Troubleshooting in Water reticulation

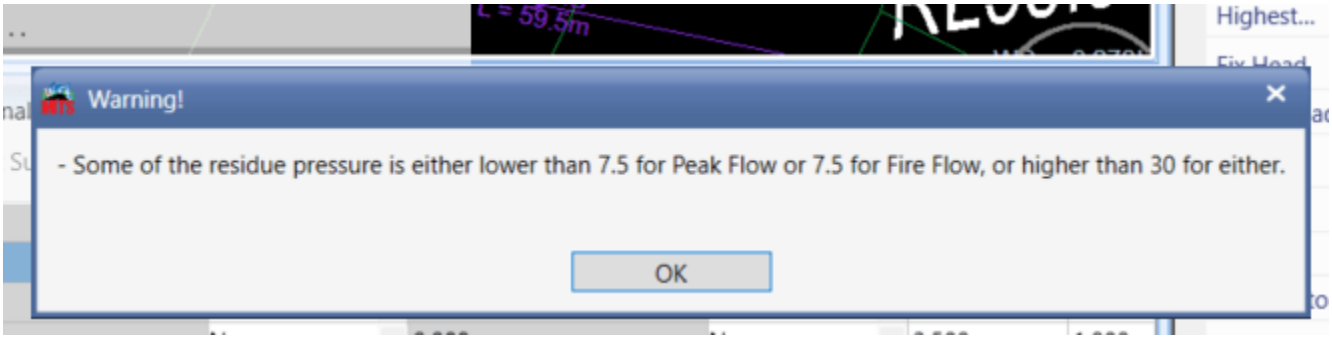
Water · https://mes100.com/docs/troubleshooting-in-water-reticulation/

You may encounter some warnings/errors while running for your water reticulation project.

Residue Pressure Problem

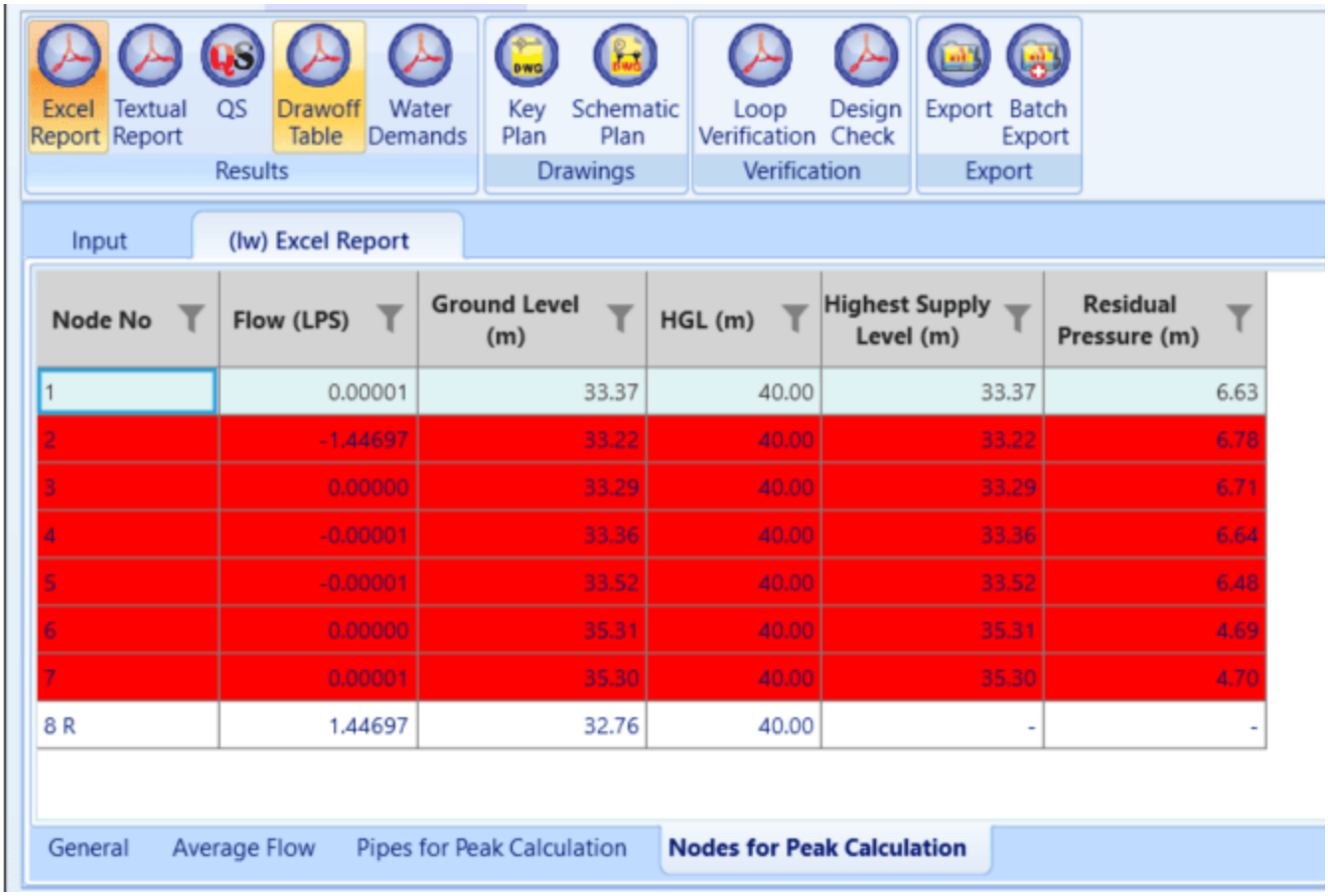
The following warning appears;

"**Some of the residue pressure is either lower than 7.5 for Peak Flow or 7.5 for Fire Flow, or higher than 30 for either**"



Where to check

Output > Excel Report > Nodes for Peak Calculation/Fire Calculation



Steps to troubleshoot

Equation to get Residual Pressure is as below:

Hydraulic Grade Line (HGL) – Highest Supply Level (HSL)

Check Fix Head value (as it will affect Hydraulic Grade Line)

“Input > Node > Spread Input > Node Head value”

How is Fix head related to Hydraulic Grade Line? The equation is as below, or you may also refer to this blog *(Water Reticulation Benchmark)*

Equation:

Hydraulic Grade Line (HGL)

= Fix Head – Head Loss

Example:

If the residual pressure is less than 7.5 m (the minimum residual pressure), you may need to check on the fixed head value whether it is too low in comparison with HSL, or have the value of water elevated tank height added with Ground Level (this is applied to elevated water tank design)?

