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PALESTINE POLYTECHNIC UNIVERSITY

COLLEGE OF ENGINEERING AND TECHNOLOGY

CIVIL &ARCHITECTURAL ENGINEERING DEPARTMENT

PROJECT TITLE:

PART OF INFRASTRUCTURE DESIGN FOR JERICHO INDUSTRIAL ZONE

BY

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A PROJECT REPORT SUBMITTED IN PARTIAL FULFILMENT OF

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SUPERVISED BY

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CERTIFICATION

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(PPU)

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The Senior Project Entitled:

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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 Civil Engineering.

Project Supervisor **Department Chairman**

MAY -2011

Dedication

To Palestine…

To our parents…

To the soul of Martyrs…

To our teachers…

To our friends…

To whom we love…

To every one who gave us help…

To Eng.SAMAH AL-JABARI

Thank you deep from our hearts for all the love and support that

You have given to us.

Work Team

A KNOWLEDGEMENT

We would like to thank and gratitude to Allah, who gives us, the most Merciful who granted us the ability and willing to start project.

We thank “Palestine Polytechnic University”,” Departement of civil and architectural engineering” and wish to it more progrss and sucsses ,We express our thanks to “Eng. Samah Al-Jabari”, who gave us knowledge, valuable help, encouragement, supervision and guidance in solving the problems that we faced from time to time during this project. We also thank “Dr. Majed Abu Sharkh”, “Eng. Nael Qafeshih”, “Eng. Anan Al-Jabari”, and Jericho munucipility for there precious help.

Finally our deep sense and sincere thanks to our parents, brothers and sisters for their patience, and for their endless support and encouragement also for every body who tried to help us during our work and gave us strength to complete this task.

Work Team

ABSTRACT

PART OF INFRASTRUCTURE DESIGN FOR JERICHO INDUSTRIAL ZONE

Prepared By:

GHADI AL-ZUGHAIR **MANAR AL-HAMMOURI**

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infrastructure of a city is the physical or structural part of the city. These things include its transportation systems roads, bridges, highways, public transportation, sewage system, water system, utility systems gas, electricity, water treatment and delivery, and its buildings schools, court houses, sports facilities, and its public and private housing developments.

Its important to focus on improving infrastructure, modernizing infrastructure will help keep country competitive, creat thousands of jobs and improve the lives of all citizens.

Palestine cities does not have complete infrastructure, since it's now in building and in some cities rebuilding and reconstracture. At least many palestinian cities dose not have drainage system, water network system, high ways and industrial areas.

Jericho like most cities in Palestine have no complete water supply network, sanitary system, sewage disposal systems and solid waste treatment. And also it dose not have industrial area.

Jericho municipality looks to design a complete and full option industrial area. The present study will prepare a part of infrastructure design of Jericho industrial zone. Our study will concentrate on the most important parts of infrastructure which is wastewater drainage system, storm water drainage system and water network for Jericho industrial zone.

Jericho city is an important and famous city due to its location, climate and characteristics, it's part of the Jordanian Rift Valley which is at 396 m below sea level. Also it considerd as agricultural area and it is looking to improve an “agro-industry”, for these reasons Jericho municipality looks to design a complete and full option industrial area.

The present study will prepare part of infrastructure design for Jericho industrial zone, which include wastewater drainage system, storm water drainage system and water network for Jericho industrial zone. It's considered the water consumption, wastwater quantities, rainfall intensity and storm water quantities, the necessary hydraulic calculation needed for the design of the three networks.

This study shows a number of important conclusions, Jericho industrial zone looking to be an agro-industrial area which has aspecial constraints that is taken in the design. Gravity flow for water network, wastewater collection system and storm water drainage system were proposed for jericho idustrial zone to minimize cost of construction and excavations.

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1.1 General

Infrastructure is the basic physical systems of a country's or community's population, including roads ,utilities, water, sewage, etc. These systems are considered essential for enabling productivity in the economy. Developing infrastructure often requires large initial investment, but the economies of scale tend to be significant.

Wastewater collection system, storm water drainage system and water network are very important part of any city infrastructure.

1.2 Problem Definition

The accelerated expansion and development of Jericho has resulted the need to generate industrial zone which will increase the water consumption and consequently generate large quantities of wastewater from various sources such as residential areas, commercial establishments and different industries. Due to the absence of wastewater collection system, the wastewater has been seeping into the ground through the overflows of the deteriorated cesspits and latrines that are commonly used in Jericho. Moreover, in some areas wastewater is flows directly to the “Wadis” through open drain in different routes causing serious environmental and health problems.

1.3 Objectives of The Project

This project entitled “Part of infrastructure design for Jericho industrial zone " includes the design of the Infra Structure work which consists of sanitary network and rainwater drainage system, water network. The project will include different items as follows:-

1. Sanitary Network

Study and design the sanitary network and system including all its subsidiaries with proper inclinations, connecting to the main municipality lines, manholes, connection systems within the project, disposal methods…etc.

1.Sewerage Materials

2. Design Wastewater Flow and Loadings

3.Prepare all engineering design drawings and details for the sanitary system network and disposal methods.

2. Rain Water Drainage System

Complete study and design for the rain water drainage system as follows:

1. Study the rainwater drainage system inside the territory of the industrial zone and prepare the design drawings that illustrate the draining directions and collection points.
2. engineering design drawings and details for the installation of sewer lines and inlets…etc

3. Water Network

1. Study and design the water pipe network and its supplementary items that will feed the industrial zone.
2. engineering design drawings and details for the installation of water lines and storage tanks.

4. importance of this project

It is expected that the “industrial zone” will be important for the economic upgrading of “Jericho” which will contribute the challenging future goals such as improvement of agriculture , promotion of “agro-industry”, and enhancement of exporting competitiveness of Palestinian export industry.

For such vital project we need a good infrastructure which is based on scientific bases and engineering roles.

1.4 Methodology

1. Site visits to Jericho industrial zone and municipality were done.
2. All needed maps and the previous studies that contain different information about industrial Jericho zone were obtained.
3. The amounts of water consumption for different purposes and consequently the amount of wastewater production for each area were obtained.
4. The different layouts of the purposed wastewater collection system ,storm water system and water network.
5. Tables and profile using sewerCAD and EPANET will be prepare.
6. Finalizing of the project that will contain the report and the needed maps and drawing.

Table 1.1: Phases of the Project With Their Expected Duration

Title	Duration								
	10/10	11/10	12/10	01/11	02/11	03/11	04/11	05/11	06/11
Data collection and survey.									
Design of infrastructure systems (wastewater collection + storm water collection + water network)f.									
Writing the report and preparing maps.									

1.6 Organization Of The Project

The study report has been prepared in accordance with the objectives and scope of work. The report consists of six chapters. The first chapter entitled "Introduction" outlines the problem, project objectives, and phases of the project.

Chapter two entitled "Characteristic of the Project Area" presents basic background data and information on the project area, water supply, wastewater disposal and rainwater quantities.

Chapter three entitled " design Systems" deals with municipal sewage system, types of wastewater collection systems, sewer appurtenances, flow in sewers, design of sewer system, and sewer construction and maintenance, rainwater quantities, types of collection system, flow in pipes, design of storm water collection system, water consumption , quantity of water, tank size and elevation , design of water network.

Chapter four entitled “Analysis and Design” presents the design calculation and maps of the systems.

Chapter five entitled “Bill of quantity” .

Chapter six entitled “Conclusions” discusses the conclusions of the study.

2.1 General

In this chapter, the basic data of Jericho industrial zone city will be briefly discussed. The topography, water consumption, and wastewater production will be briefly presented.

2.2 Project Area

City of Jericho is the oldest town in the world dating back to more than 10 thousand years and is located in (396) meter below sea level, making it the lower town on the globe.

Jericho is in the middle of Palestine surrounded by from north Tubas, from north west Nablus, from east Jordan river, and from south Jerusalem and Dead Sea, Its 36 kilometers east of Jerusalem on the road to Amman, the Jordanian capital, makes the point of intersection with the highway leading to the area of Lake Tiberias in the north (Figure 2.1).

The candidate industrial site is located at the southern part of the Jericho municipality, about 4.5 Km from the city center, consist of a state-owned land let I (11.5 ha) and privately-owned state let II (50 ha) and let III (50 ha) (Figure 2.2) and (Figure 2.3).

The elevation of the candidate site ranges from (288 to 313) meter below the sea level. in the privately-owned land, a Wadi (dried up river) flows from west to east.

