Steady State Peaking Flow Analysis

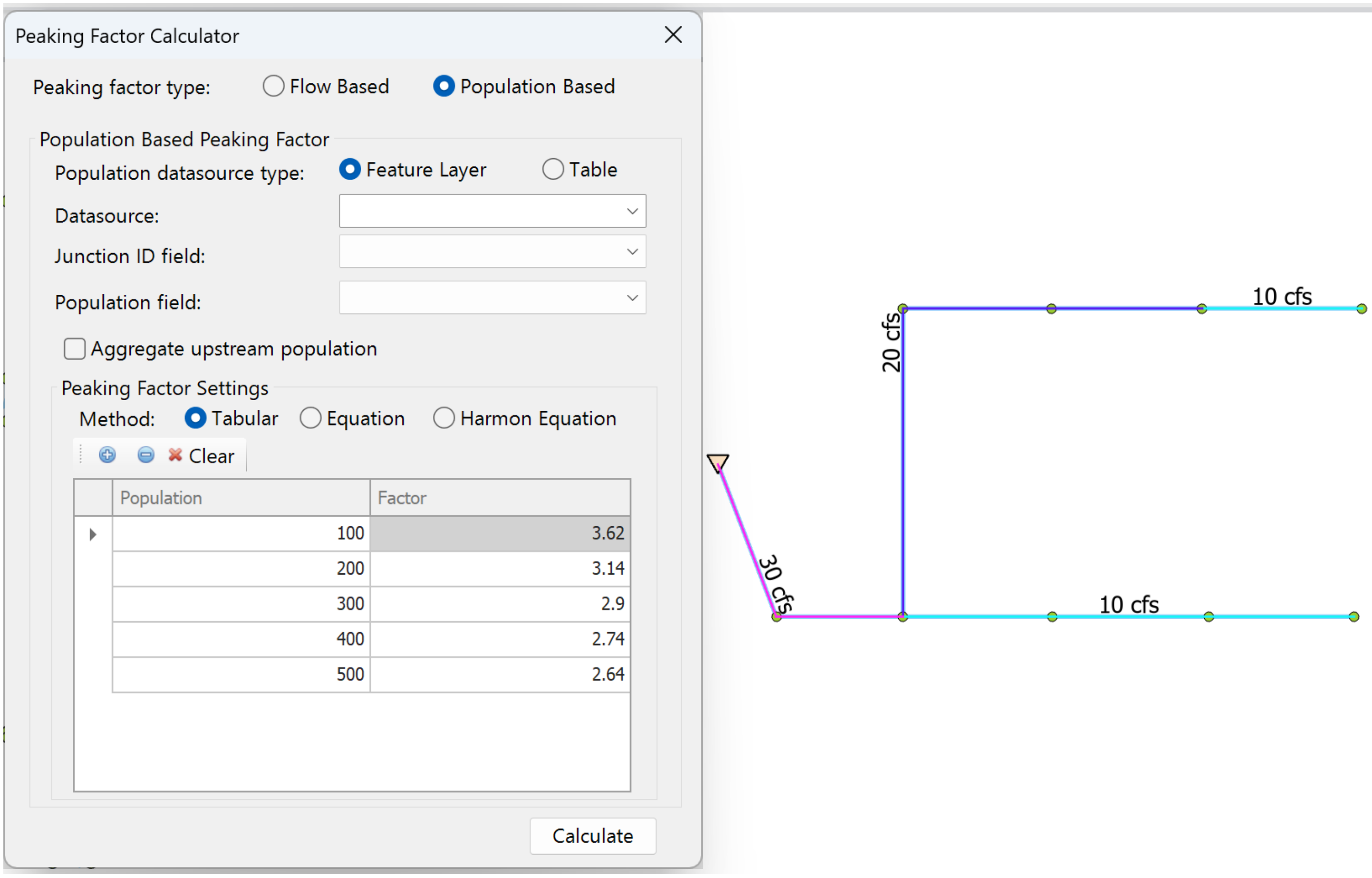

Figure 1: Example of adding the peaking factors in AquaTwin Sewer.

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Adding Peaking Factors

Adding Population Based Peaking Factors

1. The *Peaking Factor Calculator* tool under *Data Explorer > Tools* (**Figure 2**) can be used to add flow/population based peaking factors into the sewer model.

