4.1General

In this project, design of wastewater collection system for Dora city will be made, and develop a future plans for construction of the collection system, corresponding to the vision of Dora municipality about their future plan, 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.

4.2 Population

4.2.1 Introduction

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.

In the city of Dora, as well as other Palestinian cities and villages, there is great uncertainty in the political and economical future. The final results of this census show that the total population of Dora is 27600 inhabitants Based on information obtained from Dora municipality.

4.2.2 Population Forecast

The rate of 3.6% per year was used for the future growth of the population of Dora city.[12]

To calculate the population at the end of the design period (year 2039), a geometric increase is assumed, represented by the following equation:

$$P = P_{\circ} (1+R)^{n} \quad \text{..... (4.1)}$$

Where, P is the future population, P_o is the present population, R is the annual population growth rate, and n is the period of projection, the population projection up to the design horizon of 2039 is shown in table 4.1

Table 4.1:- Population forecasts for Dora city

YEAR	2014	2024	2034	2039
POPULATION	27600	39311	55990	66820

4.2.3 Population Density

In our project the population densities on the city structure plan, which serves for issuing buildings permit. The data obtained for population density from Dora municipality are shown in Figure (4.1).

4.3 Layout of the System

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

In establishing the layout of wastewater collection system for Dora 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 Dora city, there are two points of the first towards Al-Fawwar and the second point towards towards the west .
4. Sketch in preliminary pipe system to serve all the contributors.
5. Pipes are located so that all the users or future users can readily tap on. They are also located so as to provide access for maintenance and thus are ordinarily placed in streets or other rights-of-way.

6. Sewers layout is followed natural drainage ways so as to minimize excavation and pumping requirements. Large trunk sewers are located in low-lying areas closely paralleled with streams or channels.
7. Revise the layout so as to optimize flow-carrying capacity at minimum cost. Pipe lengths and sizes are kept as small as possible, pipe slopes are minimized, and followed the ground surface slope to minimize the depth of excavation, and the numbers of appurtenances are kept as small as possible.
8. The pumping is avoided across drainage boundaries. Pumping stations are costly and add maintenance problems.

The final layout of wastewater collection system of Dora city is illustrated in Figure (4.2), and Figure (4.3).

four main trunks and three sub-main are located on the layout.

4.4 Quantity Of Wastewater

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

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

Design example: Design a gravity flow sanitary sewer

Design a gravity flow main sanitary sewer for the area to outfall (line D) shown in Figure (4.4). The following data will be collected and analyzed.

1. For current water consumption uses 70L/c.day.
2. For future water consumption uses 120L/c.day.
3. For current population
4. For future population : using the equation (4.1) .
5. For population growth rate 3.6 %.
6. For design period use 25 years as a design period.
7. The wastewater calculates as 80% of the water consumption.
8. For infiltration allowance use 10% of the domestic sewerage flow.
9. Peaking factor depending on the formula :

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

Where q = average industrial sewage flow.

10. For the hydraulic design equation use the Manning equation with an n value of 0.01. To simplify the computations, we use the tables.
11. Minimum pipe size: The building code specifies 200 mm (8 in) as the smallest pipe size permissible for this situation.
12. Minimum velocity: To prevent the deposition of solids at low wastewater flows, use minimum velocity of 0.6 m/s during the peak flow conditions.
13. Minimum cover (minimum depth of cover over the top of sewer). The minimum depth

of cover is 1.5 m.

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 (4.2) , The data in the table are calculated as follow:
4. The entries in columns 1 and 2 are used to identify the line numbers and street sewer name.
5. The entries in columns 3 through 5 are used to identify the sewer manholes, their numbers and the spacing between each two 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 columns 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 3.2 as: $P_f = 1.5 + 2.5/\sqrt{q}$, 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% $fQ_{average}$ (10% * column 9). Column 13 and column 15 used to show the maximum flow design which is come from column 11+ column 1

The calculation and design tables for the wastewater collection system of Dora city are shown in Appendix A .

We will use Bently Sewer CAD Program in design, The following pages show how to use the program.

4.5 Bently Sewer CAD Program Works:

- Open Bently Sewer CAD, select create new project , figure (4.5) below shows this step.

