

Urban Modelling

In this guide, we introduce 1D urban modelling. You will load an urban network and visualise aspects of the underlying drainage system. You will learn how to edit the properties of the nodes and links that make up the network, and how to adjust settings in the associated simulation. Finally, you will run a 1D urban simulation and explore a selection of the multiple ways Flood Modeller allows visualisation of the results from this.

Introduction

In this guide, we will look at loading an existing 1D urban network into Flood Modeller, running a simulation and viewing the results from this.

We assume (and highly recommend!) readers of this guide have previously completed ['Getting Started – Essentials'](#), however the guide can still be followed without having done so.

Please note that there are a variety of ways to undertake different tasks in Flood Modeller. Throughout this guide, we provide details of selected methods only.

We will use data contained in the UrbanModelling folder for this tutorial, which can be found within the GettingStartedData folder. [Access this here](#) if needed.

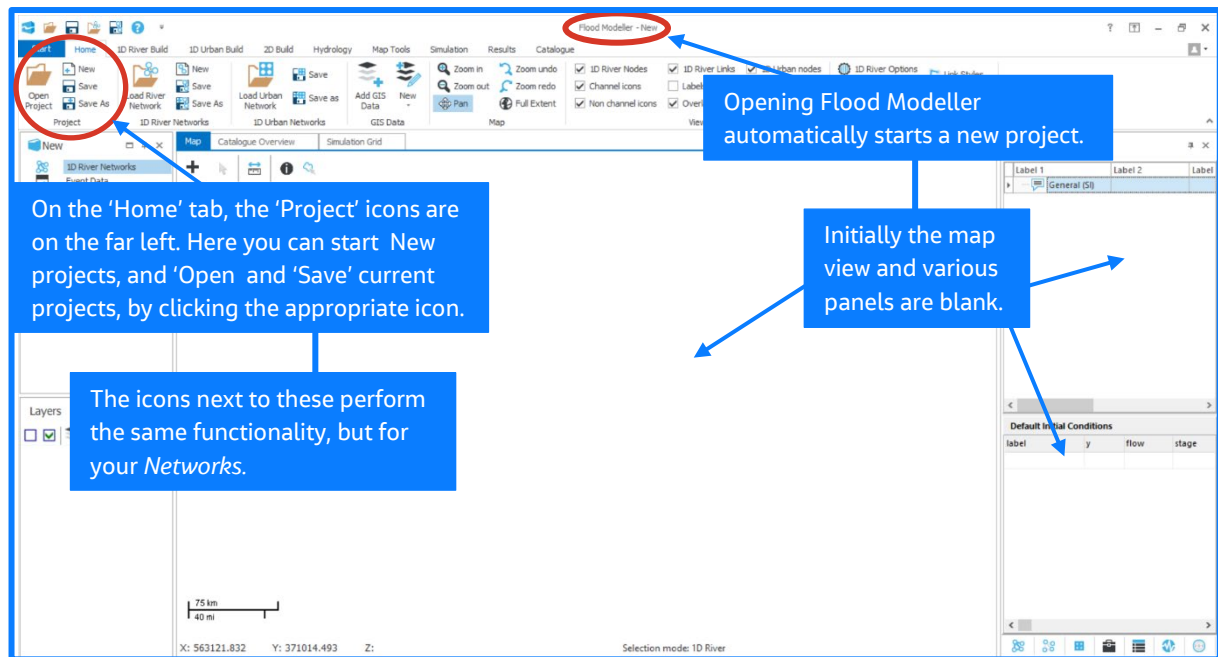
Tip: We recommend reading the entirety of each instruction, including the labels on the image provided, before carrying out each step.

Let's get going!

Step 1

Initially open Flood Modeller (or start a new project if already open).

A project file references all the different parts of the model – you might refer to multiple network files and simulation files, among other file types, all within a single project.

