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ANALYSIS AND DESIGN OF WATER DISTRIBUTION NETWORK FOR TAFOUH TOWN

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HEBRON- WEST BANK

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In accordance with the recommendation of the project supervisors, 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 Department for the degree of Bachelor of Science in Engineering.

Project Supervisors **Department Chairman**

الإهداء

إلى الزهرة التي لا تذبل ......نبع الحنان .... إلى أمي

إلى الماس الذي لا ينكسر.....نبع العطاء .... إلى والدي

إلى فلذة كبدي ....بسمة عمري.....................الى ولدي

إلى رفيق عمري..........شريك دمعي.... إلى زوجي

إلى ملائكة الأرض ....شقائق النعمان.................. إلي أشقائي

إلى أمي الثانية..........وأبي الثاني .... إلى أم وأب عمر

إلى قناديل الدرب..........الشموع التي لا تنطفئ .... إلى أساتذتي

إلى رفاق الدرب .... بناة المستقبل .... إلى أصدقائي

إلى صناع الكرامة .... رايات المجد .... إلى شهدائنا

إلى من رفضوا الخضوع .... من طلبوا العزة ....إلى أسرانا

إليكم جميعا أحبتي اهدي هذا الجهد المتواضع

.......رشا حمدان

الإهداء

إلى شهدائنا الأبرار الذين قدموا أرواحهم رخيصة في سبيل الله ثم الوطن

إلى الرجال الرجال إلى الأسود الرابضة خلف القضبان

إلى كل الأسرى

إلى كل من ضحى من اجل دينه وأرضه وعرضه

إلى خنساوات العصر

إليكن أمهات الشهداء و الأسرى والجرحى

إليكم جميعا نهدي هذا العمل المتواضع

فريق البحث

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We can find no words to express our sincere, appreciation and gratitude to our parents, sisters and brothers, for their endless support and encouragement, we are deeply indebted to you and we hope that we may someday reciprocate it in someway.

Work Team

ABSTRACT

Analysis and Design of Water Distribution Network for Tafouh Town

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Tafouh town faces big problems in water supply and water services due to population growth. Hence, the water distribution network is not servicing all the areas in the town, and many pipes are very old. The people in the town depend mainly on water coming through the network and on water tanking and constructed cisterns for water supply. In view of this bad condition, the need for water supply scheme that will supply the entire area of Tafouh town with water requirements become pressing, and subsequently this work was conducted to study and evaluate the present situation and redesign of the existing water distribution network using water cad software.

The present study considered the annual population growth and their water demand for the coming 25 years that will be the design period, along. The hydraulic calculation needed for the design of the main and sub main pipelines will be carried out using water cad software.

By the end the project, a complete design for water distribution network for Tafouh town will be ready along with bill of quantities, cost estimate, and the suggested phases of construction.

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CHAPTER

1 *INTRODUCTION*

1.1 General

1.2 Problem Definition

1.3 Technical Objectives

1.4 Project Area

1.5 Work Plan

1.6 Structure of the Report

CHAPTER ONE
INTRODUCTION

1.1 General

Tafouh town is located 8 Km to the west of the Hebron city. It is area with an average height of 850 m with respect to sea level. The temperature is relatively high in summer 34°C and winter temperature is 9°C .The average rainfall is around 450 mm per year and the present population is around 12,000 persons in the year 2006.

Tafouh town faces -like other cities and towns in the West Bank- water shortage. Water demand in the town is increasing from year to year due to increase in the population. At the same time, the development of additional water supplies has been however, far short of the increase in water demand.

The amount of water supplies to the town is very little (450 m^3/day), and the existing water supply network is very old and does not satisfy the need of water. The amount of water that is lost in the distribution system is about 30% of the quantity of water supplied. Also, Palestinian Water Authority (which supplies town with water) faces some difficulties in offering good water services that delay any improvement in the existing water supply network.

In view of this condition, the need for water supply scheme that will, supply reliably adequate amounts of water has become pressing and subsequently, this study is conducted to assess the existing water supply for Tafouh town and design a new water distribution network.

1.2 Problem Definition

Water is indispensable to human life and is also a vital necessity of plant and animal life. The wide expansion and accelerated development of Tafouh town had led to an increase in amount of water consumption for domestic, public and irrigation uses. The average consumption of water in the town for all purposes does not exceed 20 cubic meters per year due to limited quantities of water and the existing water distribution system. This water demand was mostly met by underground water.

Tafouh faces great difficulties and different problems in water supply and water services due to population growth. Hence, the amount of water supplies to the town is very little and the existing water supply network is very old and does not satisfy the needs of water. And as mentioned earlier, the municipality faces some difficulties in offering good water services that delay any improvement in the existing water supply network.

At present, the existing water supply system of Tafouh town is almost supplied by water coming from Palestinian Water Authority main pipes passing near the town. The water in the town is distributed directly by a network of steel pipelines, most of them are very old and exposed to the traffic. The pipelines range from 0.5" to 6" in diameter and many are in bad state of repair. The amount of water that is lost in the distributing system or is unaccounted for is about 30% of the quantity of water supplied.

1.3 Technical Objectives

The overall objective of this project is to produce feasible planning scheme for the water supply of Tafouh town. Achievement of this objective requires the water resources potential of the town, estimation the town population, water requirement for different purposes, location of the water source and topography of the town. It also requires evaluation of the existing water distribution network. More specifically, the main objectives of this project may be classified as follows:

1. Estimate the annual amount of water required per capita for all purposes up to the planning horizon of 2035 taking into consideration the present and future population.
2. Study and evaluation of the existing water network in Tafouh town, and display the difficulties, which the municipality faces in order to develop and improve the existing water mains.
3. Investigation and discussion of the appropriate changes in the existing mains and presentation of the proposed water supply network, which meet the present and future water demand for all purposes and around 24 hour water supply.

4. Development of several plans for the construction of the proposed water supply scheme and prepare bill of quantities.
5. Finally, providing suggestions and recommendations regarding Tafouh town water supply.

1.4 Project Area

Tafouh town is located 8 Km to the west of the Hebron city. The location map of the town is illustrated in Figure (1.1) and the general views are shown in Figures (1.2) and (1.3). The average elevation of the town is 850 m with respect to sea level. The present total administrative area of the town is about 20300 dounm. The total population within the administrative borders was estimated to be around 12,000 persons in the year 2006. The total population is expected to grow substantially up to year 2035, which is planning horizon of this project.

The ground elevation within this area range from 650 m with respect to sea level in the west of the town to 850 m in the center of the town to around 640 m in the east part of the town. The climate of Tafouh tend to be cold in winter and warm in summer and relatively humid. The average maximum temperature is about 34°C in summer and the average minimum temperature is 9°C in winter. The average rainfall is about 450 mm per year and the relative humidity varies between 25-75%.

Most of the water supply to Tafouh comes from underground water wells. The pipe lines, which conveyed water from the source to the municipal bounder are owned and operated by the Palestinian water authority. These pipelines also supply other Palestinian communities. Small scales of the water supply come from local production wells. At present, there are inadequate water resources to meet all the water demand, with these results Tafouh municipality finds it necessary to distribute water according to rational program during the summer on the demand increase and water supply is limited. The total water supplied 450 m^3/day in year 2009 and the leakage in the water network is 30%.