Given:

Fix head = 40 m,

**if you are using Elevated Water Tank, the value of Fix Head is height of the building + Ground Level*

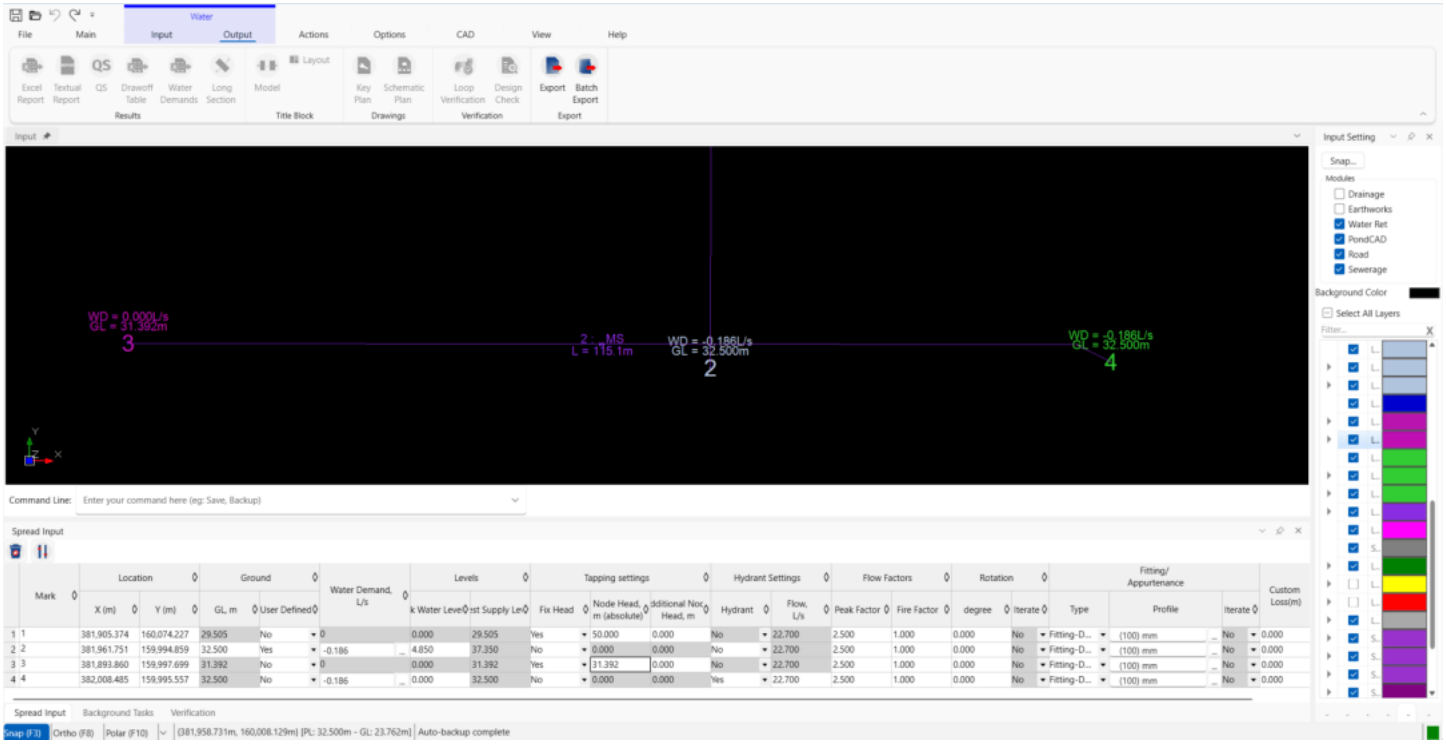
Highest Supply Level = 33.47 m

Head Loss = ~ 0 m

Residual Pressure = 6.53 m (less than the minimum 7.5 m)

Above calculation shows that the residual pressure is less than the minimum, therefore you might need to recheck the value of the Fixed Head. Same goes to the situation if the residual pressure is above the maximum, the fixed head value might be too high. If the Fixed Head is correct, see No. 2.

In an uncommon case, at the tapping point (fix head point), the node head is close or not high enough compared to to ground level where it sits on, it may result in insufficient pressure for water delivery in the system (could cause no flow or negative pressures).



Take this example, the water system will flow from Node 3 to Node 4.

Given;

Pipe length = 115.1m

Fix head (Node 3) = 31.392m

GL at Node 3 = 31.392m

GL at Node 4 = 32.50m

Highest Supply Level (Node 4) = 32.5m

Head loss (From Node 3 to Node 4) = 0.002m

Residual pressure = Fix head - Head Loss - Highest Supply Level

= 31.392m - 0.002m - 32.50m

= -1.11m (< 7.5m)

The residual pressure will be less than the minimum residual pressure required. This is because the Fix Head = Ground Level at Node 3, and it is slightly lower than HSL at Node 4 by 1.108m. In other words, the node being at ground level means no pressure head is available to drive the water to flow to the network.

Input | (Iw) Key Plan | (Iw) Excel Report

Node No	Node Coordinates	Flow (LPS)	Ground Level (m)	HGL (m)	Highest Supply Level (m)	Residual Pressure, GL (m)	Residue Pressure, HSL (m)
1 R	{381,905.374, 160,074.227}	0.466	29.505	50.000	-	-	-
2	{381,961.751, 159,994.859}	-0.466	32.500	49.986	37.350	17.486	12.636
3 R	{381,893.860, 159,997.699}	0.466	31.392	31.392	-	-	-
4	{382,008.485, 159,995.557}	-0.466	32.500	31.390	32.500	-1.110	-1.110

In this case, the user may need to set the fixed head at node 3 to a higher elevation, or use pump at node 4 to boost the pressure.. You may refer here on how to add a pump.

The user may also have to check whether they input the ground level or node head wrongly at the fix head level.

Check Ground Level value (as it will affect the Highest Supply Level)

“Input > Node > Ground Level”

How is Ground Level related to Highest Supply Level? The equation is as below, or you may also refer to this blog (*Water Reticulation Benchmark*)

Equation:

Highest Supply Level (HSL)

= Ground Level + Tank Water Level

Example:

Referring to the image below, one of the residual pressures is more than the maximum (30 m maximum).



The calculation of the residual pressure for the Node 2 above is

= HGL - Ground Level + Tank Water Level

= 40 - 0 + 5

= 35 m

0 m ground level at Node 2 seems to be odd in comparison with the surrounding levels. So you might need to recheck on the ground level for that particular node, since it will affect the HSL and residual pressure.

But what if all of the above troubleshootings are done and the values of GL, Fix head are all correct, that the residual pressure is impossible to satisfy the pressure range specified by the authority. Therefore, you might need to opt for an additional pump or valve.