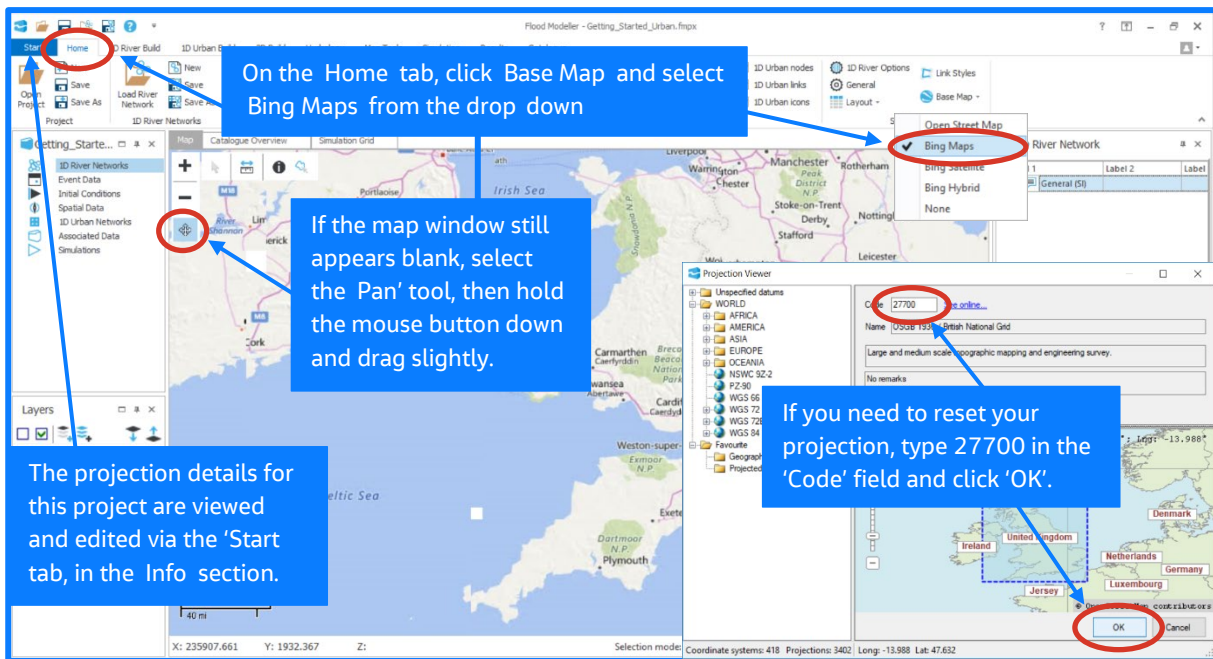


Step 2

Let's add a background map and save the project before progressing.

Background mapping is for visualisation only and is not used as part of the calculations.

Flood Modeller will automatically select the default projection specified in the 'Application Settings' window, which will be set at OSGB 1936 as needed (unless you have changed your default projection, in which case you will want to adjust the projection for this tutorial).



Tip: Save your project in the folder UrbanModelling containing your network file. The results from your simulations will, by default, attempt to save in this folder. Projects are saved with extension .fmpx.