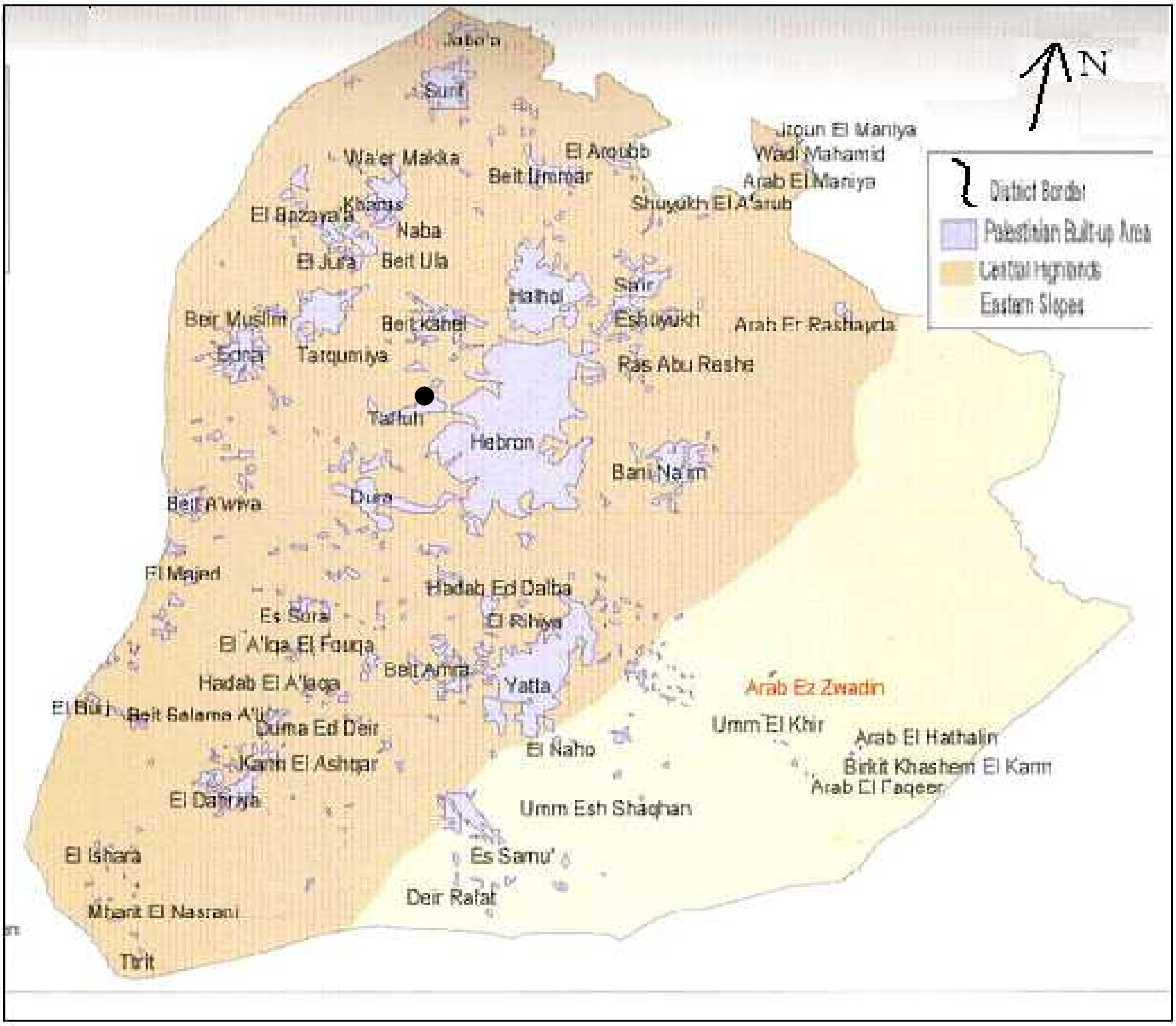

Figure (1.1): Location Map for the Project Area (Tafouh Town)

Figure (1.2): General View of the Tafouh Town

Figure (1.3): Internal View of the Tafouh Town

1.5 Work Plan

The main tasks, which had been under taken in order to develop this project, are as follows:

1. Make some visits to the town public committee to discuss the problems that the existing water network faces, and knowing the complaints which the consumers reports.
2. Obtaining on the existing water network map from Hebron municipality along with the detail Aerial photogrammetric map which shows the contour lines, roads, and houses, and its elevations.
3. Collection of previous statistically studies concerning the population distribution and describes it in zones in order to determine the population forecasts for Tafouh town.
4. Estimate the water demand for the town up to the design period of 2035 taking into consideration the present and future population, and the future water sources.
5. Setup the existing water network with all branches on the Aerial photogrammetric map to review and assessment of the existing situation.
6. Filling up all the necessary data (demand, elevation, nodes, and coordinate) to the EPANET computer program for the analysis and design of the network.
7. Design a new pipelines network completely for 25 years toward with all requirements.
8. Prepare bill of quantities to the proposed new water distribution network.
9. Preparation of the report.

1.6 Structure of the Report

The project report has been prepared in accordance with the objectives and scope of work. The report consists of five chapters.

The title of ***Chapter One "Introduction"*** outlines the general background, problem definition, technical objectives, project area, work plan and structure of the report.

Chapter Two entitled ***"Water Distribution Systems"*** deals with methods of water distribution , types of pipes, pipe appurtenances, service reservoirs pumps and pumping, and excavation and backing fill.

Chapter Three entitled ***"Design and Planning Criteria "*** presents population and population forecast, projected water demand, water supply and distribution, computational scheme and town structure plan.

Chapter Four entitled ***"Analysis and Design"*** is devoted to the analysis and discussion of results, and development of future plans and appropriate technology for reconstruction and upgrading of the existing water network in Tafouh town.

Chapter Five entitled ***"Analysis and Discussion of Results"*** is devoted to the analysis and discussion of results, the method of evaluating the existing water network will be described followed by discussion of results for the appropriate changes and modifications in the present mains and the future proposed water supply network.

Chapter Six entitled ***" Bill Of Quantities "*** .

The overall "***Conclusions"*** are given in ***Chapter Seven***.

CHAPTER

2 *WATER DISTRIBUTION SYSTEMS*

2.1 General

2.2 Methods of Distribution

2.3 Types of Pipes

2.4 Pipes Appurtenances

2.5 Service Reservoirs

2.6 Pumps and Pumping

2.7 Excavation and Backing fill

CHAPTER TWO

WATER DISTRIBUTION SYSTEMS

2.1 General

The term distribution system is used to describe collectively the facilities used to supply water from its source to the point of usage. To deliver water to individual consumers with appropriate quantity, quality, and pressure in a community setting requires an extensive system of pipes, storage reservoirs, pumps, and related appurtenances. It is the purpose of this chapter to explain these elements.

2.2 Methods of Distribution

Depending upon the topography, location of the source, and other considerations, water can be transported to a community in a number of ways. For transportation of water, canals, flumes, tunnels, and pressure pipes can be employed. Water can be supplied to the consumers with adequate pressure either by means of gravity, pumping, or a combination of both (see Figure 2.1)(Peary, Rowe and Techobanolous, 1985).

2.2.1 Gravity Distribution System

In this system, the water from the high leveled source is distributed to the consumers at lower levels, by the mere action of gravity without any pumping. For proper functioning of this system, the difference of head available between the source and localities, must be sufficient enough, as maintain adequate pressure at the consumer's door –steps, after allowing the frictional and other loss in the pipes. This method is the most economical and reliable, since no pumping is involved at any stage. However, it needs a lake or reservoir as a source of supply (Garge,1998).

2.2.2 Pumping With Storage System

In this system, the water is pumped at a constant rate and stored into an elevated distribution reservoir, from where it distributed to the consumers by the mere action of gravity. Sometimes, the entire water is first of all pumped into the distribution reservoir, many times , it is pumped into the distribution mains and reservoirs simultaneously. This method thus, combined as well as gravity flow (Garge,1998).

