REPUBLIC OF TURKEY
BİNGÖL UNIVERSITY
INSTITUTE OF SCIENCE

IMPACTS OF KOWASHE INDUSTRIAL AREA ON GROUNDWATER POLLUTION IN SEMEL DISTRICT-DUHOK CITY-KURDISTAN REGION-IRAQ

MASTER THESIS

Niwar A. MOHAMMED HAMID

SOIL SCIENCE AND PLANT NUTRITION

SUPERVİSOR OF THESİS
Assoc. Prof. Dr. Ali Rıza DEMİRKIRAN

BİNGÖL-2017

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This dissertation was accepted by the following committee on 10.07.2017 with the vote unity

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In the name of Allah, the Most Gracious and the Most Merciful

All praise be to God and to Him alone. All the ends of the nerve, the joints, limbs, organs and faculty of the mine are indebted to God for all the good things he has given me to enable me to successfully finish this letter. Words are insufficient to describe my gratitude and appreciation to him in the whole process of preparing, compiling and writing this letter. In moments of trouble, he led me, showed me what to do, removed all the obstacles from and lit my way, inspired me, relaxed the arduous task of writing, and gave me excess energy so I could stay until night after night and put down words on paper. Without him, I was not able to do this arduous task. He is my world, always there at every moment! What interests me is that he accepts this contribution of mine that inspired me to write; help me by sending me various messenger at every crucial juncture. Praise be to Allaah!

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Niwar A. MOHAMMED HAMID

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LIST OF SYMBOLS

%	: Percentage
°C	: Degree Celsius
µS	: microSiemens
Al	: Aluminum
APHA	: American Public Health Association
Ca	: Calcium
CaCO3	: Calcium Carbonate
Cd	: Cadmium
Cl	: Chloride
Co	: Cobalt
COD	: Chemical Oxygen Demand
Cr	: Chromium
Cu	: Copper
DO	: Dissolved Oxygen
EC	: Electrical Conductivity
EDTA	: Ethylenediaminetetraacetic Acid
Fe	: Iron
H2SO4	: Sulfuric acid
K	: Potassium
L	: Litter
m	: Meter
Mg	: Magnisium
mg/L	: Mille Gram per litter
min	: Minute
Mn	: Manganese
Na	: Sodium

Ni	: Nickel
No3	: Nitrate
NTU	: Nephelometric Turbidity Unit
P	: Phosphorus
Pb	: Lead
pH	: Potential of Hydrogen
ppm	: Part Per Million
TDS	: Total Dissolved Solid
TH	: Total Hardness
UV-VIS	: Ultraviolet-Visible Spectrophotometry
WHO	: World Health Organization
Zn	: Zinc

DUHOK ŞEHRİ (KÜRDİSTAN BÖLGESİ-IRAK) SEMEL BÖLGESİNDEKİ KOWASHE ENDÜSTRİYEL ALANININ YERALTI SUYU KİRLİLİĞİNİN İNCELENMESİ

ÖZET

Kuzey Irak bölgesi Duhok şehrindeki Semel semtine komşu olan aşağı Kowashe sanayi bölgesinde on adet artezyen kuyusu seçilmiş ve bu kuyulardaki endüstriyel atık kirleticilerinin etkileri incelenmiştir. Sonuçlar aşağıda özetlenmiştir: Sanayi bölgesi çevresinde dağılmış olan artezyen kuyularının su sıcaklıkları 20-22 ^{o}C civarında değişmektedir. Bulanıklık 0,5-0,9 NTU arasında değişir. EC 420-730 µS arasında bulunmuştur. TDS değerleri 278 mg / L ve 472 mg / L (4. Lokasyon) arasında elde edilmiştir. Ölçülen pH'nın 7,3 (5.lokasyon) ile 7,7 (6. lokasyon) arasında olduğu belirlenmiştir. En yüksek TH seviyesi Girash'da 404 mg / L olarak kaydedilmiştir. Çözünebilir oksijen (DO), 1. lokasyonda en az (5,7 mg / L) ve 7. lokasyonda maksimum olarak (8,54 mg / L) gözlenmiştir.

Ca içeriği, 67 mg / L'den (3. Lokasyon) 89 mg / L'ye (Sarshor'da) kadar değişmektedir. En yüksek Mg içeriği 48 mg / L ile Girrash'ta kaydedilmiştir. K içeriğinin kayıt edilen yüksek içeriği 7 mg / L'nin üzerindedir. 27 mg / L olarak kaydedilen Na'un maksimum seviyesi lokasyon 6'da belirlenmiştir.

Anyon olarak SO_4 iyonlarının içeriği 3. lokasyonda 2,8 mg / L olarak nispeten düşüktür, Girrash bölgesinde ise 28,6 mg / L olarak yüksek düzeydedir. Klorür iyonu konsantrasyonu 1-5 arasındaki lokasyonlarda düşük, 6 ila 10 lokasyonları arasındaki bölgelerde yüksek seviyede olup, Girrash lokasyonunda en yüksektir (30 mg / L). NO_3 konsantrasyonu, 55,3 ml / L ile Girrish mevkiinde en yüksek seviyede kaydedilmiştir ve bu değer içme suyu için güvenilir değildir.

Ağır metal olarak Fe elementinin yüksek seviyeleri, 3. ve 7. noktalarda 0,0162 mg / L olarak kaydedilmiştir. Cd'un en yüksek değerleri 0,008451 mg / L ve 0,008391 mg / L olarak sırasıyla lokasyon 1 ve 10'da kaydedilmiştir. Pb konsantrasyonu birinci lokasyonda en yüksek (0,00397 mg / L) ve onuncu lokasyonda en düşük (0,000718 mg / L) düzeydedir. Zn konsantrasyonu, 7. lokasyonda 0,4212mg / L'ye ulaşmıştır. As konsantrasyonun en yüksek seviyesi 0,00185 mg / L olarak (lokasyon 7) tespit edilmiştir. Yüksek bakır seviyesi 1,3761 mg / L ile birinci lokasyondadır. Yüksek Kobalt konsantrasyonu 1. lokasyonda 0,000173mg / L olarak bulunmuştur. Mn konsantrasyonunun en yüksek değeri 1. lokasyonda olup 0,0765mg / L'dir. Ni konsantrasyonu 0,0717mg / L'ye olarak 2. Lokasyonda maksimum olmuştur. Al içeriği ise, 6. lokasyonda 0,020555 mg / L olarak elde edilmiştir.

Anahtar Kelimeler: Yeraltı suları, kirlilik, endüstriyel alan, Semel, ağır metal.

IMPACTS OF KOWASHE INDUSTRIAL AREA ON GROUNDWATER POLLUTION IN SEMEL DISTRICT-DUHOK CITY-KURDISTAN REGION-IRAQ

ABSTRACT

Ten artesian wells are selected adjacent and the downward Kowashe industrial area in Semel district, Duhok governorate, Kurdistan region-Iraq as a source of groundwater to study the impacts of industrial effluents pollutants in these wells. The results are summarized below. The temperature of studied artesian wells distributed around the industrial area is ranged around 20-22 ^oC. The turbidity is ranged between 0.5-0.9 NTU. The EC ranged between 435-738 µS. The TDS levels were ranged 278 mg/L to 472 mg/L (in location 4). The pH recorded between 7.3 in location 5 and 7.7 in location 6. The TH high level recorded at Girash 404 mg/L. The DO is ranged between 5.7 mg/L as a minimum in location 1 and 8.54 mg/L as a maximum in location 7.

The content of Ca ranged between 67 mg/L in third locations to 89 in Sarshor location. The high content of Mg was recorded at Girrash with 48 mg/L. The content of K recorded high level over 7 mg/L. The high content of Na level was found in location 6 (27 mg/L).

As anions, the content of SO_4 ions are relatively low in location 3 which is 2.8 mg/L and high level was recorded in Girrash 28.6 mg/L. The chloride ions concentration is low from location 1 to 5 but relatively high from location 6 to 10 recording high level in Girrash locations (30 mg/L). The concentration of NO_3 recorded high level in Girrish location of 55.3 ml/L which is not safely for drinking water.

As a heavy metal, the concentration of Fe high levels recorded in location 3 and 7 to be 0.0162 mg/L. The highest values of Cd are recorded in location 1 and 10 to be 0.008451 mg/L and 0.008391 mg/L, respectively. The concentration of Pb are in high levels in location 1 (0.00397 mg/L) and low in location 10 (0.000718 mg/L). The concentration of Zn it has a high level in location 7 to reach 0.4212 mg/L. The concentration of As recorded high level 0.00185 mg/L (in location 7). High cupper level was in location 1 to record 0.3761 mg/L. The high concentration of Cobalt is concentrated at location 1 to reach 0.000173 mg/L. The high Mn concentration was in location 1 and recorded 0.0765 mg/L. The concentration of Ni was recorded maximum in location 2 to reach 0.0717 mg/L. The Al content is concentrated at location 6 to be 0.020555 mg/L.

Keywords: Groundwater, pollution, industrial area, Semel, heavy metal.

1. INTRODUCTION

Before we begin to write this research, we have to understand to our sources of life on this earth. The main source of life is the water. Water affects all sides of life directly or indirectly. Without it, there will be no plants on land, no oxygen for the animals to take a breath, and not the human and the planet look quite different from what you have seen do today. Water is essential to keep people's bodies and the environment healthy and should be respected and protected as the precious resource. Groundwater is therefore one of the fundamental types of the hydrological cycle, which performs many functions in our daily lives. Most of the earth's water is salt, about 97.5% of the total water on the earth is salt, however, only 2.5% is freshwater, of all the waters of the earth and of those waters groundwater is 1.2% of all water on the earth and about 30.1% of freshwater (Morgan and Collins 2001).

Groundwater is underground water, underground in cracks, spaces or pores in the soil, sand and fractures in rocks, which provide water cycle (hydrological cycle). The main three types of rocks are known as sedimentary rocks, metamorphic rocks, and igneous rocks, and the changes between them are related to how they are formed. Here sedimentary rocks are the types which have the properties to hold water (USGS 2014).

In the aquifers ground water is stored and slowly moving from one side to another, layers of sand, soil, and rocks. The aquifers usually contain sand, sandstone, and gravel or fractured rock, such as basalt or limestone. Those materials have a permeability of holding water because of large connected spaces of that material due to allowing water to flow through. Water naturally transported to the surface of the aquifer through a spring or can be discharged into streams and lakes. This water can also be pulled out from well drilled into the aquifer; aquifers divided into three types:

Confined aquifer. Those in which there is an impermeable layer of dirt-rock, which prevents the water from entering the aquifer from the ground surface of the soil directly above. Instead, the water leaks into the confined aquifers farthest from where the impermeable layer does not exist. Unconfined aquifer. That is the water that flows from the surface of the earth directly into the aquifer. Perched aquifers. Perched aquifer is a type of unconfined aquifer located above another aquifer is undivided because the water infiltrating from the surface is restricted or "perched" on the confined superficial groundwater (US EPA 2012).

The main type of contamination of ground water is known by industrial wastes, domestic and agricultural activity in those types of pollution are a serious problem confronted by developing countries. Industrial wastewater, sewage sludge and solid waste materials are presently being discharged into the environment at random. These substances enter subterranean aquifers, leading to pollution of irrigation and drinking water. These substances enter subterranean aquifers, leading to contamination of irrigation and drinking water (Forstner 1981). Over-reliance on groundwater has resulted in 66 million people in 22 states being threatened by excessive fluoride and 10 million in arsenic threats in six states (Gush 2007). As well, The excessive salinity are the serious problems, especially in coastal areas, nitrates, iron and others (Desai 1990). Nearby 195,800 people are affected by poor water quality due to chemical parameters (CPCB 1999).

It has been estimated that once the pollution enters the subsurface environment, it may remain hidden for many years, becoming discrete over wide areas of groundwater aquifer and rendering groundwater supply of non-potable groundwater and other uses. The rate of depletion of groundwater levels and a worsening of groundwater quality is of instant concern in main cities and towns of the country. The increased dependency on groundwater has made water conservation improvement top importance in water management studies. The challenge ahead is to provide water of the correct quality and quantity at the right place and time. In the context of the above situation, the objective of the present study was to analyze the physicochemical parameters and heavy metals of the artesian wells of groundwater in the Kowashe industrial area to know the impact of industrial and its environs. The evaluation of water quality index has been required because of a large number of industries in the Kowashe study area. The influence on the quality of groundwater on the quality of life of inhabitants in the villages nearby the industrial area was evaluated based on the analysis of the WHO questionnaire.

When rainwater or surface water enters contaminated soil during leakage into the ground, it can become contaminated and may transfer pollution from soil to groundwater. Groundwater can also become polluted when liquid hazardous materials themselves are severely reduced through the soil or rocks in groundwater. Some liquid hazardous substances do not blend with the groundwater, but continue to rally within the soil or bedrock. These common materials can performance as long-term sources of groundwater contamination, where groundwater flows through or connects to soil or rocks. Groundwater can become contaminated by two way point sources and non-point sources (Adams and Foster 1992).

In the industrial water commonly used for cooling, cleaning, heating, cooling and generating streams, like as solvent and transport of dissolved materials, and industrial used water as an important part to product itself. The removal of water for the industry is usually much greater than the amount already consumed (WWAP 2006).

Heavy metals are commonly present in groundwater at trace concentrations. The most common sources of pollution include mining, urban and industrial wastes, agricultural wastes, sewage sludge, fertilizers and fossil fuels. Heavy metals can be very toxic to humans even at low concentrations, due to a tendency to bioaccumulation in the food chain (Alloway and Jackson 1991).

The aim of this research is to:

- The hazardous environmental effluent of industrial areas effluents on groundwater pollution.
- Selecting ten artisans well distributed downward and around the industrial area to study the impacts on their physiochemical parameters and heavy metal contents.
- To assess the influence of industrial pollutions on the quality parameters of groundwater as physic-chemical properties like PH, Ec, TDS, alkalinity, and hardness.
- To determine the quality of soluble salts as ions like nitrate, sulfate, and chloride in these wells.
- Focusing heavy metal accumulation in groundwater downward the watersheds of these effluents in ten artesian wells distributed in the study area.

2. LITERATURE REVIEW

2.1. Importance of Groundwater

We may ask, why groundwater is important? Actually, it's the very important type of water. Groundwater is extensively used in a variety of ways, like for industrial water supply, residential water supply, crop irrigation, washing, cleaning, any place that well water is used its water used for many purposes, but especially for 'drinking' cause groundwater is the cleanest water we ever have. And most of it doesn’t need to be cleaned or filtered. Farms, cities, and factories often depend on groundwater. The temperature of groundwater is constant throughout the year, because of its properties that stop at same temperature it can be used to cool houses in summer and heat them in winter. In some parts, groundwater has become increasingly significant as a source of heat for "heat pumps." Because of the little rain falls in some part of world , only groundwater are the source of water. Without groundwater no one could live in those places, and no plants would grow (Bayer et al. 2006).

Groundwater, as a source of domestic and drinkable water supply, has some advantages over surface one. It is, as a rule, characterized with a higher quality (availability of components, necessary for human vital activities) and better protection from contamination and evaporation. Groundwater resources, due to the availability of adaptive capacity, are not subjected to multi annual and seasonal variations. In some northern and arid zones, where surface water flows froze up or dry up in some periods of a year, groundwater is the only water supply source. In many cases, it is possible to be summarized ground water in the direct vicinity of a consumer. Putting well fields into operation can be made slowly with the increasing growth of consumption, while hydro technical constructing, for surface water use, needs usually large one-time expenses. All the conditions mentioned predetermined a considerable increase of groundwater use for the drinkable and domestic supply of the population, if compared with surface water, particularly, taking into account its better protection from contamination. The role of groundwater for public water supply in different countries and in different Period changed significantly. On the hole, at the incipient stages of developing a central municipal water supply, spring or river water was, as a rule, used as a source of water supply (where it was possible). With a growth of water consumption, surface water was used more intensively. And Groundwater provides 97% of the Earth's potable water. Here about the distribution of the water on the earth (in the earth's crust) 97.5% of all water on the earth is salt water which located in the oceans and seas while a few of it approximately about 2.5% is the freshwater presenting in lakes, rivers, ice caps, springs, and glaciers. And the groundwater which approximations about 1.2% of earth's total water and 30.1% of total freshwater (Peter 1993).

