College of Engineering and Technology
Civil & Architecture Engineering Department

Project Title

Environmental Assessment of Lack Infrastructure on Ground and Surface Water Quality ,Physical Biochemical and Possible Engineering Solutions for Tugu' Area Bethlehem

Project Team

Ahmad Halayka **Hamza Jebreen**

Mountaser Hamad

Project Supervisor

Eng. Nibal AL-Batsh

Hebron – Palestine

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CERTIFICATION

Palestine Polytechnic University

Hebron- Palestine

The Senior Project Entitled:

Environmental Assessment of Lack Infrastructure on Ground and Surface Water Quality ,Physical Biochemical and Possible Engineering Solutions for Tugu' Area Bethlehem

Prepared By:

Ahmad Halayka **Hamza Jebreen**

Mountaser Alaref

In accordance with the recommendations of the project supervisor, and the acceptance of all examining committee members, this project has been submitted to the Department of Civil and Architectural Engineering in the College of Engineering and Technology in partial fulfillment of the requirements of the department for the degree of Bachelor of Science in Engineering.

إهــداء

إلى من جرع الكأس فارغا ليسقيني قطرة حب

إلى من كلت أنامله ليقدم لنا لحظة سعادة

إلى من حصد الأشواك عن دربي ليمهد لي طريق العلم

إلى القلب الكبير.............(والدي العزيز)

إلى من أرضعتني الحب والحنان

إلى رمز الحب وبلسم الشفاء........(والدتي الحبيبة)

إلى القلوب الطاهرة الرقيقة والنفوس البريئة إلى رياحين حياتي

إلى من يحملون في عيونهم ذكريات طفولتي وشبابي ..... إخوتي و أخواتي

إلى من سرنا سويا ونحن نشق الطريق معا نحو النجاح والابداع ..... زملائي وزميلاتي

إلى من ضحوا بحريتهم من أجل حرية غيرهم.......... الأسرى والمعتقلين

إلى من هم أكرم منا مكانة......... شهداء فلسطين

إلى هذا الصرح العلمي الفتي والجبار.......جامعة بوليتكنك فلسطين

إلى من احتضنتني كل هذا الكم من السنين ..... فلسطين الحبيبة

فريق العمل

شكر و تقدير

لنجاح اناس يقدرون معناه وللابداع اناس يحصدونه , فمن اي ابواب الثناء سندخل وبأي ابيات القصيد نعبر.

أول الشكر وأول الثناء وأول العرفان نبدأ به هو لمن كانوا منارات تضيء لنا طريقنا للوصول الى هذا النجاح .

هو الاهل,هو الوالد, هي الوالدة , الاخ, الاخت

نقول لكم كل الشكر والثناء لكم على كل لمسة من جودكم وعطائكم المعنوي والمادي الذي سهل لنا طريق الوصول الى هذا النجاح .

وفي ثنائنا وشكرنا لا ننسى جامعتنا العزيزة وكلية الهندسة التي كانت بمثابة سحابة معطاءه سقت الارض فخضرت واثمرت نجاحنا هذا

وبكل فخر نتقدم بأسما أيات الشكر والعرفان الى الذين لم يبخلوا علينا من جودهم وعطائهم وعلمهم ما يحول بيننا وبين الوصول الى هذا النجاح , اساتذتنا ومعلمينا نتمنى ان نكون على قدر المسؤولية وحمل رسالتكم الشامخة في بناء هذا الوطن من خلال الوصول الى هذا النجاح .

واخيرا وليس اخرا نود ان نشكر ولكن عجزت الكلمات عن وصف حجم الثناء والتقدير الخاص بمشرفتنا ومربيتنا العزيزه المهندسة نبال البطش لما لها من دور عظيم في متابعتها لهذا المشروع من البداية وحتى الختام وتكليله بمتابعتها الدائمة حتى اوصلته الى هذه المرحلة

ونتقدم بجزيل الشكر للسادة في بلدية تقوع لما قدموه لنا من معلومات وتسهيلات ودعم لانجاز هذا المشروع ومتطلباته

فريق العمل

Abstract

Tuqu’ lacks a public sewage network; most of the population uses cesspits as a means for wastewater disposal. According to PCBS's Population and Housing Census in 2007 and PWA data, the majority of Tuqu’'s housing units (99.7%) use cesspits for wastewater disposal, 0.1% of the housing units have no means for wastewater collection and disposal, while the means for wastewater disposal is unknown for the remaining units (0.2%). The wastewater collected by cesspits is discharged by wastewater tankers directly to open areas or nearby valleys without any regard for the environment. Here it should be noted that there is no wastewater treatment either at the source or at the disposal sites and this poses a serious threat to the environment and the public health.

The main objectives of the study is to investigate and specify the impacts of the rawwastewater (septic tank) on the quality of groundwater and household cisterns in the drainagebasin, as well as the socio-economic factors, and to pinpoint on possible measures to improve the situation.

On the other hand, this study aims to:fill the gap regarding the lack of the environmental studies about the study area,Assist the Palestinian decision-makers to make the right decisions related to the current situation in the region, based on the main results of this study, Designing a sanitary network for Tuqu' area.

Determine the water quality of the household cisterns and ground water to improve the quality of the water sources .

Two data sources have been identified for this research:The primary data are extracted mainly from the direct observations from the study area. The primary data used are conceptual and provides visions for the future, it is also informatics and helps to understand the current situation. Meanwhile, the secondary data are built through circulations of the available data in the forms of archived researches, literature reviews, published documents, mapping, and interpretation.Mainly the methodologies of data collection classified according to the aspects to be investigated in this thesis research are the water quality and the Socio-economic aspects. The methodology of water quality assessment consisted of four samplings campaigns for the study area which are: in order to evaluate the different trends of water quality regarding the chemical, microbial, physical and biological composition. All the samples of water were analyzed in

Palestine polytechnic university laboratories. water samples were also collected by 1-Leter sterilized glass bottles and analyzed for pH, TDS, EC, TC and FC .

The other part of methodology is statistical; the adopted approach for this assignment based on a written questionnaire that has been designed for this study, seeking for representing most of the life's aspects, it consists of the three following sections :Healthy section , Socio-Economic section ,Environmental section The survey was conducted for a random sample, which amounted to 375 persons The results have been analyzed through SPSS Statistics application; a software package that is used for statistical analysis. And the survey results were presented by means of tabulations, charts and graphs, by which a clear vision would be created about the significance of wastewater effects on the two localities life's aspects , In addition, a sewerage system for the Tuqu' area will be designed as a solution to these problems. as an expected result for this reseach, evaluating the social, economical and environmental issues for tuqu area and design sanitary network.

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Acronym	DESCRIPTION
WHO	**World Health Organization.**
JMP	**Joint Moitioring Programme.**
UNICEF	**United Nations Children's Emergency Fund.**
PCBS	**Palestine Central of Bureau Statistics.**
PWA	**Palestinian Water Authority.**
SDGs	**Sustainable Development Goals.**
UNDP	**United Nations Development Programme.**
PH	**Potential of Hydrogen.**
TDS	**Total Dissolved Solids.**
TC	**Total Coliform Bacteria.**
FC	**Fecal Coliform Bacteria.**
SPSS	**Statistic Package for the Social Sciences.**
RWH	**Rain Water Harvesting.**
FE	**Ferrus Element.**
EC	**Electrical Conductivity.**
Cd	**Cadmium Element.**
Mn	**Manganese Element.**
C	**Celsius.**
Pb	**Lead Element.**
Cr	**Chromium Element.**
Cu	**Copper Element.**
Zn	**Zinc Element.**
Ni	**Nickel Element.**
TCU	**True Color Units.**
NTU	**Nephotometric Turbidity Unit.**
EPA	**Enviromental Protection Agency.**
ML	**Millilitre.**
µM	**Micro Metere.**
PSI	**Palestine Standard Institution.**
µSCM	**Micro Siemens per Centimetre.**
%	**Percentage.**
ICMR	**Indian Council of Medical Research.**
BIS	**Bank for International Settlements.**
WQI	**Water Quality Index.**
SAR	**Sodium Adsorption Ratio**
Na	**Sodium.**
COD	**Chemical Oxygen Demand.**
BOD5	**Biochemical Oxygen Demand.**
Kg N/H*Yr	**kilogram Nitrogen per Hectare* Yard.**
CFU	**Fecal Coliform Unit.**
DEM	**Digital Elevation Model**
TIN	**Triangular Irregular Networks**

CHAPTER ONE

"INTRODUCTION"

1.1 General

Safe potable water should be available to every human being, now and in the future Water is essential for life, the deterioration of its quality or its shortage affects every living being. As the populatio poor water qualitn of the world increases, demand on water also significantly increases. Together with y and inadequate sanitation, water scarcity threatens the lives of millions around the World(El-Fadel , 2000). According to statistics issued in the Joint Monitoring Programme (JMP), 663 million people still lack access to safe water (WHO and UNICEF, 2015). Spearheaded by the United Nations, Governments have set an ambitious goal within the framework of the Sustainable Development Goals (SDGs) to achieve universal and equitable access to safe and affordable drinking water for all by 2030. To succeed this challenging endeavor practitioners will have to tap into resources both conventional and nonconventional. (United Nations Development Program (UNDP,2000).
for that This research is studying the multiple impacts of untreated wastewater flow effluents on the groundwater quality and socio-economic issues of Tuqu Catchment.

Wastewater isliquid waste or water whose quality has been adversely affected by human influence. These include liquid waste discharged from residential, commercial, industrial, and agricultural complexes, and may also contain a wide range of potential pollutants and different concentrations. As the general term refers to liquid wastes from human and container complexes on a wide range of pollutants resulting from the mixing of effluents from various sources.

Sewage refers to a section of wastewater, contaminated with faeces or urine, but is often used to refer to all types of effluents.Palestine lacks sanitation facilities and infrastructure. People generally use latrines and absorbent cesspools, and a few of them use sewage tanks, which are emptied by the cesspit and tankers from time to time. These latrines and cesspits are deteriorating and are in very poor condition, leading to increased water consumption and thus increased wastewater production, resulting in the flow of water from cesspits, leading to pollution of groundwater, soil and other problems.

As in other towns in Palestine, there is no sewage network in the town of Tuqu. The expansion and development of the town of Tuqu has led to increased water consumption and thus the generation of large amounts of wastewater from different sources. In the absence of a sewage collection system, wastewater flows to the ground Through the surplus of absorbent cesspools and intermittent toilets that are commonly used in the town of Tuqu. In some areas, wastewater flows into valleys through open drains in different ways causing serious environmental and health problems.

Owing to these poor conditions and the absence of sewerage systems, there is a rapid increase in the environmental and health problem. The study and design of the sewage collection system in the town of Tuqu becomes an urgent necessity in order to solve all the problems mentioned above.

1.2 Problem statement

Tuqu' lacks a public sewage network; most of the population uses cesspits as a means for wastewater disposal. According to PCBS's Population and Housing Census in 2007 and PWA data, the majority of Tuqu''s housing units (99.7%) use cesspits for wastewater disposal, 0.1% of the housing units have no means for wastewater collection and disposal, while the means for wastewater disposal is unknown for the remaining units (0.2%). Based on the estimated daily per capita water consumption, the estimated amount of wastewater generated per day is approximately 195 cubic meters or 72 thousand cubic meters annually. At the individual level in the town it is estimated that the per capita wastewater generation is approximately 22 liters per day. The wastewater collected by cesspits is discharged by wastewater tankers directly to open areas or nearby valleys without any regard for the environment. Here it should be noted that there is no wastewater treatment either at the source or at the disposal sites and this poses a serious threat to the environment and the public health. The local wastewater already destroyed thousands of dunums of agricultural land. That valley has been the basket of field crops in the region which have been contaminated with chemicals mainly heavy toxic .

elements and waste sludge. Consequently, farmers abandon their lands. Farmers' opinions have been explored about this issue through field visits where the farmers agreed on the importance of urgent need for remediation of their lands. In the other hand, wastewater flow may infiltrate downward the groundwater espically Tuqu’ located in eastern basin and affect the quality of Tuqu’ well. The discharge of untreated wastewater into streams leads to increased contamination from organic and inorganic substances. Additionally, wastewater contains a variety of potential human pathogenic parasites, bacteria, and viruses. Therefore, permanent contamination may occur in stream below municipal discharges.

Figure 1.1: waste water pollution onTuqu’

1.3 Objectives of the Project

The main objective of the study is to investigate and specify the impacts of the rawwastewater (septic tank) on the quality of groundwater and household cisterns in the drainagebasin, as well as the socio-economic factors, and to pinpoint on possible measures toimprove the situation.

On the other hand, this study aims to:

- fill the gap regarding the lack of the environmental studies about the study area;
- Assist the Palestinian decision-makers to make the right decisions related to the current situation in the region, based on the main results of this study.
- Designing a sanitary network for Tuqu' area.

Determine the water quality of the household cisterns and ground water to improve the quality of the water sources

1.4 Methodology

Two data sources have been identified for this research, namely; primary and secondary data resources. The primary data are extracted mainly from the direct observations from the study area. The primary data used are conceptual and provides visions for the future, it is also informatics and helps to understand the current situation. Meanwhile, the secondary data are built through circulations of the available data in the forms of archived researches, literature reviews, published documents, mapping, and interpretation.Mainly the methodologies of data collection classified according to the aspects to be investigated in this thesis research are the water quality and the Socio-economic aspects. The methodology of water quality assessment consisted of four samplings campaigns for the study area which are: in order to evaluate the different trends of water quality regarding the chemical, microbial, physical and biological composition. All the samples of water were analyzed in Palestine polytechnic university laboratories. water samples were also collected by 1-Leter sterilized glass bottles and analyzed for pH, TDS, EC, TC and FC .

Figure 1.2:collection of water samples from sites

The other part of methodology is statistical; the adopted approach for this assignment based on a written questionnaire that has been designed for this study, seeking for representing most of the life’s aspects, it consists of the three following sections:

- Healthy section
- Socio-Economic section
- Environmental section The survey was conducted for a random sample, which amounted to 375 persons The results have been analyzed through SPSS Statistics application; a software package that is used for statistical analysis. And the survey results were presented by means of tabulations, charts and graphs, by which a clear vision would be created about the significance of wastewater effects on the two localities life’s aspects.

1.4.1Household survey

A set of indicators was designed to define the main socio-economic characteristics of the community and look into different water aspects.

with a sample size designed using PCBS population projections of 2016. The survey methodology was based on a quantitative approach involving structured interviews. A total of 375 questionnaires were completed.

The sample of households was estimated by utilizing Herbert Larkin equation:

$$\boxed{n = \frac{p(1-p)}{(SE \div t) + [p(1-p) \div N]}}$$

n: Sample Size.

N: The population size.

t: Z-score corresponds to the level of significance of 0.95 and equals to 1.96

SE: percentage errors=0.05

p: The proportion of property= 0.50

1.5 Research Structure

This research thesis consists of four chapters, by which the effects of wastewater on water quality and socio-economic aspects will be tested.

•Chapter One: Introduction

This chapter presents the precursory background that introduces for the followingcontents of the research; it recognizes the scope and level of intervention of theresearch. Moreover, it clearly identifies the problem statements, the researchhypothesis, goals and methodology, and systematically itemized on research themeand context.

•Chapter Two: Study Area and theoretical analysis

This chapter contains the analysis of the study area (Tuquarea), and the specifiedterms of their physical, geopolitical, economic, environmental and other characteristics. In Theoretical Analysis part provides a survey of the existing literature about the subject of the research, it discusses the definition of the wastewater, previous studies about the impact of wastewater on fresh water quality, public health and environment, and finally the possible wastewater treatment processes, based on three hierarchical levels: global, regional and local levels.

•Chapter three :Wastewater Effects on Socio-Economic Aspects

This chapter clarifies the effect of the wastewater pollution on the socio-economic factors within the study area, divided into three sections: healthy, socio-economic and the environmental sections, based on the results of a structured questionnaire that have been prepared for this study

•Chapter four :Water Quality Results:

The objective of this part of the study was to test the physical, chemical and, microbiological parameters of water stored in cisterns. And give some recommendations and solution for current situation in Tuquarea.

- **Chpter Five : Design Parameters:**

deals with municipal sewage system, types of wastewater collection systems, sewer appurtenances, flow in sewers, design of sewer system, and sewer construction and maintenance.

- **Chpter six : Analysis& Design:**

presents the design calculations,action steps and maps of the system.

- **Chpter Seven :Bill of Quantities:**

deals with the quantities of pipes manhole excavation, backfilling and…etc.

- **Chpter eighth : Conclusions:**

discusses the conclusions of the study.

CHAPTER TWO

"STUDY AREA AND THEORETICAL ANAlLYSIS"

2.1 Study area:

Tuqu’ is a Palestinian town in Bethlehem Governorate located 12km (horizontal distance) south-east of Bethlehem City. Tuqu’ is bordered by Tuqu’ wilds to the east, Jannatah town to the north, Al Manshiya and MarahRabah villages to the west, and Al Maniya and Kisan villages to the south, the total population of Tuqu’ in 2007 was 8,881; of whom 4,555 are males and 4,326 are females. Tuqu’ lies on a total area of about 191,262 dunums of which 188,845 dunums are considered arable land, and 590 dunums are residential land.

It is Located between the heights of Bethlehem and the mountains of Hebron on the eastern edge of these mountains, Tuqu is located between the Bethlehem Mountains and the city of Hebron. Also It is Located on a top that ends in the western and northern parts of the plain, covering most of the olive trees, which earns permanent greenery.

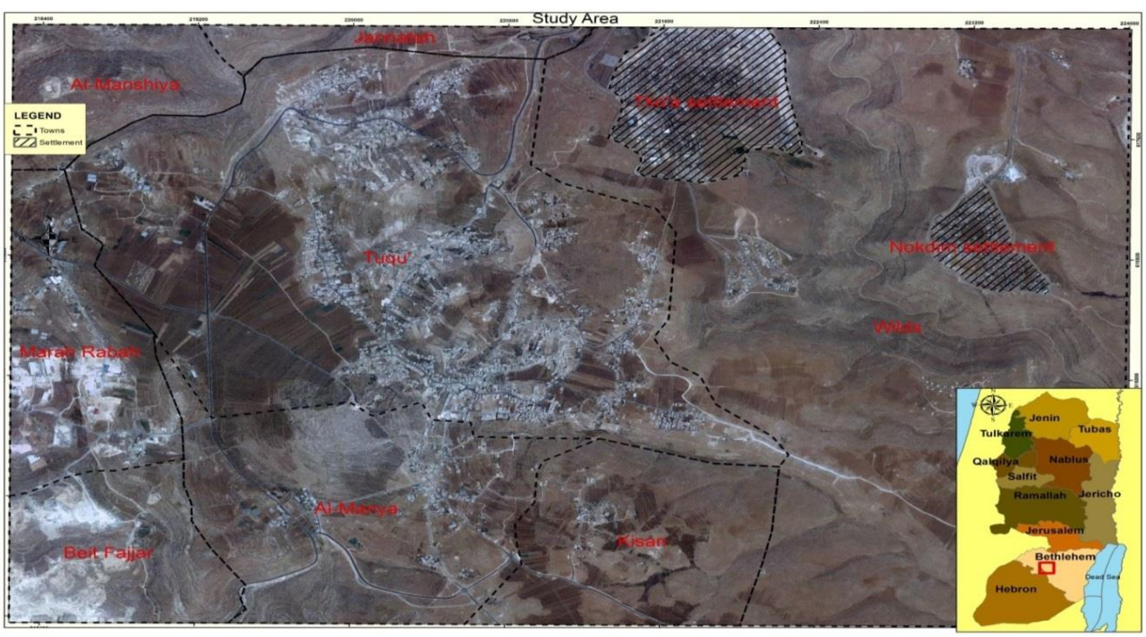


Figure 2.1: Study Area

2.2 Population

According to the Palestinian Central Bureau of Statistics (PCBS) the total population of Tuqu’ in 2007 was 8,881; of whom 4,555 are males and 4,326 are females. There are 1,368 households living in 1,444 housing units.

2.3 Education

According to the results of the PCBS Population, Housing and Establishment Census- 2007, the illiteracy rate among Tuqu’ population is about 9.9 percent, of whom 66.1 percent are females. Of the literate population, 18.5 percent can read and write, 28 percent had elementary education, 29.1 percent had preparatory education, 18.4 percent had secondary education, and 5.9 percent completed higher education.

2.4 Economic Activities

The economy in Tuqu’ is dependent on several economic sectors, mainly: the Israeli labor market, which absorbs 45 percent of the town workforce . The results of a field survey for the distribution of labor by economic activity in Tuqu’ are the following(PCBS 2007): • Israeli Labor Market (45%) • Agriculture Sector (30%) • Government or Other Employees Sector (10%) • Trade Sector (10%) • Service Sector (5%)

2.5 Agricultural Sector

Tuqu’ lies on a total area of about 191,262 dunums of which 188,845 dunums are considered arable land, and 590 dunums are residential land(PCBS 2007).