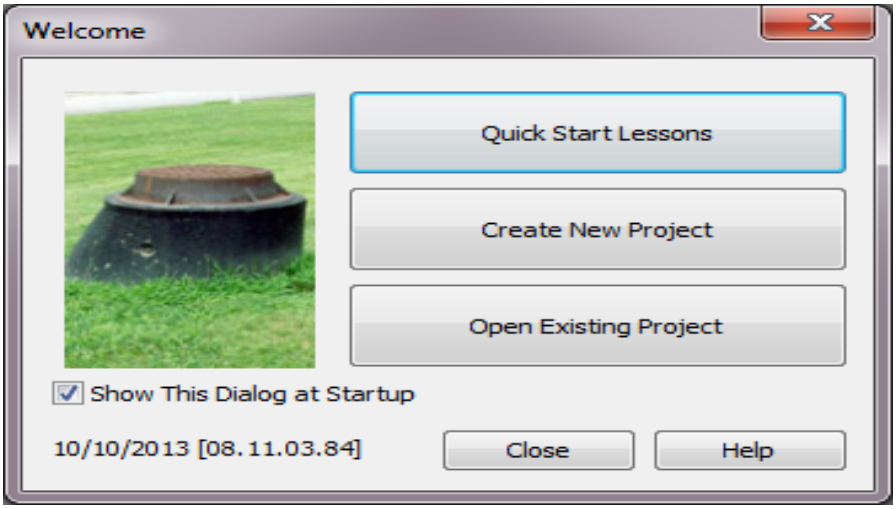


Figure (4.5) create new project

- View →background layers → New → file, figure (4.6) below shows this step.

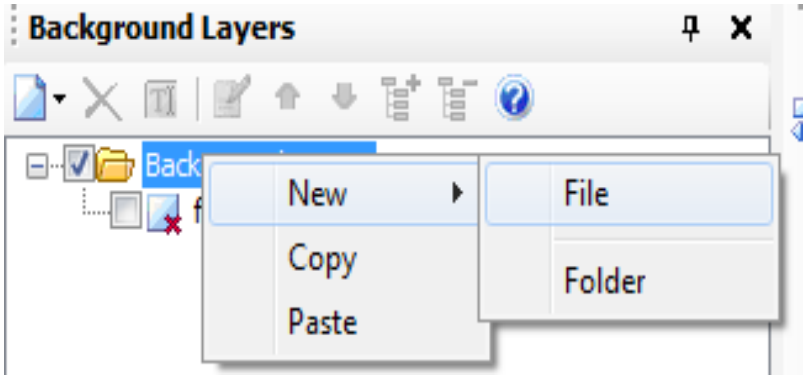


Figure (4.6) Importing DXF File

- Specify file location and then press open, figure (4.7) below shows this step. Figure (4.8) shows a line example.

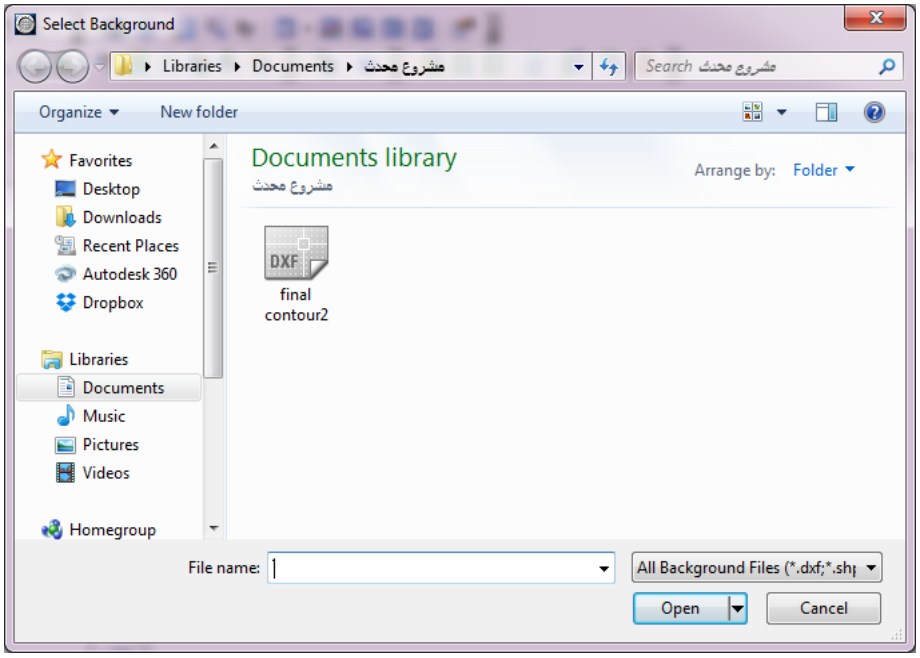


Figure (4.7): Opening the DXF file.