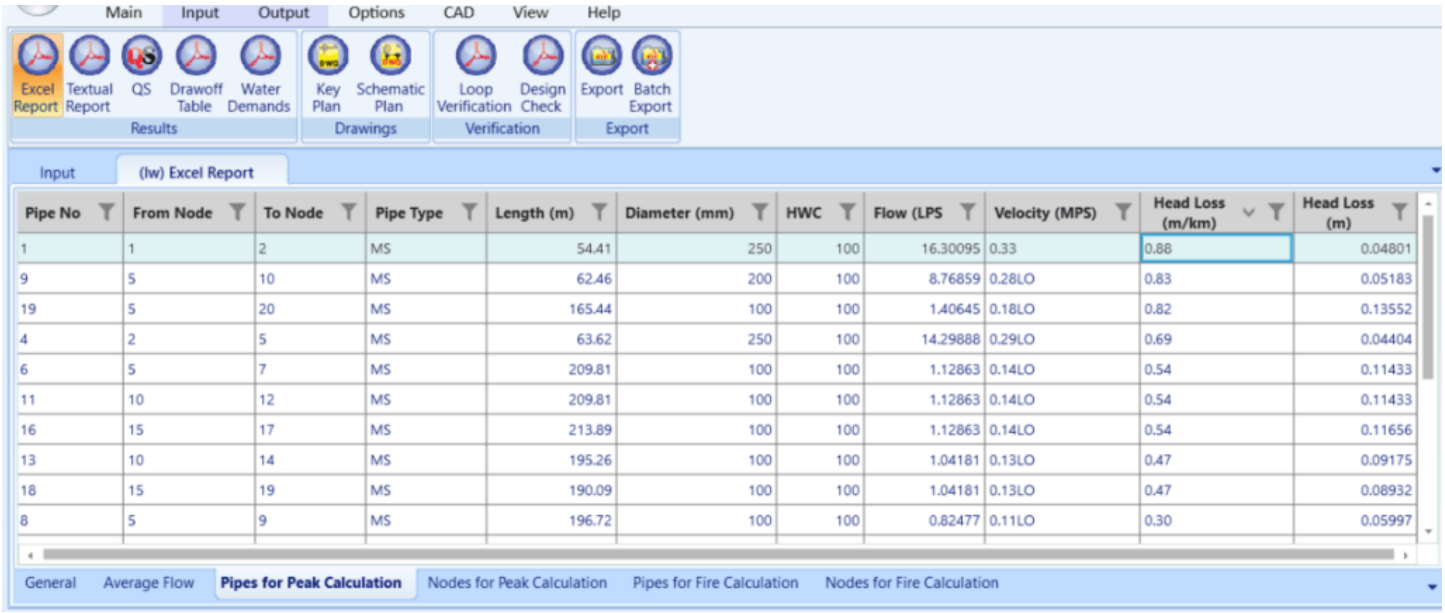
Change the Diameter of the Pipe

Residual pressure can also be affected by head loss. One of the components included in the calculation of head loss is Diameter. As diameter changes, the head loss also will be changed. By lowering the value of head loss, the residual pressure can be increased. In order to decrease the head loss, diameter can be adjusted by increasing the size of the diameter, and vice versa.

The calculation of the head loss can be referred to in this "Manual Head Loss Calculation Benchmark with MES Software" blog, or you can refer to this Online Calculator.

Where to check the head loss value

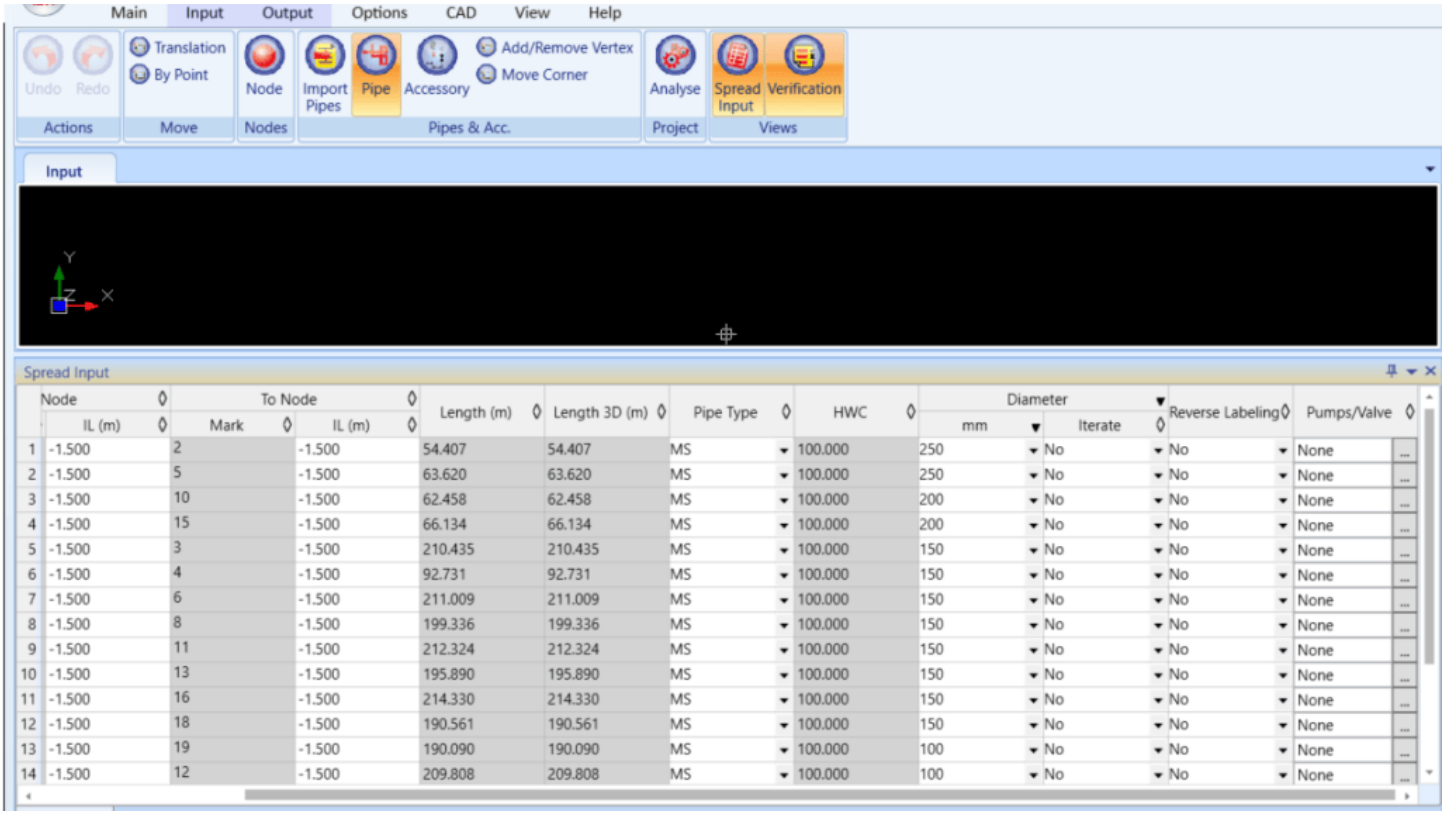
Output > Excel Report > Pipes for Peak/Fire Calculation > Head Loss



Pipe No	From Node	To Node	Pipe Type	Length (m)	Diameter (mm)	HWC	Flow (LPS	Velocity (MPS)	Head Loss (m/km)	Head Loss (m)
1	1	2	MS	54.41	250	100	16.30095	0.33	0.88	0.04801
9	5	10	MS	62.46	200	100	8.76859	0.28LO	0.83	0.05183
19	5	20	MS	165.44	100	100	1.40645	0.18LO	0.82	0.13552
4	2	5	MS	63.62	250	100	14.29888	0.29LO	0.69	0.04404
6	5	7	MS	209.81	100	100	1.12863	0.14LO	0.54	0.11433
11	10	12	MS	209.81	100	100	1.12863	0.14LO	0.54	0.11433
16	15	17	MS	213.89	100	100	1.12863	0.14LO	0.54	0.11656
13	10	14	MS	195.26	100	100	1.04181	0.13LO	0.47	0.09175
18	15	19	MS	190.09	100	100	1.04181	0.13LO	0.47	0.08932
8	5	9	MS	196.72	100	100	0.82477	0.11LO	0.30	0.05997