2.6 Water Resources:

Tuqu’ is provided with water by the West Bank water Department, through the public water network established in 1983, and about 99.8 percent of the housing units are connected to the water network, while the source of water supply is unknown for the remaining units (0.2%) (PCBS, 2007). The quantity of water supplied to Tuqu’ in 2008 was about 143,730 cubic meters/year, therefore the estimated rate of water supply per capita is about 45 liters/day

(PWA, 2008). Here it should be noted that no Tuqu' citizen in fact consumes this amount of water because of water losses, which is about 39 percent. The losses happen at the main source,

major transport lines, distribution network, and at the household level (PWA, 2008), thus the rate of water consumption per capita in Tuqu' is 27.5 liters per day. This is a low rate compared with the minimum quantity proposed by the World Health Organization, which is 100 liters per capita per day. Also, located in Tuqu' are 95 rainwater harvesting cisterns and 3 wells (Tuqu' Municipality, 2010).

These five lines connected to five tanks:(Tuqu' Municipality, 2015)

- Khirbet al-Deirtank (Main pipe)
- The bukaa- tank(Main pipe)
- Al-hulkom tank
- Buten Al-gueltank
- Al-rouj tank
- Al- oumor tank (Collective)

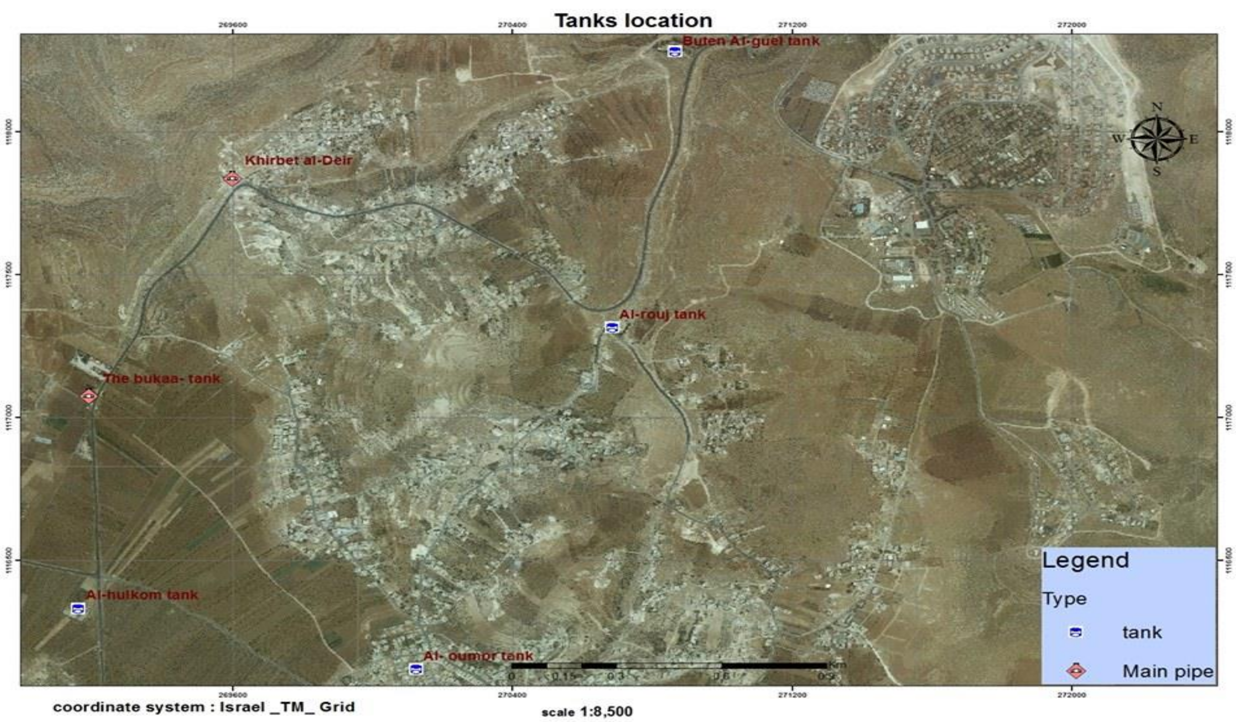


Figure 2.2: Tanks Location

The main obstacles facing Tuqu' are

- Reduction in water supply due to limited resource of water.
- Insufficiency of the water network in meeting demand, because it is old and not function.
- The water is polluted.
- water losses through the phenomenon of stealing.
- An unavailability of technicians.

Figure 2.3 :Khirbet al-Deirtank (Main pipe)

Figure 2.4 :The bukaa- tank(Main pipe)

Figure 2.5 :Al-hulkom tank

Figure 2.6 :Buten Al-gueltank

Figure 2.7: Al-rouj tank

Figure2.8 :Al- oumor tank

2.7 Sanitation:

Tuqu’ lacks a public sewage network; most of the population uses cesspits as a means for wastewater disposal. According to PCBS's Population and Housing Census in 2007 and PWA data, the majority of Tuqu’'s housing units (99.8%) use cesspits for wastewater disposal, 0.1% of the housing units have no means for wastewater collection and disposal, while the means for wastewater disposal is unknown for the remaining units (0.2%). Based on the estimated daily per capita water consumption, the estimated amount of wastewater generated per day is approximately 195 cubic meters or 72 thousand cubic meters annually. At the individual level in the town it is estimated that the per capita wastewater generation is approximately 22 liters per day. The wastewater collected by cesspits is discharged by wastewater tankers directly to open areas or nearby valleys without any regard for the environment. Here it should be noted that there is no wastewater treatment either at the source or at the disposal sites and this poses a serious threat to the environment and the public health.

2.8 literature review

1. Hassan A. Arafat et al. (2009) presented the results of a study Environmental management of rainwater harvesting (Cisterns) in southern Palestine of rainwater based on physiochemical and microbiological parameters testing. In this study, 100 cisterns were sampled and tested for physiochemical and microbiological parameters such that study showed Most of the tested physiochemical parameters were within the acceptable limits of WHO and Palestinian standards except turbidity, calcium and magnesium where 24%, 47% and 32% of the samples were nonconforming, respectively. High percentage of cisterns were found to be contaminated with total Coliforms (TC) and fecal Coliforms (FC) , enduring the cistern water unacceptable for drinking , and recommended means of improving the situation. And Take Different remediation measures, such as cleaning cisterns and rainwater collection surfaces and discarding water from the first season storm, were recommended to enhance and protect the cistern water quality. As a key prevention measure, harvested rainwater should be disinfected (e.g., via chlorination) before usage for drinking purposes. Were recommended to enhance and protect the cistern water quality.

2. Scientific research team at Thiagarajar College of Engineering/India (2015) presented the results to study focused on evaluation of groundwater quality in Madurai in India, Totally groundwater samples were collected with different zones during respectively. All the samples (45 samples) were analyzed as well as the various physical and chemical parameters like pH, electrical conductivity, total dissolved solids, total hardness, and total alkalinity and were compared with the standard guideline limits by WHO, ICMR, and BIS. Results indicated that the pH, EC, TDS, hardness, alkalinity level in groundwater samples were above critical limits The geochemical data was interpreted using WQI in relation to drinking water quality proved that all the water samples were found to be poor and 60% of the samples are not suitable for drinking purposes and SAR, %Na, shows that 50–60% of the groundwater samples were found suitable for irrigation. The results concluded that groundwater quality is 60% suitable for irrigation and poor for drinking , this may due to long-term use of wastewater irrigation. Proper drainage facilities and minor treatment before irrigation are needed to avoid contamination of groundwater in wastewater irrigated areas.

3 .Scientific research team at University Mohammed I/ Yemen (2015) presented the results To study Impact of wastewater on groundwater resources in Sana'a, analysis of 28 samples of groundwater, wastewater, and soil was conducted in different times between 2013 and2014, such that results show that the shallow aquifer presents a high concentration of nitrates, COD and BOD5. The contamination comes from the wastewater and pesticides used for irrigation. The recommendations were, the authorities must make an urgent decision to change this contamination quickly.

4. Scientific research team at(Shiraz University/Iran(2006) presented the results To study negative Impact of untreated wastewater irrigation on soils and crops in Shiraz suburban area were taken sampled along the Khoshk River channel in suburban area of Shiraz City, SW Iran , samples of soil profiles (0–60 cm in depth) and crops were collected from two wastewater irrigated sites and a tube well-irrigated (control) site such that results showed the use of untreated wastewater has caused the following changes as compared to control site: a 20–30% increase in organic matter content of soil; increase in pH by 2–3 units; excessive accumulation of Ni and Pb in wheat due to continual addition of heavy metals through long-term wastewater application. The study concludes that strict protection measures, stringent guidelines and an integrated system for the treatment and recycling of wastewater are needed to minimize the negative impacts of wastewater irrigation in the study area. Strict legislation and stringent standards must be enforced to prevent the use of wastewater for irrigation purposes and an integrated system for the treatment and recycling of wastewater needs to be developed in the study area. For this purpose, governmental authorities should provide prompting or supporting mechanisms. Loans with low interest rate and long term bank credits are proper options. Also, state and local governmental agencies should make legal constraints easy to any person desiring to dig a tube-well and With respect to long term application of wastewater in affected sites, operational monitoring should be conducted to verify the buildup of heavy metals in view of their significant accumulation in phytoavailable fraction associated with changes in soil properties.

5. A case study of urban wastewater balancing to study wastewater pollution loads and groundwater pollution in the city of Nablus-East (Palestine) The research aimed to evaluate the pollution resulted by wastewater exfiltration of the sewer networks in Nablus-East region, where the wastewater samples have been collected from the main and sub-main catchment's outlets, for both the water mass balance and the nitrogen (Shaheen, 2013). The study found out the exfiltration rate, where the daily exfiltration per kilometer was (0.02 m3/day). Regarding the water mass balance results showed that (82.2%) of the consumed water ends in the sewer network, compared to (17.8%) that is used outdoor. Moreover. The exfiltration wastewater from the sewer network was (12.8%) of the consumed water, while (65.2%) flows to Al-SajorWadi, and (4.2%) ends up in cesspits (Shaheen, 2013). The 'annual urban nitrogen loading' has been found to be 688 (kg N/ha*yr) for Nablus-East region wastewater, which is very high when compared to figures for urban areas in Europe and Africa (Shaheen, 2013).

6. Nitrogen and Heavy Metal Fluxes from Cesspits in Palestine - BeitDajan and BeitFourik as a Case Study. The aim of this research was to evaluate the contamination in BeitDajan and BeitFourik villages that are located in Nablus governorate, in terms of total nitrogen and heavy metals from cesspits (Amous, 2014). The average concentration of heavy metals in the cesspit septagewere : (Cu 0.24 mg/l), (Ni 0.03 mg/l), (Pb 0.01 mg/l), (Mn 0.47 mg/l), (Fe 12.56 mg/l), (Cr 0.04 mg/l), and (Zn 1.23 mg/l) (Amous, 2014). After being moved through soil; the concentrations of heavy metals in the infiltrated septage have been reduced. By which Copper (Cu), Nickel (Ni) and Chromium (Cr) have not been found in the infiltrates, other metals have been reduced dramatically such as manganese (Mn), iron (Fe) and zinc (Zn) (Amous, 2014).

7 . Wastewater irrigation and environmental health: Implications for water governance and public policy Based on the hypothesis "Wastewater reuse and nutrient capture can contribute in climate change adaptation and mitigation", Hanjra et.al. (2011) examined the potential for wastewater irrigation regarding its benefits and risks. The study also presents a blue-print for future water governance and public policies to protect environmental health. Using reused wastewater in irrigation, which resulted in other activates like crop yields and changes in cropping patterns reduces the water footprint of food production on the environment. The study recommended a better integration for water reuse by governance polices to grantee environmental health protection during these process

CHAPTER THREE

"WASTEWATER EFFECTS ON SOCIO-ECONOMIC ASPECTS"

3.1 Size and components of the household sample

Table (3.1)number of members in each family of household sample

number of family members	Count	percent (%)
3 and less	10	2.7%
4 – 7	198	52.8%
8 and more	167	44.5%
Total	375	%100.0

Regarding to number of person per family table(3.1)show that the average total number of families contain three member or less was 10 (2.7%),the vast majority of samples contains more than 8 member with 52.8% of samples while the families contains 8 and more was 44.5% of samples

Table (3.2): Size and components of the household sample

	Count (%)	Mean
Total males		3.8
Males, 0 -18		1.7
Males, 18 – 65		2.1
Males, Older than 65		0.1
Total Females		3.1
Females, 0 -18		1.2
Females, 18 – 65		1.9
Females, Older than 65		0.1

Regarding the gender table (3.2) , the average of the total number of males per household was four males. Besides, the average number of males with ages ranging from 0 to 18 years old per household was tow males. And, the average number of males with ages ranging from 18 to 65 years old per household was two males Moreover, the average number of males with ages over 65 years old was zero male

Furthermore, the average of the total number of females per household was three females. Besides, the average number of females with ages ranging from 0 to 18 years old per household was one female. And, the average number of females with ages ranging from 18 to 65 years old per households was two females. Moreover, the average number of females with ages over 65 years old per household was zero female

3.2 Income of the household sample

Table (3.3):Income of the household sample.

Source of income	Count	percent (%)
Agriculture	12	3.20%
Herding	11	2.90%
Employee - civil Sector	4	1.10%
Employee - Government Sector	31	8.30%
private sector employee	66	17.60%
Works in Israel	207	55.20%
does not work	44	11.70%
Total	375	100%

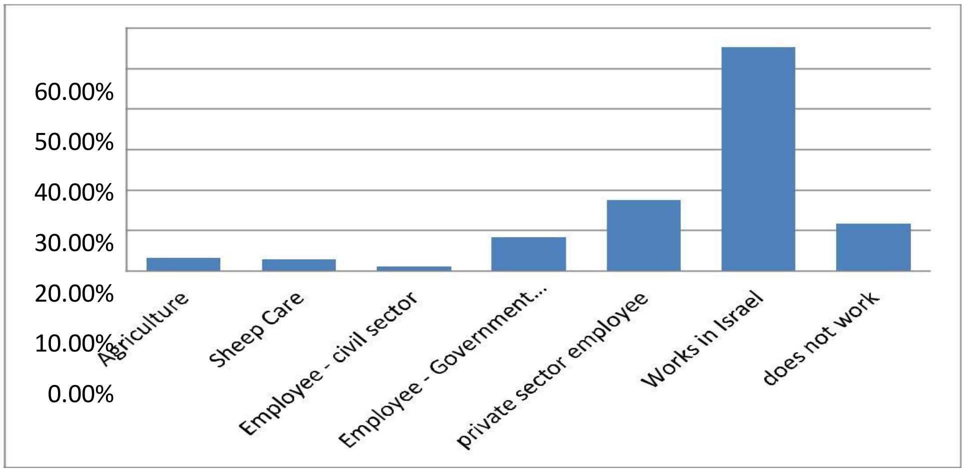
As shown in table (3.3) the primary source of income varied among the household sample as 55.2% (no. = 207) was found to be working in Israel, 8.3% (no. = 31) were employed by the Government, 3.2% (no. = 12) in agriculture, 1.1% (no. = 4) in NGOs, 2.9% (no. = 11) in herding, 11.7% (no. = 44) were unemployed, and the remaining 17.6% (no. = 66) their primary income came from sources other than that mentioned above.

Regarding the average monthly household income New Israeli Shekels (NIS), more than half of the household sample (52.8%, no. 198) were earning 1000-3000 NIS, 36% (no. = 135) were earning 3000-5000 NIS, 6.7% (no. = 25) were earning less than 1000 NIS, and 4.5% (no. =17) were earning more than 5000 NIS.

Table (3.4): average monthly household income

Average income	Count	percent (%)
Less than 1000	25	6.70%
1000 - 3000	198	52.80%
3000 - 5000	135	36.00%
More than 5000	17	4.50%
Total	375	100.00%

Regarding the average monthly household income New Israeli Shekels (NIS), more than half of the household sample (52.8%, no. 198) were earning 1000-3000 NIS, 36% (no. = 135) were earning 3000-5000 NIS, 6.7% (no. = 25) were earning less than 1000 NIS, and 4.5% (no. =17) were earning more than 5000 NIS.



Figure(3.1): Primary income source of the household sample

3.3 Expenditure on water of the household sample

Table(3.5) Expenditure on water of the household sample

	Count (%)	Mean
Average expenditure on water Summer (NIS/month)		77
Winter (NIS/month)		69

Regarding the expenditure as show in table (3.5) on water, In Summer, the average was 77 shekels per month. Whereas, in winter, the average was 69 shekels per month.

3.4 living condition of the household sample

Table(3.6): living condition of the household sample

		Count (%)	Mean
Type of housing	Apartment	27 (7.2 %)	
	Separate housing	348 (92.8%)	
Internal house area (m2)			147.4
Roof area (m2)			152.4
number of floors			1.9

According to Table (3.6), the vast majority of the household sample (92.8%, n=348) were living in separate housing, 7.2% (n=27) in apartments, . For the internal house area, the average was 147.4 m^2. And the average roof area was 152.4 m^2. Regarding the number of floors, the average was (1.9)

Table (3.7) :number of member in each floor of the household samples

number of individuals per floor	Count	percent (%)
3 and less	65	17.30%
4-7	242	64.50%
8 and more	68	18.10%
Total	375	100%

The above table shows that the highest percentage of people on the floor was(4-7)individuals by (64.5%), followed by (8) individuals and more by (18.1%), then came (3) individuals and less by (17.3%).

3.5 wastewater disposal of the household sample

Table(3.8): wastewater disposal of the household sample

		Count (%)	Mean
Wastewater disposal	Wastewater network	0 (0.0%)	
	Cesspit	346 (92.3%)	
	Septic tank	23 (6.1%)	
	Open channels	6 (1.6%)	
Wastewater disposal	Every Month	101(26.9 %)	
	Every Two months	67 (17.9%)	
	3 months and more	207 (55.2%)	
Frequency of empting cesspit/septic tank (times/month)			2.3

Regarding the wastewater disposal, the vast majority of the sample (92.3%, n=346) useed cesspit for water disposal, 6.1% (n=23) used deaf hole, and 1.6% (n=6) used Open channels ways for wastewater disposal. , the highest number of times the wastewater was discharged from the cesspit was every three months and more by (55.2%) followed by (26.9%) in second place(17.9%).For the frequency of emptying cesspit/septic tank, the average was 2 times per month

Sufficiency of water of the household samples

Table (3.9): Sufficiency of water of the household sample

Sufficiency of water of the household samples	Count	percent (%)
25 %less than	3	0.80%
25-50%	8	2.10%
50-75%	34	9.10%
75 %more than	330	88.00%
Total	375	100.00%

Regarding the sufficiency of water from all sources, the majority of the household sample (88%, n=330) agreed that it covers more than 75% of their actual needs, 9.10% (n=34) stated that it covers 50% to 75% of their actual needs, 2.10% (n=8) agreed that it covers 25-50% of their actual needs, and 0.8% (n=3) agreed that it cover less that 25% of their actual needs

3.6 Water Network

Table(3.10): fees and water supply frequencies by water network

	Summer Mean	Winter Mean
Monthly fees paid (NIS)	58.9	51.3
Water supply frequency (hour)	16.8	17.0

According to Table (3.10), we can see that the average monthly fees paid by the household sample for the water network during the summer was 59 shekels, and during the winter was 51 shekels. For the water supply frequency, in summer the average was 16.8 hours per day and in winter 17 hours per day.

3.7 Tankers

Purchasing water from tankers by household sample

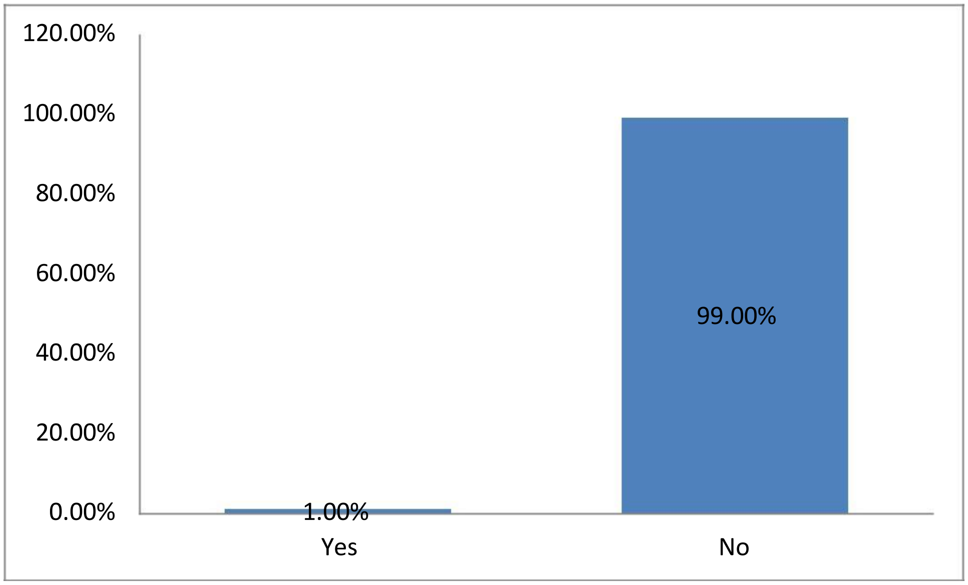


Figure (3.2): purchasing water from tankers

According to Figure (3.2), we can see that majority of the household sample (99%, n=371) didn't purchase water from tankers, and 1% (n=4) .purchased water from tankers

Table (3.11): number and prices of tankers purchased

	Summer Mean	Winter Mean
Number of tankers purchased	0.04	0.01
Price of paid per tank (NIS)	121.1	35.8

For the number of tankers purchased and the price per tank, during the summer, the average was almost 0.04 and the average price was 121 shekels, and during the winter, the average number of tankers was almost 0.01 and the average price per tank was 36 shekels.

