



QGIS PLUGIN FOR THE CREATION OF REALISTIC MODELS OF  
WATER DISTRIBUTION NETWORKS

## USER'S MANUAL



**Directed by Fernando Martínez Alzamora**

[fmartine@upv.es](mailto:fmartine@upv.es)

**Developed by Néstor Lerma**

[nestorlerma@upv.es](mailto:nestorlerma@upv.es)



**REDHISP Group**

[www.redhisp.upv.es](http://www.redhisp.upv.es)

*Institute of Water and Environmental Engineering*

Technical University of Valencia

València, Spain

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## INTRODUCTION

QGISRed is a tool to help the hydraulic engineer in the task of modelling a water distribution network and in the decision-making process, within the environment of a Geographic Information System (GIS). This tool is designed as a plugin to the free software QGIS. However, QGISRed uses the source code of the GISRed software, an application designed as a desktop tool for the Windows operating system.

The QGISRed plugin is developed with the objective of being able to take advantage of all the tools that a GIS environment can provide in a native way. For example, geo-processing tools, use of satellite images, style management, etc. On the contrary, this plugin will have some limitations against the potential that may include the GISRed tool.

## DETAILS OF CURRENT VERSION

### Version 0.8

*QGIS versions: 3.0-3.99*

#### *What's new:*

- Editing properties of the main elements through a dialog window, being able to navigate from it through the different elements contained in the model.
- Insertion/Elimination of valves and pumps in pipes. In the first case, by clicking on a point in the pipe, the pipe will be split or shortened (whichever the case may be) to introduce the new element. In the second case, by clicking on the valve or pump element, it will be eliminated by joining the adjacent pipes if possible.
- Editing the network layout, being able to move nodes of the model so that the rest of the connected elements also move accordingly.
- Rearrangement of all the buttons of the plugin in 5 categories to facilitate the handling of the different options.
- Correction of some bugs as control rules are read.
- Dialogs for editing analysis options and default values.
- Verification of repeated IDs during their generation.
- Hiding of legend data tables (Patterns, Curves, Controls, Rules, Options and Default Values).
- Changes in the results selection menu to show a single variable per node or per line. Reduction of refresh time.
- Option to visualize the value of the chosen parameter for each element by using static labels.
- Elimination of administrator permissions to install the necessary dependencies.
- Some improvements on the features already offered in previous versions.

## DETAILS OF PREVIOUS VERSIONS

### Version 0.7

*QGIS versions: 3.0-3.99*

#### *Features:*

- Abstract report with the number of elements of each type, as well as the flow units, the pressure loss formula and if any quality parameter is modeled.

- Modulation Curves Manager: Allows you to edit, create, delete, clone, export and import new patterns. Adds the option to define the pattern type. It also indicates which elements are associated with that pattern. Finally, it includes the functionality of working with real values (depending on the base value associated with the pattern) or with a multiplier or factor (traditional form).
- Curves Manager: Allows you to edit, create, delete, clone, export and import new curves. For curves associated with pumps, in the case of 1 or 3 points, the equation of the approximate curve is specified. The elements associated with these curves are also specified.
- Simple Controls Manager: Allows editing, adding, deleting, cloning and ordering Simple control laws. It includes the option of being able to disable a control law.
- Rules Manager: Allows editing, adding, deleting, cloning and ordering Rules. It includes the option of being able to disable a Rule. You can combine different conditions through the OR and AND operators, as well as select the appropriate combined condition to apply to the Rule.
- In both Controls managers its definition is done interactively and not by typing text (traditional way).

## Version 0.6

*QGis versions: 2.0-3.99*

### *Features:*

- Manage QGISRed projects. It is possible to open, create, import, clone or delete projects.
- Create or edit a QGISRed project. It allows to create vector layers (SHPs) of the basic elements that the EPANET software works with. If the user removes any of these SHPs, it is possible to recreate them.
- Data import from INP (EPANET) or SHPs files. In the first format you can import complete models developed with the popular EPANET software. Using SHPs, you can create or complete a model specifying for each type of element, the SHP from which you want to import information and which fields contain certain information needed for the model.
- Validation of the model, informing if there has been any error or warning when processing the information contained in the SHPs.
- Export to EPANET INP file, with the option to open this software once the file is generated.
- Simulation with the EPANET Toolkit to show the hydraulic and quality results.
- Plugin includes a set of tools associated with the layout (elimination of overlapped elements, simplification of aligned vertices, creation of T-type connections, pipe union with the same characteristics or analysis of network connectivity), with the properties of the elements (analysis of lengths, diameters, materials, installation dates, change of state of pipes or elevation interpolation), to add components (connections, hydrants, drains) or to sectorize (hydraulic sectors and demand sectors).

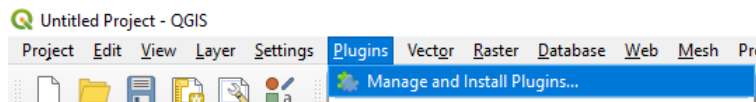
## INSTALLATION

The QGISRed plugin requires the installation of the GISRed libraries (as detailed below). The GISRed libraries work under Windows operating system and require the installation of version 4.5 of the Windows .Net Framework component. Therefore, the QGISRed plugin will only work under these conditions.

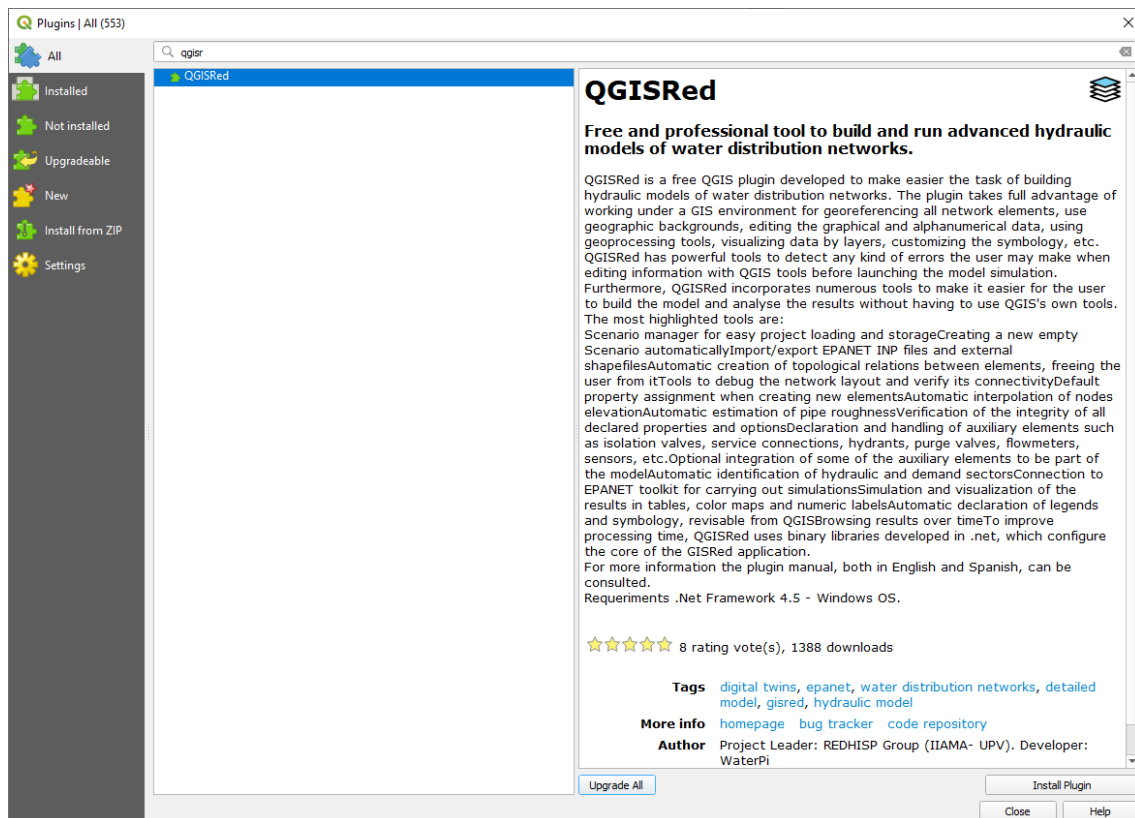
### Repository

To install the plugin or an update from the official QGIS repository, follow these steps:

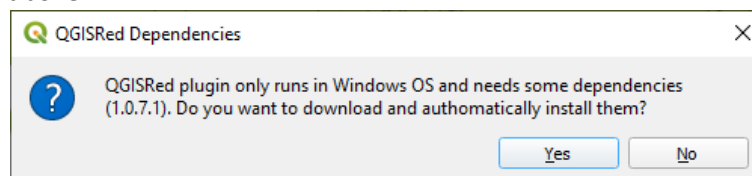
1. Start QGIS v3.x
2. Go to Plugins menu → Manage and Install Plugins...



3. Select the "All" tab, in the top bar type QGISRed. Then select the only item that appears and finally press the button to install it in the lower right corner ("Install Plugin").

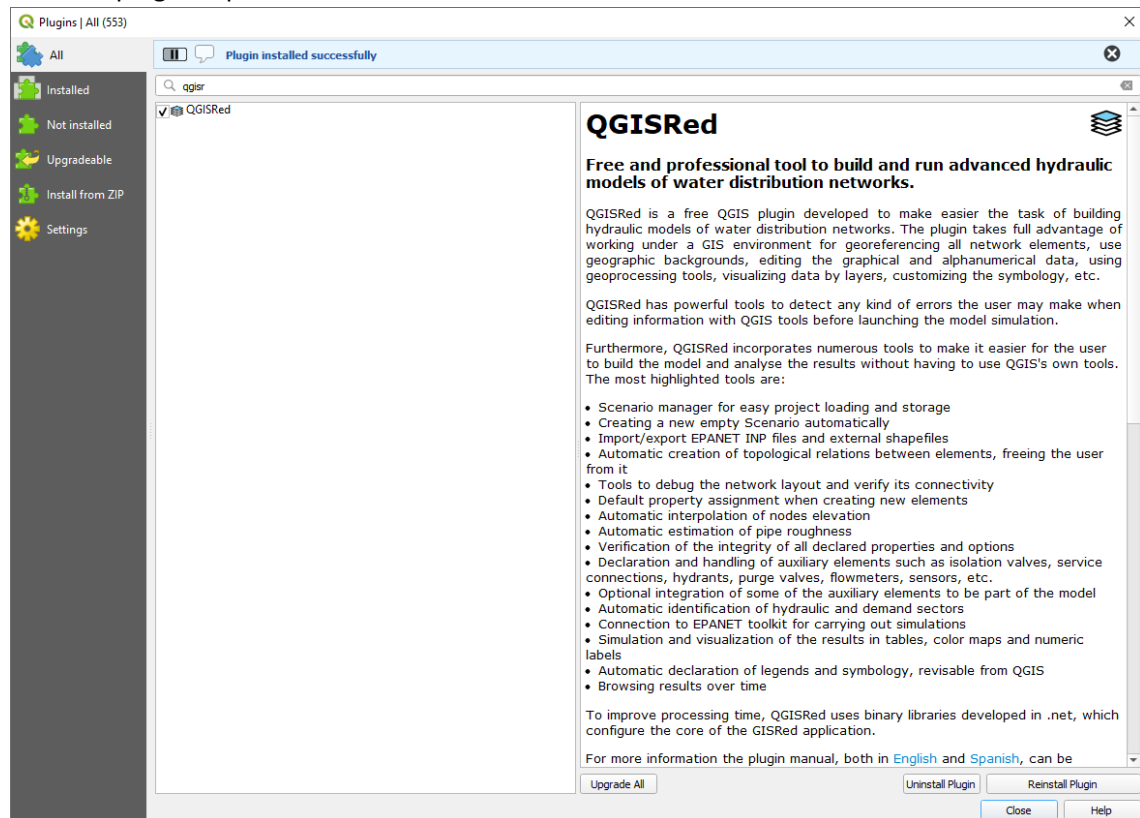


4. Once installed, a message will appear indicating the need to install the GISRed libraries mentioned above.



5. Clicking on the "Yes" button will download and install the necessary dependencies for the operation of the plugin (does not require administrator permissions).