Where to change the pipe diameter

Input > Pipe > Spread Input > Diameter



	Node		To Node		Length (m)	Length 3D (m)	Pipe Type	HWC	Diameter		Reverse Labeling	Pumps/Valve
	IL (m)	Mark	IL (m)						mm	Iterate		
1	-1.500	2	-1.500	54.407	54.407	MS	100.000	250	No	No	None	
2	-1.500	5	-1.500	63.620	63.620	MS	100.000	250	No	No	None	
3	-1.500	10	-1.500	62.458	62.458	MS	100.000	200	No	No	None	
4	-1.500	15	-1.500	66.134	66.134	MS	100.000	200	No	No	None	
5	-1.500	3	-1.500	210.435	210.435	MS	100.000	150	No	No	None	
6	-1.500	4	-1.500	92.731	92.731	MS	100.000	150	No	No	None	
7	-1.500	6	-1.500	211.009	211.009	MS	100.000	150	No	No	None	
8	-1.500	8	-1.500	199.336	199.336	MS	100.000	150	No	No	None	
9	-1.500	11	-1.500	212.324	212.324	MS	100.000	150	No	No	None	
10	-1.500	13	-1.500	195.890	195.890	MS	100.000	150	No	No	None	
11	-1.500	16	-1.500	214.330	214.330	MS	100.000	150	No	No	None	
12	-1.500	18	-1.500	190.561	190.561	MS	100.000	150	No	No	None	
13	-1.500	19	-1.500	190.090	190.090	MS	100.000	100	No	No	None	
14	-1.500	12	-1.500	209.808	209.808	MS	100.000	100	No	No	None	

Check on Water Demand

Residual pressure is also affected by the flow discharge, Q which came from the water demand input. As Q is affected, the head loss also will be affected. The calculation of the head loss can be referred in the blog post as attached in the section 1.2.3. Although wrong input of water demand rarely happens, you may also need to recheck on the value in case there is any misinput.

Benchmarks of water reticulation can also be referred to in this “Water Reticulation Benchmark” blog.

Where to check the Q

Output > Excel Report > Pipes for Peak/Fire Calculation > Flow

Where to check on Water Demand

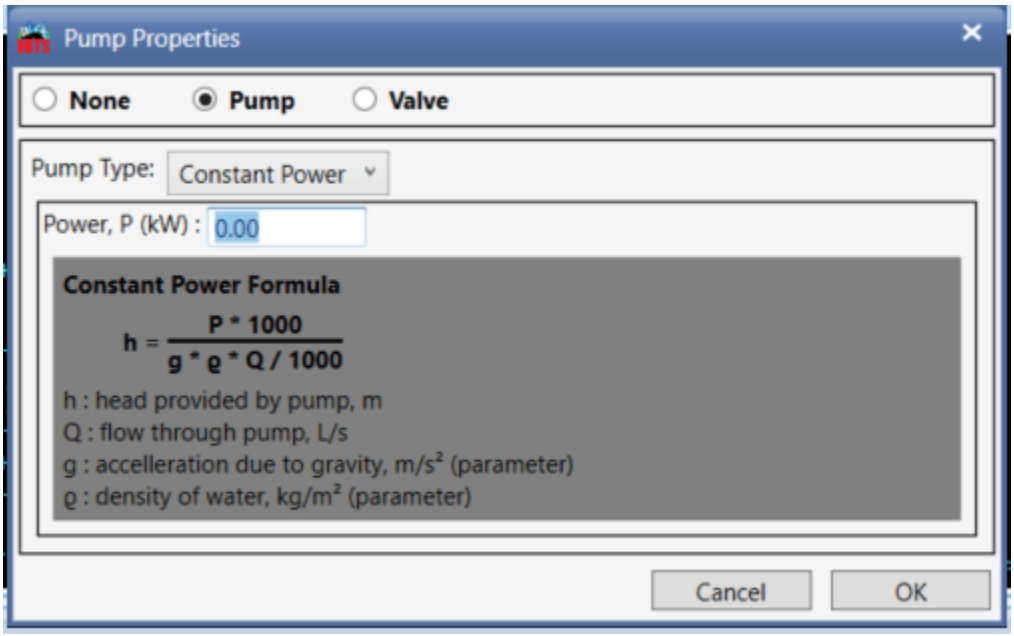
Input > Node > Spread Input > Water Demand

Add Pump

Given a situation that the pressure is not sufficient to satisfy the minimum residual pressure, therefore you might need a pump in order to boost the pressure.

Where to add

Pipe > Spread Input > Pumps/Valve



Other related posts:

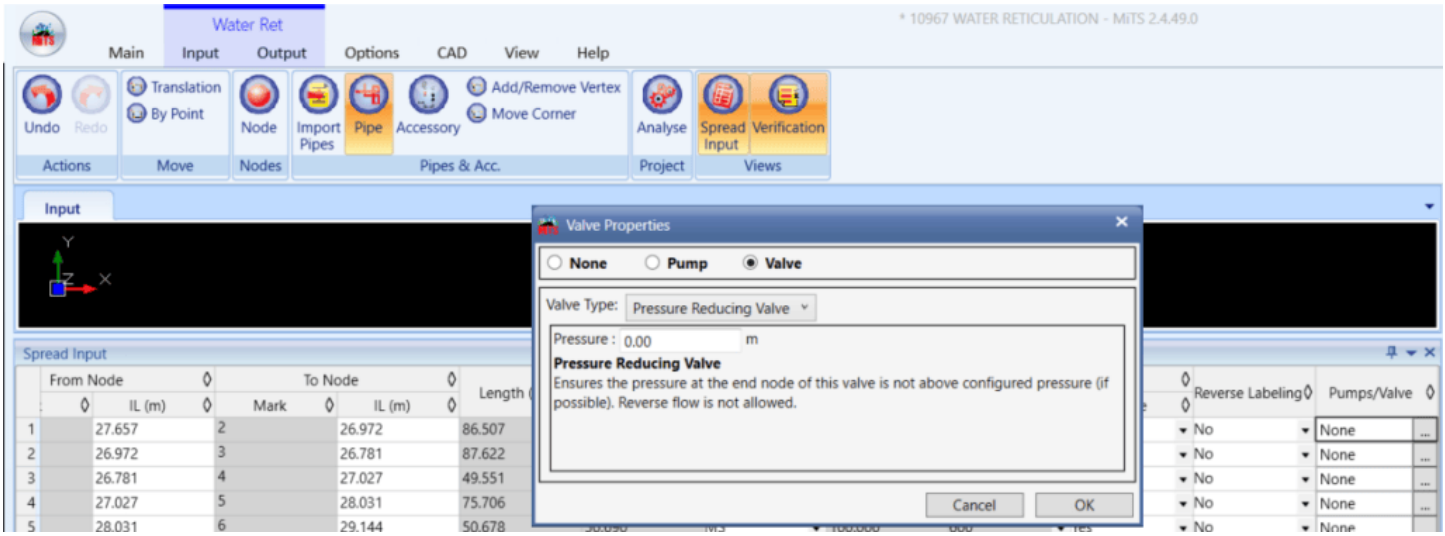
- LW+: How to apply pump & valve to keep pressure within range
- Why does the pump at the end of the water pipe not work?
- Loopwin+ : Pump Curve design

Add Valve

Say the maximum residual pressure is 30 m and the analysis shows you 40 m residual pressure, which fails the analysis. Therefore, you might need to add a valve in order to control the pressure to be within range.

