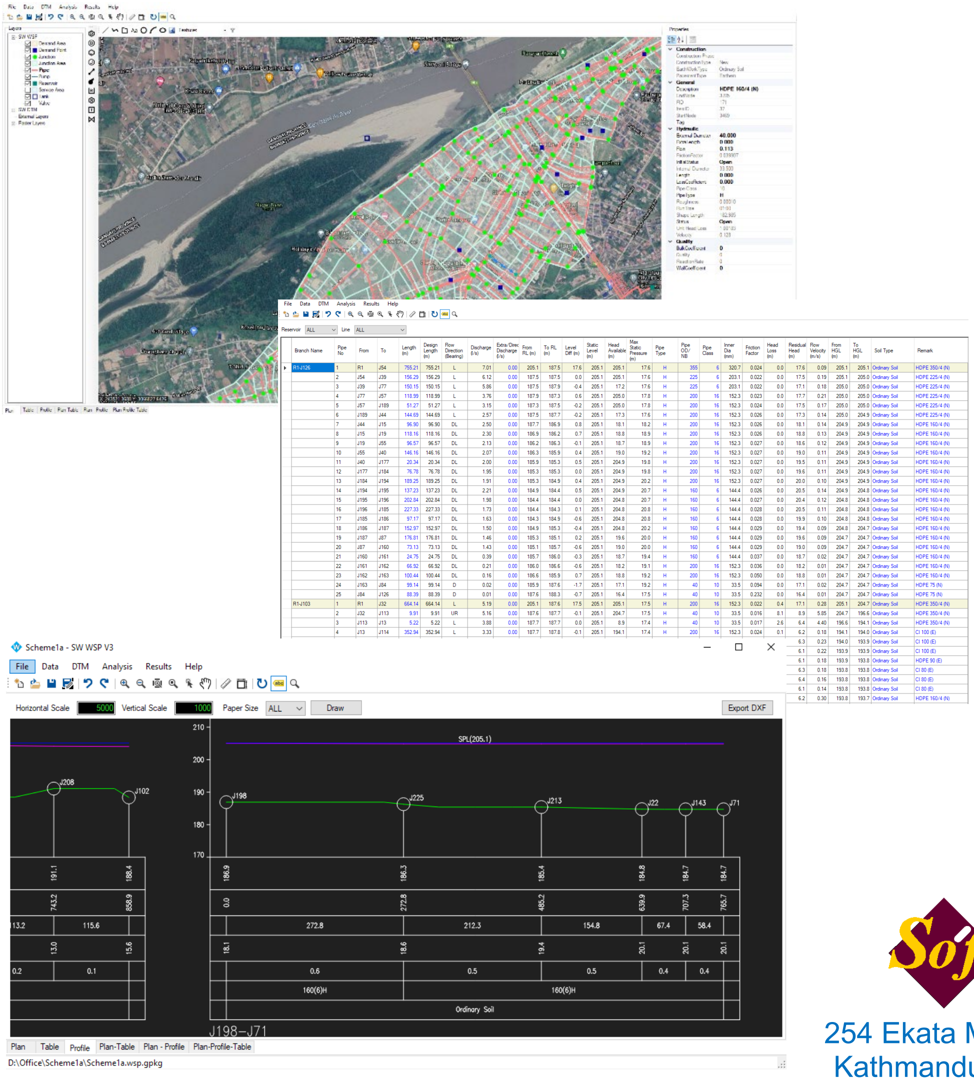
SW WSP V3

Operation Manual

(Version 3.0.0)



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About SW WSP

a) The SW WSP was developed during 1996 by WELINK Consultants. Later it was adopted by SOFTWEL (A sister concern of WELINK) and has been upgrading and supporting it since 2000. A comprehensive update was done during 2005 for the ADB Funded CBWSSP. It was extensively applied in design and drawings of many rural water supply projects in Nepal.

b) Present SW WSP V3 is a significant upgrade to the previous version of SW WSP/SW CBWSSP. It includes facilities for integration with GIS, mobile application based survey with Professional GPS integration, Digital Terriam Modeling and cost estimation. The version is self-updating such that user gets automated update notice.

c) In order to support the community water supply in Nepal, the SW WSP V3 is released as a free software without any license fees.

Development Credits

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Support

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Specification

- Built-in tool, DTM for topomap preparation.
- Plan/Profile/ Design Table can be viewed in same window.
- Support online tile imagery and offline images for background reference.
- Support Digital elevation Model for design.
- Export drawing in print-ready format.
- Export detail quantities and cost instantly for reporting.
- Prepare BoQ of the project.

System Requirement

- Operating System: Windows based OS (Windows 10 Recommended)
- Supported OS: Windows 7 with SP1, Windows 8.1, Windows 10
- Microsoft .NET Framework 4.8
- Processor: 2.5 GHz (3+ GHz recommended)
- Memory: 4 GB (8GB recommended)
- Disk space: 2.0 GB.
- DirectX 10

Installation Note

1) *Setup Instructions for SW WSP v3*

Note: Microsoft .NET Framework 4.8 is required to run the Software. You can download it from Microsoft official page.

- Register an account with Softwel. You can register an account from Softwel official page.
- Once you register, an e-mail will be sent to you containing the activation link. Click on the link to sign in and activate your Softwel account.
- Go to the Downloads page of Softwel.
- Download the SW WSP Setup.
- Run the SW WSP Setup.

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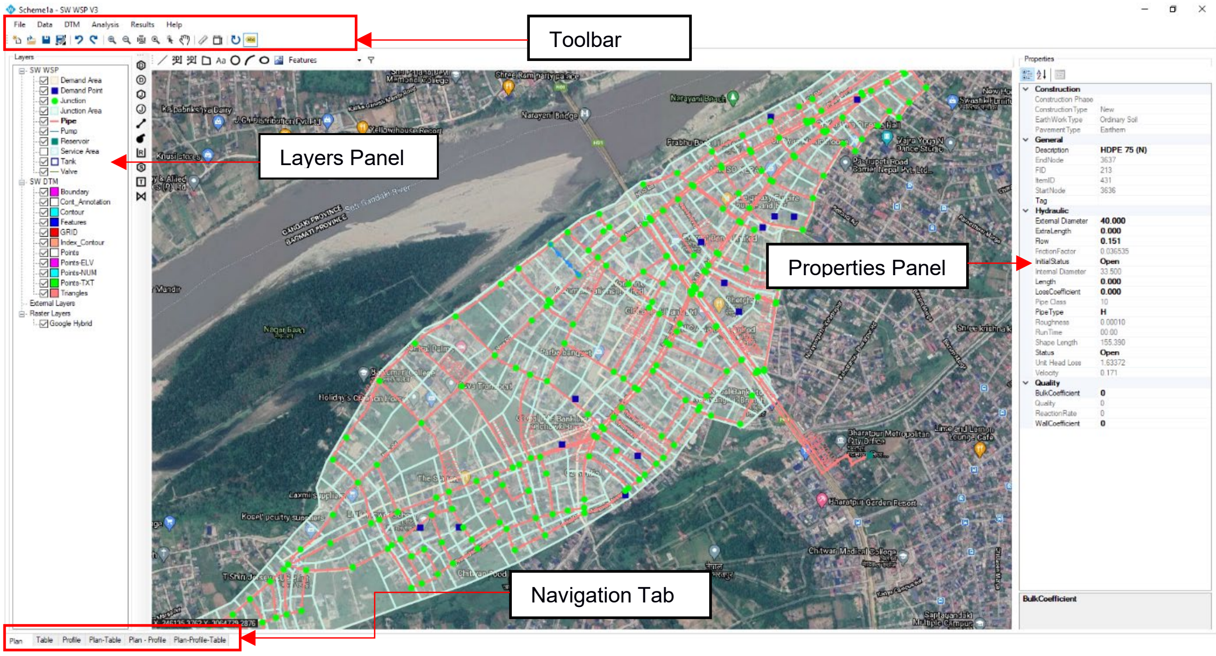
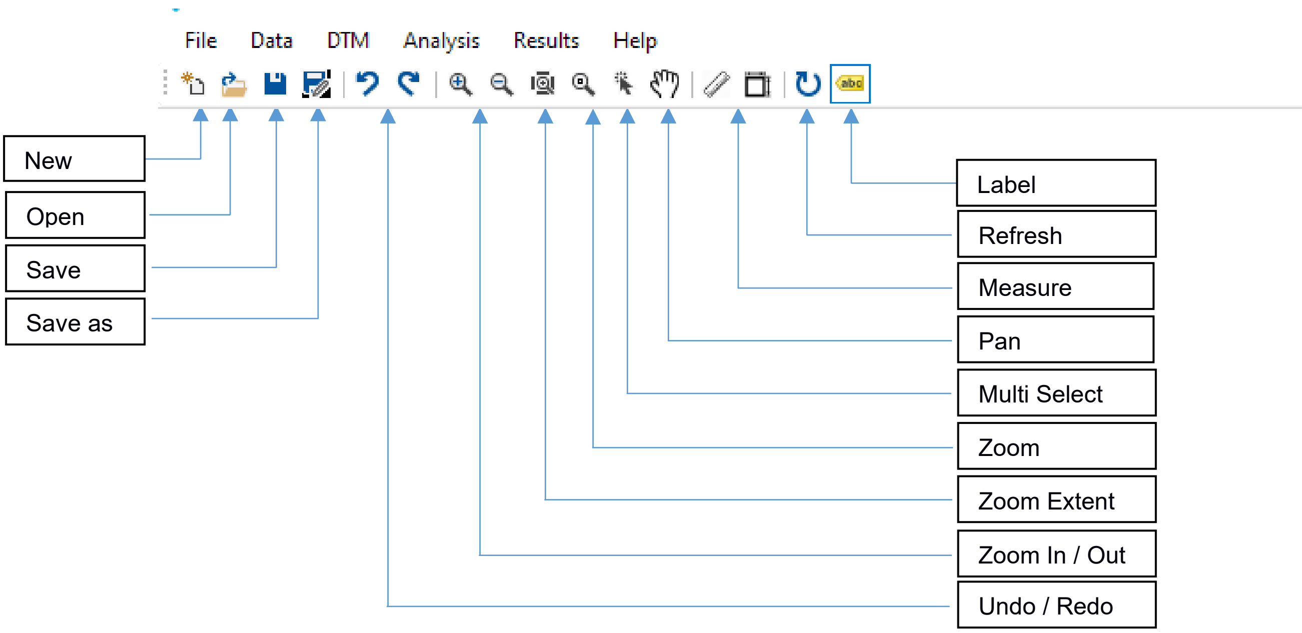
1 INTRODUCTION (USER INTERFACE)

1.1 Main Window (Plan Window)



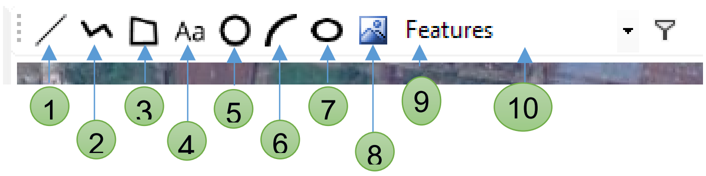
1.2 Main Toolbar



1. New
   Quits the current project to open a new project.
2. Open
   Quits the current project to open another existing project.
3. Save / Save as
   "Save" saves the current project. "Save as" allows users to save the project modifyfing the file name and directory.
4. Label
   Toggles the labels for junctions, reservoirs, pipes, tanks, valves and pumps on or off. The labels to be shown in Plan window can be modified using "Label Options" under "Results" menu.

5. Refresh
   This button refreshe the current view to show changes made.
6. Measure
   These tools are used to measure the length of lines, area and perimeters of polygons.
7. Pan
   This button allows user to move the displayed content in Plan window. It can also be used with the middle mouse button.
8. Multi Select Tool
   This button is allows users to select data multiple data of same/different layers in Plan window.
9. Zoom Window
   This button allows users to pick two corners of a rectangle and zooms in to the drawn rectangle.
10. Zoom Extent
    This button is used to zoom in on the entire working area in Plan window. This tool can also be accessed by pressing the middle mouse button twice.
11. Zoom In / Out
    This button is used to maginfy and shrink the display in Plan window.
12. Undo / Redo
    This button is used to undo and redo the actions

1.3 Draw Toolbar

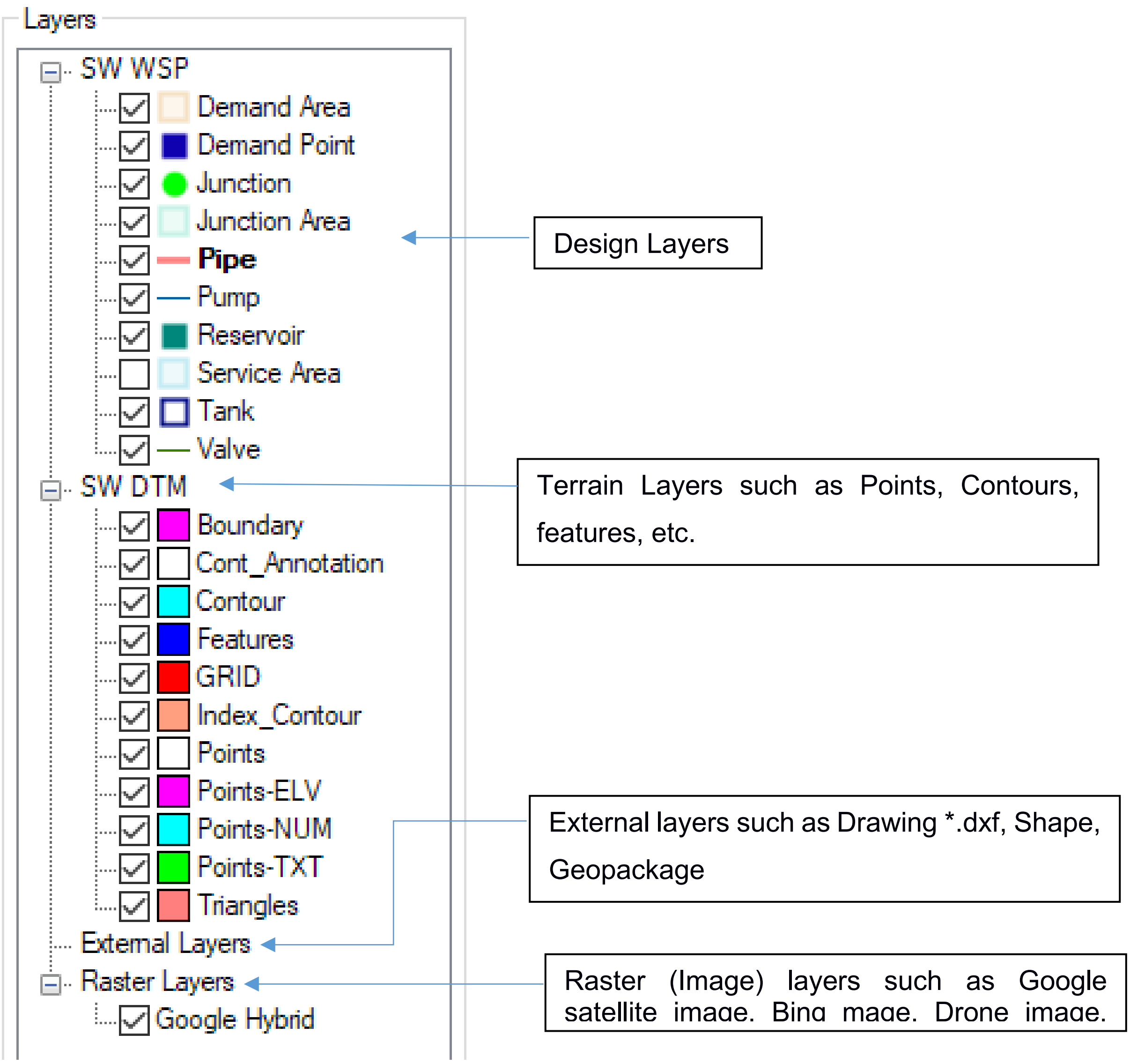


1. Draw Line
2. Draw 2d-Polyline
3. Draw Polygon
4. Draw Text
5. Draw Circle
6. Draw Arc
7. Draw Ellipse
8. Add Image
9. Active Layer

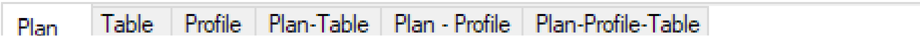
- While using “Draw Toolbar”, **mouse right-click completes the command, to undo inserted vertex, press keyboard “Backspace” key**.
- “Draw 3D-Polyline” is used to draw the 3d-features that indicate the terrain undulation such as road edge, steps in terrain, cutting edge, etc.
- All the drawn features are added in active layer under SW DTM . So at first, select required layer under which features are to be added using “Active Layer”.

1.4 Layers Panel:

It controls the display of the design layers under SW WSP group (such as junctions pipes, demand area, junction area etc), terrain layers under SW DTM group (such as points, features, contours, etc), imported external layers under External Layers (drawing file (*.dxf), shape (*.shp), geopackage (*.gpkg), etc) and imported raster layers under Raster Layers (satellite imagery, topographic map, drone images in *.tif or *.mbtiles format).


Layers
SW WSP
Demand Area
Demand Point
Junction
Junction Area
Pipe
Pump
Reservoir
Service Area
Tank
Valve
SW DTM
Boundary
Cont_Annotation
Contour
Features
GRID
Index_Contour
Points
Points-ELV
Points-NUM
Points-TXT
Triangles
External Layers
Raster Layers
Google Hybrid
Design Layers
Terrain Layers such as Points, Contours, features, etc.
External layers such as Drawing *.dxf, Shape, Geopackage
Raster (Image) layers such as Google satellite image, Bing mage, Drone image.

1.4.1 Navigation Tab:



Navigation Tab is used to switch between various window. These windows can be arranged in a different configuration to make the designing job comfortable. The job will be more comfortable if the user uses multiple monitors for parallel referencing.

