DETERMINATION OF GROUNDWATER THRESHOLD VALUES: A METHODOLOGY APPLIED TO GEDIZ BASIN

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ABSTRACT

DETERMINATION OF GROUNDWATER THRESHOLD VALUES: A METHODOLOGY APPLIED TO GEDIZ BASIN

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Turkish bylaw on Protection of Groundwater against Pollution and Deterioration requires the establishment of groundwater thresholds in groundwater bodies. According to this regulation, water status, as good or not, is to be determined based on the chemical status. Indeed, in a EU Project entitled “Background Criteria for the Identification of Groundwater Thresholds-BRIDGE”, in an attempt to the implementation of Water Frame Directive, a methodological framework has been developed to determine threshold values (TV) for pollutants which cause the groundwater body to be characterized as ‘at risk’. In this respect, Ministry of Forestry and Water Affairs of Turkey (MFWA) is in charge to determine the river basin based TV values for the priority and specific pollutants in Turkey. To this end, a methodology that would be followed in Turkey needs to be developed. A methodology developed by the BRIDGE has some flexibility as it allows countries to make some choices depending on the groundwater body characteristics and available monitoring data. In this study, taking the BRIDGE methodology as a basis, TVs will be determined for a pilot-basin, namely, Gediz Basin of Turkey. Basically, TV will be determined by comparing the natural background level (NBL) of a quality parameter in a basin with the appropriate reference value (REF). NBL is the value that represents a naturally occurring level or a level that could occur without human-caused changes

in a river basin. This value will be determined through the statistical analysis of field measurements belonging to the target contaminant or quality parameter as suggested by BRIDGE. Whereas REF is the criterion value which is set by governmental authorities to regulate the water usage, depending on the intended use of water bodies. While determining TVs, groundwater monitoring data produced by the MFWA through three different monitoring campaigns were used. Statistical analysis was performed using “MATLAB” and “Excel”.

Keywords: Groundwater, Gediz Basin, Threshold Value, Natural Background Level

ÖZ

YERALTI SULARINDA EŞİK DEĞER BELİRLENMESİ: GEDİZ HAVZASINDA UYGULANAN METODOLOJİ

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"Yeraltı Sularının Kirlenmeye ve Bozulmaya Karşı Korunması Hakkındaki Yönetmelik" gereğince, Türkiye'deki yeraltı suları için eşik değerler (ED) belirlenmelidir. Bu yönetmeliğe göre, yeraltı suyunun durumu, iyi ya da kötü şekilde, kimyasal durumuna bakılarak belirlenmelidir. Bu duruma açıklık getirmek, Su Çerçeve Direktifini uygulamaya koymak ve yeraltı sularında "risk" teşkil edebilecek kimyasallar için ED belirleme amacıyla Avrupa Birliği, "Background Criteria for the Identification of Groundwater Thresholds-BRIDGE" adlı bir proje gerçekleştirmişlerdir. Bu bakımdan, Orman ve Su İşleri Bakanlığı (OSİB), öncelikli ve spesifik kirleticiler için havza bazında ED belirlemek için görevlendirmede bulunmuşlardır. Öncelikle, Türkiye'de uygulanabilir bir metodoloji geliştirilmesi gerekmektedir. BRIDGE projesi kapsamında geliştirilen metodoloji incelendiğinde, ülkelerin yeraltı sularının karakteristiğine ve kullanılabilir izleme verisinin miktarına göre esnek olduğu görülmüş, belirtilen durumlara göre metodolojide değişiklik yapılabileceği anlaşılmıştır. Bu çalışmada, BRIDGE metodolojisi temel alınarak, pilot havza seçilen Gediz Havzasında ED'leri belirlemek hedeflenmiştir. Temel olarak, ED, kalite parametrelerinin doğal arka planları (DAP) ve uygun bir referans değerin (REF) karşılaştırılması ile bulunmaktadır. DAP değeri, bir havzada doğal olarak bulunan

kimyasal seviyesidir. Bu değer, izleme sonuçlarına dayanılarak yapılan istatistiksel analizler sonucunda elde edilmektedir. Diğer yandan, REF değeri, otorite tarafından belirlenmiş ve su kullanımını yöneten değerlerdir. ED'ler belirlenirken, OSİB tarafından elde edilen 3 dönem izleme verileri kullanılmıştır. İstatistiksel analizler "MATLAB" ve "Excel" aracılığı ile yapılmıştır.

Anahtar Kelimeler: Yeraltı Suları, Gediz Havzası, Eşik Değer, Doğal Arka Plan Seviyesi

To My Beloved Family

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LIST OF ABBREVIATIONS

ABBREVIATIONS

AA-EQS	Annual Average Environmental Quality Standard
AF	Assessment Factor
BRIDGE	Background Criteria for the Identification of Groundwater Threshold Values
DO	Dissolved Oxygen
DWS	Drinking Water Standard
EQS	Environmental Quality Standard
EToxV	Eco-Toxicological Value
EU	European Union
GWB	Groundwater Body
LOD	Limit of Detection
MAX-EQS	Maximum Environmental Quality Standard
NBL	Natural Background Level
NOEC	No Effect Concentration
REF	Reference Value
SHW	State Hydraulic Works
TV	Threshold Value
WFD	Water Framework Directive
WHO	World Health Organization

CHAPTER 1

INTRODUCTION

1.1. General

The ultimate aim in groundwater management is to achieve a good status in both quantity and quality. To this end, indeed, one of the main objectives of the Water Framework Directive (WFD) (200/60/EC) (European Comission, 2000) is that groundwater has to be in good chemical condition. In this respect, the criteria to be considered in assessing whether the groundwater bodies are chemically in good status are mentioned, but relevant criteria are not specified in the Directive; just, member states are asked to implement the measures necessary to prevent or reduce the pollution of groundwater taking into account the applicable standards set out in relevant Community legislation. In other words, a general description of good status as related to the chemical composition of groundwater is given in the WFD, but not specific criteria (quality standards and thresholds) to be used for evaluation.

The Directive on the Protection of Groundwater Against Pollution and Deterioration (2006/118/EC) (Groundwater Directive, GWD) (European Directive, 2006) completes the WFD in this respect. Within the scope of this groundwater directive, the criteria to be used for assessing the chemical status of groundwater bodies (GWBs) are specified as groundwater quality standards and thresholds. In addition, it has been stated that threshold values (TVs) for pollutants that cause groundwater bodies to be identified at risk as a result of the "Risk Assessment" carried out under "Initial Characterization" studies should be determined by member states. Assessment of chemical status of GWBs is based on a comparison of the measured values of pollutant parameters and/or pollutant indicator parameters to a set of quality standards (i.e. TVs). The European Union GWD (2006/118/EC) requests the Member States to derive appropriate TVs for several potentially harmful substances, taking into account the natural background levels (NBLs) when necessary, in order to assess the chemical status of groundwater bodies.

The essence of setting TVs lays in determination of the NBLs, which are affected by several factors; such as, chemical and biological processes in the unsaturated zone, the residence time of water in the aquifer, recharge by rain, relations with the other aquifers, water-rock interactions, atmosphere, rainfall composition (Appelo & Postma, 2005; Edmunds & Shand, 2008; Preziosi et al., 2014; Urresti-Estala et al., 2013; Jenifer & Jha, 2018). In addition to natural factors, the groundwater composition is also linked to agricultural, industrial and mining activities due to pollution. Pollution can alter the composition by enhanced mineral dissolution due to redox conditions variation and so the NBLs may change (Preziosi et al., 2014). While the occurrence of synthetically produced chemicals (e.g. pesticides) in groundwater is linked to anthropogenic sources, the occurrence of inorganics may be related with both natural and anthropogenic sources. In this context, in assessing groundwater quality, the evaluation of NBLs is crucial in order to distinguish anthropogenic pollution from naturally occurring contamination (Reinmann & Carritat, 2017).

Although the first approach to NBL estimation was based on a geochemical prospective in which the concentration data is belonging to aquifers on which anthropogenic pressure does not exist, the typical approach employed is by the statistical analysis of monitored water quality data (Edmunds and Shand, 2008). In cases where the concentration data is from an aquifer, which is not pristine, the geochemical approaches cannot certainly be used for the estimation of NBL in which case statistical methods should be used. The statistical approaches aim to separate the natural population of geochemical data from the anthropogenic one by assuming a normal distribution, starts from the idea that the monitored concentration data is a mixture of contributions of natural and/or anthropogenic origin (Molinari et al., 2012). In line with this, the European research project entitled “BRIDGE” (Background cRiteria for the Identification of Groundwater thrEsholds) conducted towards the determination of TVs suggests a methodology termed as pre-selection, that is based on statistical evaluation of water quality data and the identification of pristine groundwater samples as representative of NBL (Müller et al., 2006). According to the method developed within the scope of this aforementioned project, data sets obtained through the monitoring programs are first eliminated by applying certain selection criteria (i.e. pre-selection) and then 90% or 97.7% of preselected data is chosen as NBL (Urresti-Estala et al., 2013). As reviewed by Sellerino et al. (2019), there are many other studies in the literature that combines the pre-selection methods and NBL setting with statistical analysis. For example, Parrone et al. (2019) applied the pre-selection of uncontaminated samples by using nitrate/ammonia as the appropriate marker and NBL setting based a normal distribution. Molinari et al. (2012) applied component separation and pre-selection methodologies and indicated that the estimated values of NBLs by these two approaches are within the same order of magnitude.

Indeed, all these methods applied for NBL setting, rely on the elimination of the outliers or extreme values assuming that the extreme values or outliers are not from the background but from another process or source, and thus the remaining data belong to the background. To this end, several different statistical techniques have been used. For example, Preziosi et al. (2014) used the probability plot method, Matschullat et al. (2000) used the 2-σ iteration technique, Cidu et al. (2017) used the median absolute deviation method, Reimann et al. (2005) used the box and whisker plot, successfully. These studies (Müller et al., 2006; Matschullat et al. 2000; Preziosi et al. 2014) were satisfactory despite the use of single statistical method for NBL determination due to the availability of relevant and accurate long-term spatial data. However, developing countries such as Turkey face great challenges when setting TV, given scarcity of long-term groundwater quality data. Such long-term comprehensive groundwater quality data is hard to collect, mainly because of the high cost of the monitoring campaigns.

In our country, Turkish bylaw on Protection of Groundwater against Pollution and Deterioration (TPGWPD) was first issued in 2012 (Official Gazette 28257, 07.04.2012) and revised in 2015 (Official Gazette 29363, 22.05.2015); taking GWD and WFD (2000/60/EC) as the basis. This bylaw obliges determination of the status of groundwater in terms of quality and quantity; and development of a program of measures. However, the quality standards already determined by the current Turkish Legislation are for pesticides and nitrates, only. For all the other parameters causing GWB to be classified as "at risk", relevant TVs should be determined.

In this framework, General Directorate of Water Management of the Ministry of Agriculture and Forestry (MoAF) (the former Ministry of Forestry and Water Affairs) carried out a pilot project titled "Developing and Implementation of Methodologies/Methods for Determination and Assessment of Groundwater Quantity and Quality: Gediz Basin Pilot Study" (MoAF, 2017) to assess the groundwater quantity and quality, in line with the above-mentioned bylaw. Within the content of this project, all provisions of the bylaw were implemented, and methodologies developed were tested on the pilot river basin, namely Gediz River Basin. One of the major implementation stages of the above-mentioned project is "Determination of TVs" under data scarcity conditions, which forms the basis of this thesis. Here the main challenge was the data scarcity to deal with. One way to deal with the data scarcity problem is to collect more data while the other is to design techniques that can deal with extremely limited data sets. The present study was directed by limited data availability and there was a need to develop a new approach to NBL determination for TV setting.

1.2. The Objective and Scope of the Study

The objective of this study is to develop a methodological approach to determine TVs, NBLs, and REFs under data scarcity conditions, and then to determine TVs for ions, metals, and metalloids, which could cause the groundwater of the Gediz Basin of Turkey to be classified at, risk.

The scope of present study was directed by limited data availability and aimed to develop a new approach to NBL determination for TV setting. The methodology developed was mainly based on the assessments used in the BRIDGE Project and the groundwater quality dataset available. As different than the BRIDGE methodology which includes the steps of "pre-selection" and "NBL setting with the use of probability plot method", the NBL determination methodology developed in this study included i) data pre-selection, ii) elimination of outlier data using box and whisker plots (data selection), and iii) determination of NBL applying three different statistical techniques (probability plot, 2-σ iteration and distribution function methods). As different than previous studies on the subject, additional step of data selection, and a modified version of statistical NBL setting adopting the use of three different statistical techniques, in order to produce more realistic and more conservative NBLs. Data selection was added to the methodology; because, the pre-selection criteria adopted in the BRIDGE Project was not fully applicable in the present study due to limited number of data available and therefore there was a need for a better elimination of outliers. NBL setting using three different statistical techniques was considered, because the distribution of data was not always normal. Also included is a comparison among the NBLs derived by the different statistical techniques in order to evaluate how far the NBLs estimated are sensitive to the chosen statistical technique. By combining pre-selection method with the above-mentioned statistical methods and by verifying its applicability at the site, it is aimed to have a conservative, and a flexible approach that can be adapted according to the availability of data. After NBLs are determined, reference (REF) values are chosen and finally, TVs are determined by comparing NBLs and REFs.

1.3. Thesis Overview

This thesis is composed of six chapters. Chapter 1 forms the "Introduction" which provides brief information regarding the chemical status assessment of groundwater bodies in line with the relevant regulations. In addition, justification for the study is given accordingly. Chapter 2 stands for the "Background Literature" which gives an information on the determination of TVs, previous relevant literature studies and applications in different countries. The study area is explained in Chapter 3, namely, Description of the Study Area. In Chapter 4 titled as Applied Methodology, data set available and statistical tools used are presented, and applied methodology to determine NBL, REF and TV is explained in detail. Parameters considered for NBL and TV determination, and results obtained are given and discussed in Chapter 5, titled as Results & Discussions. Finally, in Chapter 6, conclusions drawn from the study and recommendations for future studies are provided.

CHAPTER 2

BACKGROUND LITERATURE

2.1. Water Framework Directive (2000/60/EC)

WFD requires that all water bodies including both surface and groundwater should be maintained in good chemical condition. In this respect, the criteria to be considered in assessing whether the groundwater bodies are chemically in good status are mentioned, but the relevant criteria are not specified in the Directive. Only, the member states are asked to implement the measures necessary to prevent or reduce the pollution of groundwater taking into account the applicable standards set out in the relevant Community legislation. In other words, a general description of good status as related to the chemical composition of groundwater is given in the WFD, but not specific criteria (quality standards and thresholds) to be used for evaluation.

The Directive on the Protection of Groundwater against Pollution and Deterioration (2006/118/EC) (Groundwater Directive) (European Directive, 2006) which completes the WFD in this respect is summarized in the following section.

2.2. Groundwater Directive (2006/118/EC)

In the Groundwater Directive (GWD), the criteria to be used for assessing the chemical status of groundwater bodies are specified as groundwater quality standards and thresholds. In addition, it has been stated that TVs for pollutants that cause groundwater bodies to be identified at risk as a result of the "Risk Assessment" carried out under "Initial Characterization" studies should be determined by member states. Assessment of chemical status of groundwater bodies is based on a comparison of the measured values of pollutant parameters and/or pollutant indicator parameters to a set of quality standards (i.e. TVs). The Directive requests the Member States to derive appropriate TVs for several potentially harmful substances, taking into account NBLs when necessary, in order to assess the chemical status of groundwater bodies.

Within the scope of GWD, the definitions given for the criteria to be used for the assessment of the chemical status of groundwater are as follows:

- Threshold Value (TV) refers to the groundwater quality standard that will be determined by Member States.
- Groundwater Quality Standard refers to the environmental quality standards (EQS) that should not be exceeded in order to protect human health and environment, as the concentrations of pollutants or pollutant groups or pollution indicators.
- Natural Background Level (NBL) refers to the level of a substance or concentration of a substance found in the groundwater body in the absence of anthropogenic change compared to the natural state, or only a slight change.

In paragraph 1 of Article 3 of the Directive, the TVs for pollutants, pollutant groups and pollution indicators which cause groundwater bodies to be identified as at risk (in accordance with the procedure specified in the annex of the Directive (Annex II, Part A); and the minimum parameter list given in the annex of the Directive (Annex II, Part B) should be determined. The article of the Directive (Annex II) consists of three parts and provides detailed information on the determination of TVs for pollutants and pollution in groundwater.

In Annex II of the Directive, there is a guideline to be followed when TVs are set in the context of Part A. In the Part B, the minimum parameter list to be taken into consideration for the determination of threshold values are given. Part C summarizes the information that Member States should provide under the River Basin Management Plans for pollutants and pollutants for which TVs are set. The Part A and B are summarized below:

Part A - Guide to be followed when setting TVs

1. Factors to be considered in the determination of TVs:

a. Dimensions of interaction between aquatic ecosystems to which groundwater is connected and terrestrial ecosystems that are dependent on groundwater;
b. Existing or potential uses and functions of groundwater;
c. All pollutants causing groundwater bodies to be identified as at risk, taking into account the minimum parameter list specified in Section B;
d. Hydrogeological characteristics including NBLs and information on water budget.

2. Separately, when TVs are set, the nature of the pollutants, possible natural occurrences, toxicity conditions and their potential for spreading, permanence and bioaccumulation must be taken into account.
3. Where NBLs of substances, ions or their indicators in groundwater are high due to natural hydrogeological conditions, background levels should also be considered when thresholds are set for these bodies. When setting NBLs, the following principles should be considered.
   a. The Member State should characterize the appropriately constructed groundwater bodies and determine the background levels by monitoring the groundwater. When the monitoring strategy is being established and the data are being displayed, it should be taken into consideration that the flow conditions and groundwater chemistry change laterally and vertically.
   b. Where more restricted groundwater monitoring data is available, more data should be collected and background levels should be determined, taking into account the data sets for which the effects of human activities are not being observed, using simple constraints. Information on geochemical clearing and processes (if this information can be obtained) needs to be taken into account.
   c. Where there is insufficient groundwater monitoring data and information on geochemical exchanges and processes is inadequate, more data and information should be collected and background levels based on statistical reference results obtained from areas with similar aquifer characteristics should be used.

4. Determination of TVs; the quality of the collected data should be supported by a control mechanism based on the evaluation of analytical factors and background levels.

Part B - Minimum pollutant list to be taken into consideration when TVs are determined

1. Substances/ions/indicators that may arise naturally or as a result of human activities: arsenic, cadmium, lead, mercury, ammonium, chloride, sulfate, nitrite, phosphorus (total), phosphate
2. Man-made synthetic materials: trichloroethylene, tetrachloroethylene
3. Parameters indicating salinity or other interventions: conductivity

In paragraph 2 of Article 3 of the Directive, it is stated that the TVs may be determined in the country, basin or groundwater body scale. On the other hand, in paragraph 6, it is stated that the list of TVs can be rearranged, if necessary, by adding new pollutants or pollution indicators to the list or re-adding those removed from the list. It is also noted that pollutants and pollution indicators, which are presently on the threshold list but no longer exert a risk for groundwater bodies, may be excluded from the list.

Moreover, there exists a guideline document prepared by the Groundwater Working Group of EU regarding the implementation of groundwater elements of the WFD names as "Groundwater Status and Trend Assessment Guide" that is 18th Guidance Document. Summary of this guideline is presented in the following sub-section with special emphasis on the determination the TVs.

2.2.1. Guide Document No: 18 - Groundwater Status and Trend Assessment Guide

In accordance with the requirements of the GWD, TVs should be determined for pollutants that cause risk for groundwater bodies. The thresholds set at this stage together with groundwater quality standards are to be used when determining the chemical status of the groundwater at later stages in accordance with WFD requirements. This guideline was developed to provide a guidance on the basic steps to be followed during the process of setting thresholds as well as the methodologies and the technical requirements. Within the scope of this guidance document, the proposed methodology for determining thresholds is based on the outputs of the BRIDGE project. The main objective of this EU-funded project is to develop and to test a methodology for determining the TVs of pollutants in groundwater bodies in accordance with the requirements of the WFD and the GWD. The scope and outputs of this project and how they are integrated into the activities carried out under this implementation step are detailed in the following sections.

2.2.2. Commission Report Prepared under Article 3.7 of the Groundwater Directive (2010)

In the GWD, the quality standards for nitrate and pesticides have been set at the EU scale while other pollutants and pollution indicators were left to be set by the Member States. These pollutants generally present in groundwater naturally due to hydrogeological conditions (i.e. NBLs), pollutant transport routes and different environmental interactions. Therefore, the member states should determine their own groundwater quality standards for these parameters. It is reported in the Commission Report that, on the necessity laid down in paragraph 7 of Article 3 of the GWD, the TVs are to be set by the Member States and the relevant information is to be provided to the Commission. The relevant information given in this report is based on reports submitted to the Commission on thresholds set by 26 member states. The TVs set for the various pollutants/indicators by the EU member states are provided in Section 2.3.

In total, thresholds for 158 different pollutants/indicators were currently determined, by the EU member states. When the number of parameters determined by the member countries is concerned, the highest number of TVs (i.e. 62) has been determined by the United Kingdom; on the other hand, no threshold value was determined in Portugal because there was no groundwater body identified at risk. The number of pollutants/indicators for which thresholds were determined up to date are as follows:

- 12 basic substances: Arsenic, Cadmium, Lead, Mercury, Ammonium, Chloride, Sulfate, Conductivity, Ammonium Nitrogen, Trichloroethylene, Tetrachloroethylene, (Total) Phosphorus or Phosphates
- 39 pesticides
- 8 plant nutrients
- 21 metal
- 62 synthetic materials
- 10 other substances (boron, calcium, bromate, cyanide, etc.)
- 6 indicators (acid capacity, hardness, pH, etc.)

As seen, two thirds of the threshold parameters are composed of pesticides and synthetic substances, while the rest are natural occurring substances and indicator parameters. In addition, as shown in Table 1 indicating the threshold parameters set by at least 10 member countries, TVs were determined mostly for the 10 pollutants/markers listed in the Appendix of the Directive (Annex II). Parameter groups, but not individual or specific parameters, are mentioned within the commission report (European Commission, 2010). In addition to these, TVs were established by 20 member countries for 106 different pollutants/indicators other than the nitrate and pesticides whose quality standards are provided in the Groundwater Directive and the minimum parameter list presented in the Groundwater Directive (Annex II) (Please see Sec 2.2). Almost two-thirds of these belong the group of synthetic materials (62) whereas the rest composes of metals (21), other substances (10), plant nutrients (7), nitrates (7) and various indicators (6) (Figure 1).

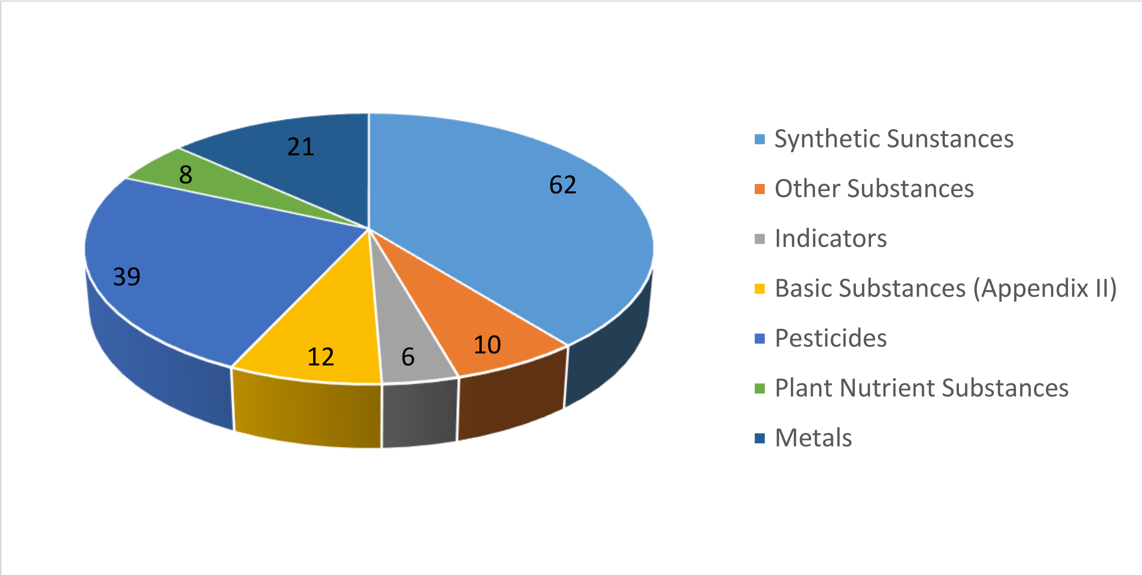

Figure 1. Distribution of TVs Set by EU States According to Groups

In addition, the range of TVs determined by at least 10 Member States could be seen from Table 1.

Table 1. Parameters versus TVs Determined by at Least 10 Member States

Pollutant/Indicator Name	Pollutant/Indicator Group	Number of Member State Determining TVs	Range of TVs		Unit
			The Lowest	The Highest	
Chlorine	Basic Substances (Appendix-II)	22	24	12300	mg/L
Arsenic	Basic Substances (Appendix-II)	21	0.75	189	µg/L
Sulfate	Basic Substances (Appendix-II)	21	129.75	4200	mg/L
Ammonium	Basic Substances (Appendix-II)	21	0.084	52	mg/L
Lead	Basic Substances (Appendix-II)	20	5	320	µg/L
Cadmium	Basic Substances (Appendix-II)	19	0.08	27	µg/L
Mercury	Basic Substances (Appendix-II)	18	0.03	1	µg/L

Table 1. (Continued)

Pollutant/Indicator Name	**Pollutant/Indicator Group**	**Number of Member State Determining TVs**	**Range of TVs**		**Unit**
			The Lowest	**The Highest**	
Conductivity	Basic Substances (Appendix-II)	14	485	10480	µS/cm
Nickel	Metals	11	10	60	µg/L
Copper	Metals	10	10.1	2000	µg/L
Tetrachloroethylene	Basic Substances (Appendix-II)	10	1.1	50	µg/L
Trichloroethylene	Basic Substances (Appendix-II)	10	1.5	50	µg/L
Sum of Tetrachloroethylene and Trichloroethylene	Basic Substances (Appendix-II)	10	5	40	µg/L

Most of the TVs (126) were determined in the country scale. In addition, there are also thresholds determined at the basin scale (24) and groundwater body scale (79).

Moreover, as stated in Section 2.2, the quality standards set out in the Groundwater Directive for a groundwater body will not be sufficient if this body or its associated surface waters and dependent terrestrial ecosystems are not able to reach the environmental targets identified in WFD; more stringent threshold values could be determined for these parameters than groundwater quality standards. For example;

- For nitrates, the five Member States set thresholds that are more stringent than the quality standard (i.e. 50 mg/L) specified in the Groundwater Directive. The lowest threshold was set as 18 mg/L by the United Kingdom.
- For pesticides, six countries set more stringent thresholds than the quality standard set in the Groundwater Directive (i.e. 0.1 µg/L for pesticides, 0.5 µg/L for total pesticide). The lowest TVs for pesticides and total pesticide are 0.0001 µg/L (United Kingdom) and 0.375 µg/L (Ireland) respectively.

Unlike some countries where more stringent thresholds have been specified when necessary, in some cases, thresholds with higher than environmental quality standards are specified. For example, in France, the TV for 1,2-Dichloropropane is 40 μg/L. This could be attributed to the fact that this compound detected in a groundwater body near to chlorine-containing solvents production industry, and therefore regarded as a synthetic substance, not as a pesticide.

2.3. Approaches in EU Countries to Determine Groundwater Threshold Values

In the document entitled "The Commission in accordance with Article 3.7 of the Groundwater Directive 2006/118/EC on the establishment of groundwater threshold values", the various EU countries' approaches to determine groundwater TV are provided. Using this source, Table 2 was prepared and the approaches of the countries are summarized. However, considering the fact that the source is dated as 2010, additional literature sources was also searched so that the current situation is fully addressed and is reflected in the table. In this table, countries that define TV, scales (i.e. country, groundwater body or river basin) considered and reference values (REF) used while defining the TV can be seen.

Table 2. Approaches Followed in EU Countries to Determine the TV for Groundwater (European Commission, 2010)

Country	**Used Quality Criteria (REF)**	**Number of Parameter**	**Scale**
Austria	Drinking water standards	21	Country
Belgium	Surface water quality criteria (for groundwater having an interaction with surface water) and Drinking water standards (for groundwater being used as drinking water)	20	Groundwater body
Bulgaria	Drinking water standards, NBL	19	River basin, Groundwater body

Table 2. (Continued)

Country	Used Quality Criteria (REF)	Number of Parameter	Scale
Cyprus	Intended use of water (mostly drinking water)	10	River basin, Groundwater body
Czech Republic	Drinking water standards	35	Country
Denmark	NBL (still working on the subject)	-	-
Estonia	Surface water standards, NBL	6	Groundwater body
Finland	Drinking water standards, NBL	42	Country
France	Drinking water standards, Surface water quality standards	33	Country
Germany	Toxicity (for human and aquatic life) (surface water quality standards and PNEC* values) NBL (when the toxic values are higher than NBL)	18	Country, state, groundwater body
Greece	-	-	-
Hungary	NBL, Surface water quality standards, Drinking water standards	6	Country, groundwater body
Ireland	Drinking water standards, NBL, Surface water quality standards	40	Country
Italy	Drinking water standards, Surface water quality standards, NBL	53	Country
Latvia	GWD Annex I, NBL	10	Country, groundwater body
Lithuania	Drinking water standards, Surface water quality standards, NBL	8	Country
Luxemburg	Drinking water standards, GWD Annex I, NBL	9	Country
Maltha	Drinking water standards, Irrigation water standards, NBL	11	Country, groundwater body

Table 2. (Continued)

Country	Used Quality Criteria (REF)	Number of Parameter	Scale
Holland	GWD Annex I	6	Groundwater body
Poland	Toxicity, NBL	52	Country
Portugal	No TV	-	-
Romania	Drinking water standards, Surface water quality standards, NBL	9	Groundwater body
Slovakia	Drinking water standards, NBL	20	Groundwater body
Slovenia	Drinking water standards	7 (highly volatile halogenated hydrocarbons)	Country
Spain	Drinking water standards, NBL	20	Groundwater body
Sweden	Drinking water standards, International reference values	15	Country
United Kingdom	Drinking water standards, Surface water quality standards, NBL	62	Groundwater body

* *PNEC – Predicted no-effect concentration*

As can be seen from Table 2, majority of the countries have taken the drinking water standards and natural background (NBL) values into consideration as a REF value (European Commission, 2010). However, the number of parameters for which TV was identified varies widely among countries. Moreover, while some countries set thresholds at country level, some others at river basin level.

In the TV identification approaches, it is understood that the TV determination is based on the comparison of the NBL values with the reference value (REF). As can be seen, countries have adopted different approaches to TV determination, depending on whether the NBL value is greater or less than the REF value.

Indeed, in the EU Project, namely, BRIDGE carried out with the aim of developing a common methodology for determining the chemical status of groundwater, TV determination approaches for both pollutants and some hydrogeological parameters are presented (Dahlstrom, 2006). In this aforementioned project, an attempt was made to develop a common methodology for determining TV on a national, a river basin basis and a groundwater body scales. The recommended methodology for this project study is summarized in Table 3.

Table 3. Approaches of the EU Countries to Determine TVs (Dahlstrom, 2006)

Case NBL<REF	**Country**	**Case NBL> REF**	**Country**
TV=NBL	Bulgaria, Czech Republic, Lithuania and Romania	**TV=NBL**	Belgium, Cyprus, Czech Republic, Germany, Denmark, Spain, Ireland, Italy, Maltha and Slovakia
TV= (REF +NBL)/2	Belgium and Slovakia	**TV= Value between NBL and REF**	Holland
TV=Value between NBL and REF	Spain and Maltha	**TV=NBL+10%**	Bulgaria
TV= REF	Germany, Denmark and Holland	**TV=NBL+20%**	Romania
		TV=2*NBL	Finland

The BRIDGE project has two proposals as TV identification approach. These approaches, called as "preliminary suggestion" and "final suggestion", are given below. Some of the member countries have applied the "preliminary suggestion" approach while the others applied the "final suggestion" approach.

The "preliminary suggestion" developed in the BRIDGE project is the approach summarized in Figure 2. As can be seen, the preliminary suggestion approach covers three different cases (Hinsby et al., 2008).

<u>Case 1</u>: NBL/REF >= 1/3 → TV = (NBL+REF)/2

Case 2: NBL/REF < 1/3 → TV = 2*NBL

Case 3: NBL/REF >= 1 → TV = NBL

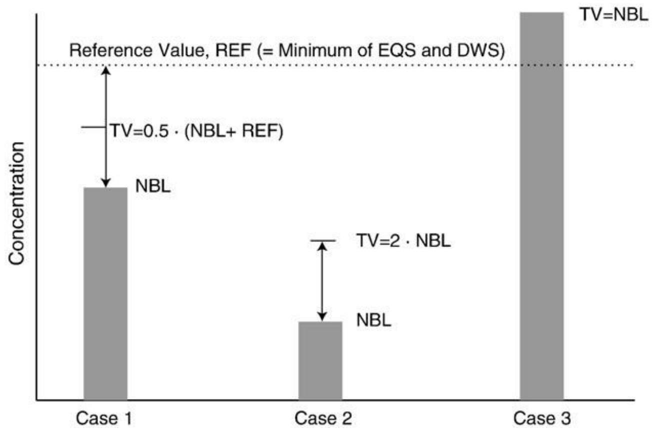

Figure 2. Preliminary Suggestion Approach of the BRIDGE Project (Hinsby et al., 2008)

The "Final Suggestion" approach proposed in the BRIDGE project covers 2 different cases for which the final recommendations are as follows (Hinsby et al., 2008; Cruz & Andrade, 2015).

Case 1: NBL/REF >= 1 → TV = NBL

Case 2: NBL/REF < 1 → TV = (NBL+REF)/2

2.4. Model Implementations on TVs Determination

In this section, some examples regarding the model implementations to determine the TVs are presented.

Guadalhorce River Basin Implementation (Malaga, southern Spain) (Urresti-Estala et al., 2013)

The Guadalhorce river basin is located in the Malaga and has an area of 3200 km^2. In addition, this area represents 40% of total area of province. There are 24 water bodies in the basin; fifteen aquifers are carbonate, eight of them are detritic and only one is evaporitic. Carbonate water bodies are generally located in limestone, dolomite or marble, mostly Mesozoic. Detritic water bodies are located in gravel, sand, sandstone or calcarenite, mostly Cenozoic. The evaporitic groundwater body is related to Triassic clays.

In this study, Cl^-, SO_4^{2-}, Na^+, K^+, Ca^{2+}, Mg^{2+}, HCO_3^- and electrical conductivity were monitored. Fourteen of the groundwater bodies were classified "at risk" because they fail to meet WFD standards. Nevertheless, NBLs were determined for all bodies as to obtain information that is more extensive.

The pressures in basin is mostly due to human activities, both diffuse and point sources. The important diffuse sources are industrial areas, urbanized areas and roads, irrigated agriculture, livestock, airports and golf courses, whereas point sources stand for petrol stations, farms, refuse tips and oil mills.

In this study, 2-σ iteration and distribution function methods were used, yielding similar results. In carbonate water bodies, the values obtained from the methods were the lowest in basin.

It was claimed that both techniques were more applicable than other methods as they do not require any elimination. In addition, there was no limitation regarding the distribution of data. Furthermore, these methods were found reliable for both large and small data sets, as the outliers did not influence them. Moreover, it was stated that 2-σ iteration and distribution function methods are good tools for estimating background levels because they enable to identify records, which are subjected to the anthropogenic influence. In the frequency distribution of the data set, the anomalies that represent human pressure can be identified in both methods.

Result of the analysis showed that nature of the aquifer affects the background level as expected. For detritic groundwater bodies, the ranges were broader with higher values, unlike for the carbonate groundwater bodies.

Sofia Valley Implementation (Executive Environment Agency, Bulgaria) (Gorova & Deneva, 2005)

Sofia valley is placed in the south part of the Iskar River Basin, Bulgaria. The area of the valley is about 1200 km^2. The 57%, 27%, 7%, 8% of the basin are used as arable land, urban areas, woodland and pastures respectively. There are 48.9-million m^3 water abstraction per year from groundwater; 40% of it is used as drinking water. In addition to the abstraction as a pressure, there are diffuse and point source types of pressure. The diffuse sources are for the agriculture and arable lands, whereas the point sources stand for a mine, which is an open, mine for iron ores, coke, refined petroleum, pharmaceutical, chemicals, textiles products, etc. In addition to these, there are some waste landfills.

For the determination of NBL, firstly, pre-selection were applied. During the pre-selection, samples from unknown depth boreholes were removed. Only data belonging to the above mentioned groundwater bodies, namely Quaternary fluviatile deposits of major streams and Tertiary deposits in the Sofia valley were processed, while the data from the hydrothermal aquifer were removed. Monitoring points with average nitrate concentration exceeding 10 mg/L were also excluded. Finally, 90 percentiles of data were accepted as NBL. Then after, reference values were chosen to compare with the corresponding NBL values. Reference values were chosen from drinking water standards and groundwater contamination threshold values. Finally, TVs were determined by comparing NBL and REF. According to methodology,

If NBL < REF then TV = (REF+NBL)/2

If NBL < REF/3 then TV=2*NBL

If NBL > REF then TV = NBL.

Cambrian-Vendian Groundwater Body, Estonia Implementation *(Marandi & Karro, 2008)*

As one of the Member States in the European Union, Estonia has to protect, enhance and restore all bodies of groundwater, ensuring the balance between recharge and abstraction. The purpose is to achieve chemically and quantitatively good groundwater status.

The location of Cambrian-Vendian groundwater body (Cm-V GWB) is in northwestern part of the Estonia. The area of Cm-V GWB is about 9,935 km^2. Topography of area is smooth, varying from zero to 140 m above sea level. The area consists of natural formations (forests, bogs) (70%), agricultural land (20%) and urban/industrial activities (10%). The average annual precipitation ranges from 420 to 820 mm. In addition, groundwater body is confined and deep-seated. Therefore, there is no significant interactions with the surrounding ecosystems.

The groundwater body is treated to supply water for Tallinn and its surrounding areas. Anthropogenic contamination does not affect the chemistry of groundwater because it is very well protected from the possible downward infiltration of water by the Lontova aquitard. On the other hand, over pumping is a potential anthropogenic disturbance for chemical balance of GWB.

Threshold values were estimated according to the method originally proposed in the BRIDGE project; as such:

- Case 1: if NBL < REF then TV1 = (NBL+REF)/2 and
- Case 2: if NBL ≥ REF then TV2 = NBL.

Before NBL calculation, simplified pre-selection process was used, as suggested in BRIDGE to avoid using the anthropogenically influenced data. However, the only criterion applied was the ion balance because Cm-V GWB is not influenced by anthropogenic pollution. After pre-selection, 90 and 97.7 percentiles were used as mentioned in the BRIDGE methodology. There were 80 monitoring wells results to evaluate NBL. The results of analysis are presented in Table 4.

Table 4. TV Results of Cm-V GWB (Estonia)

Substance	Percentile	Unit	REF	NBL	TV1	TV2
EC	97.7	µS/cm	2500	1486	1993	
	90			1162	1831	
Cl^-	97.7	mg/L	250	397		397
	90			287		287
SO_4^{2-}	97.7	mg/L	250	42.3	146.2	
	90			22.8	141.9	
Ba	97.7	mg/L	0.7	3.1		3.1
	90			2.4		2.4
Pb	97.7	mg/L	0.01	0.015		0.015
	90			0.007	0.009	
Hg	97.7	mg/L	0.0004	0.0005		0.0005
	90			0.0005		0.0005
NH_4^+	97.7	mg/L	0.5	1.3		1.3
	90			0.8		0.8
Cd	97.7	mg/L	0.001	0.001	0.001	
	90			0.0005	0.0008	
As	97.7	mg/L	0.005	0.01		0.008
	90			0.01	0.005	

According to results, Cm-V GWB was found not affected by surface pollution. The most important pressures appeared as abstraction for water supply, seawater intrusion and up coining of saline groundwater. Estonian drinking water standard was used as REF. As mentioned before, after checking for the ion balance, data were used directly to determine NBL. As a result, TVs were estimated by using two approaches as mentioned in BRIDGE.

