Flow Depth Mode in Sewerage Module

Sewer · https://mes100.com/docs/flow-depth-mode-in-sewerage-module/

Starting from MiTS 3.3, Flow Depth Mode options are introduced for gravity sewers. Depending on the design approach, users will have the option between full-flow, proportional-flow and actual-flow which will affect the velocity calculation.

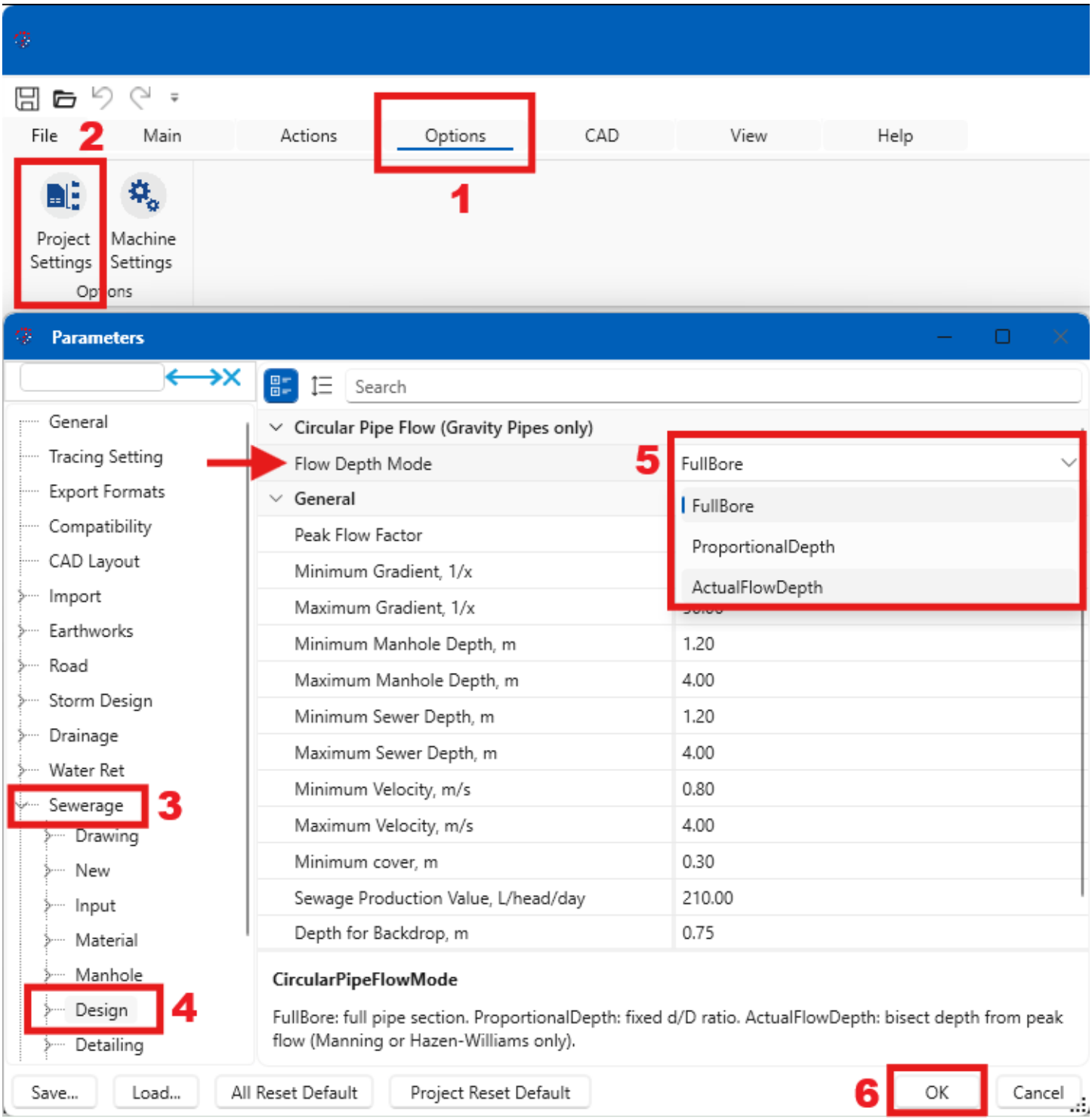
It is worth noting that any changes to the option will only take effect on the Manning or Hazen-Williams velocity equations. It is not applicable when the velocity equation set is Colebrook White.

