# EPA SWMM5 for Novice/Advanced Users
# EWRI2025 Pre-Conference Workshop, May 17, 2025 (Anchorage AK)

## Exercise 1: Build a Basic Stormwater Model

This exercise uses the U.S. Environmental Protection Agency's Storm Water Management Model (SWMM5, 64-bit version of build 5.2.4) and is in U.S. customary units. It is assumed that you are sufficiently familiar with the SWMM5 user interface, so that only the key commands and input values are highlighted in bold.

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**Key Learning Objectives**

1. Learn how to build a basic stormwater model.
2. Understand how to develop and apply rainfall input (design storms and continuous simulation).

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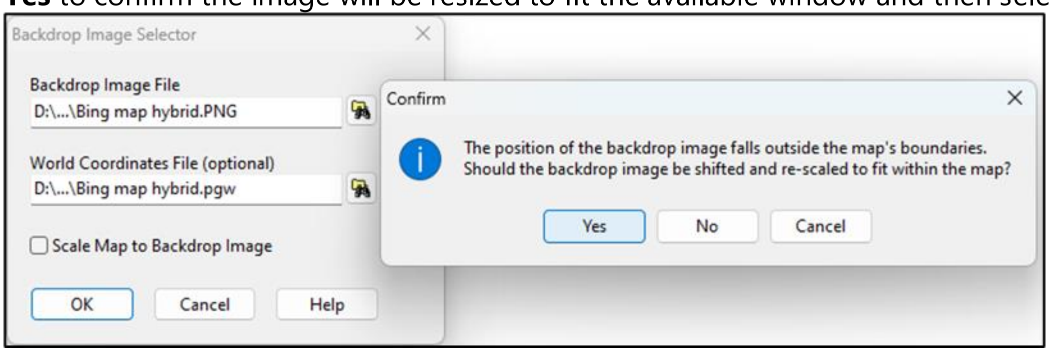
### 1 Set Up the Stormwater Model

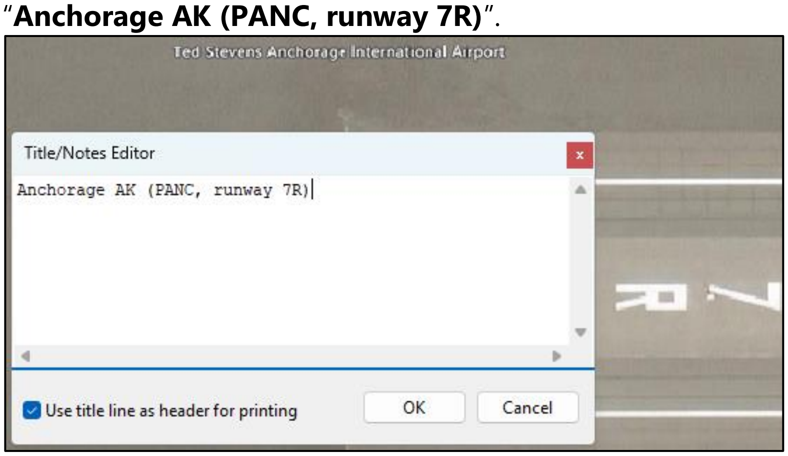
The model will be built based on a map image of the end of Runway 7R at Ted Stevens Anchorage International Airport (airport code PANC). It will include one subcatchment representing a 1-acre, 100% impervious area and drained by a single pipe to an outfall. The model will be applied to a simple pulsed rainfall with a constant intensity of 1 inch/hour for one hour. Under these conditions, the rational method would indicate a peak runoff rate of 1 cfs.

**1-1** **Launch SWMM 5.2** (executable file "epaswmm5.exe", version 5.2.4, 64-bit edition, downloaded from the EPA website at https://www.epa.gov/water-research/storm-water-management-model-swmm).

**1-2** **Load** the image (select View | Backdrop | Load from the Main Menu). In the Backdrop Image Selector, select the **image file "Bing map hybrid.PNG"** and **coordinates file "Bing map hybrid.pgw"**. Select **Yes** to confirm the image will be resized to fit the available window and then select **OK**.

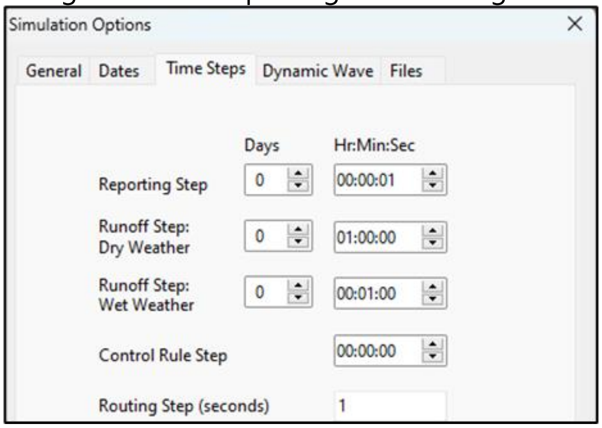



**1-3** In the **Title/Notes** Editor (select the Edit icon at the bottom of the Project panel), enter the following: "**Anchorage AK (PANC, runway 7R)**".