The TVs calculated by the BRIDGE methodology were approximately same with the proposed TVs by local authorities. BRIDGE methodology worked well in case of deep-seated confined GWB. TVs estimated by the BRIDGE methodology were found representative, allowing for assessing the status of the GWB.

Upper Rhine Valley (France, Switzerland and Germany) Implementation (Wendland, et al., 2008)

The study area, which is Upper Rhine Valley, is a transboundary river basin located between France, Switzerland and Germany. The total area is 9,290 km2. It is a very important drinking water reservoir serving for high population density. In turn, the possibility of various anthropogenic impacts (intensive agriculture, industry etc.) on groundwater quality were of concern.

By considering the anthropogenic activities in the area, nitrate and ammonium were determined as the key substances in this study. Therefore, samples displaying concentrations of these substances exceeding a certain value are excluded. The exclusion criteria are given below.

- NO_3 > 10 mg/L in oxidized aquifers (O_2 > 2 mg/L and Fe(II) < 0.2 mg/L) or
- NH_4 > 0.5 mg/L in reduced aquifers (O_2 < 2 mg/L and Fe(II) > 0.2 mg/L).

After pre-selection, 90th percentiles of parameter's values were set as NBL. In addition, NBLs for purely synthetic substances were set as zero.

TVs were established by comparing the NBL and REF values. REF values were taken as either drinking water standard (DWS) or environmental quality standard (EQS) or eco-toxicological value (EToxV). There were three cases considered to calculate TVs:

- Case 1: NBL ≤ REF
  - TV = (REF + NBL)/2
- Case 2: NBL < (1/3)*REF
  - TV = 2*NBL
- Case 3: NBL ≥ REF
  - TV = NBL

After applying the nitrate and ammonium criteria, 1129 samples were removed from the data set. Thirty five percent (594) of groundwater samples remained. TVs determined are presented in Table 5. Results can be seen below.

Table 5. TVs Derived for Upper Rhine Valley

Parameter	Unit	P90	Ref	TV	Case
B	mg/L	0.1	1	0.2	2
Cl	mg/L	84	250	167	1
Fe(II)	mg/L	3.6	0.2	3.6	3
K	mg/L	7.2	10	8.6	1
Mg	mg/L	25	50	37	1
Mn(II)	mg/L	0.82	0.05	0.8	3
Na	mg/L	41	200	83	2
SO4	mg/L	173	250	211	1
EC	µS/cm	951	2500	1726	1
As	µg/L	4	10	7	1
NH4	mg/L	0.39	0.5	0.45	1
NO2	mg/L	0.04	0.5	0.08	2
NO3	mg/L	8.2	50	16.4	2
PO4	mg/L	0.17	6.7	0.34	2

2.5. Statistical Tools for NBL Determination

2.5.1. Box & Whisker Plot

The box plot method is a method that can be used without any pre-selection. The method is capable of characterizing the distribution. Very small and very big outliers can be detected using the box plot (Reimann et al., 2005).

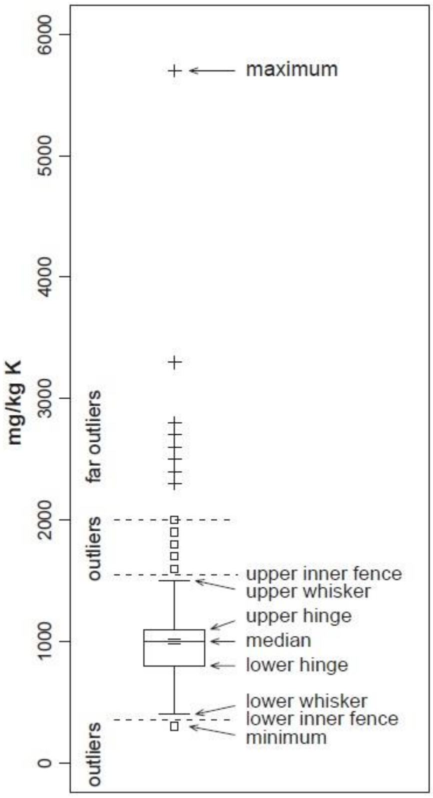

Figure 3. Sample Box & Whisker Plot (Reimann et al., 2005)

Figure 3 shows a sample box graph and outlier are shown. The middle line of the box graph represents the median of the data set. The upper line of the box represents 75% of data set and the bottom line of the box represents 25% of the data set. The top and bottom lines, expressed as whisker, show the maximum and minimum values, respectively. The maximum value of the dataset should not be greater than 1.5 times of the difference between 75% and 25% from upper line of the box. Outliers are determined accordingly.

2.5.2. Probability Plot

When groundwater is not under any pressure, it is expected that natural, in other words, normal data distribution is observed for the measurements (Kumar, 2010). In addition, Molinari et al. (2012) said that the statistical approaches aim to separate the natural population of geochemical data from the anthropogenic one by assuming a normal or lognormal distribution, starts from the idea that the monitored concentration data is a mixture of contributions of natural and/or anthropogenic origin.

Although the first approach to NBL estimation was based on a geochemical prospective in which the concentration data is belonging to aquifers on which anthropogenic pressure does not exist, the typical approach employed is by the statistical analysis of monitored water quality data (Edmunds & Shand, 2008). Therefore, statistical analysis was chosen to determine NBL. The data set can be examined without any pre-selection and the outliers in the data set can be visually detected with this method. Thus, it is easily understood if the data set exhibits a normal distribution.

An example probability plot is shown in Figure 4. The distribution in the plot does not reflect a normal distribution. In this way, when the normal distribution is not projected, the NBL is determined as the value covering the 90 % of data set. Otherwise, i.e. in the case of being normal distribution, the value covering the 97.7 % of data set will be determined as the NBL (Hinsby et al., 2008).

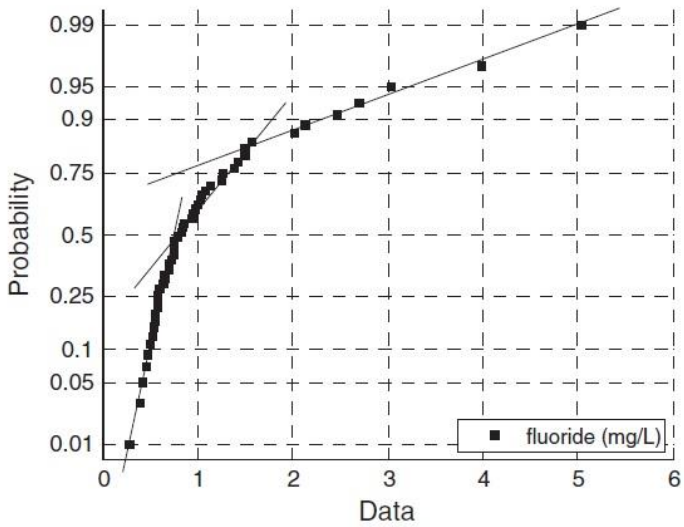

Figure 4. Sample Probability Plot (Preziosi et al., 2014)

2.5.3. 2-σ Iteration Method

This method differs from other methods in that it handles data adjusted by iteration until a normal distribution is achieved. A sample data set under human print is shown in Figure 5. Iteration is applied until the normal distribution is obtained and the "mean" and "standard deviation" values of this normal distribution are calculated. An "interval" is determined from these values. Any value outside of this range is removed. The method evaluates on the basis of the mode value of the original data set. This method controls the normal distribution fitness of the data with the Lilliefors test. This test shows whether this method is a suitable method to calculate NBL, or not. During the Lilliefors test, the t-test is performed and the calculated t-value is compared with the t-critical value (α value is 0.05 or 95% confidence level). If the calculated t-value is smaller than the t-critical value, it is decided that the obtained distribution is a normal distribution. Then, this method can be considered as suitable for calculating the NBL (Urresti-Estala et al., 2013). The t-critical value represents the t value that should be in the normal distribution and it has a known value previously calculated for different confidence levels (Aplied Statistics for Engineers, 1972).

This method has the advantage of eliminating anomalies below the lower limit of the specified range, which is useful when evaluating the dissolved oxygen (DO) parameter because low DO is a sign of high pollution. However, the suitability of this method varies depending on the frequency of data distribution or in other words the frequency distribution and on the properties of the parameters (Urresti-Estala et al., 2013). In cases where the parameter values are very variable, the method is not deemed as suitable because the median value of the data is high and the number of data to be eliminated is high.

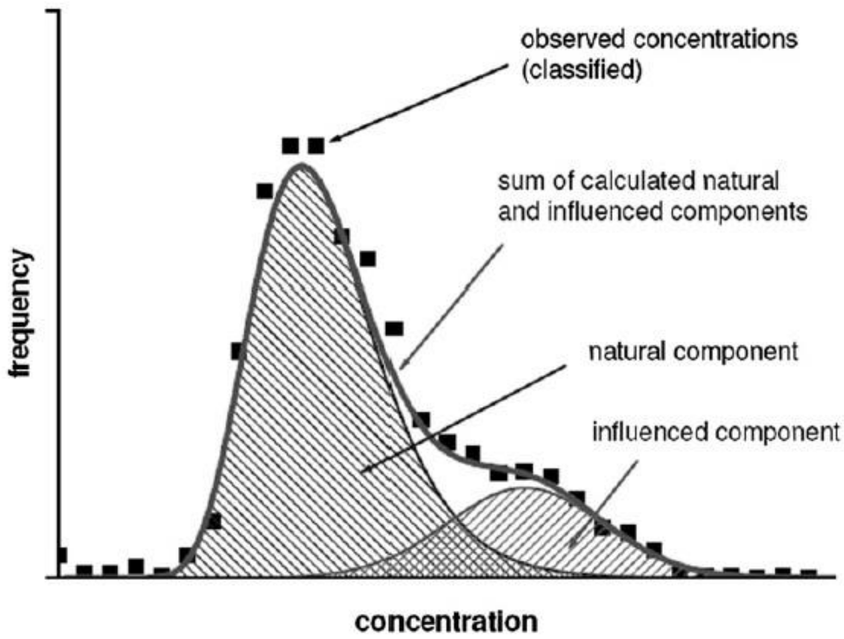

Figure 5. Sample Data Set under Human Pressure (Urresti-Estala et al., 2013)

In Figure 5, the left part of the graph shows the distribution of the data to be encountered without the human print (i.e. natural component) whereas the right part represents human print effect (i.e. influenced component). The sum of these parts is also presented in this figure, indicating the distribution of a water analysis data set under human print. As mentioned earlier, this method attempts to give a normal distribution to the data set by removing results of this effect.

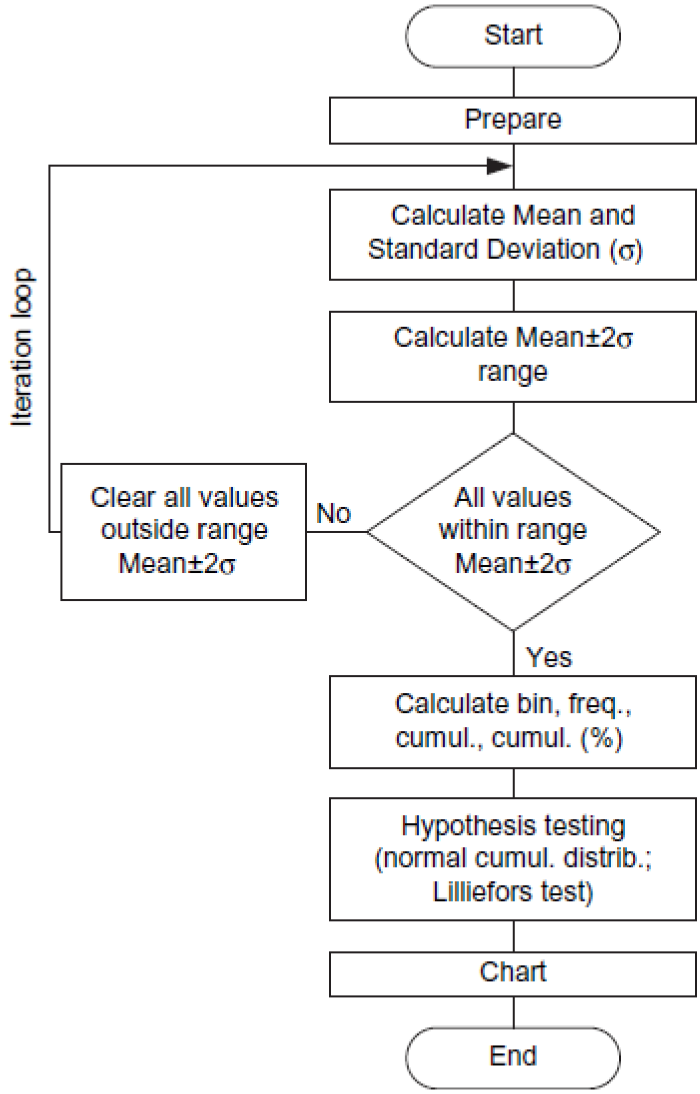

Figure 6. The Methodology of 2-σ Iteration Method (Nakic et al., 2007)

Figure 6 shows the methodology to be followed in this method. All the data are sieved until all the data are within mean ± 2σ and the residual data are plotted in the cumulative graph. Figure 7 shows an example application of the 2-σ iteration method. Finally, the remaining data are subjected to the Lilliefors test to judge about the normal distribution.

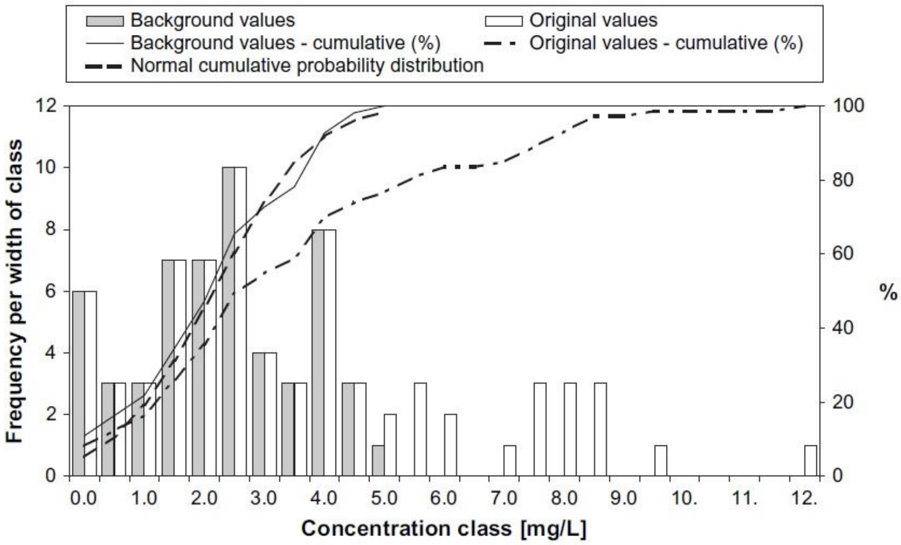

Figure 7. An Example of 2-σ Iteration Method İmplementation (NBL range: 0-4.8, t-value: 0,064, t-critical: 0,119) (Nakic et al., 2007)

The bars, expressed in white color in Figure 7, represent the values of the data after the pre-elimination and elimination are done. The grey bars show the data after the elimination performed by the iteration method. The lines represent the cumulative values of the numbers of the repetitions of the values. During the NBL derivation, the Lilliefors test is conducted as such: the sample mean ($\bar{x}$) and sample standard deviation (s) are computed, and then the normalized sample values (Z_i) are calculated using the below equation:

$$Z_i = \frac{x_i - \bar{x}}{s} \qquad \textit{Equation 1}$$

$i = 1,2 \dots \dots . n$

Then, the t-test is performed calculating t-value from the equation given below:

$$t = sup|F^*(x) - S(x)| \qquad \textit{Equation 2}$$

Where;

t is the supremum, over all x, of the absolute value of the difference $F^*(x) - s(x)$,

$F^*(x)$ is the cumulative distribution function of a normal distribution with mean zero and standard deviation one,

$S(x)$ is the empirical distribution function of the values of Z_i.

The calculated t-value is compared to the t-critical value (α value is 0.05 or 95% confidence level). If the calculated t-value is smaller than the t-critical value, it is decided that the obtained distribution is a normal distribution. In this case, this method is deemed suitable for calculating the NBL (Urresti-Estala et al., 2013) and the "mean+ 2-σ" value is taken as NBL range (i.e. 0-4.8). Nakic et al. (2007) pointed out that this technique is appropriate for calculating TVs as the upper limit of the NBL.

2.5.4. Distribution Function Method

In principle, this method works in a similar way with the 2-σ iteration method and looks for the normal distribution (Figure 8). The difference is that the concentration data above the median are removed from the data set and the concentration data between the minimum and median are considered to be free from human effects (Matschullat et al., 2000) and therefore represent NBLs (Urresti-Estala et al., 2013). The Lilliefors test is applied to the data between the minimum and the median values to check for normal distribution through the comparison of the calculated "t" value with the t-critical (95% confidence level). The resulting "mean+ 2-σ" value is taken as NBL. Like for the 2-σ Iteration method, the suitability of this method depends on the frequency distribution of the data and the nature of the parameter.

The suitability of this method varies depending on the frequency distribution and the properties of parameters (Urresti-Estala et al., 2013). In cases where the parameter values are high and natural, the probability of finding a low measurement value is low. In this case, the median value of the data is high and the method is not applicable.

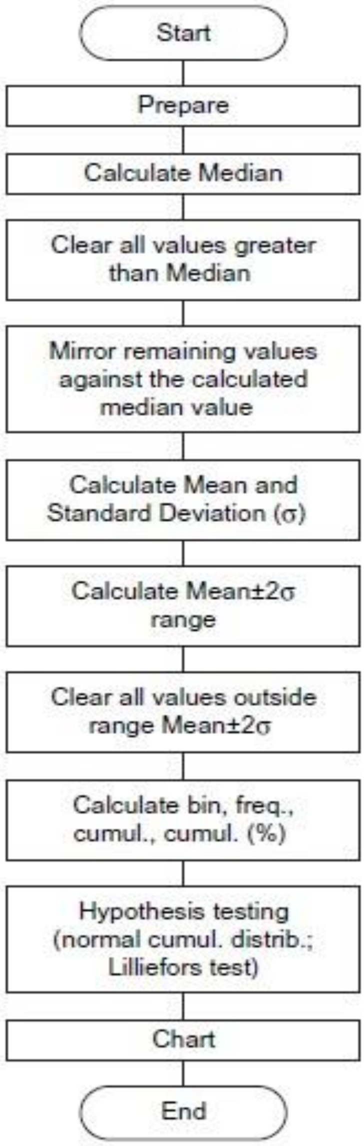

Figure 8. The Methodology of Distribution Function Method (Nakic et al., 2007)

CHAPTER 3

DESCRIPTION OF THE STUDY AREA

The study area is the Gediz River Basin, which is listed among the nine river basins in Turkey, having priority for the national bylaw to be implemented according to the "Action Plan on Groundwater Management" put in force in 2013. The location of the Gediz River Basin is shown in Figure 9. The basin is named after its major river (Gediz River) having an approximate length of 400 km, draining a basin of about 17,500 km^2 and discharging to Aegean Sea, along the western coast of Turkey. Gediz River emerges from the Murat and Saphane Mountains, which are located in Kütahya. Finally, it discharges into the İzmir Gulf after passing through Foca and Camaltı Tuzlası. The annual average flow rate of the river is around 60 m^3/s.

Geology of the Gediz Basin has been described in detail in a report prepared by State Hydraulic Works (SHW, 2015). According to this report, basement rocks of the basin are made up of metamorphic rocks of Menderes Massive. Paleozoic units are unconformably overlain by Mesosoic schists intercalated with metaconglomerates. These units are further overlain conformably carbonates, while the transition zone is identified by alternating dolomite, quartzite and calcschists. Massive dolomites overlying these alternating units are located beneath very thick (reaching to 1500 m) massive marbles. İzmir-Ankara zone, made up of ophiolite and flysch units, is situated on top of Menderes metamorphics by the thrust faults. These units are unconformably overlain by terrestrial and lacustrine sequences of Noegene sedimentary units, volcanic and igneous units. All the above-mentioned base units of the Gediz Basin are overlain by Quaternary basalts and alluvium units. Basalts in Kula region are well known for about 80 volcanic cones of lava and tephra. Other Quaternary units of the basin are the uncemented alluvium, talus, fan and terrace deposits.

Moreover, hydrogeology of the Gediz Basin has also been detailed within the scope of this aforementioned report where hydrogeological properties of the geological units and their corresponding groundwater-abstraction potential (based on their specific discharge, hydraulic conductivity, transmissivity, well and spring yields, etc.) are provided. Based on the results of these studies, aquifers of the basin have been identified. The karstic rock groundwater bodies composed of marble, limestone, dolomite and travertine are described as aquifers providing significant amounts of groundwater. In addition to these karstic units; granular units, which are commonly observed in the basin and are deposited as alluvial sediments, alluvial fans, cones and slope debris; also have significant groundwater potential. In the basin, groundwater can be obtained with high rates from Neogene aged clastic rock mass, depending on the sandstone and conglomerate levels it contains. Similarly, Neogene aged volcanic rocks in the basin can provide groundwater at regional and local scale where they have secondary porosity. In addition to these units, clayey limestone units of Neogene limestone in the basin are also used to supply groundwater locally. However, in the regions where the clay content is high, specific capacities of wells drilled in this unit are reduced. On the other hand, Paleozoic metamorphic rocks and Mesozoic flysch units, having very low specific capacities, are defined as the units not having potential to be classified as aquifers. Furthermore, all the aquifers have been grouped according to their groundwater-abstraction potentials, as follows: Neogene clastic rocks, volcanic rocks, and clayey limestone of the basin, which were classified as lower-yield aquifers of limited groundwater potential; while Paleozoic marbles, Mesozoic and Neogene limestone and uncemented units (alluvium, alluvial fans, and talus) were classified as higher-yield aquifers of significant groundwater potential.

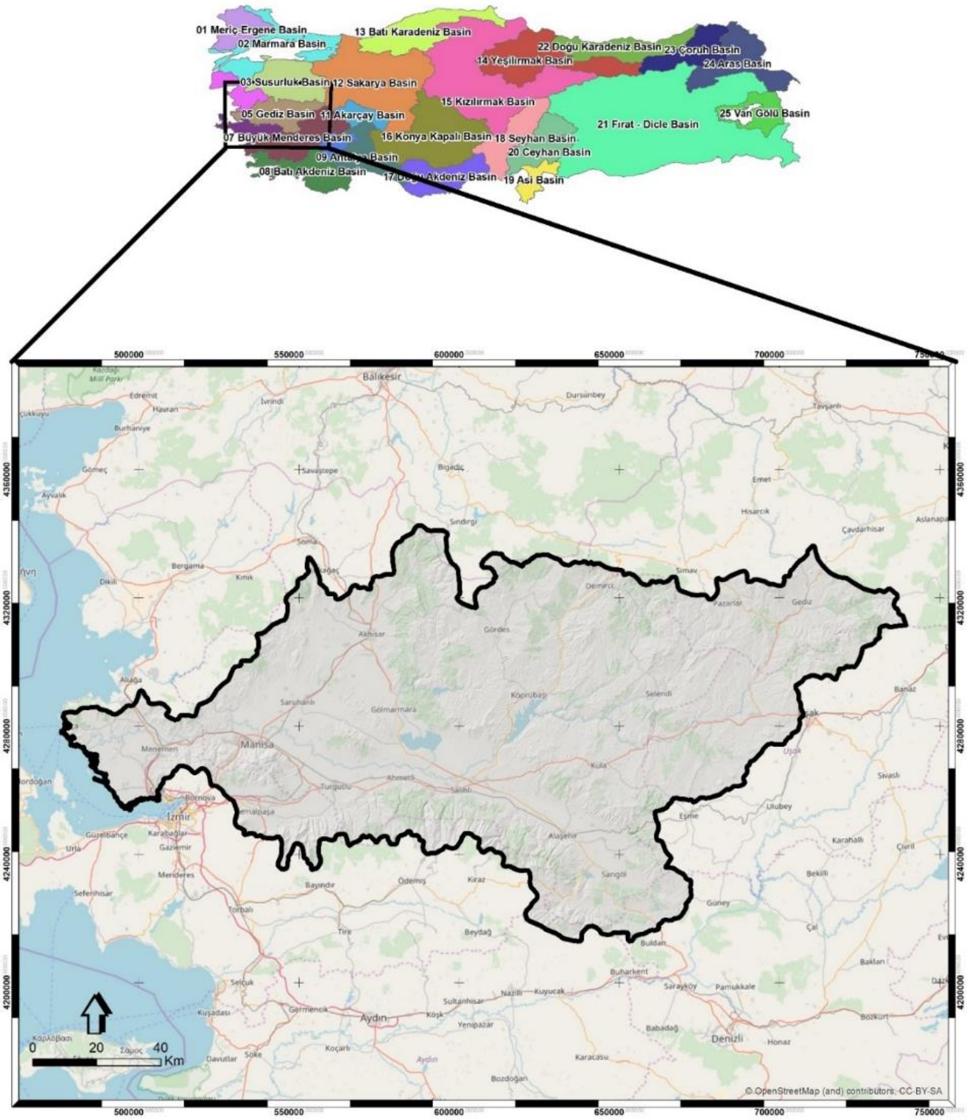

Figure 9. Location map of the Gediz River Basin (Karaaslan, 2017)

The Gediz River Basin hosts the very fertile agricultural lands, animal husbandry activities, organized industrial sites, high potential geothermal fields, variety of mineral deposits that depends on a number of factors: the aquifer mineralogy, the permeability and nature of groundwater flow; the presence and nature of overlying deposits; the pH and redox conditions; groundwater flow paths and the groundwater residence times (Tedd et al., 2017); in addition to the densely populated settlements. Two thirds of the basin stays natural, free from anthropogenic activities, mostly located in the northern and northeast parts of the basin (MoAF, 2017). In a project conducted in 2017 by Fugro Sial Geosciences Consulting and Engineering Ltd. Co. for the Ministry of Agriculture and Forestry, the main pressures on quality of groundwater were examined in two main groups as point and diffuse pollutions. Urban and industrial activities, as well as mining and geothermal activities, were classified as point pollutions; while agriculture, livestock and solid waste storage activities were classified as diffuse pollutions.

CHAPTER 4

APPLIED METHODOLOGY

4.1. Data Set

Within the framework of a project funded by the Ministry of Agriculture and Forestry (MoAF, 2017), a monitoring program was developed for the Gediz Basin in order to determine the quality and quantity of GWBs. Considering the duration and the scope of this project, it was considered appropriate to monitor three periods during the project in such a way to represent both wet and dry conditions (i.e. March-May 2013, September-November 2013 and March-May 2014). During the design of sampling network, the locations were selected in such a way that they are capable of representing the quality of GWBs, considering the locations of all wells and springs within the boundaries of GWBs in the basin.

In the afore-mentioned project work, the sampling network included wells and springs with a variable spacing, covering the entire basin. Some of the wells/springs were located far from the anthropogenic pollutant sources in order to obtain some pristine water samples, while some others were located nearby anthropogenic pollutant sources, as the monitoring activity was run for not only NBL assessment but also overall groundwater quality assessment. In addition, groundwater flow directions were also taken into consideration and possible areas that may be impacted by these anthropogenic pollutant sources were considered in order to reveal the effects on groundwater quality. 110 sampling locations representing 71 out of 76 GWBs within the basin were identified and samples were collected. There were no wells/springs suitable for sampling in 5 of the GWBs. Distribution of monitoring points can be seen from Figure 10.

In the process of determining the parameters to be included into the monitoring program, industrial activities and possible contaminants that may emerge from those and the pesticides that are widely used in the basin and relatively with high potential for leaching to groundwater were considered. In addition, the results from surface water quality monitoring programs carried out by the Ministry at 43 locations throughout the basin were evaluated. It should be noted that parameter values below LOQ was taken as equal to LOQ/2 during the statistical analysis.

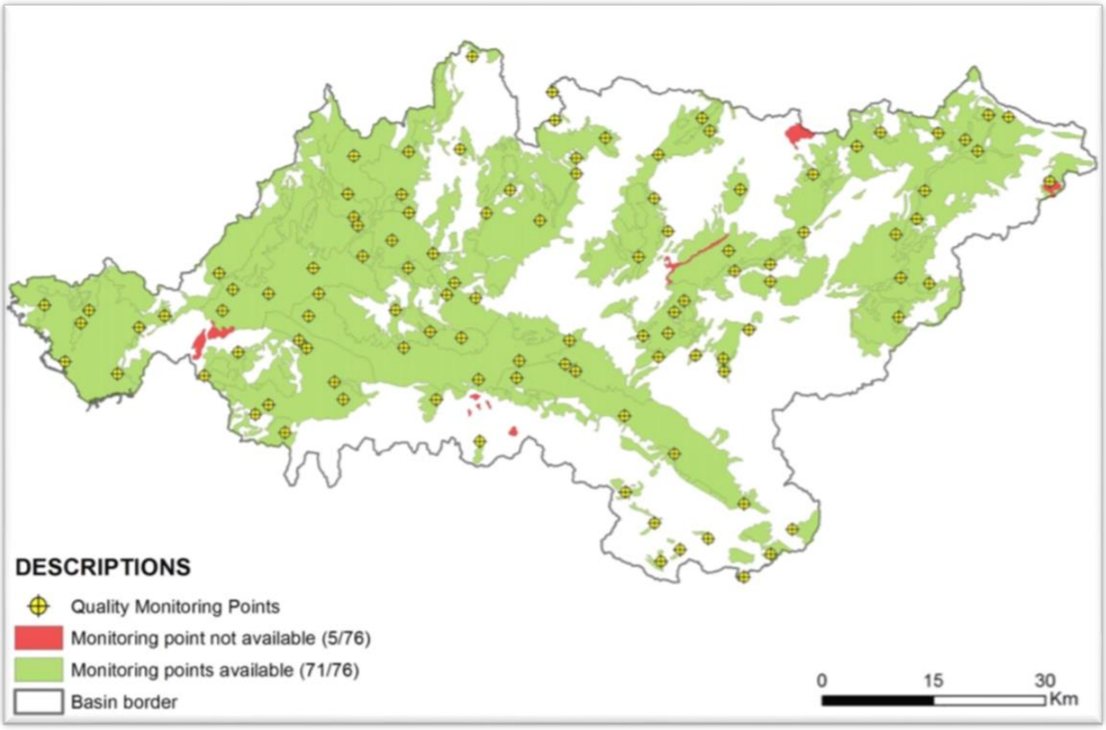

Figure 10. Position of the Water Quality Monitoring Points in the Study Area

4.2. Determination of TVs

One of the most important aspects in the TV establishment process is to determine the NBL value. Therefore, firstly, determination of NBLs for the parameters of concern needs to be performed.

As also stated earlier, when dealing with large-scale aquifer systems having data scarcity, it could be convenient to analyze available data monitored through statistical analysis methods. In this respect, the method presented in Figure 11 was followed in developing TVs. This method is mainly composed of i) NBL assessment which includes data preselection, outlier elimination (or data selection) by the box and whisker plots, and NBL estimation using three different statistical methods, ii) determination of REF value, iii) TV setting based on the comparison of the NBL and the selected corresponding REF value.

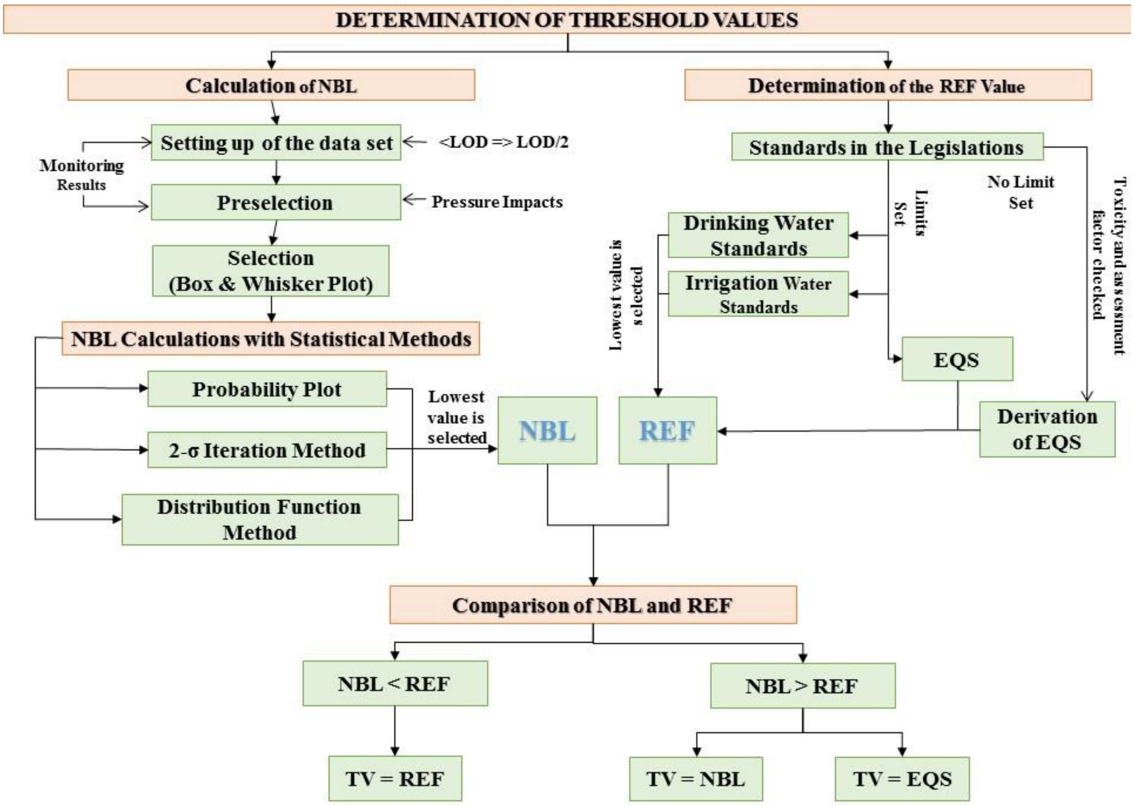

Figure 11. Methodology Used for Setting Threshold Values

4.2.1. Assessment of NBL

<u>*Preselection:*</u> Within the framework of the BRIDGE project, Wendland et al. (2005, 2008) proposed a pre-selection as a simplified approach for NBL determination. Pre-selection is applied where a limited set of quality data is available and therefore it is not possible to adopt a component separation method. In component separation method, the observed concentration frequency distribution is fitted by the

superimposition of two individual distributions that represent the natural and the influenced component. Once the distribution of the natural component is assessed, the related data are used to estimate the NBL (Müller et al., 2006).

The pre-selection methodology involves selecting sampling locations that meet certain criteria for exclusion of samples affected by human influence. The criteria considered in this preselection method (Hinsby et al., 2008), as suggested in BRIDGE, are summarized below.

- Data set belonging to the stations under the pressure of geothermal and salt intrusion (NaCl > 1000 mg/L) impact should be excluded.
- Data belonging to the stations with a nitrate concentration > 10 mg/L should be removed from the data set as it shows significant anthropogenic impact.
- Sampling points should be at the same depth
- Very high concentration values of parameters originating from natural geological structure within the region should not be included in the assessments.
- Dissolved oxygen data lower than 1 mg/L should be excluded from the data set.

Indeed, for applying this above-mentioned pre-selection method, there is a prerequisite regarding the ion balance, i.e. deviation of the ion balance < 10 %, as a common minimum requirement for groundwater quality data. The ion balance compares the concentrations of anions such as carbonate, bicarbonate, sulfate, chloride and nitrate with cations such as calcium, magnesium, potassium and sodium in water. However, there are some studies that applied this criterion (European Commission, 2010) while some others did not (Wendland, et al., 2008). In the study by Wendland et al., although they followed the BRIDGE method, they did not apply this preselection criterion. In our study, it was decided not to apply this pre-selection criterion, since it would be more appropriate not to apply this criterion, as there are very limited numbers of available sampling points satisfying the ion balance criterion.

Otherwise, the data remaining for determining NBL would be very limited if all eligibility criteria were taken into account. Likewise, considering the high number of sampling points (90 sampling points) with a concentration greater than 10 mg/L nitrate in the Gediz basin, indicating a high agricultural pressure, it was deemed that the 50 mg/L value given in the Nitrate Directive (91/676/EEC) would be more appropriate to take account as the criterion for elimination. Accordingly, the adopted criteria in the present study encompassed the following constraints: (a) locations where chloride concentration>1000 mg/L; (b) locations where nitrate concentration >50 mg/L; and (c) locations where there is geothermal pressure are assumed to be contaminated and removed from the data set. The other exclusion criteria that would ideally be adopted (e.g., redox conditions, anaerobic conditions) could not been applied, given that there remained very limited numbers of available sampling points to be used.

Selection - Box and Whisker Plots: After this pre-selection, distribution of the data for each parameter was examined using Box and Whisker plots for determining whether distribution is skewed and whether there are potential unusual values or outliers in the data set. This step forms the selection of the data to be used in the determination of NBL using statistical methods. The values in the data set under limit of quantification (LOQ) values were assumed equal to LOQ/2 in accordance with the European Union directive (European Commission, 2009) and included in creating the Box and Whisker plots.

NBL Setting: Subsequently, the NBL is estimated based on the modified distribution of the concentration data, applying three different statistical methods, namely,

- Probability plot
- 2-σ Iteration method
- Distribution function method

After the determination of NBL by the application of these methods, the lowest value was considered as the final NBL. The general principle of these methods, like for the Box and Whisker plots, is that dataset belonging to the natural must have a normal distribution and values outside the normal distribution are regarded as outliers. In other words, it is expected that a normal data distribution will be observed in the measurements when groundwater is not under any pressure.

Indeed, the probability plot method is the one used within the scope of the BRIDGE project where the value covering 90% or 97.7% of the dataset was accepted as the NBL (Müller et al., 2006). The use of these percentages depends on the size of the data sets. For small data sets (<60 data) 90% is used, while for large data sets 97.7% is used (Hinsby et al., 2008). In addition, the use of 90% value in the data sets that human print cannot eliminate with the existing criteria is proposed as a safer approach. Within the scope of this project; parallel to the BRIDGE project proposal, a value of 90% (for the number of data <60), or 97.7% (for the number of data> 60) was considered as the NBL after the preliminary operations were performed according to the criteria mentioned above.

On the other hand, in the context of the 2-σ iteration method and the distribution function method, such fractions are not used directly. However, the normal distribution with two standard deviations (σ) around the mean, used in the 2-σ iteration method, is actually statistically equivalent to 95%. In the distribution function method, the normal distribution is searched around the median (above 50% of the data) value. In fact, in the final run, the value that includes mean + 2 σ of the remaining data after screening (95% data coverage) is accepted as the NBL. During this evaluation, in both methods, the 95% confidence interval was considered in the normal distribution fit analysis at the end of the test. (Urresti-Estala et al., 2013). In the literature, it is seen that different percentages are used (90%, 95% and 97.7%) in the relevant studies and this was reported to be caused by the differences in the number of data and hydrogeological data level (Preziosi et al., 2014). In the context of this diversity, Urresti-Estala et al. (2013) stated that 90% of the values used in the BRIDGE project after preselection were subjective, indicating the risk of reaching incorrect results. It has also been noted that the elimination of outliers (even if apparently due to the pressure) in some water bodies already known to be under human pressure (or undoubtedly) may cause some problems. These problems have been attributed to the insufficient number of data to analyze statistically after the pre-selection, especially in the case of water bodies under pressure, where the high value of the denominated parameter may affect some other parameters in the water body. For this reason, two methods (2-σ iteration method and distribution function method) are recommended as they are based on more realistic criterion. Urresti-Estala et al. also emphasized that log-normal, bimodal, polymodal distributions, where probability graph application is based on the assumption that data are normally distributed but not always valid, suggests that the two methods proposed do not require a specific distribution of data. Both methods offer many statistical and methodological advantages, and are based on the frequency distribution of natural water parameter values and on the anomalies imposed by human influence. Thus, natural background values and abnormal values can be distinguished. In both methods, the normal distribution suitability of the data set is determined by the Lilliefors test, and the 95% confidence interval in the "t-test" applied in this process is used.