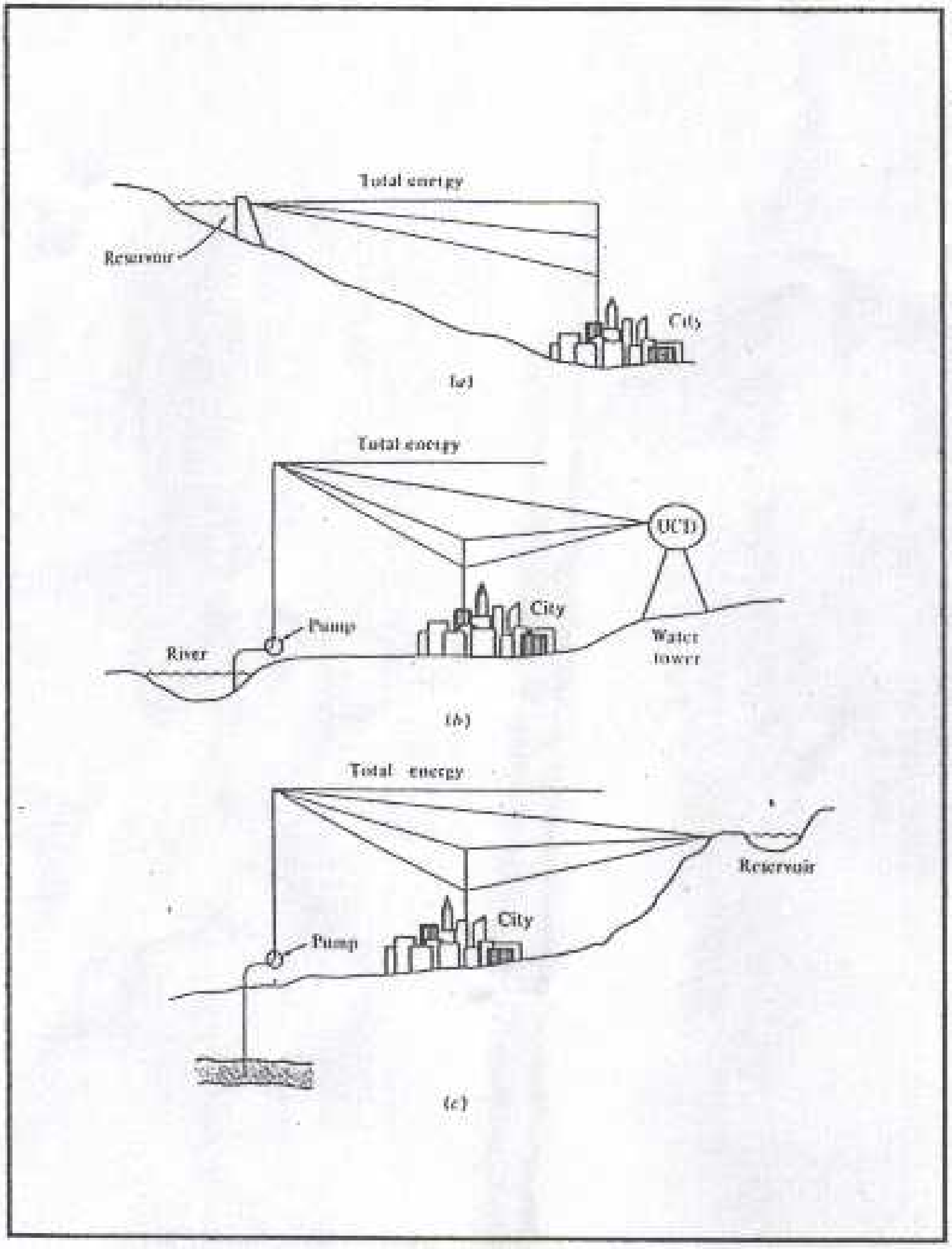

Figure (2.1): Typical Distribution System: (a) Gravity, (b) Pumped, and (c) Combined

2.2.3 Pumping Without Storage System

In the pumping system, the water is directly pumped into the distribution mains without storing it anywhere. High lift pumps are required in this system, which have to operate at variable speeds, so as to meet the variable demand of water. Thus a continuous attendance is needed at the pumping station, so to ensure the desired flow in the distribution system (Garge,1998). Moreover, if the power supply fails there will be complete stoppage of water supply, and if by chance, a fire breaks out at such a time, it will bring disaster. This method is therefore, generally not used. However, the only advantage of this method is that during fires, it can force large volumes of water under high pressure in the required direction, so that the motor pumps may be eliminated.

2.3 Types of Pipes

The pipe is a circular closed conduit, used for conveying water from a point to another one, under gravity or under pressure. The pipes are generally classified into three categories of usage:

(i) Mains: A large pipes which go through the main streets in cities or towns and used to convey water to other pipes (sub-mains) in the network, or from one reservoir to another.

(ii) Sub-mains: Smaller pipes connected to mains and supplies water to service pipes.

(iii) Service pipes: The pipes which supply water to consumers, houses, flats, and farms and connect to mains and sub-main pipes.

(iv) Plumping pipes: Pipes work within a building for the distribution of water of various appliances.

Pipes are also classified according to their material of construction. The following types of pipes are in use for construction of mains:

1. Cast iron pipes
2. Asbestos cement pipes
3. Steel pipes
4. Reinforced concrete pipes
5. Plastic pipes

The selection of particular types of material for a pipe depends mainly upon the first cost, maintenance cost, durability, carrying capacity, the maximum pressure, the maximum permissible size, availability of materials and labor for their construction, etc. The type of water to be conveyed and its possible corrosive effect upon the pipe material must be taken into account.

In Palestine, the use of steel pipes is more favorable considering the rocky terrain and steep slopes along most of the lines. Steel pipelines under such conditions are less exposed to damages by subsequent construction activities than other material pipes.

2.4 Pipes Appurtenances

In order to isolate and drain the pipeline sections for tests, inspection, cleaning and repairs, a number of appurtenances such as pipe fittings, valves, manholes, etc. are provided at various suitable places along the pipelines, as described below.

2.4.1 Pipe Fittings

The various pipe fittings such as bends, crosses, tees, elbows, wye, union, capes, reducers, plugs, etc. are frequently used in making service connections and bigger sized mains or sub-mains. Fittings are supplied in case of interruption of pipelines, such as change in diameters, materials, pipeline direction or if valve and water meters have to be installed. Various types of bends and other important pipe fittings are shown in Fig. 2.2 Proper selection and installation of joints and fittings is very important because they are often source of leakage (Steel and McGhee 1991).

2.4.2 Valves

A large number of different types of valves are required for the proper functioning of the pipelines. Generally, valves have three main tasks: flow and/or regulation (e.g. flow control valves, pressure reducing valves, etc.), exclusion of the parts of the network due to emergency or maintenance reasons, and protection of reservoirs and pumps in the system (e.g. float valves, non-return valves). With respect to the purpose, the following types of valves can be distinguished.

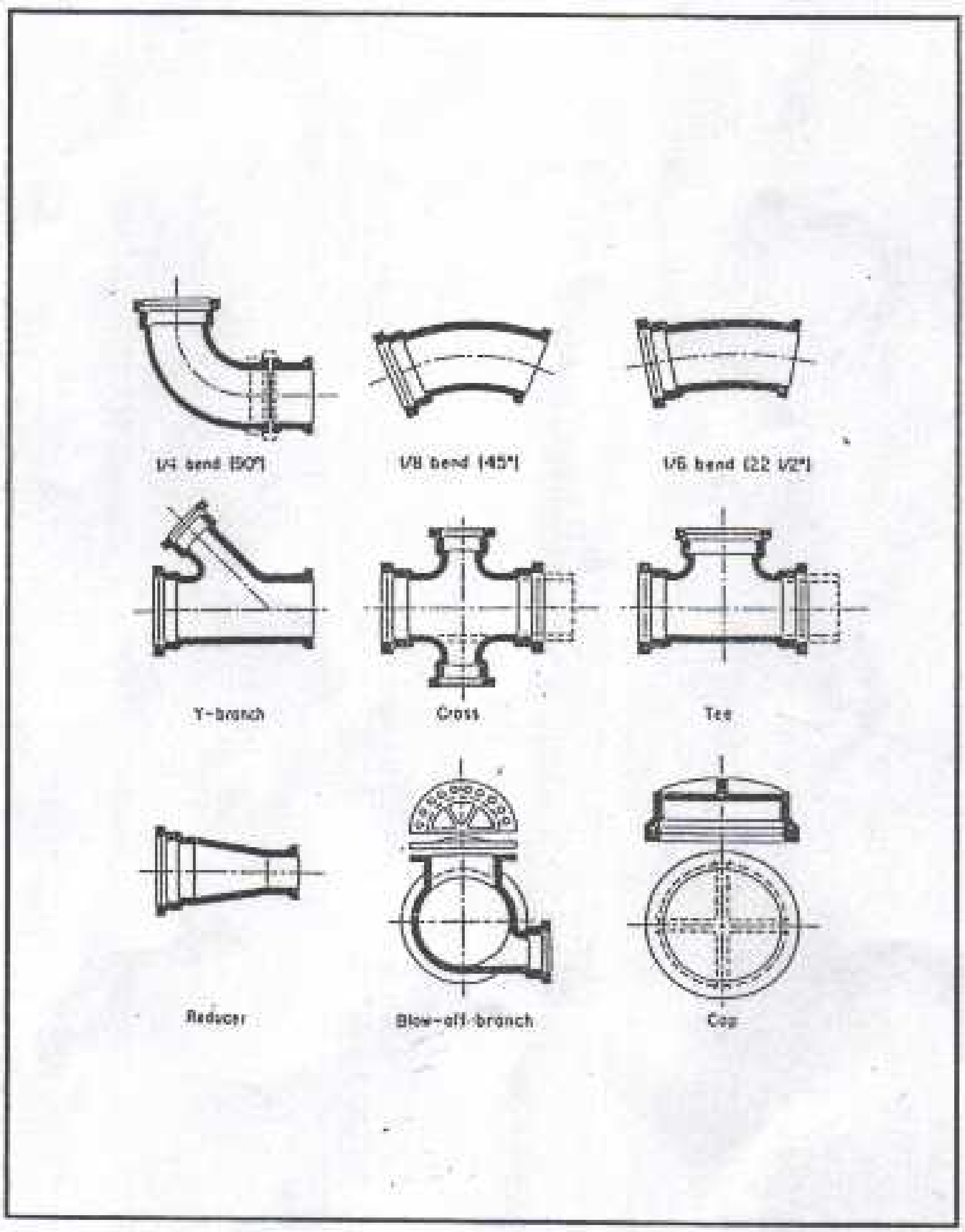

Figure (2.2):Various Pipe Fitting

1. **Gate Valves or Sluice Valves:** They are isolating valves, used most often in the distribution system to shut off the flow whenever desired, especially, when repairs are needed in the system, they are also helpful in dividing the water mains into suitable sections. Gate valves have the advantage of low cost, availability and low head losses when fully opened. In general, these valves are installed at street crossing where lines intersect.

