.0159±0.0186	0.003-0.006	0.0045±0.0021	0.003-0.006	0.0045±0.0021	**NR**
	Copper	Cu	0.0071-0.009	0.0081±0.0013	0.0062-0.0071	0.0067±0.0006	ND-0.003	0.0015±0.0021	ND[f]-0.001	0.0005±0.0007	**≤1**
	Iron	Fe	0.3738-0.479	0.4264±0.0744	0.3061-0.4231	0.3646±0.0827	0.054-0.081	0.0675±0.0191	ND-0.103	0.0515±0.0728	**≤0.05**
	Manganese	Mn	0.0252-0.09	0.0576±0.0458	0.0874-0.0916	0.0895±0.0029	0.055-0.101	0.078±0.0325	0.008±0.017	0.0125±0.0064	**NR**
	Nickel	Ni	0.0473-0.053	0.0502±0.004	0.0311-0.0327	0.0319±0.0011	ND-0.001	0.0005±0.0007	ND-0.005	0.0025±0.0035	**≤0.02**
	Lead	Pb	0.0035-0.005	0.0043±0.0011	0.0048-0.005	0.0049±0.0001	0.002-0.004	0.003±0.0014	0.004-0.007	0.0055±0.0021	**≤0.001**
	Zinc	Zn	0.0058-0.015	0.0104±0.0065	0.0087-0.0092	0.0089±0.0004	0.006-0.023	0.0145±0.012	0.018-0.026	0.022±0.0057	**≤1**

(a):Autumn (Oct to Dec2012),Winter (Jan to March 2013), Spring (Apr to Jun2013), Summer (Jul to Sep2013)
(b): Mean ± Standard Deviation, (C): NA: Not Analyzed, (f): ND: Not Detected
(d): EMCL: Egyptian Maximum Contaminant Limit for Raw Water, MWRI Decree 402 for 2009, (e): NR: Not Recommended

Table 4.28: Seasonal variation of heavy metals concentrations in water samples of the sample site H03 Mahmoudia Canal:

Point	Element	Symbol	Autumn[(a)]		winter		Spring		Summer		EMCL[(d)]
			Range	Mean±SD[(b)]	Range	Mean±SD	Range	Mean±SD	Range	Mean±SD	
Zarkon	Aluminium	Al	0.368-0.4354	0.4017±0.0477	0.1995-0.2513	0.2254±0.0366	0.027-0.045	0.036±0.0127	0.042-0.049	0.0455±0.0049	**NR[(e)]**
	Cadmium	Cd	ND-0.006	0.003±0.0042	0.0027-0.0036	0.0032±0.0006	0.004-0.005	0.0045±0.0007	0.001-0.003	0.002±0.0014	**≤0.003**
	Cobalt	Co	0.0016-0.004	0.0028±0.0017	0.0024-0.0026	0.0025±0.0001	0.002-0.003	0.0025±0.0007	0.003-0.007	0.005±0.0028	**NR**
	Copper	Cu	0.0078-0.008	0.0079±0.0001	0.0056-0.0063	0.0059±0.0005	0.001-0.002	0.0015±0.0007	ND[(f)]	ND	**≤1**
	Iron	Fe	0.437-0.5978	0.5174±0.1137	0.2599-0.373	0.3165±0.0799	0.052-0.081	0.0665±0.0205	0.029-0.031	0.03±0.0014	**≤0.05**
	Manganese	Mn	0.0422-0.058	0.0501±0.0112	0.0547-0.0674	0.0611±0.0089	0.081-0.103	0.092±0.0156	0.011-0.03	0.0205±0.0134	**NR**
	Nickel	Ni	0.064-0.0763	0.0702±0.0087	0.0511-0.0531	0.0521±0.0014	ND-0.004	0.002±0.0028	ND-0.02	0.001±0.0014	**≤0.02**
	Lead	Pb	0.004-0.0045	0.0043±0.0004	0.0039-0.0041	0.004±0.0001	0.003-0.005	0.004±0.0014	0.004-0.005	0.0045±0.0007	**≤0.001**
	Zinc	Zn	0.014-0.0173	0.0157±0.0023	0.0003-0.0006	0.0005±0.0002	0.006-0.018	0.012±0.0085	ND-0.012	0.006±0.0085	**≤1**

(a):Autumn (Oct to Dec2012),Winter (Jan to March 2013), Spring (Apr to Jun2013), Summer (Jul to Sep2013)
(b): Mean ± Standard Deviation, (C): NA: Not Analyzed, (f): ND: Not Detected
(d): EMCL: Egyptian Maximum Contaminant Limit for Raw Water, MWRI Decree 402 for 2009, (e): NR: Not Recommended

Table 4.29: Seasonal variation of heavy metals concentrations in water samples of the sample site H04 Mahmoudia Canal:

Point	Element	Symbol	Autumn[(a)]		winter		Spring		Summer		EMCL[(d)]
			Range	Mean±SD[(b)]	Range	Mean±SD	Range	Mean±SD	Range	Mean±SD	
End of Khandak	Aluminium	Al	0.3265-0.462	0.3943±0.0958	0.3265-0.3267	0.3266±0.0001	0.03-0.05	0.04±0.0141	0.099-0.152	0.1255±0.0375	**NR**
	Cadmium	Cd	ND-0.006	0.003±0.0042	0.0026-0.0028	0.0027±0.0001	0.004-0.005	0.0045±0.0007	ND-0.003	0.0015±0.0021	**≤0.003**
	Cobalt	Co	0.0012-0.005	0.0031±0.0027	0.0012-0.0027	0.0019±0.0011	0.003-0.005	0.004±0.0014	0.003-0.006	0.0045±0.0021	**NR**
	Copper	Cu	0.0062-0.011	0.0086±0.0034	0.0059-0.0061	0.006±0.0001	ND-0.003	0.0015±0.0021	ND[(f)]	ND	**≤1**
	Iron	Fe	0.4156-0.693	0.5543±0.1962	0.3444-0.4156	0.38±0.0504	0.076-0.096	0.086±0.0141	0.116-0.175	0.1455±0.0417	**≤0.05**
	Manganese	Mn	0.0228-0.077	0.0499±0.0383	0.0228-0.0584	0.0406±0.0252	0.034-0.107	0.0705±0.0516	0.01-0.02	0.015±0.0071	**NR**
	Nickel	Ni	0.0517-0.116	0.0839±0.0455	0.0412-0.0517	0.0465±0.0074	ND-0.003	0.0015±0.0021	ND-0.004	0.002±0.0028	**≤0.02**
	Lead	Pb	0.0042-0.005	0.0046±0.0006	0.0039-0.0042	0.0041±0.0002	0.002-0.003	0.0025±0.0007	0.004-0.005	0.0045±0.0007	**≤0.001**
	Zinc	Zn	0.0062-0.019	0.0126±0.0091	ND-0.0062	0.0031±0.0044	ND-0.016	0.008±0.0113	ND-0.052	0.026±0.0368	**≤1**

(a):Autumn (Oct to Dec2012),Winter (Jan to March 2013), Spring (Apr to Jun2013), Summer (Jul to Sep2013)
(b): Mean ± Standard Deviation, (C): NA: Not Analyzed, (f): ND: Not Detected
(d): EMCL: Egyptian Maximum Contaminant Limit for Raw Water, MWRI Decree 402 for 2009, (e): NR: Not Recommended

Table 4.30: Seasonal variation of heavy metals concentrations in water samples of the sample site H05 Mahmoudia Canal:

Point	Element	Symbol	Autumn[a]		winter		Spring		Summer		EMCL[d]
			Range	Mean±SD[b]	Range	Mean±SD	Range	Mean±SD	Range	Mean±SD	
Zawyat Ghazal	Aluminium	Al	0.3118-0.317	0.3144±0.0037	0.142-0.2252	0.1836±0.0588	0.038-0.105	0.0715±0.0474	0.093-0.094	0.0935±0.0007	**NR**
	Cadmium	Cd	ND-0.006	0.003±0.0042	0.0031-0.0027	0.0029±0.0003	0.004-0.005	0.0045±0.0007	ND-0.003	0.0015±0.0021	**≤0.003**
	Cobalt	Co	0.0011-0.004	0.0026±0.0021	0.0027-0.006	0.0044±0.0023	0.002-0.003	0.0025±0.0007	0.003-0.006	0.0045±0021	**NR**
	Copper	Cu	0.0068-0.009	0.0079±0.0016	0.001-0.0068	0.0039±0.0041	0.001-0.002	0.0015±0.0007	ND[f]	ND	**≤1**
	Iron	Fe	0.3648-0.444	0.4044±0.056	0.2114-0.3305	0.2709±0.0842	0.039-0.138	0.0885±0.07	0.199-0.266	0.2325±0.0474	**≤0.05**
	Manganese	Mn	0.0161-0.024	0.0201±0.0056	0.012-0.0477	0.0299±0.0252	0.049-0.091	0.07±0.0297	0.025-0.036	0.0305±0.0078	**NR**
	Nickel	Ni	0.0445-0.057	0.0508±0.0088	0.0321-0.0473	0.0397±0.0108	ND-0.002	0.001±0.0014	ND-0.001	0.0005±0.0007	**≤0.02**
	Lead	Pb	0.0036-0.004	0.0038±0.0003	0.0042-0.005	0.0046±0.0006	0.0015-0.003	0.0023±0.0011	0.004-0.005	0.0045±0.0007	**≤0.001**
	Zinc	Zn	0.002-0.004	0.003±0.0014	0.0011-0.015	0.0081±0.0098	0.015-0.021	0.018±0.0042	ND-0.011	0.0055±0.0078	**≤1**

(a):Autumn (Oct to Dec2012),Winter (Jan to March 2013), Spring (Apr to Jun2013), Summer (Jul to Sep2013)
(b): Mean ± Standard Deviation, (C): NA: Not Analyzed, (f): ND: Not Detected
(d): EMCL: Egyptian Maximum Contaminant Limit for Raw Water, MWRI Decree 402 for 2009, (e): NR: Not Recommended

Table 4.31: Seasonal variation of heavy metals concentrations in water samples of the sample site H06 Mahmoudia Canal:

Point	Element	Symbol	Autumn[a]		winter		Spring		Summer		EMCL[d]
			Range	Mean±SD[b]	Range	Mean±SD	Range	Mean±SD	Range	Mean±SD	
Abou Hommos	Aluminium	Al	0.2596-0.438	0.3488±0.1262	0.317-0.3659	0.3415±0.0346	0.038-0.091	0.0645±0.0375	0.091-0.135	0.113±0.0311	**NR**
	Cadmium	Cd	ND-0.006	0.003±0.0042	0.0028-0.006	0.0044±0.0023	0.004-0.005	0.0045±0.0007	0.002-0.003	0.0025±0.0007	**≤0.003**
	Cobalt	Co	0.0008-0.004	0.0024±0.0023	0.0025-0.004	0.0033±0.0011	0.003-0.0033	0.0032±0.0002	0.003-0.01	0.0065±0.0049	**NR**
	Copper	Cu	0.0061-0.009	0.0076±0.0021	0.009-0.0135	0.0113±0.0032	0.001-0.002	0.0015±0.0007	ND[f]	ND	**≤1**
	Iron	Fe	0.2793-0.605	0.4422±0.2303	0.444-0.4684	0.4562±0.0173	0.039-0.061	0.05±0.0156	0.099-0.109	0.104±0.0071	**≤0.05**
	Manganese	Mn	0.021-0.046	0.0335±0.0177	0.024-0.0605	0.0423±0.0258	0.042-0.049	0.0455±0.0049	0.027-0.046	0.0365±0.0134	**NR**
	Nickel	Ni	0.033-0.07	0.0515±0.0262	0.057-0.0645	0.0608±0.0053	ND-0.001	0.0005±0.0007	ND-0.004	0.002±0.0028	**≤0.02**
	Lead	Pb	0.0037-0.004	0.0039±0.0002	0.004-0.005	0.0045±0.0007	0.003-0.262	0.1325±0.1831	0.004-0.006	0.005±0.0014	**≤0.001**
	Zinc	Zn	0.0048-0.005	0.0049±0.0001	ND-0.002	0.001±0.0014	0.004-0.015	0.0095±0.0078	ND-0.029	0.0145±0.0205	**≤1**

(a):Autumn (Oct to Dec2012),Winter (Jan to March 2013), Spring (Apr to Jun2013), Summer (Jul to Sep2013)
(b): Mean ± Standard Deviation, (C): NA: Not Analyzed, (f): ND: Not Detected
(d): EMCL: Egyptian Maximum Contaminant Limit for Raw Water, MWRI Decree 402 for 2009, (e): NR: Not Recommended

Table 4.32: Seasonal variation of heavy metals concentrations in water samples of the sample site H07 Mahmoudia Canal:

Point	Element	Symbol	Autumn[(a)]		winter		Spring		Summer		EMCL[(d)]
			Range	Mean±SD[(b)]	Range	Mean±SD	Range	Mean±SD	Range	Mean±SD	
Kafr El-Dawar	Aluminium	Al	0.3176-0.364	0.3408±0.0328	0.2608-0.364	0.3124±0.0729	0.052-0.127	0.0895±0.053	0.125-0.276	0.2005±0.1068	**NR[(e)]**
	Cadmium	Cd	ND-0.006	0.003±0.0042	0.0028-0.006	0.0044±0.0023	0.004-0.005	0.0045±0.0007	ND-0.003	0.0015±0.0021	**≤0.003**
	Cobalt	Co	0.0012-0.004	0.0026±0.0019	0.0025-0.004	0.0033±0.0011	0.003-0.007	0.005±0.0028	0.003-0.006	0.0045±0.0021	**NR**
	Copper	Cu	0.0077-0.009	0.0084±0.0009	0.009-0.0105	0.0098±0.0011	0.002-0.003	0.0025±0.0007	ND[(f)]	ND	**≤1**
	Iron	Fe	0.4099-0.481	0.4455±0.0503	0.4034-0.481	0.4422±0.0549	0.069-0.118	0.0935±0.0347	0.134-0.138	0.136±0.0028	**≤0.05**
	Manganese	Mn	0.0248-0.026	0.0254±0.0009	0.026-0.05	0.038±0.0169	0.078-0.092	0.085±0.0099	0.028-0.039	0.0335±0.0078	**NR**
	Nickel	Ni	0.06-0.0758	0.0679±0.0112	0.0462-0.06	0.0531±0.0098	ND-0.009	0.0045±0.0064	ND-0.002	0.001±0.0014	**≤0.02**
	Lead	Pb	0.0036-0.004	0.0038±0.0003	0.004-0.0049	0.0045±0.0006	0.003-0.004	0.0035±0.0007	0.004-0.007	0.055±0.0021	**≤0.001**
	Zinc	Zn	0.005-0.0114	0.0082±0.0045	0.005-0.0052	0.0051±0.0001	0.023-0.027	0.025±0.0028	ND-0.091	0.0455±0.0644	**≤1**

(a):Autumn (Oct to Dec2012),Winter (Jan to March 2013), Spring (Apr to Jun2013), Summer (Jul to Sep2013)
(b): Mean ± Standard Deviation, (C): NA: Not Analyzed, (f): ND: Not Detected
(d): EMCL: Egyptian Maximum Contaminant Limit for Raw Water, MWRI Decree 402 for 2009, (e): NR: Not Recommended

Table 4.33: Seasonal variation of heavy metals concentrations in water samples of the sample site H08 Mahmoudia Canal:

Point	Element	Symbol	Autumn[(a)]		winter		Spring		Summer		EMCL[(d)]
			Range	Mean±SD[(b)]	Range	Mean±SD	Range	Mean±SD	Range	Mean±SD	
Khorshid	Aluminium	Al	0.2967-0.336	0.3164±0.0278	0.311-0.415	0.363±0.0735	0.062-0.196	0.129±0.0948	0.156-0.415	0.2855±0.1831	**NR[(e)]**
	Cadmium	Cd	0.003-0.006	0.0045±0.0021	0.0027-0.006	0.0044±0.0023	0.004-0.005	0.0045±0.0007	ND-0.003	0.0015±0.0021	**≤0.003**
	Cobalt	Co	0.0012-0.004	0.0026±0.0019	ND-0.0026	0.0013±0.0018	0.003-0.005	0.004±0.0014	0.003-0.006	0.0045±0.0021	**NR**
	Copper	Cu	0.0072-0.009	0.0081±0.0013	0.0096-0.174	0.0918±0.1163	0.002-0.062	0.032±0.0424	ND[(f)]	ND	**≤1**
	Iron	Fe	0.41-0.4169	0.4135±0.0049	0.047-0.3919	0.2195±0.2439	0.077-0.177	0.127±0.0707	0.155-0.174	0.1645±0.0134	**≤0.05**
	Manganese	Mn	0.0198-0.022	0.0209±0.0016	0.003-0.0526	0.0278±0.0351	0.051-0.086	0.0685±0.0248	0.022-0.047	0.0345±0.0177	**NR**
	Nickel	Ni	0.052-0.0579	0.0549±0.0042	0.0542-0.0616	0.0579±0.0052	0.001-0.044	0.0225±0.0304	ND-0.003	0.0015±0.0021	**≤0.02**
	Lead	Pb	0.004-0.0045	0.0043±0.0004	0.0041-0.008	0.0061±0.0028	0.003-0.004	0.0035±0.0007	0.004-0.008	0.006±0.0028	**≤0.001**
	Zinc	Zn	0.005-0.006	0.0055±0.0007	ND-0.065	0.0325±0.0459	0.003-0.03	0.0165±0.0191	0.003-0.065	0.034±0.0438	**≤1**

(a):Autumn (Oct to Dec2012),Winter (Jan to March 2013), Spring (Apr to Jun2013), Summer (Jul to Sep2013)
(b): Mean ± Standard Deviation, (C): NA: Not Analyzed, (f): ND: Not Detected
(d): EMCL: Egyptian Maximum Contaminant Limit for Raw Water, MWRI Decree 402 for 2009, (e): NR: Not Recommended

Table 4.34: Seasonal variation of heavy metals concentrations in water samples of the sample site H09 Mahmoudia Canal:

Point	Element	Symbol	Autumn[(a)]		winter		Spring		Summer		EMCL[(d)]
			Range	Mean±SD[(b)]	Range	Mean±SD	Range	Mean±SD	Range	Mean±SD	
Seiouf WTP Intake	Aluminium	Al	0.2444-0.451	0.3477±0.1461	0.3058-0.317	0.3114±0.0079	0.091-0.124	0.1075±0.0233	0.124-0.246	0.185±0.0863	**NR[(e)]**
	Cadmium	Cd	0.002-0.006	0.004±0.0028	0.0027-0.006	0.0044±0.0023	0.005-0.006	0.0055±0.0007	0.003-0.005	0.004±0.0014	**≤0.003**
	Cobalt	Co	0.0009-0.005	0.0029±0.0029	0.0023-0.004	0.0032±0.0012	0.003-0.004	0.0035±0.0007	0.003-0.004	0.0035±0.0007	**NR**
	Copper	Cu	0.0063-0.01	0.0082±0.0026	0.009-0.0093	0.0092±0.0002	ND	ND	ND[(f)]	ND	**≤1**
	Iron	Fe	0.3034-0.686	0.4947±0.2705	0.444-0.4853	0.4647±0.292	ND-0.135	0.0675±0.0955	0.095-0.135	0.115±0.0283	**≤0.05**
	Manganese	Mn	0.0248-0.038	0.0314±0.0093	0.024-0.0875	0.0558±0.0449	0.001-0.101	0.051±0.0707	0.045-0.101	0.073±0.0396	**NR**
	Nickel	Ni	0.0366-0.091	0.0638±0.0385	0.057-0.1114	0.0842±0.0385	ND-0.094	0.047±0.0665	ND-0.094	0.047±0.0665	**≤0.02**
	Lead	Pb	0.0035-0.004	0.0038±0.0004	0.0004-0.0041	0.004±0.0001	0.003-0.004	0.0035±0.0007	0.004-0.005	0.0045±0.0007	**≤0.001**
	Zinc	Zn	0.004-0.008	0.006±0.0028	0.002-0.0038	0.0029±0.0013	ND-0.021	0.0105±0.0149	0.021-0.493	0.257±0.3338	**≤1**

(a):Autumn (Oct to Dec2012),Winter (Jan to March 2013), Spring (Apr to Jun2013), Summer (Jul to Sep2013)
(b): Mean ± Standard Deviation, (C): NA: Not Analyzed, (f): ND: Not Detected
(d): EMCL: Egyptian Maximum Contaminant Limit for Raw Water, MWRI Decree 402 for 2009, (e): NR: Not Recommended

Table 4.35: Seasonal variation of heavy metals concentrations in water samples of the sample site H10 Mahmoudia Canal:

Point	Element	Symbol	Autumn[(a)]		winter		Spring		Summer		EMCL[(d)]
			Range	Mean±SD[(b)]	Range	Mean±SD	Range	Mean±SD	Range	Mean±SD	
Nozha WTP Intake	Aluminium	Al	0.2743-0.305	0.2897±0.0217	0.3646-0.438	0.4013±0.0519	0.071-0.135	0.103±0.0453	0.132-0.135	0.1335±0.0021	**NR[(e)]**
	Cadmium	Cd	0.003-0.006	0.0045±0.0021	0.0028-0.006	0.0044±0.0023	0.005-0.006	0.0055±0.0007	0.003-0.005	0.004±0.0014	**≤0.003**
	Cobalt	Co	0.001-0.004	0.0025±0.0021	0.0026-0.004	0.0033±0.0009	0.003-0.004	0.0035±0.0007	0.003-0.006	0.0045±0.0021	**NR**
	Copper	Cu	0.0067-0.008	0.0074±0.0009	0.0088-0.009	0.0089±0.0001	0.001-0.0016	0.0013±0.0004	ND-0.001	0.0005±0.0007	**≤1**
	Iron	Fe	0.3357-0.418	0.3769±0.0582	0.4103-0.605	0.5077±0.1377	0.001-0.126	0.0685±0.0813	0.12-0.126	0.123±0.0042	**≤0.05**
	Manganese	Mn	0.0147-0.037	0.0259±0.0158	0.046-0.0595	0.0528±0.0096	0.024-0.076	0.05±0.0368	0.024-0.076	0.05±0.0368	**NR**
	Nickel	Ni	0.0419-0.049	0.0455±0.005	0.0676-0.07	0.0688±0.0017	ND-0.002	0.001±0.0014	ND[(f)]	ND	**≤0.02**
	Lead	Pb	0.004	0.004±0	0.004-0.0044	0.0042±0.0003	0.0023-0.003	0.0027±0.0005	0.003-0.004	0.0035±0.0007	**≤0.001**
	Zinc	Zn	0.0052-0.01	0.0076±0.0034	0.005-0.0093	0.0072±0.003	0.005-0.011	0.008±0.0042	0.004-0.011	0.0075±0.0049	**≤1**

(a):Autumn (Oct to Dec2012),Winter (Jan to March 2013), Spring (Apr to Jun2013), Summer (Jul to Sep2013)
(b): Mean ± Standard Deviation, (C): NA: Not Analyzed, (f): ND: Not Detected
(d): EMCL: Egyptian Maximum Contaminant Limit for Raw Water, MWRI Decree 402 for 2009, (e): NR: Not Recommended

Table 4.36: Seasonal variation of heavy metals concentrations in water samples of the sample site H11 Mahmoudia Canal:

Point	Element	Symbol	Autumn[a]		winter		Spring		Summer		EMCL[d]
			Range	Mean±SD[b]	Range	Mean±SD	Range	Mean±SD	Range	Mean±SD	
Manshia WTP Intake	Aluminium	Al	0.255-0.276	0.2655±0.0148	0.317-0.438	0.3775±0.0856	0.095-0.163	0.1177±0.0393	0.163-0.407	0.285±0.1725	**NR[e]**
	Cadmium	Cd	0.004-0.006	0.005±0.0014	0.0045-0.006	0.0053±0.0011	0.005-0.006	0.0057±0.0006	0.003-0.005	0.004±0.0014	**≤0.003**
	Cobalt	Co	0.002-0.004	0.003±0.0014	0.0021-0.004	0.0031±0.0013	0.003-0.005	0.0037±0.0012	0.025-0.003	0.014±0.0156	**NR**
	Copper	Cu	0.007-0.008	0.0075±0.0007	0.005-0.009	0.007±0.0028	0.003-0.007	0.0043±0.0023	ND[f]-0.003	0.0015±0.0021	**≤1**
	Iron	Fe	0.38-0.383	0.3815±0.0021	0.444-0.605	0.5245±0.1138	0.025-0.159	0.0697±0.0774	0.139-0.159	0.149±0.0141	**≤0.05**
	Manganese	Mn	0.015-0.017	0.016±0.0014	0.024-0.046	0.035±0.0156	0.037-0.088	0.054±0.0294	0.011-0.088	0.0495±0.0544	**NR**
	Nickel	Ni	0.05-0.051	0.0505±0.0007	0.057-0.07	0.0635±0.0092	ND-0.001	0.0005±0.0007	ND-0.001	0.0005±0.0007	**≤0.02**
	Lead	Pb	0.002-0.04	0.003±0.0014	0.004	0.004±0	0.0033-0.004	0.0038±0.0004	0.002-0.004	0.003±0.0014	**≤0.001**
	Zinc	Zn	0.0015-0.003	0.0023±0.0011	0.002-0.005	0.0035±0.0021	0.007-0.019	0.011±0.0069	0.019-0.026	0.0225±0.0049	**≤1**

(a):Autumn (Oct to Dec2012),Winter (Jan to March 2013), Spring (Apr to Jun2013), Summer (Jul to Sep2013)
(b): Mean ± Standard Deviation, (C): NA: Not Analyzed, (f): ND: Not Detected
(d): EMCL: Egyptian Maximum Contaminant Limit for Raw Water, MWRI Decree 402 for 2009, (e): NR: Not Recommended

Table 4.37: Seasonal variation of heavy metals concentrations in water samples of the sample site N01 Nubaria Canal:

Point	Element	Symbol	Autumn[a]		winter		Spring		Summer		EMCL[d]
			Range	Mean±SD[b]	Range	Mean±SD	Range	Mean±SD	Range	Mean±SD	
Boline Bridge	Aluminium	Al	0.014-0.1861	0.1001±0.122	0.1-0.4724	0.3188±0.1946	0.006-0.051	0.0285±0.0318	0.113-0.115	0.114±0.0014	**NR[e]**
	Cadmium	Cd	0.002-0.006	0.004±0.003	ND-0.002	0.001±0.0014	0.005-0.007	0.006±0.0014	0.003-0.005	0.004±0.0014	**≤0.003**
	Cobalt	Co	0.003-0.004	0.0033±0.0004	0.0001-0.002	0.001±0.0009	0.004-0.007	0.0055±0.0021	0.003-0.006	0.0045±0.0021	**NR**
	Copper	Cu	0.005-0.008	0.0065±0.002	0.0023-0.005	0.0054±0.003	0.003-0.017	0.01±0.0099	ND[f]	ND	**≤1**
	Iron	Fe	0.2791-1.778	1.0286±1.0599	0.03-0.506	0.3127±0.2503	0.065-0.143	0.104±0.0552	0.034-0.037	0.0355±0.0021	**≤0.05**
	Manganese	Mn	0.009-0.0142	0.0116±0.0037	0.018-0.0572	0.0423±0.0213	0.021-0.041	0.031±0.0141	0.009-0.019	0.014±0.0071	**NR**
	Nickel	Ni	0.0021-0.0039	0.003±0.0013	0.005-0.0012	0.0031±0.0027	0.001-0.0096	0.0054±0.006	0.001-0.005	0.0031±0.0023	**≤0.02**
	Lead	Pb	0.0036-0.004	0.0038±0.0003	0.0014-0.003	0.002±0.0009	0.006-0.011	0.0085±0.0035	0.005	0.005±0	**≤0.001**
	Zinc	Zn	0.0023-0.168	0.0852±0.1172	0.016-0.0454	0.0281±0.0154	0.025-0.028	0.0265±0.0021	0.013-0.021	0.017±0.0057	**≤1**

(a):Autumn (Oct to Dec2012),Winter (Jan to March 2013), Spring (Apr to Jun2013), Summer (Jul to Sep2013)
(b): Mean ± Standard Deviation, (C): NA: Not Analyzed, (f): ND: Not Detected
(d): EMCL: Egyptian Maximum Contaminant Limit for Raw Water, MWRI Decree 402 for 2009, (e): NR: Not Recommended

Table 4.38: Seasonal variation of heavy metals concentrations in water samples of the sample site N02 Nubaria Canal:

Point	Element	Symbol	Autumn[a]		winter		Spring		Summer		EMCL[d]
			Range	Mean±SD[b]	Range	Mean±SD	Range	Mean±SD	Range	Mean±SD	
Delingat Drain	Aluminium	Al	0.2158-0.345	0.2804±0.091	0.057-0.401	0.2757±0.1901	0.031-0.167	0.099±0.0962	0.053-0.088	0.0705±0.0248	**NR[e]**
	Cadmium	Cd	0.0022-0.006	0.0041±0.003	ND	ND	0.005-0.007	0.006±0.0014	0.003-0.005	0.004±0.0014	**≤0.003**
	Cobalt	Co	0.0039-0.004	0.0039±0.0007	ND-0.0012	0.0007±0.0006	0.004-0.007	0.0055±0.0021	0.003-0.006	0.0045±0.0021	**NR**
	Copper	Cu	0.008-0.0088	0.0084±0.001	0.002-0.0077	0.0043±0.003	0.003-0.011	0.007±0.0057	ND[f]	ND	**≤1**
	Iron	Fe	0.3791-0.478	0.4286±0.069	0.041-0.481	0.3139±0.2383	0.035-0.125	0.08±0.0636	0.015-0.022	0.0185±0.0049	**≤0.05**
	Manganese	Mn	0.017-0.0194	0.0182±0.0017	0.023-0.0938	0.0645±0.0369	0.01-0.093	0.0515±0.0587	0.012-0.038	0.025±0.0184	**NR**
	Nickel	Ni	0.0016-0.0065	0.0041±0.0035	0.0019-0.009	0.0057±0.0053	0.0036-0.008	0.0056±0.0028	0.0014-0.004	0.0025±0.0016	**≤0.02**
	Lead	Pb	0.0036-0.004	0.0038±0.0003	ND-0.0012	0.001±0.0003	0.006-0.009	0.0075±0.0021	0.004	0.004±0	**≤0.001**
	Zinc	Zn	0.0034-0.007	0.0052±0.0026	0.0078-0.019	0.0128±0.0054	0.015-0.048	0.0315±0.0233	0.018-0.021	0.0195±0.0021	**≤1**

(a):Autumn (Oct to Dec2012),Winter (Jan to March 2013), Spring (Apr to Jun2013), Summer (Jul to Sep2013)
(b): Mean ± Standard Deviation, (C): NA: Not Analyzed, (f): ND: Not Detected
(d): EMCL: Egyptian Maximum Contaminant Limit for Raw Water, MWRI Decree 402 for 2009, (e): NR: Not Recommended

Table 4.39: Seasonal variation of heavy metals concentrations in water samples of the sample site N03 Nubaria Canal:

Point	Element	Symbol	Autumn[(a)]		winter		Spring		Summer		EMCL[(d)]
			Range	Mean±SD[(b)]	Range	Mean±SD	Range	Mean±SD	Range	Mean±SD	
Kheneza Bridge	Aluminium	Al	0.2133-0.282	0.2477±0.049	0.059-0.385	0.2476±0.1689	0.045-0.236	0.1425±0.1351	0.07-0.132	0.101±0.0438	**NR[(e)]**
	Cadmium	Cd	0.0021-0.006	0.0041±0.028	ND-0.004	0.0021±0.0028	0.005-0.011	0.008±0.0042	0.003-0.005	0.004±0.0014	**≤0.003**
	Cobalt	Co	0.0037-0.004	0.0039±0.0002	ND-0.003	0.0019±0.0016	0.004-0.01	0.007±0.0042	0.003-0.006	0.0045±0.0021	**NR**
	Copper	Cu	0.008-0.0088	0.0084±0.0006	0.0014-0.006	0.0046±0.0028	0.001-0.015	0.008±0.0099	ND-0.003	0.0015±0.0021	**≤1**
	Iron	Fe	0.326-0.3503	0.3382±0.0172	0.036-0.3886	0.2455±0.1854	0.021-0.164	0.0925±0.1011	0.011-0.021	0.016±0.0071	**≤0.05**
	Manganese	Mn	0.019-0.0227	0.0209±0.0026	0.024-0.0477	0.0349±0.0119	0.01-0.05	0.03±0.0283	0.009-0.017	0.013±0.0057	**NR**
	Nickel	Ni	0.0014-0.003	0.0019±0.0008	0.0019-0.009	0.0057±0.0053	0.002-0.004	0.003±0.0013	0.003-0.004	0.009±0.0099	**≤0.02**
	Lead	Pb	0.004-0.0059	0.0049±0.0013	0.0013-0.005	0.0026±0.0021	0.006-0.012	0.009±0.0042	0.004-0.005	0.0045±0.0007	**≤0.001**
	Zinc	Zn	0.014-0.0116	0.0128±0.0017	0.016-0.0284	0.0211±0.0065	0.01-0.047	0.0285±0.0262	0.001-0.012	0.0065±0.0078	**≤1**