Table (3.12): capacity of water tankers

	Mean
Capacity of water tanker (m3)	9.9

Regarding the capacity of water tankers, the average capacity was al almost 9.9 m^3.

Satisfaction with water quality from tankers and the source of the tankers water:

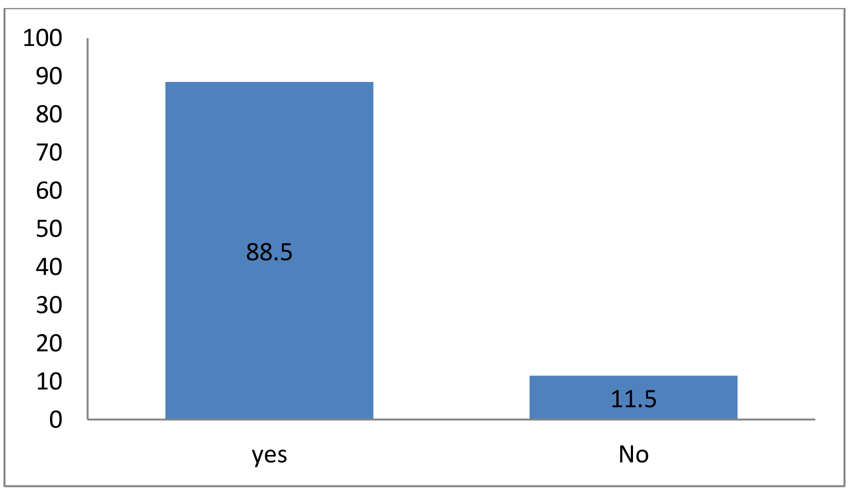


Figure (3.3): Satisfaction with water quality from tankers

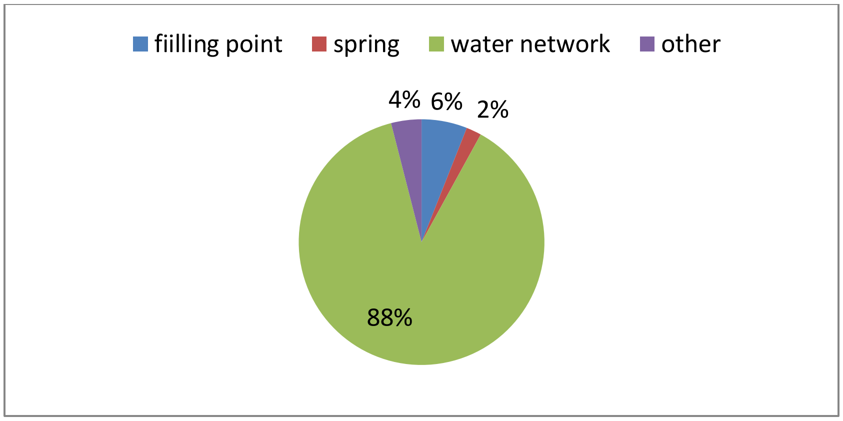


Figure (3.4): source of tankers water

Regarding the satisfaction with water quality from tankers, the vast majority (88.5%, n=332) were satisfied, while 11.5% (n=43) were not satisfied. For the source of tankers water, most of the household sample (6%, n=21) stated that their tankers water were from filling points, 88% (n=331) from water network,2% (n=8) from spring and 4% (n=15) from other sources

3.8 Cistern

Table(3.13): Availability of cistern.

There is a Cistern	Count	percent (%)
Yes	276	73.60%
No	99	26.40%
Total	375	100.00%

Regarding the availability of cistern, we can see that of the household sample (73.6%, n=276) have cistern, and 26.4% (n=99) didn't have any cistern.

Table (3.14): type of Cistern

Type of Cistern	Count	percent (%)
tank	174	46.4
pear shape	125	33.3
Don’t have	76	20.3
Total	375	100.00%

Regarding the type of cistern, we can see that of the household sample (46.4%, n=174) have cistern to tanks type, (33.3%, n=125) have cistern to agasa type and 20.3% (n=76) didn’t have

Table (3.15) capacity of the tank

Type of Cistern	Mean
Tank	84.6
pear shape	89.8

the capacity of the tank , the average capacity of the tank was 84.6 m^3, the pear shape was 89.8 m^3,

Table (3.16): Catchment type

Catchment type	Count	percent (%)
roof area	293	78.10%
Road	6	1.60%
open	2	0.50%
Don’t have	74	19.70%

For the catchment type , the vast majority (78.1%, 293) use the roof area, 1.6% (n=6) the road, 0.5% (n=2) the open area and 19.7% (n=74) don't have

Table (3.17) Catchment area (m2)

Type of Cistern	Maen
tank	154.1
pear shape	164.3

the Catchment area of the tank , the average capacity of the tank was 154.1 m^2, the pear shape was 164.1 m^2

Table (3.18)Year of construction

Year of construction	Count	percent (%)
1980 and less	23	6.10%
2000-1981	97	25.90%
2001 and more	174	46.40%
Don't have	81	6.21%

for the year of construction, for the 1980 and less cistern the percent was (6.10%)the between (1981-2000) cistern the percent was (25.9%) , the 2001 and more cistern the percent was (46.4%) , and the Don't have the percent was (21.6%)

Table (3.19)Construction cost

Type of Cistern	Maen
tank	7954.5
pear shape	Uknown

For the construction cost, the average for tank was 7954.5 shekels, the pear shape uknown because it originated in ancient times.

Table (3.20): Storing water from other sources in the cisterns

Storing water from other sources in the cisterns	Count	percent (%)
Yes	300	80
No	18	4.8
Do not have or did not answer	57	15.2
Total	375	100.00%

For Storing water from other sources in the cisterns, the vast majority of the household sample (80%, n=300) store water from other sources in the cisterns and 20% (n=75) sisn't do that.

Table (3.21): Cleaning of cistern.

Cleaning of cistern	Count	percent (%)
Yes	367	97.9
No	8	2.1

For the cleaning of cisterns, the vast majority (97.9%, n=367) cleaned their cisterns and 2.1% (n=8) didn't do that.

Table (3.22): Frequency of cleaning the cistern

Frequency of cleaning the cistern	Mean
year	1.8

for the frequency of cleaning the cistern, the average was every two years

Table (3.23): Method of cleaning the cistern

Cleaning methods	Count	percent (%)
Water alone	364	97.1
Disinfectants such as chlorine	11	2.9

for the methods of cleaning the cisterns, most of the household sample (97.1%, n=364) used the water alone, 2.9% (n=11) Disinfectants such as chlorine

Table (3.24): Cleaning of catchment area prior to rainwater harvesting

Cleaning of catchment area prior to rainwater harvesting	Count	percent (%)
Yes	373	99.5
No	2	0.5

Regarding the cleaning of catchment area prior to rainwater harvesting, 99.5% (n=373) cleaned it and 0.5% (n=2) didn't do that

Table (3.25): Satisfaction with rainwater quality

Satisfaction with rainwater quality	Count	percent (%)
Yes	367	97.9
No	8	2.1

For the satisfaction with rainwater quality, the vast majority of the household sample (97.9%, n=367) were satisfied, while 2.1% (n=8) were not satisfied with the rainwater quality .

Table (3.26): satisfaction with the taste, color and smell of the water by the household sample

satisfaction	Count	percent (%)
Excellent	22	5.9
Good	265	70.7
Acceptable	42	11.2
Not acceptable	46	12.2

According to Table (3.26), we can see that of the household sample (5.9%, n=22) found the taste, color, and smell of the water is excellent, 70.7% (n=265) found it good, and 11.2% (n=42) found itacceptable 12.2% (n=46) found it Not acceptable

Table (3.27): frequency of wastewater flooding near the cistern

frequency of wastewater flooding near the cistern	Count	percent (%)
Yes	3	0.8
No	372	99.2

We can see from Table (3.27) that the vast majority of the household sample (99.2%, n=372) don't have wastewater flooding near the cistern, and just 0.8% (n=3) have frequent wastewater flooding near the cistern.

Table (3.28): treating harvested rainwater prior to use

treating harvested rainwater prior to use	Count	percent (%)
Yes	17	4.5
No	358	95.5

For treating harvested rainwater prior to use, the majority (95.5%, n=358) don't treat it, and 4.5% (n=17) treat it before using it.

CHAPTER FOUR

"WATER QUALITY RESULTS"

4.1 Water Quality Parameters :

Septic systems discharge a variety of contaminants which can affect surface waters, includingnutrients, pathogens, organic matter and solids. Conventional septic tank and drainfield systemstream wastewater by settling solids and partly digesting the organic matter, allowing liquid effluent, whichstill contains nutrients and pathogens (bacteria, protozoa and viruses) to be discharged into the soilbeneath the drainfield.

Wastewater leaving the drainfield of a septic system trickles first to unsaturated soil above thewater table, and eventually to the water table below. All continuously operated septic systemsare expected to discharge to groundwater eventually (Woessner in McDowell, 2001 newsletter). Wherethe depth to the water table is shallow and overlying soils are permeable, as is typical in valleys nearstreams, rivers, or lakes within the inland Northwest, recharge from septic systemsto groundwater is relatively rapid. Although it is possible forwastewater to be absorbed by plant roots, in reality this shouldnot happen because properly-designed drainfields areinstalled below the root zone of grasses and outside therooting areas of trees. Therefore, most septic effluentreaches the water table. This water carries with it some ofthe soluble contaminants of effluent that are not absorbedby soil, including nitrogen, various bacteria and viruses.

4.1.2 surface waters: how do contaminants get from ground water to streams and lakes:

To understand how pollutants from septic systems can contaminate surface water, it is importantto first understand the ways in which groundwater flows beneath the earth's surface and interacts with surface streams and lakes. Groundwater does not stay in one place, but flows from areas of higher water table elevation towards areas of lower water table elevation. Streams, rivers and lakes are usually low points in a watershed, and shallow groundwater within a watershed flows toward and discharges to these water bodies.Groundwater and surface water interact in complex and dynamic ways. The important concept is that surface water and groundwater are not separate, but rather consist of the same water circulating through the hydrologic system. Consequently, any impact to groundwater, such as the discharge from septic systems, will ultimately impact surface water. Managers of septic systems and other sources of groundwater contamination need to recognize that—in many of the geologic settings, such as basin-fill river valleys and lakeshores undergoing intense development pressure—groundwater contamination can have an impact on our surface waters, and vice versa.river and lakes. Thus, one would expect to find that, in some cases, septic systems are contributing significant amounts of nutrients to surface waters, and causing negative impacts to area waters. This indeed turns out to be the case. Below are examples where such impacts have been documented and linked to the cumulative load from individual septic systems.

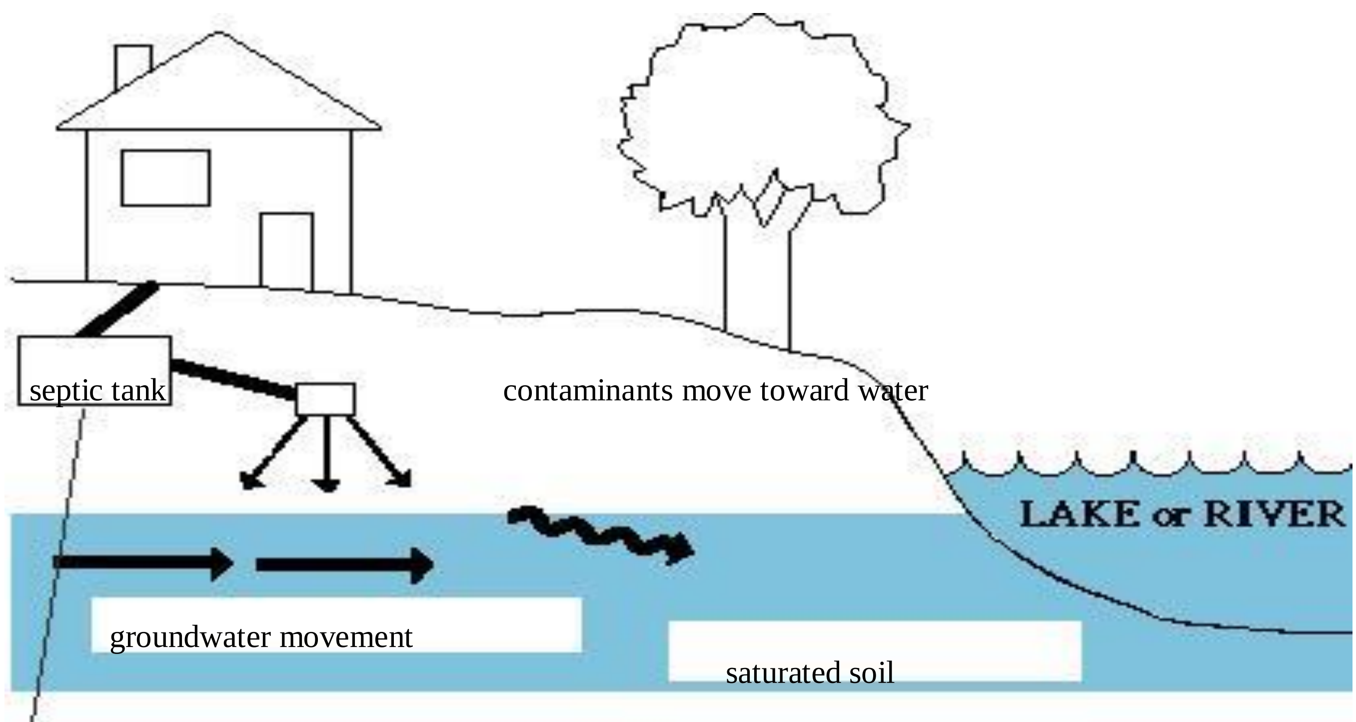


Figure 4.1:How do contaminants get from ground water to streams and lakes

and in this study we evaluate the water quality through examine water samples from some household cisterns in order to evaluate the effect of infiltration of wastewater from septic tank to cisterns,and there is a lot of paper in this field we show some of it :In a study conducted in Kefaloniaisland titled "Rainwater harvesting, quality assessment and utilization in Kefalonia Island, Greece" the researcher referred the problem of water scarcity to be strongly connected to the problem of water quality. Industrialization, human activities, and urban development decrease the quality of water and, in some cases make it non-potable (Sazakli et al, 2007).Throughout three years of monitoring, twelve seasonal samplings, 144 mixed water samples and 156 rainwater samples were collected from cisterns and cement catchment areas in order to assess the quality of RWH in the northern area of Kefalonia Island in SW Greece (Sazakli et al, 2007).

The physical, chemical and pathogenic parameters were tested in order to determine water quality including anions and cations as well as the metals (Fe,,Cd, Mn, Pb, Cr, Cu, Zn and Ni), (Sazakli et al, 2007).

The study showed that the microbiological and chemical parameters fluctuate on a seasonal basis. Microbiological parameters are affected by cleaning practices of the catchment area, contamination by feces of bird and other animals while chemical parameters are affected by human activities, agricultural usage of fertilizers, traffic emission and industrial pollution (Sazakli et al, 2007).

As in the conclusions of these studies earlier studies have reported that rainwater stored in tanks was of acceptable quality (Dillaha and Zolan, 1985). However, in more recent studies, either chemical or microbiological contaminants have been found in the collected rainwater, often in levels above international or national guidelines set for safe drinking water (Simmons et al., 2001; Chang et al., 2004; Zhu et al., 2004). What is clear is that the quality of the RWH depends on the characteristics of the individual areas such as weather conditions, topography, closeness to pollution sources (Va´squez et al., 2003),the kind of the catchment area (Chang et al., 2004; Zhu et al., 2004), the type of storage facility (Dillaha and Zolan, 1985; Evison and Sunna, 2001) and the management and handling of the water (Pinfold et al., 1993; Evison and Sunna, 2001).

4.2Water quality parameters

4.2.1 Physical parameters :

The physical parameters of water can be determined by senses of sight, touch, taste and smell such as turbidity and suspended solids by detecting color caused by floating impurity (Cretu, et al., 2015).

4.2.2WHO Guidelines for Physical Parameters :

Table 4.1 shows the WHO Guidelines for Drinking Water Quality for physical parameters (WHO, 2004).

Table(4.1): WHO Guidelines for Drinking Water Quality: Physical (WHO, 2004*)*.

Parameter	WHO Guideline
Color	Aesthetic value of < 15 True Color Units (TCU)
Odor	Aesthetic only, no health based value is proposed
Temperature	Aesthetic only, no health based value is proposed
Turbidity	<5 NTU

4.2.3 Temperature

The e temperature of water can considerably contribute to changing some of the important properties and characteristics of water: thermal capacity, density, specific weight, viscosity, surface tension, specific conductivity, etc. Chemical and biological reaction rates increase with high temperature. Reaction rates are usually assumed to double for an increase in temperature of 10 °C. The temperature of water in streams and rivers throughout the world varies from 0 to 35 °C (WHO, 2004).

4.2.4 Color

Color in water is primarily a concern of water quality for aesthetic reason. Colored water seems unsuitable for dinking or even washing purposes, although it may be safe to use it. Color presence in water is an indication for organic substances being there as algae or humiccompounds. More recently, color has been used as a quantitative assessment of the presence of potentially hazardous or toxic organic materials in water.

4.2.5 Turbidity

Turbidity in drinking water comes from particulate matter that may be present in source water because of bad filtration or from suspension of sediment in the distribution system or reservoirs. It may also be due to the presence of inorganic particulate matter in some ground waters or sloughing of biofilm within the distribution system. A turbidity of less than 5 NTU in water is usually acceptable to consumers, although this may vary with local circumstances. Particulates can protect microorganisms from the effects of disinfection and can stimulate bacterial growth. In all cases where water is disinfected, the turbidity must be low (less than 5 NTU) so that disinfection can be effective. Turbidity is also an important operational indicator in process control and can indicate problems with treatment processes, particularly coagulation/sedimentation and filtration. As the rainwater meets the ground surface and moves from catchment area into storage facility, a significant variation in the water turbidity is expected to take place (Awadallahet al, 2011).

4.3 Chemical parameters

The chemical composition of water highly affects its quality, because some chemical constituents of water could cause serious health issues specially with repeated exposure. Table 1.1 illustrates water quality standards (Palestinian, EPA and WHO) for human consumption (Al-Salaymeh et al., 2011).

There are few chemical constituents of water that can lead to health problems resulting from a single time exposure, except through massive accidental contamination of drinking water supply. Moreover, experience shows that in many, but not all, incidents, the water becomes undrinkable owing to unacceptable taste, odor and appearance (WHO, 2004).

Table (4.2): Source of chemicals in water, (WHO, 2004)

Source of chemical constituents	**Examples of sources**
Naturally occurring	Rocks, soils and the effects of the geological setting and climate
Industrial sources and human dwellings	Mining (extractive industries) and manufacturing and processing industries, sewage, solid wastes, urban runoff, fuel leakages
Agricultural activities	Manures, fertilizers, intensive animal practices and pesticides
Water treatment or materials in contact with drinking-water	Coagulants, DBPs, piping materials
Pesticides used in water for public health	Larvicides used in the control of insect vectors of disease
Cyanobacteria	Eutrophic lakes

4.3.1 pH

Although pH does not have any direct impact on human health, it is an important operational water quality parameter. It is necessary to control pH at all stages of water treatment to ensue complete clarification and disinfection. It is important to know the pH since more alkaline water demands a longer contact time or a higher chlorine dose at the end of contact time to have suitable disinfection(0.4-0.5 mg/liter at pH 6-8, raising to 0.6mg/liter at pH 8-9: chlorination may be ineffective at pH above 9). The optimum pH will vary in different supplies according to the water composition and the construction materials used in the supply/storage systems, but it is usually 6.5-8. pH is normally affected by the catchment area and type of storage facility. (Awadallah et al, 2011).

4.3.2 Total Dissolved Solids (TDS)

Total Dissolved Solids (TDS) is a parameter which measures the amount of total substances dissolved in a water sample. A high TDS value is usually used as an indicator which signals the presence of potentially alarming factors such as high hardness, chemical deposits, etc. thus necessitating the measurement of other parameters. WHO has defined a TDS threshold of 600 mg/l for good drinking water. TDS values exceeding 1000 mg/l can only be used for the irrigation of selected crop types. TDS can also be measured using another indicator known as Electrical Conductivity (EC) which is twice as much in value. TDS values of harvested rainwater are affected by the surrounding conditions of the catchment area and storage facility (Awadallah et al, 2011).

4.4 Microbiological Aspects :

Not all microorganisms found in water samples have a potential health impact on consumers(WHO, 2004). Impact of some may be limited to aesthetic implications causing increased turbidity and foul odor while others may have fatal consequences.

4.4.1 Bactria

4.4.1.1Total Coliforms Bacteria:

The presence and concentration of Total Coliforms Bacteria can be used as an indicator to test treatment effectiveness and assess distribution systems conveying water to consumers. This group includes both fecal and environmental species, high values are used as a signal to inform the reader of potentially hazardous bacteria (WHO, 2004).

