Storm Sync Time Area Hydrology

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Storm Sync Time Area converts rainfall excess over each catchment into a runoff hydrograph using travel-time bands. It is available in Storm Design analysis alongside the Rational methods. This guide covers the rainfall, catchment-band, and loss-model setup. Before going further on the user guide, it is best for users first understand the fundamentals of Time Area Method.

Understanding Time Area Method

The Time Area Method is a hydrological method used to estimate how runoff from a catchment reaches its outlet over time. During rainfall, runoff is generated from different parts of a catchment and travels towards a common outlet. However, runoff does not reach the outlet all at once. Water from areas closer to the outlet generally arrives sooner, while water from areas further away takes longer to arrive.

The Time Area method accounts for these differences in travel time by grouping the catchment into areas based on how long runoff takes to reach the outlet. It then estimates the runoff contributions arriving at each time interval and combines them to produce a runoff hydrograph, showing how the flow rate changes throughout a storm. The method focuses purely on the translation (timing/delay) of runoff from different sub-areas as they reach the outlet.

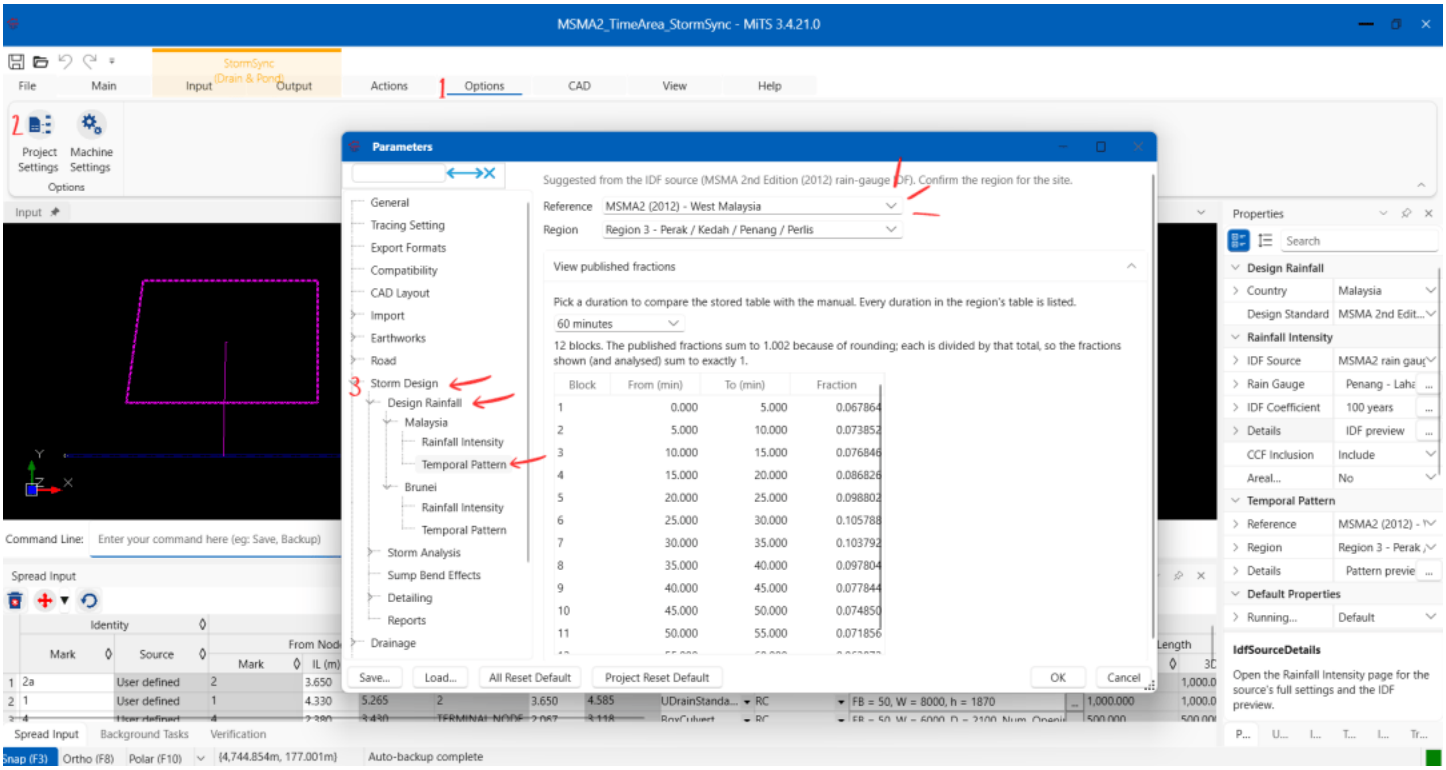
Choose the rainfall temporal pattern and storm durations

A rainfall temporal pattern is the distribution of total storm rainfall over time during a given precipitation event. It shows how rainfall intensity rises, peaks, and subsides throughout the duration of a storm.

Select the temporal pattern reference and region of the project from Project Settings or RHS Property Grid