(a):Autumn (Oct to Dec2012),Winter (Jan to March 2013), Spring (Apr to Jun2013), Summer (Jul to Sep2013)
(b): Mean ± Standard Deviation, (C): NA: Not Analyzed, (f): ND: Not Detected
(d): EMCL: Egyptian Maximum Contaminant Limit for Raw Water, MWRI Decree 402 for 2009, (e): NR: Not Recommended

Table 4.40: Seasonal variation of heavy metals concentrations in water samples of the sample site N04 Nubaria Canal:

Point	Element	Symbol	Autumn[(a)]		winter		Spring		Summer		EMCL[(d)]
			Range	Mean±SD[(b)]	Range	Mean±SD	Range	Mean±SD	Range	Mean±SD	
Rayyah El-Nasery	Aluminium	Al	ND-0.409	0.2045±0.2892	0.05-0.3129	0.2213±0.1484	0.041-0.129	0.085±0.0622	0.083-0.095	0.089±0.0085	**NR[(e)]**
	Cadmium	Cd	0.002-0.006	0.004±0.0028	ND-0.0003	0.0012±0.0012	0.005-0.007	0.006±0.0014	0.003-0.05	0.004±0.0014	**≤0.003**
	Cobalt	Co	0.0027-0.004	0.0034±0.0009	ND-0.0009	0.0008±0.0001	0.004-0.007	0.0055±0.0021	0.003-0.006	0.0045±0.0021	**NR**
	Copper	Cu	0.0043-0.007	0.0057±0.0019	0.0015±0.002	0.0034±0.0028	0.002-0.007	0.0045±0.0035	ND[(f)]	ND	**≤1**
	Iron	Fe	ND-0.379	0.1895±0.2679	0.02-0.3523	0.2401±0.1906	0.037-0.054	0.0455±0.012	0.031-0.034	0.0325±0.0021	**≤0.05**
	Manganese	Mn	0.0025-0.015	0.0088±0.0088	0.011-0.0412	0.0288±0.0158	0.008-0.027	0.0175±0.0134	0.01-0.012	0.011±0.0014	**NR**
	Nickel	Ni	0.0014-0.004	0.0025±0.0016	0.0014-0.003	0.0019±0.0008	0.004-0.009	0.0062±0.0033	0.0024-0.0039	0.0032±0.0011	**≤0.02**
	Lead	Pb	0.0031-0.004	0.0036±0.0006	0.001-0.0012	0.0011±0.0001	0.006-0.008	0.007±0.0014	0.004-0.005	0.0045±0.0007	**≤0.001**
	Zinc	Zn	ND-0.002	0.001±0.0014	0.003-0.0235	0.0149±0.0106	0.02-0.022	0.021±0.0014	0.007-0.012	0.0095±0.0035	**≤1**

(a):Autumn (Oct to Dec2012),Winter (Jan to March 2013), Spring (Apr to Jun2013), Summer (Jul to Sep2013)
(b): Mean ± Standard Deviation, (C): NA: Not Analyzed, (f): ND: Not Detected
(d): EMCL: Egyptian Maximum Contaminant Limit for Raw Water, MWRI Decree 402 for 2009, (e): NR: Not Recommended

Table 4.41: Seasonal variation of heavy metals concentrations in water samples of the sample site N05 Nubaria Canal:

Point	Element	Symbol	Autumn[a]		winter		Spring		Summer		EMCL[d]
			Range	Mean±SD[b]	Range	Mean±SD	Range	Mean±SD	Range	Mean±SD	
Boustan Bridge	Aluminium	Al	0.1924-0.334	0.2632±0.1001	0.065-0.3284	0.2167±0.1362	0.058-0.252	0.155±0.1378	0.096-0.116	0.106±0.0141	**NR[e]**
	Cadmium	Cd	0.0021-0.006	0.0041±0.0028	ND-0.0007	0.0006±0.0001	0.005-0.007	0.006±0.0014	0.003-0.005	0.004±0.0014	**≤0.003**
	Cobalt	Co	0.0036-0.004	0.0038±0.0003	ND-0.001	0.0009±0.0001	0.004-0.007	0.0055±0.002	0.003-0.006	0.0045±0.0021	**NR**
	Copper	Cu	0.007-0.0082	0.0076±0.0009	0.0009-0.003	0.0031±0.0023	0.004-0.012	0.008±0.0057	ND[f]-0.004	0.002±0.0028	**≤1**
	Iron	Fe	0.2771-0.354	0.3156±0.0544	0.018-0.3422	0.2097±0.17	0.041-0.166	0.1035±0.088	0.037-0.042	0.0395±0.0035	**≤0.05**
	Manganese	Mn	0.0141-0.015	0.0146±0.0006	0.005-0.0337	0.0162±0.0154	0.009-0.037	0.023±0.0198	0.009-0.014	0.0115±0.0035	**NR**
	Nickel	Ni	0.004-0.0054	0.0045±0.0013	0.002-0.004	0.0026±0.0015	0.0085-0.009	0.009±0.0007	0.0025-0.003	0.0029±0.0005	**≤0.02**
	Lead	Pb	0.0035-0.004	0.0038±0.0004	0.0005-0.001	0.0008±0.0003	0.006-0.01	0.008±0.0028	0.005-0.006	0.0055±0.0007	**≤0.001**
	Zinc	Zn	ND-0.0058	0.0029±0.0041	0.002-0.0265	0.0152±0.0124	0.014-0.025	0.0195±0.008	0.009-0.015	0.021±0.0042	**≤1**

(a):Autumn (Oct to Dec2012),Winter (Jan to March 2013), Spring (Apr to Jun2013), Summer (Jul to Sep2013)
(b): Mean ± Standard Deviation, (C): NA: Not Analyzed, (f): ND: Not Detected
(d): EMCL: Egyptian Maximum Contaminant Limit for Raw Water, MWRI Decree 402 for 2009, (e): NR: Not Recommended

Table 4.42: Seasonal variation of heavy metals concentrations in water samples of the sample site N06 Nubaria Canal:

Point	Element	Symbol	Autumn[a]		winter		Spring		Summer		EMCL[d]
			Range	Mean±SD[b]	Range	Mean±SD	Range	Mean±SD	Range	Mean±SD	
Boustan Drain	Aluminium	Al	0.2961-0.415	0.3556±0.0841	0.031-0.4928	0.2659±0.231	0.016-0.177	0.0965±0.1138	0.044-0.071	0.0575±0.0191	**NR[e]**
	Cadmium	Cd	ND-0.006	0.003±0.0042	ND-0.003	0.0016±0.0021	0.004-0.007	0.0055±0.0021	0.003-0.005	0.004±0.0014	**≤0.003**
	Cobalt	Co	0.0021-0.006	0.0041±0.0028	ND-0.003	0.0021±0.0013	0.003-0.007	0.005±0.0023	0.003-0.006	0.0045±0.0021	**NR**
	Copper	Cu	0.0071-0.009	0.0081±0.0013	0.005-0.0077	0.0059±0.0016	0.002-0.007	0.0045±0.0035	ND[f]-0.001	0.0005±0.0007	**≤1**
	Iron	Fe	0.3738-0.479	0.4264±0.0744	0.3-0.4594	0.2782±0.2224	0.045-0.143	0.094±0.0693	0.012-0.014	0.013±0.0014	**≤0.05**
	Manganese	Mn	0.0252-0.09	0.0576±0.0458	0.016-0.0528	0.0348±0.0184	0.008-0.099	0.0535±0.0644	0.021-0.036	0.0285±0.0106	**NR**
	Nickel	Ni	0.0473-0.053	0.0502±0.004	0.003-0.0036	0.0033±0.0005	0.003-0.009	0.0057±0.0044	0.0014-0.004	0.0028±0.0019	**≤0.02**
	Lead	Pb	0.0035-0.005	0.0043±0.0011	0.0008-0.004	0.0025±0.0016	0.002-0.008	0.005±0.0042	0.003-0.004	0.0035±0.0007	**≤0.001**
	Zinc	Zn	0.0058-0.015	0.0104±0.0065	0.0172-0.095	0.044±0.0441	0.013-0.037	0.025±0.0169	0.016-0.057	0.0365±0.0289	**≤1**

(a):Autumn (Oct to Dec2012),Winter (Jan to March 2013), Spring (Apr to Jun2013), Summer (Jul to Sep2013)
(b): Mean ± Standard Deviation, (C): NA: Not Analyzed, (f): ND: Not Detected
(d): EMCL: Egyptian Maximum Contaminant Limit for Raw Water, MWRI Decree 402 for 2009, (e): NR: Not Recommended

Table 4.43: Seasonal variation of heavy metals concentrations in water samples of the sample site N07 Nubaria Canal:

Point	Element	Symbol	Autumn[a]		winter		Spring		Summer		EMCL[d]
			Range	Mean±SD[b]	Range	Mean±SD	Range	Mean±SD	Range	Mean±SD	
El – Abd Bridge	Aluminium	Al	0.2086-0.334	0.2713±0.0887	0.074-0.3834	0.2752±0.1744	0.03-0.226	0.128±0.1386	0.117-0.122	0.1195±0.0035	**NR[e]**
	Cadmium	Cd	0.0021-0.006	0.0041±0.0028	ND-0.0003	0.0003±0	0.004-0.007	0.0055±0.002	0.003-0.005	0.004±0.0014	**≤0.003**
	Cobalt	Co	0.0039-0.04	0.0039±0.0007	ND-0.0013	0.0011±0.0003	0.003-0.007	0.005±0.0028	0.003-0.006	0.0045±0.0021	**NR**
	Copper	Cu	0.008-0.0083	0.0082±0.0002	0.0017-0.002	0.0037±0.0032	0.002-0.012	0.007±0.0071	ND[f]-0.002	0.001±0.0014	**≤1**
	Iron	Fe	0.3748-0.39	0.3824±0.0108	0.023-0.5	0.3164±0.2568	0.058-0.1	0.079±0.0297	0.052-0.059	0.0555±0.0049	**≤0.05**
	Manganese	Mn	0.0319-0.059	0.0455±0.0192	0.0178-0.0422	0.0293±0.0123	0.006-0.04	0.023±0.024	0.01-0.015	0.0125±0.0035	**NR**
	Nickel	Ni	0.001-0.0074	0.0044±0.0042	0.0014-0.0023	0.0019±0.0006	0.006-0.008	0.0068±0.002	0.0016-0.004	0.0027±0.0015	**≤0.02**
	Lead	Pb	0.0034-0.004	0.0037±0.0004	ND-0.0017	0.0016±0.0001	0.003-0.008	0.0055±0.004	0.004-0.005	0.0045±0.0007	**≤0.001**
	Zinc	Zn	0.067-0.01	0.0084±0.0023	0.004-0.0136	0.0104±0.0055	0.01-0.02	0.015±0.0071	0.005-0.015	0.01±0.0071	**≤1**

(a):Autumn (Oct to Dec2012),Winter (Jan to March 2013), Spring (Apr to Jun2013), Summer (Jul to Sep2013)
(b): Mean ± Standard Deviation, (C): NA: Not Analyzed, (f): ND: Not Detected
(d): EMCL: Egyptian Maximum Contaminant Limit for Raw Water, MWRI Decree 402 for 2009, (e): NR: Not Recommended

Table 4.44: Seasonal variation of heavy metals concentrations in water samples of the sample site N08 Nubaria Canal:

Point	Element	Symbol	Autumn[a]		winter		Spring		Summer		EMCL[d]
			Range	Mean±SD[b]	Range	Mean±SD	Range	Mean±SD	Range	Mean±SD	
EL-Umum Drain	Aluminium	Al	0.2202-0.331	0.2756±0.0784	0.047-0.3693	0.2474±0.1749	0.028-0.165	0.0965±0.097	0.083-0.201	0.142±0.0834	**NR[e]**
	Cadmium	Cd	0.0023-0.006	0.0042±0.0026	ND-0.0004	0.0003±0.0001	0.004-0.007	0.0055±0.002	0.003-0.007	0.005±0.0028	**≤0.003**
	Cobalt	Co	0.0035-0.004	0.0038±0.0004	ND-0.0015	0.0013±0.0004	0.003-0.007	0.005±0.0028	0.003-0.01	0.0065±0.0049	**NR**
	Copper	Cu	0.009-0.0115	0.0103±0.0018	0.001-0.0066	0.0032±0.0029	0.002-0.006	0.004±0.0028	ND[f]-0.009	0.0045±0.0064	**≤1**
	Iron	Fe	0.3398-0.431	0.3854±0.0645	0.015±0.4237	0.2739±0.2252	0.047-0.056	0.0515±0.006	0.06-0.063	0.0615±0.0021	**≤0.05**
	Manganese	Mn	0.0258-0.032	0.0289±0.0044	0.005±0.0342	0.0181±0.0148	0.006-0.027	0.0165±0.015	0.017-0.018	0.0175±0.0007	**NR**
	Nickel	Ni	0.004-0.0075	0.0056±0.0028	0.0011-0.009	0.0054±0.006	0.002-0.009	0.0057±0.005	0.0024-0.004	0.0032±0.0011	**≤0.02**
	Lead	Pb	0.004-0.0046	0.0043±0.0004	0.0005-0.003	0.0015±0.0013	0.003-0.008	0.0055±0.004	0.005-0.006	0.0055±0.0007	**≤0.001**
	Zinc	Zn	0.014-0.0257	0.0199±0.0082	0.002-0.0145	0.0074±0.0064	0.009-0.015	0.012±0.0042	0.013-0.064	0.0385±0.0361	**≤1**

(a):Autumn (Oct to Dec2012),Winter (Jan to March 2013), Spring (Apr to Jun2013), Summer (Jul to Sep2013)
(b): Mean ± Standard Deviation, (C): NA: Not Analyzed, (f): ND: Not Detected
(d): EMCL: Egyptian Maximum Contaminant Limit for Raw Water, MWRI Decree 402 for 2009, (e): NR: Not Recommended

Table 4.45: Seasonal variation of heavy metals concentrations in water samples of the sample site N09 Nubaria Canal:

Point	Element	Symbol	Autumn[a]		winter		Spring		Summer		EMCL[d]
			Range	Mean±SD[b]	Range	Mean±SD	Range	Mean±SD	Range	Mean±SD	
El-Moudir Bridge	Aluminium	Al	0.2044-0.312	0.2582±0.0761	0.066-0.369	0.2382±0.1557	0.024-0.148	0.086±0.0877	0.1-0.101	0.1005±0.0007	**NR[e]**
	Cadmium	Cd	0.002-0.006	0.004±0.0028	ND-0.0009	0.0007±0.0003	0.004-0.007	0.0055±0.002	0.003-0.005	0.004±0.0014	**≤0.003**
	Cobalt	Co	0.0037-0.004	0.0039±0.0002	ND-0.0008	0.0007±0.0001	0.003-0.007	0.005±0.0028	0.003-0.006	0.0045±0.0021	**NR**
	Copper	Cu	0.077-0.008	0.008±0.0002	0.0057-0.003	0.0036±0.0019	0.002-0.007	0.0045±0.004	ND[f]-0.003	0.0015±0.0021	**≤1**
	Iron	Fe	0.309-0.353	0.331±0.0311	0.031-0.3998	0.2475±0.1926	0.029-0.077	0.053±0.034	0.065-0.068	0.0665±0.0021	**≤0.05**
	Manganese	Mn	0.0135-0.049	0.0313±0.0251	0.006-0.0362	0.0181±0.0159	0.006-0.023	0.0145±0.012	0.012-0.013	0.0125±0.0007	**NR**
	Nickel	Ni	0.009-0.0095	0.009±0.0007	0.0012-0.005	0.0031±0.0026	0.001-0.002	0.002±0.0006	0.006-0.0079	0.0068±0.0016	**≤0.02**
	Lead	Pb	0.0033-0.004	0.0037±0.0005	ND-0.0013	0.0012±0.0002	0.003-0.008	0.0055±0.004	0.004-0.005	0.0045±0.0007	**≤0.001**
	Zinc	Zn	0.014-0.0196	0.0168±0.0039	0.0069-0.012	0.0091±0.0026	0.01-0.014	0.012±0.0028	ND-0.012	0.006±0.0085	**≤1**

(a):Autumn (Oct to Dec2012),Winter (Jan to March 2013), Spring (Apr to Jun2013), Summer (Jul to Sep2013)
(b): Mean ± Standard Deviation, (C): NA: Not Analyzed, (f): ND: Not Detected
(d): EMCL: Egyptian Maximum Contaminant Limit for Raw Water, MWRI Decree 402 for 2009, (e): NR: Not Recommended

Table 4.46: Seasonal variation of heavy metals concentrations in water samples of the sample site N10 Nubaria Canal:

Point	Element	Symbol	Autumn[a]		winter		Spring		Summer		EMCL[d]
			Range	Mean±SD[b]	Range	Mean±SD	Range	Mean±SD	Range	Mean±SD	
Drain No. 3	Aluminium	Al	0.1586-0.236	0.1973±0.0547	0.051-0.4188	0.2349±0.2601	0.017-0.12	0.0685±0.073	0.039-0.076	0.0575±0.0262	**NR[e]**
	Cadmium	Cd	0.002-0.006	0.004±0.0028	ND-0.0006	0.0006±0	0.004-0.01	0.007±0.0042	0.003-0.005	0.004±0.0014	**≤0.003**
	Cobalt	Co	0.0037-0.004	0.0039±0.0002	0.0008-0.001	0.0009±0.0001	0.003-0.009	0.006±0.0042	0.003-0.006	0.0045±0.0021	**NR**
	Copper	Cu	0.0077-0.008	0.0079±0.0002	0.004-0.0288	0.0164±0.0175	0.003-0.016	0.0095±0.009	ND[f]	ND	**≤1**
	Iron	Fe	0.3073-0.414	0.3607±0.0755	0.034-0.4057	0.2199±0.2628	0.041-0.095	0.068±0.038	0.036-0.038	0.037±0.0014	**≤0.05**
	Manganese	Mn	0.0113-0.085	0.0482±0.0521	0.008-0.0223	0.0152±0.0101	0.004-0.08	0.042±0.0537	0.01-0.012	0.011±0.0014	**NR**
	Nickel	Ni	0.0473-0.053	0.0502±0.004	0.0311-0.0327	0.0319±0.0011	ND-0.001	0.0005±0.0007	ND-0.005	0.0025±0.0035	**≤0.02**
	Lead	Pb	0.0033-0.004	0.0037±0.0005	0.002-0.0029	0.0025±0.0006	0.002-0.01	0.006±0.0057	0.004-0.005	0.0045±0.0007	**≤0.001**
	Zinc	Zn	0.0018-0.038	0.0199±0.0256	0.014-0.0196	0.0168±0.0039	0.008-0.021	0.0145±0.009	ND-0.022	0.011±0.0156	**≤1**

(a):Autumn (Oct to Dec2012),Winter (Jan to March 2013), Spring (Apr to Jun2013), Summer (Jul to Sep2013)
(b): Mean ± Standard Deviation, (C): NA: Not Analyzed, (f): ND: Not Detected
(d): EMCL: Egyptian Maximum Contaminant Limit for Raw Water, MWRI Decree 402 for 2009, (e): NR: Not Recommended

Table 4.47: Seasonal variation of heavy metals concentrations in water samples of the sample site N11 Nubaria Canal:

Point	Element	Symbol	Autumn[(a)]		winter		Spring		Summer		EMCL[(d)]
			Range	Mean±SD[(b)]	Range	Mean±SD	Range	Mean±SD	Range	Mean±SD	
Dain No. 1	Aluminium	Al	0.292-0.39	0.341±0.0693	0.053-0.3438	0.1984±0.2056	0.011-0.137	0.074±0.0891	0.083-0.092	0.0875±0.0064	**NR[(e)]**
	Cadmium	Cd	ND-0.006	0.003±0.0042	ND-0.0002	0.0001±0.0001	0.004-0.007	0.0055±0.002	0.003-0.005	0.004±0.0014	**≤0.003**
	Cobalt	Co	0.0012-0.005	0.0031±0.0027	0.001-0.0012	0.0011±0.0001	0.003-0.007	0.005±0.0028	0.003-0.006	0.0045±0.0021	**NR**
	Copper	Cu	0.0073-0.011	0.0092±0.0026	0.003-0.0086	0.0058±0.0039	0.002-0.01	0.006±0.0057	ND[(f)]	ND	**≤1**
	Iron	Fe	0.4176-6.6	3.5088±4.372	0.036-0.4184	0.2272±0.2704	0.046-0.078	0.062±0.0226	0.02-0.04	0.03±0.0141	**≤0.05**
	Manganese	Mn	0.038-0.088	0.063±0.0354	0.014-0.0158	0.0149±0.0013	0.017-0.05	0.0335±0.023	0.01-0.02	0.015±0.0071	**NR**
	Nickel	Ni	0.079-0.1248	0.1019±0.0324	0.0511-0.053	0.0521±0.0014	ND-0.004	0.002±0.0028	ND-0.02	0.001±0.0014	**≤0.02**
	Lead	Pb	0.0041-0.006	0.0051±0.0013	ND-0.0016	0.0008±0.0011	0.002-0.009	0.0055±0.005	0.004-0.006	0.005±0.0014	**≤0.001**
	Zinc	Zn	0.0248-0.997	0.5109±0.6875	0.005-0.0128	0.0089±0.0055	0.008-0.021	0.0145±0.009	0.002-0.021	0.0115±0.0134	**≤1**

(a):Autumn (Oct to Dec2012),Winter (Jan to March 2013), Spring (Apr to Jun2013), Summer (Jul to Sep2013)
(b): Mean ± Standard Deviation, (C): NA: Not Analyzed, (f): ND: Not Detected
(d): EMCL: Egyptian Maximum Contaminant Limit for Raw Water, MWRI Decree 402 for 2009, (e): NR: Not Recommended

Table 4.48: Seasonal variation of heavy metals concentrations in water samples of the sample site N12 Nubaria Canal:

Point	Element	Symbol	Autumn[(a)]		winter		Spring		Summer		EMCL[(d)]
			Range	Mean±SD[(b)]	Range	Mean±SD	Range	Mean±SD	Range	Mean±SD	
Janaclis Bridge	Aluminium	Al	0.1998-0.249	0.2244±0.0348	0.043-0.3409	0.2293±0.1624	0.028-0.178	0.103±0.1061	0.104-0.149	0.1265±0.0318	**NR[(e)]**
	Cadmium	Cd	0.0021-0.009	0.0056±0.0049	ND-0.001	0.0008±0.0003	0.004-0.007	0.0055±0.002	0.003-0.005	0.004±0.0014	**≤0.003**
	Cobalt	Co	0.0039-0.008	0.0059±0.0029	ND-0.001	0.0009±0.0001	0.003-0.007	0.005±0.0028	0.003-0.006	0.0045±0.0021	**NR**
	Copper	Cu	0.0079-0.014	0.0109±0.0043	0.0037-0.008	0.0056±0.0023	0.002-0.011	0.0065±0.006	ND[(f)]-0.002	0.001±0.0014	**≤1**
	Iron	Fe	0.3501-0.373	0.3616±0.0162	0.024-0.3458	0.2372±0.1846	0.049-0.091	0.07±0.0297	0.074-0.075	0.0745±0.0007	**≤0.05**
	Manganese	Mn	0.0138-0.07	0.0419±0.0397	0.012-0.0381	0.0215±0.0145	0.01-0.038	0.024±0.0198	0.011-0.013	0.012±0.0014	**NR**
	Nickel	Ni	0.003-0.0036	0.0033±0.0005	0.0014-0.004	0.0028±0.0019	0.017-0.036	0.0265±0.013	0.002-0.016	0.009±0.0099	**≤0.02**
	Lead	Pb	0.0037-0.01	0.0069±0.0045	0.001-0.0013	0.0011±0.0002	0.003-0.009	0.006±0.0042	0.004-0.005	0.0045±0.0071	**≤0.001**
	Zinc	Zn	0.0103-0.012	0.0112±0.0012	0.006-0.0228	0.0123±0.0091	0.011-0.037	0.024±0.0184	0.002-0.017	0.0095±0.0106	**≤1**

(a):Autumn (Oct to Dec2012),Winter (Jan to March 2013), Spring (Apr to Jun2013), Summer (Jul to Sep2013)
(b): Mean ± Standard Deviation, (C): NA: Not Analyzed, (f): ND: Not Detected
(d): EMCL: Egyptian Maximum Contaminant Limit for Raw Water, MWRI Decree 402 for 2009, (e): NR: Not Recommended

Table 4.49: Seasonal variation of heavy metals concentrations in water samples of the sample site N13 Nubaria Canal:

Point	Element	Symbol	Autumn[(a)]		winter		Spring		Summer		EMCL[(d)]
			Range	Mean±SD[(b)]	Range	Mean±SD	Range	Mean±SD	Range	Mean±SD	
Nubaria WTP Intake	Aluminium	Al	0.2147-0.34	0.2774±0.0886	0.044-0.4449	0.3053±0.1781	0.162-0.208	0.185±0.0325	0.088-0.095	0.0915±0.0049	**NR[(e)]**
	Cadmium	Cd	0.002-0.009	0.0055±0.0049	0.0002-0.0027	0.0019±0.0012	0.007-0.009	0.008±0.0014	0.003-0.005	0.004±0.0014	**≤0.003**
	Cobalt	Co	0.0038-0.008	0.0059±0.0029	0.0015-0.0023	0.002±0.0004	0.006-0.007	0.0065±0.001	0.003-0.006	0.0045±0.0021	**NR**
	Copper	Cu	0.0074-0.011	0.0092±0.0026	0.006-0.0077	0.0069±0.0009	0.008-0.013	0.0105±0.004	ND[(f)]-0.005	0.0025±0.0035	**≤1**
	Iron	Fe	0.349-0.477	0.413±0.0905	0.019-0.6053	0.3727±0.2494	0.095-0.146	0.1205±0.036	0.035-0.036	0.0355±0.0007	**≤0.05**
	Manganese	Mn	0.0217-0.048	0.0349±0.0186	0.01-0.0236	0.0186±0.0059	0.027-0.036	0.0315±0.006	0.009-0.013	0.011±0.0028	**NR**
	Nickel	Ni	0.0445-0.057	0.0508±0.0088	0.0321-0.0473	0.0397±0.0108	ND-0.002	0.001±0.0014	ND-0.001	0.0005±0.0007	**≤0.02**
	Lead	Pb	0.0035-0.009	0.0063±0.0039	0.0011-0.0041	0.0031±0.0014	0.006-0.008	0.007±0.0014	0.005	0.005±0	**≤0.001**
	Zinc	Zn	0.0028-0.014	0.0084±0.0079	0.0057-0.0238	0.0113±0.0086	0.013-0.016	0.0145±0.002	0.011-0.034	0.0225±0.0163	**≤1**

(a):Autumn (Oct to Dec2012),Winter (Jan to March 2013), Spring (Apr to Jun2013), Summer (Jul to Sep2013)
(b): Mean ± Standard Deviation, (C): NA: Not Analyzed, (f): ND: Not Detected
(d): EMCL: Egyptian Maximum Contaminant Limit for Raw Water, MWRI Decree 402 for 2009, (e): NR: Not Recommended

Table 4.50: Seasonal variation of heavy metals concentrations in water samples of the sample site N14 Nubaria Canal:

Point	Element	Symbol	Autumn[(a)]		winter		Spring		Summer		EMCL[(d)]
			Range	Mean±SD[(b)]	Range	Mean±SD	Range	Mean±SD	Range	Mean±SD	
K40 WTP Intake	Aluminium	Al	0.1795-0.311	0.2453±0.0929	0.058-0.4553	0.3276±0.1875	0.197-0.28	0.2385±0.0587	0.121-0.142	0.1315±0.0149	**NR[(e)]**
	Cadmium	Cd	0.002-0.009	0.0055±0.0049	ND-0.0027	0.002±0.0012	0.007-0.009	0.008±0.0014	0.003-0.005	0.004±0.0014	**≤0.003**
	Cobalt	Co	0.0036-0.008	0.0058±0.0031	ND-0.0018	0.0015±0.0006	0.007	0.007±0	0.003-0.006	0.0045±0.0021	**NR**
	Copper	Cu	0.0073-0.011	0.0092±0.0026	0.002-0.0088	0.0062±0.0033	0.006-0.009	0.0075±0.0021	ND[(f)]-0.001	0.0005±0.0007	**≤1**
	Iron	Fe	0.2872-0.377	0.3321±0.0635	0.022-0.5635	0.3796±0.2554	0.178-0.217	0.1975±0.0276	0.094-0.095	0.0945±0.0007	**≤0.05**
	Manganese	Mn	0.012-0.019	0.0155±0.0049	0.013-0.0435	0.0298±0.016	0.04-0.062	0.051±0.0156	0.012-0.017	0.0145±0.0035	**NR**
	Nickel	Ni	0.0021-0.0039	0.003±0.0013	0.005-0.0012	0.0031±0.0027	0.001-0.009	0.0054±0.006	0.001-0.005	0.0031±0.0023	**≤0.02**
	Lead	Pb	0.0032-0.009	0.0061±0.0041	0.014-0.036	0.025±0.0156	0.008-0.009	0.0085±0.0007	0.004-0.005	0.0045±0.0007	**≤0.001**
	Zinc	Zn	0.0005-0.017	0.0088±0.0117	ND-0.0125	0.0109±0.0027	0.014-0.061	0.0375±0.0332	0.015-0.045	0.03±0.0212	**≤1**

(a):Autumn (Oct to Dec2012),Winter (Jan to March 2013), Spring (Apr to Jun2013), Summer (Jul to Sep2013)
(b): Mean ± Standard Deviation, (C): NA: Not Analyzed, (f): ND: Not Detected
(d): EMCL: Egyptian Maximum Contaminant Limit for Raw Water, MWRI Decree 402 for 2009, (e): NR: Not Recommended

4.2 Bactriological analysis of water samples:

4.2. 1. Total Coliform

The total coliform group is a large collection of different kinds of bacteria. Fecal coliforms are types of total coliform that mostly exist in feces.

When a water sample is sent to a lab, it is tested for total coliform. If total coliform is present, the sample will also be tested for either fecal coliform or E. coli, depending on the lab testing method.

Total coliform in all water samples varied from 400 CFU/100 ml in sample site H01 to 39000 CFU/100 ml in sample site H02 in Mahmoudia canal and varied from 450 CFU/100 ml in sample site N05 to 280000 CFU/100 ml in sample site N10 in Nubaria canal.

4.2. 2. Fecal Coliform

Fecal Coliform counts exceeded the WHO Guidelines (4) of 1000 CFU/100 ml in almost water samples sites; the median is 12500 CFU/100 ml. This is an indication of the discharge of human wastes in Mahmoudia and Nubaria canals.