These aforementioned statistical methods described in Section 2.5 were applied to the remaining data set after pre-selection and selection and the NBL values of the parameters were determined. In other words, pre-selection, selection and statistical methods have been adopted. Considering the type of parameter(s) and size of data set, it was aimed to use a combination of pre-selection, selection and statistical methods to achieve a more accurate result. After determination of NBL values by application of different methods, the smallest value in order to remain on safe side was accepted as the final NBL.

4.2.2. Determination of REF

After setting the NBL, it is necessary to determine the TV to be based on the REF setting phase. The critical at this stage is what value/values will be taken as the "REF". As presented in Figure 2, the majority of EU member states use drinking water standards as "REF" values. In addition, generally, when water quality needs of groundwater dependent ecosystems is not known, surface water mean annual environmental quality standards (EQS) or drinking water standards (DWS) are used as proxies for REF values (Danielopol et al., 2003; Hose, 2005; Scheidleder, 2012). On the other hand, considering groundwater bodies in Gediz basin are used as drinking water and irrigation water, REF determination has been carried out. The methodology for determining the REF value is given below.

- Drinking water standards and irrigation water standards are compared and the smaller value is considered as the REF.
- Environmental quality standards (EQS) values are used for parameters that have not drinking water and irrigation water standards.
- An EQS can be derived according to the European Union Technical Guidance Document 27 for parameters that have not drinking water, irrigation water standards and EQS, or World Health Organization drinking water criteria are used.

4.2.3. Setting of TV

In the TV identification process, all alternative approaches that have been implemented in the EU countries, such as the NBL, have been examined and the methodology has been assessed in accordance with the recommendations of the Administration (i.e. The Ministry of Agriculture and Forestry).

The threshold value determination is carried out by applying the methodology below by comparing the NBL and the REF as indicated in Figure 11. According to this;

- if; $NBL/REF \geq 1$ so, $TV = NBL$
- if; $NBL/REF < 1$ so, $TV = REF$

CHAPTER 5

RESULTS & DISCUSSIONS

5.1. Parameters for NBL and TV Determination

According to the Turkish legislation, for the groundwater bodies which are classified to be at risk; it is required to set TVs at the most appropriate scale (national, river basin district or groundwater body) for each parameter that causes the groundwater body to be classified as at risk. Therefore, in an attempt to determine the parameters for which TVs need to be determined, the parameters monitored through the project funded by Ministry of Agriculture and Forestry (MoAF, 2017) were examined.

In Turkey, for the common groundwater pollutants of nitrates and pesticides, there are quality standards set at the national scale by TPGWPD. Therefore, within the scope of the present study, only 29 pollutants (excluding nitrates), which are not purely anthropogenic and that may cause groundwater bodies in the Gediz Basin to be classified at risk were taken into consideration. In doing this, the quality data collected for a total of 29 were firstly processed to estimate the average concentration for each parameter. For the calculation of average concentrations, values below the limit of quantification (LOQ) were set to half of the value of the LOQ concerned as suggested by the Guidance Document No. 19 of the European Commission (European Comission, 2009). The average concentrations were then compared with the corresponding LOQs in order to produce an average dataset that represents the average groundwater characteristics and to determine the parameters posing risk. In case the calculated mean value for a parameter exceeds its LOQ at more than three sampling stations, this parameter was considered as posing risk; therefore, its TV has to be determined. There were 7 parameters (F^-, CN^-, Ba, Be, Sb, Ti and Ag) which were classified as “not posing risk”. As a result, a list of 22 naturally occurring parameters given in Table 6 was formed to take into account in assessing NBLs and in setting TVs. Appendix-A presents the monitoring data collected for 22 posing risk and 7 non-risk posing parameters separately.

Table 6. Risk Bearing Parameters

Group	Substances
Ions	Cl^{-1}, SO_4^{-2}, S^{-2}, PO_4^{-3}-P
Metals	Cd, Hg, Cu, Zn, Fe, Co, Mn, Mo, Ni, V, Cr, Pb, Na, Al
Metalloids	As, B, Se
Other	Electrical Conductivity

5.2. NBL Determination

5.2.1. Pre-selection

As a first step in setting the NBLs, data pre-selection was performed. When the pre-selection criteria mentioned in Section 4.2.1 were applied to the original data set presented in Appendix A, a subset of the original data, which is classified as "pre-selected data", was formed for 22 parameters. As shown in Appendix B that shows statistical values (max, min, number of sampling points etc.) about original and remaining data after preselection, almost half of the original data was eliminated based on the criteria considered. In this context, number of measurement points eliminated based on each criteria can be summarized as:

- The data belonging to the 4 measurement points which are not at the same depth with others,
- The data belonging to total of 39 measurement points which are under geothermal pressure,
- The data belonging to 5 measurement points with nitrate greater than 50 mg/L.

5.2.2. Exclusion of Outlier Data Using Box Plots (Selection)

At the data selection step, data after preselection was fitted to a normal distribution on the assumption that the range of NBL data should follow this distribution once all polluted samples were removed as outliers. With the elimination of outliers that are likely to be due to human impacts using box and whisker plots, the distribution of data was understood better and the data was made ready for further statistical analysis and identification of the NBLs. Figure 12 presents box and whisker plots for only 19 of the considered 22 parameters, as there was no data left after pre-selection for S^{-2}, B and Se.

As can be seen from both Appendix A and B there was a remarkable decrease in the number of sampling points that provided acceptable data for NBL assessment, and in turn in the dataset after the selection using the box and whisker plots. The number of sampling points that can be considered in the NBL assessment was about half of the sampling points from which water quality data was collected during the monitoring campaign. Appendix B also indicates evidently that there was a serious change in the statistical characteristics of the water quality data following the data pre-selection. For almost all the parameters, 75th percentile values were found to decrease as compared to the original data. These results have confirmed that the groundwater in the Gediz River Basin are under a very serious anthropogenic stress, and therefore the task of NBL setting in the presence of the data scarcity problem is a challenging task for this river basin.

Box and Whisker Plots

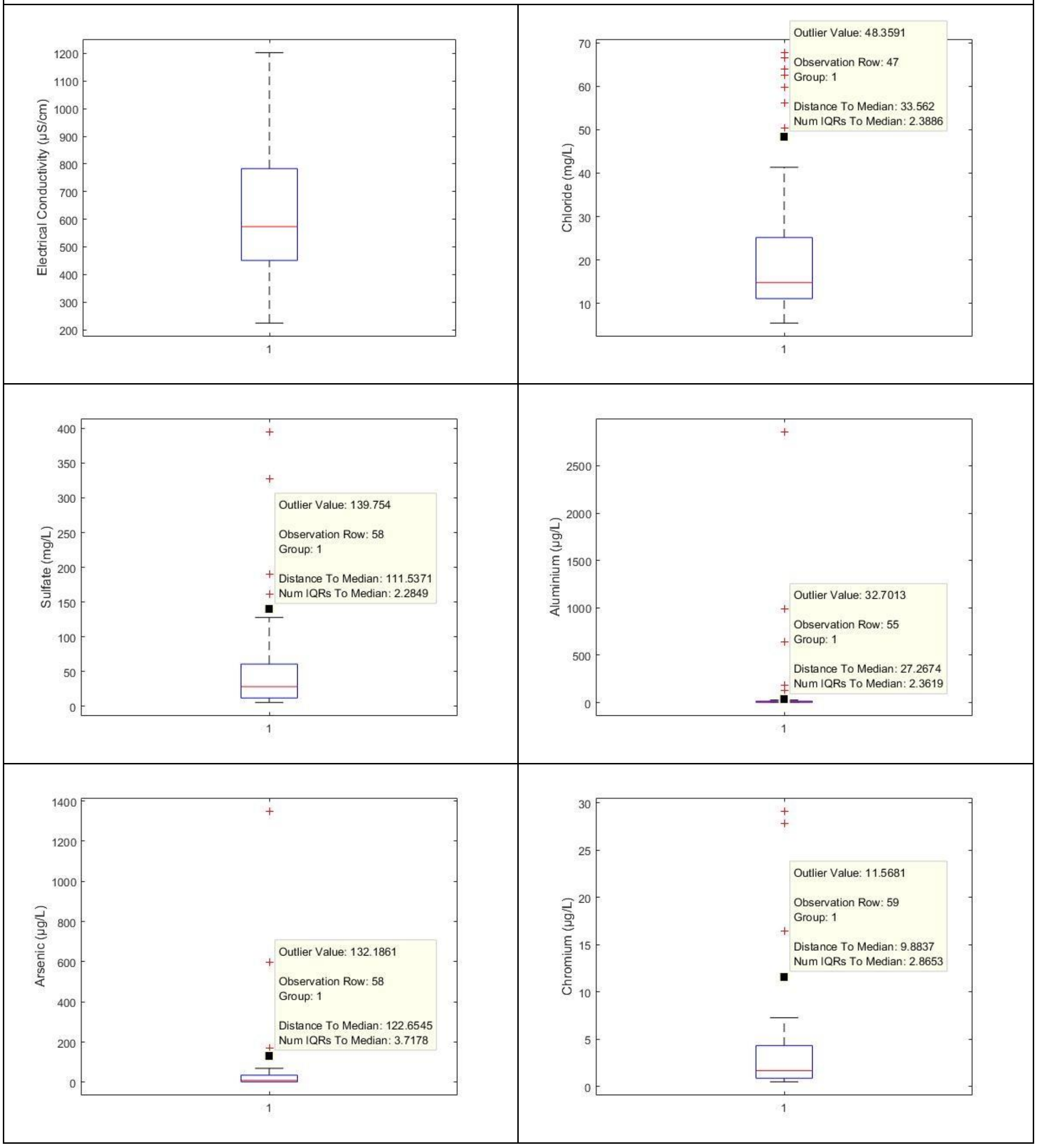

Figure 12. (Continued)

Box and Whisker Plots

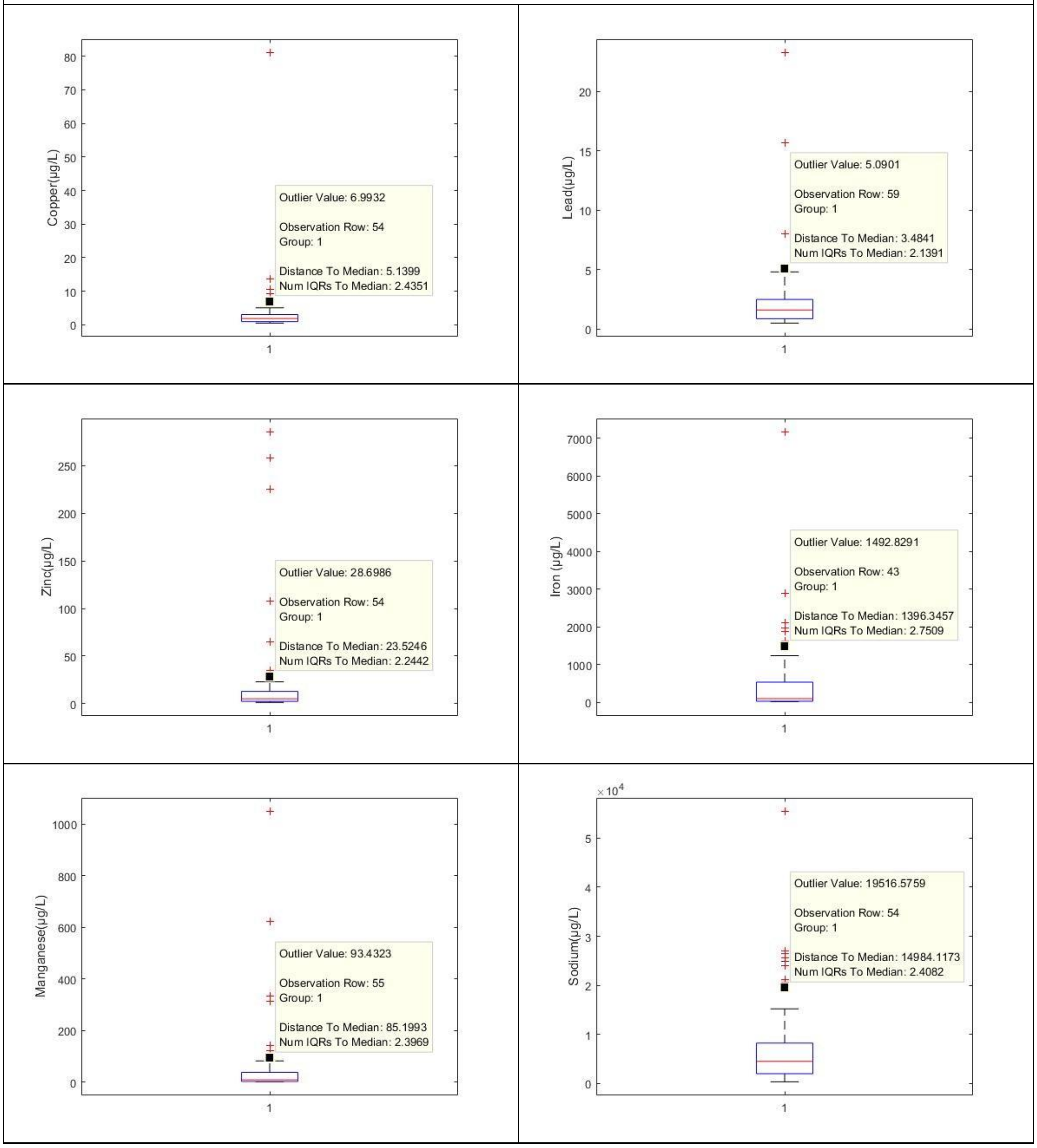

Figure 12. (Continued)

Box and Whisker Plots

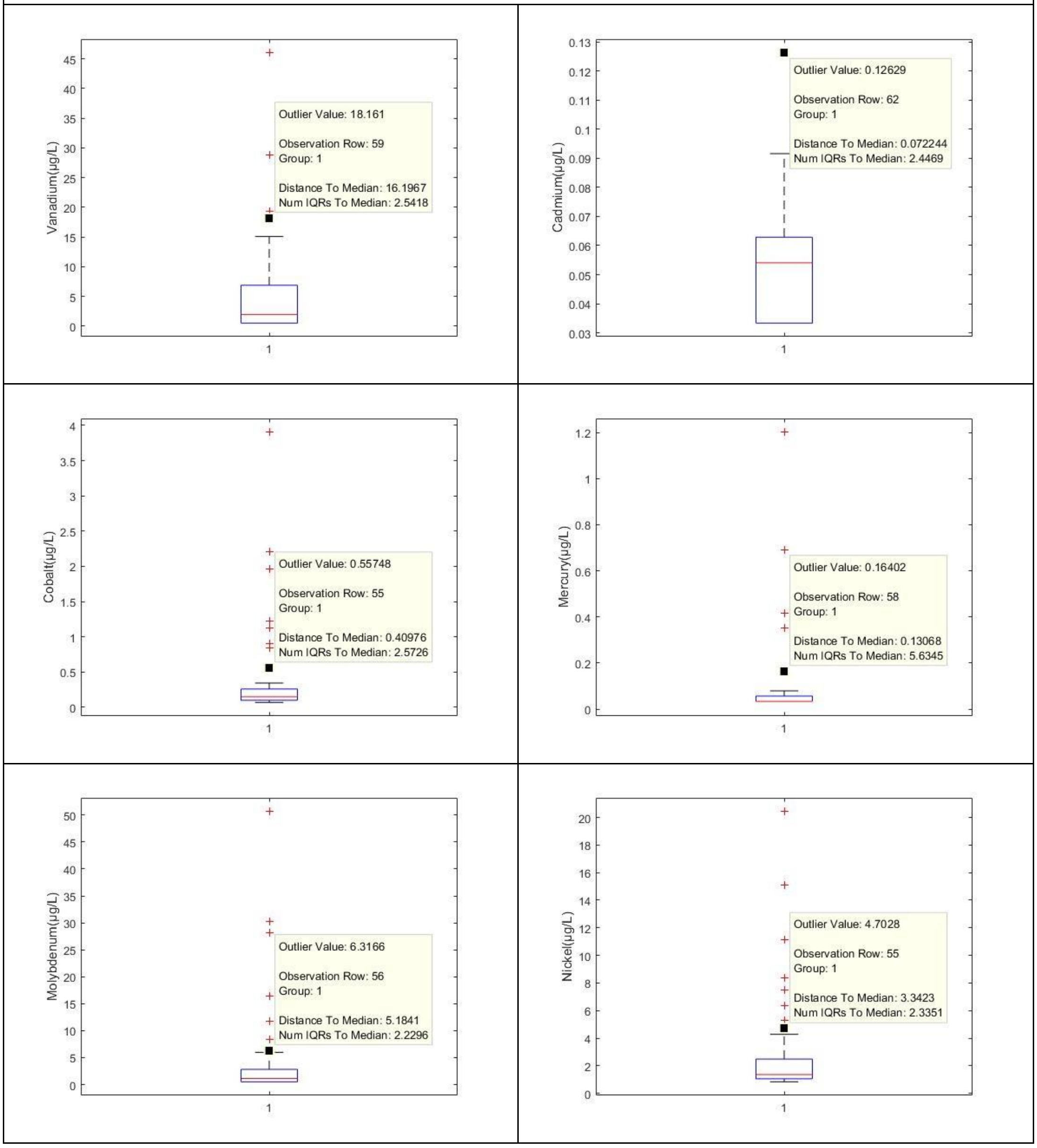

Figure 12. (Continued)

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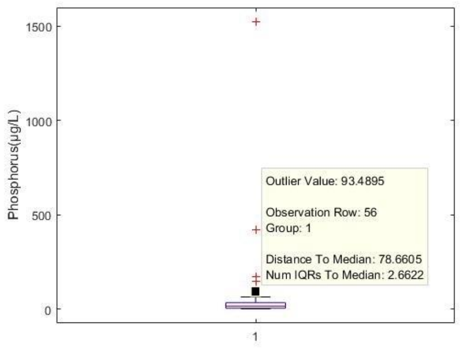
<tr><td>
</td><td>Sulfur, Boron and Selenium are not analysed due to the available number of sample points.</td></tr>
</table>

Figure 12. Box and whisker plots in for pre-selected datasets

5.2.3. Statistical Assessment of NBL Using Probability Plots

Once outliers from the pre-selected datasets were removed using the box and whisker plots, probability plots were constructed with the remaining data. The plots for each parameter at the basin scale are presented in Figure 13. A straight line in a probability plot indicates that the data fit the normal distribution and a deviation from this straight line could indicate an upper limit for the background population, hence a possible threshold between natural and influenced concentrations (Preziosi et al., 2014). The percentiles selected for the probability plot method are based on the values suggested the BRIDGE project (Hinsby et al., 2008), as 90th percentile if < 60 data points and 97.7th percentile if > 60 data points.

A review of the plots indicate that:

- A review of the probability plots indicated that most of the parameters follow near to normal distribution except Fe, Mn, V and Hg, which tend to exhibit relatively a poorer distribution. The probability plots for Al, As, Cr, Zn, Cd, Co, Mo and Ni show a bimodal distribution. Among those with a high frequency of results for LoQ concentrations are As, V, Cd and Mo. The dataset for these four parameters clearly includes a high number of results reported at LoQ/2 values. The inclusion of a high number of LoQ results is likely to skew the selection of the 90th and 97.7th percentiles away from actual NBLs when using these probability plots.

- The 97.7th percentile was used only for electrical conductivity because the distribution of data sets were around normal distribution and has higher than 60 sampling points.
- The data plots for sulphate and chloride show a similar pattern to each other, but it is not possible to link this to any specific geochemical process in the river basin without doing in depth studies that are outside of the scope of this work.
- Sulfur, boron and selenium parameters were not considered suitable for analysis due to the low number of data below LOQ (number of data below LOQ <12) (Idaho Department of Environmental Quality Water Quality Division, 2014, p. 10). NBLs are accepted as LOQ/2.

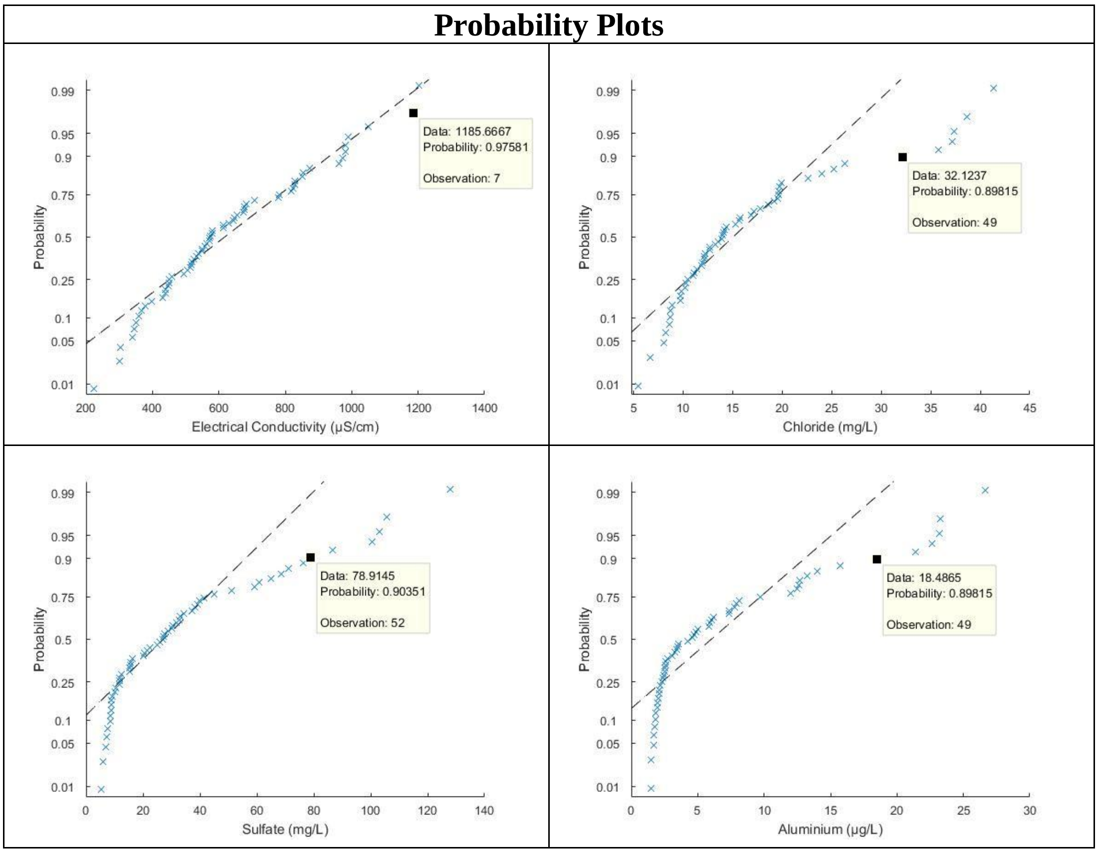


Figure 13. (Continued)

Probability Plots

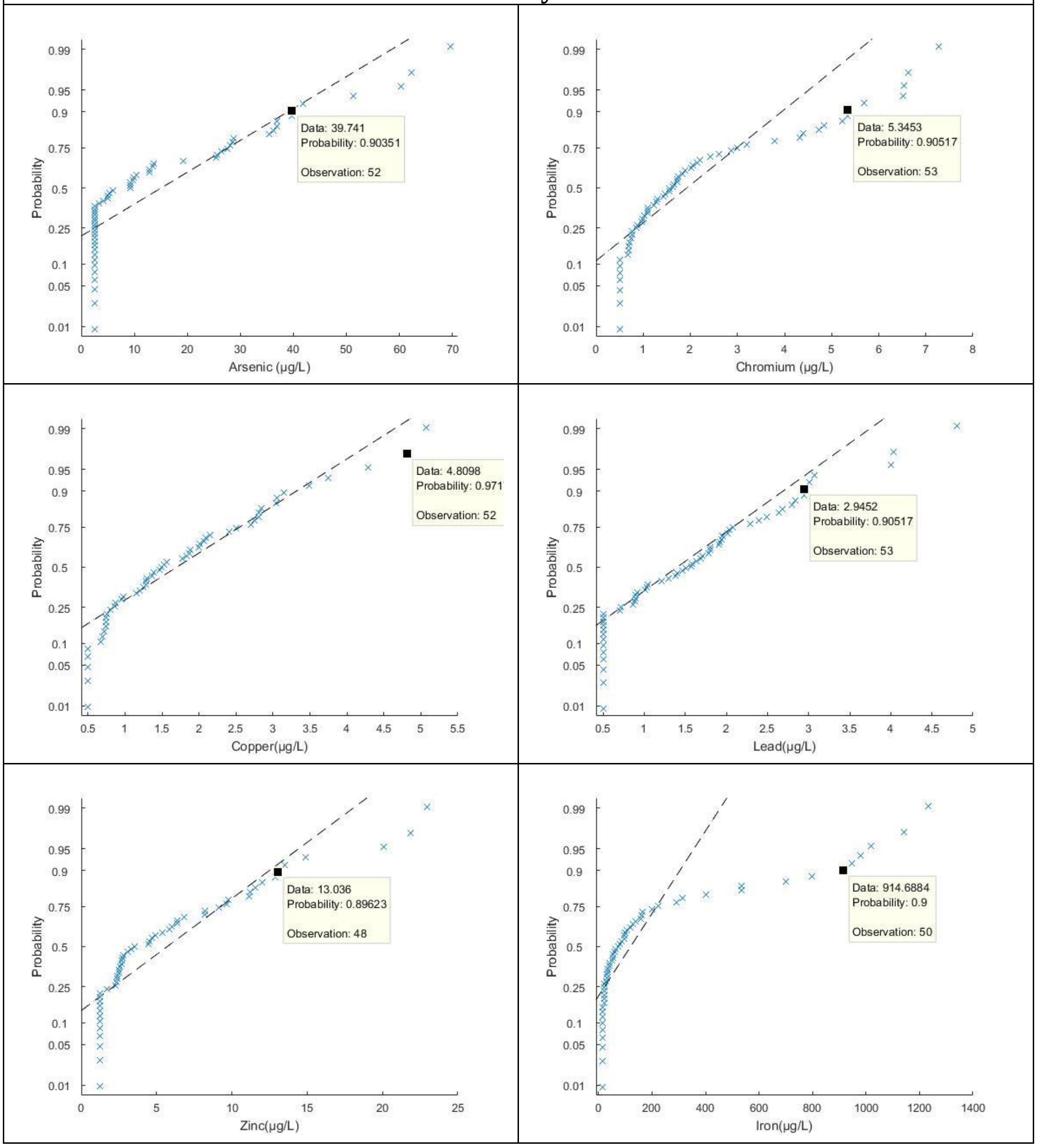


Figure 13. (Continued)

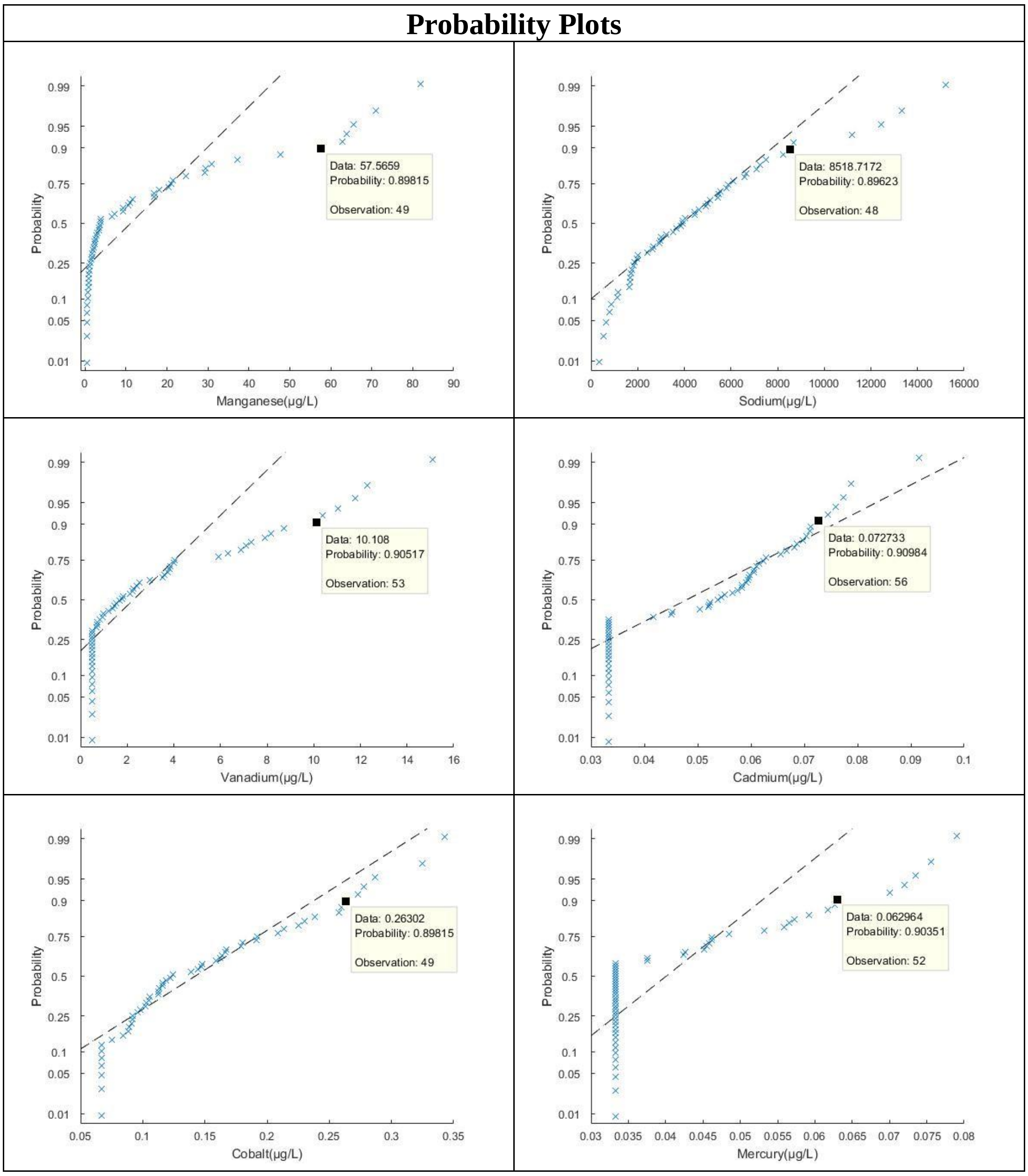


Figure 13. (Continued)

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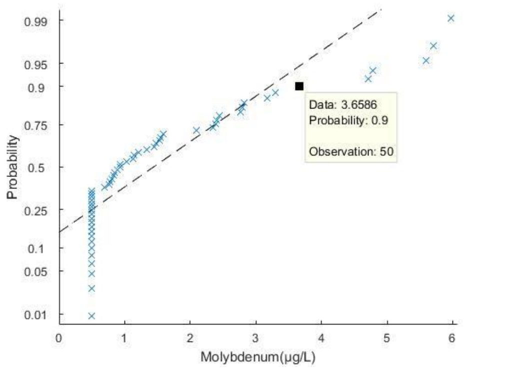
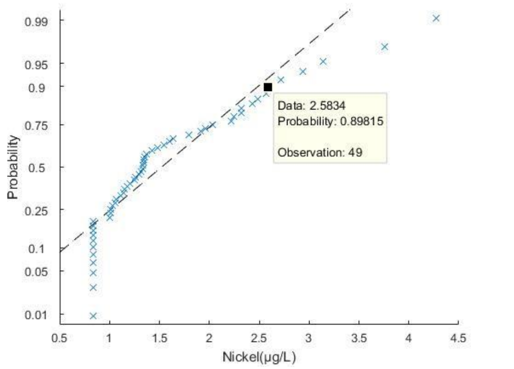
<tr><td>
</td><td>
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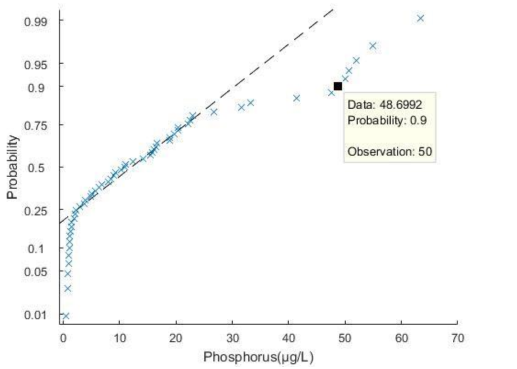
<tr><td>
</td><td>Sulfur, Boron and Selenium are not analysed due to the available number of sample points.</td></tr>
</table>

Figure 13. Probability Plot Results

5.2.4. Statistical Assessment of NBL Using 2-σ Iteration Method and Distribution Function Method

After the evaluation of NBLs by probability plots, 2-σ Iteration Method and Distribution Function Method were applied to obtain NBL values. Methods were applied as mentioned in Section 2.5. These two methods were found to be applicable for the parameters having sufficient data that fit into normal distribution. The results can be seen in Figure 14.

A review of the methods indicate that:

- Both methods cannot be applied for arsenic, cadmium and mercury. The 2-σ iteration method and the distribution function method are not implemented for arsenic because the calculated t-values are higher than the t-critical values. This is because arsenic data range is large (LOQ = 5 μg/L, max: 3252.5 μg/L), as well as many values in the arsenic data set are the same (LOQ/2). These are considered why normal distribution cannot be achieved. A similar situation has been pointed out in the work of Uresti-Estala et al. (2013), the suitability of these methods varies depending on the frequency and distribution of data. In cases where the values are very variable, these methods are not suitable because the median or mod of data is high and the number of eliminated data is high. It is estimated that this condition observed due to the property of the arsenic parameter because Uresti-Estala et al. stated that some parameters have important contact with evaporitic substrata that very different values can be measured in such cases, and these methods may not be suitable. In another study supporting this situation, it is emphasized that hydrochemistry of groundwater has a significant effect on arsenic mobilization (Mapoma et al., 2016). As arsenic situation, the 2-σ iteration method and the distribution function method were not implemented for cadmium and mercury because the calculated t-values are higher than the t-critical values. It is estimated that this could be caused by several values in the cadmium dataset being the same (LOQ/2).

- 2-σ Iteration Method cannot be applied for iron, vanadium and molybdenum. As arsenic situation, the 2-σ iteration method is not implemented for iron because the calculated t-values are higher than the t-critical values. This is due to the fact that many of the values in the dataset are the same (LOQ/2), as well as the wide range of iron data (min: LOQ = 30 μg/L, max: 7165.5 μg/L). The above assessment for arsenic is also valid for iron. However, unlike arsenic, although the 2-σ iteration method cannot be applied, the distribution function method can be applied. Urresti-Estala et al (2013) have also reported such a situation, in other words, the fact that one of these two methods is feasible but the other is not. On the other hand, 2-σ iteration method cannot be applied for vanadium and molybdenum too because many values in the data set are the same (LOQ/2).

- Sulfur, boron and selenium parameters were not considered suitable for analysis due to the low number of data below LOQ (number of data below LOQ <12) (Idaho Department of Environmental Quality Water Quality Division, 2014, p. 10). NBLs are accepted as LOQ/2.