Where to add

Pipe > Spread Input > Pumps/Valve



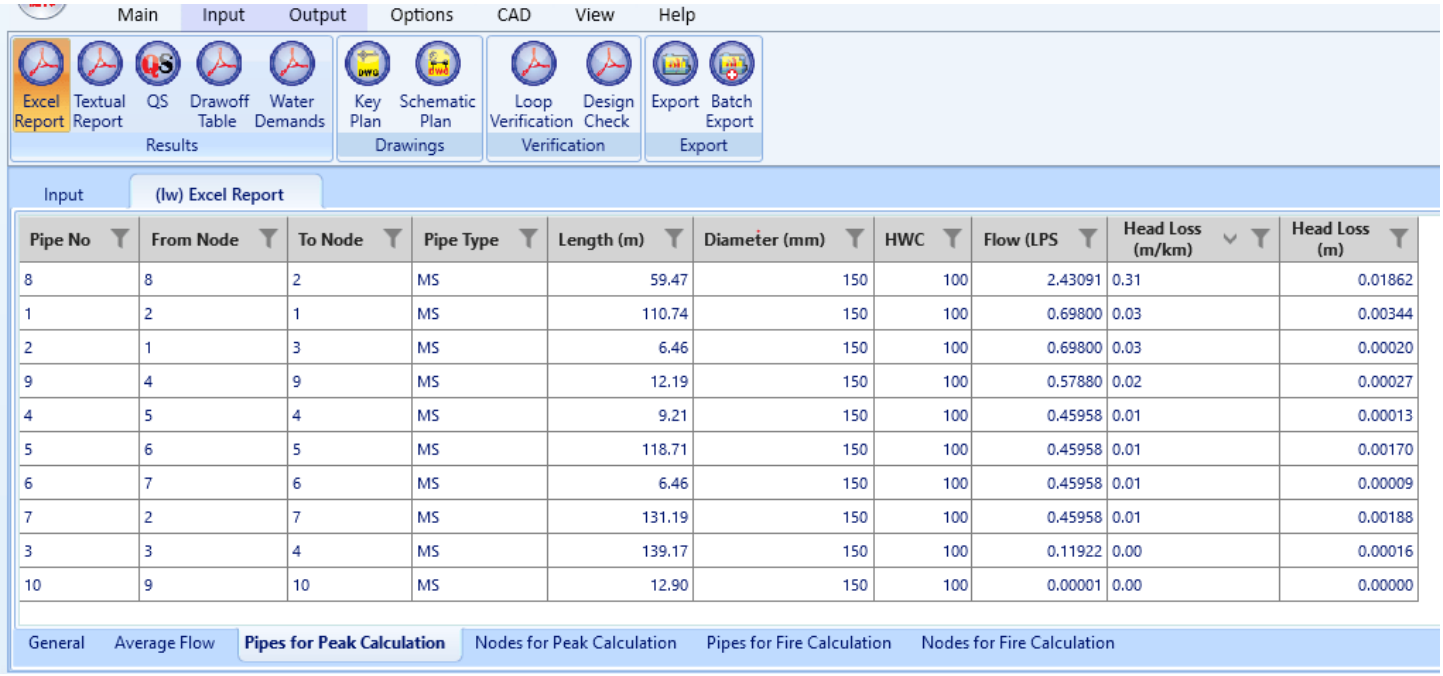
Authority Discussion

What if the values are all correct and the pump/valves are not possible for your layout, you might need to discuss with authority and present them with the calculation, showing that the requirement is indeed not possible given the constraint.

Low or High Head Loss

Where to check

Output > Excel Report > Pipes for Peak Calculation/Fire Calculation > Head Loss column



Pipe No	From Node	To Node	Pipe Type	Length (m)	Diameter (mm)	HWC	Flow (LPS	Head Loss (m/km)	Head Loss (m)
8	8	2	MS	59.47	150	100	2.43091	0.31	0.01862
1	2	1	MS	110.74	150	100	0.69800	0.03	0.00344
2	1	3	MS	6.46	150	100	0.69800	0.03	0.00020
9	4	9	MS	12.19	150	100	0.57880	0.02	0.00027
4	5	4	MS	9.21	150	100	0.45958	0.01	0.00013
5	6	5	MS	118.71	150	100	0.45958	0.01	0.00170
6	7	6	MS	6.46	150	100	0.45958	0.01	0.00009
7	2	7	MS	131.19	150	100	0.45958	0.01	0.00188
3	3	4	MS	139.17	150	100	0.11922	0.00	0.00016
10	9	10	MS	12.90	150	100	0.00001	0.00	0.00000

Steps to troubleshoot:

Firstly, you have to know the basic equation of calculating the head loss, only then you are able to identify the variables.

Hazen-Williams Equation: $V = k\,C\,(D/4)^{0.63}\,S^{0.54}$ where $S = h_f / L$ and $Q = V\,\pi\,D^2 / 4$

V = velocity (m/s)

k = conversion factor (1.85 for SI unit)

C = Hazen-Williams Coefficient

D = diameter (m)

S = energy Slope (m/km)

hf = head loss (m)

L = length (m)

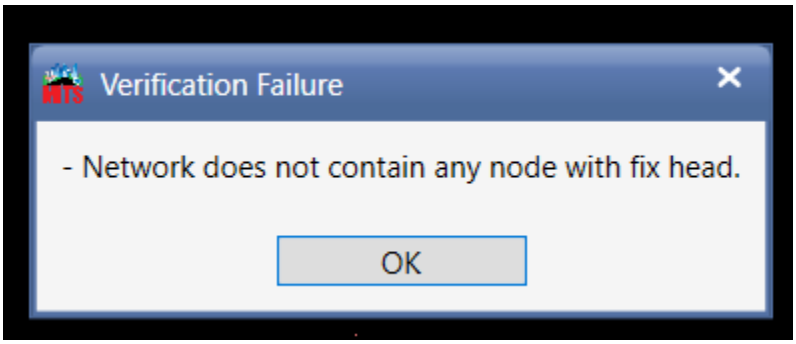
Q = discharge (m3/s)

You may also refer to this blog post for further details; **Manual Head Loss Calculation benchmark with MES Software**. You may also refer to this online **calculator** for trial and error calculation.

Usually, water demand and the length are fixed, so there is not much to be changed on those variables. Therefore, what's left is to change the Diameter of the pipe. *(please refer to the equation, or refer to the blog post to understand better).*