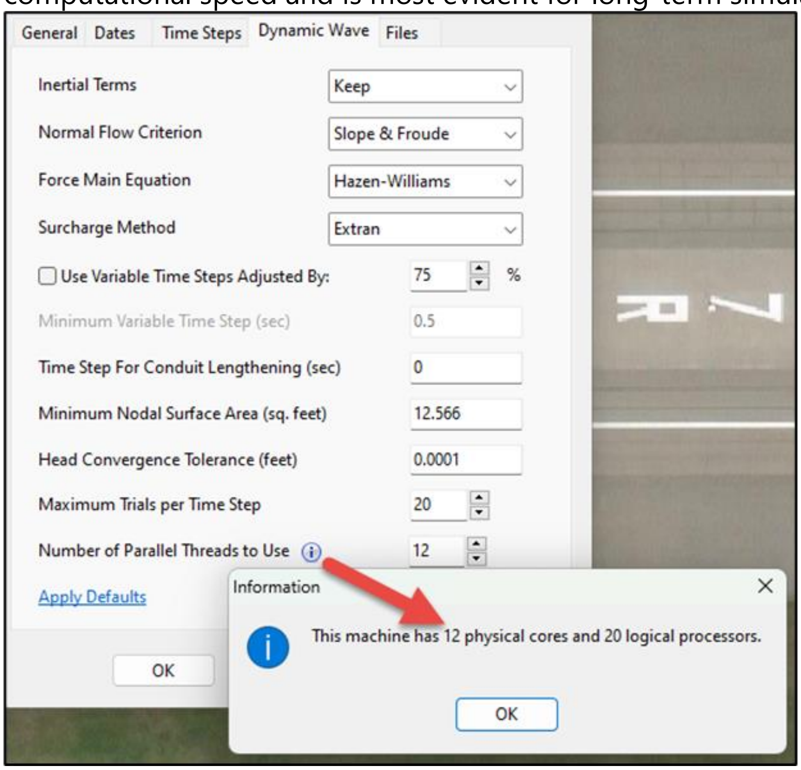


**1-4** **Save** the project (select File | Save from the Main Menu, or the icon on the Main toolbar) with the filename "**ANC1_1in1hr.inp**".

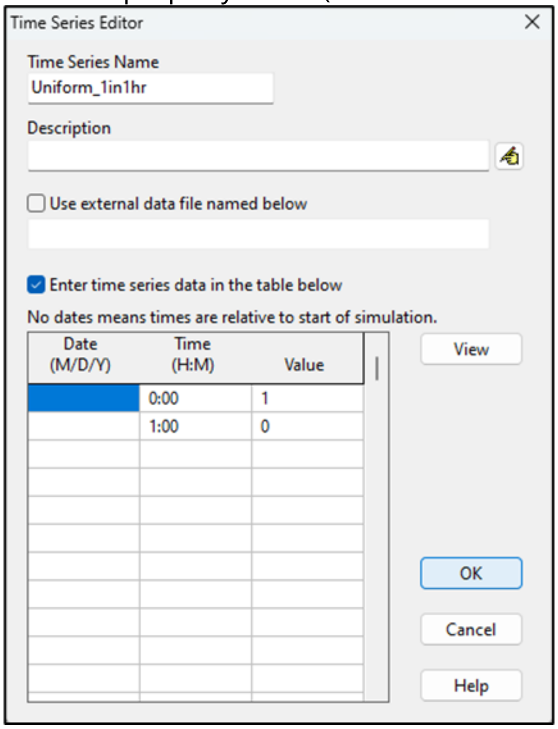
**1-5** In the **Time Steps tab** of the Simulation Options editor (under Options in the Project panel), change the **Reporting Step to 1 sec**, the **Wet Weather Runoff Step to 1 min**, and the **Routing Step to 1 sec**. Using the same Reporting and Routing timestep will allow graphing of all the computed results.



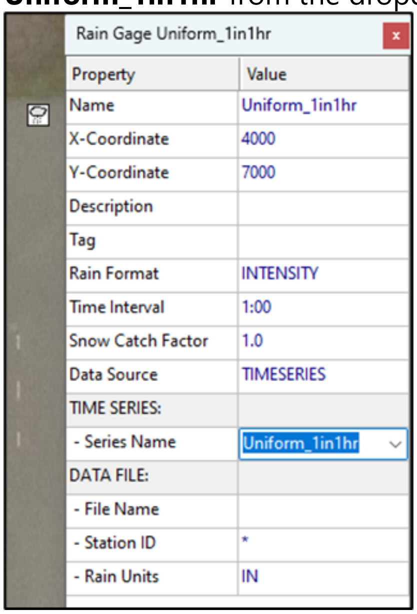

**1-6** In the **Dynamic Wave tab** of the Simulation Options editor, set the **Inertial Terms to Keep**, **uncheck Variable Time Steps**, change the **Head Convergence Tolerance to 0.0001 ft**, and the **Maximum Trials to 20**. Select the info button beside **Number of Parallel Threads to Use** and note the number of physical cores available on your computer. **Enter this value** in the input box. This will improve the computational speed and is most evident for long-term simulations (e.g., part 3 of this exercise).




**1-7** **Add a new Time Series** (under Time Series in the Project panel, select the Add icon at the bottom) with the **Name "Uniform_1in1hr"**, and enter a **value of 1 at time 0:00** and a **value of 0 at time 1:00**, leave the Date property blank (dates in the Dates tab of the Simulation Options editor will be used), select **OK**.