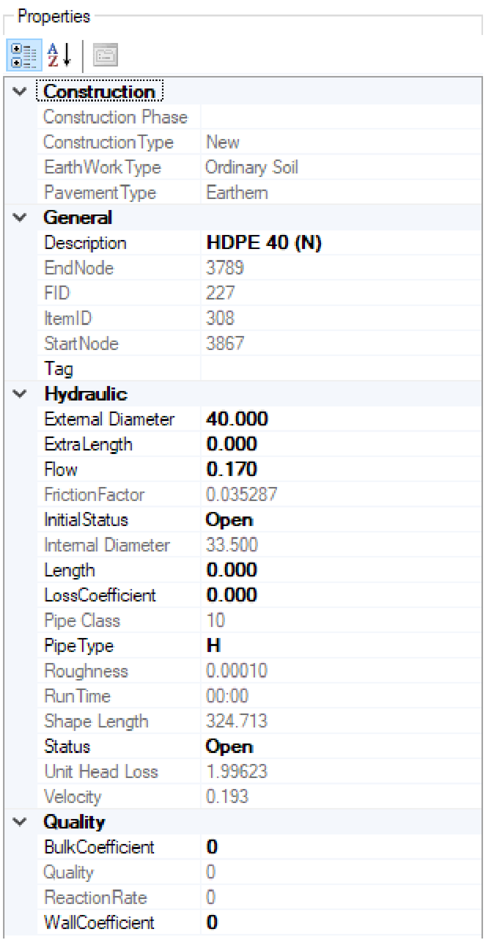
1.5 Properties Panel:

Properties panel is located at the right side of display. This panel allows uses to modify the parameters of design elements such pipes, junctions, demand area etc. Properties of each element can be accessed by selecting the element.

The properties of each element is displayed in categories by default but it can also be set to view by alphabetical order using . The values displayed in bold format are variables that can be changed by the user and the values that are greyed out are calculated by the software and hence cannot be changed. This manual only discusses properties of some of the elements briefly, for more information refer to the EPANET manual.

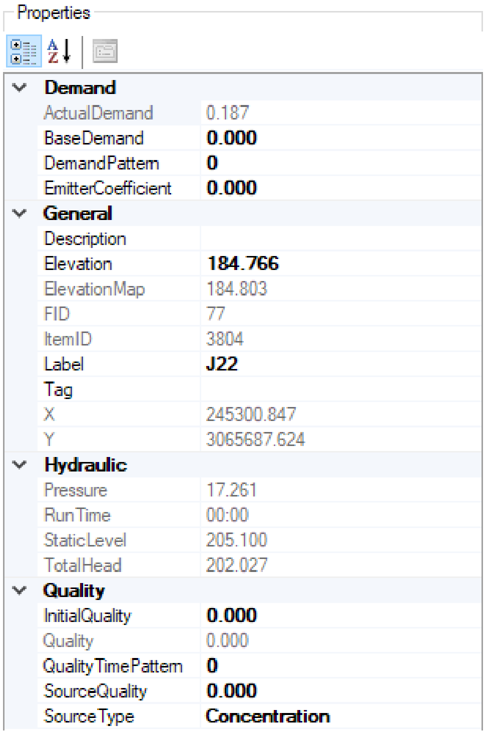
1.5.1 Pipe Properties:

The pipe properties panel allows user to change the properties of selected pipe/pipes. The following image shows the pipe properties of selected pipe in categorized view.



1.5.2 Junction Properties:

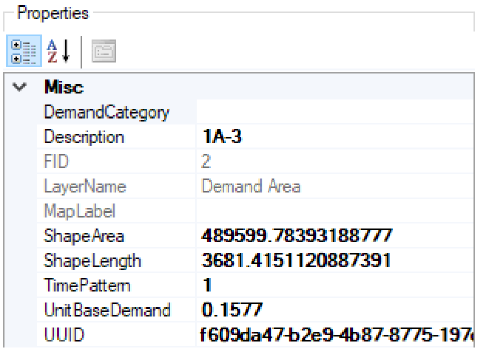
The junction properties panel allows user to change the properties of selected junction/junctions. The following image shows the pipe properties of selected junction.



Properties

Demand	
ActualDemand	0.187
BaseDemand	**0.000**
DemandPattern	**0**
EmitterCoefficient	**0.000**
General	
Description	
Elevation	**184.766**
ElevationMap	184.803
FID	77
ItemID	3804
Label	**J22**
Tag	
X	245300.847
Y	3065687.624
Hydraulic	
Pressure	17.261
RunTime	00:00
StaticLevel	205.100
TotalHead	202.027
Quality	
InitialQuality	**0.000**
Quality	0.000
QualityTimePattern	**0**
SourceQuality	**0.000**
SourceType	**Concentration**

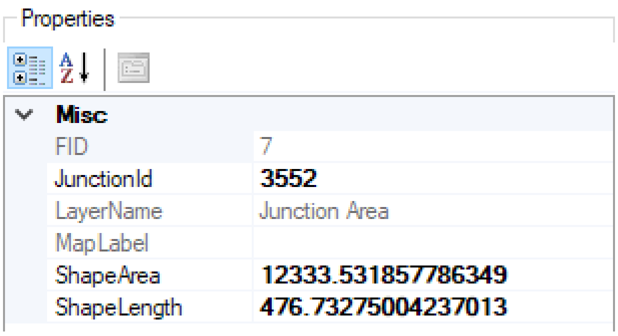
1.5.3 Demand Area Properties:



Properties

Misc	
DemandCategory	
Description	**1A-3**
FID	2
LayerName	Demand Area
MapLabel	
ShapeArea	**489599.78393188777**
ShapeLength	**3681.4151120887391**
TimePattern	**1**
UnitBaseDemand	**0.1577**
UUID	**f609da47-b2e9-4b87-8775-197**

1.5.4 Junction Area Properties:



Properties

Misc	
FID	7
JunctionId	**3552**
LayerName	Junction Area
MapLabel	
ShapeArea	**12333.531857786349**
ShapeLength	**476.73275004237013**

1.5.5 Reservoir Properties:

Properties

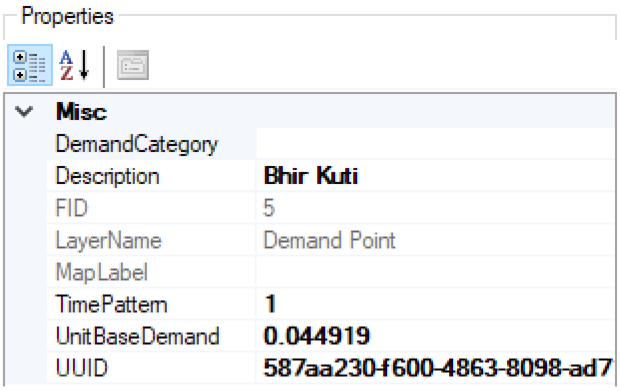
General	
Description	
Elevation	**205.100**
ElevationMap	0.000
FID	1
ItemID	3943
Label	**R1**
Tag	
X	246501.884
Y	3065411.497
Hydraulic	
HeadPattern	**0**
NetInFlow	-12.203
Pressure	0.000
RunTime	00:00
TotalHead	**205.100**
Quality	
InitialQuality	**0.000**
Quality	0.000
QualityTimePattern	**0**
SourceQuality	**0.000**
SourceType	**Concentration**

1.5.6 Pump Properties:

Properties

General	
Description	
EndNode	-1
ItemID	1810
StartNode	-1
Tag	
Hydraulic	
Flow	0.000
HeadLoss	0.000
RunTime	0:00
Shape Length	31.148
Status	
Misc	
FID	-1
MapLabel	[ID] 1810[PO] 0.000[Q] 0.000[HL] 0.0
Pump	
EfficCurve	**0**
EnergyPrice	**0.00**
InitialStatus	**Open**
Pattern	**0**
Power	**0.000**
PricePattern	**0**
PumpCurve	**0**
Speed	**0.000**
Quality	
Quality	0.000

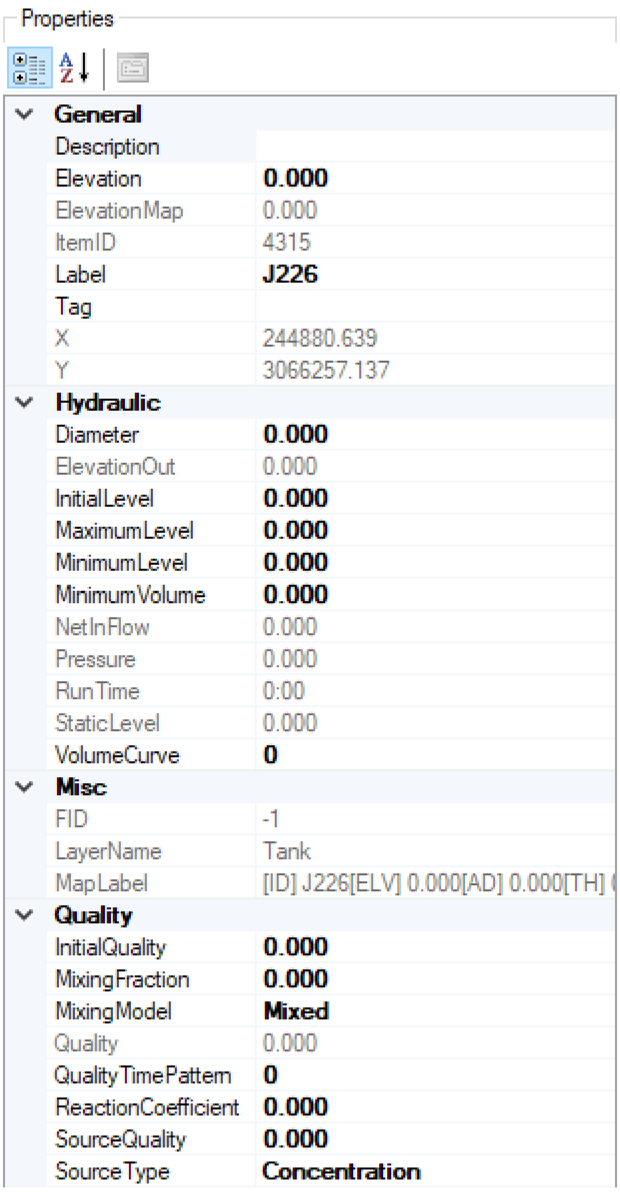
1.5.7 Demand Point Properties:



Properties

Misc	
DemandCategory	
Description	**Bhir Kuti**
FID	5
LayerName	Demand Point
MapLabel	
TimePattern	**1**
UnitBaseDemand	**0.044919**
UUID	**587aa230-f600-4863-8098-ad7**

1.5.8 Tank Properties:



Properties

General	
Description	
Elevation	**0.000**
ElevationMap	0.000
ItemID	4315
Label	**J226**
Tag	
X	244880.639
Y	3066257.137
Hydraulic	
Diameter	**0.000**
ElevationOut	0.000
InitialLevel	**0.000**
MaximumLevel	**0.000**
MinimumLevel	**0.000**
MinimumVolume	**0.000**
NetInFlow	0.000
Pressure	0.000
RunTime	0:00
StaticLevel	0.000
VolumeCurve	**0**
Misc	
FID	-1
LayerName	Tank
MapLabel	[ID] J226[ELV] 0.000[AD] 0.000[TH] (
Quality	
InitialQuality	**0.000**
MixingFraction	**0.000**
MixingModel	**Mixed**
Quality	0.000
QualityTimePattern	**0**
ReactionCoefficient	**0.000**
SourceQuality	**0.000**
SourceType	**Concentration**

1.5.9 Valve Properties:

Properties

General	
Description	
EndNode	-1
FID	-1
ItemID	1810
StartNode	-1
Tag	
Hydraulic	
Diameter	**0.000**
FixedStatus	
Flow	0.000
HeadLoss	0.000
LossCoefficient	**0**
RunTime	0:00
Setting	**0.000**
Shape Length	31.148
Status	
Type	**PRV**
Velocity	0.000
Misc	
MapLabel	[ID] 1810[HL] 0.000[D] 0.000[TYP] P
Quality	
Quality	0.000

1.6 Table Window

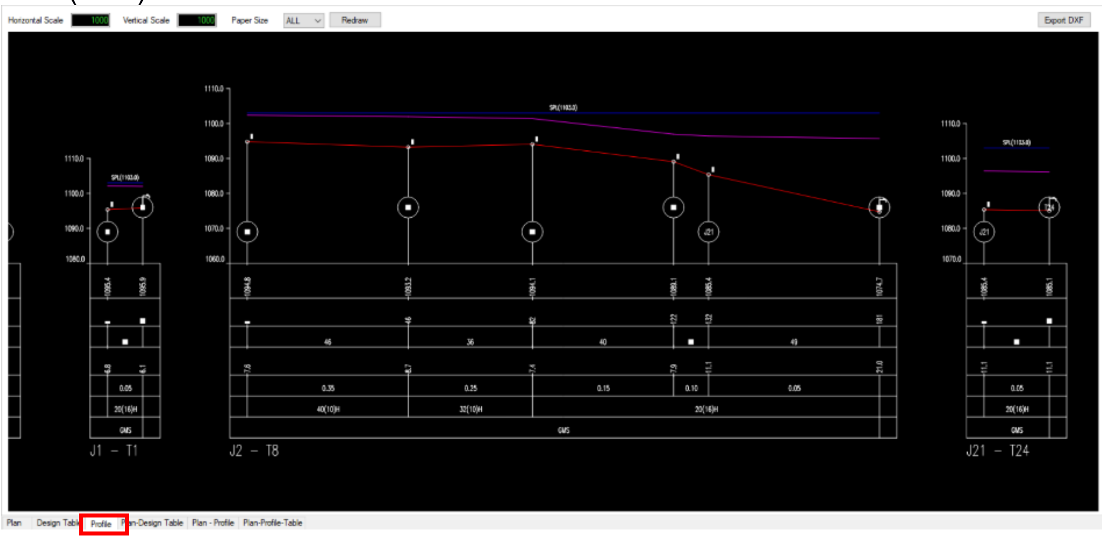
This window is used to perform the hydraulic design of pipe elements. It allows user to change the design parameter of pipe elements and check the result associated to changes made to meet the required design criteria.

Reservoir ALL Line ALL

Branch Name	Pipe No	From	To	Length (m)	Design Length (m)	Flow Direction (Bearing)	Discharge (l/s)	Extra/Direc Discharge (l/s)	From RL (m)	To RL (m)	Level Diff (m)	Static Level (m)	Head Available (m)	Max Static Pressure (m)	Pipe Type	Pipe OD/ NB	Pipe Class	Inner Dia (mm)	Friction Factor	Head Loss (m)	Residual Head (m)	Flow Velocity (m/s)	From HGL (m)	To HGL (m)	Soil Type	Remark
R1-J126	1	R1	J54	755.21	755.21	L	29.21	0.00	205.1	187.5	17.6	205.1	205.1	17.6	H	355	6	320.7	0.017	0.3	17.3	0.36	205.1	204.8	Ordinary Soil	HDPE 350/4 (N)
	2	J54	J39	156.29	156.29	L	25.44	0.00	187.5	187.5	0.0	205.1	204.8	17.6	H	225	6	203.1	0.016	0.4	16.9	0.79	204.8	204.4	Ordinary Soil	HDPE 225/4 (N)
	3	J39	J77	150.15	150.15	L	24.37	0.00	187.5	187.9	-0.4	205.1	16.5	17.6	H	225	6	203.1	0.016	0.4	16.2	0.75	204.4	204.1	Ordinary Soil	HDPE 225/4 (N)
	4	J77	J57	118.99	118.99	L	15.59	0.00	187.9	187.3	0.6	205.1	204.1	17.8	H	200	16	152.3	0.017	0.5	16.3	0.86	204.1	203.6	Ordinary Soil	HDPE 225/4 (N)
	5	J57	J189	51.27	51.27	L	13.07	0.00	187.3	187.5	-0.2	205.1	203.6	17.8	H	200	16	152.3	0.018	0.2	15.9	0.72	203.6	203.4	Ordinary Soil	HDPE 225/4 (N)
	6	J189	J44	144.69	144.69	L	10.67	0.00	187.5	187.7	-0.2	205.1	15.8	17.6	H	200	16	152.3	0.018	0.3	15.5	0.59	203.4	203.1	Ordinary Soil	HDPE 225/4 (N)
	7	J44	J15	96.90	96.90	DL	10.41	0.00	187.7	186.9	0.8	205.1	16.3	18.2	H	200	16	152.3	0.018	0.2	16.1	0.57	203.1	202.9	Ordinary Soil	HDPE 160/4 (N)
	8	J15	J19	118.16	118.16	DL	9.63	0.00	186.9	186.2	0.7	205.1	16.8	18.9	H	200	16	152.3	0.019	0.2	16.6	0.53	202.9	202.7	Ordinary Soil	HDPE 160/4 (N)
	9	J19	J55	96.57	96.57	DL	8.88	0.00	186.2	186.3	-0.1	205.1	16.5	18.9	H	200	16	152.3	0.019	0.1	16.3	0.49	202.7	202.6	Ordinary Soil	HDPE 160/4 (N)
	10	J55	J40	146.16	146.16	DL	8.61	0.00	186.3	185.9	0.4	205.1	16.7	19.2	H	200	16	152.3	0.019	0.2	16.5	0.47	202.6	202.4	Ordinary Soil	HDPE 160/4 (N)
	11	J40	J177	20.34	20.34	DL	8.33	0.00	185.9	185.3	0.5	205.1	202.4	19.8	H	200	16	152.3	0.019	0.0	17.0	0.46	202.4	202.3	Ordinary Soil	HDPE 160/4 (N)
	12	J177	J184	76.78	76.78	DL	8.11	0.00	185.3	185.3	0.0	205.1	202.3	19.8	H	200	16	152.3	0.020	0.1	16.9	0.45	202.3	202.2	Ordinary Soil	HDPE 160/4 (N)
	13	J184	J194	189.25	189.25	DL	7.95	0.00	185.3	184.9	0.4	205.1	202.2	20.2	H	200	16	152.3	0.020	0.2	17.1	0.44	202.2	202.0	Ordinary Soil	HDPE 160/4 (N)
	14	J194	J195	168.64	168.64	DL	9.19	0.00	184.9	184.4	0.5	205.1	202.0	20.7	H	160	6	144.4	0.019	0.4	17.3	0.56	202.0	201.7	Ordinary Soil	HDPE 160/4 (N)
	15	J195	J196	202.84	202.84	DL	8.27	0.00	184.4	184.4	0.0	205.1	201.7	20.7	H	160	6	144.4	0.019	0.3	16.9	0.50	201.7	201.3	Ordinary Soil	HDPE 160/4 (N)
	16	J196	J185	227.33	227.33	DL	7.29	0.00	184.4	184.3	0.1	205.1	201.3	20.8	H	160	6	144.4	0.020	0.3	16.7	0.44	201.3	201.0	Ordinary Soil	HDPE 160/4 (N)
	17	J185	J186	97.17	97.17	DL	6.90	0.00	184.3	184.9	-0.6	205.1	201.0	20.8	H	160	6	144.4	0.020	0.1	16.0	0.42	201.0	200.9	Ordinary Soil	HDPE 160/4 (N)
	18	J186	J187	152.97	152.97	DL	6.40	0.00	184.9	185.3	-0.4	205.1	200.9	20.2	H	160	6	144.4	0.020	0.2	15.4	0.39	200.9	200.7	Ordinary Soil	HDPE 160/4 (N)
	19	J187	J87	176.81	176.81	DL	6.22	0.00	185.3	185.1	0.2	205.1	15.6	20.0	H	160	6	144.4	0.020	0.2	15.4	0.38	200.7	200.5	Ordinary Soil	HDPE 160/4 (N)
	20	J87	J160	73.13	73.13	DL	6.13	0.00	185.1	185.7	-0.6	205.1	14.8	20.0	H	160	6	144.4	0.021	0.1	14.8	0.37	200.5	200.4	Ordinary Soil	HDPE 160/4 (N)
	21	J160	J161	24.75	24.75	DL	1.62	0.00	185.7	186.0	-0.3	205.1	14.4	19.4	H	160	6	144.4	0.028	0.0	14.4	0.10	200.4	200.4	Ordinary Soil	HDPE 160/4 (N)
	22	J161	J162	66.92	66.92	DL	0.98	0.00	186.0	186.6	-0.6	205.1	13.9	19.1	H	200	16	152.3	0.033	0.0	13.9	0.05	200.4	200.4	Ordinary Soil	HDPE 160/4 (N)
	23	J162	J163	100.44	100.44	DL	0.72	0.00	186.6	185.9	0.7	205.1	14.5	19.2	H	200	16	152.3	0.036	0.0	14.5	0.04	200.4	200.4	Ordinary Soil	HDPE 160/4 (N)
	24	J163	J84	99.14	99.14	D	0.10	0.00	185.9	187.6	-1.7	205.1	12.8	19.2	H	40	10	33.5	0.040	0.1	12.8	0.11	200.4	200.4	Ordinary Soil	HDPE 75 (N)
	25	J84	J126	88.39	88.39	D	0.03	0.00	187.6	188.3	-0.7	205.1	12.0	17.5	H	40	10	33.5	0.058	0.0	12.0	0.03	200.4	200.4	Ordinary Soil	HDPE 75 (N)
R1-J103	1	R1	J32	664.14	664.14	L	21.63	0.00	205.1	187.6	17.5	205.1	205.1	17.5	H	200	16	152.3	0.016	5.0	12.5	1.19	205.1	200.1	Ordinary Soil	HDPE 350/4 (N)
	2	J32	J113	9.91	9.91	UR	21.48	0.00	187.6	187.7	-0.1	205.1	200.1	17.5	H	40	10	33.5	0.012	108.5	-96.1	24.37	200.1	91.6	Ordinary Soil	HDPE 350/4 (N)
	3	J113	J13	5.22	5.22	L	16.08	0.00	187.7	187.7	0.0	205.1	-96.1	17.4	H	40	10	33.5	0.013	33.6	-129.7	18.25	91.6	58.0	Ordinary Soil	HDPE 350/4 (N)
	4	J13	J114	352.94	352.94	L	13.86	0.00	187.7	187.8	-0.1	205.1	58.0	17.4	H	200	16	152.3	0.017	1.2	-131.0	0.76	58.0	56.8	Ordinary Soil	CI 100 (E)
	5	J114	J27	121.60	121.60	L	17.31	0.00	187.8	187.6	0.2	205.1	56.8	17.5	H	200	16	152.3	0.017	0.6	-131.4	0.95	56.8	56.2	Ordinary Soil	CI 100 (E)
	6	J27	J7	211.15	211.15	L	16.65	0.00	187.6	187.8	-0.2	205.1	-131.6	17.5	H	200	16	152.3	0.017	1.0	-132.6	0.91	56.2	55.2	Ordinary Soil	CI 100 (E)
	7	J7	J9	56.91	56.91	UR	13.87	0.00	187.8	187.8	0.0	205.1	-132.6	17.3	H	200	16	152.3	0.017	0.2	-132.8	0.76	55.2	55.0	Ordinary Soil	HDPE 90 (E)