4.51: Seasonal variation of the Microbiological parameters in water samples of the sample site H01 in Mahmoudia canal:

Point	Element	Unit	Autumn[(a)]		winter		Spring		Summer	
			Range	Mean±SD[(b)]	Range	Mean±SD	Range	Mean±SD	Range	Mean±SD
H01	Total Coliform	cfu/100 mL	2500-17000	7566.7±8177	400-7900	3233.3±4072.3	2300-4500	3133.3±1193	2300-21000	10566.7±9536.4
	Fecal Coliform	cfu/100 mL	360-4000	1653.3±2035.8	100-1900	700±1039.2	300-1000	600±360.6	700-9100	4066.7±4441

(a):Autumn (Oct to Dec2012),Winter (Jan to March 2013), Spring (Apr to Jun2013), Summer (Jul to Sep2013)- (b): Mean ± Standard Deviation

4.52: Seasonal variation of the Microbiological parameters in water samples of the sample site H02 in Mahmoudia canal:

Point	Element	Unit	Autumn[(a)]		winter		Spring		Summer	
			Range	Mean±SD[(b)]	Range	Mean±SD	Range	Mean±SD	Range	Mean±SD
H02	Total Coliform	cfu/100 mL	4000-23000	10866.7±10538.2	2000-7200	4733.3±2610.2	3300-10000	7733.3±3839.7	3700-39000	21566.7±17654
	Fecal Coliform	cfu/100 mL	400-600	513.3±102.6	100-2000	766.7±1069.2	1000-3600	1900±1473.1	1000-6000	2733.3±2830.8

(a):Autumn (Oct to Dec2012),Winter (Jan to March 2013), Spring (Apr to Jun2013), Summer (Jul to Sep2013)- (b): Mean ± Standard Deviation

4.53: Seasonal variation of the Microbiological parameters in water samples of the sample site H03 in Mahmoudia canal:

Point	Element	Unit	Autumn[(a)]		winter		Spring		Summer	
			Range	Mean±SD[(b)]	Range	Mean±SD	Range	Mean±SD	Range	Mean±SD
H03	Total Coliform	cfu/100 mL	4400-7500	5833.3±156.1	1200-11000	6166.7±4901.4	3800-5400	4400±871.8	5000-11000	7566.7±3092.5
	Fecal Coliform	cfu/100 mL	540-700	613.3±80.8	300-3000	1400±1417.7	900-1500	1200±300	2100-6900	3866.7±2638.8

(a):Autumn (Oct to Dec2012),Winter (Jan to March 2013), Spring (Apr to Jun2013), Summer (Jul to Sep2013)- (b): Mean ± Standard Deviation

4.54: Seasonal variation of the Microbiological parameters in water samples of the sample site H04 in Mahmoudia canal:

Point	Element	Unit	Autumn[(a)]		winter		Spring		Summer	
			Range	Mean±SD[(b)]	Range	Mean±SD	Range	Mean±SD	Range	Mean±SD
H04	Total Coliform	cfu/100 mL	4200-12000	8033.3±3901.7	1500-9800	5366.7±4178.9	9100-11000	10000±953.9	9700-16000	12566.7±3188
	Fecal Coliform	cfu/100 mL	1100-1600	1366.7±251.7	100-2200	966.7±1096.9	1100-4000	2600±1452.6	2600-7500	4633.3±2554.1

(a):Autumn (Oct to Dec2012),Winter (Jan to March 2013), Spring (Apr to Jun2013), Summer (Jul to Sep2013)- (b): Mean ± Standard Deviation

4.55: Seasonal variation of the Microbiological parameters in water samples of the sample site H05 in Mahmoudia canal:

Point	Element	Unit	Autumn[(a)]		winter		Spring		Summer	
			Range	Mean±SD[(b)]	Range	Mean±SD	Range	Mean±SD	Range	Mean±SD
H05	Total Coliform	cfu/100 mL	4700-12000	8133.3±3669.2	2300-9300	5500±3538.4	4100-8500	6733.3±2324.5	6700-18000	10800±6255.4
	Fecal Coliform	cfu/100 mL	700-1100	966.7±230.9	300-1800	1033.3±750.6	1100-2400	1866.7±680.7	2400-3300	2900±958.3

(a):Autumn (Oct to Dec2012),Winter (Jan to March 2013), Spring (Apr to Jun2013), Summer (Jul to Sep2013)- (b): Mean ± Standard Deviation

4.56: Seasonal variation of the Microbiological parameters in water samples of the sample site H06 in Mahmoudia canal:

Point	Element	Unit	Autumn[(a)]		winter		Spring		Summer	
			Range	Mean±SD[(b)]	Range	Mean±SD	Range	Mean±SD	Range	Mean±SD
H06	Total Coliform	cfu/100 mL	4300-8300	6133.3±2020.7	500-8000	4766.7±3855.3	4000-9100	6633.3±2554	5400-5800	5600±200
	Fecal Coliform	cfu/100 mL	500-900	736.7±209.8	800-2600	1433.3±1011.6	1800-2900	2200±608.3	1900-2200	2066.7±152.8

(a):Autumn (Oct to Dec2012),Winter (Jan to March 2013), Spring (Apr to Jun2013), Summer (Jul to Sep2013)- (b): Mean ± Standard Deviation

4.57: Seasonal variation of the Microbiological parameters in water samples of the sample site H07 in Mahmoudia canal:

Point	Element	Unit	Autumn[a]		winter		Spring		Summer	
			Range	Mean±SD[b]	Range	Mean±SD	Range	Mean±SD	Range	Mean±SD
H07	Total Coliform	cfu/100 mL	7000-11000	9100±2007.5	4000-7300	5300±1757.8	6000-11000	8033.3±2627.4	4600-13000	8466.7±4239.5
	Fecal Coliform	cfu/100 mL	200-1900	1100±854.4	800-2400	1366.7±896.3	1800-4500	3066.7±1357.7	1800-3500	2633.3±850.5

(a):Autumn (Oct to Dec2012),Winter (Jan to March 2013), Spring (Apr to Jun2013), Summer (Jul to Sep2013)- (b): Mean ± Standard Deviation

4.58: Seasonal variation of the Microbiological parameters in water samples of the sample site H08 in Mahmoudia canal:

Point	Element	Unit	Autumn[a]		winter		Spring		Summer	
			Range	Mean±SD[b]	Range	Mean±SD	Range	Mean±SD	Range	Mean±SD
H08	Total Coliform	cfu/100 mL	6900-11000	8500±2193.2	5900-19000	11400±6797.8	8000-12000	10000±2000	12000	12000±0
	Fecal Coliform	cfu/100 mL	500-1500	1066.7±513.2	800-4900	2200±2338.8	1300-3200	2500±1044	4600-5500	5033.3±451

(a):Autumn (Oct to Dec2012),Winter (Jan to March 2013), Spring (Apr to Jun2013), Summer (Jul to Sep2013)- (b): Mean ± Standard Deviation

4.59: Seasonal variation of the Microbiological parameters in water samples of the sample site H09 in Mahmoudia canal:

Point	Element	Unit	Autumn[a]		winter		Spring		Summer	
			Range	Mean±SD[b]	Range	Mean±SD	Range	Mean±SD	Range	Mean±SD
H09	Total Coliform	cfu/100 mL	12000-24000	16333.3±6658.3	10000-18000	13000±4358.9	7500-9500	8366.7±1026.3	17000-23000	19666.7±3055
	Fecal Coliform	cfu/100 mL	300-9100	3343.3±4988.1	1100-4800	2466.7±2030.6	300-2600	1633.3±1193	4800-8600	7133.3±2043

(a):Autumn (Oct to Dec2012),Winter (Jan to March 2013), Spring (Apr to Jun2013), Summer (Jul to Sep2013)- (b): Mean ± Standard Deviation

4.60: Seasonal variation of the Microbiological parameters in water samples of the sample site H10 in Mahmoudia canal:

Point	Element	Unit	Autumn[(a)]		winter		Spring		Summer	
			Range	Mean±SD[(b)]	Range	Mean±SD	Range	Mean±SD	Range	Mean±SD
H10	Total Coliform	cfu/100 mL	2400-6100	4333.3±1855.6	2600-6100	4166.7±1778.6	1800-2400	2100±300	4000-13000	9000-9582.6
	Fecal Coliform	cfu/100 mL	400-540	480±72.1	100-800	433.3±351.2	500-600	533.3±57.7	800-3800	2200-1510

(a):Autumn (Oct to Dec2012),Winter (Jan to March 2013), Spring (Apr to Jun2013), Summer (Jul to Sep2013)- (b): Mean ± Standard Deviation

4.61: Seasonal variation of the Microbiological parameters in water samples of the sample site H11 in Mahmoudia canal:

Point	Element	Unit	Autumn[(a)]		winter		Spring		Summer	
			Range	Mean±SD[(b)]	Range	Mean±SD	Range	Mean±SD	Range	Mean±SD
H11	Total Coliform	cfu/100 mL	2200-5300	4066.7±1644.2	3500-5100	4200±818.5	3500-6000	4666.7±1258.3	3400-10000	6466.7±3324.7
	Fecal Coliform	cfu/100 mL	180-400	293.3±110.2	400-700	600±173.2	400-750	583.3±175.6	500-3000	1533.3±1305.1

(a):Autumn (Oct to Dec2012),Winter (Jan to March 2013), Spring (Apr to Jun2013), Summer (Jul to Sep2013)- (b): Mean ± Standard Deviation

4.62: Seasonal variation of the Microbiological parameters in water samples of the sample site N01 in Nubaria canal:

Point	Element	Unit	Autumn[a]		winter		Spring		Summer	
			Range	Mean±SD[b]	Range	Mean±SD	Range	Mean±SD	Range	Mean±SD
N01	Total Coliform	cfu/100 mL	1100-12000	6500±5450.7	1400-12000	4966.7±6091.3	2500-4500	3500±100	2100-25000	9800±13164
	Fecal Coliform	cfu/100 mL	220-1900	1306.7±942.4	170-2400	946.7±1259.6	440-680	583.3±126.6	450-3100	1716.7±1328.8

(a):Autumn (Oct to Dec2012),Winter (Jan to March 2013), Spring (Apr to Jun2013), Summer (Jul to Sep2013)- (b): Mean ± Standard Deviation

4.63: Seasonal variation of the Microbiological parameters in water samples of the sample site N02 in Nubaria canal:

Point	Element	Unit	Autumn[a]		winter		Spring		Summer	
			Range	Mean±SD[b]	Range	Mean±SD	Range	Mean±SD	Range	Mean±SD
N02	Total Coliform	cfu/100 mL	11000-160000	66000±81798.5	28000-49000	35666.7±11590.2	25000-33000	28000±4358.9	4000-74000	31333.3±37434.4
	Fecal Coliform	cfu/100 mL	2500-13000	6766.7±5519.4	7000-10000	8500±1500	3100-5500	4500±1249	500-12000	6233.3±5750.1

(a):Autumn (Oct to Dec2012),Winter (Jan to March 2013), Spring (Apr to Jun2013), Summer (Jul to Sep2013)- (b): Mean ± Standard Deviation

4.64: Seasonal variation of the Microbiological parameters in water samples of the sample site N03 in Nubaria canal:

Point	Element	Unit	Autumn[a]		winter		Spring		Summer	
			Range	Mean±SD[b]	Range	Mean±SD	Range	Mean±SD	Range	Mean±SD
N03	Total Coliform	cfu/100 mL	2100-4000	3500±1228.8	1300-5200	3466.7±1985.8	2500-7800	4600±2816	1900-2800	2466.7±493.3
	Fecal Coliform	cfu/100 mL	140-1100	723.3±512.3	200-710	406.7±268.4	590-820	706.7±115.04	310-760	593.3±246.6

(a):Autumn (Oct to Dec2012),Winter (Jan to March 2013), Spring (Apr to Jun2013), Summer (Jul to Sep2013)- (b): Mean ± Standard Deviation

4.65: Seasonal variation of the Microbiological parameters in water samples of the sample site N04 in Nubaria canal:

Point	Element	Unit	Autumn[a]		winter		Spring		Summer	
			Range	Mean±SD[b]	Range	Mean±SD	Range	Mean±SD	Range	Mean±SD
N04	Total Coliform	cfu/100 mL	630-2100	1310±741.1	500-700	616.7±104.1	500-1300	833.3±416.3	1000-2200	1466.7±643
	Fecal Coliform	cfu/100 mL	120-310	186.7±106.9	190-310	240±62.4	140-340	230±101.5	180-660	470±255.1

(a):Autumn (Oct to Dec2012),Winter (Jan to March 2013), Spring (Apr to Jun2013), Summer (Jul to Sep2013)- (b): Mean ± Standard Deviation

4.66: Seasonal variation of the Microbiological parameters in water samples of the sample site N05 in Nubaria canal:

Point	Element	Unit	Autumn[a]		winter		Spring		Summer	
			Range	Mean±SD[b]	Range	Mean±SD	Range	Mean±SD	Range	Mean±SD
N05	Total Coliform	cfu/100 mL	450-200000	67850±114453	2000-3300	2733.3±665.8	900-3700	2633.3±1514.4	2300-2800	2600±264.6
	Fecal Coliform	cfu/100 mL	90-16000	5693.3±8937.2	320-630	526.7±179	300-750	493.3±231.6	690-1100	843.3±223.7

(a):Autumn (Oct to Dec2012),Winter (Jan to March 2013), Spring (Apr to Jun2013), Summer (Jul to Sep2013)- (b): Mean ± Standard Deviation

4.67: Seasonal variation of the Microbiological parameters in water samples of the sample site N06 in Nubaria canal:

Point	Element	Unit	Autumn[a]		Winter		Spring		Summer	
			Range	Mean±SD[b]	Range	Mean±SD	Range	Mean±SD	Range	Mean±SD
N06	Total Coliform	cfu/100 mL	25000-34000	28666.7±4725.8	13000-29000	19333.3±8504.9	9600-20000	13866.7±5445.5	8500-18000	12500±4924.4
	Fecal Coliform	cfu/100 mL	2650-5900	3850±1784	420-4600	2540±2090.6	1800-4700	3066.7±1484.4	400-3200	2033.3±1457.2

(a):Autumn (Oct to Dec2012),Winter (Jan to March 2013), Spring (Apr to Jun2013), Summer (Jul to Sep2013)- (b): Mean ± Standard Deviation

4.68: Seasonal variation of the Microbiological parameters in water samples of the sample site N07 in Nubaria canal:

Point	Element	Unit	Autumn[a]		winter		Spring		Summer	
			Range	Mean±SD[b]	Range	Mean±SD	Range	Mean±SD	Range	Mean±SD
N07	Total Coliform	cfu/100 mL	630-130000	44410±74129.7	800-3500	1933.3±1401.2	800-2300	1600±755	900-1200	1033.3±152.8
	Fecal Coliform	cfu/100 mL	70-1500	776.7±715.1	180-790	423.3±323.2	210-560	426.7±189.3	310-760	496.7±234.6

(a):Autumn (Oct to Dec2012),Winter (Jan to March 2013), Spring (Apr to Jun2013), Summer (Jul to Sep2013)- (b): Mean ± Standard Deviation

4.69: Seasonal variation of the Microbiological parameters in water samples of the sample site N08 in Nubaria canal:

Point	Element	Unit	Autumn[a]		winter		Spring		Summer	
			Range	Mean±SD[b]	Range	Mean±SD	Range	Mean±SD	Range	Mean±SD
N08	Total Coliform	cfu/100 mL	720-2000	1373.3±640.4	800-29000	10666.7±15892.6	1300-4000	2233.3±1530.8	1200-19000	7200±10219.6
	Fecal Coliform	cfu/100 mL	70-450	196.7±219.4	370-11000	3990±6072	220-810	486.7±299.1	240-700	403.3±257.4

(a):Autumn (Oct to Dec2012),Winter (Jan to March 2013), Spring (Apr to Jun2013), Summer (Jul to Sep2013)- (b): Mean ± Standard Deviation

4.70: Seasonal variation of the Microbiological parameters in water samples of the sample site N09 in Nubaria canal:

Point	Element	Unit	Autumn[a]		winter		Spring		Summer	
			Range	Mean±SD[b]	Range	Mean±SD	Range	Mean±SD	Range	Mean±SD
N09	Total Coliform	cfu/100 mL	2700-21000	9300±10160.2	1500-6100	3333.3±2437.9	900-1600	1300±360.6	800-1400	1133.3±305.5
	Fecal Coliform	cfu/100 mL	90-950	663.3±496.5	40-1300	636.7±632.6	250-560	450±173.5	230-660	493.3±230.7

(a):Autumn (Oct to Dec2012),Winter (Jan to March 2013), Spring (Apr to Jun2013), Summer (Jul to Sep2013)- (b): Mean ± Standard Deviation

4.71: Seasonal variation of the Microbiological parameters in water samples of the sample site N10 in Nubaria canal:

Point	Element	Unit	Autumn[a]		winter		Spring		Summer	
			Range	Mean±SD[b]	Range	Mean±SD	Range	Mean±SD	Range	Mean±SD
N10	Total Coliform	cfu/100 mL	92000-280000	174000±96270.5	15000-45000	29333.3±15044.4	1700-66000	43233.3±36024.5	3200-18000	8800±8029.9
	Fecal Coliform	cfu/100 mL	10000-16000	12000±3464	880-9300	3926.7±4667.3	490-7300	3930±3405.5	1200-2400	1966.7±665.8

(a):Autumn (Oct to Dec2012),Winter (Jan to March 2013), Spring (Apr to Jun2013), Summer (Jul to Sep2013)- (b): Mean ± Standard Deviation

4.72: Seasonal variation of the Microbiological parameters in water samples of the sample site N11 in Nubaria canal:

Point	Element	Unit	Autumn[a]		winter		Spring		Summer	
			Range	Mean±SD[b]	Range	Mean±SD	Range	Mean±SD	Range	Mean±SD
N11	Total Coliform	cfu/100 mL	4500-19000	10533±7550.1	3800-9000	5600±2946.2	1600-3300	2300±888.8	2100-33000	18700±15577.9
	Fecal Coliform	cfu/100 mL	1100-2500	1566.7±808.3	200-1000	550±409.3	300-630	470±165.2	450-5600	3550±2730.8

(a):Autumn (Oct to Dec2012),Winter (Jan to March 2013), Spring (Apr to Jun2013), Summer (Jul to Sep2013)- (b): Mean ± Standard Deviation

4.73: Seasonal variation of the Microbiological parameters in water samples of the sample site N12 in Nubaria canal:

Point	Element	Unit	Autumn[a]		winter		Spring		Summer	
			Range	Mean±SD[b]	Range	Mean±SD	Range	Mean±SD	Range	Mean±SD
N12	Total Coliform	cfu/100 mL	720-2400	1640±851.4	2300-26000	10233.3±13654.4	1100-2200	1566.7±568.6	1000-1700	1266.7±378.6
	Fecal Coliform	cfu/100 mL	110-310	216.7±100.7	460-1200	733.3±406.1	340-520	410±96.4	270-490	366.7±112.4

(a):Autumn (Oct to Dec2012),Winter (Jan to March 2013), Spring (Apr to Jun2013), Summer (Jul to Sep2013)- (b): Mean ± Standard Deviation

4.74: Seasonal variation of the Microbiological parameters in water samples of the sample site N13 in Nubaria canal:

Point	Element	Unit	Autumn[(a)]		winter		Spring		Summer	
			Range	Mean±SD[(b)]	Range	Mean±SD	Range	Mean±SD	Range	Mean±SD
N13	Total Coliform	cfu/100 mL	1300-7300	3500±3304.5	2100-2900	2600±435.9	1000-1500	1233.3±251.7	1000-3200	2200±1113.6
	Fecal Coliform	cfu/100 mL	220-460	380±138.6	200-1000	530±418	290-420	333.3±75.1	260-730	420±268.5

(a):Autumn (Oct to Dec2012),Winter (Jan to March 2013), Spring (Apr to Jun2013), Summer (Jul to Sep2013)- (b): Mean ± Standard Deviation

4.75: Seasonal variation of the Microbiological parameters in water samples of the sample site N14 in Nubaria canal:

Point	Element	Unit	Autumn[(a)]		winter		Spring		Summer	
			Range	Mean±SD[(b)]	Range	Mean±SD	Range	Mean±SD	Range	Mean±SD
N14	Total Coliform	cfu/100 mL	1200-2500	2066.7±750.6	800-1800	1200±529.2	1000-15000	1233.3±251.7	1000-2200	1633.3±602.8
	Fecal Coliform	cfu/100 mL	310-430	383.3±46.3	240-380	310±70	180-410	276.7±119.3	240-330	296.7±49.3

(a):Autumn (Oct to Dec2012),Winter (Jan to March 2013), Spring (Apr to Jun2013), Summer (Jul to Sep2013)- (b): Mean ± Standard Deviation

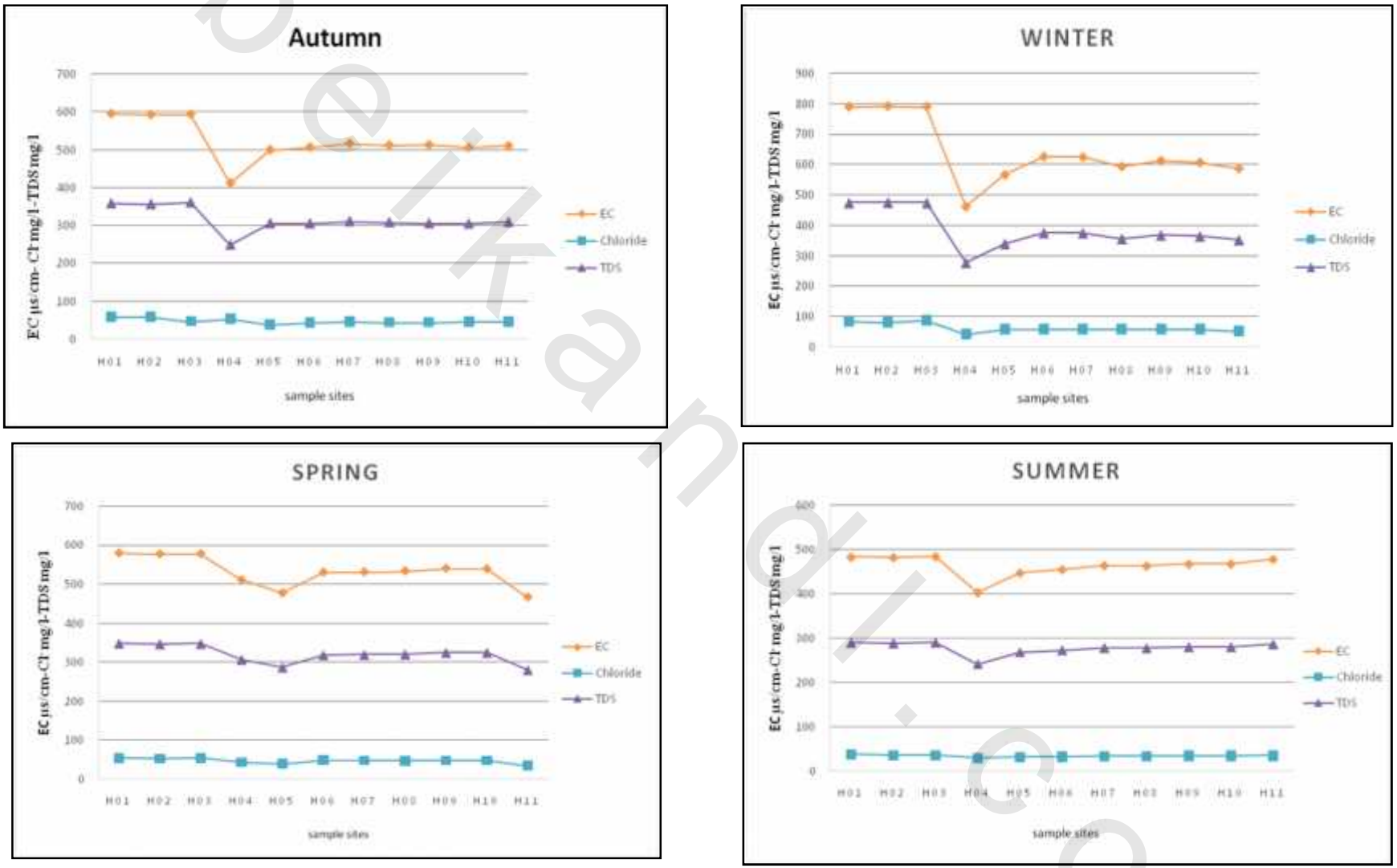


Figure 4.1: Seasonal variation EC, Chloride, and TDS in Mahmoudia canal

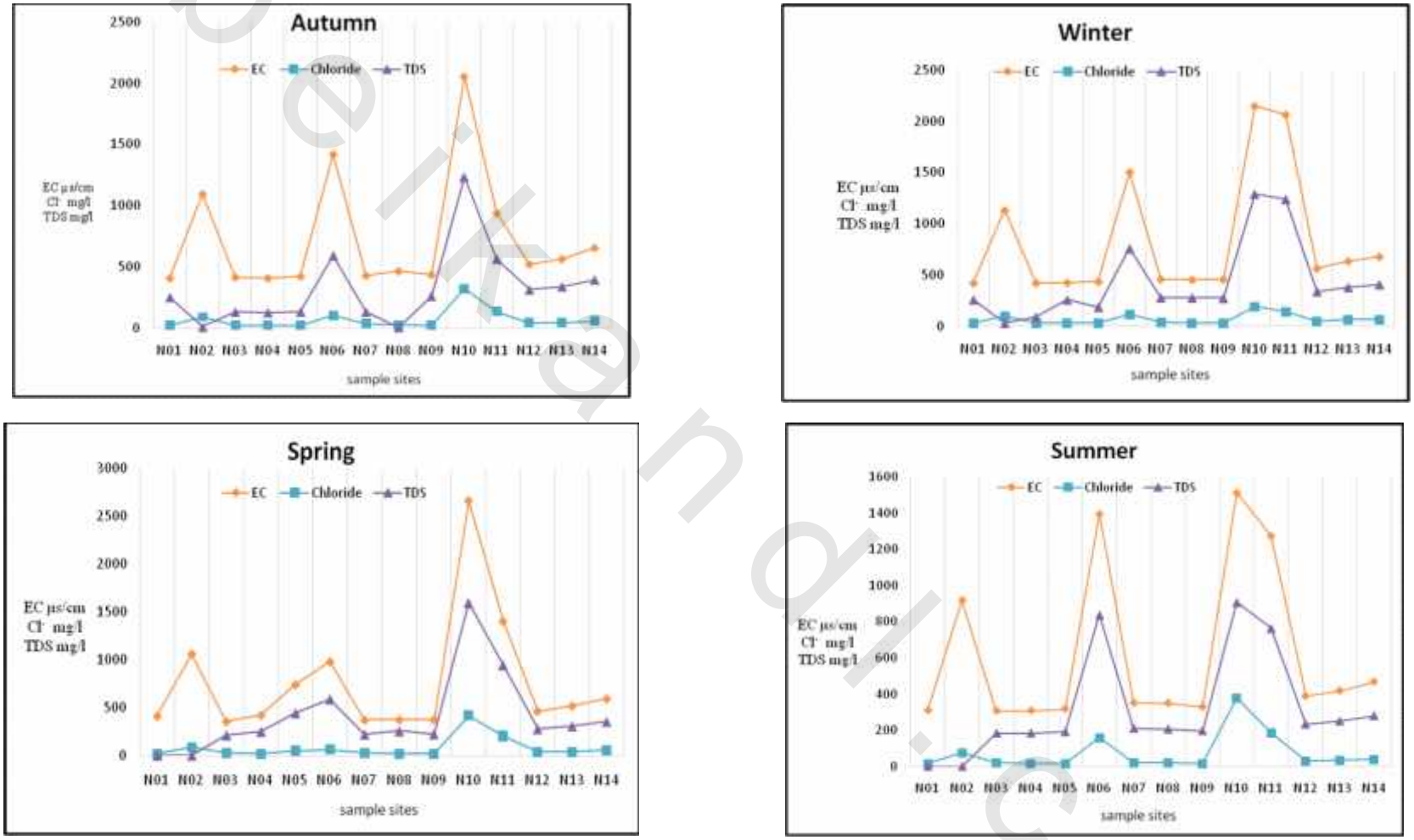


Figure 4.2: Seasonal variation EC, Chloride, and TDS in Nubaria canal

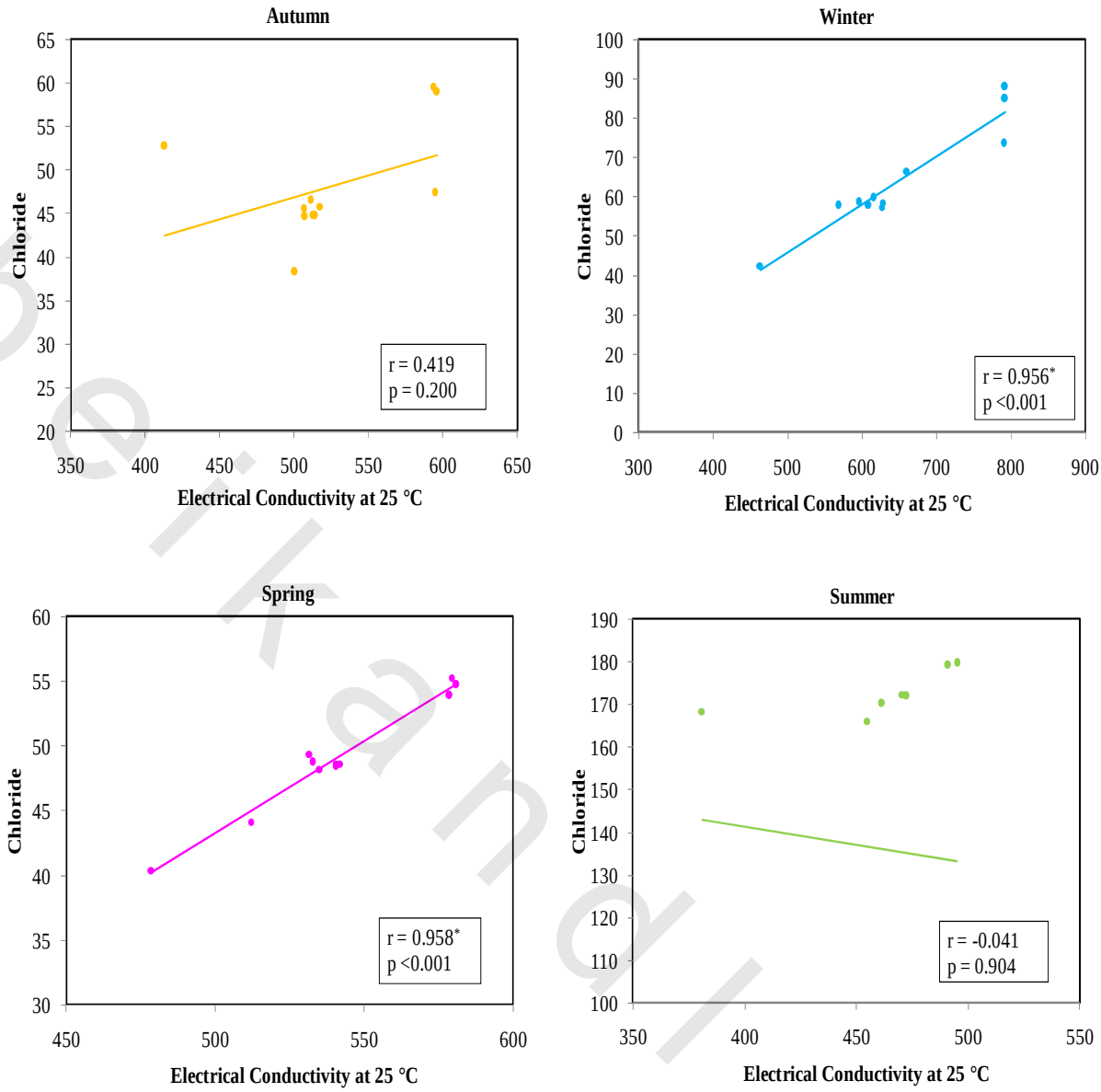


Figure 4.3: Correlation between EC and Chloride in Mahmoudia canal

Figure 4.3 showed that in winter and spring strong correlation (r > 0.75) were observed with statistical significant difference. On the other hand, moderate correlation was observed with no significant difference ($p > 0.05$) in autumn and negative correlation was observed with no significant difference ($p > 0.05$) in summer.