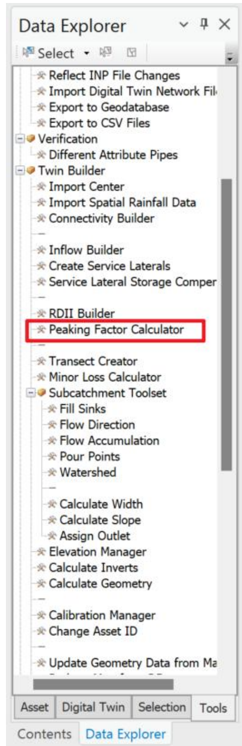


Figure 2: The *Peaking Factor Calculator* tool location.

2. For population based, the *Peaking Factor Calculator* requires a population dataset associated with junctions or nodes to calculate the subsequent peaking factors. This population dataset can be a feature class or external table with matching junction asset IDs. **Figure 3** shows how to import the population data from a feature layer based on matching junction asset IDs.

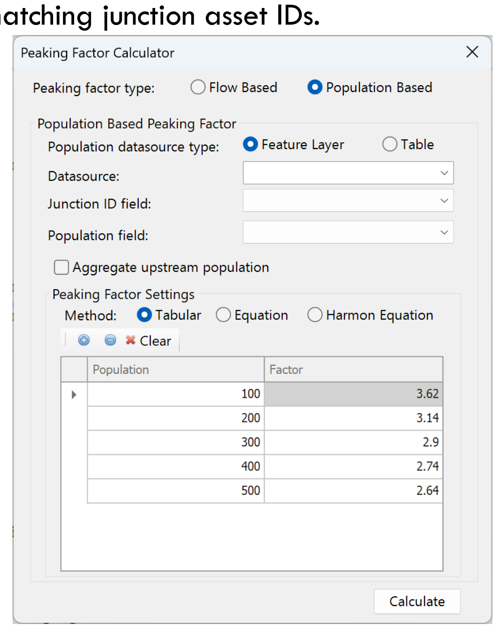


Figure 3: Population data source in the *Peaking Factor Calculator*.

3. AquaTwin Sewer allows the user to import their population based peaking factor in two separate ways:
    - Tabular Method: The tabular method allows the user to create a table of population vs peaking factors.

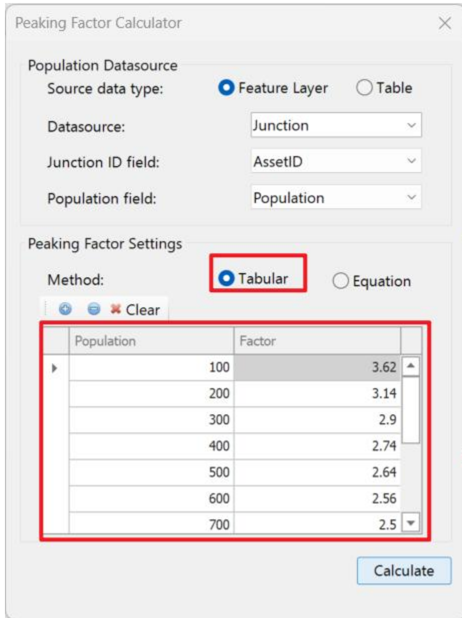


Figure 4: An example of tabular peaking factors.

    - Equation Method: The equation method allows the user to add peaking factors based on a general exponential equation as shown in **Figure 5**. This generic equation is,

$$\text{Peaking Factor} = c_1 + \frac{c_2 + (m_1 P)^{e_1}}{c_3 + (m_2 P)^{e_2}}$$

    Where, $c_1, c_2, c_3, m_1, m_2, e_1$, and e_2 are all constants.

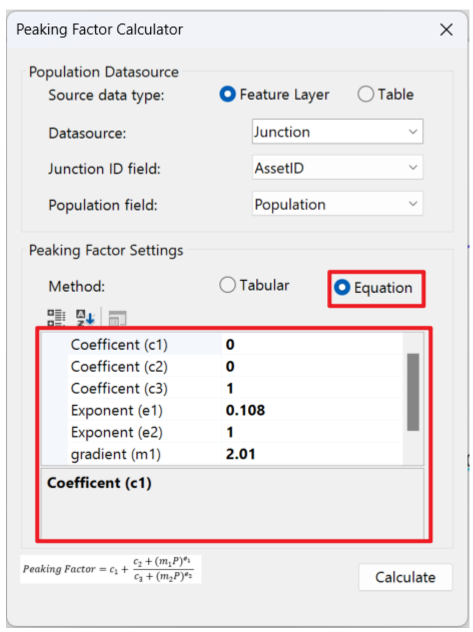


Figure 5: An example of peaking factors based on generic equation.