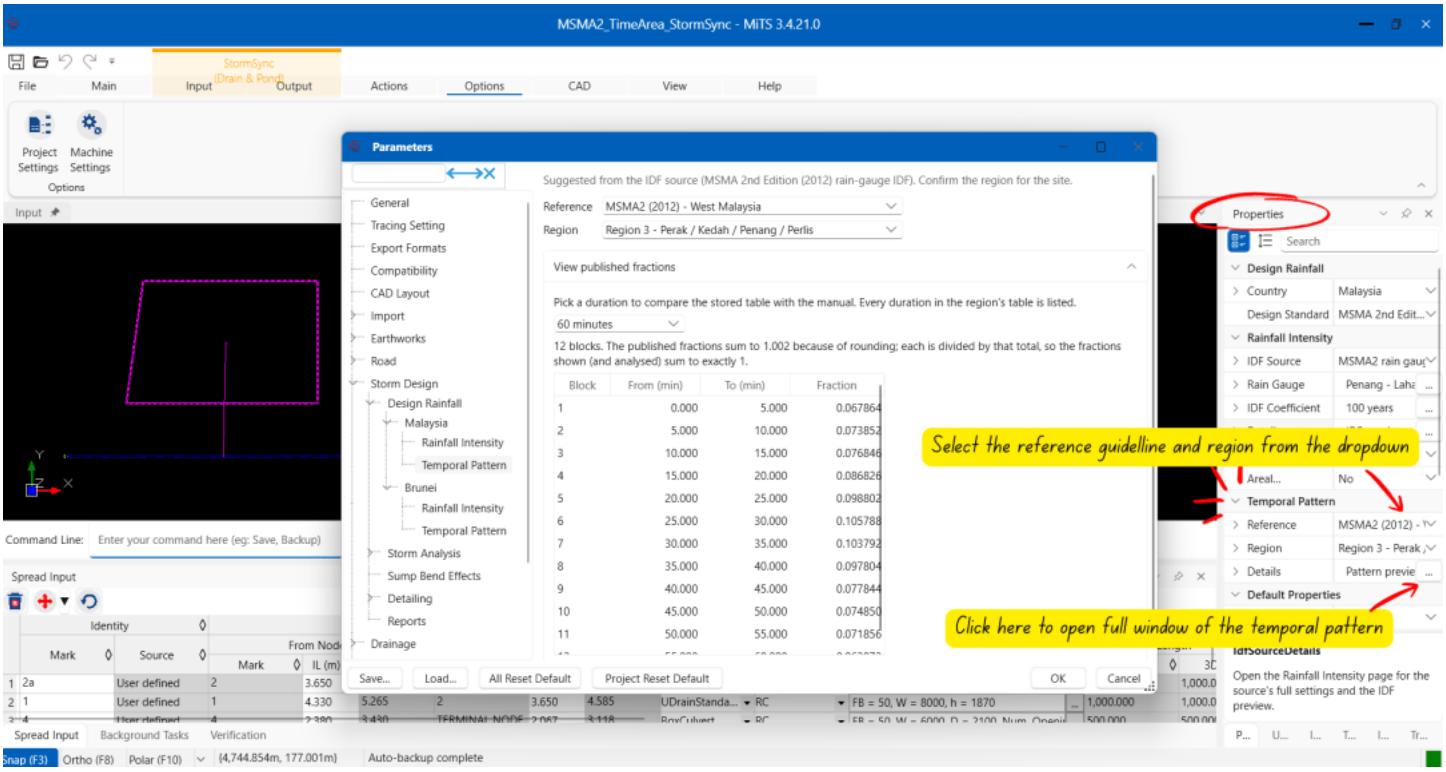
In Project Settings

1. Go to Options → Project Settings
2. Go to **Storm Design → Design Rainfall → Malaysia → Temporal Pattern** (or **Brunei → Temporal Pattern** for a Brunei project).
3. Choose the **Reference** and **Region** of the project from the dropdown.



In RHS Property Grid

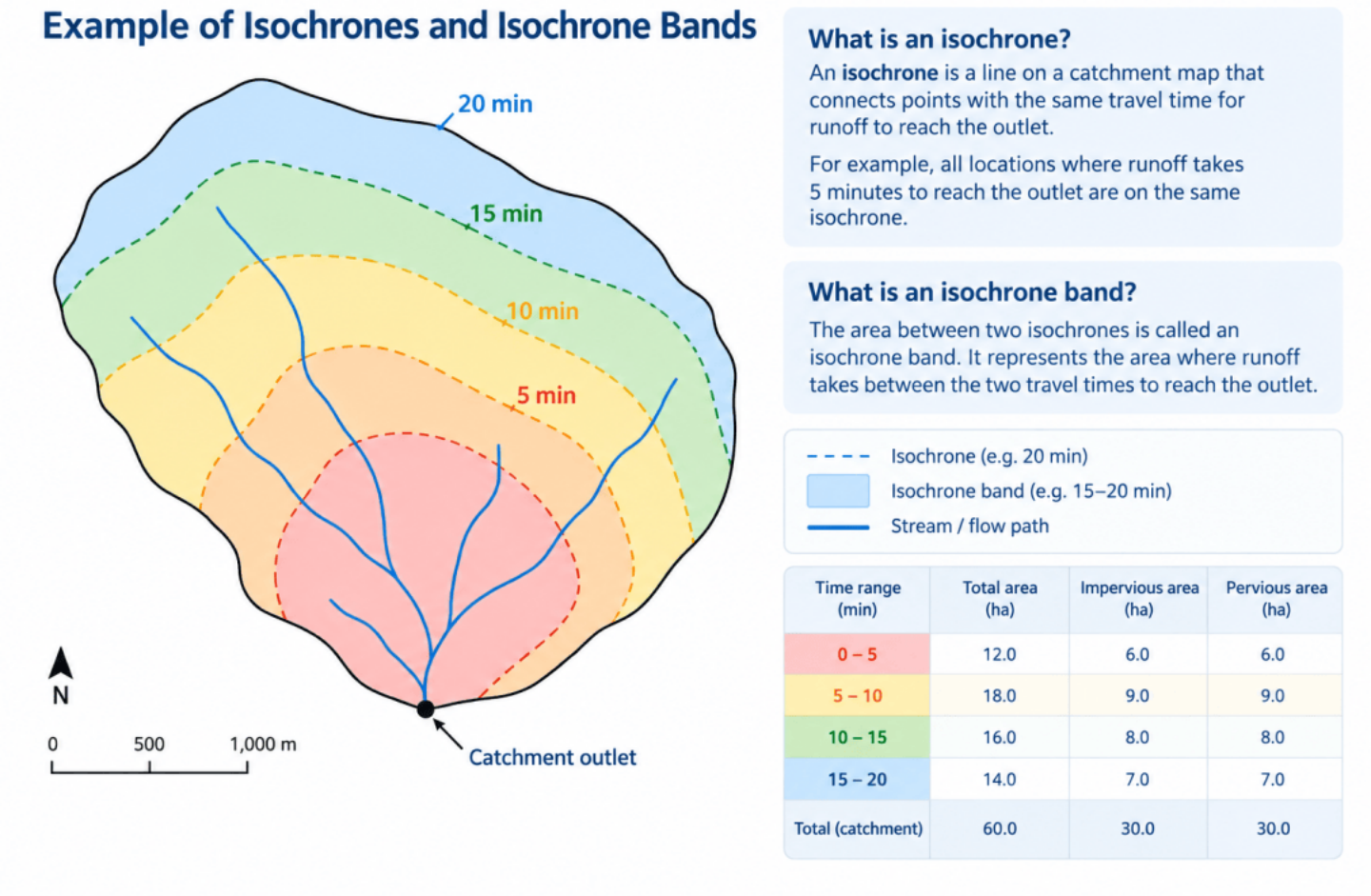
1. Go to StormSync **RHS Property Grid → Temporal Pattern**.
2. Choose the **Reference** and **Region** of the project from the dropdown.



Until a pattern is chosen explicitly, MiTS suggests one from the selected IDF source; the page marks it as suggested. Only storm durations supported by the selected temporal pattern are analysed. Unsupported storm durations are skipped, even if ticked.

Configure catchment bands

The Time–Area method uses isochrones to divide a catchment into isochrone bands according to the travel time of runoff to the catchment outlet. An **isochrone** is **a line connecting locations with the same runoff travel time to the catchment outlet**, while an isochrone **band** is the **area between two isochrones**.