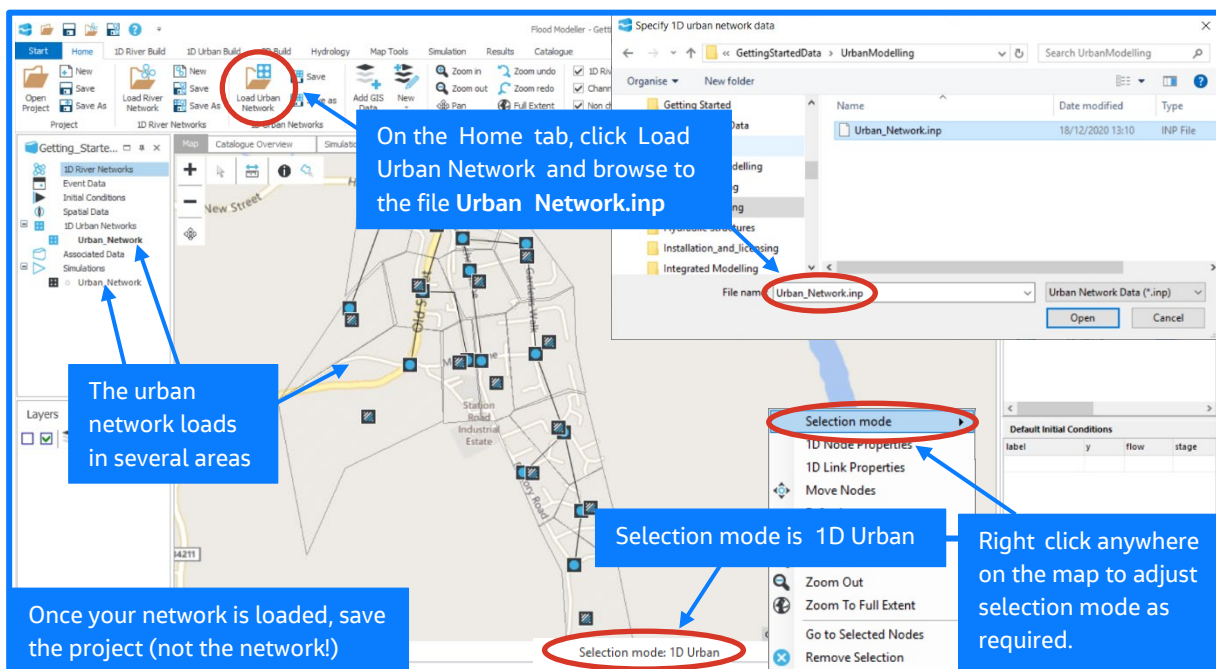
Note: If you are having issues with your basemap not displaying, the article [here](#) may help.

Step 3

Load the network Urban_Network.inp (in the UrbanModelling folder). This shows the drainage system itself in the map window. This consists of a series of icons, lines and polygons that represent the nodes and links within the network. Save the project again.

The map view shows this urban network consists of a 'Rain Gage' node and various 'Subcatchment' nodes. The 'Rain Gage' node specifies the rain falling on each subcatchment, and thus the flow entering the drainage system. 'Junction' nodes are used through the urban network and 'Conduit' links allow the water to flow between these nodes. These specify details such as the shape and roughness of the pipes. Finally, a boundary is necessary to allow water to leave the system; an 'Outfall' node is used in this case.

Your map will have automatically adjusted to '1D Urban' selection mode when you loaded the urban network. This can be switched between urban and river through the right-click menu on the map view. For this tutorial, urban selection mode is used throughout.



Note: When you click 'Load Urban Network', there may be a slight delay of a few seconds as the software checks your licence.

Step 4

The urban network has loaded in several areas of the interface.

Turning labels on (using the checkbox on the 'Home' or '1D Urban Build' tab) makes it clear which nodes are closer to the 'Outfall' node (such as J1) and which are further (such as J12).

Alongside the nodes and links in the map view, you will also see the urban network loaded into the 'Project' panel on the left of the screen, under both the '1D Urban Networks' and 'Simulations' sections.

The urban network is also visible in the '1D Urban Network' panel on the right. In this panel, tabs are provided to enable you to change view between the nodes and links that make up the network.

Your urban network is shown in the 1D Urban Networks section of the Project panel.

Check boxes allow you to add labels and icons to the map.

Nodes such as J1 are near the Outfall node

The Outfall node is near the river

The simulation associated to your urban network is shown in the 'Simulations' section of the Project panel.

Nodes such as J12 are located further from the Outfall node

Data is displayed in the 1D Urban Network table.

