`

Design of Wastewater Collection System For Nahaleen Village

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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**

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الإهداء

بدأنا بأكثر من يد وقاسينا أكثر من هم وعانينا الكثير من الصعوبات وهانحن اليوم والحمد الله نطوي سهر الليالي وتعب الأيام وخلاصة مشوارنا بين دفتي هذا العمل المتواضع.

الكريم سيدنا إلى منارة العلم والإمام المصطفى إلى الأمي الذي علم العالمين إلى سيد الخلق إلى رسولنا محمد ﷺ.

إلى الينبوع الذي لا يمل العطاء إلي من حاكت سعادتنا بخيوط منسوجة من قلبها إلى أمهاتنا الغاليات.

إلى من سعى وشقى لننعم بالراحة والهناء الذي لم يبخل بشيء من أجل دفعنا في طريق النجاح إلى الذي علمنا أن نرتقي سلم الحياة بحكمة وصبر إلى آبائنا الكرام.

إلى من حبهم يجري في عروقنا ويلهج بذكراهم فؤادنا إلى أخواتي وأخواني إلى من سرنا سوياً ونحن نشق الطريق معاً نحو النجاح والإبداع إلى من تكاتفنا يداً بيد ونحن نقطف زهرة العلم إلى أصدقائنا وزملائنا.

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Abstract

Design of Wastewater Collection System For Nahleen Village

Prepared by:

Rateeba ALKaraki **Majd ALNatsheh**

Supervised by:

Dr. Itissam Abuiziah

The aim of this study is to design a wastewater collection system for Nahaleen Village , this Village are suffered from shortage of existing Infrastructure, such as wastewater collection system. Therefore; the dispose wastewater without any treatment, will cause danger to human health, unacceptable damage to the natural environment, and water resources (surface and underground water).

To design Wastewater collection we do preliminary studies: first, Prepare Contour Map and Geotechnical Investigation (soil type) and detail Map of the area showing street. Second, known water supply and consumption studies and identification of the area. Third, collected all the information about the village such as the number of its residents, then after we divided the area and we named the streets and determined the areas covered by the network, and then we named all the data such as manholes, pipes ... etc., then the flow quantity for each pipe was calculated to design a sewage network.

After finishing our project we expect to design a wastewater collection system , that provide a good sanitary environmental condition of Nahaleen protecting public health ,dispose the human excrete to a safe place by a safe and protective means , to dispose of all liquid waste from community to a proper place for preventing a favorable condition of mosquito breeding ,fly developing or bacteria growing , to transport liquid to wastewater treatment plant so as not danger or land to get of polluted where it is disposed off . The present study considered the annual population growth and their water consumption for the coming 25 years that will be the design period the necessary hydrulic calculation needed for the design of the main trunks was carried out by simple calculation.

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الملخص

تهدف هذه الدراسة إلى تصميم نظام لجمع مياه الصرف الصحي لقرية نحالين ، حيث تعاني هذه القرية من نقص البنية التحتية ، مثل نظام جمع مياه الصرف الصحي، وبالتالي يعتبر التخلص من مياه الصرف الصحي دون أي معالجة ، فانه يتسبب في خطر على صحة الإنسان ، وأضرار غير متوقعة على البيئة الطبيعية وموارد المياه (المياه السطحية والجوفية).

اتبعنا منهجية معينة عند تصميم شبكة مياه الصرف الصحي فقد قومنا بإجراء دراسات أولية: أولاً ، إعداد خريطة تفصيله والتحقيق الجيو تقني (نوع التربة) وخريطة تفصيلية للمنطقة التي تظهر الشارع. ثانيًا ، دراسات معروفة عن إمدادات المياه واستهلاكها وتحديد المنطقة. ثالثًا، جمع كل المعلومات عن القرية مثل عدد سكانها، ثم بعد أن قسمنا المنطقة وقمنا بتسمية الشوارع وتحديد المناطق التي تغطيها الشبكة، ثم قمنا بتسمية جميع البيانات مثل المناهل والأنابيب. ..إلخ ،ومن ثم تم حساب كمية التدفق لكل انبوب ليتم تصميم شبكة صرف صحي .

بعد الانتهاء من مشروعنا ، نتوقع تصميم نظام لجمع مياه الصرف الصحي ، والذي يوفر حالة بيئية صحية جيدة لنحالين تحمي الصحة العامة ، وتخلص الإنسان من مياه الصرف الصحي في مكان آمن بوسائل آمنة ووقائية ،وتخلص من جميع النفايات السائلة من المجتمع إلى مكان مناسب لمنع حالة لتكاثر البعوض أو نمو الذبابة أو نمو البكتيريا ، لنقل السائل إلى محطة معالجة مياه الصرف الصحي حتى لا يكون خطرًا او يؤدي الى تلوث الارض حيث يتم التخلص منه. تناولت الدراسة الحالية النمو السكاني السنوي واستهلاكها للمياه على مدى السنوات الـ 25 القادمة التي ستكون فترة التصميم ، وتم إجراء الحساب الهيدروليكي اللازم لتصميم الشوارع الرئيسة عن طريق الحساب البسيط.

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1.6 Organization of the Project

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1.1 General

In most of the cities, wastewater is let out partially treated or untreated and it either percolates into the ground and in turn contaminates the ground water or it is discharged into the natural drainage system causing pollution in downstream water bodies.

In the past disposal of waste from water closets was carried out manually and wastewater generated from kitchen and bathrooms was allowed to flow along the open drains. This primitive method was modified and replace by a system, in which these wastes are mixed with sufficient quantity of water. This waste is carried through closed conduits under the conditions of gravity flow. This mixture of water and waste products is known as sewage.

So the aim of this study is to design a wastewater collection system for Nahaleen regions, this area are suffered from shortage of existing Infrastructure, such as wastewater collection system. Therefor; the dispose wastewater without any treatment, will cause danger to human health, unacceptable damage to the natural environment, and water resources (surface and underground water).

1.2 Problem Definition

The daily activities of human beings produce both liquid and solid wastes. The liquid portion of the wastewater is necessarily the water supplied by the authority or through private water sources, after it has fouled by variety of uses. The sources of wastewater generation can be defined as a combination of the liquid or water-carried wastes removed from residences, institutions, and commercial and industrial establishments, together with groundwater, surface water, and storm water as may be present.

If the untreated wastewater is allowed to accumulate, it will lead to highly unhygienic conditions. The organic matter present in the wastewater will undergo decomposition with production of large quantities of malodorous gases. In view of these bad conditions, and since there is no sewage networks exist, along with fast increasing of the environmental and health problem. The design of wastewater collection system study becomes a pressing necessity so as to solve all problems that mentioned above. This study will consider the annual growth of the people and their water consumption for the coming 25 years, which will be the design period.

After finishing our project we expect to design a wastewater collection system , that provide a good sanitary environmental condition of Nahaleen protecting public health ,dispose the human excrete to a safe place by a safe and protective means , to dispose of all liquid waste from

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community to a proper place for preventing a favorable condition of mosquito breeding ,fly developing or bacteria growing , to transport liquid to wastewater treatment plant so as not danger or land to get of polluted where it is disposed off

1.3 Objectives of the Project

The main objectives of this project are:-

1. Estimation of population and their densities for the design period for each catchment area.

2. Determination of the water consumption and consequently the wastewater production from the different sources for each catchment area.

3. Evaluation of the collected data, propose collection system of the region and design of the main trunks of the network.

4. Showing the proposed wastewater network its parts on different maps for different purposes.

5. Preparation of Bill of Quantities for the main trunks.

6. Preparation the profiles of pipes.

1.4 Methodology

The way to do our project to design Wastewater Collection:

1. Collecting of topographical maps for all the area.

2. Collecting of meteorological and hydrological data (temperature, wind, speed, rainfall…etc) from different sources.

3. Draw the layout of the network and compare it with the real situation in Nahaleen Village then make adjustment and last draw the final layout, this task is the most important.

4. Evaluation of the contour maps and matching it with actual ground levels in the region.

5. Determination of the wastewater quantities.

6. Determination of the wastewater quantities and projection of the wastewater production in year 2044.

7. Finalizing of the project that will contain the report and the needed maps and drawings.

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1.5 Phases of the Project

The project will consist of the four phases as shown in Table (1.1).

Title	Duration								
	09/15	10/15	11/15	12/15	01/15	02/15	03/15	04/15	05/31
Data collection and survey.									
Preparing layout for wastewater collection system and calculate the amount of wastewater.									
Design of wastewater collection system.									
Writing the report and preparing maps.									

1.5.1 First Phase: - Data Collection and Survey

In this phase, available data and information were collected from different sources. Moreover, many site visits to both the region and the municipality were done. This phase include the following tasks.

1. Collecting of topographical maps for all the area.

2. Collecting of meteorological and hydrological data (temperature, wind, speed, rainfall, evaporation…etc) from different sources.

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3. Evaluation of population densities in each zone of the region with their water consumption and predicting their numbers, densities and their water consumption in year 2044.

1.5.2 Second Phase: - Preparing Layout for the Network and Calculate the Amount of Wastewater.

In this phase layout will prepared and put in its final shape and then quantities of wastewater were determined. This phase includes the following tasks:

1. Draw the layout of the network and compare it with the real situation in Nahleen village then make adjustment and last draw the final layout, this task is the most important.

2. Evaluation of the contour maps and matching it with actual ground levels in the region.

3. Determination of the wastewater quantities.

4. Determination of the wastewater quantities and projection of the wastewater production in year 2044.

1.5.3 Third Phase: - Design Of Wastewater Collection Systems

In this phase the necessary hydraulic calculation needed for the design of the main trunks were carried out. This phase includes the following tasks:

2. Establish the catchments and sub-catchments areas and routes of the sewers.

3. Establish the design criteria and conducting the needed sewer diameter hydraulic calculations.

4. Preparing needed different drawings for the designed sewers.

1.5.4 Fourth Phase: - Writing the Report and Other Needed Jobs

After finishing the design calculation of the main trunks the project team prepared the specifications drawing, bill of quantities and preliminary maps. Final report of the project was prepared and submitted to the Department of civil and Architectural Engineering at Palestine Polytechnic University.

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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 five 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.

Chapter three entitled "Design Criteria" deals with municipal sewage system, types of wastewater collection systems, sewer appurtenances, flow in sewers, design of sewer system, and sewer construction and maintenance.

Chapter four entitled "Analysis and Design" presents the design calculations and maps of the system.

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

Chapter six entitled "Conclusions" discusses the conclusions of the study.

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Chapter Tow

Characteristics of the project area

2.1 General

2.2 Project Area

2.3 Population

- **2.3.2 Geometrical Increase Method**
- **2.3.1 Arithmetical Increase Method**
- **2.3.3 Incremental Increase Method**
- **2.3.4 Graphical Method**
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2.4 Population Density

2.5 Water Consumption

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2.7 Land Use

2.8 Meteorological Data

- **2.8.1 Temperature**
- **2.8.2 Relative Humidity**
- **2.8.3 Wind**
- **2.8.4 Rainfall**

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2.1 General

In this chapter, the basic data of Nahaleen Village will be briefly discussed. The topography, population water consumption, wastewater production, Land Use, and Meteorological Data will be briefly presented.

2.2 Project Area

Nahaleen Village situated at the west of Bethlehem city, about 15m away from Bethlehem, as shown on the project location plan Figure (2.1), and the location of village respect to other cities is shown on Figure (2.1) .The average height of the village is 650m with respect to sea level, the ground elevations range from 835m to 600m as shown on figure (2.2) . The topography within the region is deep valleys and is surrounded by high mountain peaks, as shown on Figure (2.2). The population within the municipal administrative borders in year 2019 is around 9047 persons living on an area of 1100 donum. This population is expected to grow substantially up to the year 2044 planning horizon of this project.

Nahaleen village is a very old gathering ,as evidenced by the presence of archaeological sites in it ,which are Roman ,Byzantine and Canaanite ruins .The name of village is derived from bees ,as it has long famous for beekeeping.

Figure (2.1): Location of Nahaleen village respect to other citifies

Figure (2.2): Topography for Nahaleen village

2.3 Population

There are several methods to calculate Population:

2.3.1 Arithmetical Increase Method

This method is suitable for large and old city with considerable development. If it is used for small, average or comparatively new cities, it will give low result than actual value. [3][4]

2.3.2 Geometrical Increase Method

In this method the percentage increase in population from decade to decade is assumed to remain

Constant. Geometric mean increase is used to find out the future increment in population. [3][4]

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2.3.3 Incremental Increase Method

This method is modification of arithmetical increase method and it is suitable for an average size town under normal condition where the growth rate is found to be in increasing order. [3][4]

2.3.4 Graphical Method

In this method, the populations of last few decades are correctly plotted to a suitable scale on graph. The population curve is smoothly extended for getting future population. [3][4]

2.3.5 Comparative Graphical Method

In this method the census populations of cities already developed under similar conditions are plotted. The curve of past population of the city under consideration is plotted on the same graph. The curve is extended carefully by comparing with the population curve of some similar cities having the similar condition of growth. [3][4]

2.3.6 Master Plan Method

The big and metropolitan cities are generally not developed in haphazard manner, but are planned and regulated by local bodies according to master plan. The master plan is prepared for next 25 to 30 years for the city. [3][4]

2.3.7 Logistic Curve Method

This method is used when the growth rate of population due to births, deaths and migrations takes place under normal situation and it is not subjected to any extraordinary changes. if the population of city is plotted with respect to time, the curve so obtained under normal condition is look like S-shaped curve and is known as logistic curve.[3][4]

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

The basis of the population projections for 2019 was obtained from Bethlehem Municipality by about 9047 inhabitants. The rate of population growth for the purpose of our study was based on estimation used for other towns of similar population composition and characteristics. The rate

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of population growth in other towns in the Bethlehem is 3.5 %. A similar rate of growth was assumed for the towns of Beitjala; therefore, the rate of 3.5% per year was used for the future growth of the population of Nahaleen village. [8]

To calculate the population at the end of the design period (year 2044), a geometric increase is assumed, represented by the following equation:

$P = P^* (1+R)^n$ (2.1)

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

Using the above assumption and equation, Table (2.1) presents the population projection up to the design horizon of 2044. The data show that the population of Nahaleen is estimated to be 16773 capita in year 2044.

Table(2.1): Population Forecasts for Nahaleen village

Year	2019	2024	2029	2034	2039	2044
Population	9047	10236	11581	13203	14824	16773

2.4 Population Density

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

2.5 Water Consumption

According to the water consumption data obtained from the previous studies, the current water consumption was 70 liters per capita per day, and the future water consumption is 120 liters per capita per day.

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2.6 Wastewater Quantity

In general the amount of domestic wastewater produced per capita per day is usually (70-80%) of water consumption.

2.7 Land Use

As mentioned earlier, the land area of Nahaleen is approximately 1100donum. There is no clear town plan defining land use in the various zones of Nahaleen. The land use can be distributed as follows:-

1. Residential areas, food stories, workshop building, public buildings.
2. Agricultural Areas.
3. Artificial Surfaces
4. Forest and Semi-Natural Area.

Figure (2.3): Landuse of Nahaleen village

Figure (2.4) : soil type of Nahaleen village

2.8 Meteorological Data

The hydrology of the 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 affect 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 Nahaleen Village tends to be cold in winter with good amount of rain, and warm in summer with relative humid.

2.8.1 Temperature

Based on information obtained from Bethlehem municipality, the temperature is characterized by considerable variation between summer and winter times. The mean temperature values at Nahaleen are given in below. [9]

The Mean maximum temperature: 24 ˚C

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The Mean minimum temperature: 16˚C

The Mean Maximum temperature record: 23.2 ˚C

The Mean Minimum temperature record: 15.9 ˚C

2.8.2 Relative Humidity

Since Nahaleen is situated at considerable distance from the sea in a mountains region, Nahaleen has low values of relative humidity compared to those in the plains. The relative humidity in Nahaleen village from 60%. [9]

2.8.3 Wind

The directions and velocities of wind vary depending on the season of the year. In winter, the wind blows in the morning from the southwest a rounds noon from southwest and west, and at night from west and northwest. In summer, northeasterly wind blows all day long. According to data obtained from Meteorological Station, average wind in winter is about 10 km/h and in summer 5.4km/h.[9]

2.8.4 Rainfall

Based on information obtained from Bethlehem municipality, the average annual rainfall in Nahaleen for the last five year is approximately 500 -700mm. [9]

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Chapter Three

Design Criteria

3.1 Type of Sewerage System

3.2 Municipal Sewerage System

- **3.2.1 Types of Sewer**
- **3.2 .2 Sewer Materials**
  - **3.2.2.1 Asbestos Cement Sewers**
  - **3.2.2.2 Plain Cement Concrete or Reinforced Cement Concrete**
  - **3.2.2.3 Vitrified Clay or Stoneware Sewers**
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  - **3.2.6 Steel Pipes**
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3.3 Types of Wastewater Collection Systems

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- **3.4.3 House Connections**
- **3.4.4 Inverted Siphons**
- **3.4.5 Pumping of Sewer**

3.5 Design Parameters

- **3.5.1 Flow Rate Projections**
- **3.5.2 The peak coefficient**
- **3.5.3 Hydraulic Design**
- **3.5.4 Design and Planning Assumptions**

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3.1 Type of Sewerage System

The sewerage system can be of following three types:

1) Combined system: In combined system along with domestic sewage, the run-off resulting from a storm is carried through the same sewers of sewerage system. In countries like India where actual rainy days are very few; this system will face the problem of maintaining self-cleansing velocity in the sewers during dry season, as the sewage discharge may be far lower as Compared to the design discharge after including storm water. [1]

2) Separate System: In separate system, separate conduits are used; one carrying sewage and other carrying storm water run-off. The storm water collected can be directly discharged into the water body since the run-off is not as foul as sewage and no treatment is generally provided. Whereas, the sewage collected from the city is treated adequately before it is discharged into the water body or used for irrigation to meet desired standards. Separate system is advantageous and economical for big towns. [1]

3) Partially separate system: In this system part of the storm water especially collected from roofs and paved courtyards of the buildings is admitted in the same drain along with sewage from residences and institutions, etc. The storm water from the other places is collected separately using separate conduits [1]

3.2 Municipal Sewerage System

3.2.1 Types of Sewer

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 sub main 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).

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3.2 .2 Sewer Materials

3.2.2.1 Asbestos Cement Sewers

• These are manufactured from a mixture of asbestos fibers, silica and cement. Asbestos Fibers are thoroughly mixed with cement to act as reinforcement.

• These pipes are available in size 10 to 100 cm internal diameter and length up to 4.0 m.

• These pipes can be easily assembled without skilled labour with the help of special Coupling, called 'Ring Tie Coupling' or Simplex joint.

• The pipe and joints are resistant to corrosion and the joints are flexible to permit 120 deflections for curved laying.

• These pipes are used for vertical transport of water. For example, transport of rainwater from roofs in multistoried buildings, for transport of sewage to grounds, and for transport of less foul collage i.e., wastewater from kitchen and bathroom. [6][7]

3.2.2.2 Plain Cement Concrete or Reinforced Cement Concrete

Plain cement concrete (1: 1.5: 3) pipes are available up to 0.45 m diameter and reinforcement Cement pipes are available up to 1.8 m diameter. These pipes can be cast in situ or precast pipes. Precast pipes are better in quality than the cast in situ pipes. The reinforcement in these pipes can be different such as single cage reinforced pipes, used for internal pressure less than 0.8 m; double cage reinforced pipes used for both internal and external pressure greater than 0.8m; elliptical cage reinforced pipes used for larger diameter sewers subjected to external pressure; and Hume pipes with steel shells coated with concrete from inside and outside. Nominal longitudinal reinforcement of 0.25% is provided in these pipes. [6][7]

3.2.2.3 Vitrified Clay or Stoneware Sewers

These pipes are used for house connections as well as lateral sewers. The size of the pipe available is 5 cm to 30 cm internal diameter with length 0.9 to 1.2 m. These pipes are rarely manufactured for diameter greater than 90 cm. These are joined by bell and spigot flexible compression joints. [6] [7]

3.2.2.4 Brick Sewers

This material is used for construction of large size combined sewer or particularly for storm water drains. The pipes are plastered from outside to avoid entry of tree roots and ground water through brick joints. These are lined from inside with stone ware or ceramic block to make them smooth and hydraulically efficient. Lining also make the pipe resistant to corrosion. [6] [7]

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3.2.2.5 Cast Iron Sewers

These pipes are stronger and capable to withstand greater tensile, compressive, as well as bending stresses. However, these are costly. Cast iron pipes are used for outfall sewers, rising mains of pumping stations, and inverted siphons, where pipes are running under pressure. These are also suitable for sewers under heavy traffic load, such as sewers below railways and highways. They are used for carried over piers in case of low lying areas. They form 100% leak proof sewer line to avoid ground water contamination. They are less resistant to corrosion; hence, generally lined from inside with cement concrete, coal tar paint, epoxy, etc. [6] [7]

3.2.6 Steel Pipes

These are used under the situations such as pressure main sewers, under water crossing, bridge crossing, necessary connections for pumping stations, laying pipes over self-supporting spans, railway crossings, etc. They can withstand internal pressure, impact load and vibrations much better than CI pipes. They are more ductile and can withstand water hammer pressure better. These pipes cannot withstand high external load and these pipes may collapse when negative pressure is developed in pipes. They are susceptible to corrosion and are not generally used for partially flowing sewers. They are protected internally and externally against the action of corrosion. [6] [7]

3.2.2.7 Ductile Iron Pipes

Ductile iron pipes can also be used for conveying the sewers. They demonstrate higher capacity to withstand water hammer. The specification for DI pipes is provided in IS: 12288-1987. The predominant wall material is ductile iron, a spheroid zed graphite cast iron. Internally these pipes are coated with cement mortar lining or any other polyethylene or poly wrap or plastic bagging/ sieving lining to inhibit corrosion from the wastewater being conveyed, and various types of external coating are used to inhibit corrosion from the environment. Ductile iron has proven to be a better pipe material than cast iron but they are costly. Ductile iron is still believed to be stronger and more fracture resistant material; like most ferrous materials, it is susceptible to corrosion. A typical life expectancy of thicker walled pipe could be up to 75 years, however with the current thinner walled ductile pipe the life could be about 20 years in highly corrosive soils without a corrosion control program like catholic protection. [6] [7]

3.2.8 Plastic sewers (PVC pipes)

Plastic is recent material used for sewer pipes. These are used for internal drainage works in house. These are available in sizes 75 to 315 mm external diameter and used in drainage works.

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They offer smooth internal surface. The additional advantages they offer are resistant to corrosion, light weight of pipe, economical in laying, jointing and maintenance, the pipe is tough and rigid, and eases in fabrication and transport of these pipes. [6] [7]

3.3 Types of Wastewater Collection Systems

3.3.1 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. [2]

3.3.2 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. [2]

3.3.3 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. [2]

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. [2]

3.4 Sewer Appurtenances

3.4.1 Manholes

The general shapes of the manholes are square, rectangular or circular in plan, the latter is common. Manholes for small sewers are generally 1.0-1.2 m in diameter. For larger sewers larger manhole bases are provided. The maximum spacing of manholes is 40-60 m depending on the size of sewer and available size of sewer cleaning equipment. [3]

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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. [3]

3.4.2 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]

3.4.3 House Connections:

The house sewers are generally 10-15 cm in diameter and constructed on a slope of 2% . 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. [3]

3.4.4 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. [3]

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. [3]

`

3.4.5 Pumping of Sewer:

There are many communities in which it is possible to convey all the sewage to a central treatment location or point of discharge in only a gravity system. In other areas with flat terrain, more than one drainage area, low-lying sections, or similar complications, pumping may be required. Pumping may also be required at or within sewage treatment plants, in the basements of buildings which are below the grade of the sewer, and to discharge treated wastewater to streams which are above the elevation of the treatment plan. [3]

Pumping of untreated sanitary sewage requires special designs, since sewage often contains large solids. Nonclog pumps have impellers, which are usually closed and have, at most, two or three vanes. The clearance between the vanes is sufficiently large that anything, which will clear the pump suction, will pass through the pump. A bladeless impeller, sometimes used as a fish pump, has also been applied to this service. For a specified capacity, bladeless impellers are larger and less efficient than vaned designs. [3]

3.5 Design Parameters

3.5.1 Flow Rate Projections

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

(1) Domestic

(2) Infiltration

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

3.5.2 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.

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3.5.3 Hydraulic Design

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

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

Where n : is the Manning , Depending on pipe materials, the typical values of n are:

- Reinforced Concrete (RC) n = 0.013

- Polyvinyl Chloride (PVC) n = 0.01

- Ductile Iron: n = 0.013

- Asbestos Cement: n = 0.012

R is the hydraulic radius = area /wetted perimeter (circular pipe flowing full, R= D/4).

The Design Criteria in Wastewater Collection are:

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.[4][5]

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. [4][5]

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 60 m. [4] [5]

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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. [4][5]

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. [4][5]

4.5.4 Design and Planning Assumptions

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

1. Design period 25 year (from 2019-2044).
2. Present (2019) population of municipality of Nahaleen village is 9047 capita.
3. The growth rate will be 3.5% .
4. The existing per capita water consumption has been assessed 120 L/c.d.
5. Total administrative area of municipality of Nahaleen village town 1100 dounm.
6. Future 2044 population of Nahaleen village 16773 capita.
7. Formula to be used in design of sewers:
(Manning formula) $V=(1/n)* R^{2/3} *S^{1/2}$ (3.2)
8. Minimum velocity 0.6 m/sec.
9. Maximum velocity 3.0 m/sec.
10. d/D =65% .
11. Maximum manhole spacing 50 m for main trunk.
12. Minimum diameter 200 mm
13. Maximum diameter 800 mm
14. Minimum cover 1 m
15. 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. Tables (A.2, A.3,A.4,… ,A.19) in Appendix A is typical of the way in which data can be calculated flow per Manhole.

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Chapter four

Design and analysis wastewater collection

4.1 General

4.2 Layout of the System

4.3 Quantity of Waste Water

4.4 The Proposed Waste Water Collection System

4.5 Sewer CAD Program Works

4.6 Profiles of Waste Water Pipes

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4.1 General

In this project, design of waste water collection system for Nahaleen Village is made, and develop a future plans for construction of the collection system, corresponding to the vision of Nahaleen Village municipality about their future plan zone, in order to reduce the problem causes by missing this important part.

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.

4.2 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 establishing the layout of waste water collection system for Nahaleen Village, the following basic steps were followed:

1. Obtain a topographic map of the area to be served.
2. Visit the location.
3. Locate the drainage outlet. This is usually near the lowest point in the area and is often along a stream or drainage way. In Nahaleen Village, the lowest points are in the South-West part and North West of the zone.
4. Sketch in preliminary pipe system to serve all the contributors.
5. Pipes are located so that all the users or future users can readily tap on. They are also located so as to provide access for maintenance and thus are ordinarily placed in streets or other rights-of-way.
6. Sewers layout is followed natural drainage ways so as to minimize excavation and pumping requirements. Large trunk sewers are located in low-lying areas closely paralleling streams or channels.
7. Revise the layout so as to optimize flow-carrying capacity at minimum cost. Pipe lengths and sizes are kept as small as possible, pipe slopes are minimized, and followed the ground surface slope to minimize the depth of excavation, and the numbers of appurtenances are kept as small as possible.
8. The pumping is avoided across drainage boundaries. Pumping stations are costly and add maintenance problems.

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The final layout of Wastewater collection system for Nahaleen village with flow direction and contour is illustrated in Figure (4.1) and Figure (4.2) . The Area and flow Direction and Line Street of Wastewater Collection Systems for Nahaleen village located in Figure (4.3) and Figure (4.4).

4.3 Quantity of Wastewater

The detailed design of sanitary sewers involves the selection of appropriate pipe sizes and slopes to transport the quantity of waste water 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. After preparing the layout of the waste water collection system the quality of waste water that the system must carry it will be calculated using the data collected about the area.

Design example: Design a gravity flow sanitary sewer

Example: Design a gravity flow sanitary sewer for the area to outfall (line Main street1) in Figure (4.4) in Appendix A. The following data will collect and analyzed:-

1. For current water consumption uses 120 L/C.day
2. For future population: using the equation (2.1)
3. For current population.
4. For Population growth rate 3.5%.
5. For design period 25 year.
6. For infiltration allowance use 10% of the domestic sewerage flow.
7. Peaking factor depending on the formula :
   $Pf = 1.5 + (2.5/\sqrt{q})$ (3.1)
   Where q = Average industrial sewage flow
8. For the hydraulic design equation use the Manning equation with an n value of 0.01.
   To simplify the computations, we use the tables.
9. Minimum pipe size: The building code specifies 200 mm (8 in) as the smallest pipe size Permissible for this situation.
10. Minimum velocity: To prevent the deposition of solids at low wastewater flows, use Minimum velocity of 0.6 m/s during the peak flow conditions.
11. Minimum cover (minimum depth of cover over the top of sewer). The minimum depth of cover is 1.5 m.