**1-8 Add a new Rain Gage** (under Hydrology | Rain Gages in the Project panel, select the Add icon at the bottom). **Click** any location in the Study Area Map and a Rain Gage object will be added to the model. **Open** the Rain Gage object, change the **Name to "Uniform_1in1hr"**, and select the **timeseries Uniform_1in1hr** from the dropdown list as the Time Series Name property. **Close** the Rain Gage editor.




**1-9 Add a new Outfall** (under Hydraulics | Nodes | Outfalls in the Project panel, select the Add icon at the bottom). **Click** on a location in the grassed area just off the tarmac, north of the threshold markings. An

Outfall object will be added to the model.

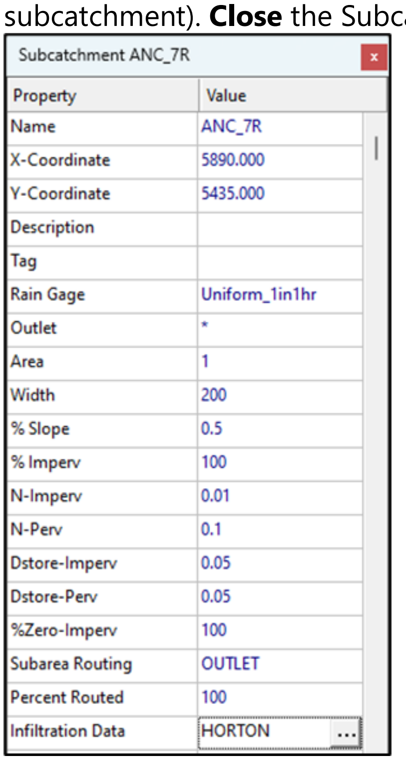

**1-10** **Open** the Outfall object, change the **Name to "STM_OF"**, and the **Invert Elevation to 124** ft-datum. The other default properties are acceptable for this exercise. Depending on where you draw the outfall, your X and Y coordinates may differ from the screen capture – the mapped location of the outfall has no impact on model results). **Close** the Outfall editor.

Outfall STM_OF

| Property | Value |
| --- | --- |
| Name | STM_OF |
| X-Coordinate | 5270 |
| Y-Coordinate | 7290 |
| Description | |
| Tag | |
| Inflows | NO |
| Treatment | NO |
| Invert El. | 124 |
| Tide Gate | NO |
| Route To | |
| Type | FREE |

**1-11** **Add a new Subcatchment** (under Hydrology | Subcatchments in the Project panel, select the Add icon at the bottom). **Draw** a subcatchment around the threshold markings of the runway. After clicking on each corner in the map, press **Enter** and a Subcatchment object will be added to the model.

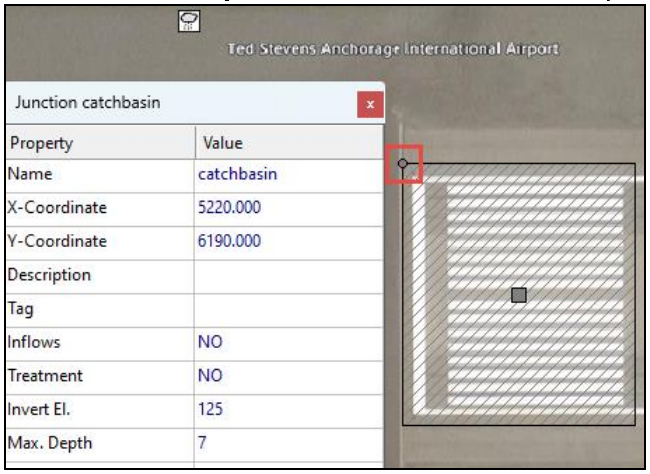

**1-12** **Open** the Subcatchment object, change the **Name to "ANC_7R"**, select the **Uniform_1in1hr rain gage** from the dropdown list, enter an **Area of 1** acre, overland flow **Width of 200** ft, **% Impervious of 100**, and **%Zero-Imperv of 100** (this will zero out the depression storage for the entire subcatchment). Depending on where you draw the subcatchment, your X and Y coordinates may differ from the screen capture – the mapped location of the subcatchment has no impact on model results). The other default properties and Infiltration Data are acceptable (infiltration is not calculated for a 100% impervious subcatchment). **Close** the Subcatchment editor when parameters have been entered.


Subcatchment ANC_7R

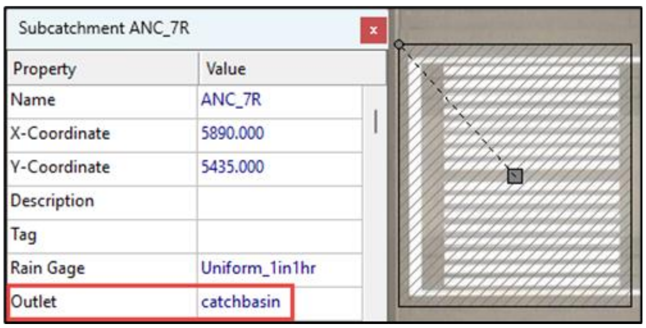
| Property | Value |
|---|---|
| Name | ANC_7R |
| X-Coordinate | 5890.000 |
| Y-Coordinate | 5435.000 |
| Description | |
| Tag | |
| Rain Gage | Uniform_1in1hr |
| Outlet | * |
| Area | 1 |
| Width | 200 |
| % Slope | 0.5 |
| % Imperv | 100 |
| N-Imperv | 0.01 |
| N-Perv | 0.1 |
| Dstore-Imperv | 0.05 |
| Dstore-Perv | 0.05 |
| %Zero-Imperv | 100 |
| Subarea Routing | OUTLET |
| Percent Routed | 100 |
| Infiltration Data | HORTON |

**1-13** **Add a new Junction** (under Hydraulics | Nodes | Junctions in the Project panel, select the Add icon at the bottom). **Click** on a location at the northwest corner of the subcatchment. A Junction object will be added to the model.