4.4.1.2Fecal Coliforms Bacteria:

Fecal Coliforms are generally found in the feces of warm blooded animals and are thus a more accurate indicator than Total Coliforms. Escherichia coli (E. coli), the major species in Fecal Coliforms, is present in very high numbers in human and animal (both mammals and birds). In general, E. coli does not grow and reproduce in the environment and is thus considered the best indicator of fecal pollution and the possible presence of pathogens. (Rivera et al. 1988, Hunter, 2003).

4.5 Testing of water samples :

Measurement of pH using a pH meter

A sample of the water was collected in a clean bottle (a). The water sample must be deep enough to cover the tip of the probe (b). The probe was cleaned with water from the sample before it was placed in the sample container.The measurement was taken when the meter came to equilibrium(c).

The most probable number method, otherwise known as the method of Poisson zeroes, is a method of getting quantitative data on concentrations of discrete items from positive/negative (incidence) data according who stander but here we used Membrane filtration**.**

- Coliforms are useful pollution indicators since they imply that the water has been in contact with plants or soils or has been polluted by sewage and this bacteria have not died out naturally or been removed by natural filtration or artificial treatment.

Coliforms are important not only because they indicate pollution but also because their absence or presence, and their number, can be determined by routine laboratory tests. Tests for pathogens are not adapted to such routine work and are made only in special investigations. The difficulties with routine testing of pathogens in water are due to the following reasons:

o Presence in low numbers

o Limited survival time

o Numerous pathogens to analyze

o Required time and cost .

Total Coliforms Bacteria:

o Sources: fecal material (inhabit the intestinal tract of animals), soil, water and grain

o Some capable of reproduction in the environment

Fecal Coliforms bacteria:

o Subset of the Total Coliforms group

o Separated from non-fecal Coliforms by growth at 44.5 ºC

o Sources: fecal material (from warm blooded animals)

o Capable of limited survival and growth in the environment

o Primary example is Escherichia coli (E. coli).

Test:

1. The membrane filter (0.45 μm) through which the sample (100 mL) has been filtered was placed onto the top of the saturated absorbent pad.

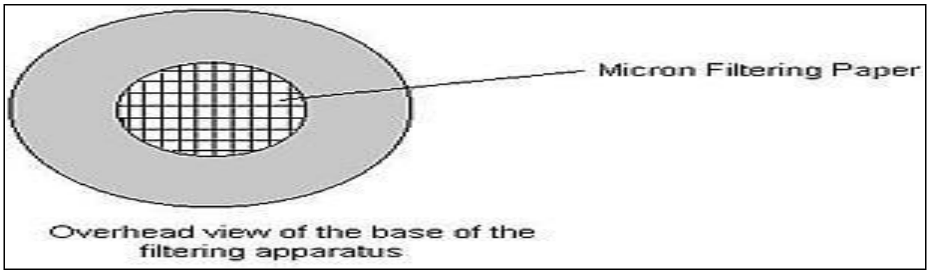


Figure 4.2: Overhead view of the base of the filtering apparatus

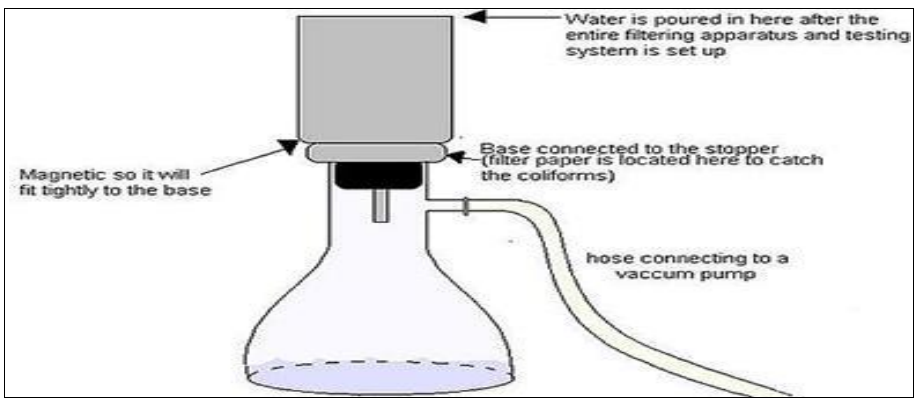


Figure 4.3: Filter the sample water.

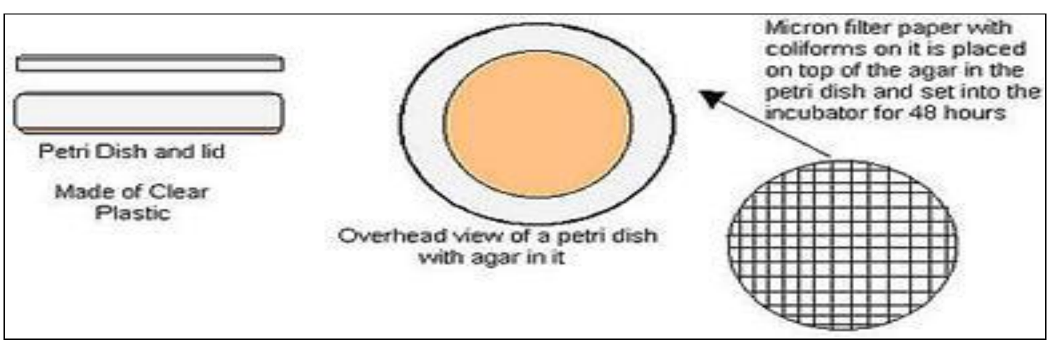


Figure 4.4: Filter the sample water.

2. The Petri dish was tightly covered and incubated at 44.5 ºC for 22 – 24 hours.

3. The number of colonies on the filter were counted.

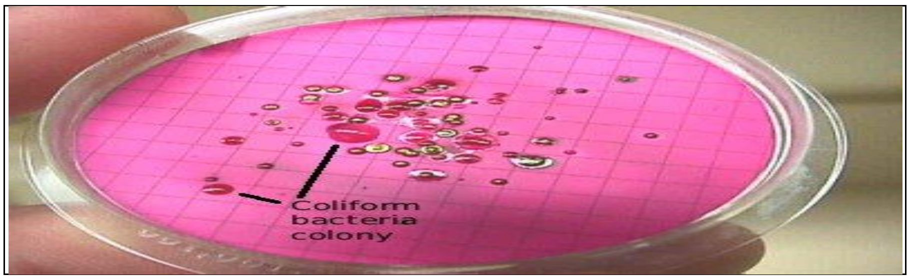


Figure4.5: Count the number of colonies found on each filter.

4.6 Water Quality Results:

The objective of this part of the study was to test the physical, chemical and, microbiological parameters of rainwater stored in cisterns.

Water samples were collected . The sample was drawn using the Sterilized Sampling Method, from a depth approximately at the middle of the water column. The samples were placed in sterilized bottles and transported to the laboratory in an ice, cooler and processed within twenty-four hours. were collected A total of 8 samples of four sites.

Figure4.6:colletion of rain water from sites.

Figure4.7:colletion of rain water from sites.

Figure4.8:colletion of rain water from sites.

Figure4.9: colletion of rain water from sites.

Table (4.3) Show the results of physical, chemical and microbiological characteristics .whereas The pH values Ranging from 7.31 to 8.00 with a mean value of 7.72.

All samples were examined for two commonly used bacterial indicators, Fecal Coliforms and Total Coliforms.

Table (4.3): Physical,chemical and microbiological characteristics of rain water samples :

Parameters	Range	Mean	Standard Deviation	Samples above MAC a(%)	PSI (2004) Guidelines	WHO (2004) Guidelines
pH	**7.31-8.00**	**7.72**	**0.25**	**0**	**6.5-8.5**	6.5-8.5
Temp (C0)	**18.8**	**18.8**	**0.00**		**NA b**	NA
Conductivity (µScm-1)	**313-787**	**463.25**	**191.55**	**0**	**Up to 2000**	Up to 2000
Turbidity (NTU)	**0.00-0.22**	**0.11**	**0.09**	**2**	**Up to 5.0**	Up to 5.0
Total Coliforms (CFU/100 ml)	**10-100**	**41.25**	**35.77**	**100**	**0-3**	0
Fecal Coliforms (CFU/100ml)	**0-100**	**28.75**	**41.28**	**75**	**0**	0

4.7 Discussion of Water Quality Results:

4.7.1Contamination with Total and Fecal Coliforms:

In spite of the acceptable chemical constitute of cisterns samples, the water is not safe for drinking, at least without any treatment, due to the pathogenic contamination. According to the results most of the samples were contaminated with both Fecal and Total Coliforms.

The percentage of contamination of inTuqu' town with Fecal and Total Coliforms was (75)% and (100)% respectively. These results are higher than those obtained through similar research conducted in Hebron City by Al-Salayma, 2008 (57% contaminated with Fecal Coliforms and 95% Total Coliforms), and another in Tulkarem (AlKatib and Orabi,2004) about (9.2% Fecal Coliform and 34% with Total Coliforms). In addition to those found in other study about the assessment of rain water quality in the West Bank by Daoudet. al., (2011), were 93% of the sampled cisterns were found to be contaminated with Total Coliforms and 90% contaminated with Fecal Coliforms.

Contamination happens in different ways and locations from collection and storage of water to the tap. Rainwater is often contaminated from the moment it falls onto the rooftop or any other catchment surface and facilities (roof tops, tunnels, small channels etc.). An important reason for contamination is due to the deposition on catchment areas.also may be from septic tank

Fecal Coliforms values range between 0 to 100 CFU/100ml with a mean value of 28.75 CFU/100ml; exceeding the WHO standard. As, samples should be completely free from Fecal Coliforms (null), most of the cisterns are contaminated and the water needs to be treated in order to be used safely.

However, wastewater may also seep into the cisterns through its sides, especially should it be pear-shaped because the walls are rocky and highly porous. About 39.1% of the household sample have pear shape cisterns. This would not be the case in reinforced cisterns which resists the intrusion of waste water. Also about 98.8% of the household sample have septic tanks have high contamination rates. According to the Palestinian Water Authority, the distance between the cesspit and cisterns should be at least 15 meters away.as well as In general, septic systems are a significant source of nutrients, especially nitrates, to groundwater and surface water in rural areas experiencing rapid growth.

Sustainable, efficient water quality disinfection methods should be applied to the water stored in cisterns. Chlorination is the most common, easily applied method. To ensure proper use, instructions should be given to the consumer for cleaning and disinfection of storage tanks and cisterns. The gate of a cistern must be raised over the cesspit or septic tank to avoid flooding wastewater from entering the cistern. Cistern users must test the water frequently to ensure cleanness and safety for drinking purposes.

CHPTER FIVE

"DESIGN PARAMETERS"

5.1 General

Once used for its intended purposes, the water supply of a community is considered to be wastewater. The individual conduits used to collect and transport wastewater to the treatment facilities or to the point of disposal are called sewers.

There are three types of sewers: sanitary, storm, and combined. Sanitary sewers are designed to carry wastewater from residential, commercial, and industrial areas, and a certain amount of infiltration /inflow that may enter the system due to deteriorated conditions of sewers and manholes. Storm sewers are exclusively designed to carry the storm water. Combined sewers are designed to carry both the sanitary and the storm flows.

The network of sewers used to collect wastewater from a community is known as wastewater collection system. The purpose of this chapter is to define the types of sewers used in the collection systems, types of wastewater collection systems that are used, the appurtenances used in conjunction with sewers, the flow in sewers, the design of sewers, and the construction and maintenance of sewers.

5.2 Municipal Sewerage System

Types Of Sewers:

The types and sizes of sewers used in municipal collection system will vary with size of the collection system and the location of the wastewater treatment facilities. The municipal or the community sewerage system consists of (1) building sewers (also called house connections), (2) laterals or branch sewers, (3) main and submain sewers, (4) trunk sewers.

House sewers connect the building plumbing to the laterals or to any other sewer lines mentioned above. Laterals or branch sewers convey the wastewater to the main sewers. Several main sewers connect to the trunk sewers that convey the wastewater to large intercepting sewers or the treatment plant.

The diameter of a sewer line is generally determined from the peak flow that the line must carry and the local sewer regulations, concerning the minimum sizes of the laterals and house connections. The minimum size recommended for gravity sewer is 200 mm (8 in).

Sewer Materials:

Sewers are made from concrete, reinforced concrete, vitrified clay, asbestos cement, brick masonry, cast iron, ductile iron, corrugated steel, sheet steel, and plastic or polyvinylchloride or ultra polyuinyl chloride. Concrete and ultra polyvinyl chlorides are the most common materials for sewer construction.

5.3 Types Of Wastewater Collection Systems

Gravity Sewer System:

Collecting both wastewater and storm water in one conduit (combined system) or in separate conduits (separate system). In this system, the sewers are partially filled. A typical characteristic is that the gradients of the sewers must be sufficient to create self-cleansing velocities for the transportation of sediment. These velocities are 0.6 to 0.7 m/s minimum when sewers are flowing full or half-full. Manholes are provided at regular intervals for the cleaning of sewers.

Pressure Type System:

Collecting wastewater only. The system, which is entirely kept under pressure, can be compared with a water distribution system. Sewage from an individual house connection, which is collected in manhole on the site of the premises, is pumped intothe pressure system. There are no requirements with regard to the gradients of thesewers.

Vacuum Type System:

Collecting wastewater only in an airtight system. A vacuum of 5-7 m is maintained in the system for the collection and transportation of the wastewater. There is no special requirement for the gradients of the sewers.

Pressure and vacuum–types systems require a comparatively high degree of mechanization, automation and skilled manpower. They are often more economical than gravity system, when applied in low population density and unstable soil conditions. Piping with flexible joints has to be used in areas with expansive soils.

5.4 Sewer Appurtenances

Manholes:

Manholes should be of durable structure, provide easy access to the sewers for maintenance, and cause minimum interference to the sewage flow. Manholes should be located at the start and at the end of the line, at the intersections of sewers, at changes in grade, size and alignment except in curved sewers, and at intervals of 40-60 m in straight lines.

The general shapes of the manholes are square, rectangular or circular in plan, the latter is common. Manholes for small sewers are generally 1.0-1.2 m in diameter. For larger sewers larger manhole bases are provided. The maximum spacing of manholes is 40-60 m depending on the size of sewer and available size of sewer cleaning equipment.

Standard manholes consist of base, risers, top, frame and cover, manhole benching, and step-iron. The construction materials of the manholes are usually precast concrete sections, cast in place concrete or brick. Frame and cover usually made of cast iron and they should have adequate strength and weight.

Drop Manholes:

A drop manhole is used where an incoming sewer, generally a lateral, enters the manhole at a point more than about 0.6 m above the outgoing sewer.

The drop pipepermits workmen to enter the manhole without fear of being wetted, avoid the splashing of sewage and corrosion of manhole bottom .

House Connections:

The house sewers are generally 10-15 cm in diameter and constructed on a slope of 2% m/m. house connections are also called, service laterals, or service connections. Service connections are generally provided in the municipal sewers during construction. While the sewer line is under construction, the connections are conveniently located in the form of wyes or tees, and plugged tightly until service connections are made. In deep sewers, a vertical pipe encased in concrete is provided for house connections.

Inverted Siphons

An inverted siphon is a section of sewer, which is dropped below the hydraulic grade line in order to avoid an obstacle such as a railway or highway cut, a subway, or a stream. Such sewers will flow full and will be under some pressure; hence they must be designed to resist low internal pressures as well as external loads. It is also important that the velocity be kept relatively high (at least 0.9 m/s) to prevent deposition of solids in locations, which would be very difficult or impossible to clean.

Since sewage flow is subject to large variation, a single pipe will not serve adequately in this application. If it is small enough to maintain a velocity of 0.9 m/s at minimum flow, the velocity at peak flow will produce very high head losses and may actually damage the pipe. Inverted siphons normally include multiple pipes and an entrance structure designed to divide the flow among them so that the velocity in those pipes in use will be adequate to prevent deposition of solids .

5.5 Design Parameters

Flow Rate Projections:

The total wastewater flow in sanitary sewers for residential area is made up of two components:

(1) Domestic

(2) Infiltration.

Sanitary sewers are designed for peak flows from domestic, and peak infiltration allowance for the entire service area. Theflow rateprojections are necessary to determine the required capacities of sanitary sewers.

- The peak coefficient

  In general, this coefficient increases when the average flow decrease, it will be determined from the practice and experience of the designer. The following relation has been used commonly by the designer and gives satisfactory results:

$$Pf = 1.5 + 2.5 / \sqrt{q}$$

Where, q (in l/s) is the daily average flow rate of the network branch under consideration and Pf is the peak factor.

Hydraulic Design:

As mentioned earlier and according to usual practice, the sewers will be designed for gravity flow using Manning's formula:

$$V = (1/n)\, R^{2/3}\, S^{1/2}$$

Depending on pipe materials, the typical values of n is 0.015

1. Minimum and Maximum Velocities

   To prevent the settlement of solid matter in the sewer, the literature suggested that the minimum velocity at half or full depth – during the peak flow period – should not be less than 0.6 m/s, Usually, maximum sewer velocities are limited to about 3 m/s in order to limit abrasion and avoid damages which may occur to the sewers and manholes due to high velocities

2. Pipes and Sewers

   Experience indicates a minimum diameter of 200 mm (8 in) for sewer pipes. For house connections.

   Pipe Materials: Different pipe materials may be recommended for the sewers. Polyvinyl chloride, vitrified clay or polyethylene material for small size pipes (approximately up to the size 400 mm in diameter).Centrifugal cast reinforced concrete pipes may be used for larger diameter.

3. Manholes and Covers

Manholes should be located at changes in size, slope direction or junction with secondary sewer. Manholes spacing generally does not exceed 45m.

4. Sewer Slope

For a circular sewer pipe, the slope must be between the minimum and maximum slope, the minimum and maximum slope is determined from minimum and maximum velocity. Generally the natural ground slope is used because it is the technical and economic solution, the solution is therefore recommended.

5. Depth of Sewer Pipe

The depth of sewers is generally 1.5 m below the ground surface. Depth should be enough to receive the sewage by gravity, avoid excessive traffic loads, and avoid the freezing of the sewer. It is recommended that the top of sewer should not be less than 1.5 m below basement floor.

Important Numbers:

- Maximum velocity = 3 m/s
- Minimum velocity = 0.6 m/s
- Maximum slope = 12%
- Minimum slope = 1%
- H/D = 75%
- Minimum diameter 200 mm
- Minimum cover 1.5m
- Maximum cover 5 m

CHAPTER SIX

"ANALYSIS& DESIGN"

6.1General

In the previous chapters, the problem of the study area has been defined and the objectives of the project have been listed. The characteristics of the project area (tuqu' town) have been described. Wastewater collection systems and design of sewer system were explained. In this chapter, basis for planning and design will be discussed including present population, population forecasting, projected water consumption, town structure plan, and the design and planning criteria of the project.

6.2 Population

6.2.1 Introduction

records, which cover The ideal approach for population forecasting is by the study and use of previous census along period. The longer the period, and the more comprehensive the census data, the more accurate will be the results, which will be obtained. In the analysis of these data, demographical, economical and political factors should be considered in order to develop a method of forecasting which will predict the expected growth rate, future population and its distribution in the different zones of the area under consideration.

In the town of tuqu', as well as other Palestinian cities and towns, there is great uncertainty in the political and economical future. Additionally, there were no accurate population data since the occupation of the West Bank in 1967, until 1997 when the Palestinian Central Bureau of Statistic (PCBS) conducted comprehensive census covering the West Bank and Gaza Strip. The final results of this census show that the total population of tuqu' town is 8880inhabitants.

Due to the unstable condition of the area during the last 50 years, it would be very difficult to develop a statistical interpretation to extrapolate future population. Some reasonable assumptions have, therefore, been made to project the future population of the town of tuqu' over the next 25 years.

6.2.2 Population Forecast

Prediction of the future population of tuqu' is very difficult due to the lack of reliable historic data, and the political uncertainties, which will greatly influence future social and economic development. At the same time, the available data on past population growth do not constitute a reliable basis for projecting the future population growth in tuqu'.

The base for the forecast is the 2007 population for tuqu' obtained from PCBS of 8800 inhabitants. The rate of population growth for the purpose of our study was based on estimation used for other towns of similar population composition and characteristics. The rate of population growth in other towns in the West Bank is 2 %. A similar rate of growth was assumed for the towns of Gaza, Therefore, the rate of 2 % per year was used for the future growth of the population oftuqu' town .

To calculate the population at the end of the design period (year 2043), a geometric increase is assumed, represented by the following equation:

$$P = P_{\circ} * (1+ r)^{n} \quad \ldots\ldots\ldots\ldots\ldots\ldots(6.1)$$

Where, P is the future population, $P_{\circ}$ is the present population, r is the annual population growth rate, and n is the period of projection.

6.2.3 Population Density

When determining the density of population, it is either related to the total municipal area (gross density) or to the built–up area only (net density). The gross density related to the municipal area includes agricultural areas, un-built areas, public parks, forests …etc. The net density is related to the built up urban area, but it includes small-scale industries, schools, public and commercial buildings, small parks for local use and roads.

Sewer design, however, is based on the net densities of population, because the provision of sewers is limited to the built-up areas. The net density of population varies considerably from town to town as well as within a town from district to district. It is between 5 –100 capita / dounm .