- Whether you click on one button or the other ("Yes" or "No") a message will appear in QGIS indicating that the plugin has been installed. In the case of pressing the "No" button, when the user tries to use any tool of the plugin will indicate the need to install the plugin dependencies.



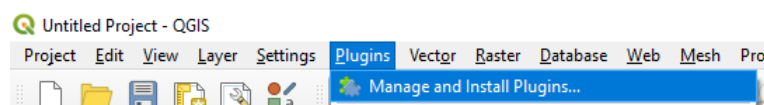
- Close the window at the end of the process.
- A new button bar and a new item should appear in the top menu.



## Local

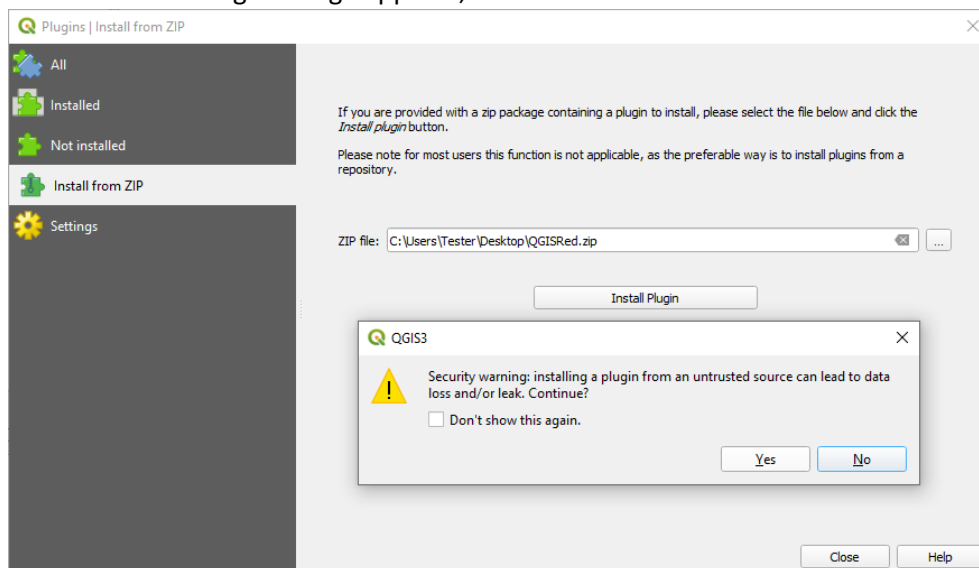
To install an update of the plugin locally, prior to the steps discussed below, it is necessary to uninstall it. To do this, you can uninstall it from the QGIS plugin manager, or manually deleting the corresponding directory.

- Start QGIS v3.x
- Go to Plugins menu → Manage and Install Plugins...





3. Select "Install from ZIP" tab, select the **QGISRed.zip** file. Then click on "Install Plugin" and if the warning message appears, click on "Yes".



4. As in the installation from the repository you will be asked to download and install some libraries.
5. Close the window at the end of the process.
6. A new toolbar and a new item should appear in the top menu.



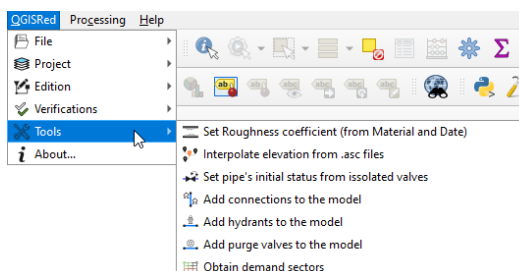
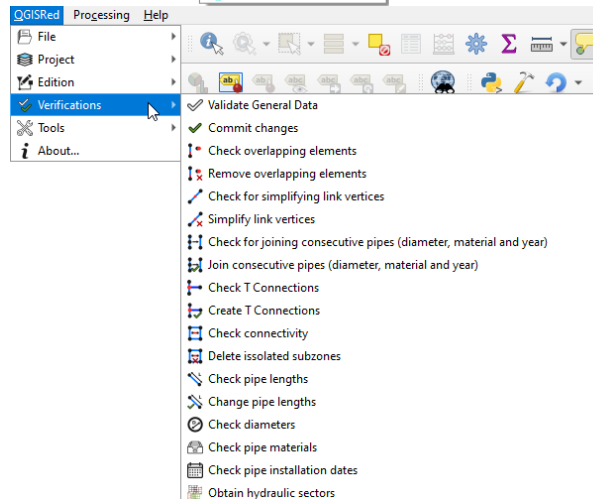
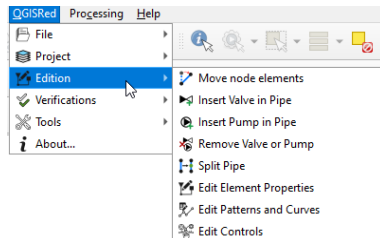
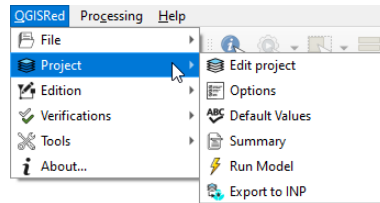
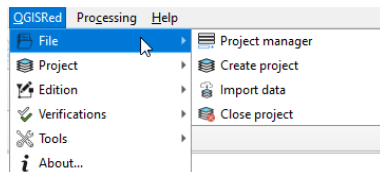
## GETTING STARTED

This section briefly introduces each tool available in the plugin. In the following sections more details will be presented.

The plugin is mainly divided into five categories, each with a set of tools shown below.

### Categories:

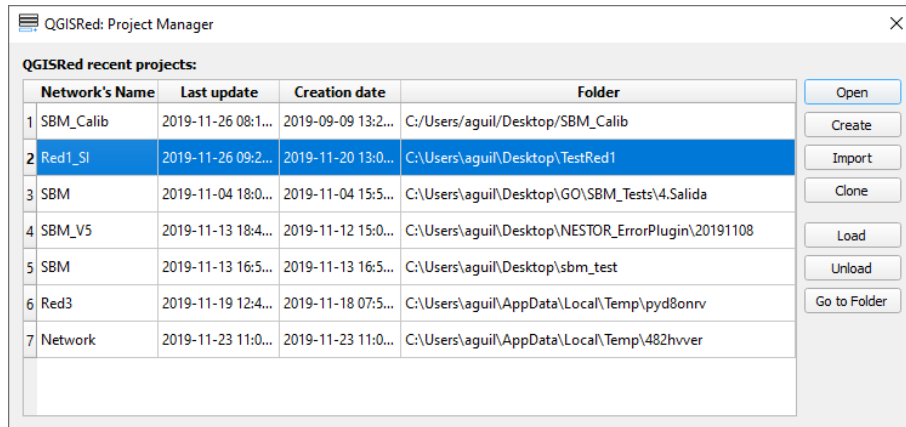
- File
- Project
- Edition
- Verifications
- Tools



### File

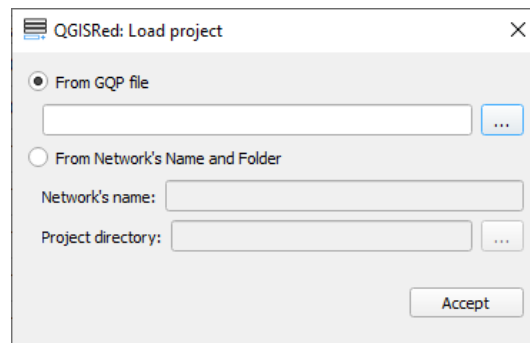
This category contains the tools related to the management of a project, that is, the basic utilities to open, create, import and close.

## Project Manager



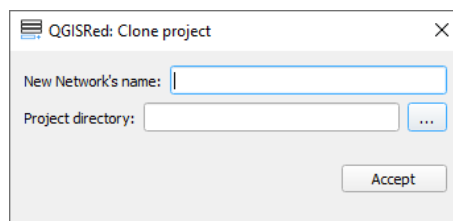
This window allows the user to manage recently opened QGISRed projects, but also to load projects that do not appear in the list, to unload those that the user do not want to appear, to make a copy of one, to create a new project, import data or to access to the project directory.

### Load



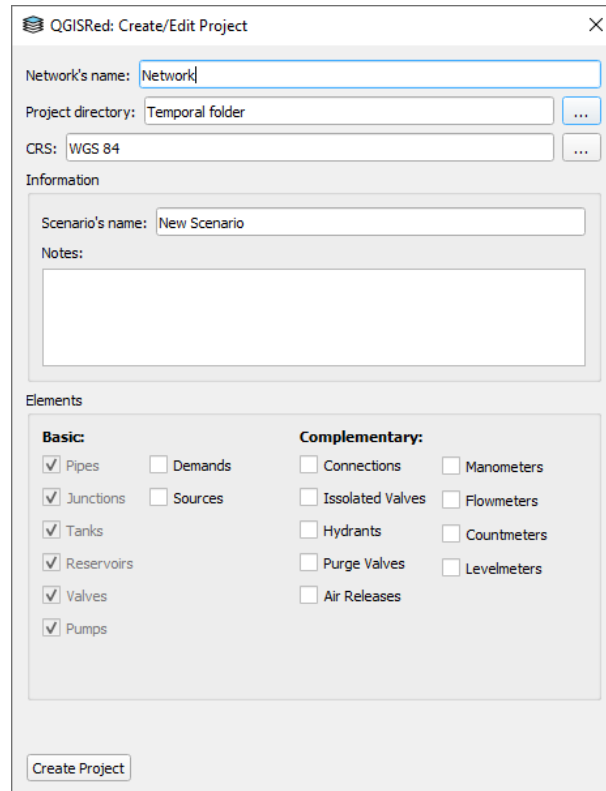
Two methods are available for importing a project. The first method is to select a file (extension ".gqp") that is generated when QGISRed project is created. The second method, specifying the name of the network and the directory where the SHPs are stored.

### Clone



To clone a project, the user must specify the new name of the network and the directory where he wants to copy it. If the network name is different from the original, the directory can be the same. In other words, there can be several QGISRed projects in the same directory.

## Create Project



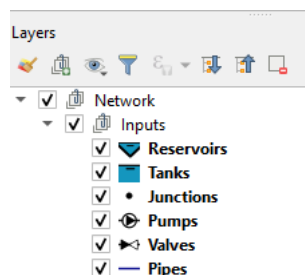
The dialog box is titled "QGISRed: Create/Edit Project". It contains the following fields and sections:

- Network's name:** A text field with "Network" entered.
- Project directory:** A text field with "Temporal folder" entered, followed by a browse button (...).
- CRS:** A text field with "WGS 84" entered, followed by a browse button (...).
- Information:**
  - Scenario's name:** A text field with "New Scenario" entered.
  - Notes:** A large empty text area.
- Elements:**
  - Basic:**
    - ☒ Pipes
    - ☒ Junctions
    - ☒ Tanks
    - ☒ Reservoirs
    - ☒ Valves
    - ☒ Pumps
    - ☐ Demands
    - ☐ Sources
  - Complementary:**
    - ☐ Connections
    - ☐ Isolated Valves
    - ☐ Hydrants
    - ☐ Purge Valves
    - ☐ Air Releases
    - ☐ Manometers
    - ☐ Flowmeters
    - ☐ Countmeters
    - ☐ Levelmeters

A "Create Project" button is located at the bottom left.

From this window it is possible to create a QGISRed project, i.e. the SHPs needed to build a model of a hydraulic network. It can also be edited, completing in case of missing layers, establishing the reference system (CRS) or providing information of the scenario (name and notes).

The required data to create a project is the name of the network and the directory where the information will be stored. If the default value "Temporary folder" is maintained in the directory field, the program will create a temporary directory that can be consulted in the Project Manager.