Click to change between tabs urban is the 3rd tab

The urban nodes and links are displayed in the map view

Name	Type	Symbol	Selected
Rain_Gage_54043	RAINGAGE		<input checked="" type="checkbox"/>
S1	SUBCATCH		<input type="checkbox"/>
S2	SUBCATCH		<input type="checkbox"/>
S3	SUBCATCH		<input type="checkbox"/>
S4	SUBCATCH		<input type="checkbox"/>
S5	SUBCATCH		<input type="checkbox"/>
S6	SUBCATCH		<input type="checkbox"/>
S7	SUBCATCH		<input type="checkbox"/>
S8	SUBCATCH		<input type="checkbox"/>
S9	SUBCATCH		<input type="checkbox"/>
S10	SUBCATCH		<input type="checkbox"/>
S11	SUBCATCH		<input type="checkbox"/>
S12	SUBCATCH		<input type="checkbox"/>
S13	SUBCATCH		<input type="checkbox"/>
S14	SUBCATCH		<input type="checkbox"/>
S15	SUBCATCH		<input type="checkbox"/>
S16	SUBCATCH		<input type="checkbox"/>
S17	SUBCATCH		<input type="checkbox"/>
S18	SUBCATCH		<input type="checkbox"/>
S19	SUBCATCH		<input type="checkbox"/>
S20	SUBCATCH		<input type="checkbox"/>
S21	SUBCATCH		<input type="checkbox"/>
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S27	SUBCATCH		<input type="checkbox"/>
S28	SUBCATCH		<input type="checkbox"/>
S29	SUBCATCH		<input type="checkbox"/>
S30	SUBCATCH		<input type="checkbox"/>
S31	SUBCATCH		<input type="checkbox"/>
S32	SUBCATCH		<input type="checkbox"/>
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S36	SUBCATCH		<input type="checkbox"/>
S37	SUBCATCH		<input type="checkbox"/>
S38	SUBCATCH		<input type="checkbox"/>
S39	SUBCATCH		<input type="checkbox"/>
S40	SUBCATCH		<input type="checkbox"/>
S41	SUBCATCH		<input type="checkbox"/>
S42	SUBCATCH		<input type="checkbox"/>
S43	SUBCATCH		<input type="checkbox"/>
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S96	SUBCATCH		<input type="checkbox"/>
S97	SUBCATCH		<input type="checkbox"/>
S98	SUBCATCH		<input type="checkbox"/>
S99	SUBCATCH		<input type="checkbox"/>
S100	SUBCATCH		<input type="checkbox"/>

Tip: Select the 'Pan' tool (from the icons in the top left of the map window) to move around the map (hold mouse button down and drag). Icons are also given to provide the option to zoom in and out; alternatively, ensure your cursor is in the map window and use your mouse scroll wheel to zoom in and out!

Step 5

View the details of some of the 'Conduit' links. Notice the shape used and the other options provided here. Check the Manning's N is set to 0.012 and that the length is provided in metres.

To view a node/link, click the 'Select' arrow icon and double click the node/link...

Click 'X' to close the window

Click in the Shape field and then on '...' to see all conduit shapes available

Click in the Length field to confirm the units

... or double click the node/link in the 1D Urban Network table

Don't forget to ensure you are on the right tab to view nodes or links!

ID	CONDUIT	From	To	Check
C18	CONDUIT	32	31	<input type="checkbox"/>
C19	CONDUIT	33	34	<input type="checkbox"/>
C20	CONDUIT	35	34	<input type="checkbox"/>
C21	CONDUIT	34	33	<input type="checkbox"/>
C23	CONDUIT	36	34	<input type="checkbox"/>
C24	CONDUIT	313	312	<input type="checkbox"/>
C25	CONDUIT	312	310	<input type="checkbox"/>
C26	CONDUIT	310	39	<input type="checkbox"/>
C27	CONDUIT	39	37	<input checked="" type="checkbox"/>
C28	CONDUIT	37	33	<input type="checkbox"/>
C29	CONDUIT	38	37	<input type="checkbox"/>
C31	CONDUIT	316	315	<input type="checkbox"/>
C32	CONDUIT	315	312	<input type="checkbox"/>
C35	CONDUIT	31	33	<input type="checkbox"/>
C36	CONDUIT	311	38	<input type="checkbox"/>

Property	Value
Name	C27
Inlet Node	J9
Outlet Node	J7
Description	
Tag	
Shape	CIRCULAR
Max. Depth	1
Length	169
Roughness	0.012
Inlet Offset	0
Outlet Offset	0
Conduit length (m)	

Tip: In the node and link property windows, click 'X' (top-right) to close the window. If changes have been made, you will then need to save your network.