6.3 Layout of the System

The first step in designing a sewerage system is to establish an overall system layout that includes a plan of the area to be sewered, showing roads, streets, buildings, other utilities, topography, and the lowest floor elevation or all buildings to be drained.

In establishing the layout of wastewater collection system for tuqu' the following basic steps were followed:-

1. Obtain a topographic map of the area to be served.

2. Visit the location.

3. Locate the drainage outlet. This is usually near the lowest point in the area and is often along a stream or drainage way. In tuqu' city, there are one point of the towards tuqu' settlement

4. Sketch in preliminary pipe system to serve all the contributors.

5. Pipes are located so that all the users or future users can readily tap on. They are also located so as to provide access for maintenance and thus are ordinarily placed in streets or other rights-of-way. .

6. Sewers layout is followed natural drainage ways so as to minimize excavation and pumping requirements. Large trunk sewers are located in low-lying areas closely paralleled with streams or channels.

7. Revise the layout so as to optimize flow-carrying capacity at minimum cost. Pipe lengths and sizes are kept as small as possible, pipe slopes are minimized, and followed the ground surface slope to minimize the depth of excavation, and the numbers of appurtenances are kept as small as possible.

8. The pumping is avoided across drainage boundaries. Pumping stations are costly and add maintenance problems.

6.4 Quantity Of Wastewater

The detailed design of sanitary sewers involves the selection of appropriate pipe sizes and slopes to transport the quantity of wastewater expected from the surroundings and upstream areas to the next pipe in series, which is subjected to the appropriate design constrains. The design computations are in the example given below.

After preparing the layout of the wastewater collection system the quantity of wastewater that the system must carry will be calculated using the data collected about the area.

Design example: Design a gravity flow sanitary sewer

Design example: Design a gravity flow sanitary sewer

Design a gravity flow main sanitary sewer for the area to outfall The following data will be collected and analyzed.

1. For current water consumption uses67L/c.day.

2. For future water consumption uses 110L/c.day.

3. For current population

4. For future population : using the equation(6.1).

5. For population growth rate 2 %.

6. For design period use 25 years as a design period.

7. The wastewater calculates as 80% of the water consumption.

8. Peaking factor depending on the formula :

$Pf = 1.5 + (2.5/\sqrt{q})$.

Where q = average industrial sewage flow.

10. For the hydraulic design equation use the Manning equation with an n value of 0.013.

To simplify the computations, we use the tables.

11. Minimum pipe size: The building code specifies 200 mm (8 in) as the smallest pipe size permissible for this situation.

12. Minimum velocity: To prevent the deposition of solids at low wastewater flows, use minimum velocity of 0.6 m/s during the peak flow conditions.

13. Minimum cover (minimum depth of cover over the top of sewer). The minimum depth of cover is 1.5 m.

To making design for all pipes a software program (GIS ,sewer CAD) was used to calculate the pipe size , slope , velocity and cover of the pipe section6.5, 6.6 is showing the basics of working on sewer GIS and CAD program .

6.5 GIS Program Works:

1. Download image(DEM) from the earth explorerWebsite

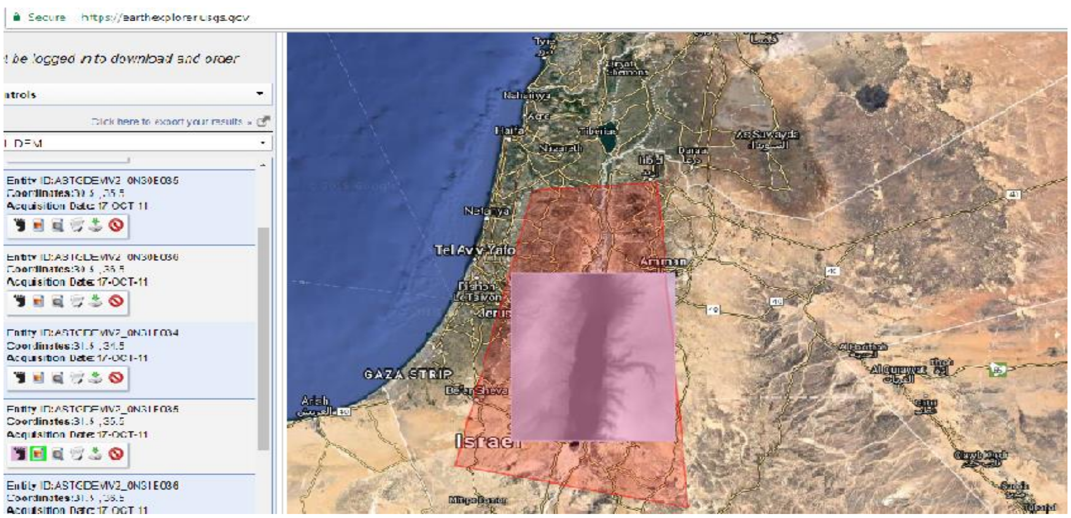


Figure (6.1): Earth Explorer

2.Bring the necessary information from GIS lab and municipality of Tuqu’

(Aerial photos ,road, houses)

3. Insert the DEM into the GIS program and make a clip based on the study area

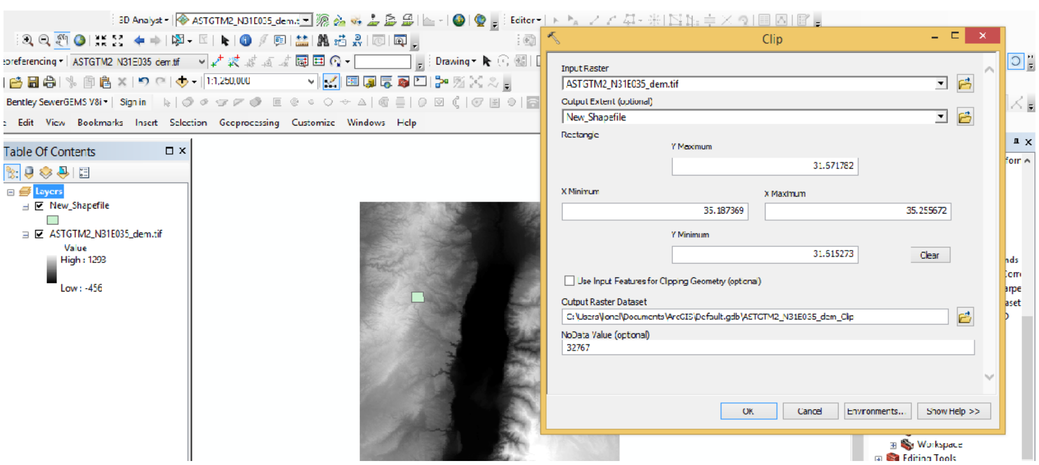


Figure (6.2): clipping of DEM using GIS

4.Process the image through fill

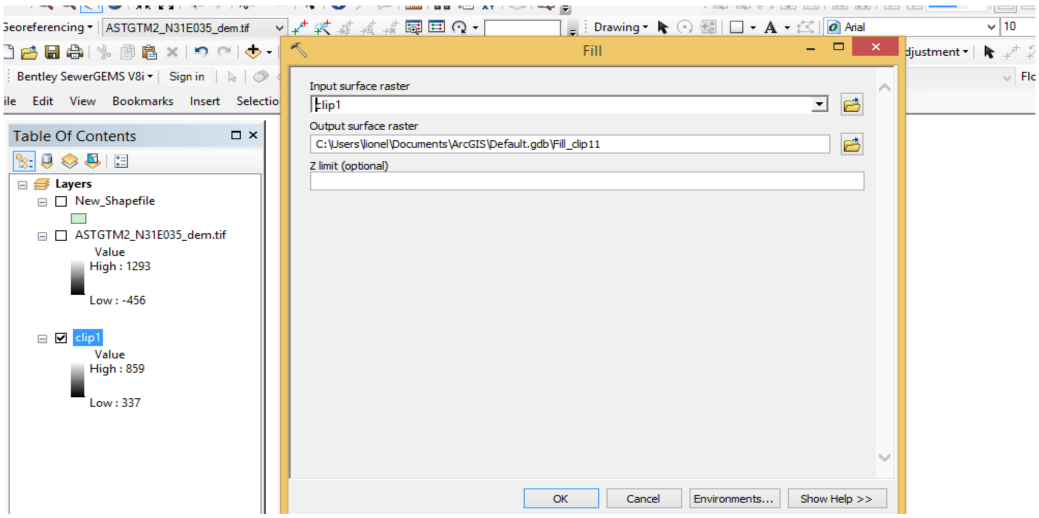


Figure (6.3): fill of DEM using GIS

5.Find flow direction

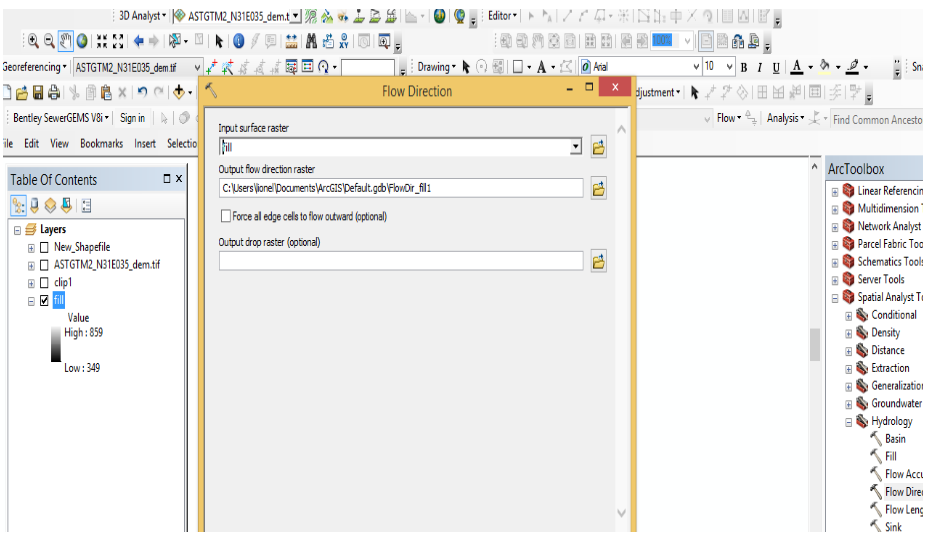


Figure (6.4): flow direction of DEM using GIS

6. Make a map of contour from the DEM

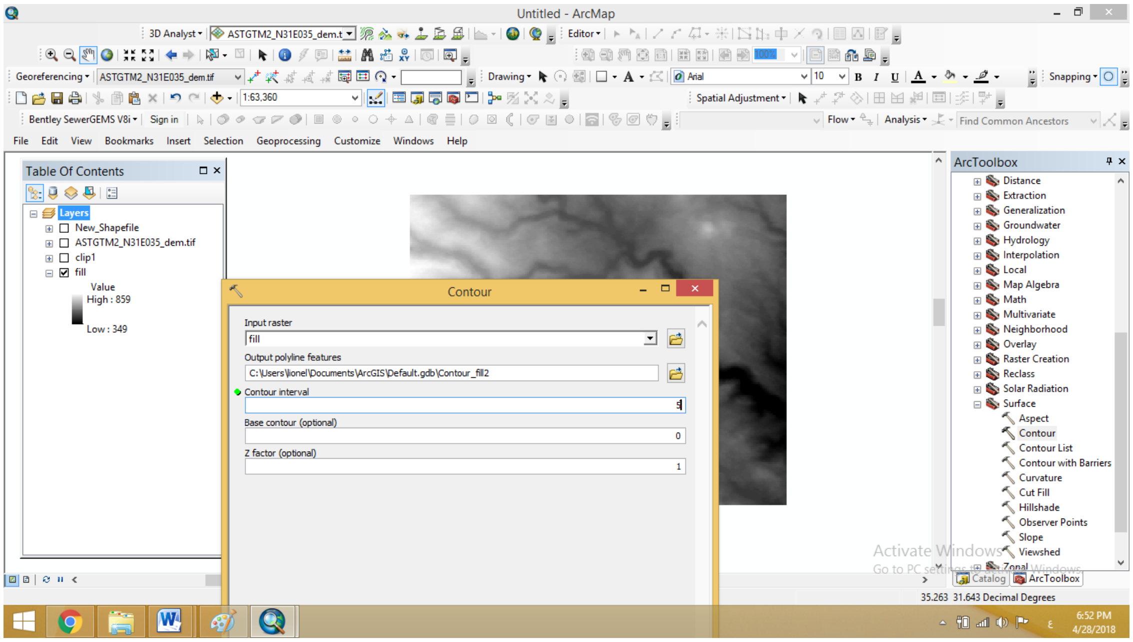


Figure (6.5): creating of countor map using gis

7.Work TIN from contour lines

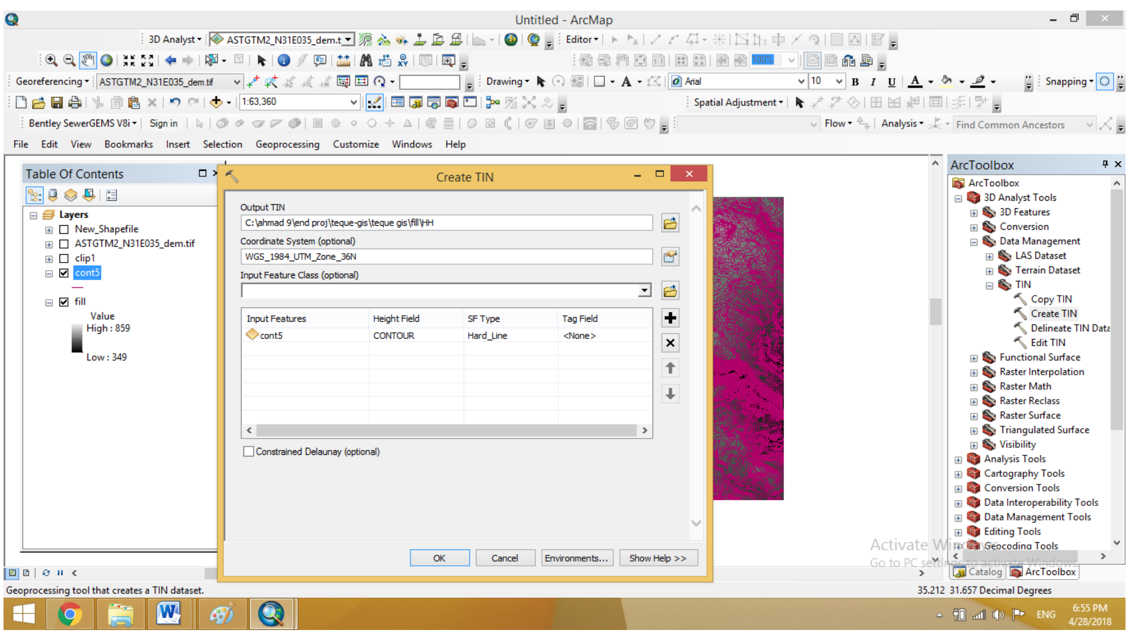


Figure (6.6): creating of TIN map using gis

8.creat New File Geodatabase

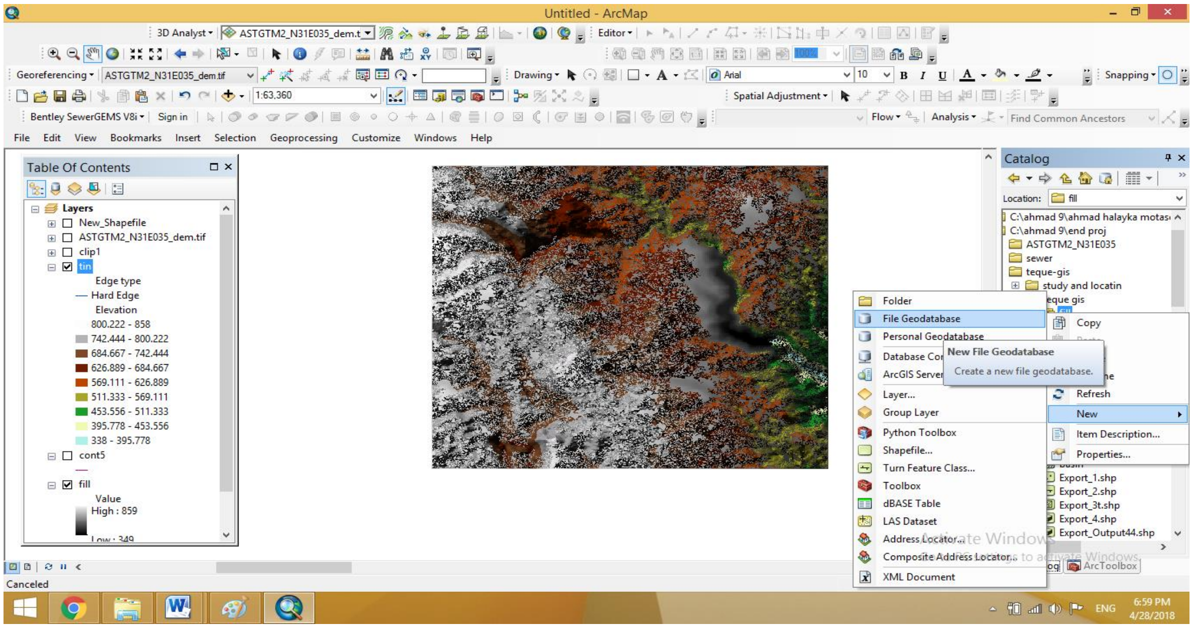


Figure (6.7): creating geodatabase

9.Create feature Class

(pipe. Manhole , tanks,border, roads,houses)