2. **Pressure Reduce Valves:** They are installed at locations along the pipelines where pressure is high, especially at low point in the network and those that are near the pump station. When pressure in the pipe exceeds the maximum allowed limit, the valve relive pressure through cross pipe. An adjustable control permits setting downstream pressure at the desired level and the valve will throttle itself until that pressure is attained.

3. **Air Relief Valves:** Water flowing through a pipelines always contain some air which tries to accumulate at high points, and may interface with the flow. Air relief valves are therefore provided at the summit along the pipe, these valves are needed to discharge air when a main is being filled and to admit air when it is being emptied.

4. **Scour or Blow off Valves:** These are ordinary sluice valves that are located either at dead end or at the lowest point of the main. They are provided to blow off or remove the sand and silt deposited in pipelines. They are operated manually.

5. **Non-Return Valves:** These valves are used to primate the flow of water in one direction only. They consist of flat disc within the pipeline, when they are forced by water they are opened. They are used through the main pipes to the pumping station to prevent reverse flowing, and at the end of suction line to prevent draining the suction when the pump stops.

6. **Float Valves:** These valves are installed at the entrance of the storage reservoirs. There task is to close or open depending on the movement of a floating sphere on water to control the water surface inside the reservoir.

2.4.3 Water Meters

Purpose of metering in water distribution systems is twofold: it provides information about hydraulic behavior of the network, useful for the future design, as well as, it basis for water billing. In both cases the accuracy is vital, so the quality and good maintenance of these devices are very important (UNDP,1990).

2.4.4 Fire Hydrants

Fire hydrants are constructed in many different versions. They are generally distinguished as underground or ground installations. Under ground installations are better protected from frost and traffic damage, but on the other hand they can be covered by parked vehicle when being requested for use. Required capacity, pressure and distance for hydrants vary from case to case and they are related to the potential risks and consequences from fire. Generally, the capacities are within the range (30-500 m^3/h), and the distance between (100-300 m) (UNDP,1990).

2.4.5 Service Connections

Service connection link users within the distribution system. The standard set-up usually consists of: connection, pipe, outdoor and indoor stop valve and water meter. In newer installation, a non return valve may be added as well.

2.5 Service Reservoirs

2.5.1 Functions

Distribution reservoirs are the storage reservoirs ,which store the water for supplying water during emergencies, such as break-down of pumps, heavy fire demand, repairs, etc. and to help in absorbing the hourly fluctuation in the normal water demand. Storage reservoirs are also used to maintain pressure and reduce pressure variation within the distribution system. In large cites, distribution reservoirs may be used at several location within the system. Regardless of the locations, the water level in the reservoir must be at sufficient elevation to permit gravity flow at an adequate pressure. Types and storage capacity of the service reservoirs is explained in the following sections.

2.5.2 Types of Service Reservoirs

The service reservoirs may be made of steel, reinforcement cement concrete, or masonry. Depending upon their elevation with respect to the ground and local environmental conditions, storage reservoirs may be classified into the following two types:

1. **Surface Reservoirs:** Surface reservoirs are circular or rectangular tanks, constructed at ground level or below the ground level. They are generally constructed at high point in the city. In gravitational type of distribution system, water is stored in the ground service reservoir, and then directly sent from there into the distribution system.

2. **Elevated Reservoirs**: Elevated reservoirs are the rectangular, circular, or elliptical over head tank erected at a certain suitable elevation above the ground level and supported on the towers. They are constructed where the pressure requirements necessitate considerable elevation above the ground surface, and where the use of stand pipes becomes impracticable (Garge,1998).

2.5.3 Operating Storage of the Reservoirs

The total storage of a service reservoir is the summation of balancing storage (or equalizing or operating storage), breakdown storage, and fire storage. The main and primary function of a service reservoir is to meet the fluctuation in demand with a constant rate of water supply. The quantity of water required to be stored in the reservoir for balancing this variable demand against the constant supply is known as balancing storage or storage capacity of a reservoir. This balancing storage can be determined analytically or graphically. In the analytically solution method, the hourly excess of demand as well as the hourly excess of supply are worked out. The summation of maximum of the excess of demand and the maximum of excess of supply will give us the required storage capacity.

The breakdown storage or the emergency storage is the storage preserved in order to tide over the emergencies posed by the failure of pump, the electricity or any other mechanism driving the pump. The amount of breakdown storage is very difficult to assess. For this reason, a lump sum provision generally made for this storage. A value of about 25 percent of total storage capacity of the reservoir, or 2 times of the average hourly supply, may be considered as enough provision for accounting this storage, under all normal circumstances.

The third component of the total reservoir storage is the fire storage. In case of fires sufficient amount of water must remain available in the reservoir for throwing it over the fire. The total volume of water required for fire fighting is generally small, say of the order of 1 to 1.5 liters per day per person.

The total reservoir storage can finally obtained by adding all the three storage's, viz., balancing storage, emergency storage, and fire storage.

2.6 Pumps and Pumping

The transport of water from low lying sources, e.g. underground water, rivers and lakes, to the elevated water towers, reservoirs, directly to the consumers under pressure is accomplished with the help pumps. In a water supply scheme, pumps are required at one or more stages.

In the design of pumping works, stand-by units must be provided that in case of break dawn or during repairs the water supply is not effected. The number of units in reserve will depend upon the particular station and operational conditions.

2.6.1 Types of Pumps

There are various types of pumps, but the two types which the hydraulic engineers generally encounter, are :

1. **Roto-dynamic pumps:** A rotodynamic pump has a wheel or a rotating elements which rotates the water in a casing, and thus imparting energy to the water. Such a pump may be of the following two types:
   a) Centrifugal pumps
   b) Axial-flow pumps

2. Displacement pumps

A displacement pumps works on the principle of mechanically inducing vacum in a chamber, thereby drawing in a volume of water which is then mechanically displaced and forced out of the chamber. Such a pump may be of the following two types:

a) The reciprocating pump

b) The rotary type pump

In addition to these two major types of pumps, other types, such as air lift pumps, jet pumps, hydraulic rams, etc. are also used under special conditions.

2.6.2 Guide for Selection of Pumps

The various factors which must be thoroughly considered while selecting a particular type of pump for a particular project are :

a) Capacity of pumps

b) Importance of water supply scheme

c) Initial cost of pumping arrangement

d) Maintenance cost

e) Space requirements for locating the pump

f) Number of units required

g) Total lift of water required

h) Quantity of water to be pumped

2.6.3 Pumping Station

The location of a pumping station is primarily governed by the location of the place from where it is to receive water, and also by the location of the place where it is to supply that water. The various points which are to be kept in mind while selecting a suitable site are enumerated below :

a) The site should be a ways from all the sources of contamination or pollution.

b) The site should be above the highest flood level of the rivers.

c) It should be so selected that its future growth and expansion is easily possible.

d) Possibilities of fire hazard should also be considered while selecting the site for the pumping stations.

e) The proximity of the site to the railways, from where the coal can be quickly made available for producing power, may also have be considered.

2.7 Excavation and Backing Fill

Great care is not necessary in lying water pipes accurately to grade, but sufficient cover is necessary to give protection against traffic loads and to prevent freezing. The filling height is usually between 1 to 1.5 m measured from the upper tip of the pipe, this depends mainly on the volume and density of the traffics in the area of the project, in addition to the material of pipes and type of filling materials.

Trenches or ditches should be wide enough to allow good workmanship. Required widths range from 0.5 to 1.2 m depends on pipe size. In rock excavation the rock should be removed so that it is at least 150 mm away from the finished pipeline. A cushion of sand or earth should be placed between rock and the pipe (Steel and McGhee,1991).

Backfill material should be free from cinders, refuse, or large stones. Backfill from the trench bottom to the centerline of the pipe should be with sand, gravel, shell or other satisfactory material laid in layers and tamped. This material should extend to the trench sides. Excavation material can be used as filling material depending on the type of soil excavation and this will save money.