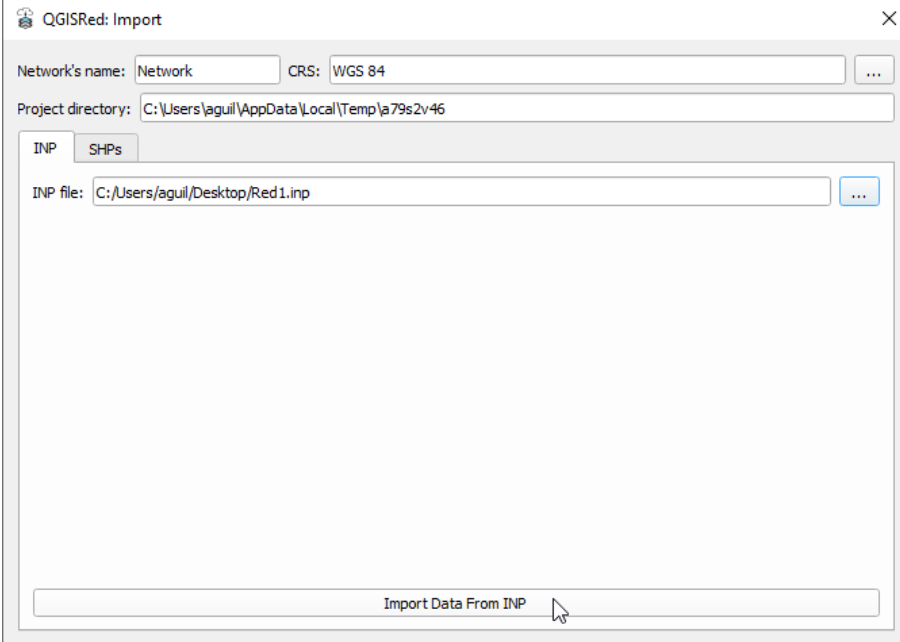
Once created, the following content will appear in the legend: A group with the name of the network which, in turn, will include another group titled "Inputs", thus indicating that this information is input data to build the model. Within the group, at least 6 SHPs are included, one for each type of EPANET base element. In addition, other elements may appear if some of the complementary elements is marked.

## Import data

QGISRed allows to import a complete model from an EPANET INP file or import data from SHPs files. In the first case, you only need to select the INP file. In the second case, it is necessary to

select the directory where the layers are stored, and then, for each type of element, select the corresponding layer and the fields to be imported.

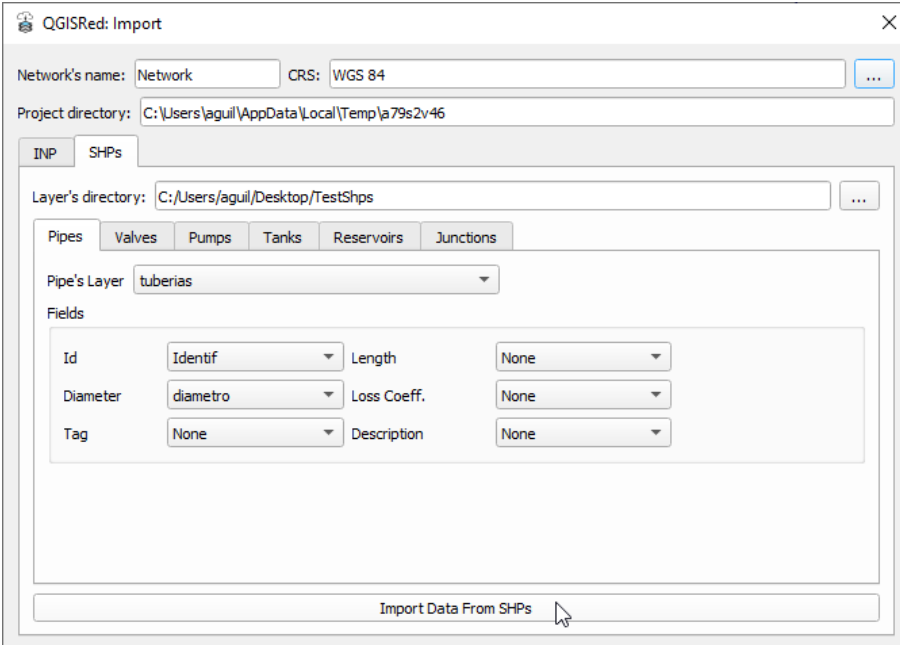
- From INP:



The 'QGISRed: Import' dialog box is shown with the 'INP' tab selected. It contains the following fields and controls:

- Network's name:** Text box with 'Network'.
- CRS:** Text box with 'WGS 84' and a browse button (...).
- Project directory:** Text box with 'C:\Users\aguil\AppData\Local\Temp\ja79s2v46'.
- INP file:** Text box with 'C:\Users\aguil\Desktop\Red1.inp' and a browse button (...).
- Import Data From INP:** A button at the bottom right.

- From SHPs:



The 'QGISRed: Import' dialog box is shown with the 'SHPs' tab selected. It contains the following fields and controls:

- Network's name:** Text box with 'Network'.
- CRS:** Text box with 'WGS 84' and a browse button (...).
- Project directory:** Text box with 'C:\Users\aguil\AppData\Local\Temp\ja79s2v46'.
- Layer's directory:** Text box with 'C:\Users\aguil\Desktop\TestShps' and a browse button (...).
- Element Type:** A row of buttons: Pipes (selected), Valves, Pumps, Tanks, Reservoirs, and Junctions.
- Pipe's Layer:** A dropdown menu with 'tuberias' selected.
- Fields:** A table with four rows and four columns for selecting fields to import.
- Import Data From SHPs:** A button at the bottom right.

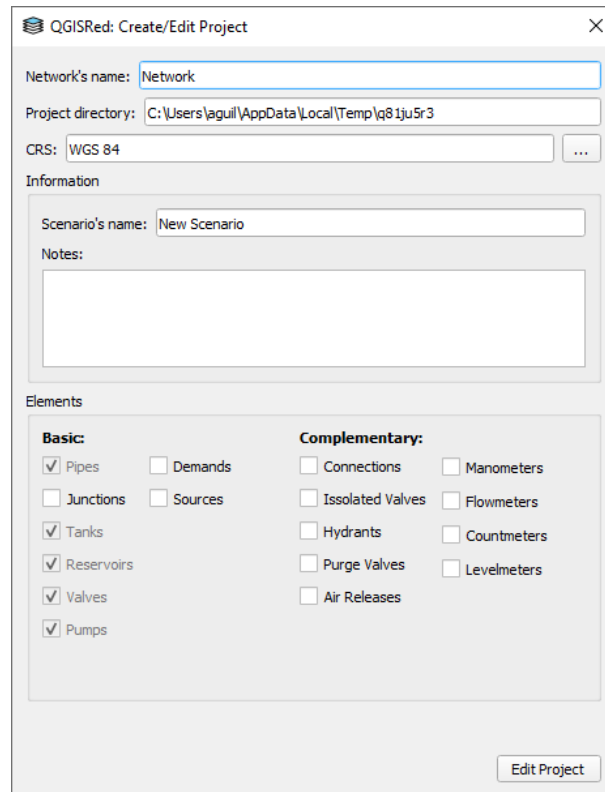
Field	Selected	Field	Selected
Id	Identif	Length	None
Diameter	diametro	Loss Coeff.	None
Tag	None	Description	None

## Project

This category allows you to edit the project, see a summary of what it contains, export it to another format and simulate the hydraulic and quality model.

## Edit Project

The editing window of a project is the same as the one used to create it. In this case it is not possible to change the name of the network or its directory. If any of the SHPs (base elements) is removed, when accessing the previous window, you will be able to mark this layer to create it again.



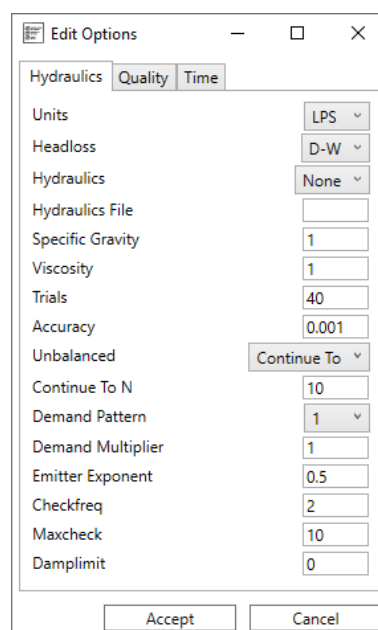
The dialog box is titled "QGISRed: Create/Edit Project". It contains the following fields and sections:

- Network's name:** A text field containing "Network".
- Project directory:** A text field containing "C:\Users\agull\AppData\Local\Temp\q81ju5r3".
- CRS:** A text field containing "WGS 84".
- Information section:**
  - Scenario's name:** A text field containing "New Scenario".
  - Notes:** A large empty text area.
- Elements section:**
  - Basic:**
    - ☒ Pipes
    - ☐ Demands
    - ☐ Junctions
    - ☐ Sources
    - ☒ Tanks
    - ☒ Reservoirs
    - ☒ Valves
    - ☒ Pumps
  - Complementary:**
    - ☐ Connections
    - ☐ Manometers
    - ☐ Isolated Valves
    - ☐ Flowmeters
    - ☐ Hydrants
    - ☐ Countmeters
    - ☐ Purge Valves
    - ☐ Levelmeters
    - ☐ Air Releases

An "Edit Project" button is located at the bottom right.

## Options

Version 0.8 includes the edition of properties associated with the calculation of the hydraulic and quality model.



The dialog box is titled "Edit Options". It has three tabs: "Hydraulics", "Quality", and "Time". The "Quality" tab is currently selected. The settings are as follows:

Property	Value
Units	LPS
Headloss	D-W
Hydraulics	None
Hydraulics File	
Specific Gravity	1
Viscosity	1
Trials	40
Accuracy	0.001
Unbalanced	Continue To
Continue To N	10
Demand Pattern	1
Demand Multiplier	1
Emitter Exponent	0.5
Checkfreq	2
Maxcheck	10
Damplimit	0

Buttons for "Accept" and "Cancel" are at the bottom.

## Default Values

Version 0.8 includes the editing of default values used in the creation of the different supported elements.

The 'Edit Default Values' dialog box, 'Properties' tab, shows default values for various elements. The 'Headloss Formula' is set to 'D-W' and 'Units' to 'SI'. A list of elements with their default values is shown below.

Element	Value
Roughness	0.1
Junction Elevation	0
Reservoir Elevation	50
Tank Elevation	50
Tank Max Level	4
Tank Diameter	20
Pipe Length	100
Pipe Diameter	200
Pipe Min Diameter	5
Pipe Max Diameter	5000
Pump Nominal Power	50
Valve Diameter	200

## Summary

Allows access to a window where the elements contained in the template are summarized, as well as some units and formulas of interest.

The 'Abstract Report' window displays a summary of the model. It includes the scenario name, notes, a list of elements with their counts, and a table of options.

**Scenario's Name:** EPANET. Red Ejemplo 1 (Unidades SI)

**Notes:** Se trata de un ejemplo sencillo para mostrar el decaimiento del cloro. Incluye coeficientes de reacción en el medio y en las paredes. Todas las unidades están expresadas en el Sistema Internacional. Incorpora además una válvula de regulación.