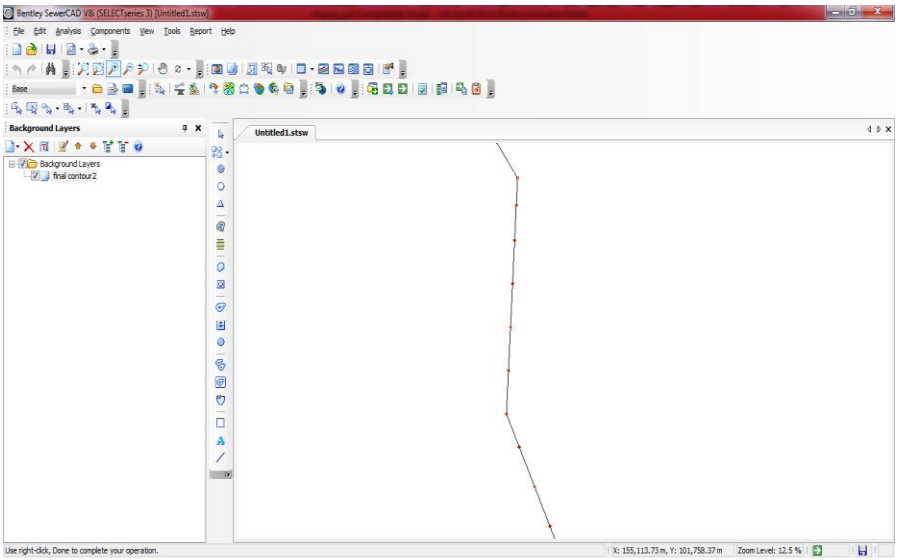


Figure (4.8) : Line Example

- Press conduit icon and connect between manholes, figure (4.9) below shows this step, figure (4.10) shows the result .

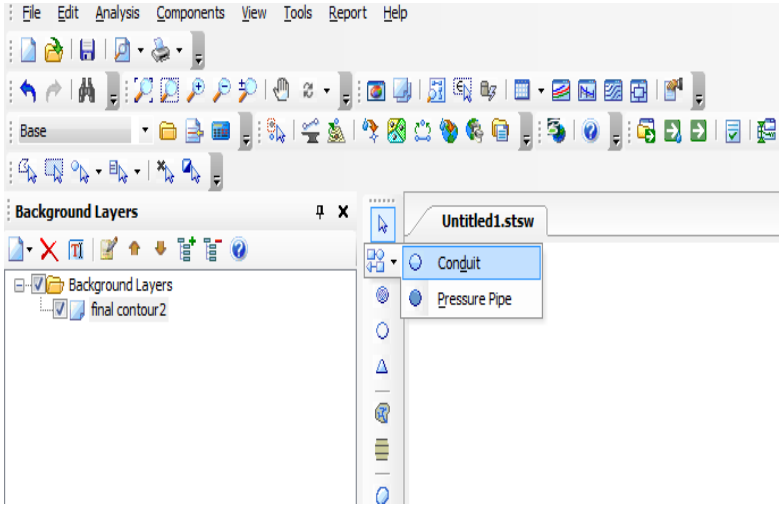


Figure (4.9): Creating a pipe network.

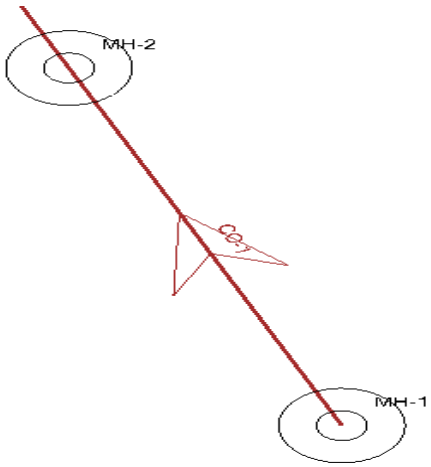


figure (4.10) : pipe network

- Tools →TRex ,here we Editing coordinate(x,y,z) fo each manhole by import 3D contour file , figure (4.11) show this step, figure(4.12)show the manhole coordinate.