To configure catchment band:

1. In Catchment Spread Input, select a catchment and click the ellipsis (…) in the **Time Area Settings** column.
2. Review the time-area bands. Each band has a start and end travel time, total area, impervious and pervious area.
3. Edit the travel-time ranges and area distribution as needed. Ensure the sum of the total areas across all bands equals the total catchment area

Button	Description
Add band	Add new band
Remove selected	Remove selected band

Button	Description
Reset default bands	Reset the band to the catchment’s overland flow time and total catchment area. The total area will be divided equally among the bands and initially treats the area as impervious

Note:

Default bands provide an initial setup only. They do not represent surveyed land-cover data and should be reviewed and adjusted before running analysis.

Rainfall losses

When rainfall occurs, not all rainfall becomes runoff. Some water infiltrates into the soil, while some may be “lost” through other processes such as depression storage, evapotranspiration and ect. These are known as rainfall losses. The amount of rainfall remaining after accounting for these losses is called rainfall excess, which contributes to surface runoff.

Four rainfall-loss models are available in MITS3, each represent these processes in different ways. The first three models apply an initial abstraction, followed by continuing loss or proportional loss while rainfall continues. Horton infiltration model applies an infiltration capacity that decays gradually from the start of rainfall. All rainfall loss models depend on the selected design standard. MSMA 2nd and 3rd Edition offer all four models. MSMA 1st Edition offers Proportional loss (the legacy PondCAD method), Constant-rate loss (MSMA1 Table 14.4) and Horton infiltration; new MSMA1 catchments start with Proportional loss.

Constant-rate loss (initial loss + constant continuing loss, IL-CL)

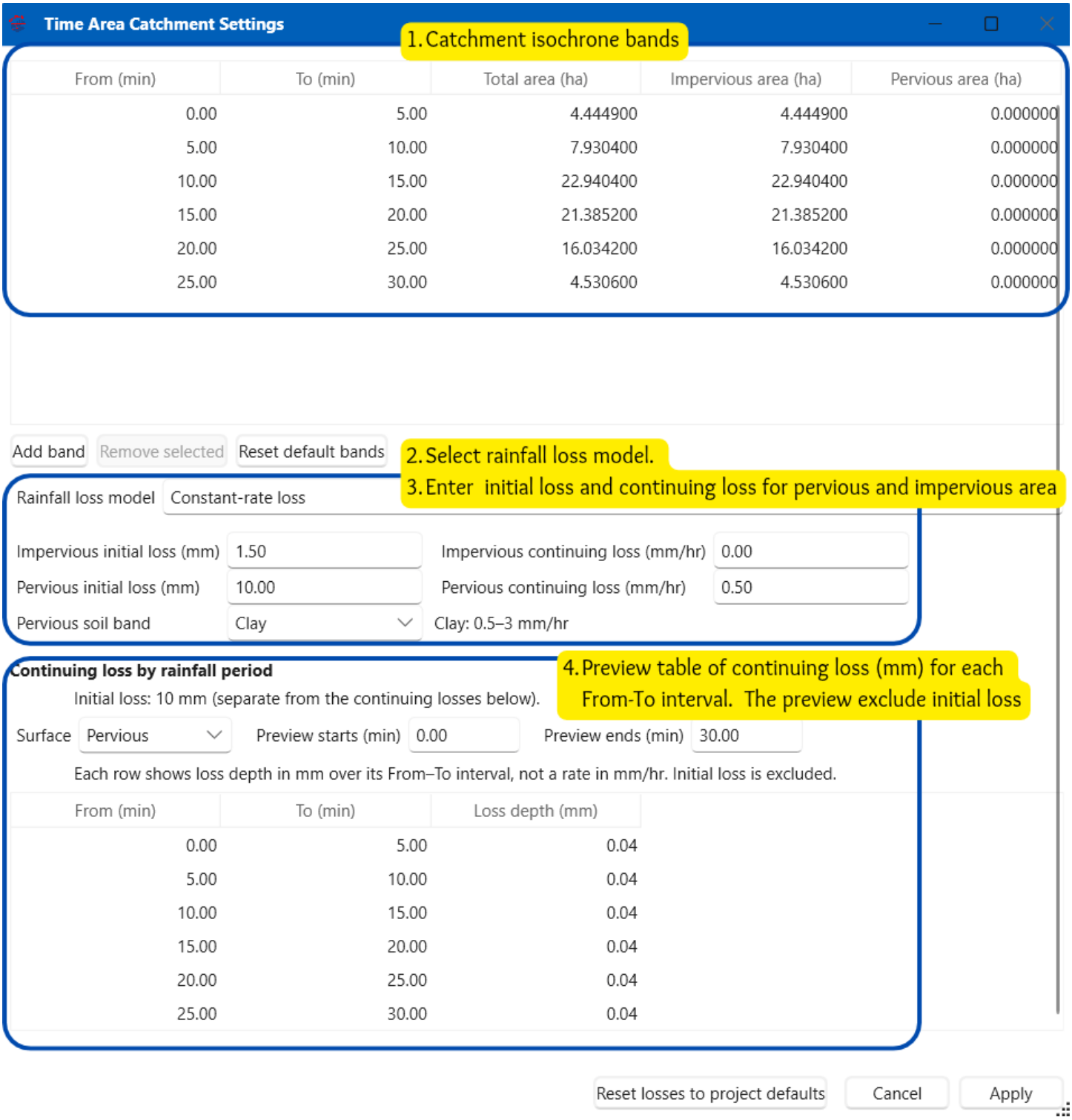
This method calculates rainfall losses in two stages:

1. **Initial loss:** A specified amount of rainfall is lost at the beginning of the storm before the continuing-loss calculation applies.
2. **Constant continuing-loss:** After the initial abstraction, rainfall continues to be lost at a constant rate throughout the storm.

The default values are from MSMA1 (Table 14.4) and MSMA2 (Table 2.6). All values are editable.

- Default initial abstraction is 1.5 mm impervious and 10 mm pervious.
- Default pervious continuing loss is 0.5 mm/h with the Clay soil band.
- Soil bands are Sandy (10–25 mm/h), Loam (3–10 mm/h) and Clay (0.5–3 mm/h); under MSMA1 there is also Shrinking clay, cracked at rainfall start (loss rate of 4–6 mm/h as specified in MSMA1 Table 14.4).
- The default continuing loss rate for impervious surfaces is 0 mm/h.

The editor’s preview table shows the continuing rainfall loss depth (mm) for each From–To time interval. The loss depth is calculated from the surface (pervious and impervious) continuing loss rate (mm/h) entered by the user. Initial loss is not included in the preview.