**Elements**

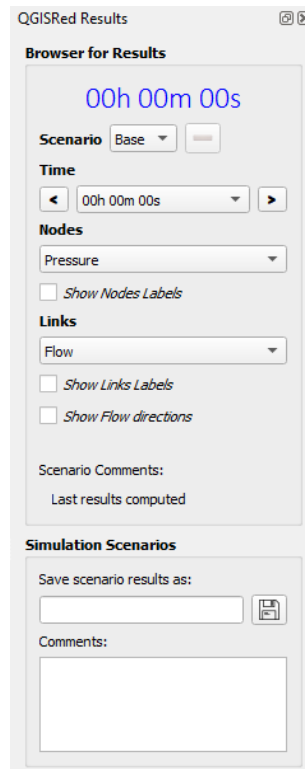
Element	Count
Nodes	12
Links	14
Junctions	10
Tanks	1
Reservoirs	1
Pipes	12
Pumps	1
Valves	1
Isolated Valves	0
Check Valves	0
Hydrants	0

**Options**

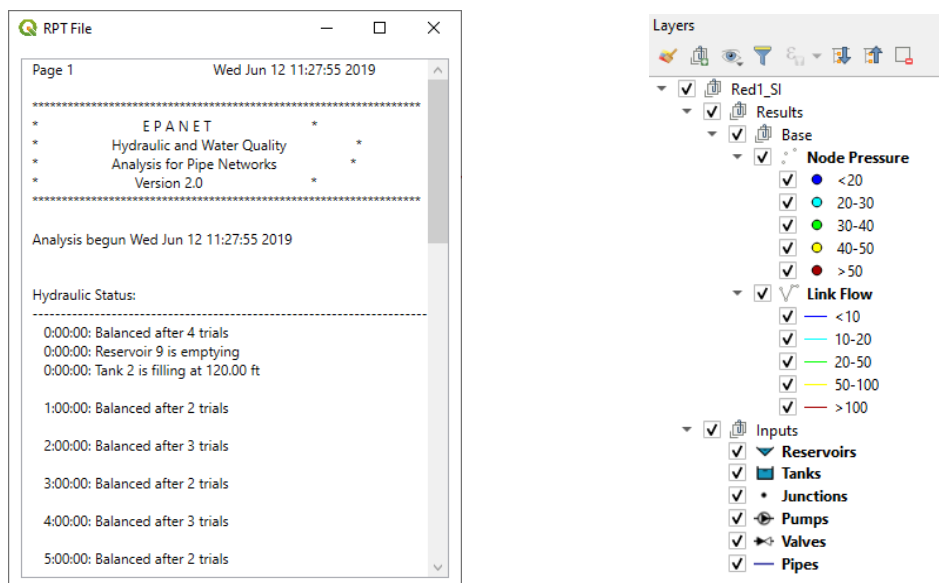
Option	Value
Flow Units	LPS
Headloss Formula	D-W
Quality Parameter	Cloro mg/l

## Run Model and Show Results

Clicking on the button ⚡ simulates the network and a Result dock (like the following image) is opened. In this dock which results and which time interval to show can be selected.



Once simulated, a window appears containing the simulation report generated by the EPANET Toolkit and the result selected in the "Browser for Results" group are opened as layers.

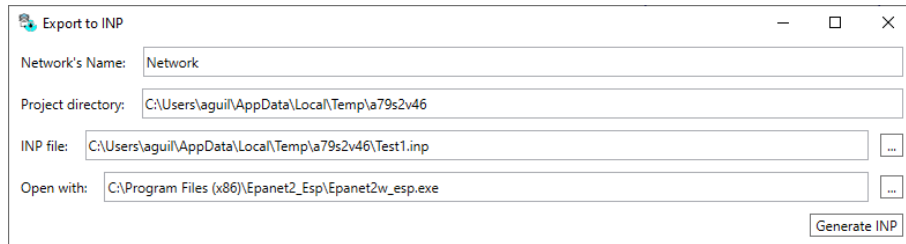


From the Result dock it is possible to open or close the different types of results, as well as change the instant of time to be displayed.

In addition, it is possible to save the simulation results by specifying a scenario name (corresponding only to the results and not to the data) and comments to indicate, for example, what characteristics that scenario has or what data has been changed.



## Export model to INP




This window allows to export to an INP file the model generated from the information contained in the QGISRed project. It also has the option of specifying with which program to open the generated file.

## Edition

This section allows you to edit the layout, element properties and other components such as curves and controls.






### Move nodes


The first button (  ) allows to move the nodes of our network (Junctions, Tanks, Reservoirs) and to move the rest of the elements that coincide spatially with this (other nodes, pipes, valves or pumps).




### Insertion/Removal of valves and pumps

The buttons   allow you to insert valves or pumps by selecting a point corresponding to a pipe. The button  is used to delete a valve or pump by pressing on it.

### Split pipe

This tool (  ) allows to divide a pipe by the indicated point, creating an intermediate node.

### Properties

This button (  ) allows you to select any element of our model and access its properties (through a dialog window) and modify them in a simple and intuitive way.

Edit element properties

Select Element: 2

Filter  
Type: All types Id:

**TANK 2**

Basic properties

Id: 2  
X: 50  
Y: 90  
Tag:  
Description:

Specific properties

Elevation: 260

Specific properties


Elevation: 260  
Initial Level: 36  
Minimum Level: 30  
Maximum Level: 45  
Diameter: 30  
Minimum Volume: 0  
Volume Curve:   
Mixing model: None  
Mixing fraction: 0  
Reaction Coeff.: -0.5

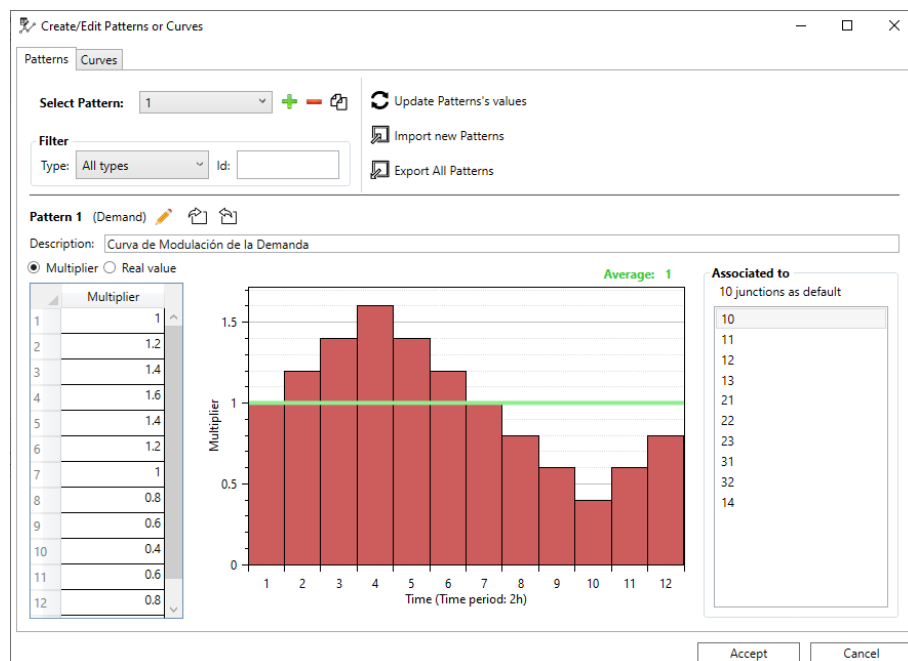
Quality properties

Initial Quality: 1  
Source Quality: 0  
Time Pattern:   
Source Type: None

Accept Cancel

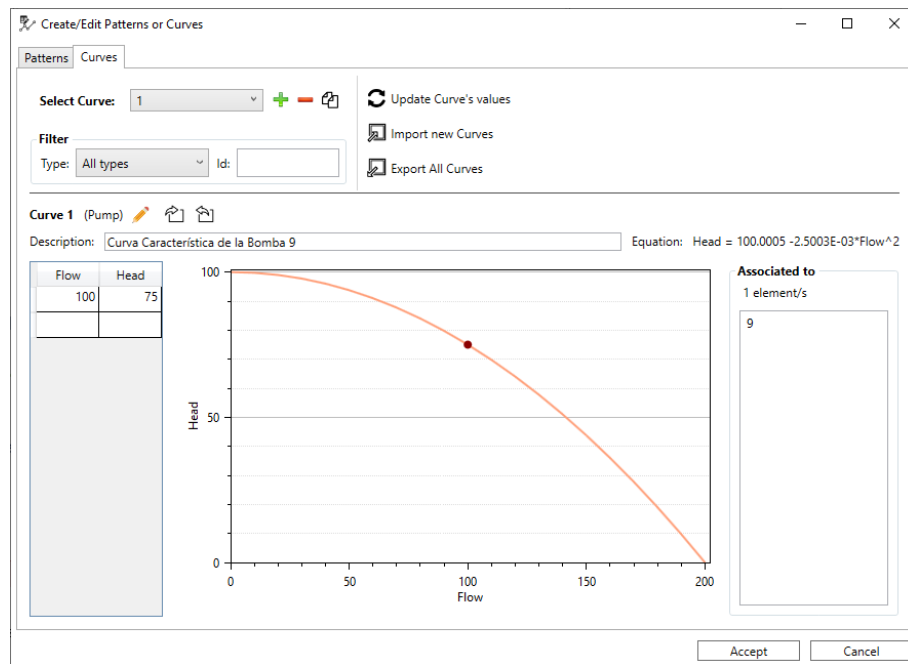
## Patterns

The button  gives access to edit Patterns and Curves. In the first tab of the window it is possible to manage the Patterns.




## Curves

From the same button, but in the second tab, you can manage the Curves.



## Simple Controls

The button  gives access to the editing of the different types of controls (Simple or Rules). In the first tab of the window you can manage the Simple controls.

**Create/Edit Controls Simple and Rules**

Simples Rules

LINK 9 OPEN IF NODE 2 BELOW 34

LINK 9 CLOSED IF NODE 2 ABOVE 43

**Edit selected Control**

Link: 9

Status: ☒ Status ☐ Setting

Based on: Open

Node: IfNode

Level: 2

Value: Below

Value: 34

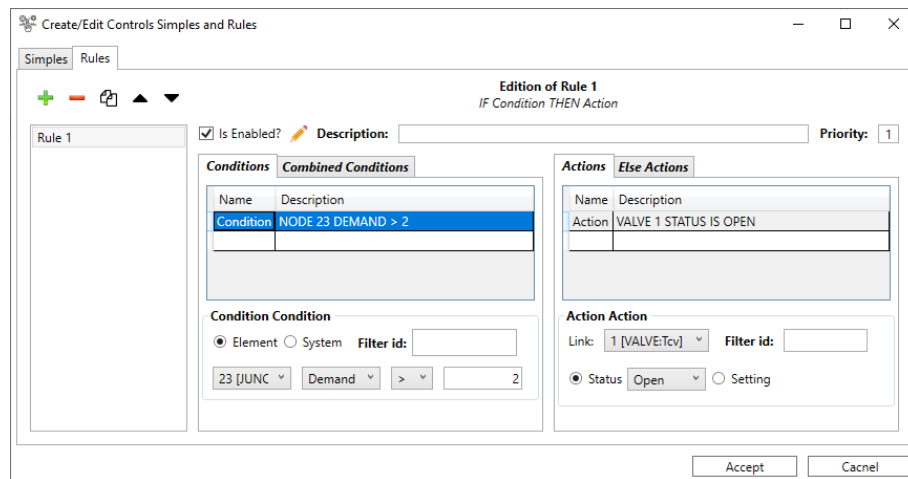
☒ Is Enabled?

Description:

Accept Cancel

## Rules

From the same button, but in the second tab, you can manage Rules.



## Verifications

This category contains a set of tools for verifying the topology and data introduced.





Most tools contain two options similar to those explained in the next point. One option allows you to view a report of the process and what elements or data it would affect, and the other option allows you to consolidate the changes and view them in the model.