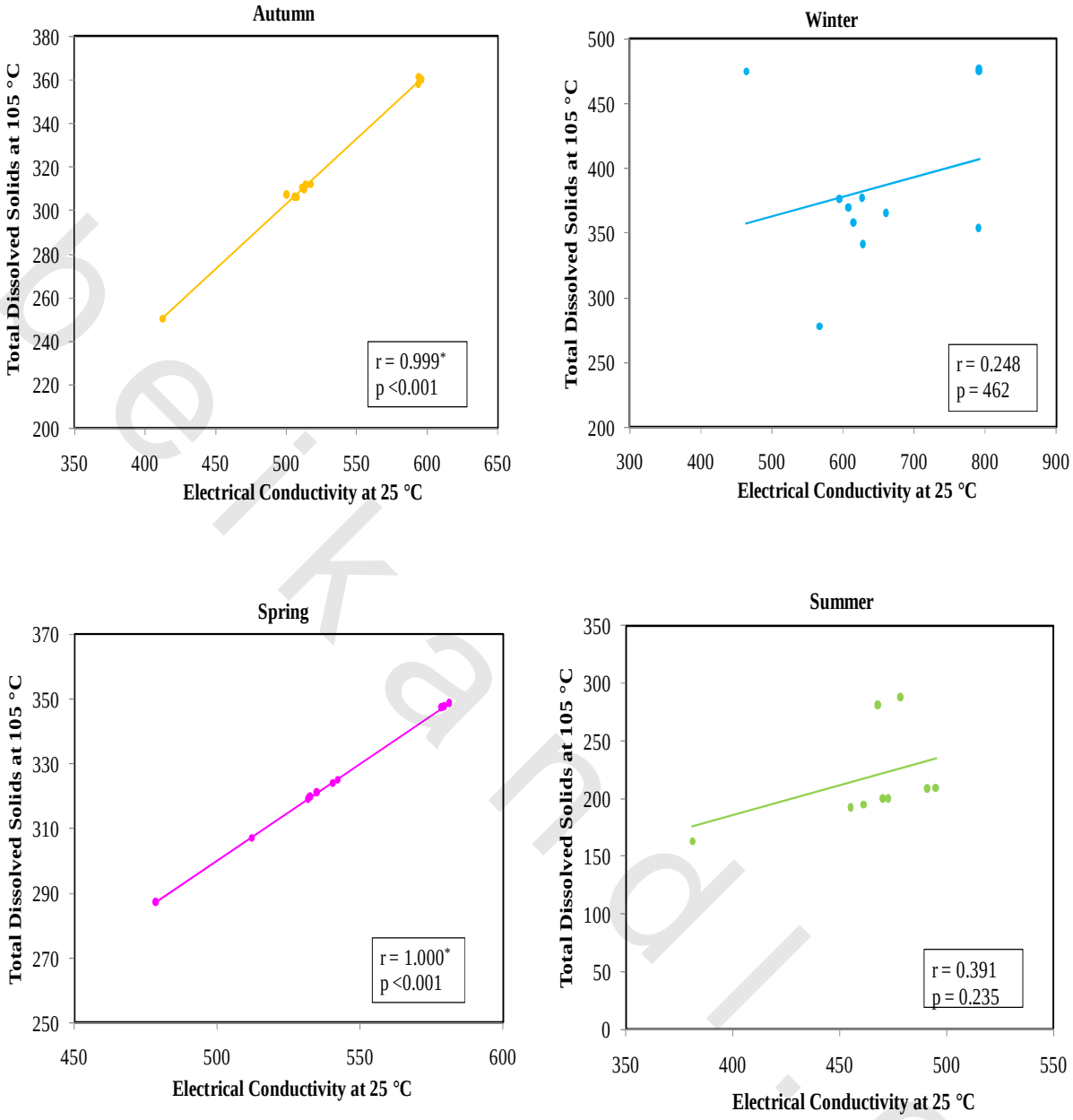


Figure 4.4: Correlation between EC and TDS in Mahmoudia canal

Figure 4.4 showed that direct relation between EC and TDS were observed -Strong correlation ($r > 0.75$) in autumn and spring, moderate correlation in summer and weak correlation ($r < 0.25$) in winter -with significant difference ($p < 0.05$) only detected in spring and autumn.

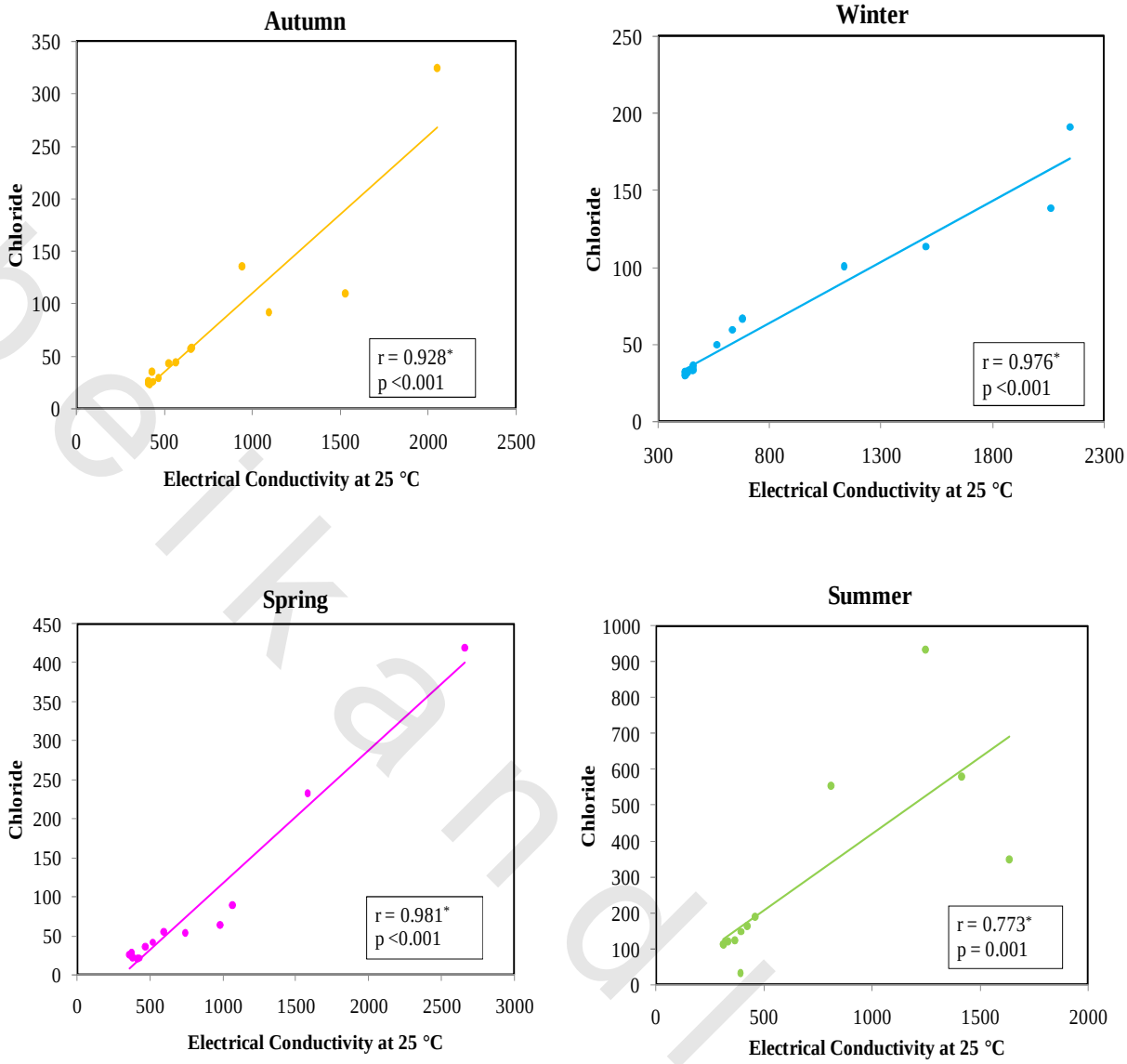


Figure 4.5: Correlation between EC and Chloride in Nubaria canal

Figure 4.5 showed that strong correlation ($r > 0.75$) was observed with statistical significant difference ($p < 0.05$) detected in all seasons.

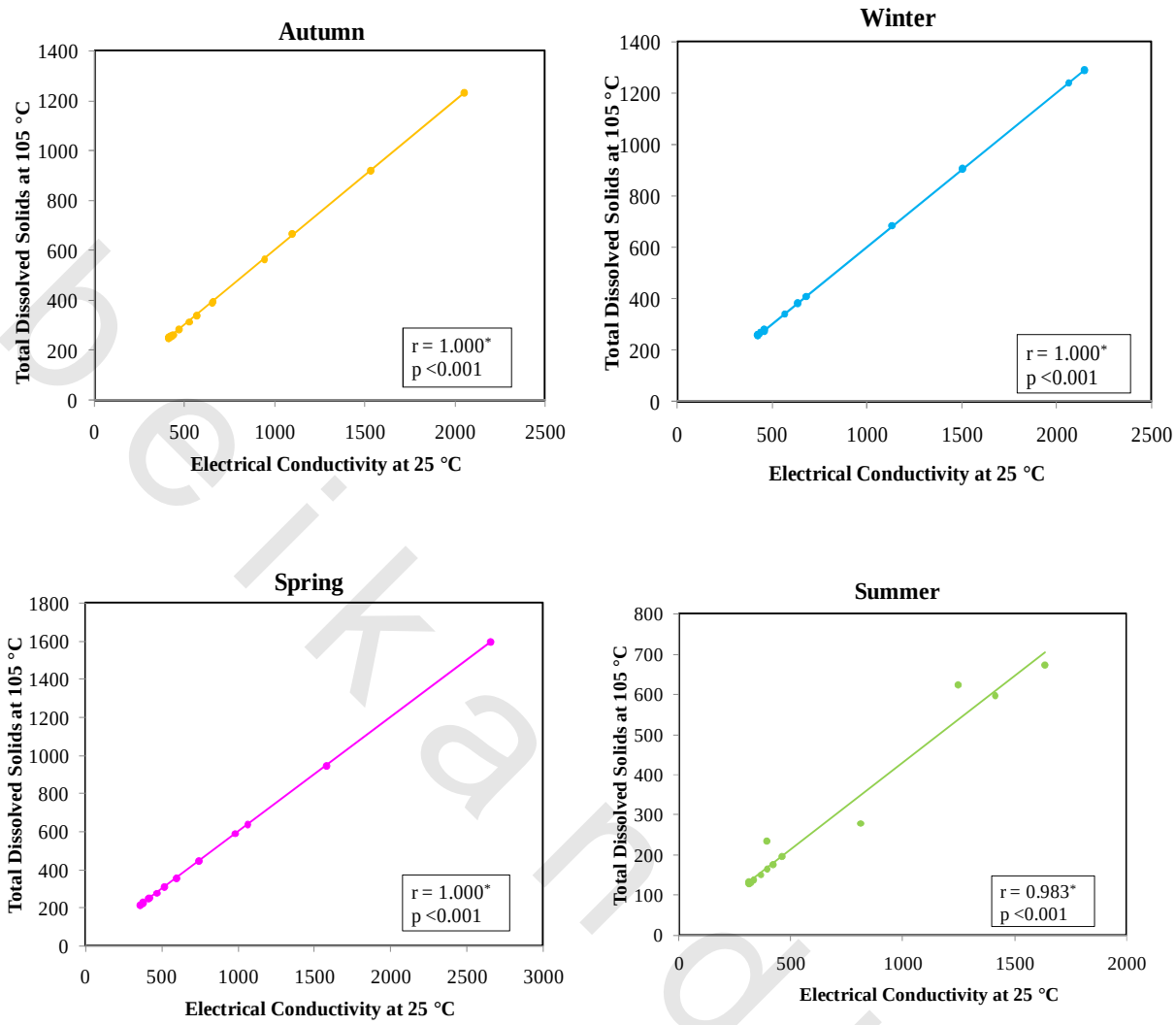


Figure 4.6: Correlation between EC and TDS in Nubaria canal

Figure 4.6 showed that strong correlation ($r > 0.75$) was observed with statistical significant difference ($p < 0.05$) detected in all seasons.

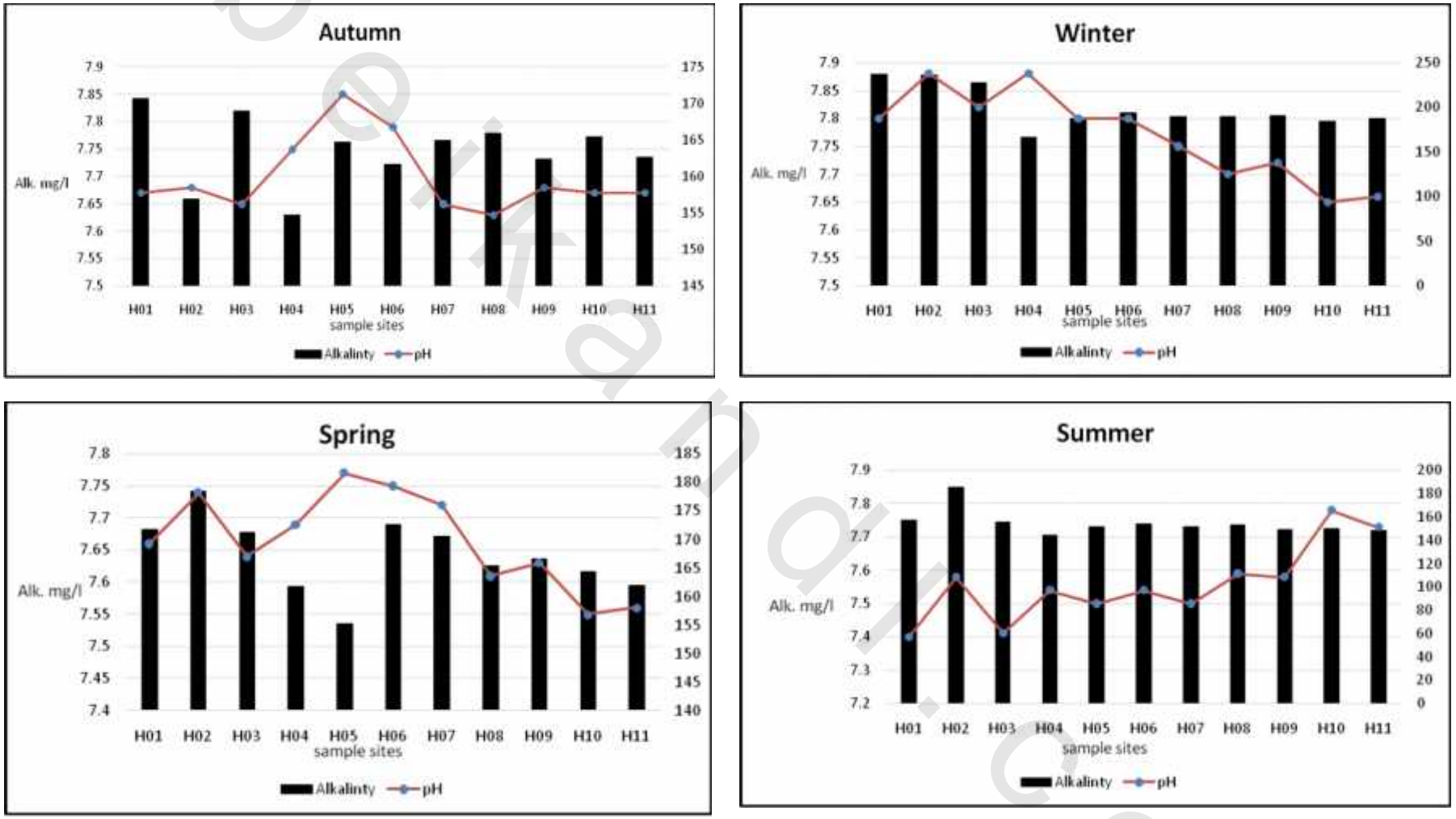


Figure 4.7: Seasonal variation pH and Alkalinity in Mahmoudia canal

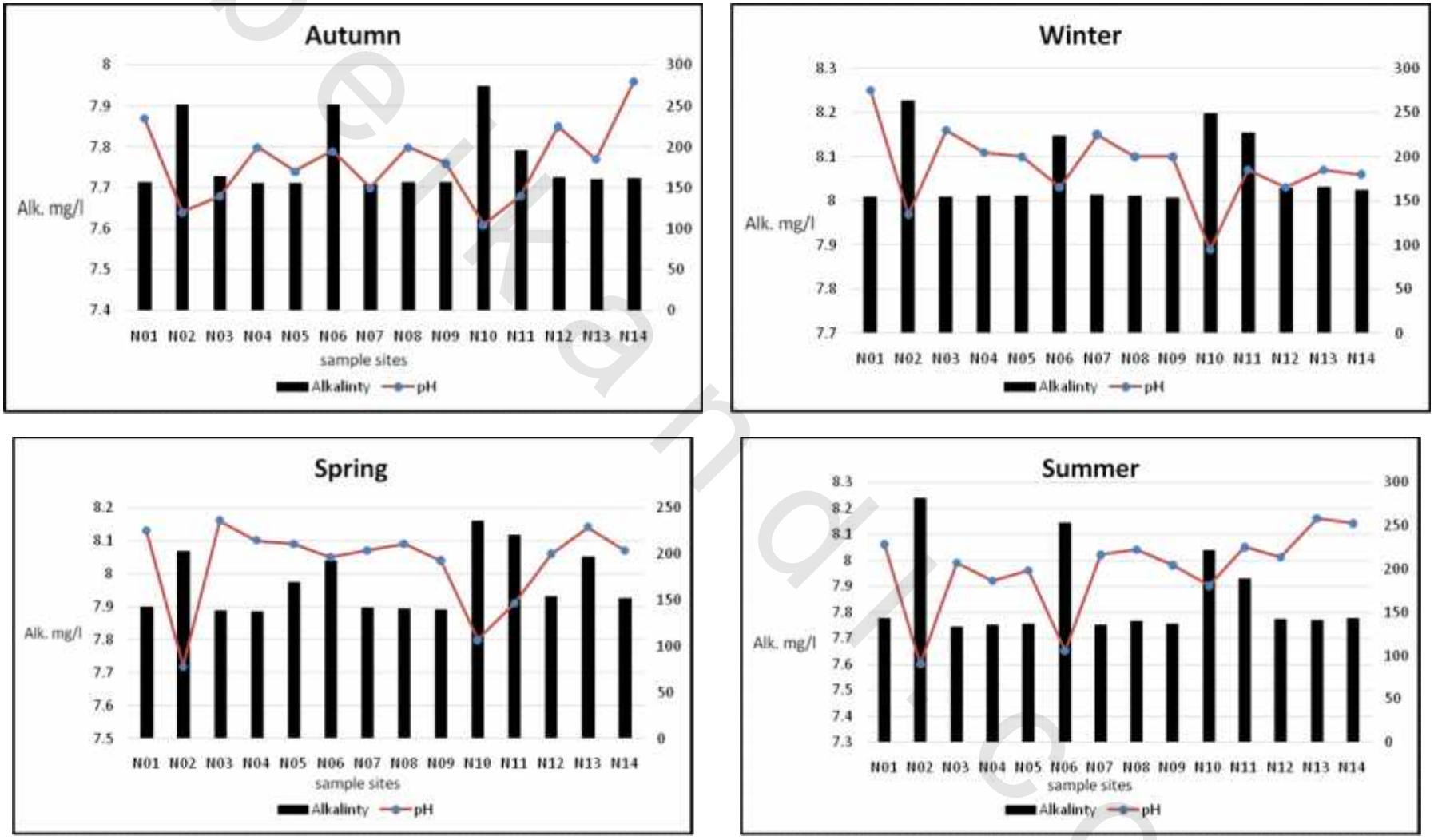


Figure 4.8: Seasonal variation pH and Alkalinity in Nubaria canal

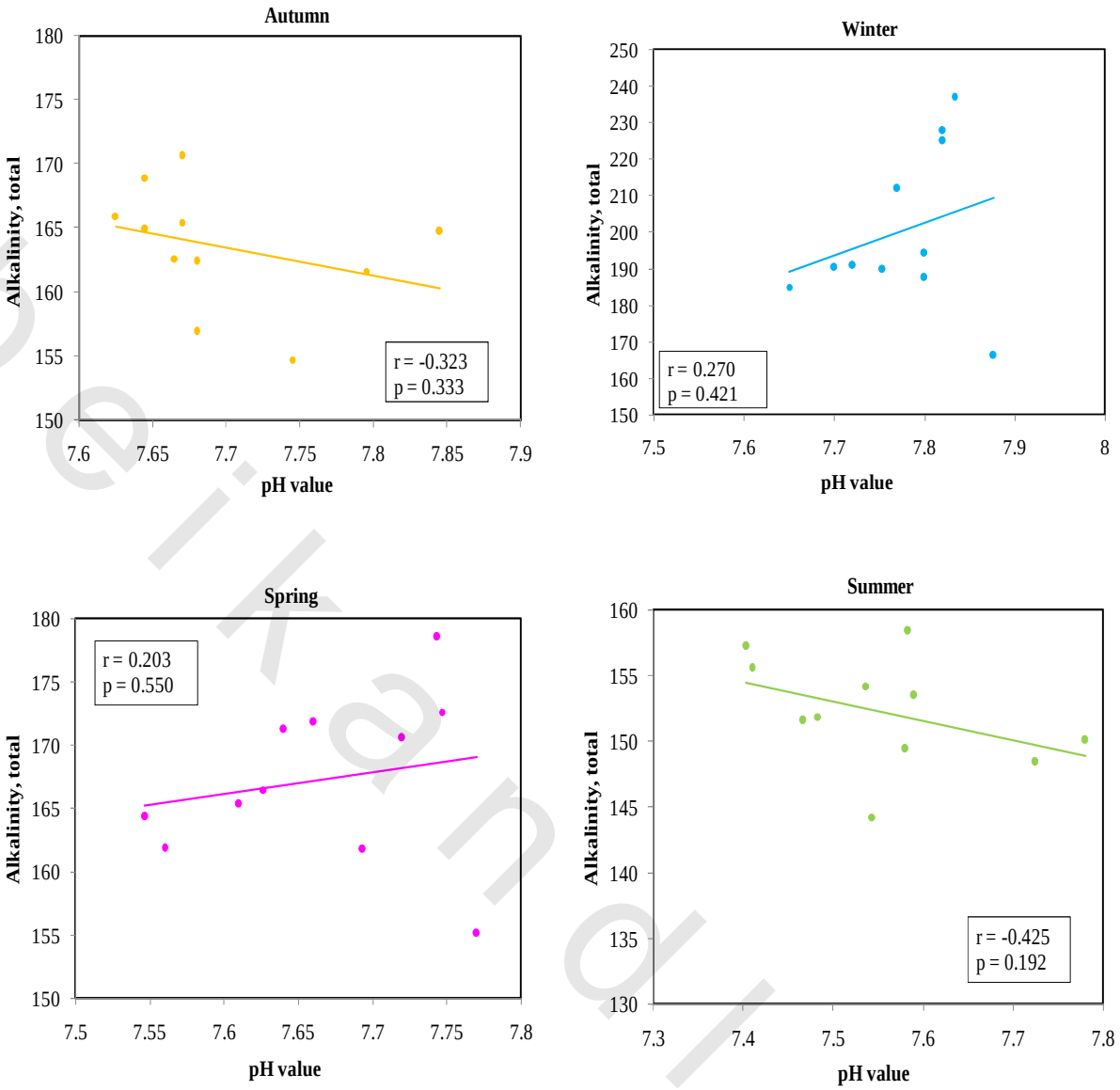


Figure 4.9: Correlation between pH and Alkalinity in Mahmoudia canal

Figure 4.9 showed that negative correlation between pH and alkalinity was observed in summer and autumn with no significant difference ($p > 0.05$) in all seasons.

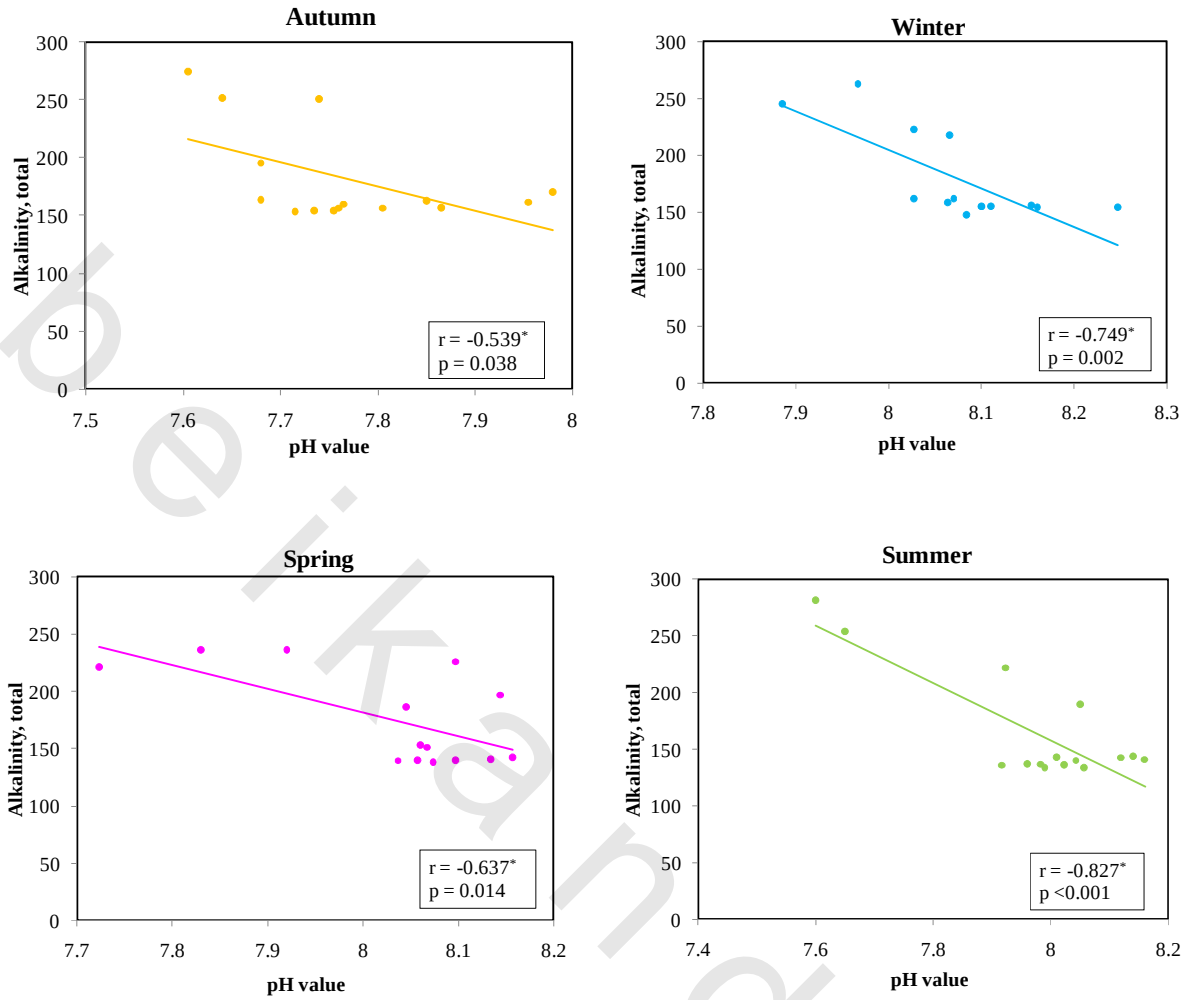


Figure 4.10: Correlation between pH and Alkalinity in Nubaria canal

Figure 4.10 showed that negative correlation between pH and alkalinity was observed in all seasons, strong correlation in winter and summer ($r > 0.75$) and moderate correlation in autumn and spring with significant difference ($p < 0.05$) in all seasons.