1.7 Profile

Display the ground (red), hydraulic (pink) and static pressure (blue) profile for each pipeline branch. User can set the horizontal and vertical scale and paper size to Export the profile in DXF (*.dxf) file format.



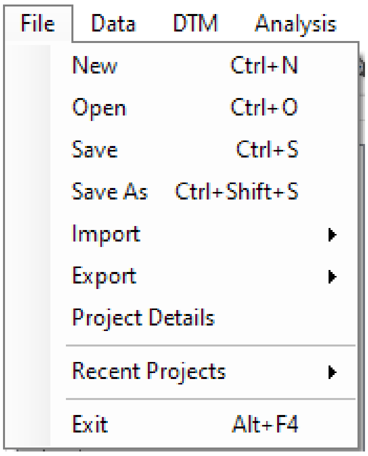
2 MAIN MENU

The entire system is grouped into menus based on their similarity of functions. The following table provides the summary of the menus and the sub-sequent section provides details of each of the menus and the sub-menus

Menus	Description
File	Contains tools to create new project, open existing project, create backup copy of project, save project, export the project into different file format, import project from (*.swmz) file format, setup project settings, browse recent projects and exit.
Data	The table of different design parameters for design elements are listed here. Eg: Design Points, Demand Areas, Demand Patterns, Curves, Junctions, Reservoirs, Tank. It contains tools to extract elevation into junction from selected Terrain Model,assign Pipe Size to selected pipe elements from Plan window.
DTM	Surveyed points are processed, contours and terrain surfaces are generated. The source of terrain file required for the design is selected whether the source is internal DTM, external DTM or Grid. The elevation data is then extracted from the terrain file for the nodes added during the design process.
Analysis	Contains tools to check the validity of network, computation of nodal demands, view demand calculation error, run the model and edit design parameter data.
Results	Contains tools for displaying results in graphical or tabular form. It also contains tools to generate distribution of pressure, head and demand etc
Help	Provides to check for updates and help.

3 FILE

File menu has been divided into following sub-division.



3.1 New Project

Create new project with default settings. Users can do nothing without creating a project.

3.2 Open Project

Open existing project.

3.3 Save Project

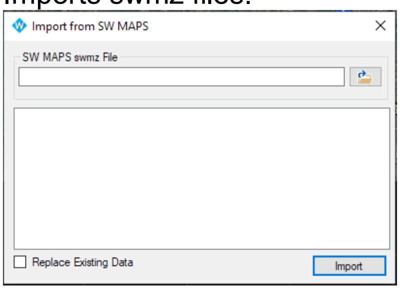
Save the project.

3.4 Save As Project

Save the project in a new copy and contine in it.

3.5 Import

Imports swmz files.

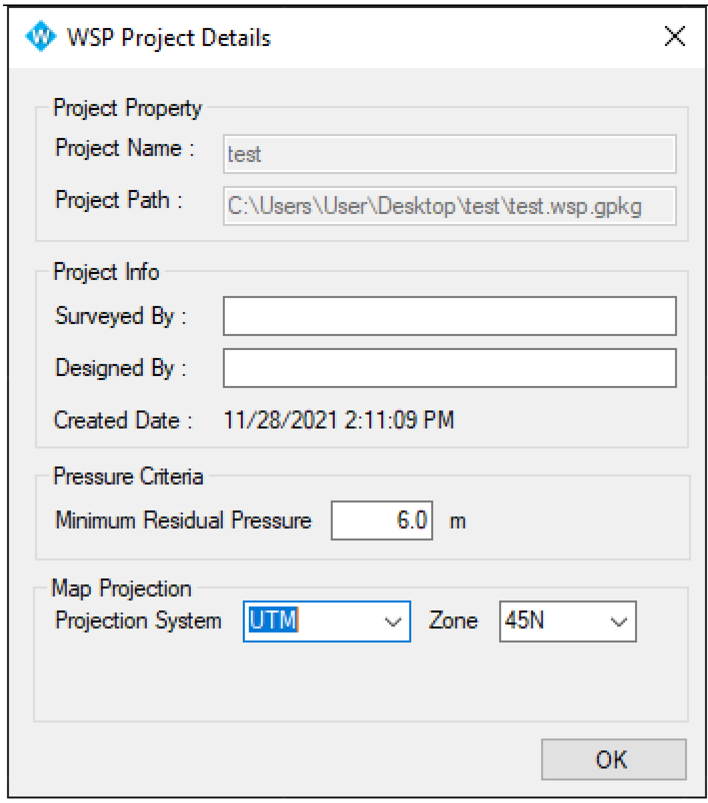


3.6 Export

Exports the project file. EPANET, DXF, KML and Shape files can be exported. The export to EPANET make “inp” file for EPANET which can be opened in the EPANET. This functionality provide cross-platform support when there is no GIS system available.

3.7 Project Detail

Displays the detail about the project file such as the file name and path. The project info category includes the name of the surveyor and the designer, both of which can be edited during or after the creation of the project file. The value for the minimum residual pressure can also be set, along with the projection system of the map.



3.8 Recent Projects

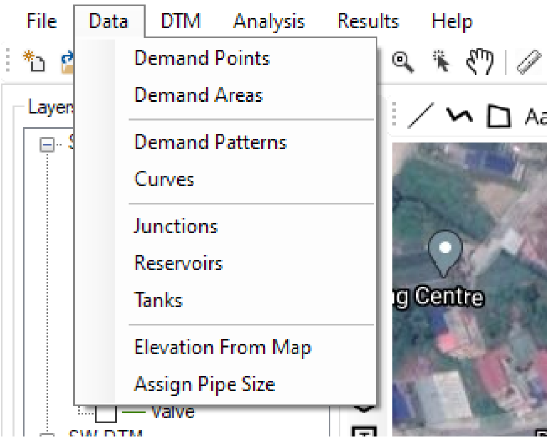
Display the list of recently opened project for quick opening of project file.

3.9 Exit

Exit the project file.

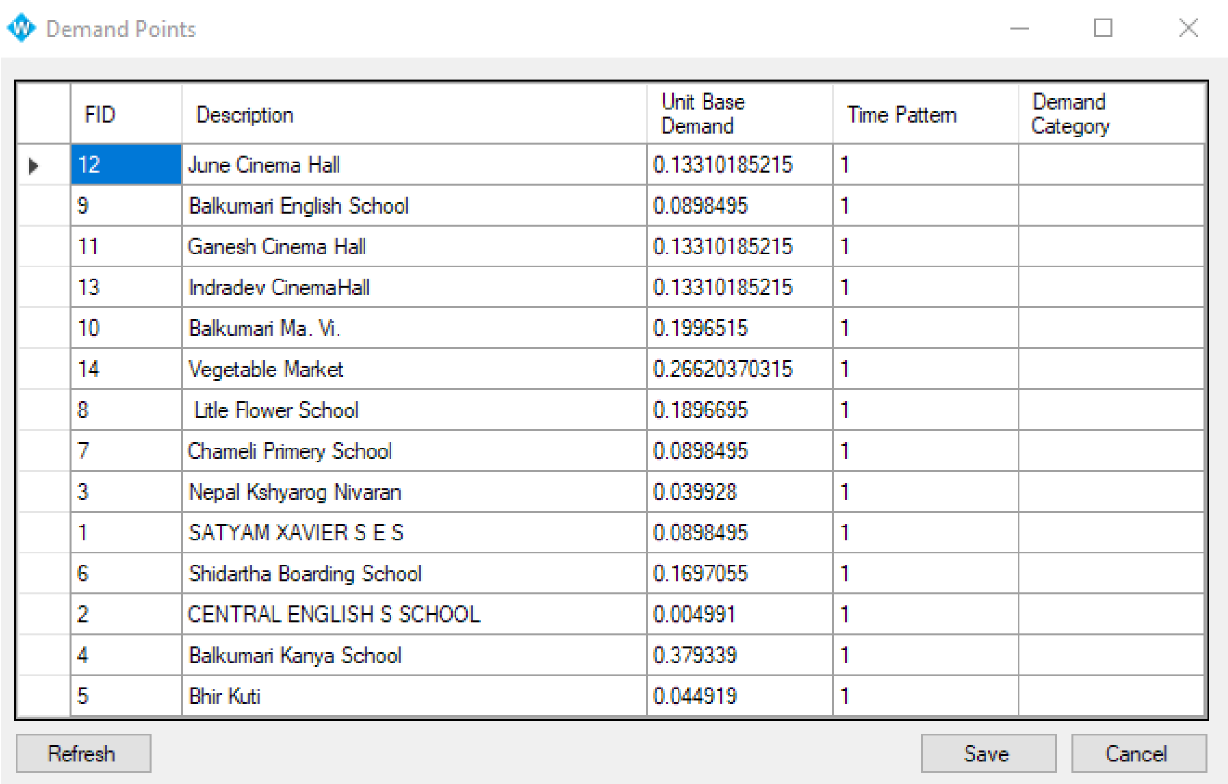
4 DATA

The table of different design parameters for design elements are categorized into following sub-menu. Also, It contains tools to extract elevation into junction from selected Terrain Model, assign pipe size to selected pipe elements from Plan window.



4.1 Demand Points

Demand Point provides more refined data for the demand allocation. Each of the customers can be assigned with a demand point and demand allocated. This is useful for the system monitoring rather than in design works where most of the customers are already identified using the customer mapping and billing records are available.

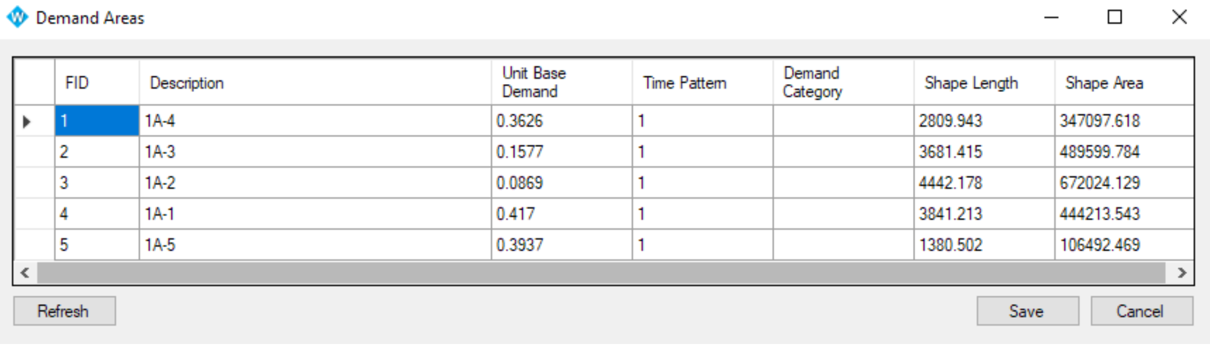

Demand Points

FID	Description	Unit Base Demand	Time Pattern	Demand Category
12	June Cinema Hall	0.13310185215	1	
9	Balkumari English School	0.0898495	1	
11	Ganesh Cinema Hall	0.13310185215	1	
13	Indradev CinemaHall	0.13310185215	1	
10	Balkumari Ma. Vi.	0.1996515	1	
14	Vegetable Market	0.26620370315	1	
8	Litle Flower School	0.1896695	1	
7	Chameli Primery School	0.0898495	1	
3	Nepal Kshyarog Nivaran	0.039928	1	
1	SATYAM XAVIER S E S	0.0898495	1	
6	Shidartha Boarding School	0.1697055	1	
2	CENTRAL ENGLISH S SCHOOL	0.004991	1	
4	Balkumari Kanya School	0.379339	1	
5	Bhir Kuti	0.044919	1	

Refresh Save Cancel

4.2 Demand Areas

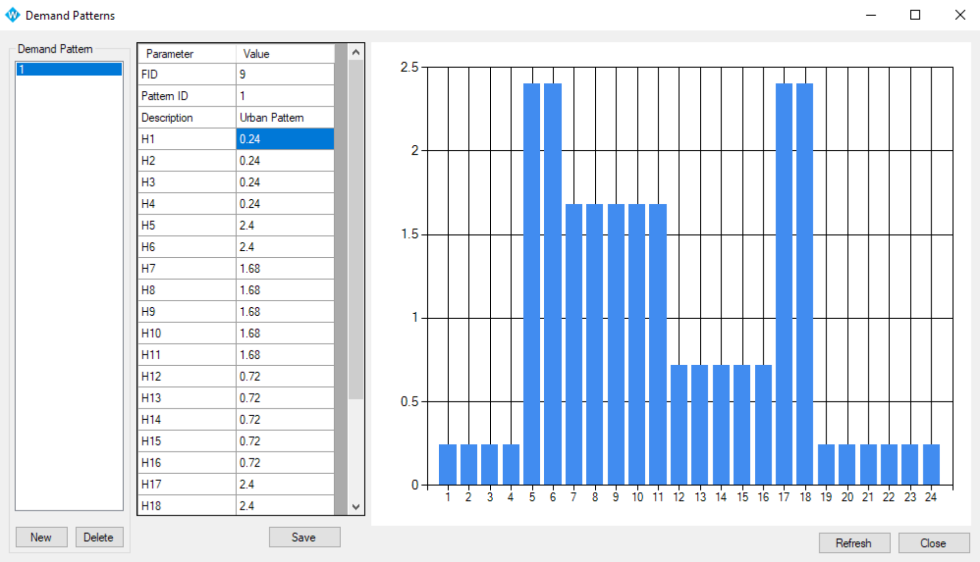
Demand Area is the graphical representation of the actual demand in the form of distributed data. Based on the characteristics of the coverage areas, there may be many demand areas which can have various unit demand values (l/s/ha) and also can have various patterns of demand.