<table>
<tr><th>2-σ Iteration Method</th><th>Distribution Function Method</th></tr>
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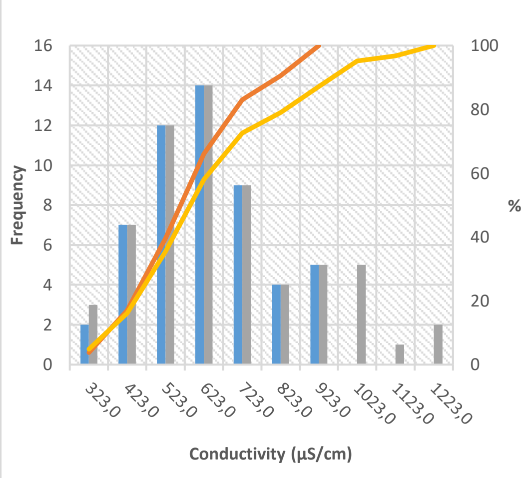
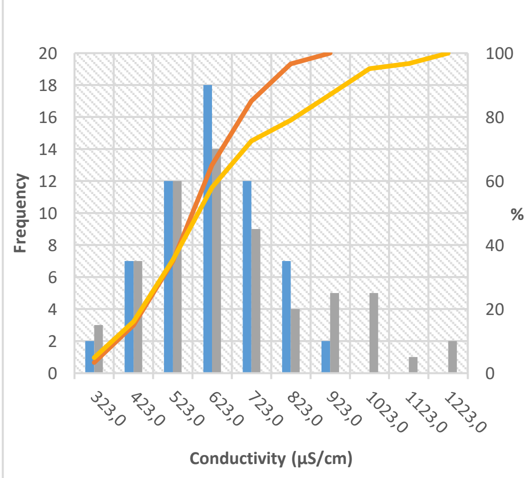
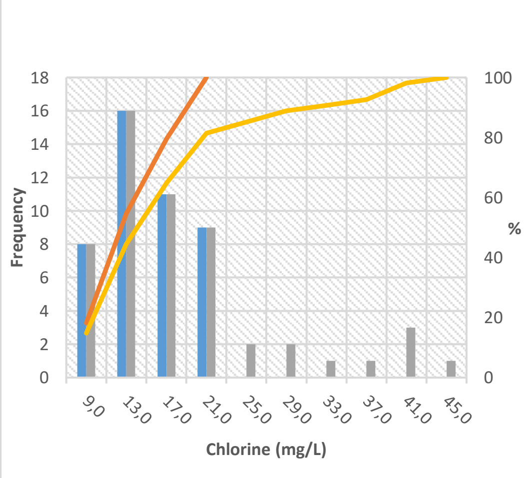
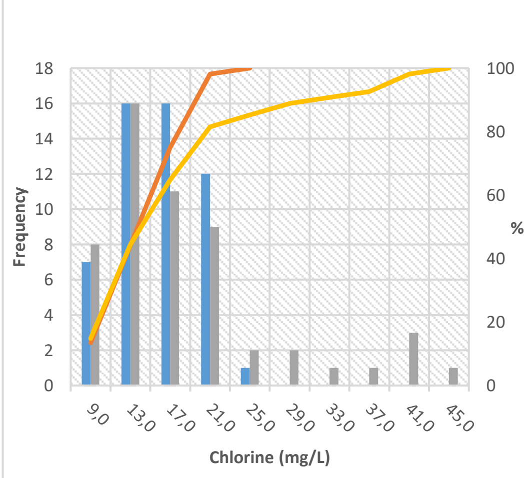
Values before the test
Values after the test – Cumulative (%)
Values before the test – Cumulative (%)</td></tr>
<tr><td>

(NBL rande:256.2-882.1; t-value:0.042; t-critical value:0.122)</td>
<td>

(NBL range:264.9-881.9; t-value:0.024; t-critical value:0.114)</td></tr>
<tr><td>

(NBL range:5.2-20.9; t-value:0.053; t-critical value:0.134)</td>
<td>

(NBL range:5.9-22; t-value:0.033; t-critical value:0.123)</td></tr>
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Figure 14. (Continued)

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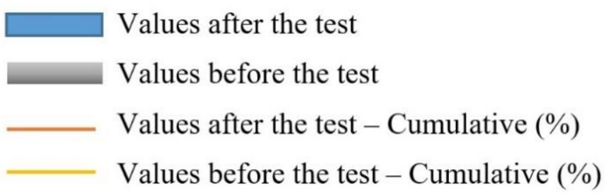
<tr><td colspan="2">
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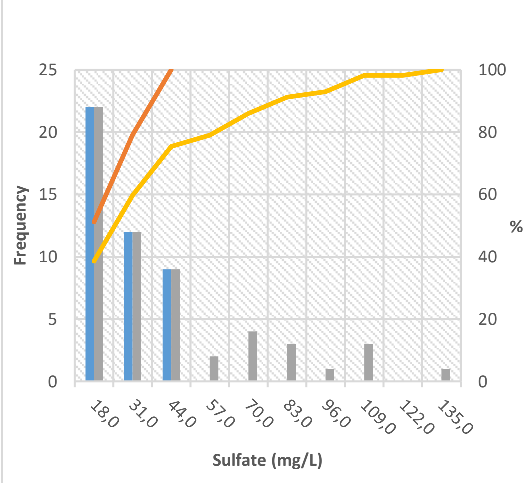
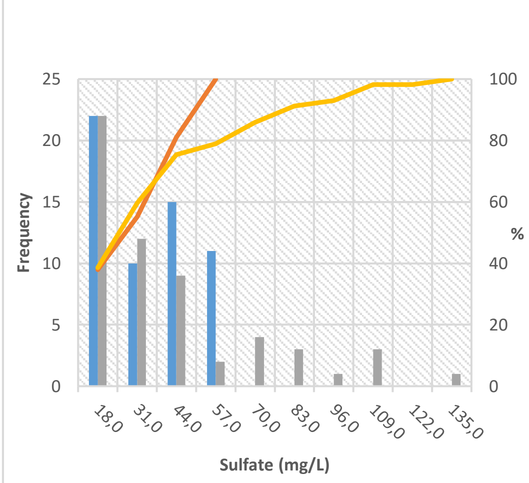
<tr><td>

(NBL range:0-42.5; t-value:0.089; t-critical value:0.135)</td>
<td>

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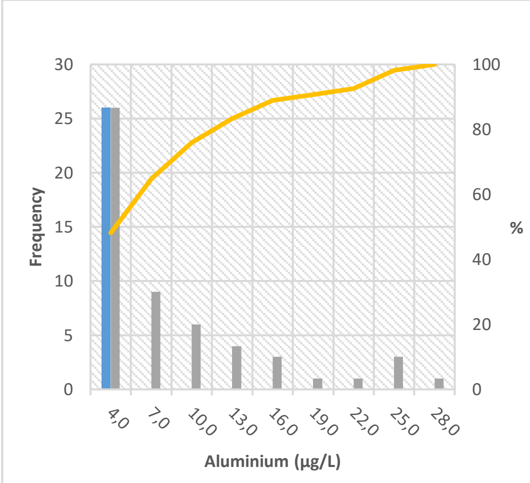
<tr><td>

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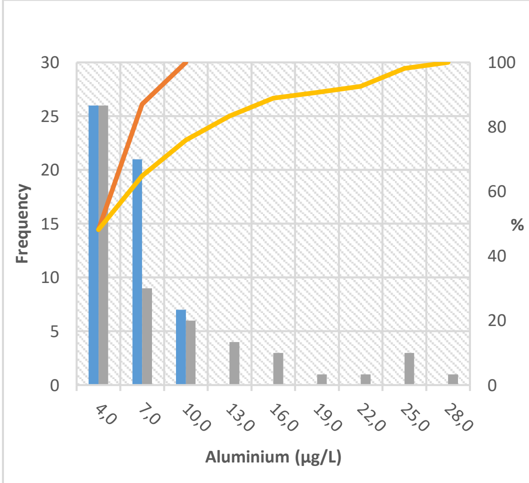
<td>

(NBL range:0.1-8.7; t-value:0.06; t-critical value:0.121)</td></tr>
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Figure 14. (Continued)

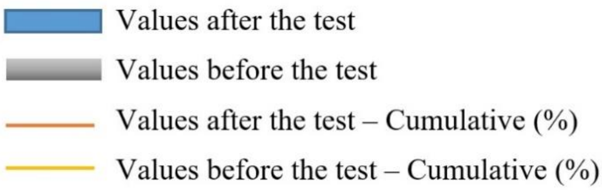
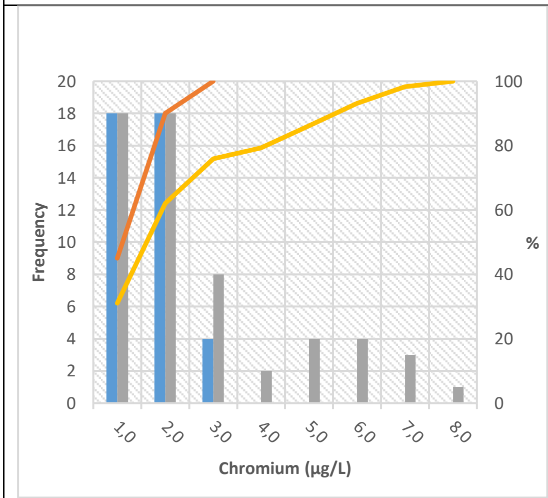
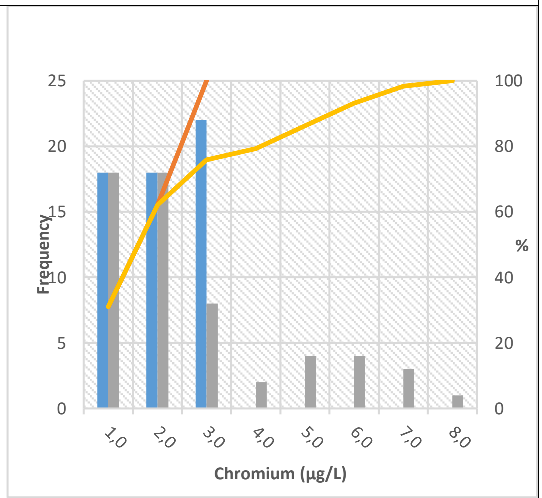
2-σ Iteration Method	Distribution Function Method
	
2-σ Iteration Method cannot be applied for Arsenic	Distribution Function Method cannot be applied for Arsenic
 (NBL range:0.1-2.2; t-value:0.078; t-critical value:0.14)	 (NBL range:0-3,2; t-value:0,09; t-critical value:0,116)

Figure 14. (Continued)

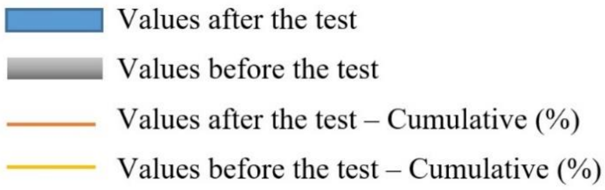
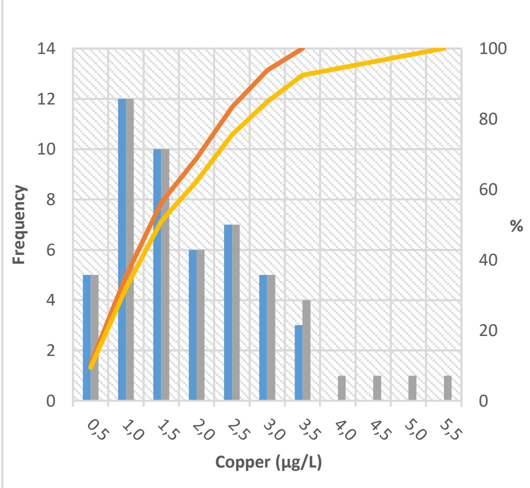
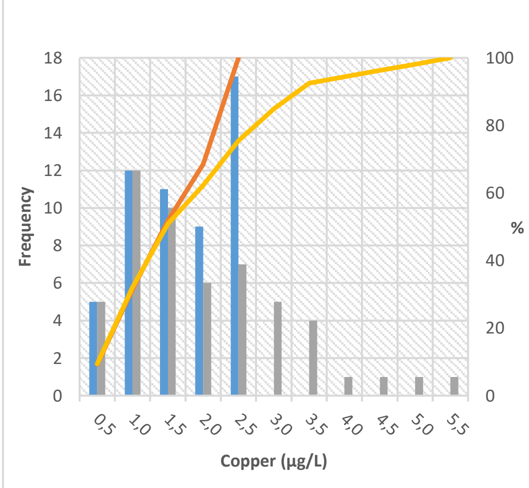
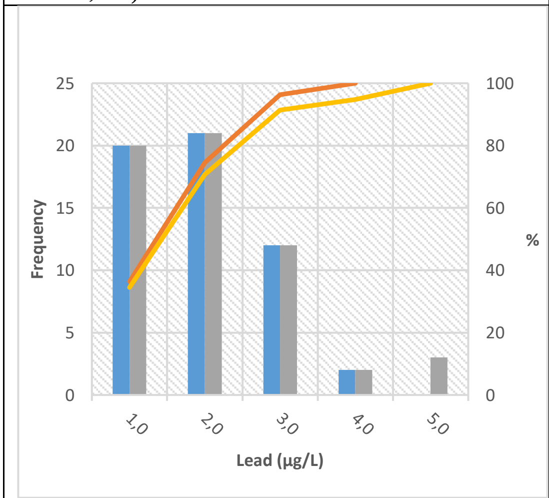
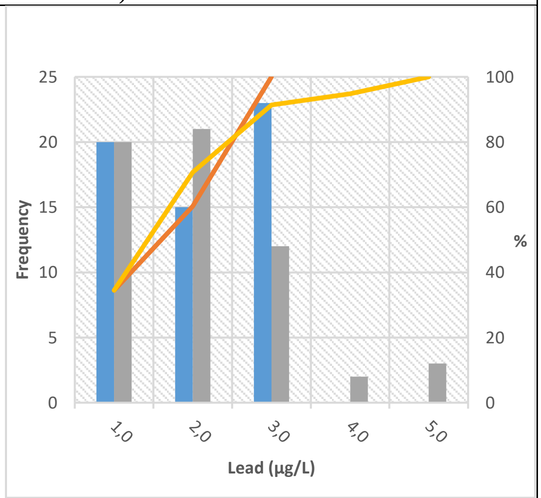
2-σ Iteration Method	Distribution Function Method
	
 (NBL range:0-3,2; t-value:0,102; t-critical value:0,128)	 (NBL range:0.2-2.8; t-value:0.094; t-critical value:0.121)
 (NBL range:0-3.1; t-value:0.083; t-critical value:0.119)	 (NBL range:0-3.2; t-value:0.113; t-critical value:0.116)

Figure 14. (Continued)

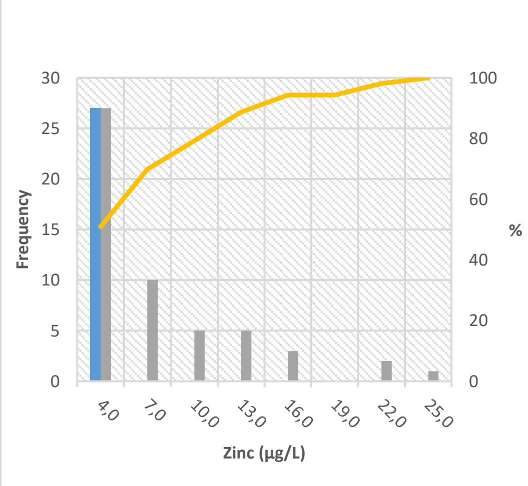
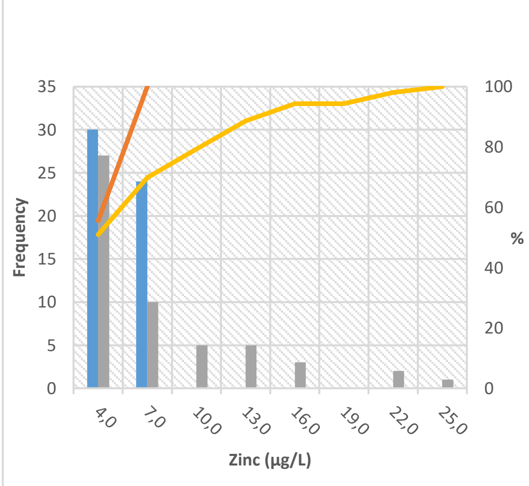
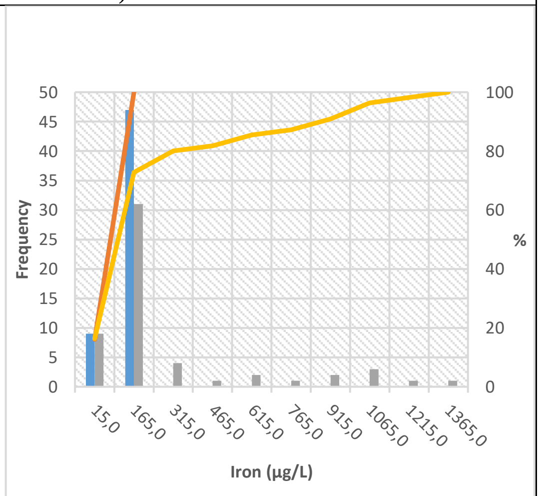
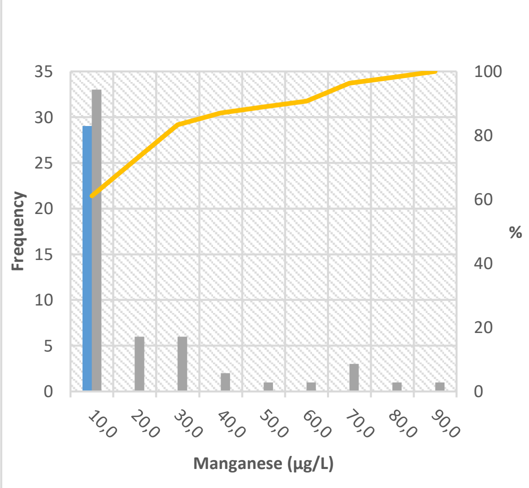
2-σ Iteration Method	Distribution Function Method
Values after the test Values before the test Values after the test – Cumulative (%) Values before the test – Cumulative (%)	
 (NBL range:0.5-3.6; t-value:0.005; t-critical value:0.173)	 (NBL range:0.1-7; t-value:0.047; t-critical value:0.121)
2-σ Iteration Method cannot be applied for Iron	 (NBL range:0-170.1; t-value:0.055; t-critical value:0.118)

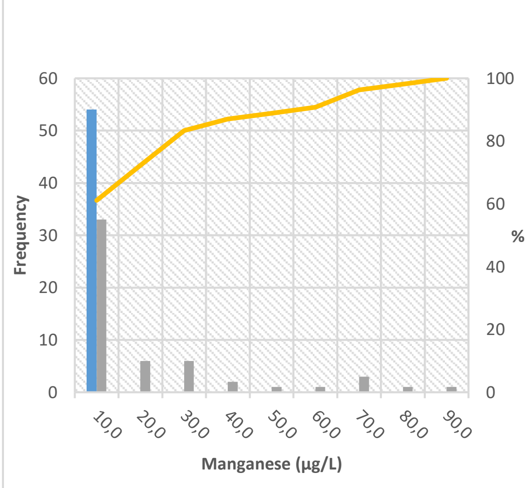
Figure 14. (Continued)

2-σ Iteration Method	Distribution Function Method

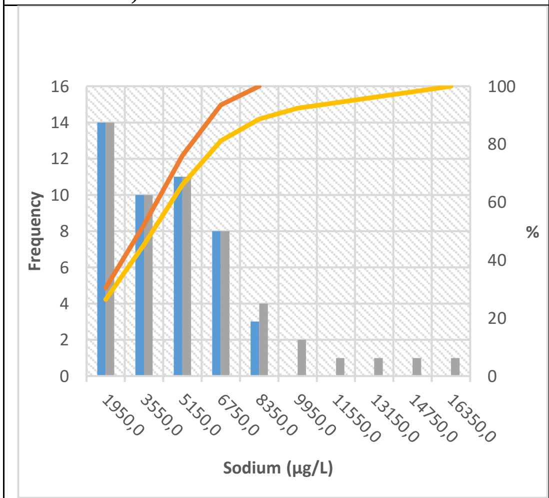
Values after the test
Values before the test
Values after the test – Cumulative (%)
Values before the test – Cumulative (%)



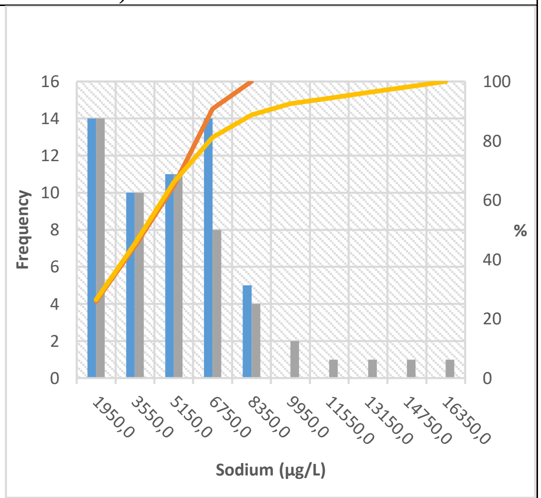
(NBL range:0-8.4; t-value:0.004; t-critical value:0.121)



(NBL range:0-8.4; t-value:0.004; t-critical value:0.121)

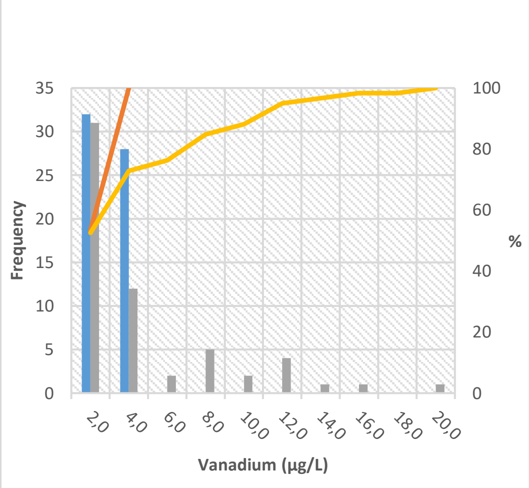


(NBL range: 0-7581.4; t-value:0.086; t-critical value:0.131)



(NBL range:0-8192.9; t-value:0.083; t-critical value:0.121)

Figure 14. (Continued)

<table>
<tr><th>2-σ Iteration Method</th><th>Distribution Function Method</th></tr>
<tr><td colspan="2">Values after the test
Values before the test
Values after the test – Cumulative (%)
Values before the test – Cumulative (%)</td></tr>
<tr><td>2-σ Iteration Method cannot be applied for Vanadium</td><td>

(NBL range:0-4.1; t-value:0.036; t-critical value:0.114)</td></tr>
<tr><td>2-σ Iteration Method cannot be applied for Cadmium</td><td>Distribution Function Method cannot be applied for Cadmium</td></tr>
</table>

Figure 14. (Continued)

<table>
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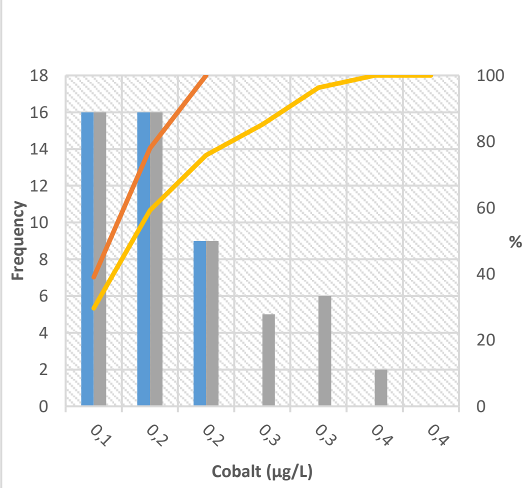
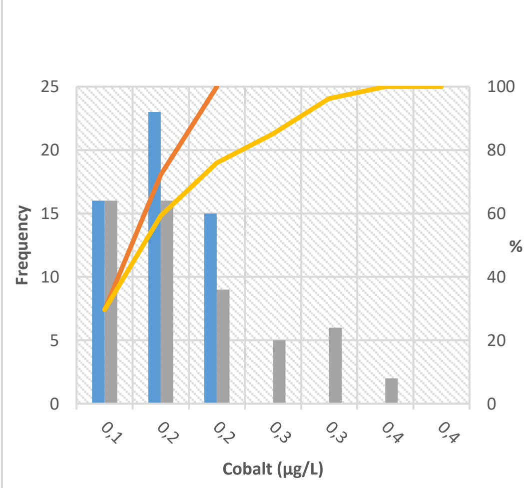
Values before the test
Values after the test – Cumulative (%)
Values before the test – Cumulative (%)</td></tr>
<tr><td>

(NBL range:0-0.2; t-value:0.054; t-critical value:0.138)</td><td>

(NBL range:0.1-0.2; t-range:0.043; t-critical range:0.121)</td></tr>
<tr><td>2-σ Iteration Method cannot be applied for Mercury</td><td>Distribution Function Method cannot be applied for Mercury</td></tr>
</table>

Figure 14. (Continued)

<table>
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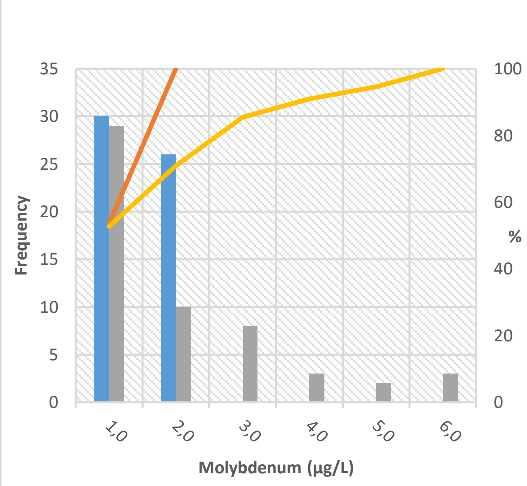
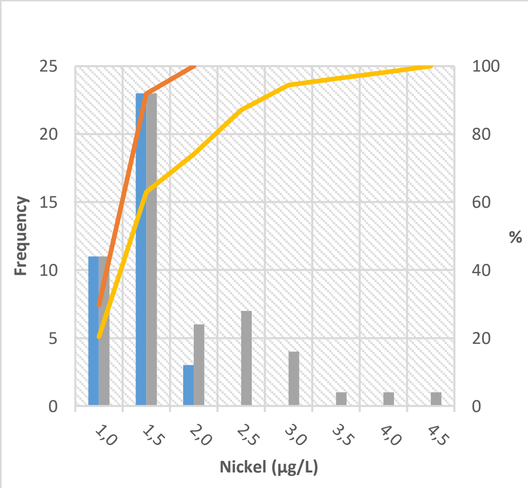
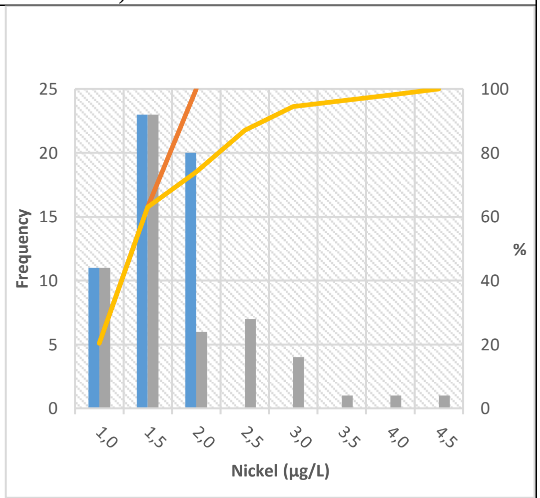
Values before the test
Values after the test – Cumulative (%)
Values before the test – Cumulative (%)</td></tr>
<tr><td>2-σ Iteration Method cannot be applied for Molybdenum</td><td>

(NBL range:0.2-1.7; t-value:0.039; t-critical value:0.118)</td></tr>
<tr><td>

(NBL range:0.6-1.6; t-value:0.007; t-critical value:0.146)</td><td>

(NBL range:0,6-2,1; t-value:0,046; t-critical value:0,121)</td></tr>
</table>

Figure 14. (Continued)

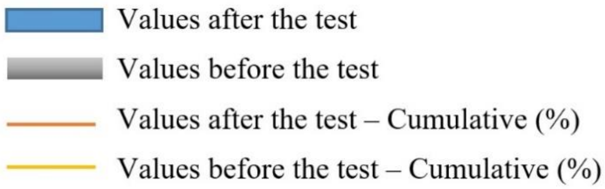
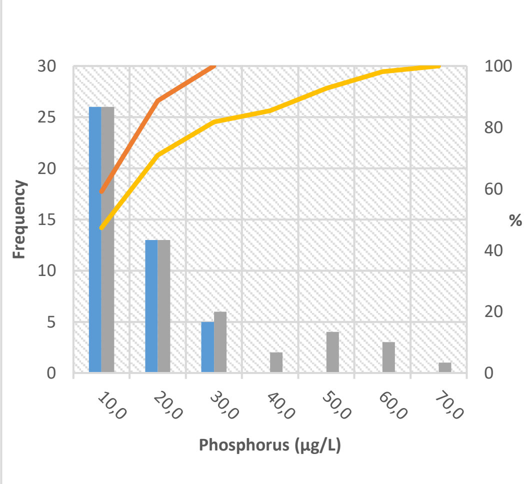
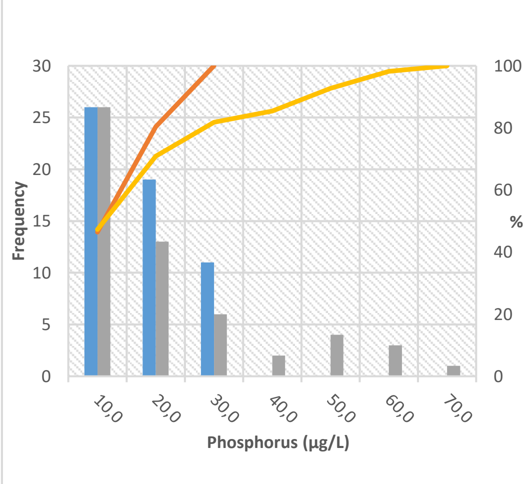
2-σ Iteration Method	Distribution Function Method
	
	
(NBL range:0-24; t-value:0.043; t-critical value:0.134)	(NBL range:0-26.2; t-value:0.08; t-critical value:0.118)
Sulfur, Boron and Selenium are not analysed due to the available number of sample points.	

Figure 14. 2-σ Iteration Method and Distribution Function Method Plots

5.2.5. Selection of NBL

Table 7 presents NBLs that were evaluated for the parameters considered. As it can be seen, in most cases, different methods yielded different NBLs. The differences between the estimated NBLs are not mostly negligible. The variation was one order of magnitude for Al, Mn, Zn, and V, which are with skewed distributions. As can be depicted from Table 7, this difference was also more pronounced for the parameter of Fe, possibly due to a poorer fit of data into normal distribution. What is also seen from Table 7 is that the methods of the 2-σ iteration and distribution function are in better agreement (except for Na), whereas the probability plot method provided quite distinctly higher NBLs for almost all the parameters. Then, it could be stated that from the point of view of TV setting, the probability plot method was the least conservative one and the 2-σ iteration and distribution function methods were more conservative. Indeed, this could be due to the fact that, in case of the probability plot method, data is not processed until normal distribution is obtained, and therefore it is not satisfactory in assessing NBL for datasets which are skewed and/or away from perfect normal distribution. The other two methods, however, process data until normal distribution is obtained. Therefore, it seems that they yielded more reliable NBLs, in general. These observations were in accordance with Uresti-Estala et al (2013) who stated that the NBLs obtained for the carbonate aquifers with the 2-σ iteration and distribution function methods produce very comparable results, owing to the fact that the dominant geology of the Gediz Basin is carbonate (Section 3).

On the other side, the applicability of the 2-σ iteration and distribution function methods was limited by the skewness of data and by the dispersion of data over a wide range of concentration values. For example; for As, which is a significant problem in the Gediz Basin due to its natural presence at high levels in the groundwater. NBL for As could not be determined with these two methods. This finding is not in agreement with Urresti-Estala et al. (2013) who indicated that the 2-σ iteration method is more suitable when the nature of the aquifer is responsible for high concentrations of parameters. The reason for this contradiction was thought to originate from the skewed distribution of As data due to the occurrence of high number of results below LoQ, as well as due to very wide range of As data (<LoQ of 5 μg/L - 3252.5 μg/L), which resulted in the calculated t-value being higher than t-critical value. Urresti-Estala et al. (2013) also stated that the 2-σ iteration method is not appropriate when the data set is dispersed and there are a large number of smaller values in the data set, confirming

the above-mentioned attribution. As also stated by them, the suitability of these methods varies depending on the frequency and distribution of data. In cases where the values are very variable, these methods are not suitable because the median or mod of data is high and the number of data eliminated is high. In another study, supportingly, Mapoma et al. (2016) could not implement these two methods for the parameter of As, claiming that hydrochemistry of groundwater has a significant effect on As mobilization and there are high numbers of As concentrations below LoQ in the As data set. Similarly, the 2-σ iteration method and the distribution function method could not be implemented for Cd and Hg because the calculated t-values were higher than the t-critical values.

On the other hand, for some parameters (Fe, V and Mo), the 2-σ iteration method was not found suitable as the Lilliefors test could not be passed while the distribution function method was implemented successfully. For these parameters, many of the values in the dataset were the same (i.e. LoQ/2) and the range of data was very wide (e.g. for Fe; min: <LoQ of 30 μg/L, max: 7165.5 μg/L). Therefore, the above assessment for As is also valid for Fe. However, unlike for As, although the 2-σ iteration method cannot be applied, the distribution function method passed the Lilliefors test. This could be due to the large numbers of smaller values in the dataset of Fe, V and Mo as compared to As.

Table 7. Final NBL Values

Parameters	Unit	NBL			
		Probability plot	2-σ İteration	Distribution function	NBL Final
Ions					
Cl^{-1}	mg/L	32.1	**20.9**[1]	22	20.9
	mEq/L	0.91	**0.59**	0.62	0.59
SO_4^{-2}	mg/L	78.9	**42.5**	56.4	42.5
S^{-2}	mg/L	NA	NA	NA	0.005[2]
PO_4^{-3}-P	µg/L	48.7	**24.0**	26.2	24.0
Metals					
Cd	µg/L	0.07	-	-	0.07
Hg	µg/L	0.06	-	-	0.06
Cu	µg/L	4.8	3.2	**2.8**	2.8
Zn	µg/L	13.0	**3.6**	7.0	3.6
Fe	µg/L	914.7	-	170.1	170.1
Co	µg/L	0.26	**0.2**	0.2	0.2
Mn	µg/L	57.6	**4.0**	8.4	4.0
Mo	µg/L	3.7	-	**1.7**	1.7
Ni	µg/L	2.6	**1.6**	2.1	1.6
V	µg/L	10.4	-	4.1	4.1
Cr	µg/L	5.3	**2.2**	3.2	2.2
Pb	µg/L	**3.0**	3.1	3.2	3.0
Metalloids					
Na	µg/L	8518.7	**7581.4**	8192.9	7581.4
As	µg/L	39.7	-	-	39.7
Al	µg/L	18.5	**3.6**	8.7	3.6
B	µg/L	NA	NA	NA	250[2]
Se	µg/L	NA	NA	NA	2.5[2]
Other					
Conductivity	µS/cm	1186	882.1	**881.9**	881.9

[1] NBL values considered as final NBL are in bold; [2] NBL values were chosen as LOQ/2 due to lack of data, NA: not applicable due to lack of data.

5.3. Reference Values

Regulation on Water for Human Consumption (Official Gazette 25730, 17.02.2005) and Regulation on Surface Water Quality (Official Gazette 28483, 30.11.2012) were evaluated to select REF values for the parameters of concern. REF values are provided in Table 8. As mentioned in Section 4.2.2, irrigation water standards and drinking water standards were compared and lower value chosen because groundwater is used for drinking or irrigation purposes in Gediz Basin. The comparison is used because the usage purpose of groundwater bodies can change (drinking to irrigation or vice versa). If there are no available standard, EQS values are used. As presented in this table, REF values considered in deriving TVs are mostly drinking water standards as the relevant authority aims to protect groundwater in the basin at this level. For two of the parameters (S^{-2} and PO_4^{-3}-P) EQS were considered, as there are no drinking water standards or irrigation water standards for these ions.

Table 8. Reference Values

Parameters	Unit	REF			
		EQS	Irrigation Water Standard	Drinking Water Standard	REF Final
Ions					
Cl^{-1}	mg/L	-	**106,5**[1]	250	106,5
	mEq/L	-	**3**	-	3
SO_4^{-2}	mg/L	-	**-**	**250**	250
S^{-2}	mg/L	**0.005**	-	-	0.005
PO_4^{-3}-P	µg/L	**200**	**-**	-	200
Metals					
Cd	µg/L	0.08	10	**5**	5
Hg	µg/L	0.07	-	**1**	1
Cu	µg/L	1.6	**200**	2000	200
Zn	µg/L	5.9	**2000**	-	2000
Fe	µg/L	36	5000	**200**	200
Co	µg/L	0.3	**50**	-	50
Mn	µg/L	500	200	**50**	50
Mo	µg/L	-	**10**	**-**	10
Ni	µg/L	4	200	**20**	20
V	µg/L	1.6	**100**	-	100
Cr	µg/L	1.6	100	**50**	50
Pb	µg/L	1.2	3000	**10**	10
Metaloids					
Na	µg/L	-	**69000**	200000	69000
As	µg/L	53	100	**10**	10
Al	µg/L	2.2	5000	**200**	200
B	µg/L	707	700	**1000**[2]	1000
Se	µg/L	15	20	**10**	10
Other					
Conductivity	µS/cm	1000	**700**	2500	700

[1] REF values considered as final NBL are in bold [2] With the decision of the administration, the criterion value of 1000 µg/L, which is the drinking water criterion for boron, was accepted.

5.4. Determination of Threshold Values

TVs determined for the parameters considered are presented in Table 9. According to methodology applied for calculating final TVs, specified in last column of this table; TVs obtained using NBL that the only example is electrical conductivity are mathematically rounded to closer integer.

Table 9. NBL, REF and TV of the parameters

Parameters	Unit	TV			
		NBL	REF	TV	Final TV
Ions					
Cl^{-1}	mg/L	20.9	106.5	106.5	106.5
	mEq/L	0.59	3	3	3
SO_4^{-2}	mg/L	42.5	250	250	250
S^{-2}	mg/L	0.005	0.005	0.005	0.005
PO_4^{-3}-P	µg/L	24	200	200	200
Metals					
Cd	µg/L	0.07	5	5	5
Hg	µg/L	0.06	1	1	1
Cu	µg/L	2.6	200	200	200
Zn	µg/L	3.6	2000	2000	2000
Fe	µg/L	170.1	200	200	200
Co	µg/L	0.2	50	50	50
Mn	µg/L	4	50	50	50
Mo	µg/L	1.7	10	10	10
Ni	µg/L	1.6	20	20	20
V	µg/L	4.1	100	100	100
Cr	µg/L	2.2	50	50	50
Pb	µg/L	3	10	10	10
Metaloids					
Na	µg/L	7581.4	69000	69000	69000
As	µg/L	39.7	10	47.6	53[1]

Table 9. (Continued)

Parameters	Unit	TV			
		NBL	**REF**	**TV**	**Final TV**
Al	µg/L	3.6	200	200	200
B	µg/L	250	1000	1000	1000
Se	µg/L	2.5	10	10	10
Other					
Conductivity	µS/cm	881.9	700	881.9	882

*[1] The Arsenic threshold value with administrative decision was calculated as NBL*1.2 and finally it was accepted as equivalent to EQS value.*

As seen from Table 9, two parameters namely arsenic and conductivity exhibited TV greater than REF values. This could be due to hydrogeological formation and/or anthropogenic activities. Figure 15 shows groundwater bodies with high arsenic concentrations in red colors. Figure 16 shows the geothermal sources in the basin. When these two figures are compared, it is seen that high arsenic regions coincide with the geothermal sources, indicating the major source of arsenic is natural. This is in agreement with the evaluation presented in Section 5.2.5. Similarly, the same situation is valid for the parameter of conductivity (Figure 17). High conductivity groundwaters exist at the locations where there are geothermal sources.