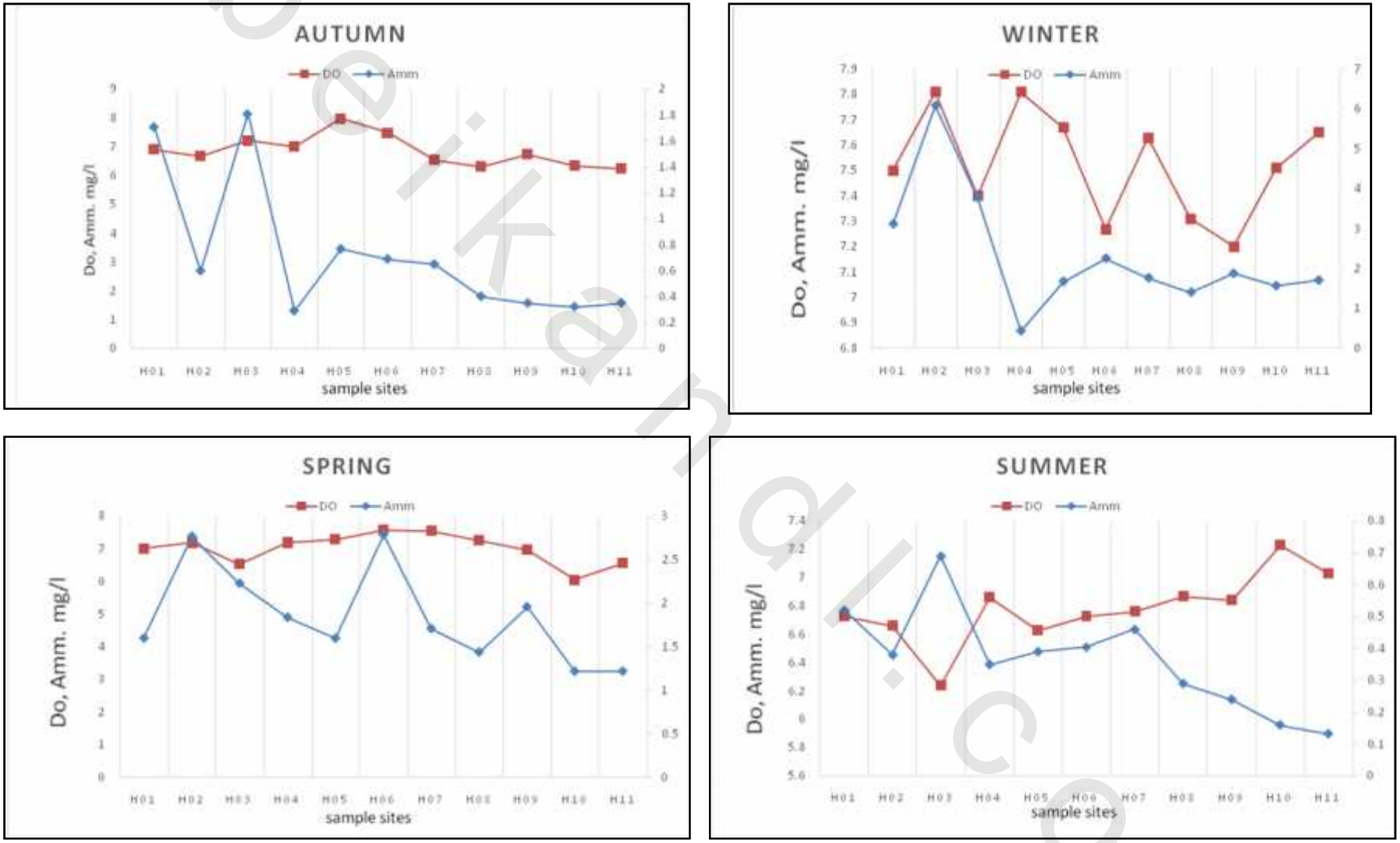


Figure 4.11: Seasonal variation DO and Ammonia in Mahmoudia canal

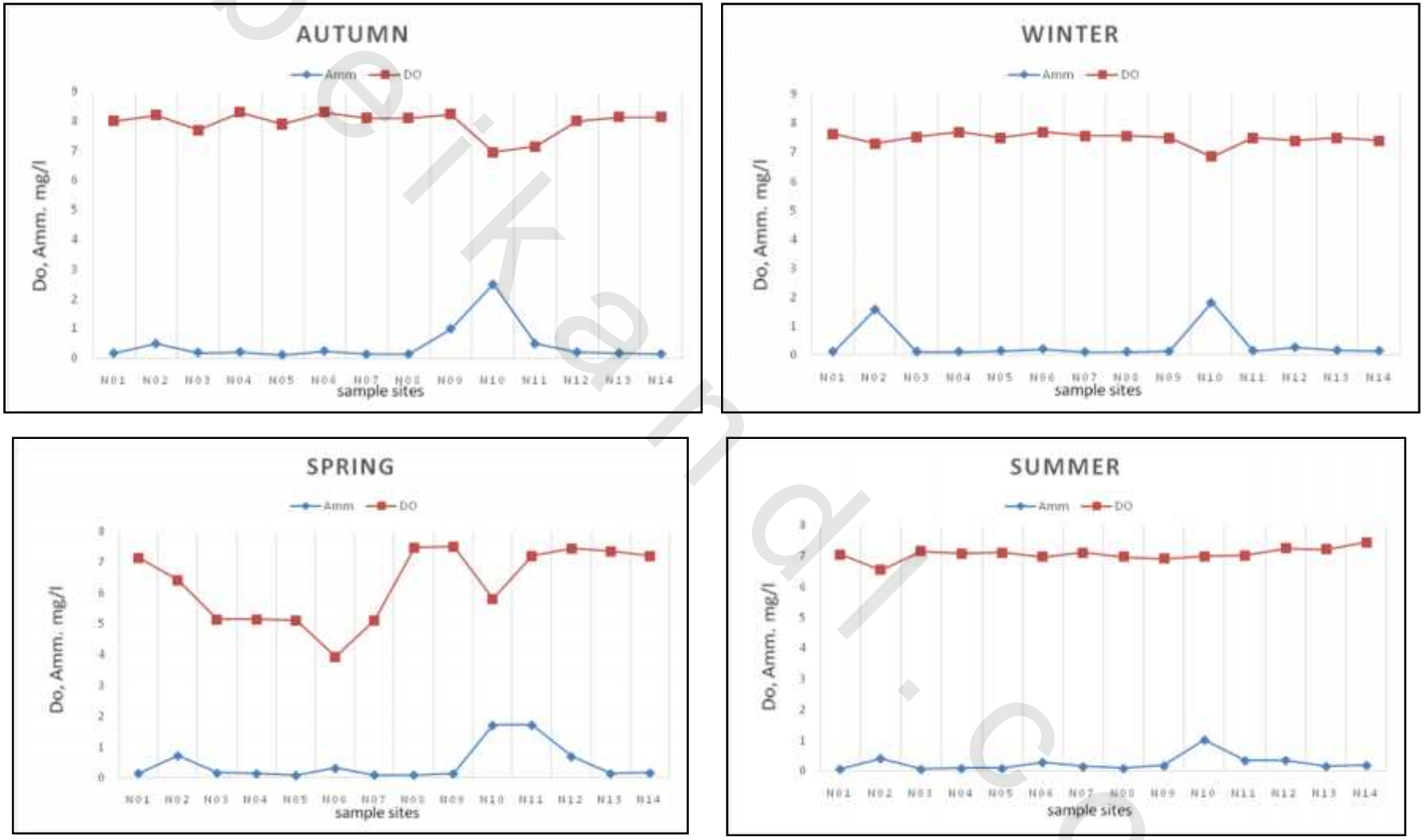


Figure 4.12: Seasonal variation DO and Ammonia in Nubaria canal

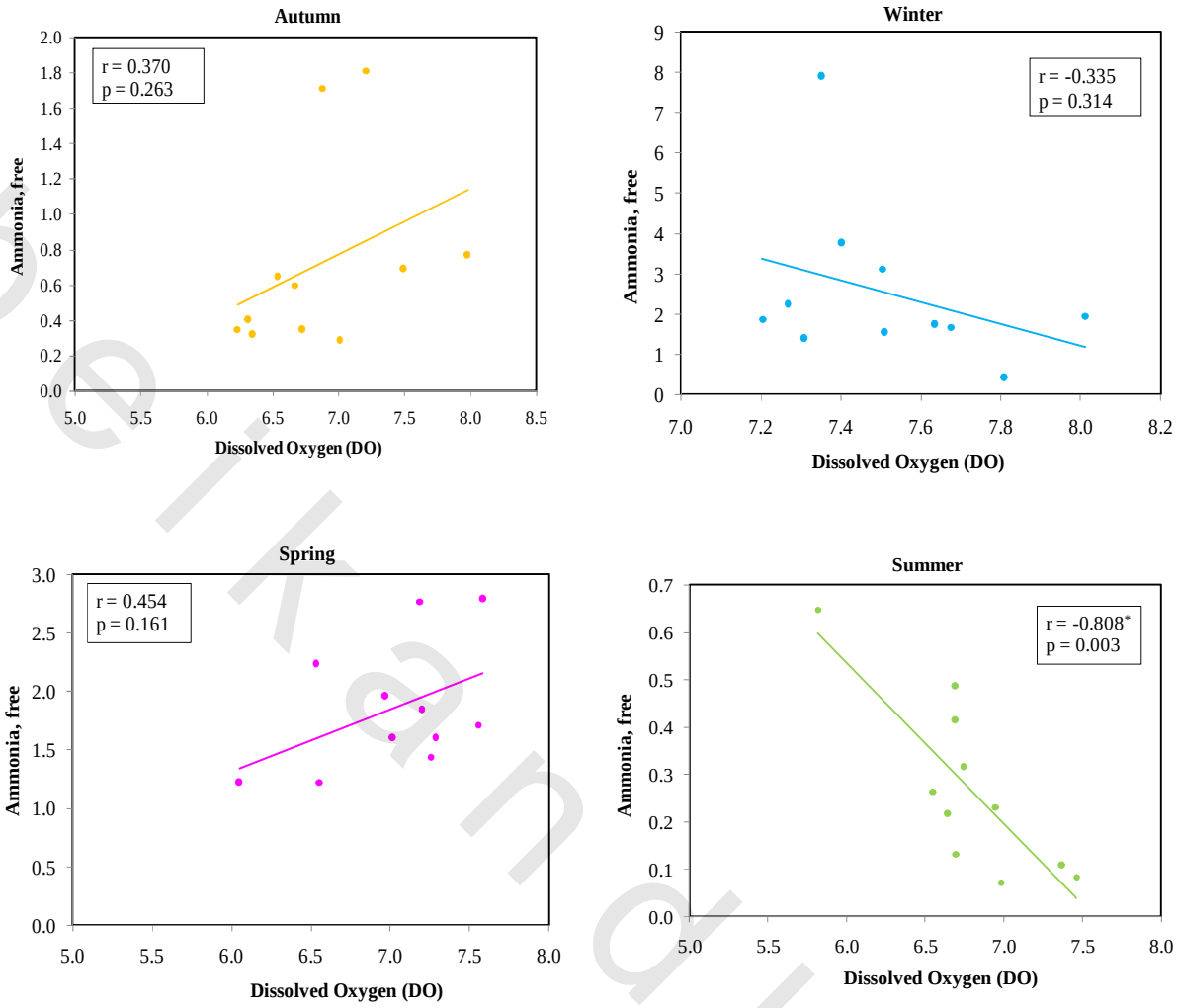


Figure 4.13: Correlation between DO and Ammonia in Mahmoudia canal

Figure 4.13 showed that negative correlation between DO and ammonia in winter and summer and positive correlation observed in autumn and spring with no significant difference ($p > 0.05$) exception significant difference ($p < 0.05$) in summer.

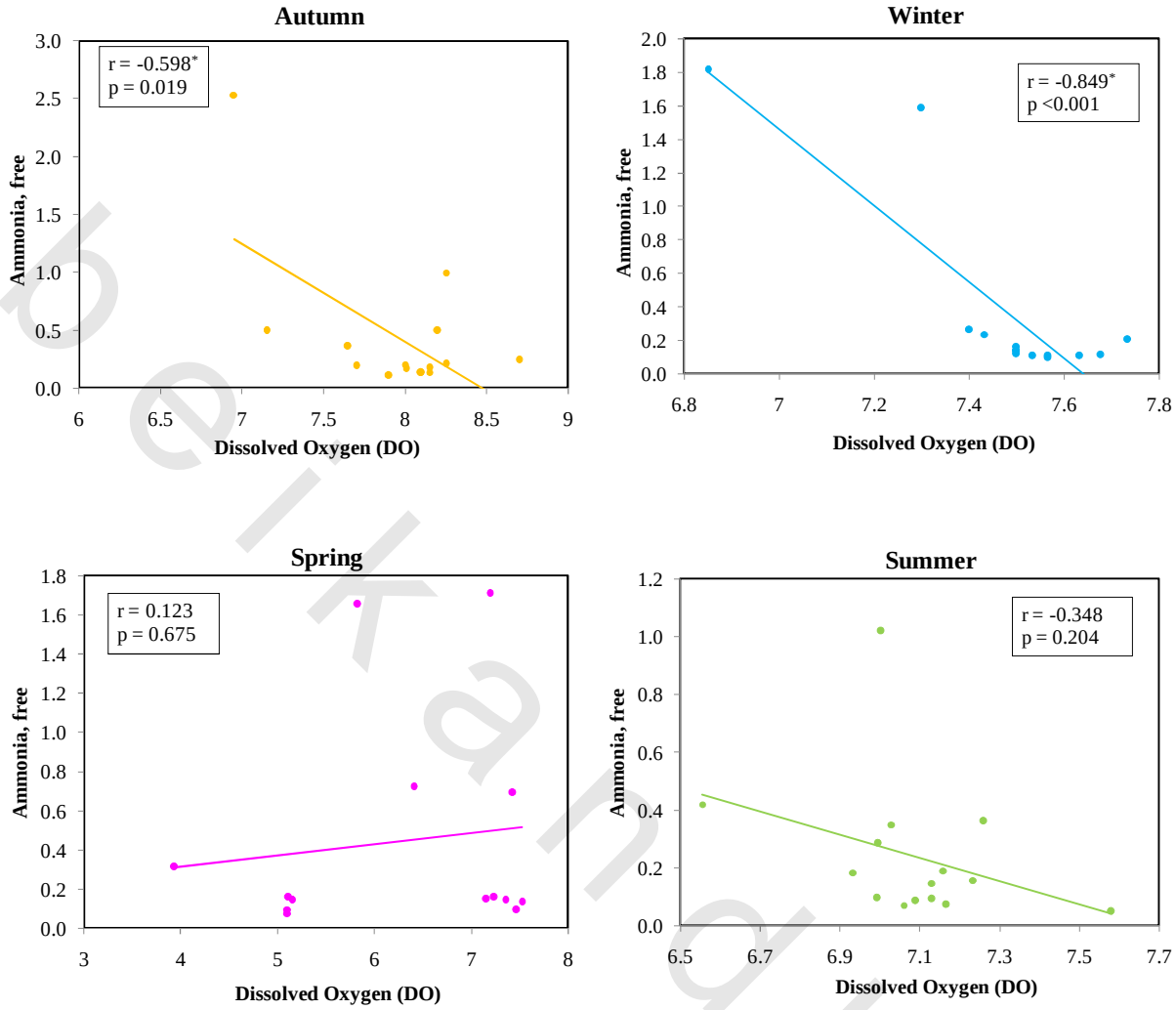
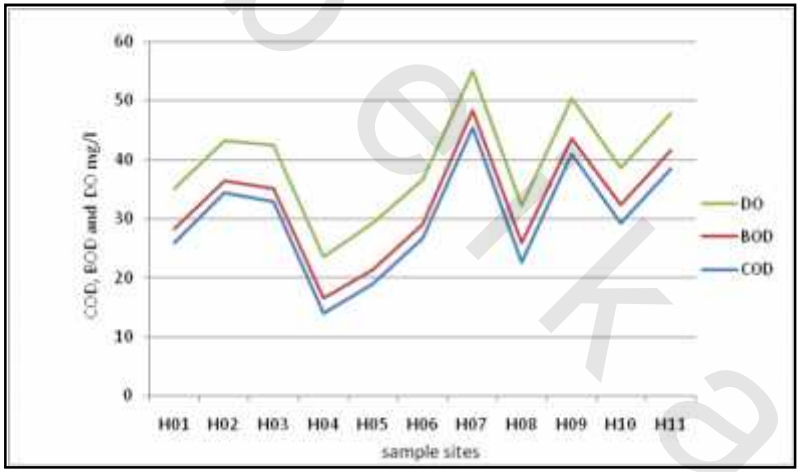
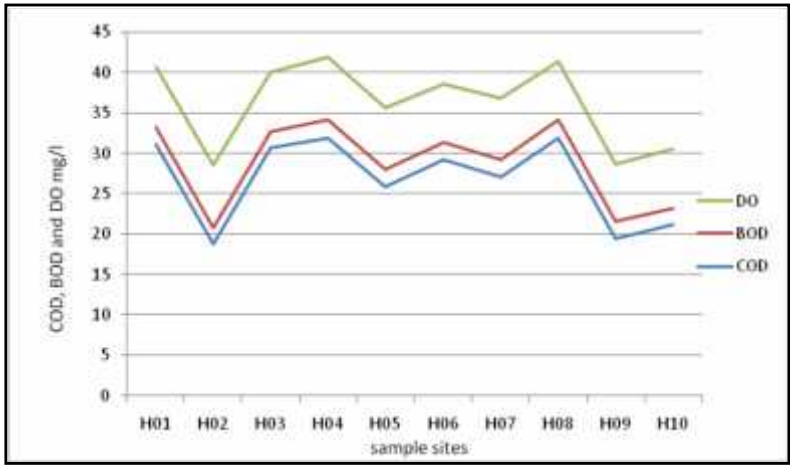


Figure 4.14: Correlation between DO and Ammonia in Nubaria canal

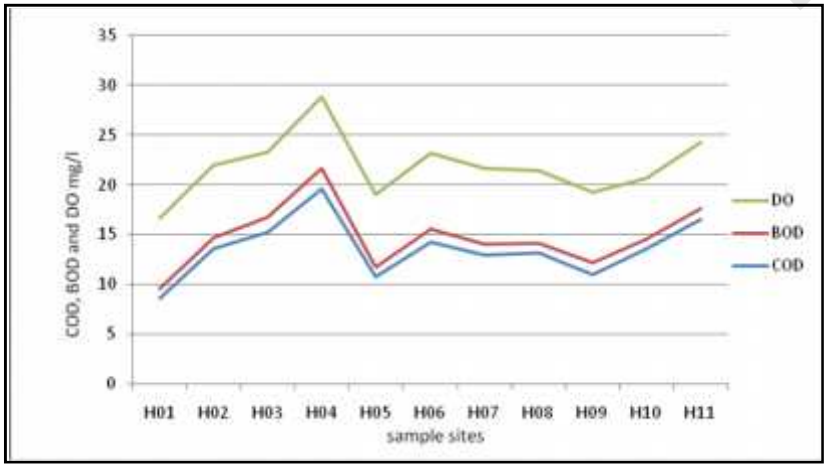
Figure 4.14 showed that negative correlation between DO and ammonia in autumn, winter and summer and positive correlation observed in spring with no significant difference ($p > 0.05$) exception significant difference ($p < 0.05$) in winter.



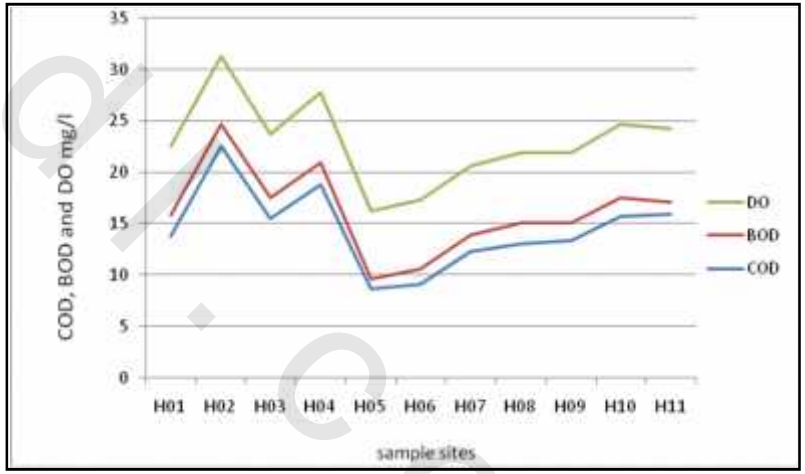
Autumn



Winter



Spring



Summer

Figure 4.15: Seasonal variation COD, BOD and DO in Mahmoudia canal

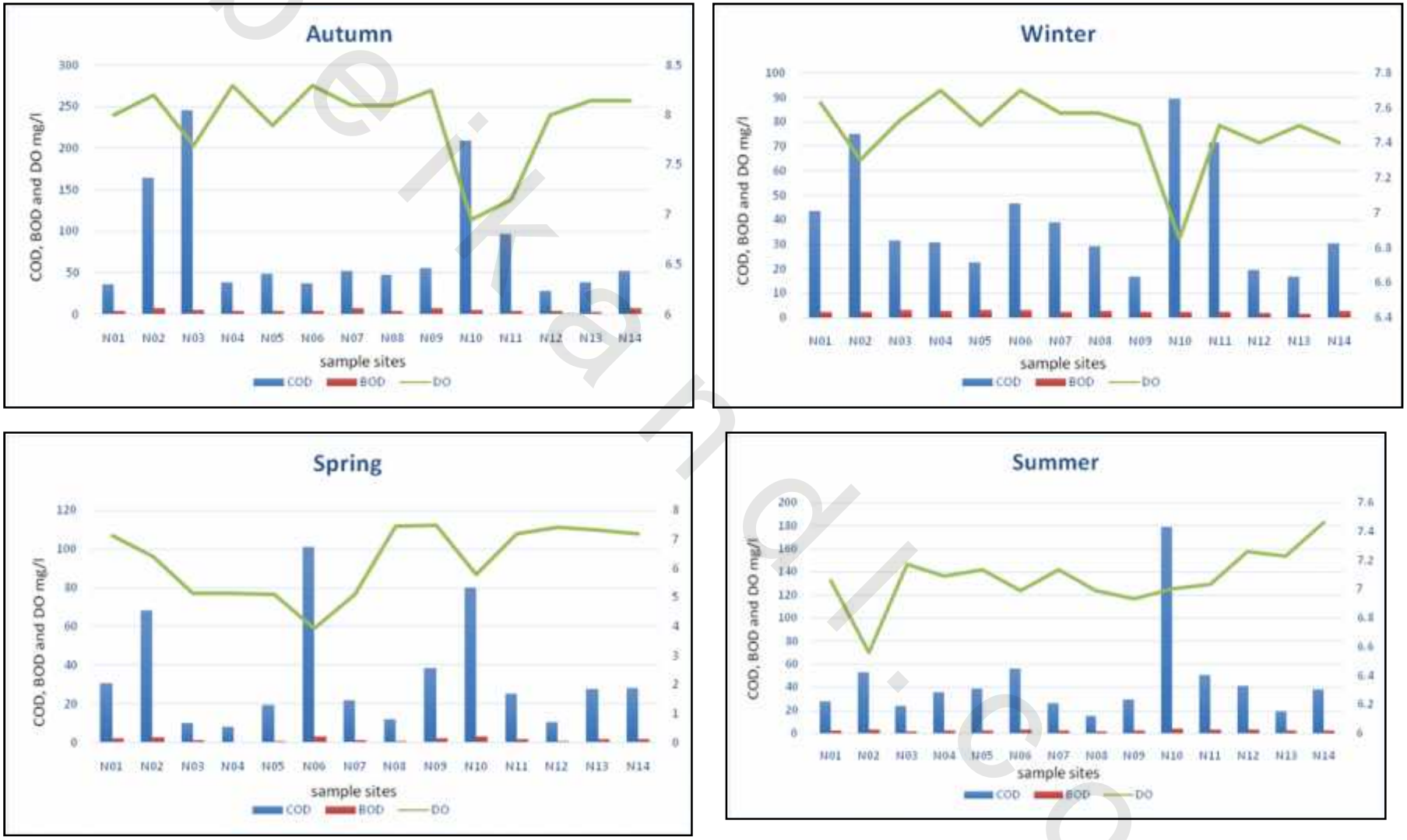


Figure 4.16: Seasonal variation COD, BOD and DO in Nubaria canal

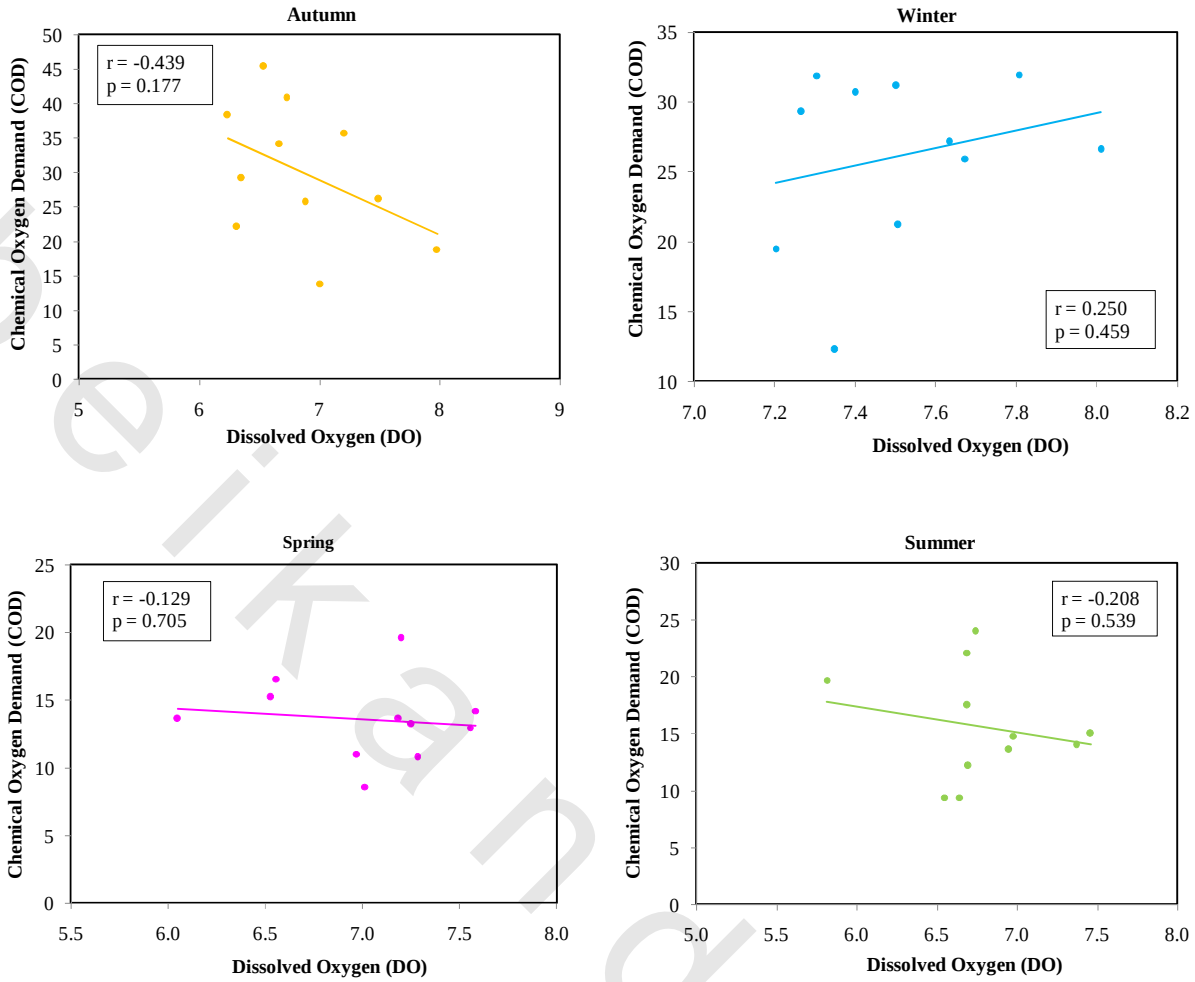


Figure 4.17: Correlation between DO and COD in Mahmoudia canal

Figure 4.17 showed that negative correlation between DO and COD in autumn, spring and summer and positive correlation observed in winter with no significant difference ($p > 0.05$) in all seasons.

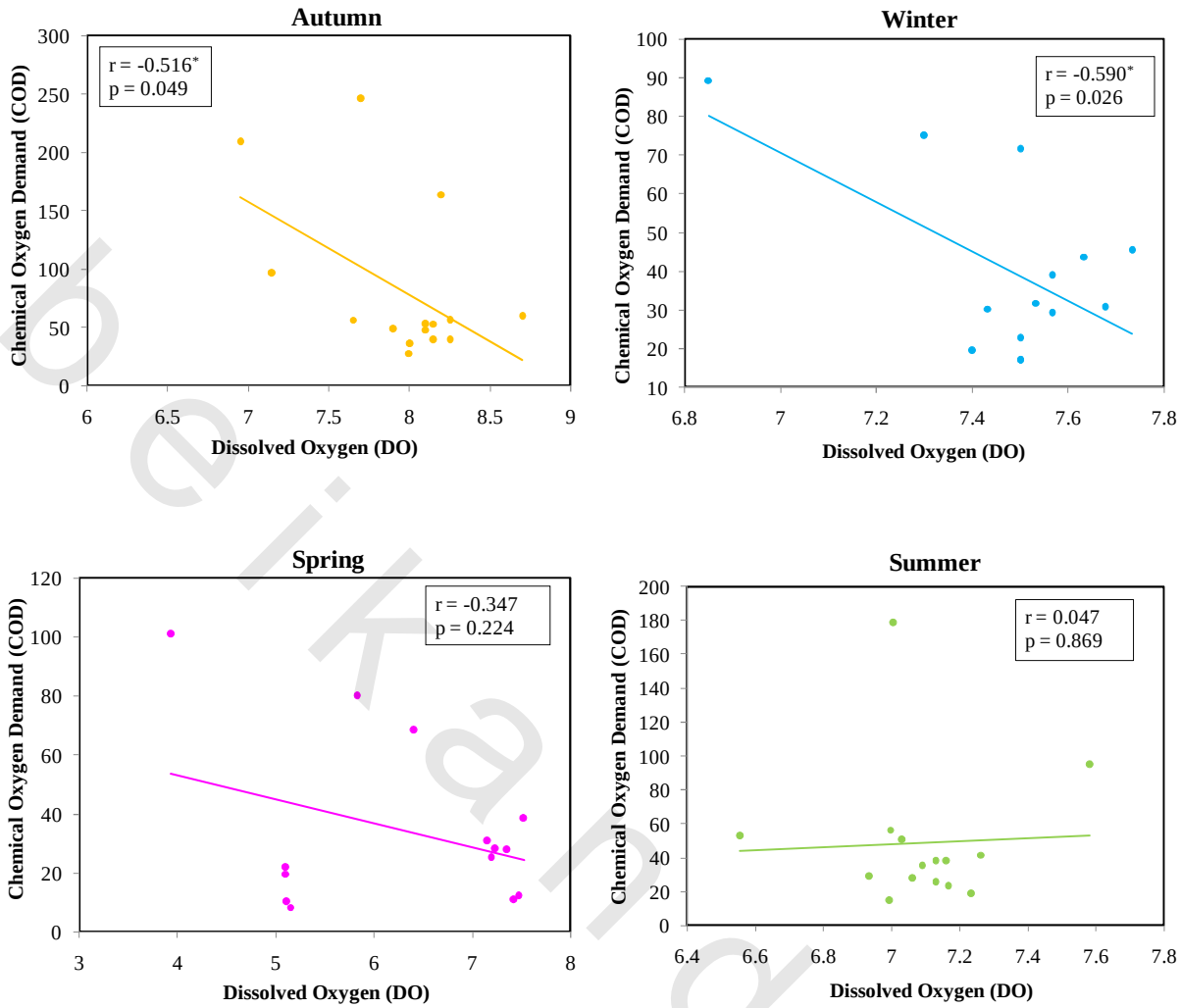


Figure 4.18: Correlation between DO and COD in Nubaria canal

Figure 4.18 showed that negative correlation between DO and COD in autumn, spring and winter and positive correlation observed in summer with no significant difference ($p > 0.05$) in spring and summer. As well as detected significant difference ($p < 0.05$) in autumn and winter.

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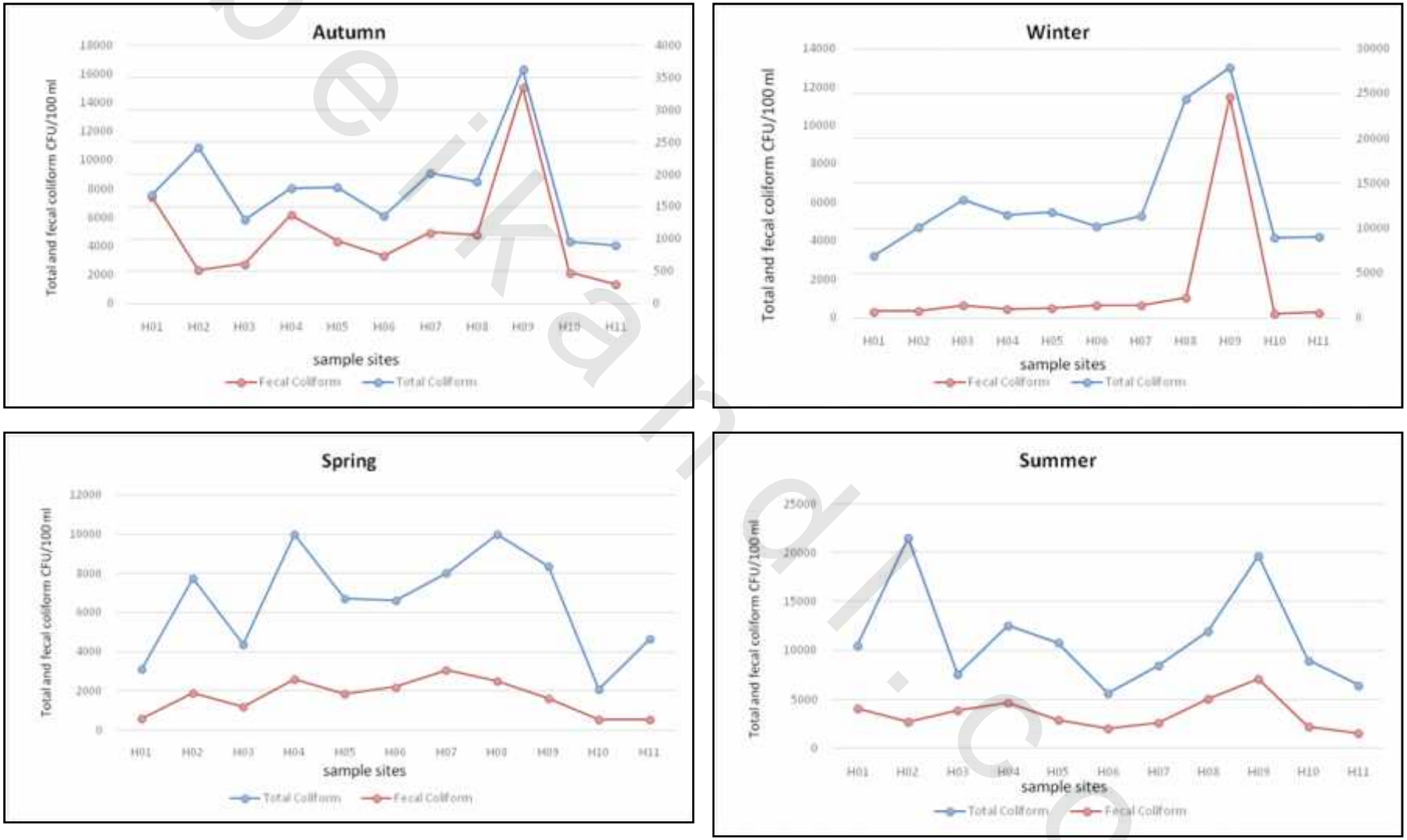

Figure 4.19: Seasonal variation Total coliform and Fecal coliform in Mahmoudia canal