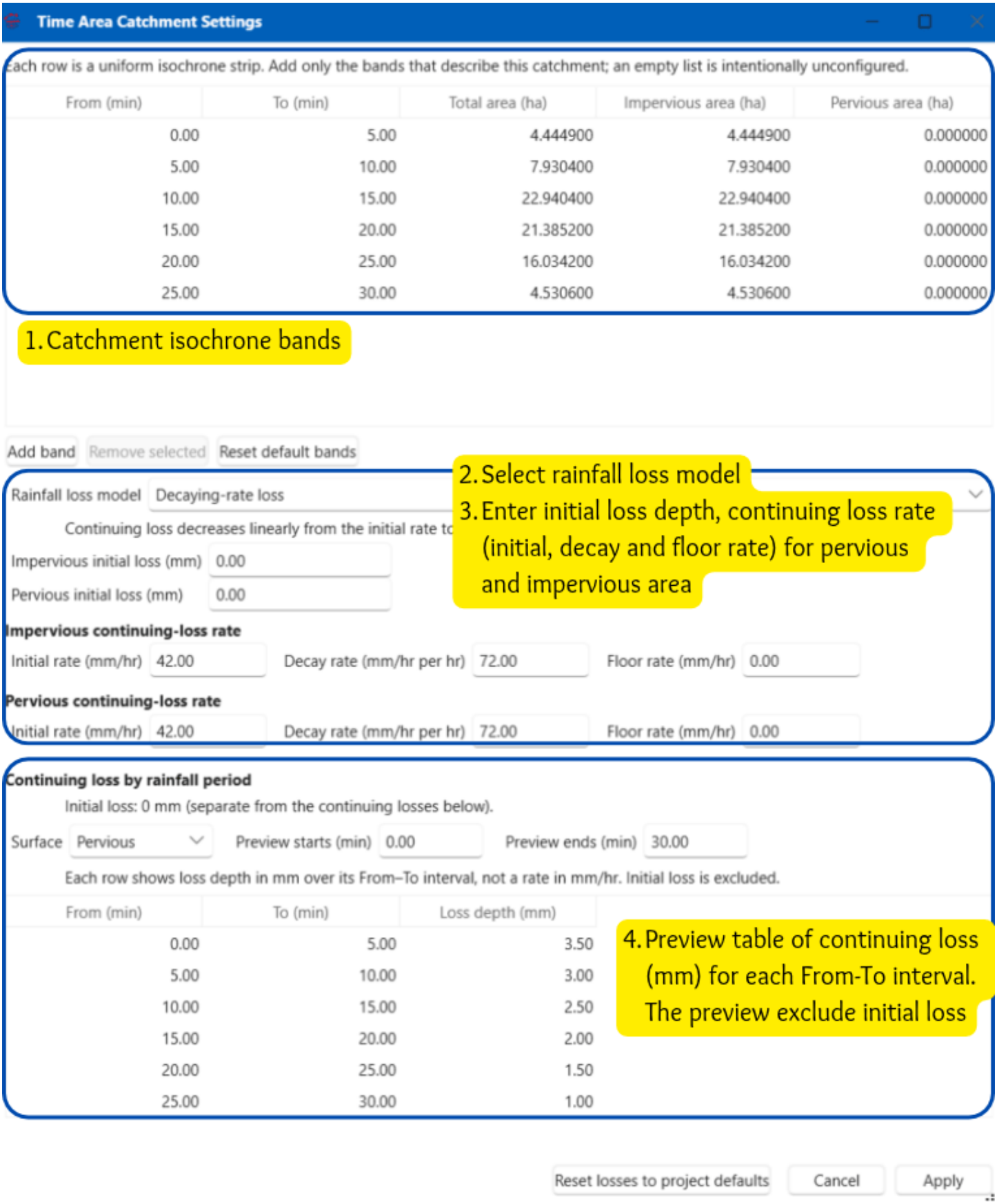


Decaying-rate loss (initial loss + decaying continuing rate, IL-DCL)

In this method, three parameters control how rainfall loss changes over time:

1. **Initial loss:** A specified amount of rainfall is lost at the beginning of the storm before the continuing-loss rate calculation applies.
2. **Decaying loss rate:** After the initial abstraction, the loss rate gradually decreases as the storm continues.
3. **Minimum loss rate (floor rate):** The loss rate decreases until it reaches a specified minimum value. It will not decrease below this value.

The default values/ model generalizes the decaying-loss example in MSMA2 Appendix 2.F2; the manual does not prescribe a general decay curve. Enter separate pervious and impervious initial losses, initial rates, decay rates and floor rates if needed. The editor’s preview table shows the continuing rainfall loss depth (mm) for each From–To time interval. The loss depth is calculated from the pervious and impervious continuing-loss rate (mm/h) entered by the user. Initial loss is not included in the preview.