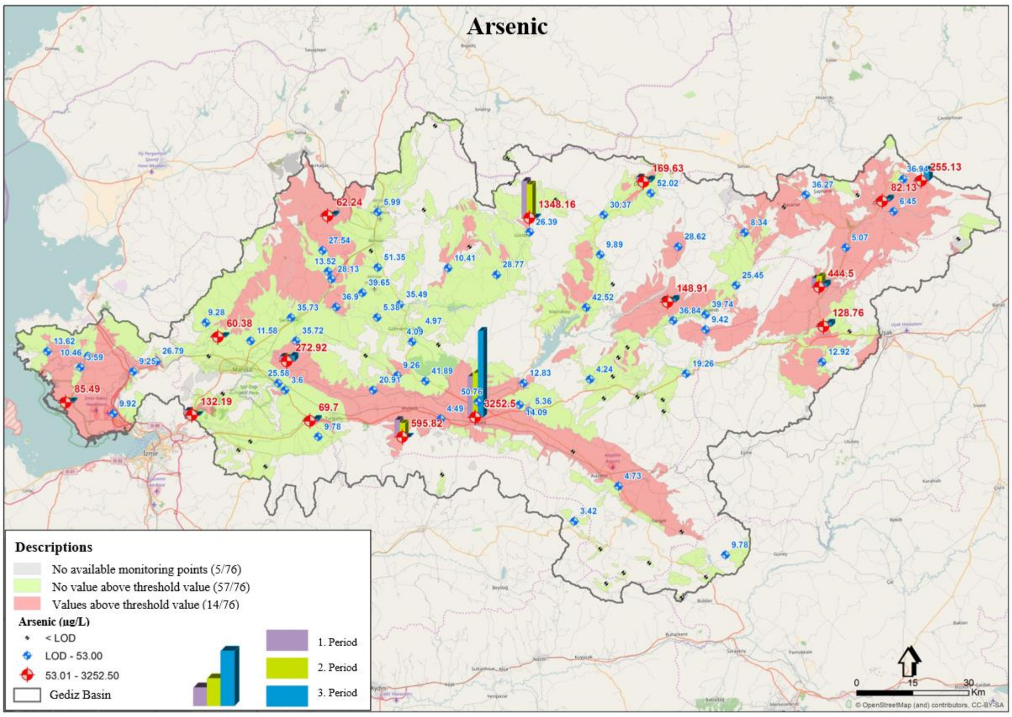


Figure 15. Distribution of Arsenic Concentration in the Basin (Fugro Sial Geosciences Consulting and Engineering Ltd. Co., 2017)

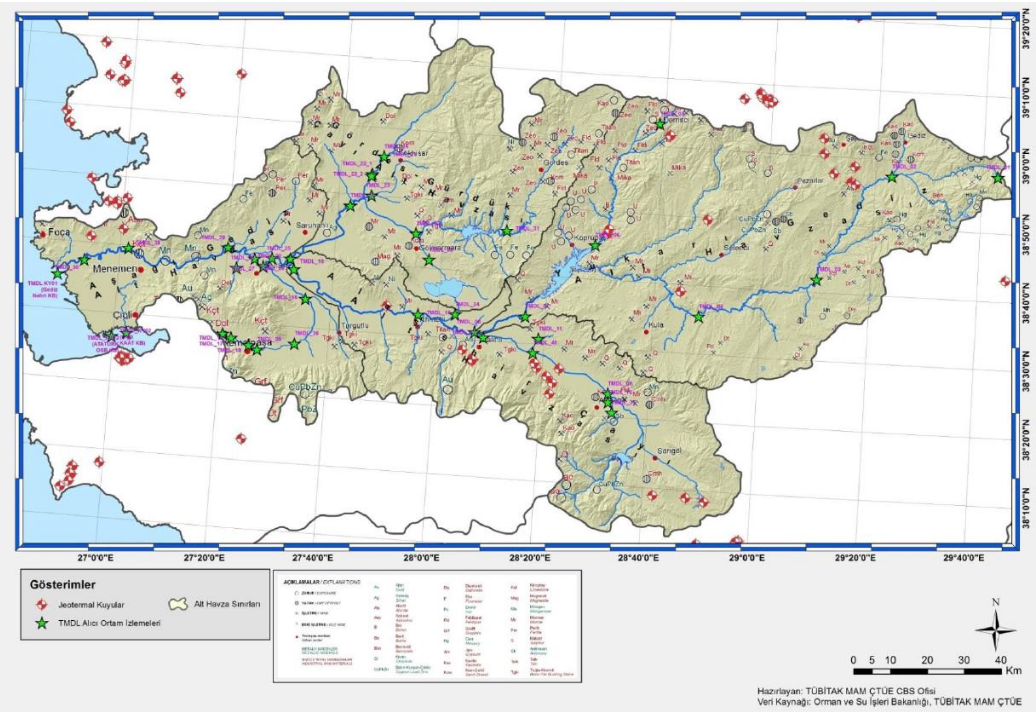


Figure 16. Map of Geothermal Sources in the Basin (Red points represent geothermal sources) (TUBITAK Marmara Research Center, 2017)

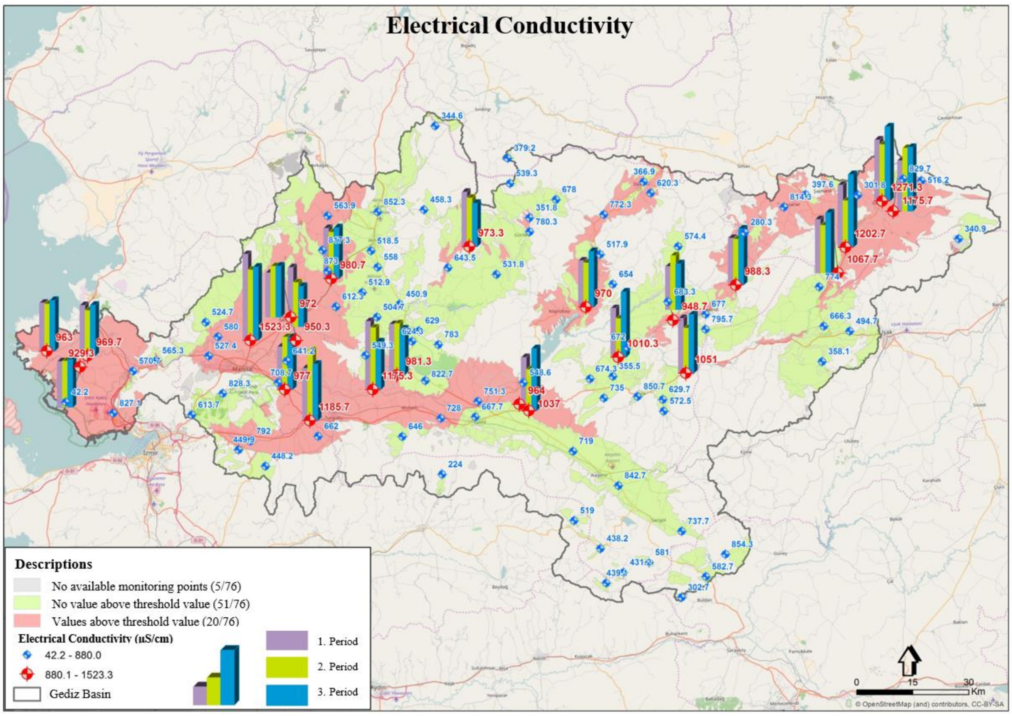


Figure 17. Distribution of Conductivity in the Basin (Fugro Sial Geosciences Consulting and Engineering Ltd. Co., 2017)

CHAPTER 6

CONCLUSIONS & RECOMMENDATIONS

6.1. Conclusions

In conclusion, this study presented a methodology to enhance the previously proposed threshold value setting approach to deal with the data scarcity issues prevalent in developing countries. When the methodology was implemented for the Gediz River Basin, it was seen that the implementation of the three-step method developed that included “pre-selection”, “selection” and “natural background level setting using probability plot, 2-σ iteration and distribution function methods” provided more accurate natural background level estimates.

The preselection method proposed by prior studies was not applicable, as it left no data to process in the absence of relevant and accurate long-term spatial data. Applying the preselection with a restricted set of criteria followed by data selection to eliminate outliers statistically was satisfactory. It was seen that data selection by this approach before natural background level assessment strengthened the process.

It was also concluded that the choice of statistical method to use in natural background level assessment is a critical issue, as the results from different statistical methods may be very different. Geological nature of aquifer, nature of pollutant, and the interaction between them influence the suitability of the statistical method to use. Therefore, when there is limited data, the integration of alternative statistical methods allowing the selection of more confident lowest natural background level appears as a more robust and confident approach.

6.2. Recommendations

- The study evaluated the data obtained from 110 monitoring points for the Gediz Basin. Larger data set would result in assessment that is more reliable.
- In EU countries, TVs are determined in country, basin or GWB scale. This study performed TV determination at the basin scale due to the limited number of monitoring points. With the rise of monitoring points, GWB scale should be evaluated.
- There were 76 GWBs in the Gediz Basin. However, samples were belonging to 71 of them. For more comprehensive and reliable results, all GWBs should be monitored.
- Data evaluated were belonging to three different periods. By increasing the number of periods, time oriented evaluation could be possible. Moreover, trend analysis for parameters could be helpful.
- In addition to the basin scale approach, grouping the GWBs according to their geological structures could be considered, which was not possible in this study due to scarcity of sampling stations.

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APPENDICES

A. DATA

Table 10. Explanations

Numbers in red:	Data eliminated after preselection
Numbers in blue:	Data eliminated after selection
ND:	No data

Table 11. Data of Conductivity and Chloride (Risk Posing Parameters)

	Conductivity (µS/cm)				Chloride (mg/L) (LOQ= 0.2 mg/L)			
Stations	**1th period**	**2nd period**	**3rd period**	**Average**	**1th period**	**2nd period**	**3rd period**	**Average**
1	412.00	473.00	811.00	565.33	24.87	19.24	37.13	27.08
2	484.00	692.00	685.00	620.33	54.71	67.82	49.27	57.27
3	480.00	561.00	671.00	570.67	45.06	55.98	67.27	56.10
4	954.00	930.00	1005.00	963.00	89.70	102.74	10.73	67.72
5	1002.00	900.00	1007.00	969.67	1.17	1.10	87.98	30.08
6	914.00	921.00	953.00	929.33	74.12	101.62	95.90	90.55
7	5.17	43.90	77.40	42.16	26.02	32.71	24.91	27.88
8	16.25	49.40	33.80	33.15	24.29	16.20	11.98	17.49
9	498.00	518.00	558.00	524.67	20.43	30.08	28.53	26.35
10	584.00	514.00	642.00	580.00	5.75	8.08	16.70	10.18
11	743.00	698.00	935.00	792.00	70.29	84.69	90.66	81.88
12	313.70	288.10	748.00	449.93	44.39	29.65	33.20	35.75
13	425.60	493.90	425.00	448.17	5.07	5.23	15.62	8.64
14	687.00	542.00	757.00	662.00	55.86	38.66	51.66	48.73
15	1040.00	1394.00	1123.00	1185.67	45.03	54.26	52.14	50.48
16	851.00	1043.00	1037.00	977.00	33.75	36.00	46.75	38.83
17	649.00	752.00	725.00	708.67	5.73	6.50	20.81	11.01
18	403.70	1039.00	481.00	641.23	7.24	8.16	20.39	11.93
19	1174.00	876.00	801.00	950.33	48.93	36.38	40.84	42.05

Table 11. (Continued)

	Conductivity (µS/cm)				Chloride (mg/L) (LOQ= 0.2 mg/L)			
Stations	**1th period**	**2nd period**	**3rd period**	**Average**	**1th period**	**2nd period**	**3rd period**	**Average**
20	348.00	652.00	555.60	518.53	148.20	104.97	26.16	93.11
21	307.40	401.30	325.00	344.57	3.30	7.32	15.58	8.73
22	445.50	368.50	561.00	458.33	4.42	10.36	16.57	10.45
23	761.00	876.00	920.00	852.33	38.82	24.11	52.95	38.63
24	553.00	490.80	648.00	563.93	8.15	13.17	20.61	13.97
25	791.00	720.00	941.00	817.33	16.32	19.98	75.66	37.32
26	878.00	705.00	1036.00	873.00	56.96	58.58	76.26	63.93
27	1003.00	924.00	1015.00	980.67	68.63	48.29	82.53	66.48
28	604.00	877.00	676.00	719.00	10.07	11.88	19.61	13.85
29	619.00	854.00	740.00	737.67	14.66	21.95	25.63	20.74
30	887.00	951.00	725.00	854.33	12.09	19.60	28.09	19.92
31	542.00	625.00	581.00	582.67	7.77	14.06	18.13	13.32
32	281.00	157.10	470.00	302.70	3.84	9.70	15.74	9.76
33	821.00	1012.00	695.00	842.67	14.52	21.34	20.69	18.85
34	1060.00	819.00	1232.00	1037.00	119.13	130.80	32.04	93.99
35	592.00	780.00	631.00	667.67	3.06	4.87	31.48	13.14
36	781.70	990.00	709.70	827.13	14.15	13.08	22.93	16.72
37	531.00	444.30	607.00	527.43	9.98	21.40	22.74	18.04
38	786.00	924.00	775.00	828.33	10.16	19.31	29.34	19.60
39	623.00	670.00	548.00	613.67	25.81	23.85	18.24	22.64
40	1711.00	1402.00	1457.00	1523.33	86.37	183.98	31.41	100.59
41	884.00	1013.00	1019.00	972.00	50.03	140.45	65.11	85.20
42	526.00	541.00	581.00	549.33	6.37	18.69	17.49	14.18
43	630.00	518.00	689.00	612.33	12.65	21.10	22.07	18.61
44	476.70	521.00	541.00	512.90	8.96	18.07	19.83	15.62
45	436.60	480.10	436.00	450.90	4.40	9.90	14.90	9.73
46	407.00	605.00	502.00	504.67	7.46	11.86	23.67	14.33
47	542.00	728.00	617.00	629.00	7.22	14.12	18.52	13.29

Table 11. (Continued)

	Conductivity (µS/cm)				Chloride (mg/L) (LOQ= 0.2 mg/L)			
Stations	**1th period**	**2nd period**	**3rd period**	**Average**	**1th period**	**2nd period**	**3rd period**	**Average**
48	540.00	707.00	626.00	624.33	13.05	13.11	23.34	16.50
49	717.00	865.00	767.00	783.00	13.54	17.72	22.19	17.82
50	787.00	791.00	890.00	822.67	29.49	30.44	36.44	32.12
51	572.00	544.00	ND	558.00	17.29	21.90	ND	19.60
52	315.00	494.70	484.00	431.23	2.76	8.42	15.06	8.75
53	379.00	492.60	443.00	438.20	11.38	18.17	21.75	17.10
54	392.00	711.00	214.30	439.10	4.25	12.80	13.90	10.31
55	389.00	688.00	480.00	519.00	92.82	75.88	19.12	62.61
56	192.50	227.50	ND	210.00	7.98	15.28	ND	11.63
57	179.10	233.80	259.00	223.97	5.48	9.16	14.89	9.84
58	1000.00	787.00	397.00	728.00	45.66	29.31	22.08	32.35
59	592.00	626.00	720.00	646.00	16.36	8.66	22.36	15.79
60	357.80	325.70	417.10	366.87	2.53	8.34	13.96	8.28
61	526.00	740.00	595.00	620.33	3.57	9.54	15.76	9.63
62	661.00	799.00	857.00	772.33	18.50	32.15	29.96	26.87
63	651.00	464.80	438.00	517.93	8.44	9.46	20.13	12.68
64	699.00	584.00	679.00	654.00	11.67	25.64	21.75	19.69
65	922.00	880.00	1108.00	970.00	18.00	26.71	33.03	25.91
66	611.00	710.00	324.90	548.63	16.58	26.36	32.57	25.17
67	892.00	1036.00	ND	964.00	54.99	63.64	ND	59.31
68	301.00	429.50	407.00	379.17	1.94	8.53	13.84	8.10
69	368.90	543.00	706.00	539.30	1.58	2.41	15.99	6.66
70	866.00	799.00	369.00	678.00	12.42	15.99	22.18	16.87
71	289.70	347.60	418.00	351.77	5.02	11.67	19.61	12.10
72	759.00	626.00	956.00	780.33	8.54	13.33	18.85	13.57
73	610.00	677.00	ND	643.50	8.58	19.16	ND	13.87
74	643.00	680.00	700.00	674.33	15.98	16.27	27.05	19.77
75	670.00	845.00	690.00	735.00	17.73	24.92	27.51	23.39

Table 11. (Continued)

	Conductivity (μS/cm)				Chloride (mg/L) (LOQ= 0.2 mg/L)			
Stations	**1th period**	**2nd period**	**3rd period**	**Average**	**1th period**	**2nd period**	**3rd period**	**Average**
76	316.00	400.10	350.50	355.53	3.60	9.92	14.71	9.41
77	970.00	765.00	1296.00	1010.33	39.49	23.15	61.89	41.51
78	577.00	740.00	699.00	672.00	17.26	23.53	26.13	22.31
79	803.00	796.00	953.00	850.67	50.18	37.00	52.52	46.57
80	580.00	714.00	423.40	572.47	31.93	37.36	42.28	37.19
81	600.00	671.00	618.00	629.67	13.73	37.75	33.20	28.22
82	1091.00	895.00	1167.00	1051.00	52.80	32.06	60.21	48.36
83	416.00	545.00	523.00	494.67	12.64	20.89	24.12	19.22
84	802.00	754.00	933.00	829.67	7.63	14.87	19.71	14.07
85	1216.00	1121.00	1477.00	1271.33	105.27	85.29	30.63	73.73
86	1005.00	1251.00	1271.00	1175.67	84.30	65.46	22.18	57.31
87	1237.00	923.00	1448.00	1202.67	23.96	20.30	27.83	24.03
88	1064.00	944.00	1195.00	1067.67	58.34	47.01	31.47	45.61
89	947.00	749.00	626.00	774.00	36.14	27.22	16.77	26.71
90	581.00	723.00	695.00	666.33	12.17	17.64	21.33	17.04
91	240.30	367.00	467.00	358.10	6.56	12.42	17.84	12.27
92	441.70	403.80	750.00	531.83	2.80	4.51	28.40	11.90
93	1087.00	968.00	865.00	973.33	6.02	13.28	16.44	11.92
94	512.00	617.00	602.00	577.00	22.67	35.08	43.40	33.72
95	1008.00	1021.00	915.00	981.33	71.36	50.17	57.66	59.73
96	652.00	843.00	759.00	751.33	14.32	17.38	22.69	18.13
97	1352.00	1224.00	950.00	1175.33	38.54	49.36	24.20	37.37
98	233.00	363.10	426.50	340.87	6.95	7.71	11.94	8.87
99	459.00	832.00	452.00	581.00	6.53	8.29	23.25	12.69
100	385.70	546.00	617.00	516.23	5.37	9.28	14.17	9.61
101	373.60	229.20	302.60	301.80	1.87	2.49	12.09	5.48
102	588.00	470.30	134.50	397.60	7.70	14.07	14.72	12.16
103	975.00	749.00	719.00	814.33	14.06	11.04	16.89	13.99

Table 11. (Continued)

	Conductivity (µS/cm)				Chloride (mg/L) (LOQ= 0.2 mg/L)			
Stations	**1th period**	**2nd period**	**3rd period**	**Average**	**1th period**	**2nd period**	**3rd period**	**Average**
104	57.30	101.70	682.00	280.33	1.56	3.72	14.14	6.48
105	456.00	479.10	788.00	574.37	3.99	10.23	20.08	11.43
106	587.00	811.00	652.00	683.33	5.48	11.69	16.18	11.12
107	859.00	1072.00	915.00	948.67	16.31	31.12	31.19	26.21
108	539.00	758.00	734.00	677.00	7.57	14.30	23.93	15.26
109	779.00	945.00	663.00	795.67	23.90	30.38	25.59	26.62
110	933.00	915.00	1117.00	988.33	50.31	42.49	31.22	41.34

Table 12. Data of Sulfate and Aluminium (Risk Posing Parameters)

	Sulfate (mg/L) (LOQ= 0.3 mg/L)				Aluminium (µg/L) (LOQ= 1 µg/L)			
Stations	**1th period**	**2nd period**	**3rd period**	**Average**	**1th period**	**2nd period**	**3rd period**	**Average**
1	37.59	34.28	56.70	42.86	79.69	67.43	0.50	49.21
2	65.99	80.37	63.94	70.10	2.50	7.41	11.73	7.21
3	83.70	77.51	75.53	78.91	2.50	1.95	32.90	12.45
4	25.25	42.21	31.98	33.15	2.50	5.13	0.50	2.71
5	2.85	8.76	110.47	40.69	2.50	4.18	2.70	3.13
6	36.35	34.25	44.07	38.22	2.50	3.78	0.50	2.26
7	9.07	15.61	12.97	12.55	2.50	8.87	0.50	3.96
8	7.09	13.02	1632.73	550.95	26.70	25.99	0.50	17.73
9	6.30	6.10	5.79	6.06	2.50	7.57	0.50	3.52
10	10.24	9.51	11.26	10.34	2.50	1.24	2.58	2.11
11	20.11	20.71	30.07	23.63	2.50	5.81	0.50	2.94
12	8.40	6.35	6.71	7.15	2.50	1.58	10.97	5.02
13	13.86	16.55	15.57	15.33	2.50	2.90	0.50	1.97
14	28.84	18.72	30.10	25.89	4920.32	4283.46	1239.45	3481.08
15	93.63	92.09	115.63	100.45	9.07	8.16	7.06	8.10
16	56.23	46.23	70.98	57.81	2.50	5.84	0.50	2.95
17	22.02	20.87	38.45	27.11	2.50	3.46	1.43	2.46
18	12.84	16.42	20.80	16.69	2.50	5.27	6.73	4.83
19	126.44	118.24	36.34	93.67	2.50	2.74	ND	2.62
20	138.84	95.32	170.77	134.97	38.71	35.28	15.77	29.92
21	7.74	8.75	9.35	8.62	2.50	5.47	61.73	23.23
22	11.51	12.75	11.51	11.92	2.50	6.19	5.09	4.59
23	9.57	10.20	10.53	10.10	18.12	25.00	36.86	26.66
24	12.38	20.40	13.71	15.50	2.50	12.61	8.25	7.79

Table 12. (Continued)

	Sulfate (mg/L) (LOQ= 0.3 mg/L)				Aluminium (µg/L) (LOQ= 1 µg/L)			
Stations	**1th period**	**2nd period**	**3rd period**	**Average**	**1th period**	**2nd period**	**3rd period**	**Average**
25	81.72	72.06	23.37	59.05	4447.82	3960.84	159.50	2856.05
26	35.92	39.04	44.57	39.85	2.50	11.60	0.50	4.87
27	45.24	41.40	37.83	41.49	2.50	2.06	0.50	1.69
28	47.14	38.70	52.09	45.98	10.69	6.44	ND	8.57
29	58.82	60.40	76.47	65.23	2.50	2.17	18.92	7.86
30	142.17	131.28	43.95	105.80	179.30	147.79	69.14	132.08
31	29.61	20.94	38.16	29.57	2.50	1.48	2.58	2.18
32	6.58	7.88	8.16	7.54	171.79	251.94	137.38	187.04
33	63.78	69.94	44.68	59.47	2.50	1.72	5.42	3.21
34	107.70	97.71	119.40	108.27	2.50	8.40	7.86	6.25
35	0.66	0.13	5.25	2.01	13.42	21.50	0.50	11.80
36	31.61	43.49	553.36	209.49	2.50	11.86	5.72	6.70
37	17.37	18.45	23.05	19.62	2.50	3.66	5.47	3.88
38	91.55	63.82	39.70	65.02	32.28	44.17	21.65	32.70
39	8.22	8.86	9.73	8.93	54.96	51.08	16.37	40.80
40	275.63	258.56	390.63	308.27	143.53	127.41	77.87	116.27
41	53.69	103.12	79.41	78.74	2.50	5.40	0.50	2.80
42	11.54	11.54	13.92	12.33	2.50	1.47	0.50	1.49
43	31.11	23.70	36.95	30.59	2.50	4.15	0.50	2.38
44	26.98	34.60	36.28	32.62	19.48	7.43	8.97	11.96
45	8.57	8.66	9.62	8.95	2.50	2.49	0.50	1.83
46	5.37	9.64	5.85	6.95	2.50	4.67	0.50	2.56
47	24.16	20.44	38.11	27.57	2.50	3.25	0.50	2.08
48	27.49	34.66	37.43	33.20	2.50	7.39	17.22	9.04
49	31.39	27.42	31.97	30.26	6.60	17.21	14.00	12.60
50	30.18	35.37	29.77	31.77	18.20	20.32	8.69	15.73
51	14.95	17.53	ND	16.24	2.50	9.21	ND	5.85
52	48.25	127.93	84.03	86.74	8.20	13.59	7.38	9.72
53	60.37	65.76	79.37	68.50	2.50	3.50	16.19	7.39
54	56.37	74.15	4.24	44.92	2.50	2.95	16.53	7.33
55	21.56	33.20	20.65	25.14	2.50	7.55	7.61	5.88
56	29.00	16.55	ND	22.78	30.82	29.44	ND	30.13
57	8.74	8.11	8.41	8.42	2.50	2.43	0.50	1.81
58	53.54	0.13	31.00	28.22	66.14	56.95	91.63	71.58
59	30.19	37.99	34.62	34.27	995.36	697.03	241.95	644.78
60	11.62	9.97	14.20	11.93	15.86	16.58	5.69	12.71
61	18.32	63.28	32.90	38.17	2.50	3.76	0.50	2.25
62	67.77	102.49	128.72	99.66	23.70	14.06	27.21	21.66
63	12.06	13.91	34.04	20.00	5.93	2.59	5.68	4.73
64	26.52	25.81	28.31	26.88	2.50	6.05	1.24	3.26
65	78.71	87.69	127.62	98.01	2.50	5.89	0.50	2.96
66	53.93	47.70	52.17	51.26	37.76	31.38	0.50	23.21

Table 12. (Continued)

	Sulfate (mg/L) (LOQ= 0.3 mg/L)				Aluminium (µg/L) (LOQ= 1 µg/L)			
Stations	**1th period**	**2nd period**	**3rd period**	**Average**	**1th period**	**2nd period**	**3rd period**	**Average**
67	40.86	39.93	ND	40.39	7.09	17.36	ND	12.23
68	6.89	4.12	5.38	5.47	2.50	3.66	11.95	6.04
69	4.29	11.35	51.15	22.26	2.50	3.20	0.50	2.07
70	23.50	19.14	22.07	21.57	6.58	5.53	43.35	18.49
71	128.24	112.24	178.78	139.75	1264.82	1004.47	693.35	987.55
72	117.70	106.58	159.16	127.81	140.06	98.95	17.85	85.62
73	46.38	95.96	ND	71.17	2.50	2.12	ND	2.31
74	30.45	19.21	36.93	28.87	2.50	3.61	0.50	2.20
75	10.50	9.02	10.01	9.84	2.50	3.66	0.50	2.22
76	7.46	6.52	7.11	7.03	16.95	22.18	0.50	13.21
77	20.50	17.16	32.41	23.36	99.48	42.29	90.43	77.40
78	5.41	4.83	5.51	5.25	2.50	7.76	24.63	11.63
79	96.29	65.67	117.42	93.13	15.11	15.91	0.50	10.51
80	71.80	63.91	93.16	76.29	11.59	8.45	3.64	7.89
81	36.96	57.27	37.53	43.92	15.39	24.00	22.75	20.71
82	159.62	117.33	208.69	161.88	2.50	3.36	3.40	3.09
83	8.74	8.09	10.04	8.96	2.50	2.75	ND	2.62
84	153.52	168.07	247.65	189.75	2.50	5.04	2.74	3.43
85	482.61	550.63	569.05	534.10	2.50	8.90	17.01	9.47
86	80.91	104.12	322.49	169.17	2.50	1.50	3.78	2.59
87	341.22	209.48	432.30	327.67	6.40	11.91	49.59	22.63
88	167.48	159.22	274.22	200.31	16.76	24.96	27.38	23.03
89	64.31	45.46	75.28	61.68	5.71	5.28	0.50	3.83
90	7.16	7.30	7.83	7.43	2.50	2.61	0.50	1.87
91	6.99	11.51	8.85	9.12	2.50	1.43	0.50	1.48
92	0.13	13.29	48.27	20.56	5.32	6.95	0.50	4.25
93	352.84	361.56	469.74	394.71	2.50	1.59	3.53	2.54
94	58.03	58.57	91.87	69.49	44.80	46.12	106.63	65.85
95	32.58	35.34	44.06	37.33	32.34	26.95	4.99	21.43
96	106.96	93.50	123.03	107.83	138.67	122.35	73.32	111.45
97	94.08	76.64	32.01	67.58	9.40	6.01	3.88	6.43
98	15.04	38.98	128.21	60.75	2.50	2.10	0.50	1.70
99	28.35	53.59	32.28	38.07	2.50	24.72	14.80	14.01
100	54.66	54.58	113.42	74.22	2.50	3.98	0.50	2.33
101	9.80	9.65	27.55	15.66	2.50	1.52	1.82	1.95
102	23.66	35.79	18.08	25.85	2.50	3.92	12.11	6.18
103	158.35	118.38	108.25	128.33	55.99	55.35	36.19	49.17
104	6.05	10.27	107.57	41.30	983.28	819.80	436.20	746.42
105	12.75	12.10	21.53	15.46	13.11	15.67	10.89	13.22
106	14.91	12.76	8.12	11.93	2.50	2.37	0.50	1.79
107	146.47	158.41	196.38	167.09	2.50	3.46	45.22	17.06
108	26.06	35.53	56.31	39.30	2.50	2.53	2.69	2.57

Table 12. (Continued)

	Sulfate (mg/L) (LOQ= 0.3 mg/L)				Aluminium (µg/L) (LOQ= 1 µg/L)			
Stations	**1th period**	**2nd period**	**3rd period**	**Average**	**1th period**	**2nd period**	**3rd period**	**Average**
109	6.66	6.07	6.30	6.34	16.65	17.10	8.09	13.95
110	2.48	16.11	290.51	103.03	2.50	7.59	0.50	3.53

Table 13. Data of Arsenic and Chromium (Risk Posing Parameters)

	Arsenic (µg/L) (LOQ= 5 µg/L)				Chromium (µg/L) (LOQ= 1 µg/L)			
Stations	**1th period**	**2nd period**	**3rd period**	**Average**	**1th period**	**2nd period**	**3rd period**	**Average**
1	35.37	36.43	8.57	26.79	2.78	3.49	3.86	3.37
2	6.11	5.94	20.40	10.82	1.57	0.50	23.24	8.44
3	2.50	2.50	22.76	9.25	0.50	0.50	1.28	0.76
4	12.87	11.59	16.41	13.62	0.50	0.50	0.50	0.50
5	9.13	9.50	12.76	10.46	0.50	1.36	1.76	1.21
6	2.50	2.50	5.77	3.59	8.00	10.88	9.10	9.33
7	79.75	91.64	85.07	85.49	0.50	1.07	4.04	1.87
8	76.53	93.66	38.73	69.64	0.50	0.50	35.21	12.07
9	6.81	13.18	7.85	9.28	1.83	2.29	2.04	2.05
10	53.38	59.89	67.88	60.38	2.86	0.50	0.50	1.29
11	2.50	2.50	2.50	2.50	0.50	2.12	1.98	1.53
12	2.50	2.50	2.50	2.50	0.50	1.02	2.38	1.30
13	2.50	2.50	2.50	2.50	2.73	1.68	0.50	1.64
14	14.72	12.12	2.50	9.78	18.08	16.86	3.02	12.65
15	44.96	48.71	115.42	69.70	2.04	1.57	2.46	2.02
16	2.50	2.50	5.81	3.60	10.25	11.60	2.47	8.11
17	22.52	24.79	29.43	25.58	0.50	0.50	3.39	1.46
18	280.19	217.47	321.11	272.92	0.50	1.19	0.50	0.73
19	32.07	39.37	ND	35.72	10.73	13.82	ND	12.28
20	2.50	2.50	2.50	2.50	23.87	17.48	12.88	18.07
21	2.50	2.50	2.50	2.50	0.50	0.50	0.50	0.50
22	2.50	2.50	2.50	2.50	0.50	1.05	3.93	1.83
23	6.04	5.43	6.50	5.99	3.61	6.09	4.83	4.84
24	61.34	43.44	81.94	62.24	0.50	1.30	1.51	1.10
25	31.73	7.54	43.33	27.54	9.00	6.54	4.07	6.54
26	10.32	20.73	9.51	13.52	7.44	7.05	7.34	7.27
27	30.01	23.93	30.46	28.13	0.50	1.64	0.50	0.88
28	2.50	2.50	ND	2.50	2.46	1.36	ND	1.91

Table 13. (Continued)

	Arsenic (µg/L) (LOQ= 5 µg/L)				Chromium (µg/L) (LOQ= 1 µg/L)			
Stations	**1th period**	**2nd period**	**3rd period**	**Average**	**1th period**	**2nd period**	**3rd period**	**Average**
29	2.50	2.50	2.50	2.50	0.50	0.50	2.64	1.21
30	6.90	5.69	16.76	9.78	0.50	0.50	1.06	0.69
31	2.50	2.50	2.50	2.50	0.50	0.50	2.46	1.15
32	2.50	2.50	2.50	2.50	0.50	0.50	3.67	1.56
33	2.50	2.50	9.20	4.73	2.00	2.59	3.62	2.73
34	2.50	7.02	6.56	5.36	1.59	8.17	7.44	5.73
35	2326.10	2517.57	4913.82	3252.50	0.50	0.50	0.50	0.50
36	7.41	15.89	6.47	9.92	10.77	7.59	4.24	7.53
37	2.50	2.50	2.50	2.50	1.19	4.76	1.80	2.58
38	2.50	2.50	2.50	2.50	2.14	1.38	1.16	1.56
39	272.28	106.07	18.21	132.19	7.97	0.50	1.15	3.21
40	11.37	10.88	12.50	11.58	5.41	3.47	7.62	5.50
41	36.08	19.95	51.16	35.73	31.90	26.64	41.39	33.31
42	2.50	2.50	2.50	2.50	3.45	7.89	4.35	5.23
43	39.18	29.38	42.14	36.90	6.00	3.52	7.54	5.69
44	41.63	36.10	41.23	39.65	9.16	10.26	15.29	11.57
45	50.61	41.29	14.57	35.49	1.17	4.47	2.16	2.60
46	5.34	5.05	5.74	5.38	26.90	20.90	39.49	29.09
47	5.48	2.50	6.94	4.97	0.50	0.50	0.50	0.50
48	2.50	7.27	2.50	4.09	1.49	0.50	2.44	1.48
49	2.50	2.50	2.50	2.50	1.77	1.82	1.34	1.64
50	45.38	44.94	35.35	41.89	0.50	0.50	1.31	0.77
51	45.24	57.47	ND	51.35	4.19	4.47	ND	4.33
52	2.50	2.50	2.50	2.50	6.82	6.08	1.26	4.72
53	2.50	2.50	2.50	2.50	0.50	0.50	0.50	0.50
54	2.50	2.50	2.50	2.50	0.50	1.07	1.34	0.97
55	2.50	5.27	2.50	3.42	0.50	0.50	2.29	1.10
56	2.50	5.66	ND	4.08	0.50	0.50	ND	0.50
57	2.50	2.50	2.50	2.50	0.50	0.50	0.50	0.50
58	2.50	2.50	8.47	4.49	1.33	7.53	2.44	3.77
59	977.22	791.87	18.37	595.82	4.43	3.04	1.16	2.87
60	260.43	110.85	137.62	169.63	2.03	2.05	1.16	1.74
61	55.42	85.90	14.74	52.02	0.50	3.32	1.47	1.76
62	21.08	48.75	21.27	30.37	0.50	0.50	1.30	0.77
63	5.65	9.16	14.87	9.89	0.50	0.50	1.03	0.68
64	2.50	2.50	2.50	2.50	0.50	2.08	0.50	1.03

Table 13. (Continued)

	Arsenic (μg/L) (LOQ= 5 μg/L)				Chromium (μg/L) (LOQ= 1 μg/L)			
Stations	**1th period**	**2nd period**	**3rd period**	**Average**	**1th period**	**2nd period**	**3rd period**	**Average**
65	34.34	58.00	35.22	42.52	0.50	0.50	0.50	0.50
66	8.24	15.85	14.42	12.84	0.50	0.50	2.69	1.23
67	14.01	14.18	ND	14.09	1.66	2.64	ND	2.15
68	2.50	2.50	2.50	2.50	0.50	2.56	1.24	1.43
69	2.50	2.50	2.50	2.50	0.50	3.47	1.69	1.89
70	2.50	2.50	2.50	2.50	1.35	1.50	2.35	1.73
71	2107.39	1906.61	30.47	1348.16	3.05	2.30	1.09	2.14
72	24.88	21.13	33.18	26.39	0.50	0.50	1.60	0.87
73	10.89	9.93	ND	10.41	2.05	2.35	ND	2.20
74	2.50	2.50	7.72	4.24	3.44	1.81	2.00	2.42
75	2.50	2.50	2.50	2.50	4.57	4.55	3.97	4.36
76	2.50	2.50	2.50	2.50	0.50	1.25	2.10	1.28
77	2.50	2.50	2.50	2.50	1.85	1.48	1.84	1.72
78	2.50	2.50	2.50	2.50	6.13	4.07	4.77	4.99
79	2.50	2.50	2.50	2.50	2.75	3.72	1.81	2.76
80	2.50	2.50	2.50	2.50	0.50	0.50	1.25	0.75
81	2.50	2.50	2.50	2.50	3.19	0.50	1.02	1.57
82	15.58	23.17	19.05	19.26	8.31	7.90	3.31	6.51
83	2.50	2.50	ND	2.50	3.32	5.48	ND	4.40
84	32.54	37.67	40.60	36.94	6.07	5.36	4.58	5.34
85	48.91	35.64	161.85	82.13	2.19	3.72	2.61	2.84
86	2.50	9.71	7.13	6.45	0.50	3.04	8.24	3.93
87	2.50	2.50	10.21	5.07	16.15	12.70	20.51	16.45
88	2.50	2.50	2.50	2.50	5.60	2.37	3.51	3.83
89	506.98	623.57	202.95	444.50	2.52	0.50	1.70	1.57
90	74.40	92.00	219.89	128.76	13.90	9.92	4.81	9.54
91	5.02	22.08	11.67	12.92	4.94	3.52	0.50	2.99
92	27.41	33.68	25.22	28.77	0.50	0.50	0.50	0.50
93	2.50	2.50	2.50	2.50	0.50	0.50	0.50	0.50
94	13.46	25.99	19.12	19.52	0.50	1.19	0.50	0.73
95	12.46	9.82	5.50	9.26	42.33	36.78	4.48	27.86
96	58.98	61.01	32.29	50.76	1.91	3.96	0.50	2.13
97	11.07	45.17	6.49	20.91	7.78	3.57	4.48	5.28
98	2.50	2.50	2.50	2.50	5.80	2.94	2.61	3.78
99	2.50	2.50	2.50	2.50	1.43	3.24	0.50	1.72
100	73.90	56.10	635.39	255.13	1.86	1.21	1.17	1.41

Table 13. (Continued)

	Arsenic (µg/L) (LOQ= 5 µg/L)				Chromium (µg/L) (LOQ= 1 µg/L)			
Stations	**1th period**	**2nd period**	**3rd period**	**Average**	**1th period**	**2nd period**	**3rd period**	**Average**
101	2.50	2.50	2.50	2.50	1.99	0.50	0.50	1.00
102	54.37	47.23	7.23	36.27	1.63	2.92	11.48	5.35
103	2.50	2.50	2.50	2.50	2.09	3.10	0.50	1.89
104	2.50	10.07	12.44	8.34	0.50	1.17	0.50	0.72
105	26.61	26.78	32.47	28.62	0.50	0.50	1.09	0.70
106	151.34	114.17	181.23	148.91	18.90	0.50	0.50	6.63
107	39.31	36.84	34.37	36.84	2.49	1.27	2.12	1.96
108	40.01	40.42	38.80	39.74	1.11	0.50	0.50	0.70
109	8.39	8.98	10.88	9.42	6.52	5.05	5.41	5.66
110	2.50	8.41	65.44	25.45	0.50	1.22	1.57	1.10

Table 14. Data of Copper and Lead (Risk Posing Parameters)

	Copper (µg/L) (LOQ= 1 µg/L)				Lead (µg/L) (LOQ= 1 µg/L)			
Stations	**1th period**	**2nd period**	**3rd period**	**Average**	**1th period**	**2nd period**	**3rd period**	**Average**
1	2.42	1.43	2.61	2.15	0.50	0.50	0.50	0.50
2	0.50	1.49	23.68	8.56	0.50	0.50	8.71	3.24
3	1.04	0.50	6.87	2.80	0.50	0.50	0.50	0.50
4	0.50	0.50	0.50	0.50	0.50	1.70	0.50	0.90
5	1.55	1.73	4.03	2.44	2.71	3.21	6.87	4.26
6	1.27	0.50	0.50	0.76	3.70	3.65	0.50	2.62
7	0.50	3.67	6.22	3.46	0.50	2.48	0.50	1.16
8	0.50	2.19	47.96	16.88	0.50	0.50	0.50	0.50
9	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
10	0.50	1.69	2.48	1.56	0.50	0.50	0.50	0.50
11	1.42	1.78	0.50	1.24	0.50	2.71	0.50	1.24
12	1.64	2.09	11.47	5.07	0.50	0.50	6.18	2.39
13	0.50	1.41	0.50	0.80	0.50	0.50	0.50	0.50
14	16.08	13.52	1.23	10.27	19.19	16.33	1.64	12.39
15	0.50	8.55	3.79	4.28	0.50	2.12	0.50	1.04
16	1.82	1.84	5.56	3.08	0.50	0.50	0.50	0.50
17	1.16	1.27	0.50	0.97	0.50	0.50	0.50	0.50
18	0.50	0.50	1.78	0.93	0.50	4.52	0.50	1.84
19	10.21	11.52	ND	10.87	0.50	1.86	ND	1.18
20	0.50	0.50	2.38	1.13	0.50	0.50	2.51	1.17
21	1.45	0.50	1.51	1.15	3.46	1.09	0.50	1.68
22	1.43	0.50	19.88	7.27	2.80	2.48	6.82	4.03
23	1.65	1.31	5.29	2.75	3.39	1.96	0.50	1.95

Table 14. (Continued)