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Solution:

1. Lay out the sewer. Draw a line to represent the proposed sewer Figure (4.4).

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 of Q for the sanitary sewer are presented in Table (B2) in Appendix B , and sewer design tables are presented in tables (C2, C3…C19) in Appendix C .The data in the table are calculated as follow:

4. The entries in column 1, column 2 and column 3 are used to identify the line(pipe) numbers and start –end Manhole.

5. The entries in column 4 and column 5 are used to identify the sewer manholes, their spacing between each two manholes and area between Manholes.

6. The entries in column 6 used to identify unit sewage. Unit sewage = 80% multiplied by the current consumption density divided area in dounm.

7. The entries in column 7 and 8 are used tributary area, column 7 used incremental area, column 8 used total area in dounm.

8. To calculate municipal maximum flow rates columns 9, 10, are used. Column9 is municipal average sewage flow (unit sewage *total area), the peak factor column 10 is calculated using equation (4.1)As: $Pf = 1.5 + 2.5/\sqrt{q}$ (4.1)

Where q = Average industrial sewage flow (Column 9).

9. Column 11 used to calculate the Q max , the value of it comes from multiply column 10* column 9. Column 12 calculate the infiltration which equal to 10% of Q average (10% * column 9). Column 13 and column 15 used to show the maximum flow design which is come from column 11+ column 12.

The calculation and design tables for the wastewater collection system of Nahaleen village are shown in table (A2, A3 , … ,A19) in Appendix A.

`

To making design for all pipes a software program (Sewer CAD) was used to calculate the pipe size, slope, velocity and cover of the pipe in Appendix B is showing the basics of working on Sewer CAD program.

The Velocity of Wastewater collection systems for Nahaleen Town as shown in Figure (4.5).

4.4 The Proposed Waste Water Collection System

In the proposed study for the Waste Water Collection System for Nahaleen village, 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, wastewater quantities are found doing the calculations given in the previous section and are given in tables (A2 TO A19) in Appendix. The appropriate pipe diameters, lengths and slopes, and location of the manholes are found doing the calculations on the Sewer CAD 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 profiles in Appendix C.

4.5 Sewer CAD Program Works

There are several steps to design wastewater Network using sewer CAD:

1. Open Sewer CAD Program Great New Hydraulic Model

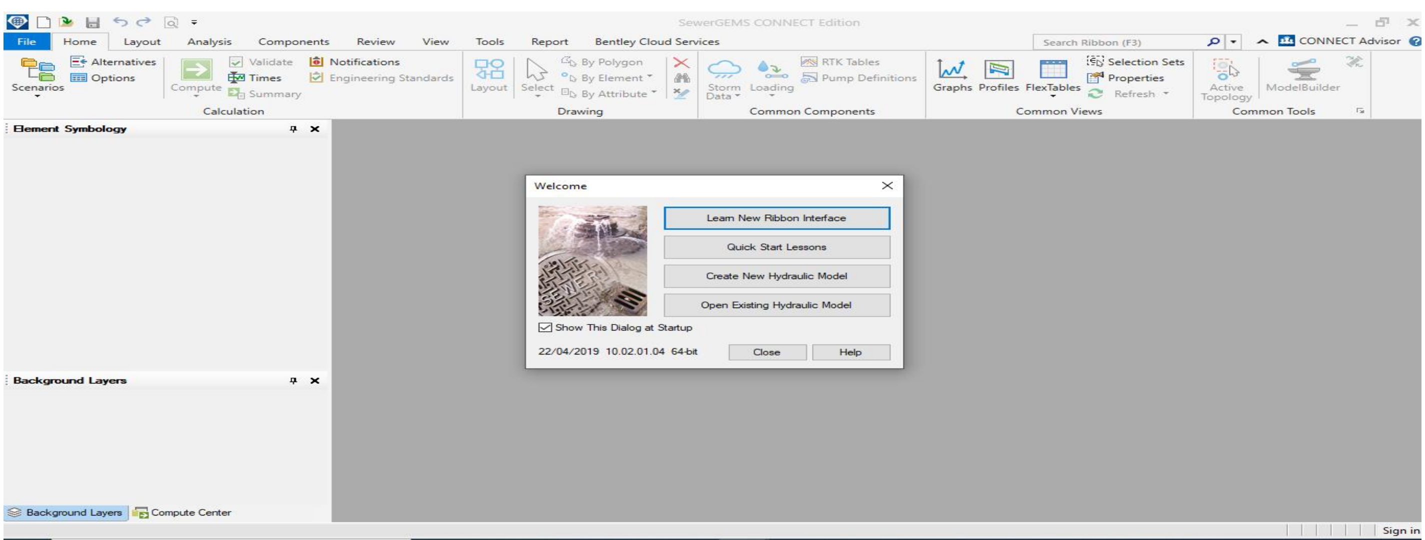

Figure (4.6) : Open Sewer Cad program

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2. From Review list << select Units Result Defaults (SI).
3. From Review list << select Model Builder << import DXFCAD.

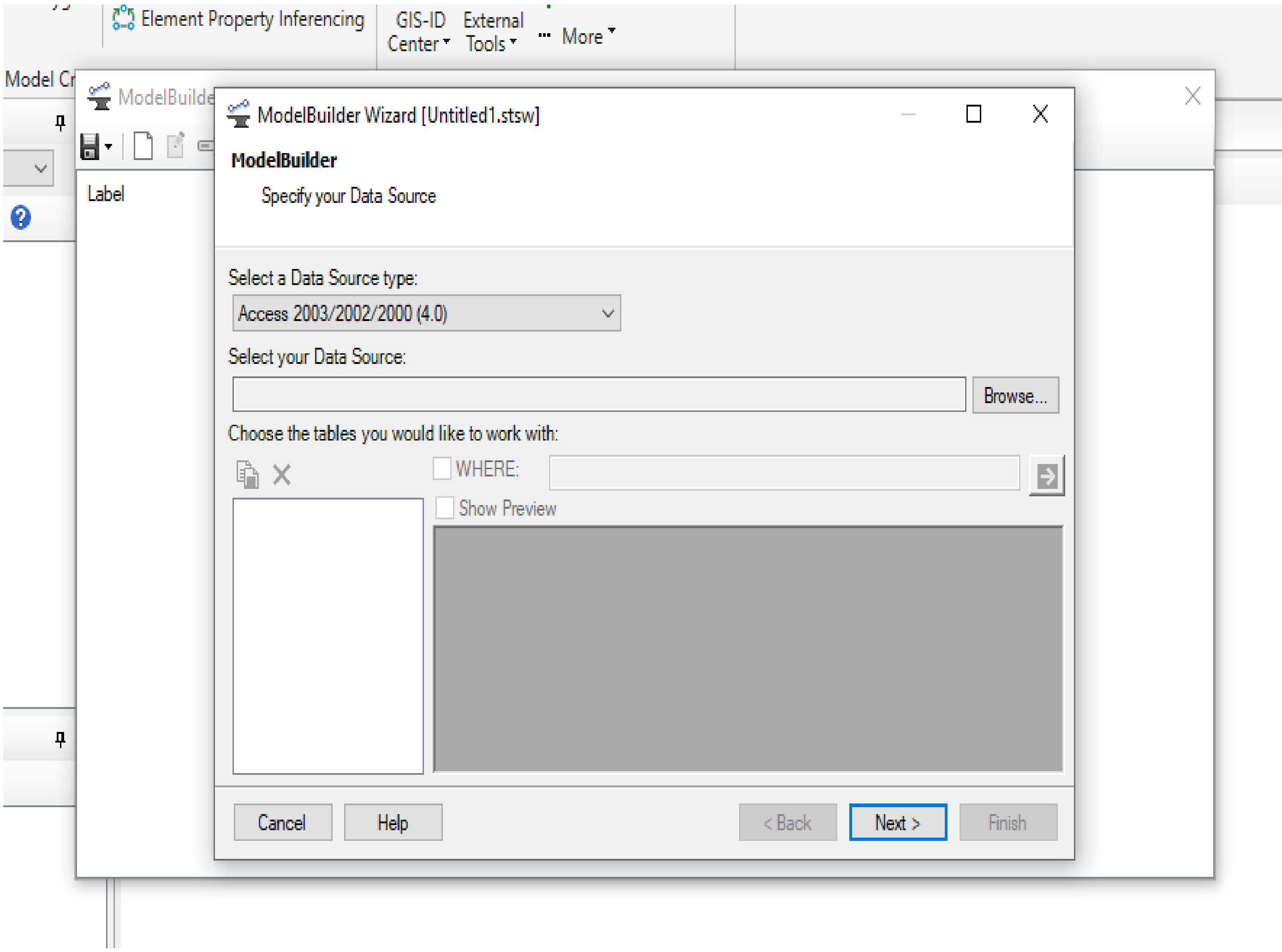

Figure (4.7) : Import Network from AutoCAD

4. Rename conduit and Manhole.
5. Enter information about Manhole:
   From Components list << catalog << Conduit catalog << Import from library < < Material (PVC) << Shape (circler).
   From Components list << Conduit << Type (Conduit catalog) << Conduit class (Circle PVC).
   From Components list << Loading << inflow control Center << inilalize fixed load for all element << (Enter load in unit (L/sec)).

`

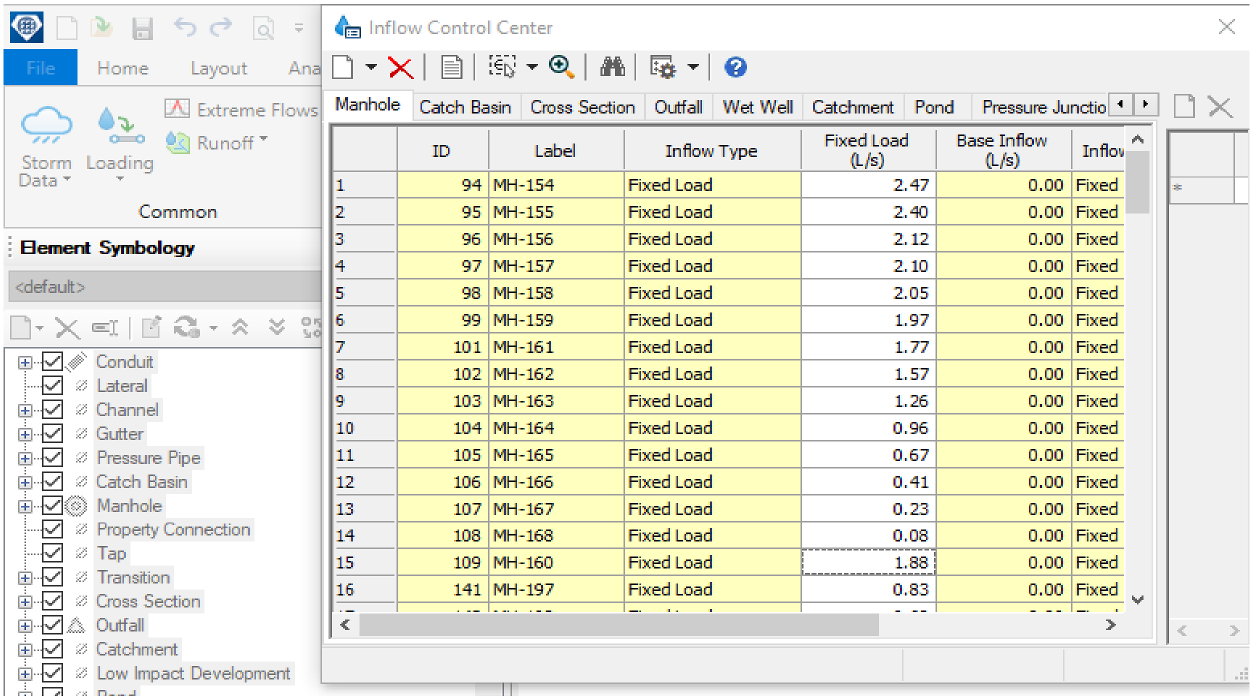

Figure (4.8) : Input inflow Control Center

6. Enter Design Criteria:
   From Analyses list << Design Constrain << Velocity << Min =0.6 (m/sec) << Max = 3 (m/sec).
   From Analyses list << Options <<Calculation options << Base design.

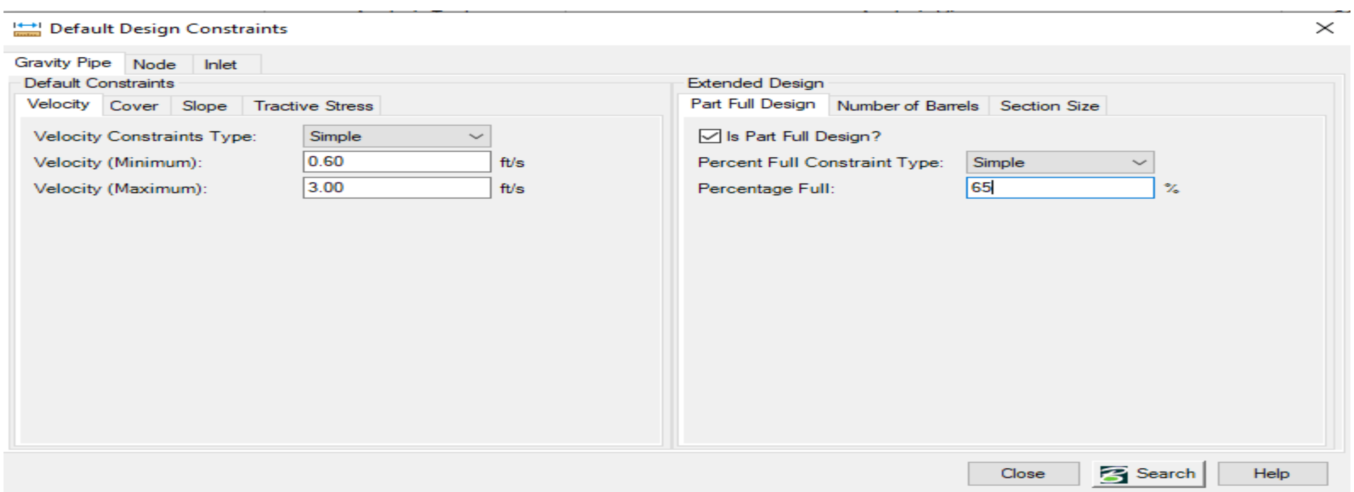

Figure (4.9) : Input Design Criteria (Velocity)

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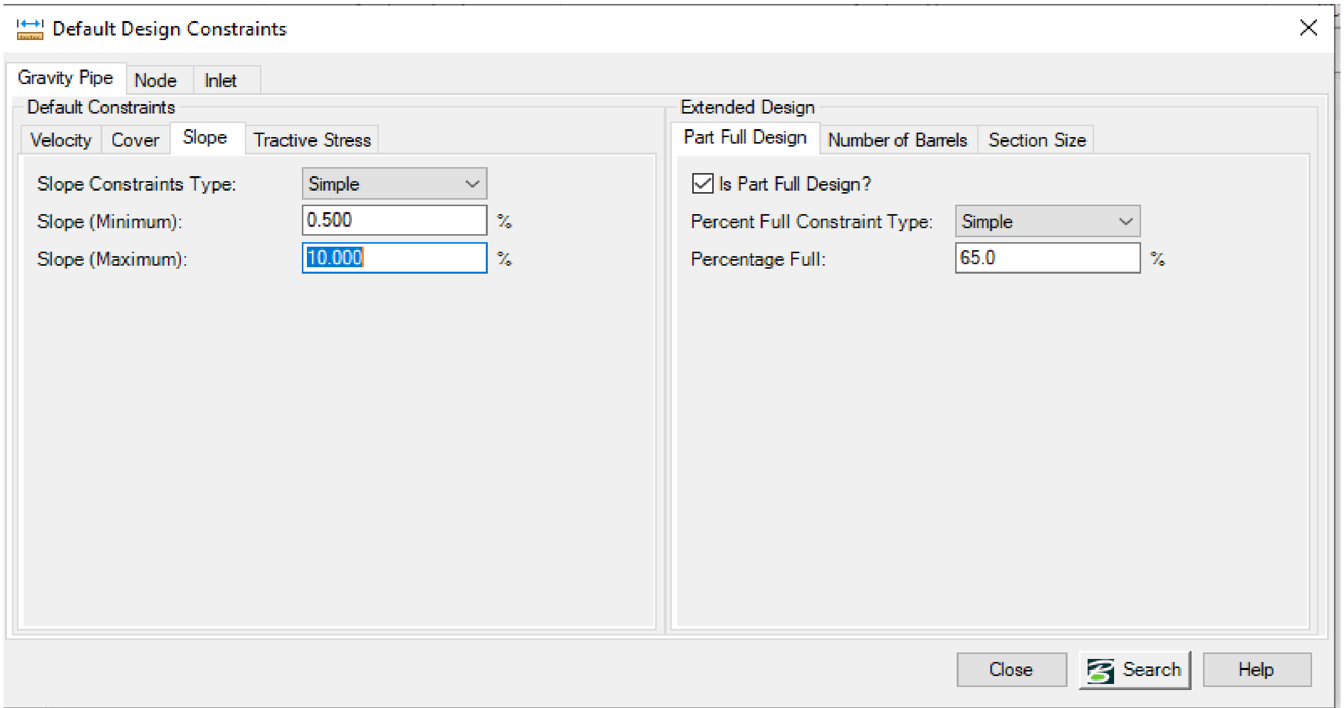

Figure (4.10): Input Design Criteria (Slop pipe)

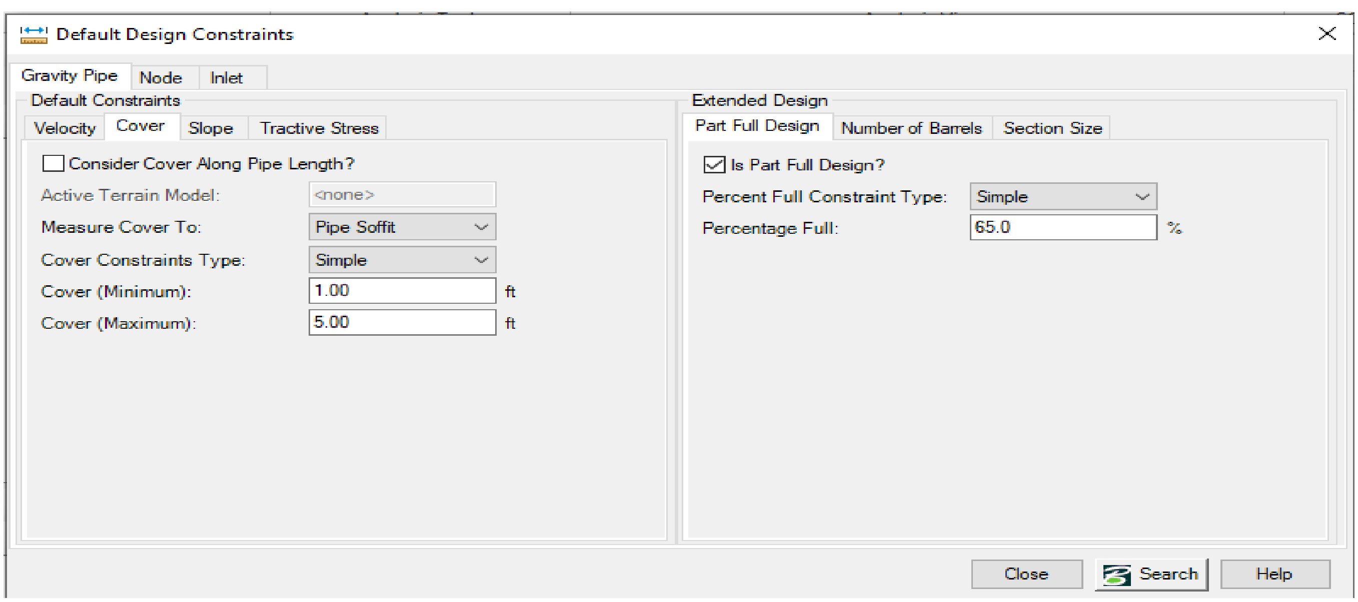

Figure (4.11) : Input Design Criteria (Cover)

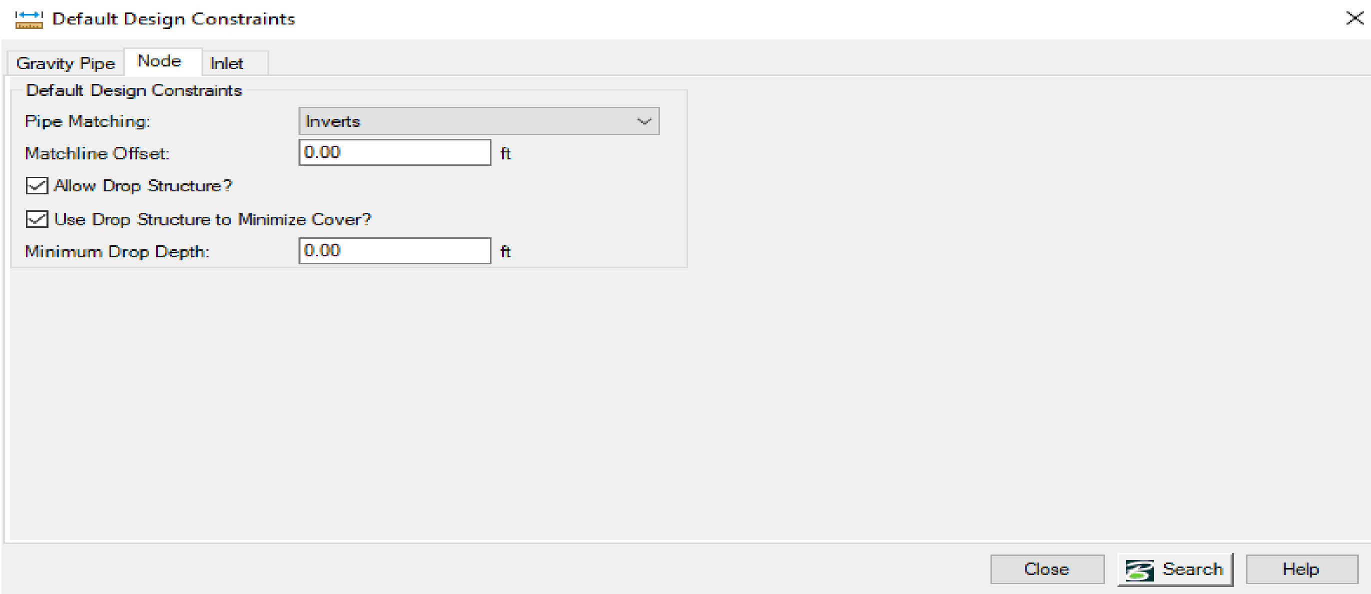

Figure (4.12) : Input Design Criteria (Drop Manhole)

7. Run the program :
   From Analyses list << Compute.
8. Output the Results :
   From Report list << Flex table << Condit table
   From Report list << Flex table << Manhole table

	ID	Label	Start Node	Set Invert to Start?	Invert (Start) (m)	Stop Node	Set Invert to Stop?	Invert (Stop) (m)	Has User Defined Length?	Length (User Defined) (m)	Length (Scaled) (m)	Slope (Calculated) (%)	Section Type	Diameter (mm)	Manning's n
284: pipe-252	284	pipe-252	MH-241	☐	608.21	MH-242	☐	608.16	☐		9.2	0.500	Circle	750.0	0.010
285: pipe-223	285	pipe-223	MH-249	☐	636.13	MH-250	☐	636.08	☐		10.0	0.500	Circle	450.0	0.010
288: pipe-38	288	pipe-38	MH-251	☐	761.59	MH-212	☐	762.54	☐		10.0	9.447	Circle	200.0	0.010
290: pipe-27	290	pipe-27	MH-17	☐	725.41	MH-216	☐	725.61	☐		10.0	2.079	Circle	200.0	0.010
291: pipe-37	291	pipe-37	MH-211	☐	760.65	MH-251	☐	761.59	☐		10.0	9.429	Circle	200.0	0.010
292: pipe-209	292	pipe-209	MH-10	☐	769.90	MH-11	☐	768.90	☐		10.0	10.000	Circle	200.0	0.010
293: pipe-213	293	pipe-213	MH-14	☐	744.85	MH-15	☐	743.85	☐		10.0	10.000	Circle	200.0	0.010
295: pipe-240	295	pipe-240	MH-37	☐	630.52	MH-38	☐	629.52	☐		10.0	10.000	Circle	750.0	0.010
296: pipe-236	296	pipe-236	MH-34	☐	633.88	MH-252	☐	633.80	☐		15.0	0.500	Circle	600.0	0.010
298: pipe-157	298	pipe-157	MH-89	☐	638.85	MH-90	☐	638.93	☐		15.0	0.500	Circle	200.0	0.010
300: pipe-212	300	pipe-212	MH-13	☐	747.67	MH-14	☐	746.17	☐		15.0	10.000	Circle	200.0	0.010
301: pipe-225	301	pipe-225	MH-24	☐	635.83	MH-253	☐	635.75	☐		15.0	0.500	Circle	600.0	0.010
303: pipe-221	303	pipe-221	MH-22	☐	636.30	MH-23	☐	636.23	☐		15.0	0.500	Circle	450.0	0.010
305: pipe-72	305	pipe-72	MH-154	☐	634.55	MH-155	☐	634.62	☐		15.0	0.500	Circle	200.0	0.010
315: pipe-76	315	pipe-76	MH-158	☐	635.15	MH-159	☐	635.22	☐		15.0	0.500	Circle	200.0	0.010
316: pipe-77	316	pipe-77	MH-159	☐	635.22	MH-160	☐	635.32	☐		20.0	0.500	Circle	200.0	0.010
319: pipe-39	319	pipe-39	MH-212	☐	762.54	MH-213	☐	764.54	☐		20.0	10.000	Circle	200.0	0.010
322: pipe-78	322	pipe-78	MH-160	☐	635.32	MH-161	☐	635.42	☐		20.0	0.500	Circle	200.0	0.010
323: pipe-253	323	pipe-253	MH-242	☐	606.76	O-1	☐	606.66	☐		20.0	0.500	Circle	900.0	0.010
325: pipe-160	325	pipe-160	MH-92	☐	639.43	MH-93	☐	639.58	☐		20.0	0.772	Circle	200.0	0.010
329: pipe-147	329	pipe-147	MH-19	☐	636.90	MH-80	☐	637.00	☐		20.0	0.500	Circle	250.0	0.010
330: pipe-222	330	pipe-222	MH-23	☐	636.23	MH-249	☐	636.13	☐		20.0	0.500	Circle	450.0	0.010
331: pipe-17	331	pipe-17	MH-77	☐	641.41	MH-196	☐	643.41	☐		20.0	10.000	Circle	200.0	0.010
336: pipe-242	336	pipe-242	MH-39	☐	621.92	MH-40	☐	620.44	☐		20.0	7.394	Circle	750.0	0.010
337: pipe-231	337	pipe-231	MH-29	☐	634.80	MH-30	☐	634.70	☐		20.0	0.500	Circle	600.0	0.010
342: pipe-79	342	pipe-79	MH-161	☐	635.42	MH-162	☐	635.55	☐		25.0	0.500	Circle	200.0	0.010
344: pipe-226	344	pipe-226	MH-253	☐	635.75	MH-25	☐	635.63	☐		25.0	0.500	Circle	600.0	0.010
345: pipe-19	345	pipe-19	MH-197	☐	652.98	MH-198	☐	653.93	☐		25.0	3.777	Circle	200.0	0.010
346: pipe-227	346	pipe-227	MH-25	☐	635.63	MH-26	☐	635.50	☐		25.0	0.500	Circle	600.0	0.010
347: pipe-232	347	pipe-232	MH-30	☐	634.70	MH-31	☐	634.58	☐		25.0	0.500	Circle	600.0	0.010
351: pipe-20	351	pipe-20	MH-198	☐	653.93	MH-199	☐	654.54	☐		25.0	2.464	Circle	200.0	0.010

Figure (4.13) : Result of conduit

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9. Draw profile :
   From View list << Profile.

10. Output the Result to AutoCAD.

4.6 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 and 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 in Appendix C. This profile has shown the ground elevation, the proposed sewer pipe line.