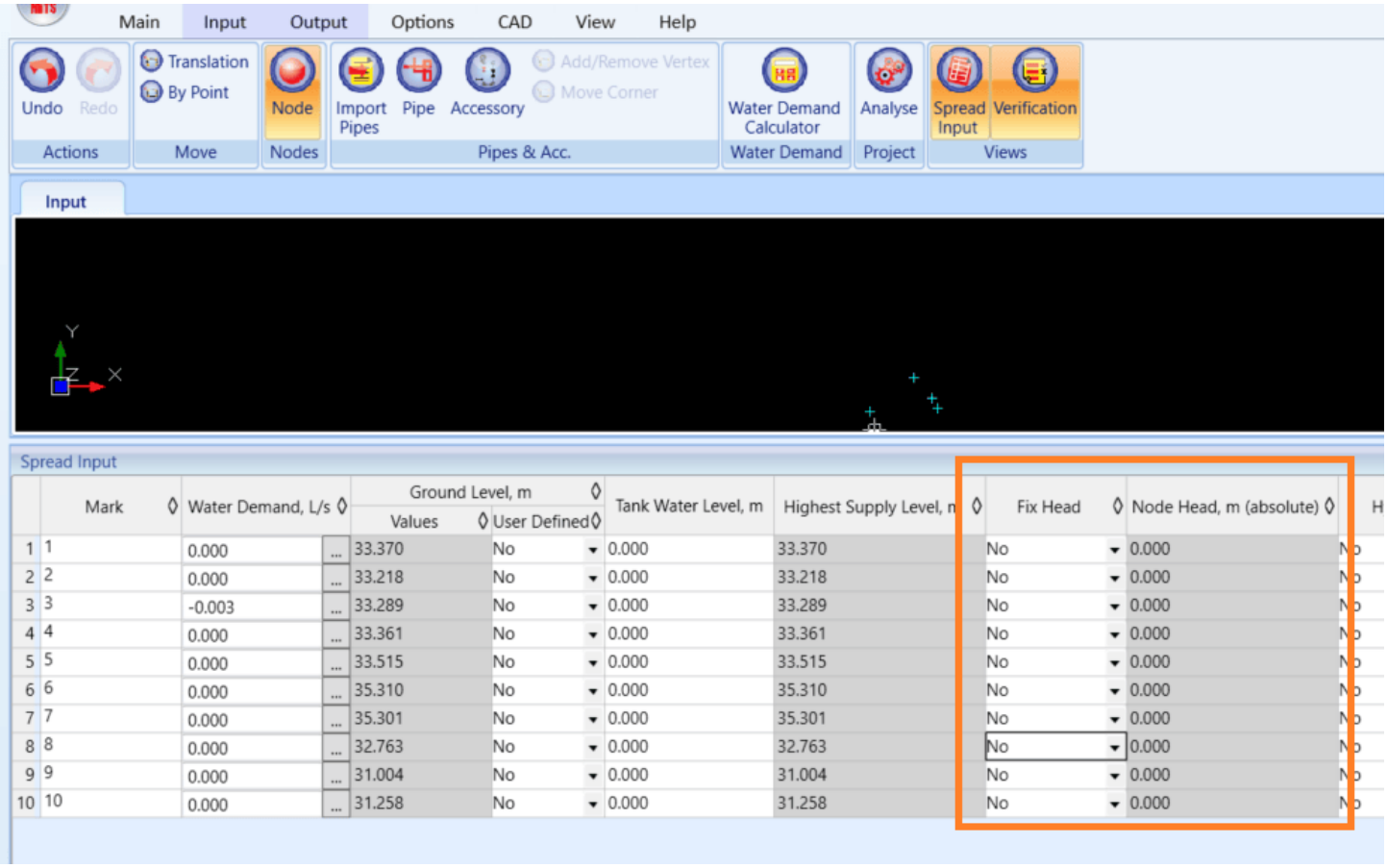
However, changes to the diameter might lead to the failure of the Residual Pressure as they are closely related to each other. Further discussion with the authority is required if further changes will fail the design, given the constraint of the project.

Network does not contain any node with fix head



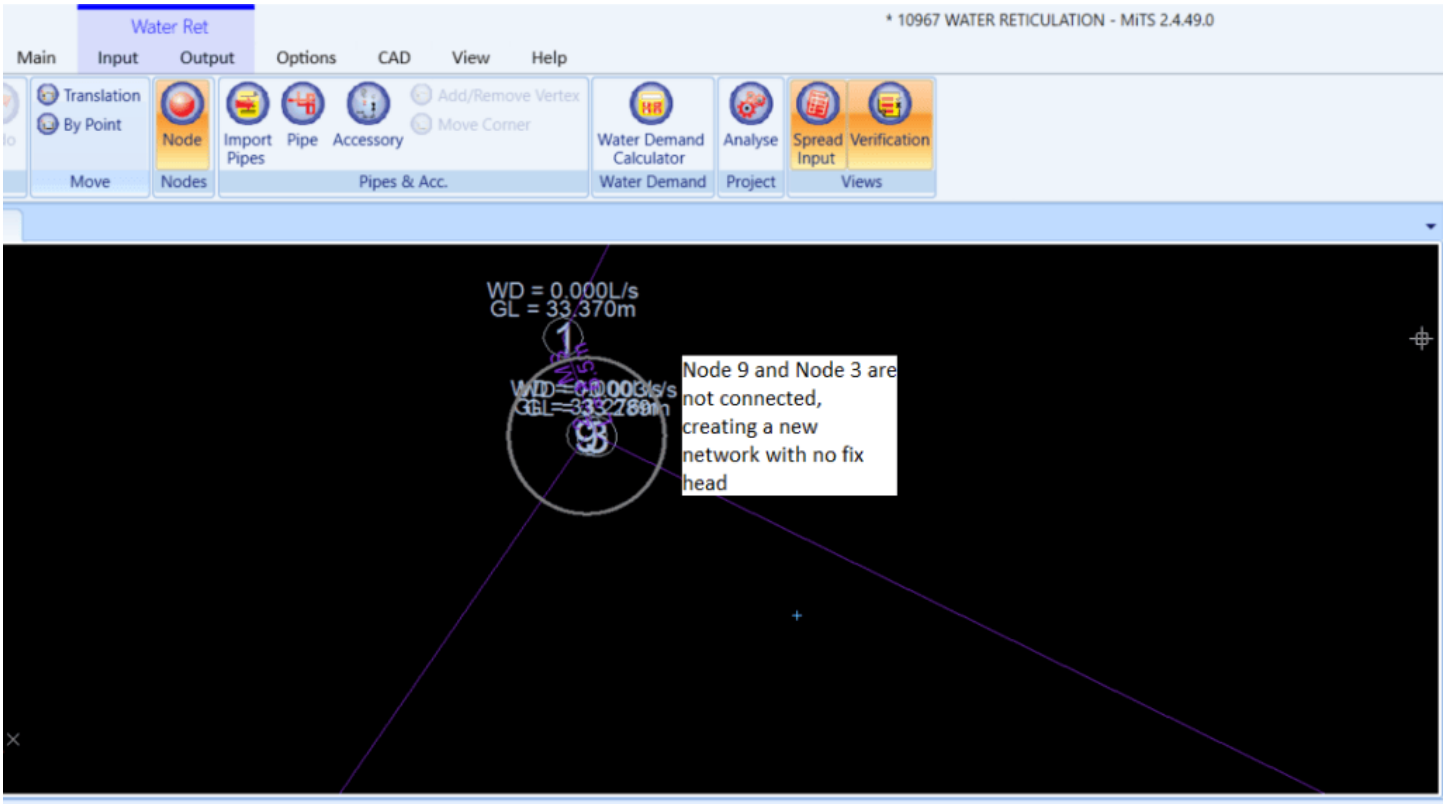
Where to check

"Input > Node > Fix Head"

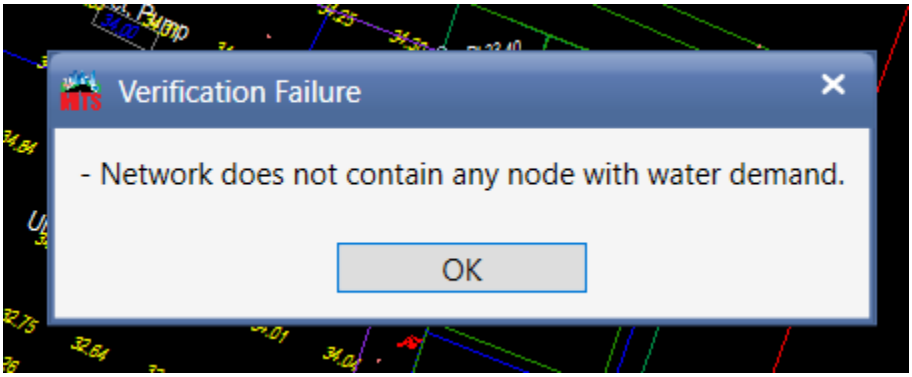


Steps to troubleshoot

1. Insert at least one fix head in Node Spread Input, **OR**
2. In rare cases, if the error still happens although a fixed head was assigned, it is most probably due to a disconnected node. So basically a new network is created and no fixed head. Therefore, adjust the nodes to be connected to resolve it.