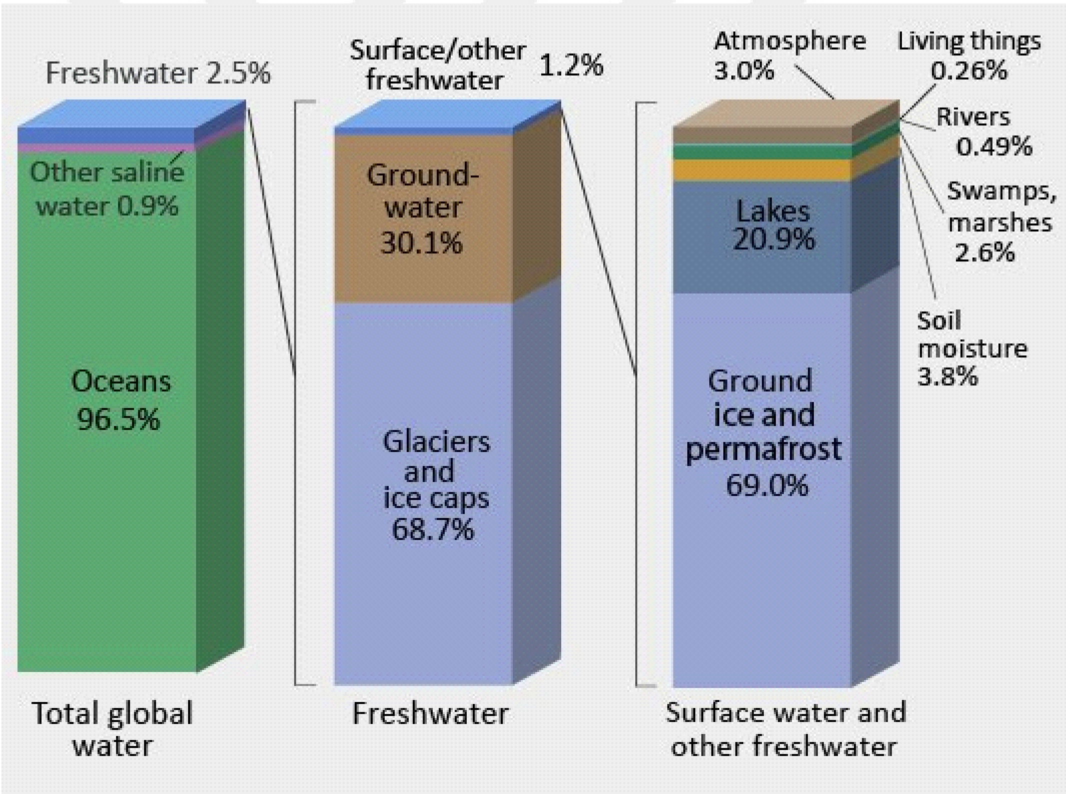

Figure 2.1. Distribution of water

2.2. Types of Rocks and Which Type Has The Properties to Hold Water

Everywhere there are some water lies behind the earth's surface, under deserts, plains, mountains and hills. It is not always possible to achieve, or fresh enough for untreated use, and it is sometimes difficult to find or measure and describe. These waters may occur near the surface of the earth, as in the marshes, or may lay hundreds of feet below the surface of the earth, as in some dry areas of the west. Water at very shallow depths might be just a little hours old at moderate profundity, it may be hundred years old and at great deepness or after having flowed long distances from places of entry, water may be several thousands of years old (Schön 2015).

Acknowledged of Groundwater by humans for many thousand of years. Many ancient records show that humans have known for a long time that much of the water is contained underground, but only recently have scientists and engineers learned how to estimate the amount of ground water stored underground and have begun to document their great potential for use. A projected one million cubic miles of the biosphere's groundwater is stored within one-half mile of the land surface. Only a part of this reservoir of ground water, however, can be practicably appointed and complete available on a perennial basis through wells and springs. The volume of groundwater storage is 30 times greater than about 125045 cubic kilometers in all freshwater lakes and more than 1250 cubic kilometers of water worldwide. It is difficult to visualize underground water. Some people think that groundwater collects in underground lakes or movements into underground rivers. In fact, ground water is simply subterranean water that completely saturated pores or cracks in the soil and rocks (Jaeger 2009).

Groundwater is recharged through rainfall, and depending on local climate and geology, water is distributed unequally in quantity and quality. When the rain falls or the snow melts, some water evaporates, some of which are reflected in the plants, some movements are by land and are collected in streams and some of his water sneak into the cracks or pores of the soil and rocks. The major water entering the soil replaces water that has been evaporated or used by plants during a former dry period. Between the surface of the earth and the groundwater is the area called the unsaturated hydrologists. From this unsaturated zone (the zone of aeration), at least there is usually a little water, commonly in smaller openings of soil and rocks. Large openings usually contain air instead of water (Kitutu et al. 2009).

After heavy rain, the area may be almost saturated; after a long dryish period, it may be almost dry. Some water is formed in the unsaturated zone by molecular attraction, and will not move towards or enter the well. Similar forces carry enough water in the spray towel to make them feel moist after they have stopped drip after the water supply of the plant and soil are satisfied, every excess water will sneak into the upper table water from the area below the holes in the saturated rocks. Under the surface of the water, all openings in the rocks are filled with water that is transported through the aquifer to the waterways, springs or wells from which water is reserved. Deep recharge of aquifers is a slow process because the groundwater slowly moves through the unsaturated area and the hollow basin. The amount of recharge is also considered important (Wada et al. 2012).

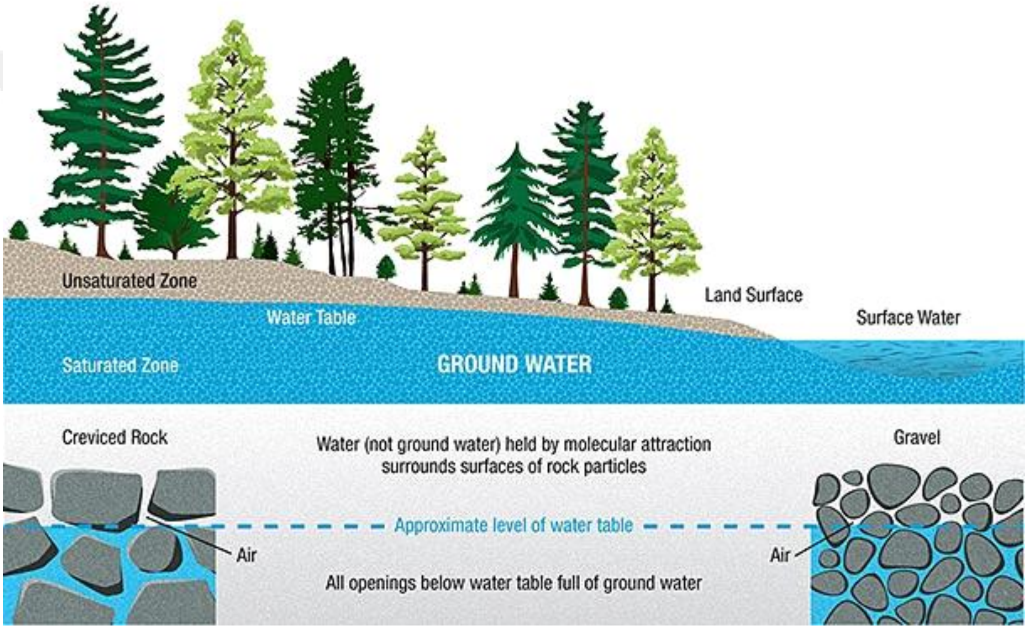

Figure 2.2. Location of groundwater

The amount of water carried by a rock depends on the porosity of the rocks as an area of pores between the grains of rocks or the cracks in the rocks that can be full with water. For example, if grains of sand or gravel are all over the same size, or "well sorted", the water-filled spaces between the grains signify a large quantity of the aquifer's size. If the grains, however, are poorly organized, the spaces between large grains may be filled with small grains instead of water. The sand and gravel water tanks, which contain well-sorted granules, hold and transport large quantities of water from those aquifers containing low-grade grains. If water is to move through rock, the pores necessity be connected to one another. If the pore spaces are linked and large enough that water can move freely through them, the rock is said to be permeable (Heidug and Wong 1996).

Rocks that produce large amount of water into springs or wells necessity have many connected to spaces of creacks. Rocks that compress almost without pore spaces, such as granite, may be absorbent if it contains enough large and related cracks or fractures. Nearly all consolidated rock creations are broken by similar systems of cracks, called joints. These joints are caused by stresses in the Earth's crust. In the first place, many joints are capillary cracks, but tend to rise through the work of many physical and chemical processes. Ice crystals made of water that freeze in the rocky cracks near the earth's surface will cause the rocks to divide open. Heated by the Sun and cooling at night cause increase and decrease that produce the same result. Water will enter the joints, and may slowly dissolve the rock or erode weathered rock and thereby enlarge the openings (Johnson and Morris 1962).

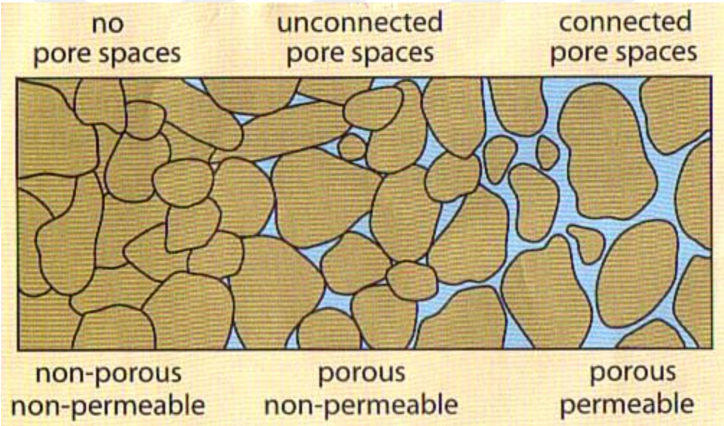

Figure 2.3. Porosity and permeability of rocks

For a land made of rocks. About Thousands of different types of rocks and minerals have been found on the Earth. Most rocks on earth consist of only eight elements: oxygen, silicon, calcium, aluminum, iron, magnesium, sodium and potassium. These elements are common in a number of ways to make rocks that are very different. The main three types of rocks are known as sedimentary rocks, metamorphic rocks, and igneous rocks, and the changes between them are related to how they are formed.Sedimentary rocks are made up of previously existing rocks. Weathering breaks the rocks into smaller bits and pieces. Wind, water and ice carry these pieces and deposit them and accumulate in layers on the surface of the earth. Metamorphic rocks form when rocks are exposed to high temperature and pressure. The heat and pressure have changed dramatically from their original shape. Huge rocks form when the rocks melt from the depth of the earth and cool down and become solid. Chemical composition of magma and refrigeration The rate of determination of the type of igneous rocks becomes. The igneous and metamorphic rocks don't have the properties to hold water because of their formation, but the sedimentary rocks can hold water cause this type of rocks have the porosity and permeability, unlike others through their cracks, spaces, and breaks caused by weathering and erosion. Sedimentary rocks become the most important type of rocks (Christopherson 2002).

2.3. Water Aquifers

The water available to planet Earth is the same water that has always been available and the only water that ever will be available. Because water covers three-quarters of the earth's surface, it might appear that there is plenty to go around. In reality, however, we have a limited amount of usable fresh water. If you think about it, water never stays in one place for too long Water is always on the move, travel on an endless journey, patrol between the earth and the sky. This is referred to as a hydrological cycle or cycle. The hydrological cycle made up of those parts as a below:

- Evaporation (and transpiration)
- Condensation
- Precipitation
- Collection

***Evaporation:** is when the sun temperatures up water in rivers or lakes or the ocean and goes it into vapor or steam. The water steam or vapor leaves the river, lake or ocean and turn into the air.

***Condensation:** Water vapor in the air becomes cold and changes back into liquid, forming clouds.

***Precipitation:** This process occurs when so much water has reduced that the air cannot hold it any longer. The clouds get heavy and water falls back to the earth in the form of snow , hail, rain, sleet or.

***Collection:** When waterfalls back to earth as precipitation, it may drop back in the oceans, lakes or rivers or it may end up on land. When it ends up on land, it will either soak into the earth and become part of the "ground water" that plants and animals use to drink or it may run over the soil and collect in the rivers, lakes or oceans where the cycle starts (Trenberth 2011).

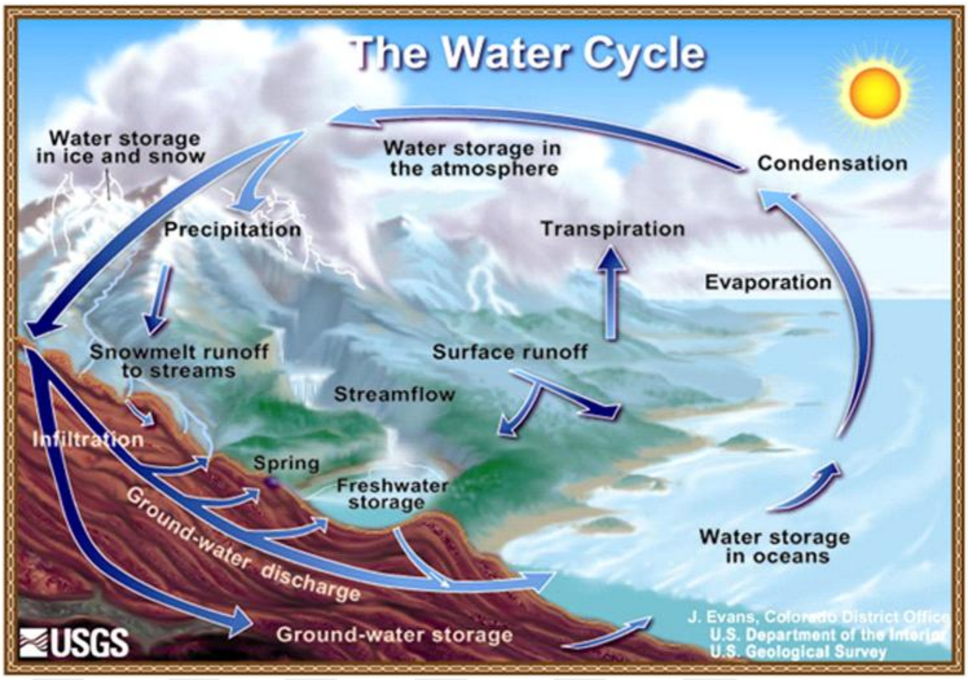

Figure 2.4. Water cycle (hydrological cycle)

The water that leaks to the ground moves downward due to gravity, passing through the pore spaces between the soil particles, until it reaches the depth of the soil where the pores are already filled or saturated with water. When water enters the saturated zone, it becomes part of groundwater. The soils of water or the composition of rocks capable of producing enough water for human use are called aquifer. In aquifers, water can move through cracks or fractures. Some types of foundation stone such as sandstone, can absorb water such as sponge, other types of foundation such as no granite.

How quickly water passes through or infiltrates, the soil is a function of the size and shape of the soil particles, a number of pore spaces between the particles, and whether the pore areas are interconnected. For example, soils that contain primarily of larger sand and gravel particles tend to have larger, interconnected pore spaces that allow water to flow easily and relatively quickly. In contrast, some soils, such as silts and clays, have poorly connected pore spaces, a soil structure which tends to slow down infiltration (Bredehoeft and Pinder 1970).

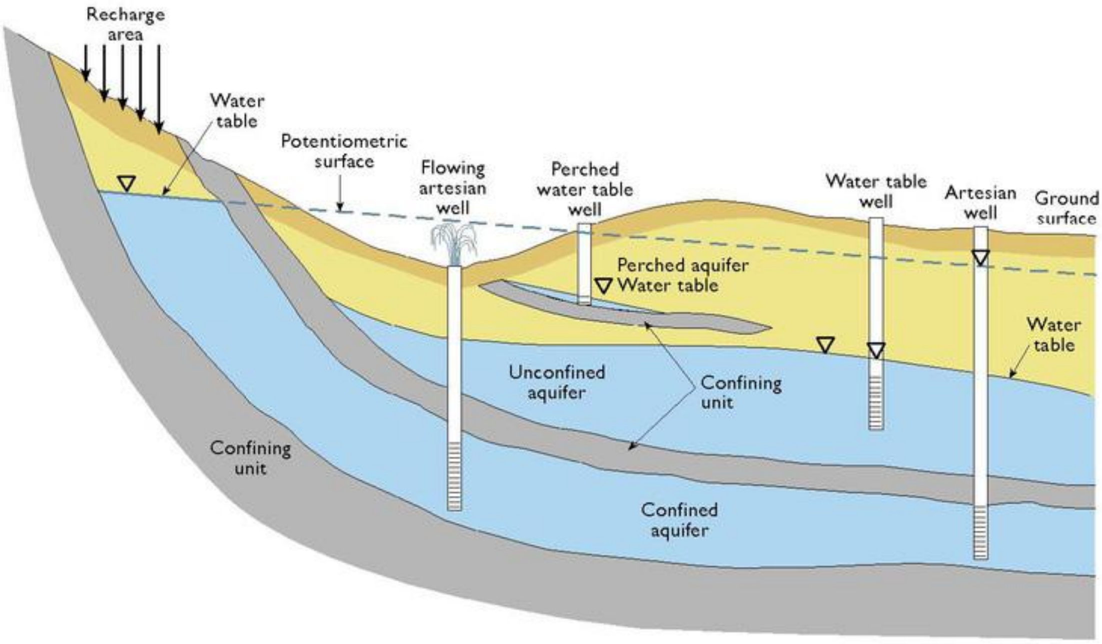

Figure 2.5. Groundwater aquifers

When the water infiltrates into the water level, it begins to move with the flow of groundwater, which tends to follow the slope, or downhill slope, the direction. Compared to water in rivers and streams, groundwater is very, very slow, moving from a little part of the foot daily in mud to up to 3-4 feet a day in sand and gravel. In time, ground water "resurfaces"-perhaps when it intersects with a nearby water body, such as a stream, river, lake, pond, or ocean; or perhaps when it emerges from the hills as a spring or as an object emerges from a rocky formation on the side of the road. Groundwater is a large part of the natural water cycle. Another way ground water resurfaces is when it is reserved from the ground by way of a well. Wells are drilled and connected to capture groundwater and pump it to the surface. In recent years, the term acetard has been formulated to characterize a less permeable family in the stratigraphic chain. This beds can be sufficiently permeable to transport water in significant quantities in the study of regional groundwater flow, but its permeability is not sufficient to allow completion of the production wells within it. Most geological layers are classified as aquifers or aquifers (Freeze and Cherry 1979).