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Chapter five

Bill of Quantity

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5.1 Bill of Quantity Collection System

No.	EXCAVATION	UNIT	QTY	UNIT PRICE		TOTAL PRICE	
				$	C	$	C
A1	Excavation of pipes trench in all kind of soil for one pipe diameter 200mm depth and disposing of the debris and the top soil unsuitable for backfill outside the site	LM	8895.9				
A2	Excavation of pipes trench in all kind of soil for one pipe diameter 250mm depth and disposing of the debris and the top soil unsuitable for backfill outside the site	LM	245.9				
Sub-Total							
B	PIPE WORK						
B1	Supplying, storing and installing of PVC	LM	9141.8				
Sub-Total							
C	PIPE BEDDING AND BACKFILLING Dimension and material	LM	9141.8				

`

C1	Supplying and embedment of sand for one pipe diameter 8 inch, depth up to 1 meter and disposing of the debris and the top soil unsuitable for backfill outside the site.	LM	8895.9				
C2	Supplying and embedment of sand for one pipe diameter 10 inch, depth up to 1 meter and disposing of the debris and the top soil unsuitable for backfill outside the site.	LM	245.9				
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 m.	NR	666.08				
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	611.43				
Sub-Total							
F	Air And Water Leakage Test						

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F1	Air leakage test for sewer pipe lines and 15 inch according to specifications, including for all temporary works.	LM	9141.8				
F2	Water leakage tests for manholes, depth up to 1 meter according to specifications.	NR	666.08				
F3	Water leakage test for manholes , depth up to 2.5 meter according to specification	NR	611.43				
	Sub-Total						
G	Survey work						
G1	Topographical survey required for shop drawings and as built DWGS using absolute Elev. And coordinate system	LM	9141.8				

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Chapter six

Conclusions and Recommendation

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6.1 Conclusions

In this project, the trial is made to design waste water collection system for Nahaleen village considering the annual growth of the people and their water consumption for the coming 25 years, the water runoff, and catchment area. The result brought out many important conclusions. The main conclusions drawn from the present study are summarized below:

1. Nahaleen has no sewage facility. The people are using laterains cesspits and septic tanks. The waste water has been seeping into the ground through the over flow of the deteriorated cesspits and laterains, causing series environmental and health problem also storm water collect in law areas and flood streets and walk ways, rapid growth has decreased the open areas available for percolation of the rainwater and has greatly increased the runoff to low lying areas.

2. The present population of Nahaleen village is 16773 person prediction of the future population of Nahaleen village is estimated depending on 3.5 % growth rate.

3. The present water consumption of Nahaleen is 120 L/c.day.

4. The slopes of sewer in the proposed waste water, collection system and storm water drainage system are followed the slope of the ground to decrease the cost of construction.

5. For the Wastewater collection system it is found that there are 3 main catchments in the area and each main catchments consists of many 3 sub-main and 12 lateral streets.

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6.2 Recommendation

1- When the Nahaleen municipality implements the sewage network , it takes our design model to implement it on the ground .

2- Implement the design of the sewage network for the area as soon as possible in order to reduce the risks and damages of resulting from the absence of a network of time now.

3- We suggest setting up two treatment plants, to treat wastewater from the network that we designed, as there are two points for collecting wastewater, taking into account all the conditions that restrict the connection of Nahaleen network to other networks.

4- Pay more attention to the infrastructure of the town .

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Appendix Calculation and Design Table

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Appendix A: Tables of Calculation for Wastewater Network.

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A.1 Introduction

The amount of wastewater for the main lines is calculated and displayed on the tables in this Appendix A. We have 3 main streets, 3 submain streets and 12 Lateral street . Where in this appendix we divided each street with a special table in it to show the amount of flow that comes out from each street, and this amount that takes in the design of the sewage network, and is entered into the Sewer CAD design program. The criteria were taken as a 3.5% population growth rate, as well as water consumption 120L/c/d. The current population density is 8437 C/km^2 .

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A.2 Table of Calculation Report For (Main Street 1)

Main Street 1														
	Current density of population (C/km²)				**8437**		(d/D) Assume	**0.65**	Growth rate (%) 3.50%	Water Consumption (L/c/d)=120				
Pipe no.	Manholes		Length (m)	Area (m²)	Population			{.8 Qavg} (m3/s) after 25 years		P_f	$Q_{max\ (p)}$ (m³/s)	$Q_{max\ (p)}$ (m³/day)	$Q_{max\ (p)}$ (m³/day) each pipe	$Q_{Design\ (p)}$ (m³/day)
	From	To			Now	After 25 years	Cumulative	Increment	Cumulative					
1	1	2	30	1310	12	23	23	2.56E-05	2.6E-05	3	0.0001	9.654	9.6537	10.6
2	1	3	27	3294	28	52	75	5.78E-05	8.3E-05	3	0.0004	30.785	21.1315	23.2
3	1	4	50	7928	67	125	200	0.000139	0.00022	3	0.0009	79.642	48.8571	53.7
4	4	5	50	9835	83	154	354	0.000171	0.00039	3	0.0016	137.527	57.8842	63.7
5	5	6	40	7441	63	117	471	0.00013	0.00052	3	0.0021	180.296	42.7693	47.0
6	6	7	26	6395	54	101	572	0.000112	0.00064	3	0.0025	216.543	36.2474	39.9
7	7	8	50	11968	101	188	760	0.000209	0.00084	3	0.0033	282.625	66.0814	72.7
8	8	9	25	8635.3	73	136	896	0.000151	0.001	3	0.0038	329.462	46.8375	51.5
9	9	10	50	13877	118	219	1115	0.000243	0.00124	3	0.0047	403.436	73.9740	81.4
10	10	11	13	5649.4	48	89	1204	9.89E-05	0.00134	3	0.0050	433.043	29.6072	32.6
11	11	12	50	13111	111	206	1410	0.000229	0.00157	3	0.0058	500.674	67.6302	74.4
12	12	13	44	4777.8	41	77	1487	8.56E-05	0.00165	3	0.0061	525.654	24.9803	27.5
13	13	14	9	3057.4	26	49	1536	5.44E-05	0.00171	3	0.0063	541.471	15.8171	17.4
14	14	15	9	14774	125	232	1768	0.000258	0.00196	3	0.0071	615.571	74.1000	81.5
15	15	16	50	7396.5	63	117	1885	0.00013	0.00209	3	0.0076	652.477	36.9063	40.6
16	16	17	41	6962	59	110	1995	0.000122	0.00222	3	0.0080	686.912	34.4344	37.9
17	17	18	50	20590	174	323	2318	0.000359	0.00258	3	0.0091	786.655	99.7437	109.7
18	18	19	23	2464	21	39	2357	4.33E-05	0.00262	3	0.0092	798.569	11.9136	13.1

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19	19	20	28	55684	470	872	3229	0.000969	0.00359	3	0.0123	1058.616	260.0470	286.1
20	20	21	40	4621.1	39	73	3302	8.11E-05	0.00367	3	0.0125	1079.891	21.2746	23.4
21	21	22	25	990.3	9	17	3319	1.89E-05	0.00369	3	0.0126	1084.835	4.9444	5.4
22	22	23	25	1247.2	11	21	3340	2.33E-05	0.00371	3	0.0126	1090.937	6.1026	6.7
23	23	24	26	1431	13	25	3365	2.78E-05	0.00374	3	0.0127	1098.195	7.2576	8.0
24	24	25	20	1452.3	13	25	3390	2.78E-05	0.00377	3	0.0128	1105.445	7.2496	8.0
25	25	26	39	3159	27	51	3441	5.67E-05	0.00382	3	0.0130	1120.209	14.7648	16.2
26	26	27	50	4255	36	67	3508	7.44E-05	0.0039	3	0.0132	1139.557	19.3475	21.3
27	27	28	50	2169	19	36	3544	0.00004	0.00394	3	0.0133	1149.930	10.3728	11.4
28	28	29	50	48823	412	764	4308	0.000849	0.00479	3	0.0158	1366.557	216.6270	238.3
29	29	30	50	2725.7	23	43	4351	4.78E-05	0.00483	3	0.0160	1378.563	12.0060	13.2
30	30	31	50	2895	25	47	4398	5.22E-05	0.00489	3	0.0161	1391.664	13.1016	14.4
31	31	32	50	2488.2	21	39	4437	4.33E-05	0.00493	3	0.0162	1402.519	10.8548	11.9
32	32	33	50	4019.4	34	64	4501	7.11E-05	0.005	3	0.0164	1420.300	17.7805	19.6
33	33	34	50	5995.6	51	95	4596	0.000106	0.00511	3	0.0167	1446.619	26.3194	29.0
34	34	35	50	5380.1	46	86	4682	9.56E-05	0.0052	3	0.0170	1470.371	23.7516	26.1
35	35	36	50	5149.2	44	2731	7413	0.003034	0.00824	3	0.0254	2193.656	723.2857	795.6
36	36	37	50	39045	330	612	8025	0.00068	0.00892	3	0.0272	2348.894	155.2373	170.8
37	37	38	50	3441.7	30	56	8081	6.22E-05	0.00898	3	0.0273	2362.993	14.0990	15.5
38	38	39	50	2626.1	23	43	8124	4.78E-05	0.00903	3	0.0275	2373.807	10.8144	11.9
39	39	40	50	1260.3	11	21	8145	2.33E-05	0.00905	3	0.0275	2379.085	5.2778	5.8
40	40	41	50	11040	94	3233	11378	0.003592	0.01264	2.90	0.0366	3166.310	787.2251	865.9
41	41	42	50	11626	99	184	11562	0.000204	0.01285	2.89	0.0372	3209.778	43.4677	47.8
42	42	43	10	3012	26	49	11611	5.44E-05	0.0129	2.89	0.0373	3221.332	11.5541	12.7
43	43	44	50	7256	62	115	11726	0.000128	0.01303	2.89	0.0376	3248.413	27.0816	29.8
44	44	45	22	3436	29	54	11780	0.00006	0.01309	2.88	0.0377	3261.113	12.6997	14.0
45	45	46	50	4650	40	75	11855	8.33E-05	0.01317	2.88	0.0379	3278.734	17.6207	19.4
46	46	47	50	4270	37	69	11924	7.67E-05	0.01325	2.88	0.0381	3294.927	16.1929	17.8

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A.3 Table of Calculation Report For (Main Street 2)

Main Street 2														
	Current density of population (C/km^2)				8437		(d/D) Assume	0.65	Growth rate (%) 3.50%	Water Consumption (L/c/d)=120				
Pipe no.	Manholes		Length (m)	Area (m^2)	Population			{.8 Qavg} (m3/s) after 25 years		P_f	$Q_{max\ (p)}$ (m^3/s)	$Q_{max\ (p)}$ (m^3/day)	$Q_{max\ (p)}$ (m^3/day) each pipe	$Q_{Design\ (p)}$ (m^3/day)
	From	To			Now	After 25 years	Cumulative	Increment	Cumulative					
1	1	2	50	47524	401	744	744	0.000827	0.00083	3	0.0032	277.064	277.064	304.8
2	1	3	31	3320	29	54	798	0.00006	0.00089	3	0.0034	295.787	18.7232	20.6
3	1	4	50	9476	80	149	947	0.000166	0.00105	3	0.0040	346.840	51.0532	56.2
4	4	5	50	7200	61	114	1061	0.000127	0.00118	3	0.0045	385.349	38.5086	42.4
5	5	6	22	3000	26	49	1110	5.44E-05	0.00123	3	0.0047	401.765	16.4164	18.1
6	6	7	50	3760	32	60	1170	6.67E-05	0.0013	3	0.0049	421.762	19.9964	22.0
7	7	8	50	3760	32	60	1230	6.67E-05	0.00137	3	0.0051	441.647	19.8849	21.9
8	8	9	22	5145	44	82	1312	9.11E-05	0.00146	3	0.0054	468.650	27.0034	29.7
9	9	10	50	201464	1700	3152	4464	0.003502	0.00496	3	0.0163	1410.025	941.375	1035.5
10	10	11	33	3800	33	62	4526	6.89E-05	0.00503	3	0.0165	1427.234	17.2091	18.9
11	11	12	50	6380	54	101	4627	0.000112	0.00514	3	0.0168	1455.189	27.9545	30.7
12	12	13	31	3460	30	56	4683	6.22E-05	0.0052	3	0.0170	1470.646	15.4576	17.0
13	13	14	50	2750	24	45	4728	0.00005	0.00525	3	0.0172	1483.046	12.4000	13.6
14	14	15	50	3350	29	54	4782	0.00006	0.00531	3	0.0173	1497.902	14.8551	16.3
15	15	16	30	612	6	12	4794	1.33E-05	0.00533	3	0.0174	1501.199	3.2975	3.6
16	16	17	50	680	6	12	4806	1.33E-05	0.00534	3	0.0174	1504.495	3.2962	3.6

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17	17	18	30	1140	10	19	4825	2.11E-05	0.00536	3	0.0175	1509.711	5.2162	5.7
18	18	19	30	2600	22	41	4866	4.56E-05	0.00541	3	0.0176	1520.956	11.2448	12.4
19	19	20	50	2650	23	43	4909	4.78E-05	0.00545	3	0.0177	1532.733	11.7770	13.0
20	20	21	20	3790	32	60	4969	6.67E-05	0.00552	3	0.0179	1549.139	16.4053	18.0
21	21	22	29	4000	34	64	5033	7.11E-05	0.00559	3	0.0181	1566.602	17.4638	19.2
22	22	23	20	2000	17	32	5065	3.56E-05	0.00563	3	0.0182	1575.321	8.7184	9.6
23	23	24	43	5767	49	91	5156	0.000101	0.00573	3	0.0185	1600.065	24.7444	27.2
24	24	25	50	3312	28	52	5208	5.78E-05	0.00579	3	0.0187	1614.173	14.1078	15.5
25	25	26	50	4580	39	73	5281	8.11E-05	0.00587	3	0.0189	1633.939	19.7665	21.7
26	26	27	50	5570	47	88	5369	9.78E-05	0.00597	3	0.0192	1657.708	23.7688	26.1
27	27	28	50	95214	804	1491	6860	0.001657	0.00762	3	0.0237	2051.462	393.753	433.1
28	28	29	50	164010	1384	2566	9426	0.002851	0.01047	2.98	0.0312	2696.724	645.262	709.8

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A.4 Table of Calculation Report For (Main Street 3)

Main Street 3															
	Current density of population (C/km²)				8437		(d/D) Assume	0.65	Growth rate (%) 3.50%	Water Consumption (L/c/d)=120					
Pipe no.	Manholes		Length (m)	Area (m^2)	Population			{.8 Qavg} (m3/s) after 25 years		P_f	$Q_{max\ (p)}$ (m^3/s)	$Q_{max\ (p)}$ (m^3/day)	$Q_{max\ (p)}$ (m^3/day) each pipe	$Q_{Design\ (p)}$ (m^3/day)	
	From	To			Now	After 25 years	Cumulative	Increment	Cumulative						
1	1	2	43	3030	26	49	49	5.44E-05	5.4E-05	3	0.0002	20.305	20.305	22.3	
2	1	3	30	2226	19	36	85	0.00004	9.4E-05	3	0.0004	34.780	14.4751	15.9	
3	1	4	40	4069	35	65	150	7.22E-05	0.00017	3	0.0007	60.351	25.5711	28.1	
4	4	5	50	5127	44	82	232	9.11E-05	0.00026	3	0.0011	91.846	31.4953	34.6	
5	5	6	41	15518	131	243	475	0.00027	0.00053	3	0.0021	181.743	89.8964	98.9	
6	6	7	40	1640	14	26	501	2.89E-05	0.00056	3	0.0022	191.123	9.3804	10.3	
7	7	8	21	220	2	4	505	4.44E-06	0.00056	3	0.0022	192.563	1.4396	1.6	
8	8	9	39	3824	33	62	567	6.89E-05	0.00063	3	0.0025	214.762	22.1996	24.4	
9	9	10	38	7062	60	112	679	0.000124	0.00075	3	0.0029	254.358	39.595	43.6	

A.5 Table of Calculation Report For (Sub Main Street 1)

Sub Main Street 1														
	Current density of population (C/km^2)				8437		(d/D) Assume	0.65	Growth rate (%) 3.50%	Water Consumption (L/c/d)=120				
Pipe no.	Manholes		Length (m)	Area (m^2)	Population			{.8 Qavg} (m3/s) after 25 years		P_f	$Q_{max\ (p)}$ (m^3/s)	$Q_{max\ (p)}$ (m^3/day)	$Q_{max\ (p)}$ (m^3/day) each pipe	$Q_{Design\ (p)}$ (m^3/day)
	From	To			Now	After 25 years	Cumulative	Increment	Cumulative					
1	1	2	27	4792	41	77	77	8.56E-05	8.6E-05	3	0.0004	31.586	31.586	34.7
2	1	3	50	4037	35	65	142	7.22E-05	0.00016	3	0.0007	57.236	25.6505	28.2
3	1	4	12	663	6	12	154	1.33E-05	0.00017	3	0.0007	61.905	4.6689	5.1
4	4	5	50	3100	27	51	205	5.67E-05	0.00023	3	0.0009	81.556	19.6510	21.6
5	5	6	18	1470	13	25	230	2.78E-05	0.00026	3	0.0011	91.086	9.5303	10.5
6	6	7	50	12399	105	195	425	0.000217	0.00047	3	0.0019	163.588	72.5016	79.8
7	7	8	50	3840	33	62	487	6.89E-05	0.00054	3	0.0022	186.077	22.4889	24.7
8	8	9	15	1940	17	32	519	3.56E-05	0.00058	3	0.0023	197.594	11.5171	12.7
9	9	10	18	2432	21	39	558	4.33E-05	0.00062	3	0.0024	211.553	13.959	15.4
10	10	11	36	2478	21	39	597	4.33E-05	0.00066	3	0.0026	225.430	13.8770	15.3
11	11	12	32	1862	16	30	627	3.33E-05	0.0007	3	0.0027	236.051	10.6216	11.7
12	12	13	30	1183	10	19	646	2.11E-05	0.00072	3	0.0028	242.755	6.7039	7.4
13	13	14	20	962	9	17	663	1.89E-05	0.00074	3	0.0029	248.739	5.9835	6.6
14	14	15	42	1986	17	32	695	3.56E-05	0.00077	3	0.0030	259.965	11.2260	12.3

A.6 Table of Calculation Report For (Sub Main Street 2)

Sub Main Street 2															
	Current density of population (C/km^2)				8437		(d/D) Assume	0.65	Growth rate (%) 3.50%	Water Consumption (L/c/d)=120					
Pipe no.	Manholes		Length (m)	Area (m^2)	Population			{.8 Qavg} (m3/s) after 25 years		P_f	$Q_{max (p)}$ (m^3/s)	$Q_{max (p)}$ (m^3/day)	$Q_{max (p)}$ (m^3/day) each pipe	$Q_{Design (p)}$ (m^3/day)
	From	To			Now	After 25 years	Cumulative	Increment	Cumulative					
1	1	2	c	11921	101	188	188	0.000209	0.00021	3	0.0009	75.038	75.038	82.5
2	1	3	46	5322	45	84	272	9.33E-05	0.0003	3	0.0012	106.962	31.9240	35.1
3	1	4	50	2552	22	41	313	4.56E-05	0.00035	3	0.0014	122.311	15.3491	16.9
4	4	5	50	9990	85	158	471	0.000176	0.00052	3	0.0021	180.296	57.9844	63.8
5	5	6	30	3980	34	64	535	7.11E-05	0.00059	3	0.0024	203.331	23.0349	25.3
6	6	7	14	2740	24	45	580	0.00005	0.00064	3	0.0025	219.390	16.0597	17.7
7	7	8	50	2053	18	34	614	3.78E-05	0.00068	3	0.0027	231.454	12.0636	13.3
8	8	9	39	5700	49	91	705	0.000101	0.00078	3	0.0030	263.463	32.0090	35.2
9	9	10	50	1386	12	23	728	2.56E-05	0.00081	3	0.0031	271.492	8.029	8.8
10	10	11	13	805	7	13	741	1.44E-05	0.00082	3	0.0032	276.020	4.5279	5.0
11	11	12	50	32263	273	507	1248	0.000563	0.00139	3	0.0052	447.591	171.571	188.7
12	12	13	50	1250	11	21	1269	2.33E-05	0.00141	3	0.0053	454.514	6.9231	7.6
13	13	14	36	660	6	12	1281	1.33E-05	0.00142	3	0.0053	458.464	3.9503	4.3
14	14	15	22	750	7	13	1294	1.44E-05	0.00144	3	0.0054	462.739	4.2748	4.7
15	15	16	33	400	4	8	1302	8.89E-06	0.00145	3	0.0054	465.367	2.6282	2.9
16	16	17	32	700	6	12	1314	1.33E-05	0.00146	3	0.0054	469.306	3.9389	4.3

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17	17	18	40	900	8	15	1329	1.67E-05	0.00148	3	0.0055	474.224	4.9179	5.4
18	18	19	43	2300	20	38	1367	4.22E-05	0.00152	3	0.0056	486.655	12.4307	13.7
19	19	20	15	2400	21	39	1406	4.33E-05	0.00156	3	0.0058	499.372	12.7166	14.0
20	20	21	35	2350	20	38	1444	4.22E-05	0.0016	3	0.0059	511.723	12.3514	13.6
21	21	22	31	2500	22	41	1485	4.56E-05	0.00165	3	0.0061	525.007	13.2840	14.6
22	22	23	35	2221	19	36	1521	0.00004	0.00169	3	0.0062	536.635	11.6284	12.8
23	23	24	40	3300	28	52	1573	5.78E-05	0.00175	3	0.0064	553.375	16.7392	18.4
24	24	25	48	4300	37	69	1642	7.67E-05	0.00182	3	0.0067	575.484	22.1098	24.3
25	25	26	49	2122	18	34	1676	3.78E-05	0.00186	3	0.0068	586.337	10.8530	11.9
26	26	27	50	2000	17	32	1708	3.56E-05	0.0019	3	0.0069	596.527	10.1901	11.2
27	27	28	50	2600	22	41	1749	4.56E-05	0.00194	3	0.0071	609.549	13.022	14.3
28	28	29	50	1200	11	21	1770	2.33E-05	0.00197	3	0.0071	616.204	6.655	7.3
29	29	30	22	840	8	15	1785	1.67E-05	0.00198	3	0.0072	620.952	4.7476	5.2
30	30	31	50	48195	407	755	2540	0.000839	0.00282	3	0.0099	854.122	233.171	256.5
31	31	32	25	740	7	13	2553	1.44E-05	0.00284	3	0.0099	858.048	3.9251	4.3

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A.7 Table of Calculation Report For (Sub Main Street 3)

Sub Main Street 3															
	Current density of population (C/km²)				8437		(d/D) Assume	0.65	Growth rate (%) 3.50%	Water Consumption (L/c/d)=120					
Pipe no.	Manholes		Length (m)	Area (m²)	Population			{.8 Qavg} (m3/s) after 25 years		P_f	$Q_{max\ (p)}$ (m^3/s)	$Q_{max\ (p)}$ (m^3/day)	$Q_{max\ (p)}$ (m^3/day) each pipe	$Q_{Design\ (p)}$ (m^3/day)
	From	To			Now	After 25 years	Cumulative	Increment	Cumulative					
1	1	2	50	31097	263	488	488	0.000542	0.00054	3	0.0022	186.438	186.438	205.1
2	1	3	36	4500	38	71	559	7.89E-05	0.00062	3	0.0025	211.909	25.4717	28.0
3	1	4	43	4222	36	67	626	7.44E-05	0.0007	3	0.0027	235.698	23.7884	26.2
4	4	5	50	1089	10	19	645	2.11E-05	0.00072	3	0.0028	242.403	6.7048	7.4
5	5	6	16	4100	35	65	710	7.22E-05	0.00079	3	0.0031	265.211	22.8078	25.1
6	6	7	39	4450	38	71	781	7.89E-05	0.00087	3	0.0034	289.906	24.6957	27.2
7	7	8	40	3400	29	54	835	0.00006	0.00093	3	0.0036	308.546	18.6399	20.5
8	8	9	22	7860	67	125	960	0.000139	0.00107	3	0.0041	351.255	42.7088	47.0
9	9	10	50	1300	11	21	981	2.33E-05	0.00109	3	0.0041	358.373	7.118	7.8
10	10	11	43	24282	205	381	1362	0.000423	0.00151	3	0.0056	485.022	126.648	139.3
11	11	12	10	3010	26	49	1411	5.44E-05	0.00157	3	0.0058	500.999	15.9773	17.6
12	12	13	15	1952	17	32	1443	3.56E-05	0.0016	3	0.0059	511.398	10.3994	11.4
13	13	14	39	2000	17	32	1475	3.56E-05	0.00164	3	0.0060	521.771	10.3726	11.4

A.8 Table of Calculation Report For (Lateral Street 1)

Lateral Street 1														
	Current density of population (C/km^2)				8437		(d/D) Assume	0.65	Growth rate (%) 3.50%	Water Consumption (L/c/d)=120				
Pipe no.	Manholes		Length (m)	Area (m^2)	Population			{.8 Qavg} (m3/s) after 25 years		P_f	$Q_{max\ (p)}$ (m^3/s)	$Q_{max\ (p)}$ (m^3/day)	$Q_{max\ (p)}$ (m^3/day) each pipe	$Q_{Design\ (p)}$ (m^3/day)
	From	To			Now	After 25 years	Cumulative	Increment	Cumulative					
1	1	2	39	303	3	6	6	6.67E-06	6.67E-06	3	0.00003	2.55370	2.55370	2.8
2	1	3	28	434	4	8	14	8.89E-06	1.56E-05	3	0.00007	5.91285	3.35915	3.7
3	1	4	22	1004	9	17	31	1.89E-05	3.44E-05	3	0.00015	12.95285	7.04000	7.7
4	4	5	11	463	4	8	39	8.89E-06	4.33E-05	3	0.00019	16.23148	3.27863	3.6
5	5	6	11	1050	9	17	56	1.89E-05	6.22E-05	3	0.00027	23.14101	6.90953	7.6
6	6	7	50	2812	24	45	101	0.00005	0.000112	3	0.00048	41.13420	17.99319	19.8
7	7	8	50	2615	23	43	144	4.78E-05	0.00016	3	0.00067	58.01562	16.88142	18.6
8	8	9	50	2500	22	41	185	4.56E-05	0.000206	3	0.00086	73.88494	15.86932	17.5

A.9 Table of Calculation Report For (Lateral Street 2)

Lateral Street 2														
	Current density of population (C/km²)				**8437**		(d/D) Assume	**0.65**	Growth rate (%) 3.50%	Water Consumption (L/c/d)=120				
Pipe no.	Manholes		Length (m)	Area (m^2)	Population			{.8 Qavg} (m3/s) after 25 years		P_f	$Q_{max\,(p)}$ (m^3/s)	$Q_{max\,(p)}$ (m^3/day)	$Q_{max\,(p)}$ (m^3/day) each pipe	$Q_{Design\,(p)}$ (m^3/day)
	From	To			Now	After 25 years	Cumulative	Increment	Cumulative					
1	1	2	50	2362	20	38	38	4.22E-05	4.2E-05	3	0.00018	15.82268	15.82268	17.4
2	1	3	50	2923	25	47	85	5.22E-05	9.4E-05	3	0.00040	34.77977	18.95709	20.9
3	1	4	50	2396	21	39	124	4.33E-05	0.00014	3	0.00058	50.19692	15.41715	17.0
4	4	5	50	2636	23	43	167	4.78E-05	0.00019	3	0.00077	66.94275	16.74583	18.4
5	5	6	50	3368	29	54	221	0.00006	0.00025	3	0.00101	87.66274	20.71999	22.8
6	6	7	50	4800	41	77	298	8.56E-05	0.00033	3	0.00135	116.71213	29.04939	32.0
7	7	8	9	310	3	6	304	6.67E-06	0.00034	3	0.00138	118.95405	2.24193	2.5

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A.10 Table of Calculation Report For (Lateral Street 3)

Lateral Street 3																
	Current density of population (C/km^2)				**8437**		(d/D) Assume	**0.65**	Growth rate (%) 3.50%	Water Consumption (L/c/d)=120					
Pipe no.	Manholes		Length (m)	Area (m^2)	Population			{.8 Qavg} (m3/s) after 25 years		P_f	$Q_{max (p)}$ (m^3/s)	$Q_{max (p)}$ (m^3/day)	$Q_{max (p)}$ (m^3/day) each pipe	$Q_{Design (p)}$ (m^3/day)
	From	To			Now	After 25 years	Cumulative	Increment	Cumulative					
1	1	2	30	3448	30	56	56	6.22E-05	6.2E-05	3	0.00027	23.14101	23.14101	25.5
2	1	3	50	3473	30	56	112	6.22E-05	0.00012	3	0.00053	45.47857	22.33756	24.6
3	1	4	50	1388	12	23	135	2.56E-05	0.00015	3	0.00063	54.50394	9.02538	9.9

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A.11 Table of Calculation Report For (Lateral Street 4)

Lateral Street 4															
	Current density of population (C/km^2)				**8437**		(d/D) Assume	**0.65**	Growth rate (%) 3.50%	Water Consumption (L/c/d)=120					
Pipe no.	Manholes		Length (m)	Area (m^2)	Population			{.8 Qavg} (m3/s) after 25 years		P_f	$Q_{max\ (p)}$ (m^3/s)	$Q_{max\ (p)}$ (m^3/day)	$Q_{max\ (p)}$ (m^3/day) each pipe	$Q_{Design\ (p)}$ (m^3/day)
	From	To			Now	After 25 years	Cumulative	Increment	Cumulative					
1	1	2	24	3800	33	62	62	6.89E-05	6.9E-05	3	0.00030	25.56321	25.56321	28.1
2	1	3	50	5340	46	86	148	9.56E-05	0.00016	3	0.00069	59.57294	34.00973	37.4
3	1	4	24	3940	34	64	212	7.11E-05	0.00024	3	0.00097	84.23098	24.65804	27.1
4	4	5	42	4200	36	67	279	7.44E-05	0.00031	3	0.00127	109.59298	25.36200	27.9
5	5	6	50	5428	46	86	365	9.56E-05	0.00041	3	0.00164	141.58730	31.99432	35.2
6	6	7	50	5015	43	80	445	8.89E-05	0.00049	3	0.00198	170.86856	29.28126	32.2
7	7	8	40	2270	20	38	483	4.22E-05	0.00054	3	0.00214	184.63307	13.76450	15.1