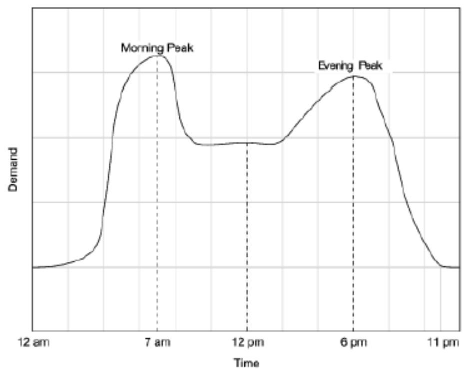
FID	Description	Unit Base Demand	Time Pattern	Demand Category	Shape Length	Shape Area
1	1A-4	0.3626	1		2809.943	347097.618
2	1A-3	0.1577	1		3681.415	489599.784
3	1A-2	0.0869	1		4442.178	672024.129
4	1A-1	0.417	1		3841.213	444213.543
5	1A-5	0.3937	1		1380.502	106492.469

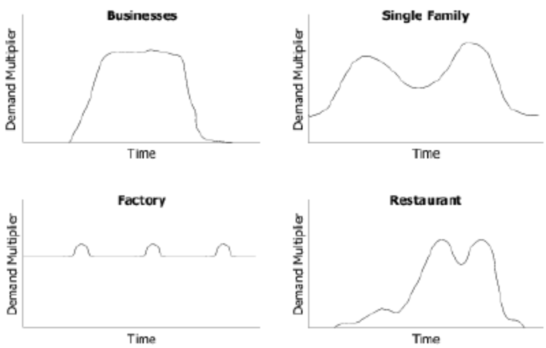
4.3 Demand Pattern

A Time Pattern is a collection of multipliers that can be applied to a quantity to allow it to vary over time. Nodal demands, reservoir heads, pump schedules, and water quality source inputs can all have time patterns associated with them. The time interval used in all patterns is a fixed value, set with the project's Time Options. Within this interval a quantity remains at a constant level, equal to the product of its nominal value and the pattern's multiplier for that time period. Although all time patterns must utilize the same time interval, each can have a different number of periods. When the simulation clock exceeds the number of periods in a pattern, the pattern wraps around to its first period again. The consumption pattern are provided for 24 hours period with one hour intervals. The ID, description and the coefficient for each hour need to be provided.



A typical diurnal curve





4.4 Curves

This provides the interface to input the curves for the model e.g. pump curve, efficiency curves etc. Curves are objects that contain data pairs representing a relationship between two variables. Two or more objects can share the same curve. An EPANET model can utilize the following types of curves:

- Pump Curve
- Efficiency Curve
- Volume Curve
- Headloss Curve

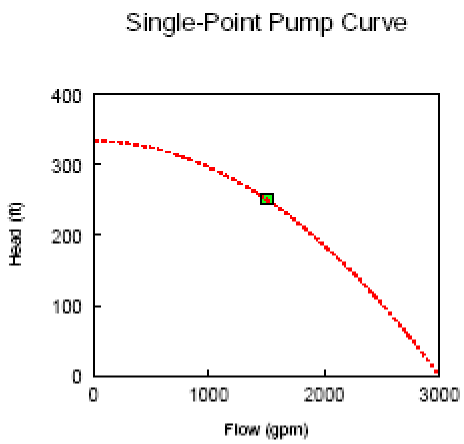
All the curves have IDs which are saved in "Curve" table.

4.4.1 Pump Curve

A Pump Curve represents the relationship between the head and flow rate that a pump can deliver at its nominal speed setting. Head is the head gain imparted to the water by the pump and is plotted on the vertical (Y) axis of the curve in feet (meters). Flow rate is plotted on the horizontal (X) axis. A valid pump curve must have decreasing head with increasing flow. EPANET will use a different shape of pump curve depending on the number of points supplied:

1. Single Point Curve

   Single-Point Curve - A single-point pump curve is defined by a single head-flow combination that represents a pump's desired operating point. EPANET adds two more points to the curve by assuming a shutoff head at zero flow equal to 133% of the design head and a maximum flow at zero head equal to twice the design flow. It then treats the curve as a three-point curve.



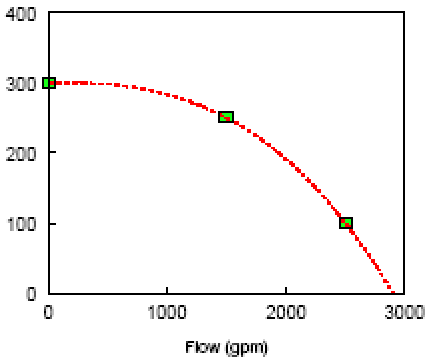
2. Three Point Curve

   Three-Point Curve - A three-point pump curve is defined by three operating points: a Low Flow point (flow and head at low or zero flow condition), a Design Flow point (flow and head at desired operating point), and a Maximum Flow point (flow and head at maximum flow). EPANET tries to fit a continuous function of the form through the three points to define the entire pump curve.

$$h_G = A - Bq^C$$

In this function, hg = head gain, q = flow rate, and A, B, and C are constants.

Three-Point Pump Curve

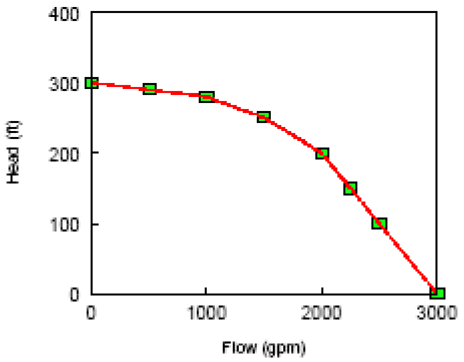


3. Multi-Point Curve

   Multi-Point Curve – A multi-point pump curve is defined by providing either a pair of head-flow points or four or more such points. EPANET creates a complete curve by connecting the points with straight-line segments. For variable speed pumps, the pump curve shifts as the speed changes. The relationships between flow (Q) and head (H) at speeds N1 and N2 are

$$\frac{Q_1}{Q_2} = \frac{N_1}{N_2} \qquad\qquad \frac{H_1}{H_2} = \left(\frac{N_1}{N_2}\right)^2$$

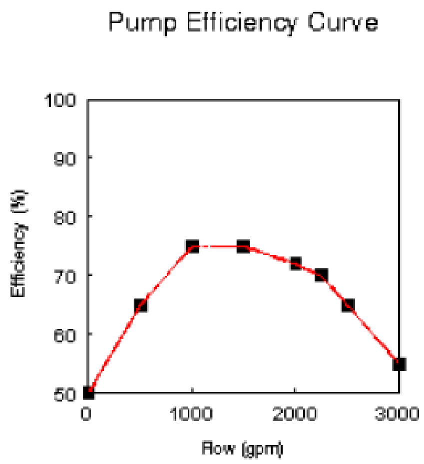
Multi-Point Pump Curve



EPANET will shut a pump down if the system demands a head higher than the first point on the curve (i.e., the shutoff head). A pump curve must be supplied for each pump in the system unless the pump is a constant energy pump.

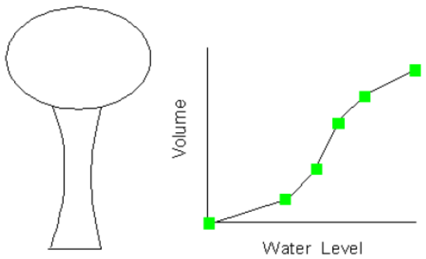
4.4.2 Efficiency Curve

An Efficiency Curve determines pump efficiency (Y in percent) as a function of pump flow rate (X in flow units). An example efficiency curve is shown below. Efficiency should represent wire-to-water efficiency that takes into account mechanical losses in the pump itself as well as electrical losses in the pump's motor. The curve is used only for energy calculations. If not supplied for a specific pump then a fixed global pump efficiency will be used.



4.4.3 Volume Curve

A Volume Curve determines how storage tank volume (Y in cubic feet or cubic meters) varies as a function of water level (X in feet or meters). It is used when it is necessary to accurately represent tanks whose cross-sectional area varies with height. The lower and upper water levels supplied for the curve must contain the lower and upper levels between which the tank operates. An example of a tank volume curve is given below.

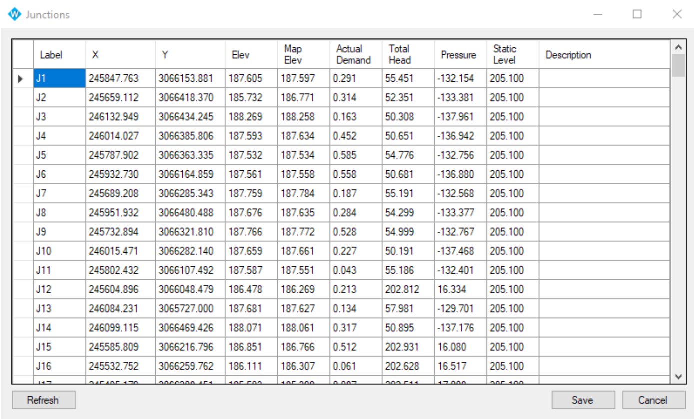


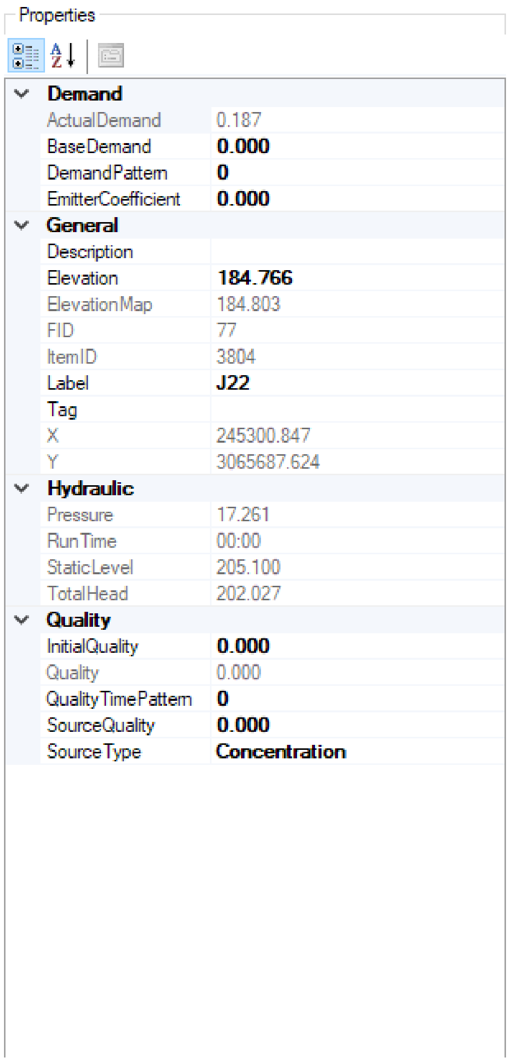
4.4.4 Headloss Curve

A Headloss Curve is used to described the headloss (Y in feet or meters) through a General Purpose Valve (GPV) as a function of flow rate (X in flow units). It provides the capability to model devices and situations with unique headloss-flow relationships, such as reduced flow - backflow prevention valves, turbines, and well draw-down behavior.

4.5 Junctions

Junction provide a location for two or more pipes to meet. Junctions may also exist at the end of a single pipe (i.e as a dead-end). The other role of a junction is to provide a location to withdraw water demanded from the system or inject inflows (as negative demands) into the system. Junction typically do not directly relate to real-world distribution components, since pipes are usually joined with fittings, and flows are extracted from the system at any number of customer connections along a pipe. From a modeling standpoint, the importance of these distinctions varies. Most water users have such a small individual impact that their withdrawals can be assigned to nearby nodes without adversely affecting a model.





a) **Junction ID:** A unique label used to identify the junction. The SW WSP automatically assigns the junction number during the "Check Network Operation". There is no need of inputting the JunctionID.

b) **X-Coordinate & Y-Coordinate:** The horizontal location of the junction on the map, measured in the map's distance units. It is automatically computed as the per the junction location in the map. The values of the coordinates are also not shown in the table. Leave this blank.

c) **Description:** An optional text string that describes other significant information about the junction.

d) **Tag:** An optional text string (with no spaces) used to assign the junction to a category, such as a pressure zone.

e) **Elevation:** The elevation in feet (meters) above some common reference (e.g. Mean sea level) of the junction. This is a required property if the option to use elevation from Map is not chosen. In case of the option of elevation from map is chosen this property will not be used instead the "ElevationMap" will be used for the junction elevation which is automatically derived from the Map from the elevation grids. Elevation is used only to compute pressure at the junction. It does not affect any other computed quantity.

f) **Base Demand:** The average or nominal demand for water by the main category of consumer at the junction, as measured in the current flow units. A negative value is used to indicate an external source of flow into the junction. If left blank then demand is assumed to be zero. If the "Demand From Map" is chosen this can be blank (or 0) as the demand from map utilizes the junction area, demand area and demand points to compute the demand in particular junction during the "Build Demand From Map"

g) **Demand Pattern:** The ID label of the time pattern used to characterize time variation in demand for the main category of consumer at the junction. The pattern provides multipliers that are applied to the Base Demand to determine actual demand in a given time period. If left blank (or 0) then the Default Time Pattern assigned in the Hydraulic Options will be used.

h) **Emitter Coefficient:** Discharge coefficient for emitter (sprinkler or nozzle) placed at junction. Units are flow units at 1 unit of pressure drop (psi or m). Leave blank or set to 0 if no emitter is present.

i) **Initial Quality:** Water quality level at the junction at the start of the simulation. Can be left blank if no water quality analysis is being made or if the level is zero.

j) **Source Quality**: Value of the source quality.

k) **Source Type:** Type of source as 'Concentration" , "Mass Booster" Etc. This is drop down list which will provide the required options.

l) **QualityTimePattern:** Time pattern for the water quality modeling Can be left "0" if no water quality modeling is to be carried out.

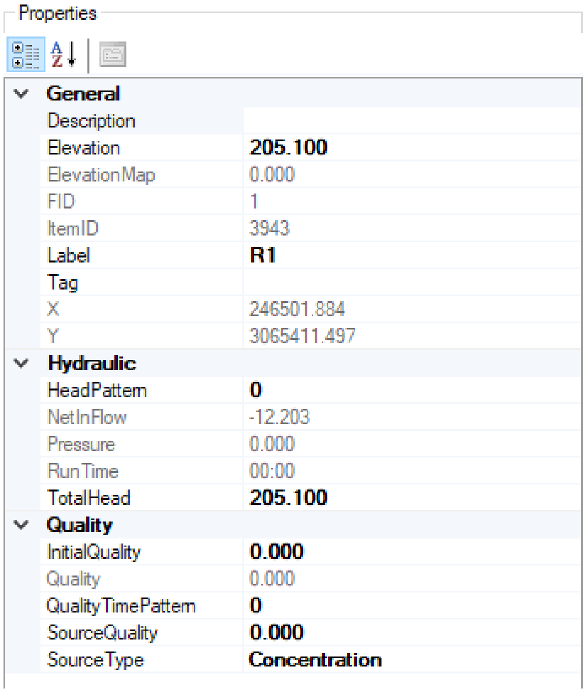
m) **ElevationMap:** Elevation automatically derived from the elevation grids (e.g. Erdas img, ESRI grid files). Editing of this value is allowed but will be reset to the values of the elevation grids again if the "Demand From Map" is run. Hence user need to be careful in editing these values.

4.6 Junction Area

Junction Area is the area of the system represented by each of the junctions. Depending upon the details of the network modeled the junction area can represent more accurate representation of the demand scenario in each of the junction. Usually the junction area is built from the ½ distances from the pipes. Some subjective judgment may also be required to delineate the area served by each junction.

4.7 Reservoirs

The term reservoir has a specific meaning with regard to water distribution system modeling that may differ slightly from the use of the word in normal water distribution construction and operation. A reservoir represents a boundary node in a model that can supply or accept water with such a large capacity that the hydraulic grade of the reservoir is unaffected and remains constant. It is an infinite source, which means that it can theoretically handle any inflow or outflow rate, for any length of time, without running dry or overflowing. In reality, there is no such thing as a true infinite source. For modeling purposes, however, there are situations where inflows and outflows have little or no effect on the hydraulic grade at a node. Reservoirs are used to model any source of water where the hydraulic grade is controlled by factors other than the water usage rate. Lakes, groundwater wells, and clearwells at water treatment plants are often represented as reservoirs in water distribution models. By model definition, storage is not a concern for reservoirs, so no volumetric storage data is needed.



a) **Reservoir ID**: The SW WSP automatically assigns the junction number during the “Check Network Operation”. There is no need of inputting the ID.

b) **X-Coordinate & Y-Coordinate:** The horizontal location of the junction on the map, measured in the map's distance units. It is automatically computed as the per the junction location in the map. The values of the coordinates are also not shown in the table. Leave this blank.

c) **Description:** An optional text string that describes other significant information about the junction.

d) **Tag:** An optional text string (with no spaces) used to assign the junction to a category, such as a pressure zone.

e) **Total Head :** The hydraulic head (elevation + pressure head) of water in the reservoir. This is a required property.

f) **Head Pattern :** The ID label of a time pattern used to model time variation in the reservoir's total head. Leave blank if none applies. This property is useful if the reservoir represents a tie-in to another system whose pressure varies with time.

g) **Initial Quality :** Water quality level at the reservoir. Can be left blank if no water quality analysis is being made or if the level is zero.

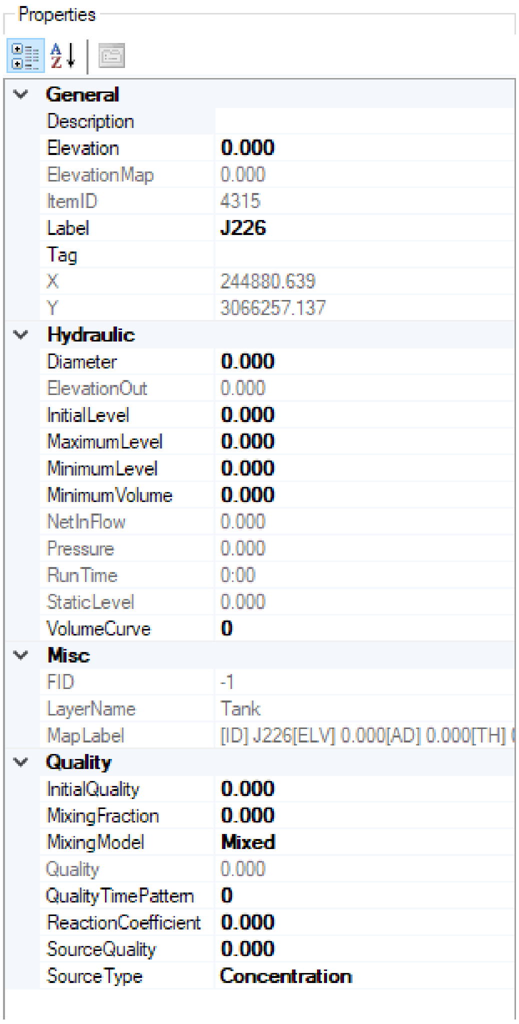
h) **Source Quality:** Value of the source quality.

i) **Source Type:** Type of source as ‘Concentration” , “Mass Booster” Etc. This is drop down list which will provide the required options.

j) **QualityTimePattern:** Time pattern for the water quality modeling Can be left “0” if no water quality modeling is to be carried out.