In second-level windows (for example, the 'Cross-Section Editor' window accessed via the 'Shape' field) click the 'X' (top-right) or the 'Cancel' button to close the window and disregard any changes made. Click 'OK' to close the window and retain any changes made.

Step 6

The 'Rain Gage' node specifies the rainfall falling on the 'Subcatchment' nodes, which then is transferred to flow entering the urban network. View the 'Rain Gage' node and look at the time series assigned.

An error has been made in the entry at 05:00; replace the value of 100mm with 200mm and view a plot of the time series this now gives. Also take note of the start and end time of the rain – we will need to ensure the simulation itself runs over the same time period (or longer).

Ensure you save this change to your urban network.

The time series defined in a 'Rain Gage' node will affect any 'Subcatchment' node assigned to that 'Rain Gage', and therefore the placement of the 'Rain Gage' node on the map is not important. In this instance, the node has been placed at the location of a real gage. 'Rain Gage' nodes will always appear at the top of your urban network in the 'Nodes' tab of the '1D Urban Network' panel.

The Rain Gage node provides the rainfall details

Double click to view the series

Click to replace the value with 200 (mm)

View' shows a plot of the data

The Rain Gage node editor shows the following details:

- Time Series Name: Rain_20Feb20
- Description: (empty)
- Use external data file named below: (unchecked)
- Time Series Editor table:

Date (M/D/Y)	Time (H-M)	Value
00:00		3.5
01:00		7
02:00		24.5
03:00		45.5
04:00		100
05:00		200
06:00		100

The 1D Urban Network panel shows the following nodes:

Name	Type	Symbol	Selected
Rain_Ga	RAINGAGE		✓
S1	SUBCATCH		
S2	SUBCATCH		
S3	SUBCATCH		
S5	SUBCATCH		
S6	SUBCATCH		
S7	SUBCATCH		
S8	SUBCATCH		
S9	SUBCATCH		
S10	SUBCATCH		
S11	SUBCATCH		
S13	SUBCATCH		
S14	SUBCATCH		
S15	SUBCATCH		
S17	SUBCATCH		
S18	SUBCATCH		
S19	SUBCATCH		
J1	JUNCTION		
J2	JUNCTION		
J3	JUNCTION		
J4	JUNCTION		
J5	JUNCTION		
J6	JUNCTION		
J7	JUNCTION		
J8	JUNCTION		

The Time Series Viewer shows a plot of the data for Rain_20Feb20, with the value at 05:00 highlighted as 200.

Tip: From now on, we recommend selecting to 'Save As' a new network file if you make any changes. Ensure you select the icon for saving urban networks – recall on the 'Home' tab, save icons are also available for both project files and river networks.