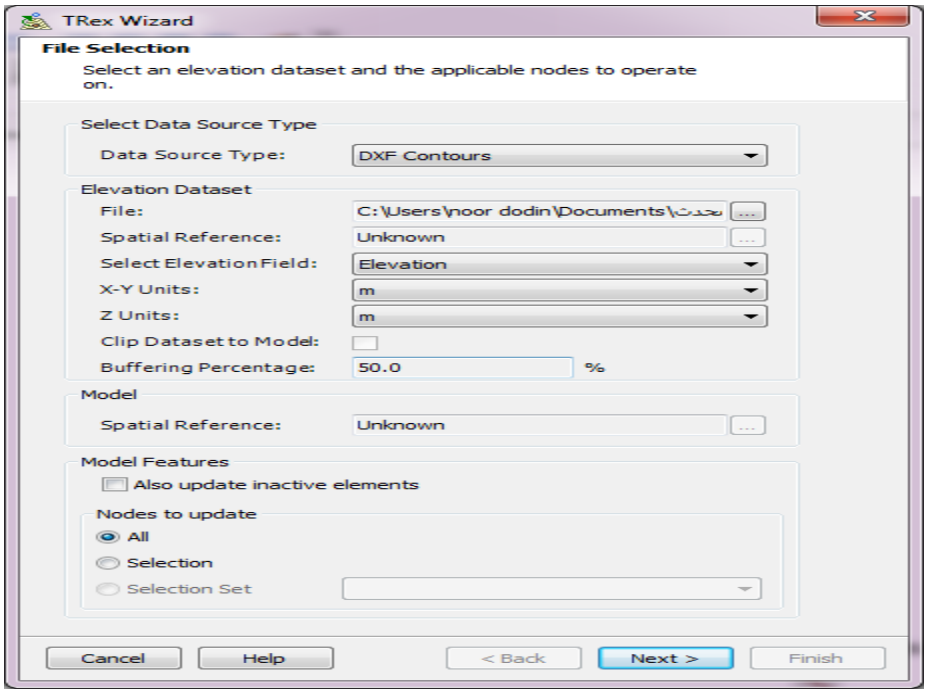
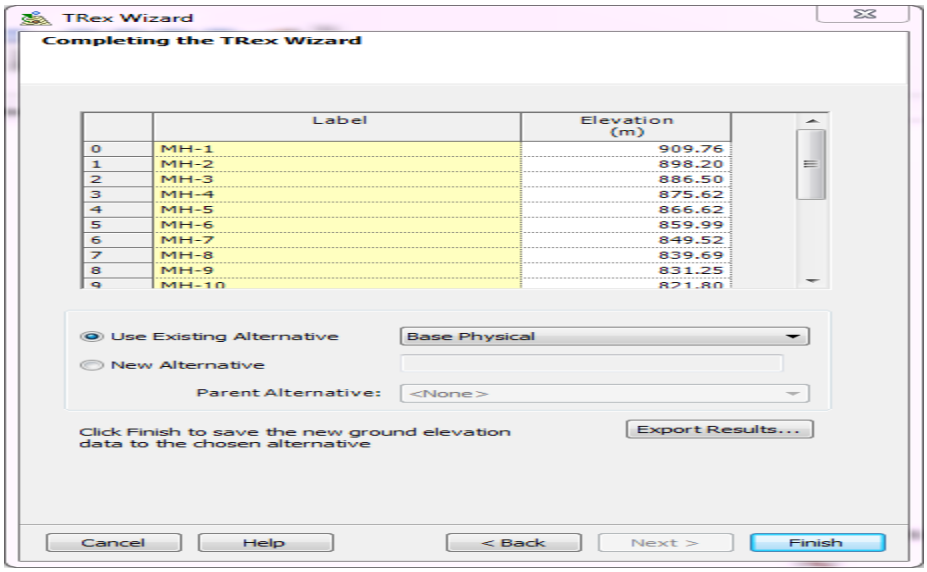


figure (4.11) : Import 3D contour



figure(4.12) : Editing manhole coordinate.

- Tools →sanitary load control center, here we change the load definition to (sanitary pattern load) and Enter the the Base flow, figure (4.13) show this step.