2.3.1. The Three Types of Aquifers

2.3.1.1. Confined Aquifers

The confined aquifer is overlain in a confined layer. Which are usually semi- pervious, allowing for vertical flows between adjacent layers. Unless it is irrational abstraction, the confined aquifers are under pressure; this means that the level of water in the piezometric well will rise above the upper part of the aquifer. this means that the water level in a piezometric well will rise above the top of the aquifer. The surface of the potentiometric can be at the top of the sub-perivius layer, above that but under water table of the unconfined aquifer covered, , above it but under the water table of the unconfined aquifer covering it, or finally above the water table. A special case is when the potentiometric surface is above the ground level, the well all-pervading the confined aquifer existence artesian. The differences in the hydraulic head between the unconfined and the confined aquifer lead to the vertical flows directed from the aquifer have an upper value for the aquifer with a lower hydraulic header value. Vertical water transport is called leakage, and therefore will be directed up or down.

The regional confined aquifer is recharged directly by precipitation in the area where the aquifer exits, which has the same characteristics as the ungrouped aquifer, and another source of recharge is infiltration in the area of agriculture similar to surface runoff born on the slopes of the hill through rain Or melting snow. This groundwater is not confined to the direct recharge area followed by the foundation stone is deepened, being covered by impermeable or semi- pervious layers and became confined groundwater. There are interesting relationships in this latter case between the confined aquifer and the coverage of the non-confined aquifer. According to the head position with water, the vertical flows are directed between the two layers down or upward.Thus the confined groundwater is refilled by direct infiltration and filtration or by leakage. In the case of a multilayered aquifer, depending on the value of water extraction, a confined layer can be recharged by vertical flows coming from the underlying aquifers and overlying (Castany 1982).

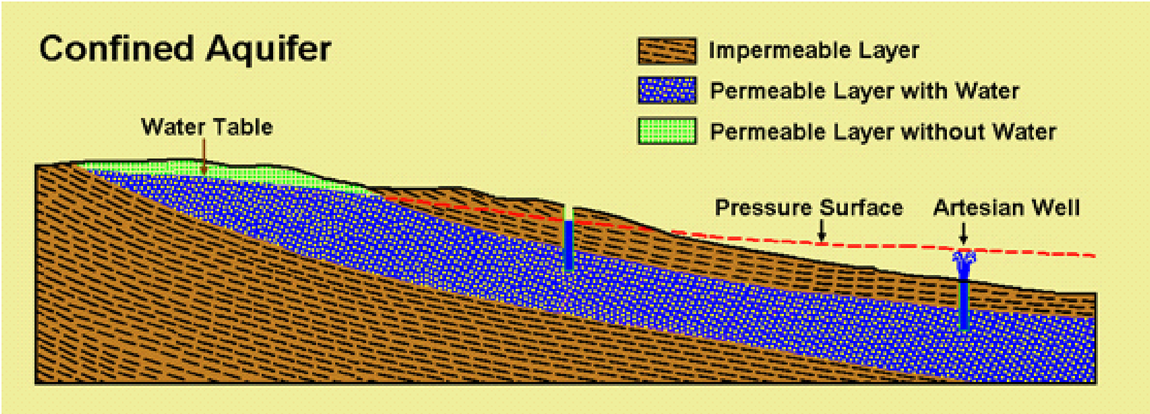

Figure 2.6. Confined aquifer

2.3.1.2. Unconfined Aquifer

Is close to the land surface, being under the direct effect of the climatic factors (precipitations fundamentally, but temperature also). The groundwater inconstancy follow with a certain lag, dependent on the deepness and the nature of the unsaturated zone, the variation of the fallen precipitations. The unconfined aquifers from the surface of the water are spread to the base of the aquifer, which is characterized by impermeable boundary. Most of the unconfined aquifers are formed by extremely permeable layers (gravel, coarse or medium sand) and less permeable creations (silt or clay) Which does not interrupt the hydraulic continuity of the permeable layers at the regional level. Natural recharge of the unconfined aquifers is mostly due to the downward leakage (or filtration) through the unsaturated zone of the excess water over passing the field capacity of the soil. Recharge can also occur through upward leakage from underlying aquifers (Castany 1968).

In irrigated areas, large amounts of water are currently exceeding field capacity penetration. Losses from water supply or urban sewerage are another source of groundwater recharge. Rivers generally depletion of aquifers, but in some cases they may lose water that feeds aquifers; this occurs when the groundwater level is less valuable than river water level or during floods when water flows into the floodplains. In arid countries, some rivers completely seep into the bed river if formed by sand or gravel. Many of the non-confined aquifers used for water supply are located in silt fans, which have large thickness and contain significant water capacities; at the same time, due to high values of hydraulic conductivity, they can convey water flow very quickly to a spongy medium (Fetter 2001).

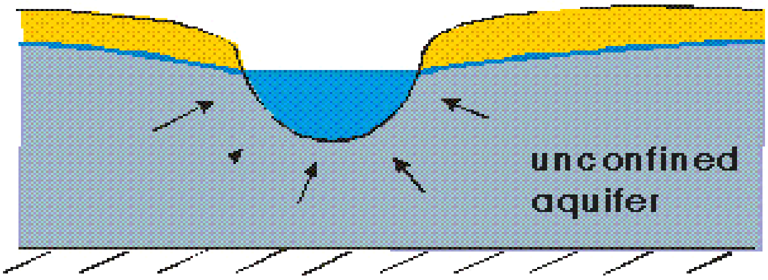

Figure 2.7. Unconfined aquifer

2.3.1.3. Perched Aquifer

Perched aquifers. Perched aquifer is a type of unconfined aquifer located above another aquifer is undivided because the water infiltrating from the surface is restricted or " perched " on the confined superficial groundwater (US EPA 2012).

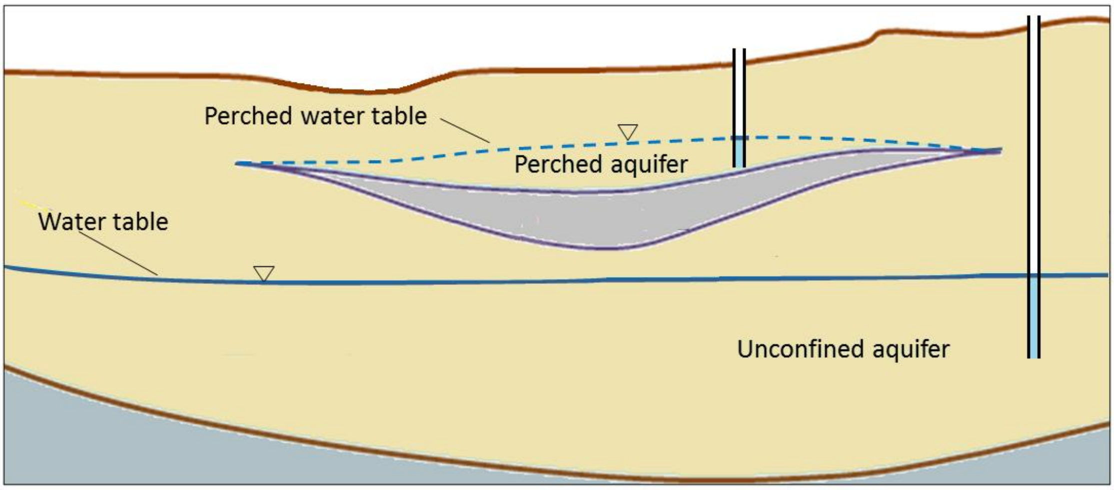

Figure 2.8. Perched aquifer

2.4. Groundwater Pollution

How groundwater becomes polluted:

Groundwater contamination is nearly always the result of human activity. In areas where population density is the high and human use of the land is intensive, ground water is especially susceptible. Almost any activity whereby chemicals or wastes may be released to the environment, either purposely or accidentally, has the possible to pollute ground water. When ground water becomes polluted, it is difficult and expensive to clean up. Ground water and surface water are connected and can be fully comprehended and rationally managed only when that fact is acknowledged. If there is a water supply well near a source of pollution, that well runs the risk of becoming polluted. If there is a nearby river or stream, that water body may also become polluted by the groundwater (Howard and Gelo 2002).

When ground water is polluted according to its physical, chemical and biological properties, the pollutant released into the environment may move within the aquifer in the same way that ground water moves. (Some contaminants, due to their physical or chemical properties, do not always follow groundwater flow). It is possible to predict, to some extent, the transport within the aquifer of those substances that move along with the flow of groundwater. For example, both water and some contaminants flow in the direction of the terrain from feeding areas to discharge areas. The porous and permeable soils tend to convey water and confirm the types of contaminants relatively easily to the aquifer below. Just as groundwater moves generally slowly, contaminants in groundwater. Because of this slow movement, pollutants tend to remain concentrated in the form of a column that flows on the same course of groundwater. The size and speed of the column depends on the quantity and type of pollutant, its solubility and density, and the velocity of the surrounding groundwater. Groundwater and pollutants can move quickly through fractures in rocks. Broken rock is a unique problem in locating and controlling contaminants because the fractions are randomly separated and do not follow the parameters of the Earth's surface or the hydraulic gradient. Pollutants can also be transferred to the groundwater system through total pores, root systems, animal burrows, abandoned wells and other systems of holes and cracks that provide pathways to contaminants. In general, the greater the distance between the source of pollution and the source of groundwater, the greater the likelihood that natural processes will reduce the effects of pollution. Processes such as oxidation, biological degradation (which makes pollutants less toxic at times), and adsorption (binding of materials to soil molecules) may take place in soil layers in the unsaturated area and reduce pollutant concentration before reaching groundwater. Even contaminants that reach groundwater directly, without passing through the unsaturated zone, can become less concentrated by dilution (mixing) with groundwater. However, since groundwater typically moves gradually, contaminants usually penetrate less than mixing in surface water (Kumar et al. 2005).

2.4.1. Sources of Groundwater Pollution

There are many different sources of groundwater contamination. Groundwater becomes polluted when it is human, or originated by people, is dissolved or mixed in water that recharges the aquifer. Examples include salt, petroleum products leaking from underground storage tanks, nitrates from excessive use of chemical fertilizers or compost in agricultural land, excessive application of chemical pesticides, leakage of liquids from landfills and landfills, and accidental spills. Contamination also results from excess natural iron, sulphides, manganese, and substances such as arsenic. Iron and manganese are the most common natural pollutants. Another form of pollution is caused by radioactive decay of uranium in the first place, making irradiated radon. Methane and other gases sometimes cause problems. Sea water can also be found in groundwater and is a common problem in coastal areas. This is referred to as salt water intrusion (Atmadja et al. 2001).

2.4.2. Water Used By Industry

In the industrial water commonly used for cooling, cleaning, heating, cooling and generating streams, like as solvent and transport of dissolved materials, and industrial used water as an important part to product itself. The removal of water for the industry is usually much greater than the amount already consumed (WWAP 2006). Following the main growth of 1960 to 1980, water withdrawals for industry almost all over the world have stabilized in Europe and are steadily increasing, but not as fast as they were in Asia. And in areas where rare groundwater uses groundwater to meet industrial demand. While it is often difficult to obtain specific data on the groundwater withdrawal of this industry, it is clearly still a small fraction of that used in agriculture.

2.4.3. Industry As An Environmental Pressure

Of greater concern is the actual volume of groundwater that has been withdrawn by industry and the potential negative impact of industry on the quality of the sub-surface environment (WWAP 2006).

This is due to the fact that the balance between the volume of withdrawn water and the much smaller volume that is already consumed becomes waste water or liquid waste to be disposed of. Usually through one of the following actions (WWAP 2006).

• Direct disposal without treatment on land, or across streams, rivers and waterways aquifers;
• Disposal of municipal sewage systems that may or may not include wastewater treatment.
• Treatment of wastewater at the site before disposal by any of the above.

Management of these large amounts of wastewater is a main challenge for urban authorities. While there is sometimes range for reclamation of industrial wastewater to make it reusable within the industry itself or by other users, most wastes are returned directly to the water cycle, often without adequate treatment. The volumes of these wastes and the concentrations of the hazardous substances they contain, together with the disposal of the underlying groundwater, are at risk of contamination (Morris et al 2003).

Therefore, in assessing industrial impacts, groundwater quality issues are likely to be more dominant than quantity. The latter, which include recovery at the groundwater level in response to the decline in industrial extraction or mining, is adequately addressed through discussions on the effects of groundwater extraction in the associated information sheets on agriculture and urbanization. This paper focuses on the effects of industrial and mining activities on groundwater quality. For developed countries, the greatest concern is often to deal with the residual effects of industrial heritage and mining in the last two centuries. By contrast, the main concern for new industrialized countries and developing countries may be the potential effects of rapidly growing, often unplanned and unregulated industrial activities. Although they may be small in scale, they are widely distributed in urban and peri-urban areas and are increasingly appearing in rural areas as well. Their potential environmental impact may not yet be observed, nor is the risk posed to groundwater (Olayinka and Alo 2004).

2.4.4. Bore Wells

Groundwater sources differ from other natural water sources, since the water cycle and the aquifer are two systems inextricably linked with each other exerting continuous effect on the other (Howell et al. 1993; Eyre et al. 1993). Described groundwater as the underground water in the saturated rock area, i.e at a depth where the full space of the rock is filled with water (Allenby et al. 1993; DLWC 1995). Ground water quality is of a higher standard compared to surface waters because of its natural cleansing. Less treatment is required where minimal treatment is a high preference (Reinhold 1992). Bore wells are also popular in many of the rural communities in both developed and developing countries, especially where the supply of treated tap water may not be feasible (SIA 2000). It is primarily used for domestic consumption, agriculture, and industrial activities. The application and usage depend on the nature and quality of the source (NDOH 2000).

2.4.5. Contaminated Land

Groundwater may be adversely impacted if contaminants on land find their way into groundwater. Industrial activity has left land contaminated with a variety of inorganic and organic contaminants, frequently including heavy metals, hydrocarbons, and organic solvents, which can lead to serious groundwater pollution. Today’s contaminated land becomes tomorrow’s groundwater pollution problem. The historical problem is widespread, but recent legislation governing industrial processes and emissions seeks to reduce future contamination. The risk of groundwater contamination is increased where the contaminant is mobile, by virtue of its solubility in water or its viscosity, and if there is a pathway to groundwater. Having entered groundwater, the impact of a chemical will depend on its toxicity and persistence. Some contaminants are therefore more likely to impact on groundwater than others (Bardos 1994).

2.4.6. Heavy Metals

Heavy metals are commonly present in groundwater at trace concentrations. The most common sources of pollution include mining, urban and industrial wastes, agricultural wastes, sewage sludge, fertilizers and fossil fuels. Heavy metals can be very toxic to humans even at low concentrations, due to a tendency to bioaccumulation in the food chain (Alloway and Jackson 1991). However, high concentrations in aquifers are not normally a problem as heavy metals are generally relatively insoluble in groundwater under normal pH conditions (6.5 to 8.5), and are therefore immobile in most aquifers. The greatest risk posed by heavy metal contamination is in shallow, acidic groundwater (Tiller 1989).

Heavy metals are commonly present in groundwater at trace concentrations. The most common sources of pollution include mining, urban and industrial wastes, agricultural wastes, sewage sludge, fertilizers and fossil fuels. Heavy metals can be very toxic to humans even at low concentrations, due to a tendency to bioaccumulation in the food chain (Shashikanth et al. 2008).

Another hands Most of these metals especially Iron, manganese, chromium, and copper in small amount are essential elements for most life systems on earth, because of their participation in many important physiological processes within the biological bodies including humans and animals. Although exceeds their level are related with an increased risk for cancer, heart disease and another disease such as endocrine problem, arthritis, diabetes and liver disease (Niederau et al. 1996).

3. MATERIAL AND METHOD

3.1. Site Description

Kowashe industrial area occurs at about 20 km west of Duhok province, North Kurdistan region-Iraq, at national grid reference (**36°59'04.2"N 42°47'50.8"E**) Figure 3.1-3.2. It has a flat physiographic area at an altitude of (555 m) above sea level. The area has a Mediterranean - type climate with mean annual precipitation of (539mm) and mean annual temperature of (19.2 °C). The soil of the area is typified as silty clay loam with low content of organic matter (nearly 1.2%). The bedrock underlying the soil in this area is calcareous (Limestone) type.