4.8 Tanks

A storage tank is also a boundary node, but unlike a reservoir, the hydraulic grade line of a tank fluctuates according to the inflow and outflow of water. Tanks have a finite storage volume, and it is possible to completely fill or completely exhaust that storage (although most real systems are designed and operated to avoid such occurrences). Storage tanks are present in most real-world distribution systems, and the relationship between an actual tank and its model counterpart is typically straightforward.



a) **Tank ID:** A unique label used to identify the junction. The SW WSP automatically assigns the junction number during the “Check Network Operation”. There is no need of inputting the ID

b) **X-Coordinate & Y-Coordinate:** The horizontal location of the junction on the map, measured in the map's distance units. It is automatically computed as the per the junction location in the map. The values of the coordinates are also not shown in the table. Leave this blank.

c) **Description:** An optional text string that describes other significant information about the junction.

d) **Tag:** An optional text string (with no spaces) used to assign the junction to a category, such as a pressure zone.

e) **Elevation:** The elevation above a common datum in feet (meters) of the bottom shell of the tank. This is a required property and is not computed by the “Elevation from Map”. This has to be manually entered.

f) **Initial Level :** The height in feet (meters) of the water surface above the bottom elevation of the tank at the start of the simulation. This is a required property.

g) **Minimum Level:** The minimum height in feet (meters) of the water surface above the bottom elevation that will be maintained. The tank will not be allowed to drop below this level. This is a required property.

h) **Maximum Level**: The maximum height in feet (meters) of the water surface above the bottom elevation that will be maintained. The tank will not be allowed to rise above this level. This is a required property.

i) **Diameter:** The diameter of the tank in feet (meters). For cylindrical tanks this is the actual diameter. For square or rectangular tanks it can be an equivalent diameter equal to 1.128 times the square root of the cross-sectional area. For tanks whose geometry will be described by a curve (see below) it can be set to any value. This is a required property.

j) **Minimum Volume:** The volume of water in the tank when it is at its minimum level, in cubic feet (cubic meters). This is an optional property, useful mainly for describing the bottom geometry of non-cylindrical tanks where a full volume versus depth curve will not be supplied.

k) **Volume Curve:** The ID label of a curve used to describe the relation between tank volume and water level. This property is useful for characterizing irregular-shaped tanks. If left blank then the tank is assumed to be cylindrical.

l) **Mixing Model:** The type of water quality mixing that occurs within the tank. The choices include fully mixed (MIXED), two-compartment mixing (2COMP), first-in-first-out plug flow (FIFO), last-in-first-out plug flow (LIFO).

m) **Mixing Fraction:** The fraction of the tank's total volume that comprises the inlet-outlet compartment of the two-compartment (2COMP) mixing model. Can be left blank if another type of mixing model is employed.

n) **Reaction Coefficient:** The bulk reaction coefficient for chemical reactions in the tank. Use a positive value for growth reactions and a negative value for decay. Time units are 1/days. Leave blank if the Global Bulk reaction coefficient will apply. See Water Quality Reactions for more information.

o) **Initial Quality:** Water quality level in the tank at the start of the simulation. Can be left blank if no water quality analysis is being made or if the level is zero.

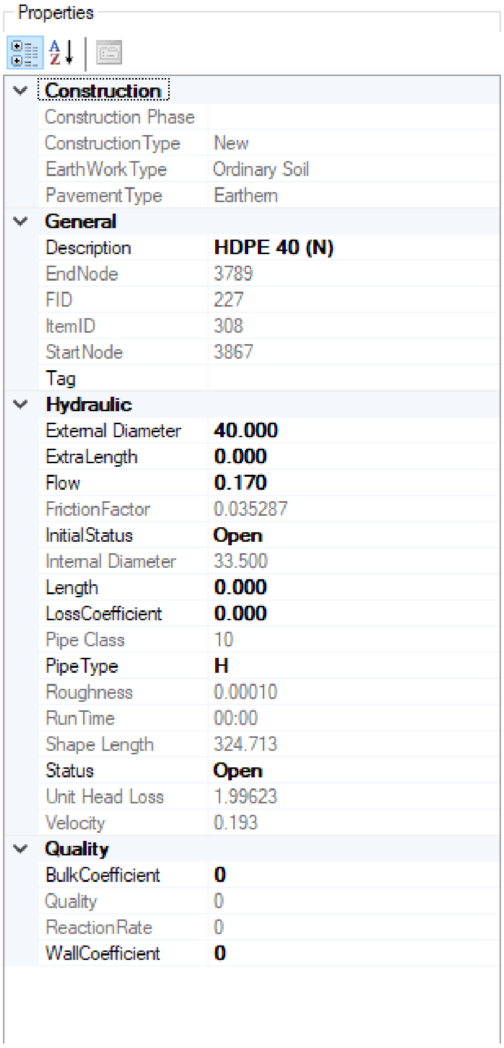
p) **Source Quality**: Value of the source quality.

q) **Source Type:** Type of source as 'Concentration" , "Mass Booster" Etc. This is drop down list which will provide the required options.

r) **QualityTimePattern:** Time pattern for the water quality modeling Can be left "0" if no water quality modeling is to be carried out.

4.9 Pipes

A pipe conveys flow as it moves from one junction node to another in a network. In the real world, individual pipes are usually manufactured in lengths of around 18 or 20 feet (6 meters), which are then assembled in series as a pipeline. Real-world pipelines may also have various fittings, such as elbows, to handle abrupt changes in direction, or isolation valves to close off flow through a particular section of pipe. For modeling purposes, individual segments of pipe and associated fittings can all be combined into a single pipe element. A model pipe should have the same characteristics (size, material, etc.) throughout its length. The losses due to the fitting are considered as minor losses and input separately.



a. **Pipe ID:** A unique label used to identify the junction. The SW WSP automatically assigns the junction number during the “Check Network Operation”. There is no need of inputting the ID.

b. **Description:** An optional text string that describes other significant information about the junction.

c. **Tag:** An optional text string (with no spaces) used to assign the junction to a category, such as a pressure zone.

d. **Length:** The actual length of the pipe in feet (meters). This is a required property. If Length from the map is chosen than this can be left blank (or 0)

e. **Diameter:** The pipe diameter in inches (mm). This is a required property.

f. **Roughness :** The roughness coefficient of the pipe. It is unitless for Hazen-Williams or Chezy-Manning roughness and has units of millifeet (mm) for Darcy-Weisbach roughness. This is a required property.

g. **Loss Coefficient:** Unitless minor loss coefficient associated with bends, fittings, etc. Assumed 0 if left blank.

h. **Initial Status:** Determines whether the pipe is initially open, closed, or contains a check valve. If a check valve is specified then any flow in the pipe must be from the Start node to the End node.

i. **Bulk Coefficient:** The bulk reaction coefficient for the pipe. Use a positive value for growth and a negative value for decay. Time units are 1/days. Leave blank if the Global Bulk reaction coefficient will apply.

j. **Wall Coefficient:** The wall reaction coefficient for the pipe. Use a positive value for growth and a negative value for decay. Time units are 1/days. Leave blank if the Global Wall reaction coefficient will apply.

k. **Wall Coefficient:** The wall reaction coefficient for the pipe. Use a positive value for growth and a negative value for decay. Time units are 1/days. Leave blank if the Global Wall reaction coefficient will apply.

Reservoir ALL Line ALL

Branch Name	Pipe No	From	To	Length (m)	Design Length (m)	Flow Direction (Bearing)	Discharge (l/s)	Extra/Direc Discharge (l/s)	From RL (m)	To RL (m)	Level Diff (m)	Static Level (m)	Head Available (m)
R1-J126	1	R1	J54	755.21	755.21	L	7.01	0.00	205.1	187.5	17.6	205.1	205.1
	2	J54	J39	156.29	156.29	L	6.12	0.00	187.5	187.5	0.0	205.1	205.1
	3	J39	J77	150.15	150.15	L	5.86	0.00	187.5	187.9	-0.4	205.1	17.2
	4	J77	J57	118.99	118.99	L	3.76	0.00	187.9	187.3	0.6	205.1	205.0
	5	J57	J189	51.27	51.27	L	3.15	0.00	187.3	187.5	-0.2	205.1	205.0
	6	J189	J44	144.69	144.69	L	2.57	0.00	187.5	187.7	-0.2	205.1	17.3
	7	J44	J15	96.90	96.90	DL	2.50	0.00	187.7	186.9	0.8	205.1	18.1
	8	J15	J19	118.16	118.16	DL	2.30	0.00	186.9	186.2	0.7	205.1	18.8
	9	J19	J55	96.57	96.57	DL	2.13	0.00	186.2	186.3	-0.1	205.1	18.7
	10	J55	J40	146.16	146.16	DL	2.07	0.00	186.3	185.9	0.4	205.1	19.0
	11	J40	J177	20.34	20.34	DL	2.00	0.00	185.9	185.3	0.5	205.1	204.9
	12	J177	J184	76.78	76.78	DL	1.95	0.00	185.3	185.3	0.0	205.1	204.9
	13	J184	J194	189.25	189.25	DL	1.91	0.00	185.3	184.9	0.4	205.1	204.9
	14	J194	J195	168.64	168.64	DL	2.21	0.00	184.9	184.4	0.5	205.1	204.9
	15	J195	J196	202.84	202.84	DL	1.98	0.00	184.4	184.4	0.0	205.1	204.8
	16	J196	J185	227.33	227.33	DL	1.73	0.00	184.4	184.3	0.1	205.1	204.8
	17	J185	J186	97.17	97.17	DL	1.63	0.00	184.3	184.9	-0.6	205.1	204.8
	18	J186	J187	152.97	152.97	DL	1.50	0.00	184.9	185.3	-0.4	205.1	204.8
	19	J187	J87	176.81	176.81	DL	1.46	0.00	185.3	185.1	0.2	205.1	19.6
	20	J87	J160	73.13	73.13	DL	1.43	0.00	185.1	185.7	-0.6	205.1	19.0
	21	J160	J161	24.75	24.75	DL	0.39	0.00	185.7	186.0	-0.3	205.1	18.7
	22	J161	J162	66.92	66.92	DL	0.21	0.00	186.0	186.6	-0.6	205.1	18.2
	23	J162	J163	100.44	100.44	DL	0.16	0.00	186.6	185.9	0.7	205.1	18.8
	24	J163	J84	99.14	99.14	D	0.02	0.00	185.9	187.6	-1.7	205.1	17.1
	25	J84	J126	88.39	88.39	D	0.01	0.00	187.6	188.3	-0.7	205.1	16.4

Pipe No	Max Static Pressure (m)	Pipe Type	Pipe OD/ NB	Pipe Class	Inner Dia (mm)	Friction Factor	Head Loss (m)	Residual Head (m)	Flow Velocity (m/s)	From HGL (m)	To HGL (m)	Soil Type	Remark
1	17.6	H	355	6	320.7	0.024	0.0	17.6	0.09	205.1	205.1	Ordinary Soil	HDPE 350/4 (N)
2	17.6	H	225	6	203.1	0.022	0.0	17.5	0.19	205.1	205.0	Ordinary Soil	HDPE 225/4 (N)
3	17.6	H	225	6	203.1	0.022	0.0	17.1	0.18	205.0	205.0	Ordinary Soil	HDPE 225/4 (N)
4	17.8	H	200	16	152.3	0.023	0.0	17.7	0.21	205.0	205.0	Ordinary Soil	HDPE 225/4 (N)
5	17.8	H	200	16	152.3	0.024	0.0	17.5	0.17	205.0	205.0	Ordinary Soil	HDPE 225/4 (N)
6	17.6	H	200	16	152.3	0.026	0.0	17.3	0.14	205.0	204.9	Ordinary Soil	HDPE 225/4 (N)
7	18.2	H	200	16	152.3	0.026	0.0	18.1	0.14	204.9	204.9	Ordinary Soil	HDPE 160/4 (N)
8	18.9	H	200	16	152.3	0.026	0.0	18.8	0.13	204.9	204.9	Ordinary Soil	HDPE 160/4 (N)
9	18.9	H	200	16	152.3	0.027	0.0	18.6	0.12	204.9	204.9	Ordinary Soil	HDPE 160/4 (N)
10	19.2	H	200	16	152.3	0.027	0.0	19.0	0.11	204.9	204.9	Ordinary Soil	HDPE 160/4 (N)
11	19.8	H	200	16	152.3	0.027	0.0	19.5	0.11	204.9	204.9	Ordinary Soil	HDPE 160/4 (N)
12	19.8	H	200	16	152.3	0.027	0.0	19.6	0.11	204.9	204.9	Ordinary Soil	HDPE 160/4 (N)
13	20.2	H	200	16	152.3	0.027	0.0	20.0	0.10	204.9	204.9	Ordinary Soil	HDPE 160/4 (N)
14	20.7	H	160	6	144.4	0.026	0.0	20.5	0.14	204.9	204.8	Ordinary Soil	HDPE 160/4 (N)
15	20.7	H	160	6	144.4	0.027	0.0	20.4	0.12	204.8	204.8	Ordinary Soil	HDPE 160/4 (N)
16	20.8	H	160	6	144.4	0.028	0.0	20.5	0.11	204.8	204.8	Ordinary Soil	HDPE 160/4 (N)
17	20.8	H	160	6	144.4	0.028	0.0	19.9	0.10	204.8	204.8	Ordinary Soil	HDPE 160/4 (N)
18	20.2	H	160	6	144.4	0.029	0.0	19.4	0.09	204.8	204.7	Ordinary Soil	HDPE 160/4 (N)
19	20.0	H	160	6	144.4	0.029	0.0	19.6	0.09	204.7	204.7	Ordinary Soil	HDPE 160/4 (N)
20	20.0	H	160	6	144.4	0.029	0.0	19.0	0.09	204.7	204.7	Ordinary Soil	HDPE 160/4 (N)
21	19.4	H	160	6	144.4	0.037	0.0	18.7	0.02	204.7	204.7	Ordinary Soil	HDPE 160/4 (N)
22	19.1	H	200	16	152.3	0.036	0.0	18.2	0.01	204.7	204.7	Ordinary Soil	HDPE 160/4 (N)
23	19.2	H	200	16	152.3	0.050	0.0	18.8	0.01	204.7	204.7	Ordinary Soil	HDPE 160/4 (N)
24	19.2	H	40	10	33.5	0.094	0.0	17.1	0.02	204.7	204.7	Ordinary Soil	HDPE 75 (N)
25	17.5	H	40	10	33.5	0.232	0.0	16.4	0.01	204.7	204.7	Ordinary Soil	HDPE 75 (N)

4.10 Valves

4.10.1 Pressure Reducing Valves (PRVs)

Pressure reducing valves (PRVs) throttle automatically to prevent the downstream hydraulic grade from exceeding a set value, and are used in situations where high downstream pressures could cause damage. Without a PRV, the hydraulic grade in the upper zone could cause pressures in the lower zone to be high enough to burst pipes or cause relief valves to open. PRVs are not associated with a pipe but are explicitly represented within a hydraulic model. A PRV is characterized in a model by the downstream hydraulic grade that it attempts to maintain, its controlling status, and its minor loss coefficient. Because the valve intentionally introduces losses to meet the required grade, a PRV's minor loss coefficient is really only a concern when the valve is wide open (not throttling). Like pumps, PRVs connect two pressure zones and have two associated hydraulic grades, so some models represent them as links and some represent them as nodes. The pitfalls of link characterization of PRVs are the same as those described previously for pumps.

4.10.2 Pressure Sustaining Valves (PSVs)

A pressure sustaining valve (PSV) throttles the flow automatically to prevent the upstream hydraulic grade from dropping below a set value. This type of valve can be used in situations in which unregulated flow would result in inadequate pressures for the upstream portion of the system. They are frequently used to model pressure relief valves. Like PRVs, a PSV is typically represented explicitly within a hydraulic model and is characterized by the upstream pressure it tries to maintain, its status, and its minor loss coefficient.

4.10.3 Flow Control Valves (FCVs)

Flow control valves (FCVs) automatically throttle to limit the rate of flow passing through the valve to a user-specified value. This type of valve can be employed anywhere that flow-based regulation is appropriate, such as when a water distributor has an agreement with a customer regarding maximum usage rates. FCVs do not guarantee that the flow will not be less than the setting value, only that the flow will not exceed the setting value. If the flow does not equal the setting, modeling packages will typically indicate so with a warning. Similar to PRVs and PSVs, EPANET directly support FCVs, which are characterized by their maximum flow setting, status, and minor loss coefficient.

4.10.4 Throttle Control Valves (TCVs)

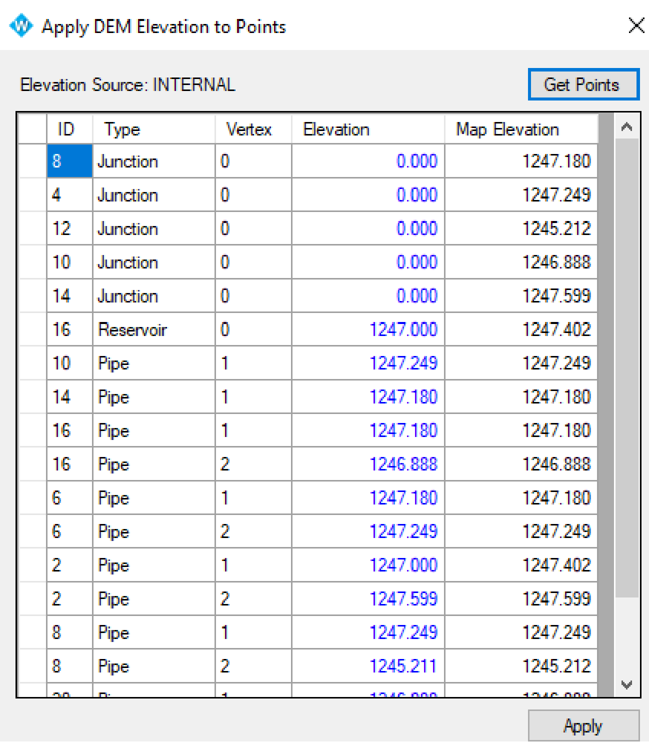
Unlike an FCV where the flow is specified directly, a throttle control valve (TCV) throttles to adjust its minor loss coefficient based on the value of some other attribute of the system (such as the pressure at a critical node or a tank water level). Often the throttling effect of a particular valve position is known, but the minor loss coefficients as a function of position are unknown. This relationship can frequently be provided by the manufacturer.

4.11 Pump

A pump is an element that adds energy to the system in the form of an increased hydraulic grade. Since water flows "downhill" (that is, from higher energy to lower energy), pumps are used to boost the head at desired locations to overcome piping head losses and physical elevation differences. Unless a system is entirely operated by gravity, pumps are an integral part of the distribution system. In water distribution systems, the most frequently used type of pump is the centrifugal pump. A centrifugal pump has a motor that spins a piece within the pump called an impeller. The mechanical energy of the rotating impeller is imparted to the water, resulting in an increase in head.