What Are the Options Available?

- **FullBore**: The Full Bore mode assumes that the sewer pipe flows completely full at all times.
- **ProportionalDepth**: The Proportional Depth mode assumes the water depth to be a fixed proportion of the pipe diameter.
- **ActualFlowDepth**: The Actual Flow Depth mode computes the actual water depth by iteratively solving the partial-flow hydraulic equations based on the specified peak flow and design gradient.

How to Assign the Flow Depth Mode

To assign or to change the Flow Depth Mode, go to *Options > Project Settings > Expand Sewerage > Click on Design > Click the Flow Depth Mode dropdown > Select the mode > Click OK.*



Detail Calculation with Comparison

Sample Project File

Details of the sewer pipe example:

Diameter: 150 mm

Design Gradient: 1:60.00 = 0.01667

Peak Flow: 0.137 L/s

Manning Coefficient, n (old): 0.017

Manning Coefficient, n (new): 0.01

Velocity Equation: Manning

Cross sectional Area Flow (A)

FullBore	ProportionalDepth	ActualFlowDepth

$$\begin{aligned} A &= \pi r^2 \\ A &= \pi \left(\dfrac{D}{2}\right)^2 \\ A &= \pi \left(\dfrac{0.15}{2}\right)^2 \\ A &= 0.0177\ \text{m}^2 \end{aligned}$$	• Proportional Depth (d/D) = 0.750 • For water depths greater than half the pipe diameter, the calculated angle θ represents the dry central angle. $$\begin{aligned} h &= D \times \left(\dfrac{d}{D}\right) \\ h &= 0.150 \times 0.750 \\ h &= 0.1125\ \text{m} \end{aligned}$$ $$\begin{aligned} r &= \dfrac{D}{2} \\ r &= 0.0750\ \text{m} \end{aligned}$$ $$\begin{aligned} \theta &= 2\cos^{-1}\left(\dfrac{h-r}{r}\right) \\ \theta &= 2\cos^{-1}\left(\dfrac{0.1125-0.075}{0.075}\right) \\ \theta &= 2.0944\ \text{rad} \end{aligned}$$ **Since the water level is more than half the pipe diameter:** $$\begin{aligned} A &= r^2 \left[\pi-\dfrac{\theta-\sin(\theta)}{2}\right] \\ A &= (0.0750)^2 \left[\pi-\dfrac{2.0944-\sin(2.0944)}{2}\right] \\ A &= 0.0142\ \text{m}^2 \end{aligned}$$	• Solve h from peak flow value Q = 0.137 L/s • h is assumed and substituted into the calculation steps until Q = 0.137 L/s is achieved. $h = 0.0079\ \text{m}$ $$\begin{aligned} r &= \dfrac{D}{2} \\ r &= 0.0750\ \text{m} \end{aligned}$$ $$\begin{aligned} \theta &= 2\cos^{-1}\left(\dfrac{r-h}{r}\right) \\ \theta &= 2\cos^{-1}\left(\dfrac{0.075-0.0079}{0.075}\right) \\ \theta &= 0.9262\ \text{rad} \end{aligned}$$ **Since the water level is less than half the pipe diameter:** $$\begin{aligned} A &= r^2 \left[\dfrac{\theta-\sin(\theta)}{2}\right] \\ A &= (0.0750)^2 \left[\dfrac{0.9262-\sin(0.9262)}{2}\right] \\ A &= 0.0004\ \text{m}^2 \end{aligned}$$

Wetted Parameter (P)

FullBore	ProportionalDepth	ActualFlowDepth
$$\begin{aligned} P &= \pi \times D \\ P &= \pi \times 0.15 \\ P &= 0.471\ \text{m} \end{aligned}$$	**Since water level is more than half diameter:** $$\begin{aligned} P &= r \times (2\pi-\theta) \\ P &= 0.0750 \times (2\pi-2.0944) \\ P &= 0.314\ \text{m} \end{aligned}$$	**Since water level is less than half diameter:** $$\begin{aligned} P &= r \times \theta \\ P &= 0.0750 \times (0.9262) \\ P &= 0.069\ \text{m} \end{aligned}$$

Hydraulic Radius (R)