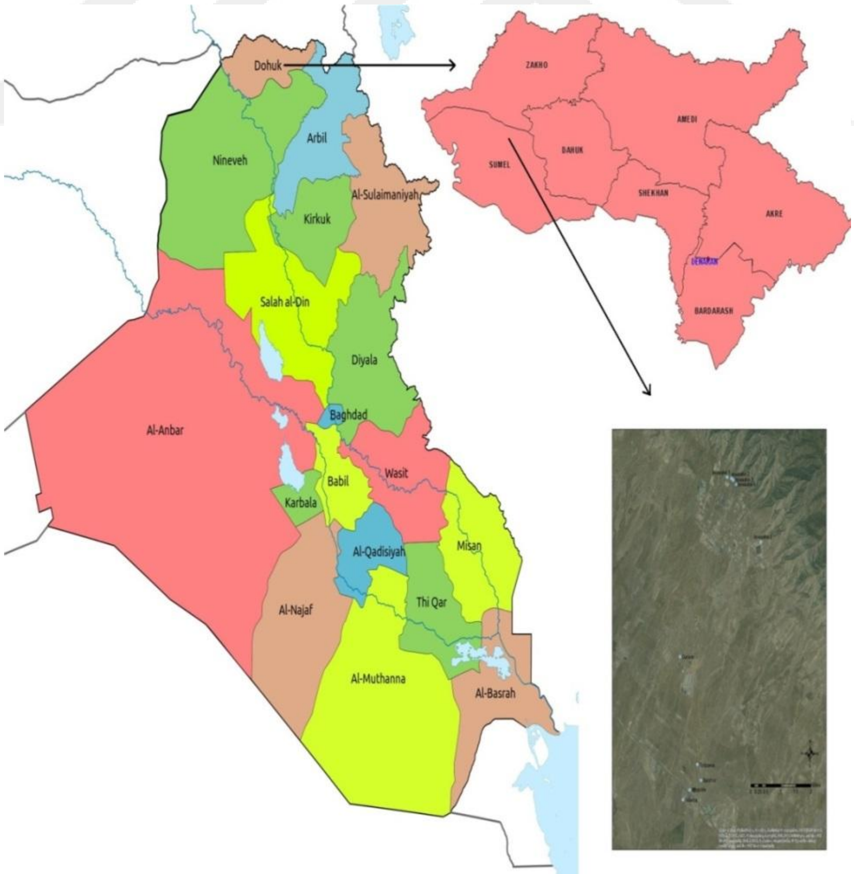

Figure 3.1. Kowashe industrial area

Figure 3.2. Study area location

3.2. Material

Ten artesian wells are selected around and downward Kowashe industrial area in Summel District, Duhok governorate, Kurdistan region-Iraq regions as a source of groundwater to study the impacts of industrial effluents pollutants in these wells and save in colored buttol. Water samples were collected for physical and chemical analysis. We take water from the artesian wells of groundwater and collect all the samples and Wells Specifications in January 2017.The air temperature, water temperature, total dissolved solid, electrical conductivity and pH were estimated on the spot at the time of sampling while other parameters were estimated in Duhok environmental director laboratory and others in the research center of Zakho university. Standard methods as prescribed by (APHA 2012).

3.3. Method

The samples are collected and analyzed Ten representative artesian wells of groundwater, samples are collect around and downward of industrial areas of Kowashe area. The samples were analyzed for physicochemical analysis of the parameters Turbidity,Color, Electrical Conductivity (EC), Total Dissolved Solids (TDS), pH and Dissolved Oxygen (DO), Total Alkalinity, Sulphate (SO4), Chloride (Cl), Nitrate (NO3), Total Hardness (TH), Calcium (Ca), Magnesium (Mg), Sodium (Na), Potassium(K), Chemical oxygen demand (COD) and the trace elements iron (Fe), cadmium (Cd), lead (Pb), arsenic (As), cobalt(Co), chromium(Cr), copper(Cu), manganese(Mn), Aluminium(Al) and zinc (Zn). The analysis was carried out by using standard procedures (APHA 2012) and the results were compared with the drinking water standards for health organization (WHO 2008). In this study, and we used Microsoft Excel 2010 for creating a figure for parameters concentration. And Statistical analysis with the objective of evaluating significant differences among the stations for all water quality variables, data was analyzed using one-way analysis of variance (ANOVA) at 0.05% level of significance. The second step in factor analysis is the determination of the parameter correlation matrix. It is used to account for the degree of mutually shared variability between individual pairs of water quality variables.

Table 3.1. Wells specifications in studied area

No	Well name	X	Y	Static Water Level (m)	Dynamic Water Level (m)	Yield (L/min)	Depth (m)	Year
1	**Kowashe S1**	36.9974	42.7986	94	110	424	230	2005
2	**Kowashe S2**	36.997	42.8007	96	100	303	218	2005
3	**Kowashe S3**	36.9966	42.8015	88	111	409	220	2005
4	**Kowahe S4**	36.9954	428028	90	115	303	226	2005
5	**Kowashe S5**	36.9807	42.8149	74.4	98	409	195	2009
6	**Girrash S6**	36.9513	42.7461	13	68	170	200	2013
7	**Marina S7**	36.9146	42.7775	18	30	208	220	2016
8	**Sarshor S8**	36.9195	42.7861	42.7843	11	454	180	1975
9	**Moqoble S9**	36.9171	42.7807	14	93	303	200	2008
10	**Tobzawa S10**	36.9236			60	208	180	2009

Table 3.2. Analytical methods and equipment used in the study by standard APHA 2012 as a reference

Sl. No.	Parameter	Method	Instruments/Equipment
A. Physico-chemical			
1	Tempretur	Electrometric	pH Meter
2	Turbidity	Electrometric	Turbidity Meter
3	Color	Spectrophotomete	Colorimeter
4	EC	Electrometric	Conductivity Meter
5	TDS	Electrometric	Conductivity/TDS Meter
6	pH	Electrometric	pH Meter
7	Total Alkanity	Titration by H2SO4	
8	TH	Titration by EDTA	
9	Chloride	Titration by AgNO3	
10	Sulphate	Turbidimetric	Turbidity Meter
11	Nitrate	Ultraviolet screening	UV-VIS Spectrophotometer
12	Ca	Titration by EDTA	
13	Mg	Titration by EDTA	
14	K	Flame emission	Flame Photometer
15	Na	Flame emission	Flame Photometer
16	DO	Electrometric	DO Meter
17	COD	Digestion followed by titration	COD Digester
B. Heavy Metals			
18	Fe	Digestion followed by Atomic Spectrometry	Atomic Absorption Spectrometer
19	Cd		
20	Pb		
21	Zn		
22	As		
23	Cu		
24	Cr		
25	Co		
26	Mn		
27	Ni		
28	Al		

4. RESULTS AND DISCUSSION

The water quality in terms of physic-chemical and heavy metal characteristic for the ranged well water is summarized in Table 4.1 and 4.2. The interpretation of the results was made with the aid of WHO potable water specifications.

Table 4.1 Water analysis of physico-chemical and heavy metal of studied area

Parameters	**Unit**	**Samples taking from this locations**				
		Kowashe S1	**Kowashe S2**	**Kowashe S3**	**Kowashe S4**	**Kowashe S5**
Temperature	°C	21	20	20.1	20.7	20
Turbidity	NTU	0.5	0.6	0.7	0.8	0.5
Electrical Conductivity	µS	525	477	446	435	455
Total Dissolved Solid	mg/L	336	305	285	278	291
pH		7.4	7.4	7.4	7.3	7.7
Sulfate	mg/L	9.4	4.2	2.8	4.2	4.2
Chloride	mg/L	12	12	8	12	10
Nitrate	mg/L	9.7	8.7	5.5	5.2	5.1
Total Hardness	mg/L	340	312	296	304	296
Total Alkalinity	mg/L	194	194	180	188	196
Calcium	mg/L	76	76	67	67	73
Magnesium	mg/L	36	29	31	33	27
Potassium	mg/L	0.2	0.9	0.7	0.7	0.8
Sodium	mg/L	5	3	2	3	3
Dissolved Oxygen	mg/L	5.7	8	6.4	6.45	8.54
Iron	mg/L	0.015	0.008	0.016	0.013	0.01
Cadmium	mg/L	0.008	0.002	0.004	0.005	0.003
Lead	mg/L	0.004	0.004	0.004	0.003	0.002
Zinc	mg/L	0.393	0.219	0.169	0.182	0.163
Arsenic	mg/L	0.001	0.001	0.001	0.0007	0.001
Copper	mg/L	0.376	0.225	0.227	0.216	0.209
Chromium	mg/L	Nill	Nill	Nill	Nill	Nill
Cobalt	mg/L	0.0002	0.00004	Nill	0.000009	0.00005
Manganese	mg/L	0.077	0.025	0.022	0.015	0.018
Nickel	mg/L	0.017	0.072	0.061	0.061	0.047
Aluminum	mg/L	0.007	0.008	0.007	0.006	0.009
Chemical Oxygen Demand	Mg/L	Low	Low	Low	Low	Low

Table 4.2. Water analysis of physico-chemical and heavy metal of studied area

Parameters	Unit	Samples taking from this locations				
		Girrash S6	**Marina S7**	**Sarshor S8**	**Moqoble S9**	**Tobzawa S10**
Temperature	°C	22	19.9	20.3	20.5	20.1
Turbidity	NTU	0.7	0.5	0.8	0.9	0.8
Electrical Conductivity	µS	738	589	607	566	586
Total Dissolved Solid	mg/L	472	377	388	362	375
pH		7.5	7.5	7.4	7.6	7.6
Sulfate	mg/L	28.6	10.6	4.4	4.2	16
Chloride	mg/L	30	24	20	28	38
Nitrate	mg/L	55.3	22.7	19.8	12.1	9.7
Total Hardness	mg/L	404	340	388	344	344
Total Alkalinity	mg/L	232	308	210	188	194
Calcium	mg/L	81	73	89	84	81
Magnesium	mg/L	48	38	40	29	34
Potassium	mg/L	7.2	0.9	0.7	2.1	1.2
Sodium	mg/L	27	13	12	9	14
Dissolved Oxygen	mg/L	8.44	8.5	8.15	7.6	7.2
Iron	mg/L	0.007	0.016	0.01	0.006	0.006
Cadmium	mg/L	0.003	0.003	0.003	0.002	0.008
Lead	mg/L	0.002	0.004	0.002	0.002	0.0007
Zinc	mg/L	0.128	0.421	0.145	0.109	0.108
Arsenic	mg/L	0.0009	0.002	0.001	0.001	0.0008
Copper	mg/L	0.206	0.295	0.244	0.213	0.213
Chromium	mg/L	Nill	Nill	Nill	Nill	Nill
Cobalt	mg/L	0.0001	0.00004	0.00009	Nill	0.0001
Manganese	mg/L	0.019	0.019	0.018	0.019	0.022
Nickel	mg/L	0.041	0.044	0.044	0.055	0.0634
Aluminum	mg/L	0.02	0.0145	0.0116	0.011	0.009
Chemical Oxygen demand	mg/L	Low	Low	Low	Low	Low

Table 4.3. Permissible level of drinking water WHO

Parameters	Unit	Permissible level of drinking water WHO
		Maximum level
Temperature	°C	-
Turbidity	NTU	5
Electrical Conductivity	µS	1250
Total Dissolved Solid	mg/L	1000
pH		6.5-8.5
Sulphate	mg/L	250
Chloride	mg/L	250
Nitrate	mg/L	50
Total Hardness	mg/L	100-500
Total Alkalinity	mg/L	125-200
Calcium	mg/L	75-200
Magnesium	mg/L	30-150
Potassium	mg/L	2-3
Sodium	mg/L	200
Dissolved Oxygen	mg/L	5
Iron	mg/L	0.3
Cadmium	mg/L	0.005
Lead	mg/L	0.05
Zinc	mg/L	3
Arsenic	mg/L	0.01
Cupper	mg/L	1
Chromium	mg/L	0.05
Cobalt	mg/L	0.005
Manganese	mg/L	0.1
Nickel	mg/L	0.1
Aluminum	mg/L	0.1
Chemical Oxygen demand	mg/L	10

4.1. Effects Of Industrial Effluents On Some Physical And Chemical Properties Of Ground Water

4.1.1. Temperature

In the Figure 4.1 the temperature of studied artesian wells distributed around industrial area are ranged around 20-22 °C, recording highly in Girrash 22 °C and Kowashe 1 wich around 21 °C, this little increases in this two locations may attributed to the low depth of wells or to the nature of limestone bedrocks of area that absorbs more heats.

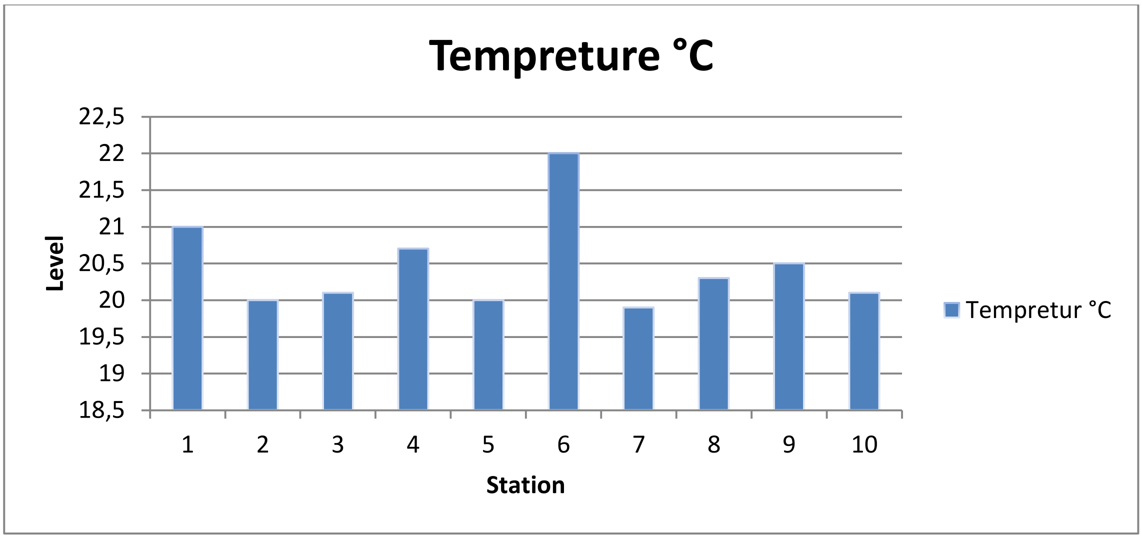

Figure 4.1. Water temperature of studied wells

4.1.2. Turbidity

The turbidity of studied groundwater artesian wells are ranged between 0.5-0.9 NTU but high turbidity recorded in locations 4,8,9 and 10 as shown in Figure 4.2 this relative high levels of turbidity may be as a result of high clay content in the bottom of this wells a muddy appearance of water when it pumped. Similar results have been obtained in other studies (Balakrishnan et al. 2008).

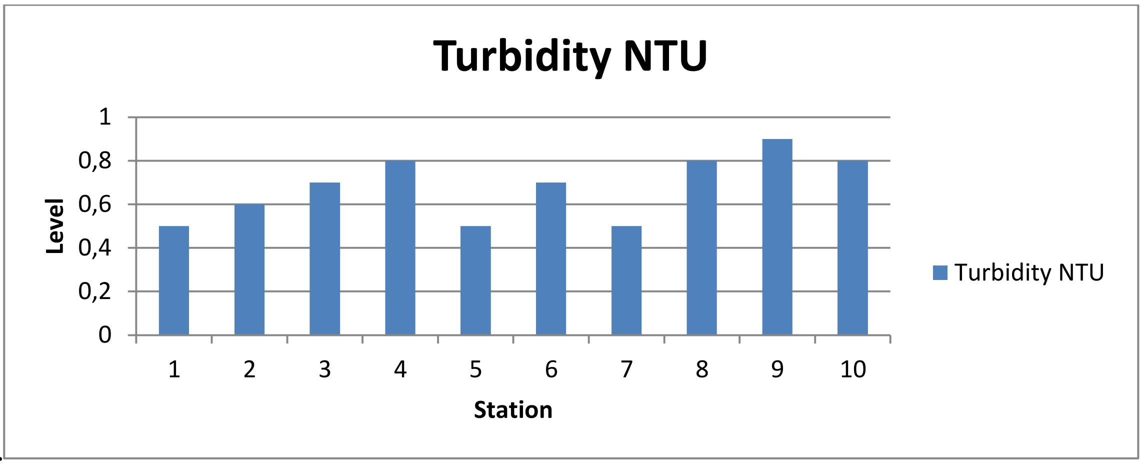

Figure 4.2. Turbidity of studied wells

4.1.3. Electrical Conductivity (EC)

The impact of health on humans for water consuming by high EC also includes upset of salt and water balance and adverse impacts in certain myocardial and people with high pressure of blood (Fatoki and Awofol 2003). The electrical conductivity of groundwater influenced by industrials effects ranged between 420-730 µS recording a high level in 6 locations as shown in Figure 4.3, which is related to the high content of soluble salts like Na and K 7-2mg/L and both Ca and Mg is indicated by high total alkalinity 232mg/L and total dissolved solid TDS 472mg/L. The similar results were recorded in another study (El-Sayed and Salem 2015).