4.12 Elevation From Map

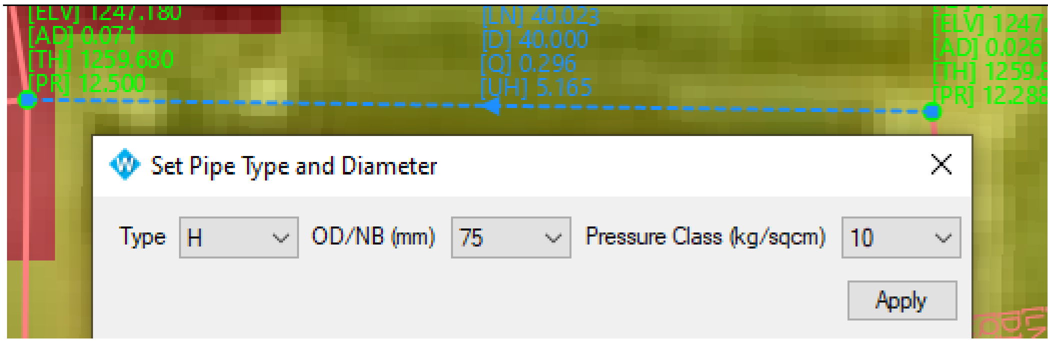
It allows user to extract the elevation of junctions from selected terrain model. User need to provide the location of the elevation grid file using “Terrain Model” under “DTM” menu. In case when the elevation could not be extracted from selected terrain model, the user can enter the data in “Elevation” field in “Junction” table under “Data” menu. The elevation for the Tanks & reservoirs are not extracted and the respective elevation or the Total head need to be provided manually.



ID	Type	Vertex	Elevation	Map Elevation
8	Junction	0	0.000	1247.180
4	Junction	0	0.000	1247.249
12	Junction	0	0.000	1245.212
10	Junction	0	0.000	1246.888
14	Junction	0	0.000	1247.599
16	Reservoir	0	1247.000	1247.402
10	Pipe	1	1247.249	1247.249
14	Pipe	1	1247.180	1247.180
16	Pipe	1	1247.180	1247.180
16	Pipe	2	1246.888	1246.888
6	Pipe	1	1247.180	1247.180
6	Pipe	2	1247.249	1247.249
2	Pipe	1	1247.000	1247.402
2	Pipe	2	1247.599	1247.599
8	Pipe	1	1247.249	1247.249
8	Pipe	2	1245.211	1245.212

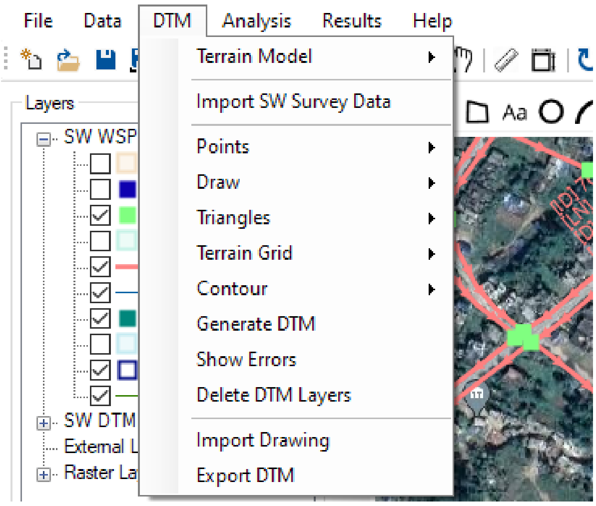
4.13 Assign Pipe Size

This tool allows user to assign the pipe size data to selected pipe elements in the Plan window .The Pipe type, outer diameter and pressure class of selected pipe elements can be set. The pipe type dropdown includes two options, H refering to High Density Polyethene and G to Galvanized Iron.The OD dropdown allows users to choose between a variety of standard sizes of pipes. The pressure class of a pipe can also be selected dropdown menu.


[ELV] 1247.180
[AD] 0.071
[TH] 1259.680
[PR] 12.500
[LN] 40.023
[D] 40.000
[Q] 0.296
[UH] 5.165
Set Pipe Type and Diameter
Type
H
OD/NB (mm)
75
Pressure Class (kg/sqcm)
10
Apply

5 DTM

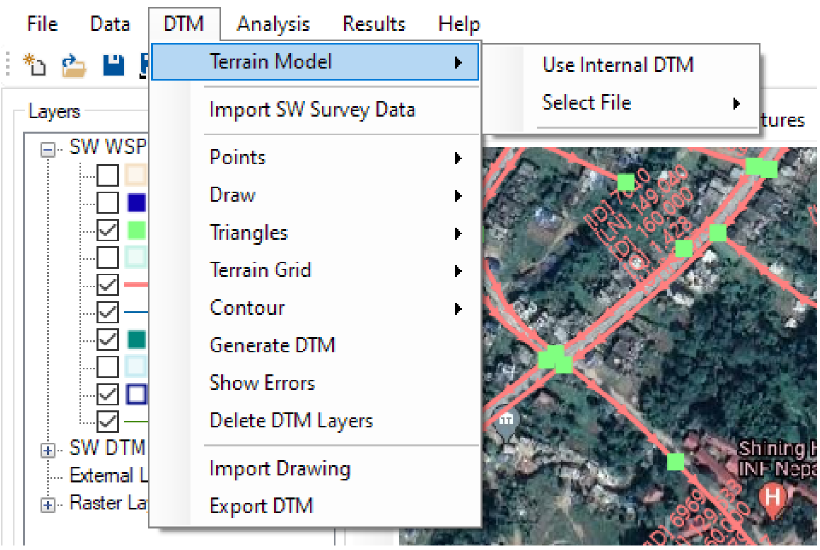
It is the built-in tools for the generation of a topographic map and terrain model. The available tools in the Terrain menu are as shown in the figure.



5.1 Terrain Model

This sub-menu specify the terrain file to be used for extraction of elevation data in junction. The terrain file may be internal DTM or external DTM/Grid file.

If the topographic data is processed and dtm is created within SW WSP, the “Internal Dtm” is used. Otherwise, external dtm or Grid can be imported to be used as terrain data.



.Dtm is the old format of digital terrain model generated by SW-DTM software. Now Grid (.tif) is also supported by the current version. User can import terrain from different DEM source such as SRTM, Palsar, etc.

5.2 Import SW Survey Data

It imports the topographic data from “SW Survey” Mobile App.

5.3 Points

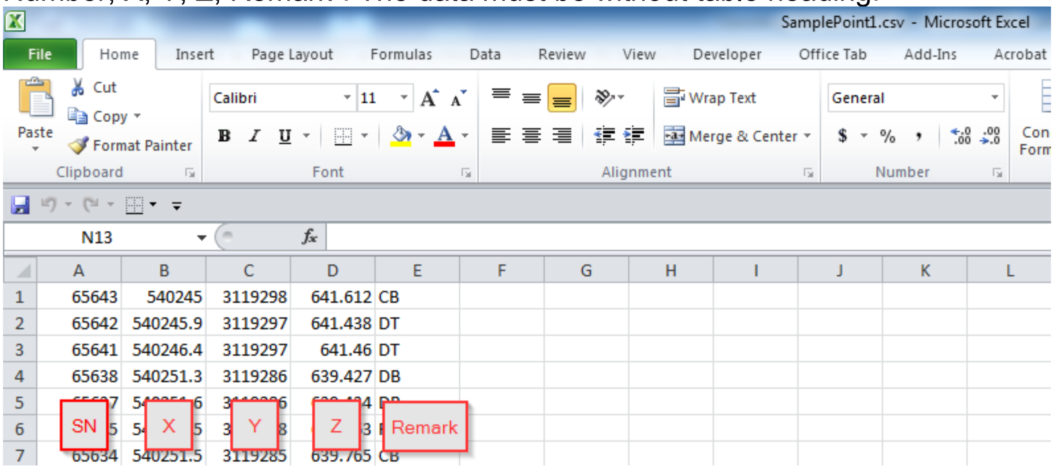
This sub-menu deals with the points data. It may be the surveyed data or generated data.

5.3.1 Add Point

It adds point with user-defined elevation.

5.3.2 Import Points from File

It imports the surveyed points from *.csv format. The data must be stored in the order "Serial Number, X, Y, Z, Remark". The data must be without table heading.



5.3.3 Set Point Block Scale

It Changes the display scale of the point in Plan window.

5.3.4 Delete Point Range

It deletes the points based on user-defined point number range.

5.3.5 Export Points

It exports the points to *.csv format.

5.4 Draw

5.4.1 Insert Block

This tool is used to insert the survey stations and benchmark block in Plan window. The coordinates of benchmark and stations must be saved in *.CSV format. The order of data must be in the order " Serial Number, X, Y, Z, Station Name".

5.4.2 Grid

This tool is used to draw the grids and coordinates in Plan window.

5.4.3 Add Boundary

It creates a boundary line around the survey data for triangulation of points.

5.4.4 Auto Boundary

It detects the data and creates boundary lines around the survey data automatically.

5.5 Triangles

5.5.1 Draw Triangles

It draws the triangles obtained after triangulation.

5.5.2 Erase Triangles

It erases the drawn triangulation.

5.6 Grid

5.6.1 Show Grid Extents

It displays extents of the grid terrain in Plan window.

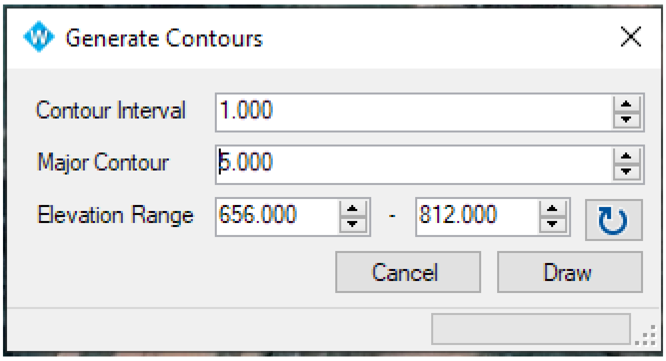
5.6.2 Erase Grid Extents

It erases the extents of the grid terrain from Plan window.

5.7 Contours

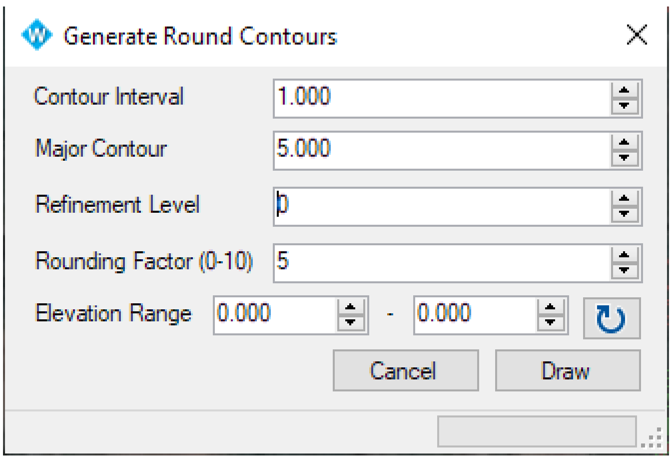
5.7.1 Draw Quick Contour

It allows the user to draw contours with the specified interval.



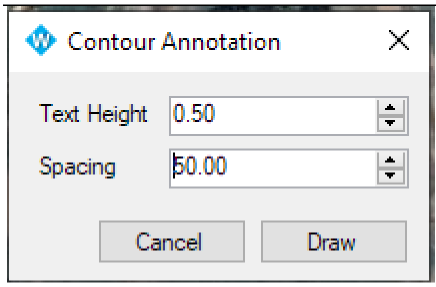
5.7.2 Draw Round Contour

It allows the user to draw smooth and round contours with the specified interval. Option for refinement level and rounding factors are provided in the form. User can modify as per requirement. Higher the refinement level and rounding factor, smoother will be the contour with longer processing time.



5.7.3 Contour Annotation

It allows the user to annotate the elevation of contour at a specified distance.



5.7.4 Erase Contour

It erases all the contours in DTM layers (not from imported external layers).

5.8 Generate DTM

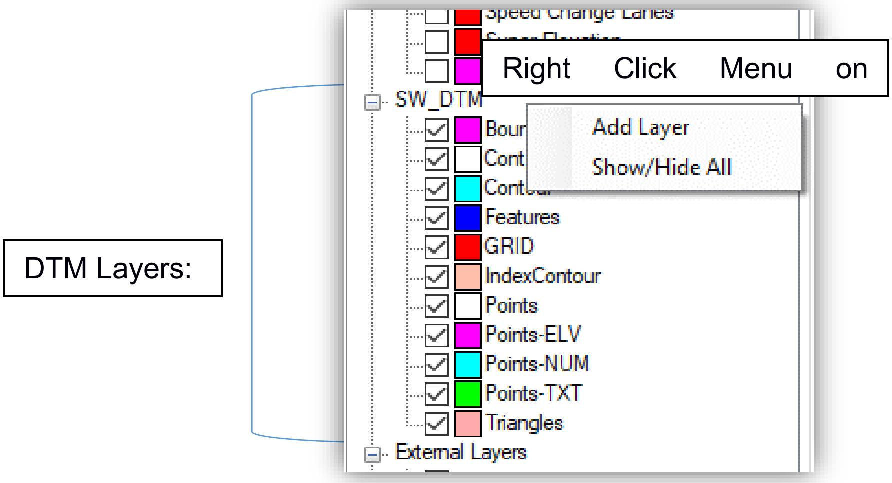
It processes all the points and features and generates dtm file which will be used as internal dtm while updating terrain. This function is equivalent to "Points>Process Points" and "Triangle>Triangulation" in SW DTM.

5.9 Show Errors

While generating dtm, the system may encounter errors due to features intersections. These errors can be viewed from this sub-menu.

5.10 Delete DTM Layers

It deletes the layers under SW_DTM. If the layers are default layers in SW_DTM, only objects in these layers are deleted.



5.11 Import Drawing

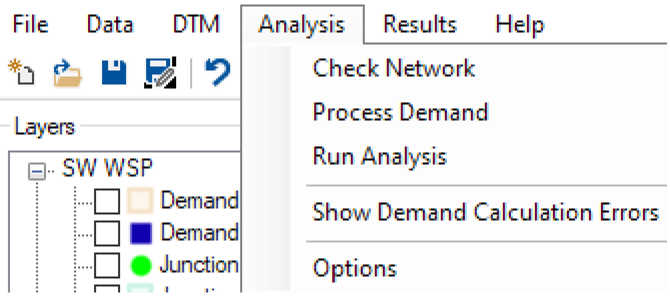
When surveyed data is processed outside the SW WSP in AutoCAD application, all the features need to be imported in SW WSP. This sub-menu imports such features including points, features, etc. These drawings can be further processed and modified within SW WSP unlike the "Import dxf" in layer panel which cannot be edited.

5.12 Export DTM

It exports the generated dtm file in the format *.dtmb so that the same terrain file can be used in another working platform.

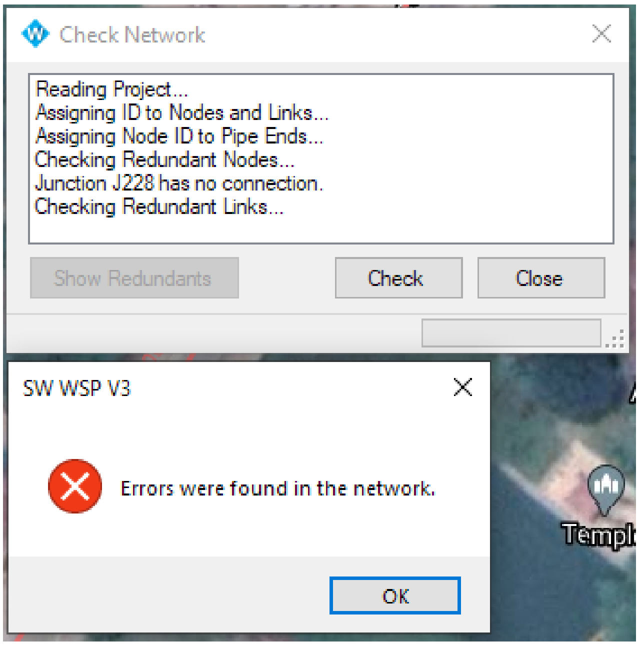
6 ANALYSIS

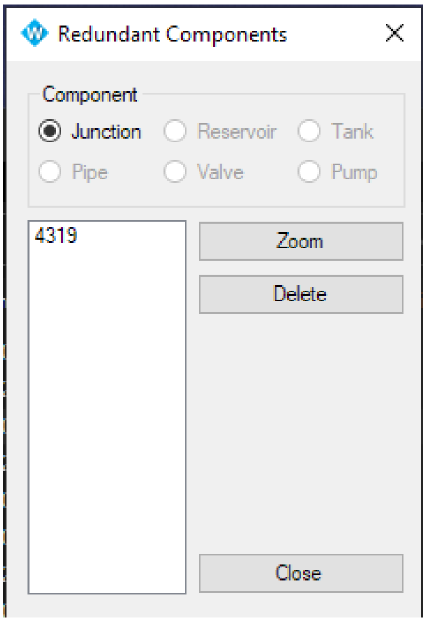
Analysis menu contains tools to check the validity of network, computation of nodal demands, view demand calculation error, run the model and edit design parameter data.

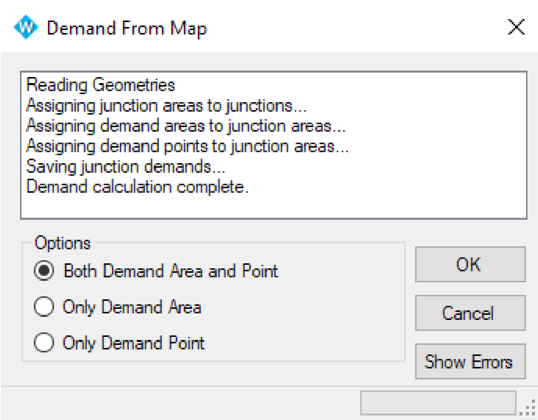


6.1 Check Network

It allows user to checks the network integrity and reports the invalid network items if they exists. If any invalid components exist, “Show redundants” button is activated. By clicking it, user can switch between the list of different redundant components. The invalid network component can be zoomed in Plan window to make required edit or deleted.