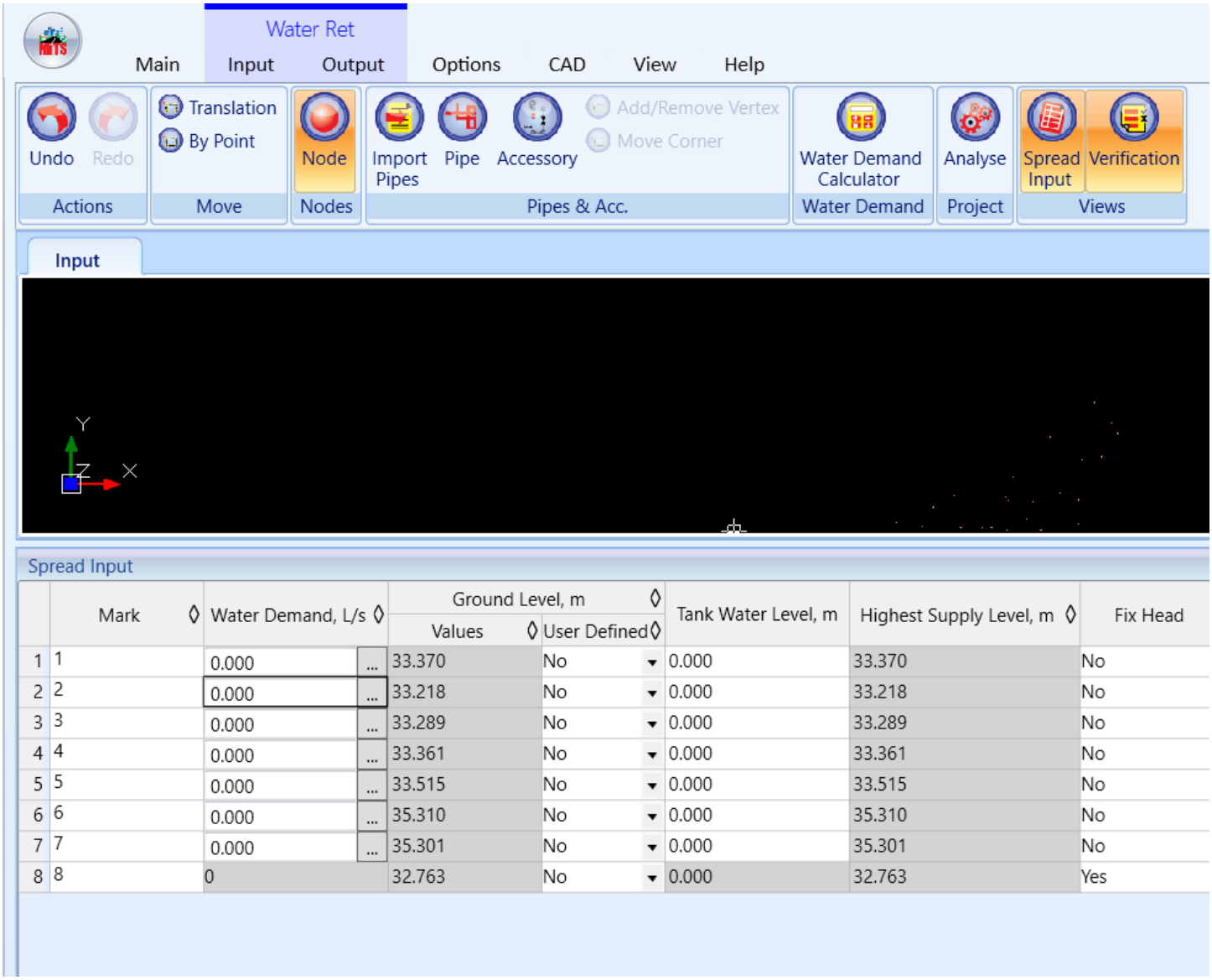


Network does not contain any node with water demand



Where to check

“Input > Node > Spread Input > Water Demand Column”

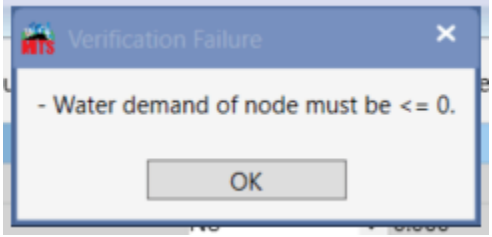


	Mark	Water Demand, L/s	Ground Level, m		Tank Water Level, m	Highest Supply Level, m	Fix Head
			Values	User Defined			
1	1	0.000	33.370	No	0.000	33.370	No
2	2	0.000	33.218	No	0.000	33.218	No
3	3	0.000	33.289	No	0.000	33.289	No
4	4	0.000	33.361	No	0.000	33.361	No
5	5	0.000	33.515	No	0.000	33.515	No
6	6	0.000	35.310	No	0.000	35.310	No
7	7	0.000	35.301	No	0.000	35.301	No
8	8	0	32.763	No	0.000	32.763	Yes

Step to troubleshoot

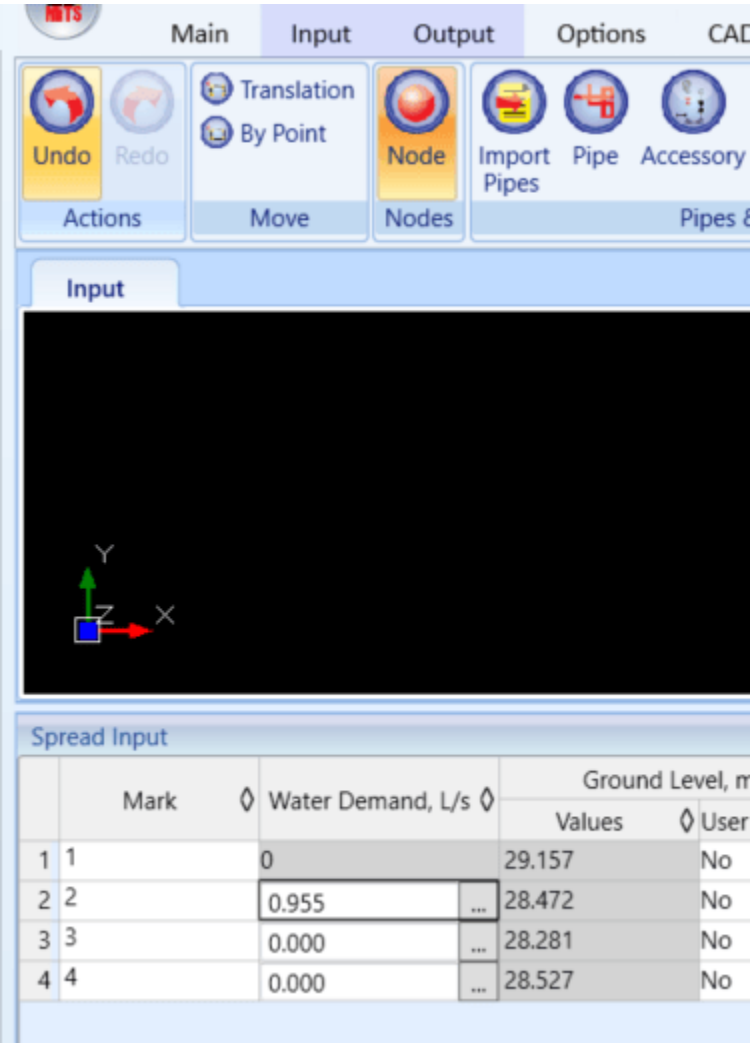
Define at least a node with water demand . Click the water demand calculator and add in water demand