Finally, the *Calculate* button will calculate and add the population based peaking factors in the *Junction Twin Attribute Tables*.

4. For the flow based peaking factors, the peaking factors will be applied based on the flows in the links.

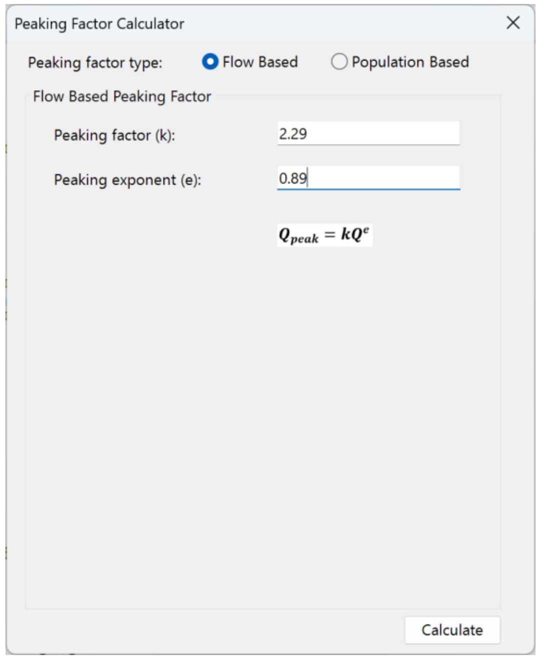
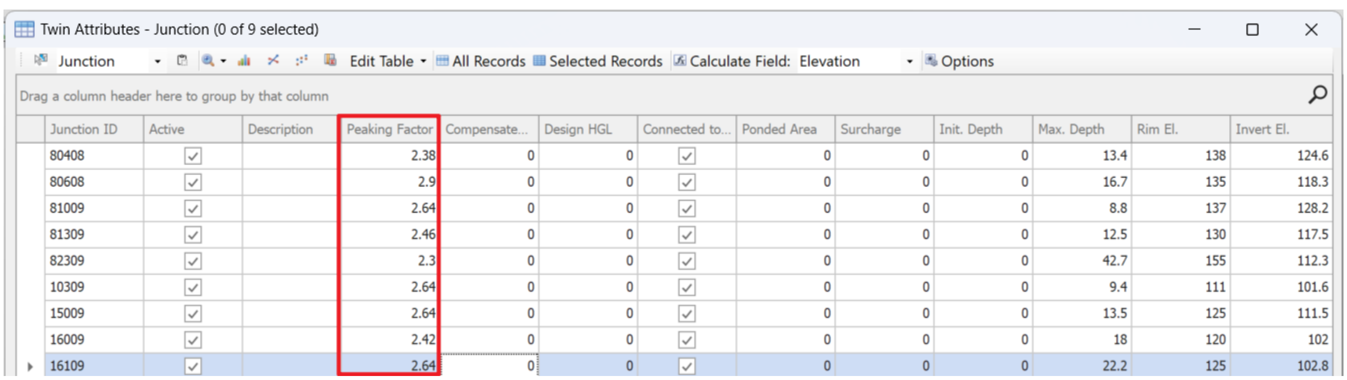


Figure 6: An example of flow based peaking factors.

Adding/Modifying Peaking Factors from Junction Twin Attribute Tables

1. The calculated peaking factors are populated as a model parameter in the *Junction Twin Attribute Table* **(Figure 7)**. The user can add new or modify the already calculated peaking factors here.



Junction ID	Active	Description	Peaking Factor	Compensate...	Design HGL	Connected to...	Ponded Area	Surcharge	Init. Depth	Max. Depth	Rim El.	Invert El.
80408	✓		2.38	0	0	✓	0	0	0	13.4	138	124.6
80608	✓		2.9	0	0	✓	0	0	0	16.7	135	118.3
81009	✓		2.64	0	0	✓	0	0	0	8.8	137	128.2
81309	✓		2.46	0	0	✓	0	0	0	12.5	130	117.5
82309	✓		2.3	0	0	✓	0	0	0	42.7	155	112.3
10309	✓		2.64	0	0	✓	0	0	0	9.4	111	101.6
15009	✓		2.64	0	0	✓	0	0	0	13.5	125	111.5
16009	✓		2.42	0	0	✓	0	0	0	18	120	102
16109	✓		2.64	0	0	✓	0	0	0	22.2	125	102.8

Figure 7: Adding/modifying the peaking factors from *Junction Twin Attribute Tables*.