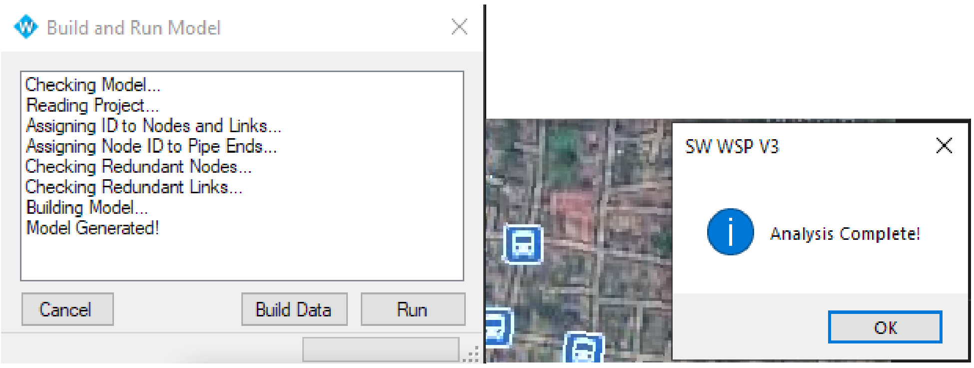
6.2 Process Demand

This is used to create the junction demand based on the provided information in the “Demand Area” and “Demand Point”. If both exists then they are summed to get the Demand for each of the Junctions.

To make this work, the “Junction Area” need to be specified and each of the “Junction Area” should contain only one Junction within. Option to use only the Demand Area or Demand point or combination of both is available.

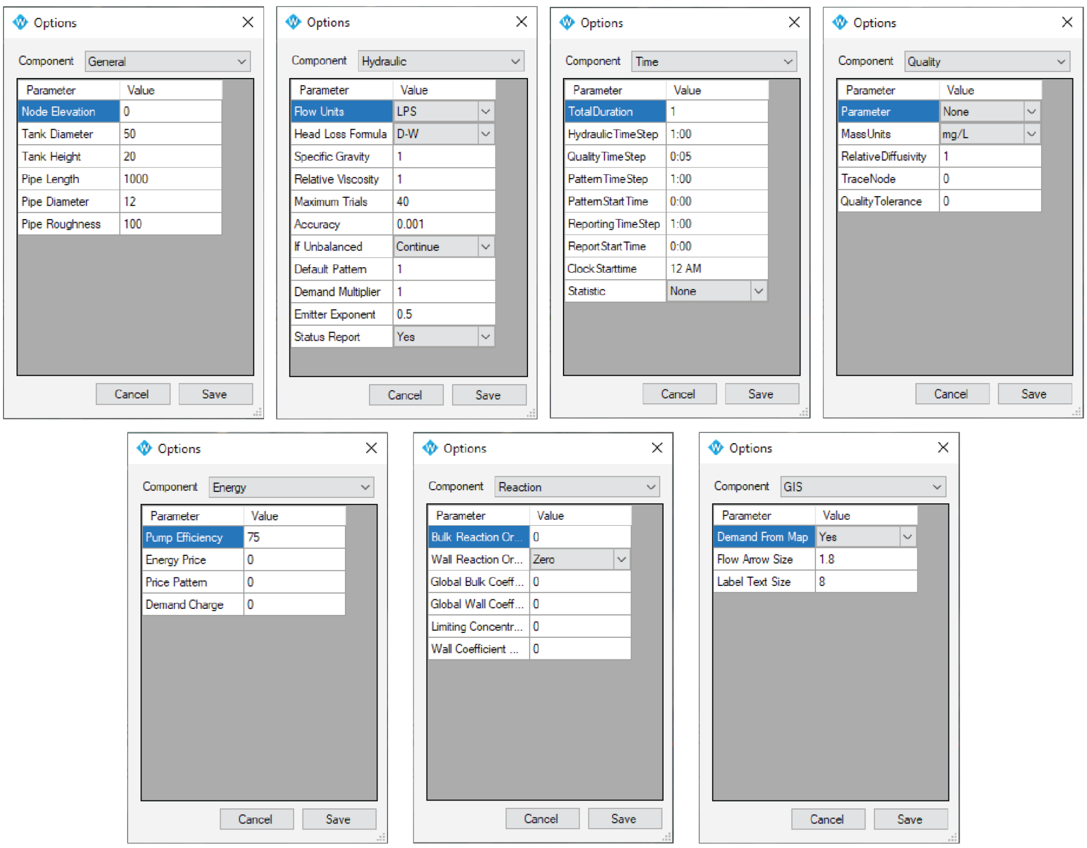
6.3 Run Analysis

This builds the data and run the model using the EPANET engine. If the run is unsuccessful, error message is displayed. As the program uses EPANET engine, the error message also corresponds to the error message in the EPANET hence the user should refer to the EPANET manual for the explanation of the error and make correction in the Model accordingly.



6.4 Options

The option includes all the parameter adjustment for the network modeling. The detailed description of the available options are available in the EPANET manual.



6.4.1 General Options:

This options provides the default values for pipe diameter, roughness etc. If the values are omitted the software will assign these values.

6.4.2 Hydraulic Options:

Hydraulics Options determine how the hydraulic behavior of the pipe network should be analyzed. They include:

a. **Flow Units :** Units in which nodal demands and link flow rates are expressed. Choosing liters or cubic meters causes all other units to be SI metric, otherwise US customary units apply. Use caution when changing flow units as it might affect all other data supplied to the project.
b. **Headloss Formula** :Formula used to compute headloss as a function of flow rate in a pipe. Choices are:
   - Hazen-Williams
   - Darcy-Weisbach
   - Chezy-Manning

   Because each formula measures pipe roughness differently, switching formulas might require that all pipe roughness coefficients be updated.

c. **Specific Gravity:** Ratio of the density of the fluid being modeled to that of water at 4 deg. C (unitless).
d. **Relative Viscosity :** Kinematic viscosity of the fluid being modeled relative to the viscosity of water at 20 deg. C (1.0 centistokes or 0.94 sq ft/day).
e. **Maximum Trials:** Maximum number of trials used to solve the nonlinear equations that govern network hydraulics at a given point in time. Suggested value is 40.
f. **Accuracy:** Convergence criterion used to signal that a solution has been found to the nonlinear equations that govern network hydraulics. Trials end when the sum of all flow changes divided by the sum of all link flows is less than this number. Suggested value is 0.001.
g. **If Unbalanced:** Action to take if a hydraulic solution is not found within the maximum number of trials. Choices are STOP to stop the simulation at this point or CONTINUE to use another 10 trials, with no link status changes allowed, in an attempt to achieve convergence.
h. **Default Pattern:** ID label of a time pattern to be applied to demands at those junctions where no time pattern is specified. If no such time pattern exists then demands will not vary at these locations.
i. **Demand Multiplier:** Multiplier applied to all baseline demands to make total system consumption vary up or down by a fixed amount. E.g., 2.0 doubles all demands, 0.5 halves them, and 1.0 leaves them as it is.
j. **Emitter Exponent:** Power to which pressure is raised when computing the flow through an emitter device. The textbook value for nozzles and sprinklers is 0.5. This may not apply to pipe leakage.
k. **Status Report:** Amount of status information to report after a simulation is made. Choices are
   - NONE (no status report)

- YES (normal status reporting - lists all changes in link status throughout the simulation)
- FULL (full reporting - normal reporting plus the convergence error from each trial of the hydraulic analysis made in each time period)

Full status reporting is only useful for debugging purposes.

6.4.3 Time Options

Times Options set values for the various time steps used in an extended period simulation. (Times can be entered as decimal hours or in hours:minutes notation).

a. **Total Duration:** otal length of a simulation. Use 0 to run a single period (snapshot) hydraulic analysis.
b. **Hydraulic Time Step:** Time interval between recomputation of system hydraulics. Normal default is 1 hour.
c. **Quality Time Step:** Time interval between routing of water quality constituent. Normal default is 5 minutes (0:05 hours).
d. **Pattern Time Step:**Time interval used with all time patterns. Normal default is 1 hour.
e. **Pattern Start Time:** Hours into all time patterns at which the simulation begins (e.g., a value of 2 means that the simulation begins with all time patterns starting at their second hour). Normal default is 0.
f. **Reporting Time Step:** Time interval between times at which computed results are reported. Normal default is 1 hour.
g. **Report Start Time:** Hours into simulation at which computed results begin to be reported. Normal default is 0.
h. **Starting Time of Day :** Clock time (e.g., 7:30 am, 10:00 pm) at which simulation begins. Default is 12:00 am (midnight).
i. **Statistic :** Type of statistical processing used to summarize the results of an extended period simulation. Choices are:
    - NONE (results reported at each reporting time step)
    - AVERAGE (time-averaged results reported)
    - MINIMUM (minimum value results reported)
    - MAXIMUM (maximum value results reported)
    - RANGE (difference between maximum and minimum results reported)

Statistical processing is applied to all node and link results obtained between the Report Start Time and the Total Duration

To run a single-period hydraulic analysis (also called a snapshot analysis) enter 0 for Total Duration. In this case entries for all of the other time options, with the exception of Starting Time of Day, are not used. Water quality analyses always require that a non-zero Total Duration be specified.

6.4.4 Energy Options

Energy Options provide default values used to compute pumping energy and cost when no specific energy parameters are assigned to a given pump. They include:

a. **Pump Efficiency:** Default pump efficiency (as a percent).
b. **Energy Price:** Price of energy per kilowatt-hour. Monetary units are not explicitly represented.
c. **Price Pattern:** ID label of a time pattern used to represent variations in energy price with time.
d. **Demand Charge:** Additional energy charge per maximum kilowatt usage

6.4.5 Quality Options

Quality Options select the type of water quality analysis to conduct and control how the calculations are carried out. They include the following:

a. **Parameter:** Type of water quality parameter being modeled. Choices include:
    - None (no quality analysis),
    - Chemical (compute chemical concentration),
    - Age (compute water age),
    - Trace (trace flow from a specific node).

   In case of Chemical, you can enter the actual name of the chemical being modeled (e.g., Chlorine).
b. **Mass Units:** Mass units used to express concentration. Choices are mg/L or ug/L. Units for Age and Trace analyses are fixed at hours and percent, respectively.
c. **Relative Diffusivity:** Molecular diffusivity of the chemical being modeled relative to that of chlorine at 20 deg. C (0.00112 sq ft/day). Use 2 if the chemical diffuses twice as fast as chlorine, 0.5 if half as fast, etc. Only used when modeling mass transfer for pipe wall reactions. Set to zero to ignore mass transfer effects.
d. **Trace Node:** ID label of the node whose flow is being traced. Applies only to source tracing.
e. **Quality Tolerance**: Smallest change in quality that will cause a new parcel of water to be created in a pipe. A typical setting might be 0.01 for chemicals measured in mg/L as well as water age and source tracing.

The Quality Tolerance determines when the quality of one parcel of water is essentially the same as another parcel. For chemical analysis this might be the detection limit of the procedure used to measure the chemical, adjusted by a suitable factor of safety. Using too large a value for this tolerance might affect simulation accuracy. Using too small a value will affect computational efficiency.

6.4.6 Reaction Options

Reaction Options select the type of water quality reactions that are included in the analysis.

a. **Bulk Reaction Order**: Power to which concentration is raised when computing a bulk flow reaction rate. Use 1 for first-order reactions, 2 for second-order reactions, etc. Use any negative number for Michaelis-Menton kinetics.
b. **Wall Reaction Order:** Power to which concentration is raised when computing a pipe wall reaction rate. Choices are FIRST (1) for first-order reactions or ZERO (0) for constant rate reactions. See Pipe Wall Reaction Rates.
c. **Global Bulk Coefficient:** Default bulk reaction rate coefficient (Kb) assigned to all pipes. This global coefficient can be overridden by editing this property for specific pipes. Use positive number for growth, negative number for decay, or 0 if no bulk

reaction occurs. Units are concentration raised to the (1-n) power divided by days, where n is the reaction order.

d. **Global Wall Coefficient:** Wall reaction rate coefficient (Kw) assigned to all pipes. Can be overridden by editing this property for specific pipes. Use positive number for growth, negative number for decay, or 0 if no wall reaction occurs. Units are ft/day (US) or m/day (SI) for first-order reactions and mass/sq ft/day (US) or mass/sq m/day (SI) for zero-order reactions.

e. **Limiting Concentration:** Maximum concentration that a substance can grow to or minimum value it can decay to. Bulk reaction rates will be proportional to the difference between the current concentration and this value. Leave blank if not applicable.

f. **Wall Coefficient Correlation:** Factor correlating wall reaction coefficient to pipe roughness. See Wall Reaction - Pipe Roughness Correlation for more details. Leave blank if not applicable.

6.4.7 Map/GIS

The “Map/GIS” provide option for :

a. **Demand From Map :** Options for the demand input. If chosen “yes” then the demand is computed from the “Demand Area” and the “Demand Point” automatically.

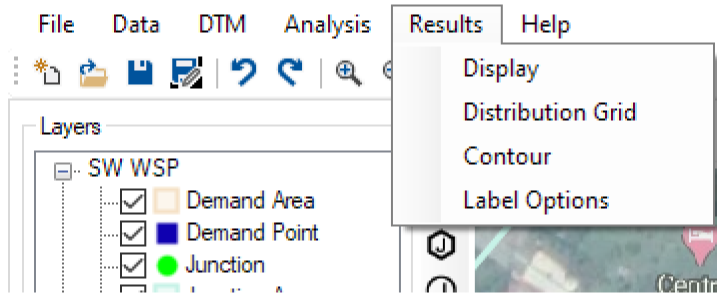
b. **Flow Arrow Size :** It sets the size of flow arrow as per the user input.

c. **Label Text Size** : It sets the size of Label displayed in the Plan window.

d. **Branching Mode :** It allows user to list branches of network on the basis of Flow or Length of branch. The profile generated will also be on the basis of selected branching mode.

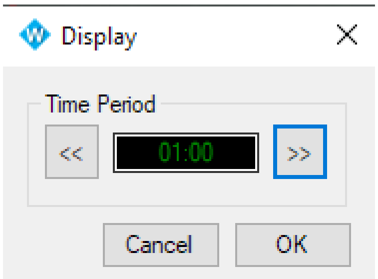
7 RESULTS

This menu is used display the output of the analysis of the model.



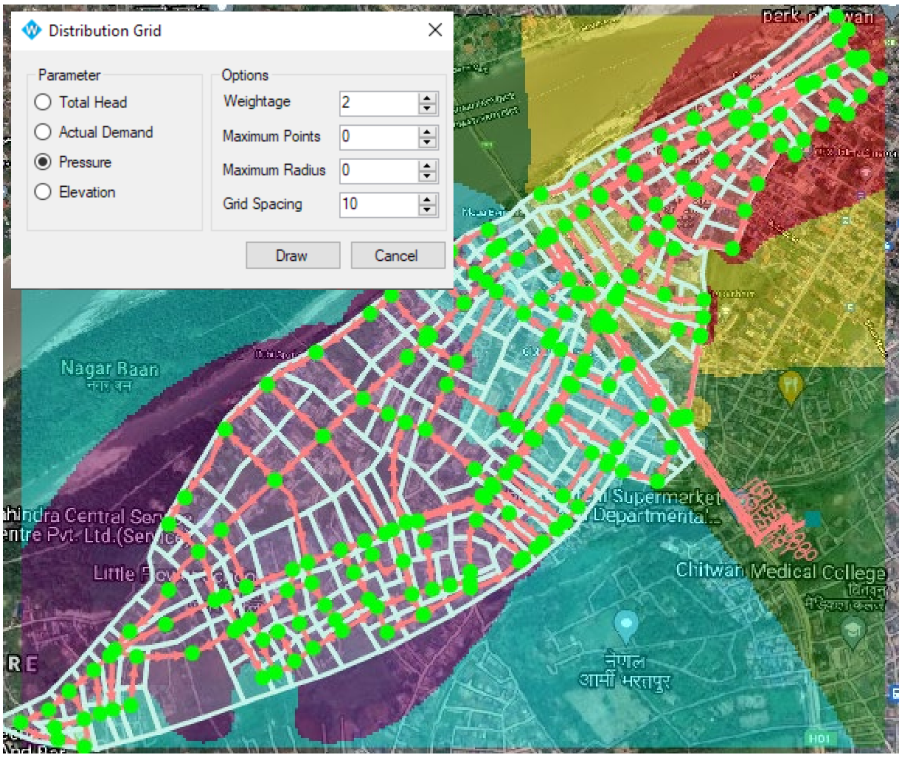
7.1 Display

This tool allows user to display the results of analysis in the Plan and Table window on the basis of selected time period. The performance may be degraded if there are numerous nodes and pipe.



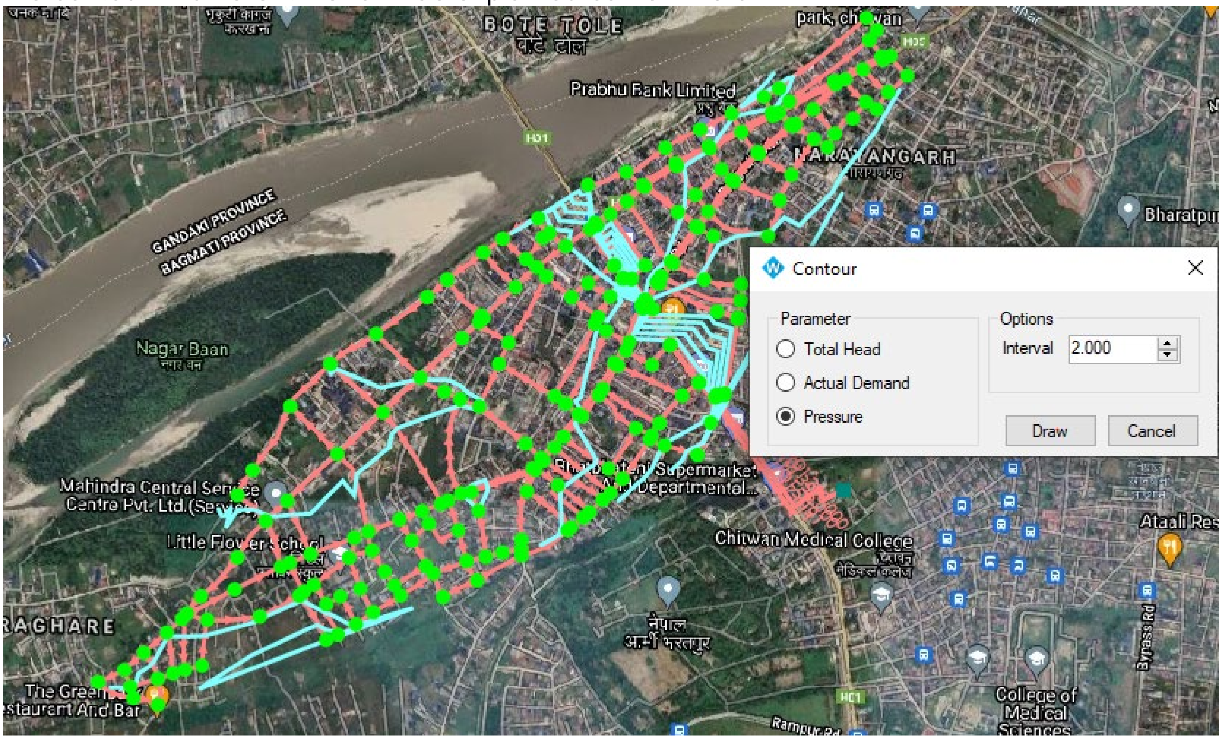
7.2 Distribution Grid

This tool prepares the spatial distribution of different design results like Pressure, Head Demand and Elevation over the network model area. The generated grid files can be found in "Grid" folder inside the project directory for use in another woking platform and are listed under "Raster Layers" in Layers panel.