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A.12 Table of Calculation Report For (Lateral Street 5)

Lateral Street 5													
	Current density of population (C/km^2)			8437		(d/D) Assume	0.65	Growth rate (%) 3.50%	Water Consumption (L/c/d)=120				
Pipe no.	Manholes		Length (m)	Area (m^2)	Population			{.8 Qavg} (m3/s) after 25 years		P_f	$Q_{max (p)}$ (m^3/s)	$Q_{max (p)}$ (m^3/day)	$Q_{max (p)}$ (m^3/day) each pipe	$Q_{Design (p)}$ (m^3/day)
	From	To			Now	After 25 years	Cumulative	Increment	Cumulative					
1	1	2	50	4273	37	69	69	7.67E-05	7.7E-05	3	0.00033	28.37934	28.37934	31.2
2	1	3	23	3000	26	49	118	5.44E-05	0.00013	3	0.00055	47.84040	19.46106	21.4
3	1	4	50	2690	23	43	161	4.78E-05	0.00018	3	0.00075	64.62024	16.77984	18.5
4	4	5	29	3725	32	60	221	6.67E-05	0.00025	3	0.00101	87.66274	23.04250	25.3
5	5	6	20	2066	18	34	255	3.78E-05	0.00028	3	0.00116	100.55589	12.89315	14.2
6	6	7	35	3610	31	58	313	6.44E-05	0.00035	3	0.00142	122.31148	21.75559	23.9

A.13 Table of Calculation Report For (Lateral Street 6)

Lateral Street 6														
	Current density of population (C/km^2)				**8437**		(d/D) Assume	**0.65**	Growth rate (%) 3.50%	Water Consumption (L/c/d)=120				
Pipe no.	Manholes		Length (m)	Area (m^2)	Population			{.8 Qavg} (m3/s) after 25 years		P_f	$Q_{max\ (p)}$ (m^3/s)	$Q_{max\ (p)}$ (m^3/day)	$Q_{max\ (p)}$ (m^3/day) each pipe	$Q_{Design\ (p)}$ (m^3/day)
	From	To			Now	After 25 years	Cumulative	Increment	Cumulative					
1	1	2	40	3945	34	64	64	7.11E-05	7.1E-05	3	0.00031	26.36887	26.36887	29.0
2	1	3	50	2710	23	43	107	4.78E-05	0.00012	3	0.00050	43.50620	17.13734	18.9

A.14 Table of Calculation Report For (Lateral Street 7)

Lateral Street 7														
	Current density of population (C/km^2)				8437		(d/D) Assume	0.65	Growth rate (%) 3.50%	Water Consumption (L/c/d)=120				
Pipe no.	Manholes		Length (m)	Area (m^2)	Population			{.8 Qavg} (m3/s) after 25 years		P_f	$Q_{max\ (p)}$ (m^3/s)	$Q_{max\ (p)}$ (m^3/day)	$Q_{max\ (p)}$ (m^3/day) each pipe	$Q_{Design\ (p)}$ (m^3/day)
	From	To			Now	After 25 years	Cumulative	Increment	Cumulative					
1	1	2	36	4200	36	67	67	7.44E-05	7.4E-05	3	0.00032	27.57577	27.57577	30.3
2	1	3	36	2482	21	39	106	4.33E-05	0.00012	3	0.00050	43.11126	15.53550	17.1
3	1	4	32	3770	32	60	166	6.67E-05	0.00018	3	0.00077	66.55596	23.44470	25.8
4	4	5	41	4000	34	64	230	7.11E-05	0.00026	3	0.00105	91.08642	24.53046	27.0
5	5	6	27	2549	22	41	271	4.56E-05	0.0003	3	0.00123	106.58625	15.49983	17.0
6	6	7	20	2041	18	34	305	3.78E-05	0.00034	3	0.00138	119.32742	12.74117	14.0
7	7	8	42	10655	90	167	472	0.000186	0.00052	3	0.00209	180.65763	61.33020	67.5

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A.15 Table of Calculation Report For (Lateral Street 8)

Lateral Street 8														
	Current density of population (C/km^2)				8437		(d/D) Assume	0.65	Growth rate (%) 3.50%	Water Consumption (L/c/d)=120				
Pipe no.	Manholes		Length (m)	Area (m^2)	Population			{.8 Qavg} (m3/s) after 25 years		P_f	$Q_{max (p)}$ (m^3/s)	$Q_{max (p)}$ (m^3/day)	$Q_{max (p)}$ (m^3/day) each pipe	$Q_{Design (p)}$ (m^3/day)
	From	To			Now	After 25 years	Cumulative	Increment	Cumulative					
1	1	2	16	1888	16	30	30	3.33E-05	3.3E-05	3	0.00015	12.54164	12.54164	13.8
2	1	3	50	2778	24	45	75	0.00005	8.3E-05	3	0.00036	30.78523	18.24359	20.1
3	1	4	20	2663	23	43	118	4.78E-05	0.00013	3	0.00055	47.84040	17.05517	18.8
4	4	5	20	2095	18	34	152	3.78E-05	0.00017	3	0.00071	61.12821	13.28782	14.6
5	5	6	25	2400	21	39	191	4.33E-05	0.00021	3	0.00088	76.19085	15.06263	16.6
6	6	7	25	2000	17	32	223	3.56E-05	0.00025	3	0.00102	88.42425	12.23340	13.5
7	7	8	50	1200	11	21	244	2.33E-05	0.00027	3	0.00112	96.39655	7.97230	8.8
8	8	9	42	725	7	13	257	1.44E-05	0.00029	3	0.00117	101.31094	4.91439	5.4
9	9	10	50	1653	14	26	283	2.89E-05	0.00031	3	0.00129	111.09428	9.78334	10.8
10	10	11	50	2400	21	39	322	4.33E-05	0.00036	3	0.00145	125.66245	14.56818	16.0

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A.16 Table of Calculation Report For (Lateral Street 9)

Lateral Street 9															
	Current density of population (C/km^2)				8437		(d/D) Assume	0.65	Growth rate (%) 3.50%	Water Consumption (L/c/d)=120					
Pipe no.	Manholes		Length (m)	Area (m^2)	Population			{.8 Qavg} (m3/s) after 25 years		P_f	$Q_{max\ (p)}$ (m^3/s)	$Q_{max\ (p)}$ (m^3/day)	$Q_{max\ (p)}$ (m^3/day) each pipe	$Q_{Design\ (p)}$ (m^3/day)	
	From	To			Now	After 25 years	Cumulative	Increment	Cumulative						
1	1	2	18	7150	61	114	114	0.000127	0.00013	3	0.00054	46.26644	46.26644	50.9	
2	1	3	35	5993	51	95	209	0.000106	0.00023	3	0.00096	83.08522	36.81878	40.5	
3	1	4	40	9513	81	151	360	0.000168	0.0004	3	0.00162	139.74261	56.65739	62.3	
4	4	5	23	4723	40	75	435	8.33E-05	0.00048	3	0.00194	167.23147	27.48886	30.2	
5	5	6	23	4770	41	77	512	8.56E-05	0.00057	3	0.00226	195.07967	27.84820	30.6	
6	6	7	50	5576	48	89	601	9.89E-05	0.00067	3	0.00263	226.84848	31.76881	34.9	
7	7	8	50	4730	40	75	676	8.33E-05	0.00075	3	0.00293	253.30492	26.45644	29.1	
8	8	9	50	2400	21	39	715	4.33E-05	0.00079	3	0.00309	266.95695	13.65204	15.0	
9	9	10	50	1740	15	28	743	3.11E-05	0.00083	3	0.00320	276.71616	9.75921	10.7	

A.17 Table of Calculation Report For (Lateral Street 10)

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Lateral Street 10															
	Current density of population (C/km^2)				8437		(d/D) Assume	0.65	Growth rate (%) 3.50%	Water Consumption (L/c/d)=120					
Pipe no.	Manholes		Length (m)	Area (m^2)	Population			{.8 Qavg} (m3/s) after 25 years		P_f	$Q_{max\ (p)}$ (m^3/s)	$Q_{max\ (p)}$ (m^3/day)	$Q_{max\ (p)}$ (m^3/day) each pipe	$Q_{Design\ (p)}$ (m^3/day)	
	From	To			Now	After 25 years	Cumulative	Increment	Cumulative						
1	1	2	45	2280	20	38	38	4.22E-05	4.2E-05	3	0.00018	15.82268	15.82268	17.4	
2	1	3	42	1651	14	26	64	2.89E-05	7.1E-05	3	0.00031	26.36887	10.54619	11.6	
3	1	4	37	807	7	13	77	1.44E-05	8.6E-05	3	0.00037	31.58563	5.21677	5.7	
4	4	5	26	184	2	4	81	4.44E-06	0.00009	3	0.00038	33.18418	1.59854	1.8	
5	5	6	30	805	7	13	94	1.44E-05	0.0001	3	0.00044	38.35948	5.17530	5.7	
6	6	7	29	220	2	4	98	4.44E-06	0.00011	3	0.00046	39.94602	1.58654	1.7	
7	7	8	20	836	8	15	113	1.67E-05	0.00013	3	0.00053	45.87258	5.92656	6.5	
8	8	9	21	1996	17	32	145	3.56E-05	0.00016	3	0.00068	58.40514	12.53256	13.8	
9	9	10	50	2127	18	34	179	3.78E-05	0.0002	3	0.00083	71.57501	13.16987	14.5	
10	10	11	22	1000	9	17	196	1.89E-05	0.00022	3	0.000904	78.109421	6.534411	7.2	

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A.18 Table of Calculation Report For (Lateral Street 11)

Lateral Street 11														
	Current density of population (C/km^2)				8437		(d/D) Assume	0.65	Growth rate (%) 3.50%	Water Consumption (L/c/d)=120				
Pipe no.	Manholes		Length (m)	Area (m^2)	Population			{.8 Qavg} (m3/s) after 25 years		P_f	$Q_{max (p)}$ (m^3/s)	$Q_{max (p)}$ (m^3/day)	$Q_{max (p)}$ (m^3/day) each pipe	$Q_{Design (p)}$ (m^3/day)
	From	To			Now	After 25 years	Cumulative	Increment	Cumulative					
1	1	2	40	1000	9	17	17	1.89E-05	1.9E-05	3	0.00008	7.16369	7.16369	7.9
2	1	3	40	1830	16	30	47	3.33E-05	5.2E-05	3	0.00023	19.49210	12.32841	13.6
3	1	4	50	2400	21	39	86	4.33E-05	9.6E-05	3	0.00041	35.17821	15.68612	17.3
4	4	5	42	3650	31	58	144	6.44E-05	0.00016	3	0.00067	58.01562	22.83740	25.1
5	5	6	37	4060	35	65	209	7.22E-05	0.00023	3	0.00096	83.08522	25.06961	27.6
6	6	7	50	4370	37	69	278	7.67E-05	0.00031	3	0.00126	109.21744	26.13222	28.7
7	7	8	28	4470	38	71	349	7.89E-05	0.00039	3	0.00157	135.67788	26.46044	29.1
8	8	9	20	2960	25	47	396	5.22E-05	0.00044	3	0.00177	152.98493	17.30705	19.0
9	9	10	17	1570	14	26	422	2.89E-05	0.00047	3	0.00188	162.49371	9.50877	10.5
10	10	11	17	1200	11	21	443	2.33E-05	0.00049	3	0.001969	170.14165	7.647943	8.4
11	11	12	30	1180	10	19	462	2.11E-05	0.00051	3	0.002049	177.03726	6.895615	7.6
12	12	13	28	670	6	12	474	1.33E-05	0.00053	3	0.002099	181.38097	4.343708	4.8
13	13	14	50	230	2	4	478	4.44E-06	0.00053	3	0.002116	182.82694	1.445972	1.6
14	14	15	15	4260	36	67	545	7.44E-05	0.00061	3	0.002395	206.90901	24.08206	26.5
15	15	16	40	1000	9	17	562	1.89E-05	0.00062	3	0.00247	212.97958	6.07058	6.7

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A.19 Table of Calculation Report For (Lateral Street 12)

Lateral Street 12															
	Current density of population (C/km^2)				8437		(d/D) Assume	0.65	Growth rate (%) 3.50%	Water Consumption (L/c/d)=120					
Pipe no.	Manholes		Length (m)	Area (m^2)	Population			{.8 Qavg} (m3/s) after 25 years		P_f	$Q_{max (p)}$ (m^3/s)	$Q_{max (p)}$ (m^3/day)	$Q_{max (p)}$ (m^3/day) each pipe	$Q_{Design (p)}$ (m^3/day)
	From	To			Now	After 25 years	Cumulative	Increment	Cumulative					
1	1	2	50	4536	39	73	73	8.11E-05	8.1E-05	3	0.00035	29.98405	29.98405	33.0
2	1	3	30	3520	30	56	129	6.22E-05	0.00014	3	0.00060	52.15675	22.17270	24.4
3	1	4	18	1690	15	28	157	3.11E-05	0.00017	3	0.00073	63.06946	10.91272	12.0
4	4	5	50	5008	43	80	237	8.89E-05	0.00026	3	0.00108	93.74383	30.67436	33.7
5	5	6	50	4701	40	75	312	8.33E-05	0.00035	3	0.00141	121.93875	28.19492	31.0
6	6	7	17	1723	15	28	340	3.11E-05	0.00038	3	0.00153	132.34554	10.40679	11.4
7	7	8	39	5330	45	84	424	9.33E-05	0.00047	3	0.00189	163.22330	30.87776	34.0
8	8	9	50	5540	47	88	512	9.78E-05	0.00057	3	0.00226	195.07967	31.85636	35.0
9	9	10	50	4455	38	71	583	7.89E-05	0.00065	3	0.00255	220.45728	25.37762	27.9
10	10	11	50	1928	17	32	615	3.56E-05	0.00068	3	0.002683	231.80800	11.350714	12.5
11	11	12	36	1580	14	26	641	2.89E-05	0.00071	3	0.002789	240.99264	9.184644	10.1
12	12	13	33	6962	59	110	751	0.000122	0.00083	3	0.003235	279.49818	38.505542	42.4
13	13	14	50	810	7	13	764	1.44E-05	0.00085	3	0.003287	284.01307	4.514888	5.0
14	14	15	28	1610	14	26	790	2.89E-05	0.00088	3	0.003391	293.02127	9.00820	9.9
15	15	16	32	2930	25	47	837	5.22E-05	0.00093	3	0.00358	309.23423	16.21296	17.8
16	16	17	22	1035	9	17	854	1.89E-05	0.00095	3	0.003647	315.076557	5.842330	6.4

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Appendix B: Tables of Sanitary Sewer Design for Wastewater Network.

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B.1 Introduction

In this appendix B, the program design results are presented, where all the outputs are displayed, so you know the details of the two-way sewage network design. The pipes show their length, starting point and end point, as well as the inclination, flow velocity and pipe diameter, as well as the amount of drilling for them and the type of pipe. As for the manholes, they display information about the depth and openings of the manholes, as well as ground elevation, invert elevation, diameter , . x coordinate, y coordinate. We have clarified in this appendix all the information we mentioned about the manholes and pipes in the 3 main Street , 3 submain street and 12 lateral streets.

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B.2 Table of Sanitary Sewer Design Report For (Main Street 1)

B2.1 Pipe Report								
Label	**Start Node**	**stop Node**	**Length Scaled (m)**	**Slope (calculated) (%)**	**Velocity (m/s)**	**Diameter (mm)**	**Cover (Average m)**	**Material**
pipe-200	MH-1	MH-2	30	10	0.66	200	1.83	PVC
pipe-201	MH-2	MH-3	30	10	0.92	200	1.05	PVC
pipe-202	MH-3	MH-4	50	10	1.22	200	1.66	PVC
pipe-203	MH-4	MH-5	50	10	1.44	200	1.66	PVC
pipe-204	MH-5	MH-6	40	10	1.58	200	1.59	PVC
pipe-205	MH-6	MH-7	25	10	1.67	200	2.9	PVC
pipe-206	MH-7	MH-8	50	10	1.8	200	2.39	PVC
pipe-207	MH-8	MH-9	25	10	1.89	200	2.27	PVC
pipe-208	MH-9	MH-10	50	10	2.01	200	2.33	PVC
pipe-209	MH-10	MH-11	10	10	2.05	200	2.8	PVC
pipe-210	MH-11	MH-12	50	10	2.14	200	2.89	PVC
pipe-211	MH-12	MH-13	40	10	2.16	200	2.81	PVC
pipe-212	MH-13	MH-14	15	10	2.19	200	2.22	PVC
pipe-213	MH-14	MH-15	10	10	2.34	200	2.76	PVC

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pipe-214	MH-15	MH-16	50	10	2.38	200	2.9	PVC
pipe-215	MH-16	MH-17	40	10	2.41	200	2.82	PVC
pipe-216	MH-17	MH-18	50	10	2.6	200	2.9	PVC
pipe-217	MH-18	MH-19	25	10	2.61	200	1.76	PVC
pipe-218	MH-19	MH-20	30	10	2.99	200	1.77	PVC
pipe-219	MH-20	MH-21	40	10	3	200	1.25	PVC
pipe-220	MH-21	MH-22	50	5.645	2.45	200	1	PVC
pipe-221	MH-22	MH-23	15	6.983	2.64	200	1	PVC
pipe-222	MH-23	MH-249	20	7.077	2.66	200	1	PVC
pipe-223	MH-249	MH-250	10	5.515	2.44	200	1	PVC
pipe-224	MH-250	MH-24	50	7.279	2.7	200	1.51	PVC
pipe-225	MH-24	MH-253	15	5	2.37	200	1.51	PVC
pipe-226	MH-253	MH-25	25	5	2.4	200	1.54	PVC
pipe-227	MH-25	MH-26	25	5	2.49	200	1.97	PVC
pipe-228	MH-26	MH-27	50	5	2.49	200	3.11	PVC
pipe-229	MH-27	MH-28	40	5	2.5	200	1.95	PVC
pipe-230	MH-28	MH-29	50	5	2.5	200	2.17	PVC
pipe-231	MH-29	MH-30	20	6.306	2.72	200	1	PVC
pipe-232	MH-30	MH-31	25	6.163	2.71	200	1	PVC

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pipe-233	MH-31	MH-32	50	5	2.52	200	2.48	PVC
pipe-234	MH-32	MH-33	40	5	2.8	200	1.96	PVC
pipe-235	MH-33	MH-34	50	5	2.83	200	2.45	PVC
pipe-236	MH-34	MH-252	15	5	2.84	200	1.22	PVC
pipe-237	MH-252	MH-35	50	4	2.62	200	2.99	PVC
pipe-238	MH-35	MH-36	50	5.5	2.94	200	3.22	PVC
pipe-239	MH-36	MH-37	45	5.5	2.94	200	3.49	PVC
pipe-240	MH-37	MH-38	10	5.5	2.95	200	1.65	PVC
pipe-241	MH-38	MH-39	50	5.5	2.96	200	3.43	PVC
pipe-242	MH-39	MH-40	20	4	2.63	200	1.34	PVC
pipe-243	MH-40	MH-41	50	4	2.64	200	2.06	PVC
pipe-244	MH-41	MH-42	50	5	2.87	200	1.02	PVC
pipe-245	MH-42	MH-240	50	5	2.87	200	2.1	PVC
pipe-246	MH-240	MH-241	50	1.538	1.84	200	1.03	PVC
pipe-252	MH-241	MH-242	9.2	0.5	1.21	250	1.01	PVC
pipe-253	MH-242	O-1	20	2.059	2.12	250	1.01	PVC

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B2.2 Manhole Report						
Label	**Ground Elevation (m)**	**Invert Elevation (m)**	**Diameter (mm)**	**Manhole Depth (m)**	**X coordinate (m)**	**Y coordinate (m)**
MH-2	819.73	818.42	1200	1.3	162,261.36	121,272.19
MH-3	816.62	814.1	1200	2.52	162,234.74	121,258.36
MH-5	803.97	801.6	1200	2.37	162,146.73	121,210.88
MH-6	798.8	793.8	1200	5	162,116.88	121,184.24
MH-7	792.5	788.51	1200	3.99	162,092.56	121,190.04
MH-8	784.71	780.97	1200	3.74	162,043.45	121,199.43
MH-9	779.67	775.82	1200	3.85	162,019.06	121,204.90
MH-10	772.02	767.22	1200	4.8	161,979.61	121,174.18
MH-11	767.42	762.44	1200	4.98	161,969.70	121,172.79
MH-12	758.64	753.81	1200	4.83	161,919.99	121,178.14
MH-13	751.01	747.37	1200	3.64	161,880.04	121,176.24
MH-15	742.55	737.55	1200	5	161,856.65	121,177.26
MH-16	733.75	728.91	1200	4.84	161,807.45	121,168.34
MH-18	717.31	714.58	1200	2.73	161,723.18	121,196.32
MH-19	713.28	710.54	1200	2.74	161,700.35	121,206.51
MH-20	708.74	707.03	1200	1.71	161,670.40	121,208.22
MH-21	704.23	703.03	1200	1.2	161,630.46	121,205.94
MH-22	701.4	700.2	1200	1.2	161,580.87	121,212.29
MH-23	700.36	699.16	1200	1.2	161,566.78	121,217.45
MH-24	695.77	693.55	1200	2.22	161,487.74	121,229.78
MH-25	691.67	688.53	1200	3.14	161,447.74	121,229.72
MH-26	688.48	683.05	1200	5.42	161,423.60	121,223.21
MH-27	681.75	678.65	1200	3.1	161,375.93	121,208.15
MH-28	677.85	674.32	1200	3.53	161,336.52	121,215.02
MH-29	673.02	671.82	1200	1.2	161,289.14	121,199.04
MH-30	671.76	670.56	1200	1.2	161,269.54	121,195.10

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MH-31	670.22	666.06	1200	4.16	161,244.99	121,190.36
MH-33	660.84	656.74	1200	4.09	161,155.08	121,186.79
MH-34	655.44	653.79	1200	1.65	161,105.10	121,185.36
MH-35	648.27	642.63	1200	5.64	161,040.29	121,180.76
MH-36	641.9	634.9	1200	6	160,990.34	121,178.51
MH-37	633.62	631.12	1200	2.5	160,945.78	121,172.23
MH-38	631.72	625.72	1200	6	160,936.16	121,169.52
MH-39	624.17	622.29	1200	1.88	160,886.47	121,175.09
MH-40	622.69	619.38	1200	3.31	160,870.00	121,186.45
MH-41	618.58	617.25	1200	1.33	160,828.09	121,213.71
MH-42	615.87	612.48	1200	3.39	160,787.20	121,242.49
MH-240	611.18	609.98	1200	1.2	160,737.26	121,240.09
MH-241	610.46	609.21	1200	1.25	160,687.68	121,233.60
MH-249	698.94	697.74	1200	1.2	161,547.08	121,220.86
MH-250	698.39	697.19	1200	1.2	161,537.18	121,222.33
MH-252	654.24	649.07	1200	5.17	161,090.10	121,185.10
MH-253	694	691.72	1200	2.28	161,472.74	121,229.87

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B.3 Table of Sanitary Sewer Design Report For (Main Street 2)

B3.1 Pipe Report								
Label	**Start Node**	**stop Node**	**Length Scaled (m)**	**Slope (calculated)(%)**	**Velocity(m/s)**	**Diameter (mm)**	**Cover (Average m)**	**Material**
pipe-199	MH-71	MH-110	30.6	3.704	2.97	250	1.5	PVC
pipe-198	MH-70	MH-71	51.5	0.606	1.34	250	1.5	PVC
pipe-197	MH-69	MH-70	49.7	4.354	2.7	200	1.5	PVC
pipe-196	MH-68	MH-69	50	6.011	2.85	200	1.5	PVC
pipe-195	MH-67	MH-68	40	5.61	2.66	200	1.5	PVC
pipe-194	MH-66	MH-67	20	7	2.87	200	1.42	PVC
pipe-193	MH-65	MH-66	30	7	2.86	200	2.04	PVC
pipe-192	MH-64	MH-65	20	7	2.85	200	2.02	PVC
pipe-191	MH-63	MH-64	50	7	2.84	200	2.13	PVC
pipe-190	MH-62	MH-63	35	7	2.84	200	1.34	PVC
pipe-189	MH-61	MH-62	30	7	2.83	200	1.55	PVC
pipe-188	MH-60	MH-61	50	1.943	1.78	200	1.5	PVC
pipe-187	MH-59	MH-60	30	2.733	2.01	200	1.58	PVC
pipe-186	MH-58	MH-59	50	0.5	1.06	200	1.58	PVC
pipe-185	MH-57	MH-58	50	0.8	1.27	200	1.5	PVC
pipe-184	MH-56	MH-57	35	0.876	1.31	200	1.5	PVC
pipe-183	MH-55	MH-56	50	5.206	2.53	200	1.5	PVC
pipe-182	MH-54	MH-55	35	4.97	2.49	200	1.5	PVC
pipe-181	MH-72	MH-54	35	7.881	2.93	200	1.5	PVC
pipe-180	MH-53	MH-72	50	7.069	2.81	200	1.5	PVC
pipe-179	MH-52	MH-53	50	4.717	2.42	200	1.5	PVC
pipe-178	MH-51	MH-52	25	2.451	1.87	200	1.62	PVC
pipe-177	MH-50	MH-51	50	0.5	0.86	200	1.62	PVC
pipe-176	MH-49	MH-50	50	10	2.47	200	1.73	PVC

pipe-175	MH-48	MH-49	50	10	2.45	200	1.79	PVC
pipe-174	MH-47	MH-48	25	7.721	2.23	200	1.57	PVC
pipe-173	MH-46	MH-47	50	0.5	0.83	200	1.78	PVC
pipe-172	MH-45	MH-46	50	0.5	0.82	200	2.04	PVC
pipe-171	MH-44	MH-45	30	0.5	0.8	200	2.52	PVC
pipe-170	MH-43	MH-44	50	0.5	0.8	200	3.15	PVC
pipe-169	MH-179	MH-43	50	4.97	0.6	200	2.47	PVC
pipe-100	MH-110	MH-111	30.1	3	2.82	250	1.67	PVC
pipe-2	MH-223	MH-224	38.8	3	2.92	250	1.24	PVC
pipe-1	MH-111	MH-223	45.8	3	2.92	250	2.14	PVC
pipe-254	MH-224	O-2	19.9	3	2.94	250	1.93	PVC

B3.2 Manhole Report						
Label	**Ground Elevation (m)**	**Invert Elevation (m)**	**Diameter (mm)**	**Manhole Depth (m)**	**X coordinate (m)**	**Y coordinate (m)**
MH-43	690.48	686.83	1200	3.64	161,825.36	121,784.15
MH-44	689.65	686.58	1200	3.07	161,776.01	121,792.24
MH-45	688.81	686.43	1200	2.37	161,746.30	121,796.41
MH-46	688.3	686.18	1200	2.12	161,703.61	121,770.38
MH-47	687.78	685.93	1200	1.85	161,664.67	121,739.02
MH-48	685.7	683.43	1200	2.28	161,644.95	121,723.65
MH-49	680.13	677.96	1200	2.17	161,607.97	121,690.00
MH-50	674.66	672.96	1200	1.7	161,571.11	121,656.22
MH-51	674.65	672.71	1200	1.94	161,533.97	121,622.74
MH-52	673.8	672.1	1200	1.7	161,549.80	121,603.39
MH-53	671.44	669.74	1200	1.7	161,511.93	121,570.73
MH-54	665.15	663.45	1200	1.7	161,451.29	121,511.22
MH-55	663.41	661.71	1200	1.7	161,440.29	121,477.99
MH-56	660.81	659.11	1200	1.7	161,431.99	121,428.69
MH-57	660.5	658.8	1200	1.7	161,428.74	121,393.84

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MH-58	660.1	658.4	1200	1.7	161,397.49	121,354.80
MH-59	660	658.15	1200	1.85	161,348.05	121,347.38
MH-60	659.03	657.33	1200	1.7	161,318.63	121,353.28
MH-61	658.06	655.75	1200	2.31	161,275.05	121,377.79
MH-62	654.85	652.96	1200	1.89	161,249.09	121,392.82
MH-63	651.71	648.26	1200	3.46	161,220.74	121,413.35
MH-64	645.96	642.71	1200	3.25	161,185.00	121,448.32
MH-65	642.51	639.22	1200	3.29	161,176.81	121,466.56
MH-66	638.32	636.27	1200	2.05	161,185.28	121,495.34
MH-67	636.07	634.37	1200	1.7	161,190.71	121,514.59
MH-68	633.83	632.13	1200	1.7	161,202.03	121,552.95
MH-69	630.82	629.12	1200	1.7	161,198.23	121,602.81
MH-70	628.66	626.91	1200	1.75	161,184.04	121,650.44
MH-71	628.35	626.6	1200	1.75	161,179.22	121,701.74
MH-72	667.91	666.21	1200	1.7	161,475.47	121,536.52
MH-110	627.21	624.62	1200	2.59	161,162.58	121,727.43
MH-111	624.97	621.44	1200	3.53	161,136.29	121,712.68
MH-179	691.02	689.32	1200	1.7	161,874.73	121,776.28
MH-223	621.32	619.58	1200	1.73	161,105.64	121,678.61
MH-224	619.67	616.56	1200	3.11	161,076.65	121,652.84