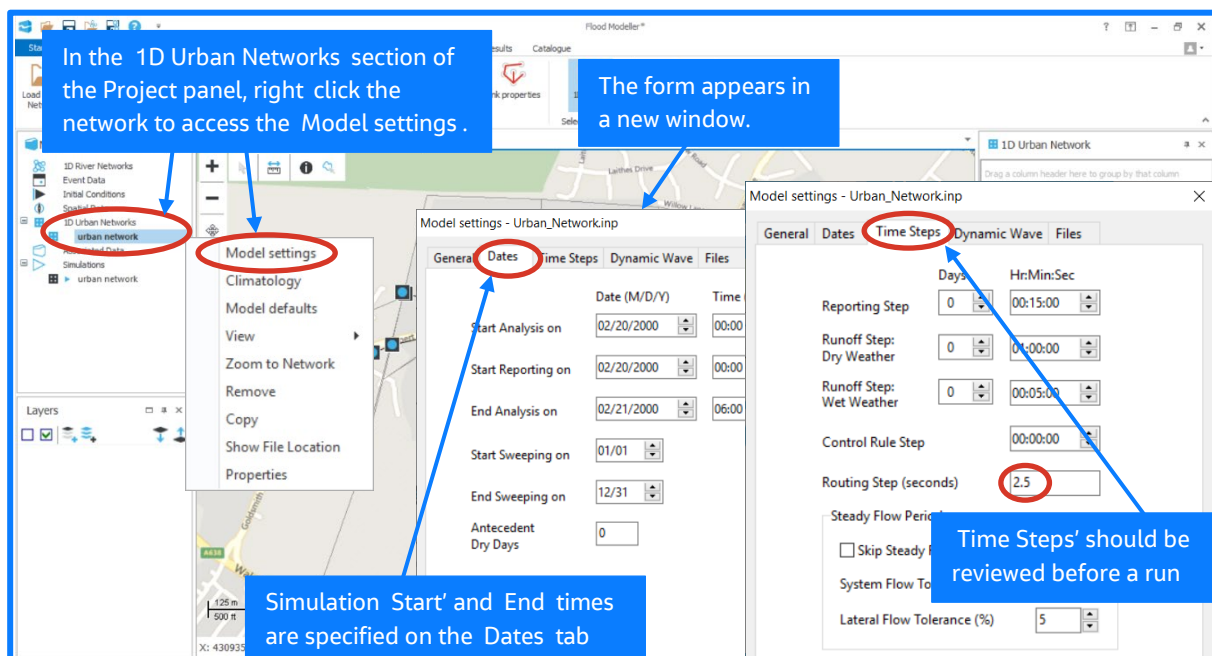
Since Flood Modeller prompts you to choose a filename when creating a new file, do not be tempted to choose an existing one (since this will be overwritten) – always choose a new filename.

Step 7

Confirm the details used in the simulation associated to the urban network through the model settings.

Dates are given in the format month/day/year and should match the time series details provided in our 'Rain Gage' node. Check that the timestep used is 2.5 seconds – your timesteps should always be reviewed prior to a run.

Larger timesteps are advantageous for faster simulation runtimes but could be too coarse to capture the detail necessary or could lead to large "jumps" in data calculated (which in turn can lead to instabilities and cause a simulation to crash). When running integrated simulations, it is also necessary to ensure timesteps of the various components are multiples of each other, but this is not something we need to consider for the purposes this guide.



Tip: Clicking the 'X' (top-right) or the 'Cancel' button closes the 'Model settings' window and disregards any changes made. Click 'OK' to close the window and retain any changes made.

Step 8

The simulation associated to your urban network is ready to run! You initially need to highlight this in the 'Simulations' section of the 'Project' panel.

The simulation itself should be very fast to complete. View the variables displayed and other information output at runtime.

Initially highlight the simulation to run

Alternatively, in the Simulations section of the Project panel, right click the network name and select 'Run' from the menu.

Once the simulation is highlighted, on the Simulation tab, click the Run icon.