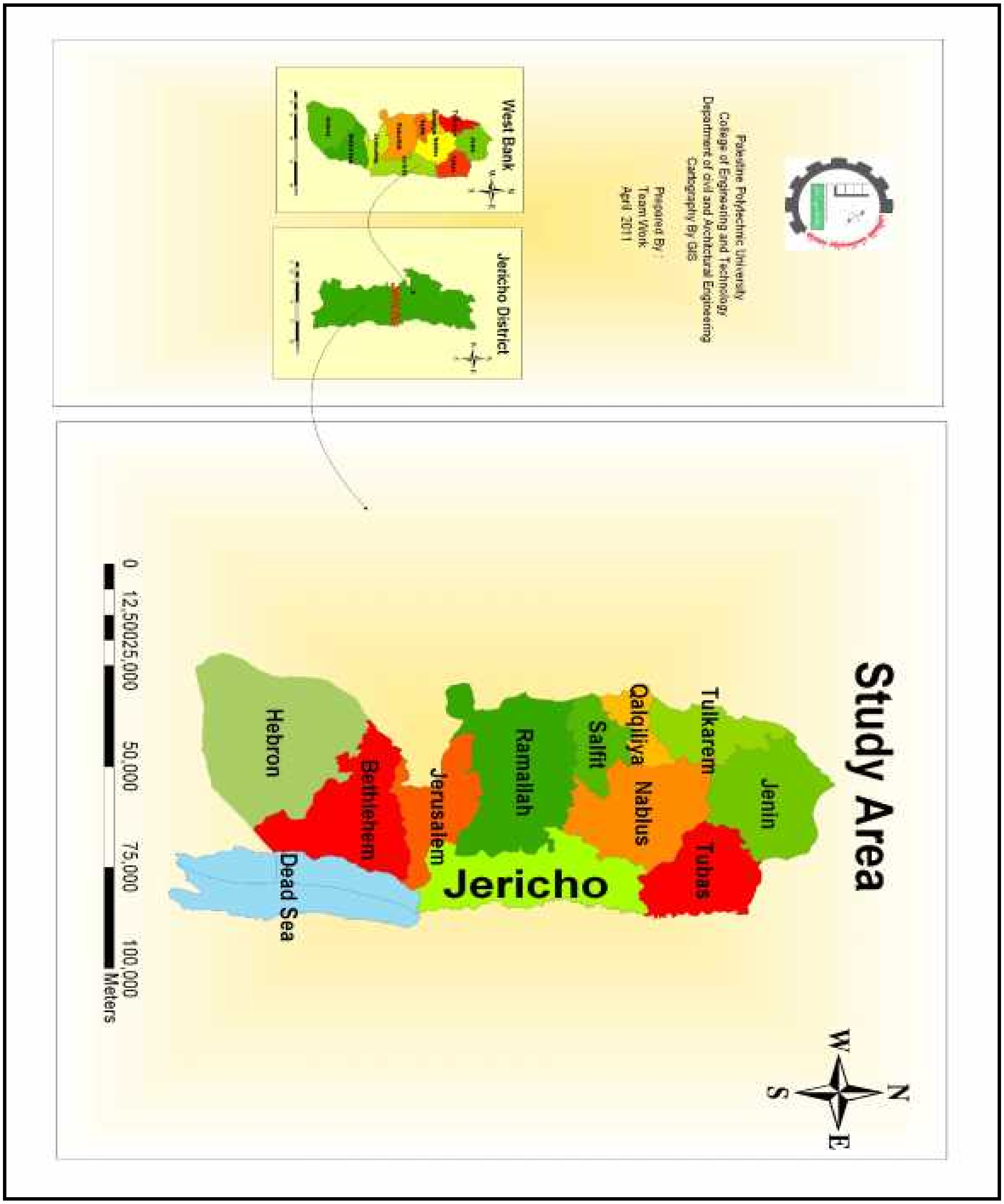

Figure 2.1. Jericho map

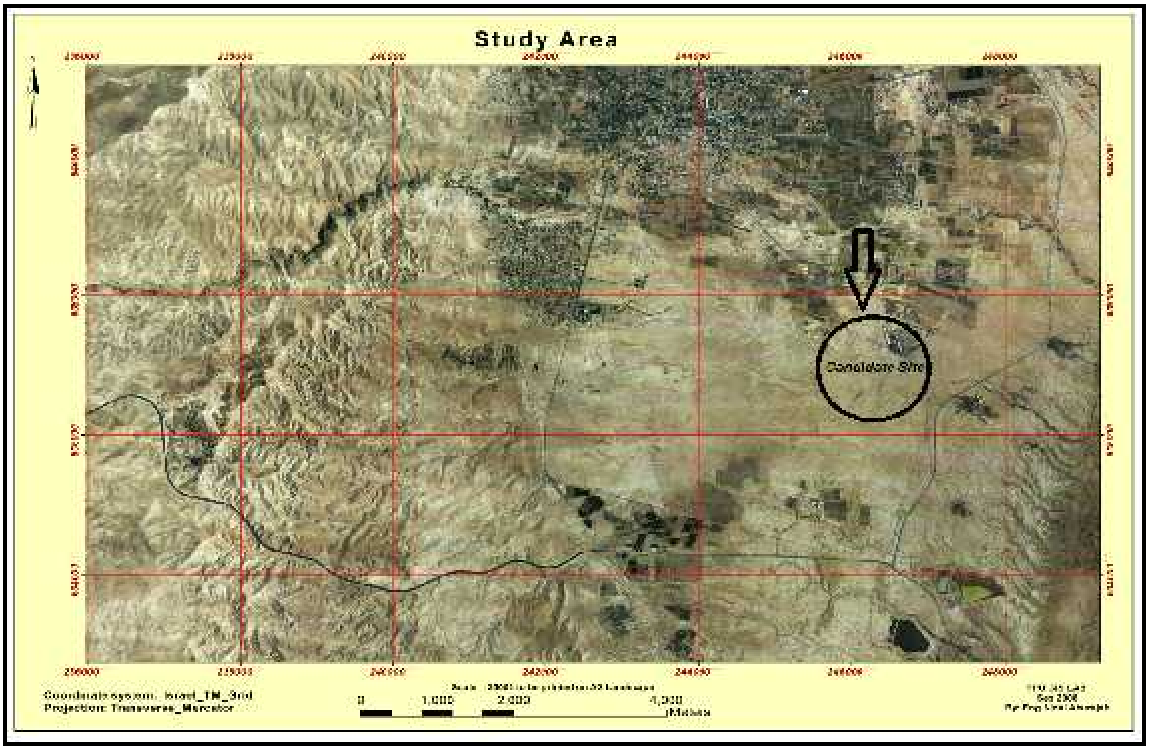

Figure 2.2 location map

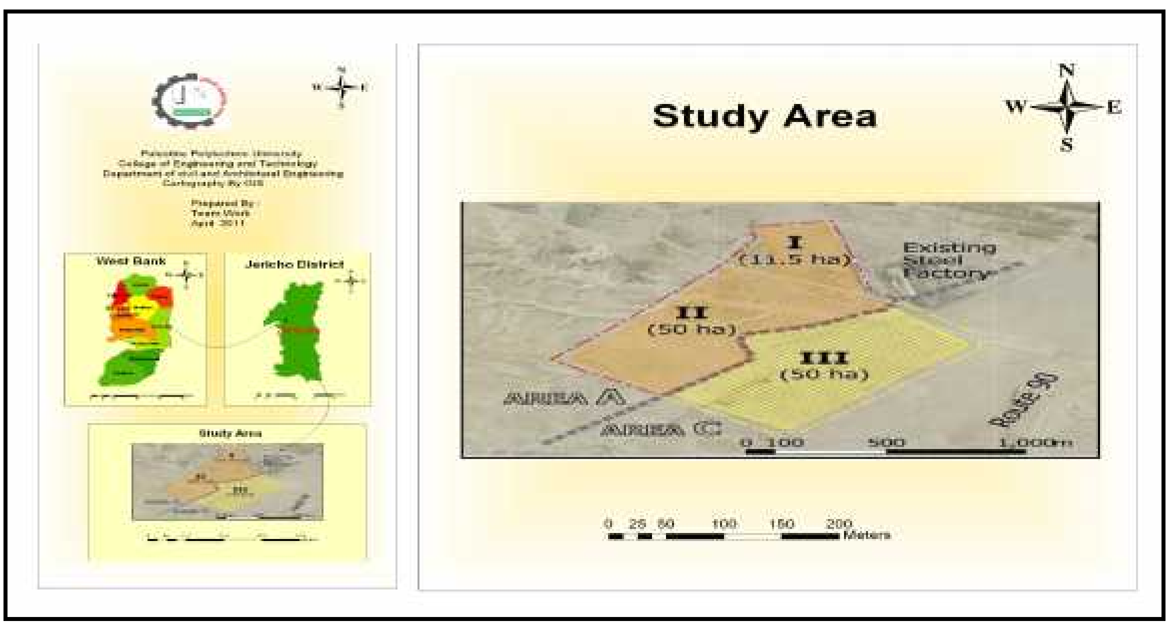

Figure 2.3 location of the candidate site[4]

2.3 Meteorological Data

The hydrology of region depends primarily on its climate, and secondarily on its topography. Climate is largely dependent on geographical position of the earth surface; humidity, temperature, and wind. These factors are affecting evaporation and transpiration. So this study will include needed data about these factors, since they play big role in the determination of water demand.

The climate of Jericho city dry, hot and very different from surrounding areas. the district is part of the Jordanian rift valley which is at (396) m below sea level at the dead sea water surface.

Rainfall

The average annual rainfall at said area reaches lower than (166) mm. Rainfall occurs between October and May while it rarely rains in the summer season from June to September. The monthly rainfall in Jericho is less than the monthly evaporation throughout the year. Table (2.1) shows the monthly rainfall.

Table 2.1 monthly rainfall of Jericho city[8]

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Rainfall (mm)	36	31	25	10	2	0	0	0	0	7	22	33	166

Temperature

The temperature is characterized by considerable variation between summer and winter times. The mean temperature values at Jericho city are given in Table (2.2).

- The mean maximum temperature: 40.0 ^{0}C
- The mean minimum temperature: 18 ^{0}C

Table 2.2 monthly temperature of Jericho city[8]

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Temperature ^{o}C	19	16	27	33	33	37	40	42	36	28	23	18	29

Relative Humidity

The mean annual relative humidity in the Jericho district is 50%. The highest percentage is observed during winter, ranging between 70% and 85% from day time to night time. In summer, the relative humidity ranges between 45% and 65% and reaches as low as 5% at very high temperatures. During spring, the relative humidity is around 30% on average but can reach up to 60%.

Wind

The wind direction in the Jericho City changes from northwest at night, to south in the early morning, with an average speed of 3 m/sec. During spring, the maximum wind speed ranges from 15 m/sec to 20 m/sec. During the rest of the year, the maximum wind speed reaches up to 12 m/sec. It is noted that the Jericho area is known for the Khamaseen or Khamaseeny wind which is a hot, dry, and sandy wind, blowing mainly from the Saudi Arabia.

2.4 Population

Introduction

According to the Palestinian Central Bureau of Statistics (PCBS), the population of Jericho city was approximately 20,416 capita in 2006. Population census was conducted by the PCBS in 2007. Its result was announced in 2008. The city has the lowest population density among the major cities in the West Bank with (69) persons/km^2. This implies that it has a potential for future population expansion.

The population of Jericho Governorate for 2015 and 2025 were estimated in the Master Plan for the Jericho Regional Development, based on the population data in 2005, with an annual average population growth of (2.7%). Estimated population for Greater Jericho for 2010, 2015 and 2025 were (22,830), (25,860) and (37,870), respectively. For the purpose of land use planning, the Jericho population is assumed to reach around (40,000) in 2025.

Population of surrounding the industrial zone

There is a new residential complex development project in Jericho area. Land for the development project is owned by the Palestinian Agricultural Relief Committee (PARC) of Jericho. Based on interviews with Palestinian Agricultural Relief Committee (PARC), the land was sold to (70) private owners.

The area is not developed yet, and most of the owners are from outside the Jericho City. The area is adjacent to the existing Roads 1 and 2, and close to the new vegetables market in Jericho. Thus, residential population in said area will be directly affected by the improvement of the existing roads during construction. The estimated total number of affected residential units is (70-100), with a total population of about (470) residents. Residents use their homes mainly as rest houses for vacation, which are not expected to be occupied for a full design.

2.5 Water Consumption

According to the water consumption data obtained from the previous studies and Jericho municipality, the total water consumption for the industrial zone is approximately (274) cubic meter per day. The total water consumption per dounm is equal 2.4 m^3/d.

2.6 Wastewater Quantity

In general The amount of industrial wastewater produced per capita per day is usually (70-80 %) of water consumption. but The quantity of industrial wastewater produced in Jericho industrial zone will calculated to be 219 m3/day of water consumption.

CHAPTER THREE

DESIGN SYSTEMS

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3.1 WASTEWATER COLLECTION SYSTEM DESIGN

3.1.1 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.

3.1.2 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 polyvinyl chloride or ultra polyuinyl chloride. Concrete and ultra polyvinyl chlorides are the most common materials for sewer construction.

3.1.3 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 into the pressure system. There are no requirements with regard to the gradients of the sewers.

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.

3.1.4 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 35-50 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 35-50 m depending on the size of sewer and available size of sewer cleaning equipment [9].

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 pipe permits workmen to enter the manhole without fear of being wetted, avoid the splashing of sewage and corrosion of manhole bottom [3].

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].