**1-14** **Open** the Junction object, change the **Name to "catchbasin"**, the **Invert Elevation to 125** ft-datum, and the **Max. Depth to 7** ft. The other default properties are acceptable. **Close** the Junction editor.

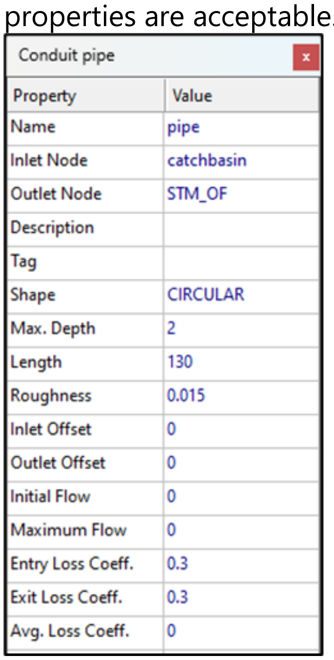



**1-15** **Open** the Subcatchment object again and change the **Outlet to "catchbasin"**. **Close** the Subcatchment editor.




**1-16** **Add a new Conduit** (under Hydraulics | Links | Conduits in the Project panel, select the Add icon at the bottom). **Click the catchbasin** junction and then **click the STM_OF outfall**. A Conduit object will be added to the model.

**1-17** **Open** the Conduit object, change the **Name to "pipe"**, the **Max. Depth to 2** ft, the **Length to 130** ft, the **Roughness to 0.015**, and the **Entry and Exit Loss Coefficients to 0.3** each. The other default properties are acceptable. **Close** the Conduit editor.



**1-18** **Run** the simulation (icon on the Main toolbar). A popup message will indicate the hydrologic and hydraulic routing continuity errors. Click **OK** to close the message. Note the Run Status in the status bar shows a green flag, indicating that results are up to date.

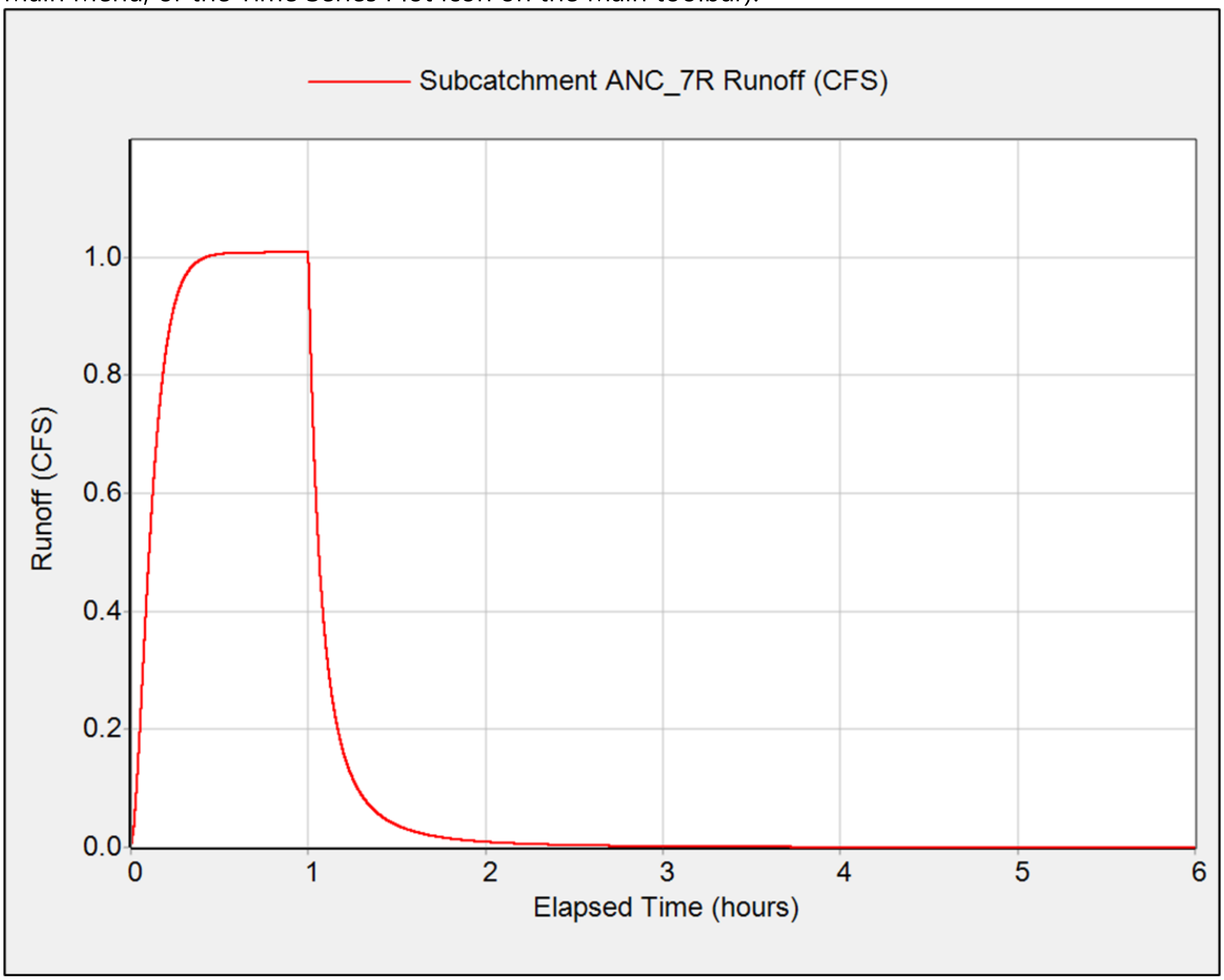
**1-19** Review the **Subcatchment** section of the **Summary Results** (select Report | Summary from the Main Menu). Note the peak computed runoff is 1 cfs and the corresponding volumetric runoff coefficient is 1.