FullBore	ProportionalDepth	ActualFlowDepth
$$\begin{aligned} R &= \dfrac{A}{P} \\ R &= \dfrac{0.0177}{0.471} \\ R &= 0.0375\ \text{m} \end{aligned}$$	$$\begin{aligned} R &= \dfrac{A}{P} \\ R &= \dfrac{0.0142}{0.314} \\ R &= 0.0453\ \text{m} \end{aligned}$$	$$\begin{aligned} R &= \dfrac{A}{P} \\ R &= \dfrac{0.0004}{0.069} \\ R &= 0.00514\ \text{m} \end{aligned}$$

Velocity (V)

FullBore	ProportionalDepth	ActualFlowDepth

Old Pipe $$\begin{aligned} V &= \dfrac{1}{n} \times R^{2/3} \times S^{1/2} \\ V &= \dfrac{1}{0.017} \times (0.0375)^{2/3} \times (0.01667)^{1/2} \\ V &= 0.851\ \text{m/s} \end{aligned}$$ **New Pipe** $$\begin{aligned} V &= \dfrac{1}{n} \times R^{2/3} \times S^{1/2} \\ V &= \dfrac{1}{0.010} \times (0.0375)^{2/3} \times (0.01667)^{1/2} \\ V &= 1.446\ \text{m/s} \end{aligned}$$	**Old Pipe** $$\begin{aligned} V &= \dfrac{1}{n} \times R^{2/3} \times S^{1/2} \\ V &= \dfrac{1}{0.017} \times (0.0453)^{2/3} \times (0.01667)^{1/2} \\ V &= 0.964\ \text{m/s} \end{aligned}$$ **New Pipe** $$\begin{aligned} V &= \dfrac{1}{n} \times R^{2/3} \times S^{1/2} \\ V &= \dfrac{1}{0.010} \times (0.0453)^{2/3} \times (0.01667)^{1/2} \\ V &= 1.639\ \text{m/s} \end{aligned}$$	**Old Pipe** $$\begin{aligned} V &= \dfrac{1}{n} \times R^{2/3} \times S^{1/2} \\ V &= \dfrac{1}{0.017} \times (0.00514)^{2/3} \times (0.01667)^{1/2} \\ V &= 0.266\ \text{m/s} \end{aligned}$$ **New Pipe** $$\begin{aligned} V &= \dfrac{1}{n} \times R^{2/3} \times S^{1/2} \\ V &= \dfrac{1}{0.010} \times (0.00514)^{2/3} \times (0.01667)^{1/2} \\ V &= 0.384\ \text{m/s} \end{aligned}$$