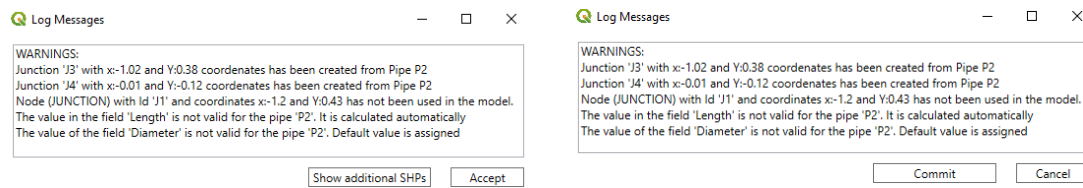
The current utilities allow:

- Validate/consolidate the data introduced.
- Search for overlapping elements (and delete them).
- Simplify aligned vertices in linear elements.
- Simplification or union of pipes with the same diameter, material and year of installation.
- Create T-type connections, that is, if a node with connectivity one coincides on a pipe, the last one is divided into two new pipes and connected all together.
- Analysis of network connectivity, showing isolated areas. This tool allows to eliminate subzones with less than a specific value of pipes indicated by the user.
- Analysis of pipe lengths. Compare the length assigned as an attribute with the Euclidean length. Displays a message if the difference is greater than a percentage specified by the user. There is the option of automatically modifying the length value with the Euclidean value if the user so indicates.
- Diameter analysis, indicating those higher or lower than pre-established thresholds.
- Analysis of materials, indicating those not recognized or unknown.
- Analysis of pipe installation dates, indicating incorrect or future dates.
- Hydraulic sectors: the tool tries to identify whether all demands can be supplied from available sources, tanks and reservoirs.

## Validate/Commit data

Validation  and Commit  are two similar tools. Both validate that the data entered in the layers and in the auxiliary tables (Options, Rules, etc.) are correct, showing a report with all the incidents that have occurred in the process of building the model with this information. The difference between the two options is that the first only shows the list of issues and allows to

load them in SPHs, while the second also rewrites the files with the necessary changes (adding or deleting of elements, changing values of the attributes, etc.).



## Tools

In this category you have a set of utilities to apply properties or insert elements massively.



Current utilities allow:

- Assignment of the roughness coefficient according to the material and the year of installation.
- Massive interpolation of the elevations of node elements (junctions, tanks and reservoirs) from ASCII files.
- Assignment of the initial state of a pipe according to the state of the isolated (or cut) valves.
- Insert connections, both as a punctual node or as a link (pipe)
- Insert hydrants, assigning the name of this one to the nearest node or in its defect creating one on the pipe in which spatially it is located.
- Insert drainage, assigning the name of this one to the nearest node or in its defect creating one on the pipe in which spatially it is located.
- Demand sectors: it allows the identification of areas of the network delimited by flowmeters and regulating elements that allow a pipe to be opened or closed.

## INPUT DATA

This section details which values must be entered in the different fields that exist in the attribute tables of the elements that appear in the QGIS legend and that are part of the QGISRed project. All data that must be entered with the same values as in EPANET will not be commented (check the EPANET manual).

### Pipes

From version 0.8 this data can be introduced from the properties window and does not need to know the available options. However, if you want to edit some data manually from the attribute table:

In the table of attributes of this type of element two additional fields appear with respect to those of EPANET, in this case, the field *Material* and *InstalDate*. The first corresponds to the material of the pipe and the values that can be defined are:

- GREY CAST IRON
- DUCTILE CAST IRON
- STEEL
- FIBER CEMENT
- GALVANIZED IRON
- CONCRETE WITH SHEET METAL JACKET
- CONCRETE WITHOUT SHEET METAL JACKET
- PRESTRESSED CONCRETE
- LEAD
- POLYETHYLENE
- ORIENTATED PVC
- UNPLASTICIZED PVC
- COPPER
- HIGHT DENSITY POLYETHYLENE
- LOW DENSITY POLYETHYLENE
- MEDIUM DENSITY POLYETHYLENE
- UNDETERMINED
- UNKNOWN

In the case of the *InstalDate* field, this corresponds to the date of installation of the pipe. The input format is *yyyyMMdd*, where *yyyy* corresponds to the four digits of the year, *MM* is the month number with two digits (adding a 0 before if necessary) and *dd* is the day (20190715, for July 15, 2019). With these two fields it is possible to estimate the roughness of the pipe.

### Links

Unlike EPANET or other tools, GISRed and, therefore, QGISRed does not require the definition of the topology, that is, for each line it is not necessary to define the Id of the initial and final node. This process is done automatically by spatial analysis.

### Patterns, Curves, Controls, Rules

From version 0.7 onwards, new tools are available for entering this information (see the corresponding section). This data is stored in data tables (DBF) that can be edited from QGIS. To modify this type of information directly from the tables, it is entered very similarly to the EPANET INP file, but rather than separated by spaces, it is separated into different columns.

In the case of Patterns, an additional field is added indicating the order of the factors within the same modulation pattern or curve.

For the Rules, there are three new fields (*RuleOrder*, *LineOrder* y *Name*). If we import from an INP file that contains Rules, the first time we open the attribute table it will be unordered (depending on the QGIS version).

	RuleOrder	LineOrder	Clause	Object	IdObj	Attribute	Operator	Value	Name
1	1	6	AND	PIPE	2	STATUS	IS	OPEN	a2
2	1	5	THEN	PIPE	1	STATUS	IS	CLOSED	a1
3	2	1	RULE		2				
4	1	7	ELSE	PIPE	3	STATUS	IS	OPEN	ea1
5	2	3	THEN	PIPE	2	STATUS	IS	OPEN	Action
6	2	2	IF	NODE	2	PRESSURE	>	20	Condition
7	1	2	IF	NODE	1	PRESSURE	>	20	c1
8	1	1	RULE		1				
9	1	4	OR	NODE	2	PRESSURE	>	15	c3
10	1	3	AND	NODE	1	DEMAND	>	1	c2

In this case, it is necessary to sort by the *LineOrder* column and then by *RuleOrder*. In this way, we will see an aspect very similar to how Rules are written in EPANET, but as two additional columns at the beginning. These columns will allow us to add or modify components of a specific Rule. We will have to assign the same *RuleOrder* for all the rows that correspond to the same Rule and then specify the appropriate order for each row in the *LineOrder* field.

	RuleOrder	LineOrder	Clause	Object	IdObj	Attribute	Operator	Value	Name
1	1	1	RULE		1				
2	1	2	IF	NODE	1	PRESSURE	>	20	c1
3	1	3	AND	NODE	1	DEMAND	>	1	c2
4	1	4	OR	NODE	2	PRESSURE	>	15	c3
5	1	5	THEN	PIPE	1	STATUS	IS	CLOSED	a1
6	1	6	AND	PIPE	2	STATUS	IS	OPEN	a2
7	1	7	ELSE	PIPE	3	STATUS	IS	OPEN	ea1
8	2	1	RULE		2				
9	2	2	IF	NODE	2	PRESSURE	>	20	Condition
10	2	3	THEN	PIPE	2	STATUS	IS	OPEN	Action

The last column "Name" allows you to name each of the conditions or actions defined, so that through the interface they can be easily recognized.

## Default Values

DefaultValues are a set of attributes that are used in the process of reading, building, or validating the model to correct or complete information. For example, the prefixes of new elements that are created, the minimum or maximum separation at the time of introducing an element on a pipe or the default values of some of the attributes of each element. The user can modify these data making a coherent use of them.

## TIPS

This section discusses some interesting points to the QGISRed user:

- In the Project Manager, to open a recent project it is enough to double-click on it.
- Importing a model from INP file replaces any previous information. However, the import of SHPs is incremental, i.e. you can import one layer and then another, obtaining at the end a combination of both.
- Any tool of the plugin that is used will take the information contained in the project directory, not only the open layers in QGIS.
- When exporting the model to INP, if the user does not want to open the generated file, it is possible to right-click on the program path, leaving it blank.
- Saving the QGIS project allows that when reopening the QGISRed project or directly the QGIS project, everything appears as the user left it when saving.
- When “Show Map Tips” option is active, it requires selecting a specific layer for the labels appear.

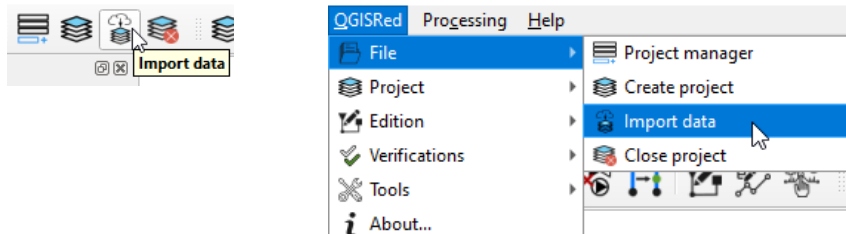


## EXAMPLES

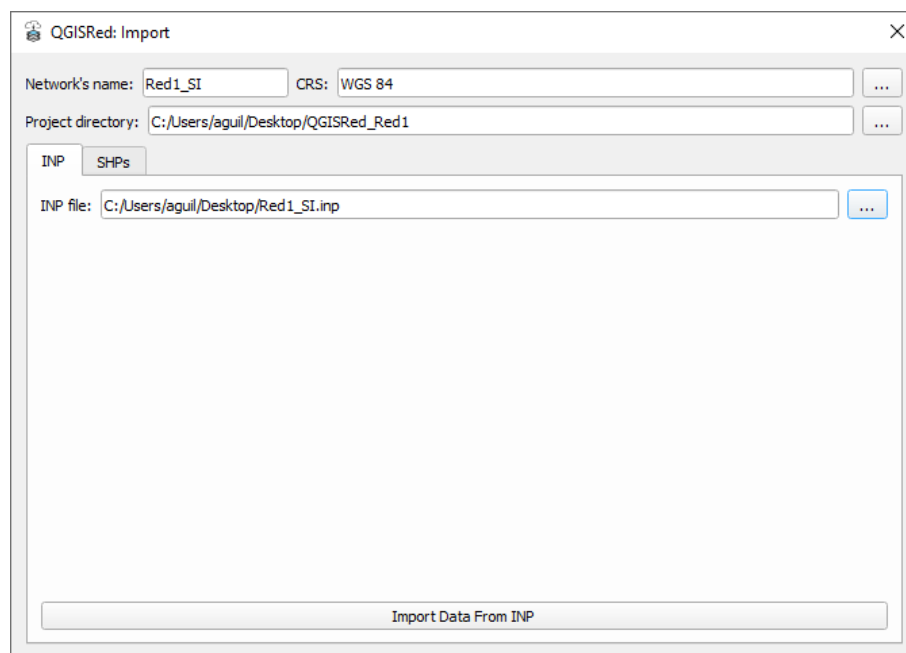
### Example 1

The first example illustrates the ease of importing a previous model available in an EPANET INP file and perform a hydraulic and quality simulation.