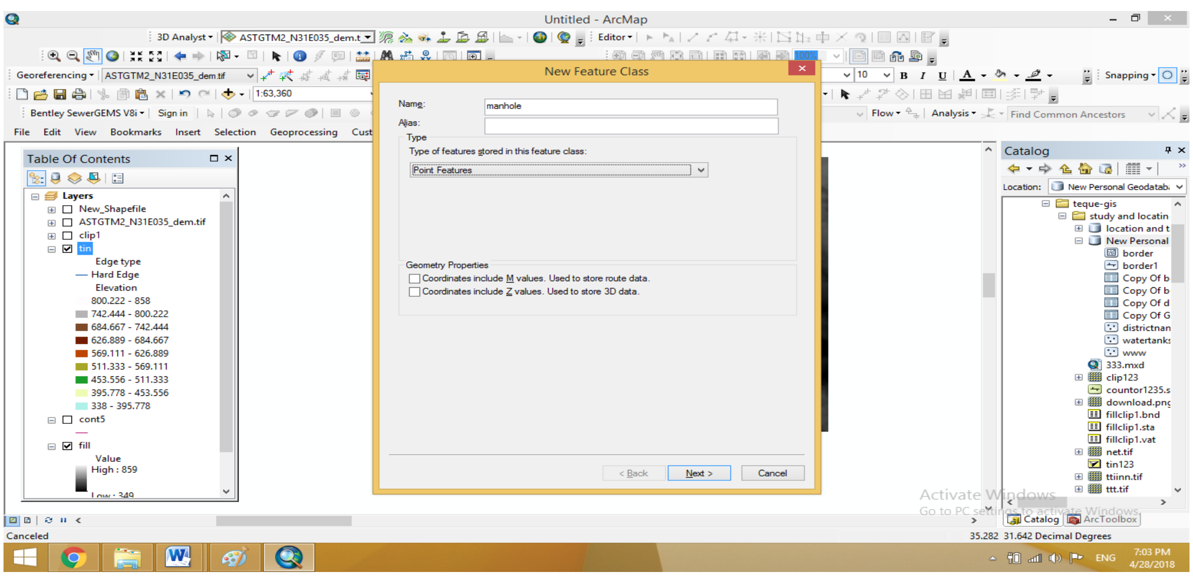


Figure (6.8): creating feature class

9. Find high manhole by GIS

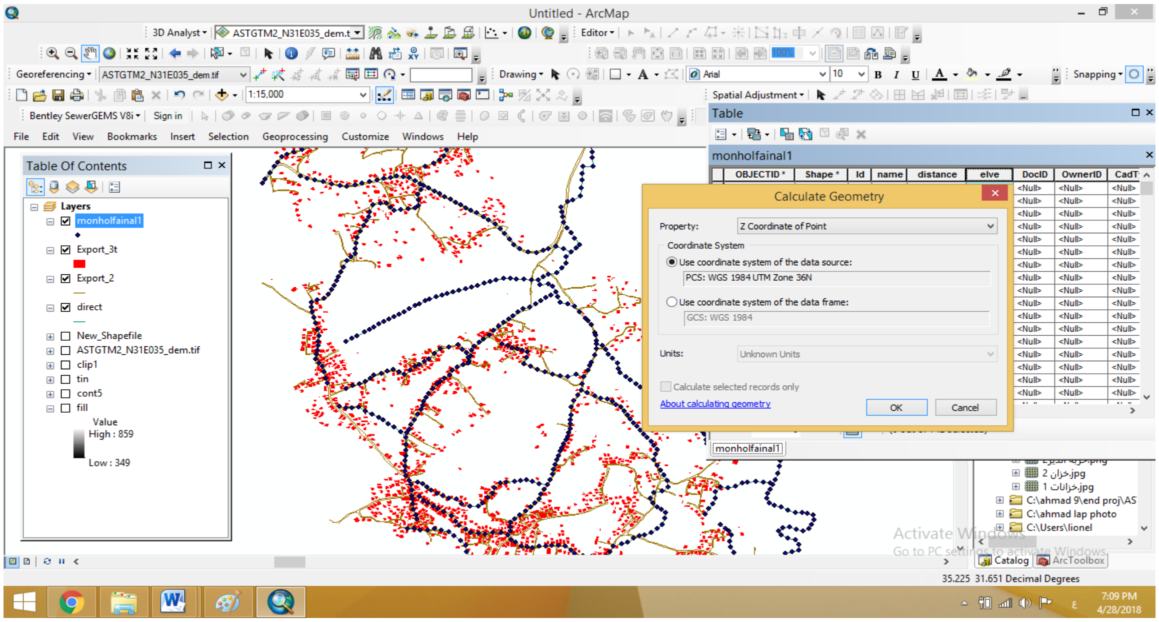


Figure (6.9): calculation of elevation

9.production maps from GIS

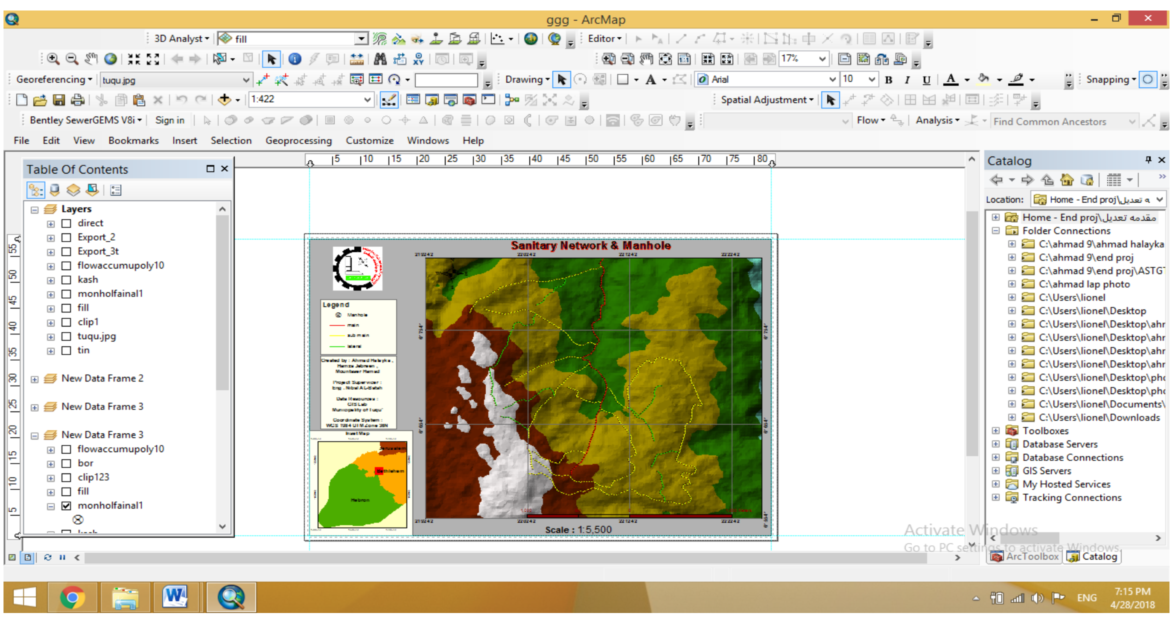


Figure (6.10): layout

6.6 Sewer CAD Vi8 Program Works:

1. Open Sewer CADvi8, select model builder.

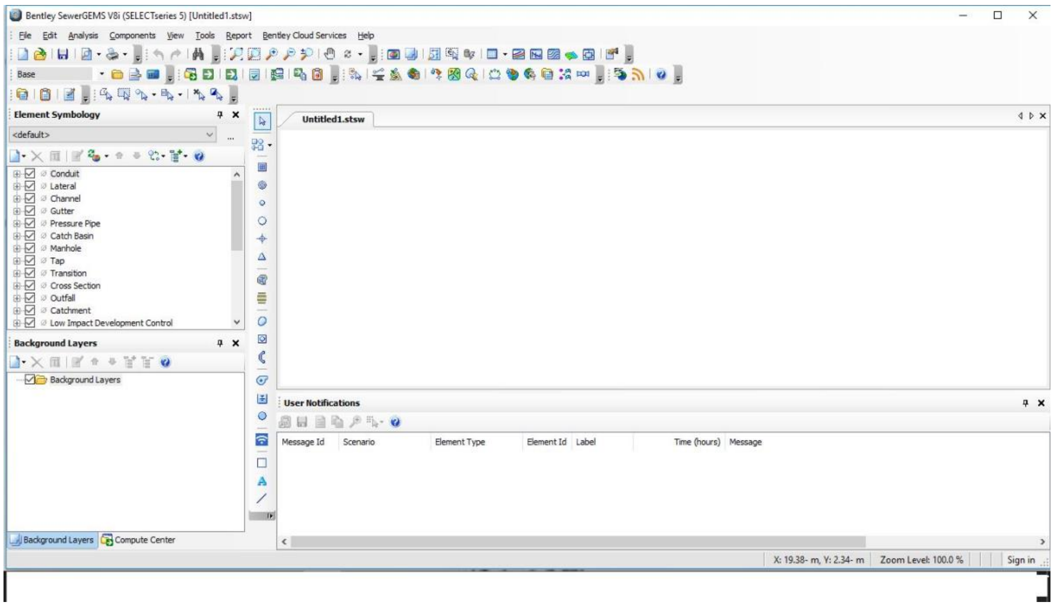


Figure (6.11):Sewer cad screen

2.In model builder,import cad files(pipe,manholes).

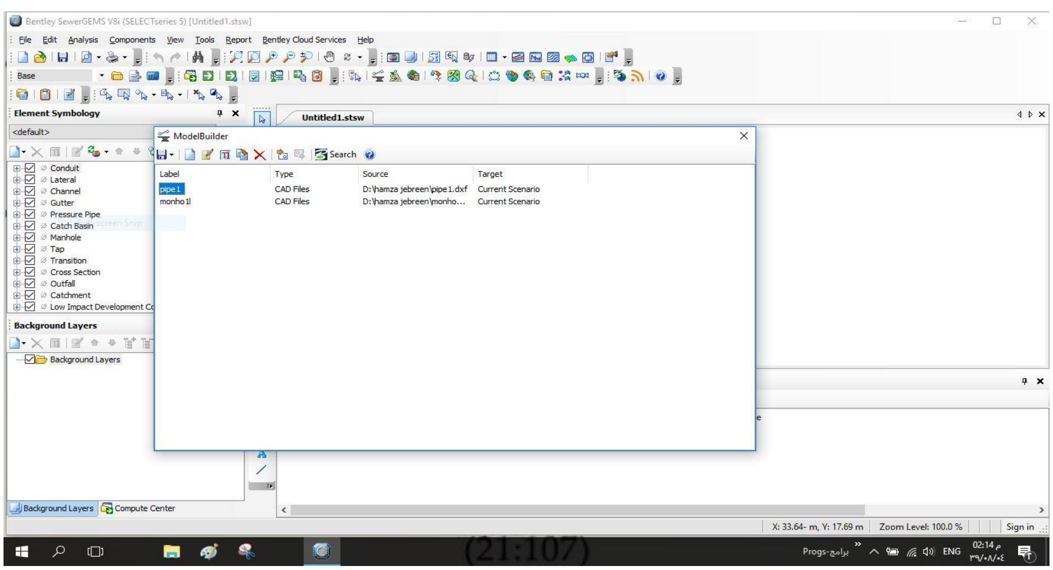


Figure (6.12):Model builder for cad files

3.Select(pipe) cad file;then select edit from click right hand mouse,click next,choose coduit label to table type,key field(label),then next.

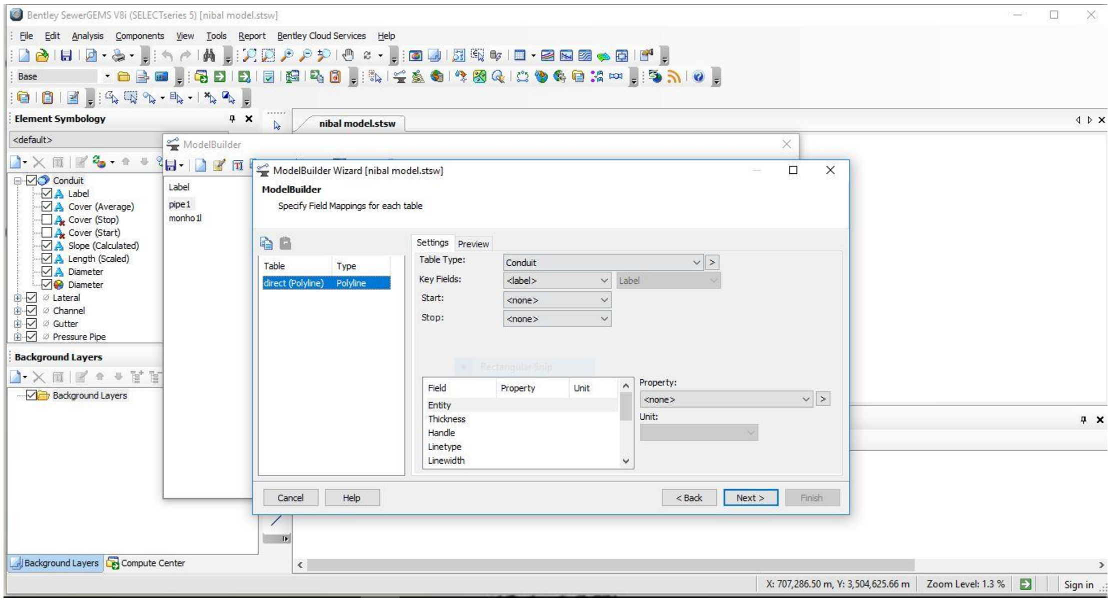


Figure (6.13):Identify cad file pipe

4. Select(manhole) cad file;then select edit from click right hand mouse,click next,choose (manhole) label to table type,key field(label),from propertychoose (elevation ground),then next.

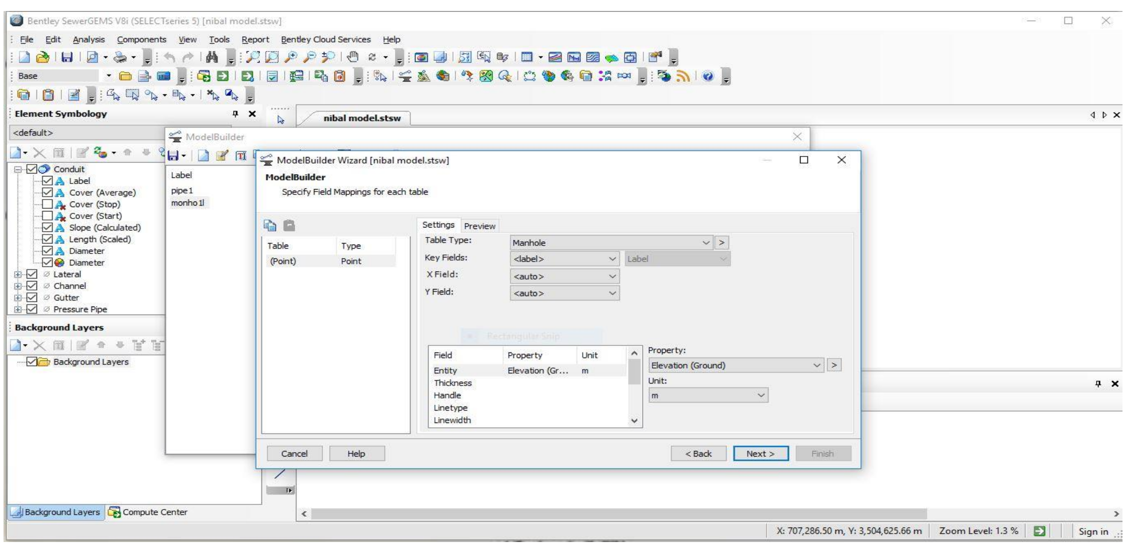


Figure (6.14):Identify cad file manhole

5. The network now apply from conduits and manholes.

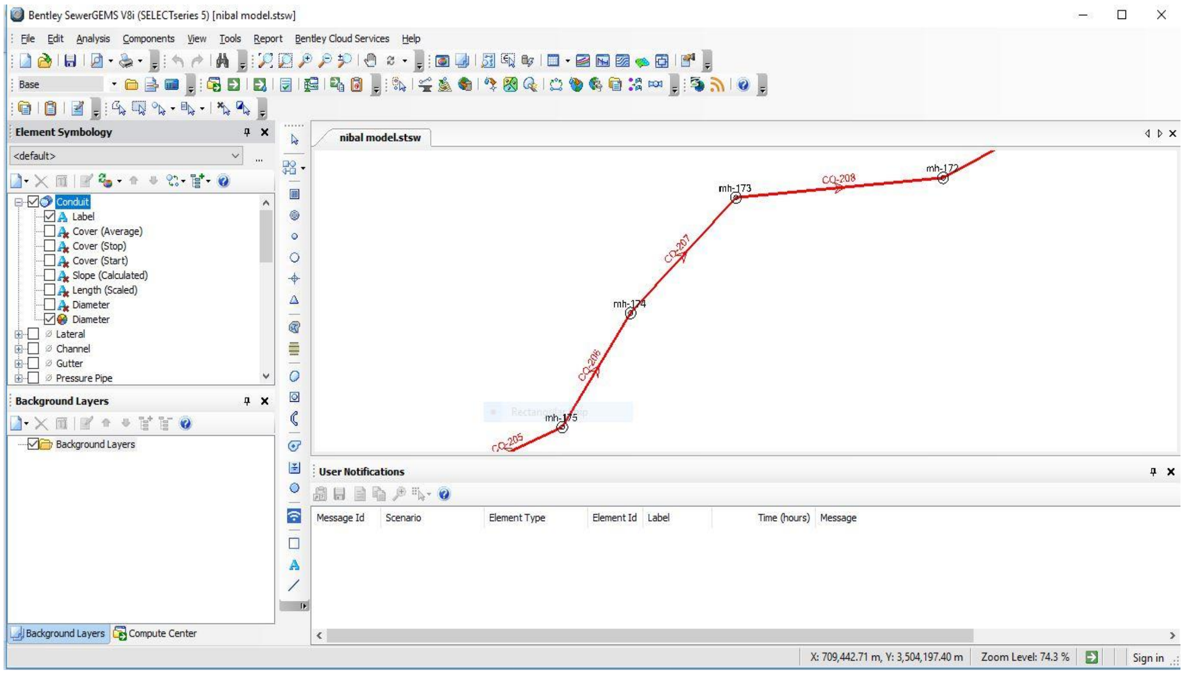


Figure (6.15) :Pipe network

6. From sewer screen,select tools→units→select(SI)unit→choose for slope%.

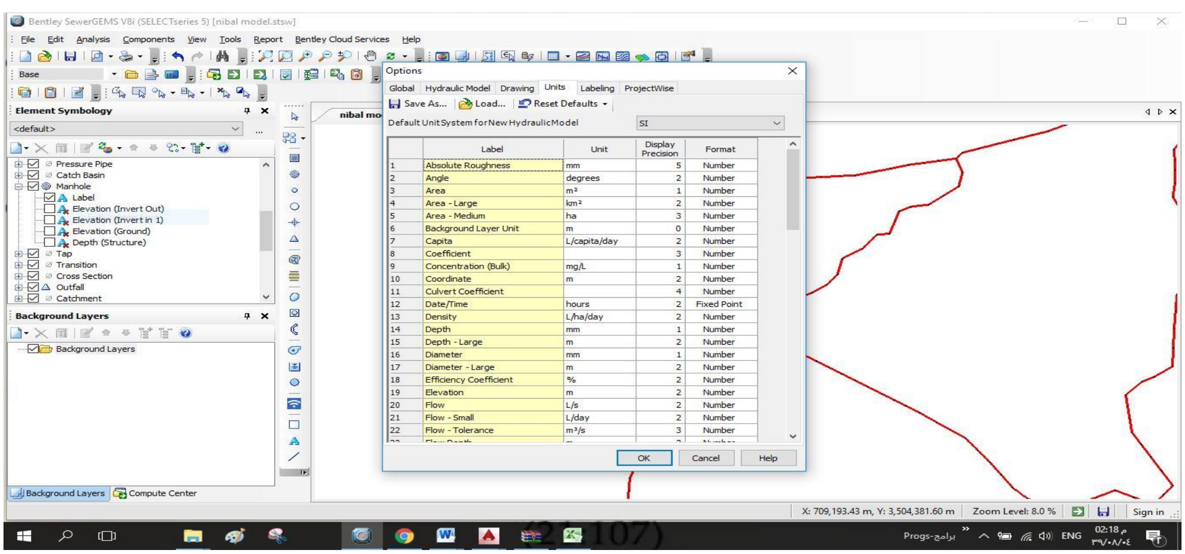


Figure (6.16):Apply reguired unit

7. From sewer screen choose anaylsis→calculation option→active numeircal solver→GVF-Convex (SewerCAD)→calculation type→design.

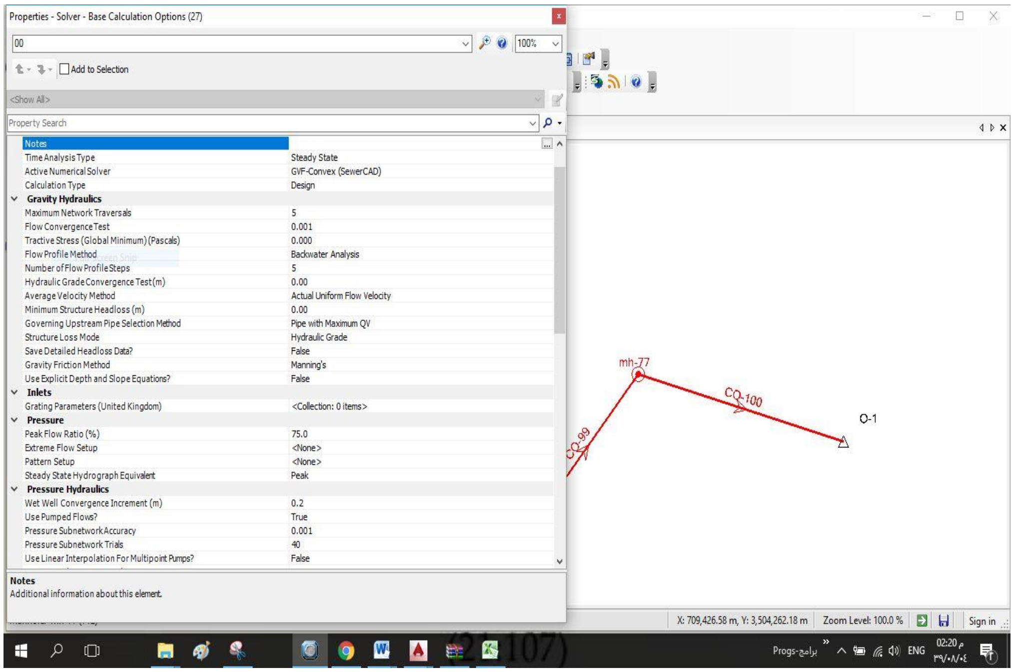


Figure (6.17):Base calculation option

8. From sewer screen choose components→defult design constrains→apply reguired constrains for gravity pipes for velocities.