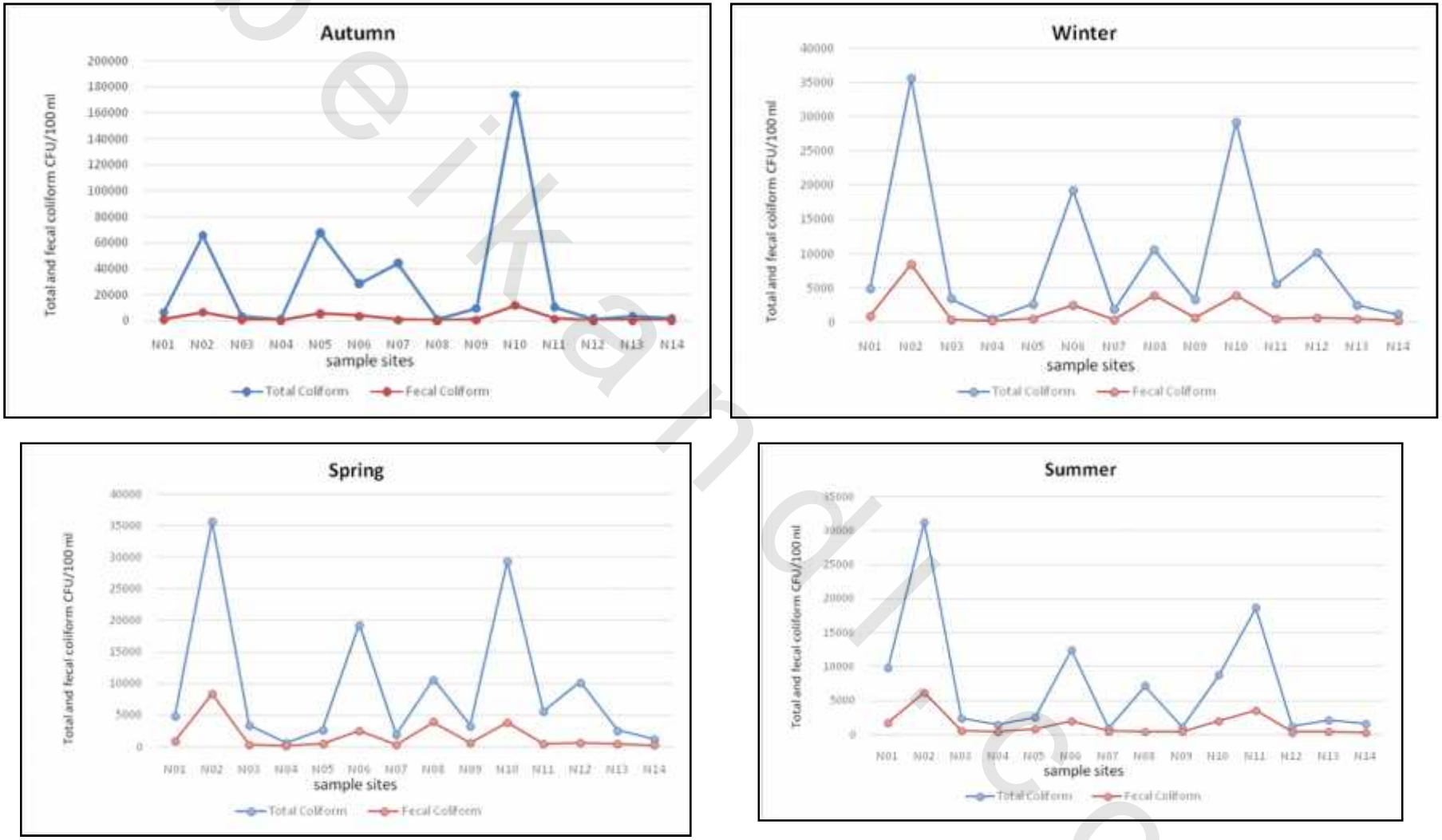

Figure 4.20: Seasonal variation Total coliform and Fecal coliform in Nubaria canal

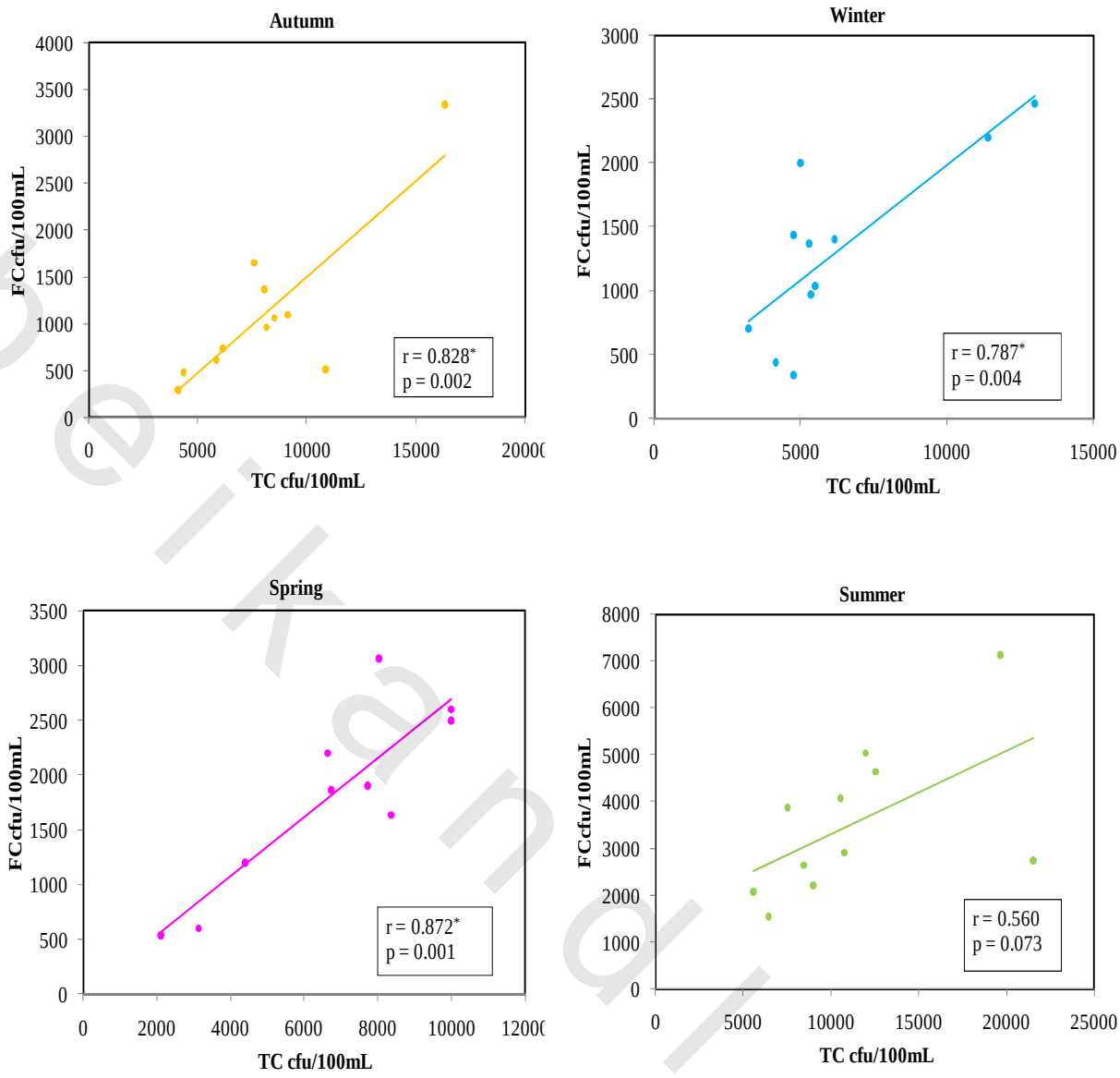

Figure 4.21: Correlation between Total coliform and fecal coliform in Mahmoudia canal

Figure 4.21 showed that strong positive correlation between total and fecal coliform ($r > 0.75$) in all seasons exception summer with statistical significant difference ($p < 0.05$) detected in all seasons also exception summer.

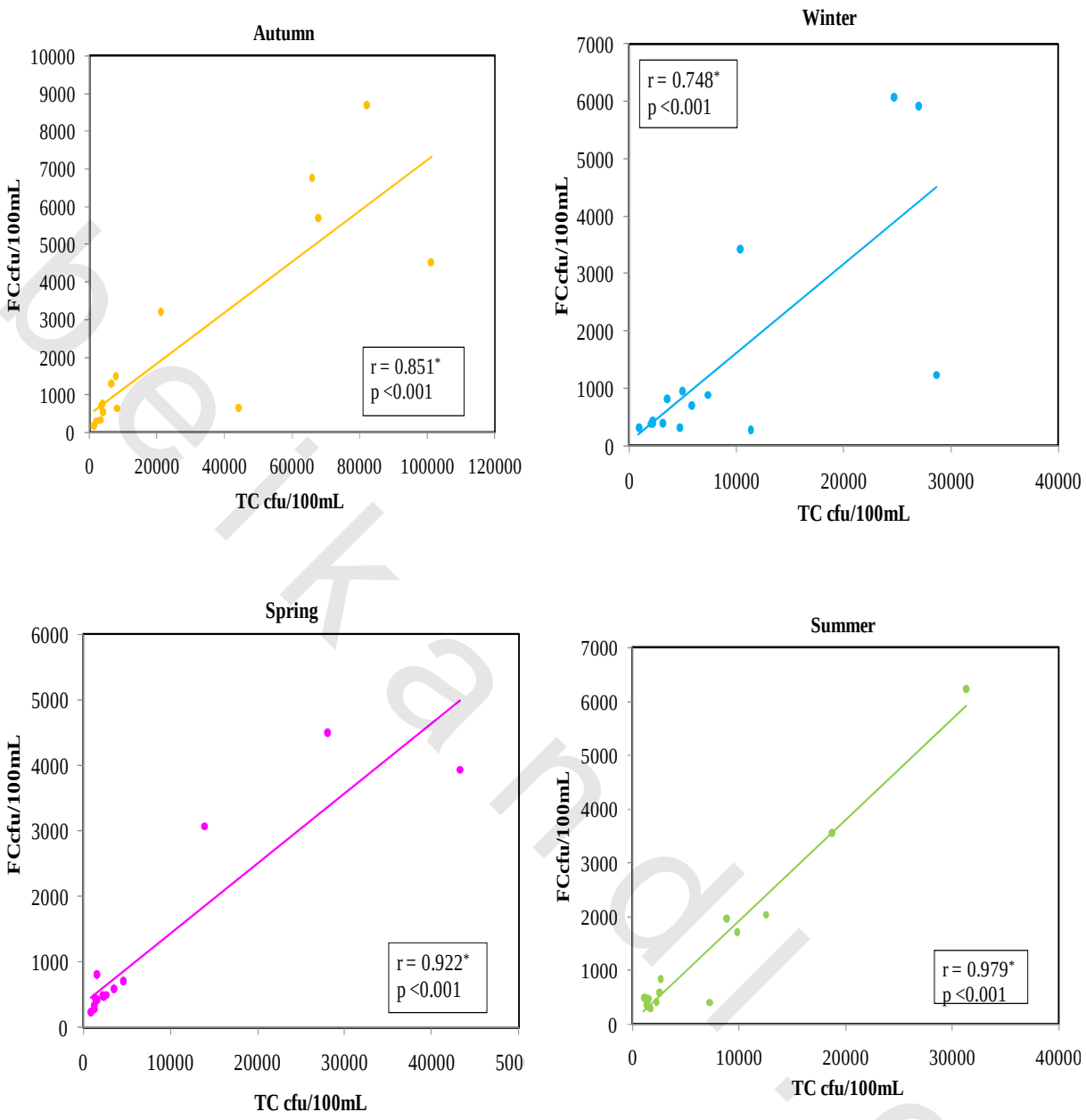

Figure 4.22: Correlation between Total coliform and fecal coliform in Nubaria canal

Figure 4.22 showed that positive correlation between total and fecal coliform ($r > 0.75$) in all seasons with statistical significant difference ($p < 0.05$) detected in all seasons.