Right click the plot to view other data, such as mass error

A pop up window shows simulation progress

View 'Output' and Variables via tabs

Green indicates successful completion of the simulation

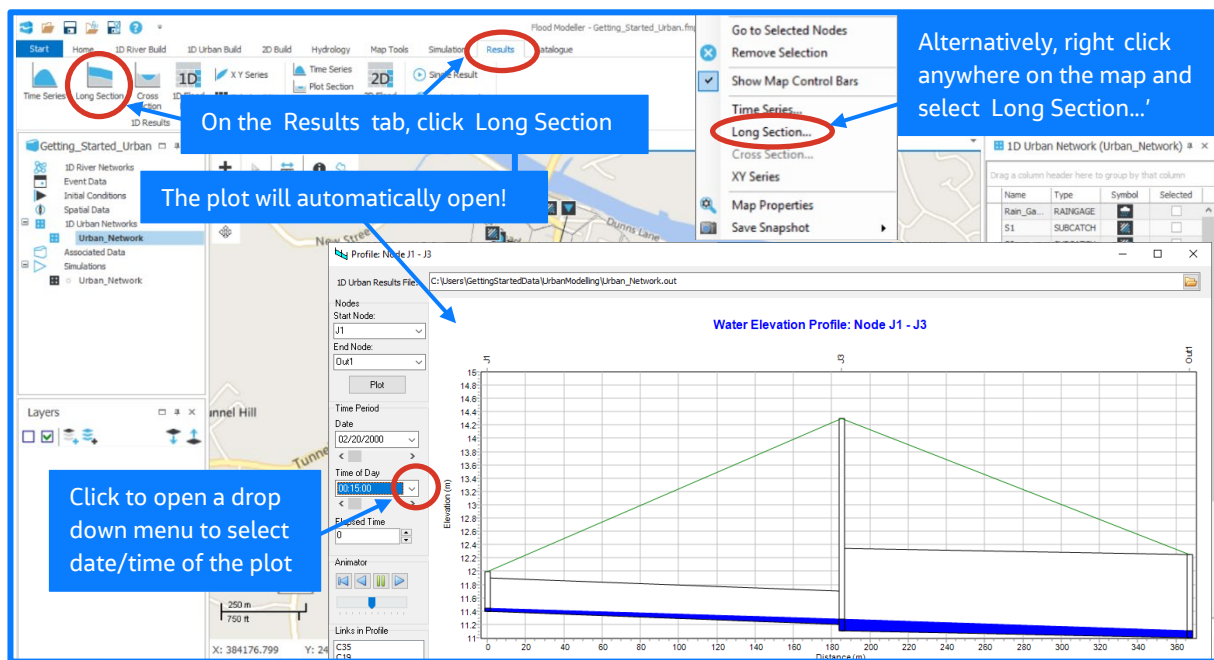
Note: Once your simulation is complete, you can just close the window – the results are automatically saved in the same folder as your project. For urban only simulations, these are contained in a file with extension .out.

Step 9

Now let's view some of the results. Create a 'Long Section' plot of your results.

If you have selected some nodes within your network beforehand, the plot will show the most direct "route" through these nodes. Otherwise, the plot shows the most direct "route" through all nodes as listed in the '1D Urban Network' panel, excluding 'Rain gage' and 'Subcatchment' nodes. In our case, this is from 'Junction' node J1 to the 'Outfall' node. We recall from step 4 that some 'Junction' nodes have a longer "route" to the 'Outfall' node than others.

On opening, the plot shows the data at the start of the simulation. Change the time to automatically update the plot and see water level adjust accordingly.