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B.4 Table of Sanitary Sewer Design Report For (Main Street 3)

B4.1 Pipe Report								
Label	**Start Node**	**stop Node**	**Length Scaled (m)**	**Slope (calculated)(%)**	**Velocity(m/s)**	**Diameter (mm)**	**Cover (Average m)**	**Material**
pipe-250	MH-244	MH-242	43.1	10	1.89	200	2.89	PVC
pipe-248	MH-245	MH-244	50	10	1.82	200	2.89	PVC
pipe-247	MH-79	MH-245	50	10	1.78	200	2.42	PVC
pipe-168	MH-78	MH-79	40	7.732	1.62	200	1	PVC
pipe-167	MH-77	MH-78	50	9.76	1.74	200	1	PVC
pipe-166	MH-76	MH-77	50	7.797	1.17	200	1	PVC
pipe-165	MH-75	MH-76	40	10	1.13	200	1.05	PVC
pipe-164	MH-74	MH-75	30	10	0.95	200	1.05	PVC
pipe-163	MH-73	MH-74	50	10	0.8	200	1.46	PVC

B4.2 Manhole Report						
Label	**Ground Elevation (m)**	**Invert Elevation (m)**	**Diameter (mm)**	**Manhole Depth (m)**	**X coordinate (m)**	**Y coordinate (m)**
MH-73	660.13	658.01	1200	2.12	160,925.54	121,377.30
MH-74	654.21	652.91	1200	1.3	160,875.64	121,380.34
MH-75	651.11	649.81	1200	1.31	160,845.66	121,379.03
MH-76	647.01	645.81	1200	1.2	160,805.78	121,376.04
MH-77	643.11	641.91	1200	1.2	160,755.91	121,372.42
MH-78	638.23	637.03	1200	1.2	160,706.25	121,366.61
MH-79	635.14	631.1	1200	4.04	160,666.25	121,365.81
MH-244	618.52	613.54	1200	4.98	160,652.58	121,266.74
MH-245	627.3	622.32	1200	4.98	160,658.50	121,316.42

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B.5 Table of Sanitary Sewer Design Report For (Sub Main Street 1)

B5.1 Pipe Report								
Label	Start Node	stop Node	Length Scaled (m)	Slope (calculated)(%)	Velocity(m/s)	Diameter (mm)	Cover (Average m)	Material
pipe-146	MH-109	MH-246	8	10	0.81	200	1.73	PVC
pipe-145	MH-108	MH-109	23.2	10	1.08	200	1.83	PVC
pipe-144	MH-107	MH-108	50	9.368	1.19	200	1.5	PVC
pipe-143	MH-106	MH-107	15	10	1.24	200	1.86	PVC
pipe-142	MH-105	MH-106	50	10	1.32	200	3.03	PVC
pipe-141	MH-104	MH-105	15	10	1.36	200	3.12	PVC
pipe-140	MH-103	MH-104	50	10	1.76	200	2.65	PVC
pipe-139	MH-102	MH-103	50	10	1.81	200	2.84	PVC
pipe-138	MH-101	MH-102	15	10	1.83	200	1.67	PVC
pipe-137	MH-100	MH-101	20	10	1.85	200	1.52	PVC
pipe-136	MH-99	MH-100	35	10	1.88	200	1.65	PVC
pipe-135	MH-98	MH-99	30	10	1.9	200	2.18	PVC
pipe-134	MH-97	MH-98	30	10	1.91	200	3.06	PVC
pipe-133	MH-96	MH-97	20	10	1.92	200	2.87	PVC
pipe-132	MH-43	MH-96	45	10	1.94	200	3.15	PVC

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B5.2 Manhole Report						
Label	**Ground Elevation (m)**	**Invert Elevation (m)**	**Diameter (mm)**	**Manhole Depth (m)**	**X coordinate (m)**	**Y coordinate (m)**
MH-43	690.48	686.83	1200	3.64	161,825.36	121,784.15
MH-96	698.27	693.28	1200	4.99	161,822.05	121,739.28
MH-97	703.01	698.57	1200	4.44	161,820.60	121,719.33
MH-98	709.13	704.31	1200	4.82	161,820.29	121,689.33
MH-99	713.48	710.43	1200	3.05	161,812.10	121,660.47
MH-100	717.29	715.28	1200	2.01	161,798.85	121,628.07
MH-101	719.32	717.59	1200	1.73	161,816.99	121,619.63
MH-102	721.17	719.12	1200	2.05	161,824.59	121,606.70
MH-103	728.84	724.47	1200	4.37	161,855.56	121,567.45
MH-104	736.14	732.14	1200	4	161,896.43	121,538.65
MH-106	748.95	744.19	1200	4.77	161,935.06	121,486.39
MH-107	751.16	748.75	1200	2.41	161,933.63	121,471.45
MH-108	755.85	754.15	1200	1.7	161,923.36	121,422.52
MH-109	758.83	756.47	1200	2.36	161,944.07	121,411.96
MH-246	760.09	757.93	1200	2.17	161,950.91	121,407.90

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B.6 Table of Sanitary Sewer Design Report For (Sub Main Street 2)

B6.1 Pipe Report								
Label	**Start Node**	**stop Node**	**Length Scaled (m)**	**Slope (calculated)(%)**	**Velocity(m/s)**	**Diameter (mm)**	**Cover (Average m)**	**Material**
pipe-131	MH-138	MH-178	50	10	1.2	200	1.57	PVC
pipe-130	MH-137	MH-138	45	7.851	1.37	200	1.5	PVC
pipe-129	MH-136	MH-137	50	10	1.58	200	1.93	PVC
pipe-128	MH-135	MH-136	50	10	1.62	200	2.28	PVC
pipe-127	MH-134	MH-135	30	10	1.75	200	2.07	PVC
pipe-126	MH-133	MH-134	15	10	1.79	200	1.94	PVC
pipe-125	MH-132	MH-133	50	10	1.82	200	2.75	PVC
pipe-124	MH-131	MH-132	40	5.501	1.5	200	1.5	PVC
pipe-123	MH-254	MH-131	50	3.78	1.35	200	1.5	PVC
pipe-122	MH-130	MH-254	15	6	1.6	200	1.5	PVC
pipe-121	MH-129	MH-130	50	1.874	1.31	200	1.5	PVC
pipe-120	MH-128	MH-129	30	4.944	1.85	200	1.5	PVC
pipe-119	MH-127	MH-128	50	1	1.05	200	1.5	PVC
pipe-118	MH-126	MH-127	40	1.75	1.28	200	1.5	PVC
pipe-117	MH-125	MH-126	20	3.5	1.64	200	1.5	PVC
pipe-116	MH-124	MH-125	50	9.157	2.31	200	1.5	PVC
pipe-115	MH-123	MH-124	50	7.836	2.19	200	1.5	PVC
pipe-114	MH-255	MH-123	15	2.494	1.47	200	1.5	PVC
pipe-113	MH-122	MH-255	30	8.966	2.32	200	1.5	PVC
pipe-112	MH-139	MH-122	15	6.465	2.07	200	1.5	PVC
pipe-111	MH-121	MH-139	35	4.478	1.84	200	1.5	PVC
pipe-110	MH-120	MH-121	35	3.334	1.66	200	1.5	PVC
pipe-109	MH-119	MH-120	35	8.103	2.28	200	1.5	PVC
pipe-108	MH-118	MH-119	40	10	2.48	200	2.82	PVC

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pipe-107	MH-117	MH-118	50	10	2.49	200	3.01	PVC
pipe-106	MH-116	MH-117	50	10	2.5	200	2.85	PVC
pipe-105	MH-115	MH-116	40	7.025	2.22	200	1.5	PVC
pipe-104	MH-114	MH-115	50	4.59	1.91	200	1.5	PVC
pipe-103	MH-113	MH-114	25	5.704	2.07	200	1.5	PVC
pipe-102	MH-112	MH-113	45	1.965	1.51	200	1.5	PVC
pipe-101	MH-111	MH-112	35.5	0.739	1.07	200	1.5	PVC

B6.2 Manhole Report						
Label	**Ground Elevation (m)**	**Invert Elevation (m)**	**Diameter (mm)**	**Manhole Depth (m)**	**X coordinate (m)**	**Y coordinate (m)**
MH-111	624.97	621.44	1200	3.53	161,136.29	121,712.68
MH-112	625.23	623.53	1200	1.7	161,159.07	121,685.48
MH-113	626.11	624.41	1200	1.7	161,170.07	121,641.84
MH-114	627.54	625.84	1200	1.7	161,166.68	121,617.07
MH-115	629.84	628.14	1200	1.7	161,142.37	121,573.38
MH-116	632.65	630.95	1200	1.7	161,123.63	121,538.04
MH-117	640.35	635.95	1200	4.4	161,111.28	121,489.59
MH-118	648.37	643.65	1200	4.72	161,083.54	121,448.00
MH-119	655	650.67	1200	4.33	161,119.26	121,430.01
MH-120	657.84	656.14	1200	1.7	161,147.68	121,409.57
MH-121	659	657.3	1200	1.7	161,180.21	121,396.66
MH-122	661.54	659.84	1200	1.7	161,222.89	121,370.62
MH-123	664.6	662.9	1200	1.7	161,258.77	121,343.48
MH-124	668.52	666.82	1200	1.7	161,299.80	121,314.91
MH-125	673.1	671.4	1200	1.7	161,342.26	121,288.52
MH-126	673.8	672.1	1200	1.7	161,359.25	121,277.96
MH-127	674.5	672.8	1200	1.7	161,382.11	121,310.78

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MH-128	675	673.3	1200	1.7	161,424.72	121,336.94
MH-129	676.48	674.78	1200	1.7	161,449.67	121,353.61
MH-130	677.42	675.72	1200	1.7	161,491.12	121,381.56
MH-131	680.21	678.51	1200	1.7	161,500.46	121,445.60
MH-132	682.41	680.71	1200	1.7	161,538.43	121,458.17
MH-133	689.91	685.71	1200	4.2	161,585.64	121,474.65
MH-134	692.29	689.71	1200	2.57	161,596.64	121,464.45
MH-135	696.43	693.59	1200	2.84	161,622.31	121,479.97
MH-136	702.99	699.73	1200	3.27	161,663.08	121,508.92
MH-137	708.86	706.29	1200	2.57	161,707.96	121,530.97
MH-138	712.39	710.69	1200	1.7	161,740.59	121,561.95
MH-139	660.57	658.87	1200	1.7	161,210.29	121,378.76
MH-178	717.54	715.69	1200	1.85	161,775.54	121,597.71
MH-254	678.32	676.62	1200	1.7	161,495.78	121,395.82
MH-255	664.23	662.53	1200	1.7	161,246.51	121,352.13

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B.7 Table of Sanitary Sewer Design Report For (Sub Main Street 3)

B7.1 Pipe Report

Label	Start Node	stop Node	Length Scaled (m)	Slope (calculated)(%)	Velocity(m/s)	Diameter (mm)	Cover (Average m)	Material
pipe-99	MH-141	MH-140	50	10	0.77	200	2.46	PVC
pipe-98	MH-142	MH-141	40	10	2.63	200	2.56	PVC
pipe-97	MH-143	MH-142	40	10	2.65	200	2.35	PVC
pipe-96	MH-144	MH-143	50	10	2.67	200	2.11	PVC
pipe-95	MH-145	MH-144	15	10	2.67	200	1.57	PVC
pipe-94	MH-146	MH-145	40	10	2.69	200	1.52	PVC
pipe-93	MH-147	MH-146	40	10	2.71	200	1.79	PVC
pipe-92	MH-148	MH-147	20	10	2.72	200	1.84	PVC
pipe-91	MH-149	MH-148	45	10	2.75	200	1.78	PVC
pipe-90	MH-150	MH-149	40	10	2.76	200	2.9	PVC
pipe-89	MH-151	MH-150	10	0.5	0.98	200	2.92	PVC
pipe-88	MH-152	MH-151	15	7.548	2.65	200	2.04	PVC
pipe-87	MH-153	MH-152	35	2.656	1.83	200	1.5	PVC
pipe-86	MH-71	MH-153	46	10	2.94	200	2.1	PVC

B7.2 Manhole Report

Label	Ground Elevation (m)	Invert Elevation (m)	Diameter (mm)	Manhole Depth (m)	X coordinate (m)	Y coordinate (m)
MH-71	628.35	626.6	1200	1.75	161,179.22	121,701.74
MH-140	687.78	684.15	1200	3.63	161,602.25	121,777.45
MH-141	680.85	677.04	1200	3.82	161,565.09	121,743.99
MH-142	674.74	671.34	1200	3.39	161,540.88	121,712.15

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MH-143	669.04	666.12	1200	2.92	161,508.14	121,689.16
MH-144	662.82	660.97	1200	1.85	161,458.89	121,680.58
MH-145	661.17	659.43	1200	1.74	161,458.12	121,665.60
MH-146	657.13	654.85	1200	2.29	161,418.35	121,669.80
MH-147	652.55	650.17	1200	2.37	161,379.02	121,677.13
MH-148	649.87	647.61	1200	2.26	161,359.64	121,682.04
MH-149	644.81	640.3	1200	4.51	161,315.27	121,689.57
MH-150	638	634.55	1200	3.45	161,276.23	121,698.28
MH-151	637.29	634.5	1200	2.79	161,266.47	121,700.46
MH-152	635.07	633.37	1200	1.7	161,258.71	121,687.62
MH-153	634.14	631.25	1200	2.9	161,223.83	121,690.55

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B.8 Table of Sanitary Sewer Design Report For (Lateral Street 1)

B8.1 Pipe Report								
Label	**Start Node**	**stop Node**	**Length Scaled (m)**	**Slope (calculated)(%)**	**Velocity(m/s)**	**Diameter (mm)**	**Cover (Average m)**	**Material**
pipe-41	MH-214	MH-215	40	10	0.42	200	1.5	PVC
pipe-40	MH-213	MH-214	30	10	0.56	200	1.78	PVC
pipe-39	MH-212	MH-213	20	10	0.71	200	1.62	PVC
pipe-38	MH-251	MH-212	10	9.447	0.74	200	1	PVC
pipe-37	MH-211	MH-251	10	9.429	0.79	200	1	PVC
pipe-36	MH-210	MH-211	50	10	0.89	200	1.18	PVC
pipe-35	MH-209	MH-210	50	9.83	1.04	200	1.1	PVC
pipe-34	MH-14	MH-209	50	10	1.14	200	1.1	PVC

B8.2 Manhole Report						
Label	**Ground Elevation (m)**	**Invert Elevation (m)**	**Diameter (mm)**	**Manhole Depth (m)**	**X coordinate (m)**	**Y coordinate (m)**
MH-209	752.27	750.87	1200	1.4	161,878.70	121,124.36
MH-210	756.98	755.78	1200	1.2	161,896.74	121,077.73
MH-211	762.35	760.78	1200	1.56	161,921.31	121,034.19
MH-212	764.24	763.04	1200	1.2	161,933.25	121,018.16
MH-213	767.47	765.04	1200	2.43	161,952.31	121,012.08
MH-214	772.2	769.35	1200	2.85	161,981.56	121,005.45
MH-215	775.03	773.91	1200	1.11	162,014.60	120,982.90
MH-251	763.29	762.09	1200	1.2	161,926.96	121,025.93

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B.9 Table of Sanitary Sewer Design Report For (Lateral Street 2)

B9.1 Pipe Report								
Label	**Start Node**	**stop Node**	**Length Scaled (m)**	**Slope (calculated)(%)**	**Velocity(m/s)**	**Diameter (mm)**	**Cover (Average m)**	**Material**
pipe-33	MH-221	MH-222	35	5.021	0.6	200	1.33	PVC
pipe-32	MH-220	MH-221	50	3.555	0.66	200	2.01	PVC
pipe-31	MH-219	MH-220	50	10	1.06	200	1.68	PVC
pipe-30	MH-218	MH-219	50	10	1.16	200	1.76	PVC
pipe-29	MH-217	MH-218	50	7.921	1.16	200	1	PVC
pipe-28	MH-216	MH-217	50	10	1.37	200	1.9	PVC
pipe-27	MH-17	MH-216	10	10	1.38	200	1.1	PVC

B9.2 Manhole Report						
Label	**Ground Elevation (m)**	**Invert Elevation (m)**	**Diameter (mm)**	**Manhole Depth (m)**	**X coordinate (m)**	**Y coordinate (m)**
MH-216	727.31	725.91	1200	1.4	161,767.37	121,163.84
MH-218	738.08	736.88	1200	1.2	161,821.10	121,079.52
MH-219	744.59	741.88	1200	2.71	161,847.80	121,037.25
MH-220	750.95	748.39	1200	2.55	161,873.95	120,994.63
MH-221	752.04	750.17	1200	1.87	161,916.54	120,968.44
MH-222	753.13	751.93	1200	1.2	161,947.05	120,951.29

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B.10 Table of Sanitary Sewer Design Report For (Lateral Street 3)

B10.1 Pipe Report								
Label	**Start Node**	**stop Node**	**Length Scaled (m)**	**Slope (calculated)(%)**	**Velocity(m/s)**	**Diameter (mm)**	**Cover (Average m)**	**Material**
pipe-61	MH-208	MH-248	11	3.624	0.6	200	1.56	PVC
pipe-60	MH-207	MH-208	29	2.085	0.6	200	1.71	PVC
pipe-59	MH-206	MH-207	50	1.447	0.6	200	2.11	PVC
pipe-58	MH-104	MH-206	40	4.202	0.9	200	1.96	PVC

B10.2 Manhole Report						
Label	**Ground Elevation (m)**	**Invert Elevation (m)**	**Diameter (mm)**	**Manhole Depth (m)**	**X coordinate (m)**	**Y coordinate (m)**
MH-104	736.14	732.14	1200	4	161,896.43	121,538.65
MH-206	738.74	736.12	1200	2.62	161,872.23	121,506.81
MH-207	738.84	736.84	1200	2	161,841.43	121,467.42
MH-208	739.27	737.45	1200	1.82	161,826.83	121,442.32
MH-248	739.55	737.85	1200	1.7	161,831.23	121,432.21

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B.11 Table of Sanitary Sewer Design Report For (Lateral Street 4)

B11.1 Pipe Report								
Label	**Start Node**	**stop Node**	**Length Scaled (m)**	**Slope (calculated)(%)**	**Velocity(m/s)**	**Diameter (mm)**	**Cover (Average m)**	**Material**
pipe-16	MH-237	MH-238	25	10	0.86	200	3.08	PVC
pipe-15	MH-236	MH-237	50	10	1.12	200	3.1	PVC
pipe-14	MH-235	MH-236	20	10	1.24	200	3.05	PVC
pipe-13	MH-234	MH-235	45	10	1.34	200	2.19	PVC
pipe-12	MH-233	MH-234	50	10	1.45	200	2.43	PVC
pipe-11	MH-232	MH-233	50	10	1.55	200	3.08	PVC
pipe-10	MH-130	MH-232	45	3.801	1.13	200	1.5	PVC

B11.2 Manhole Report						
Label	**Ground Elevation (m)**	**Invert Elevation (m)**	**Diameter (mm)**	**Manhole Depth (m)**	**X coordinate (m)**	**Y coordinate (m)**
MH-130	677.42	675.72	1200	1.7	161,491.12	121,381.56
MH-232	679.13	677.43	1200	1.7	161,534.34	121,369.02
MH-233	687.3	682.43	1200	4.87	161,578.33	121,345.25
MH-234	694.17	690.6	1200	3.57	161,626.61	121,332.26
MH-235	700.05	696.97	1200	3.08	161,667.93	121,350.10
MH-236	705.15	700.35	1200	4.8	161,687.28	121,355.13
MH-237	713.36	708.45	1200	4.91	161,735.62	121,367.92
MH-238	719.01	714.16	1200	4.85	161,741.64	121,392.18

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B.12 Table of Sanitary Sewer Design Report For (Lateral Street 5)

B12.1 Pipe Report

Label	Start Node	stop Node	Length Scaled (m)	Slope (calculated)(%)	Velocity(m/s)	Diameter (mm)	Cover (Average m)	Material
pipe-57	MH-194	MH-195	50	10	0.89	200	2.6	PVC
pipe-56	MH-193	MH-194	20	10	1.04	200	2.52	PVC
pipe-55	MH-192	MH-193	50	8.432	1.08	200	1.5	PVC
pipe-54	MH-191	MH-192	25	10	1.26	200	2.34	PVC
pipe-53	MH-190	MH-191	20	10	1.31	200	1.79	PVC
pipe-52	MH-52	MH-190	35	10	1.39	200	2.92	PVC

B12.2 Manhole Report

Label	Ground Elevation (m)	Invert Elevation (m)	Diameter (mm)	Manhole Depth (m)	X coordinate (m)	Y coordinate (m)
MH-52	673.8	672.1	1200	1.7	161,549.80	121,603.39
MH-190	680.14	675.6	1200	4.54	161,576.17	121,580.38
MH-191	682.73	680.44	1200	2.29	161,596.15	121,581.23
MH-192	686.92	683.53	1200	3.39	161,619.74	121,572.93
MH-193	691.13	689.43	1200	1.7	161,658.47	121,604.55
MH-194	695.16	691.43	1200	3.73	161,674.26	121,592.27
MH-195	702.36	698.46	1200	3.9	161,723.37	121,601.64

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B.13 Table of Sanitary Sewer Design Report For (Lateral Street 6)

B13.1 Pipe Report								
Label	**Start Node**	**stop Node**	**Length Scaled (m)**	**Slope (calculated)(%)**	**Velocity(m/s)**	**Diameter (mm)**	**Cover (Average m)**	**Material**
pipe-63	MH-176	MH-177	50	6.201	0.74	200	1.5	PVC
pipe-62	MH-169	MH-176	35	10	1.02	200	1.79	PVC

B13.2 Manhole Report						
Label	**Ground Elevation (m)**	**Invert Elevation (m)**	**Diameter (mm)**	**Manhole Depth (m)**	**X coordinate (m)**	**Y coordinate (m)**
MH-169	686.8	683.15	1200	3.65	161,544.98	121,778.56
MH-176	690.89	688.6	1200	2.29	161,573.44	121,798.94
MH-177	693.99	692.29	1200	1.7	161,617.54	121,822.51

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B.14 Table of Sanitary Sewer Design Report For (Lateral Street 7)

B14.1 Pipe Report

Label	Start Node	stop Node	Length Scaled (m)	Slope (calculated)(%)	Velocity(m/s)	Diameter (mm)	Cover (Average m)	Material
pipe-70	MH-174	MH-175	40	3.409	0.61	200	2.08	PVC
pipe-69	MH-173	MH-174	35	2.305	0.6	200	2.98	PVC
pipe-68	MH-172	MH-173	30	1.357	0.6	200	3.38	PVC
pipe-67	MH-171	MH-172	40	0.776	0.6	200	3.49	PVC
pipe-66	MH-170	MH-171	25	0.5	0.61	200	3.46	PVC
pipe-65	MH-169	MH-170	25	0.5	0.7	200	3.43	PVC
pipe-64	MH-141	MH-169	40	10	2.36	200	2.47	PVC

B14.2 Manhole Report

Label	Ground Elevation (m)	Invert Elevation (m)	Diameter (mm)	Manhole Depth (m)	X coordinate (m)	Y coordinate (m)
MH-141	680.85	677.04	1200	3.82	161,565.09	121,743.99
MH-169	686.8	683.15	1200	3.65	161,544.98	121,778.56
MH-170	686.9	683.29	1200	3.61	161,520.02	121,779.95
MH-171	687.12	683.41	1200	3.71	161,495.03	121,779.19
MH-172	687.4	683.72	1200	3.68	161,455.04	121,780.02
MH-173	687.62	684.13	1200	3.49	161,426.27	121,788.53
MH-174	687.8	684.94	1200	2.86	161,396.64	121,807.15
MH-175	688	686.3	1200	1.7	161,367.93	121,835.01

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B.15 Table of Sanitary Sewer Design Report For (Lateral Street 8)

B15.1 Pipe Report								
Label	**Start Node**	**stop Node**	**Length Scaled (m)**	**Slope (calculated)(%)**	**Velocity(m/s)**	**Diameter (mm)**	**Cover (Average m)**	**Material**
pipe-51	MH-188	MH-189	20	10	0.7	200	1.59	PVC
pipe-50	MH-187	MH-188	45	10	0.92	200	2.5	PVC
pipe-49	MH-186	MH-187	25	10	1.04	200	1.82	PVC
pipe-48	MH-185	MH-186	25	7.505	1.02	200	1.5	PVC
pipe-47	MH-184	MH-185	20	8.363	1.13	200	1.5	PVC
pipe-46	MH-183	MH-184	25	8.603	1.19	200	1.5	PVC
pipe-45	MH-182	MH-183	45	5.184	1.03	200	1.5	PVC
pipe-44	MH-181	MH-182	50	1.044	0.6	200	1.65	PVC
pipe-43	MH-180	MH-181	50	1.172	0.64	200	1.65	PVC
pipe-42	MH-150	MH-180	50	0.865	0.6	200	2.37	PVC

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B15.2 Manhole Report						
Label	Ground Elevation (m)	Invert Elevation (m)	Diameter (mm)	Manhole Depth (m)	X coordinate (m)	Y coordinate (m)
MH-150	638	634.55	1200	3.45	161,276.23	121,698.28
MH-180	636.68	634.98	1200	1.7	161,272.34	121,648.43
MH-181	637.56	635.57	1200	1.99	161,267.10	121,598.71
MH-182	637.79	636.09	1200	1.7	161,251.38	121,551.24
MH-183	640.13	638.43	1200	1.7	161,254.37	121,506.34
MH-184	642.28	640.58	1200	1.7	161,276.70	121,495.10
MH-185	643.95	642.25	1200	1.7	161,293.91	121,484.92
MH-186	645.83	644.13	1200	1.7	161,318.80	121,487.30
MH-187	648.96	646.63	1200	2.34	161,341.54	121,497.68
MH-188	655.46	651.76	1200	3.7	161,383.23	121,514.62
MH-189	657.65	655.76	1200	1.89	161,400.02	121,503.74

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B.16 Table of Sanitary Sewer Design Report For (Lateral Street 9)

B16.1 Pipe Report								
Label	**Start Node**	**stop Node**	**Length Scaled (m)**	**Slope (calculated)(%)**	**Velocity(m/s)**	**Diameter (mm)**	**Cover (Average m)**	**Material**
pipe-9	MH-230	MH-231	20	10	1.04	200	2.96	PVC
pipe-8	MH-229	MH-230	35	10	1.24	200	2.81	PVC
pipe-7	MH-228	MH-229	40	10	1.45	200	2.56	PVC
pipe-6	MH-227	MH-228	30	10	1.54	200	2.9	PVC
pipe-5	MH-226	MH-227	20	9.893	1.61	200	1.5	PVC
pipe-4	MH-225	MH-226	45	10	1.68	200	1.61	PVC
pipe-3	MH-224	MH-225	51.2	3.968	1.26	200	1.5	PVC

16.2 Manhole Report						
Label	**Ground Elevation (m)**	**Invert Elevation (m)**	**Diameter (mm)**	**Manhole Depth (m)**	**X coordinate (m)**	**Y coordinate (m)**
MH-224	619.67	616.56	1200	3.11	161,076.65	121,652.84
MH-225	621.7	620	1200	1.7	161,036.78	121,620.68
MH-226	626.43	624.5	1200	1.93	161,003.18	121,590.75
MH-227	628.41	626.71	1200	1.7	161,016.90	121,576.20
MH-228	634.21	629.71	1200	4.5	161,014.52	121,546.30
MH-230	646.46	642.13	1200	4.33	161,028.87	121,485.13

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B.17 Table of Sanitary Sewer Design Report For (Lateral Street 10)

B17.1 Pipe Report								
Label	**Start Node**	**stop Node**	**Length Scaled (m)**	**Slope (calculated)(%)**	**Velocity(m/s)**	**Diameter (mm)**	**Cover (Average m)**	**Material**
pipe-26	MH-204	MH-205	40	5.049	0.6	200	1.92	PVC
pipe-25	MH-203	MH-204	40	3.351	0.6	200	3.49	PVC
pipe-23	MH-201	MH-202	25	2.889	0.61	200	4.68	PVC
pipe-22	MH-200	MH-201	29.2	2.563	0.61	200	4.35	PVC
pipe-21	MH-199	MH-200	30	2.372	0.6	200	3.82	PVC
pipe-20	MH-198	MH-199	25	2.109	0.6	200	3.48	PVC
pipe-19	MH-197	MH-198	25	5.864	0.92	200	3.14	PVC
pipe-18	MH-196	MH-197	50	10	1.18	200	1.87	PVC
pipe-17	MH-77	MH-196	20	10	1.21	200	1.76	PVC
pipe-24	MH-202	MH-203	40	3.013	0.61	200	4.49	PVC