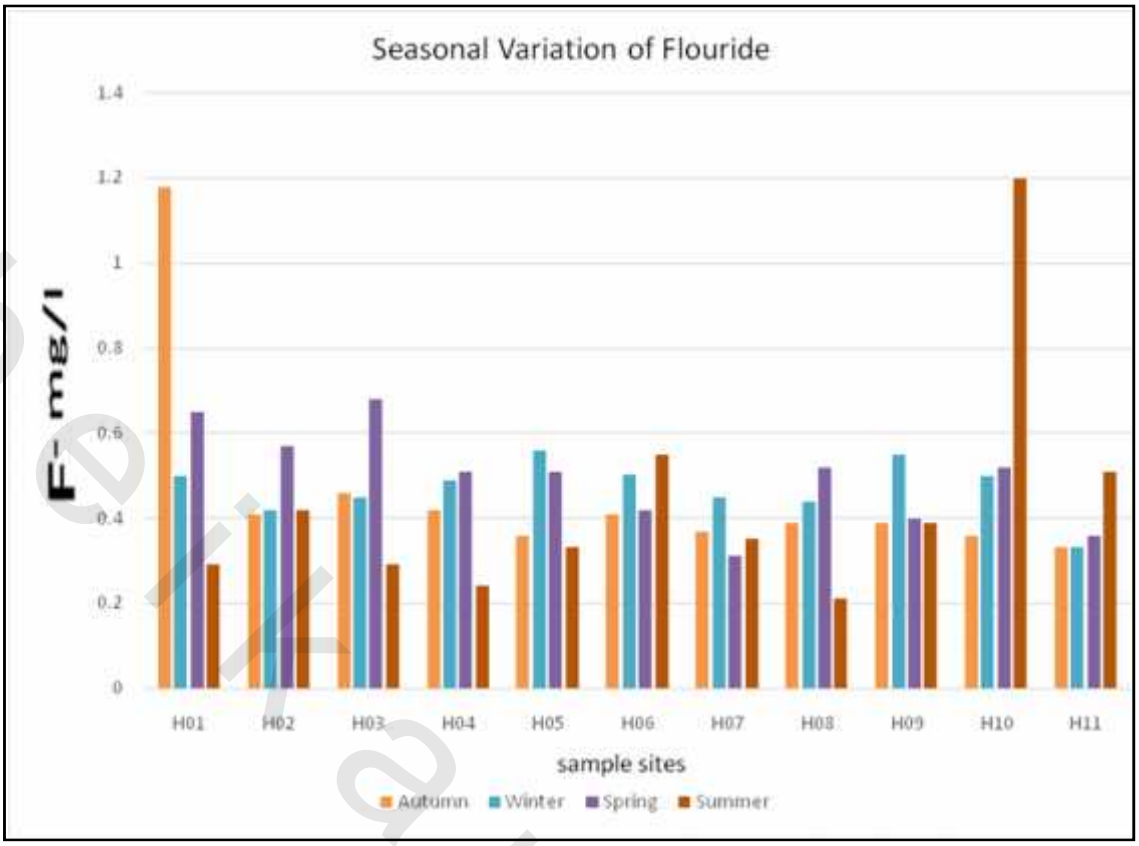

Figure 4.23: Seasonal variation of Fluorid in Mahmoudia canal

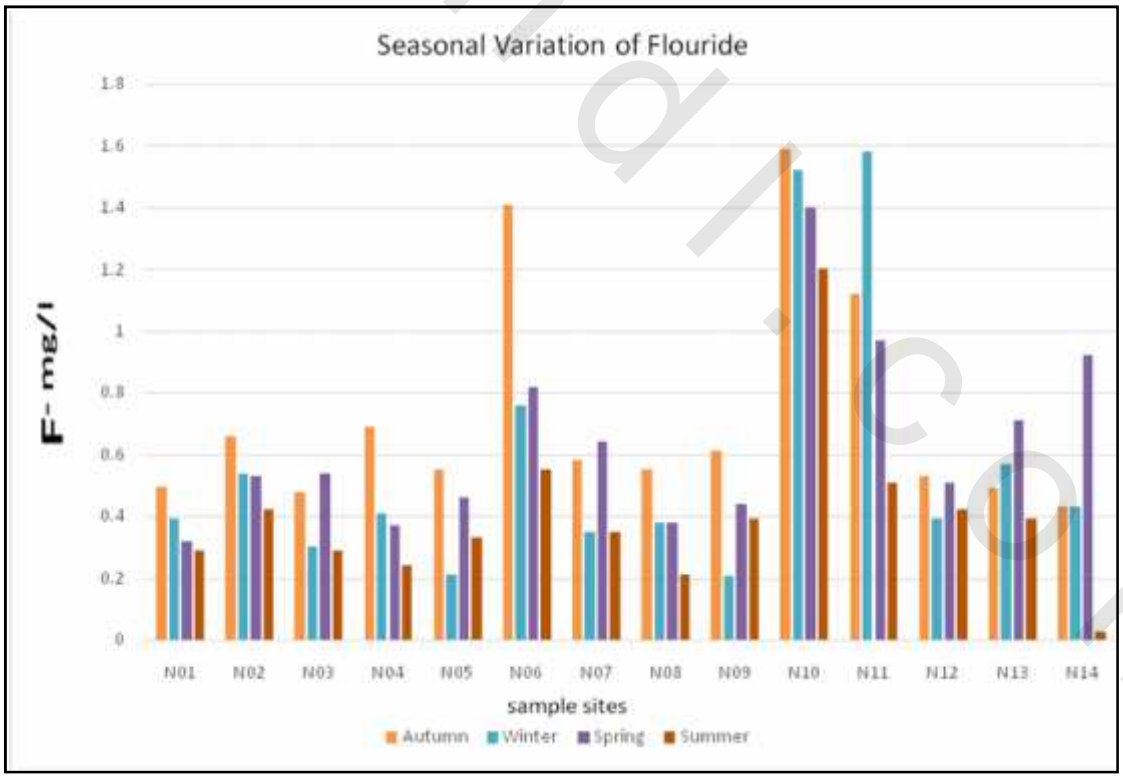

Figure 4.24: Seasonal variation of Fluorid in Nubaria canal

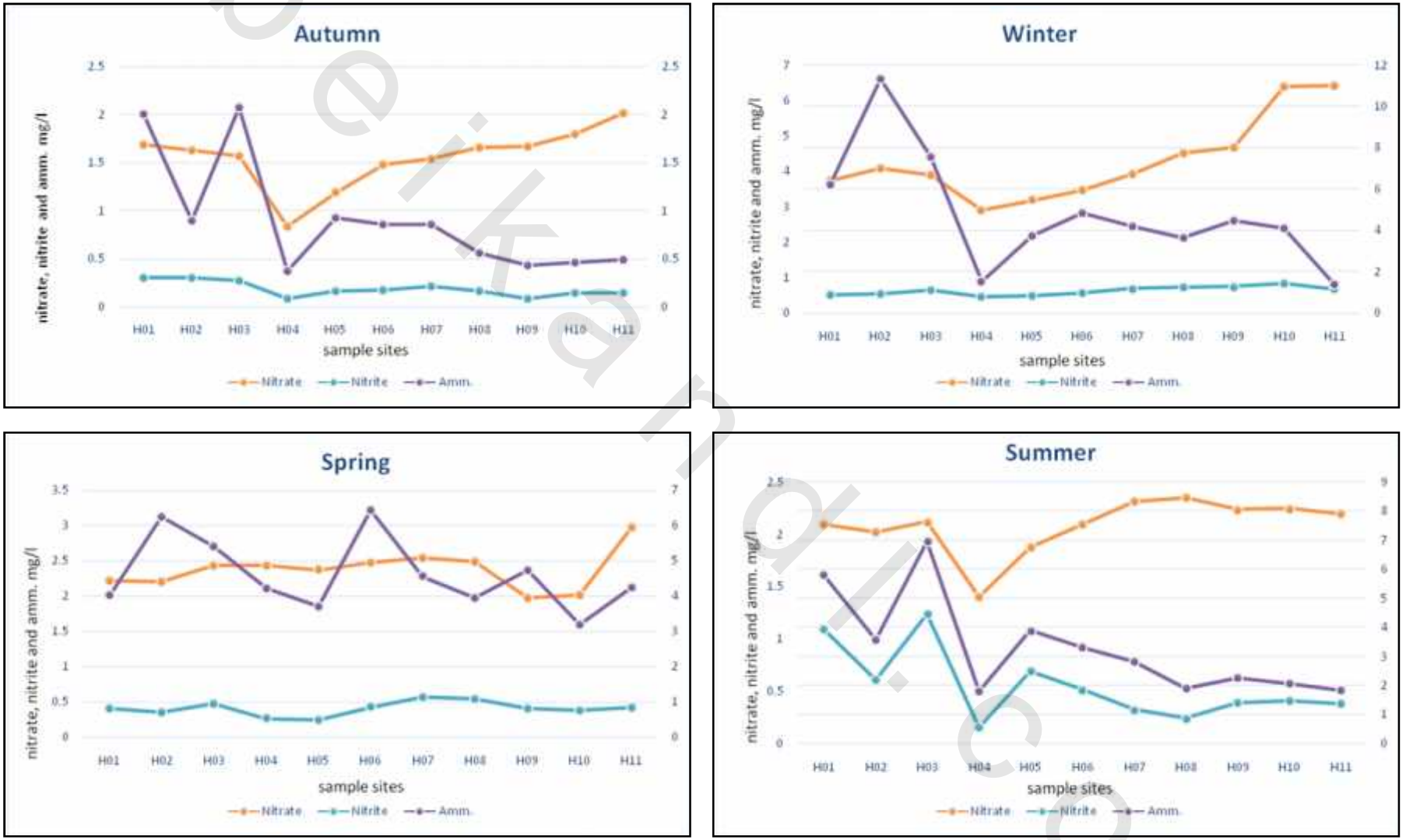

Figure 4.25: Seasonal variation of Nitrate, Nitrite and Amm. in Mahmoudia canal

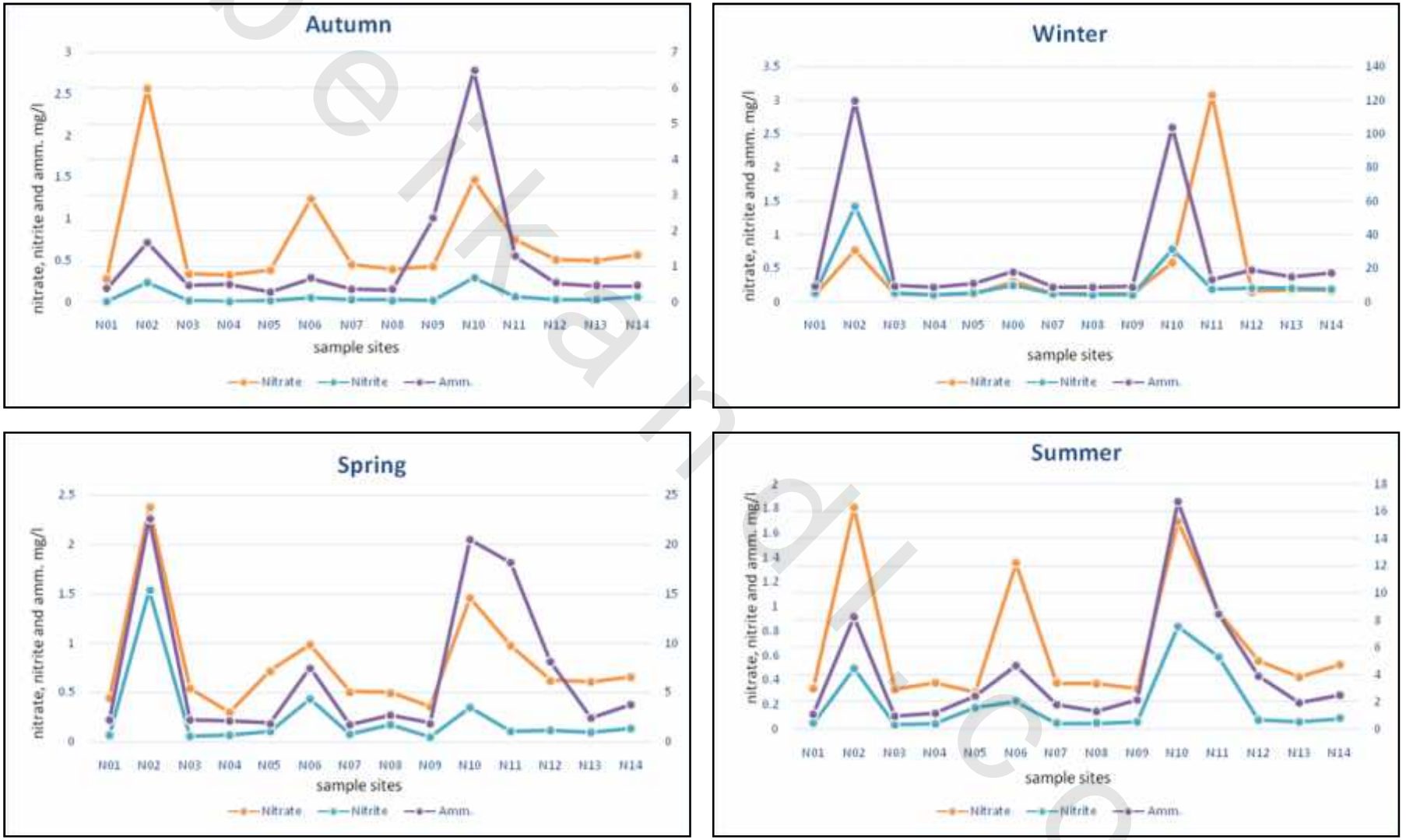

Figure 4.26: Seasonal variation of Nitrate, Nitrite and Amm. in Nubaria canal

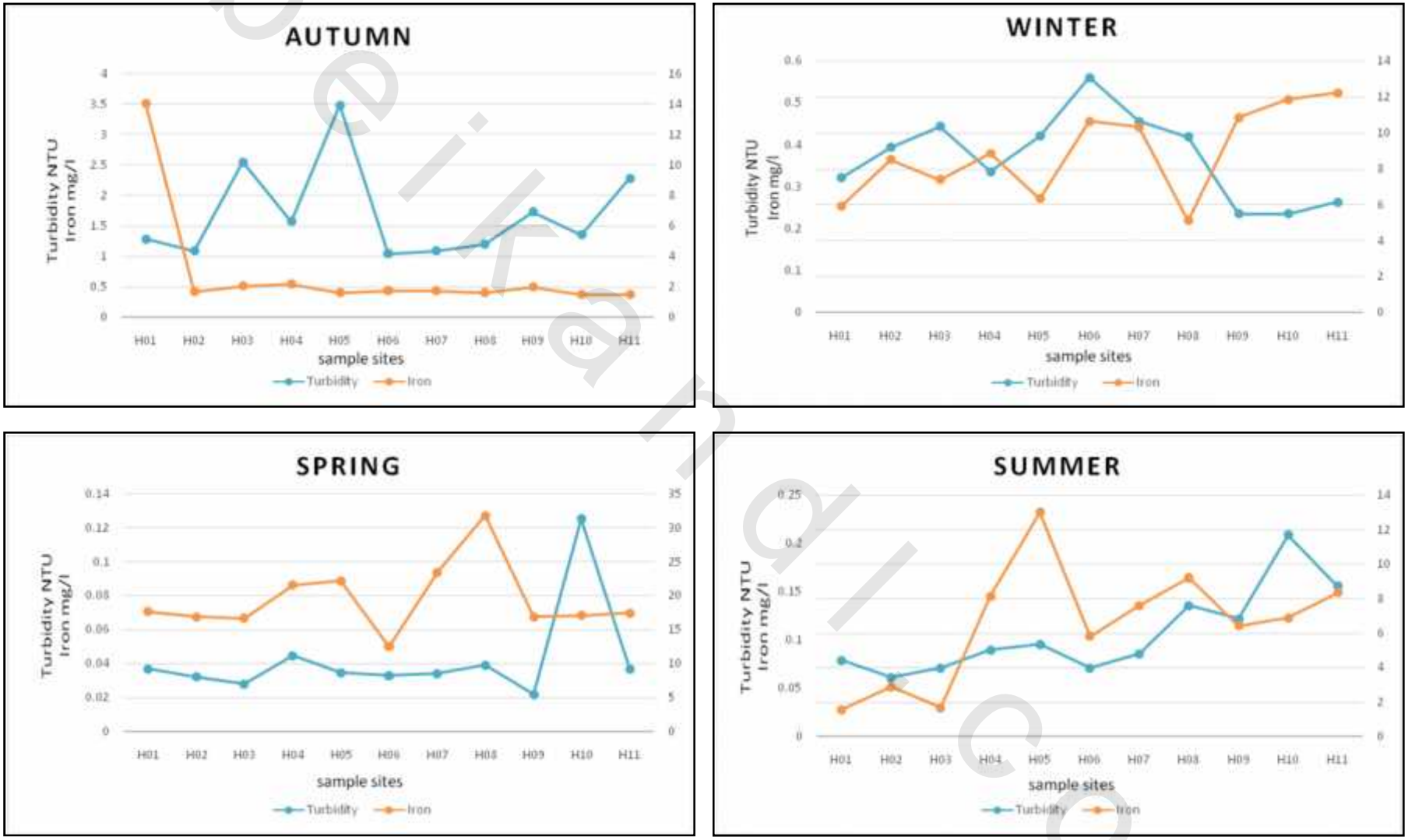

Figure 4.27: Seasonal variation of Iron and Turbidity in Mahmoudia canal

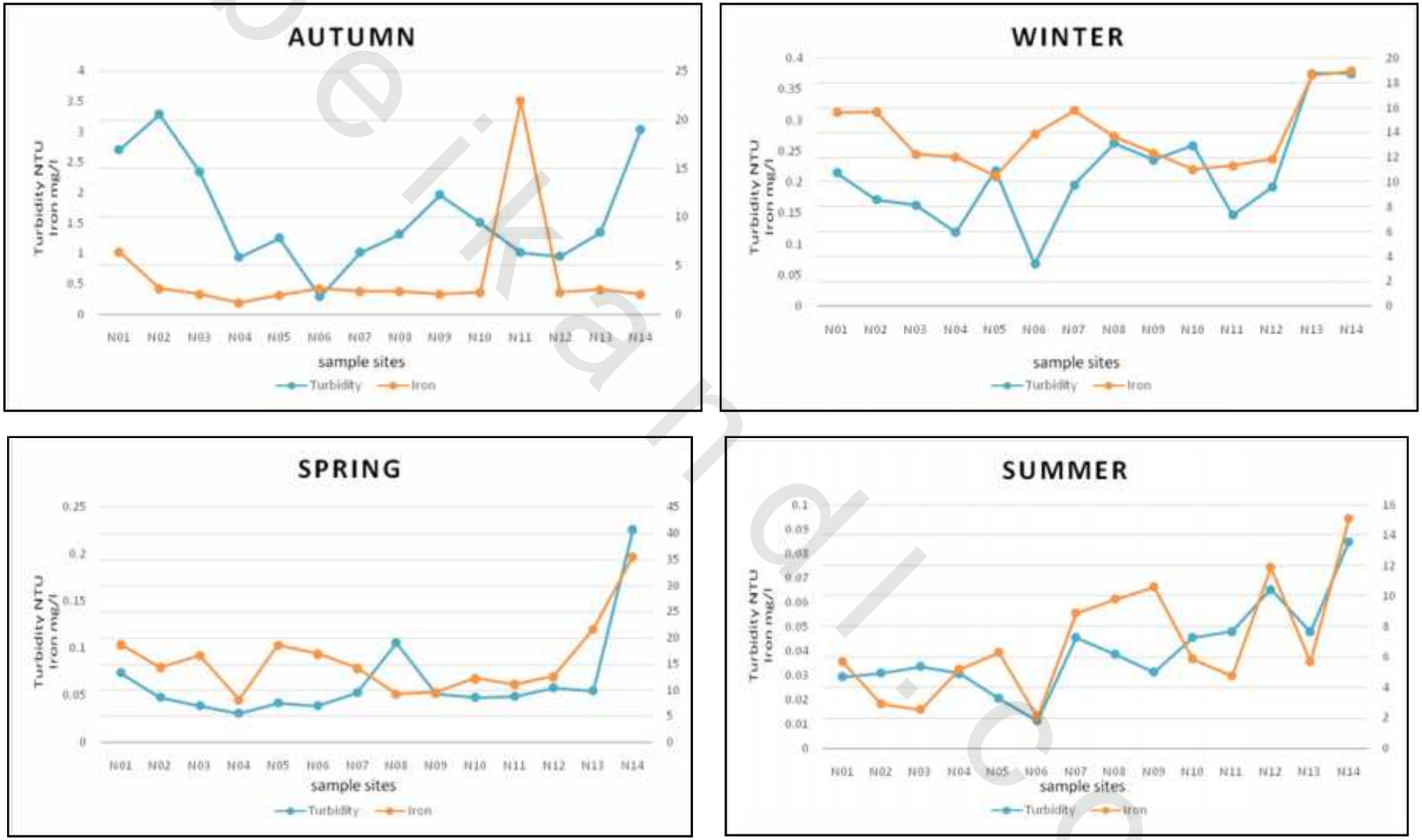

Figure 4.28: Seasonal variation of Iron and Turbidity in Nubaria canal

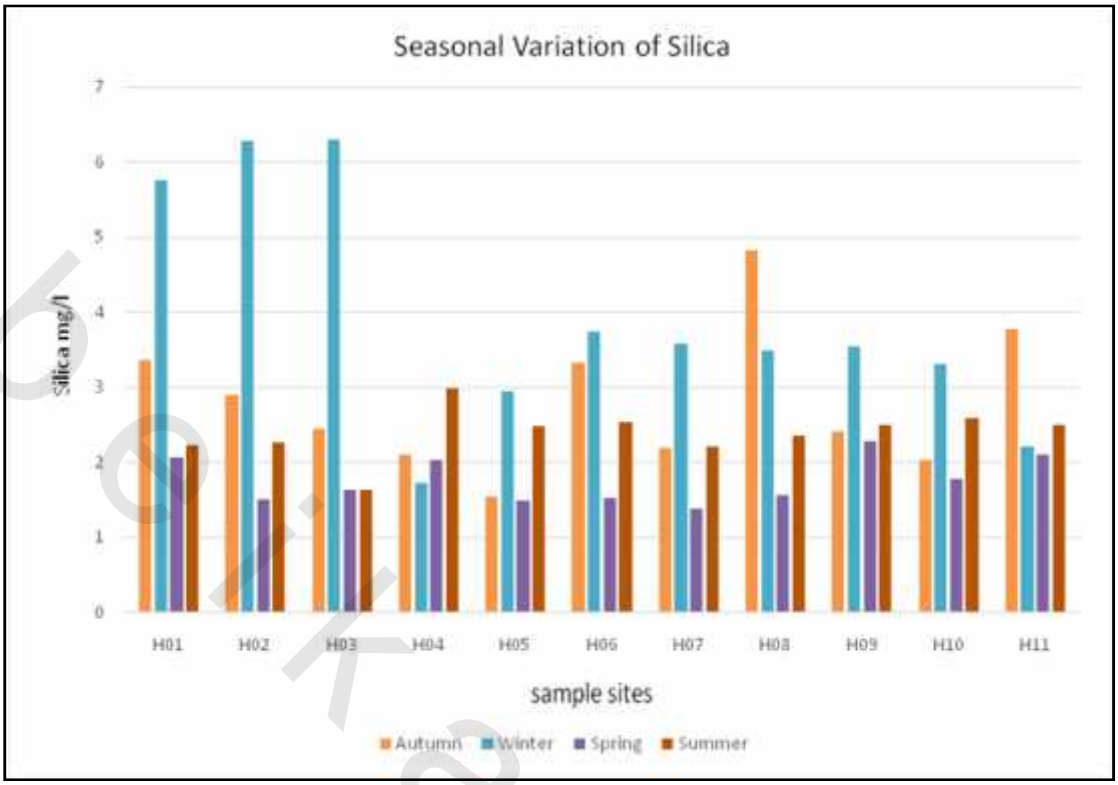

Figure 4.29: Seasonal variation of Silica in Mahmoudia canal

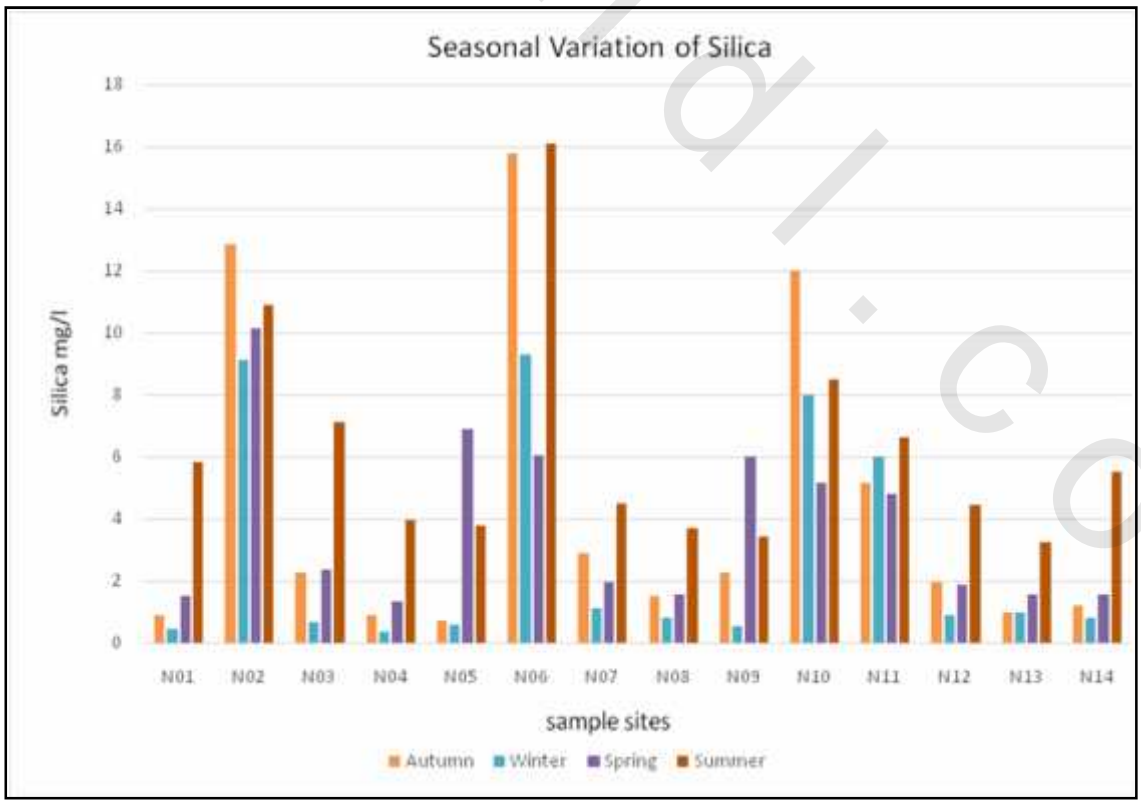

Figure 4.30: Seasonal variation of Silica in Mahmoudia canal

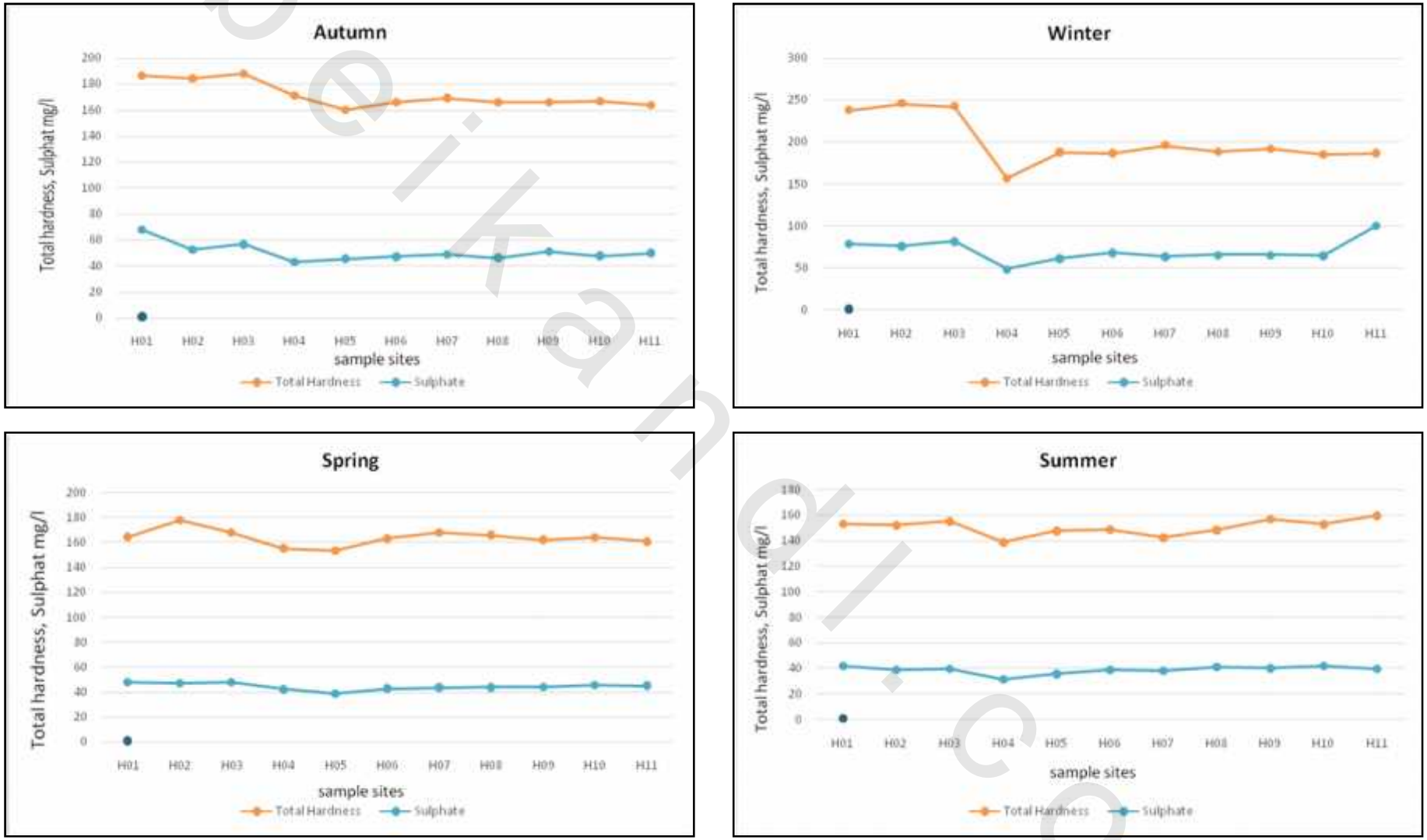

Figure 4.31: Seasonal variation of Total hardness and Sulphate in Mahmoudia canal