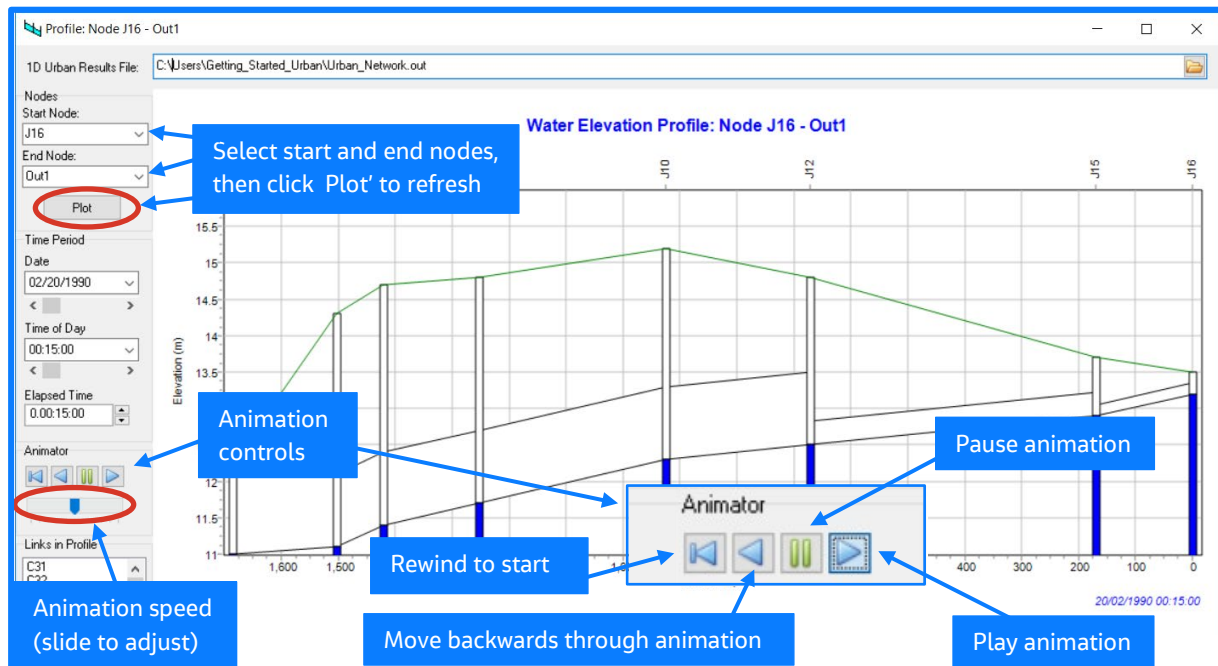


Step 10

Look at some 'Long Section' plots through some other routes of the urban network.

Animate a 'Long Section' plot to see the water levels changing along the route.

'Time Series' plots are also available for your 1D urban results, with options provided to plot flow, stage, velocity and water depth, alongside other outputs.



Tip: The button provided to move backwards through an animation only works when the animation is already playing (forwards).

Summary

You have now had an initial introduction to 1D urban modelling.

We loaded an urban network into Flood Modeller and noticed how it involved multiple nodes and links. In our particular urban network, a 'Rain Gage' node detailed the water falling on various 'Subcatchment' nodes, and in-turn entering the system through 'Junction' nodes. We edited the rainfall time series assigned to the 'Rain Gage' node, and saw how easily we could view, edit, and plot this data.

'Conduit' links were used to enable the water to flow between the 'Junction' nodes. We viewed the properties of these links and explored the variety of shapes available and how to change parameters used. We observed the general schematisation of the drainage system; taking note that the network was completed with an 'Outfall' node located near to the river, and that certain 'Junction' nodes had a longer "route" through to the 'Outfall' node than others.

We explored the settings used in the simulation associated to the urban network, using the tabs to navigate through sections of details such as the routing model selected and the timesteps used. We ensured our start and end times were sufficient (to cover the time of the storm!) and selected a timestep of 2.5 seconds whilst saving the results every 15 minutes. We then ran a 1D urban simulation using settings.

Finally, we visualised the results from our 1D simulation. We created 'Long Section' plots for various "routes" through the drainage system and saw how intuitive it is to adjust the data plotted, through selection of both different nodes and different times. We animated the stage data calculated, showing the water level varying over time. We discussed options provided via 'Time Series' plots to plot flow, stage, velocity and water depth, alongside other outputs.

The water exiting the urban network through the 'Outfall' node was completely lost from the system for our simulation. To explore where this water goes, together with any other water leaving the system (for example, flooding out of 'Junction' nodes), we would need to integrate our 1D urban network with other modelling components; connecting to a 1D river network and/or 2D domains. This is covered in the guide ['Getting Started – Integrated Modelling'](#).

What's next?

If you would like to find out more about the 1D urban solver, check out our [YouTube channel](#), [user manual](#) or get in touch with our support team.

You also may be interested in the other ['Getting Started' guides](#) in this series.