Water demand of the node must be <= 0



Where to check

“Input > Node > Spread Input > Water Demand”

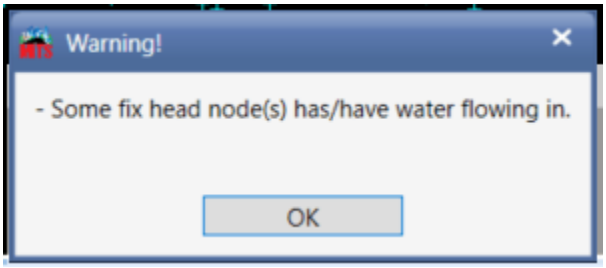


Steps to troubleshoot

Water demand is drawing out the water, hence it must be -ve sign

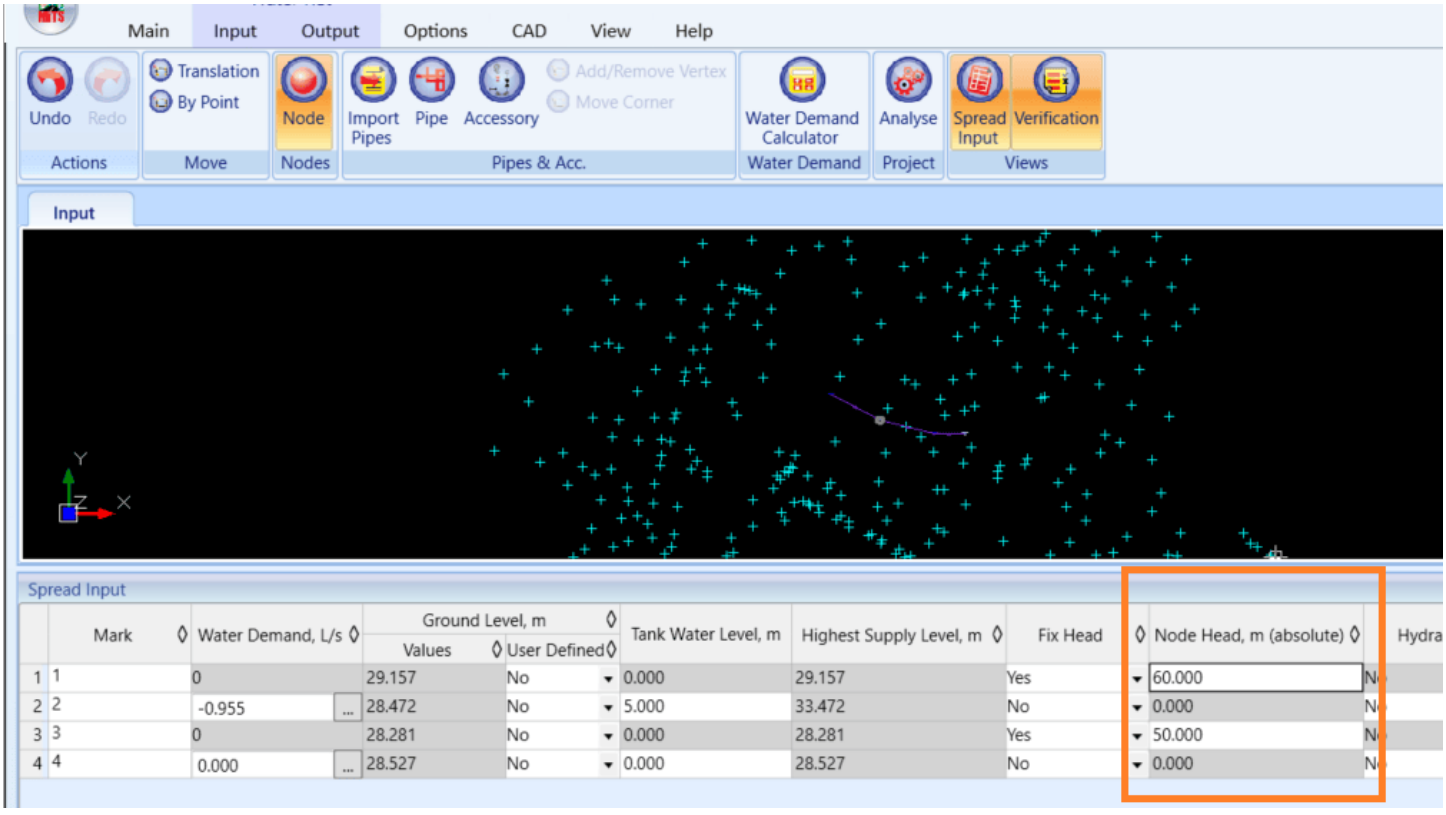
1. Add negative sign of the keyed in water demand, **OR**
2. Use Water Demand Calculator as it will automatically calculate it for you

Some fix head node(s) has/have water flowing in



Where to check

“Input > Node > Spread Input > Fix Head > Node Head”

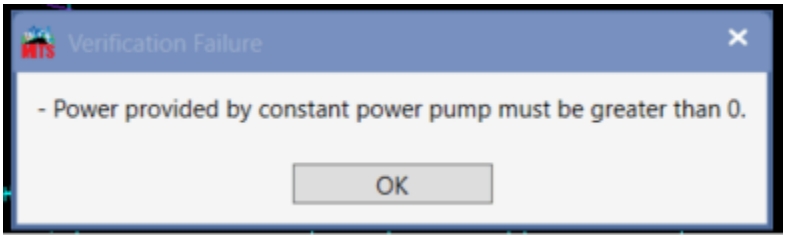


Steps to troubleshoot

1. Recheck on the number of Fix Head in a network (usually only one fix head for a network), **OR**

2. If there are multiple fix heads, recheck on the Node Head value and make sure that the values are not more than one another

Power provided by constant power pump must be greater than 0



Where to check

“Input > Pipe > Spread Input > Pumps/Valve column > Pump > Power Value”

Step to troubleshoot

- Insert a value which is more than 0 for the Power

Valve x can not be connected to a tank

Where to check

“Input > Pipe > Spread Input > Pumps/Valve column > Valve”

Step to troubleshoot

- Valves cannot be placed at the first pipe. If you insist on placing it at the first pipe, create a dummy pipe, as long as the valve is not located at the first pipe.

Fire flow calculation is not generated

Where to check

- Fire flow calculation is not included in Excel Report Output
- Fire flow calculation is not included in Textual Report Output
- Fire flow is not shown in Schematic Plan Output

Steps to troubleshoot

1. Assign hydrants

“Input > Node > Spread Input > Hydrant (assign Yes)”

2. Fire flow calculation is not generated although Hydrant Accessory is assigned. Accessories are only symbolic of the item, hence it does not have any effect on the calculation. Therefore, refer to step number 1 to solve it.

Blank Loop Verification Output

Where to check

Your network design type (looped/branch)

Explanation

Loop Verification Output is only for looped networks. If the network is branched, this output will not be generated.

Other related documents:

- Water Reticulation Benchmark
- Manual Headloss Calculation Benchmark with MES Software
- LW+: How to apply pump & valve to keep pressure within range

- Why does the pump at the end of the water pipe not work?
- Loopwin+ : Pump Curve design

Related



Ngu Soon Hui

I'm the Benevolent Dictator for Life for MiTS Software cum Editor of this website. Read more here.

You can also contact me at soonhui@mes100.com