Steady State Analysis

Starting a Steady State Analysis

To run a steady state simulation in AquaTwin Sewer, the user will need to go to *Digital Twin* > *Run Options* > *General* > *Routing model* and select either *Peak_DWF_Pre_Routing* or *Peak_DWF_Post_Routing* from the dropdown menu **(Figure 8)**.

Peak_DWF_Pre_Routing and *Peak_DWF_Post_Routing* are both used for steady state peak flow analysis. For either of these options, AT Sewer will disable all the patterns and run the dynamic model

(*Dynamic_Wave* or *Implicit_FSGI* flow routing) with just the baseline (Direct) and average (DWF) inflows until the solution reaches steady state.

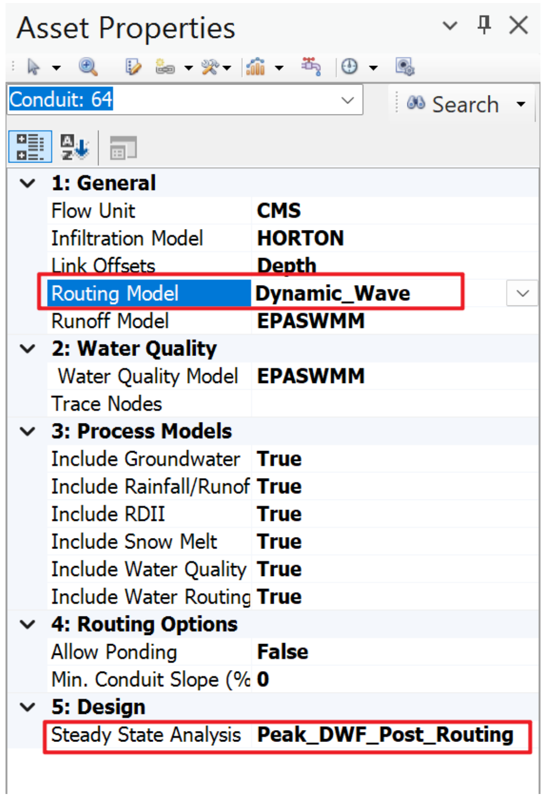


Figure 8: Routing options for steady state analysis.

For the ***Peak_DWF_pre_routing*** option, the average DWF will be peaked (based on the peaking factors associated with your junctions) and then baseline + peaked DWF will be routed through the network.

For the ***Peak_DWF_post_routing*** option, the model first routes the baseline flows alone. Next, it routes the baseline + average DWF together. After both simulations are complete, the routed baseline flows are subtracted from the routed baseline + average DWF results. This isolates the routed DWF portion of the flow. The program then applies the peaking factors to this routed DWF portion, and finally adds the baseline flows back in to produce the total peak flow. For most steady-state peak flow analyses conducted in the U.S., the ***Peak_DWF_post_routing*** approach is the recommended and appropriate method.

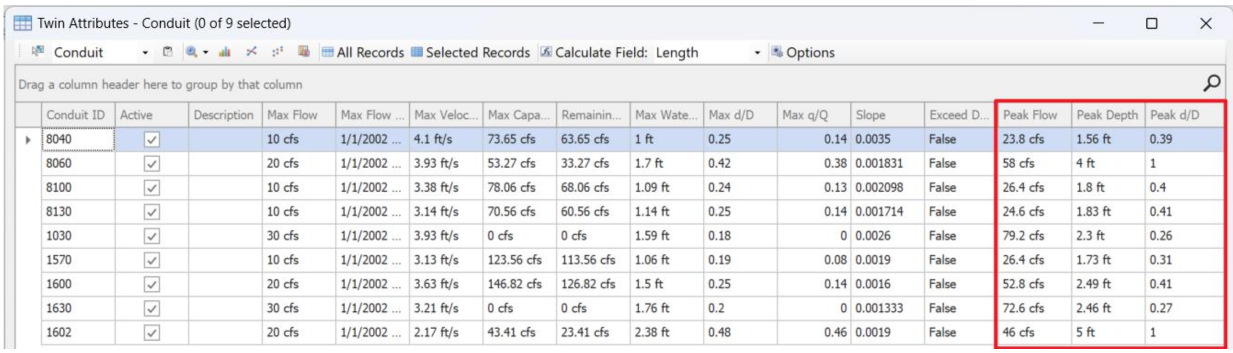
NOTE 1: The *Run Options* > *Time Steps* > *Steady Flow Periods* > *System Flow* Tolerance setting controls how the model determines convergence during a steady-state simulation. The default tolerance is 5%, which is suitable for most cases. However, for some models, using a lower tolerance (less than 1%) can yield more accurate and stable results.