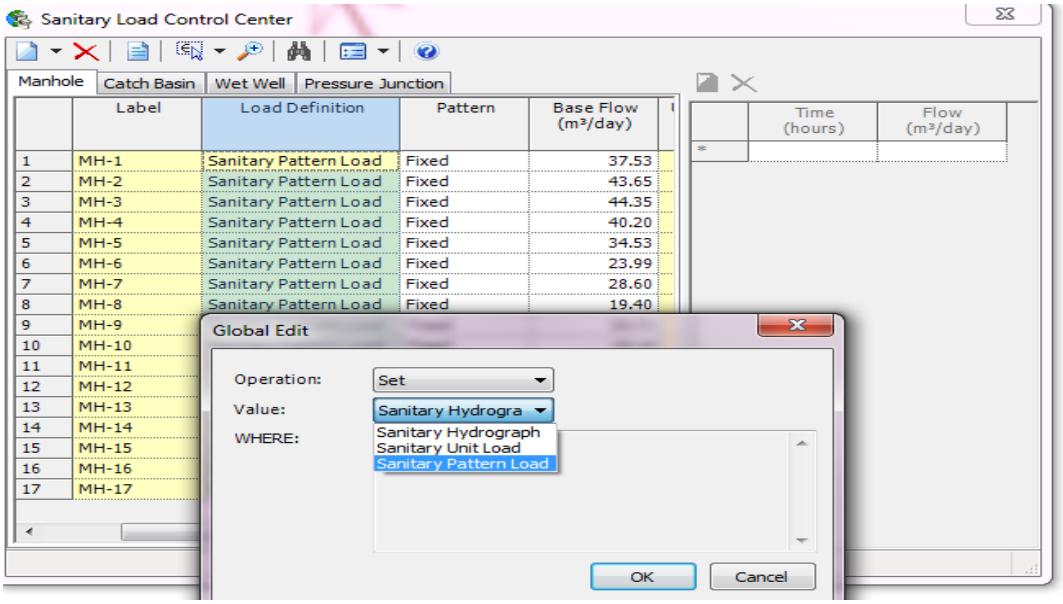


figure (4.13) : Editing Base flow

- In this step we Editing required data in the table of (manhole ,conduit,out fall) like length of conduit,diameter of manhole(1200mm),type of conduit(circuler)and its material(PVC) and other , figure (4.14) Show this step.

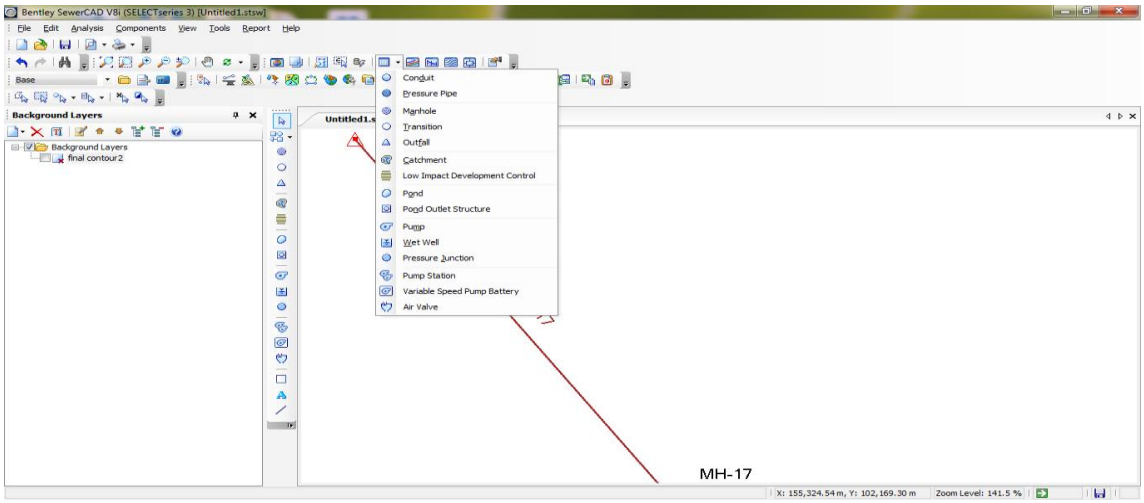


figure (4.14): Editing required data for design

- component →Defualt design constraints, here we Editing the design Parameters(velocity,cover,slope), figure (4.15) Show this step.