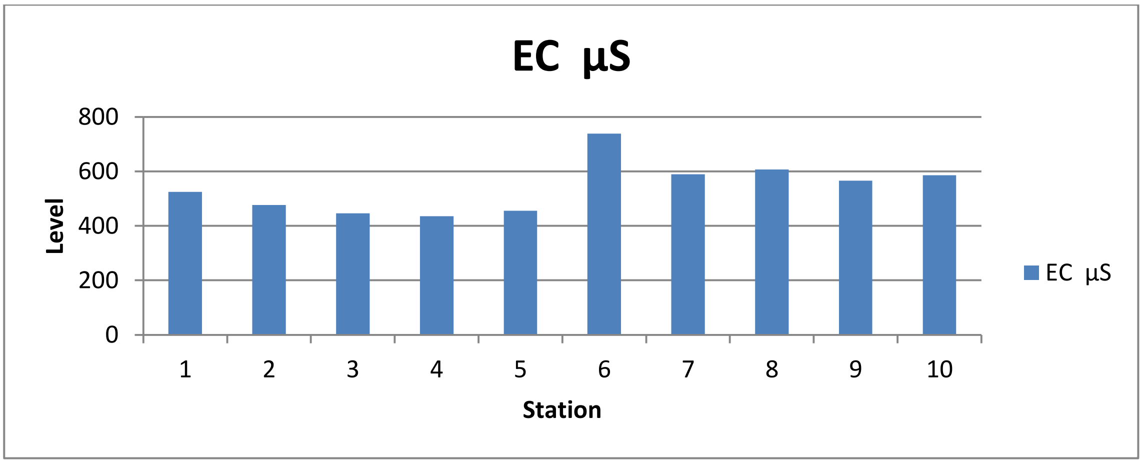

Figure 4.3. Electrical conductivity of studied wells

4.1.4. Total Dissolved Solid (TDS)

The concentration of total dissolved solid is the fully melted minerals in the water.used total dissolved solid as an indication of the general salinity nature of water. For any purpose, the concentration of total dissolved solid is an essential parameter in drinking water to determine the groundwater suitability. It is an important to classify groundwater depending on its hydrochemical properties based total dissolved solid values. (Freeze and Cherry 1979). The total dissolved solid where ranged 278mg/L in location 4 to 472mg/L in Girrash as shown in Figure 4.4, the high TDS is related to its location that helps in high contamination of industrial effluents in this area as well as the geomorphological features of this village. Similar results have been obtained in other studies (Aydin 2007).

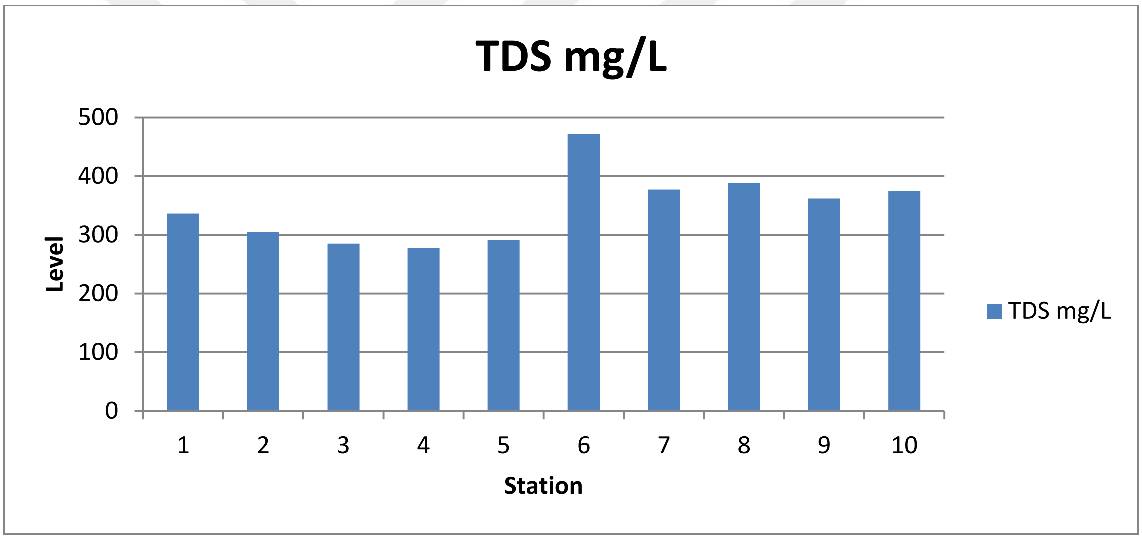

Figure 4.4. The concentration of total dissolved solid

4.1.5. pH

The value obtained from the pH is normal, as the pH in the water usually in the Kurdistan region of Iraq is characterized by a shift towards the alkalie side of neutrality due to the geological composition of the area which is mainly composed of CaCO3 .According to WHO guidelines (WHO, 2008) for the pH of drinking water from 6.5 to 8.5. The pH of studied locations are not highly influenced by industrial effluent seepage to groundwater recorded between 7.3 in location 5 to 7.7 in location 6 as shown in Figure 4.5, these returned to the high CaCo3 in limestone bedrocks of wells that give high puffery capacity to both soil and ground water pH. the similar results were recorded in another study (Saravanakumar and Ranjith 2011).

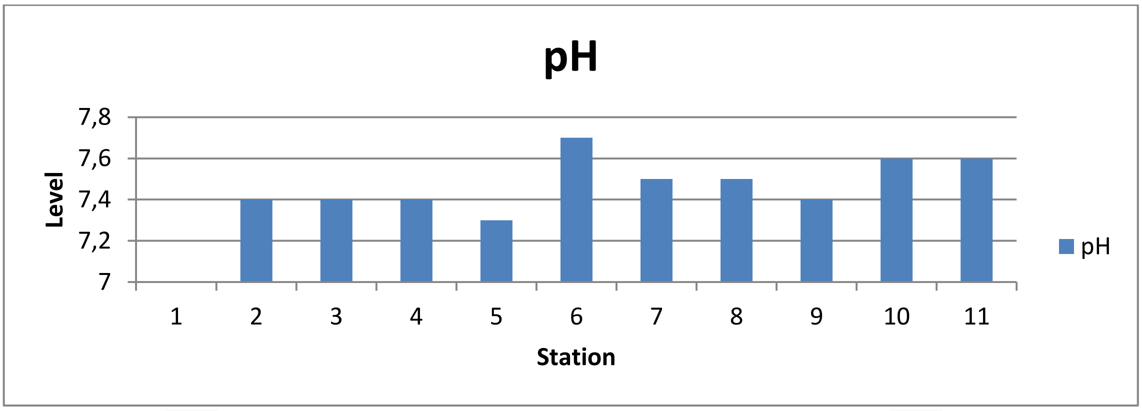

Figure 4.5. pH of the water studied wells

4.1.6. Total Hardness

The adverse effects of water has no known impact of hardness; however, Some evidence suggests its role in heart disease and inadequate water hard for domestic use (Schroeder and Chron 1960). According to (Sawyer and McCarthy 1967), Hardness is commonly classified, in terms of degree of hardness as poor: 0 to 75 mg/l, temperate: 75 mg/l to 150 mg/l, Hard: 150 mg/l to 300 mg/l, and very hard: above 300 mg/l. The total hardness result from the dryland cations in the ground waters like Ca, Mg which prevent soap to give the foam. The Total hardness is uniform in locations, but high level recorded at Girash 404 mg/L as shown in Figure 4.6. This uniformity returned to the calcareous soils and limestone bedrocks which contain high amounts of Ca. The similar results were recorded in another study (Buridi et al. 2014). Higher degree of hardness is due to disposing of sewage and untreated industrial effluents (Haniffa et al. 1994).

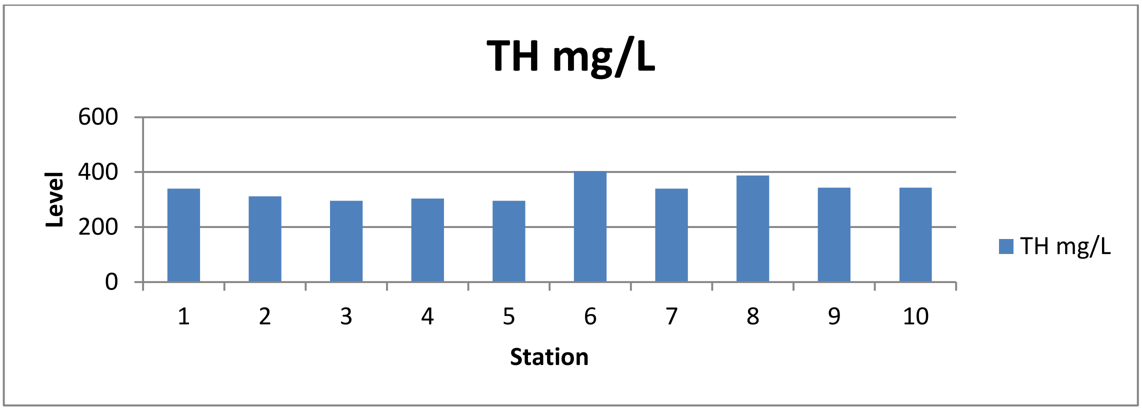

Figure 4.6.The concentration of total hardness

4.1.7. Total Alkalinity

The bitter test of water indicates the large amount of alkalinity imparts. in studied area indicate the large amount of total alkalinity. Figure 4.7, show the total alkalinity which resulted from alkaline ions like K , Mg and Ca are also uniform in 10 locations except location 6 and 7 which is recorded 232 and 308 mg/L respectively. In location 6,7 and 8 the concentration of alkalinity was above WHO range that is not safe for drinking water. The amounts of alkaline cations in bedrock of this area are the reason on uniform alkalinity that may be indicated in slide pH increase over 7 that ranged between 7.3 to 7.7. The similar results was recorded in other study (Sharma et al. 2013).

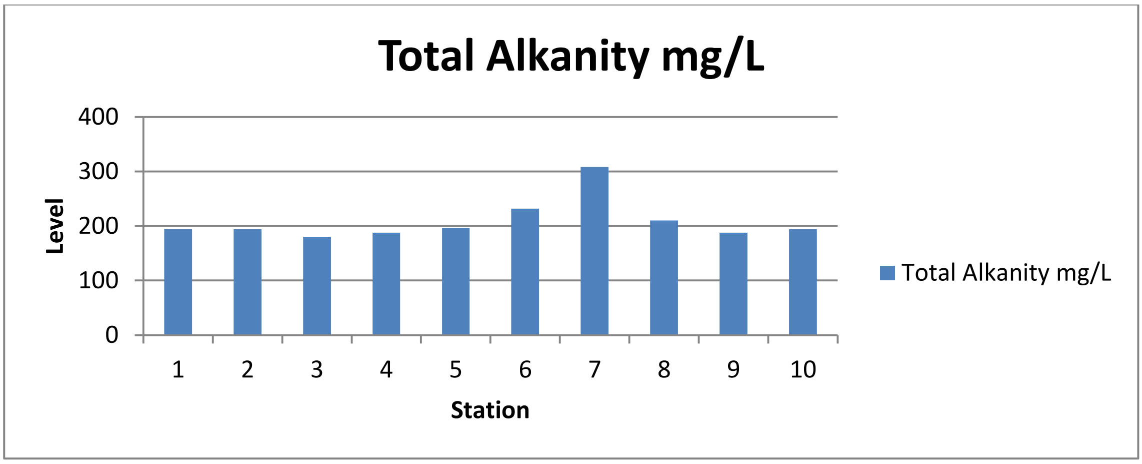

Figure 4.7. The concentration of total alkalinity

4.1.8. Dissolved Oxygen (DO)

The concentration of dissolved oxygen has high impact of groundwater quality by adaptable valence state o trace metals and bacterial metabolism constraining of dissolved organic species. For these details, the measurement of dissolved oxygen concentration must be considered important in most water quality investigations. As shown in Figure 4.8, the dissolved oxygen is about homogeneous in all groundwater artesian well and ranged between 5.7mg/L as minimum in location 1 and 8.54mg/L as maximum in location 5, these ranges are near standards of drinking water , the relative low dissolved oxygen is due to the deepness of these artesian well with 200m depth as ranges will decrease the aeration of aquifers as a result of clayey nature of soils this area (Buridi et al. 2014; Adekunle et al. 2007).

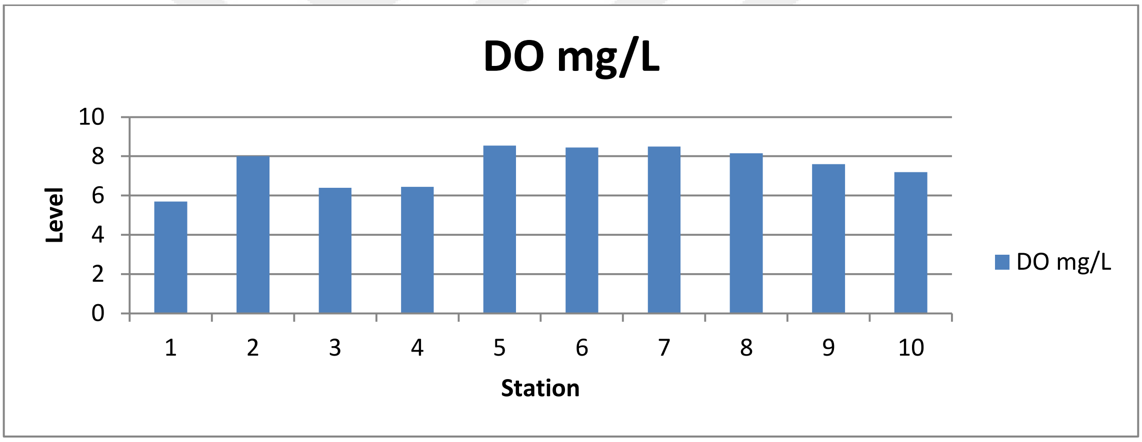

Figure 4.8. The concentration of dissolved oxygen

4.1.9. Calcium (Ca)

One of the essential elements is Calcium to developing proper bone growth. In nature, it is found in alkaline. Commonly groundwater contains calcium content, because most of the rocks contain available calcium content and also have higher solubility. The content of Ca uniform in selected studied the location and ranged between 67 mg/L in the third location to 89 in Sarshor location. The limestone CaCO3 bedrocks are the reasons of high Ca content in the water as shown in Figure 4.9. The similar results were recorded in another study (Aghazadeh et al. 2010).

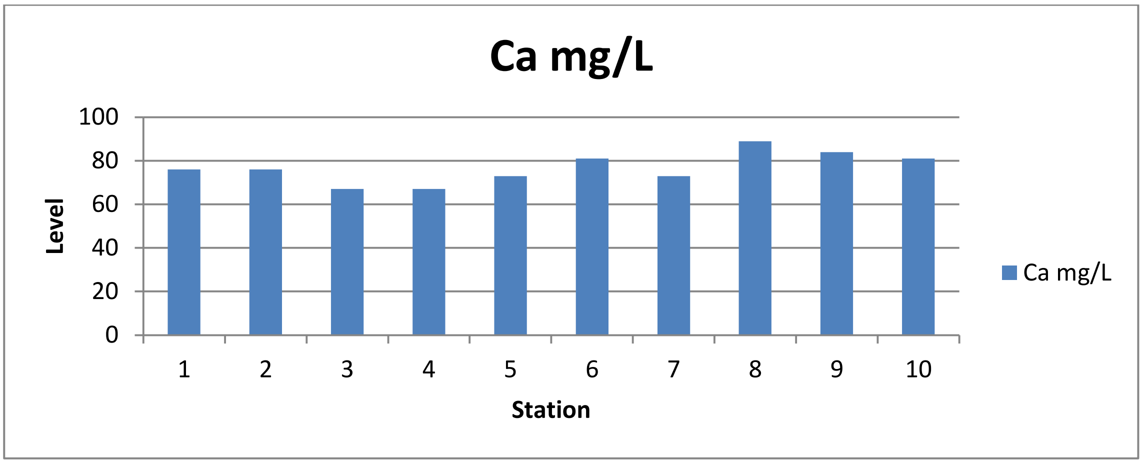

Figure 4.9. The concentration of calcium

4.1.10. Magnesium (Mg)

Figure 4.10 show The content of Mg is slide variants with Ca in studied area because the distributions of Mg is not equal in studied location and high level was recorded at Girrash with 48 mg/L which indicates from high hardness and alkalinity associated with this alkaline elements. Similar results have been obtained in other studies (Anwar et al. 2014)

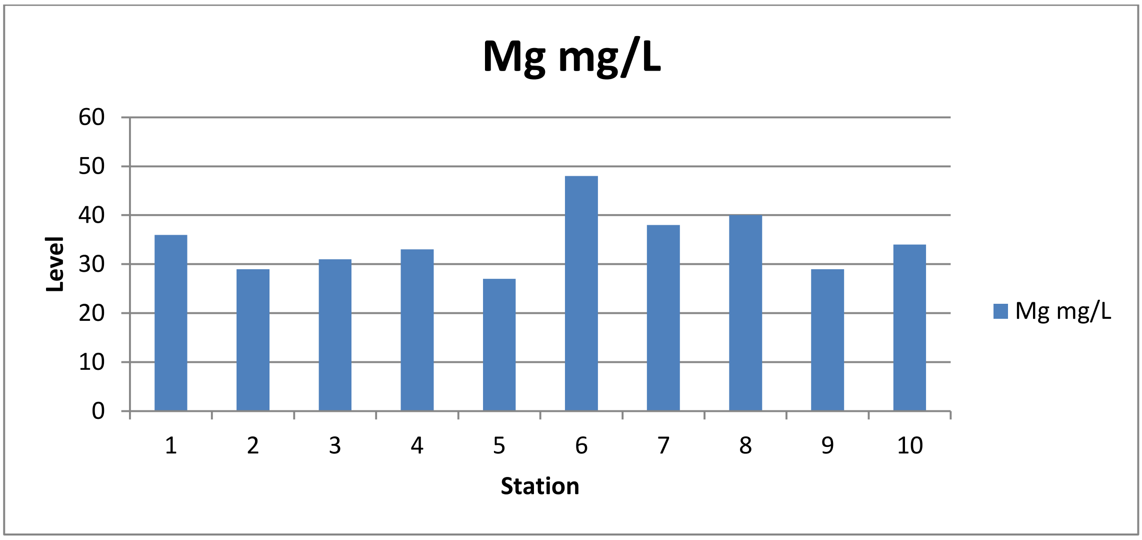

Figure 4.10.The concentration of magnesium

4.1.11. Potassium (K)

Figure 4.11 shows the content of K in all locations is low and not exceeded than 2 mg/L except Girrash location which records over 7 mg/L.This range is above the level of concentration of Potassium that compared with the permission level of potassium which is about 2-3 mg/l. Kidney failure is the greatest common cause of high potassium. When kidneys fail or do not work properly, they cannot remove extra potassium from your body. This can lead to the building of potassium. This significant increase in potassium in this location gives another proof that this location is more exposed to both industrial effluent and agricultural fertilizer pollutants. The main source of potassium in natural freshwater is the temperament of rocks, but the increase in quantities of contaminated water due to the disposal of sewage (Trivedy and Goel 1986). Similar results have been obtained in other studies (Babir et al. 2016).