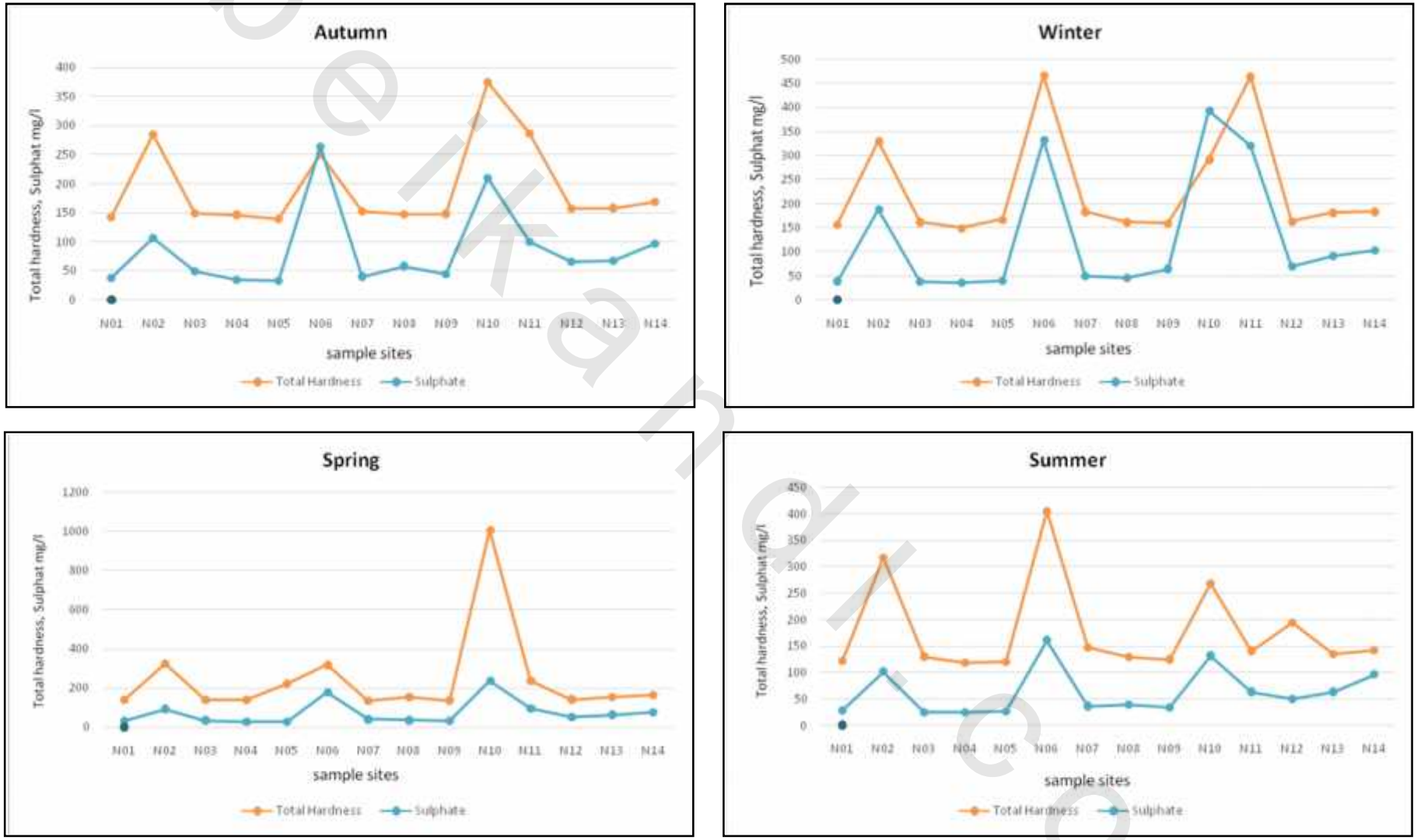

Figure 4.32: Seasonal variation of Total hardness and Sulphate in Nubaria canal

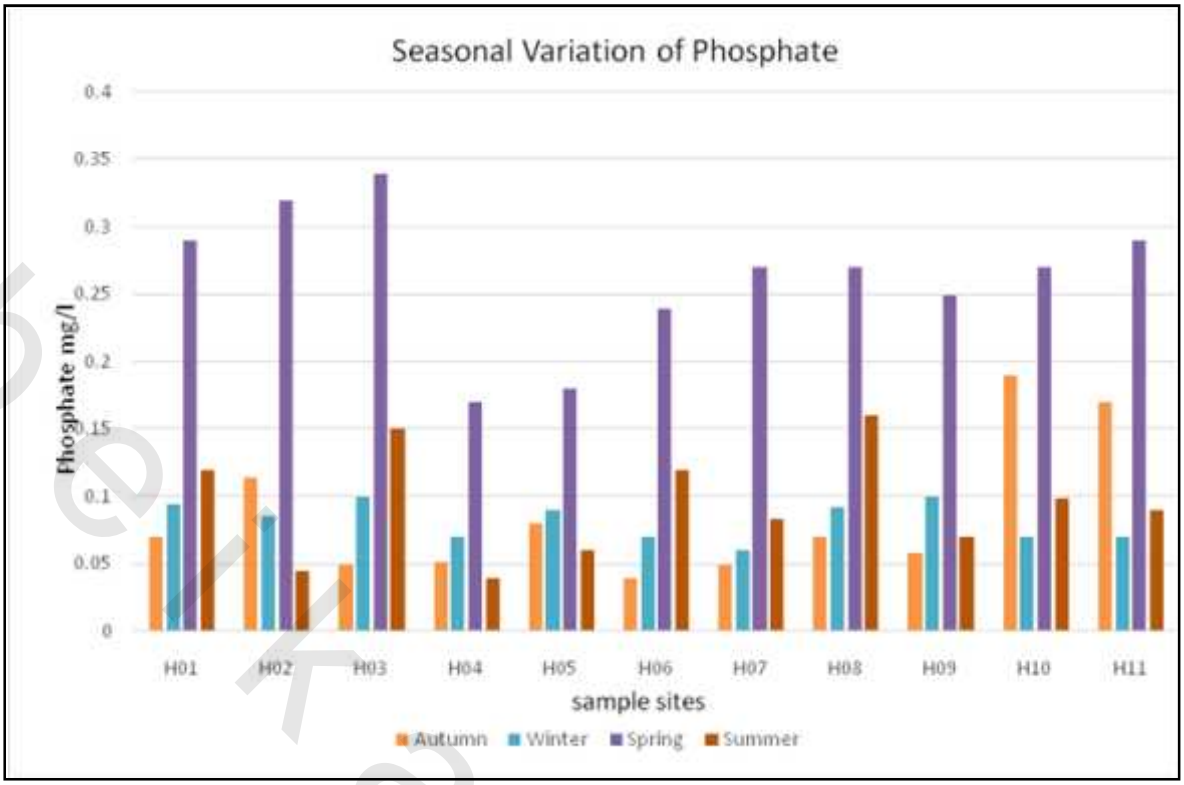

Figure 4.33: Seasonal variation of Phosphate in Mahmoudia canal

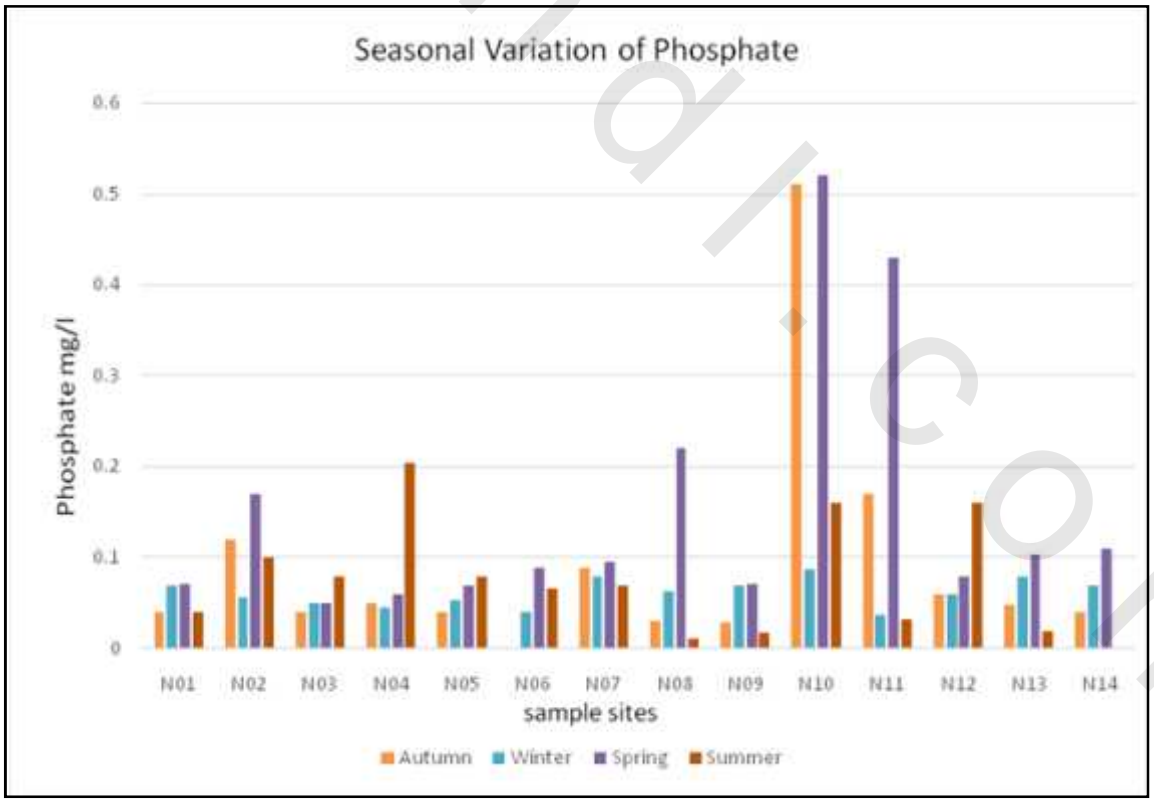

Figure 4.34: Seasonal variation of Phosphate in Nubaria canal

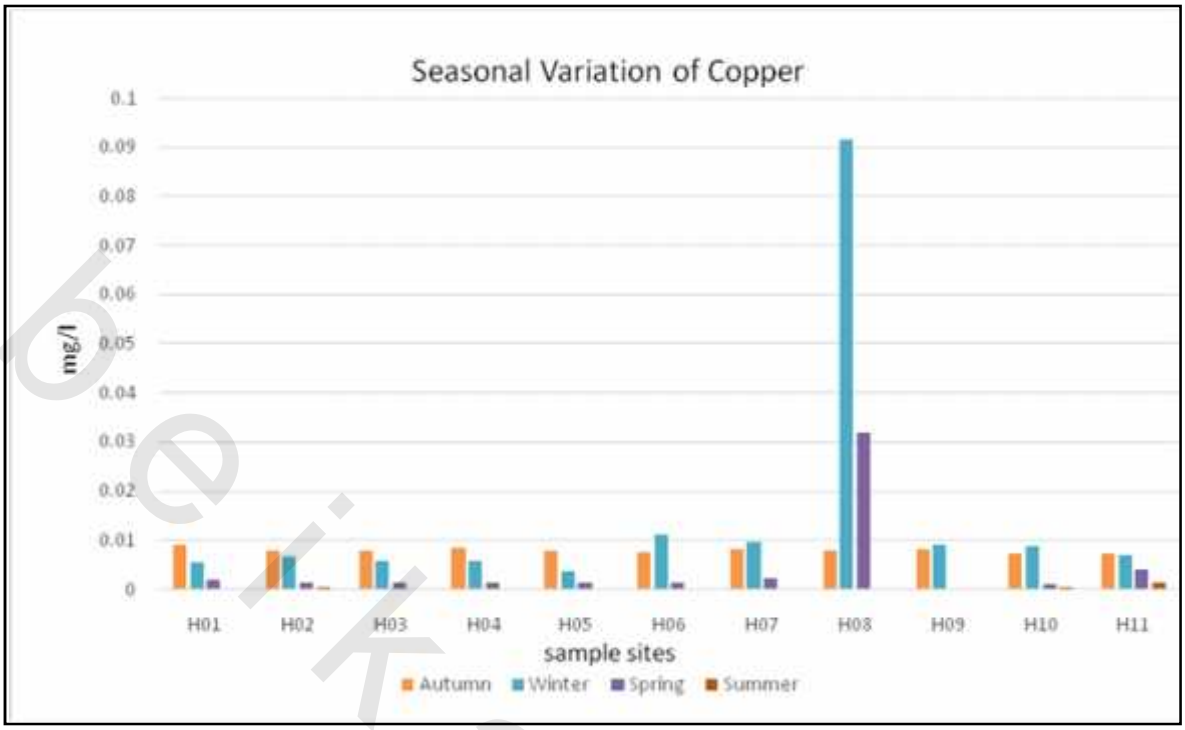

Figure 4.35: Seasonal variation of Copper in Mahmoudia canal

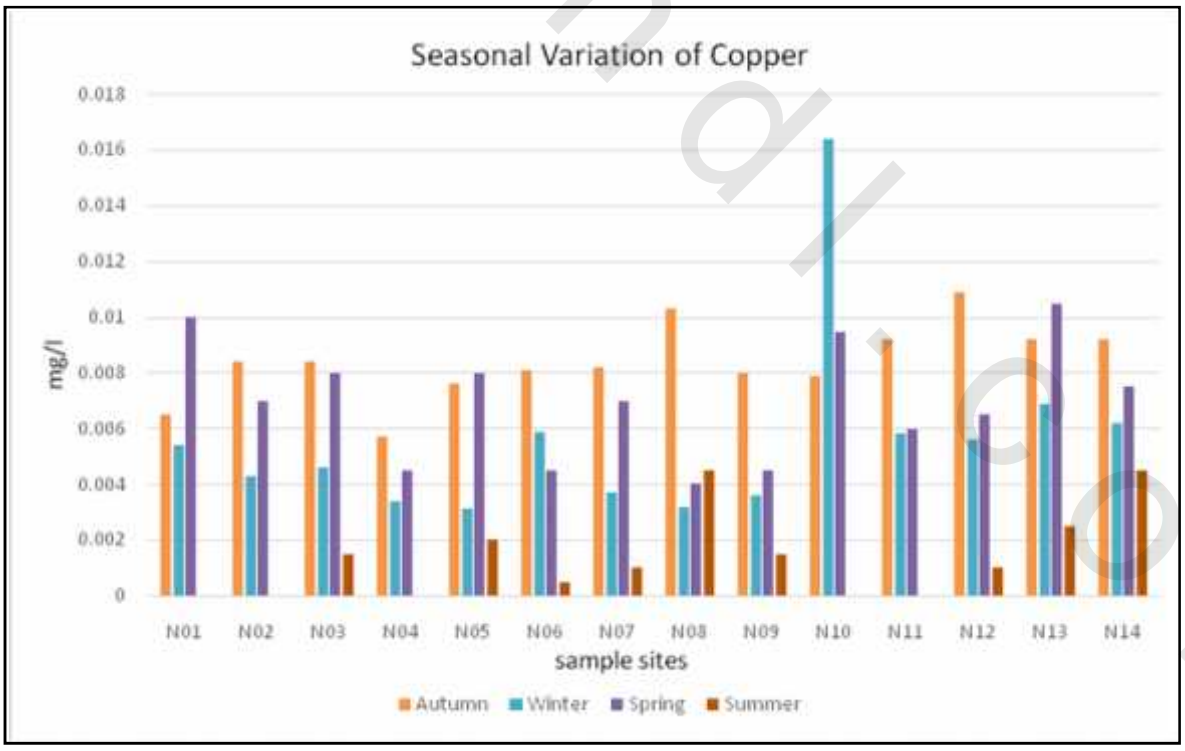

Figure 4.36: Seasonal variation of Copper in Nubaria canal

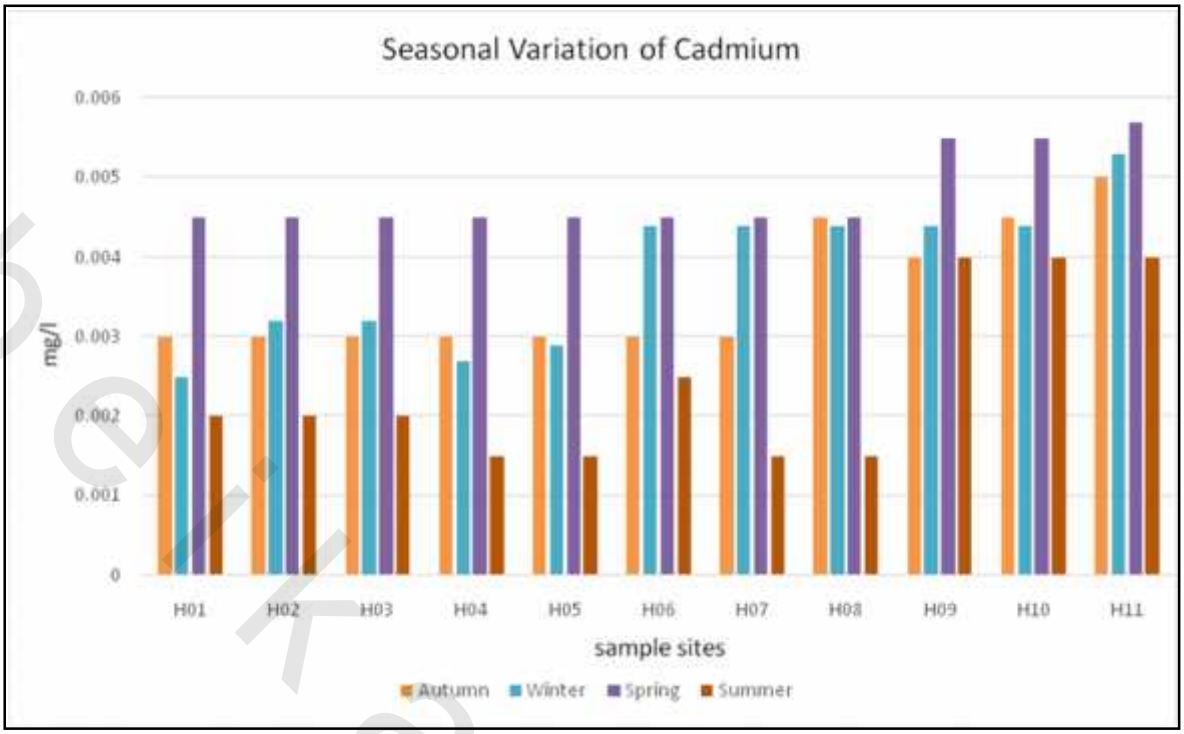

Figure 4.37: Seasonal variation of Cadmium in Mahmoudia canal

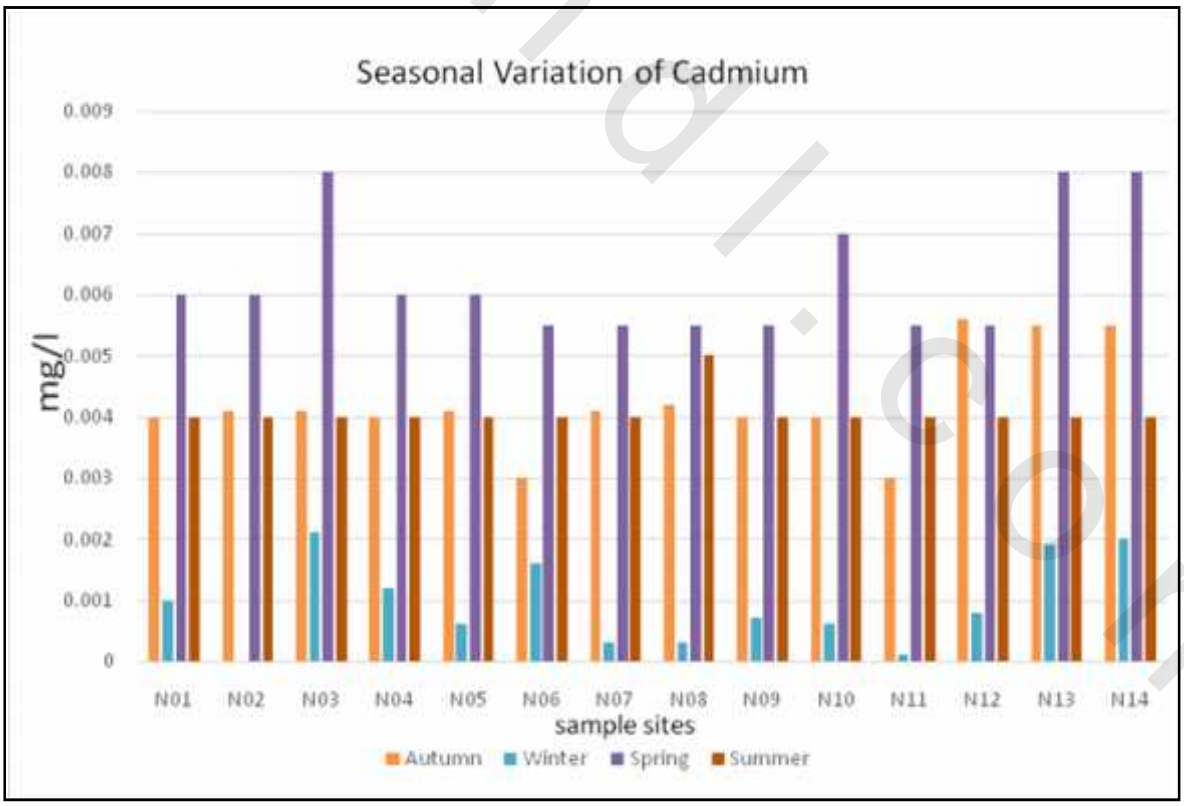

Figure 4.38: Seasonal variation of Cadmium in Nubaria canal

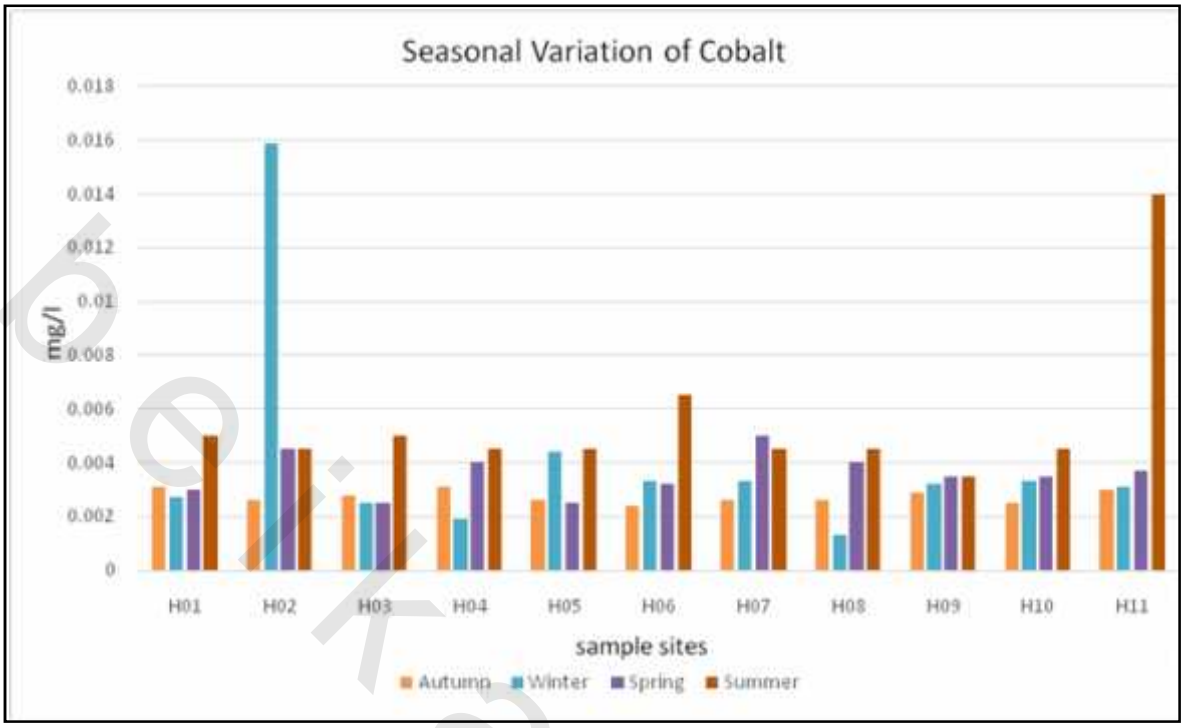

Figure 4.39: Seasonal variation of Cobalt in Mahmoudia canal

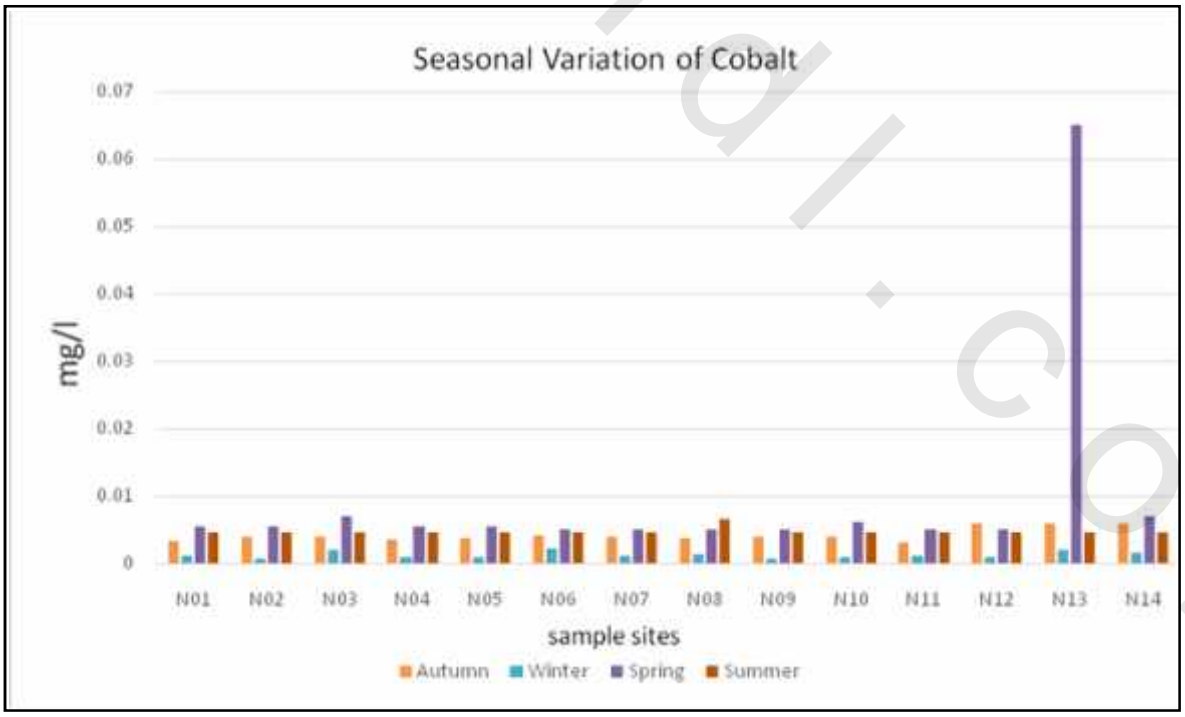

Figure 4.40: Seasonal variation of Cobalt in Nubaria canal

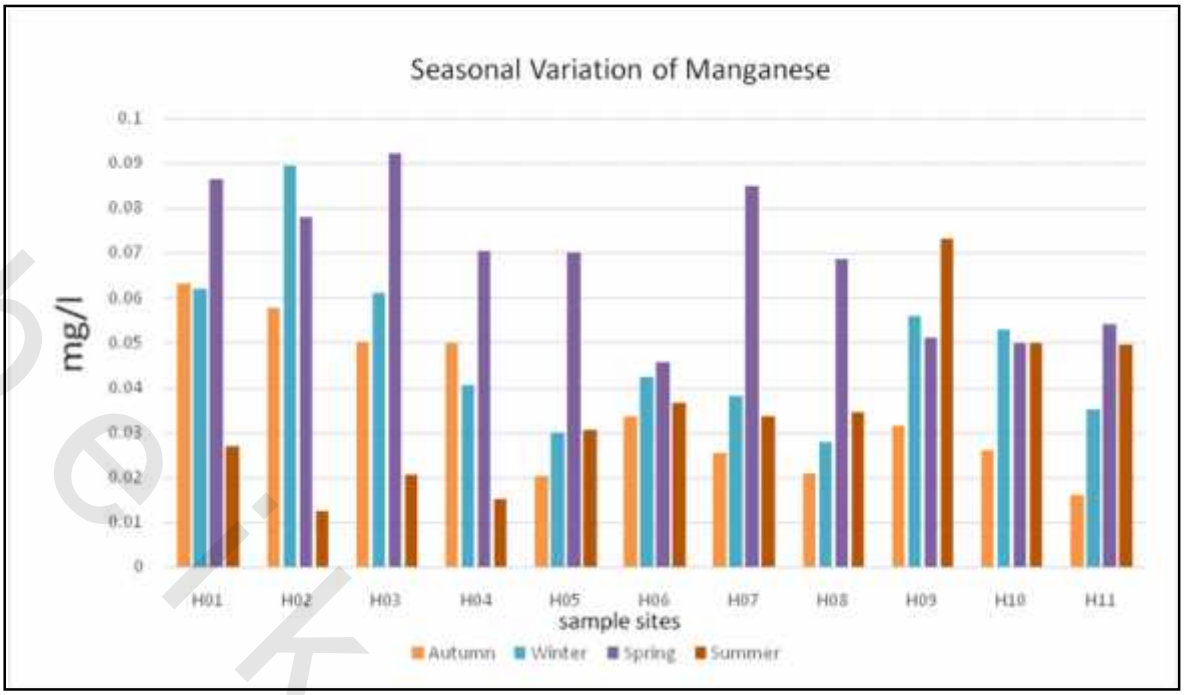

Figure 4.41: Seasonal variation of Manganese in Mahmoudia canal

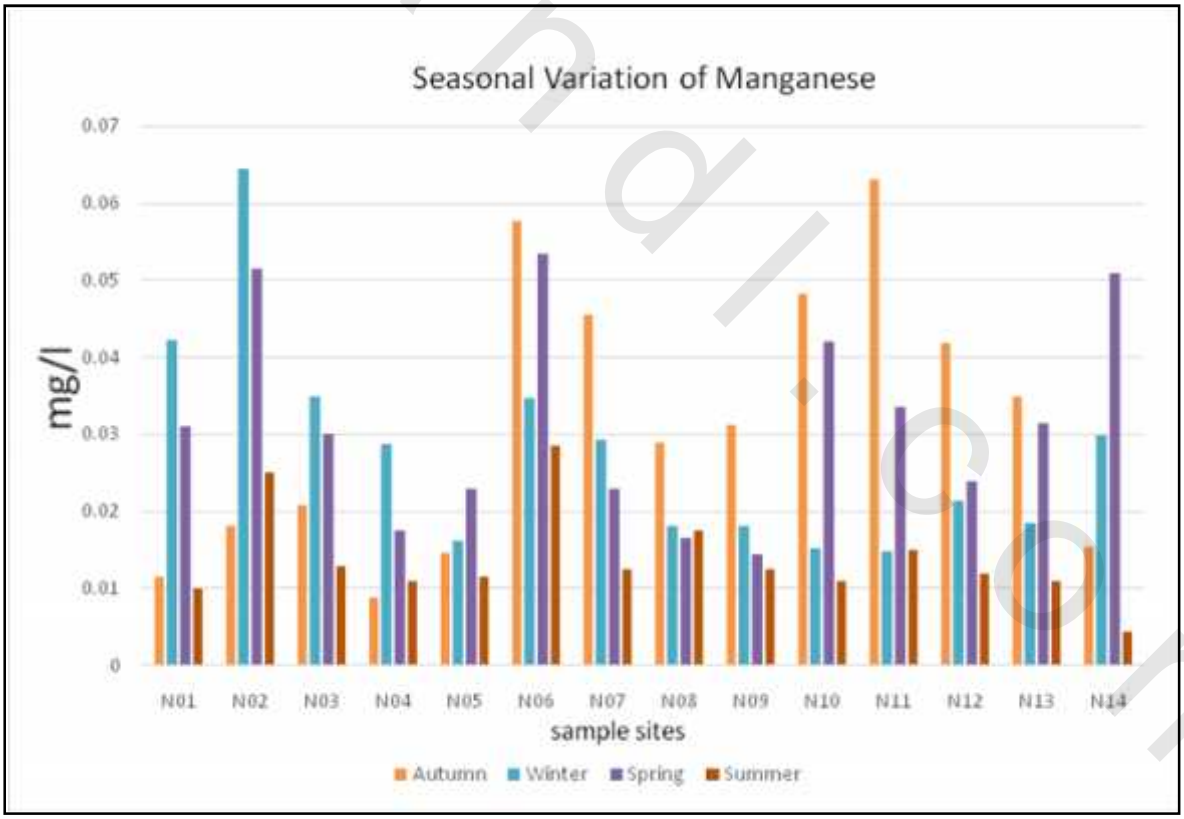

Figure 4.42: Seasonal variation of Manganese in Nubaria canal

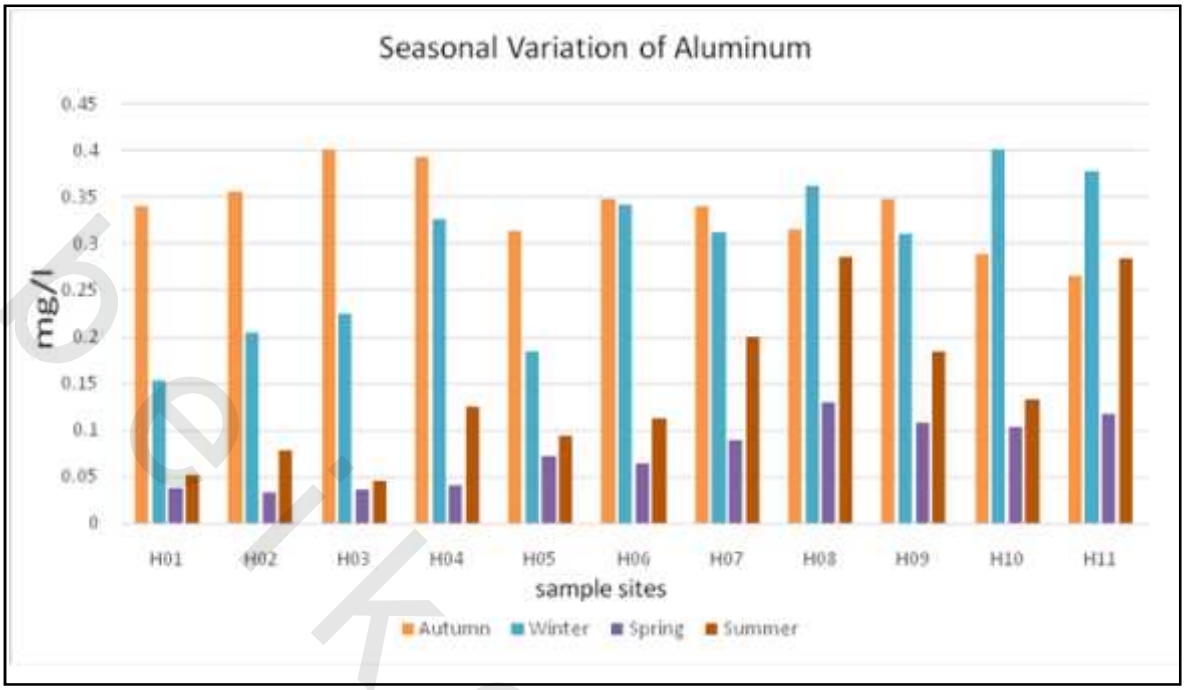

Figure 4.43: Seasonal variation of Aluminum in Mahmoudia canal

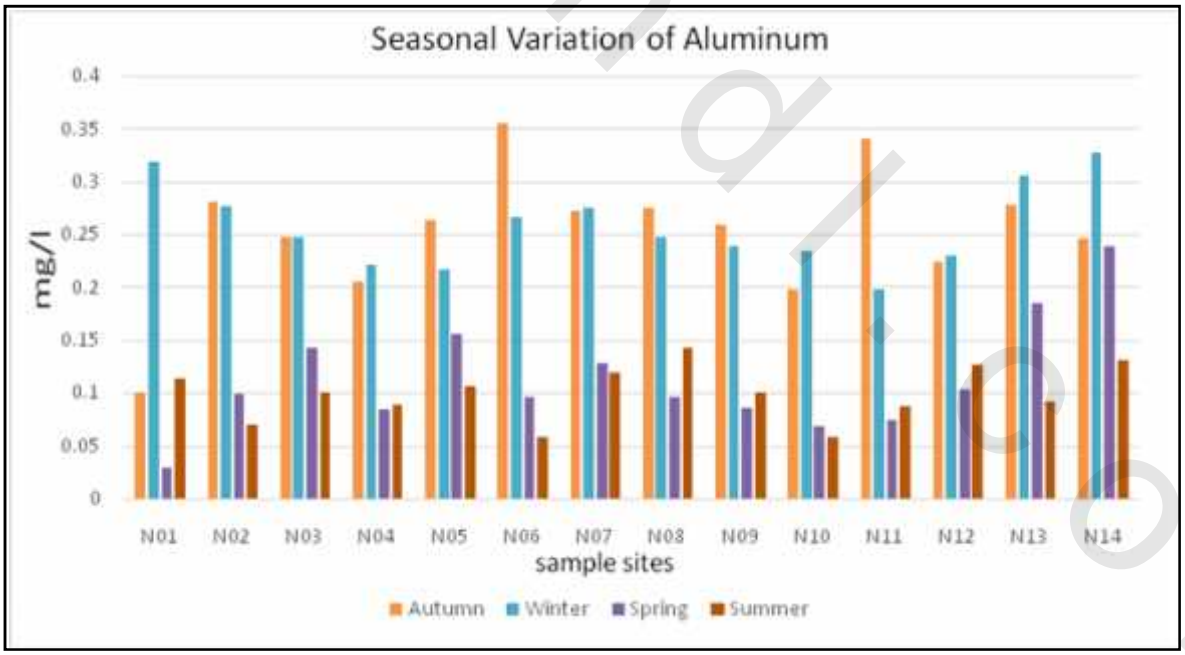

Figure 4.44: Seasonal variation of Aluminum in Nubaria canal

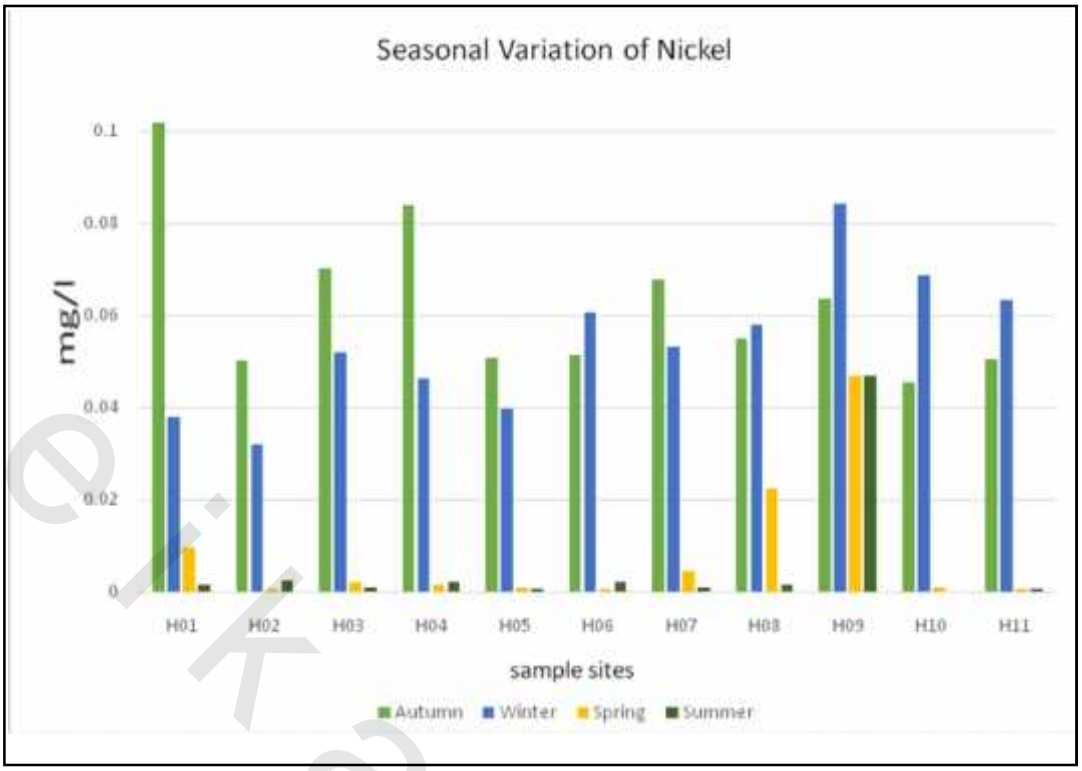

Figure 4.45: Seasonal variation of Nickel in Mahmoudia canal

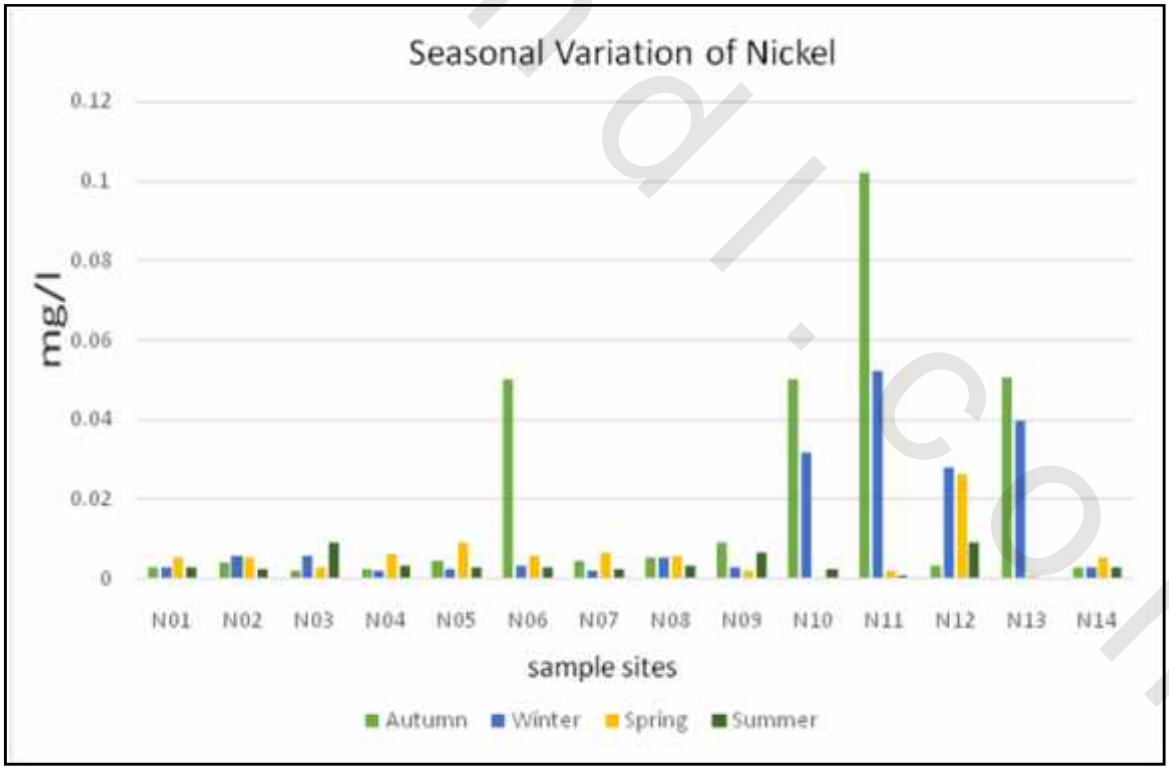

Figure 4.46: Seasonal variation of Nickel in Nubaria canal

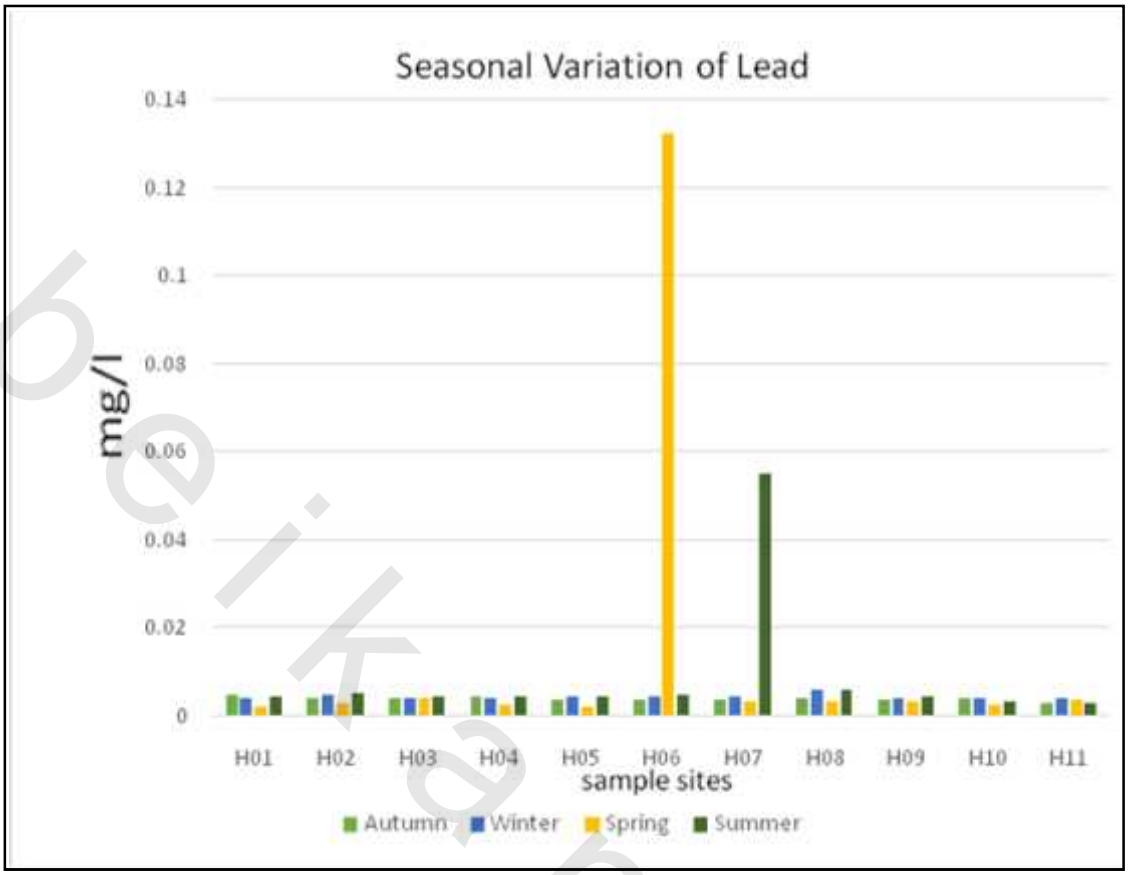

Figure 4.47: Seasonal variation of Lead in Mahmoudia canal

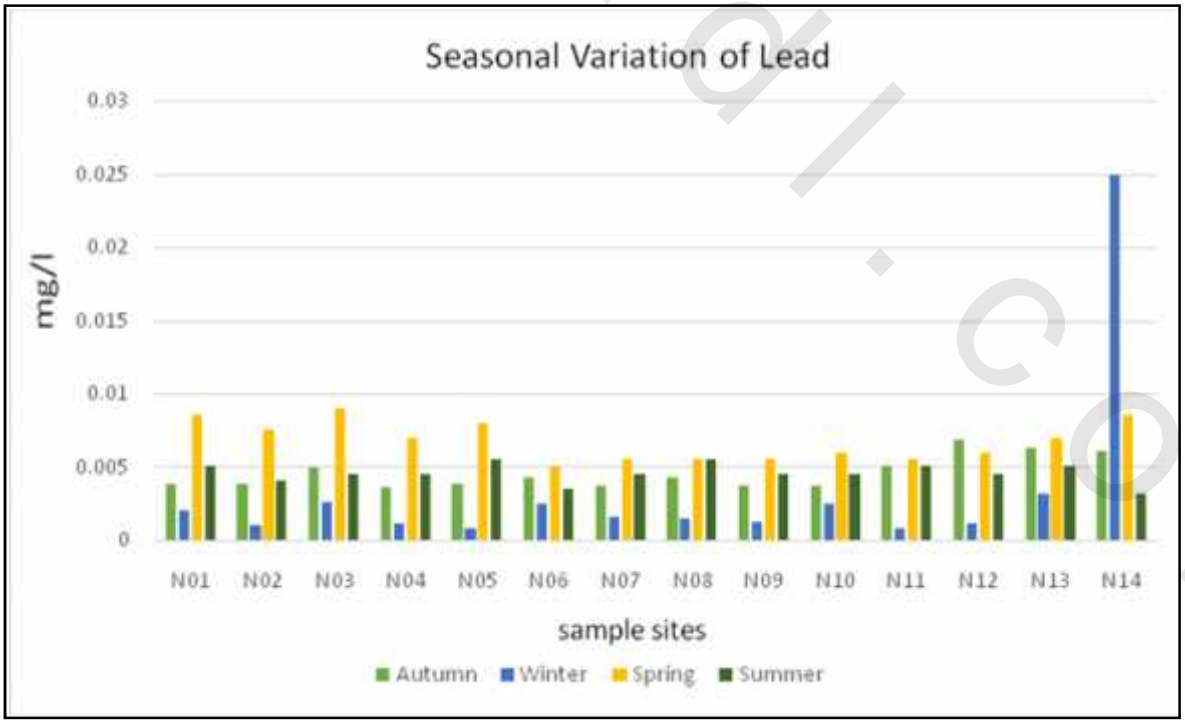

Figure 4.48: Seasonal variation of Lead in Nubaria canal

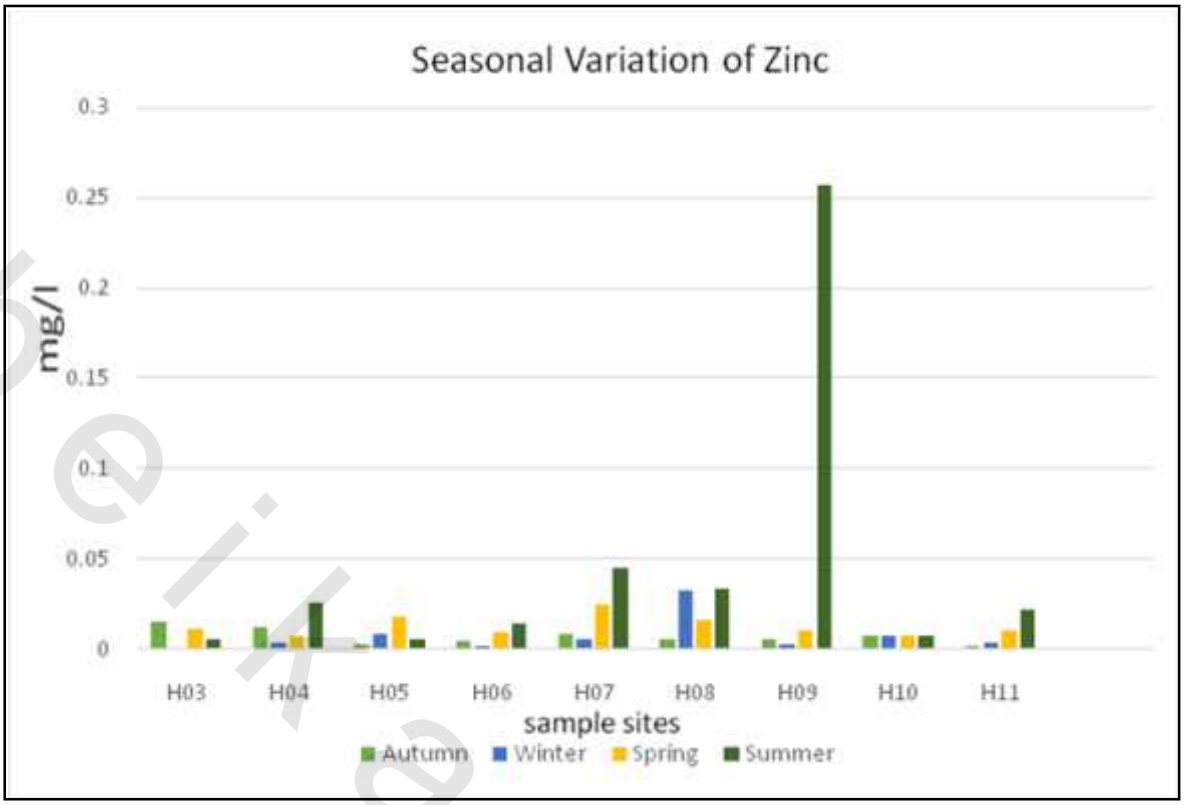

Figure 4.49: Seasonal variation of Zinc in Mahmoudia canal

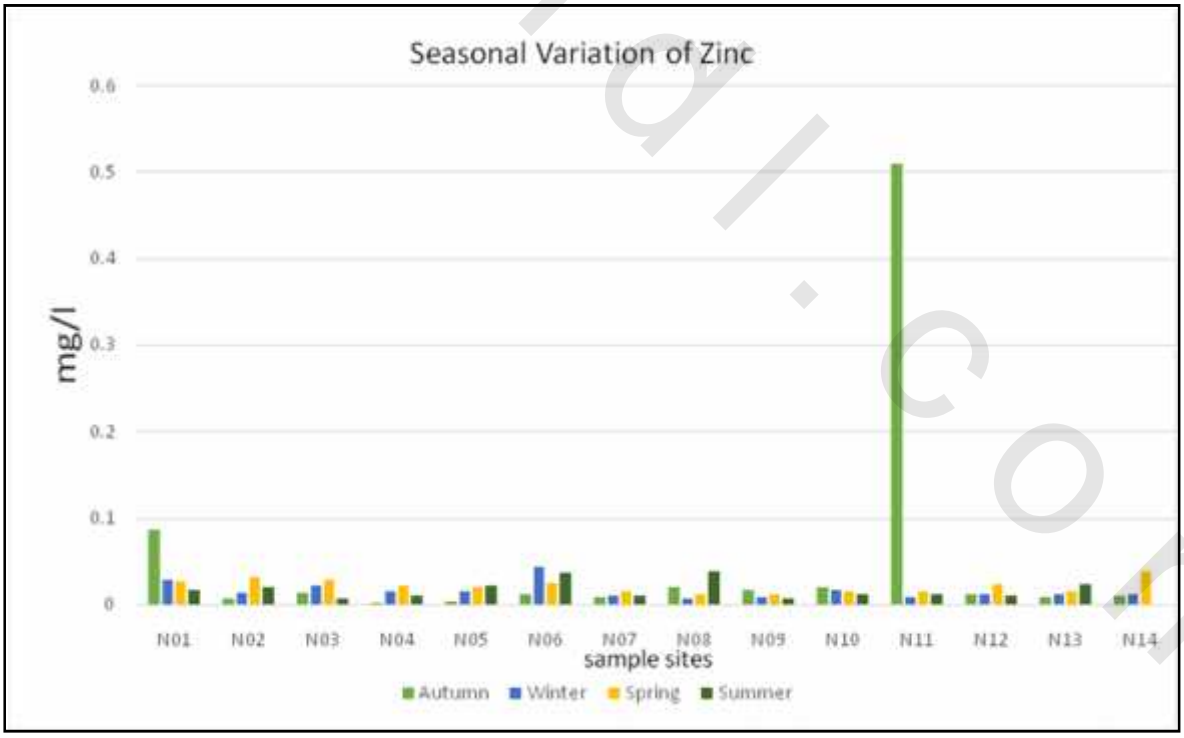

Figure 4.50: Seasonal variation of Zinc in Nubaria canal