`

B17.2 Manhole Report						
Label	**Ground Elevation (m)**	**Invert Elevation (m)**	**Diameter (mm)**	**Manhole Depth (m)**	**X coordinate (m)**	**Y coordinate (m)**
MH-196	646.63	643.91	1200	2.73	160,758.14	121,392.29
MH-197	653.38	650.43	1200	2.95	160,792.85	121,428.29
MH-198	655.63	651.9	1200	3.73	160,817.68	121,431.20
MH-199	656.07	652.43	1200	3.64	160,839.64	121,443.13
MH-200	657.53	653.14	1200	4.39	160,851.47	121,470.69
MH-201	658.6	653.89	1200	4.71	160,824.67	121,482.19
MH-202	659.66	654.61	1200	5.05	160,803.83	121,468.39
MH-203	660.15	655.81	1200	4.34	160,764.04	121,472.49
MH-204	660.2	657.15	1200	3.05	160,724.27	121,476.80
MH-205	660.37	659.17	1200	1.2	160,692.83	121,501.52

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B.18 Table of Sanitary Sewer Design Report For (Lateral Street 11)

B18.1 Pipe Report								
Label	**Start Node**	**stop Node**	**Length Scaled (m)**	**Slope (calculated)(%)**	**Velocity(m/s)**	**Diameter (mm)**	**Cover (Average m)**	**Material**
pipe-85	MH-167	MH-168	40	2.589	0.37	200	0.96	PVC
pipe-84	MH-166	MH-167	45	4.4	0.6	200	1.77	PVC
pipe-83	MH-165	MH-166	50	2.627	0.6	200	2.88	PVC
pipe-82	MH-164	MH-165	40	1.716	0.6	200	3.26	PVC
pipe-81	MH-163	MH-164	50	1.236	0.6	200	2.61	PVC
pipe-80	MH-162	MH-163	50	1.784	0.74	200	1.46	PVC
pipe-79	MH-161	MH-162	25	4.28	1.08	200	1	PVC
pipe-78	MH-160	MH-161	20	6.9	1.32	200	1	PVC
pipe-77	MH-159	MH-160	20	6.95	1.34	200	1	PVC
pipe-76	MH-158	MH-159	15	8.4	1.46	200	1	PVC
pipe-75	MH-157	MH-158	30	3.633	1.1	200	1	PVC
pipe-74	MH-156	MH-157	30	3.167	1.05	200	1	PVC
pipe-73	MH-155	MH-156	45	4.444	1.19	200	1	PVC
pipe-72	MH-154	MH-155	15	8.635	1.55	200	1	PVC

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B18.2 Manhole Report						
Label	Ground Elevation (m)	Invert Elevation (m)	Diameter (mm)	Manhole Depth (m)	X coordinate (m)	Y coordinate (m)
MH-154	670.75	667.56	1200	3.2	161,223.50	121,215.58
MH-155	672.05	670.85	1200	1.2	161,216.63	121,228.91
MH-156	674.05	672.85	1200	1.2	161,195.40	121,268.59
MH-157	675	673.8	1200	1.2	161,165.42	121,269.46
MH-158	676.09	674.89	1200	1.2	161,140.21	121,253.20
MH-159	677.35	676.15	1200	1.2	161,126.06	121,248.20
MH-160	678.74	677.54	1200	1.2	161,106.11	121,249.58
MH-161	680.12	678.92	1200	1.2	161,086.19	121,251.39
MH-162	681.19	679.99	1200	1.2	161,062.25	121,258.60
MH-163	683.01	680.88	1200	2.13	161,019.05	121,283.76
MH-164	684.99	681.5	1200	3.49	160,971.23	121,298.37
MH-165	685.61	682.19	1200	3.42	160,931.51	121,303.09
MH-166	686.23	683.5	1200	2.73	160,881.52	121,304.21
MH-167	686.68	685.48	1200	1.2	160,839.46	121,320.19
MH-168	687.63	686.52	1200	1.11	160,804.32	121,339.31

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B.19 Table of Sanitary Sewer Design Report For (Lateral Street 12)

B19.1 Pipe Report								
Label	Start Node	stop Node	Length Scaled (m)	Slope (calculated)(%)	Velocity(m/s)	Diameter (mm)	Cover (Average m)	Material
pipe-162	MH-94	MH-95	50	10	0.91	200	1.74	PVC
pipe-161	MH-93	MH-94	30	10	1.08	200	1.95	PVC
pipe-160	MH-92	MH-93	20	10	1.15	200	2.45	PVC
pipe-159	MH-91	MH-92	50	10	1.29	200	2.51	PVC
pipe-158	MH-90	MH-91	50	10	1.39	200	2.52	PVC
pipe-157	MH-89	MH-90	15	10	1.43	200	1.25	PVC
pipe-156	MH-88	MH-89	40	10	1.54	200	2.32	PVC
pipe-155	MH-87	MH-88	50	10	1.62	200	2.19	PVC
pipe-154	MH-86	MH-87	50	10	1.67	200	2.78	PVC
pipe-153	MH-85	MH-86	50	10	1.7	200	2.96	PVC
pipe-152	MH-84	MH-85	35	10	1.72	200	2.89	PVC
pipe-151	MH-83	MH-84	35	10	1.8	200	2.85	PVC
pipe-150	MH-82	MH-83	45	10	1.81	200	2.02	PVC
pipe-149	MH-81	MH-82	30	10	1.82	200	2.16	PVC
pipe-148	MH-80	MH-81	35	9.391	1.81	200	1	PVC
pipe-147	MH-19	MH-80	20	6.223	1.58	200	1	PVC

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B19.2 Manhole Report						
Label	**Ground Elevation (m)**	**Invert Elevation (m)**	**Diameter (mm)**	**Manhole Depth (m)**	**X coordinate (m)**	**Y coordinate (m)**
MH-81	717.81	716.61	1200	1.2	161,730.32	121,252.14
MH-82	723.13	719.61	1200	3.52	161,755.42	121,268.57
MH-83	729.66	726.43	1200	3.23	161,773.43	121,309.81
MH-84	736.86	731.96	1200	4.9	161,807.72	121,302.79
MH-85	744.14	739.16	1200	4.98	161,835.23	121,324.44
MH-86	753.07	747.94	1200	5.13	161,881.74	121,342.78
MH-87	761.63	756.87	1200	4.76	161,931.63	121,346.11
MH-88	769.01	765.43	1200	3.58	161,980.53	121,335.68
MH-89	775.66	771.81	1200	3.85	162,019.78	121,327.98
MH-90	777.67	775.96	1200	1.71	162,034.43	121,324.74
MH-92	793.73	789.5	1200	4.23	162,130.31	121,296.97
MH-93	798.62	794.53	1200	4.09	162,149.48	121,291.24
MH-94	803.51	800.42	1200	3.09	162,177.69	121,281.05

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Appendix C: Profiles of Wastewater Network

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C.1 Introduction

In this appendix "C", information about images and profiles displayed in the sewer CAD program, where these profiles show information about the length of the pipe, its diameter, type, and cumulative flow, in addition to the inclination of the earth, its ground elevation, invert elevation . which facilitates the process of reading the data.

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C.2: Figure 1 Profile for Main Street 1.1

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C.3: Figure 2 Profile for Main street 1.2

C.4: Figure 3 Profile for Main street 1.3

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C.5: Figure 4 Profile for Main street 1.4

C.6: Figure 5 Profile for Main street 1.5

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C.7: Figure 6 Profile for Main street 1.6

C.8: Figure 7 Profile for Main street 1.7

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C.9: Figure 8 Profile for Lateral street 12.1

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C.10: Figure 9 Profile for Lateral street 12.2

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C.11: Figure 10 Profile for Lateral street 1

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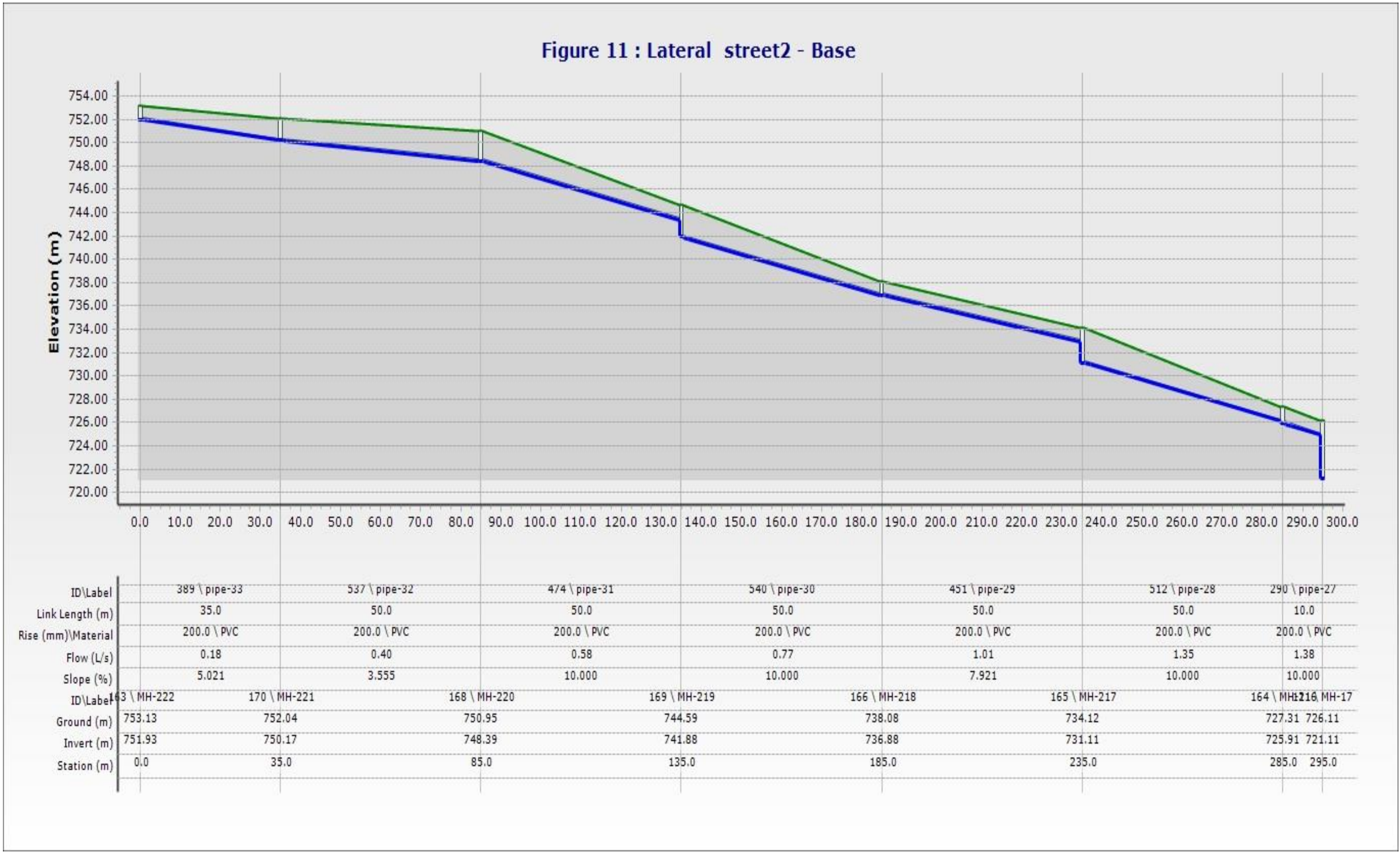

C.12: Figure 11 Profile for Lateral street 2

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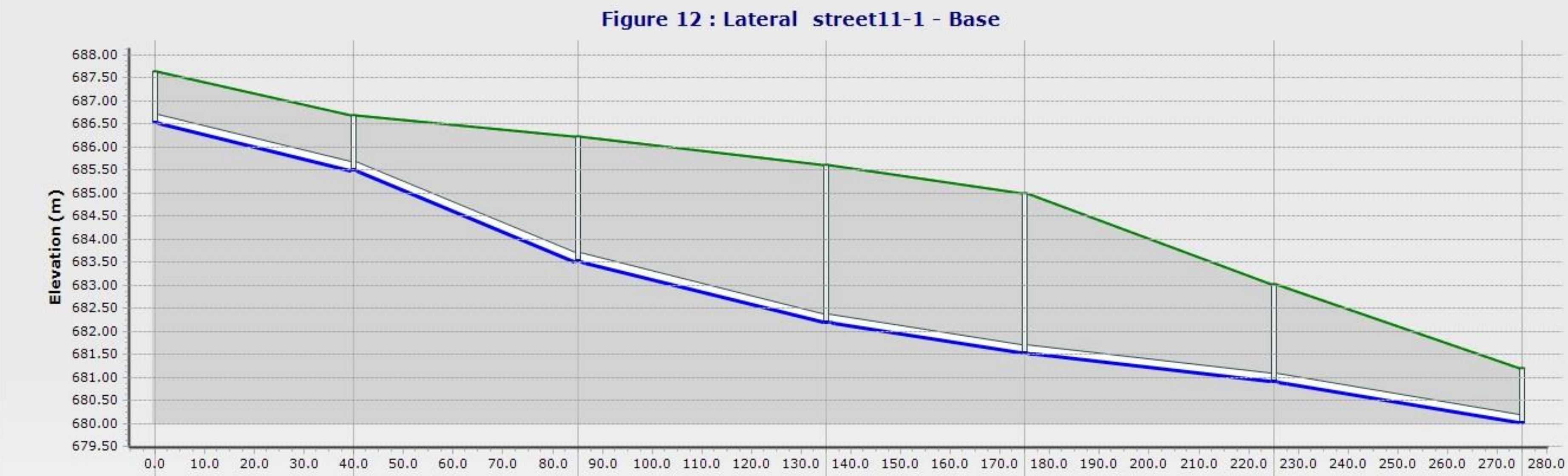

ID\Label	415 \ pipe-85	438 \ pipe-84	465 \ pipe-83	433 \ pipe-82	473 \ pipe-81	539 \ pipe-80
Link Length (m)	40.0	45.0	50.0	40.0	50.0	50.0
Rise (mm)\Material	200.0 \ PVC	200.0 \ PVC	200.0 \ PVC	200.0 \ PVC	200.0 \ PVC	200.0 \ PVC
Flow (L/s)	0.08	0.23	0.41	0.67	0.96	1.26
Slope (%)	2.589	4.400	2.627	1.716	1.236	1.784

ID\Label	08 \ MH-168	107 \ MH-167	106 \ MH-166	105 \ MH-165	104 \ MH-164	103 \ MH-163	102 \ MH-162
Ground (m)	687.63	686.68	686.23	685.61	684.99	683.01	681.19
Invert (m)	686.52	685.48	683.50	682.19	681.50	680.88	679.99
Station (m)	0.0	40.0	85.0	135.0	175.0	225.0	275.0

C.13: Figure 12 Profile for Lateral street 11.1

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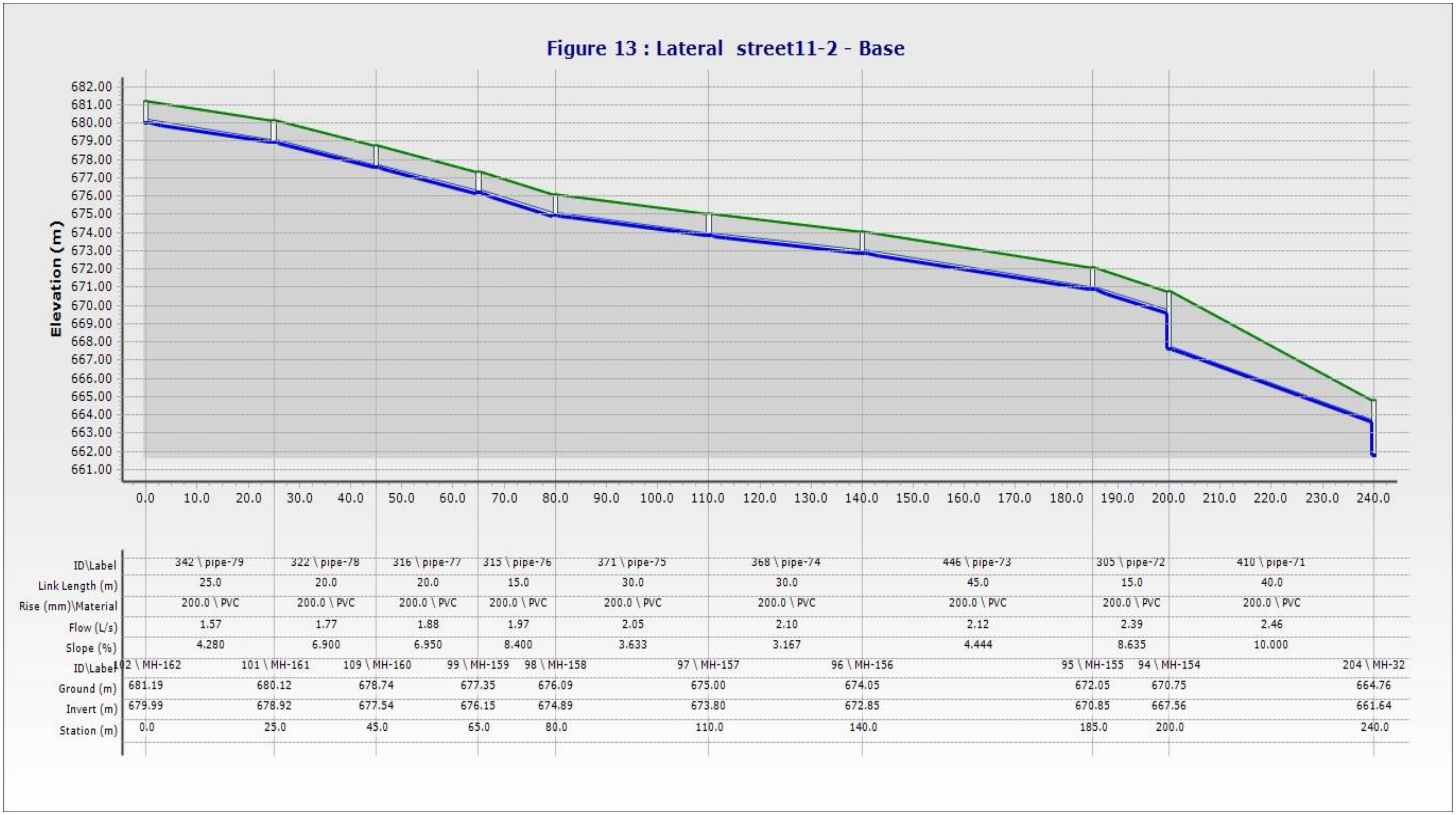

C.14: Figure 13Profile for Lateral street 11.2

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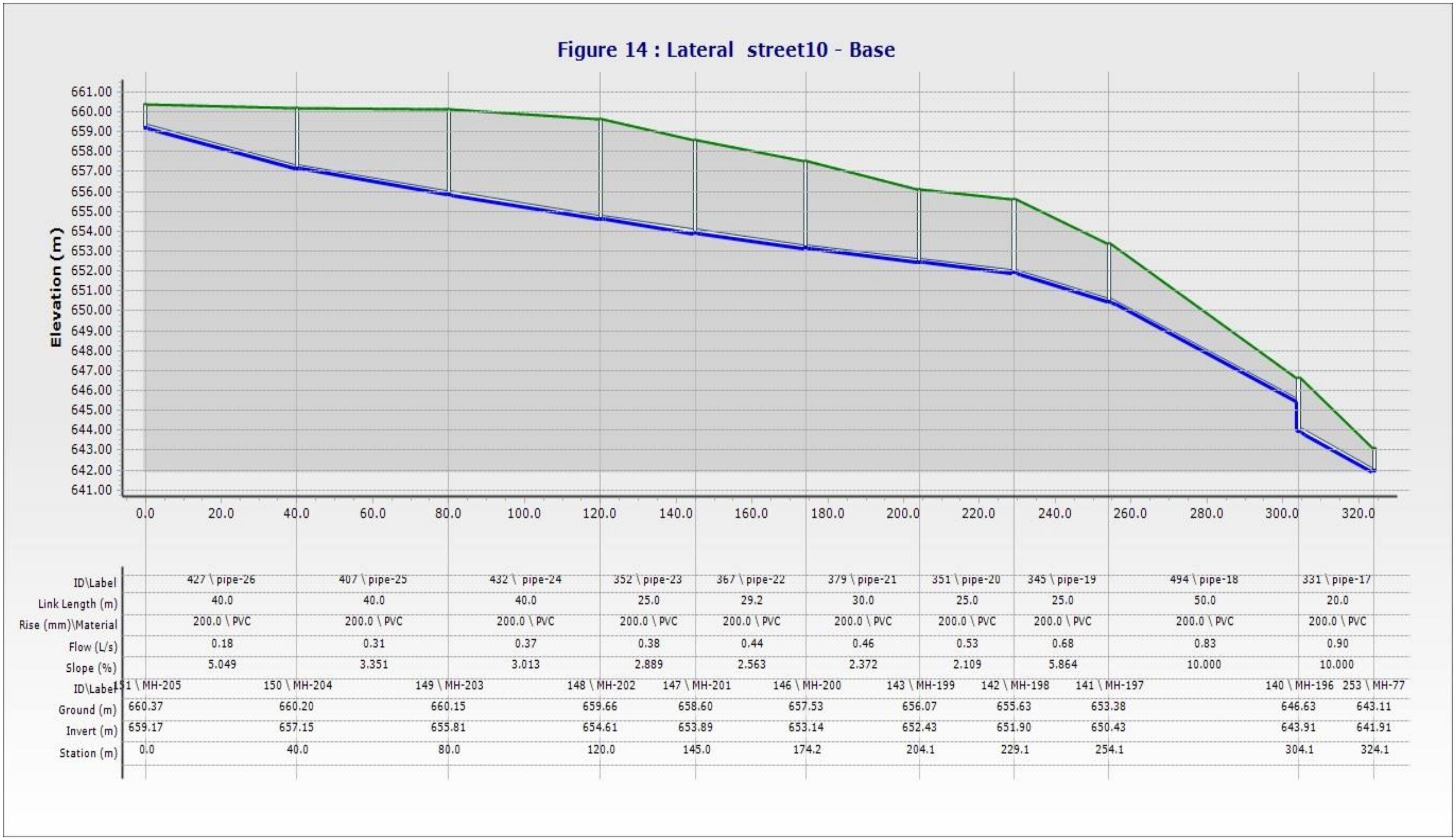

C.15: Figure 14 Profile for Lateral street 10

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C.16: Figure 15 Profile for Main street3.1

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C.17: Figure 16 Profile for Main street3.2

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C.18: Figure17 Profile for Main street3

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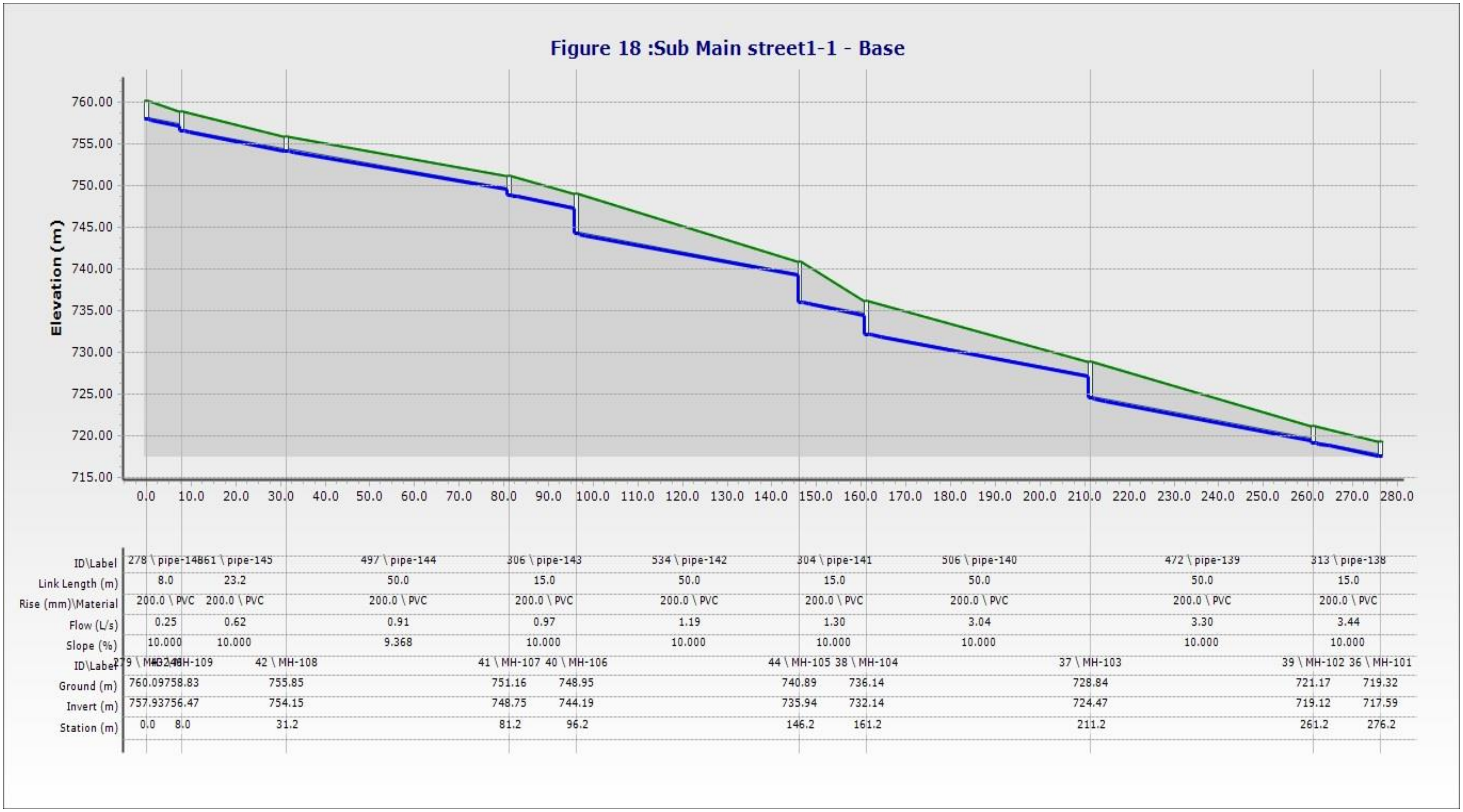
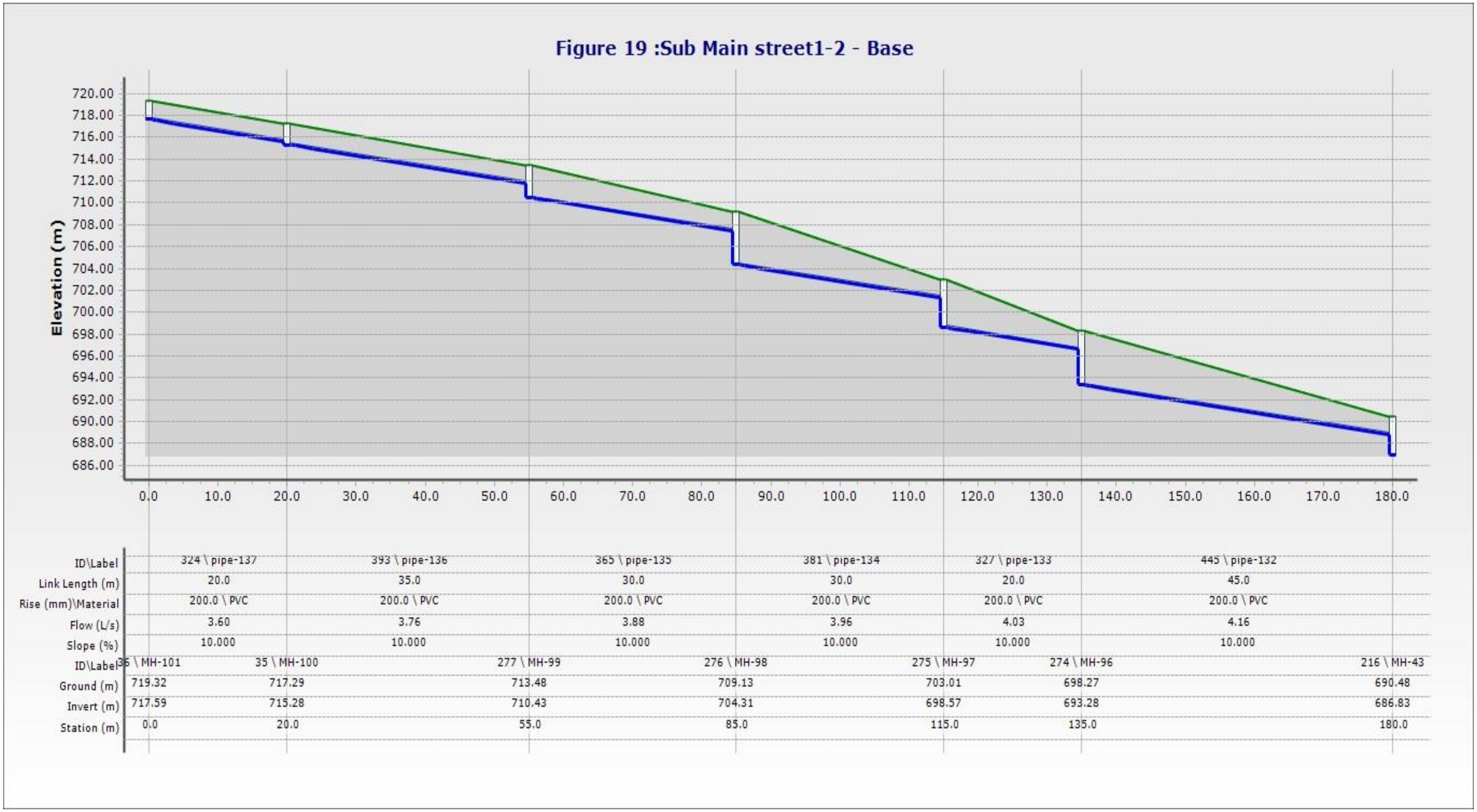