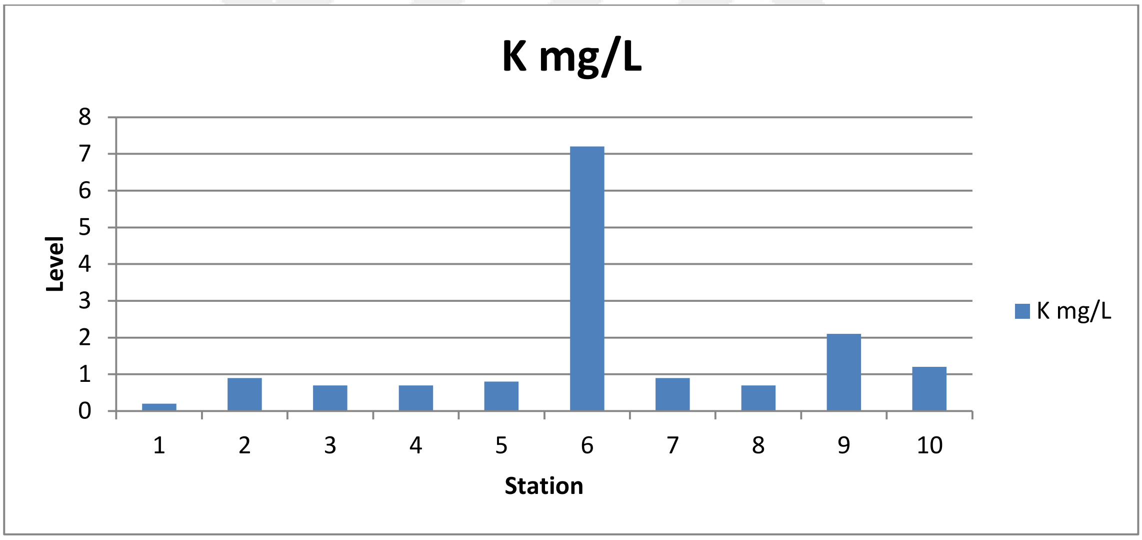

Figure 4.11. The concentration of potassium

4.1.12. Sodium (Na)

Sodium concentration is important in classifying irrigation water because sodium causes an increase in the hardness of the soil because it tends to be absorbed by clay particles, displacing magnesium and calcium ions, when high in irrigation water. This exchange process reduces the permeability and results in soil with poor internal drainage (Tijani 1994). Figure 4.12 show the content of Na is low in location 1-5 and not exceed more than 5 mg/L, but it about doubles in location 7-10 that recorded 14 mg/L. The high Na content again recorded in Girrash location 27 mg/L which exposed to induced pollution. Similar results have been obtained in other studies (Sarada 2016).

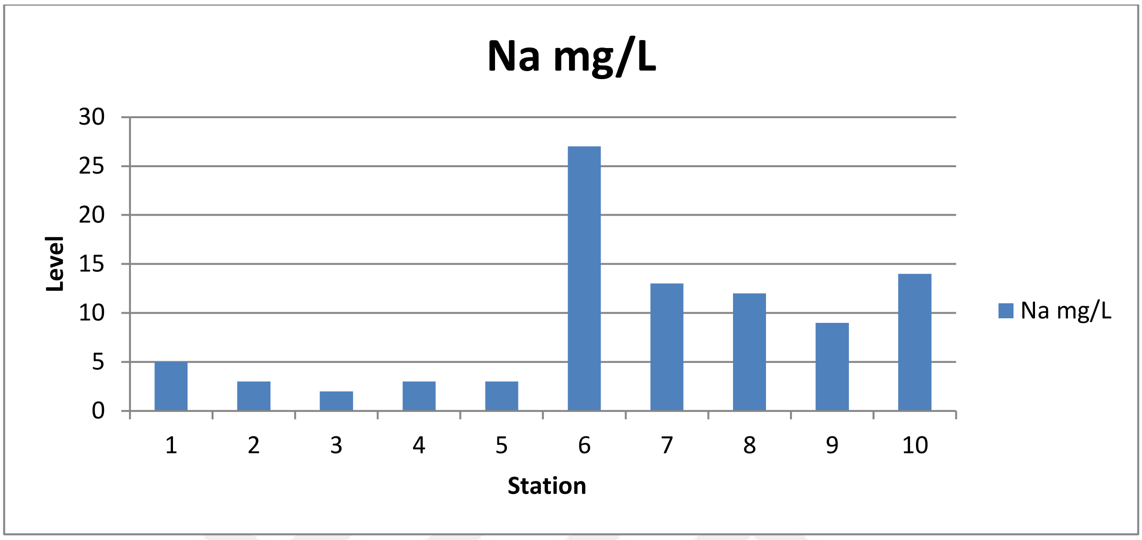

Figure 4.12.The concentration of sodium

4.2. The Quantity of Soluble Salts

The solubility salts as ions like nitrate, sulfate, and chloride which carry negative charges considered as a good indicator for groundwater pollution because it easily leached with rain water to groundwater as a result of their repulsions with soil colloid that carries the same negative charge.

4.2.1. Sulfate SO_4

One of the essential parameters for determining the suitability of water is the sulfate content in water for public and industrial supplies. The high sulfate concentration in water can cause malfunctioning of the alimentary canal and shows he cathartic effect on human beings (Lenin Sunder et al. 2008). Figure 4.13 shows the content of So4 ions studied artesian wells are relatively low except in location 10 which is 16mg/L and high level was recorded in Girrash 28.6 which indicate their close location to the point source of effluents that determinate its quality indicators. Similar results have been obtained in other studies (Aghazadeh et al. 2010).

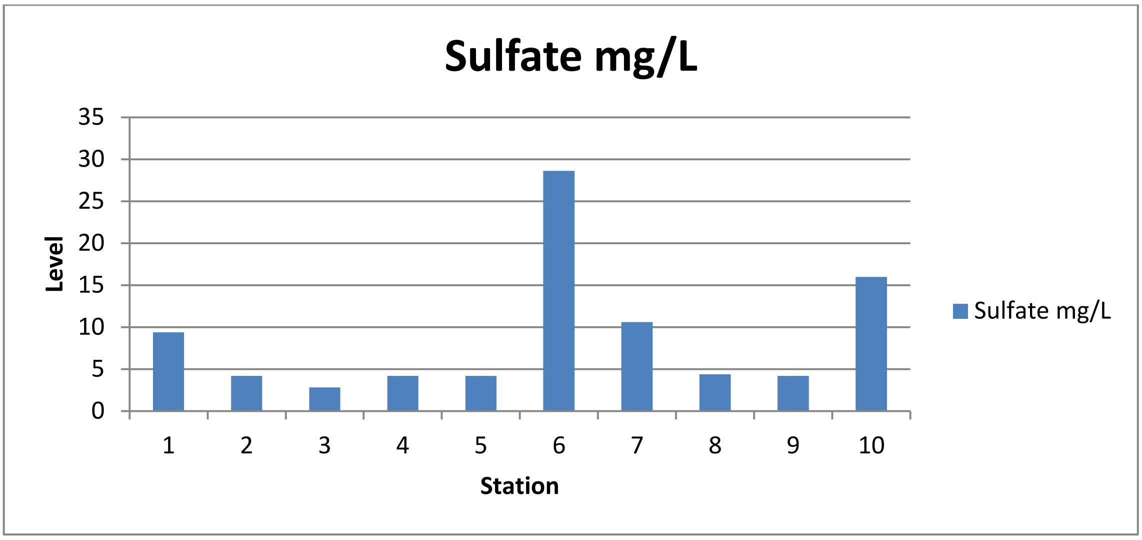

Figure 4.13. The concentration of sulfate

4.2.2. Chloride (Cl)

Figure 4.14 shows the chloride ions concentration are low in location 1-5 bur relatively high in location 6-10 recording high level in Girrash locations 30mg/L. These relatively high concentrations it may attributed to the salt contaminating nature of this location that locate the down-word location of water runoff from bitter mountain. Nearly results have been obtained in other studies (Balakrishnan et al. 2008).

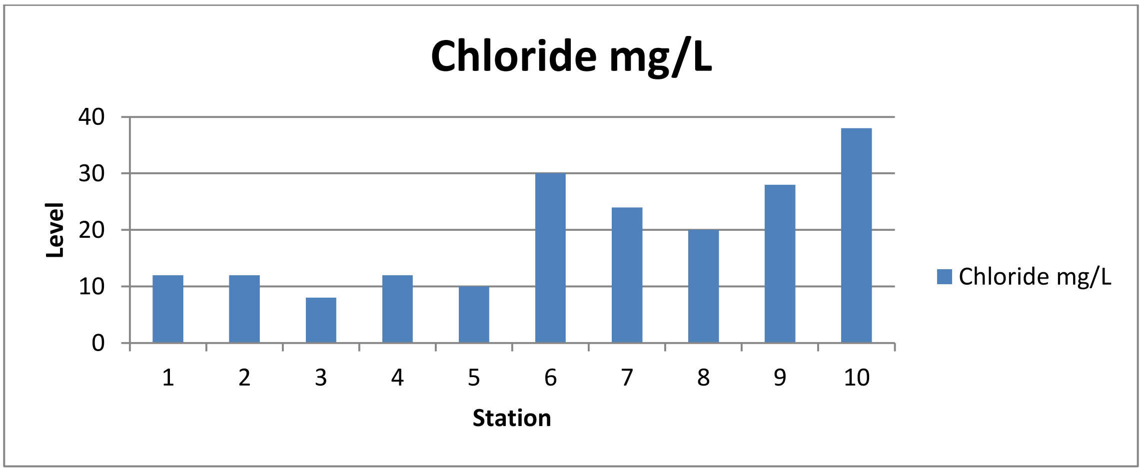

Figure 4.14. The concentration of chloride

4.2.3. Nitrate NO_3

The nitrate ions is probably the most concerned ions associated with drinking water pollution as will know health damaging ions like methemoglobinemia and permeation of carcinogenic and mutagenic nature amine. Figure 4.15 show the concentration of NO3 is sure for drinking in location 1-5 and 10 but is not sure in locations 8,9 and 7 for drinking for ruffians and children below on years. but the risk level pointed in Girrish location of 55.3 ml/L which is not saved for adults also and used for irrigation and cattle's drinking. The Girrash location is more influenced by induced human pollution like industry and high fertilization of wheat crops in fields around the well. Similar results have been obtained in other studies (Sarada 2016).

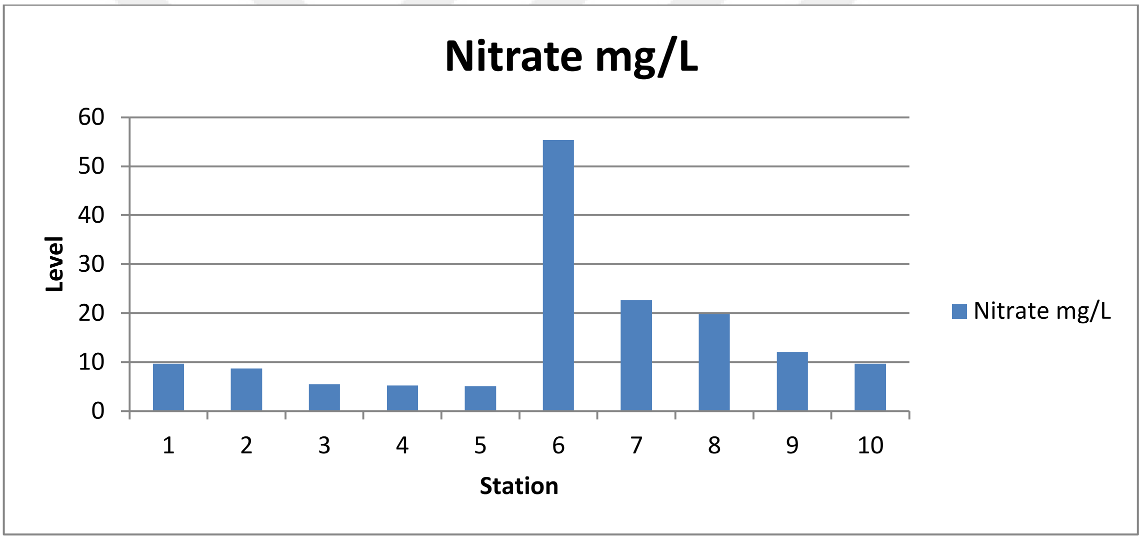

Figure 4.15. The concentration of nitrate

4.3. Contamination of Groundwater By Heavy Metals

The risks of heavy metal pollution in slightly alkaline soils are rare both in soil and groundwater because the cationic heavy metal like Fe, Cd, Cu, Zn, Mn, Ni and Co quickly precipitated at PH ranges between 6.5-8.5 so there are no public health issues are identified in these alkaline soil all over the world . But the solubility of anions heavy metal like As, Mo, Se, and B are increased in these soil sand the attention must payid to those anionic metals.

4.3.1. Iron (Fe)

Biologically Iron is an essential element which is important to all organisms and existing in hemoglobin system. Figure 4.16 show The concentration of iron is varied according to the location where high levels recorded in location 1,3 and 7 to be 0.0162mg/L and low levels recorded at location 9 and 10 to be 0.0056mg/L respectively. The variance of Fe contents is attributed to the variance of mineralogical properties of aquifer bedrocks that may contain a high level of hematite minerals. Similar results have been obtained in other studies (Mukherjee et al. 2006).

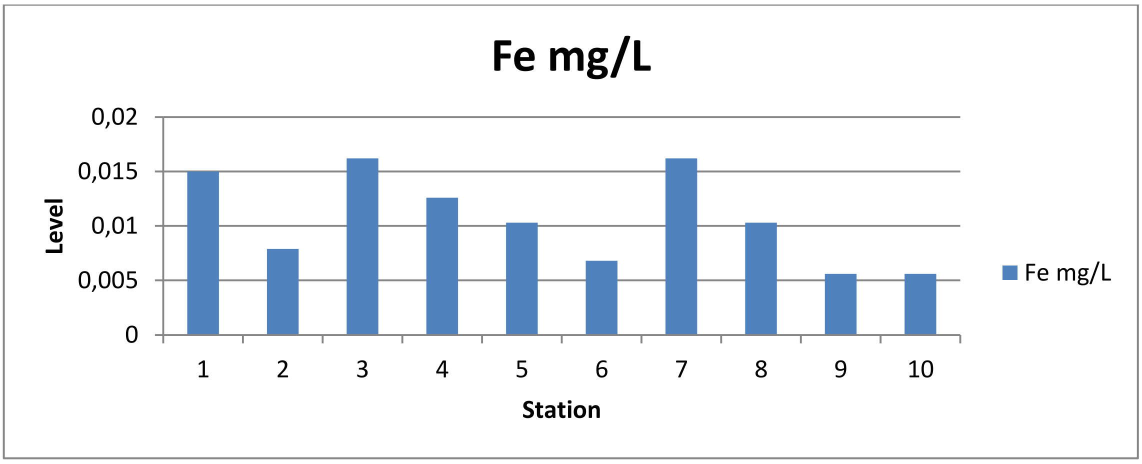

Figure 4.16. The concentration of iron

4.3.2. Cadmium (Cd)

As indicated by the Figure 4.17 the highest values of Cd are recorded in location 1 and 10 to be 0.008451mg/L that are in risky levels for human consumptions. The rest of wells are on the safe levels for drinking water. high levels of Cd are well-known to cause bones, swelling and pain because it replace Ca in bone tissues and cause severe pain in joints (itai-itai) disease and also associated with kidney failure. The excess amounts of Cd in 1 and 10 locations may be due to the dumping of solid waste in these two places like car batteries and tires they contain a huge amount of Cd. The high concentration of cadmium is dangerous, but cadmium in low amount taken over for a long period also bioaccumulation in the body and cause serious illness (Sabhapandit P et al. 2011). The similar results were recorded in another study (Babir et al. 2016).