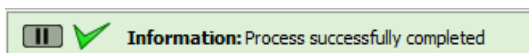
With the INP file ("Red1\_SI.inp") and QGIS opened, click on the import button (in the toolbar or in the upper menu):



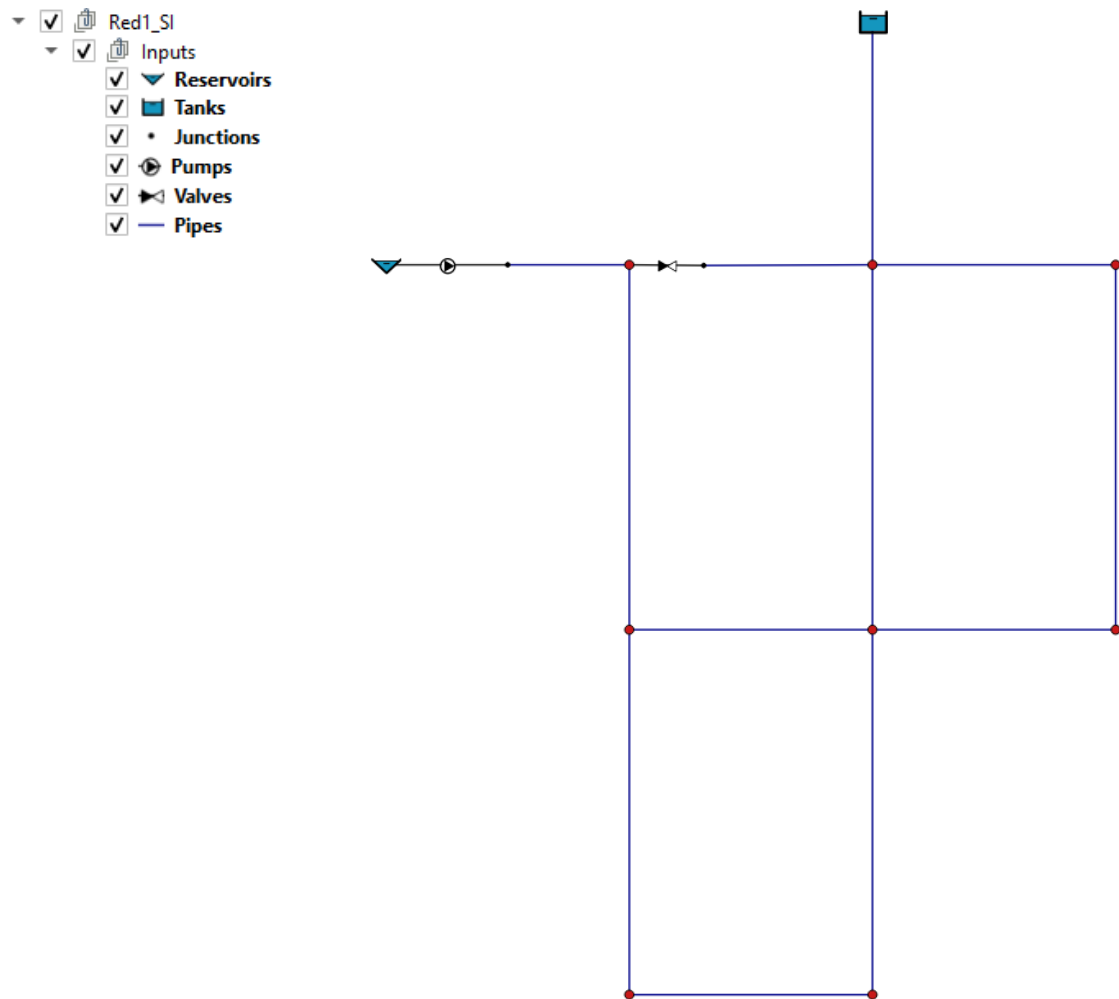
The following window will be opened, in which the user must define the name of the network, the directory where the SHPs will be stored, as well as the reference system (CRS) and the INP file. Once this information is indicated, press the "Import Data From INP" button.





In this example there is no warning in the import process, but if there were, a pop-up window would appear with the log.

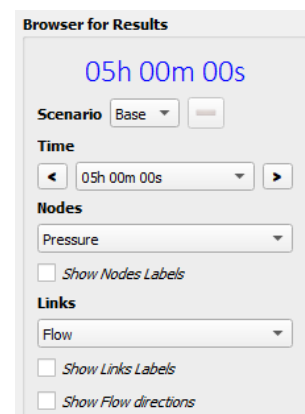
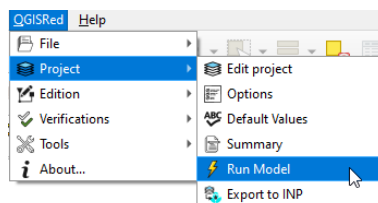


In the main QGIS window the model layers and tables with non-spatial information will appear:

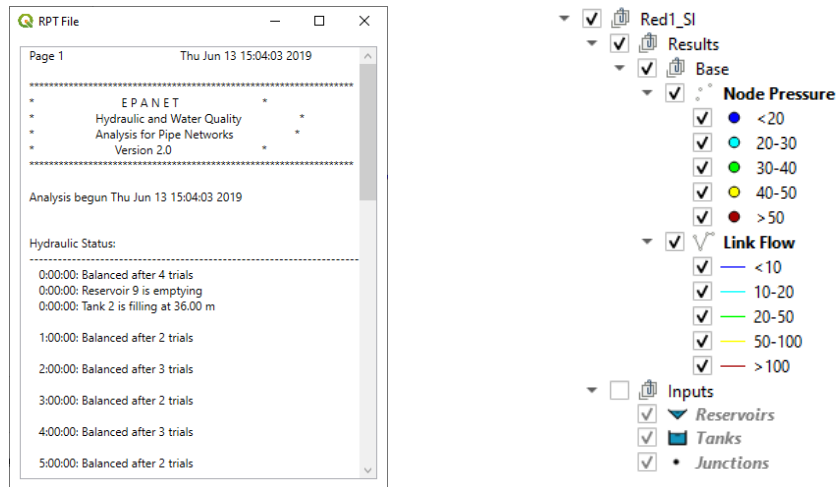


From version 0.7 onwards, data relating to curves (modeling and behavior) can be edited using the corresponding buttons. From version 0.8, the properties of each element can also be edited using the tool that allows access to the data through a dialog window. However, it is also possible to consult the data contained in each of the items that appear in the legend by accessing its attribute table (secondary button on each layer or with the button available on the top toolbar ). If you want to modify any value, you must enable the editing mode  for the selected layer or table, change or even add some element and finally save the changes.

Assuming in this example that the model is completely defined, the hydraulic and quality simulation could be run. To do so, click on the "Run model" button and a right menu will appear.

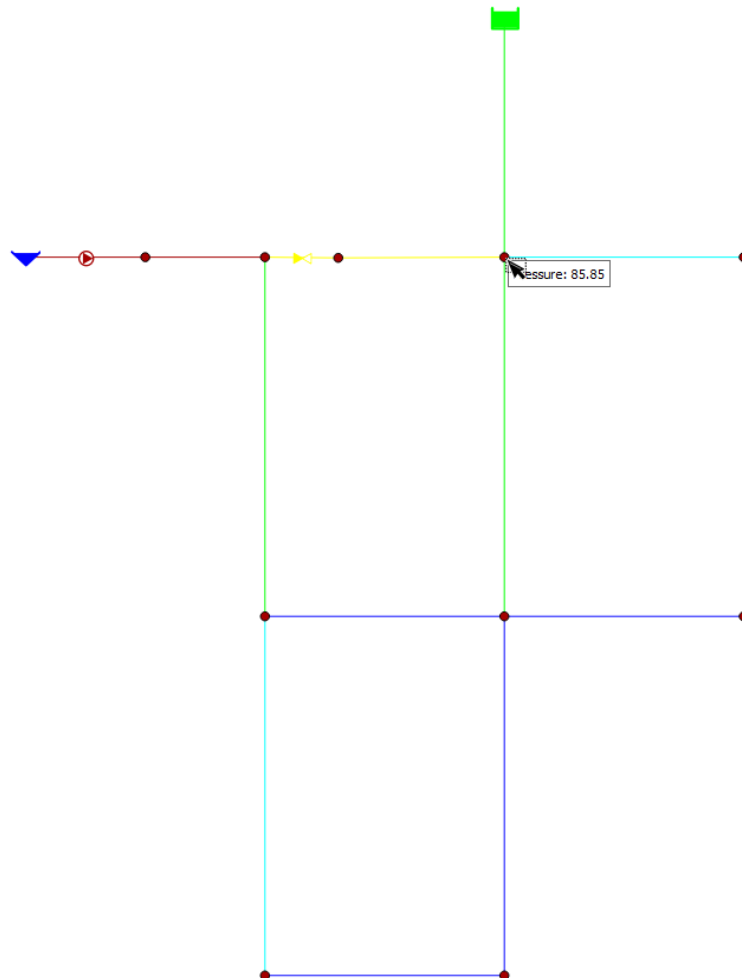



After performing the simulation, instantaneously for this example, a pop-up window appears with the report generated by the EPANET ToolKit, at the same time that the selected results are loaded (Flow and Pressure) in QGIS legend.



From the right menu that appears when clicking on the simulate button, it is possible to show the different results, as well as change the instant of time to represent.

It is recommended to deactivate the Inputs group visualization, so that the representative colors of the results are better appreciated.

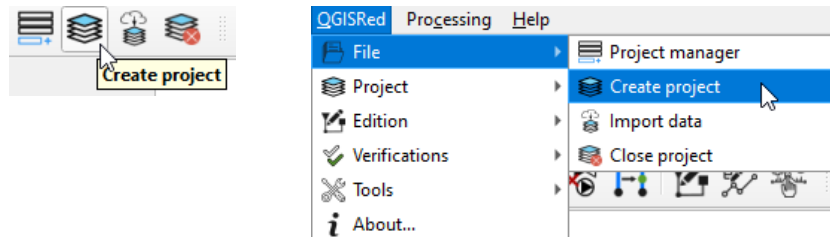


If the "Show Map Tips" option  is activated (if not), selecting a layer of results and holding the cursor over an element displays the value associated with that variable for the selected time.

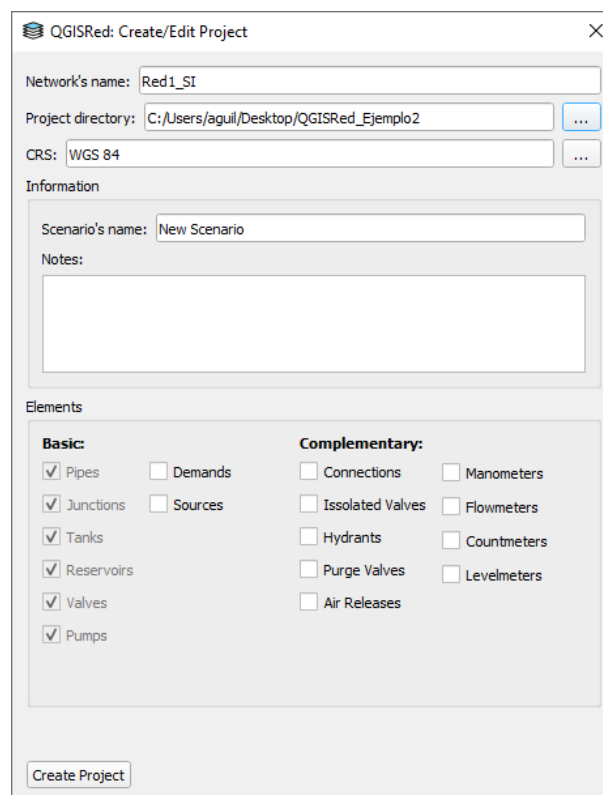
## Example 2

This example shows how to build the model of the previous example (*Red1\_SI*) from the beginning, without importing, that is, creating the different elements in QGIS.

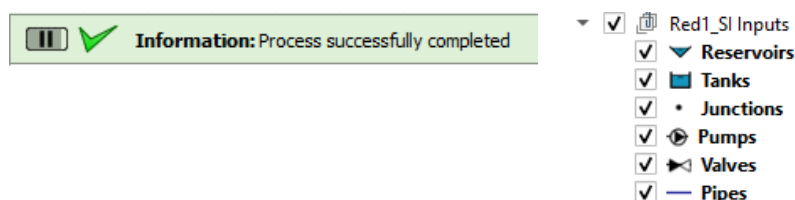
The first thing to do, once QGIS is opened, is to click on "Create Project". This can be done from the top menu or from the QGISRed plugin's own toolbar.



A window will be opened where the user must fill in the network name, the working directory and the reference system (CRS). For this example, that does not have a specific spatial location we can select the WGS 84. Then click on the "Create Project" button.