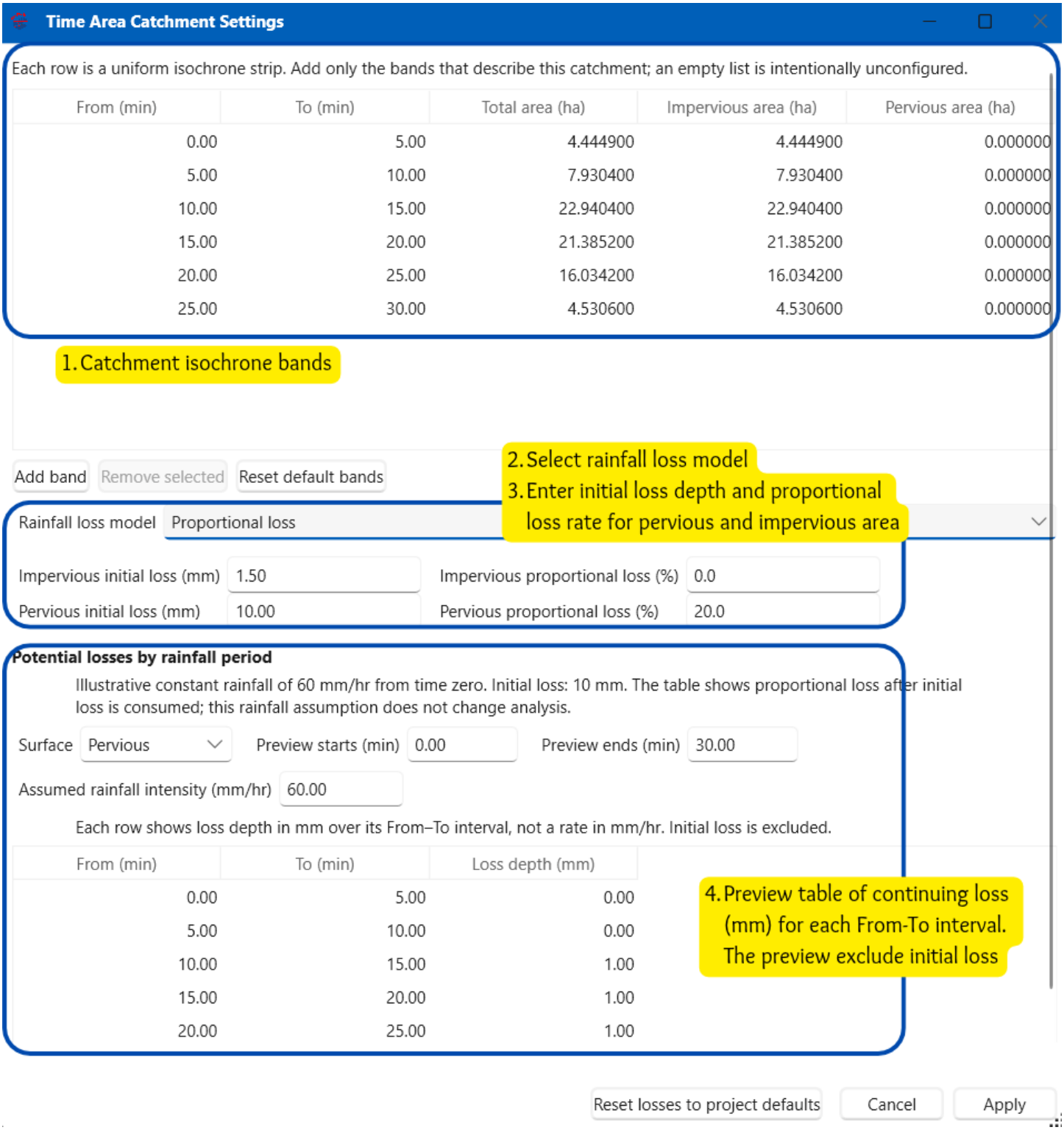

Time Area Catchment Settings
Each row is a uniform isochrone strip. Add only the bands that describe this catchment; an empty list is intentionally unconfigured.
From (min) To (min) Total area (ha) Impervious area (ha) Pervious area (ha)
0.00 5.00 4.444900 4.444900 0.000000
5.00 10.00 7.930400 7.930400 0.000000
10.00 15.00 22.940400 22.940400 0.000000
15.00 20.00 21.385200 21.385200 0.000000
20.00 25.00 16.034200 16.034200 0.000000
25.00 30.00 4.530600 4.530600 0.000000
1. Catchment isochrone bands
Add band
Remove selected
Reset default bands
Rainfall loss model
Decaying-rate loss
Continuing loss decreases linearly from the initial rate to
2. Select rainfall loss model
3. Enter initial loss depth, continuing loss rate (initial, decay and floor rate) for pervious and impervious area
Impervious initial loss (mm) 0.00
Pervious initial loss (mm) 0.00
Impervious continuing-loss rate
Initial rate (mm/hr) 42.00
Decay rate (mm/hr per hr) 72.00
Floor rate (mm/hr) 0.00
Pervious continuing-loss rate
Initial rate (mm/hr) 42.00
Decay rate (mm/hr per hr) 72.00
Floor rate (mm/hr) 0.00
Continuing loss by rainfall period
Initial loss: 0 mm (separate from the continuing losses below).
Surface Pervious
Preview starts (min) 0.00
Preview ends (min) 30.00
Each row shows loss depth in mm over its From–To interval, not a rate in mm/hr. Initial loss is excluded.
From (min) To (min) Loss depth (mm)
0.00 5.00 3.50
5.00 10.00 3.00
10.00 15.00 2.50
15.00 20.00 2.00
20.00 25.00 1.50
25.00 30.00 1.00
4. Preview table of continuing loss (mm) for each From-To interval. The preview exclude initial loss
Reset losses to project defaults
Cancel
Apply

Proportional loss (initial loss + proportional loss, IL-PL)

This method reproduces the legacy PondCAD proportional-loss calculation for comparison. It calculates rainfall losses in two stages:

1. **Initial loss:** A specified amount of rainfall is lost at the beginning of the storm before the continuing-loss rate calculation applies.
2. **Proportional loss:** The percentage of rainfall lost after the initial loss has been accounted for (%).

Defaults are 10 mm initial loss and 20% proportional loss for pervious area; 1.5 mm and 0% for impervious area as specified in MSMA1 (Table 14.4). All values are editable. The editor’s preview table shows the rainfall loss depth (mm) for each From–To time interval. The loss depth is calculated from the pervious and impervious proportional loss percentage entered by the user. Initial loss is not included in the preview. Proportional loss needs rainfall amounts, so its preview assumes a constant rainfall intensity that you enter; that assumption does not change the analysis.