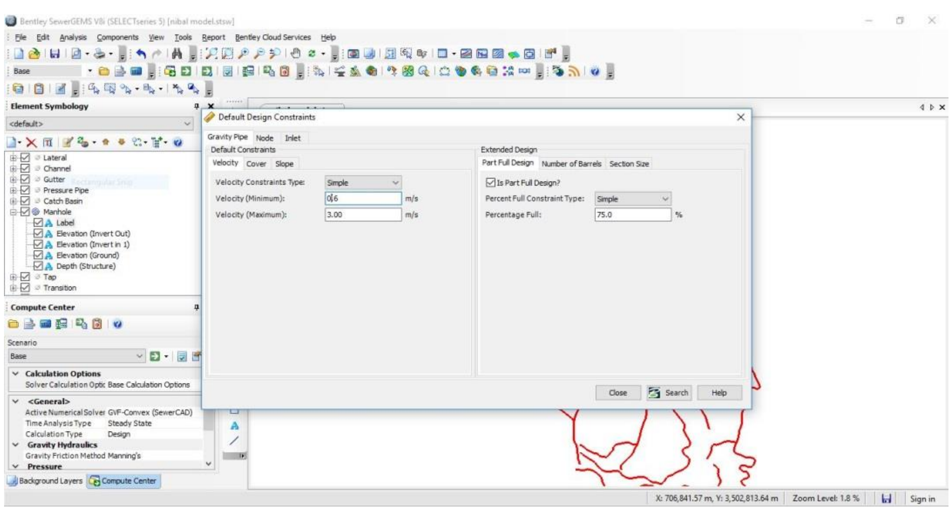


Figure (6.18):Constrains for gravity pipes(velocities)

9. From sewer screen choose components→defult design constrains→apply reguired constrains for gravity pipes→cover.

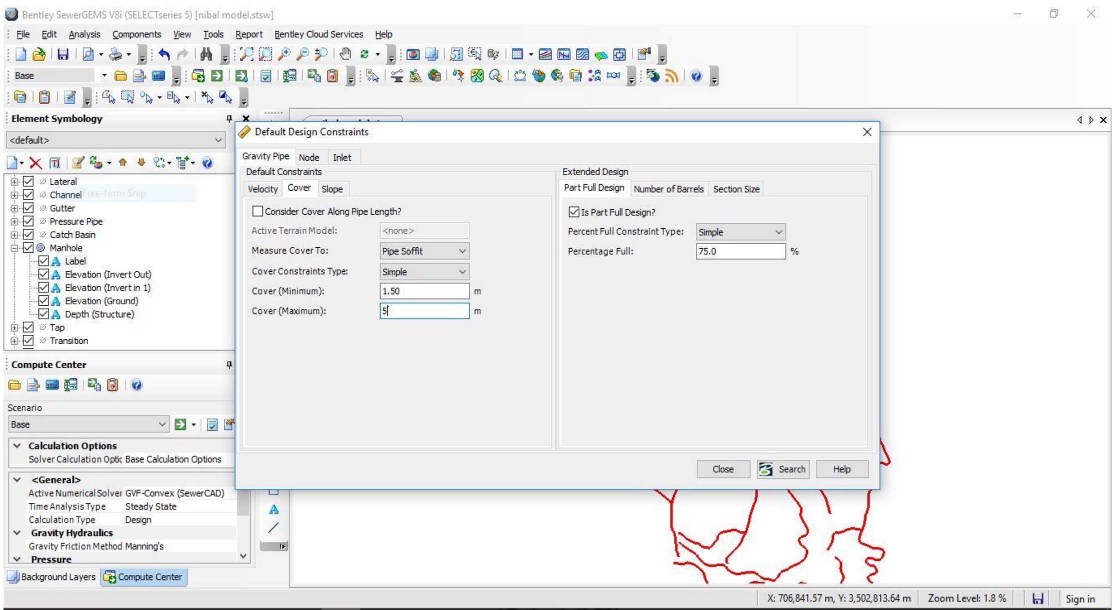


Figure (6.19):Constrains for gravity pipes(cover)

10. Then choose (nodes) from same screen above to apply consrtains.

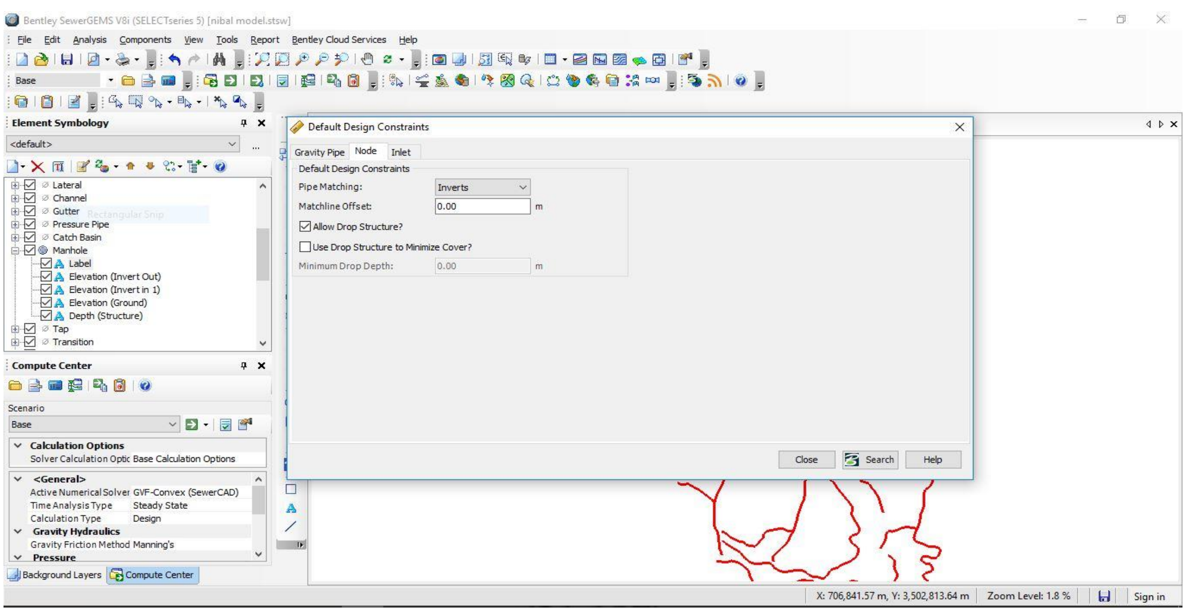


Figure (6.20):Constrains for nodes

11. From sewer screen choose tools→sanitary load control center→unit load→choose from lap→apartment→entire unit load and number of unit load count from excel sheet.

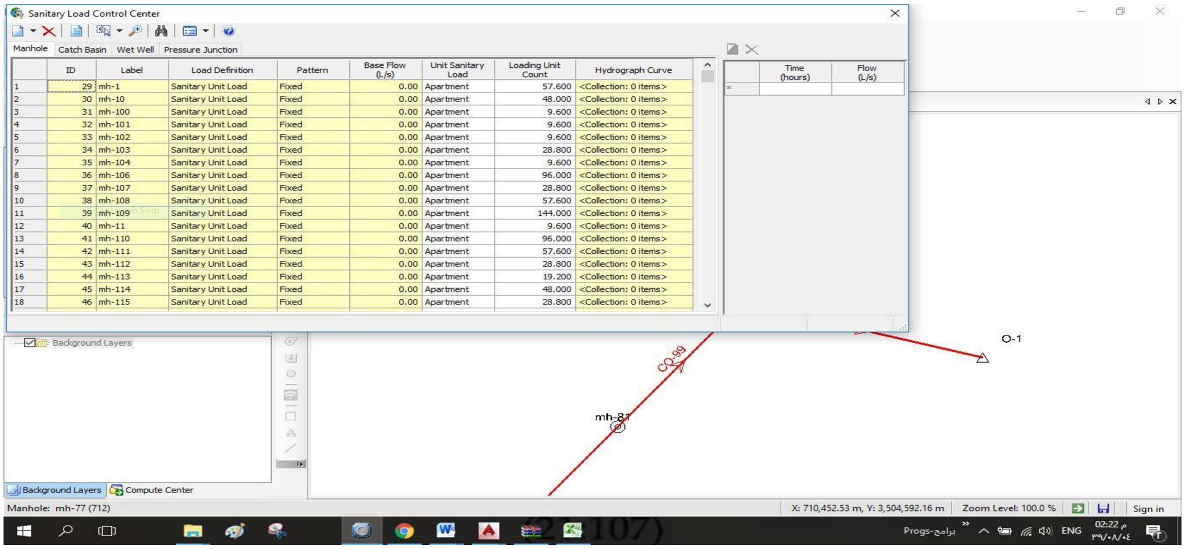


Figure (6.21):Sanitary load control center

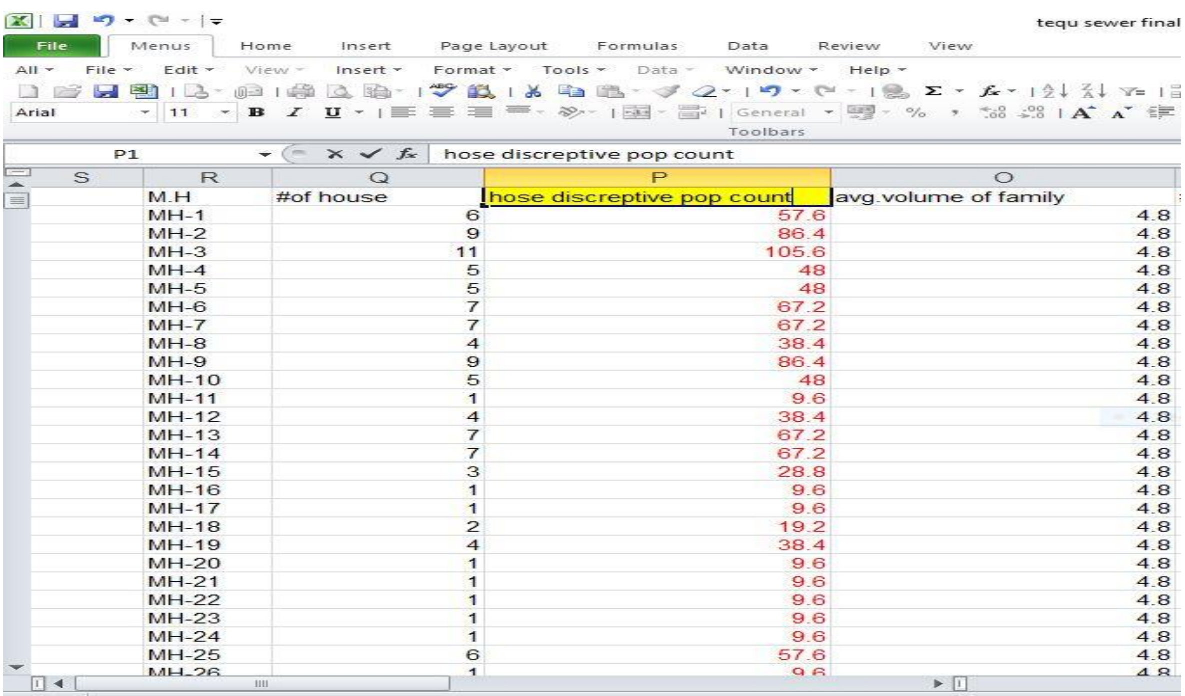


Figure (6.22): Excel sheet for unit load count

12. From sewer screen select (validate) to discover if we have error or not ,if we have correct them .

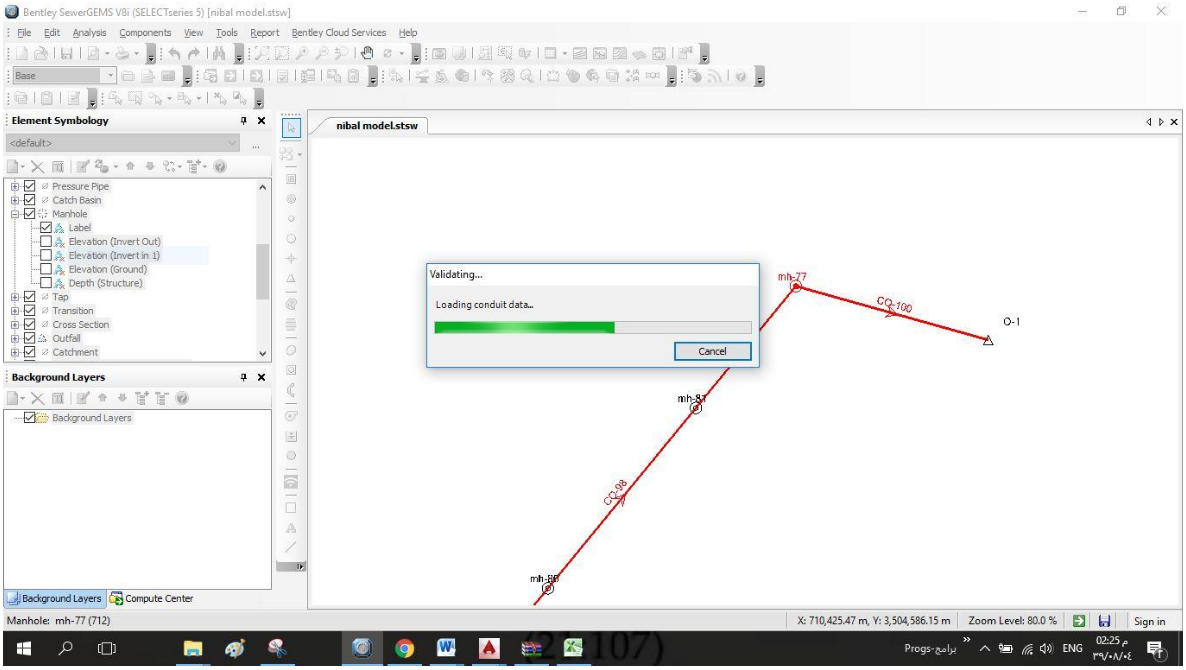


Figure (6.23): Validation discover

13. From sewer screen select(compute arrow) to design the net work with future flow and gravity hydraulic to outlet.

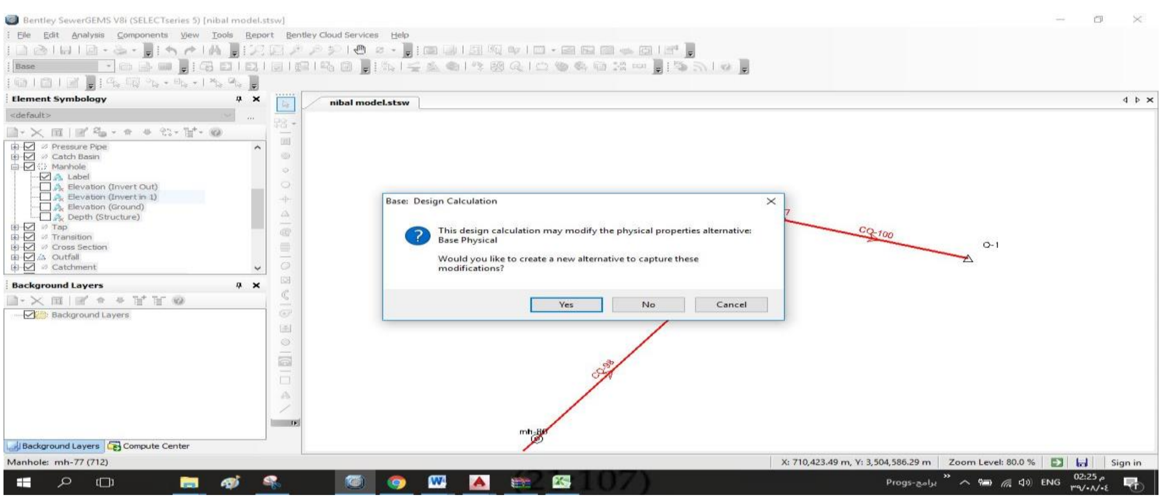


Figure (6.24):Compute for net work hydraulic

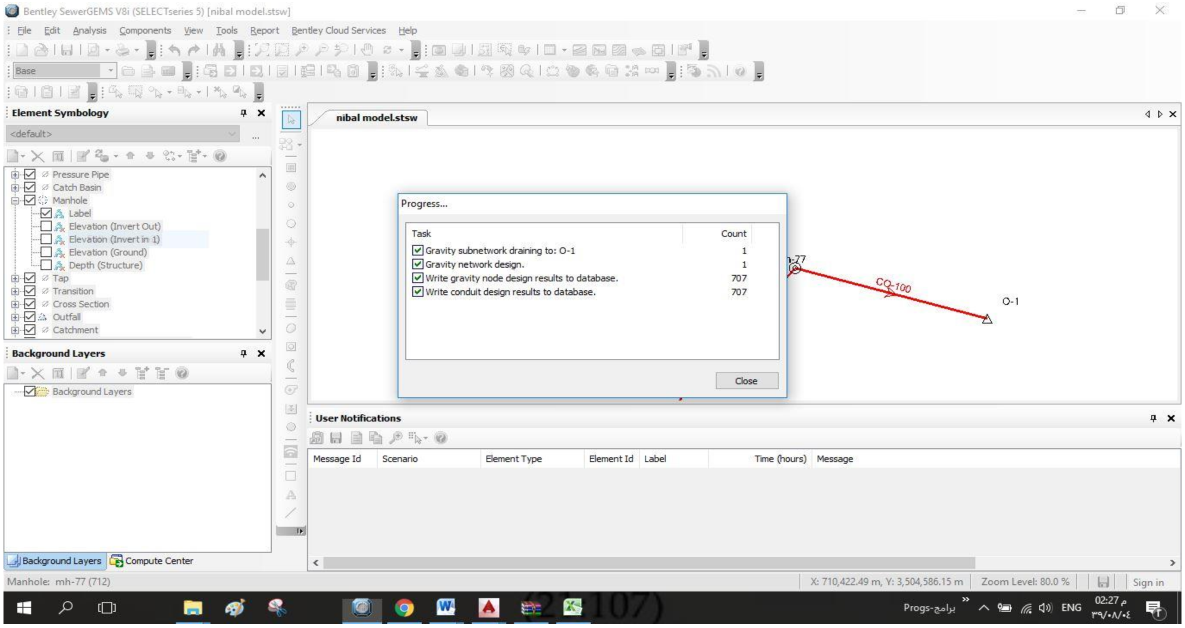
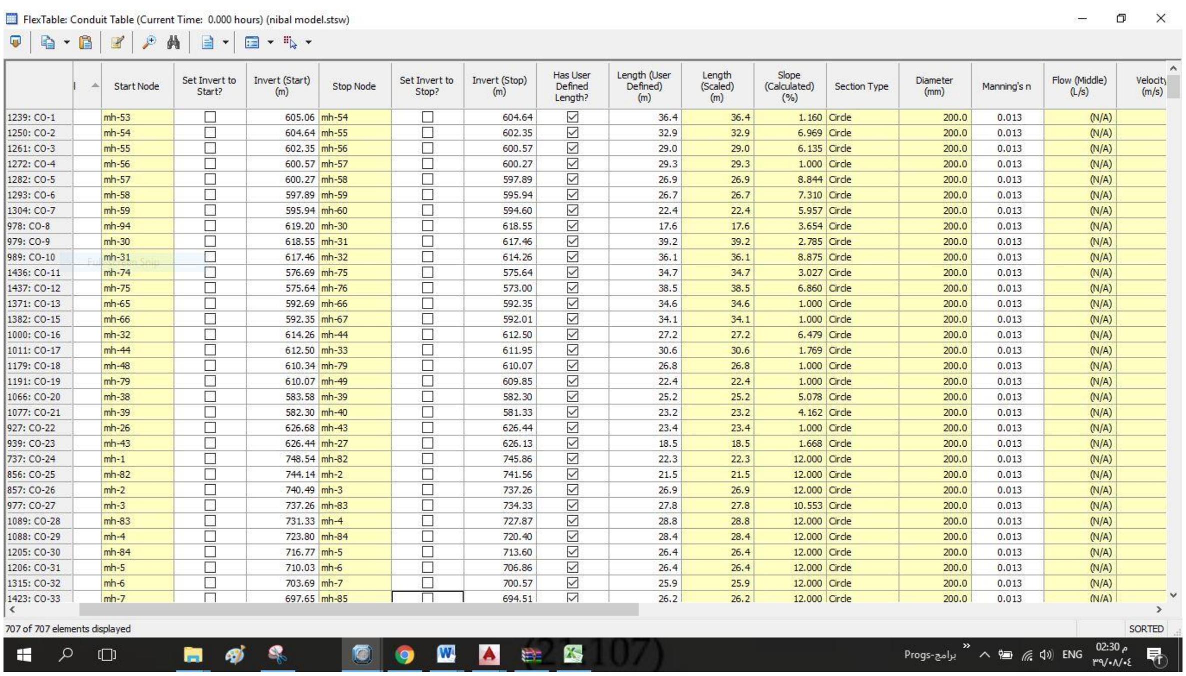


Figure (6.25):Compute for net work hydraulic

14. After designing select from sewer screen reports for conduits.


FlexTable: Conduit Table (Current Time: 0.000 hours) (nibal model.stsw)