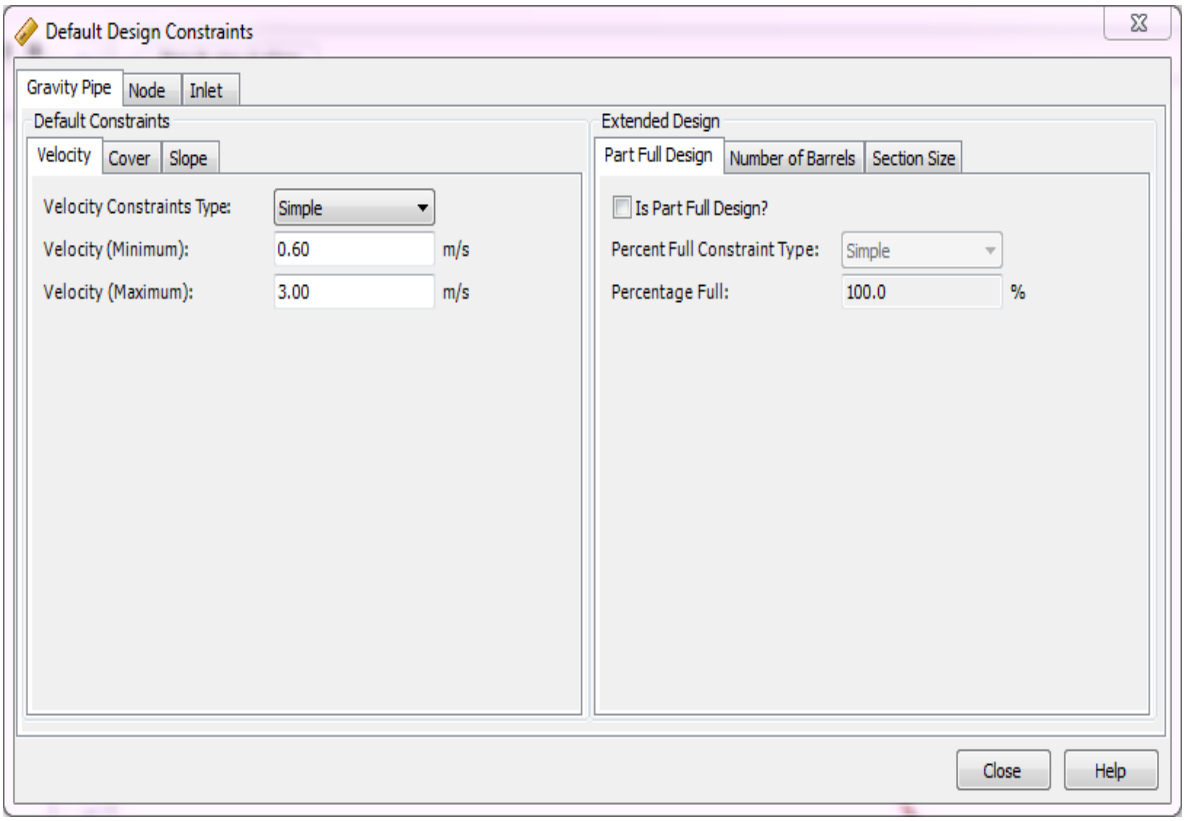


figure (4.15) : Editing Design Parameters – Part1

- Analyse →calculation options→Base calculation options→calculation options→Design, here we change the calculation type from Analyse to design, figure (4.16) Show this step.

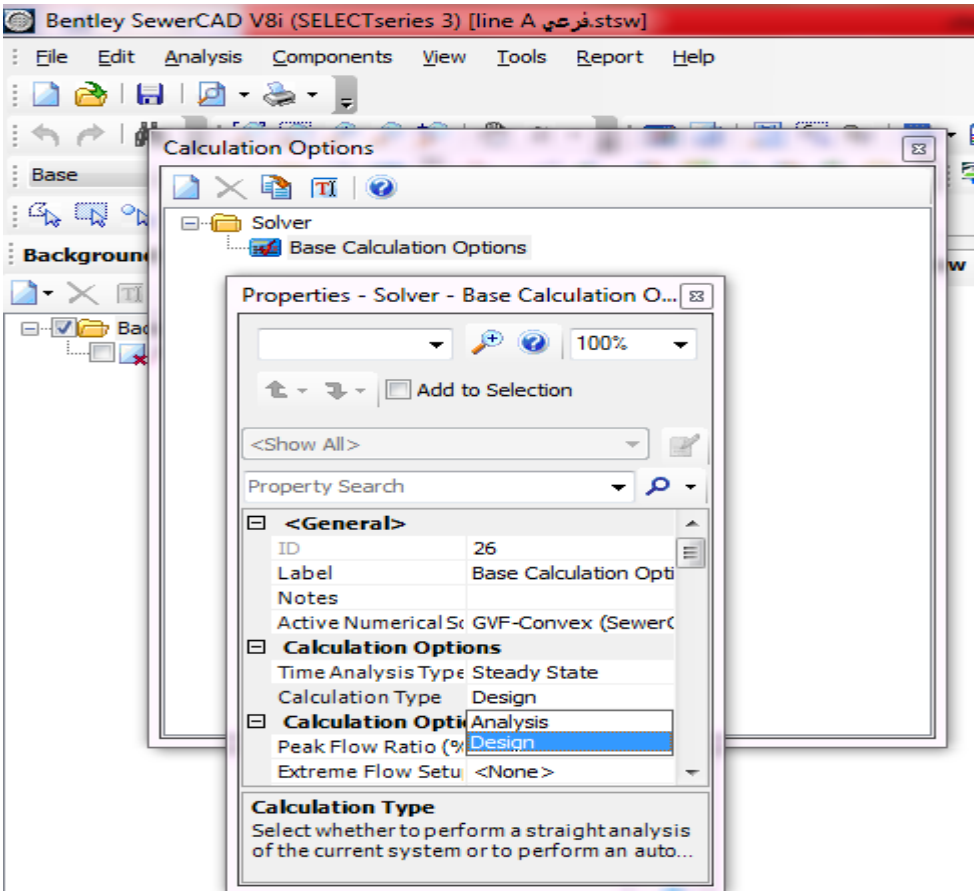


figure (4.16) : Editing Design Parameters – Part2

- Last step press save, press compute button to start design If you have green light that mean there is no problems in the design work, but if you have yellow or red light that's mean there is problem, read the massages and fix these problems. figure (4.17) below shows the step.