3.1.5 Design Parameters

Flow Rate Projections

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

(1) industrial (2) infiltration. Sanitary sewers are designed for peak flows from industrial, and peak infiltration allowance for the entire service area. The flow rate projections 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:

$$Pf = 1.5 + 2.5 / \sqrt{q} \qquad (3.1)$$

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:

$$V = (1/n)\, R^{2/3}\, S^{1/2} \qquad (3.2)$$

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 50 m.

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 [9].

Important Numbers

- Maximum velocity = 3 m/s
- Minimum velocity = 0.6 m/s
- Maximum slope = 15%
- Minimum slope = 0.5%
- H/D = 50%
- Minimum diameter 200 mm
- Maximum diameter 600 mm
- Minimum cover 1.5 m
- Maximum cover 5 m

After the preliminary sewer layout plan is prepared, the design computations are accomplished. Design computations for sewers are repetitious and therefore, are best performed in a tabular format. Table 3.1 is typical of the way in which data can be organized to facilitate computations for closed system.

Table 3.1 typical calculation of sanitary system

Line Road

Line No	Location			Length	Water consumption	Tributary area		Flow Rates					
	Street Sewer	Upper Mh No	Lower Mh No			Incremental	Total	Industry Average	Industry Peak Factor	Industry Maximum	Infiltration	Total Maximum	Q max
	Name			m	m^3/d.dounm	dounm	dounm	m^3/day		m^3/day	m^3/day	m^3/day	m^3/day
1	2	3	4	5	6	7	8	9	10	11	12	13	14
1													
2													
3													
4													
5													
6													
7													
8													
9													
10													
Σ													

Design Assamptions and data

1) Water comnsumption is	2.4	m3/d.d which	80%	return to sewer	7) Minimum slope Smin =	0.5	%
2) Peak coefficient ec	2				8) Maximum slope Smax =	15	%
3) Infiltration is equal	10	% of the average industrial wastewater flow.			9) Maximum manhole spacing =	50 m	
4) Minimum pipe diameter=	200	mm			10) Minimum depth of sewe	1.5 m	
5) Minimum velocity Vmin =	0.6	m/sec			11) Design depth of flow h/d	0.5	
6) Maximum velocity Vmax =	3	m/sec			12) Maining coefficient n=	0.011	

3.2 STORM DRAINAGE SYSTEM DESIGN

3.2.1 General

Rapid effective removal of storm runoff was a luxury not found in many cities in the early nineteenth century. Today, the modern city dweller has come to think of this as an essential service. Urban drainage facilities have progressed from crude ditches and stepping stones to the present intricate coordinates systems of curbs, gutters, inlets, and underground conveyance.

The design must consider meteorological factors, geomorphologic factors, and the economic value of the land, as well as human value considerations such as aesthetic and public safety aspects of the design. The design of storm water detention basins should also consider the possible effects of inadequate maintenance of the facility

3.2.2 Storm Water Runoff

Storm water runoff is that portion of precipitation which flows over the ground surface during and a short time after a storm. The dependence parameters that controlled the quantity of the storm water which carried by a storm or combined sewer are the surface of the drainage area (A, ha), the intensity of the rainfall (i, l/s.ha), and runoff coefficient C dimensionless (the condition of the surface). There are many methods and formulas to determine the storm flow, and in all of them above parameters show up. One of the most common methods is Rational method which will be discussed below.

Rational Method

The rational method has probably been the most popular method for designing storm systems. It has been applied all over the world and runoff is related to rainfall intensity by the formula,

$$Q = C.i.A \tag{3.3}$$

Where Q = peak runoff rate (l/sec)

C = runoff coefficient, which is actually the ratio of the peak runoff rate to the average rainfall for a period known as the time of concentration.

i = average rainfall intensity, mm/min, for period equal to the time of concentration

A = drainage area, hectar

For small catchments areas, it continues to be a reasonable method, provided that it is used properly and that results and design concepts are assessed for reasonableness. This procedure is suitable for small systems where the establishment of a computer model is not warranted.

The steps in the rational method calculation procedure are summarised below:

1. The drainage area is first subdivided into sub-areas with homogeneous land use according to the existing or planned development.

2. For each sub-area, estimate the runoff coefficient *C* and the corresponding area *A*.

3. The layout of the drainage system is then drawn according to the topography, the existing or planned streets and roads and local design practices.

4. Inlet points are then defined according to the detail of design considerations. For main drains, for example, the outlets of the earlier mentioned homogeneous sub-areas should serve as the inlet nodes. On the other hand in very detailed calculations, all the inlet points should be defined according to local design practices.

5. After the inlet points have been chosen, the designer must specify the drainage sub-area for each inlet point A and the corresponding mean runoff coefficient *C*. If the

sub-area for a given inlet has non-homogeneous land use, a weighted coefficient may be estimated.

6. The runoff calculations are then done by means of the general rational method equations for each inlet point, proceeding from the upper parts of the watershed to the final outlet. The peak runoff, which is calculated at each point, is then used to determine the size of the downstream trunk drain using a hydraulic formula for pipes flowing full.

7. After the preliminary minor system is designed and checked for its interaction with the major system, reviews are made of alternatives, hydrological assumptions are verified, new computations are made, and final data obtained on street grades and elevations. The engineer then should proceed with final hydraulic design of the system.

Runoff Coefficient, C

Runoff coefficient is a function of infiltration capacity, interception by vegetation, depression storage, and evapotranspiration. It is requires greatest exercise of judgment by engineer and assumed constant, actually variable with time. It is desirable to develop composite runoff coefficient (weighted average) for each drainage area as:

$$C = \frac{\sum Ci.Ai}{\sum Ai} \qquad (3.4)$$

Where Ai = i th area.

Ci = i th runoff coefficient.

The range of coefficients with respect to general character of the area is given in the following tables (Table 3.2 and Table 3.3).

Table 3.2 The Range of Coefficient With Respect to General Character of the Area [12]

Description of Area	Runoff Coefficients
Business	
Down town Neighborhood	0.70 to 0.95 0.50 to 0.70
Residential	
Single-Family Multi-unit, detached Multi-unit, attached	0.30 to 0.50 0.40 to 0.60 0.60 to 0.75
Residential (suburban)	0.25 to 0.40
Apartment	0.50 to 0.70
Industrial	
Light Heavy	0.50 to 0.80 0.60 to 0.90
Parks, Cemeteries	0.10 to 0.25
Playground	0.20 to 0.35
Railroad yard	0.20 to 0.35
Unimproved	0.10 to 0.30

Table 3.3 The Range of Coefficient With Respect to Surface Type of the Area[12]

Character of Surface	Runoff Coefficients
Pavement	
Asphalt and concrete	0.70 to 0.95
Brick	0.70 to 0.85
Lawns, Sandy soil	
Flat, 2 percent	0.05 to 0.10
Average,2to7percent	0.10 to 0.15
Steep, 7 percent	0.15 to 0.20
Roofs	0.75 to 0.95
Lawns, heavy soil	
Flat, 2 percent	0.13 to 0.17
Average,2 to 7percent	0.18 to 0.22
Steep, 7 percent	0.25 to 0.35

Rainfall Intensity, i

In determining rainfall intensity for use in rational formula it must be recognized that the shorter the duration, the greater the expected average intensity will be. The critical duration of rainfall will be that which produces maximum runoff and this will be that which is sufficient to produce flow from the entire drainage area. Shorter periods will provide lower flows since the total area is not involved and longer periods will produce lower average intensities. The storm sewer designer thus requires some relationship between duration and expected intensity. Intensities vary from place to another and curves or equations are specified for the areas for which they were developed.

The rainfall intensity depends on many factors through which we can do our calculations; we can list these factors as follow:

1. Average frequency of occurrence of storm (1/n) or (f).

Average frequency of occurrence is the frequency with which a given event is equaled or exceeded on the average, once in a period of years. Probability of occurrence, which is the reciprocal of frequency, (n) is preferred by sum engineers. Thus, if the frequency of a rain once a 5-year (1/n=5), then probability of occurrence n=0.20. Selection of storm design rain frequency based on cost-benefit analysis or experience. There is range of frequency of often used:

a. Residential area: f = 2 to 10 years (5 year most common).

b. Commercial and high value districts: f = 10 to 50 (15 year common).

c. Flood protection: f = 50 year.

2. Intensity, duration and frequency characteristics of rainfall.

Basic data derived from gage measurement of rainfall (Point rainfall) over a long period can be used to obtain a rainfall height diagram that show the relation between the height of rain (mm) and time (min). The slope of the curve or rain height per unit time is defined as rain intensity:

i= (Δ height of rain / Δ time) $\left[\frac{mm}{\min}\right]$

The rain intensity in liter per second . hectare is equal:

$$i(\frac{l}{s.ha}) = 166.7i\left[\frac{mm}{\min}\right]$$

in order to drive intensity-duration-frequency curves long-term observation of rainfall is needed. Analysis of such observation is given in any text in sanitary engineering.

3- Time of Concentration

The time of concentration is the time required for the runoff to become established and flow from the most remote part (in time) of the drainage area to the point under design.

$$t_c = t_i + t_f \qquad (3.5)$$

Where t_c: time of concentration.

t_i: inlet time.

t_f: flow time.

Time of flow in storm, $t_f = \frac{\text{Length of pipe line (L)}}{\text{Velocity of flow (v)}}$

Inlet time (t_i): is the time required for water to flow over ground surface and along gutters to drainage inlet. Inlet time is function of rainfall intensity, surface slope, surface roughness, flow distance, and infiltration capacity and depression storage.

3.2.3 Hydraulic Consideration

Introduction

storm water usually designed as open channels except where lift stations of the flows, and the fact that an unconfined or free surface exists. The driving are required to overcome topographic barriers. The hydraulic problems associated with these flows are complicated in some cases by the quality of the fluid, the highly variable nature force for open-channel flow and sewer flow is gravity. For the hydraulic calculations of sewers, it is usually assumed uniform flow in which the velocity of flow is constant, and steady flow condition in which the rate discharge at any point of a sewer remains constant [6].

Hydraulic design equations

In principle all open channel flow formulas can be used in hydraulic design of sewer pipes. The following are the most important formulas:

1. Chezy's formula:

$$V = C\sqrt{RS} \tag{3.6}$$

Where V: the velocity of flow (m/s).

C: the Chezy coefficient; $C = \dfrac{100\sqrt{R}}{m+\sqrt{R}}$, where m = 0.35 for concrete pipe or 0.25 for vitrified clay pipe

R: the hydraulic radius (m)

S: the slope of the sewer pipe (m/m).

2. Darcy-Weisbach formula: It is not widely used in wastewater collection design and evaluation because a trial and error solution is required to determine pipe size for a given flow and head loss, since the friction factor is based on the relative roughness which involves the pipe diameter, making it complicated. Darcy-Weishbach formula states that

$$H = \lambda \frac{L \times V^2}{D \times 2g} \tag{3.7}$$

Where H: the pressure head loss (mwc).

L: the length of pipe (m).

D: the diameter of pipe (m)

λ : the dimensionless friction factor generally varying between 0.02 to 0.075.