C.19: Figure 18 Profile for Sub Main street1.1



C.20: Figure 19 Profile for Sub Main street1.2

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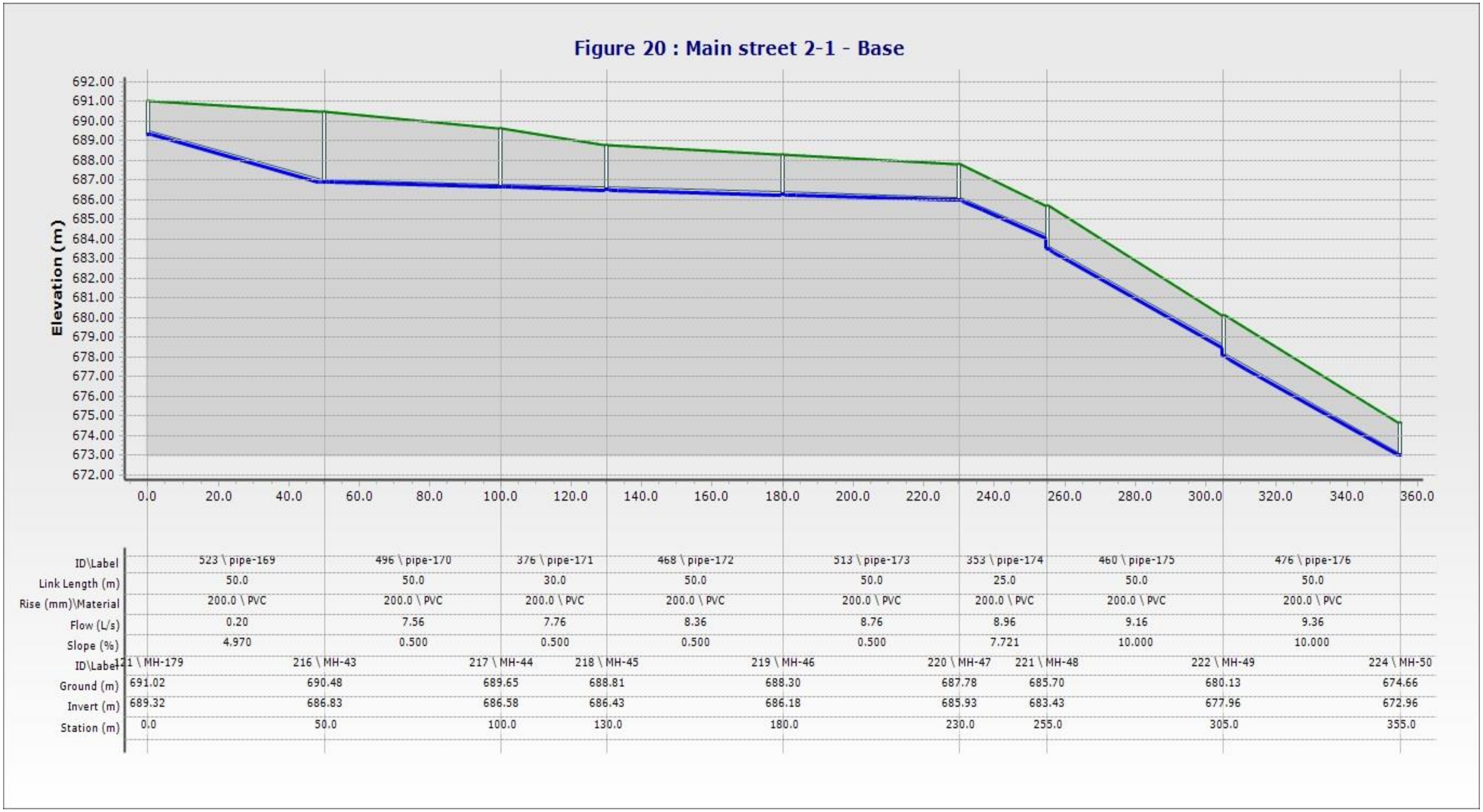

C.21: Figure 20 Profile for Main street2.1

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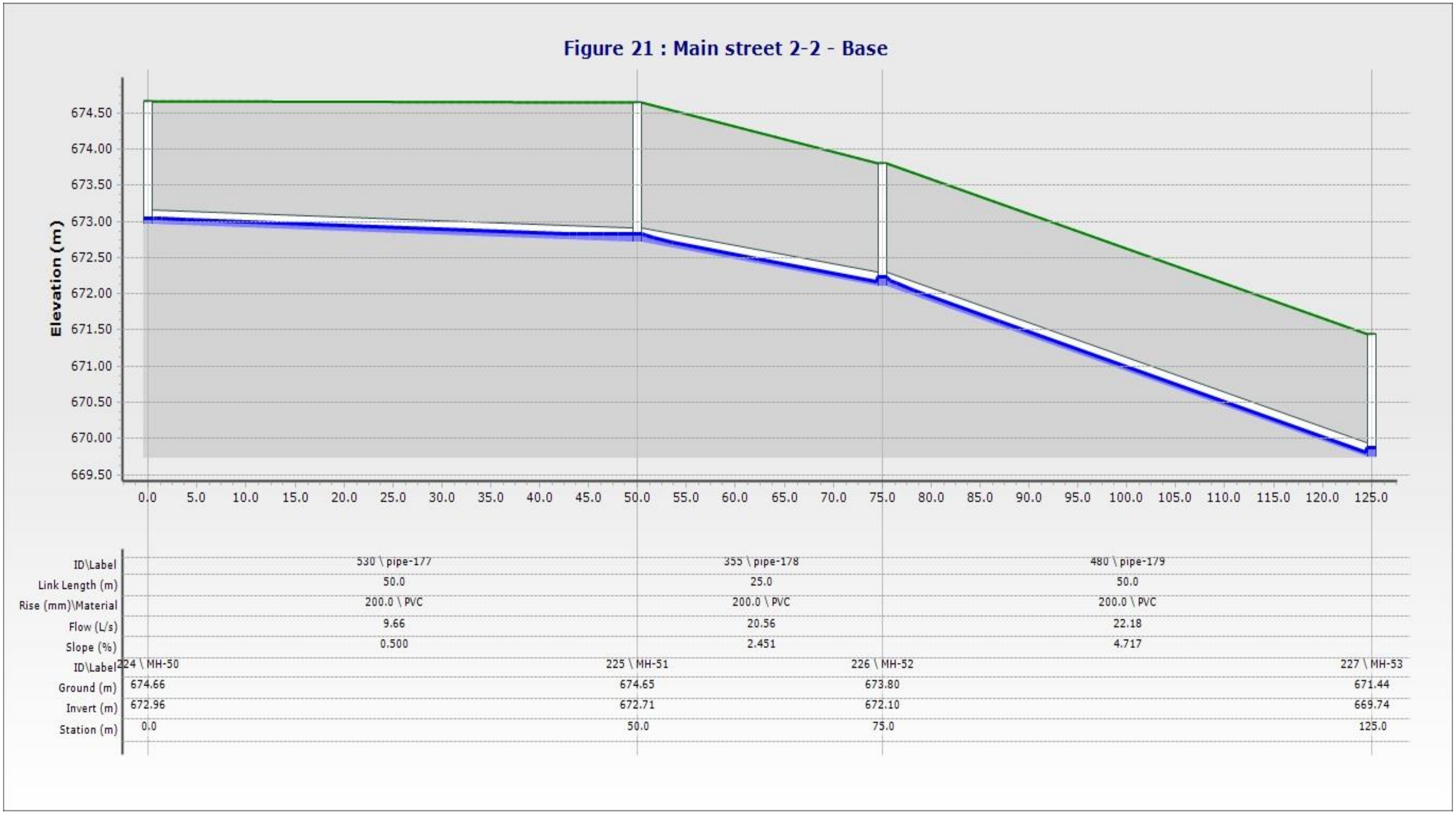

C.22: Figure 21 Profile for Main street2.2

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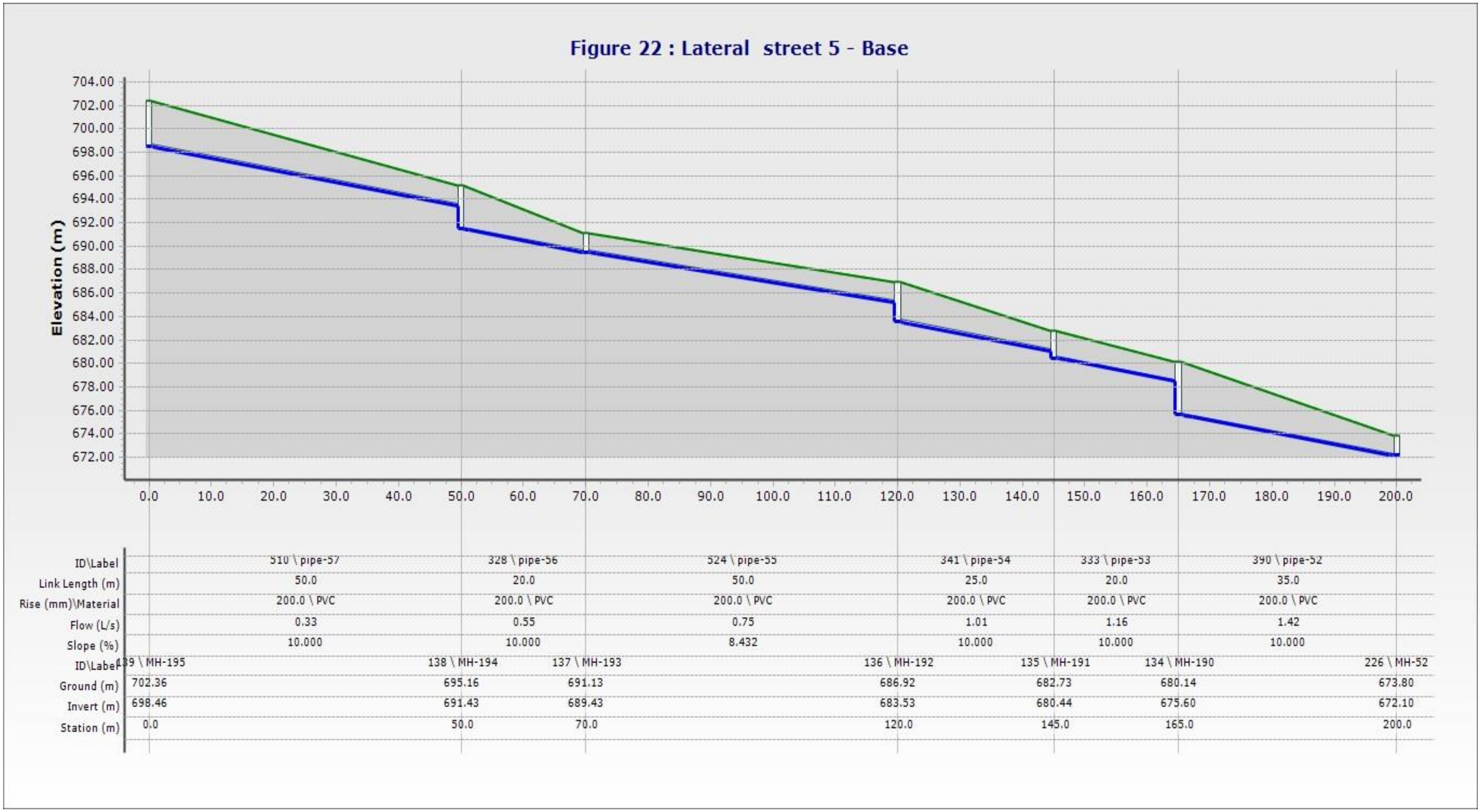

C.23: Figure 22 Profile for Lateral street5

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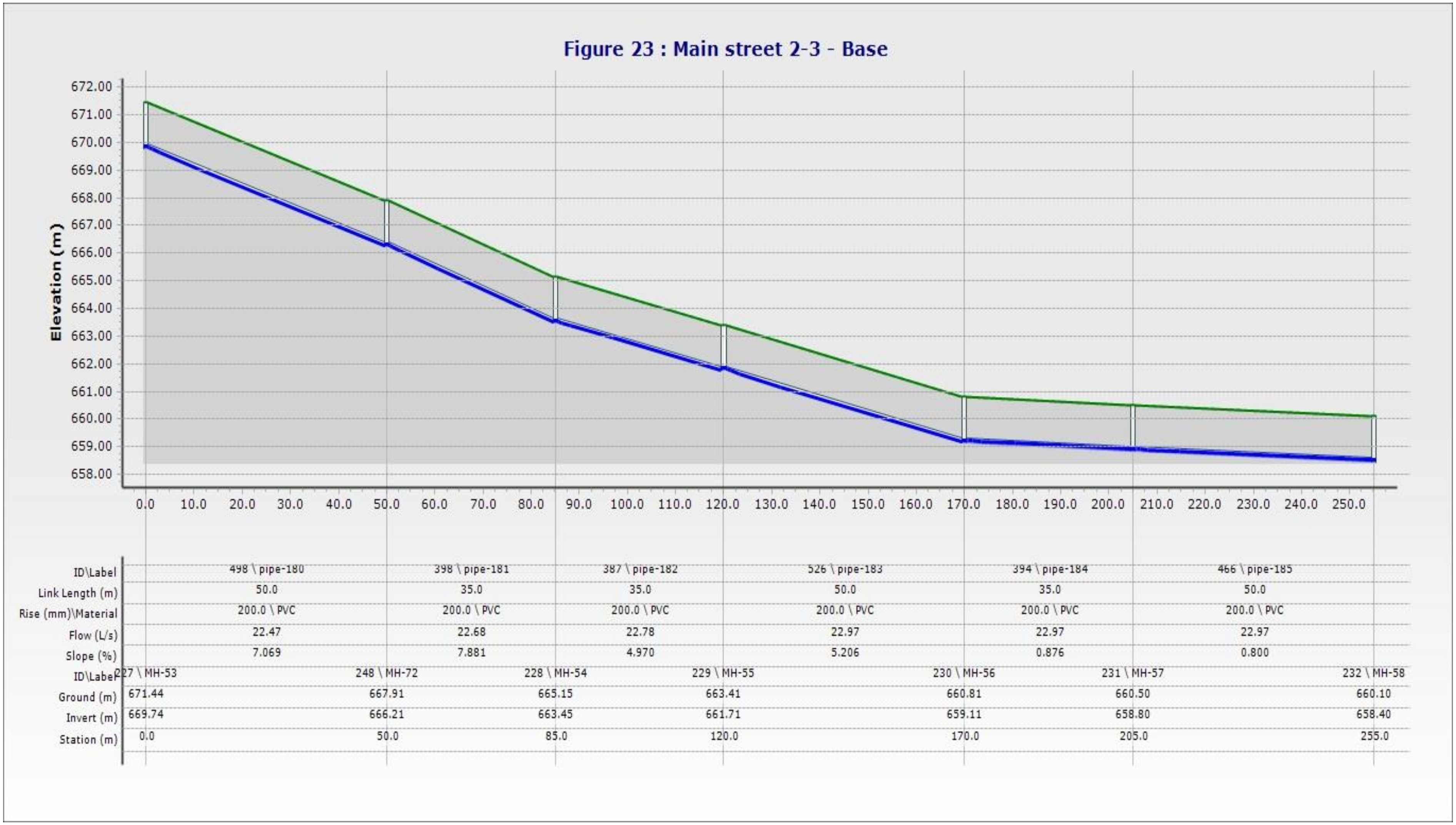

C.24: Figure 23 Profile for Main street2.3

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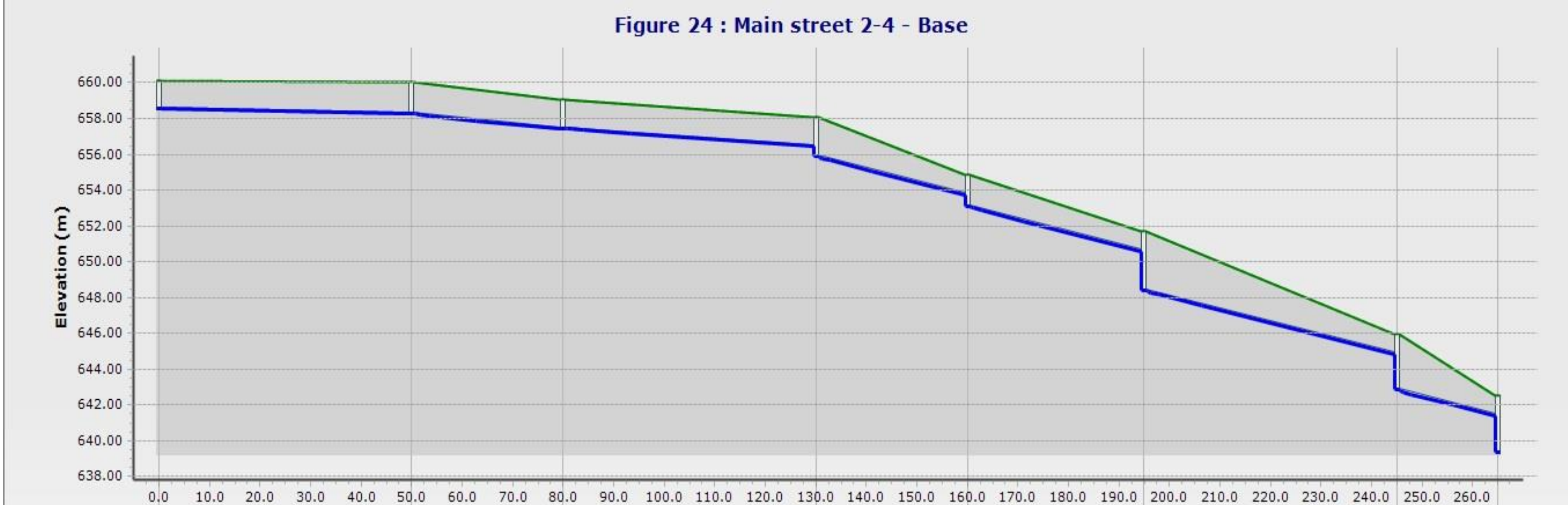

ID\Label	508 \ pipe-186	363 \ pipe-187	487 \ pipe-188	373 \ pipe-189	400 \ pipe-190	503 \ pipe-191	320 \ pipe-192
Link Length (m)	50.0	30.0	50.0	30.0	35.0	50.0	20.0
Rise (mm)\Material	200.0 \ PVC	200.0 \ PVC	200.0 \ PVC	200.0 \ PVC	200.0 \ PVC	200.0 \ PVC	200.0 \ PVC
Flow (L/s)	23.07	23.18	23.28	23.47	23.68	23.78	24.07
Slope (%)	0.500	2.733	1.943	7.000	7.000	7.000	7.000

ID\Label	232 \ MH-58	233 \ MH-59	235 \ MH-60	236 \ MH-61	237 \ MH-62	238 \ MH-63	239 \ MH-64	240 \ MH-65
Ground (m)	660.10	660.00	659.03	658.06	654.85	651.71	645.96	642.51
Invert (m)	658.40	658.15	657.33	655.75	652.96	648.26	642.71	639.22
Station (m)	0.0	50.0	80.0	130.0	160.0	195.0	245.0	265.0

C.25: Figure 24 Profile for Main street2.4

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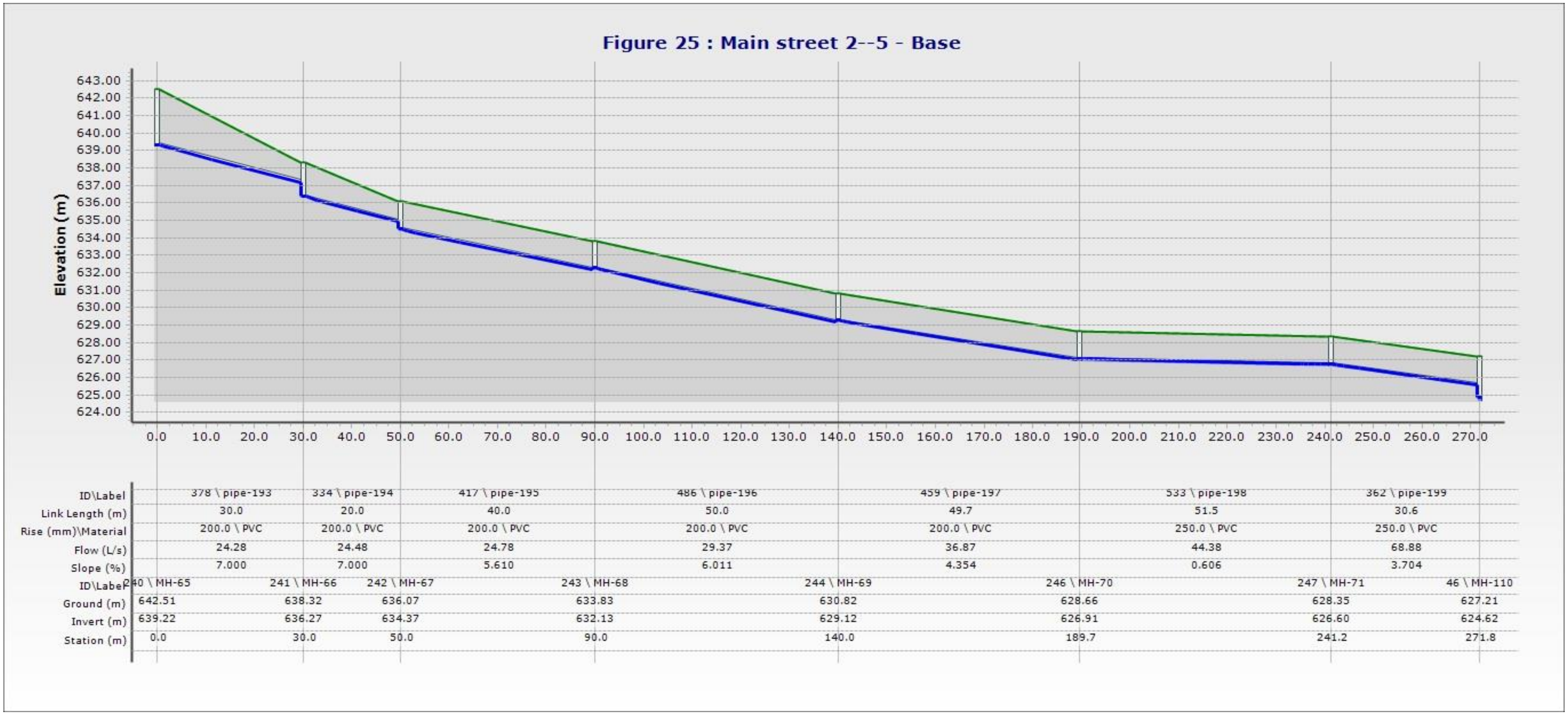

C.26: Figure 25 Profile for Main street2.5

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C.27: Figure 26 Profile for Main street2.6

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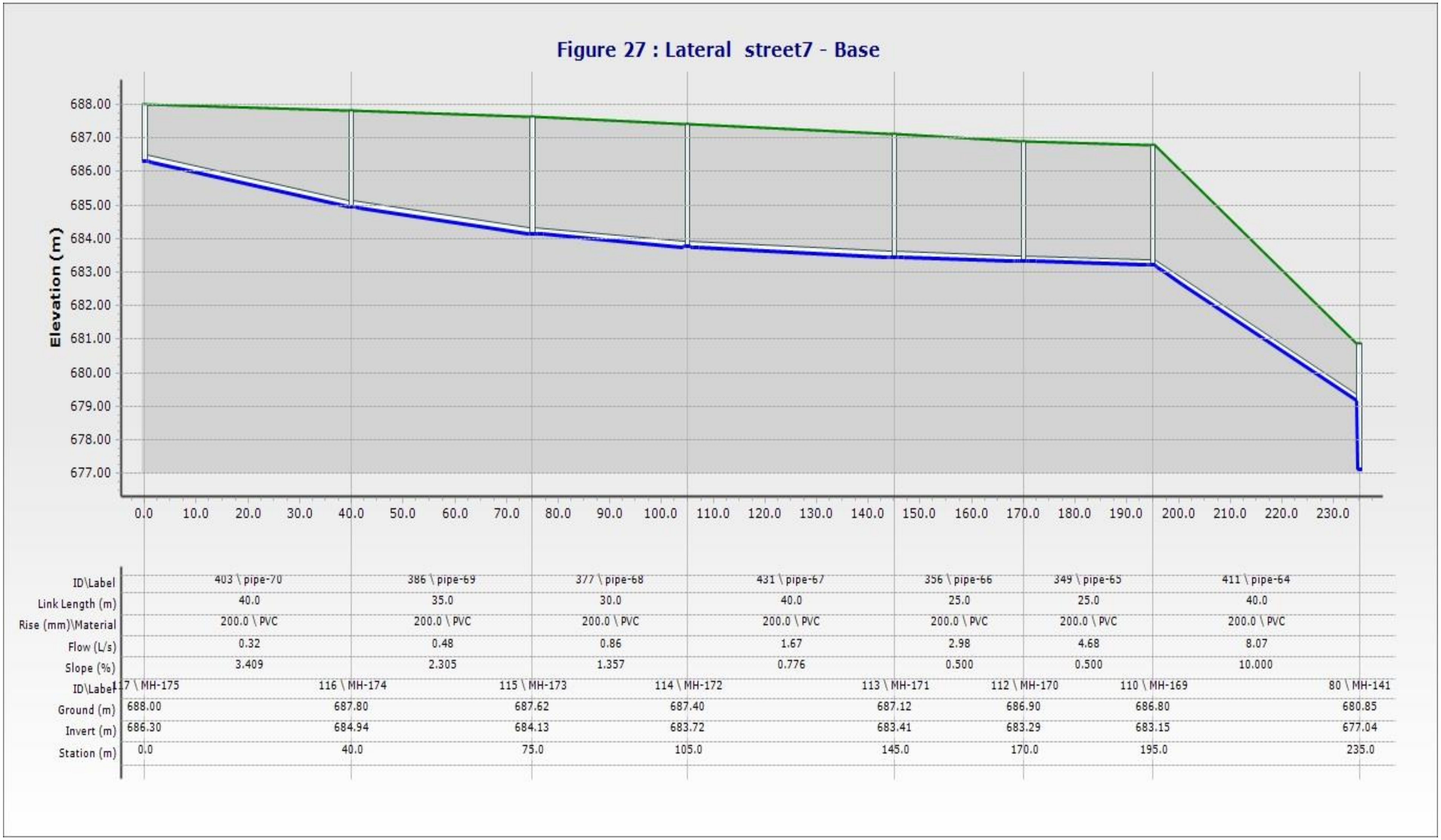