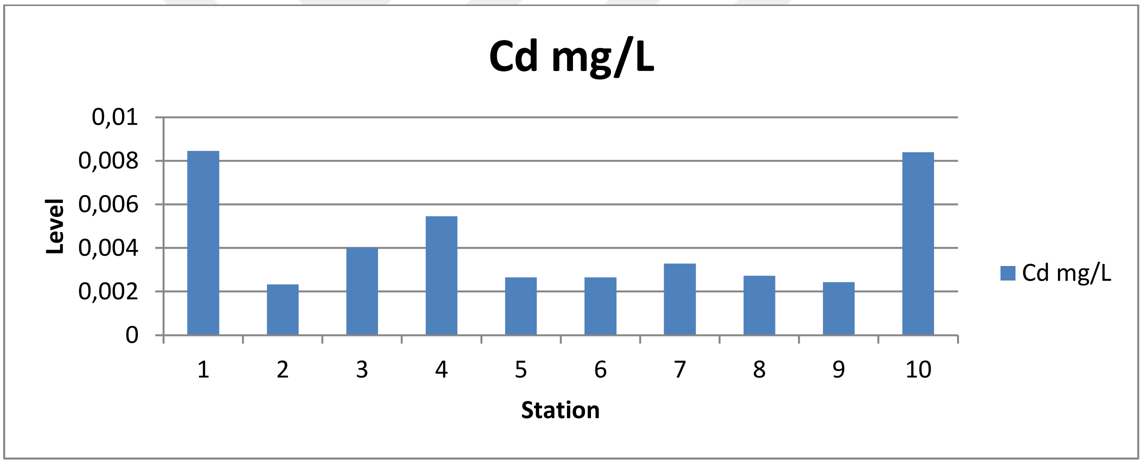

Figure 4.17. The concentration of cadmium

4.3.3. Lead (Pb)

Lead is one of the potentially dangerous and possibly harmful contaminants. It has an effect on humans and animals. The symptoms of lead poisoning usually develop slowly. It prevents the formation of hemoglobin by interacting with the SH group and interfering with many enzyme functions (Sabhapandit P et al. 2011). The concentration of lead as shown in the Figure 4.18 is in high levels in location 1 then uniformly decreased to the location 10 except a shifting in location 7 and ranged between 0.00397 and 0.000718 mg/L. The regression of head decreasing is obvious that the Pb pollutant plume is concentrated in location 1 which is near a point source of effluent discharge or may attributed to the mineralogical properties of mountain area that may cause from uranium disintegration series that lead to lead formation. The similar results were recorded in another study (Mukherjee et al. 2006).

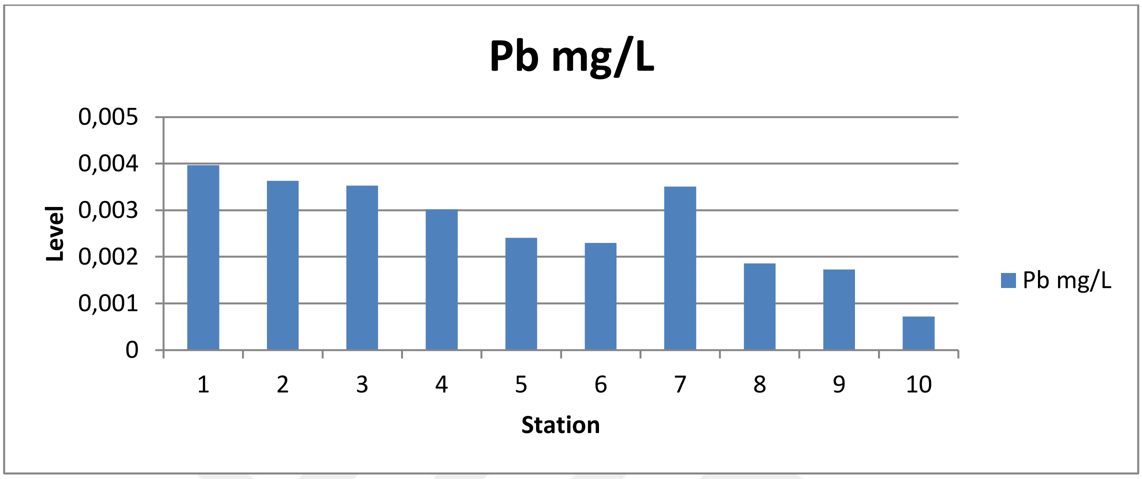

Figure 4.18. The concentration of lead

4.3.4. Zinc (Zn)

Figure 4.19 shows the concentration of Zn is studied wells that associated with Cd because it has the same chemical behavior and may closely related with Cd concentration, so it has a high level in location 6, but it increased in location 7 to reach 0.4212mg/L, not in 10 this case returned to that the pollutant plume of Zn is reached to location 7 and may be moved to location 10 in a few years in the future. Zen is considered a micronutrient necessary for plant growth because it contributes to the formation of an enzyme which is essential for human health and zinc leakage may cause prostate gland cancer, unlike a dam that has no beneficial role in both plant life and causes serious diseases for humans. They cause a special type of dermatitis known as (Zinc pox). The similar results were recorded in another study (Anwar et al. 2014).

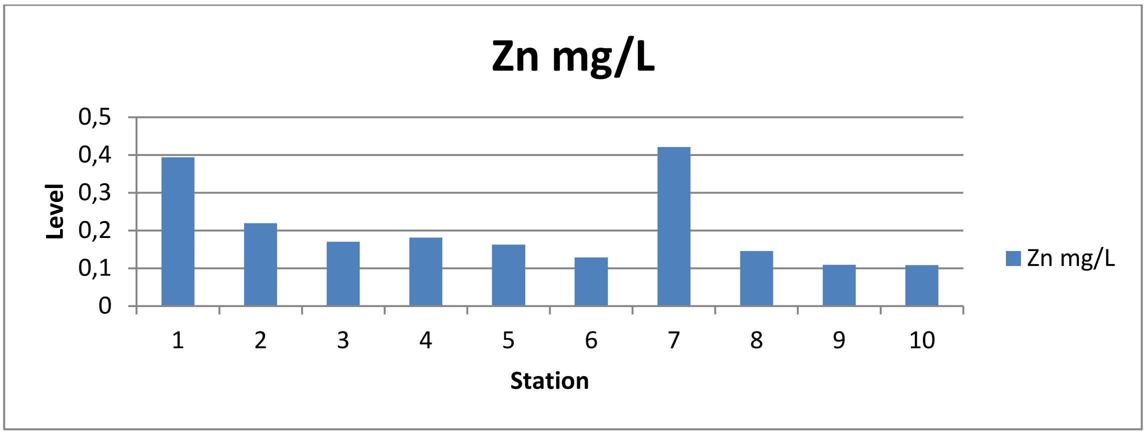

Figure 4.19. The concentration of zinc

4.3.5. Arsenic (As)

Drinking water is a well-recognized pathway to As exposure. It has been associated with various forms of cancer, renal, central nervous system and cardiovascular disease in humans (Ryan et al. 2000). The Figure 4.20 shows that the concentration of As is relatively same in all studied well and have tendency to increase and concentrated in location 1,3,7 and 8 and reach 0.001397mg/L although it not reached to risky levels but a continues pollution of this area will lead to the increment of this very poisonous heavy metals in drinking and consuming water for bathrooms will cause a skin cancer like well-known skin cancer in Bangladesh caused by river polluted with this element, because these areas contain a tannery factories that used a huge amount of As. Similar results have been obtained in other studies (Balakrishnan et al. 2008).

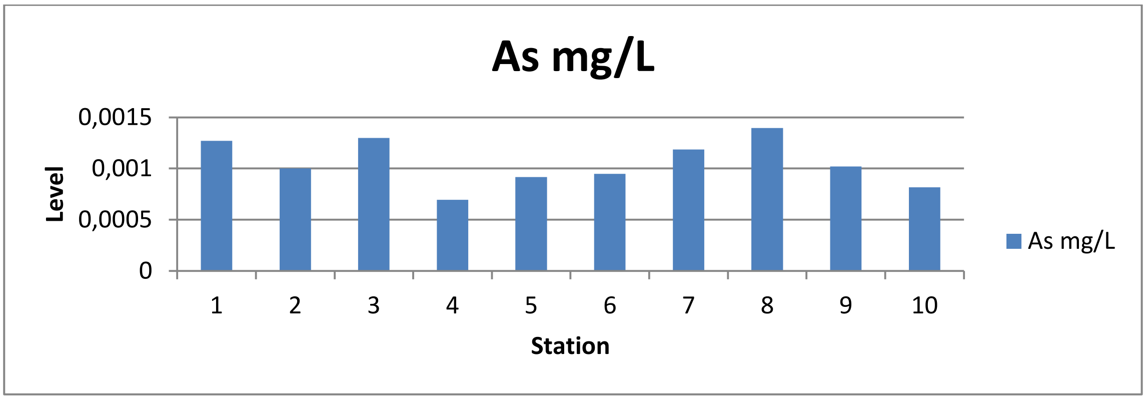

Figure 4.20. The concentration of arsenic

4.3.6. Copper (Cu)

Copper is an essential element in human metabolism. Human copper is especially required as a trace element in the formation of R.B.C and some enzymes. 0.05 m / L is not generally considered toxic but more than 1.5 mg / L may cause disease and in extreme cases liver damage (Marwari et al. 2012). Figure 4.21 shows that the chemical behavior of this element is close to both Zn and Pb and even Fe. High level was pointed in the center of pollution plume in location 1to record 0.3761mg/L and then decreased as regression till location 6 then recording a shifting in location 7 that may be a center of another pollution plume to be decreased to location 10. But Ca like Zn have a great role in plant life and considered essential plant nutrient as it contributes in nitrogenize enzyme which fixes atmospheric nitrogen besides another vital role in plant life . Similar results have been obtained in other studies (Anwar et al. 2014).

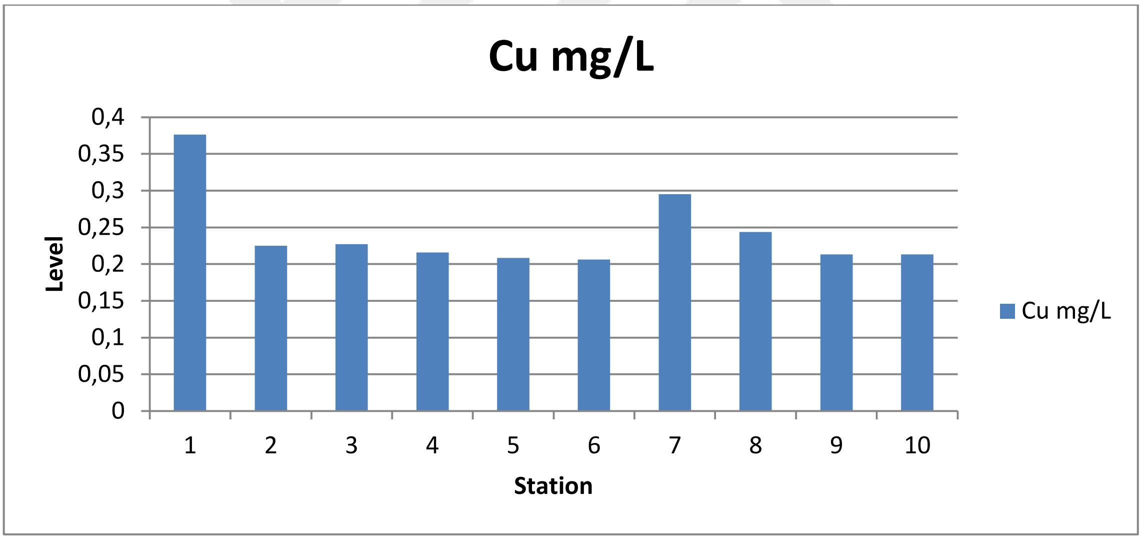

Figure 4.21. The concentration of copper

4.3.7. Cobalt (Co)

Figure 4.22 show another evidence of the concentration of heavy metal plume is concentrated at location 1 to reach 0.000173mg/L and moved toward location 6 to be 0.000134 and is probably no pollution by Co in both location 3 and 9. Cobalt enters groundwater through effluents from industries that deal with corrosion and wear-resistant alloys. Other sources of pollution are colors and dyes used for coloring glass, ceramic objects, lithium batteries, cobalt and permanent magnets. Oil-based industries are also the cause of cobalt pollution in the environment (Kaur 2012).

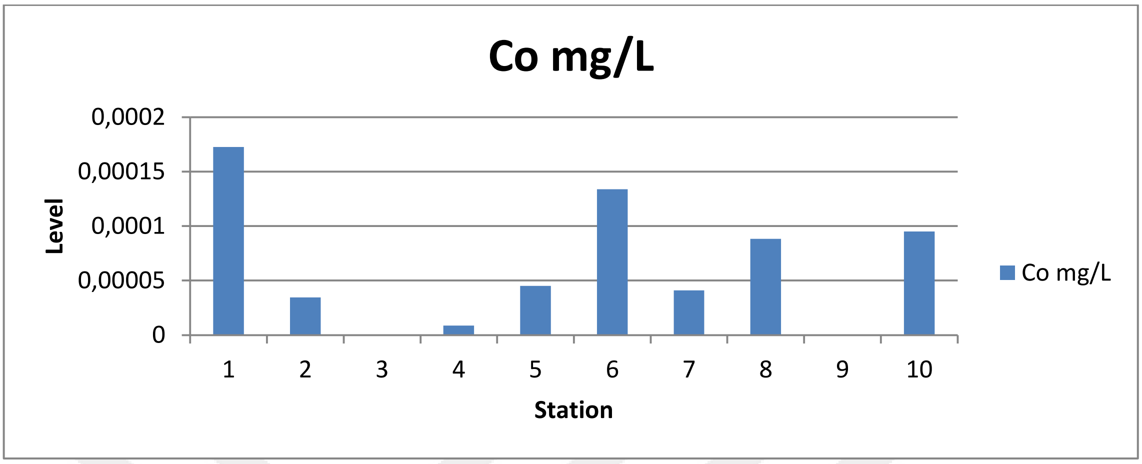

Figure 4.22. The concentration of cobalt

4.3.8. Manganese (Mn)

Manganese is one of the most abundant minerals in the earth's crust and usually occurs along with iron. The most abundant compounds of manganese are sulfide, oxide, carbonate, and silicate. Manganese can form insoluble oxides that can lead to unwanted deposits and color problems in distribution systems (APHA 2005). Figure 4.23 show that the Mn concentration was at peak in the center of pollution plume in location 1 and record 0.0765mg/L that gives a strong prove that this location is in the front of point source of industrial effluents that contain various types of pollutant especially heavy metals that moves by mass flow as pollution plume in heavy rainy seasons in winter and spring. Mn like Cu and Zn considered essential plant nutrient as a constituent in enzyme structure and its leakage in food may come to a health problem for a human being also. Similar results have been obtained in other studies (Babir et al. 2016).

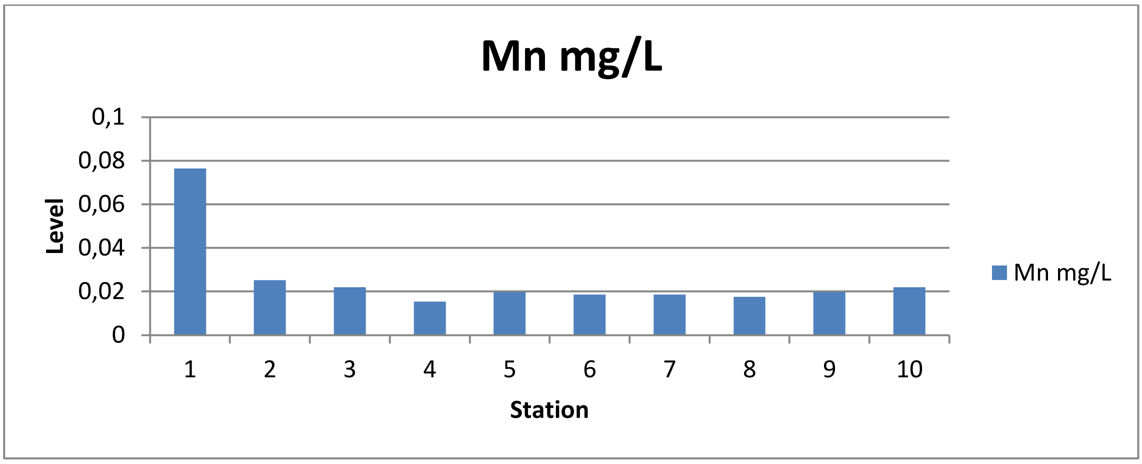

Figure 4.23. The concentration of manganese

4.3.9. Nickel (Ni)

Figure 4.24 shows that the concentration of Ni was very from the rest of heavy metal and concentrated at location 2 instead of location 1 to reach 0.0717mg/L then tend to decrease to location 6 to reach 0.0413mg/L, and increased constantly to location 10 to be 0.0634mg/L. Similar results have been obtained in other studies (Gummadi et al. 2016).