<u>CHAPTER</u>

3 *DESIGN AND PLANNING CRITERIA*

3.1 General

3.2 Poulation

3.3 Future Water Demand

3.4 Water Sources

3.5 Design Parameters

CHAPTER THREE
DESIGN AND PLANNING CRITERIA

3.1 General

In the previous chapter, the problem of the study has been defined and the objectives of the study have been listed. The water distribution system have been described. In this chapter, design and planning criteria will be discussed including population and population forecasting, future water demand, water sources, and design parameters.

3.2 Population

The ideal approach for population forecasting is by the study and use of previous census records, which cover along period. The longer the period, 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 Tafouh town, 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 and later in different years 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 Tafouh town is 12000 for year 2006 inhabitants.

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 Tafouh town over the next 25 years.

3.2.1 Population Forecast

Prediction of the future population of Tafouh town 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 Tafouh town.

The base for the forecast is the 2006 population for Tafouh town obtained from PCBS of 12000 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 between 3.0-3.5%. Therefore, the rate of 3.0% per year was used for the future growth of the population of Tafouh town.

To calculate the population at the end of the design period (year 2032), a geometric increase is assumed, represented by the following equation:

$$P = Po * (l + r)^{n} \quad (3.1)$$

Where, P is the future population, Po is the present population, r is the annual population growth rate, and n is the period of projection.

Using the above assumption and equation, Table 3.1 presents the population projection up to the design horizon of 2032. The data show that the population of Tafouh town is estimated to be 28279 in year 2035.

Table 3.1: Population Forecasts for Tafouh Town

Year	2006	2010	2020	2025	2030	2035
Population	12000	13506	18151	21042	24394	28279

3.2.2 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 large industrial areas, agricultural areas, un-built areas, public parks, large water surfaces, forests ... etc. The net density is related to the built up area, but it includes small-scale industries, schools, public and commercial buildings, and roads.

Water supply system, however, is based on the net densities of population, because the provision of net works is limited to the built-up areas. The net density of population varies considerably from district to district. It is nearly (30 capita per hectare).

There are no studies done concerning the population densities in Tafouh town. Population densities are based on the twon structure plan, which serves for issuing building permit the data for population density.

3.3 Future Water Demand

3.3.1 Introduction

Water consumption is not constant, yearly, monthly, weekly, daily, and hourly variations in water consumption are observed. Certain dry years cause more consumption. In hot months water is consumed in drinking, bathing, and watering lawns and gardens. On holidays and weekends the water consumption may be high Even during a day water use varies with high use during morning hours and close to noon and low use at night.

Maximum daily demand or maximum daily consumption usually occurs during summer months. The ideal approach to assess the existing and future per capita water consumption is by analyzing and extrapolating the available record on water consumption and demand in conjunction with the expected social and economical development. This approach can be adopted in areas having continuous supply systems where reliable information about population, population distribution and demand are known. There are problems in adopting this approach for Hebron area including Tafouh town due to insufficient data and also the intermittent water supply.

Restrictions on the Palestinian use of the annual ground water resources of the West Bank led to the availability limited quantities of water and due to this condition, the average consumption of water in Tafouh town for all purposes does not exceed 21.9 cubic meter per capita per year. Given these circumstances, the approach to determine per capita water consumption depends on the analysis of the existing information. The existing per capita consumption has already been assessed at (60 litter/capita, day).

3.3.2 Present Water Demand

According to the data obtained from the previous studies (Abu Sharkh, 1994) and municipality on water consumption in Tafouh town, the per capita annual water consumption is approximately 21.9 cubic meter (60 l/c.d).

3.3.3 Future Water Demand

The present average consumption of water for domestic use in Tafouh town is low (60 liter/capita.day) and does not represent the present and actual demand of water. So, the present water demand for domestic purposes of Tafouh town where estimated with the assumption of better living standard and economic condition.

Subsequently figure of litter per capita per day water demand was employed (1.5 times present water consumption, which allow adequate (minimum) water demand in the present).

The forecast of future water consumption (demand) is made on the following
Assumptions:

1. The living standard of the population will gradually improve leading to a corresponding increase of the per capita water demand.
2. The development of new water resources and design a network distribution system.
3. Present annual consumption is 21.9 cubic meter per capita (60 l/c.d), and the rate of increase in the annual water consumption per capita is equal to 1.5%
4. The population of the town in year 2006 is 12000 person, and population growth rate is 3.0 %.
5. Design period (period or time of calculation) equal 25 years, up to 2035.

Based on the above assumptions, the population of Tafouh town at years 2020, 2030 and 2035, and the annual residential water demand per capita for the same years were calculated along with water demand per capita per day. The data obtained were given in Table 3.2.

Table 3.2: Future Water Demand for Tafouh Town

Year	Population	Water Demand(m^3/year)		Water Demand(l/c.d)
		Per Capita	Total	
2010	13506	32.9	444347	90
2020	18151	38.3	695183	105
2030	24394	44.2	1078215	121
2035	28279	47.5	1343252	130

Note: (60l/c.d*1.5=90l/c.d)

It may be noted from Table 3.2 that the projected water demand for the design period (year 2035) is 130 liter per capita per day.

3.4 Water Sources

The water supply for Tafouh town falls short of the requirements due to insufficient water sources and due to limited quantities of water supplied to the towns and villages by the Palestinian Water Authortiy. The water is provided to the town by cisterns, water tanking, and underground water.

3.5 Design Parameters

The design and planning assumptions used in this project are as follow:

1. Design period 25 year (from 2010-2035).
2. Present (2010) population of municipality of Tafouh town is 3000 capita.
3. The growth rate will be 3.0% .
4. The existing per capita water consumption has been assessed 90 l/c.d.
5. Total administrative area of municipality of Tafouh town 20300 dounm.
6. Future 2035 population of Tafouh town 28279 capita.
7. Per capita water consumption by 2035 will reaches 130 l/c.d.

8. Formula to be used in design of pipes :(Hazen- William's formula)

$$V = 0.85\ C_H\ R^{0.63}\ S^{0.54} \qquad (3.2)$$

9. Dimensionless coefficient (C_H) ranges between 110-150 according to the material of the pipes.
10. Minimum velocity 0.1 m/sec.
11. Maximum velocity 2 m/sec.
12. Minimum pressure = 0.5 bar (5m)
13. Maximum pressure = 9 bar (90m)
14. Minimum diameter of 2"(50 mm)

CHAPTER

4 *ANALYSIS AND DESIGN*

4.1 General

4.2 Method of Calaculation

4.3 Network Design Steps

4.4 The ExistingWater Distribution Network

4.5 Summary

CHAPTER FOUR
ANALYSIS AND DESIGN

4.1 General

In this project, an attempt is made to study and evaluate the proposed water distribution network in Tafouh town and develop a future plans and appropriate technology for reconstruction and upgrading of the network, corresponding to population and population growth and water demand in the future, in order to supply all the inhabitants of Tafouh town with a sufficient amount of good quality drinking water. In this chapter, the method of calculation will be described followed by discussion of the Proposed Main Network.

4.2 Method of Calculation

The computer program EPANET performs the calculations necessary for the network design. This computer program is develop by the Risk Reduction Engineering Laboratory, Office of Resource and Development, U.S Environmental protection Agency, Cincinnati, Ohio (Rossman, 1994).

EPANET is a computer program that performs extended period simulation of hydraulic and waters quality behavior within drinking water distribution system. A network can consist of pipes, nodes (pipe functions), pumps, valves, and storage tank or reservoirs. EPANET tracks the flow of water in each pipe, the pressure at each node, the height of water in each tank, and the concentration of the substance throughout the network during a multi-time period simulation. In addition to substance concentration, water age and source tracing can also performed. The water quality is equipped to the model such phenomena as reactions within the bulk flow, reactions at the pipe wall, and mass transport between the bulk flow and pipe wall.

The algorithm makes of the Hardy-Cross method. This method makes use of the Hazen-Williams formula. The computer program assumes distribution of flow in the network and balances the head losses. Pipe flow formulas are used to determine the actual head losses, correction will then be made in the flow until the heads losses are balanced. The flow corrections are based on the concept that the flow at a node will continue, which means that the sum of the incoming flows equals the sum of the outgoing flows.

The computer program facilitates the selection of the appropriate pipe diameter. A number of data is required before the program can start its calculations. The length of pipes, the reservoir level, the demand per node, the elevation of the nodes, the Hazen –Williams coefficient for the friction, the stopping criterion for the Hardy- Cross algorithm, and the expected diameter for each pipe are required for this computer program. The program uses a simplified layout of the network All significant components in the network were marked by nodes (Rossman, 1994).