Summary Results

Topic: Subcatchment Runoff    Click a column header to sort the column.

| Subcatchment | Total Precip in | Total Runon in | Total Evap in | Total Infil in | Imperv Runoff in | Perv Runoff in | Total Runoff in | Total Runoff 10^6 gal | Peak Runoff CFS | Runoff Coeff |
|---|---|---|---|---|---|---|---|---|---|---|
| ANC_7R | 1.00 | 0.00 | 0.00 | 0.00 | 1.00 | 0.00 | 1.00 | 0.03 | 1.01 | 0.999 |

**1-20** **Plot the runoff hydrograph** for the subcatchment (select Report | Graph | Time Series from the Main Menu, or the Time Series Plot icon on the Main toolbar).

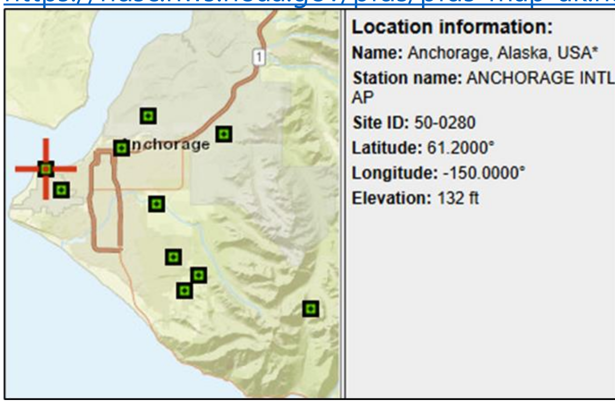


## 2 Create and Apply Design Storm Events

Inputting rainfall with local design storm events is very common for model applications related to master planning, stormwater infrastructure design, and flood hazard assessments. Design storms may include a variety of event durations, hyetograph shapes/distributions, and return periods, based on long-term Intensity-Duration-Frequency (IDF) statistics. The two local design storms are:

- SCS100yr24hr: rainfall hyetograph for the 100-year return period event with a 24-hour duration and fitted to an SCS Type 1 distribution (at a 6-minute time interval).
- Chicago100yr3hr: rainfall hyetograph for the 100-year return period event with a 3-hour duration and fitted to a Chicago distribution (at a 5-minute time interval).

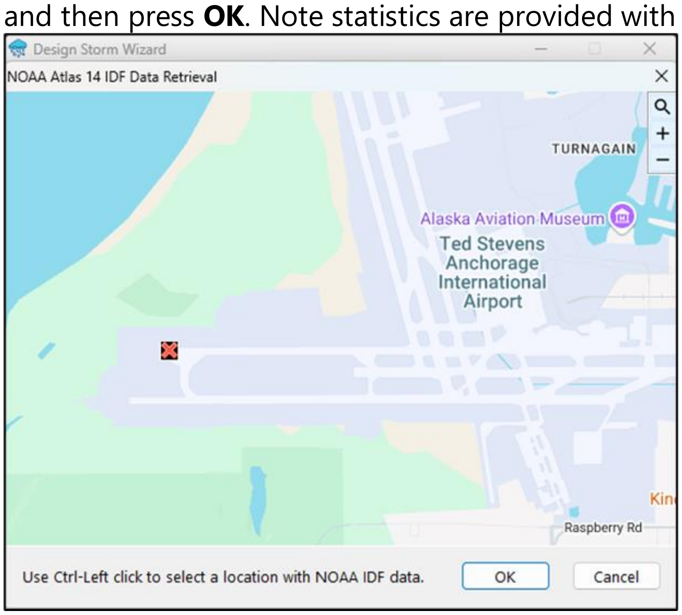
The hyetographs will be created using the Dstorm (Design Storm Wizard) program. Rainfall statistics at the airport are available through NOAA's Precipitation Frequency Data Server (Atlas 14 Volume 7 Version 2) at https://hdsc.nws.noaa.gov/pfds/pfds_map_ak.html.




**2-1** In SWMM5.2, **Save** the current project, **Save As "ANC1_Chicago100yr3hr.inp"**, and then **Save As "ANC1_SCS100yr24hr.inp"**.