3. The Manning formula: Manning's formula, though generally used for gravity conduits like open channel, it is also applicable to turbulent flow in pressure conduits and yields good results, provided the roughness coefficient n is accurately estimated. Velocity, according to Manning's equation is given by:

$$V = (1/n)\ R^{2/3} S^{1/2} \tag{3.8}$$

Where n: the Manning's roughness coefficient [1/n (k_{str}) = 75 m/$s^{1/3}$].

R: the hydraulic radius = area /wetted perimeter (R = A/P)

- For circular pipe flowing full, R= (D/4).
- For open channel flowing full, R= [(b*d)/ (b+2d)].

The Manning's roughness coefficient depends on the material and age of the conduit. Commonly used values of n for different materials are given in Table (3.4).

Table 3.4 Common Values of Roughness Coefficient Used in the Manning Equation [12]

Material	Commonly Used Values of n
Concrete	0.013 and 0.015
Vitrified clay	0.013 and 0.015
Cast iron	0.013 and 0.015
Brick	0.015 and 0.017
Corrugated metal pipe	0.022 and 0.025
Asbestos cement	0.013 and 0.015
Earthen channels	0.025 and 0.003
PVC	0.011

Hydraulics of Partially Field Section

The filling rate of a sewer is an important consideration, as sewers are seldom running full, so storm water sewers designed for 70% running full, that is means only 70% of the pipe capacity should be utilized to carry the peak flow.

Partially filled sewers are calculated by using partial flow diagram and tables indicating the relation between water depth, velocity of flow and rate flow .The hydraulic characteristics are similar as for open channels, but the velocity of flow is reduced by increased air friction in the pipe with increasing water level, particularly near the top of the pipe. The velocity of flow and the flow rate are reduced at filling rates between 60% and 100%; the water level in the pipe is unstable at filling rates above 90% or 95%.

3.2.4 Storm Water Sewers Design

Designing a community storm system is not a simple task. It requires considerable experience and a great deal of information to make proper decisions concerning the layout, sizing, and construction of a storm network that is efficient and cost-effective. The design engineer needs to generally undertake the following tasks [9]:

1. Define the service area.
2. Conduct preliminary investigations.
3. Develop preliminary layout plan and profile.
4. Selection of design parameters.
5. Review construction considerations.
6. Conduct field investigation and complete design and final profiles

Service Area

Service area is defined as the total area that will eventually be served by the drainage system. The service area may be based on natural drainage or political boundaries, or both. It is important that the design engineers and project team become familiar with the surface area of the proposed project.

Preliminary Investigation

The design engineer must conduct the preliminary investigations to develop a layout plan of the drainage system. Site visits and contacts with the city and local planning agencies and state officials should be made to determine the land use plans, zoning regulations, and probable future changes that may affect both the developed and undeveloped land. Data must be developed on topography, geology, hydrology, climate, ecological elements, and social and economic conditions. Topographic maps with existing and proposed streets and other utility lines provide the most important information for preliminary flow routing [9].

If reliable topographic maps are not available, field investigations must be conducted to prepare the contours, place bench marks, locate building, utility lines, drainage ditches, low and high areas, stream, and the like. All these factors influence the sewer layout.

Layout Plan

Proper storm sewer layout plan and profiles must be completed before design flows can be established. The following is a list of basic rules that must be followed in developing a sewer plan and profile.

1. Select the site for disposal of the storm water at the end of the network, generally the lowest elevation of the entire drainage area.
2. The preliminary layout of storm sewers is made from the topographic maps. In general, sewers are located on streets, or on available right-of-way; and sloped in the same direction as the slope of the natural ground surface.
3. The trunk storm sewers are commonly located in valleys. Each line is started from the intercepting sewer and extended uphill until the edge of the drainage area is reached, and further extension is not possible without working downhill.
4. Main storm sewers are started from the trunk line and extended uphill intercepting the laterals.
5. Preliminary layout and routing of storm sewage flow is done by considering several feasible alternatives. In each alternative, factors such as total length of storm sewers, and cost of construction of laying deeper lines versus cost of construction, operation, and maintenance of lift station, should be evaluated to arrive at a cost- effective drainage system.
6. After the preliminary storm sewer layout plan is prepared, the street profiles are drawn. These profiles should show the street elevations, existing storm sewer lines, and manholes and inlets. These profiles are used to design the proposed lines.

Finally, these layout plans and profiles are revised after the field investigations and storm sewer designs are complete. [10]

Selection of Design Parameters

Many design factors must be investigated before storm sewer design can be completed. Factors such as design period; peak, average, and minimum flow; storm sewer slopes and minimum velocities; design equations …etc. are all important in developing storm sewer design. Many of the factors are briefly discussed below.

1. Design Flow Rate

   Storm water sewers should be designed to carry the largest storm that occurred in the period of design; commonly it is 5 years because of consideration of the cost and the frequently factors.

2. Minimum Size

   The minimum storm sewer size recommended is 250 to 300 mm for closed system, and for open channel depend on the type of profile that selected.

3. Minimum and Maximum Velocities

   In storm water sewers, solids tend to settle under low-velocity conditions. Self-cleaning velocities must be developed regularly to flush out the solids. Most countries specify minimum velocity in the sewers under low flow conditions. The minimum allowable velocity is 0.75 m/s, and 0.9 m/s is desirable. This way the lines will be flushed out at least once or twice a day. The maximum velocities for storm water system are between 4 to 6 m/s. The maximum velocity is limited to prevent the erosion of sewer inverts.

4. Slope

   For closed system minimum slopes determined from minimum velocities, for minimum velocity 1 m/s, the slopes are shown in Table (3.5).

Table 3.5 Minimum Recommended Slopes of Storm Sewer (n = 0.015) [12]

Pipe Diameter (D)		Slope (min)	Slope (max) =1/D
Mm	Inch	Mm	Cm
250	10	0.00735	0.04
300	12	0.00576	0.033
450	18	0.00336	0.0222
600	24	0.00229	0.0167

Note: for a velocity of 0.75m/s the slopes shown above should be multiplied by 1.56.

Maximum slopes determined from maximum velocities, 1/D (cm) can be used as a guide. For open channel, the slope also depends on the profile type, and generally used as the slope of the road.

5. Depth

The depth of storm sewers when using closed system is generally just enough to receive flow but not less than 1 m below the ground surface. Depth depends on the water table, lowest point to be served, topography, and the freeze depth. But for the open channel it is at the ground surface.

6. Appurtenances

Storm Sewer appurtenances include manholes, inlets, outlets and outfall, and others. Appropriate storm sewer appurtenances must be selected in design of storm water sewers.

7. Design Equations and Procedures

Storm water sewers are mostly designed to flow partially full. Once the peak, average, and minimum flow estimates and made general layout and topographic features for each line are established, the design engineer begins to size the sewers. Design equations proposed by Manning, Chezy, Gangullet, Kutter, and Scobey have been used for designing sewers and drains. The Manning equation, however, has received most widespread application. This equation is expressed below:

$$V = (1/n)\ R^{2/3} S^{1/2} \tag{3.2}$$

And as mentioned earlier, the runoff flow is calculated using the following formula:

$$Q = C.i.A \tag{3.3}$$

Various types of nomographs have been developed for solution of problems involving sewers flowing full. Nomographs based on Manning's equation for circular pipe flowing full and variable n values are provided in Figure 3.1. Hydraulic elements of circular pipes under partially-full flow conditions are provided in Figure 3.2. It may be noted that the value of n decreases with the depth of flows Figure 3.1. However, in most designs n is assumed constant for all flow depths. Also, it is a common practice to use d, v, and q notations for depth of flow, velocity, and discharge under partial flow condition while D, V, Q notations for diameter, velocity, and discharge for sewer flowing full. Use of equations 3.3 and 3.8 and (Figures 3.1 and 3.2), one can design the drainage system.

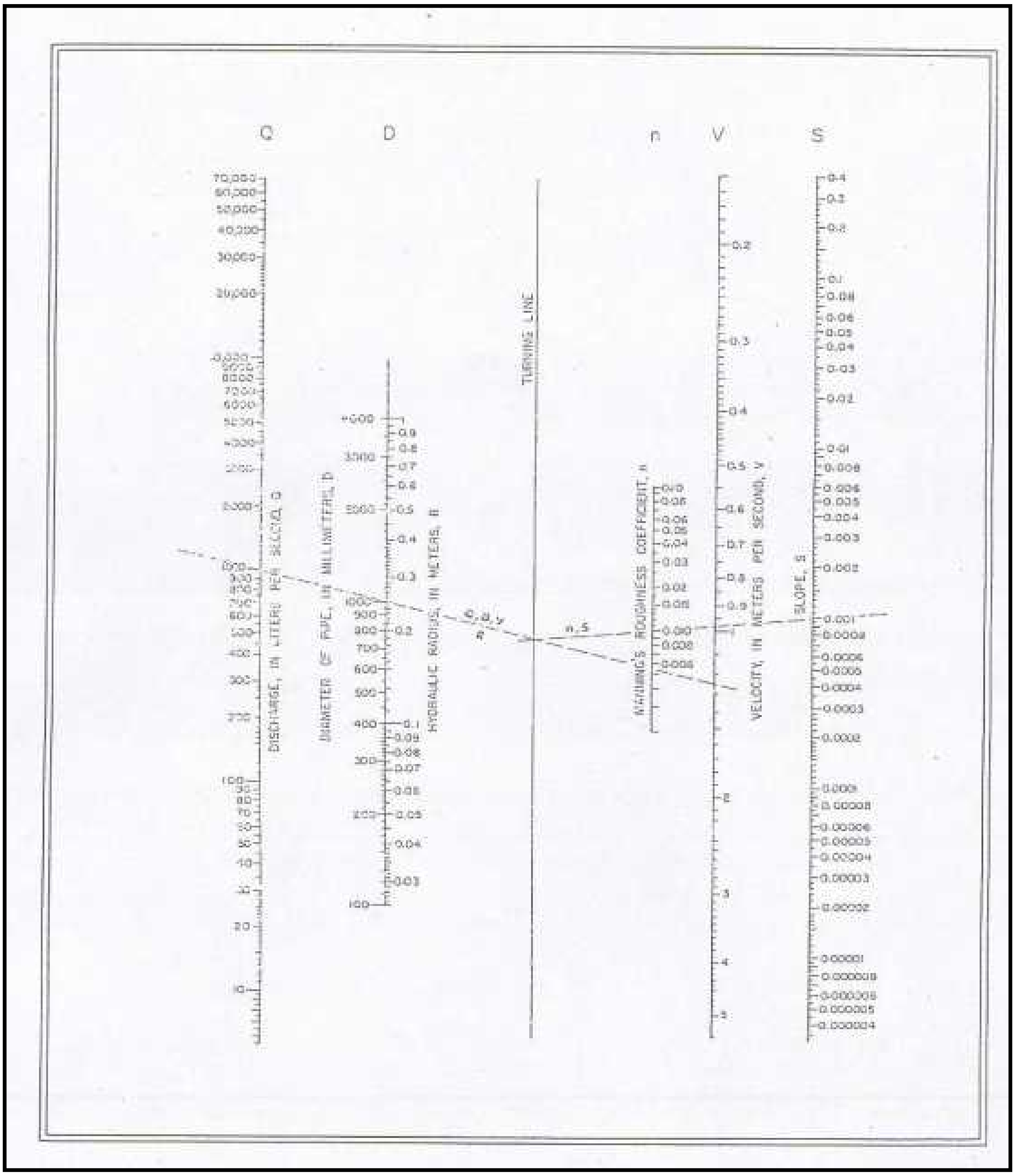

Figure 3.1 nomograph for solution of maining formula[1]