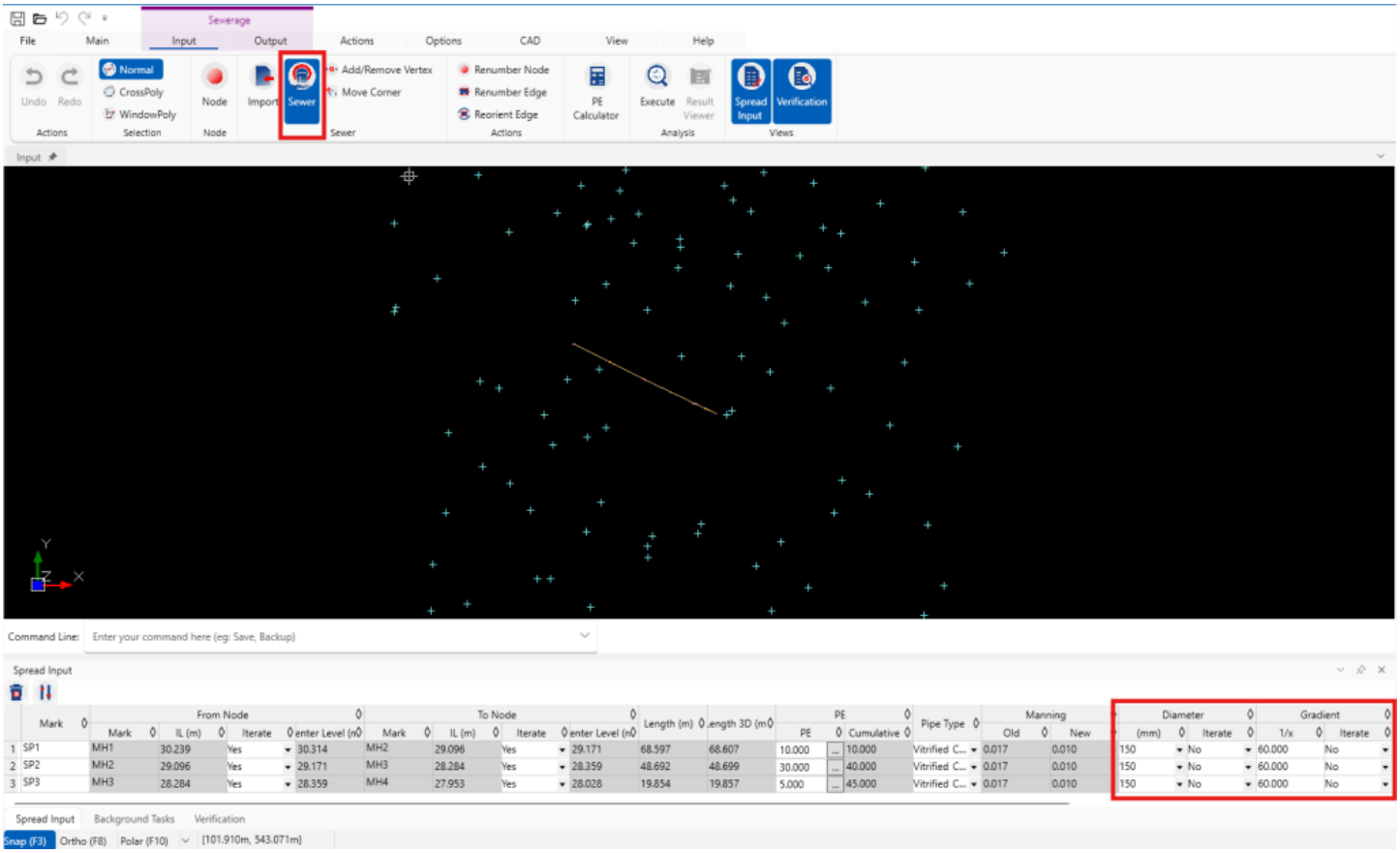
Pipe Flow (Q)

FullBore	ProportionalDepth	ActualFlowDepth

Old Pipe $$\begin{aligned} Q &= V \times A \times 1000 \\ Q &= 0.851 \times 0.0177 \times 1000 \\ Q &= 15.035\ \text{L/s} \end{aligned}$$ **New Pipe** $$\begin{aligned} Q &= V \times A \times 1000 \\ Q &= 1.446 \times 0.0177 \times 1000 \\ Q &= 25.559\ \text{L/s} \end{aligned}$$	**Old Pipe** $$\begin{aligned} Q &= V \times A \times 1000 \\ Q &= 0.964 \times 0.0142 \times 1000 \\ Q &= 13.710\ \text{L/s} \end{aligned}$$ **New Pipe** $$\begin{aligned} Q &= V \times A \times 1000 \\ Q &= 1.639 \times 0.0142 \times 1000 \\ Q &= 23.307\ \text{L/s} \end{aligned}$$	**Old Pipe** $$\begin{aligned} Q &= V \times A \times 1000 \\ Q &= 0.266 \times 0.0004 \times 1000 \\ Q &= 0.095\ \text{L/s} \end{aligned}$$ **New Pipe** $$\begin{aligned} Q &= V \times A \times 1000 \\ Q &= 0.384 \times 0.0004 \times 1000 \\ Q &= 0.137\ \text{L/s} \end{aligned}$$

Discussion

The results above are compared with constant pipe size and gradient or in the MiTS environment, we set them to be ‘Iterate = No’. In the case that Iterate setting is set to ‘Iterate = Yes’, you will notice that the pipe size and gradients will be different between the three flow modes as the software will suggest the suitable properties based on the flow condition.



With the same pipe type, pipe size, gradient, and peak flow, different flow depth modes produce different hydraulic properties as they assume different flow conditions within the pipe.