Horton infiltration

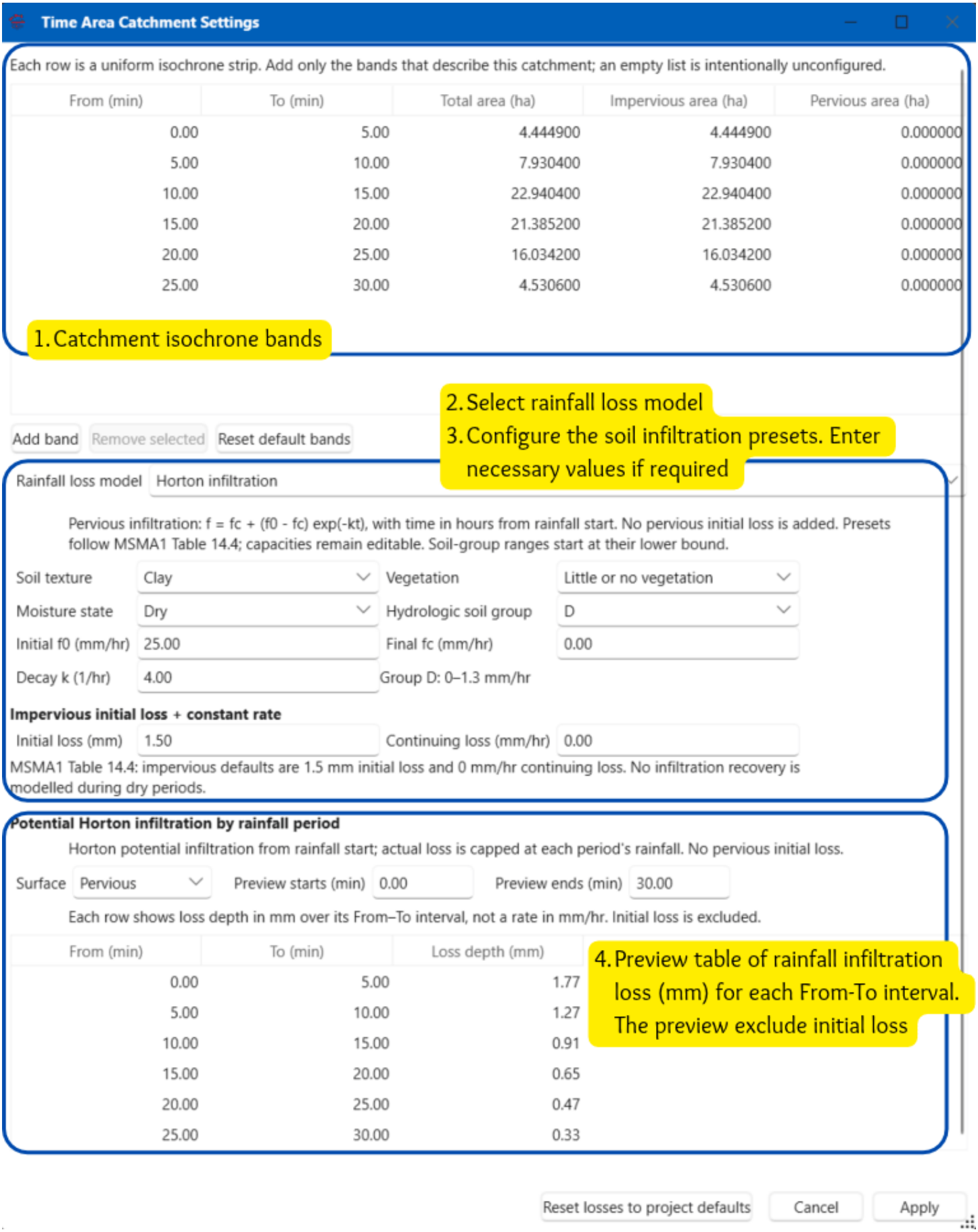
This method estimates how much water enters the soil. The pervious infiltration capacity follows MSMA1 Equation 14.9, f = f_c + (f_0 - f_c)e^{-kt}, with t in hours from the start of rainfall. No

pervious initial loss is added. The impervious surface keeps its own initial loss and constant rate.

Default f_0 = 25 mm/h, f_c = 0 mm/h and k = 4/hour. Soil texture, vegetation, moisture state and hydrologic soil group presets follow MSMA1 Table 14.4, using the lower value of each range as the default.; All values are editable. The partial-drying divisor starts at 2 (MSMA1 recommends 1.5–2.5). Saturated conductivity Ks has no MSMA1 default, so enter a measured or justified value. Impervious defaults are 1.5 mm initial loss and 0 mm/h.

Note: Horton is offered under all three design standards, with its presets taken from MSMA1. Offering it under MSMA 2nd or 3rd Edition does not make those presets prescribed by those editions. Infiltration capacity does not recover during dry periods within the storm.

The editor’s preview table shows potential infiltration from the start of rainfall; the actual loss in an interval is capped at that interval’s rainfall during analysis.


Time Area Catchment Settings
Each row is a uniform isochrone strip. Add only the bands that describe this catchment; an empty list is intentionally unconfigured.
From (min) To (min) Total area (ha) Impervious area (ha) Pervious area (ha)
0.00 5.00 4.444900 4.444900 0.000000
5.00 10.00 7.930400 7.930400 0.000000
10.00 15.00 22.940400 22.940400 0.000000
15.00 20.00 21.385200 21.385200 0.000000
20.00 25.00 16.034200 16.034200 0.000000
25.00 30.00 4.530600 4.530600 0.000000
1. Catchment isochrone bands
2. Select rainfall loss model
3. Configure the soil infiltration presets. Enter necessary values if required
Add band
Remove selected
Reset default bands
Rainfall loss model
Horton infiltration
Pervious infiltration: f = fc + (f0 - fc) exp(-kt), with time in hours from rainfall start. No pervious initial loss is added. Presets follow MSMA1 Table 14.4; capacities remain editable. Soil-group ranges start at their lower bound.
Soil texture
Clay
Vegetation
Little or no vegetation
Moisture state
Dry
Hydrologic soil group
D
Initial f0 (mm/hr)
25.00
Final fc (mm/hr)
0.00
Decay k (1/hr)
4.00
Group D: 0–1.3 mm/hr
Impervious initial loss + constant rate
Initial loss (mm)
1.50
Continuing loss (mm/hr)
0.00
MSMA1 Table 14.4: impervious defaults are 1.5 mm initial loss and 0 mm/hr continuing loss. No infiltration recovery is modelled during dry periods.
Potential Horton infiltration by rainfall period
Horton potential infiltration from rainfall start; actual loss is capped at each period's rainfall. No pervious initial loss.
Surface
Pervious
Preview starts (min)
0.00
Preview ends (min)
30.00
Each row shows loss depth in mm over its From–To interval, not a rate in mm/hr. Initial loss is excluded.
From (min) To (min) Loss depth (mm)
0.00 5.00 1.77
5.00 10.00 1.27
10.00 15.00 0.91
15.00 20.00 0.65
20.00 25.00 0.47
25.00 30.00 0.33
4. Preview table of rainfall infiltration loss (mm) for each From-To interval. The preview exclude initial loss
Reset losses to project defaults
Cancel
Apply

Rainfall losses are calculated for pervious and impervious areas across **every isochrone bands**, before their runoff contributions are delayed and added at the outlet. In the current implementation, one pervious and one impervious rainfall-excess series are calculated for the catchment and applied to the corresponding surface areas in all its bands. The Time Area translation then routes the resulting runoff to the outlet **without calculating additional infiltration along its travel path**. Although **Green–Ampt** describes infiltration into soil over time, accounting for runoff from one band infiltrating into another would require explicit run-on routing and surface-water accounting, which is **not included in the current implementation**.