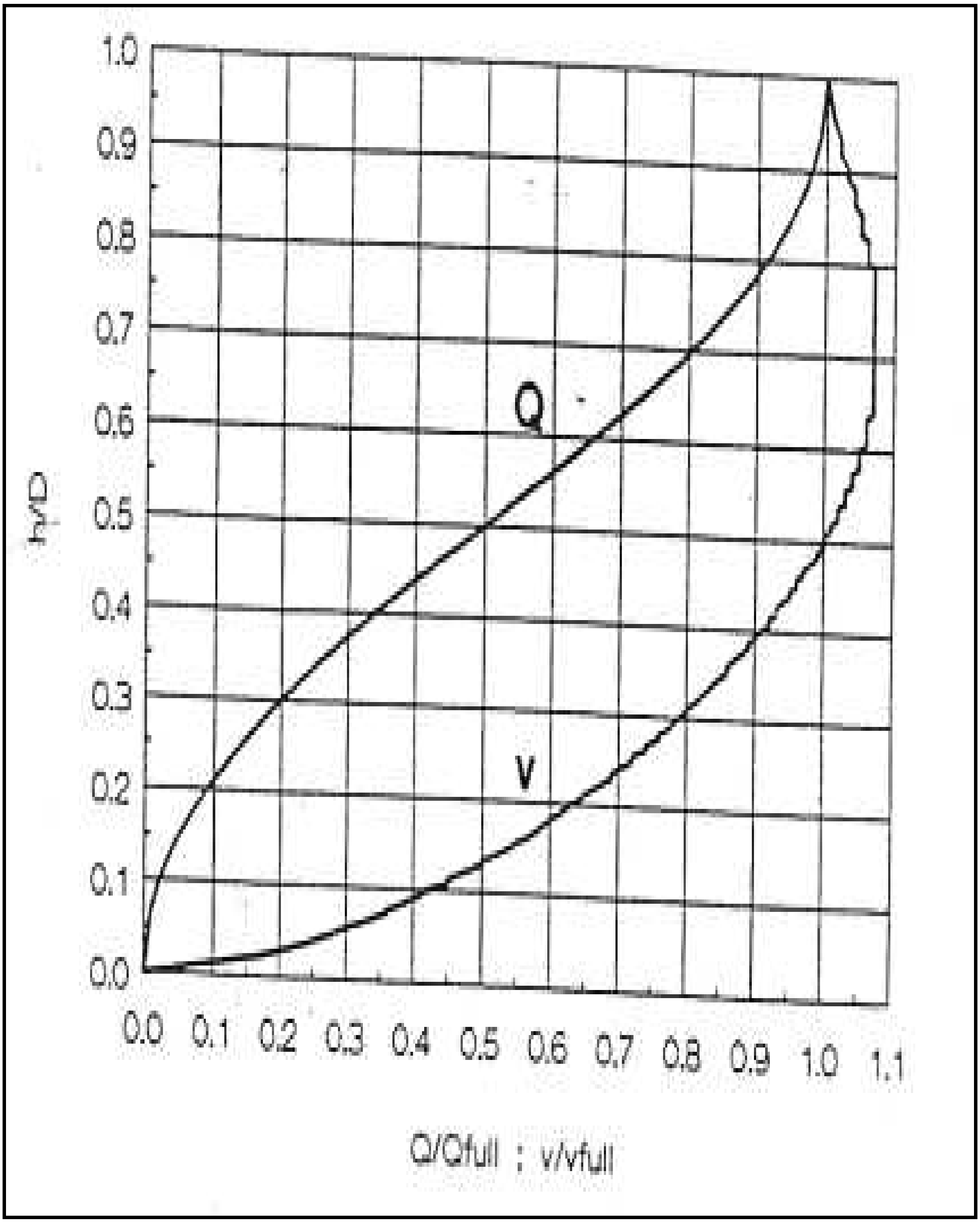

Figure 3.2 hydraulic properties of circular sewer[1]

Design Computation

After the preliminary sewer layout plan and profile are prepared, the design computations are accomplished. Design computations for sewers are repetitious and therefore, are best performed in a tabular format. Table 3.6 is typical of the way in which data can be organized to facilitate computations for closed system.

Preparation of Maps and Profile

It is important that the detailed drawings be prepared and specifications completed before the bide can be requested. The contract drawings should show (1) surface features, (2) depth and character of material to be excavated, (3) the existing structures that are likely to be encountered, and (4) the details of sewer and appurtenances to be constructed.

Important Numbers

- Maximum velocity = 5 m/s
- Minimum velocity = 1 m/s
- Maximum slope = 15%
- Minimum slope = 0.5%
- H/D = 70%
- Minimum Diameter 250-300 mm
- Minimum cover 1 m
- Maximum cover 5 m

Table 3.6 typical StormWater Design Computations

Line Road **B**

NUMBER	LOCATION			LENGTH	LENGTH COMULATIVE	AREA of Street and industry	C FACTOR Street and industry	C.A	SUM(AC) COMULATIVE	Tc	(i)	(I)	Q	Qi
	LINE NAME	UPPER MH. NO.	LOWER MH. NO.	(m)	(m)	(ha)		(ha)	(ha)	(min)	(mm/hr)	(l/s.ha)	(l/s)	(l/s)
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1														
2														
3														
4														
5														

3.3 WATER DISTRIBUTION SYSTEMS

3.3.1 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 section to explain these elements.

3.3.2 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:

1. 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.
2. Sub-mains: Smaller pipes connected to mains and supplies water to service pipes.
3. Service pipes: The pipes which supply water to consumers, houses, flats, and farms and connect to mains and sub-main pipes.
4. 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.

3.3.3 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.

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 (Figure 3.3). Proper selection and installation of joints and fittings is very important because they are often source of leakage [13].

Figure 3.3 Pipe Fittings [13]

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 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.

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.

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 [2].

Fire Hydrants

Fire hydrants are constructed in many different versions. They are generally distinguished as underground or ground installations. Underground 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) [2].

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.

3.3.4 SERVICE RESERVOIRS

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.

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.

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, balancing storage, emergency storage, and fire storage.

3.3.5 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.

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:

   - Centrifugal pumps
   - 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 :

   - The reciprocating pump
   - 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.

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 :

1. Capacity of pumps
2. Importance of water supply scheme
3. Initial cost of pumping arrangement
4. Maintenance cost
5. Space requirements for locating the pump
6. Number of units required
7. Total lift of water required
8. Quantity of water to be pumped

3.3.6 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 [13].

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.

Important Numbers

- Maximum velocity = 3 m/s
- Minimum velocity = 0.2 m/s
- Maximum pressure head = 90 m
- Minimum pressure head = 10m
- Minimum Diameter 25 mm (1")

CHAPTER FOUR

ANALYSIS AND DESIGN

4.1 ANALYSIS AND DESIGN FOR WASTEWATER COLLECTION SYSTEM

4.1.1 INTRODUCTION

4.1.2 LAYOUT OF SYSTEM

4.1.3 DESIGN COMPUTATION

4.1.4 THE PROPOSED WASTE WATER COLLECTION SYSTEM

4.1.5 PROFILE OF WASTE WATER PIPES

4.2 ANALYSIS AND DESIGN FOR STORM DRAINAGE COLLECTION SYSTEM

4.2.1 INTRODUCTION

4.2.2 LAYOUT OF SYSTEM

4.2.3 DESIGN COMPUTATION

4.2.4 THE PROPOSED STORM DRAINAGE COLLECTION SYSTEM

4.2.5 PROFILE OF DRAINAGE PIPES

4.3 ANALYSIS AND DESIGN FOR WATER NET WORK

4.3.1 INTRODUCTION

4.3.2 METHOD OF CALCULATION

4.3.3 NETWORK DESIGN

4.3.4 THE PROPOSED MAIN NETWORK

ANALYSIS AND DESIGN
FOR WASTEWATER COLLECTION SYSTEM

4.1.1 Introduction

In this project, design of wastewater collection system for Jericho industrial zone is made, and develop a future plans for construction of the collection system, corresponding to the vision of Jericho municipality about their future industrial zone, in order to reduce the problem causes by missing this important part of city infrastructure.

In this section, the layout of the system established is presented, and the computation procedures and tables are given along the drawings of layout and profiles for all the lines designed.

4.1.2 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 Drawing (D2, D3) in appendix B. Where part of the drainage area to be served is undeveloped and proposed development plans are not yet available , care must be taken to provide adequate terminal manholes that can later be connected to the system constructed serving the area .

In establishing the layout of wastewater collection system for Jericho area, the following basic steps were followed:

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

2. Locate the drainage outlet. This is usually near the lowest point in the area and is often along a stream or drainage way. In Jericho industrial zone, the lowest point is in the southern part of the zone.
3. Sketch in preliminary pipe system to serve all the contributors.
4. 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.
5. 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 paralleling streams or channels.
6. Establish preliminary pipe sizes. Eight inches pipe size (usually the minimum allowable) can serve several hundred residences even at minimal grades.
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.

The final layout of wastewater collection system for Jericho industrial zone is illustrated in (Figure 4.1) and drawing (D4, D5) in appendix B.

Figure 4.1 A3 sanitary

4.1.3 Design Computations

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, subject to the appropriate design constrains. The design computations in the example given below.

Design example: Design a gravity flow sanitary sewer

Design a gravity flow trunk sanitary sewer for the area to outfall (line B) in (Figure 4.1). Assume that the following design criteria have been developed and adopted based on an analysis of local conditions and codes.

1. For water consumption uses 2.4 m^3/d.dounm.
2. The wastewater calculates as 80% of the water consumption.
3. For infiltration allowance use 10% of the domestic sewerage flow.
4. For the hydraulic design equation use the Manning equation with n value of 0.011.

Solution

1. Lay out the trunk sewer. Draw a line to represent the proposed sewer (Figure 4.1).
2. Locate and number the manholes. Locate manholes at (1) change in direction, (2) change in slope, (3) pipe junctions, (4) upper ends of sewers, and (5) intervals from 35 to 50 m or less. Identify each manhole with a number.
3. Prepare a sewer design computation table. Based on the experience of numerous engineers, it has been found that the best approach for carrying out sewer computations is to use a computation table. The necessary computations for the sanitary sewer are presented in (Table 4.1). The data in the table are calculated as follow:
   a. The entries in columns 1 and 2 are used to identify the line numbers and street sewer name.

b. The entries in columns 3 through 5 are used to identify the sewer manholes, their numbers and the spacing between each two manholes.
c. The entries in column 6 used water consumption. Water consumption = water demand in cubic meter per day divided area in dounm.
d. The entries in columns 7 and 8 are used tributary area, column 7 used incremental area, column 8 used total area in dounm.
e. To calculate industry maximum flow rates columns 9, 10,11,12 are used. Column 9 is industry average sewage flow (80%*water consumption*total area), Column 10 peak factor which is taken as 2, Column 11 represents the Maximum industrial (Q) in (m^3/day), the value of it is obtained from multiplying column 9 by column 10. Column 12 gives the infiltration allowance, which equal (0.10 * Column 9).
f. The entries in columns 13 (total maximum flow rate) is calculated by sum the Column 11 and Column 12.
g. The entries in column 14 is Q max separately (not cumulative).