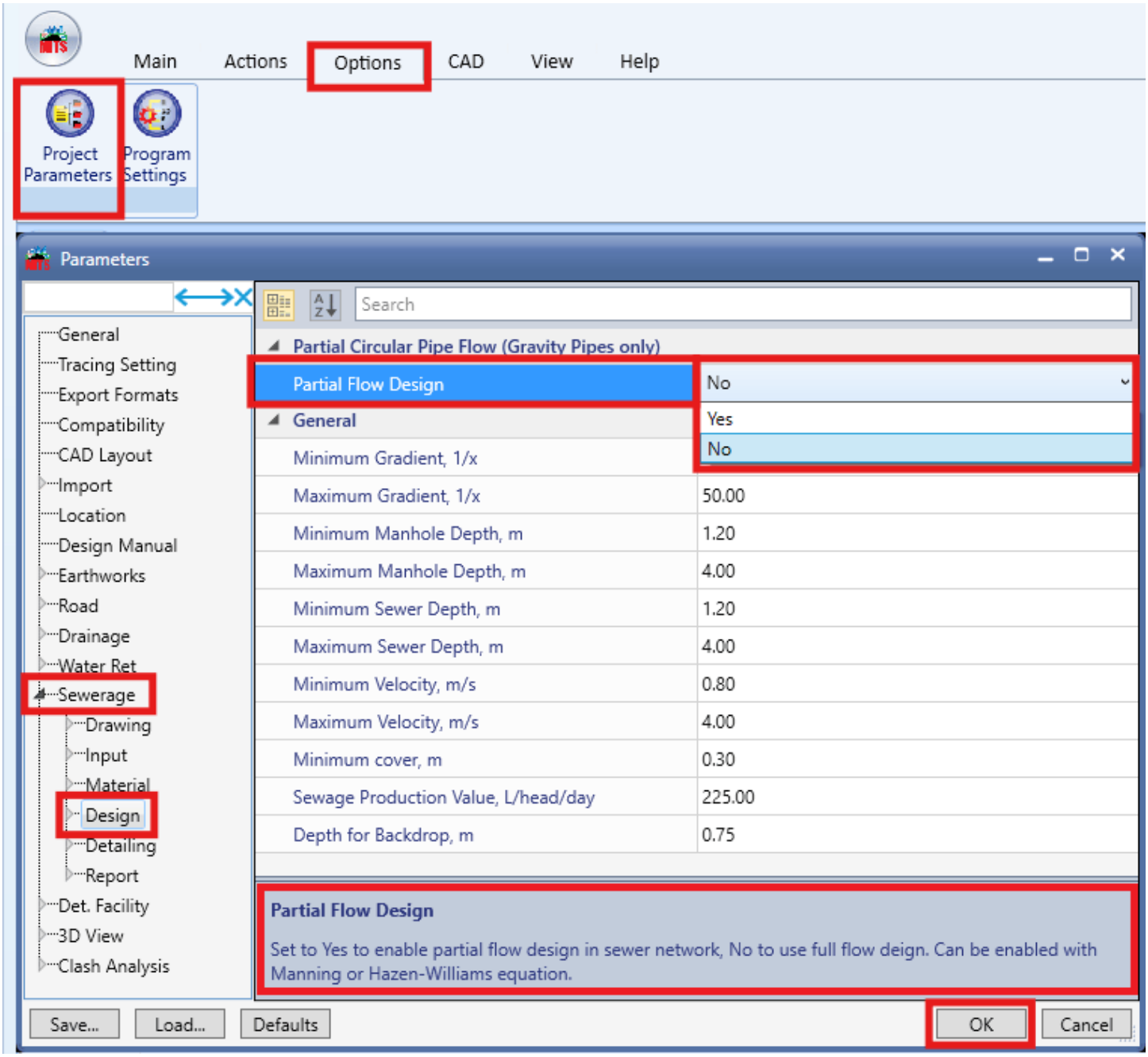
As the wetted area and wetted parameter are both governed by the depth of flow, they influence the hydraulic radius, which subsequently affect the velocity calculation.

What About Previous MiTS Version Files?