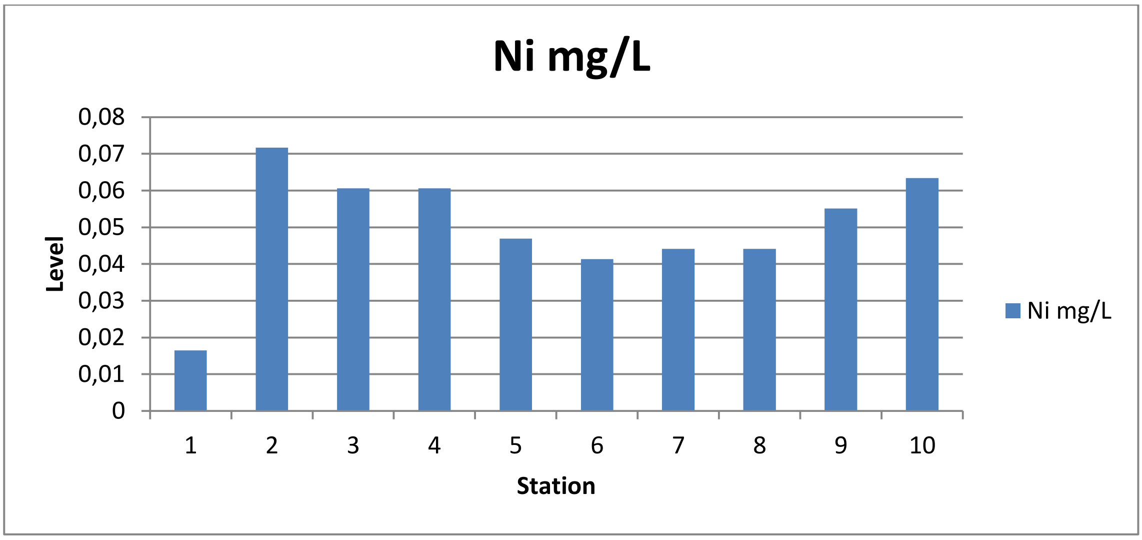

Figure 4.24. The concentration of nickel

4.3.10 Aluminum (Al)

Figure 4.25 shows that the Al plume is concentrated at location 6 to be 0.020555mg/L and not associated with another heavy metal behavior because it was the source of soil acidity beside H^+ ions and the soil colloidal system have argent role in the reaction of this element in soil and prevent it to reach groundwater table. Especially its enter in an aluminum octahedral sheet of clay minerals. Spatial distribution refers to more than one source that may be geologically or related to the industries. The presence of large concentrations of aluminum in groundwater can cause serious health effects, such as damage to the central nervous system, dementia, memory loss, intolerance and extreme trembling (Fakhare and Rashid 2013).

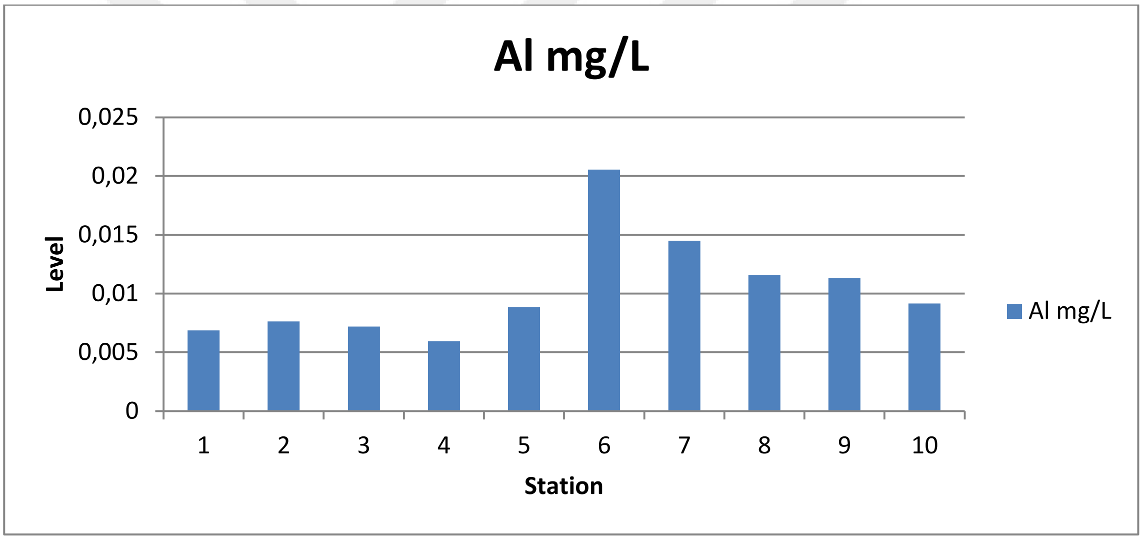

Figure 4.25. The concentration of aluminum

4.3.11. Chromium (Cr)

The Chromium element is not detected in the water samples of the study area as shown in the table (4.1 and 4.2).

4.4. Statistical Analysis

With the objective of evaluating significant differences among the stations for all water quality variables, data was analyzed using one-way analysis of variance (ANOVA) at 0.05% level of significance.

The second step in factor analysis is the determination of the parameter correlation matrix. It is used to account for the degree of mutually shared variability between individual pairs of water quality variables. The correlation matrix with which we can observe the relationship between parameters was obtained and tabulated in (Table 4.6).

4.4.1. One-Sample Statistics

The One-Sample Statistics of physicochemical parameters under groundwater in Semel district-Duhok city studied are given in Tables 4.4 and 4.5 They provide a summary of the mean, standard deviation and standard error mean values of 25 measured parameters for ten stations's data.

The all of data (Turbidity, Color, Electrical Conductivity, Total Dissolved Solids, pH and Dissolved Oxygen,Total Alkalinity, Sulphate, Chloride, Nitrate, Total Hardness, Calcium, Magnesium, Sodium, Potassium, Chemical oxigyn demand, iron, cadmium, lead, arsenic, cobalt, chromium, copper, manganese, Aluminium and zinc) were significantly affected according to the stations of groundwaters (*($P<0.05$), ** ($P<0.01$)).

Table 4.4. The One-sample statistics of physiochemical parameters under groundwater in Semel district-Duhok city

Parameters	N (Station)	Mean	Std. Deviation	Std. Error Mean
Temperature	10	20,4600	,64498	,20396
Turbidity	10	,6800	,14757	,04667
EC	10	542,4000	94,34476	29,83443
TDS	10	346,9000	60,40686	19,10233
pH	10	7,4800	,12293	,03887
Sulphate	10	8,8600	8,07908	2,55483
Cl	10	19,4000	10,20022	3,22559
No3	10	15,3800	15,25180	4,82304
TH	10	336,8000	36,94079	11,68170
Total Alkalinity	10	208,4000	37,85117	11,96959
Ca	10	76,7000	7,13442	2,25610
Mg	10	34,5000	6,31137	1,99583
K	10	1,5400	2,04787	,64759
Na	10	9,1000	7,79530	2,46509
DO	10	7,4980	1,01599	,32128
Fe	10	,0106	,00419	,00132
Cd	10	,0042	,00240	,00076
Pb	10	,0027	,00105	,00033
Zn	10	,2040	,11118	,03516
As	10	,0010	,00048	,00015
Cu	10	,2427	,05495	,01738
Cr	10	,0000	,00000[a]	,00000
Co	10	,0001	,00006	,00002
Mn	10	,0256	,01827	,00578
Ni	10	,0504	,01537	,00486
Al	10	,0103	,00451	,00143

a. t cannot be computed because the standard deviation is 0.

Table 4.5. The significance analyses with one-sample statistics analyses of physiochemical parameters by ANOVA

	Test Value = 0					
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference Lower	Upper
Temperature	100,313	9	,000**	20,46000	19,9986	20,9214
Turbidity	14,571	9	,000**	,68000	,5744	,7856
EC	18,180	9	,000**	542,40000	474,9098	609,8902
TDS	18,160	9	,000**	346,90000	303,6875	390,1125
pH	192,421	9	,000**	7,48000	7,3921	7,5679
Sulphate	3,468	9	,007**	8,86000	3,0806	14,6394
Cl	6,014	9	,000**	19,40000	12,1032	26,6968
No3	3,189	9	,011***	15,38000	4,4695	26,2905
TH	28,831	9	,000**	336,80000	310,3741	363,2259
Total_Alkalinity	17,411	9	,000**	208,40000	181,3229	235,4771
Ca	33,997	9	,000**	76,70000	71,5963	81,8037
Mg	17,286	9	,000**	34,50000	29,9851	39,0149
K	2,378	9	,041*	1,54000	,0750	3,0050
Na	3,692	9	,005**	9,10000	3,5236	14,6764
DO	23,338	9	,000**	7,49800	6,7712	8,2248
Fe	8,039	9	,000**	,01065	,0077	,0136
Cd	5,550	9	,000**	,00422	,0025	,0059
Pb	7,988	9	,000**	,00265	,0019	,0034
Zn	5,803	9	,000**	,20400	,1245	,2835
As	6,652	9	,000**	,00102	,0007	,0014
Cu	13,967	9	,000**	,24270	,2034	,2820
Co	3,253	9	,010*	,00006	,0000	,0001
Mn	4,429	9	,002**	,02558	,0125	,0386
Ni	10,369	9	,000**	,05040	,0394	,0614
Al	7,245	9	,000**	,01034	,0071	,0136

* (P<0.05), ** (P<0.01)

4.4.2. Correlation Matrix

The covariance matrix of the 25 analyzed variables was calculated from normalized data by **One-Sample Statistics method**; therefore, it coincided with correlation matrix. High and positive correlations with bold values were observed between chloride (Cl), sodium (Na), potassium (K), sulfate (SO_4), nitrate (NO_3), magnesium (Mg), total hardness (TH), and total dissolved salts (TDS), which are related to soluble salts in water and responsible for water mineralization. Nitrate nitrogen is positively correlated with EC, TDS and sulfate representing by infiltration from agricultural runoff. As a result, DO was negatively correlated with cadmium. Some heavy metals like Pb-Fe, Zn-Fe, Zn-Pb, Cu-Zn, Mn-Cu, Mn-Co were also positively correlated with each other, as the elements are responsible from the industrial area near Duhok ground waters studied. In addition, Fe-Ca, Pb-Cl, Ni-Cu, Ni-Co and Ni-Mn were negatively correlated with the between each the characteristics (Table 4.6).

Table 4.6. Correlation matrix of the 25 physico-chemical parameters in Duhok groundwaters

	T	**Tur**	**EC**	**TDS**	**pH**	**So4**	**Cl**	**No3**	**TH**	**TA**	**Ca**	**Mg**	**K**
T	1												
Tur	.142	1											
EC	.584	.183	1										
TDS	.583	.182	1,000**	1									
Ph	-.179	-.086	.212	.214	1								
So4	,704*	-.018	,823**	,823**	.192	1							
Cl	.226	.449	,770**	,771**	.432	,654*	1						
No3	,728*	.029	,895**	,894**	.051	,847**	.501	1					
TH	.606	.272	,946**	,946**	.023	,681*	,650*	,823**	1				
TA	-.025	-.408	.481	.482	.088	.366	.308	.504	.348	1			
Ca	.200	.405	,690*	,690*	.284	.278	.620	.400	,789**	.033	1		
Mg	,699*	.036	,839**	,838**	-.229	,784**	.444	,883**	,856**	.500	.369	1	
K	,788**	.190	,761*	,760*	.180	,833**	.492	,904**	,647*	.202	.300	,670*	1
Na	.611	.195	,971**	,971**	.223	,898**	,781**	,923**	,878**	.488	.552	,850**	,833**
DO	-.109	-.110	.450	.450	.509	.246	.326	.479	.346	.530	.394	.200	.396
Fe	-.211	-.537	-.412	-.412	-.464	-.339	-.622	-.255	-.377	.295	-,641*	-.009	-.470
Cd	.069	-.033	-.118	-.116	-.149	.147	.142	-.306	-.098	-.229	-.152	.017	-.312
Pb	-.005	-,660*	-.420	-.420	-.551	-.268	-,744*	-.144	-.403	.171	-,635*	-.085	-.254
Zn	-.118	-,740*	-.093	-.091	-.278	-.065	-.284	-.059	-.114	.582	-.321	.111	-.347
As	-.054	-.040	.292	.293	-.477	.017	.115	.202	.336	.524	.134	.403	-.113
Cu	.066	-.557	-.010	-.008	-.297	-.044	-.226	-.091	.063	.271	-.063	.170	-.356
Cr	.c	.c	.c	.c	.c	.c	.c	.c	.c	.c	.c	.c	.c
Co	.540	-.312	.561	.562	.020	.619	.268	.456	.610	.121	.421	.618	.296
Mn	.238	-.463	-.082	-.080	-.199	.020	-.257	-.155	-.003	-.157	-.032	.035	-.242
Ni	-.464	.450	-.346	-.347	-.013	-.279	.048	-.314	-.414	-.274	-.194	-.466	-.103
Al	.564	.043	,906**	,906**	.256	,776**	.580	,961**	,801**	.593	.467	,788**	,857**

Table 4.7. (Coıntinue): Correlation matrix of the 25 physico-chemical parameters in Duhok groundwaters

	Na	DO	Fe	Cd	Pb	Zn	As	Cu	Cr	Co	Mn	Ni	Al
Na	1												
DO	.468	1											
Fe	-.418	-.392	1										
Cd	-.107	-,734*	.166	1									
Pb	-.446	-.319	,752*	-.038	1								
Zn	-.166	-.177	,715*	.239	,732*	1							
As	.179	-.128	.461	.039	.343	.565	1						
Cu	-.145	-.442	.603	.482	.572	,864**	.547	1					
Cr	.c	.c	.c	.c	.c	.c	.c	.c	1				
Co	.491	-.091	-.070	.461	-.035	.268	.117	.545	.c	1			
Mn	-.206	-.605	.333	.602	.464	.581	.206	,863**	.c	,656*	1		
Ni	-.240	.152	-.354	-.262	-.259	-.540	-.237	-,762*	.c	-,734*	-,706*	1	
Al	,925**	,644*	-.299	-.426	-.261	-.094	.187	-.170	.c	.337	-.289	-.264	1

T=Temprature, TUR=Turbidity, pH=Potential of Hydrogen, TDS=Total Dissolved Solid, TH= Total Hardness, TA= Total Alkalinity, Cl= Chloride, SO_4= Sulfate, NO_3= Nitrate, Ca=Calcium, Mg=Magnesium, Na=Sodium, K=Potassuim, DO=Dissolved Oxygen, Fe=Iron, Cd=Cadmium, Pb=Lead, Zn=Zinc, Cu=Cobalt, Cr=Chromium, Co=Copper, Mn=Manganese, Ni=Nickel, Al=Aluminum, COD=Chemical Oxygen Demand.

**: Correlation is significant at the 0.01 level (2-tailed)
*: Correlation is significant at the 0.05 level (2-tailed)
C: Cannot be computed because at least one of the variables is constant

5. CONCLUSIONS

1- The Girash (location 6) have recorded the high levels of temperature, EC, K and Na and great levels of turbidity, chloride, total alkalinity and Ca because it locate the down ward of the effluent collection in Valley ended near this well. The increase of previously mentioned parameters gives non desirable taste and small at this water as mentioned by local people in this area especially nitrates over 50 mg/L that is not saved for drinking water according to WHO standard that should not exceed more than 50 mg/L to save for drinking. And also Potassium over 7 mg/L that compared with the permission level of potassium that should not exceed 2-3 mg/l.

2- The accumulation of heavy metal in Girrash well is very low comparing with the other anions like NO_3, CL, SO_4 and element like Ca, Mg and Na. this fact is as an excellent prove that the high soil pH over 7 and soil content of both $CaCO_3$ and clay have a great role to precipitate cationic heavy metal and render it an active in the soil and prevent it to reach ground water unlike negative anions like NO_3 that carry the same negative charge of soil colloid to repulse and washed easily with seeping water to percolate in groundwater.

3- In most cases, the accumulation of heavy metals pollution plume are in Kowashe (location 1) and moved gradually toward the down ward well. Then is suspected another pollution plume in location 7 and gradually distributed to the adjacent artesian wells.

4- There are no levels of heavy metals accumulations over standard WHO for drinking water except cadmium in location 1, 4 and 10.

5- Due to our results the attention most pointed in future to this area and to banned the excess use of such elements like As and Cd to prevent their accumulation in groundwater from causing more human health defects.

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