**2-2** **Launch Dstorm** (executable file "dstorm.exe", version 1.1.1, downloaded from the website at https://sites.google.com/view/dstorm). Select **Next**, **check Use IDF Data**, select **Next**, and then select the link to **Retrieve from NOAA Atlas 14**.

**2-3** In Dstorm, **Pan** over to Alaska and **Zoom** into the Anchorage area on the map. With the cursor placed at the end of the runway, press **CTRL+Left** to mark the location where the IDF statistics will be pulled, and then press **OK**. Note statistics are provided with rainfall intensities with units of in/hr. Click **Next**.



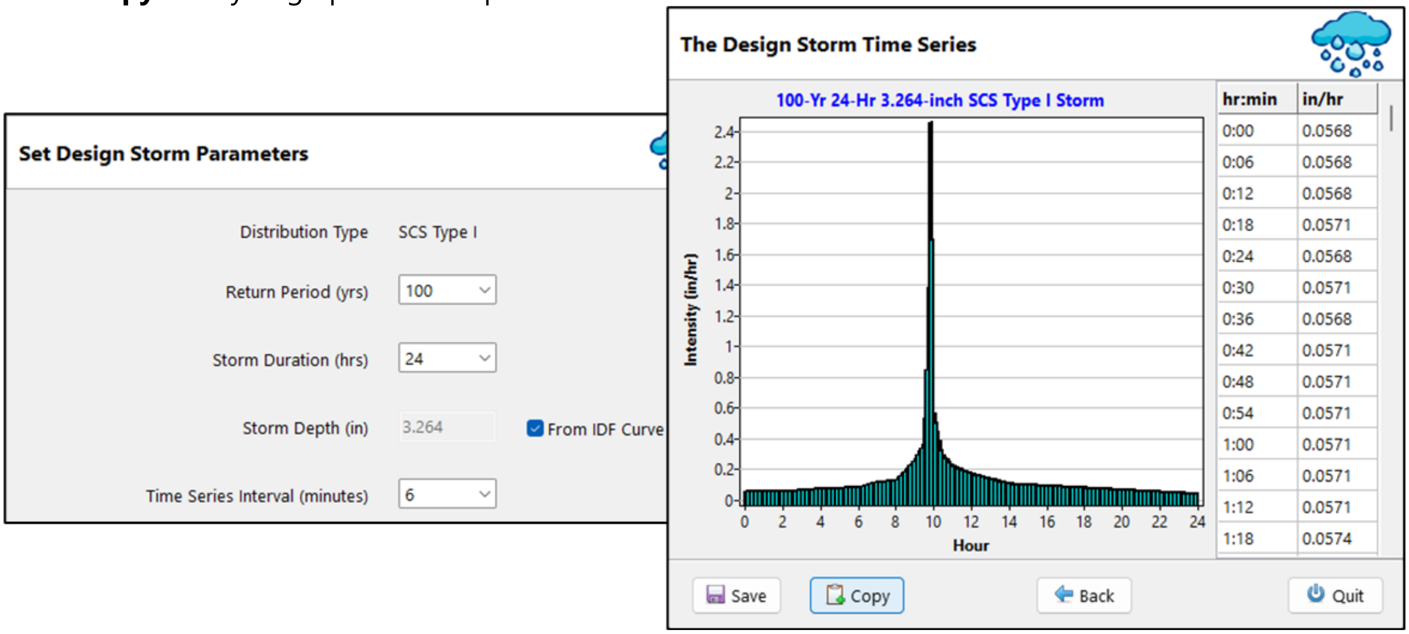

**Provide IDF Curve Data**

Enter storm intensities (in/hr) for desired durations and return periods. Help

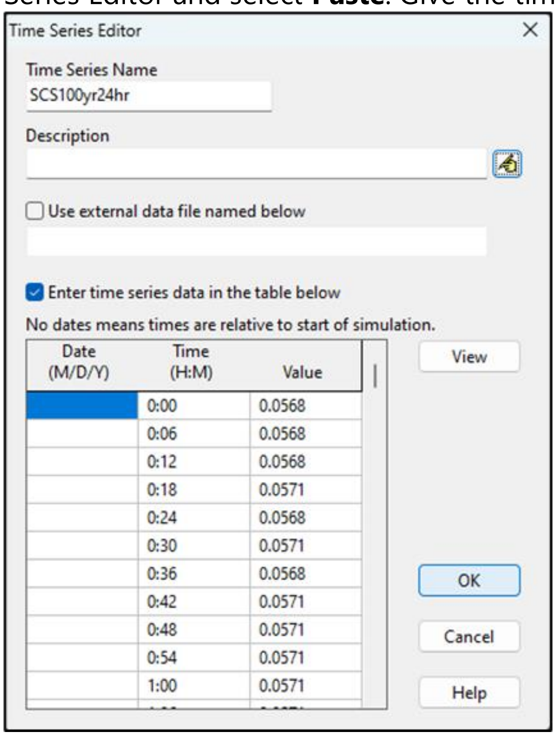
Return Period, Years

| Duration | 1 | 2 | 5 | 10 | 25 | 50 | 100 |
|---|---|---|---|---|---|---|---|
| 5-min | 0.996 | 1.28 | 1.66 | 1.97 | 2.39 | 2.71 | 3.05 |
| 10-min | 0.666 | 0.858 | 1.11 | 1.32 | 1.60 | 1.82 | 2.05 |
| 15-min | 0.520 | 0.672 | 0.868 | 1.03 | 1.25 | 1.42 | 1.60 |
| 30-min | 0.346 | 0.446 | 0.576 | 0.684 | 0.830 | 0.944 | 1.06 |
| 1-hr | 0.237 | 0.305 | 0.394 | 0.468 | 0.569 | 0.647 | 0.725 |
| 2-hr | 0.154 | 0.198 | 0.256 | 0.304 | 0.369 | 0.420 | 0.471 |
| 3-hr | 0.126 | 0.162 | 0.209 | 0.248 | 0.302 | 0.343 | 0.385 |
| 6-hr | 0.092 | 0.118 | 0.153 | 0.181 | 0.221 | 0.251 | 0.282 |
| 12-hr | 0.065 | 0.083 | 0.109 | 0.129 | 0.156 | 0.177 | 0.199 |