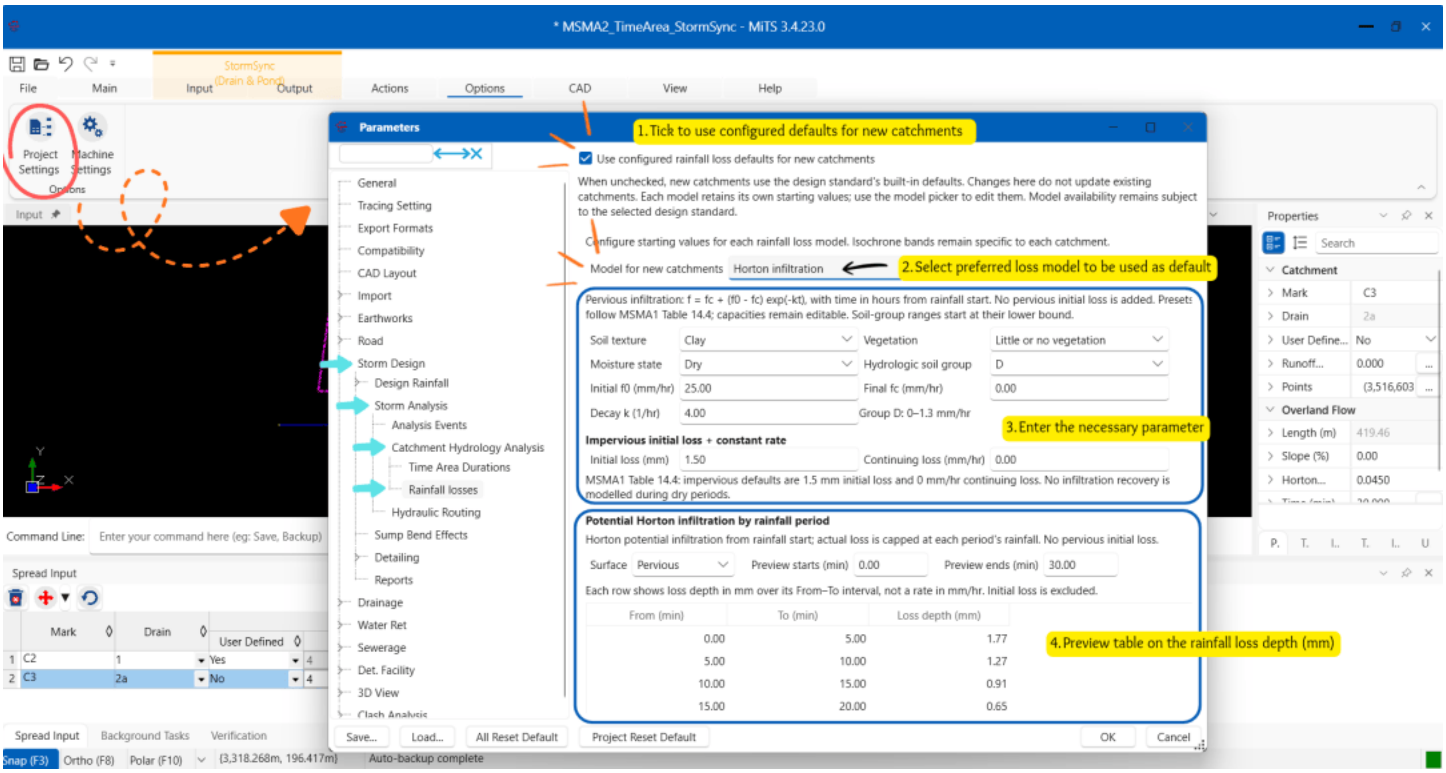
The applied loss in each rainfall interval cannot exceed that interval's rainfall amount. For example, if 5 mm of rain falls during an interval but the loss is 7 mm, only 5 mm can be counted as the loss for that interval. The remaining effective rainfall is 0 mm.

Set rainfall-loss defaults for new catchments

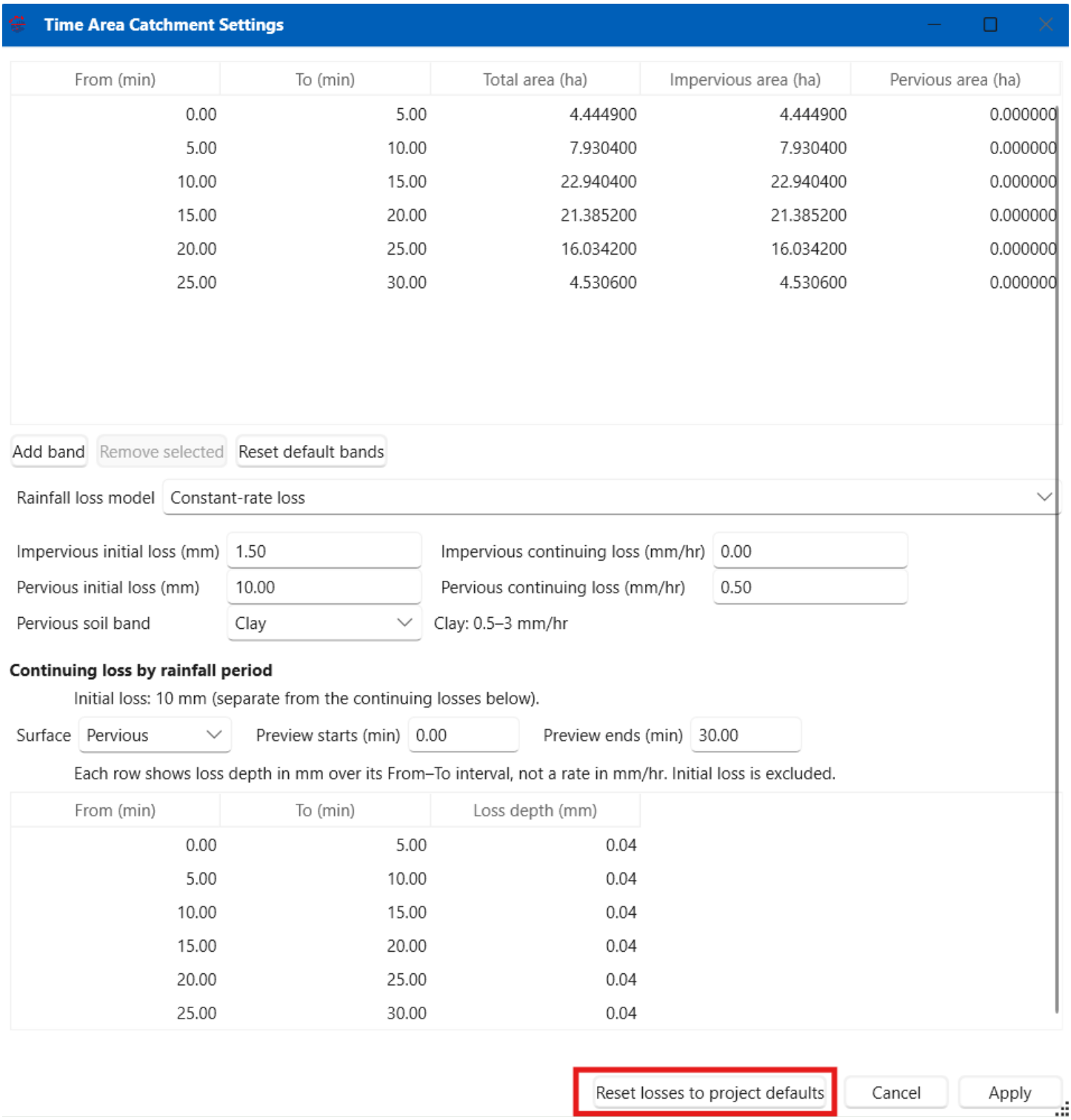
1. In the **Project Settings**, go to **Storm Design → Storm Analysis → Catchment Hydrology Analysis → Rainfall losses**
2. Tick **Use configured rainfall loss defaults for new catchments** to customise the default rainfall loss settings for newly created catchments. When unticked, new catchments use the design standard's built-in defaults. Model availability still follows the selected design standard.
3. Select the preferred rainfall loss model in **Model for new catchments** to be the default and configure the their respective parameter values.