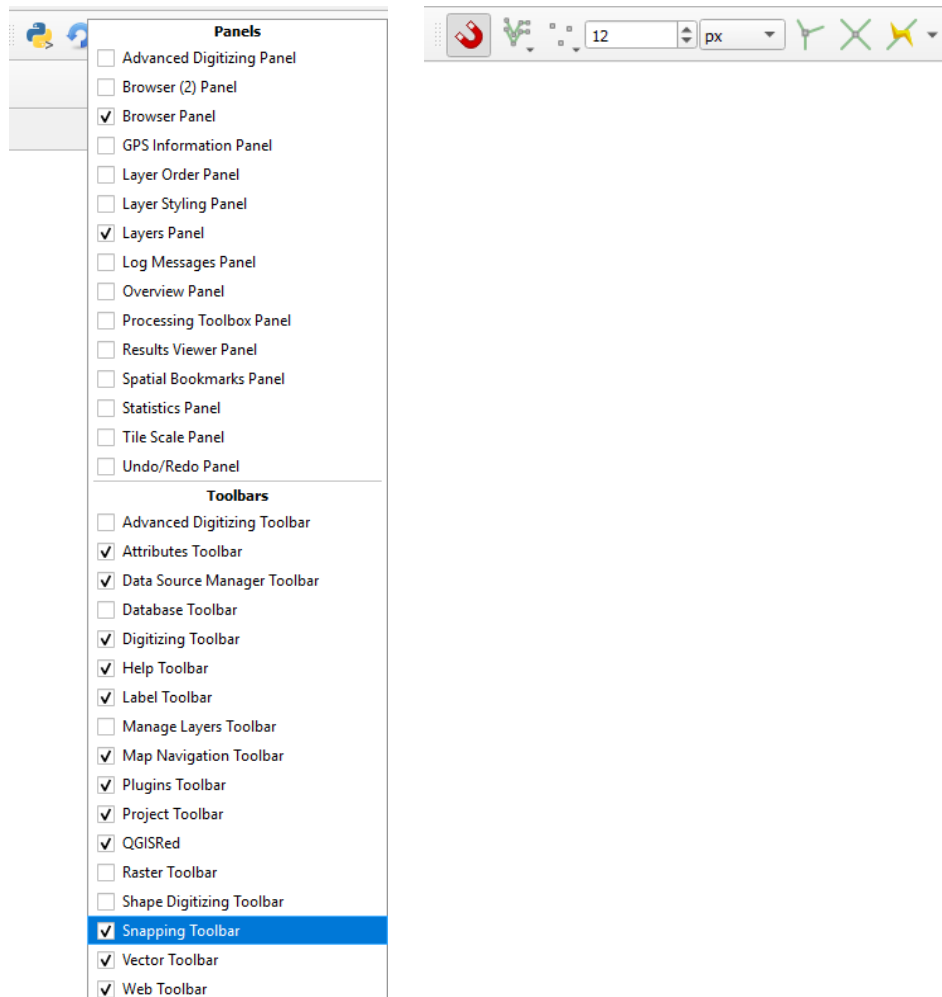
The image shows the 'QGISRed: Create/Edit Project' dialog box. It has several input fields: 'Network's name' (Red1\_SI), 'Project directory' (C:/Users/aguil/Desktop/QGISRed\_Ejemplo2), and 'CRS' (WGS 84). Below these is an 'Information' section with 'Scenario's name' (New Scenario) and a 'Notes' text area. At the bottom is an 'Elements' section with two columns of checkboxes: 'Basic' (Pipes, Junctions, Tanks, Reservoirs, Valves, Pumps) and 'Complementary' (Connections, Isolated Valves, Hydrants, Purge Valves, Air Releases, Manometers, Flowmeters, Countmeters, Levelmeters). A 'Create Project' button is at the bottom left.



A message will appear showing that the process has been successfully completed and the legend will include the layers and tables (empty or with default values).



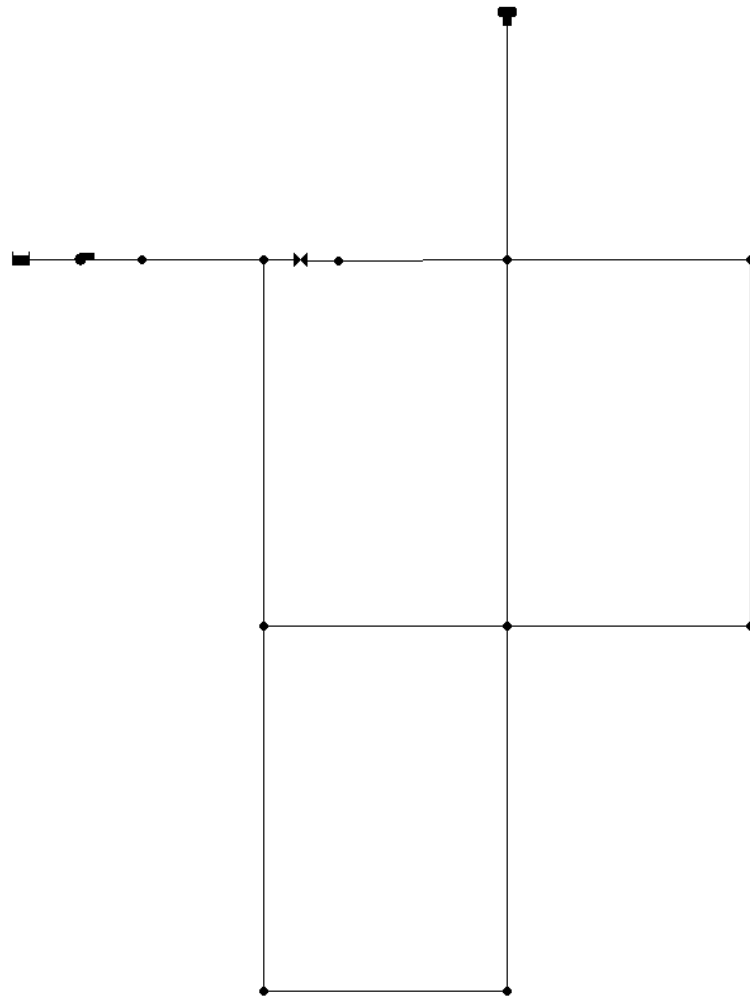
Before continuing and, as the process of create the network can take time, it is advisable to save the project with QGis. Thus, the next time we want to continue, whether we open the QGis project or the QGISRed project, everything will be the same as we left it the last time we saved it.

Before starting to draw the layout of our model it is convenient to activate the option of "Snapping" of QGis. This option will facilitate the creation of an element from a previous point of our model. To do this, show the "Snapping Toolbar" and activate the first button.

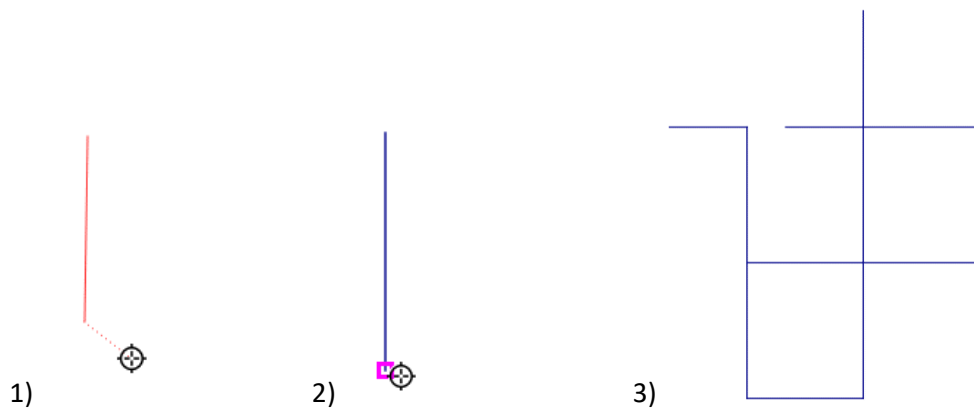


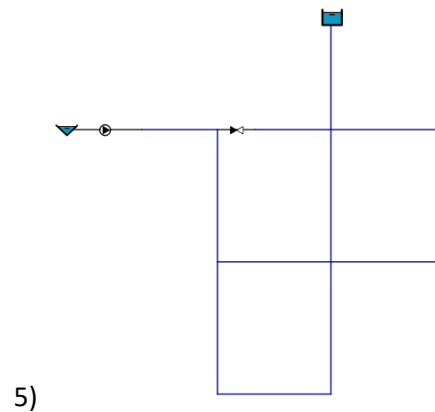
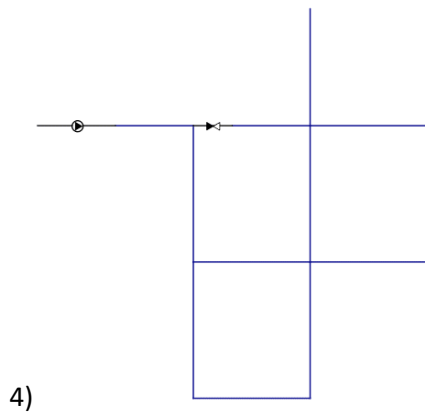
At this point we can begin to draw the layout. Possibly the most convenient thing is to begin with the pipes, then valves and pumps and, finally, tanks and reservoirs. Therefore, we should activate the Pipes layer in edit mode , select the button  to create a new line.

The model we must build is the following. As a starting point we can choose the pipe that starts from the upper tank.



First steps:





- 1) After selecting the second point of our pipe, we press right button to accept that link. At that moment a window appears to introduce the data associated to the model and that are contained in the table of attributes. In any case, when we generate or consolidate the model, the necessary empty data will be filled in.

Pipes - Atributos del objeto espacial

Acciones

Id	NULL
Length	NULL
Diameter	200.000
RoughCoeff	0.010
LossCoeff	0.000
IniStatus	NULL
BulkCoeff	0.000
WallCoeff	0.000
Tag	NULL
Descrip	NULL
Sector	NULL


Aceptar Cancelar

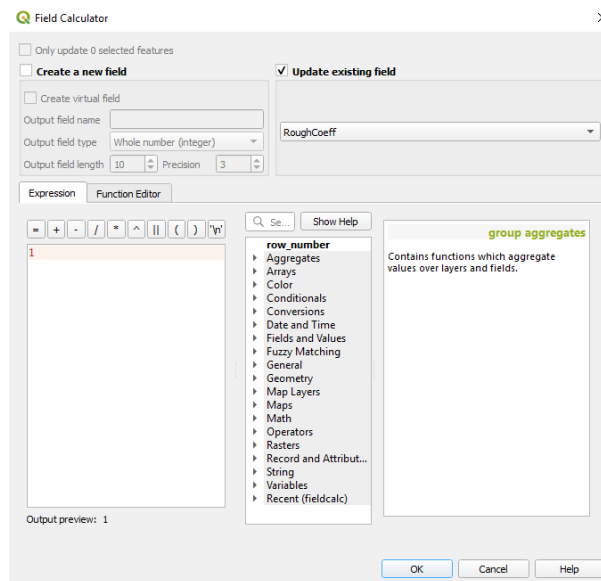
- 2) The fuchsia square facilitates the selection of the end of the previous pipe.
- 3) We finish drawing the rest of the pipes.
- 4) Draw the pump (activate layer edition) and the valve (activate layer edition).
- 5) Draw the tank (activate layer edition) and the reservoir (activate layer edition).


Once the topology has been built, the data for each element must be filled. To do this, we must save all the changes in the different edited layers. Once done, selecting the properties editing tool we can click on each element and modify its data.

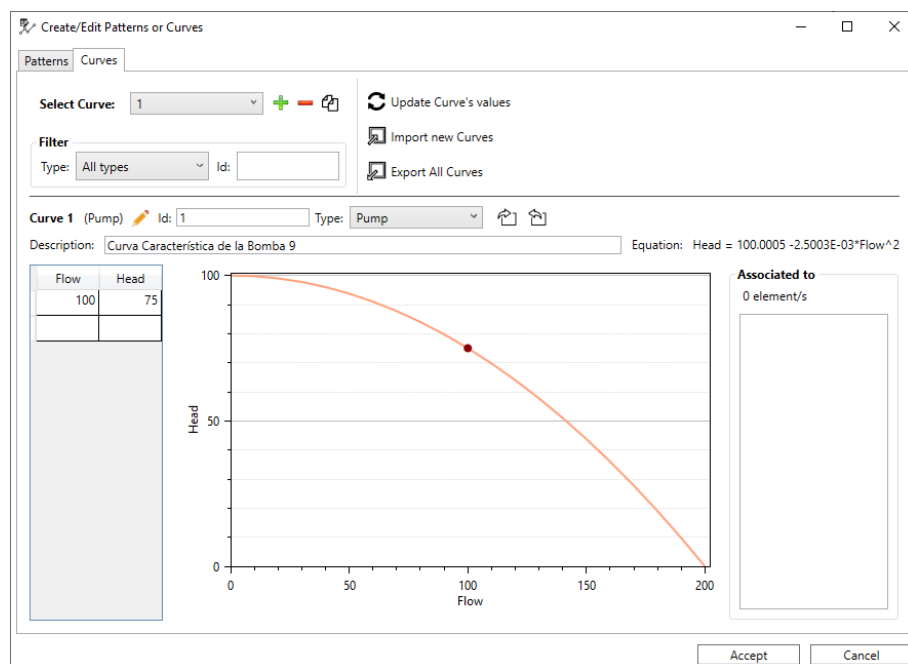





An additional option when the value of a field is repeated in all or almost all elements (e.g. the roughness coefficient of the pipes in the example), it is possible to use the field calculator . Select the option to update existing field, select the field and complete the desired value.