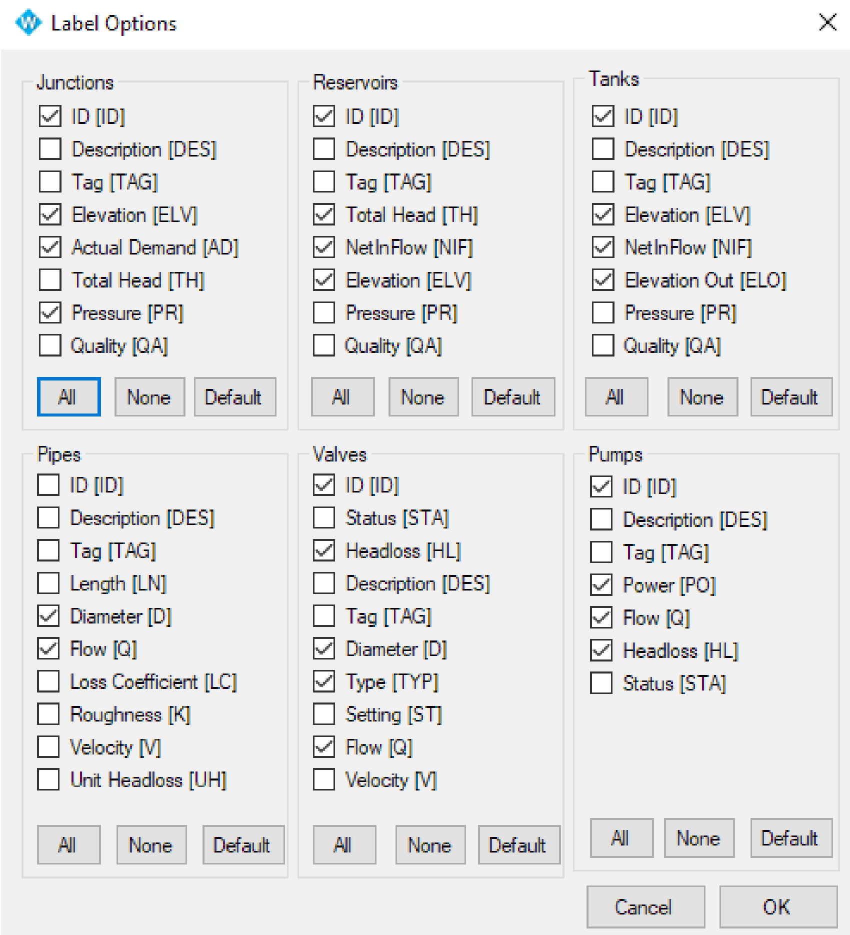
7.3 Contour

This tool generates the contour of different design results like Total Head, Actual Demand and Pressure over network model area. The generated contour is listed under Layers Panel in the name of selected contour parameter. For use in different working platforms, user can export the contour in different file form as explained earlier in 3.6



7.4 Label Option

This can be used to select the data that are to be displayed for each component of the network.



8 HELP

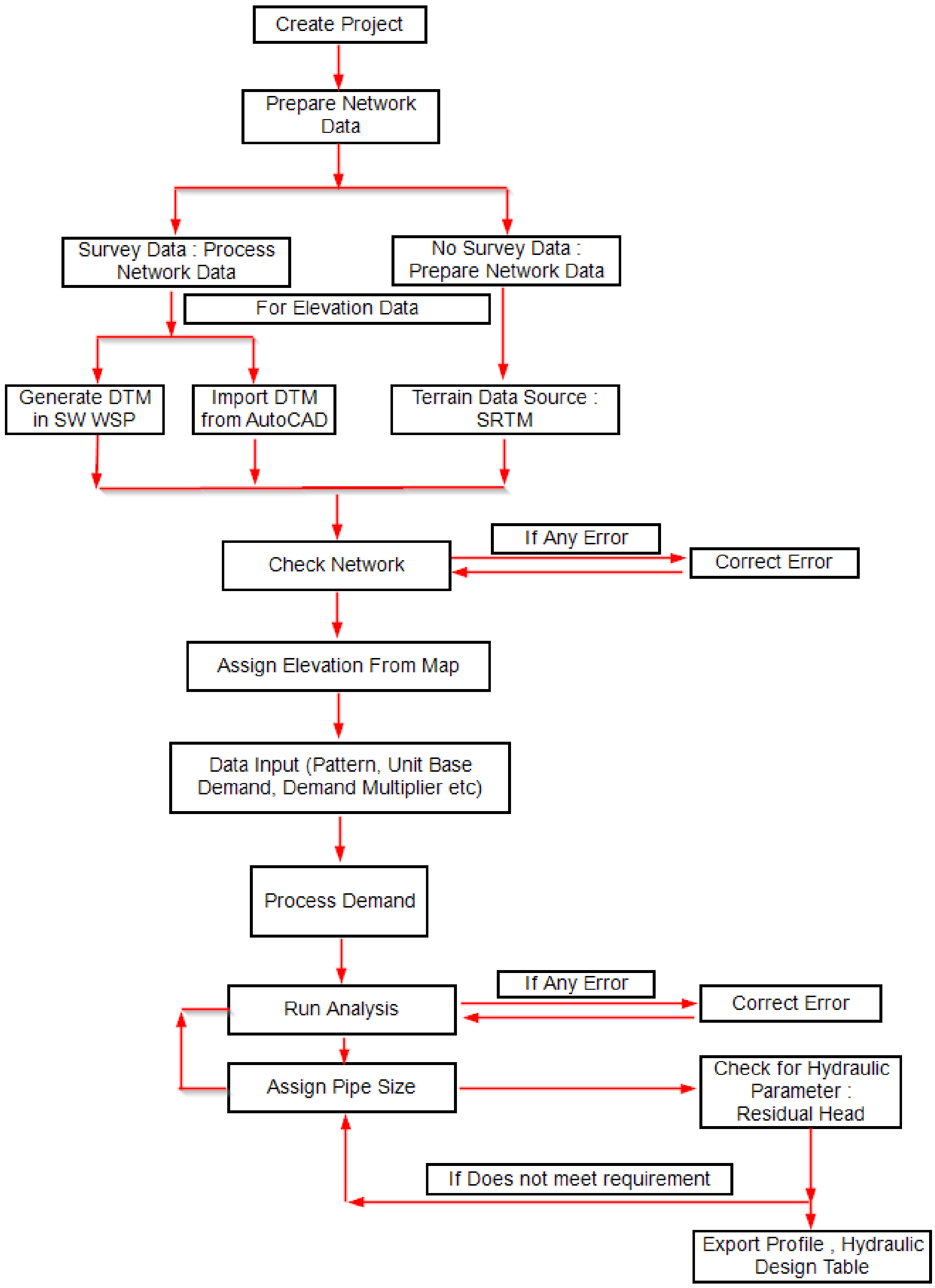
8.1 Check for Updates:

Checks for any updates and notifies users if updates are available. It is recommended to check for updates regularly for a better experience with the software.

8.2 About

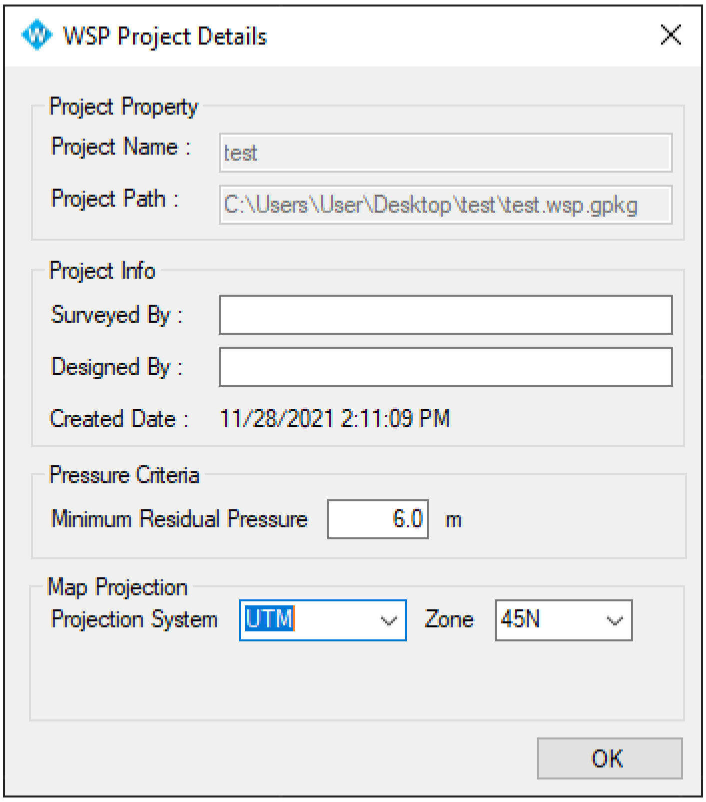
Displays the build number, licence status and contact information of the developer, Softwel (P) ltd. Users are adviced to contact the developers for help should they need it.

9 DESIGN WORKFLOW

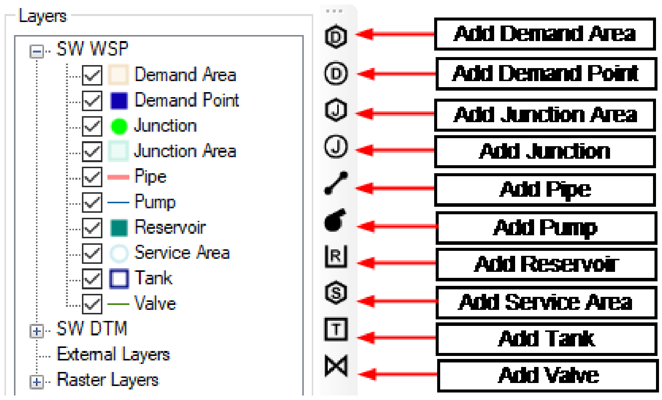


9.1 Create Project:

Create the project using Menu (File>New) or shortcut Ctrl+N. This will create a project file with the file extension *.wsp.gpkg. Input the project details such as project information (optional) and map projection system. By default, it is set to UTM-45N. It can be changed at any time during the design as explained in 3.8



9.2 Prepare Network Data



9.2.1 Add Junction

Add Junction at bends or places where pipe intersects. . The detailed description regarding Junction is explained in 4.5.

9.2.2 Draw Junction Area

Draw Junction area for each junction. Junction area cannot have multiple junctions. Junction Area is the graphical representation where the demand of area is supplied by each junction.

9.2.3 Add Pipe

Connect each junction with pipe. The start and end of pipe must be junction or reservoir. A pipe should not connect more than two junctions. The detailed description regarding Pipe is explained in 4.9.

9.2.4 Add Reservoir

Add Reservoir at desired location. The detailed description regarding Reservoir is explained in 4.7.

9.2.5 Add Tank

Add Tank at desired location. The detailed description regarding Tank is explained in 4.8.

9.2.6 Add Valve

Add Valve at desired location. The detailed description regarding Valve is explained in 4.10.

9.2.7 Add Demand Point

Add Demand Point if demand points are to be considered while calculating demand for each junctioin . The detailed description regarding Demand Point is explained in 4.1.

9.2.8 Draw Demand Area

Draw Demand Area as per the demand characteristics . The detailed description regarding Demand Area is explained in 4.2.

9.2.9 Draw Service Area

Service Area represents District Metered Area (DMA). Draw Service Areas to separate DMAs as per the planning.

9.2.10 Add Pump

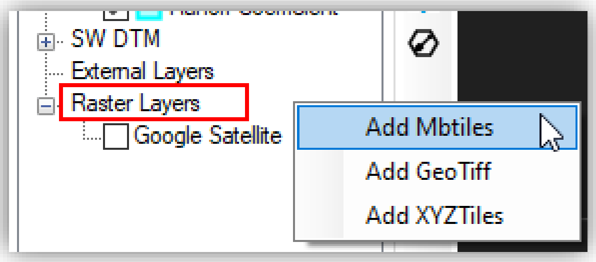
Add pump between two junctions to model pump in the network. The detailed description regarding Pump is explained in 4.11 and 4.4.1.

9.3 Select Terrain Model

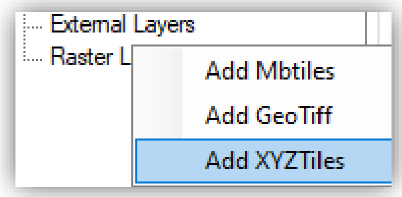
If there are detailed topographic survey data, it can be processed either within SW WSP software or in Autocad using the SW DTM software. The approach is the same for both methods. The detailed steps are explained in 5.1

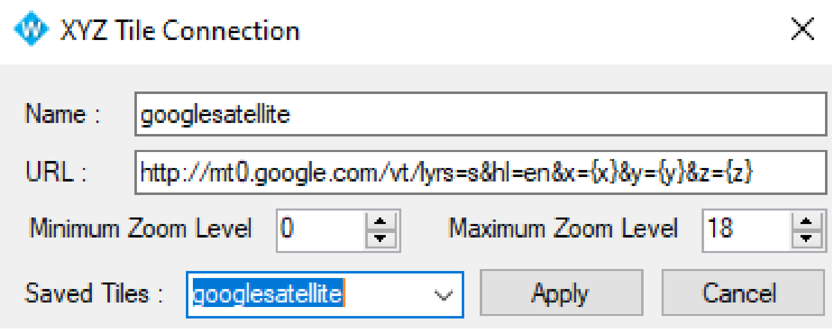
9.4 Base Map for Reference

The base map may be drone imagery or satellite imagery. Raster imagery can be added from the Layers panel>Right click on Raster Layers> choose the suitable options from the list (Mbtiles, GeoTiff, XYZ tiles).



If the offline tile is not available we can add online tiles from XYZ tiles. (Layers panel>Right click on Raster Layers>Add XYZTiles)





For the first time use, provide the name of the tile, URL link for tile and maximum zoom level. URL link for google satellite image is "http://mt0.google.com/vt/lyrs=s&hl=en&x={x}&y={y}&z={z}". Then it will be saved in the list. The list can be selected from "Saved Tiles" aftwards.

9.5 Check Network

Use this tool to find any error in the network. The detailed steps are explained in 6.1

9.6 Assign Elevation From Map

Once the network is error free, elevation for each junction, tank and reservoir can be assigned using this tool. The detailed steps are explained in 4.12

9.7 Data Input

Various data like Demand Pattern, Unit Base Demand fro each Demand Area etc are to be provided before proceding further. The detailed explanation is done in 4

9.8 Process Demand

The demand for each junction is assigned using this tool. The detailed step is explained in 6.2

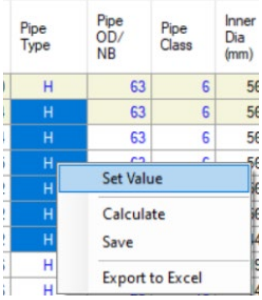
9.9 Run Analysis

Run the model as per given data. If the run is unsuccessful, make correction in the Model and re-run the model.

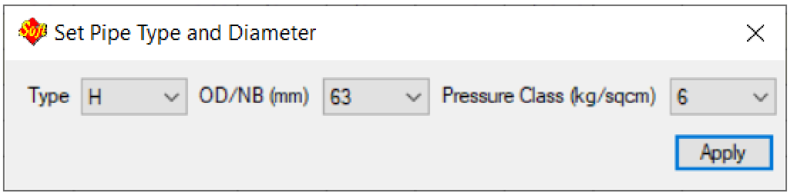
9.10 Assign Pipe Size

To perfrom hydraulic design of pipe, follow the steps below:

1. Select number of pipe segments whose pipe parameter are to be changed and press right mouse click. Following tool pops out.



2. Click “Set Value”. It will generate following window.



3. Select appropriate Type, Diameter and Class and click Apply.
4. Run the model again.
5. To display the changes made, use “Display” as explained in 7.1
6. Changes to other parameters can be seen in the design table.
7. User can save, export the finalized design table using “Save” and “Export to Excel” tool respectively.

Note:

- Parameters in blue colour are editable.
- If the design criteria is not met, those parameters are displayed in red colour.

Calculate Save

Pipe Type	Pipe OD/ NB	Pipe Class	Inner Dia (mm)	Friction Factor	Head Loss (m)	Residual Head (m)	Flow Velocity (m/s)	From HGL (m)	To HGL (m)	Soil Type
H	63	6	56.7	0.035	0.0	17.0	0.00	1,120.0	1,120.0	GMS
H	32	10	26.7	0.031	13.5	45.9	1.88	1,103.0	1,089.5	GMS
H	32	10	26.7	0.031	6.6	23.5	1.52	1,089.5	1,083.0	GMS
H	32	10	26.7	0.032	3.1	12.1	1.07	1,083.0	1,079.9	GMS
H	32	10	26.7	0.033	0.5	7.5	0.98	1,079.9	1,079.3	GMS
H	32	10	26.7	0.033	2.7	-18.2	0.80	1,079.3	1,076.6	GMS
H	50	6	44.9	0.050	0.0	-23.3	0.06	1,076.6	1,076.5	GMS
H	25	12.5	19.9	0.043	0.2	-19.0	0.32	1,076.5	1,076.3	GMS
H	20	16	14.9	0.048	0.3	-19.8	0.29	1,076.3	1,076.0	GMS

9.11 Output

The pipe network can be exported in different file format like EPANET INP, AutoCAD Dxf, Google Earth KML, Shapefile for map making purposes as explained in 3.6. Also, Hydraulic Design Table can be exported in Excel file format. For this, use right click mouse botton in Table window. User can export the profile diagram as explained in 1.6