The pipelines are divided from node to node. The reservoir is represented as a node. At these nodes the water supply or consumption of the surrounding area is linked.

The result of this approach is that every node has its share in (1/s) of the demand of the total area. The friction of the pipeline is taken into account by using the Hazen-Williame`s coefficient. This dimensionless coefficient (C) ranges between 110-150 according to the material of the pipes. The chosen coefficient for this network is 130. The stopping criterion for the Hardy –Cross is chosen at 0.01.

Filling up the computer program only the pipe diameters remain. Varying these diameters enables then computer program to calculate the head losses, the velocity, the flow in each pipe and the pressure at each node. The velocity and the pressure are restricted between margins. These margins should be considered, but can be crossed if sensible. Finally the most suitable diameters are found, so that the pressure in the nodes will meet the requirements as close as possible (5-90 m) and the velocities will mostly be between the range of (0.1-2 m/s).

4.2.1 Pipe Hydraulics

As mentioned earlier, pipe hydraulic calculation has been carried out by the EPANET software, which uses the Hazen-Williams equation to calculate the friction head loss. The design criteria adopted for different parameters are:

(i)Velocity:

- Minimum velocity = 0.1 m/s to prevent deposits of silt in the pipe (achieve self-cleansing).
- Maximum velocity = 2.0 m/s to minimize friction loss and water hammer effect.

(ii) Pressure:

- Minimum pressure = 0.5 bar (5m)
- Maximum pressure = 9 bar (90m)

The minimum and maximum pressures in the distribution lines are defined as the pressure at the nodes in the model. The minimum value of 5 m is adopted to let the water rise at least one story and overcome the frictional resistance of the house connection pipes and small diameter distribution. The upper value is limited to 90 m in order to have excessive pressure in the network and so minimize the leakage from the system.

(iii) Pipe: The pipes of the distribution system are chosen to be steel pipes due to their advantages. Minimum diameter of 1"(25 mm) is taken. The Hazen –Williams constant of a new steel pipes is 130.

4.2.2 Reservoir

Reservoirs are required to provide emergency storage in case there is a temporary loss of bulk supplies or in case there are exceptional demand on the system (e.g. for fire fighting). It is also required for balancing storage to take account of normal and daily fluctuation in demand compared with average demand. In Tafouh town, small municipal water reservoirs are available. Most households have cisterns and/or large roof tanks that provide additional storage in the system. At the same time, the availability of funds and land needed to build the reservoir are factors to be considered in deciding whether we need reservoir or not. In this project, it is suggested to build one large reservoir on available land located in the highest point of Tafouh town.

4.2.3 Valves

Gate valves are placed at the street corners where lines are intersected. Air relief valves are only fitted to main pump because taps of houses work as air relief valves for the distributing lines.

4.3 Network Design Steps

In general, the following steps must be done while planning and designing a municipal water supply scheme:

1. Estimated the future population of the study area to determine the quantity of water which is required to be provided by the project.
2. Located a reliable source of water, so as to fulfill the needs and requirements of the area.
3. Obtained a detailed map of the area to be served on which topographic contours and the locations of present and future are identified.
4. Based on the topography, selected possible locations for distribution reservoirs. If the area to be served is large it may be divided into several sub-areas to be served with separate distribution system.
5. Estimated the average and peak water use for the area or each sub-area, allowing for fire fighting and future growth.
6. Estimated pipe size on the basis of water demand and local code requirements.
7. Laid out a skeleton system of supply mains leading from the distribution reservoir or other source of supply.
8. Analyzed the flow and pressures in the supply network.
9. Suggested pipe sizes to reduce pressure irregularities in the basic grid.
10. Added distribution mains to the grid system.
11. Reanalyzed the hydraulic capacity of the system.
12. Added street mains for domestic service.
13. Located the necessary values and fire hydrants.
14. Prepared final design drawings and quantity takeoffs.

4.4 The Existing Water Distribution Network

In the proposed study for the water distribution network, the trial is made to design the network for year 2035. The appropriate pipe diameters will be found using the computer program filled with basic data (nodes water demand in year 2035, elevation of the nodes, the length of each pipe). So that, the pressure in the nodes and velocity in the links will meet the requirements as close as possible. The existing water distribution network is plotted in Figure ٤.1.

CHAPTER

5 ANALYSIS AND DISCUSSION OF RESULTS

5.1 General INTRODUCTION

5.2 CALCULATION SCHEME

5.3 THE EXISTING WATER DISTRIBUTION NETWORK

5.4 THE PROPOSED WATER DISTRIBUTION NETWORK

CHAPTER FIVE

ANALYSIS AND DISCUSSION OF RESULTS

٥.1 GENERAL INTRODUCTION

In this project, an attempt is made to study and evaluate the existing water distribution network in Tafouh town, and develop a future plans and appropriate technology for reconstruction and upgrading of the network, corresponding to population and population growth and water demand in the future, in order to supply all inhabitants of Tafouh town with a sufficient amount of good quality drinking water. In this chapter, the method of evaluating the existing water network will be described followed by discussion of results for the appropriate changes and modifications in the present mains and the future proposed water supply network.

٥.2 CALCULATION SCHEME

As mentioned earlier, the analysis and design were carried out for Tafouh water distribution network in three phases. First study and evaluate the existing water distribution network, secondly designing and constructing a new network with 90 l\cd water demand without exchanging the pipes diameters in year 2035 (case I), and thirdly designing and constructing a new network with 130 l\cd water demand with exchanging the pipes diameters in year 2035 (case II). The calculation necessary for the network design is performed by the computer program EPANET, which make of use of Hardy-Cross method. The computations and the results of each of the three phases will be described and presented below.

٥.3 THE EXISTING WATER DISTRIBUTION NETWORK

The existing water distribution network has been studied and evaluated. The existing water network consists of main pipelines and sub-mains. The main pipeline receives the water from a storage reservoir almost supplied by water coming from Palestinian Water Authority main pipes passing near the town. The water in the town is distributed directly by a network of steel pipelines, most of them are very old and exposed to the traffic. The pipelines range from 0.5" to 6" in diameter and many are in bad state of repair. The amount of water that is lost in the distributing system or is unaccounted for is about 30% of the quantity of water supplied. The existing water network is shown in the layout of the existing network in Fig. A.1

٥.4 THE PROPOSED WATER DISTRIBUTION NETWORK

In year 2035, Tafouh town is in direct need of larger quantities of water and more adequate supply scheme. In the proposed study for the water distribution network, the trial is made to redesign the network for year 2035 by partly using the old network. This section deals with the results of the proposed water distribution network for year 2035.

The calculations have been done for the proposed water network and try to repair or redesign the existing network for year 2010. The demand of water for each node necessary for the calculation where estimated by multiplying the population density by the area in which each node serves by water demand per capita per year. The elevation of each node and length of pipelines are calculated from the aerial map. The results for the existing network are given in the following paragraphs.

The computer program is used for doing the calculation and obtaining the results. The input data are given in Table 5.1 and shown in the layout of the proposed network in Fig. A.2 and Fig. A.3. The output values of velocity, head loss, and pressure are given in Tables 5.2 and 5.3.

It may be seen that many values of the velocity and pressure are within the allowable ranges. The velocity in many pipes is less than 0.1 m/s and the head loss is very high.

Table (5.1) X, Y Coordinates of Nodes for the EXISTING Network.

Node #	X coordinate	Y coordinate
Tank	155928.07	105482.41
1	152783.94	105049.11
2	153225.74	105019.45
3	153657.45	104613.06
4	153524.30	104787.63
5	153793.07	104981.15
6	154094.02	105171.49
7	153969.19	98321.690
8	154126.20	98348.055
9	154426.05	98388.19
10	154432.92	98401.85
11	154650.10	98407.55
12	154764.26	98416.95
13	154719.80	98384.81
14	154756.10	98439.89
15	154848.59	98438.29
16	154863.70	98457.26
17	155021.70	98409.76
18	155349.61	98447.08
19	154932.10	98472.17
20	155244.29	98565.50
21	155055.14	98590.53
22	155548.51	98598.31
23	155908.27	98610.76
24	156133.84	98510.44
25	155701.63	98572.66
26	155438.93	98593.24
27	155165.08	98641.28
28	155551.78	98568.22
29	155923.50	98639.20
30	155444.28	98630.55
31	155173.24	98686.37
32	154916.31	98644.35
33	155315.98	105095.35
34	154944.01	105166.11

5.4.1 The Proposed Network- Case I

As discussed earlier, the appropriate pipe diameters are found by use of the computer program filled with basic data (nodes water demand in year 2035, elevation of the nodes, the length of each pipe). So that, the pressure in the nodes and velocity in the links will meet the requirements as close as possible. The appropriate diameters for proposed network are found and given in Table 5.4 along with the elevation and demand data. The same data are shown in Figs A.4 , A.5 , A.6 , A.7 ,A.8 , A.9 . The calculated velocities, head loss, grads, and pressure are given in Tables 5.2 , 5.3 , 5.4 , and 5.5 The proposed water distribution network for year 2035 is plotted in Figure 5.3, the diameters and lengths of all pipes are shown in the figure.