	Copper (µg/L) (LOQ= 1 µg/L)				Lead (µg/L) (LOQ= 1 µg/L)			
Stations	**1th period**	**2nd period**	**3rd period**	**Average**	**1th period**	**2nd period**	**3rd period**	**Average**
24	1.07	2.43	4.93	2.81	3.48	1.36	0.50	1.78
25	25.44	0.50	2.21	9.38	24.26	21.25	1.61	15.70
26	0.50	0.50	8.13	3.04	2.02	3.52	0.50	2.01
27	1.15	0.50	7.78	3.14	2.57	4.83	0.50	2.64
28	0.50	2.85	ND	1.68	2.89	0.50	ND	1.70
29	1.94	1.38	6.45	3.26	3.55	2.45	3.35	3.12
30	3.33	1.31	4.54	3.06	3.59	3.95	1.69	3.07
31	1.74	0.50	115.44	39.23	0.50	0.50	5.21	2.07
32	1.18	0.50	2.06	1.25	4.40	0.50	0.50	1.80
33	1.61	2.85	11.83	5.43	4.03	4.92	6.52	5.15
34	0.50	11.40	0.50	4.13	3.14	3.97	0.50	2.53
35	0.50	3.25	0.50	1.42	3.34	3.20	0.50	2.35
36	0.50	1.12	2.78	1.47	0.50	0.50	0.50	0.50
37	0.50	0.50	1.03	0.68	0.50	0.50	0.50	0.50
38	0.50	18.65	1.83	6.99	0.50	1.60	0.50	0.87
39	1.88	7.42	15.27	8.19	0.50	0.50	0.50	0.50
40	1.75	0.50	1.39	1.21	0.50	0.50	0.50	0.50
41	0.50	6.35	4.85	3.90	0.50	0.50	0.50	0.50
42	1.32	3.29	1.58	2.06	0.50	2.03	0.50	1.01
43	2.44	3.52	2.57	2.84	2.81	3.55	0.50	2.28
44	1.62	0.50	0.50	0.87	3.70	0.50	0.50	1.57
45	10.98	8.26	3.76	7.67	3.75	0.50	0.50	1.58
46	1.21	0.50	0.50	0.74	3.00	1.92	0.50	1.81
47	1.18	2.21	0.50	1.30	2.90	0.50	0.50	1.30
48	1.61	1.24	6.09	2.98	3.12	3.27	0.50	2.30
49	2.79	0.50	2.06	1.78	2.56	1.84	0.50	1.63
50	1.64	5.09	0.50	2.41	4.42	1.18	0.50	2.03
51	1.32	1.09	ND	1.21	3.33	0.50	ND	1.92
52	0.50	0.50	1.25	0.75	0.50	1.16	0.50	0.72
53	11.95	14.33	5.56	10.61	0.50	0.50	0.50	0.50
54	2.16	1.92	0.50	1.53	4.12	0.50	0.50	1.71
55	0.50	3.81	1.33	1.88	11.22	12.31	0.50	8.01
56	0.50	0.50	ND	0.50	3.46	4.39	ND	3.92
57	0.50	1.15	0.50	0.72	3.31	4.59	0.50	2.80
58	1.35	2.86	33.92	12.71	3.42	2.29	7.22	4.31
59	7.37	0.50	3.37	3.75	4.55	3.48	0.50	2.84
60	153.08	63.50	26.67	81.08	36.24	31.78	1.74	23.25
61	2.88	1.89	4.64	3.14	4.10	4.72	0.50	3.11
62	2.44	0.50	2.61	1.85	2.91	0.50	0.50	1.30
63	1.16	1.42	1.28	1.29	4.10	4.23	0.50	2.95
64	1.61	4.34	0.50	2.15	5.14	3.38	0.50	3.01
65	18.81	0.50	8.00	9.10	6.85	2.06	0.50	3.14

Table 14. (Continued)

	Copper (µg/L) (LOQ= 1 µg/L)				Lead (µg/L) (LOQ= 1 µg/L)			
Stations	**1th period**	**2nd period**	**3rd period**	**Average**	**1th period**	**2nd period**	**3rd period**	**Average**
66	5.37	10.99	7.86	8.07	0.50	0.50	0.50	0.50
67	1.48	1.83	ND	1.66	0.50	0.50	ND	0.50
68	1.09	0.50	0.50	0.70	3.20	0.50	0.50	1.40
69	1.17	8.80	0.50	3.49	2.83	5.50	0.50	2.94
70	2.50	0.50	1.48	1.50	4.98	2.57	0.50	2.68
71	6.24	1.37	0.50	2.70	8.38	6.39	0.50	5.09
72	4.48	5.12	4.84	4.81	4.73	0.50	0.50	1.91
73	13.77	13.50	ND	13.63	3.66	0.50	ND	2.08
74	0.50	1.22	0.50	0.74	0.50	1.64	0.50	0.88
75	3.34	7.05	3.74	4.71	0.50	3.25	0.50	1.42
76	1.98	1.98	1.17	1.71	3.94	3.84	0.50	2.76
77	12.29	13.67	1.01	8.99	4.18	3.13	0.50	2.60
78	0.50	4.88	3.06	2.81	0.50	3.30	1.79	1.86
79	0.50	0.50	6.50	2.50	0.50	2.56	0.50	1.19
80	1.09	0.50	2.57	1.39	3.89	3.10	0.50	2.50
81	4.04	2.13	0.50	2.22	0.50	3.65	0.50	1.55
82	1.38	3.36	1.30	2.01	0.50	3.14	0.50	1.38
83	0.50	3.17	ND	1.84	0.50	0.50	ND	0.50
84	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
85	2.10	3.50	4.09	3.23	0.50	0.50	1.07	0.69
86	1.13	3.14	2.22	2.16	0.50	2.35	0.50	1.12
87	0.50	0.50	5.27	2.09	0.50	0.50	1.68	0.89
88	2.05	2.91	11.11	5.35	0.50	4.28	0.50	1.76
89	0.50	1.18	0.50	0.73	0.50	0.50	0.50	0.50
90	0.50	1.09	0.50	0.70	0.50	0.50	0.50	0.50
91	0.50	2.24	3.26	2.00	0.50	0.50	0.50	0.50
92	1.50	0.50	2.42	1.47	2.85	0.50	1.07	1.47
93	0.50	0.50	0.50	0.50	2.64	0.50	0.50	1.21
94	1.52	1.84	1.52	1.63	2.87	0.50	0.50	1.29
95	1.69	5.31	0.50	2.50	3.20	2.12	0.50	1.94
96	2.72	0.50	0.50	1.24	3.02	2.67	0.50	2.06
97	1.54	2.28	0.50	1.44	2.88	2.62	0.50	2.00
98	0.50	0.50	0.50	0.50	0.50	1.75	0.50	0.92
99	0.50	0.50	1.23	0.74	0.50	1.12	0.50	0.71
100	1.84	6.73	0.50	3.02	6.06	4.94	0.50	3.84
101	1.00	0.50	0.50	0.67	3.53	0.50	0.50	1.51
102	1.05	0.50	4.07	1.87	0.50	2.40	9.10	4.00
103	0.50	2.60	0.50	1.20	0.50	0.50	0.50	0.50
104	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
105	1.85	0.50	0.50	0.95	5.59	8.34	0.50	4.81
106	0.50	1.74	1.59	1.28	0.50	2.08	0.50	1.03
107	1.15	2.52	2.55	2.07	0.50	0.50	0.50	0.50

Table 14. (Continued)

	Copper (µg/L) (LOQ= 1 µg/L)				Lead (µg/L) (LOQ= 1 µg/L)			
Stations	**1th period**	**2nd period**	**3rd period**	**Average**	**1th period**	**2nd period**	**3rd period**	**Average**
108	0.50	0.50	1.57	0.86	0.50	0.50	0.50	0.50
109	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
110	0.50	1.72	1.87	1.36	0.50	0.50	0.50	0.50

Table 15. Data of Zinc and Iron (Risk Posing Parameters)

	Zinc (µg/L) (LOQ= 2.5 µg/L)				Iron (µg/L) (LOQ= 30 µg/L)			
Stations	**1th period**	**2nd period**	**3rd period**	**Average**	**1th period**	**2nd period**	**3rd period**	**Average**
1	35.68	34.97	3.93	24.86	250.84	290.02	15.00	185.29
2	5.94	9.57	130.80	48.77	15.00	15.00	3017.85	1015.95
3	9.65	10.87	8.85	9.79	57.75	46.38	491.33	198.48
4	1.25	4.86	11.42	5.84	15.00	31.52	190.90	79.14
5	5.99	6.60	36.49	16.36	15.00	15.00	15.00	15.00
6	2.61	3.09	3.22	2.98	15.00	15.00	15.00	15.00
7	29.48	31.25	267.11	109.28	328.33	235.22	2394.00	985.85
8	77.29	87.76	1.25	55.43	286.40	452.25	1253.55	664.07
9	3.20	3.54	1.25	2.66	15.00	15.00	15.00	15.00
10	1.25	1.25	33.57	12.02	15.00	15.00	15.00	15.00
11	1.25	3.13	1.25	1.88	306.63	158.85	54.13	173.20
12	2.86	1.25	769.95	258.02	37.41	15.00	816.48	289.63
13	9.61	12.56	5.31	9.16	15.00	15.00	15.00	15.00
14	32.24	43.52	1.25	25.67	7678.22	8983.92	764.63	5808.92
15	9.12	13.21	43.28	21.87	391.69	351.64	2000.73	914.69
16	1.25	1.25	4.04	2.18	15.00	33.43	398.75	149.06
17	19.90	23.54	1.25	14.90	15.00	34.26	265.58	104.94
18	1.25	1.25	4.75	2.42	15.00	15.00	141.10	57.03
19	49.80	32.63	ND	41.21	15.00	15.00	ND	15.00
20	1.25	13.26	3.72	6.08	52.50	54.50	91.83	66.28
21	1.25	1.25	1.25	1.25	15.00	15.00	58.83	29.61
22	1.25	4.95	12.97	6.39	42.75	82.30	2716.69	947.25
23	172.42	128.25	375.00	225.23	48.84	32.89	273.38	118.37
24	1.25	1.25	4.55	2.35	15.00	46.12	876.35	312.49
25	27.76	28.44	12.69	22.96	2539.01	2187.90	154.84	1627.25
26	1.25	3.19	5.52	3.32	15.00	15.00	268.42	99.47
27	1.25	1.25	6.81	3.10	33.70	15.00	116.79	55.16

Table 15. (Continued)

	Zinc (μg/L) (LOQ= 2.5 μg/L)				Iron (μg/L) (LOQ= 30 μg/L)			
Stations	**1th period**	**2nd period**	**3rd period**	**Average**	**1th period**	**2nd period**	**3rd period**	**Average**
28	1.25	4.42	ND	2.84	1054.97	1150.12	ND	1102.54
29	3.80	4.70	9.71	6.07	15.00	31.51	53.02	33.18
30	6.00	6.91	7.49	6.80	480.15	322.99	397.69	400.28
31	1.25	1.25	158.82	53.77	55.42	15.00	396.51	155.64
32	5.57	1.25	1.25	2.69	295.45	152.57	41.08	163.03
33	6.52	9.44	70.36	28.77	15.00	15.00	101.53	43.84
34	1.25	1.25	2.89	1.80	15.00	15.00	765.00	265.00
35	8.16	5.64	1.25	5.02	1339.26	1381.58	481.35	1067.39
36	34.90	22.79	46.77	34.82	695.19	636.76	477.51	603.15
37	1.25	2.59	1.25	1.70	15.00	46.61	64.63	42.08
38	1.25	3.97	3.17	2.80	170.22	132.45	3118.17	1140.28
39	15.52	20.17	24.58	20.09	1776.26	1110.51	48.78	978.51
40	1.25	5.90	1.25	2.80	886.04	114.99	932.84	644.62
41	1.25	3.88	35.68	13.60	56.13	58.77	15.00	43.30
42	1.25	1.25	1.25	1.25	30.26	15.00	15.00	20.09
43	1.25	1.25	8.15	3.55	15.00	15.00	31.08	20.36
44	1.25	4.61	1.25	2.37	182.22	167.30	1746.88	698.80
45	158.91	161.54	3.08	107.84	34.35	15.00	51.02	33.46
46	2.52	1.25	1.25	1.67	15.00	55.40	34.67	35.02
47	1.25	1.25	1.25	1.25	15.00	37.57	15.00	22.52
48	1.25	3.06	12.58	5.63	478.86	749.63	630.14	619.54
49	26.98	1.25	6.49	11.57	84.84	105.61	33.40	74.62
50	1.25	5.08	1.25	2.53	329.03	72.54	81.03	160.87
51	7.04	9.41	ND	8.22	157.42	160.31	ND	158.87
52	1.25	4.72	1.25	2.41	15.00	15.00	59.65	29.88
53	17.56	17.64	50.89	28.70	32.12	15.00	139.64	62.25
54	14.15	17.96	1.25	11.12	1965.71	1542.44	192.91	1233.69
55	1.25	7.05	5.16	4.49	830.04	753.83	15.00	532.96
56	1.25	5.15	ND	3.20	849.20	445.79	ND	647.50
57	1.25	1.25	1.25	1.25	50.12	72.66	32.97	51.92
58	1.25	14.31	1354.11	456.56	263.79	452.21	4228.32	1648.11
59	28.02	26.01	49.45	34.49	2876.54	1354.29	4423.62	2884.82
60	492.17	326.16	37.74	285.36	1714.51	1279.49	58.37	1017.46
61	6.41	6.82	10.55	7.93	37.87	51.54	15.00	34.80
62	1.25	4.36	1.25	2.29	52.17	31.58	64.79	49.51
63	1.25	1.25	36.61	13.04	15.00	15.00	15.00	15.00

Table 15. (Continued)

	Zinc (µg/L) (LOQ= 2.5 µg/L)				Iron (µg/L) (LOQ= 30 µg/L)			
Stations	**1th period**	**2nd period**	**3rd period**	**Average**	**1th period**	**2nd period**	**3rd period**	**Average**
64	1.25	3.50	2.95	2.57	67.51	70.95	121.21	86.55
65	16.44	14.08	8.52	13.01	15.00	42.93	15.00	24.31
66	12.33	18.05	10.08	13.48	162.35	133.02	86.54	127.30
67	1.25	3.45	ND	2.35	58.32	57.68	ND	58.00
68	1.25	1.25	1.25	1.25	15.00	35.01	15.00	21.67
69	1.25	1.25	91.48	31.33	15.00	15.00	15.00	15.00
70	1.25	4.32	1.25	2.27	79.34	15.00	197.87	97.40
71	15.60	1.25	1.25	6.03	3380.82	2791.30	131.73	2101.28
72	3.04	5.71	6.06	4.94	2132.96	2287.66	57.87	1492.83
73	7.11	9.34	ND	8.23	48.09	61.33	ND	54.71
74	3.68	5.72	19.54	9.64	15.00	15.00	15.00	15.00
75	4.11	6.90	8.74	6.58	15.00	15.00	55.35	28.45
76	1.25	4.33	1.25	2.28	15.00	15.00	15.00	15.00
77	46.09	36.54	2.61	28.41	199.38	157.24	56.42	137.68
78	1.25	2.71	673.51	225.82	15.00	15.00	86.37	38.79
79	5.01	3.18	21.65	9.95	38.63	43.18	15.00	32.27
80	5.01	1.25	1.25	2.50	162.80	213.31	34.75	136.95
81	3.39	3.08	1.25	2.57	93.38	113.55	15.00	73.97
82	1.25	1.25	1.25	1.25	50.10	33.07	38.55	40.57
83	1.25	1.25	ND	1.25	15.00	15.00	ND	15.00
84	3.51	3.11	7.45	4.69	15.00	49.84	15.00	26.61
85	1.25	5.03	1.25	2.51	298.26	295.64	5217.92	1937.27
86	2.77	4.36	1.25	2.79	15.00	40.87	112.34	56.07
87	45.06	37.04	17.75	33.28	56.98	15.00	2316.26	796.08
88	1.25	2.94	21.48	8.55	113.82	156.09	15.00	94.97
89	1.25	1.25	1.25	1.25	15.00	40.20	15.00	23.40
90	1.25	4.77	1.25	2.42	154.44	15.00	15.00	61.48
91	1.25	1.25	31.17	11.22	15.00	15.00	21466.50	7165.50
92	1.25	1.25	16.67	6.39	64.72	72.31	43.81	60.28
93	1.25	1.25	1.25	1.25	15.00	15.00	33.22	21.07
94	1.25	3.46	4.01	2.91	75.06	75.67	144.98	98.57
95	2.61	4.36	1.25	2.74	2781.33	2913.65	249.72	1981.56
96	1.25	4.08	14.14	6.49	650.96	594.86	56.45	434.09
97	5.66	6.67	1.25	4.53	80.71	85.45	15.00	60.39
98	1.25	1.25	1.25	1.25	15.00	15.00	15.00	15.00

Table 15. (Continued)

	Zinc (µg/L) (LOQ= 2.5 µg/L)				Iron (µg/L) (LOQ= 30 µg/L)			
Stations	**1th period**	**2nd period**	**3rd period**	**Average**	**1th period**	**2nd period**	**3rd period**	**Average**
99	1.25	7.20	187.50	65.32	518.28	942.92	141.43	534.21
100	1.25	8.12	1.25	3.54	15.00	15.00	131.24	53.75
101	1.25	6.49	5.85	4.53	15.00	256.69	15.00	95.56
102	1.25	1.25	13.73	5.41	15.00	15.00	5638.27	1889.42
103	1.25	1.25	1.25	1.25	15.00	457.89	74.04	182.31
104	9.53	14.66	1.25	8.48	115.08	211.32	747.74	358.04
105	1.25	1.25	1.25	1.25	15.00	15.00	89.20	39.73
106	1.25	1.25	1.25	1.25	15.00	15.00	15.00	15.00
107	12.86	9.73	5.79	9.46	40.91	35.83	163.50	80.08
108	1.25	1.25	1.25	1.25	15.00	15.00	36.66	22.22
109	11.21	11.10	128.74	50.35	15.00	36.76	37.28	29.68
110	1.25	36.06	1.25	12.85	268.79	342.68	57.18	222.88

Table 16. Data of Manganese and Sodium (Risk Posing Parameters)

	Manganese (µg/L) (LOQ= 20 µg/L)				Sodium (µg/L) (LOQ= 20 µg/L)			
Stations	**1th period**	**2nd period**	**3rd period**	**Average**	**1th period**	**2nd period**	**3rd period**	**Average**
1	127.85	117.56	0.50	81.97	14683.07	7103.88	6604.26	9463.74
2	0.50	0.50	356.07	119.02	5230.00	7629.32	11386.47	8081.93
3	0.50	0.50	2.31	1.10	10707.25	13884.67	8932.85	11174.92
4	2.23	3.20	4.71	3.38	25511.31	23090.06	28297.20	25632.86
5	0.50	2.45	1.33	1.42	11185.43	15948.43	10611.48	12581.78
6	0.50	1.51	1.71	1.24	11219.66	19730.22	11499.00	14149.63
7	802.48	877.36	798.31	826.05	179751.42	167370.59	259049.10	202057.04
8	532.80	344.51	1010.87	629.39	495941.89	235004.25	1124309.88	618418.67
9	0.50	1.29	0.50	0.76	5906.61	12131.73	6686.00	8241.45
10	0.50	0.50	0.50	0.50	2711.12	3685.70	2478.92	2958.58
11	5.62	0.50	1.75	2.62	4683.22	7068.56	6771.97	6174.58
12	0.50	1.05	195.26	65.60	756.99	974.91	14692.51	5474.80
13	1.04	0.50	0.50	0.68	1225.77	1341.63	821.37	1129.59
14	665.20	578.82	46.89	430.30	6022.95	6093.81	5884.65	6000.47
15	114.10	94.16	72.04	93.43	17928.10	25424.40	20317.70	21223.40
16	0.50	0.50	1.80	0.93	7900.41	7119.90	8343.63	7787.98
17	0.50	2.70	2.23	1.81	2512.74	4088.67	3065.83	3222.41
18	0.50	0.50	103.91	34.97	4825.30	9641.57	5821.61	6762.83
19	8.28	4.16	ND	6.22	11538.90	8276.73	ND	9907.82
20	11.82	17.35	8.04	12.40	13458.20	10666.85	9521.64	11215.56
21	0.50	2.16	5.99	2.88	1788.21	2129.33	1129.87	1682.47

Table 16. (Continued)

	Manganese (µg/L) (LOQ= 20 µg/L)				Sodium (µg/L) (LOQ= 20 µg/L)			
Stations	**1th period**	**2nd period**	**3rd period**	**Average**	**1th period**	**2nd period**	**3rd period**	**Average**
22	2.35	3.72	206.66	70.91	1594.68	2894.48	1375.90	1955.02
23	1.72	1.66	2.84	2.08	7641.70	5012.71	7043.86	6566.09
24	0.50	1.11	19.79	7.13	2335.90	4789.62	1928.05	3017.86
25	585.40	390.69	24.99	333.69	4995.22	3967.50	4351.47	4438.06
26	0.50	7.28	2.09	3.29	7037.92	5339.36	5924.04	6100.44
27	0.50	2.72	2.57	1.93	18647.29	14512.46	12505.92	15221.89
28	186.75	68.94	ND	127.84	3229.26	8544.38	ND	5886.82
29	0.50	1.43	0.50	0.81	4659.73	6504.30	5638.11	5600.71
30	16.39	10.13	259.50	95.34	6690.14	9352.03	3914.55	6652.24
31	15.01	12.47	11.40	12.96	2365.19	3061.74	2753.89	2726.94
32	32.53	22.88	6.10	20.50	2442.13	2451.62	2392.95	2428.90
33	0.50	1.05	3.82	1.79	8560.43	12949.39	5546.80	9018.88
34	0.50	0.50	4.66	1.89	13705.98	12783.96	17377.14	14622.36
35	271.97	352.74	3636.25	1420.32	14234.95	19602.98	8041.44	13959.79
36	103.76	144.69	92.42	113.63	199095.43	183597.46	189453.06	190715.32
37	0.50	1.46	2.76	1.57	2822.08	4930.77	3246.27	3666.37
38	12.44	6.93	68.61	29.33	22015.05	25992.64	31268.65	26425.45
39	131.27	113.15	1.02	81.81	5335.72	3639.39	2831.82	3935.64
40	14.62	13.67	14.05	14.11	22533.92	27887.48	29696.99	26706.13
41	0.50	0.50	5.80	2.27	14332.43	26479.36	15869.26	18893.68
42	0.50	0.50	0.50	0.50	1150.19	2835.98	987.49	1657.89
43	0.50	0.50	0.50	0.50	5336.97	5098.38	4337.28	4924.21
44	6.92	3.12	24.39	11.48	4935.52	4568.51	4376.53	4626.85
45	1.19	1.98	0.50	1.22	1643.69	2878.37	1536.10	2019.39
46	0.50	2.00	0.50	1.00	3205.43	6111.99	2475.03	3930.82
47	0.50	0.50	0.50	0.50	3704.12	4189.74	2646.24	3513.37
48	2.53	3.23	8.68	4.81	6398.20	23002.27	6443.48	11947.98
49	2.01	1.29	3.44	2.24	5500.56	5657.32	4106.72	5088.20
50	16.16	11.21	5.72	11.03	17742.89	30657.94	13350.11	20583.65
51	3.07	2.26	ND	2.66	5340.54	5571.08	ND	5455.81
52	5.14	3.62	22.78	10.51	735.93	850.66	1020.50	869.03
53	0.50	1.50	2.75	1.58	4113.54	3686.04	3254.62	3684.73
54	593.55	337.14	3.91	311.53	2098.31	1952.46	1150.85	1733.87
55	38.86	21.30	2.60	20.92	1510.70	1586.10	2356.78	1817.86
56	147.74	209.82	ND	178.78	2144.00	3492.63	ND	2818.31
57	17.95	11.50	21.31	16.92	2036.57	2393.35	7149.94	3859.95
58	10.34	6.00	302.80	106.38	7590.89	9892.77	3097.00	6860.22
59	225.61	172.02	30.72	142.78	3562.52	2502.28	2731.65	2932.15
60	13.25	12.38	2.45	9.36	846.87	966.26	615.85	809.66
61	0.50	0.50	0.50	0.50	1610.32	1448.67	1794.45	1617.81
62	2.11	1.07	3.79	2.32	13718.85	16835.04	9331.18	13295.02
63	0.50	0.50	1.64	0.88	7853.38	2954.61	2484.67	4430.89

Table 16. (Continued)

Stations	Manganese (µg/L) (LOQ= 20 µg/L)				Sodium (µg/L) (LOQ= 20 µg/L)			
	1th period	2nd period	3rd period	Average	1th period	2nd period	3rd period	Average
64	24.65	14.65	11.19	16.83	5045.39	8184.39	4414.34	5881.37
65	0.50	0.50	0.50	0.50	25602.62	21754.40	34174.79	27177.27
66	16.33	9.49	2.19	9.33	6724.98	8809.45	10499.89	8678.10
67	2.77	1.14	ND	1.95	15308.74	21520.15	ND	18414.44
68	0.50	1.24	3.26	1.67	676.79	670.98	571.85	639.87
69	0.50	0.50	10.41	3.80	1039.49	1219.89	1195.28	1151.55
70	9.26	7.82	174.32	63.80	5549.46	5866.11	5280.34	5565.30
71	1525.54	1588.31	34.96	1049.60	20140.18	29355.06	22507.41	24000.88
72	55.41	45.17	42.21	47.59	6843.61	4889.20	13823.34	8518.72
73	0.50	1.09	ND	0.80	5415.99	6172.75	ND	5794.37
74	0.50	1.53	0.50	0.84	6631.11	7684.95	7426.85	7247.64
75	0.50	0.50	0.50	0.50	3119.59	3869.60	3030.91	3340.03
76	0.50	0.50	0.50	0.50	4238.75	5598.97	4379.23	4738.98
77	2.85	1.31	7.45	3.87	7494.32	8679.83	9461.76	8545.30
78	0.50	0.50	1.56	0.85	6818.21	9111.21	6686.68	7538.70
79	2.97	6.47	3.19	4.21	7519.74	9607.97	6532.41	7886.70
80	2.04	4.24	1.05	2.44	6057.70	9833.63	6638.13	7509.82
81	76.42	4.88	161.23	80.85	6688.22	9288.01	8045.72	8007.32
82	1048.83	814.52	3.01	622.12	14404.05	11026.08	14599.86	13343.33
83	0.50	6.87	ND	3.68	2371.85	2912.62	ND	2642.23
84	3.24	2.19	1.69	2.37	3283.68	5196.02	3604.21	4027.97
85	51.84	36.47	147.83	78.71	11862.85	13756.53	12243.14	12620.84
86	360.07	340.66	1.74	234.15	4151.88	5449.61	4380.08	4660.52
87	1.86	1.98	15.51	6.45	10128.23	14604.64	12557.67	12430.18
88	5.64	8.58	6.54	6.92	9137.15	10670.54	9708.24	9838.64
89	0.50	1.84	1.26	1.20	3410.84	3291.16	2861.07	3187.69
90	1.28	0.50	8.64	3.47	2847.72	3710.98	2978.51	3179.07
91	0.50	1.01	62.64	21.38	2070.20	3210.07	2772.49	2684.25
92	29.04	24.80	38.77	30.87	20444.69	31135.31	29236.13	26938.71
93	18.40	14.84	21.16	18.13	5007.02	5361.68	4577.67	4982.13
94	11.19	16.57	10.10	12.62	8420.27	11711.44	11028.91	10386.88
95	39.21	27.96	6.64	24.60	20298.40	32418.96	22200.63	24972.67
96	244.41	197.53	57.24	166.39	8828.27	8928.01	7390.40	8382.23
97	3.91	4.44	0.50	2.95	38102.97	36027.13	21661.52	31930.54
98	199.55	168.25	0.50	122.77	287.59	545.75	219.11	350.82
99	66.39	75.68	30.63	57.57	6073.05	8731.09	6513.68	7105.94
100	0.50	1.60	3.65	1.92	3427.12	4029.97	811.18	2756.09
101	0.50	1.63	0.50	0.88	620.97	540.27	423.67	528.30
102	16.82	5.01	89.81	37.21	1574.44	2026.18	1516.59	1705.73
103	1.13	0.50	16.87	6.17	2684.04	2875.15	2641.08	2733.42
104	12.74	11.69	101.96	42.13	1429.14	2457.88	4992.15	2959.72
105	3.17	2.10	5.91	3.73	1266.85	1376.43	2391.19	1678.16

Table 16. (Continued)

	Manganese (µg/L) (LOQ= 20 µg/L)				Sodium (µg/L) (LOQ= 20 µg/L)			
Stations	**1th period**	**2nd period**	**3rd period**	**Average**	**1th period**	**2nd period**	**3rd period**	**Average**
106	0.50	0.50	0.50	0.50	1549.39	2346.26	1638.97	1844.87
107	13.98	13.77	5.84	11.20	10043.97	12102.65	5596.75	9247.79
108	69.64	56.87	61.84	62.78	21339.67	18486.05	18724.00	19516.58
109	130.34	127.57	1.78	86.56	3798.17	4274.64	3761.91	3944.91
110	43.23	38.86	5.33	29.14	85271.83	75509.27	5534.79	55438.63

Table 17. Data of Vanadium and Cadmium (Risk Posing Parameters)

	Vanadium (µg/L) (LOQ= 1 µg/L)				Cadmium (µg/L) (LOQ= 0.1 µg/L)			
Stations	**1th period**	**2nd period**	**3rd period**	**Average**	**1th period**	**2nd period**	**3rd period**	**Average**
1	2.81	3.00	8.03	4.61	0.05	0.08	0.025	0.052
2	5.44	3.80	8.78	6.01	0.05	0.025	0.095	0.057
3	3.27	2.77	15.91	7.32	0.05	0.082	0.025	0.052
4	0.50	1.14	0.50	0.71	0.05	0.1	0.025	0.058
5	3.72	4.44	5.43	4.53	0.05	0.025	0.025	0.033
6	1.64	2.63	2.18	2.15	0.05	0.062	0.025	0.046
7	0.50	1.58	0.50	0.86	0.05	0.025	0.025	0.033
8	2.13	0.50	0.50	1.04	0.05	0.094	0.025	0.056
9	10.12	10.80	14.38	11.77	0.05	0.025	0.025	0.033
10	3.74	4.23	4.10	4.02	0.05	0.025	0.025	0.033
11	0.50	0.50	0.50	0.50	0.05	0.14	0.025	0.072
12	0.50	0.50	3.33	1.44	0.05	0.106	0.025	0.06
13	0.50	0.50	0.50	0.50	0.05	0.025	0.025	0.033
14	19.38	5.87	2.53	9.26	0.135	0.083	0.025	0.081
15	0.50	0.50	0.50	0.50	0.05	0.025	0.025	0.033
16	1.10	1.28	1.37	1.25	0.05	0.089	0.025	0.055
17	1.02	1.30	0.50	0.94	0.05	0.025	0.025	0.033
18	0.50	0.50	0.50	0.50	0.05	0.025	0.025	0.033
19	14.30	13.82	ND	14.06	0.05	0.025	ND	0.038
20	4.98	5.88	6.25	5.70	0.05	0.123	0.025	0.066
21	2.13	2.80	1.81	2.24	0.05	0.082	0.025	0.052
22	0.50	0.50	3.62	1.54	0.05	0.104	0.025	0.06
23	19.46	15.76	22.68	19.30	0.05	0.122	0.025	0.066
24	3.67	3.19	3.75	3.54	0.05	0.081	0.025	0.052
25	36.63	31.93	18.04	28.87	0.192	0.162	0.025	0.126

Table 17. (Continued)

	Vanadium (µg/L) (LOQ= 1 µg/L)				Cadmium (µg/L) (LOQ= 0.1 µg/L)			
Stations	**1th period**	**2nd period**	**3rd period**	**Average**	**1th period**	**2nd period**	**3rd period**	**Average**
26	9.06	12.58	8.69	10.11	0.05	0.025	0.025	0.033
27	12.27	15.13	9.52	12.31	0.05	0.153	0.025	0.076
28	0.50	0.50	ND	0.50	0.05	0.08	ND	0.065
29	3.46	4.00	4.69	4.05	0.05	0.064	0.025	0.046
30	1.49	1.60	0.50	1.20	0.05	0.114	0.025	0.063
31	0.50	1.30	1.51	1.11	0.05	0.025	0.025	0.033
32	0.50	0.50	0.50	0.50	0.05	0.103	0.025	0.059
33	0.50	0.50	1.80	0.93	0.05	0.077	0.025	0.051
34	1.74	2.88	3.88	2.83	0.05	0.342	0.025	0.139
35	0.50	0.50	0.50	0.50	0.05	0.074	0.025	0.05
36	3.00	2.41	3.04	2.82	0.05	0.079	0.025	0.051
37	0.50	1.11	1.09	0.90	0.05	0.158	0.025	0.078
38	0.50	0.50	0.50	0.50	0.05	0.025	0.025	0.033
39	90.20	47.38	0.50	46.03	0.05	0.131	0.025	0.069
40	5.47	6.42	6.41	6.10	0.05	0.12	0.025	0.065
41	29.70	22.66	41.75	31.37	0.05	0.121	0.025	0.065
42	0.50	1.17	0.50	0.72	0.05	0.125	0.025	0.067
43	3.30	3.70	3.78	3.59	0.05	0.107	0.025	0.061
44	6.59	5.83	8.88	7.10	0.05	0.06	0.025	0.045
45	1.82	2.01	2.52	2.12	0.05	0.2	0.025	0.092
46	6.18	5.74	7.03	6.31	0.05	0.025	0.025	0.033
47	1.76	1.68	1.61	1.68	0.05	0.05	0.025	0.042
48	0.50	3.18	0.50	1.39	0.05	0.065	0.025	0.047
49	2.24	2.31	2.25	2.26	0.05	0.102	0.025	0.059
50	3.06	4.32	4.10	3.83	0.05	0.025	0.025	0.033
51	3.19	2.72	ND	2.95	0.05	0.06	ND	0.055
52	0.50	1.09	0.50	0.70	0.05	0.025	0.025	0.033
53	0.50	0.50	0.50	0.50	0.05	0.157	0.025	0.077
54	0.50	0.50	0.50	0.50	0.05	0.088	0.025	0.054
55	0.50	0.50	0.50	0.50	0.05	0.025	0.025	0.033
56	0.50	1.68	ND	1.09	0.05	0.115	ND	0.083
57	0.50	0.50	0.50	0.50	0.05	0.136	0.025	0.07
58	1.17	0.50	3.46	1.71	0.05	0.051	0.025	0.042
59	9.86	7.38	0.50	5.92	0.05	0.025	0.025	0.033
60	14.05	8.24	8.81	10.36	0.05	0.025	0.025	0.033

Table 17. (Continued)

	Vanadium (µg/L) (LOQ= 1 µg/L)				Cadmium (µg/L) (LOQ= 0.1 µg/L)			
Stations	**1th period**	**2nd period**	**3rd period**	**Average**	**1th period**	**2nd period**	**3rd period**	**Average**
61	0.50	1.16	0.50	0.72	0.05	0.13	0.025	0.068
62	1.53	0.50	2.19	1.40	0.05	0.12	0.025	0.065
63	10.54	8.06	7.57	8.72	0.05	0.138	0.025	0.071
64	0.50	0.50	0.50	0.50	0.05	0.161	0.025	0.079
65	2.81	0.50	3.22	2.18	0.05	0.166	0.025	0.08
66	1.37	2.48	3.35	2.40	0.05	0.025	0.025	0.033
67	3.50	4.51	ND	4.01	0.05	0.025	ND	0.038
68	0.50	0.50	0.50	0.50	0.05	0.13	0.025	0.068
69	0.50	0.50	0.50	0.50	0.05	0.109	0.025	0.061
70	3.49	3.45	4.31	3.75	0.05	0.139	0.025	0.071
71	17.46	15.20	0.50	11.05	0.05	0.025	0.025	0.033
72	2.31	1.71	1.42	1.81	0.05	0.025	0.025	0.033
73	2.25	0.50	ND	1.38	0.05	0.051	ND	0.05
74	3.14	3.33	5.50	3.99	0.05	0.108	0.025	0.061
75	1.91	2.27	2.51	2.23	0.05	0.225	0.025	0.1
76	6.74	7.80	9.36	7.96	0.05	0.025	0.025	0.033
77	10.17	10.79	18.30	13.08	0.05	0.06	0.025	0.045
78	9.95	10.96	10.05	10.32	0.05	0.097	0.025	0.057
79	4.74	4.13	6.59	5.15	0.05	0.052	0.025	0.042
80	0.50	0.50	0.50	0.50	0.05	0.097	0.025	0.057
81	2.09	1.09	1.70	1.63	0.05	0.168	0.025	0.081
82	1.37	1.73	2.31	1.80	0.05	0.025	0.025	0.033
83	0.50	0.50	ND	0.50	0.05	0.089	ND	0.07
84	6.85	7.07	9.81	7.91	0.05	0.143	0.025	0.073
85	3.82	4.79	11.31	6.64	0.05	0.229	0.025	0.101
86	0.50	1.09	0.50	0.70	0.05	0.162	0.025	0.079
87	0.50	0.50	1.52	0.84	0.05	0.112	0.025	0.062
88	0.50	1.94	0.50	0.98	0.05	0.053	0.025	0.043
89	17.03	12.83	3.39	11.08	0.05	0.15	0.025	0.075
90	5.60	6.73	8.18	6.84	0.05	0.06	0.025	0.045
91	0.50	1.64	9.38	3.84	0.05	0.025	0.025	0.033
92	0.50	0.50	0.50	0.50	0.05	0.025	0.025	0.033
93	0.50	0.50	0.50	0.50	0.05	0.104	0.025	0.06
94	1.66	2.03	2.96	2.22	0.05	0.164	0.025	0.08
95	8.06	7.64	4.91	6.87	0.05	0.095	0.025	0.057

Table 17. (Continued)

	Vanadium (µg/L) (LOQ= 1 µg/L)				Cadmium (µg/L) (LOQ= 0.1 µg/L)			
Stations	**1th period**	**2nd period**	**3rd period**	**Average**	**1th period**	**2nd period**	**3rd period**	**Average**
96	3.34	3.35	3.46	3.38	0.05	0.202	0.025	0.092
97	5.31	6.36	3.45	5.04	0.05	0.092	0.025	0.056
98	0.50	0.50	0.50	0.50	0.05	0.061	0.025	0.045
99	0.50	0.50	0.50	0.50	0.05	0.086	0.025	0.054
100	12.45	12.69	0.50	8.55	0.05	0.119	0.025	0.065
101	0.50	0.50	0.50	0.50	0.05	0.1	0.025	0.058
102	18.62	16.18	10.46	15.08	0.05	0.148	0.025	0.074
103	0.50	0.50	0.50	0.50	0.05	0.181	0.025	0.085
104	1.07	0.50	0.50	0.69	0.05	0.086	0.025	0.054
105	9.59	11.38	3.58	8.18	0.05	0.025	0.025	0.033
106	16.68	16.58	21.22	18.16	0.05	0.025	0.025	0.033
107	2.43	2.59	3.29	2.77	0.05	0.052	0.025	0.042
108	0.50	1.93	0.50	0.98	0.05	0.025	0.025	0.033
109	5.19	5.44	9.04	6.56	0.05	0.025	0.025	0.033
110	0.50	0.50	6.55	2.52	0.05	0.025	0.025	0.033

Table 18. Data of Cobalt and Mercury (Risk Posing Parameters)