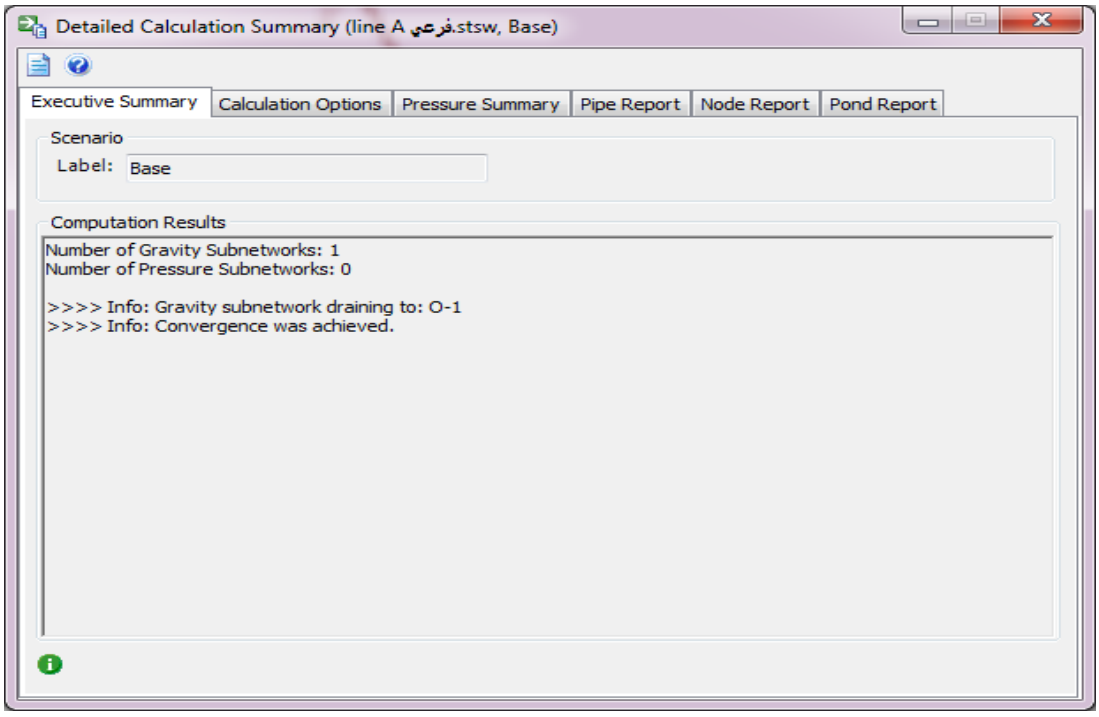


Figure (4.17): Checking The Design

- After finishing design work we need to show the pipe line profile and the profile, gravity pipe report and gravity node report. Press profile button to make the profile see figure (4.18), here we should put the scale of the profile.