Table 4.1. Sanitary Sewer Design Computations

Line Road B

Line No	Location			Length	Water consumption	Tributary area		Flow Rates					
	Street Sewer Name	Upper Mh No	Lower Mh No			Incremental	Total	Industry			Infiltration	Total Maximum	Q max
								Average	Peak Factor	Maximum			
				m	m^3/d.dounm	dounm	dounm	m^3/day		m^3/day	m^3/day	m^3/day	m^3/day
1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	road B	c1	b1	39.5498	2.4	5.80	5.80	11.14	2.00	22.28	1.11	23.39	23.39
2	road B	b1	b2	40	2.4	3.07	8.88	17.04	2.00	34.08	1.70	35.79	12.39
3	road B	b2	b3	40	2.4	2.99	11.86	22.78	2.00	45.55	2.28	47.83	12.04
4	road B	b3	b4	40	2.4	2.77	14.63	28.10	2.00	56.19	2.81	59.00	11.17
5	road B	b4	b5	40	2.4	2.74	17.37	33.36	2.00	66.71	3.34	70.05	11.05
6	road B	b5	b6	33.42	2.4	2.63	20.00	38.41	2.00	76.81	3.84	80.65	10.61
7	road B	b6	a1	26.1	2.4	2.61	22.61	43.41	2.00	86.82	4.34	91.16	10.51
∑				264.07									

Design Assamptions and data

1) Water comsumption is	2.4	m3/d.d which	80%	return to sewer	7) Minimum slope Smin =	0.5	%
2) Peak coefficient equa	2				8) Maximum slope Smax =	15	%
3) Infiltration is equal	10	% of the average industrial wastewater flow.			9) Maximum manhole spacing =	50	m
4) Minimum pipe diameter=	200	mm			10) Minimum depth of sewer	1.5	m
5) Minimum velocity Vmin =	0.6	m/sec			11) Design depth of flow h/d =	0.5	
6) Maximum velocity Vmax =	3	m/sec			12) Maining coefficient n=	0.011	

4.1.4 The Proposed Waste Water Collection System

In the proposed study for the WasteWater Collection System for Jericho industrial zone, the trial is made to design the main trunks of the collection system. This section deals with the results of the wastewater collection system.

Manholes number , pipes lengths, water consumption, areas, industrial wastewater quantities are found doing the calculations given in the previous section and are given in tables (1 -4) in appendix A**.**

The appropriate pipe diameters, lengths and slopes, and location of the manholes are found doing the calculations on the sewerCAD software program. During and once the sewer design computations have been completed, alternative alignments have be examined, and the most cost and energy effective alignment has Collection System for the area, slopes ,lengths of the pipes ,the calculated velocities and flow rates are given in Tables (5-12) in Appendix-A.

4.1.5 Profiles Of Waste water Pipes

The profiles of sewer area assist in the design and are used as the basis of construction drawings. The profile is usually prepared for pipe sewer line at a horizontal and vertical scale. The profile shows the ground or street surface, inlets locations, elevation of street surface, pipe surface, pipe basement.

After all the calculation is completed and all the maps of the proposed waste water collection system are prepared, detailed profile for sewer pipe line is drawn. The profile of sewer pipe line is shown in Drawing (D6 – D12) in Appendix-B. This profile has shown the ground elevation, the proposed sewer pipe line.

ANALYSIS AND DESIGN FOR
STORM DRAINAGE COLLECTION SYSTEM

4.2.1 Introduction

In this project, design of storm water drainage system for the Jericho industrial zone, in order to solve the problem causes by the cumulative flooded storm water in the streets.

In this section, the layout of the system established will be presented followed by discussion of detailed design computations and the final design and profile of the suggested storm water drainage system.

4.2.2 Layout Of The System

The first step in designing a storm water drainage system is to establish an overall system layout that includes a plan of the area, showing roads, streets, buildings, other utilities, topography.

In suggesting the layout of storm water drainage system for the Jericho zone area, the following basic steps were followed:

1. Obtain a topographic map of the area to be served.
2. Locate the catchment of the site and determine the area of these catchment.
3. Sketch in preliminary closed pipe system to serve the area.
4. Sewer layout is followed natural drainage ways so as to minimize excavation and pumping requirements.
5. Establish preliminary pipe diameter that can drain the required water runoff.
6. Revise the layout so as to optimize flow-carrying capacity at minimum cost.

The final layout of storm water drainage system for Jericho zone is illustrated in (Figure 4.2) and drawing (D13, D14) in appendix B.

FIGURE A3 4.2 storm

4.2.3 Design Computations

The detailed design of storm water sewers involves the selection of appropriate pipe diameters and slopes to transport the quantity of storm water from the surrounding and upstream areas to the next pipe in series, subject to the appropriate design constrains. The design computations and procedure for design storm water drainage system for Jericho zone using sewerCAD is illustrated in the design example given below.

Design Example: **Design a gravity flow storm water drainage pipe:**

Design a gravity flow storm water drainage pipe for the area Jericho industrial zone shown in the accompanying (Figure 4.2). Assume that the following design criteria have been developed and adopted based on an analysis of local conditions and codes.

1. For weighted Runoff coefficient (C) use 0.5
2. For Inlet time (Ti) use 5 minutes
3. For Concentration time (T_c) use equations

$$T_c = t_i + t_f \qquad (3.5)$$

4. For Runoff rate depending on the formula:

$$Q = C.i.A \qquad (3.3)$$

5. for Rainfall intensity use (Figure 4.3).

(Figure 4.3). presents the typical rainfall intensity-duration curve.

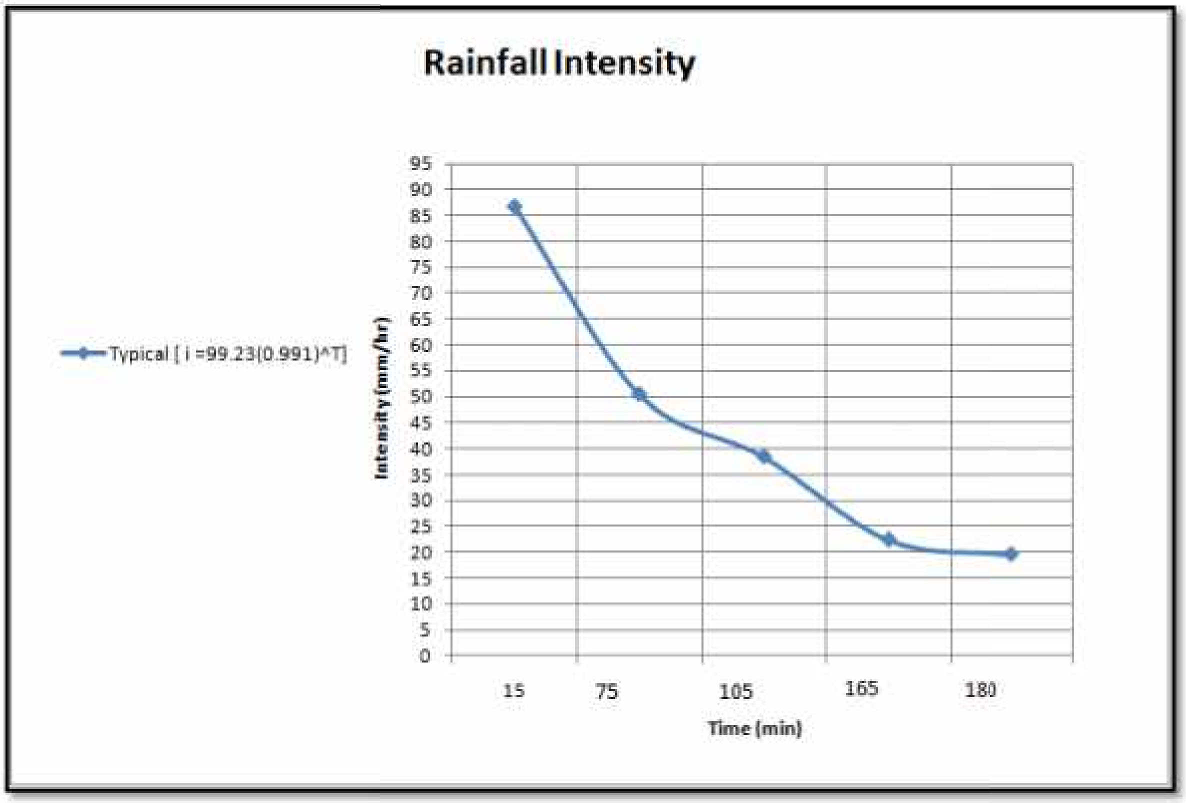

Figure 4.3 rainfall intensity [8]

Solution

1. Lay out the storm water sewer. Draw a line to represent the proposed sewer (See Figure 4.2) and (D13, D14) in appendix B.
2. Locate and number the upper and lower points of the line B.
3. The necessary computations for the storm water sewer shown in Figure presented in the (Table 4.2). The data in the table are calculated as follow:

a. The entries in columns 1 through 6 are used to identify the point locations, their numbers and the length between them.

b. The entries in columns 7 used to identify the sewered area, column 7 shows the partial sewered area in hectare.

c. The entries in columns 8 through 14 are used to calculate the design flow. Runoff coefficient (C) is entered in column 8. The partial sewered area in hectare is multiplied by runoff coefficient (C) and the result is given in column 9. The cumulative multiplication of the sewered area in hectare is multiplied by runoff coefficient (C) are given in column 10. The concentration time is shown in column 11 and rainfall intensity (mm/hr) is shown in column 12, rainfall intensity (l/s.ha) is shown in column 13 its calculated by dividing column 12 over 60 minutes and then multiplying by 166.67, Column 14 shows runoff rate (Q) which obtained by multiply column 10 by column 13, Column 15 shows the runoff rate (Qi) in (l/s) separately between two inlets.

Table 4.2. StormWater Design Computations

Line Road B

NUMBER	LOCATION			LENGTH	LENGTH COMULATIVE	AREA of Street and industry	C FACTOR Street and industry	C.A STREET	SUM(AC) COMULATIV	T c	(i)	(i)	Q	Qi
	LINE NAME	UPPER MH. NO.	LOWER MH. NO.	(m)	(m)	(ha)		(ha)	(ha)	(min)	(mm/hr)	(l/s.ha)	(l/s)	(l/s)
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	Line b	B1	B2	119.926	119.926	0.578	0.500	0.289	0.289	7.221	83.870	232.977	67.286	67.286
2	Line b	B2	B3	102.099	222.025	0.748	0.500	0.374	0.663	9.112	83.302	231.399	153.328	86.041
3	Line b	B3	A1(rd A)	36.256	258.281	0.685	0.500	0.343	1.005	9.783	83.860	232.949	234.167	80.839

4.2.4 The Proposed Storm Water Drainage System

In the proposed study for the Storm Water Drainage System for Jericho industrial zone, the trial is made to design the main trunks of the collection system. This section deals with the results of the storm water drainage system.