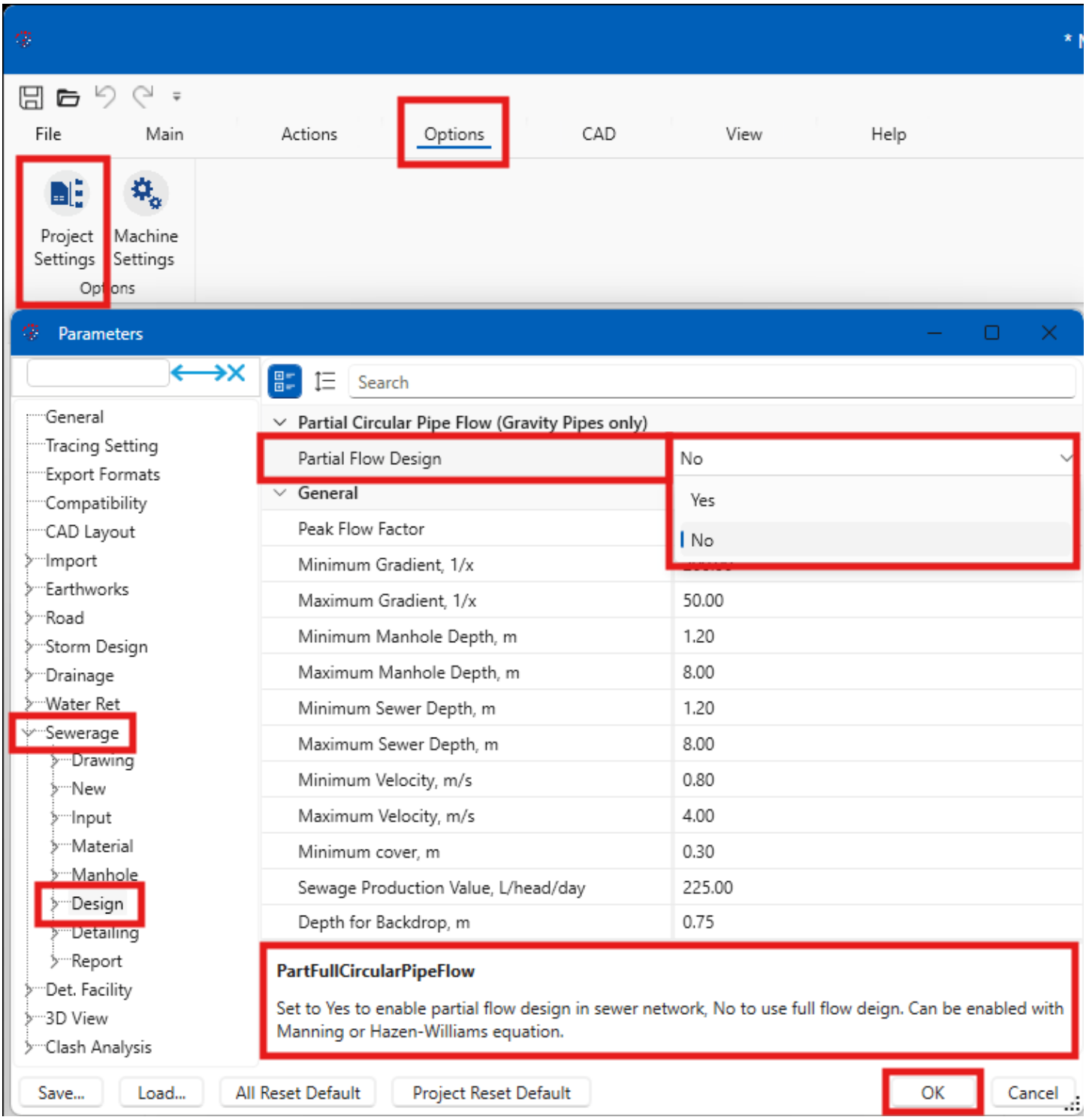
In the previous MiTS 2 and MiTS 3.2 releases, we only provided the partial flow design setting either ‘No’ or ’Yes’. So the users are only able to select either to analyse as full flow or partial flow in the previous versions.

Please rest assured that no changes will be made to the previous setting without your knowledge. Below are the setting conditions when you open the project file in MiTS 3.3 (if your project files are previously saved or created in a lower version than MiTS 3.3).

Previous Setting	New Setting
Partial Flow Design = ‘No’	FullBore
Partial Flow Design = ‘Yes’	ProportionalDepth
New additional flow depth setting ActualFlowDepth in MiTS 3.3	



Previous Partial Flow Design Setting in MiTS 2



Previous Partial Flow Design Setting in MiTS 3.2

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

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