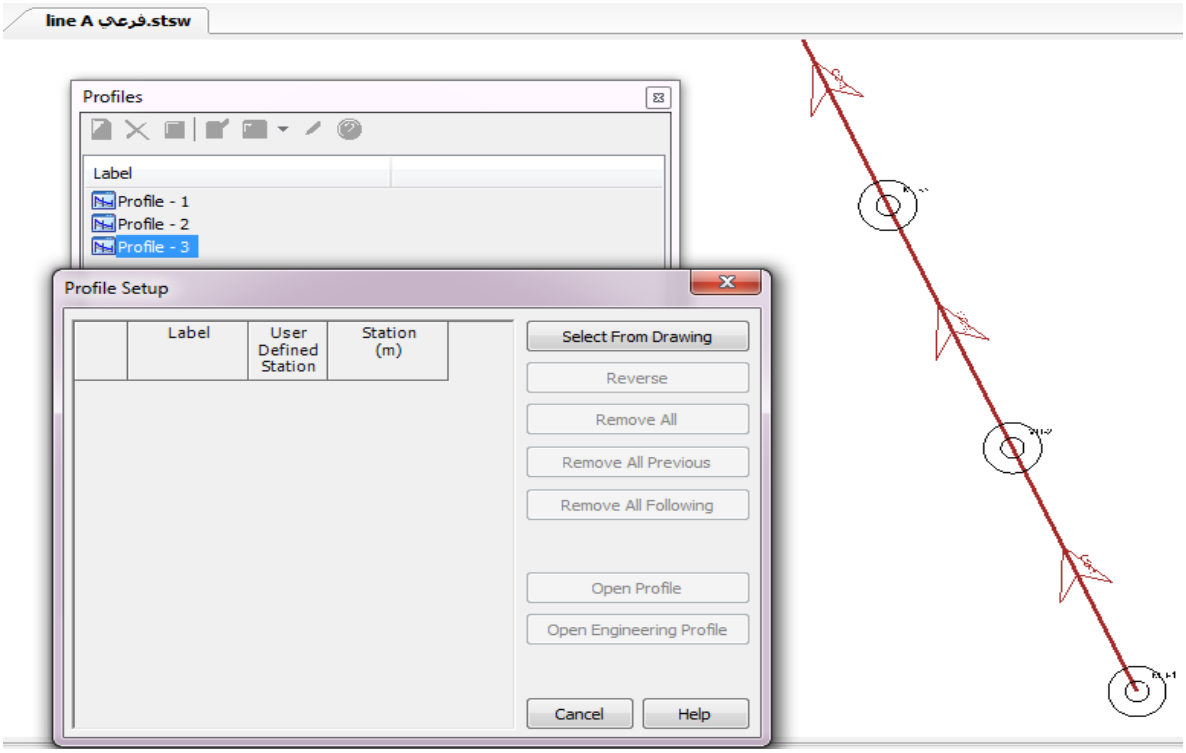


Figure (4.18): Creating Profile

- We can get the required tables by pressing tabular report button see figure (4.19), and then choose gravity pipe report and gravity node report.

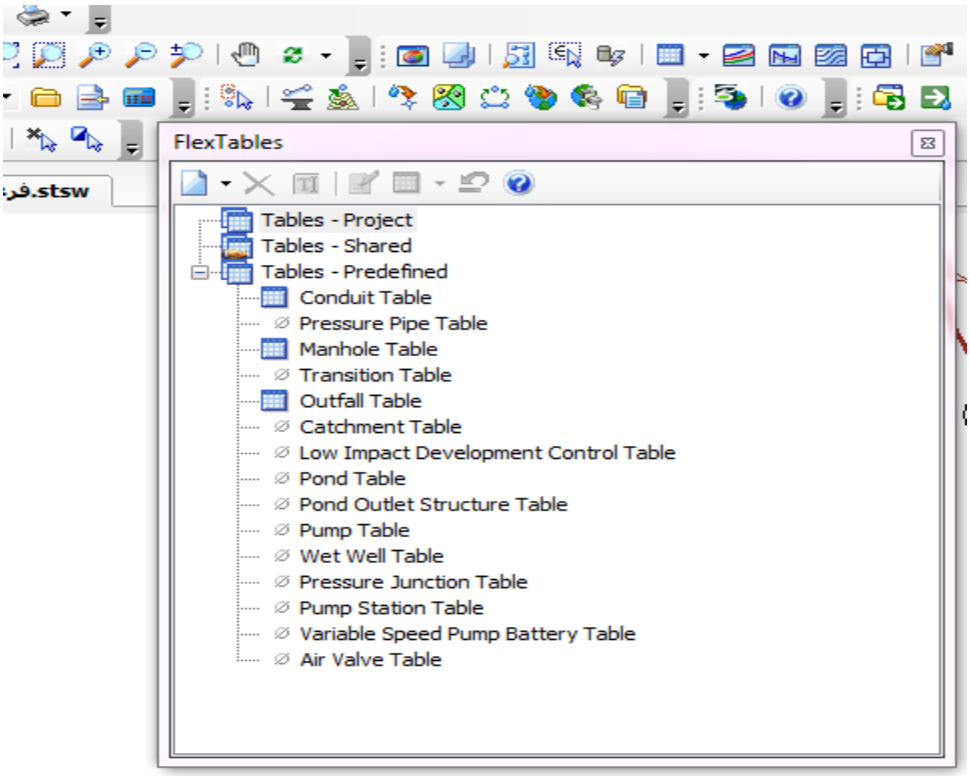


Figure (4.19): Creating Tables

Table 4.4 show the calculations for line A1 and figure 4.20 show the profile for same line. Calculation and drawings for all other lines are shown in (Appendix B) and the profiles for all lines are shown in (Appendix C).