| 24-hr | 0.044 | 0.057 | 0.075 | 0.088 | 0.107 | 0.121 | 0.136 |

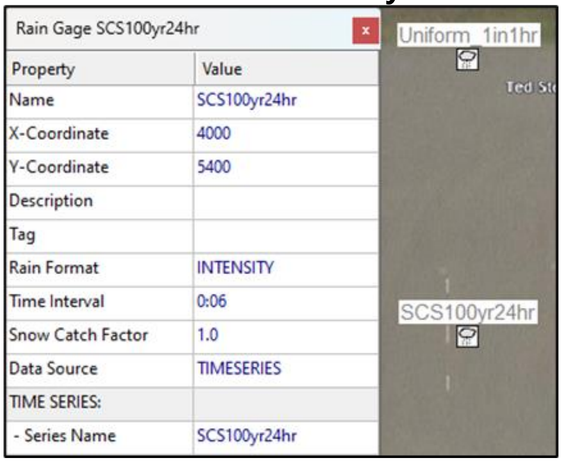
**2-4** Select the **SCS distribution** and then **Next**. Choose **Type 1** and then **Next**. Set the design storm parameters by selecting the **100-year** return period, **24-hour** duration, **6-minute** interval, and then **Next**. **Copy** the hyetograph to the clipboard and select **OK**.




**2-5** In SWMM5.2, **Open "ANC1_SCS100yr24hr.inp"**, and **Add a new Time Series** (under Time Series in the Project panel, select the Add icon at the bottom). **Right-click** in the data table at the bottom of the Time Series Editor and select **Paste**. Give the timeseries the **Name** "**SCS100yr24hr**" and select **OK**.




**2-6** **Add a new Rain Gage** (under Hydrology | Rain Gages in the Project panel, select the Add icon at the bottom). **Click** any location in the Study Area Map and a Rain Gage object will be added to the model. **Open** the Rain Gage object, change the **Name to "SCS100yr24hr"**, the **Time Interval to 0:06**, and select the **timeseries SCS100yr24hr** from the dropdown list. **Close** the Rain Gage editor.


Rain Gage SCS100yr24hr

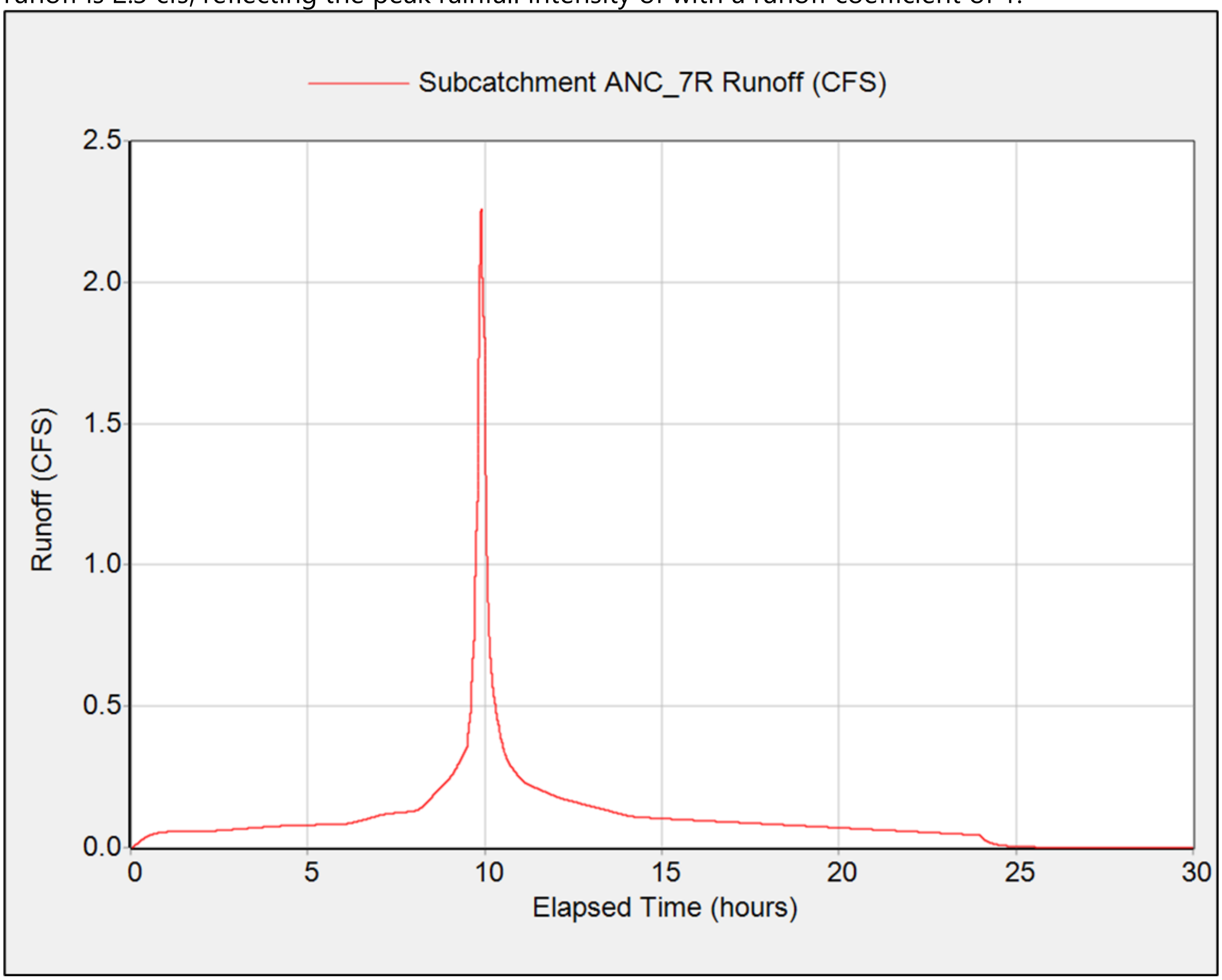
| Property | Value |
|---|---|
| Name | SCS100yr24hr |
| X-Coordinate | 4000 |
| Y-Coordinate | 5400 |
| Description | |
| Tag | |
| Rain Format | INTENSITY |
| Time Interval | 0:06 |
| Snow Catch Factor | 1.0 |
| Data Source | TIMESERIES |
| TIME SERIES: | |
| - Series Name | SCS100yr24hr |