C.28: Figure 27 Profile for Lateral street7

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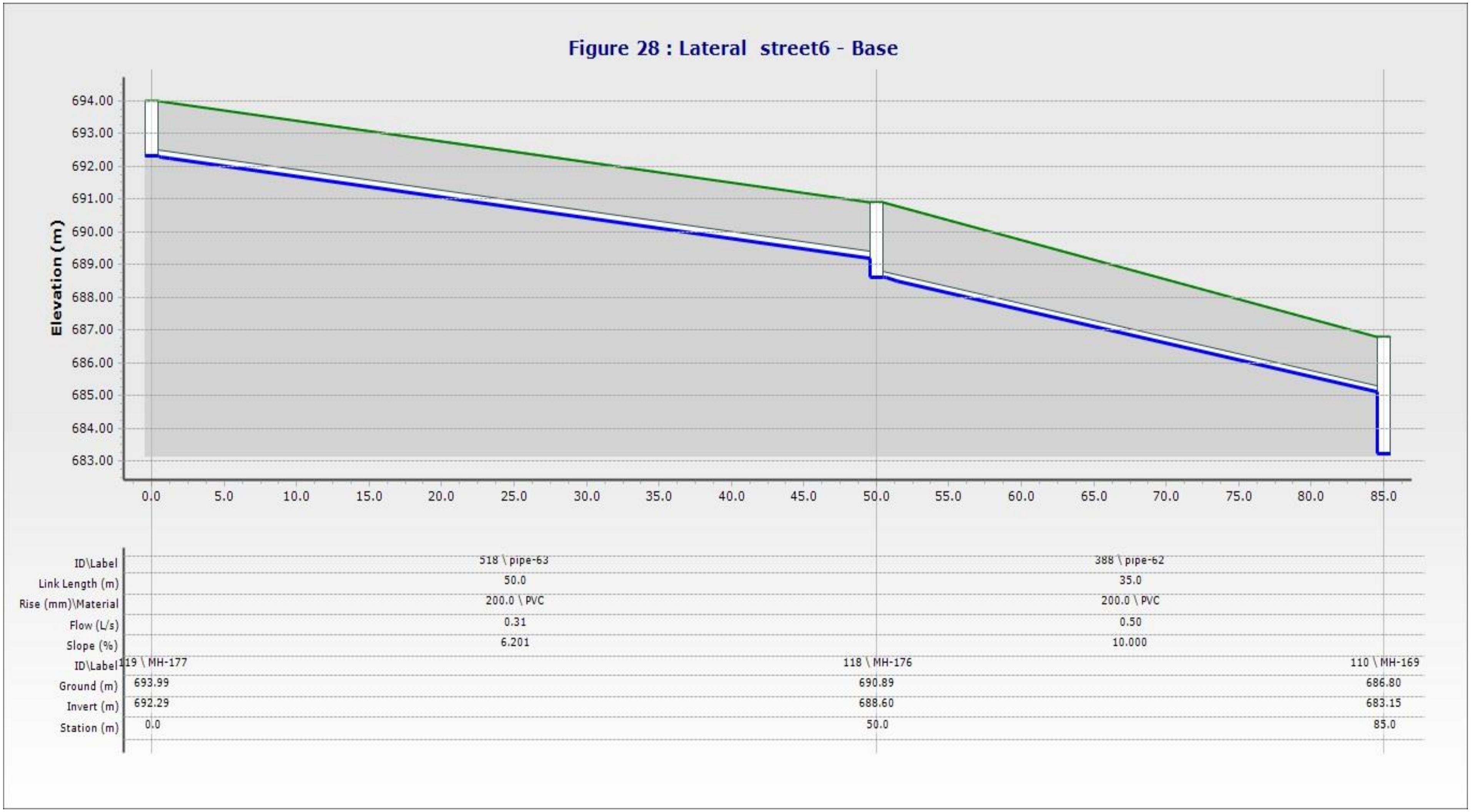

C.29: Figure 28Profile for Lateral street6

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ID\Label	489 \ pipe-99	426 \ pipe-98	408 \ pipe-97	509 \ pipe-96	314 \ pipe-95	
Link Length (m)	50.0	40.0	40.0	50.0	15.0	
Rise (mm)\Material	200.0 \ PVC	200.0 \ PVC	200.0 \ PVC	200.0 \ PVC	200.0 \ PVC	
Flow (L/s)	0.20	11.67	11.96	12.24	12.32	
Slope (%)	10.000	10.000	10.000	10.000	10.000	
ID\Label	79 \ MH-140	80 \ MH-141	81 \ MH-142	82 \ MH-143	83 \ MH-144	84 \ MH-145
Ground (m)	687.78	680.85	674.74	669.04	662.82	661.17
Invert (m)	684.15	677.04	671.34	666.12	660.97	659.43
Station (m)	0.0	50.0	90.0	130.0	180.0	195.0

C.30: Figure (29) : Profile for Sub Main street3.1

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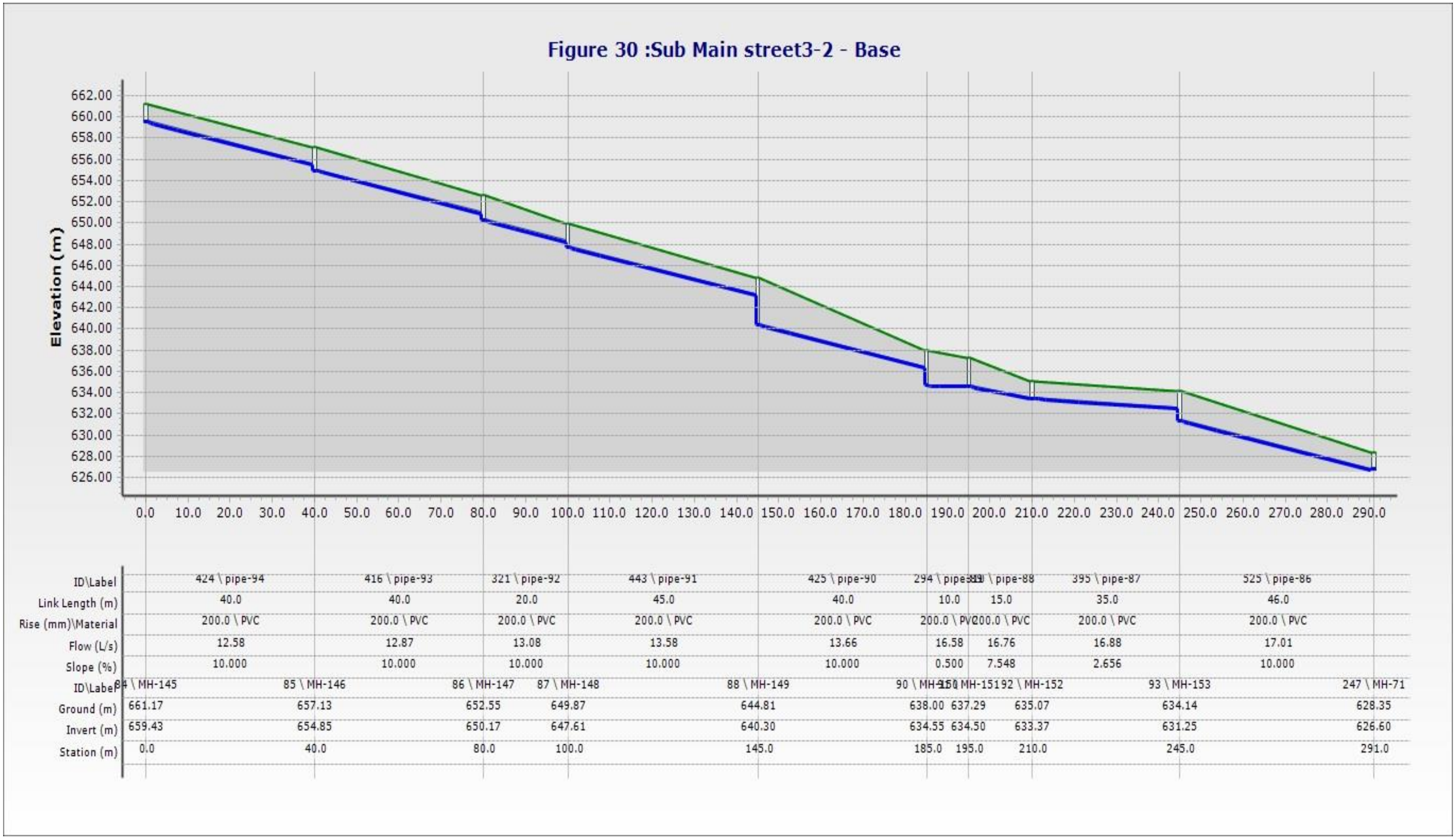

C.31: Figure 30 Profile for Main street3.2

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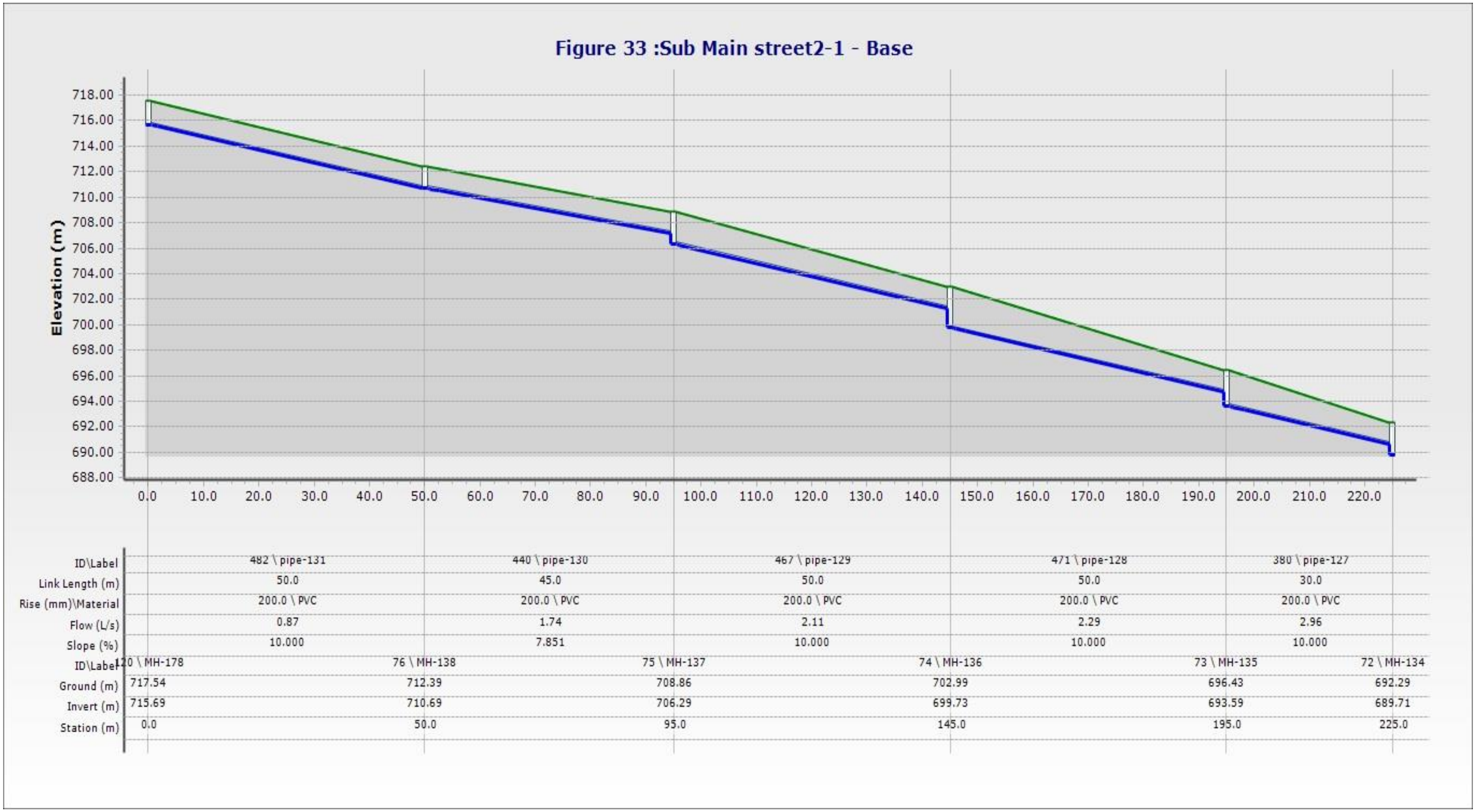
ID\Label	335 \ pipe-51	437 \ pipe-50	348 \ pipe-49	343 \ pipe-48	338 \ pipe-47	339 \ pipe-46	447 \ pipe-45	463 \ pipe-44	481 \ pipe-43	529 \ pipe-42
Link Length (m)	20.0	45.0	25.0	25.0	20.0	25.0	45.0	50.0	50.0	50.0
Rise (mm)\Material	200.0 \ PVC	200.0 \ PVC	200.0 \ PVC	200.0 \ PVC	200.0 \ PVC	200.0 \ PVC	200.0 \ PVC	200.0 \ PVC	200.0 \ PVC	200.0 \ PVC
Flow (L/s)	0.14	0.36	0.55	0.71	0.88	1.02	1.11	1.17	1.29	1.45
Slope (%)	10.000	10.000	10.000	7.505	8.363	8.603	5.184	1.044	1.172	0.865

ID\Label	131 \ MH-189	130 \ MH-188	129 \ MH-187	128 \ MH-186	127 \ MH-185	132 \ MH-184	126 \ MH-183	125 \ MH-182	124 \ MH-181	123 \ MH-180	90 \ MH-150
Ground (m)	657.65	655.46	648.96	645.83	643.95	642.28	640.13	637.79	637.56	636.68	638.00
Invert (m)	655.76	651.76	646.63	644.13	642.25	640.58	638.43	636.09	635.57	634.98	634.55
Station (m)	0.0	20.0	65.0	90.0	115.0	135.0	160.0	205.0	255.0	305.0	355.0

C.32: Figure 31 Profile for Lateral street8

C.33: Figure 32Profile for Lateral street4



C.34: Figure33Profile for Sub Main street2.1

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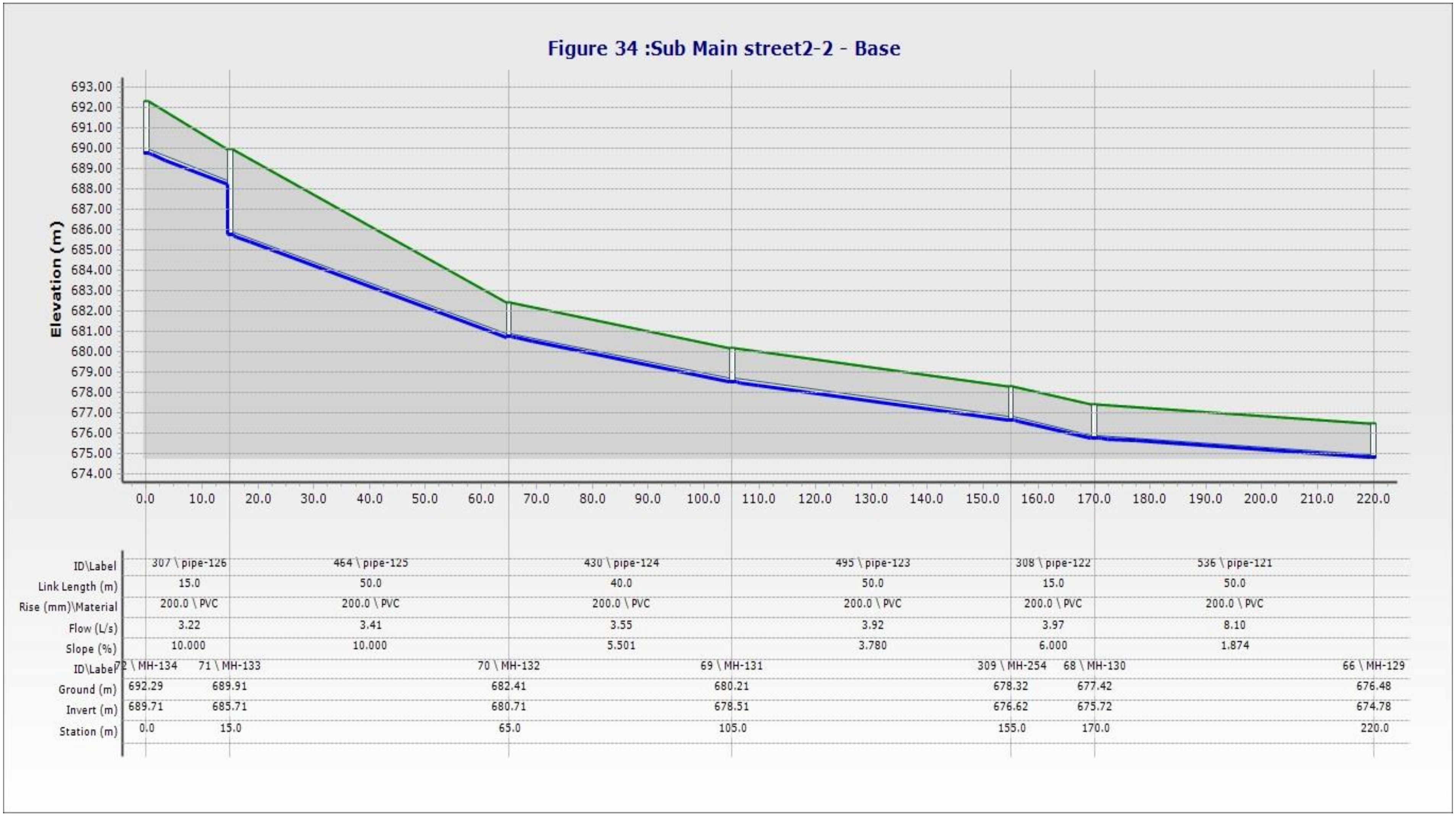
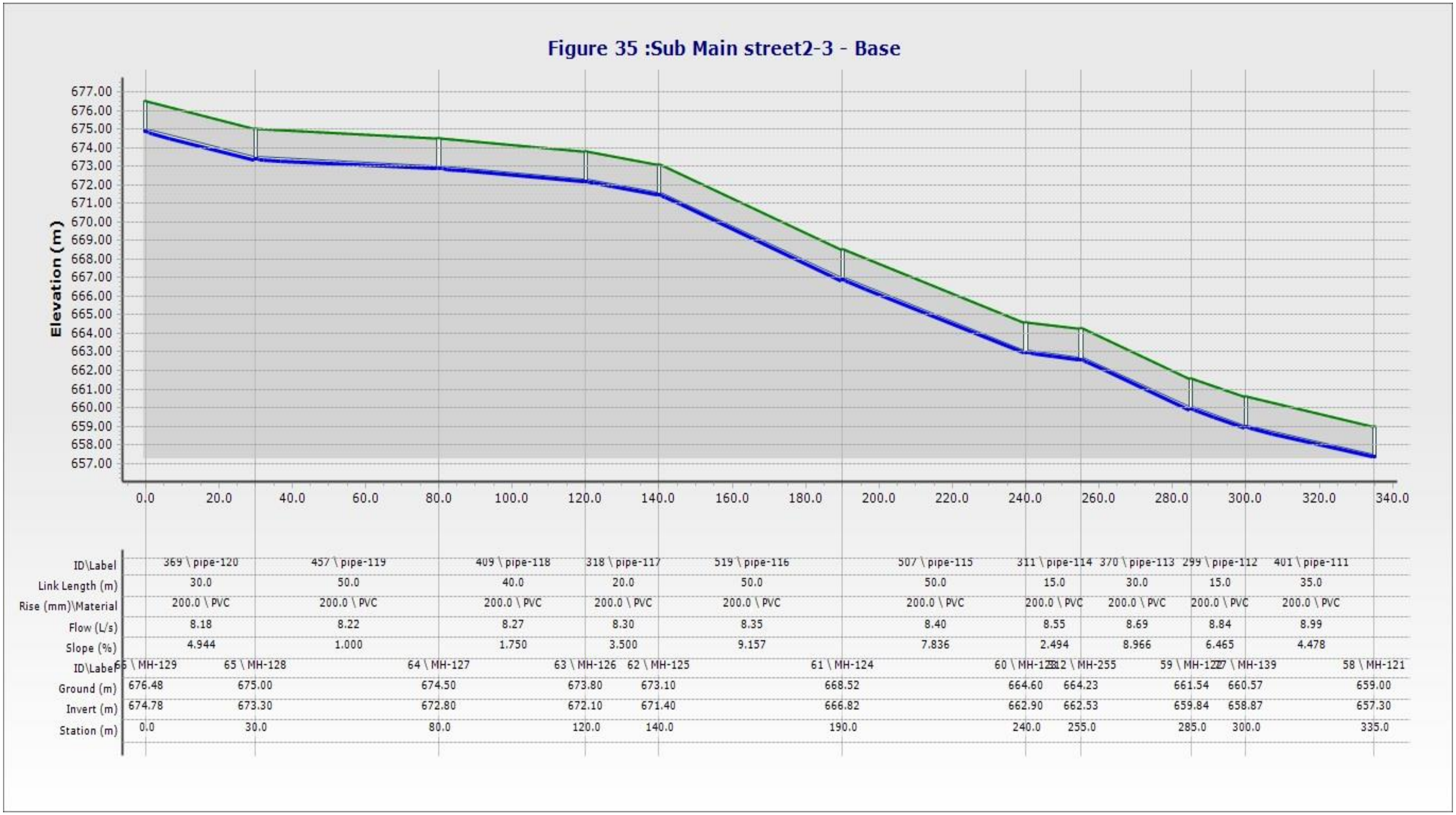


C.35: Figure 34 Profile for Sub Main street2.2



C.36: Figure 35 Profile for Sub Main street2.3

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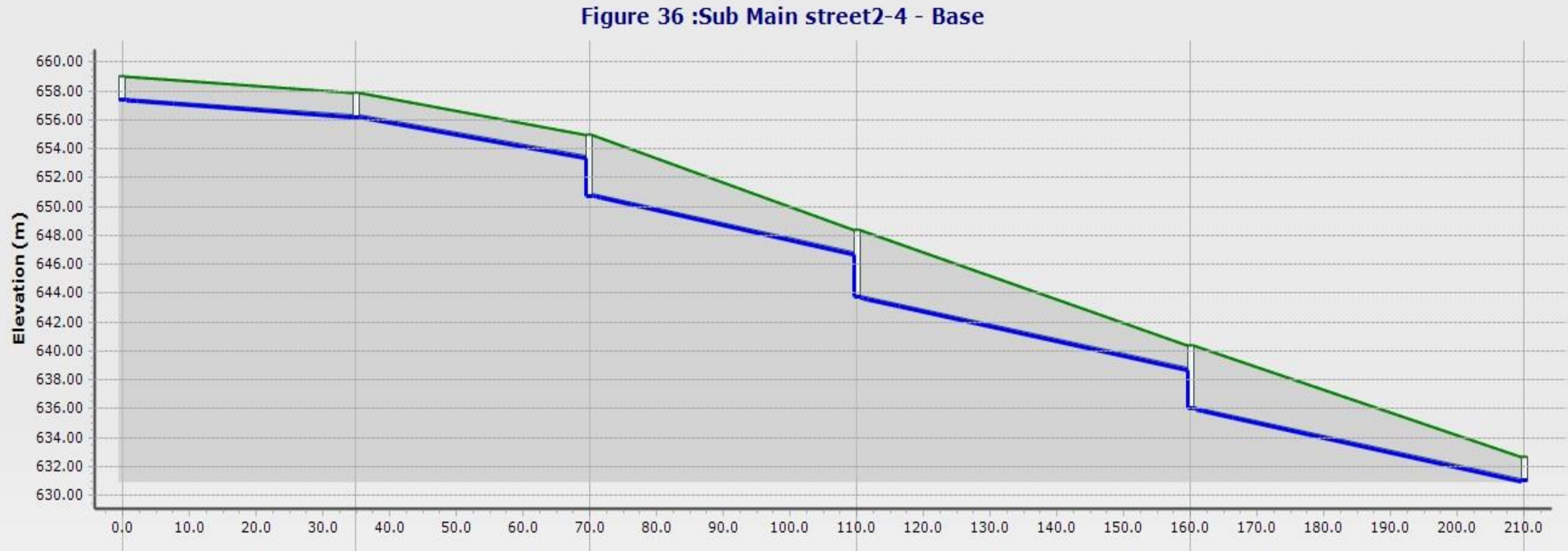

ID\Label	385 \ pipe-110	399 \ pipe-109	406 \ pipe-108	470 \ pipe-107	490 \ pipe-106
Link Length (m)	35.0	35.0	40.0	50.0	50.0
Rise (mm)\Material	200.0 \ PVC	200.0 \ PVC	200.0 \ PVC	200.0 \ PVC	200.0 \ PVC
Flow (L/s)	9.13	9.32	9.58	9.70	9.82
Slope (%)	3.334	8.103	10.000	10.000	10.000

ID\Label	58 \ MH-121	57 \ MH-120	55 \ MH-119	54 \ MH-118	53 \ MH-117	52 \ MH-116
Ground (m)	659.00	657.84	655.00	648.37	640.35	632.65
Invert (m)	657.30	656.14	650.67	643.65	635.95	630.95
Station (m)	0.0	35.0	70.0	110.0	160.0	210.0

C.37: Figure 36 Profile for Sub Main street2.4

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C.38: Figure 37Profile for Sub Main street2.5

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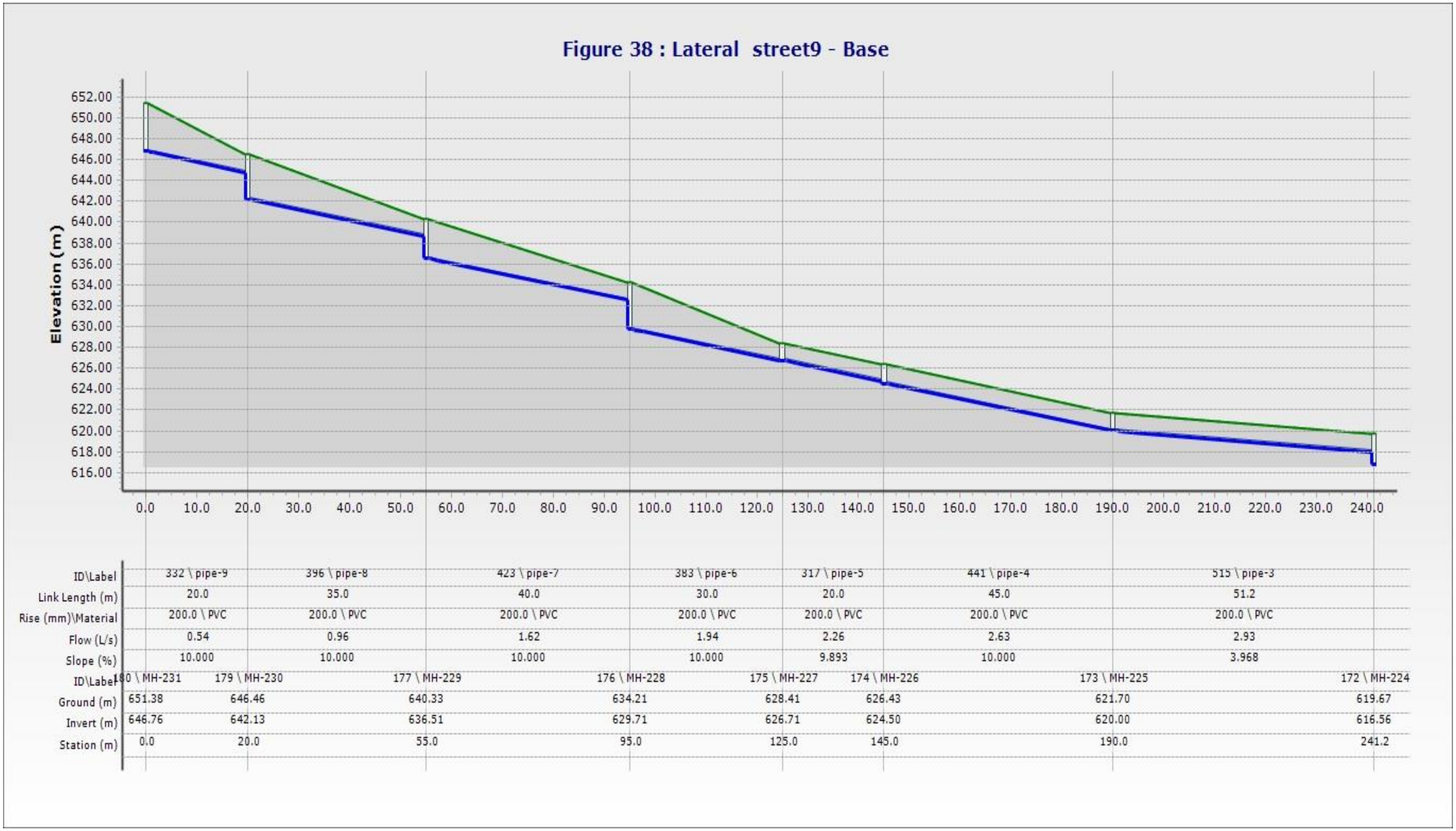

C.39: Figure 38 Profile for Lateral street9

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Reference

1- Mc Ghee, Terence J. (1991), "Water Supply and Sewage", Sixth Edition, Mc Ghee- Hill International Edition, U.S.A.

2- Clift, Mortimer A., James F. Snyder, and Hicks E. Genevia. "Apparatus for transporting sewage and waste liquids." U.S. Patent No. 3,211,167. 12 Oct. 1965.

3- Gorasia, Rohit J. Behaviour of ribbed piles in clay. Diss. City University London, 2013.

4- Water Research Centre (Great Britain). Sewers for Adoption: A Design and Construction Guide for Developers. Water Research Centre, 1995.

5- KAFFESHAH, SHAHD, and W. A. L. A. AL-NATSHEH. "DESIGN OF WASTEWATER COLLECTION SYSTEM FOR TAFFOUH TOWN." (2012).

6- McGhee, Terence J., and Ernest William Steel. Water supply and sewerage. Vol. 6. New York: McGraw-Hill, 1991.

7- Davis, M.L., 2010. Water and wastewater engineering: design principles and practice. McGraw-Hill.

8- Palestinian Central Bureau of Statistics (2017) , Estimated mid-year population for Bethlehem Governorate.

9- Palestinian Central Bureau of Statistics (2018) , Average rate of Weather changes for Bethlehem Governorate.