Manholes number, pipes lengths, water consumption, areas, industrial wastewater quantities are found doing the calculations given in the previous section and are given in tables (13-16) in appendix A**.**

The appropriate pipe diameters, lengths and slopes, and location of the manholes are found doing the calculations on the sewerCAD software program. During and once the sewer design computations have been completed, alternative alignments have be examined, and the most cost and energy effective alignment has Collection System for the area, slopes ,lengths of the pipes ,the calculated velocities and flow rates are given in Tables (17-24) in Appendix-A.

4.2.5 Profiles Of Drainage Pipes

The profiles of sewer area assist in the design and are used as the basis of construction drawings. The profile is usually prepared for pipe sewer line at a horizontal and vertical scale. The profile shows the ground or street surface, in lets locations, elevation of street surface, pipe surface, pipe basement.

After all the calculation is completed and all the maps of the proposed storm water drainage system are prepared, detailed profile for sewer pipe line is drawn. The profile of sewer pipe line is shown in Drawings (D15 – D20) in Appendix-B. This profile has shown the ground elevation, the proposed sewer pipe line.

ANALYSIS AND DESIGN FOR WATER NET WORK

4.3.1 INTRODUCTION

In this project, an attempt is made to study and evaluate the existing water distribution network in Jericho city, and develop a future plans and appropriate technology for reconstruction and upgrading of the network, in order to supply all factories of Jericho industrial zone with a sufficient amount of good quality drinking water. In this section, the method of designing water network.

4.3.2 METHOD OF CALCULATION

The computer program EPANET performs the calculation 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 [11].

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 junctions) , 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 concentration , 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 make use 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 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, 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 [11].

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

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

Filling up the computer program only the pipe diameter 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 (10-90)m and the velocities will mostly be between the range (0.2-3) m/s.

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:

Velocity

Minimum velocity = 0.2 m/s

Maximum velocity = 3 m/s

Pressure

Minimum pressure = 1 bar = 10 m

Maximum pressure = 9 bar = 90 m

The minimum and maximum pressure in the distribution lines are defined as the pressure at the nodes in the model. The minimum value of 10 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.

Pipe

The pipe of the distribution system are chosen to be steel pipes due to their advantages. Minimum diameter of (25 mm) is taken. The Hazen-Williams of a new steel pipes is 130.

Estimation of Water Demand

Factory

Similar to the power demand, the water demand for factories is estimated by multiplying the estimated annual production volume by the water demand per production volume. This water demand is set at a mean value of 2.0 m^3/ton/year based on the results of investment survey. The estimated water demand for the factories stage I of development is shown below.

Table 4.3 Water demand of factories [4]

Item	Stage I
Production volume (ton/year)	38,000
Water Demand (MCM/ year)	0.08

Office building and business development service (BDS) center

Water demand for office buildings and the BDS center is estimated by multiplying the estimated number of employ by water demand per employ of 73.0m3/person/year, which is taken from the Palestine statistical data in 2006.

Table 4.4 Water Demand for Office Buildings and BDS Center [4]

Item	Stage I
No. of employees (person)	100
Water demand (MCM/year)	0.01

Distribution facilities

The water demand for distribution facilities is estimated by multiplying the estimated number of employees by the water demand per employee of 73 m^3/person/year.

Table 4.5 Water Demand for Distribution Facilities [4]

Item	Stage I
No. of employees (person)	130
Water demand (MCM/year)	0.01

On the basis of the above estimates, the total water demand for the Jericho industrial zone is determined below.

Table 4.6 water demand of Jericho industrial zone [4]

	Stage I
Factory	0.08
Office buildings and BDS center	0.01
Distribution facilities	0.01
Total	0.10
Value for planning	0.1

Required Quantity

Water supply facilities are planned to accommodate daily and hourly fluctuation of water demand in the Jericho industrial zone. Design water quantities are thus assumed based on the following conditions:

1. Daily Average Water Demand (DAWD) is calculated by dividing the annual water demand by 365 days.

2. Daily Average Water Consumption (DAWC) is assumed to be the DAWD plus unaccounted water of 10%. The effective ratio is set at 90%.
3. Daily Maximum Water Consumption (DMWC) is assumed to be 1.8 times of the DAWC.
4. Hourly Maximum Water Consumption (HMWC) is assumed to be 1.3 times of the DMWC.

Defined water quantities for development stage I shown below. These design quantities are used for the planning and design of the water supply facilities.

Table 4.7 Design Quantities of Water Supply System [4]

Design Water Quantity	Unit	Stage I
Annual water demand	MCM	0.1
Daily average water demand	m^3/day	274
Daily average water consumption	m^3/day	304
Daily maximum water consumption	m^3/day	547
Hourly maximum water consumption	m^3/hour	30

Preliminary Design of Water Transmission Pipeline

The main function of a water transmission pipeline is to convey water from the source to the water tank in the Jericho industrial zone, in order to accommodate the DMWC. The transmission pipelines for the park are designed based on the following conditions:

Alignment

The water transmission pipeline is designed to be located along the existing or planned road for the Jericho industrial zone in view of easy maintenance.

Flow Velocity

Flow velocity shall be faster than 0.2 m/s to avoid settlement of sediments in the pipe, but shall be lower than 3.0 m/s to avoid abrasion of the pipe.

The required diameter of the transmission pipeline from each water source is examined by the Hazen-Williams formula as expressed below:

$$I = 10.666 * C^{-1.85} * D^{-4.87} * Q^{1.85}$$

Where, I :gradient (%)

C :Flow velocity coefficient (-120)

D :Inside diameter (m)

Q :Flow discharge (m^3/s)

Effective Storage of Water Tank

The function of the water tank is to receive and store the water from the transmission pipeline to regulate fluctuation of the hourly water demand and to provide fire-fighting water. Required effective storage is calculated by the following formula which is indicated in the "Design Guidelines for the Construction of Water Tanks (2003)":

$$S_e = A + B + C$$

Where:

Se: Total effective storage , m^3

A: Fire suppression storage capacity , m^3

B: Balancing storage capacity equal to 25% of DMWC , m^3

C: Emergency storage capacity , m^3

Table 4.8 Required Effective Storage of Water Tank [4]

Item	Stage I	Unit
A	120	m^3
B	137	m^3
C	64	m^3
Total	321	m^3

Type And Size Of Water Tank

Based on the pipeline network calculation, the water head at the water tank is required to be 7 m. In order to secure this water head, there are two options, to adopt:

1. a tower type of water tank
2. on-ground type water tank with pump.

The first option requires more expensive initial investment, but almost free operation cost because water is supplied by gravity. The second option has an advantage of lower initial investment, but operation cost is required continuously, as well as the possibility of water supply interruption due to power supply outages or mechanical malfunctioning of the pump. Many industrial estates thus adopt distribution systems without a pump facility as much as possible. Accordingly, the first option, which is the tower-type water tank, is selected for the preliminary design.

4.3.3 network design

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

1. Located a reliable source of water, so as to fulfill the needs and requirements of the area.
2. Obtained details map of the area to served on which topographic contours and the locations of present and future are identified.
3. Based on the topography, selected possible location for distribution reservoir. If the area to be served is large it may be divided into several sub-area to be served with separate distribution system.
4. Estimated the average and peak water use for the area or each sub-area, allowing for fire fighting and future growth.
5. Estimated pipe size on the basis of water demand and local code requirements.
6. Lay out a skeleton system of supply mains leading from the distribution reservoir or other source of supply.
7. Analyzed the flow and pressure in the supply network.
8. Suggested pipe size to reduce pressure irregularities in the basic grid.
9. Added distribution mains to grid system.
10. Reanalyzed the hydraulic capacity of the system.
11. Added street mains for domestic services.
12. Located the necessary valves and fire hydrants.
13. Prepared final design drawings and quantity takeoffs ,(D21) in appendix B.

4.3.4 THE PROPOSED MAIN NETWORK

In the proposed study for the water distribution network, the trial is made to design the network for Jericho industrial zone. The appropriate pipe diameters are found by use of the computer program filled with basic data (nodes water demand, 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 are given in table(26) in appendix A. The calculated velocities, head loss, grads, and pressure are given table(27) in appendix A. the proposed water distribution network for Jericho industrial zone is plotted in Drawing (D21-D27) in appendix B.

CHAPTER FIVE

BILL OF QUANTITY

5.1 BILL OF QUANTITY FOR THE PROPOSEDWASTEWATER COLLECTION SYSTEM

5.2 BILL OF QUANTITY FOR THE PROPOSE STORM WATER DRAINAGE SYSTEM

5.3 BILL OF QUANTITY FOR THE PROPOSED WATER NETWORK COLLECTION SYSTEM

BILL OF QUANTITY

5.1 BILL OF QUANTITY FOR THE PROPOSED WASTEWATER 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 8 inch depth and disposing of the debris and the top soil unsuitable for backfill outside the site	LM	351				
A2	Excavation of pipes trench in all kind of soil for one pipe diameter 10 inch depth and disposing of the debris and the top soil unsuitable for backfill outside the site	LM	489				
A3	Excavation of pipes trench in all kind of soil for one pipe diameter 12 inch depth and disposing of the debris and the top soil unsuitable for backfill outside the site	LM	40				

A4	Excavation of pipes trench in all kind of soil for one pipe diameter 15 inch depth and disposing of the debris and the top soil unsuitable for backfill outside the site	LM	80				
A5	Excavation of pipes trench in all kind of soil for one pipe diameter 18 inch depth and disposing of the debris and the top soil unsuitable for backfill outside the site	LM	120				
A6	Excavation of pipes trench in all kind of soil for one pipe diameter 24 inch depth and disposing of the debris and the top soil unsuitable for backfill outside the site	LM	528				
Sub-Total							
B	**PIPE WORK**						
B1	Supplying, storing and installing of uPVC	LM	1608				
Sub-Total							
C	**PIPE BEDDING AND BACKFILLING** **Dimension and material**						

C1	Supplying and embedment of sand for one pipe diameter 8 inch, depth up to 1.00 meter and disposing of the debris and the top soil unsuitable for backfill outside the site.	LM	351				
C2	Supplying and embedment of sand for one pipe diameter 10 inch, depth up to 1.00 meter and disposing of the debris and the top soil unsuitable for backfill outside the site.	LM	489				
C3	Supplying and embedment of sand for one pipe diameter 12 inch, depth up to 1.00 meter and disposing of the debris and the top soil unsuitable for backfill outside the site.	LM	40				
C4	Supplying and embedment of sand for one pipe diameter 15 inch, depth up to 1.00 meter and disposing of the debris and the top soil unsuitable for backfill outside the site.	LM	80				