It is observed from the tables and the figures that new pipelines are suggested for some places where no pipelines are available at present in these places. It is also proposed to replace many existing pipelines, and keep the other pipelines as it is now. This conclusion agreed with our point of view of constructing new mains and using some of the existing one.

Table 5.2 – Input Data for the First Proposed Network (Nodes)

Node #	Elevation (m)	Demand (l /s)
1	740	0.53
2	760	0.70
3	790	1.31
4	780	2.26
5	790	0.32
6	800	1.52
7	804	1.01
8	800	0.75
9	800	1.14
10	800	1.29
11	800	1.41
12	780	1.07
13	770	1.34
14	780	0.73
15	800	0.89
16	780	0.17
17	770	1.70
18	770	0.15
19	790	1.52
20	820	2.35
21	815	1.76
22	845	2.15
23	870	0.19
24	835	0.17
25	820	0.23
26	820	0.13
27	830	0.98
28	800	0.28
29	850	0.22
30	790	0.21
31	735	0.21
32	810	1.52
33	800	00
34	805	00

Table 5.3 – Input Data for the First Proposed Network (pipes)

Pipe #	Head Node	Tail Node	Length (m)	Diameter (mm)
1	1	2	646.3508	٥٠
2	2	4	558.3999	٥٠
3	4	5	320.4872	75
4	5	6	364.2827	75
5	6	10	332.4668	75
6	10	11	247.4385	٧٥
7	11	15	200.778	150
8	22	23	747.3615	١٥٠
9	25	26	264.324	100
10	24	25	438.8486	100
11	26	33	127.6560	100
12	25	29	711.3929	50
13	26	28	579.8765	50
14	28	30	386.4657	50
15	27	32	272.7651	75
16	32	14	160.7524	75
17	15	12	227.9388	50
18	12	13	253.1528	50
19	13	31	518.4062	25
20	22	33	284.2534	150
21	22	20	443.6494	100
22	20	19	515.9550	100
23	11	9	273.17136	100
24	9	8	322.598	100
25	8	7	163.1585	100
26	7	3	352.9712	100
27	18	17	370.6077	50
28	17	16	256.6009	50
29	27	33	295.2959	75
30	15	34	99.7	150
31	16	34	355.9700	50
32	21	34	108.78	150
33	21	33	261.83	150
34	٢٣	٣٥	23.67	150

Table 5.4 - Values of Velocity and Head Loss in Pipe for the First Proposed Network

Pipe #	Diameter (mm)	Flow (L/s)	Velocity (m/sec)	Head Loss (m/km)
١	٥٠	-.53	0.27	3.93
2	٥٠	-1.23	0.63	18.70
3	75	-3.49	0.79	17.90
4	75	-3.81	0.86	21.06
5	75	-5.33	1.21	39.22
6	٧٥	-6.62	1.50	58.59
7	150	-12.24	0.69	6.25
8	١٥٠	30.02	1.70	32.92
9	100	0.62	0.08	0.18
10	100	0.17	0.02	0.02
11	100	1.24	0.16	0.65
12	50	0.22	0.11	0.77
13	50	0.49	0.25	3.40
14	50	0.21	0.11	0.71
15	75	2.25	0.51	7.94
16	75	0.73	0.17	0.99
17	50	2.62	1.33	75.86
18	50	1.55	0.79	28.70
19	25	0.21	0.43	20.72
20	150	-24.00	1.36	21.75
21	100	3.87	0.49	5.34
22	100	1.52	0.19	0.95
23	100	4.21	0.54	6.24
24	100	3.07	0.39	3.48
25	100	2.32	0.30	2.07
26	100	1.31	0.17	0.72
27	50	0.15	0.08	0.38
28	50	1.85	0.94	39.82
29	75	3.23	0.73	15.51
30	150	-15.75	0.89	9.97
31	50	2.02	1.03	46.87
32	150	-17.77	1.01	12.47
33	150	-19.53	1.11	14.85
34	150	-30.21	1.71	33.31

Table 5.5 – The Pressure at Each Node for the First Proposed Network

Node #	Demand (l/s)	Elevation (m)	Grade (m)	Pressure (m)
1	0.53	740	807	67.00
2	0.70	760	809.54	49.54
3	1.31	790	857.52	67.52
4	2.26	780	819.99	39.99
5	0.32	790	825.72	35.72
6	1.52	800	833.40	33.40
7	1.01	804	857.77	53.77
8	0.75	800	858.11	58.11
9	1.14	800	859.23	59.23
10	1.29	800	846.44	46.44
11	1.41	800	860.93	60.93
12	1.07	780	844.90	64.90
13	1.34	770	837.63	67.63
14	0.73	780	861.52	81.52
15	0.89	800	862.19	62.19
16	0.17	780	846.50	66.50
17	1.70	770	836.28	66.28
18	0.15	770	836.14	66.14
19	1.52	790	871.75	81.75
20	2.35	820	872.24	52.24
21	1.76	815	864.54	49.54
22	2.15	845	874.61	29.61
23	0.19	870	899.21	29.21
24	0.17	835	868.29	33.29
25	0.23	820	868.30	48.30
26	0.13	820	868.34	48.34
27	0.98	830	863.85	33.85
28	0.28	800	866.37	66.37
29	0.22	850	867.75	17.75
30	0.21	790	866.10	76.10
31	0.21	735	826.89	91.89
32	1.52	810	861.68	51.68
33	00	800	868.43	68.43
34	00	805	863.18	58.18

5.4.2 The Proposed Network- Case II

Filling up the computer program with basic data, varying the diameter of the links, and obtained the calculated head losses, velocities and pressures. The procedure were repeated for the proposed network –case II until the most suitable diameters that meet the water demand are found. The data obtained for the diameter and basic data are listed in Table 5.٦ , The layout of the proposed network is shown in Figure 5.3. The predicted values of velocity, head loss, pressure, and grade are given in Tables 5.8 , 5.7 and 5.9 . Figure A.10 , A.11 , A.12 , A.13 , A.14 and A.15 represents the final drawings of the second proposed water distribution network with 130 l\cd water demand .

It may be seen in the figures the new pipelines suggested for Tafouh water network for year 2035. By comparing the existing link diameters with that obtained for year 2035, it is found many existing pipelines are proposed to be replaced by larger pipelines and other suggested remaining same. This conclusion also agreed with our point of view of constructing new mains and using some of the existing,

Table 5.6 – Input Data for the Second Proposed Network (Nodes)

Node #	Elevation (m)	Demand (l /s)
1	740	0.76
2	760	1.01
3	790	1.89
4	780	3.27
5	790	0.46
6	800	2.20
7	804	1.47
8	800	1.09
9	800	1.64
10	800	1.86
11	800	2.04
12	780	1.54
13	770	1.93
14	780	1.05
15	800	1.29
16	780	0.25
17	770	2.45
18	770	0.21
19	790	2.19
20	820	3.40
21	815	2.54
22	845	3.10
23	870	0.28
24	835	0.25
25	820	0.33
26	820	0.19
27	830	1.41
28	800	0.41
29	850	0.32
30	790	0.31
13	770	1.93
14	780	1.05
15	800	1.29
16	780	0.25

Table 5.7 - Input Data for the Second Proposed Network (Pipes)