	Cobalt (µg/L) (LOQ= 0.013 µg/L)				Mercury (µg/L) (LOQ= 0.1 µg/L)			
Stations	**1th period**	**2nd period**	**3rd period**	**Average**	**1th period**	**2nd period**	**3rd period**	**Average**
1	0.53	0.17	0.05	0.25	0.05	0.025	0.025	0.033
2	0.10	0.27	4.78	1.71	0.05	0.025	0.025	0.033
3	0.10	0.20	0.05	0.12	0.05	0.025	0.025	0.033
4	0.10	0.39	0.05	0.18	0.05	0.025	0.025	0.033
5	0.10	0.13	0.05	0.09	0.05	0.256	0.025	0.11
6	0.10	0.15	0.05	0.10	0.05	0.078	0.025	0.051
7	0.24	1.41	0.12	0.59	0.05	1312.00	0.785	0.716
8	0.55	0.41	0.26	0.41	0.05	0.061	10798.00	3636.00
9	0.10	0.34	0.05	0.16	0.05	0.025	0.135	0.07
10	0.10	0.13	0.05	0.09	0.05	0.025	0.025	0.033
11	0.10	0.55	0.05	0.23	0.05	0.025	0.025	0.033
12	0.10	0.56	1.85	0.84	0.05	0.025	0.025	0.033
13	0.10	0.16	0.05	0.10	0.05	0.025	0.025	0.033
14	13.70	7.04	0.69	7.14	0.05	0.025	0.025	0.033
15	0.10	0.25	0.23	0.19	0.05	0.025	0.025	0.033
16	0.10	0.24	0.05	0.13	0.05	0.025	0.025	0.033
17	0.10	0.15	0.05	0.10	0.05	0.025	0.984	0.353

Table 18. (Continued)

	Cobalt (µg/L) (LOQ= 0.013 µg/L)				Mercury (µg/L) (LOQ= 0.1 µg/L)			
Stations	**1th period**	**2nd period**	**3rd period**	**Average**	**1th period**	**2nd period**	**3rd period**	**Average**
18	0.10	0.42	0.05	0.19	0.05	0.025	0.025	0.033
19	0.10	0.27	ND	0.18	0.05	0.076	ND	0.063
20	0.21	0.60	0.05	0.29	0.05	0.025	0.025	0.033
21	0.10	0.10	0.05	0.08	0.05	0.025	0.025	0.033
22	0.10	0.05	3.22	1.12	0.05	0.062	0.025	0.046
23	0.10	0.71	0.05	0.29	0.05	0.064	0.025	0.046
24	0.10	0.16	0.37	0.21	0.05	0.025	0.025	0.033
25	6.41	5.02	0.28	3.91	0.05	0.025	0.025	0.033
26	0.10	0.22	0.05	0.12	0.05	0.025	0.025	0.033
27	0.10	0.68	0.05	0.28	0.05	0.025	0.025	0.033
28	0.10	0.31	ND	0.21	0.05	0.025	ND	0.038
29	0.10	0.14	0.05	0.10	0.05	0.185	0.06	0.098
30	1.00	0.64	1.08	0.91	0.05	0.025	0.025	0.033
31	0.10	0.05	0.42	0.19	0.05	0.223	0.025	0.099
32	0.39	0.14	0.05	0.19	0.05	0.073	1123.00	0.415
33	0.10	0.11	0.05	0.09	0.05	0.025	0.185	0.087
34	0.10	0.91	0.16	0.39	0.05	0.254	0.051	0.118
35	0.10	0.24	0.58	0.31	0.05	0.025	0.025	0.033
36	0.40	0.82	0.24	0.49	0.285	0.418	1050.00	0.584
37	0.10	0.26	0.05	0.14	0.05	1522.00	0.057	0.543
38	0.10	0.16	0.77	0.34	0.05	0.025	0.025	0.033
39	0.10	0.63	0.05	0.26	0.05	0.025	0.025	0.033
40	0.28	0.13	0.21	0.20	0.05	0.025	0.025	0.033
41	0.10	0.34	0.05	0.16	0.05	0.025	0.089	0.055
42	0.10	0.17	0.05	0.11	0.05	0.025	0.025	0.033
43	0.10	0.28	0.05	0.14	0.05	0.162	0.025	0.079
44	0.10	0.05	0.05	0.07	0.05	0.025	0.025	0.033
45	0.10	0.05	0.05	0.07	0.05	0.095	0.025	0.057
46	0.10	0.16	0.05	0.10	0.05	0.025	0.025	0.033
47	0.10	0.21	0.05	0.12	0.05	0.025	0.025	0.033
48	0.10	1.29	0.05	0.48	0.05	0.025	0.025	0.033
49	0.10	0.05	0.05	0.07	0.05	0.025	0.025	0.033
50	0.10	0.20	0.05	0.12	0.05	0.366	0.076	0.164
51	0.10	0.05	ND	0.08	0.05	0.062	ND	0.056
52	0.10	0.05	0.05	0.07	0.05	0.085	0.025	0.053
53	0.10	0.53	0.05	0.23	0.05	0.025	0.141	0.072
54	0.34	0.11	0.05	0.16	0.05	0.093	0.077	0.073
55	0.10	0.19	0.05	0.11	0.05	0.126	0.051	0.076
56	0.10	0.55	ND	0.32	0.05	0.025	ND	0.038
57	0.10	0.27	0.05	0.14	1573.00	1111.00	0.922	1202.00
58	0.24	0.27	2.18	0.90	0.05	0.589	0.025	0.221
59	4.51	1.21	0.15	1.96	0.05	0.025	0.025	0.033

Table 18. (Continued)

	Cobalt (µg/L) (LOQ= 0.013 µg/L)				Mercury (µg/L) (LOQ= 0.1 µg/L)			
Stations	**1th period**	**2nd period**	**3rd period**	**Average**	**1th period**	**2nd period**	**3rd period**	**Average**
60	0.10	0.62	0.05	0.26	0.138	0.025	0.025	0.063
61	0.10	0.89	0.05	0.35	0.05	0.025	0.196	0.09
62	0.10	0.15	0.12	0.12	0.05	0.025	0.025	0.033
63	0.10	0.12	0.05	0.09	0.05	0.025	0.025	0.033
64	0.10	0.35	0.05	0.17	0.05	0.025	0.025	0.033
65	0.10	1.29	0.05	0.48	0.05	0.108	0.025	0.061
66	0.10	0.14	0.05	0.10	0.05	0.11	0.025	0.062
67	0.10	0.16	ND	0.13	0.05	0.085	ND	0.067
68	0.10	0.12	0.05	0.09	0.05	0.06	0.062	0.057
69	0.10	0.67	0.05	0.27	0.05	0.025	0.025	0.033
70	0.10	0.53	0.16	0.26	0.05	0.025	0.025	0.033
71	1.35	5.24	0.05	2.21	0.05	0.114	0.025	0.063
72	0.51	0.22	0.24	0.32	0.05	0.025	0.025	0.033
73	0.10	0.26	ND	0.18	0.05	0.025	ND	0.038
74	0.10	0.56	0.05	0.24	0.05	0.025	0.025	0.033
75	0.10	0.30	0.05	0.15	3446.00	2799.00	0.025	2090.00
76	0.10	0.15	0.05	0.10	0.05	0.025	0.025	0.033
77	0.10	0.21	0.19	0.17	0.05	0.025	0.025	0.033
78	0.10	0.18	0.05	0.11	0.05	0.025	0.808	0.294
79	0.10	0.12	0.05	0.09	0.05	0.025	0.025	0.033
80	0.10	0.05	0.05	0.07	0.05	0.025	0.025	0.033
81	0.10	0.50	0.05	0.22	0.05	0.025	0.025	0.033
82	0.10	0.24	0.10	0.15	0.05	0.025	0.025	0.033
83	0.10	0.23	ND	0.17	0.05	0.025	ND	0.038
84	0.10	0.54	0.05	0.23	0.05	0.025	0.025	0.033
85	0.10	0.64	0.13	0.29	0.05	0.025	0.025	0.033
86	0.10	0.63	0.05	0.26	0.05	0.025	0.025	0.033
87	0.10	0.05	0.29	0.15	0.05	0.07	0.025	0.048
88	0.10	0.16	0.14	0.13	0.05	0.104	0.025	0.06
89	0.10	0.77	0.05	0.31	0.05	0.025	0.025	0.033
90	0.10	0.05	0.05	0.07	0.05	0.025	0.058	0.044
91	0.10	0.05	0.33	0.16	0.05	0.102	0.025	0.059
92	0.10	0.19	0.05	0.11	0.05	0.025	0.025	0.033
93	0.10	0.19	0.05	0.11	0.802	1250.00	0.025	0.692
94	0.10	0.72	0.24	0.35	0.05	0.025	0.025	0.033
95	0.10	0.12	0.05	0.09	0.05	0.064	0.025	0.046
96	0.43	0.58	0.05	0.36	0.05	0.025	0.058	0.044
97	0.10	0.15	0.05	0.10	0.05	0.061	0.025	0.045
98	0.10	0.22	0.05	0.12	0.05	0.062	0.025	0.046
99	0.61	0.88	0.19	0.56	0.05	0.061	0.025	0.045
100	0.10	0.23	1.52	0.62	0.05	0.025	0.025	0.033
101	0.10	0.49	0.05	0.21	0.05	0.025	0.025	0.033

Table 18. (Continued)

	Cobalt (µg/L) (LOQ= 0.013 µg/L)				Mercury (µg/L) (LOQ= 0.1 µg/L)			
Stations	**1th period**	**2nd period**	**3rd period**	**Average**	**1th period**	**2nd period**	**3rd period**	**Average**
102	0.10	0.71	2.86	1.22	0.05	0.025	0.052	0.042
103	0.10	1.17	0.05	0.44	0.05	0.025	0.025	0.033
104	0.27	0.05	0.05	0.12	0.05	0.06	0.025	0.045
105	0.10	0.05	0.05	0.07	0.05	0.025	0.025	0.033
106	0.10	0.16	0.05	0.10	0.05	0.025	0.025	0.033
107	0.10	0.05	0.05	0.07	0.05	0.053	0.025	0.043
108	0.10	0.05	0.12	0.09	0.05	0.053	0.025	0.043
109	0.10	0.05	0.05	0.07	0.05	0.025	0.025	0.033
110	0.10	0.05	0.05	0.07	0.05	0.025	0.025	0.033

Table 19. Data of Molybdenum and Nickel (Risk Posing Parameters)

	Molybdenum (µg/L) (LOQ= 1 µg/L)				Nickel (µg/L) (LOQ= 1 µg/L)			
Stations	**1th period**	**2nd period**	**3rd period**	**Average**	**1th period**	**2nd period**	**3rd period**	**Average**
1	2.01	1.49	1.09	1.53	10.74	7.18	1.95	6.62
2	1.15	1.26	1.55	1.32	1.50	3.09	47.08	17.22
3	0.50	1.41	0.50	0.80	1.50	1.44	0.50	1.15
4	8.77	7.05	9.34	8.39	1.50	2.64	0.50	1.55
5	3.31	3.96	3.27	3.51	1.50	3.00	0.50	1.67
6	0.50	1.64	1.15	1.10	1.50	1.87	0.50	1.29
7	5.83	6.85	6.05	6.24	1.50	2.93	1.64	2.02
8	3.62	4.32	5.19	4.38	5.98	4.42	22.48	10.96
9	0.50	2.37	0.50	1.12	1.50	1.96	0.50	1.32
10	0.50	0.50	0.50	0.50	1.50	0.50	1.21	1.07
11	0.50	0.50	0.50	0.50	1.50	2.14	0.50	1.38
12	0.50	0.50	0.50	0.50	1.50	1.93	4.29	2.57
13	0.50	0.50	0.50	0.50	1.50	1.54	0.50	1.18
14	0.50	0.50	0.50	0.50	27.02	13.52	1.77	14.10
15	6.08	6.19	5.64	5.97	1.50	1.27	1.25	1.34
16	0.50	0.50	0.50	0.50	1.50	1.26	0.50	1.09
17	3.47	4.14	3.37	3.66	4.60	3.67	1.16	3.14
18	2.04	4.67	2.56	3.09	1.50	1.79	0.50	1.26
19	2.72	1.15	ND	1.94	1.50	1.16	ND	1.33
20	0.50	0.50	0.50	0.50	3.62	3.78	2.30	3.23
21	0.50	0.50	0.50	0.50	1.50	0.50	0.50	0.83
22	0.50	0.50	0.50	0.50	1.50	0.50	6.15	2.72

Table 19. (Continued)

	Molybdenum (µg/L) (LOQ= 1 µg/L)				Nickel (µg/L) (LOQ= 1 µg/L)			
Stations	**1th period**	**2nd period**	**3rd period**	**Average**	**1th period**	**2nd period**	**3rd period**	**Average**
23	0.50	0.50	0.50	0.50	1.50	5.46	0.50	2.49
24	6.53	4.78	5.80	5.70	1.50	4.32	1.93	2.58
25	0.50	4.97	1.85	2.44	32.47	27.56	1.27	20.43
26	0.50	1.81	0.50	0.94	1.50	1.76	0.50	1.25
27	6.29	5.70	2.36	4.78	1.50	2.81	0.50	1.60
28	0.50	3.93	ND	2.22	1.50	1.02	ND	1.26
29	3.70	4.32	4.01	4.01	1.50	0.50	0.50	0.83
30	85.96	64.62	1.47	50.68	19.27	23.72	2.27	15.09
31	2.23	2.21	0.50	1.65	1.50	0.50	25.87	9.29
32	2.47	1.38	0.50	1.45	1.50	0.50	2.03	1.34
33	1.93	3.20	1.26	2.13	1.50	0.50	24.33	8.78
34	1.14	1.95	1.28	1.46	1.50	4.80	0.50	2.27
35	3.22	3.82	19.46	8.83	1.50	0.50	0.50	0.83
36	7.70	4.47	8.13	6.77	1.50	0.50	2.45	1.48
37	0.50	0.50	0.50	0.50	1.50	1.16	0.50	1.05
38	30.54	26.24	34.20	30.32	1.50	0.50	2.27	1.42
39	1.07	1.22	0.50	0.93	1.50	3.90	1.26	2.22
40	5.99	5.48	5.50	5.66	1.50	2.62	2.65	2.25
41	1.72	2.65	3.32	2.56	1.50	2.99	0.50	1.66
42	0.50	0.50	0.50	0.50	4.93	5.49	5.48	5.30
43	3.06	3.52	3.32	3.30	1.50	1.02	0.50	1.01
44	2.48	2.50	2.06	2.35	1.50	1.09	0.50	1.03
45	2.47	2.57	2.11	2.38	1.50	1.03	0.50	1.01
46	0.50	0.50	0.50	0.50	1.50	1.42	0.50	1.14
47	0.50	1.34	0.50	0.78	1.50	1.79	0.50	1.26
48	0.50	0.50	0.50	0.50	1.50	6.77	2.01	3.43
49	0.50	0.50	0.50	0.50	1.50	0.50	0.50	0.83
50	2.80	1.88	2.54	2.41	1.50	0.50	1.16	1.05
51	0.50	2.45	ND	1.47	1.50	4.37	ND	2.94
52	2.81	3.58	2.01	2.80	1.50	2.65	1.75	1.96
53	0.50	0.50	1.08	0.69	1.50	3.37	6.39	3.75
54	0.50	0.50	0.50	0.50	1.50	0.50	0.50	0.83
55	0.50	0.50	0.50	0.50	1.50	0.50	2.11	1.37
56	0.50	0.50	ND	0.50	1.50	1.98	ND	1.74
57	0.50	0.50	0.50	0.50	1.50	0.50	0.50	0.83
58	0.50	0.50	0.50	0.50	1.50	0.50	3.07	1.69

Table 19. (Continued)

	Molybdenum (µg/L) (LOQ= 1 µg/L)				Nickel (µg/L) (LOQ= 1 µg/L)			
Stations	**1th period**	**2nd period**	**3rd period**	**Average**	**1th period**	**2nd period**	**3rd period**	**Average**
59	0.50	0.50	0.50	0.50	6.90	5.81	1.39	4.70
60	23.27	21.37	39.98	28.20	1.50	3.38	0.50	1.79
61	0.50	1.08	0.50	0.69	1.50	4.78	0.50	2.26
62	1.41	2.12	1.72	1.75	1.50	0.50	0.50	0.83
63	0.50	0.50	0.50	0.50	1.50	0.50	0.50	0.83
64	1.41	1.86	1.31	1.53	1.50	1.99	0.50	1.33
65	3.27	2.32	3.55	3.05	1.50	5.01	0.50	2.34
66	1.71	2.42	0.50	1.54	1.50	1.86	3.59	2.32
67	1.93	2.83	ND	2.38	1.50	0.50	ND	1.00
68	0.50	1.29	0.50	0.76	1.50	0.50	0.50	0.83
69	0.50	0.50	0.50	0.50	1.50	11.18	20.68	11.12
70	1.15	1.22	1.06	1.14	1.50	2.11	1.29	1.63
71	13.01	20.96	15.13	16.37	12.82	11.73	0.50	8.35
72	4.95	5.86	24.32	11.71	1.50	2.13	3.67	2.43
73	1.35	1.33	ND	1.34	1.50	1.09	ND	1.29
74	1.08	2.70	1.01	1.59	1.50	4.73	0.50	2.24
75	0.50	0.50	0.50	0.50	1.50	1.10	0.50	1.03
76	5.77	6.97	5.82	6.19	1.50	1.57	0.50	1.19
77	1.97	1.85	2.38	2.07	1.50	2.09	0.50	1.36
78	1.40	1.80	1.46	1.55	1.50	1.03	0.50	1.01
79	0.50	1.21	0.50	0.74	1.50	0.50	1.65	1.22
80	0.50	0.50	0.50	0.50	1.50	1.01	0.50	1.00
81	3.94	0.50	6.14	3.53	1.50	2.24	0.50	1.41
82	0.50	1.48	0.50	0.83	1.50	1.25	3.35	2.03
83	0.50	1.20	ND	0.85	1.50	1.20	ND	1.35
84	2.06	2.58	1.63	2.09	3.69	5.10	4.04	4.28
85	12.28	11.93	14.39	12.86	20.14	19.60	40.51	26.75
86	1.10	0.50	1.16	0.92	13.41	12.24	10.91	12.19
87	1.11	2.01	0.50	1.21	5.52	3.97	9.67	6.38
88	0.50	2.13	0.50	1.04	3.20	4.44	6.31	4.65
89	3.99	1.81	4.15	3.32	4.14	3.43	0.50	2.69
90	0.50	0.50	0.50	0.50	1.50	4.07	3.64	3.07
91	0.50	0.50	0.50	0.50	1.50	0.50	2.04	1.35
92	0.50	0.50	0.50	0.50	1.50	0.50	0.50	0.83
93	0.50	0.50	0.50	0.50	1.50	0.50	0.50	0.83
94	2.43	3.45	3.19	3.02	1.50	5.60	4.32	3.81

Table 19. (Continued)

	Molybdenum (µg/L) (LOQ= 1 µg/L)				Nickel (µg/L) (LOQ= 1 µg/L)			
Stations	**1th period**	**2nd period**	**3rd period**	**Average**	**1th period**	**2nd period**	**3rd period**	**Average**
95	2.75	6.32	5.05	4.71	1.50	0.50	0.50	0.83
96	2.36	3.61	3.37	3.11	4.21	2.02	1.21	2.48
97	2.60	3.88	0.50	2.33	1.50	2.83	1.17	1.83
98	0.50	0.50	0.50	0.50	1.50	4.15	1.30	2.32
99	0.50	1.67	0.50	0.89	1.50	3.76	0.50	1.92
100	2.68	3.21	1.76	2.55	4.75	2.02	204.16	70.31
101	0.50	1.51	1.08	1.03	1.50	2.45	0.50	1.48
102	9.14	7.14	0.50	5.59	1.50	3.16	17.84	7.50
103	0.50	3.52	0.50	1.51	6.95	6.53	4.52	6.00
104	0.50	6.02	6.16	4.23	1.50	0.50	0.50	0.83
105	2.23	3.12	4.15	3.17	1.50	0.50	1.61	1.20
106	2.89	2.71	2.88	2.83	1.50	0.50	0.50	0.83
107	2.35	3.04	2.00	2.46	1.50	1.11	1.59	1.40
108	2.93	3.05	2.33	2.77	1.50	0.50	0.50	0.83
109	0.50	0.50	0.50	0.50	1.50	2.53	0.50	1.51
110	0.50	1.47	16.98	6.32	1.50	1.35	0.50	1.12

Table 20. Data of Phosphorus and Sulfur (Risk Posing Parameters)

	Phosphorus (µg/L) (LOQ= 1 µg/L)				Sulfur (mg/L) (LOQ= 0.01 mg/L)			
Stations	**1th period**	**2nd period**	**3rd period**	**Average**	**1th period**	**2nd period**	**3rd period**	**Average**
1	621.86	513.46	407.21	514.18	0.005	0.005	0.005	0.005
2	95.43	78.99	116.17	96.87	0.005	0.005	0.005	0.005
3	12.05	17.14	20.11	16.43	0.005	0.005	0.005	0.005
4	22.10	16.91	3.64	14.21	0.005	0.005	0.005	0.005
5	0.50	0.50	0.50	0.50	0.005	0.005	0.005	0.005
6	3.02	3.72	0.50	2.41	0.005	0.005	0.005	0.005
7	449.06	232.73	156.40	279.39	0.005	0.005	0.005	0.005
8	423.94	560.78	118.54	367.75	0.005	0.005	0.005	0.005
9	77.35	101.54	11.17	63.36	0.005	0.005	0.005	0.005
10	3.01	2.40	0.50	1.97	0.005	0.005	0.005	0.005
11	0.50	2.41	0.50	1.14	0.005	0.005	0.005	0.005
12	0.50	1.83	3.94	2.09	0.005	0.005	0.005	0.005
13	0.50	3.11	0.50	1.37	0.005	0.005	0.005	0.005
14	274.25	310.44	162.60	249.10	0.005	0.005	0.005	0.005
15	26.12	13.77	40.22	26.70	0.005	0.005	0.005	0.005
16	24.11	23.43	5.94	17.82	0.005	0.005	0.005	0.005

Table 20. (Continued)

	Phosphorus (µg/L) (LOQ= 1 µg/L)				Sulfur (mg/L) (LOQ= 0.01 mg/L)			
Stations	**1th period**	**2nd period**	**3rd period**	**Average**	**1th period**	**2nd period**	**3rd period**	**Average**
17	0.50	3.02	5.24	2.92	0.005	0.005	0.005	0.005
18	123.56	181.65	192.13	165.78	0.005	0.005	0.013	0.008
19	26.12	27.72	ND	26.92	0.005	0.005	0.005	0.005
20	31.14	30.16	21.64	27.65	0.930	0.005	0.005	0.313
21	15.07	13.23	4.29	10.87	0.005	0.005	0.005	0.005
22	0.50	1.04	1.92	1.15	0.005	0.005	0.005	0.005
23	11.05	14.02	21.26	15.44	0.005	0.005	0.005	0.005
24	23.11	12.00	14.65	16.58	0.005	0.005	0.005	0.005
25	638.94	452.71	164.75	418.80	0.005	0.005	0.005	0.005
26	22.10	18.89	20.11	20.37	0.005	0.005	0.005	0.005
27	48.22	69.27	47.18	54.89	0.005	0.005	0.005	0.005
28	42.19	35.78	ND	38.98	0.005	0.005	0.005	0.005
29	44.20	33.95	17.13	31.76	0.005	0.005	0.005	0.005
30	47.22	28.96	66.60	47.59	0.005	0.005	0.005	0.005
31	0.50	3.13	13.40	5.68	0.005	0.005	0.005	0.005
32	98.45	137.42	67.19	101.02	0.005	0.005	0.005	0.005
33	26.12	36.03	22.87	28.34	0.005	0.005	0.005	0.005
34	6.03	3.92	0.50	3.48	0.040	0.005	0.005	0.017
35	720.32	919.85	250.22	630.13	0.005	0.005	0.005	0.005
36	58.27	38.97	21.84	39.69	0.005	0.005	0.005	0.005
37	12.06	6.28	6.70	8.35	0.005	0.005	0.005	0.005
38	0.50	3.11	20.11	7.91	0.005	0.005	0.005	0.005
39	29.13	30.00	7.40	22.18	0.005	0.005	0.005	0.005
40	35.16	39.20	41.38	38.58	0.005	0.005	0.005	0.005
41	31.14	26.94	24.68	27.59	0.005	0.005	0.005	0.005
42	0.50	1.37	0.50	0.79	0.005	0.005	0.005	0.005
43	18.08	23.39	5.86	15.78	0.005	0.005	0.005	0.005
44	9.04	11.73	9.75	10.17	0.005	0.005	0.005	0.005
45	3.01	3.29	0.50	2.27	0.005	0.005	0.005	0.005
46	65.30	45.40	35.40	48.70	0.005	0.005	0.005	0.005
47	20.09	30.07	18.83	23.00	0.005	0.005	0.005	0.005
48	62.28	45.00	47.06	51.45	0.005	0.005	0.005	0.005
49	6.03	7.43	1.74	5.07	0.005	0.005	0.005	0.005
50	21.10	26.95	8.71	18.92	0.005	0.005	0.005	0.005
51	14.06	18.14	ND	16.10	0.005	0.005	ND	0.005
52	0.50	1.51	0.50	0.84	0.005	0.005	0.005	0.005
53	32.15	45.07	46.92	41.38	0.005	0.005	0.005	0.005
54	0.50	1.73	8.94	3.72	0.005	0.005	0.005	0.005
55	8.04	6.04	0.50	4.86	0.005	0.005	0.005	0.005
56	103.47	140.57	ND	122.02	0.005	0.005	ND	0.005
57	0.50	2.28	0.50	1.09	0.005	0.005	0.005	0.005
58	54.25	42.32	56.92	51.16	0.005	0.005	0.005	0.005

Table 20. (Continued)

	Phosphorus (μg/L) (LOQ= 1 μg/L)				Sulfur (mg/L) (LOQ= 0.01 mg/L)			
Stations	**1th period**	**2nd period**	**3rd period**	**Average**	**1th period**	**2nd period**	**3rd period**	**Average**
59	77.35	53.38	21.19	50.64	0.005	0.005	0.005	0.005
60	92.42	124.47	63.57	93.49	0.005	0.005	0.015	0.008
61	6.03	6.79	11.09	7.97	0.005	0.005	0.005	0.005
62	60.28	79.48	0.50	46.75	0.005	0.005	0.010	0.007
63	20.09	12.36	0.50	10.98	0.005	0.005	0.005	0.005
64	10.05	6.34	0.50	5.63	0.005	0.005	0.005	0.005
65	132.60	174.59	73.73	126.97	0.005	0.005	0.005	0.005
66	55.25	39.27	0.50	31.67	0.005	0.005	0.005	0.005
67	0.50	3.06	ND	1.78	0.005	0.005	ND	0.005
68	0.50	2.94	0.50	1.31	0.005	0.005	0.005	0.005
69	0.50	1.97	0.50	0.99	0.005	0.005	0.005	0.005
70	187.86	236.52	15.64	146.67	0.005	0.005	0.005	0.005
71	1902.99	2661.24	0.50	1521.57	0.005	0.005	0.005	0.005
72	28.13	38.98	0.50	22.54	0.005	0.005	0.005	0.005
73	0.50	0.50	ND	0.50	0.005	0.005	ND	0.005
74	91.42	112.36	140.75	114.84	0.005	0.005	0.005	0.005
75	24.11	33.21	0.50	19.27	0.005	0.005	0.005	0.005
76	68.31	37.14	15.64	40.36	0.005	0.005	0.005	0.005
77	57.26	73.96	98.30	76.51	0.005	0.005	0.005	0.005
78	32.15	42.43	0.50	25.02	0.005	0.005	0.005	0.005
79	51.23	73.91	6.70	43.95	0.005	0.005	0.005	0.005
80	20.09	25.38	11.17	18.88	0.005	0.005	0.005	0.005
81	74.34	45.25	31.63	50.41	0.005	0.005	0.005	0.005
82	65.30	84.04	0.50	49.95	0.005	0.005	0.005	0.005
83	0.50	2.37	ND	1.44	0.005	0.005	0.005	0.005
84	80.37	75.22	0.50	52.03	0.005	0.005	0.005	0.005
85	36.17	35.06	33.51	34.91	0.170	0.005	0.005	0.060
86	0.50	1.77	0.50	0.92	0.760	1.022	0.005	0.596
87	11.05	15.37	0.50	8.97	0.005	0.005	0.005	0.005
88	0.50	1.97	0.50	0.99	0.005	0.005	0.005	0.005
89	10.05	10.19	16.27	12.17	0.005	0.005	0.005	0.005
90	9.04	8.48	3.57	7.03	0.005	0.005	0.005	0.005
91	0.50	1.72	0.50	0.91	0.005	0.005	0.005	0.005
92	31.14	35.50	33.16	33.27	0.005	0.005	0.005	0.005
93	28.13	19.39	11.38	19.64	1.270	0.013	0.005	0.429
94	21.10	28.68	34.00	27.93	0.005	0.005	0.005	0.005
95	180.82	231.47	94.35	168.88	0.005	0.012	0.005	0.007
96	98.45	147.17	86.70	110.77	0.005	0.005	0.005	0.005
97	28.13	35.55	18.92	27.53	0.005	0.005	0.017	0.009
98	7.03	7.06	13.72	9.27	0.005	0.005	0.005	0.005
99	7.03	4.25	0.50	3.93	0.005	0.005	0.005	0.005
100	0.50	1.01	0.50	0.67	0.005	0.005	0.005	0.005

Table 20. (Continued)

	Phosphorus (µg/L) (LOQ= 1 µg/L)				Sulfur (mg/L) (LOQ= 0.01 mg/L)			
Stations	**1th period**	**2nd period**	**3rd period**	**Average**	**1th period**	**2nd period**	**3rd period**	**Average**
101	0.50	2.42	0.50	1.14	0.005	0.005	0.005	0.005
102	16.07	8.22	1.05	8.45	0.005	0.005	0.005	0.005
103	7.03	8.95	8.94	8.31	0.005	0.005	0.005	0.005
104	21.10	13.33	33.51	22.64	0.005	0.013	0.005	0.008
105	20.09	12.40	4.84	12.44	0.005	0.005	0.005	0.005
106	6.03	7.85	5.17	6.35	0.005	0.005	0.005	0.005
107	26.12	19.01	11.19	18.77	0.005	0.005	0.005	0.005
108	27.12	28.33	5.75	20.40	0.005	0.005	0.005	0.005
109	13.06	18.45	24.57	18.70	0.005	0.005	0.005	0.005
110	11.05	7.09	2.23	6.79	0.005	0.005	0.005	0.005

Table 21. Data of Boron and Selenium (Risk Posing Parameters)

	Boron (µg/L) (LOQ= 500 µg/L)				Selenium (µg/L) (LOQ= 5 µg/L)			
Stations	**1th period**	**2nd period**	**3rd period**	**Average**	**1th period**	**2nd period**	**3rd period**	**Average**
1	250.00	250.00	250.00	250.00	2.50	2.50	2.50	2.50
2	250.00	250.00	250.00	250.00	2.50	2.50	2.50	2.50
3	250.00	250.00	250.00	250.00	2.50	2.50	2.50	2.50
4	250.00	250.00	250.00	250.00	2.50	2.50	2.50	2.50
5	250.00	250.00	250.00	250.00	2.50	2.50	2.50	2.50
6	250.00	250.00	250.00	250.00	2.50	2.50	2.50	2.50
7	935.07	19855.68	738.66	7176.47	2.50	2.50	2.50	2.50
8	1152.37	1109.45	1055.15	1105.66	2.50	2.50	42.49	15.83
9	250.00	250.00	250.00	250.00	2.50	2.50	2.50	2.50
10	250.00	250.00	250.00	250.00	2.50	2.50	2.50	2.50
11	250.00	250.00	250.00	250.00	2.50	2.50	2.50	2.50
12	250.00	250.00	250.00	250.00	2.50	2.50	2.50	2.50
13	250.00	250.00	250.00	250.00	2.50	2.50	2.50	2.50
14	250.00	250.00	250.00	250.00	8.98	2.50	2.50	4.66
15	250.00	250.00	250.00	250.00	2.50	2.50	2.50	2.50
16	250.00	250.00	250.00	250.00	2.50	2.50	2.50	2.50
17	250.00	250.00	250.00	250.00	2.50	2.50	2.50	2.50
18	250.00	250.00	250.00	250.00	2.50	2.50	2.50	2.50
19	250.00	250.00	ND	250.00	6.68	2.50	ND	4.59
20	250.00	250.00	250.00	250.00	2.50	2.50	2.50	2.50
21	250.00	250.00	250.00	250.00	2.50	2.50	2.50	2.50
22	250.00	250.00	250.00	250.00	2.50	2.50	2.50	2.50
23	250.00	250.00	250.00	250.00	2.50	2.50	2.50	2.50
24	250.00	250.00	250.00	250.00	5.85	2.50	2.50	3.62

Table 21. (Continued)

Stations	Boron (µg/L) (LOQ= 500 µg/L)				Selenium (µg/L) (LOQ= 5 µg/L)			
	1th period	2nd period	3rd period	Average	1th period	2nd period	3rd period	Average
25	250.00	798.24	250.00	432.75	2.50	2.50	2.50	2.50
26	250.00	250.00	250.00	250.00	2.50	2.50	2.50	2.50
27	250.00	250.00	250.00	250.00	9.84	5.22	2.50	5.85
28	250.00	250.00	ND	250.00	2.50	2.50	ND	2.50
29	250.00	250.00	250.00	250.00	2.50	2.50	2.50	2.50
30	250.00	250.00	250.00	250.00	2.50	2.50	2.50	2.50
31	250.00	250.00	250.00	250.00	2.50	2.50	2.50	2.50
32	250.00	250.00	250.00	250.00	2.50	2.50	2.50	2.50
33	250.00	250.00	250.00	250.00	2.50	2.50	2.50	2.50
34	951.47	250.00	250.00	483.82	2.50	2.50	2.50	2.50
35	250.00	250.00	250.00	250.00	2.50	2.50	2.50	2.50
36	937.59	1612.81	685.90	1078.77	2.50	2.50	2.50	2.50
37	250.00	250.00	250.00	250.00	2.50	2.50	2.50	2.50
38	857.18	1360.07	1278.63	1165.30	2.50	2.50	2.50	2.50
39	250.00	250.00	250.00	250.00	13.20	2.50	2.50	6.07
40	250.00	250.00	250.00	250.00	11.58	2.50	14.81	9.63
41	250.00	555.49	250.00	351.83	2.50	2.50	2.50	2.50
42	250.00	250.00	250.00	250.00	2.50	2.50	2.50	2.50
43	250.00	250.00	250.00	250.00	2.50	2.50	2.50	2.50
44	250.00	250.00	250.00	250.00	2.50	2.50	2.50	2.50
45	250.00	250.00	250.00	250.00	2.50	2.50	2.50	2.50
46	250.00	250.00	250.00	250.00	2.50	2.50	2.50	2.50
47	250.00	250.00	250.00	250.00	2.50	2.50	2.50	2.50
48	250.00	250.00	250.00	250.00	2.50	2.50	2.50	2.50
49	250.00	250.00	250.00	250.00	2.50	2.50	2.50	2.50
50	250.00	250.00	250.00	250.00	2.50	2.50	2.50	2.50
51	250.00	250.00	ND	250.00	2.50	2.50	ND	2.50
52	250.00	250.00	250.00	250.00	2.50	7.92	2.50	4.31
53	250.00	250.00	250.00	250.00	2.50	2.50	2.50	2.50
54	250.00	250.00	250.00	250.00	2.50	2.50	2.50	2.50
55	250.00	250.00	250.00	250.00	2.50	2.50	2.50	2.50
56	250.00	250.00	ND	250.00	2.50	2.50		2.50
57	250.00	250.00	250.00	250.00	2.50	2.50	2.50	2.50
58	250.00	250.00	250.00	250.00	2.50	2.50	2.50	2.50
59	250.00	250.00	250.00	250.00	2.50	2.50	2.50	2.50
60	250.00	250.00	250.00	250.00	2.50	2.50	2.50	2.50
61	250.00	250.00	250.00	250.00	2.50	2.50	2.50	2.50
62	250.00	596.01	250.00	365.34	2.50	2.50	2.50	2.50
63	250.00	250.00	250.00	250.00	2.50	2.50	2.50	2.50
64	250.00	250.00	250.00	250.00	2.50	2.50	2.50	2.50
65	1799.06	1189.69	1846.78	1611.84	2.50	2.50	2.50	2.50
66	250.00	250.00	250.00	250.00	2.50	2.50	2.50	2.50

Table 21. (Continued)

	Boron (µg/L) (LOQ= 500 µg/L)				Selenium (µg/L) (LOQ= 5 µg/L)			
Stations	**1th period**	**2nd period**	**3rd period**	**Average**	**1th period**	**2nd period**	**3rd period**	**Average**
67	250.00	250.00	ND	250.00	2.50	7.03	ND	4.77
68	250.00	250.00	250.00	250.00	2.50	2.50	2.50	2.50
69	250.00	250.00	250.00	250.00	2.50	2.50	2.50	2.50
70	250.00	250.00	250.00	250.00	2.50	2.50	5.16	3.39
71	250.00	250.00	250.00	250.00	2.50	2.50	2.50	2.50
72	250.00	250.00	250.00	250.00	2.50	2.50	2.50	2.50
73	250.00	250.00	ND	250.00	2.50	2.50	ND	2.50
74	250.00	250.00	250.00	250.00	2.50	2.50	2.50	2.50
75	250.00	250.00	250.00	250.00	2.50	2.50	2.50	2.50
76	250.00	250.00	250.00	250.00	2.50	2.50	2.50	2.50
77	250.00	250.00	250.00	250.00	2.50	2.50	2.50	2.50
78	250.00	250.00	250.00	250.00	2.50	2.50	2.50	2.50
79	250.00	250.00	250.00	250.00	2.50	2.50	5.05	3.35
80	250.00	250.00	250.00	250.00	2.50	2.50	2.50	2.50
81	250.00	250.00	250.00	250.00	2.50	2.50	2.50	2.50
82	250.00	250.00	250.00	250.00	2.50	2.50	2.50	2.50
83	250.00	250.00	ND	250.00	2.50	2.50	ND	2.50
84	250.00	250.00	250.00	250.00	2.50	2.50	2.50	2.50
85	1527.11	1525.27	661.28	1237.89	2.50	2.50	2.50	2.50
86	250.00	250.00	250.00	250.00	2.50	2.50	2.50	2.50
87	504.04	250.00	250.00	334.68	2.50	2.50	2.50	2.50
88	250.00	250.00	250.00	250.00	2.50	2.50	2.50	2.50
89	250.00	250.00	250.00	250.00	2.50	2.50	2.50	2.50
90	250.00	250.00	250.00	250.00	2.50	2.50	2.50	2.50
91	250.00	250.00	250.00	250.00	2.50	2.50	2.50	2.50
92	250.00	250.00	250.00	250.00	2.50	2.50	2.50	2.50
93	250.00	509.92	250.00	336.64	2.50	2.50	2.50	2.50
94	250.00	250.00	250.00	250.00	2.50	2.50	2.50	2.50
95	250.00	250.00	250.00	250.00	2.50	2.50	2.50	2.50
96	250.00	250.00	250.00	250.00	2.50	2.50	2.50	2.50
97	4098.06	3617.71	250.00	2655.26	2.50	2.50	2.50	2.50
98	250.00	250.00	250.00	250.00	2.50	2.50	2.50	2.50
99	250.00	250.00	250.00	250.00	2.50	2.50	2.50	2.50
100	250.00	1476.05	250.00	658.68	2.50	2.50	2.50	2.50
101	250.00	250.00	250.00	250.00	2.50	2.50	2.50	2.50
102	250.00	250.00	250.00	250.00	2.50	2.50	2.50	2.50
103	250.00	250.00	250.00	250.00	2.50	2.50	2.50	2.50
104	250.00	250.00	250.00	250.00	2.50	2.50	2.50	2.50
105	250.00	250.00	250.00	250.00	2.50	2.50	2.50	2.50
106	250.00	250.00	250.00	250.00	2.50	2.50	2.50	2.50
107	250.00	250.00	250.00	250.00	2.50	2.50	2.50	2.50
108	250.00	250.00	250.00	250.00	2.50	2.50	2.50	2.50

Table 21. (Continued)