Note

Changing the defaults does not update existing catchments. To apply the updated defaults to an existing catchment, open its Time Area settings and click **Reset losses to project defaults**. This replaces only the rainfall loss settings; the existing isochrone bands remain unchanged. Click **Cancel** to discard the reset along with any other unsaved changes.



Setting up customized rainfall loss default setting for newly-created catchments



Click “Reset losses to project defaults” to apply the configured default to the existing catchment

Run the analysis

To run analysis, click **Execute** button

Analysis Type

- Set the Analysis Type to **Analysis**
- Set the inflow source to **CatchmentHydrology**

Design ARI

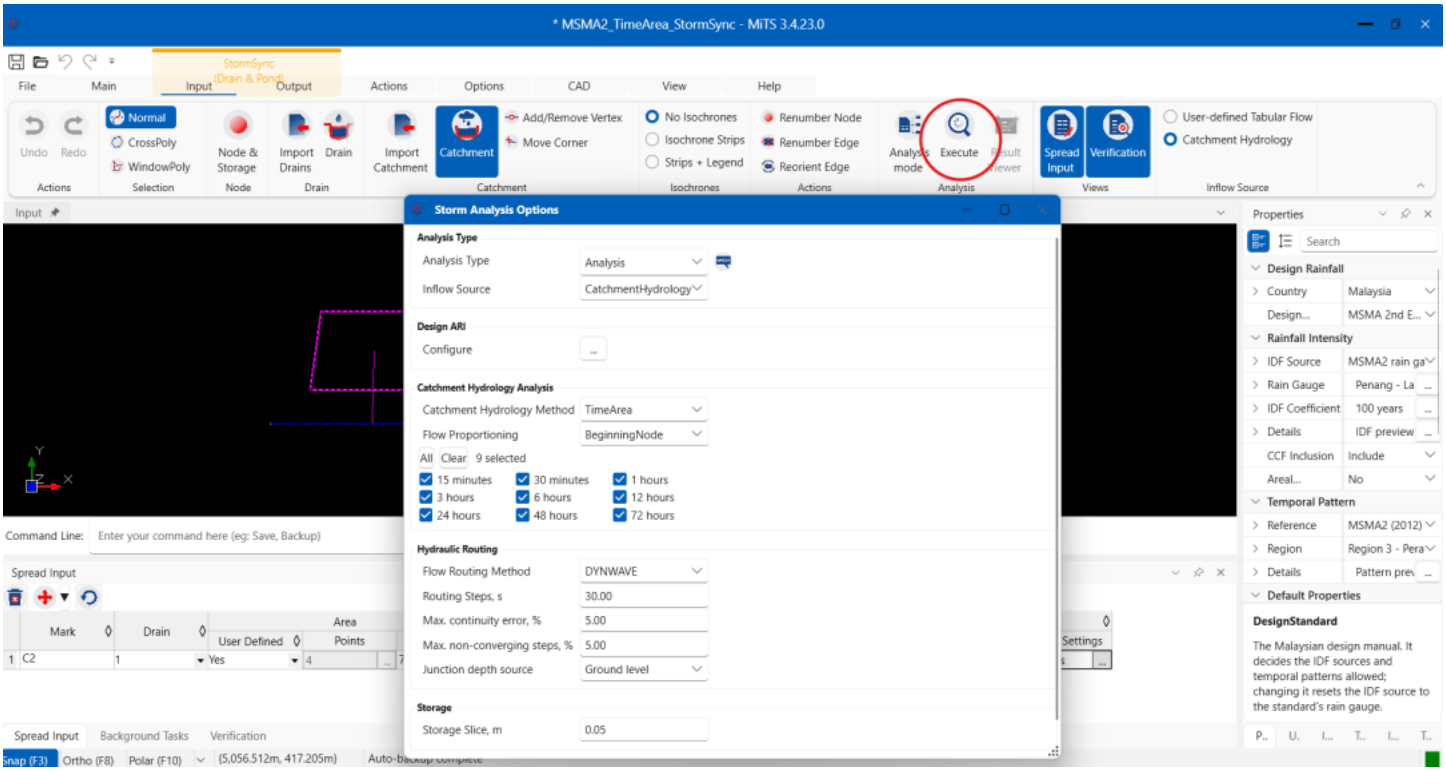
- Configure the Design ARI for **Minor, Major and Secondary Storm Design**

Catchment Hydrology Analysis

- Set the Catchment Hydrology Method to **TimeArea**
- **Flow Proportioning:** Choose how catchment runoff is distributed to the drain
    - **BeginningNode:** Assigns all runoff to the drain's beginning node.
    - **EndNode:** Assigns all runoff to the drain's end node.
    - **Split:** Divides the runoff equally between both nodes.
- **Duration checklist**
    - Tick/Untick individual checkboxes to select/deselect specific storm durations. Only storm durations supported by the selected temporal pattern will be analysed. Unsupported durations will be skipped from the analysis, even if ticked.
    - **All:** Selects all storm durations.
    - **Clear:** Unticks all selected storm durations.
- **Hydraulic Routing**
    - **Flow Routing Method:** Choose routing method. See *Hydraulics flow routing method* for details.
    - **Routing steps, s:** The time interval (in seconds) at which the software recalculates the uniform or non-uniform flow of water through the drainage network's conduits and nodes.
    - **Max continuity error %:** Maximum allowable percentage difference in the water balance calculation during the simulation.
    - **Max non-converging steps %:** Maximum allowable percentage of calculation steps that fail to converge to a stable solution during the simulation.

- **Junction depth source:** Specifies whether the sump elevation
  - **Ground Level:** The sump depth is measured from the sump IL to the ground level.
  - **Connected Drain Crown:** The sump depth is measured from the sump IL to the crown of the connected drains.

- **Storage**
  - **Storage slice, m:** Specifies the vertical interval to divide the storage depth into sections for calculating the storage volume at different water levels.



After a successful run, refer to Storm Sync Time Area Results guide to review graphs, the Catchment Hydrology report, isochrone strips, and EPA SWMM export.

Related



Ngu Soon Hui

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

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