Pipe #	Head Node	Tail Node	Length (m)	Diameter (mm)
1	1	2	646.3508	75
2	2	4	558.3999	75
3	4	5	320.4872	75
4	5	6	364.2827	75
5	6	10	332.4668	75
6	10	11	247.4385	100
7	11	15	200.778	150
8	22	23	747.3615	200
9	25	26	264.324	100
10	24	25	438.8486	100
11	26	33	127.6560	100
12	25	29	711.3929	75
13	26	28	579.8765	75
14	28	30	386.4657	75
15	27	32	272.7651	75
16	32	14	160.7524	75
17	15	12	227.9388	50
18	12	13	253.1528	50
19	13	31	518.4062	50
20	22	33	284.2534	150
21	22	20	443.6494	100
22	20	19	515.9550	100
23	11	9	273.17136	100
24	9	8	322.598	100
25	8	7	163.1585	100
26	7	3	352.9712	100
27	18	17	370.6077	75
28	17	16	256.6009	75
29	27	33	295.2959	75
30	15	34	99.7	150
31	16	34	355.9700	75
32	21	34	108.78	150
33	21	33	261.83	150
34	٢٣	٣٥	23.67	200

Table 5.8 – Values of Velocity and Head Loss in Pipe for the Second Proposed Network

Pipe #	Diameter (mm)	Flow (L/s)	Velocity (m/sec)	Head Loss (m/km)
1	75	-0.76	0.17	1.06
2	75	-1.77	0.40	5.09
3	75	-5.04	1.14	35.36
4	75	-5.50	1.24	41.57
5	75	-7.70	0.01	0.00
6	100	-9.56	0.03	0.01
7	150	-17.69	1.00	12.36
8	200	43.42	1.38	16.06
9	100	0.90	0.11	0.36
10	100	0.25	0.11	0.36
11	100	1.81	0.23	1.31
12	75	0.32	0.07	0.21
13	75	0.72	0.16	0.96
14	75	0.31	0.07	0.20
15	75	3.31	0.75	16.23
16	75	1.05	0.24	1.94
17	50	3.77	1.92	148.84
18	50	2.23	1.14	56.29
19	50	0.30	0.15	1.37
20	150	-34.73	1.97	43.12
21	100	5.59	0.71	10.55
22	100	2.19	0.28	1.86
23	100	6.09	0.78	12.36
24	100	4.45	0.57	6.92
25	100	3.36	0.43	4.11
26	100	1.89	0.24	1.42
27	75	0.21	0.05	0.10
28	75	2.66	0.60	10.83
29	75	4.72	1.07	31.31
30	150	-22.75	1.29	19.70
31	75	2.91	0.66	12.79
32	150	-25.66	1.45	24.62
33	150	-28.20	1.60	29.32
34	200	-43.70	1.39	16.25

Table 5.9 – The Pressure at Each Node for the Second Proposed Network

Node #	Demand (l/s)	Elevation (m)	Grade (m)	Pressure (m)
1	0.76	740	797.73	57.73
2	1.01	760	798.42	38.42
3	1.89	790	853.78	63.78
4	3.27	780	801.26	21.26
5	0.46	790	812.59	22.59
6	2.20	800	827.73	27.73
7	1.47	804	854.28	50.28
8	1.09	800	854.95	54.95
9	1.64	800	857.18	57.18
10	1.86	800	853.50	53.50
11	2.04	800	860.56	60.56
12	1.54	780	829.11	49.11
13	1.93	770	814.86	44.86
14	1.05	780	861.37	81.37
15	1.29	800	863.04	63.04
16	0.25	780	860.45	80.45
17	2.45	770	857.67	87.67
18	0.21	770	857.64	87.64
19	2.19	790	881.97	91.97
20	3.40	820	882.93	62.93
21	2.54	815	867.68	52.68
22	3.10	845	887.61	42.61
23	0.28	870	899.62	29.62
24	0.25	835	875.08	40.08
25	0.33	820	875.10	55.10
26	0.19	820	875.19	55.19
27	1.41	830	866.11	36.11
28	0.41	800	874.63	74.63
29	0.32	850	874.94	24.94
30	0.٣١	7٩٠	874.55	84.55
31	0.30	735	814.15	79.15
32	2.20	810	861.68	51.68
33	00	800	875.36	75.36
34	00	805	865.00	60.00

5.5 SUMMARY

In this chapter, the existing water distribution network for Tafouh has been studied and evaluated. The result of calculation necessary for the network design have been given and discussed. The proposed water distribution network has been presented.

CHAPTER

6 BILL OF QUANTITIES

BILL OF QUANTITIES
FOR THE PROPOSED WATER DISTRIBUTION NETWORKS

Item	Description	Unit	Case I	Case II	Rate($)
	Note: (1) The contractor shall when pricing this bill take into consideration to include and allow for all costs or expenses of all requirements stipulated (2) The exact length of the required pipes, the exact number of the required valves and the exact quantities of concrete will be determined during the implementation of the work.				
1.	**Water pipes** Supply and install straight in the trench water pipes including excavation, shoring, bidding, backfilling, testing and reinstatement. This include also all necessary parts, jointing compounds, fittings, reducers and plugs, complete as per technical specifications, to complete all the work as described in the specifications, shown in the drawing, approved and	L.M.	00.00	771.03	
	directed by the engineer for:	L.M.	1726.4	955.34	
	A. 8 inch dia	L.M.	2902.3	3149.8	
	B. 6 inch dia	L.M.	1993.5	5611.7	
	C. 4 inch dia	L.M.	4118.8	999.50	
	D. 3 inch dia	L.M.	518.42	00.00	
	E. 2 inch dia				
	F. 1 inch dia				
2.	**Pressure reduce valve:** Supply and install straight in the manhole pressure reduce valve of 15 bars working pressure including all necessary flanges and accessories needed installation and jointing, testing and all necessary parts and works needed to complete the work, approved and specified by the engineer .	No.	10	12	

Item	Description	Unit	Case I	Case II	Rate($)
3.	**Gate valve:** Supply and install straight in the manhole gate chamber of 15 bar working pressure with all necessary flanges and accessories needed for installation, jointing, testing, and all necessary parts and work needed to complete the work. Approved and specified by the engineer for:				
	A. 250 mm dia valve	No.	0	0	
	B. 200 mm dia valve	No.	0	1	
	C. 150 mm dia valve	No.	5	5	
	D. 100 mm dia valve	No.	2	2	
	E. 75 mm dia valve	No.	2	1	
	F. 50 mm dia valve	No.	1	1	
4.	**Pipe reducer and adapter**: Supply and install straight in the trench reducer adapted to connect ductile pipe including excavation, shoring , jointing, bedding, backfilling, testing, and reinstatement and all necessary works and parts needed to complete the work, approved and specified by the engineer for:		0	1	
	8 inch to 6 inch	No.	3	4	
	6 inch to 4 inch	No.	2	3	
	4 inch to 3 inch	No.	4	0	
	3 inch to 2 inch	No.	2	0	
	4 inch to 2 inch	No.		1	
	6 inch to 2 inch	No.			

5.	**Chambers:** Supply and place cast-in-site concrete class B300 to construct valve chambers and chambers This includes excavation, shoring, formwork, compacting, jointing, backfilling, testing, reinstatement and all necessary steel reinforcement and concrete works. This includes also all necessary works and parts required to complete the work, approved and specify by the engineer.	No.	3	3	

CHAPTER

7 *CONCLUSIONS*

CHAPTER SEVEN
CONCLUSIONS

In this project, the proposed water distribution network in Tafouh town has been studied and evaluated. The trial is also made to design the village network for year 2035. It is also brought out many important conclusions. The main conclusions drawn from the present study are summarized below:

1. Restrictions on the Palestinian use of the annual ground water resources of the West Bank led to limited quantities of water supplied to the village and due to this condition the average consumption of water in the town in general is very low and does not represent the present actual demand of water.

2. The present population of Tafouh town is around 13506 person. Prediction of the future population of Tafouh town is very difficult due the political uncertainties. The rate of population growth is taken as 3.0%.

3. The socio-economic survey shows that the total water demand for domestic use in the town for year 2010 is around 444347 cubic meter per year, 695183 cubic meter per year for year 2020, and 1343252 cubic meter per year for year 2035, which means that water demand will be around four times the present quantity in year 2035 which is possible to arrange from our natural resources.

4. Water source is available from the Palestinian Water Authority.
5. The results of the existing water distribution network show that the most values of velocities and pressures are do not within the allowable ranges, for that most of the existing links have to be changed.

6. In year 2035, Tafooh town is in direct need of larger quantities of water and more adequate supply scheme. In redesign the water distribution network, the results show that a new network are to be constructed.

7. The project present two proposed water distribution networks, in which a new pipelines networks completely for 25 years toward with all modish required are

proposed. In first case the twon should be supplied by water with 90 l\cd water demand without changing diameters of the existing pipes. In second case the twon should be supplied by water with 130 l\cd water demand with changing diameters of the existing pipes. Project such this required a huge budget and financial help.

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APPENDIX

- ***FIGUERS***
- ***EPANET MANUAL***