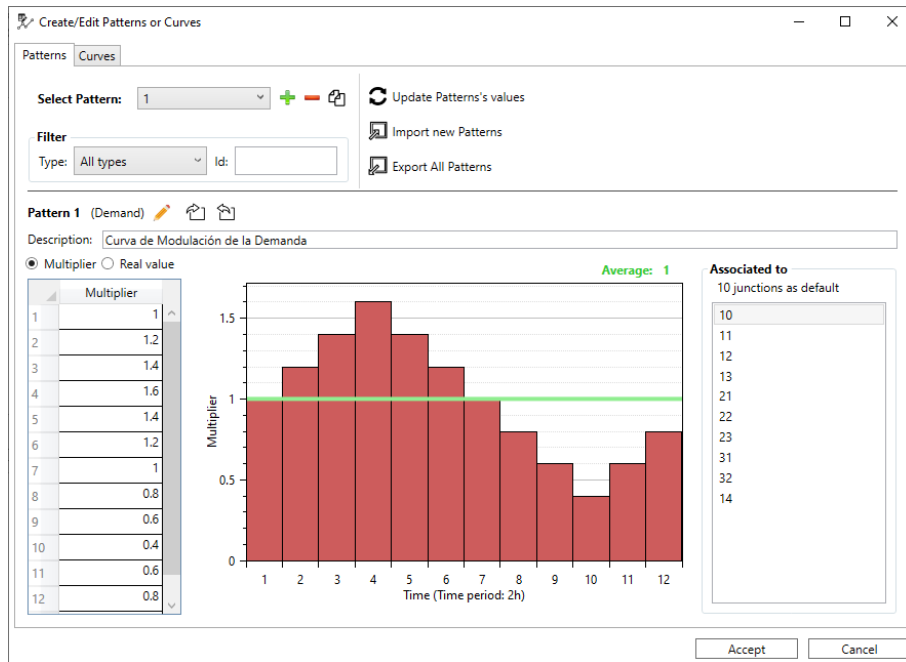


Once all the element data has been entered, the pump characteristic curve data must be completed. To do this, press the button  and we access the edition of curves. In this example it is only necessary to enter a point of the curve and specify the type of curve.





The procedure is: add a new curve, edit the curve type with the icon , select the PUMP option and then add the corresponding pair of Flow-Head values.

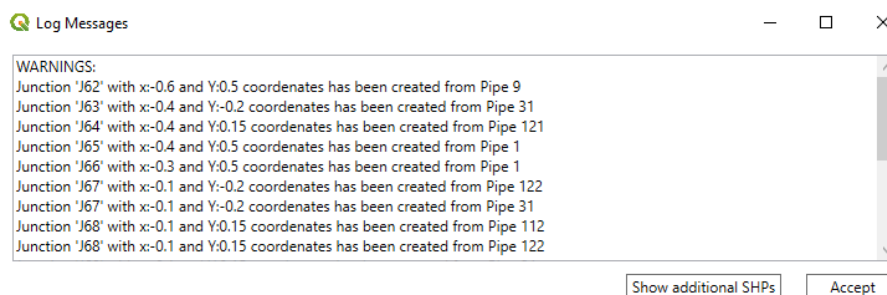
It is also necessary to enter the modulation curve data. From the same window, but in the corresponding tab, enter the values of the example.




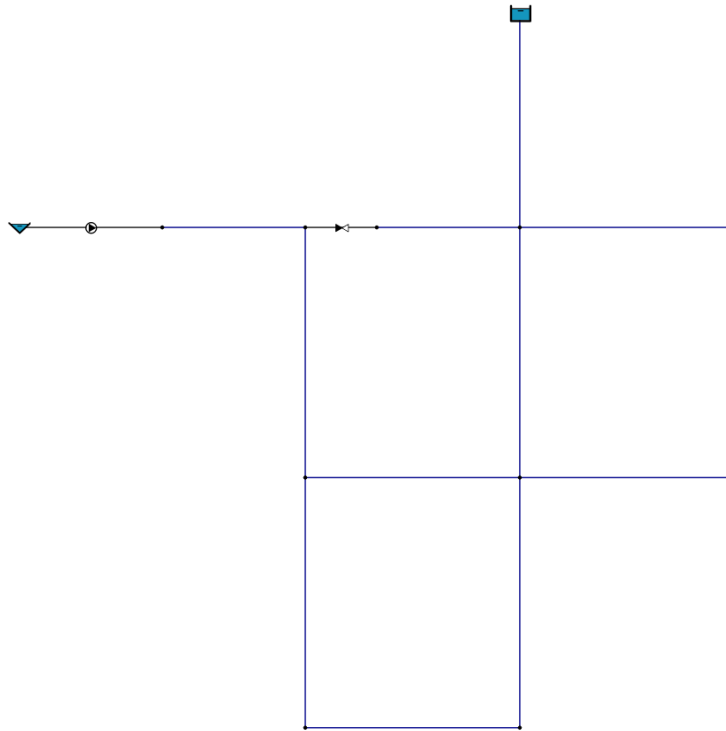
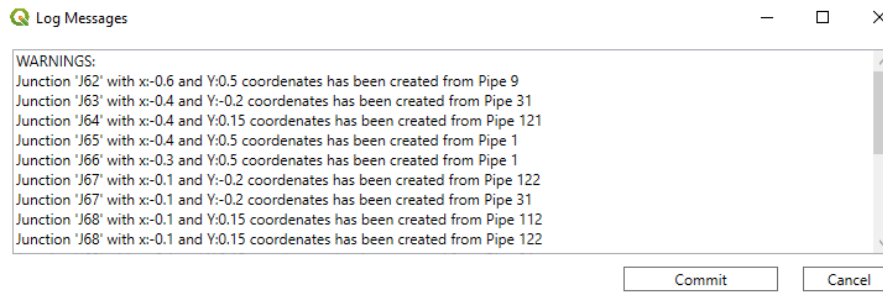
Once you have finished entering these data, click on the "Accept" button to save these changes. Then, it will be necessary in the pump to specify the Id of the curve in the *IdHFCurve* field.

As the reader will have observed, no junctions have been introduced at this time. They could be added manually one by one and complete their information or, once we validate and commit the model, these elements will be created and it will be enough to complete the data such as, for example, those related to the base demand.

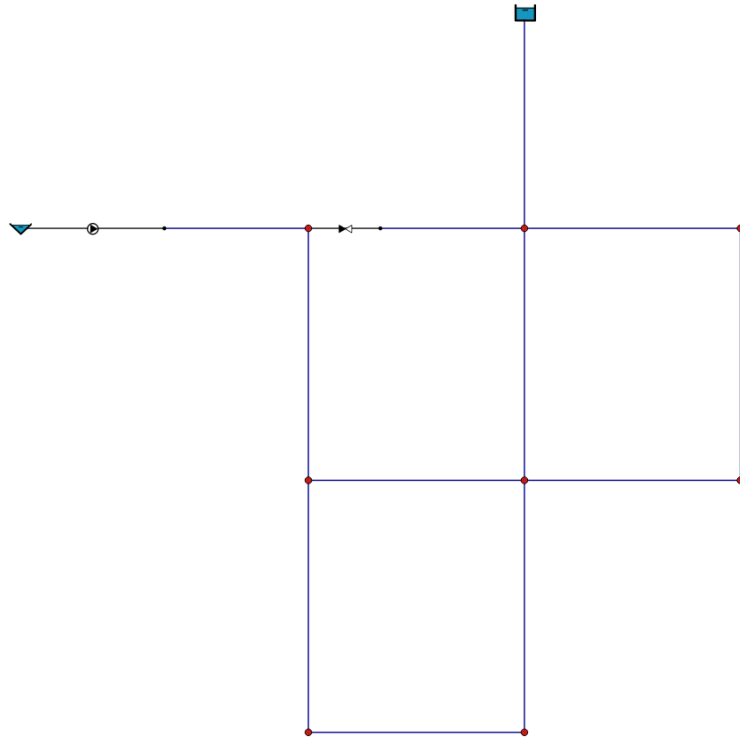
At this point, we can validate the topology and data entered. Pressing the button  will show a list of messages, corresponding only to the creation of nodes (*junctions*) from pipes. However, we can see in QGIS how these elements have not been created. This is the difference with the Commit button , which, apart from showing the corresponding warnings, applies the changes to our SHPs files.



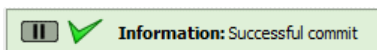
If we therefore proceed to commit , the same list of messages will appear. If we consider it correct, when clicking on the Commit button (pop-up window), we will see how the missing nodes have been created in the layout.




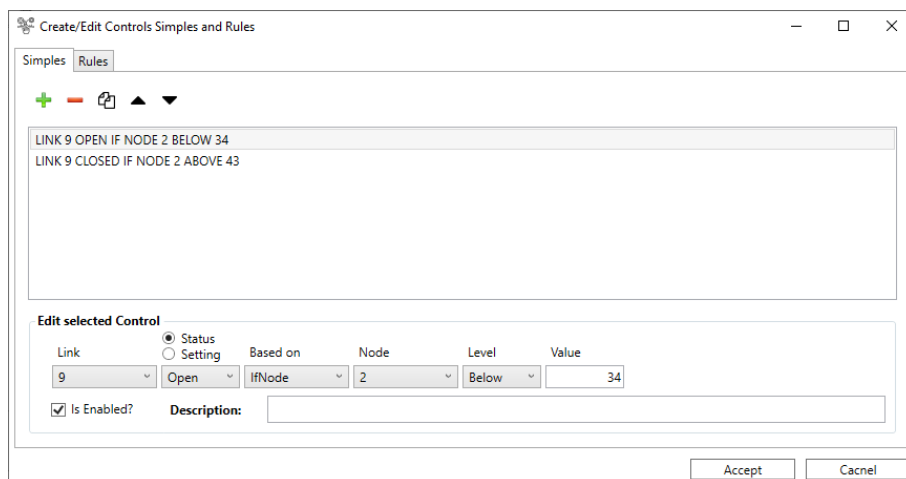
Once we have the nodes, we can complete their data, as has been done with the rest of the elements. Now we must visualize our scheme with the following figure.




If we validate again, we'll see how no messages appear in the log pop-up window.



Another aspect to complete are the simple controls that are defined for this example. It is accessed with the button  and, in the first tab, we create the two simple controls.



To finish, before proceeding with the simulation, it is necessary to modify the relevant options, to do so we press the button  and modify the following.

HEADLOSS	D-W
UNBALANCED	CONTINUETO
CONTINUETO	10
QUALITY TYPE	CHEMICAL
CHEMICAL LABEL	Cloro
CONCENTRATION UNITS	mg/l

DURATION	24:00 (1.00:00:00)
QUALITY TIMESTEP	00:05
STATUS	YES
SUMMARY	NO

It should be mentioned that, the PATTERN by default that appears in the options is the Id 1. In this example corresponds to the Id of the pattern that has been created. Otherwise, it would be necessary to change it if we want to assign to all the junctions that curve or, to specify the corresponding Id in each node.

If we simulate in the same way as in the Example 1, we will see that the same results are obtained.