C5	Supplying and embedment of sand for one pipe diameter 18 inch, depth up to 1.00 meter and disposing of the debris and the top soil unsuitable for backfill outside the site.	LM	120				
C6	Supplying and embedment of sand for one pipe diameter 24 inch, depth up to 1.00 meter and disposing of the debris and the top soil unsuitable for backfill outside the site.	LM	528				
Sub-Total							
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, size 1200mm, depth up to 1.00m.	NR	45				
D2	Supplying and installing of precasted manhole including excavation pipe connection, epoxytar coating, 25-ton cast iron cover and backfill, size 1000mm, depth up to 2.5m.	NR	5				
Sub-Total							
E	**Concrete Surround**						

E1	Suppying and installing of reinforced concrete (B 200) protection concrete encasement for sewer pipe.	LM	1608				
Sub-Total							
F	**Air And Water Leakage Test**						
F1	Air leakage test for sewer pipe lines 8,10,12,15,18and 24inch according to specifications, including for all t emporary works.	LM	1609				
F2	Water leakage tests for manholes, depth up to 1.00 meter according to specifications.	NR	45				
F3	Water leakage test for manholes , depth up to 2.5 meter according to specification	NR	5				
Sub-Total							
G	**Survey work**						
G1	Topographical survey required for shop drawings and as built DWGS using absoluet Elev. And coordinate system	LM	1609				

5.2 BILL OF QUANTITY FOR THE PROPOSED STORM WATER DRAINAGE 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 10 inch depth and disposing of the debris and the top soil unsuitable for backfill outside the site	LM	240				
A2	Excavation of pipes trench in all kind of soil for one pipe diameter 15 inch depth and disposing of the debris and the top soil unsuitable for backfill outside the site	LM	333				
A3	Excavation of pipes trench in all kind of soil for one pipe diameter 18 inch depth and disposing of the debris and the top soil unsuitable for backfill outside the site	LM	105				
A4	Excavation of pipes trench in all kind of soil for one pipe diameter 24 inch depth and disposing of the debris and the top soil unsuitable for backfill outside the site	LM	366				

A5	Excavation of pipes trench in all kind of soil for one pipe diameter 30 inch depth and disposing of the debris and the top soil unsuitable for backfill outside the site	LM	118.5				
A6	Excavation of pipes trench in all kind of soil for one pipe diameter 35 inch depth and disposing of the debris and the top soil unsuitable for backfill outside the site	LM	293				
Sub-Total							
B	**PIPE WORK**						
B1	Supplying, storing and installing of uPVC	LM	1456				
Sub-Total							
C	**PIPE BEDDING AND BACKFILLING** **Dimension and material**						
C1	Supplying and embedment of sand for one pipe diameter 10 inch, depth up to 1.00 meter and disposing of the debris and the top soil unsuitable for backfill outside the site.	LM	240				

C2	Supplying and embedment of sand for one pipe diameter 15 inch, depth up to 1.00 meter and disposing of the debris and the top soil unsuitable for backfill outside the site.	LM	333				
C3	Supplying and embedment of sand for one pipe diameter 18 inch, depth up to 1.00 meter and disposing of the debris and the top soil unsuitable for backfill outside the site.	LM	105				
C4	Supplying and embedment of sand for one pipe diameter 24 inch, depth up to 1.00 meter and disposing of the debris and the top soil unsuitable for backfill outside the site.	LM	366				
C5	Supplying and embedment of sand for one pipe diameter 30 inch, depth up to 1.00 meter and disposing of the debris and the top soil unsuitable for backfill outside the site.	LM	118.5				

C6	Supplying and embedment of sand for one pipe diameter 35 inch, depth up to 1.00 meter and disposing of the debris and the top soil unsuitable for backfill outside the site.	LM	293				
Sub-Total							
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, size 1200mm, depth up to 1.00m.	NR	9				
D2	Supplying and installing of precasted manhole including excavation pipe connection, epoxytar coating, 25-ton cast iron cover and backfill, size 1200mm, depth up to 2.5m.	NR	9				
Sub-Total							
E	**Concrete Surround**						
E1	Suppying and installing of reinforced concrete (B 200) protection concrete encasement for sewer pipe.	LM	1456				

Sub-Total							
F	**Air And Water Leakage Test**						
F1	Air leakage test for sewer pipe lines10,15,18,24,30,and 35 inch according to specifications, including for all temporary works.	LM	1456				
F2	Water leakage tests for manholes, depth up to 1.00 meter according to specifications.	NR	9				
F3	Water leakage test for manholes , depth up to 2.5 meter according to specification	NR	9				
Sub-Total							
G	**Survey work**						
G1	Topographical survey required for shop drawings and as built DWGS using absoluet Elev. And coordinate system	LM	1456				

5.3 BILL OF QUANTITY FOR THE PROPOSED WATER NETWORK 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 1 inch depth and disposing of the debris and the top soil unsuitable for backfill outside the site	LM	375				
A2	Excavation of pipes trench in all kind of soil for one pipe diameter 2 inch depth and disposing of the debris and the top soil unsuitable for backfill outside the site	LM	815				
A3	Excavation of pipes trench in all kind of soil for one pipe diameter 3 inch depth and disposing of the debris and the top soil unsuitable for backfill outside the site	LM	350				
A4	Excavation of pipes trench in all kind of soil for one pipe diameter 4 inch depth and disposing of the debris and the top soil unsuitable for backfill outside the site	LM	35				
Sub-Total							
B	**PIPE WORK**						

B1	Supplying, storing and installing of steel	LM	1576				
B2	Fire hydrants with 2” quick connection coupling	NR	22				
B3	Welding and installation of 4” gate valve with dresser coupling	NR	6				
Sub-Total							
C	**PIPE BEDDING AND BACKFILLING** **Dimension and material**						
C1	Supplying and embedment of sand for one pipe diameter 1 inch, depth up to 1.10 meter and disposing of the debris and the top soil unsuitable for backfill outside the site.	LM	375				
C2	Supplying and embedment of sand for one pipe diameter 2 inch, depth up to 1.10 meter and disposing of the debris and the top soil unsuitable for backfill outside the site.	LM	815				
C3	Supplying and embedment of sand for one pipe diameter 3 inch, depth up to 1.10 meter and disposing of the debris and the top soil unsuitable for backfill outside the site.	LM	350				

C4	Supplying and embedment of sand for one pipe diameter 4 inch, depth up to 1.10 meter and disposing of the debris and the top soil unsuitable for backfill outside the site.	LM	35				
Sub-Total							
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, size 1200mm, depth up to 1.00m.	NR	1				
D2	Supplying and installing of precasted manhole including excavation pipe connection, epoxytar coating, 25-ton cast iron cover and backfill, size 1000mm, depth up to 2.5m.	NR	0				
Sub-Total							
E	**Concrete Surround**						
E1	Suppying and installing of reinforced concrete (B 200) protection concrete encasement for pipes.	LM	1575				
Sub-Total							
F	**Air And Water Leakage Test**						

F1	Air leakage test for pipe lines 1,2,3,and 4 inch according to specifications, including for all temporary works.	LM	1575				
F2	Water leakage tests for manholes, depth up to 1.00 meter according to specifications.	NR	1				
F3	Water leakage test for manholes , depth up to 2.5 meter according to specification	NR	0				
Sub-Total							
G	**Survey work**						
G1	Topographical survey required for shop drawings and as built DWGS using absoluet Elev. And coordinate system	LM	1575				

CHAPTER SIX

CONCLUSIONS

CONCLUSIONS

In this project, project team made a trial to design part of infrastructure for Jericho industrial zone, which consist in this part of project a design of water network, design of wastewater collection system and design of storm water drainage system for the project area, and so we find the following important conclusions:

1. The industrial area that Jericho municipality looking to find is an “Agro-Industrial” area which has a special constraint.
2. Water consumption for Agro Industrial area taken as 0.1 MCM/year, its calculated a long with quantity of (factory, office buildings and BDS center and distribution facilities).
3. Water storage take calculated as the summation of balancing storage and emergency and fire storage is equal 321 m^3.
4. Water network is running by gravity, since the water tank is raised to 7 m up to 297 m below dead sea level.
5. A fire hydrant is taken for every factory in the area.
6. The unit water consumption per one donum of industrial area is taken as 2.4 m^3/d.donum.
7. The peak factor for wastewater collection system is taken to be 2, that because the industry zone is mostly agro industrial which consume water much than other industries. And also produce less water than others.
8. In the design of wastewater collection system four main trunks is designed to cover stage I of Jericho industrial zone and also four main trunks of storm water drainage system is designed to cover stage I.
9. The flow in the proposed wastewater collection system and storm water drainage system are going by gravity [gravity flow sanitary system].

10. The slopes of sewer in the proposed wastewater collection system and storm water drainage system are followed the slope of the ground to decrease the cost of construction.
11. In the design of storm water drainage system we use a typical curve to calculate the rainfall intensity for Jericho industrial zone.
12. In the design of storm water drainage system runoff coefficient is taken to be 0.5.

APPENDIX A

- SANITARY SYSTEM CALCULATION TABLES.
- SANITARY SYSTEM CALCULATIONS TABLES. (FROM SWERCAD).
- STORM DRAINAGE SYSTEM CALCULATION TABLES.
- STORM DRAINAGE SYSTEM DESIGN TABLES. (FROM SWERCAD).
- WATER NET WORK CALCULATION TABLES.
- WATER NET WORK DESIGN TABLES. (FROM EPANET).

REFERENCES

References

1- Al- Jabari, S and Al-Herbawi, H, “Design of wastewater collection system for Bani Naim town”, Palestine Polytechnic University, Hebron, Palestine, 2002.
2- Charles G. Cunnerson and David C. stuckey, Integrate Resource Recovery Anacrobic Digestion, UNDP, world bank, 1988.
3- Hammer, Mark J. (1977), water and wastewater technology”, John Wiley and sons, INC., U.S.A. .
4- Jericho Municipality.
5- Mc Ghee, Terence J. (1991),”water supply and sewage”, sixith edition, Mc Ghee-Hill International editions, U.S.A.
6- Metcalf and Eddy ”waste water engineering and reuse”, Mc Graw-Hill Higher Education, 2003.
7- Palestinian Bureau Of Statistics (1999),”locality type booklet: population, housing, and establishment census, “Statistical report series “, Ramallah, West bank, Palestine.
8- Palestinian Metrological Department.
9- Qasim, Sayed R. (1985),”wastewater treatment plants planning, design, and operation”. The University of Texas at Arlington, U.S.A.
10- Viesman, Warren. JR. and Hammer, Mark J. 1985 ”Water Supply and Pollution Control”, Fourth Edition, Harper and Row, Publisher, Inc, New York, USA.
11- Rossman, L.(1994) “Epanet user manual” , drinking water research division ,risk reduction engineering laboratory , Cincinnati ,Ohio , U.S.A.
12- Sarikaya, H, “sanitary engineering”, civil engineering department, Jeddah, 1984.
13- Steel , E.W, and McGhee , TJ (1991) “Water supply and sewerage” , Sixth edition , McGraw Hill , Inc. Tosho printing Co. , Ltd, Tokyo, Japan.

CHAPTER TWO

CHARACTERISTICS OF THE PROJECT AREA