NOTE 2: Setting the *Steady State Analysis* to either *Peak_DWF_Pre_Routing* or *Peak_DWF_Post_Routing* causes the model to ignore all patterns and inflow hydrographs at junctions. In this mode, only the constant direct inflows and constant DWF values at junction nodes are used for steady-state calculations. The peaking factors are applied **only** when one of these Steady State Analysis options is enabled.

NOTE 3: The *Steady_Flow* routing model cannot simulate adverse-sloped pipes or backwater effects. In addition, a Divider node may be necessary to correctly distribute flows when three or more conduits connect to a single junction. Further details on the limitations of the *Steady_Flow* routing method are provided in the [EPA SWMM Hydraulic Manual](). Because of these limitations, using Dynamic Wave / Implicit FSGI flow routing is recommended.

Viewing Peaked Flow Results

1. After running the simulation, the peaked flow at all the conduits can be viewed from the *Conduit Twin Attribute > Options > Summary results* (**Figure 9**).



Conduit ID	Active	Description	Max Flow	Max Flow ...	Max Veloc...	Max Capa...	Remainin...	Max Wate...	Max d/D	Max q/Q	Slope	Exceed D...	Peak Flow	Peak Depth	Peak d/D
8040	✓		10 cfs	1/1/2002 ...	4.1 ft/s	73.65 cfs	63.65 cfs	1 ft	0.25	0.14	0.0035	False	23.8 cfs	1.56 ft	0.39
8060	✓		20 cfs	1/1/2002 ...	3.93 ft/s	53.27 cfs	33.27 cfs	1.7 ft	0.42	0.38	0.001831	False	58 cfs	4 ft	1
8100	✓		10 cfs	1/1/2002 ...	3.38 ft/s	78.06 cfs	68.06 cfs	1.09 ft	0.24	0.13	0.002098	False	26.4 cfs	1.8 ft	0.4
8130	✓		10 cfs	1/1/2002 ...	3.14 ft/s	70.56 cfs	60.56 cfs	1.14 ft	0.25	0.14	0.001714	False	24.6 cfs	1.83 ft	0.41
1030	✓		30 cfs	1/1/2002 ...	3.93 ft/s	0 cfs	0 cfs	1.59 ft	0.18	0	0.0026	False	79.2 cfs	2.3 ft	0.26
1570	✓		10 cfs	1/1/2002 ...	3.13 ft/s	123.56 cfs	113.56 cfs	1.06 ft	0.19	0.08	0.0019	False	26.4 cfs	1.73 ft	0.31
1600	✓		20 cfs	1/1/2002 ...	3.63 ft/s	146.82 cfs	126.82 cfs	1.5 ft	0.25	0.14	0.0016	False	52.8 cfs	2.49 ft	0.41
1630	✓		30 cfs	1/1/2002 ...	3.21 ft/s	0 cfs	0 cfs	1.76 ft	0.2	0	0.001333	False	72.6 cfs	2.46 ft	0.27
1602	✓		20 cfs	1/1/2002 ...	2.17 ft/s	43.41 cfs	23.41 cfs	2.38 ft	0.48	0.46	0.0019	False	46 cfs	5 ft	1

Figure 9: Viewing peaked flow results from the conduit twin attribute table.

2. Individual peaked flows can be viewed from the Asset Properties window (**Figure 10**).

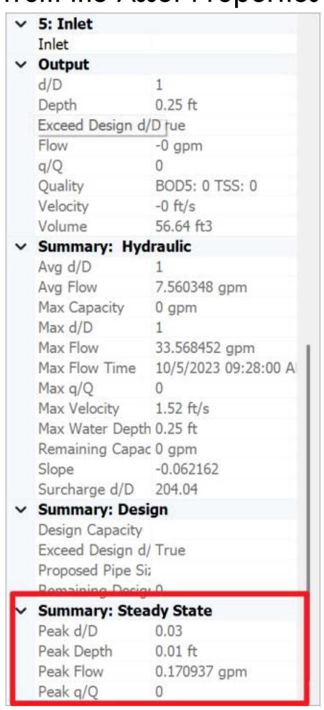


Figure 10: Individual peaked flow in the asset properties window.

Moreover, the map display option if also available for peaked flow results.

NOTE 4: The regular output and summary results do not apply to Steady State Analysis. When reviewing these results, the model will display only the baseline + average DWF simulation outcomes, without any peaking factors applied. As a result, the steady-state peak flow adjustments will not appear in the standard output or summary tables.