	Boron (µg/L) (LOQ= 500 µg/L)				Selenium (µg/L) (LOQ= 5 µg/L)			
Stations	**1th period**	**2nd period**	**3rd period**	**Average**	**1th period**	**2nd period**	**3rd period**	**Average**
109	250.00	250.00	250.00	250.00	2.50	2.50	2.50	2.50
110	7278.54	4118.44	250.00	3882.33	2.50	2.50	2.50	2.50

Table 22. Data of Fluoride and Cyanide (Non Risk Posing Parameters)

	Fluoride (mg/L) (LOQ= 0.2 mg/L)				Cyanide (mg/L) (LOQ= 0.013 mg/L)			
Stations	**1th period**	**2nd period**	**3rd period**	**Average**	**1th period**	**2nd period**	**3rd period**	**Average**
1	0.10	0.10	0.10	0.10	0.01	0.01	0.01	0.01
2	0.10	0.10	0.10	0.10	0.01	0.01	0.01	0.01
3	0.10	0.10	0.10	0.10	0.01	0.01	0.01	0.01
4	0.10	0.10	0.10	0.10	0.01	0.01	0.01	0.01
5	0.10	0.10	0.10	0.10	0.01	0.01	0.01	0.01
6	0.10	0.10	0.10	0.10	0.01	0.01	0.01	0.01
7	0.10	0.10	0.10	0.10	0.01	0.01	0.01	0.01
8	0.10	0.10	0.10	0.10	0.01	0.01	0.01	0.01
9	0.10	0.10	0.10	0.10	0.01	0.01	0.01	0.01
10	0.10	0.10	0.10	0.10	0.01	0.01	0.01	0.01
11	0.10	0.10	0.10	0.10	0.01	0.01	0.01	0.01
12	0.10	0.10	0.10	0.10	0.01	0.01	0.01	0.01
13	0.10	0.10	0.10	0.10	0.01	0.01	0.01	0.01
14	0.10	0.10	0.10	0.10	0.01	0.01	0.01	0.01
15	0.10	0.10	0.10	0.10	0.01	0.01	0.01	0.01
16	0.10	0.10	0.10	0.10	0.01	0.01	0.01	0.01
17	0.10	0.10	0.10	0.10	0.01	0.01	0.01	0.01
18	0.10	0.10	0.10	0.10	0.01	0.01	0.01	0.01
19	0.10	0.10	0.10	0.10	0.01	0.01	0.01	0.01
20	0.10	0.10	0.10	0.10	0.01	0.01	0.01	0.01
21	0.10	0.10	0.10	0.10	0.01	0.01	0.01	0.01
22	0.10	0.10	0.10	0.10	0.01	0.01	0.01	0.01
23	0.10	0.10	0.10	0.10	0.01	0.01	0.01	0.01
24	0.10	0.10	0.10	0.10	0.01	0.01	0.01	0.01
25	0.10	0.10	0.10	0.10	0.01	0.01	0.01	0.01
26	0.10	0.10	0.10	0.10	0.01	0.01	0.01	0.01
27	0.10	0.10	0.10	0.10	0.01	0.01	0.01	0.01
28	0.10	0.10	0.10	0.10	0.01	0.01	0.01	0.01

Table 22. (Continued)

	Fluoride (mg/L) (LOQ= 0.2 mg/L)				Cyanide (mg/L) (LOQ= 0.013 mg/L)			
Stations	**1th period**	**2nd period**	**3rd period**	**Average**	**1th period**	**2nd period**	**3rd period**	**Average**
29	0.10	0.10	0.10	0.10	0.01	0.01	0.01	0.01
30	0.10	0.10	0.10	0.10	0.01	0.01	0.01	0.01
31	0.10	0.10	0.10	0.10	0.01	0.01	0.01	0.01
32	0.10	0.10	0.10	0.10	0.01	0.01	0.01	0.01
33	0.10	0.10	0.10	0.10	0.01	0.01	0.01	0.01
34	0.10	0.10	0.10	0.10	0.01	0.01	0.01	0.01
35	0.10	0.10	0.10	0.10	0.01	0.01	0.01	0.01
36	0.10	0.10	0.10	0.10	0.01	0.01	0.01	0.01
37	0.10	0.10	0.10	0.10	0.01	0.01	0.01	0.01
38	0.10	0.10	0.10	0.10	0.01	0.01	0.01	0.01
39	0.10	0.10	0.10	0.10	0.01	0.01	0.01	0.01
40	0.10	0.10	0.10	0.10	0.01	0.01	0.01	0.01
41	0.10	0.10	0.10	0.10	0.01	0.01	0.01	0.01
42	0.10	0.10	0.10	0.10	0.01	0.01	0.01	0.01
43	0.10	0.10	0.10	0.10	0.01	0.01	0.01	0.01
44	0.10	0.10	0.10	0.10	0.01	0.01	0.01	0.01
45	0.10	0.10	0.10	0.10	0.01	0.01	0.01	0.01
46	0.10	0.10	0.10	0.10	0.01	0.01	0.01	0.01
47	0.10	0.10	0.10	0.10	0.01	0.01	0.01	0.01
48	0.10	0.10	0.10	0.10	0.01	0.01	0.01	0.01
49	0.10	0.10	0.10	0.10	0.01	0.01	0.01	0.01
50	0.10	0.10	0.10	0.10	0.01	0.01	0.01	0.01
51	0.10	0.10	ND	0.10	0.01	0.01	ND	0.01
52	0.10	0.10	0.10	0.10	0.01	0.01	0.01	0.01
53	0.10	0.10	0.10	0.10	0.01	0.01	0.01	0.01
54	0.10	0.10	0.10	0.10	0.01	0.01	0.01	0.01
55	0.10	0.10	0.10	0.10	0.01	0.01	0.01	0.01
56	0.10	0.10	ND	0.10	0.01	0.01	ND	0.01
57	0.10	0.10	0.10	0.10	0.01	0.01	0.01	0.01
58	0.10	0.10	0.10	0.10	0.01	0.01	0.01	0.01
59	0.10	0.10	0.10	0.10	0.01	0.01	0.01	0.01
60	0.10	0.10	0.10	0.10	0.01	0.01	0.01	0.01
61	0.10	0.10	0.10	0.10	0.01	0.01	0.01	0.01
62	0.10	0.10	0.10	0.10	0.01	0.01	0.01	0.01
63	0.10	0.10	0.10	0.10	0.01	0.01	0.01	0.01
64	0.10	0.10	0.10	0.10	0.01	0.01	0.01	0.01

Table 22. (Continued)

	Fluoride (mg/L) (LOQ= 0.2 mg/L)				Cyanide (mg/L) (LOQ= 0.013 mg/L)			
Stations	**1th period**	**2nd period**	**3rd period**	**Average**	**1th period**	**2nd period**	**3rd period**	**Average**
65	0.10	0.10	0.10	0.10	0.01	0.01	0.01	0.01
66	0.10	0.10	0.10	0.10	0.01	0.01	0.01	0.01
67	0.10	0.10	ND	0.10	0.01	0.01	ND	0.01
68	0.10	0.10	0.10	0.10	0.01	0.01	0.01	0.01
69	0.10	0.10	0.10	0.10	0.01	0.01	0.01	0.01
70	0.10	0.10	0.10	0.10	0.01	0.01	0.01	0.01
71	0.10	0.10	0.10	0.10	0.01	0.01	0.01	0.01
72	0.10	0.10	0.10	0.10	0.01	0.01	0.01	0.01
73	0.10	0.10	ND	0.10	0.01	0.01	ND	0.01
74	0.10	0.10	0.10	0.10	0.01	0.01	0.01	0.01
75	0.10	0.10	0.10	0.10	0.01	0.01	0.01	0.01
76	0.10	0.10	0.10	0.10	0.01	0.01	0.01	0.01
77	0.10	0.10	0.10	0.10	0.01	0.01	0.01	0.01
78	0.10	0.10	0.10	0.10	0.01	0.01	0.01	0.01
79	0.10	0.10	0.10	0.10	0.01	0.01	0.01	0.01
80	0.10	0.10	0.10	0.10	0.01	0.01	0.01	0.01
81	0.10	0.10	0.10	0.10	0.01	0.01	0.01	0.01
82	0.10	0.10	0.10	0.10	0.01	0.01	0.01	0.01
83	0.10	0.10	0.10	0.10	0.01	0.01	0.01	0.01
84	0.10	0.10	0.10	0.10	0.01	0.01	0.01	0.01
85	0.10	0.10	0.10	0.10	0.01	0.01	0.01	0.01
86	0.10	0.10	0.10	0.10	0.01	0.01	0.01	0.01
87	0.10	0.10	0.10	0.10	0.01	0.01	0.01	0.01
88	0.10	0.10	0.10	0.10	0.01	0.01	0.01	0.01
89	0.10	0.10	0.10	0.10	0.01	0.01	0.01	0.01
90	0.10	0.10	0.10	0.10	0.01	0.01	0.01	0.01
91	0.10	0.10	0.10	0.10	0.01	0.01	0.01	0.01
92	0.10	0.10	0.10	0.10	0.01	0.01	0.01	0.01
93	0.10	0.10	0.10	0.10	0.01	0.01	0.01	0.01
94	0.10	0.10	0.10	0.10	0.01	0.01	0.01	0.01
95	0.10	0.10	0.10	0.10	0.01	0.01	0.01	0.01
96	0.10	0.10	0.10	0.10	0.01	0.01	0.01	0.01
97	0.10	0.10	0.10	0.10	0.01	0.01	0.01	0.01
98	0.10	0.10	0.10	0.10	0.01	0.01	0.01	0.01
99	0.10	0.10	0.10	0.10	0.01	0.01	0.01	0.01
100	0.10	0.10	0.10	0.10	0.01	0.01	0.01	0.01

Table 22. (Continued)

	Fluoride (mg/L) (LOQ= 0.2 mg/L)				Cyanide (mg/L) (LOQ= 0.013 mg/L)			
Stations	1th period	2nd period	3rd period	Average	1th period	2nd period	3rd period	Average
101	0.10	0.10	0.10	0.10	0.01	0.01	0.01	0.01
102	0.10	0.10	0.10	0.10	0.01	0.01	0.01	0.01
103	0.10	0.10	0.10	0.10	0.01	0.01	0.01	0.01
104	0.10	0.10	0.10	0.10	0.01	0.01	0.01	0.01
105	0.10	0.10	0.10	0.10	0.01	0.01	0.01	0.01
106	0.10	0.10	0.10	0.10	0.01	0.01	0.01	0.01
107	0.10	0.10	0.10	0.10	0.01	0.01	0.01	0.01
108	0.10	0.10	0.10	0.10	0.01	0.01	0.01	0.01
109	0.10	0.10	0.10	0.10	0.01	0.01	0.01	0.01
110	0.79	0.10	0.10	0.33	0.01	0.01	0.01	0.01

Table 23. Data of Barium and Beryllium (Non Risk Posing Parameters)

	Barium (µg/L) (LOQ= 500 µg/L)				Beryllium (µg/L) (LOQ= 1 µg/L)			
Stations	1th period	2nd period	3rd period	Average	1th period	2nd period	3rd period	Average
1	250.00	250.00	250.00	250.00	0.50	0.50	0.50	0.50
2	250.00	250.00	250.00	250.00	0.50	0.50	0.50	0.50
3	250.00	250.00	250.00	250.00	0.50	0.50	0.50	0.50
4	250.00	250.00	250.00	250.00	0.50	0.50	0.50	0.50
5	250.00	250.00	250.00	250.00	0.50	0.50	0.50	0.50
6	250.00	250.00	250.00	250.00	0.50	1.16	0.50	0.72
7	523.16	250.00	723.36	498.84	0.50	0.50	0.50	0.50
8	250.00	535.25	250.00	345.08	0.50	0.50	21.13	7.38
9	250.00	250.00	250.00	250.00	0.50	0.50	0.50	0.50
10	250.00	250.00	250.00	250.00	0.50	0.50	0.50	0.50
11	250.00	250.00	250.00	250.00	0.50	0.50	0.50	0.50
12	250.00	250.00	250.00	250.00	0.50	0.50	0.50	0.50
13	250.00	250.00	250.00	250.00	0.50	0.50	0.50	0.50
14	250.00	250.00	250.00	250.00	0.50	0.50	0.50	0.50
15	250.00	250.00	250.00	250.00	0.50	0.50	0.50	0.50
16	250.00	250.00	250.00	250.00	0.50	0.50	0.50	0.50
17	250.00	250.00	250.00	250.00	0.50	0.50	0.50	0.50
18	250.00	250.00	250.00	250.00	0.50	0.50	0.50	0.50
19	250.00	250.00	ND	250.00	0.50	0.50	ND	0.50
20	250.00	250.00	250.00	250.00	0.50	1.37	0.50	0.79

Table 23. (Continued)

	Barium (µg/L) (LOQ= 500 µg/L)				Beryllium (µg/L) (LOQ= 1 µg/L)			
Stations	**1th period**	**2nd period**	**3rd period**	**Average**	**1th period**	**2nd period**	**3rd period**	**Average**
21	250.00	250.00	250.00	250.00	0.50	1.20	0.50	0.73
22	250.00	250.00	250.00	250.00	0.50	0.50	0.50	0.50
23	683.29	250.00	746.81	560.03	0.50	0.50	0.50	0.50
24	250.00	250.00	250.00	250.00	0.50	1.20	0.50	0.73
25	250.00	250.00	250.00	250.00	1.38	0.50	0.50	0.79
26	250.00	250.00	250.00	250.00	0.50	0.50	0.50	0.50
27	250.00	250.00	250.00	250.00	0.50	0.50	0.50	0.50
28	250.00	250.00	ND	250.00	0.50	0.50	ND	0.50
29	250.00	250.00	250.00	250.00	0.50	0.50	0.50	0.50
30	250.00	250.00	250.00	250.00	0.50	0.50	0.50	0.50
31	250.00	250.00	250.00	250.00	0.50	0.50	0.50	0.50
32	250.00	250.00	250.00	250.00	0.50	0.50	0.50	0.50
33	250.00	250.00	250.00	250.00	0.50	0.50	0.50	0.50
34	250.00	250.00	250.00	250.00	0.50	0.50	0.50	0.50
35	250.00	250.00	514.48	338.16	0.50	0.50	0.50	0.50
36	250.00	505.26	250.00	335.09	0.50	0.50	0.50	0.50
37	250.00	250.00	250.00	250.00	0.50	0.50	0.50	0.50
38	250.00	250.00	250.00	250.00	0.50	0.50	0.50	0.50
39	534.24	250.00	250.00	344.75	0.50	0.50	0.50	0.50
40	250.00	250.00	250.00	250.00	0.50	0.50	0.50	0.50
41	250.00	250.00	250.00	250.00	0.50	0.50	0.50	0.50
42	250.00	250.00	250.00	250.00	0.50	0.50	0.50	0.50
43	250.00	250.00	250.00	250.00	0.50	0.50	0.50	0.50
44	250.00	250.00	250.00	250.00	0.50	0.50	0.50	0.50
45	250.00	250.00	250.00	250.00	0.50	0.50	0.50	0.50
46	250.00	250.00	250.00	250.00	0.50	2.20	0.50	1.07
47	250.00	250.00	250.00	250.00	0.50	0.50	0.50	0.50
48	250.00	250.00	250.00	250.00	0.50	0.50	0.50	0.50
49	250.00	250.00	250.00	250.00	0.50	0.50	0.50	0.50
50	250.00	250.00	250.00	250.00	0.50	0.50	0.50	0.50
51	250.00	250.00	ND	250.00	0.50	0.50	ND	0.50
52	250.00	250.00	250.00	250.00	0.50	0.50	0.50	0.50
53	250.00	250.00	250.00	250.00	0.50	2.05	0.50	1.02
54	250.00	250.00	250.00	250.00	0.50	0.50	0.50	0.50
55	250.00	250.00	250.00	250.00	0.50	0.50	0.50	0.50
56	250.00	250.00	ND	250.00	0.50	0.50	ND	0.50

Table 23. (Continued)

	Barium (µg/L) (LOQ= 500 µg/L)				Beryllium (µg/L) (LOQ= 1 µg/L)			
Stations	**1th period**	**2nd period**	**3rd period**	**Average**	**1th period**	**2nd period**	**3rd period**	**Average**
57	250.00	250.00	250.00	250.00	0.50	0.50	0.50	0.50
58	250.00	250.00	250.00	250.00	0.50	0.50	0.50	0.50
59	250.00	250.00	250.00	250.00	0.50	0.50	0.50	0.50
60	250.00	250.00	250.00	250.00	0.50	0.50	0.50	0.50
61	250.00	250.00	250.00	250.00	0.50	0.50	0.50	0.50
62	250.00	250.00	250.00	250.00	0.50	0.50	0.50	0.50
63	250.00	250.00	250.00	250.00	0.50	0.50	0.50	0.50
64	250.00	250.00	250.00	250.00	0.50	0.50	0.50	0.50
65	250.00	250.00	250.00	250.00	0.50	0.50	0.50	0.50
66	250.00	250.00	250.00	250.00	0.50	0.50	0.50	0.50
67	250.00	250.00	ND	250.00	0.50	0.50	ND	0.50
68	250.00	250.00	250.00	250.00	0.50	0.50	0.50	0.50
69	250.00	250.00	250.00	250.00	0.50	0.50	0.50	0.50
70	250.00	250.00	250.00	250.00	0.50	0.50	0.50	0.50
71	250.00	250.00	250.00	250.00	0.50	0.50	0.50	0.50
72	250.00	250.00	250.00	250.00	0.50	0.50	0.50	0.50
73	250.00	250.00	ND	250.00	0.50	0.50	ND	0.50
74	250.00	250.00	250.00	250.00	0.50	0.50	0.50	0.50
75	250.00	250.00	250.00	250.00	0.50	0.50	0.50	0.50
76	250.00	250.00	250.00	250.00	0.50	0.50	0.50	0.50
77	250.00	250.00	250.00	250.00	0.50	1.37	0.50	0.79
78	250.00	250.00	250.00	250.00	0.50	0.50	0.50	0.50
79	250.00	250.00	250.00	250.00	0.50	0.50	0.50	0.50
80	250.00	250.00	250.00	250.00	0.50	0.50	0.50	0.50
81	250.00	250.00	250.00	250.00	0.50	0.50	0.50	0.50
82	250.00	250.00	250.00	250.00	0.50	0.50	0.50	0.50
83	250.00	250.00	ND	250.00	0.50	0.50	ND	0.50
84	250.00	250.00	250.00	250.00	0.50	0.50	0.50	0.50
85	250.00	250.00	250.00	250.00	0.50	1.16	0.50	0.72
86	250.00	250.00	250.00	250.00	0.50	0.50	0.50	0.50
87	250.00	250.00	250.00	250.00	0.50	0.50	0.50	0.50
88	250.00	250.00	250.00	250.00	0.50	0.50	0.50	0.50
89	250.00	250.00	250.00	250.00	0.50	0.50	0.50	0.50
90	250.00	250.00	250.00	250.00	0.50	0.50	0.50	0.50
91	250.00	250.00	250.00	250.00	0.50	0.50	0.50	0.50
92	250.00	250.00	250.00	250.00	0.50	0.50	0.50	0.50

Table 23. (Continued)

	Barium (µg/L) (LOQ= 500 µg/L)				Beryllium (µg/L) (LOQ= 1 µg/L)			
Stations	**1th period**	**2nd period**	**3rd period**	**Average**	**1th period**	**2nd period**	**3rd period**	**Average**
93	250.00	250.00	250.00	250.00	0.50	0.50	0.50	0.50
94	250.00	250.00	250.00	250.00	0.50	0.50	0.50	0.50
95	250.00	250.00	250.00	250.00	0.50	1.19	0.50	0.73
96	250.00	250.00	250.00	250.00	0.50	0.50	0.50	0.50
97	250.00	250.00	250.00	250.00	0.50	0.50	0.50	0.50
98	250.00	250.00	250.00	250.00	0.50	1.01	0.50	0.67
99	250.00	250.00	250.00	250.00	0.50	1.45	0.50	0.82
100	250.00	250.00	250.00	250.00	0.50	0.50	0.50	0.50
101	250.00	250.00	250.00	250.00	0.50	0.50	0.50	0.50
102	250.00	250.00	250.00	250.00	0.50	0.50	0.50	0.50
103	250.00	250.00	250.00	250.00	0.50	0.50	0.50	0.50
104	250.00	250.00	250.00	250.00	0.50	0.50	0.50	0.50
105	250.00	250.00	250.00	250.00	0.50	0.50	0.50	0.50
106	250.00	250.00	250.00	250.00	0.50	0.50	0.50	0.50
107	250.00	250.00	250.00	250.00	0.50	0.50	0.50	0.50
108	250.00	250.00	250.00	250.00	0.50	0.50	0.50	0.50
109	250.00	250.00	250.00	250.00	0.50	0.50	0.50	0.50
110	1172.60	250.00	250.00	557.53	0.50	0.50	0.50	0.50

Table 24. Data of Antimony and Titanium (Non Risk Posing Parameters)

	Antimony (µg/L) (LOQ= 3 µg/L)				Titanium (µg/L) (LOQ= 10 µg/L)			
Stations	**1th period**	**2nd period**	**3rd period**	**Average**	**1th period**	**2nd period**	**3rd period**	**Average**
1	1.50	1.50	1.50	1.50	5.00	5.00	5.00	5.00
2	1.50	1.50	1.50	1.50	5.00	5.00	12.64	7.55
3	1.50	1.50	1.50	1.50	5.00	5.00	5.00	5.00
4	1.50	1.50	1.50	1.50	5.00	5.00	5.00	5.00
5	1.50	1.50	1.50	1.50	5.00	5.00	5.00	5.00
6	1.50	1.50	1.50	1.50	5.00	5.00	5.00	5.00
7	1.50	5.22	1.50	2.74	5.00	11.32	5.00	7.11
8	1.50	1.50	1.50	1.50	5.00	5.00	5.00	5.00
9	1.50	1.50	1.50	1.50	5.00	5.00	5.00	5.00
10	1.50	1.50	1.50	1.50	5.00	5.00	5.00	5.00
11	1.50	1.50	1.50	1.50	5.00	5.00	5.00	5.00
12	1.50	1.50	1.50	1.50	5.00	5.00	5.00	5.00

Table 24. (Continued)

	Antimony (µg/L) (LOQ= 3 µg/L)				Titanium (µg/L) (LOQ= 10 µg/L)			
Stations	**1th period**	**2nd period**	**3rd period**	**Average**	**1th period**	**2nd period**	**3rd period**	**Average**
13	1.50	1.50	1.50	1.50	5.00	5.00	5.00	5.00
14	1.50	1.50	1.50	1.50	18.65	21.27	17.24	19.05
15	1.50	1.50	1.50	1.50	5.00	5.00	5.00	5.00
16	1.50	1.50	1.50	1.50	5.00	5.00	5.00	5.00
17	1.50	1.50	1.50	1.50	5.00	5.00	5.00	5.00
18	1.50	1.50	1.50	1.50	5.00	5.00	5.00	5.00
19	1.50	1.50	ND	1.50	5.00	5.00	ND	5.00
20	1.50	1.50	1.50	1.50	5.00	5.00	5.00	5.00
21	1.50	1.50	1.50	1.50	5.00	5.00	5.00	5.00
22	1.50	1.50	1.50	1.50	5.00	5.00	18.97	9.66
23	1.50	1.50	1.50	1.50	5.00	5.00	5.00	5.00
24	1.50	1.50	1.50	1.50	5.00	5.00	5.00	5.00
25	1.50	1.50	1.50	1.50	11.08	5.00	5.00	7.03
26	1.50	1.50	1.50	1.50	5.00	5.00	5.00	5.00
27	1.50	1.50	1.50	1.50	5.00	5.00	5.00	5.00
28	1.50	1.50	ND	1.50	5.00	5.00	ND	5.00
29	1.50	1.50	1.50	1.50	5.00	5.00	5.00	5.00
30	1.50	1.50	1.50	1.50	5.00	5.00	5.00	5.00
31	1.50	1.50	1.50	1.50	5.00	5.00	5.00	5.00
32	1.50	1.50	1.50	1.50	5.00	5.00	5.00	5.00
33	1.50	1.50	1.50	1.50	5.00	5.00	5.00	5.00
34	1.50	1.50	1.50	1.50	5.00	5.00	5.00	5.00
35	1.50	1.50	1.50	1.50	5.00	5.00	5.00	5.00
36	1.50	1.50	1.50	1.50	5.00	5.00	5.00	5.00
37	1.50	1.50	1.50	1.50	5.00	5.00	5.00	5.00
38	1.50	1.50	1.50	1.50	5.00	5.00	5.00	5.00
39	1.50	1.50	1.50	1.50	5.00	5.00	5.00	5.00
40	1.50	1.50	1.50	1.50	5.00	5.00	5.00	5.00
41	1.50	1.50	1.50	1.50	5.00	5.00	5.00	5.00
42	1.50	1.50	1.50	1.50	5.00	5.00	5.00	5.00
43	1.50	1.50	1.50	1.50	5.00	5.00	5.00	5.00
44	1.50	1.50	1.50	1.50	5.00	5.00	5.00	5.00
45	4.72	1.50	1.50	2.57	5.00	5.00	5.00	5.00
46	1.50	1.50	1.50	1.50	5.00	5.00	5.00	5.00
47	1.50	1.50	1.50	1.50	5.00	5.00	5.00	5.00

Table 24. (Continued)

	Antimony (µg/L) (LOQ= 3 µg/L)				Titanium (µg/L) (LOQ= 10 µg/L)			
Stations	**1th period**	**2nd period**	**3rd period**	**Average**	**1th period**	**2nd period**	**3rd period**	**Average**
48	1.50	1.50	1.50	1.50	5.00	16.32	5.00	8.77
49	1.50	1.50	1.50	1.50	5.00	5.00	5.00	5.00
50	1.50	1.50	1.50	1.50	5.00	5.00	5.00	5.00
51	1.50	1.50	ND	1.50	5.00	5.00	ND	5.00
52	1.50	1.50	1.50	1.50	5.00	5.00	5.00	5.00
53	1.50	1.50	1.50	1.50	5.00	5.00	5.00	5.00
54	1.50	1.50	1.50	1.50	5.00	5.00	5.00	5.00
55	1.50	1.50	1.50	1.50	5.00	5.00	5.00	5.00
56	1.50	1.50	ND	1.50	5.00	5.00	ND	5.00
57	1.50	1.50	1.50	1.50	5.00	5.00	5.00	5.00
58	1.50	1.50	1.50	1.50	5.00	5.00	5.00	5.00
59	1.50	1.50	1.50	1.50	50.06	5.00	5.00	20.02
60	1.50	1.50	1.50	1.50	5.00	5.00	5.00	5.00
61	1.50	3.05	1.50	2.02	5.00	11.14	5.00	7.05
62	1.50	1.50	1.50	1.50	5.00	5.00	5.00	5.00
63	1.50	1.50	1.50	1.50	5.00	5.00	5.00	5.00
64	1.50	1.50	1.50	1.50	5.00	5.00	5.00	5.00
65	1.50	11.12	1.50	4.71	5.00	5.00	5.00	5.00
66	1.50	1.50	1.50	1.50	5.00	5.00	5.00	5.00
67	1.50	1.50	ND	1.50	5.00	5.00	ND	5.00
68	1.50	1.50	1.50	1.50	5.00	5.00	5.00	5.00
69	1.50	1.50	1.50	1.50	5.00	5.00	5.00	5.00
70	1.50	1.50	1.50	1.50	5.00	5.00	5.00	5.00
71	1.50	1.50	1.50	1.50	5.00	5.00	5.00	5.00
72	1.50	1.50	1.50	1.50	12.95	5.00	5.00	7.65
73	1.50	1.50	ND	1.50	5.00	5.00	ND	5.00
74	1.50	1.50	1.50	1.50	5.00	5.00	5.00	5.00
75	1.50	1.50	1.50	1.50	5.00	5.00	5.00	5.00
76	1.50	1.50	1.50	1.50	5.00	5.00	5.00	5.00
77	1.50	1.50	1.50	1.50	5.00	5.00	5.00	5.00
78	1.50	1.50	1.50	1.50	5.00	5.00	5.00	5.00
79	1.50	1.50	1.50	1.50	5.00	10.73	5.00	6.91
80	1.50	1.50	1.50	1.50	5.00	5.00	5.00	5.00
81	1.50	1.50	1.50	1.50	5.00	5.00	5.00	5.00
82	1.50	1.50	1.50	1.50	5.00	5.00	5.00	5.00

Table 24. (Continued)

	Antimony (µg/L) (LOQ= 3 µg/L)				Titanium (µg/L) (LOQ= 10 µg/L)			
Stations	**1th period**	**2nd period**	**3rd period**	**Average**	**1th period**	**2nd period**	**3rd period**	**Average**
83	1.50	1.50	ND	1.50	5.00	5.00	ND	5.00
84	1.50	1.50	1.50	1.50	5.00	5.00	5.00	5.00
85	1.50	1.50	1.50	1.50	5.00	5.00	5.00	5.00
86	1.50	1.50	1.50	1.50	5.00	5.00	5.00	5.00
87	1.50	1.50	1.50	1.50	5.00	5.00	5.00	5.00
88	1.50	1.50	1.50	1.50	5.00	5.00	5.00	5.00
89	1.50	1.50	1.50	1.50	5.00	5.00	5.00	5.00
90	1.50	1.50	1.50	1.50	5.00	5.00	5.00	5.00
91	1.50	1.50	1.50	1.50	5.00	5.00	5.00	5.00
92	1.50	1.50	1.50	1.50	5.00	5.00	5.00	5.00
93	1.50	1.50	1.50	1.50	5.00	5.00	5.00	5.00
94	1.50	1.50	1.50	1.50	5.00	12.53	5.00	7.51
95	1.50	1.50	1.50	1.50	5.00	5.00	5.00	5.00
96	1.50	1.50	1.50	1.50	5.00	5.00	5.00	5.00
97	1.50	1.50	1.50	1.50	5.00	5.00	5.00	5.00
98	1.50	1.50	1.50	1.50	5.00	5.00	5.00	5.00
99	1.50	1.50	1.50	1.50	5.00	11.94	5.00	7.31
100	1.50	1.50	15.44	6.15	5.00	5.00	5.00	5.00
101	1.50	1.50	1.50	1.50	5.00	5.00	5.00	5.00
102	1.50	1.50	1.50	1.50	5.00	5.00	5.00	5.00
103	1.50	1.50	1.50	1.50	5.00	5.00	5.00	5.00
104	1.50	1.50	1.50	1.50	5.00	5.00	5.00	5.00
105	1.50	1.50	1.50	1.50	5.00	5.00	5.00	5.00
106	1.50	1.50	1.50	1.50	5.00	5.00	5.00	5.00
107	1.50	1.50	1.50	1.50	5.00	5.00	5.00	5.00
108	1.50	1.50	1.50	1.50	5.00	5.00	5.00	5.00
109	1.50	1.50	1.50	1.50	5.00	5.00	5.00	5.00
110	1.50	1.50	1.50	1.50	5.00	5.00	5.00	5.00

Table 25. Data of Silver (Non Risk Posing Parameters)

	Silver (µg/L) (LOQ= 1 µg/L)			
Stations	**1th period**	**2nd period**	**3rd period**	**Average**
1	0.50	1.72	0.50	0.91
2	0.50	0.50	0.50	0.50
3	0.50	0.50	0.50	0.50
4	0.50	0.50	0.50	0.50
5	0.50	0.50	0.50	0.50
6	0.50	0.50	0.50	0.50
7	0.50	0.50	0.50	0.50
8	0.50	0.50	0.50	0.50
9	0.50	0.50	0.50	0.50
10	0.50	0.50	0.50	0.50
11	0.50	0.50	0.50	0.50
12	0.50	0.50	0.50	0.50
13	0.50	0.50	0.50	0.50
14	0.50	0.50	0.50	0.50
15	0.50	0.50	0.50	0.50
16	0.50	0.50	0.50	0.50
17	0.50	0.50	0.50	0.50
18	0.50	0.50	0.50	0.50
19	0.50	0.50	ND	0.50
20	0.50	0.50	0.50	0.50
21	0.50	0.50	0.50	0.50
22	0.50	0.50	0.50	0.50
23	0.50	0.50	0.50	0.50
24	0.50	0.50	0.50	0.50
25	0.50	0.50	0.50	0.50
26	0.50	0.50	0.50	0.50
27	0.50	0.50	0.50	0.50
28	0.50	0.50	ND	0.50
29	0.50	0.50	0.50	0.50
30	0.50	0.50	0.50	0.50
31	0.50	0.50	0.50	0.50
32	0.50	0.50	0.50	0.50
33	0.50	0.50	0.50	0.50
34	0.50	0.50	0.50	0.50
35	0.50	0.50	0.50	0.50
36	0.50	0.50	0.50	0.50

Table 25. (Continued)

	Silver (µg/L) (LOQ= 1 µg/L)			
Stations	**1th period**	**2nd period**	**3rd period**	**Average**
37	0.50	0.50	0.50	0.50
38	0.50	0.50	0.50	0.50
39	0.50	0.50	0.50	0.50
40	0.50	0.50	0.50	0.50
41	0.50	0.50	0.50	0.50
42	0.50	0.50	0.50	0.50
43	0.50	0.50	0.50	0.50
44	0.50	0.50	0.50	0.50
45	0.50	0.50	0.50	0.50
46	0.50	0.50	0.50	0.50
47	0.50	0.50	0.50	0.50
48	0.50	0.50	0.50	0.50
49	0.50	0.50	0.50	0.50
50	0.50	0.50	0.50	0.50
51	0.50	0.50	ND	0.50
52	0.50	0.50	0.50	0.50
53	0.50	0.50	0.50	0.50
54	0.50	0.50	0.50	0.50
55	0.50	0.50	0.50	0.50
56	0.50	0.50	ND	0.50
57	1.49	0.50	0.50	0.83
58	0.50	0.50	0.50	0.50
59	0.50	0.50	0.50	0.50
60	0.50	0.50	0.50	0.50
61	0.50	0.50	0.50	0.50
62	0.50	0.50	0.50	0.50
63	0.50	0.50	0.50	0.50
64	0.50	0.50	0.50	0.50
65	0.50	0.50	0.50	0.50
66	0.50	0.50	0.50	0.50
67	0.50	0.50	ND	0.50
68	0.50	0.50	0.50	0.50
69	0.50	0.50	0.50	0.50
70	0.50	0.50	0.50	0.50
71	0.50	0.50	0.50	0.50
72	0.50	0.50	0.50	0.50

Table 25. (Continued)

	Silver (µg/L) (LOQ= 1 µg/L)			
Stations	**1th period**	**2nd period**	**3rd period**	**Average**
73	0.50	0.50	ND	0.50
74	0.50	0.50	0.50	0.50
75	0.50	0.50	0.50	0.50
76	0.50	0.50	0.50	0.50
77	0.50	0.50	0.50	0.50
78	0.50	0.50	0.50	0.50
79	0.50	0.50	0.50	0.50
80	0.50	0.50	0.50	0.50
81	0.50	0.50	0.50	0.50
82	0.50	0.50	0.50	0.50
83	0.50	0.50	ND	0.50
84	0.50	0.50	0.50	0.50
85	5.79	0.50	0.50	2.26
86	0.50	0.50	0.50	0.50
87	0.50	0.50	0.50	0.50
88	0.50	0.50	0.50	0.50
89	0.50	0.50	0.50	0.50
90	0.50	0.50	0.50	0.50
91	0.50	0.50	0.50	0.50
92	0.50	0.50	0.50	0.50
93	0.50	0.50	0.50	0.50
94	0.50	0.50	0.50	0.50
95	0.50	0.50	0.50	0.50
96	0.50	0.50	0.50	0.50
97	0.50	0.50	0.50	0.50
98	0.50	0.50	0.50	0.50
99	0.50	0.50	0.50	0.50
100	0.50	0.50	0.50	0.50
101	0.50	0.50	0.50	0.50
102	0.50	0.50	0.50	0.50
103	0.50	0.50	0.50	0.50
104	0.50	0.50	0.50	0.50
105	0.50	0.50	0.50	0.50
106	0.50	0.50	0.50	0.50
107	0.50	0.50	0.50	0.50
108	0.50	0.50	0.50	0.50

Table 25. (Continued)

	Silver (µg/L) (LOQ= 1 µg/L)			
Stations	**1th period**	**2nd period**	**3rd period**	**Average**
109	0.50	0.50	0.50	0.50
110	0.50	0.50	0.50	0.50

B. DATA STATISTICS

Table 26. Number of groundwater samples in sample points and statistical parameters for the parameters exceeding LOD

(Statistical values calculated by assuming below LOD values equal to LOD/2)

Parameter	Unit	Original Data						After Preselection					
		# of Sampling Points	Min	Max	Percentile			# of Sampling Points	Min	Max	Percentile		
					25th	50th	75th				25th	50th	75th
Ions													
Cl^{-1}	mg/L	110	5.48	100.57	12.37	19.03	37.29	62	5.48	67.72	11.20	14.80	24.89
SO_4^{-2}	mg/L	110	2.01	550.95	15.81	37.70	75.78	62	5.47	394.71	12.03	28.22	60.32
S^{-2}	mg/L	11	0.01	0.60	0.01	0.01	0.01	3	0.01	0.43	0.01	0.01	0.01
PO_4^{-3}-P	µg/L	108	0.50	1521.57	5.64	19.10	47.38	61	0.50	1521.57	3.77	14.83	32.87
Metals													
Cd	µg/L	81	0.03	0.14	0.03	0.06	0.07	39	0.03	0.13	0.03	0.05	0.06
Hg	µg/L	54	0.03	3.64	0.03	0.03	0.06	28	0.03	1.20	0.03	0.03	0.06
Cu	µg/L	102	0.50	81.08	1.20	2.01	3.41	57	0.50	81.08	0.95	1.85	3.05
Zn	µg/L	96	1.25	456.56	2.44	5.74	13.57	50	1.25	285.36	2.38	5.17	12.65
Fe	µg/L	97	15.00	7165.50	33.25	90.76	533.90	53	15.00	7165.5	27.36	96.48	533.90
Co	µg/L	100	0.07	7.14	0.10	0.17	0.29	55	0.07	3.91	0.10	0.15	0.25
Mn	µg/L	101	0.50	1420.32	1.80	6.69	61.48	57	0.50	1049.6	1.70	8.23	35.63
Mo	µg/L	79	0.50	50.68	0.50	1.52	3.12	42	0.50	50.68	0.50	1.13	2.82
Ni	µg/L	95	0.83	70.31	1.14	1.53	2.71	51	0.83	20.43	1.06	1.36	2.47
V	µg/L	87	0.50	46.03	0.72	2.22	6.26	44	0.50	46.03	0.50	1.96	6.73
Cr	µg/L	100	0.50	33.31	1.10	1.89	4.81	55	0.50	29.09	0.90	1.68	4.19
Pb	µg/L	83	0.50	23.25	0.69	1.57	2.59	49	0.50	23.25	0.87	1.61	2.47
Metalloids													
Na	µg/L	110	350.8	618418.7	3058.2	5943.6	11205.4	62	350.8	55438.6	2121.8	4532.5	8058.5
As	µg/L	74	2.50	3252.50	2.50	9.60	35.73	40	2.50	1348.16	2.50	9.53	33.81
Al	µg/L	110	1.48	3481.08	2.65	6.56	18.30	62	1.48	2856.05	2.48	5.43	13.81
B	µg/L	15	250.00	7176.47	250.00	250.00	250.00	5	250.00	3882.33	250.00	250.00	250.00
Se	µg/L	11	2.50	15.83	2.50	2.50	2.50	5	2.50	6.07	2.50	2.50	2.50
Other													
Conductivity	µS/cm	110	33.15	1523.33	518.7	650.0	839.42	62	224.0	1202.7	452.8	573.4	782.3