		Start Node	Set Invert to Start?	Invert (Start) (m)	Stop Node	Set Invert to Stop?	Invert (Stop) (m)	Has User Defined Length?	Length (User Defined) (m)	Length (Scaled) (m)	Slope (Calculated) (%)	Section Type	Diameter (mm)	Manning's n	Flow (Middle) (L/s)	Velocity (m/s)
1239: CO-1		mh-53	☐	605.06	mh-54	☐	604.64	☑	36.4	36.4	1.160	Circle	200.0	0.013	(N/A)	
1250: CO-2		mh-54	☐	604.64	mh-55	☐	602.35	☑	32.9	32.9	6.969	Circle	200.0	0.013	(N/A)	
1261: CO-3		mh-55	☐	602.35	mh-56	☐	600.57	☑	29.0	29.0	6.135	Circle	200.0	0.013	(N/A)	
1272: CO-4		mh-56	☐	600.57	mh-57	☐	600.27	☑	29.3	29.3	1.000	Circle	200.0	0.013	(N/A)	
1282: CO-5		mh-57	☐	600.27	mh-58	☐	597.89	☑	26.9	26.9	8.844	Circle	200.0	0.013	(N/A)	
1293: CO-6		mh-58	☐	597.89	mh-59	☐	595.94	☑	26.7	26.7	7.310	Circle	200.0	0.013	(N/A)	
1304: CO-7		mh-59	☐	595.94	mh-60	☐	594.60	☑	22.4	22.4	5.957	Circle	200.0	0.013	(N/A)	
978: CO-8		mh-94	☐	619.20	mh-30	☐	618.55	☑	17.6	17.6	3.654	Circle	200.0	0.013	(N/A)	
979: CO-9		mh-30	☐	618.55	mh-31	☐	617.46	☑	39.2	39.2	2.785	Circle	200.0	0.013	(N/A)	
989: CO-10		mh-31	☐	617.46	mh-32	☐	614.26	☑	36.1	36.1	8.875	Circle	200.0	0.013	(N/A)	
1436: CO-11		mh-74	☐	576.69	mh-75	☐	575.64	☑	34.7	34.7	3.027	Circle	200.0	0.013	(N/A)	
1437: CO-12		mh-75	☐	575.64	mh-76	☐	573.00	☑	38.5	38.5	6.860	Circle	200.0	0.013	(N/A)	
1371: CO-13		mh-65	☐	592.69	mh-66	☐	592.35	☑	34.6	34.6	1.000	Circle	200.0	0.013	(N/A)	
1382: CO-15		mh-66	☐	592.35	mh-67	☐	592.01	☑	34.1	34.1	1.000	Circle	200.0	0.013	(N/A)	
1000: CO-16		mh-32	☐	614.26	mh-44	☐	612.50	☑	27.2	27.2	6.479	Circle	200.0	0.013	(N/A)	
1011: CO-17		mh-44	☐	612.50	mh-33	☐	611.95	☑	30.6	30.6	1.769	Circle	200.0	0.013	(N/A)	
1179: CO-18		mh-48	☐	610.34	mh-79	☐	610.07	☑	26.8	26.8	1.000	Circle	200.0	0.013	(N/A)	
1191: CO-19		mh-79	☐	610.07	mh-49	☐	609.85	☑	22.4	22.4	1.000	Circle	200.0	0.013	(N/A)	
1066: CO-20		mh-38	☐	583.58	mh-39	☐	582.30	☑	25.2	25.2	5.078	Circle	200.0	0.013	(N/A)	
1077: CO-21		mh-39	☐	582.30	mh-40	☐	581.33	☑	23.2	23.2	4.162	Circle	200.0	0.013	(N/A)	
927: CO-22		mh-26	☐	626.68	mh-43	☐	626.44	☑	23.4	23.4	1.000	Circle	200.0	0.013	(N/A)	
939: CO-23		mh-43	☐	626.44	mh-27	☐	626.13	☑	18.5	18.5	1.668	Circle	200.0	0.013	(N/A)	
737: CO-24		mh-1	☐	748.54	mh-82	☐	745.86	☑	22.3	22.3	12.000	Circle	200.0	0.013	(N/A)	
856: CO-25		mh-82	☐	744.14	mh-2	☐	741.56	☑	21.5	21.5	12.000	Circle	200.0	0.013	(N/A)	
857: CO-26		mh-2	☐	740.49	mh-3	☐	737.26	☑	26.9	26.9	12.000	Circle	200.0	0.013	(N/A)	
977: CO-27		mh-3	☐	737.26	mh-83	☐	734.33	☑	27.8	27.8	10.553	Circle	200.0	0.013	(N/A)	
1089: CO-28		mh-83	☐	731.33	mh-4	☐	727.87	☑	28.8	28.8	12.000	Circle	200.0	0.013	(N/A)	
1088: CO-29		mh-4	☐	723.80	mh-84	☐	720.40	☑	28.4	28.4	12.000	Circle	200.0	0.013	(N/A)	
1205: CO-30		mh-84	☐	716.77	mh-5	☐	713.60	☑	26.4	26.4	12.000	Circle	200.0	0.013	(N/A)	
1206: CO-31		mh-5	☐	710.03	mh-6	☐	706.86	☑	26.4	26.4	12.000	Circle	200.0	0.013	(N/A)	
1315: CO-32		mh-6	☐	703.69	mh-7	☐	700.57	☑	25.9	25.9	12.000	Circle	200.0	0.013	(N/A)	
1423: CO-33		mh-7	☐	697.65	mh-85	☐	694.51	☑	26.2	26.2	12.000	Circle	200.0	0.013	(N/A)	

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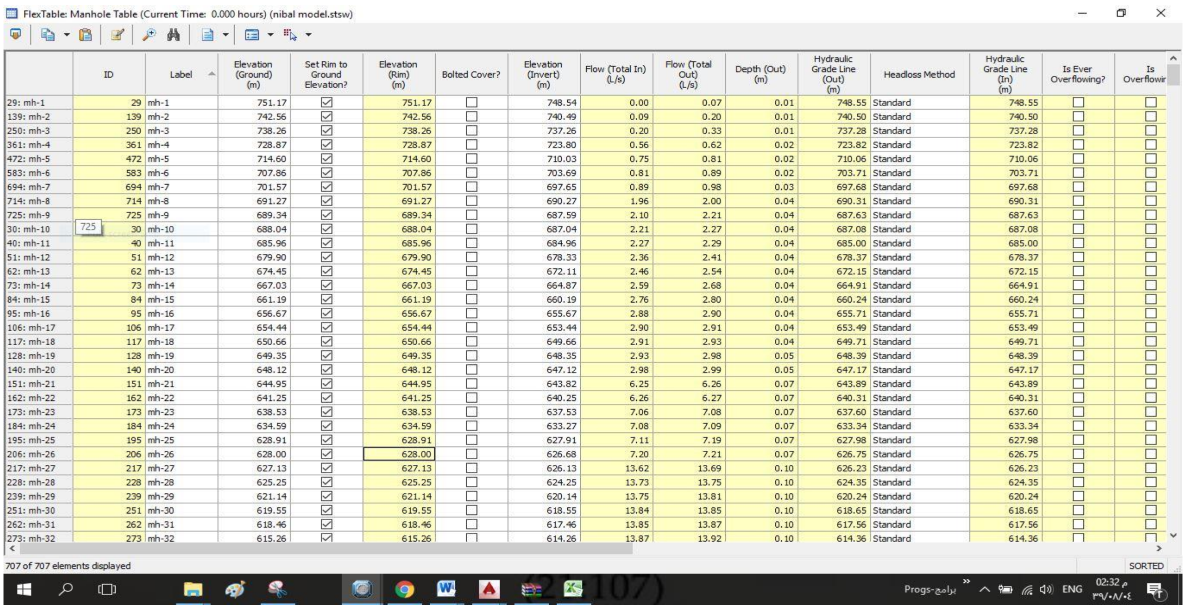
Figure (6.26) Conduits table after design

15. After designing select from sewer screen reports for manholes.


FlexTable: Manhole Table (Current Time: 0.000 hours) (nibal model.stsw)

	ID	Label	Elevation (Ground) (m)	Set Rim to Ground Elevation?	Elevation (Rim) (m)	Bolted Cover?	Elevation (Invert) (m)	Flow (Total In) (L/s)	Flow (Total Out) (L/s)	Depth (Out) (m)	Hydraulic Grade Line (Out) (m)	Headloss Method	Hydraulic Grade Line (In) (m)	Is Ever Overflowing?	Is Overflowir
29: mh-1	29	mh-1	751.17	☑	751.17	☐	748.54	0.00	0.07	0.01	748.55	Standard	748.55	☐	☐
139: mh-2	139	mh-2	742.56	☑	742.56	☐	740.49	0.09	0.20	0.01	740.50	Standard	740.50	☐	☐
250: mh-3	250	mh-3	738.26	☑	738.26	☐	737.26	0.20	0.33	0.01	737.28	Standard	737.28	☐	☐
361: mh-4	361	mh-4	728.87	☑	728.87	☐	723.80	0.56	0.62	0.02	723.82	Standard	723.82	☐	☐
472: mh-5	472	mh-5	714.60	☑	714.60	☐	710.03	0.75	0.81	0.02	710.06	Standard	710.06	☐	☐
583: mh-6	583	mh-6	707.86	☑	707.86	☐	703.69	0.81	0.89	0.02	703.71	Standard	703.71	☐	☐
694: mh-7	694	mh-7	701.57	☑	701.57	☐	697.65	0.89	0.98	0.03	697.68	Standard	697.68	☐	☐
714: mh-8	714	mh-8	691.27	☑	691.27	☐	690.27	1.96	2.00	0.04	690.31	Standard	690.31	☐	☐
725: mh-9	725	mh-9	689.34	☑	689.34	☐	687.59	2.10	2.21	0.04	687.63	Standard	687.63	☐	☐
30: mh-10	30	mh-10	688.04	☑	688.04	☐	687.04	2.21	2.27	0.04	687.08	Standard	687.08	☐	☐
40: mh-11	40	mh-11	685.96	☑	685.96	☐	684.96	2.27	2.29	0.04	685.00	Standard	685.00	☐	☐
51: mh-12	51	mh-12	679.90	☑	679.90	☐	678.33	2.36	2.41	0.04	678.37	Standard	678.37	☐	☐
62: mh-13	62	mh-13	674.45	☑	674.45	☐	672.11	2.46	2.54	0.04	672.15	Standard	672.15	☐	☐
73: mh-14	73	mh-14	667.03	☑	667.03	☐	664.87	2.59	2.68	0.04	664.91	Standard	664.91	☐	☐
84: mh-15	84	mh-15	661.19	☑	661.19	☐	660.19	2.76	2.80	0.04	660.24	Standard	660.24	☐	☐
95: mh-16	95	mh-16	656.67	☑	656.67	☐	655.67	2.88	2.90	0.04	655.71	Standard	655.71	☐	☐
106: mh-17	106	mh-17	654.44	☑	654.44	☐	653.44	2.90	2.91	0.04	653.49	Standard	653.49	☐	☐
117: mh-18	117	mh-18	650.66	☑	650.66	☐	649.66	2.91	2.93	0.04	649.71	Standard	649.71	☐	☐
128: mh-19	128	mh-19	649.35	☑	649.35	☐	648.35	2.93	2.98	0.05	648.39	Standard	648.39	☐	☐
140: mh-20	140	mh-20	648.12	☑	648.12	☐	647.12	2.98	2.99	0.05	647.17	Standard	647.17	☐	☐
151: mh-21	151	mh-21	644.95	☑	644.95	☐	643.82	6.25	6.26	0.07	643.89	Standard	643.89	☐	☐
162: mh-22	162	mh-22	641.25	☑	641.25	☐	640.25	6.26	6.27	0.07	640.31	Standard	640.31	☐	☐
173: mh-23	173	mh-23	638.53	☑	638.53	☐	637.53	7.06	7.08	0.07	637.60	Standard	637.60	☐	☐
184: mh-24	184	mh-24	634.59	☑	634.59	☐	633.27	7.08	7.09	0.07	633.34	Standard	633.34	☐	☐
195: mh-25	195	mh-25	628.91	☑	628.91	☐	627.91	7.11	7.19	0.07	627.98	Standard	627.98	☐	☐
206: mh-26	206	mh-26	628.00	☑	628.00	☐	626.68	7.20	7.21	0.07	626.75	Standard	626.75	☐	☐
217: mh-27	217	mh-27	627.13	☑	627.13	☐	626.13	13.62	13.69	0.10	626.23	Standard	626.23	☐	☐
228: mh-28	228	mh-28	625.25	☑	625.25	☐	624.25	13.73	13.75	0.10	624.35	Standard	624.35	☐	☐
239: mh-29	239	mh-29	621.14	☑	621.14	☐	620.14	13.75	13.81	0.10	620.24	Standard	620.24	☐	☐
251: mh-30	251	mh-30	619.55	☑	619.55	☐	618.55	13.84	13.85	0.10	618.65	Standard	618.65	☐	☐
262: mh-31	262	mh-31	618.46	☑	618.46	☐	617.46	13.85	13.87	0.10	617.56	Standard	617.56	☐	☐
273: mh-32	273	mh-32	615.26	☑	615.26	☐	614.26	13.87	13.92	0.10	614.36	Standard	614.36	☐	☐

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Figure (6.27):Manholes table after design

16. From sewer screen select element symbology →conduit→label,then adding reguired label (length,diameter,slope,cover average,color label).

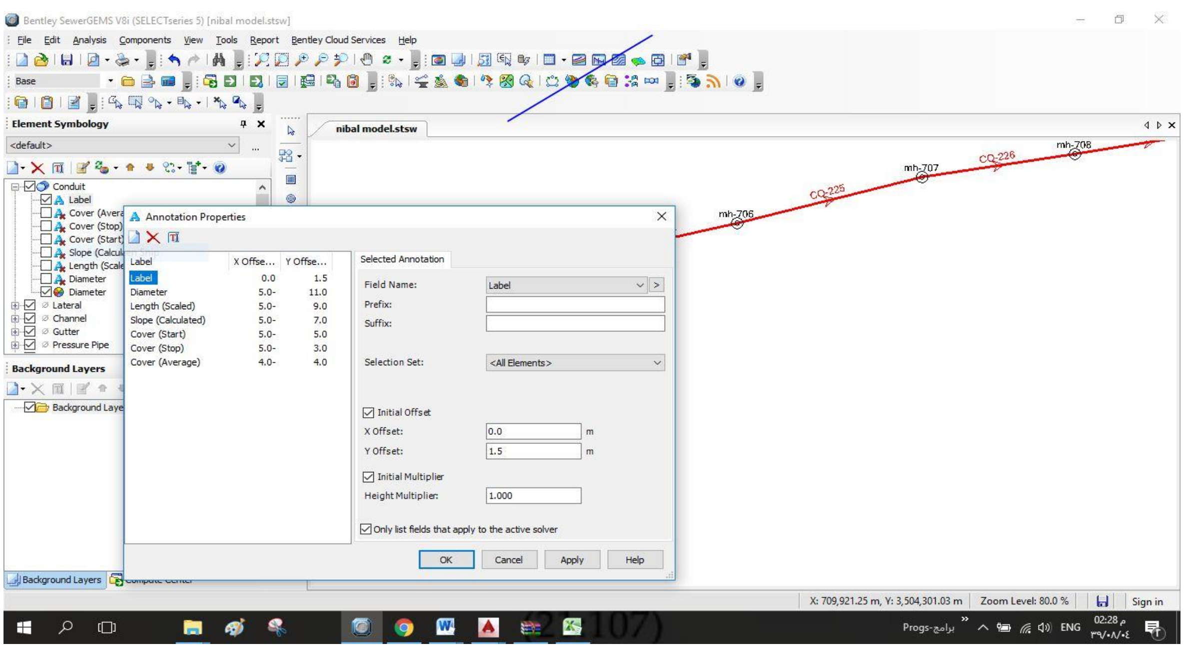

Figure (6.28): Conduits labels

17. From sewer screen select element symbology →manhole→label,then adding reguired label (label,elevation in,elevation out,elevation ground,depth).

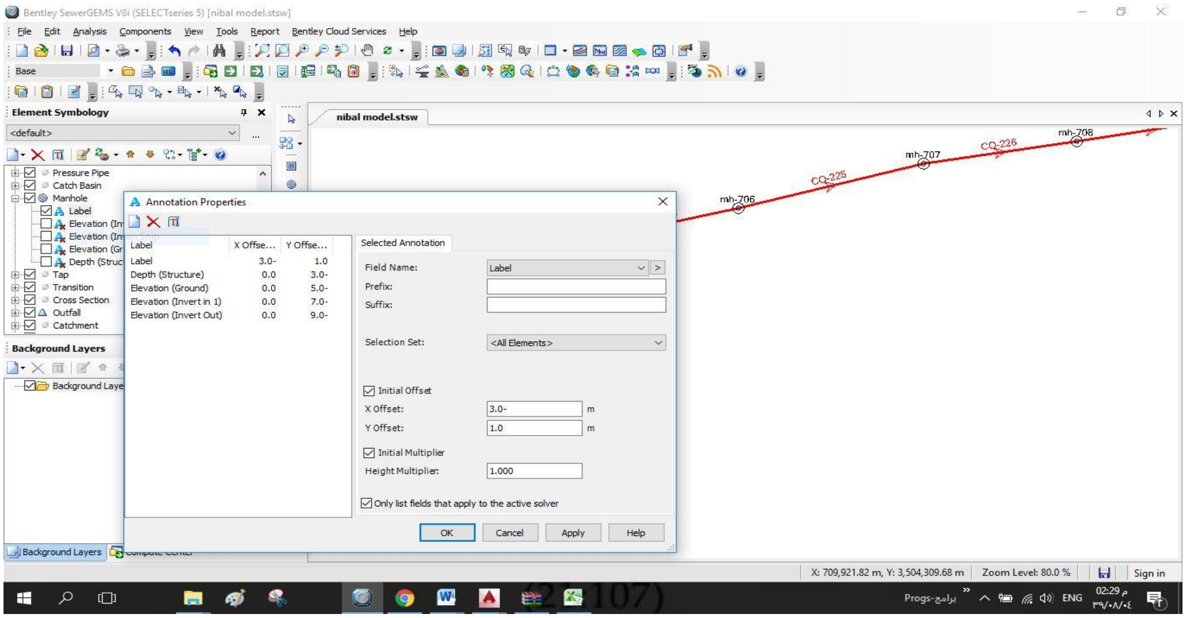

Figure (6.29): Manholes labels

18. Applying all labels on sewer network .

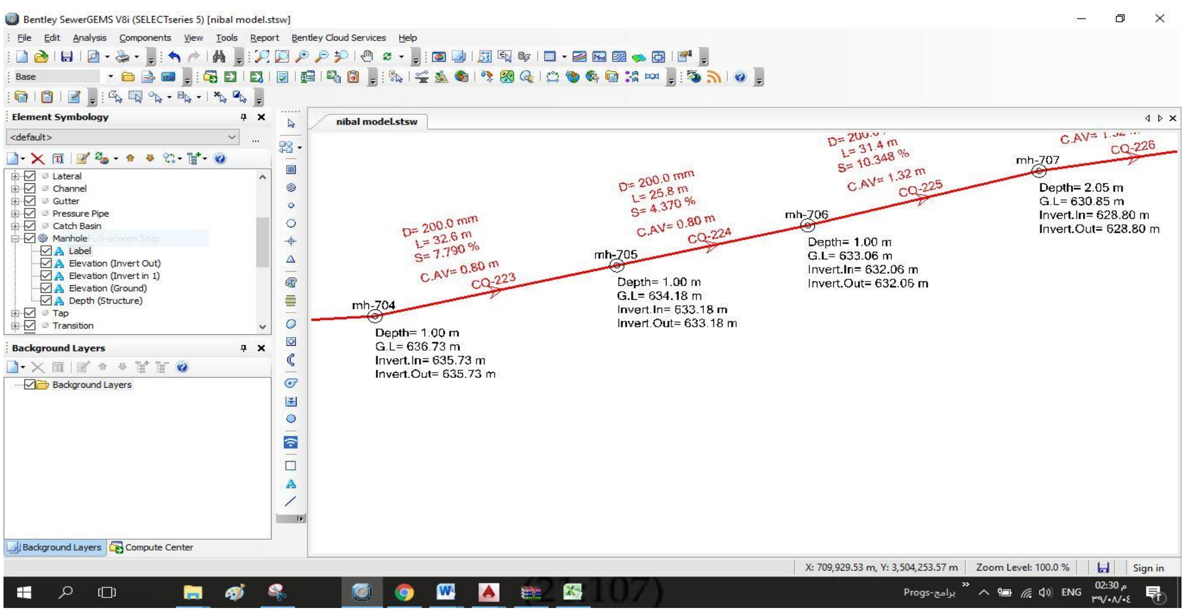

Figure (6.30): Sewer network labels

CHAPTER SEVEN

" BILL of QUANITIES "

Table(7.1): Collection System.

No.	EXCAVATION	UNIT	QTY	UNIT PRICE		TOTAL PRICE	
				$	C	$	C
A1	Excavation of pipes trench in all kind of soil for one pipe diameter 200mm depth and disposing of the debris and the top soil unsuitable for backfill outside the site	LM	19509				
A2	Excavation of pipes trench in all kind of soil for one pipe diameter 300mm depth and disposing of the debris and the top soil unsuitable for backfill outside the site	LM	97				
Sub-Total							
B	**PIPE WORK**						
B1	Supplying, storing and installing of PVC	LM	19606				

Sub-Total							
C	**PIPE BEDDING AND BACKFILLING** **Dimension and material**	LM	19606				
C1	Supplying and embedment of sand for one pipe diameter 200mm, depth up to 1.5 meter and disposing of the debris and the top soil unsuitable for backfill outside the site.	LM	155618				
C2	Supplying and embedment of sand for one pipe diameter 300mm, depth up to 1.5 meter and disposing of the debris and the top soil unsuitable for backfill outside the site.	LM	97				
D	**MANHOLES, Details according to the drawing**						
D1	Supplying and installing of precasted manhole including excavation pipe connection, epoxytar coating, 25-ton cast iron cover and backfill, depth up to 1.5m.	NR	326				
D2	Supplying and installing of precasted manhole including excavation pipe connection, epoxytar coating, 40-ton cast iron cover and backfill, depth up to 1.5m.	NR	383				

D3	Supplying and installing of precasted manhole including excavation pipe connection, epoxytar coatingsize1200mm.	NR	433				
D4	Supplying and installing of precasted manhole including excavation pipe connection, epoxytar coatingsize1500mm.	NR	276				
Sub-Total							
E	**Survey work**						
E1	Topographical survey required for shop drawings and as built DWGS using absolute Elev. And coordinate system	LM	19606				

CHAPTER EIGHT

"CONCLUSIONS"

8.1 CONCLUSIONS

In this project a trial is made to design a waste water collection system for Tuqu' city considering the annual growth of the people and their water consumption for the coming 25 years the main conclusion drown from the present study are summarized below : -

1- The proposed is a waste water collections system for Tuqu' city is obtained and it will cover all of the area.

2- The senitary system is consisting of one main lines ,All lines in the senitary system are running by gravity

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