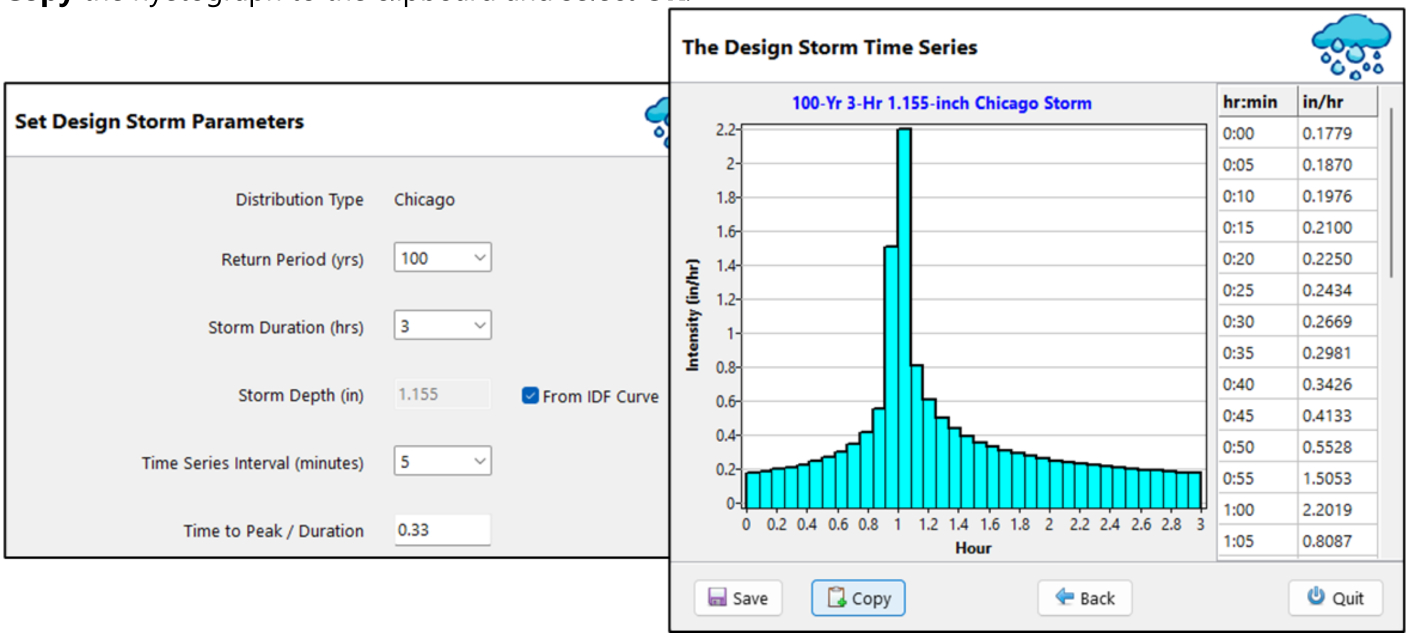
**2-7** **Open** the Subcatchment object and change the **Rain Gage to "SCS100yr24hr"** from the dropdown list. **Close** the Subcatchment editor.

**2-8** In the **Dates tab** of the Simulation Options editor (under Options in the Project panel), **add one day to the End Analysis on** date, so that the simulation duration is 30 hours.

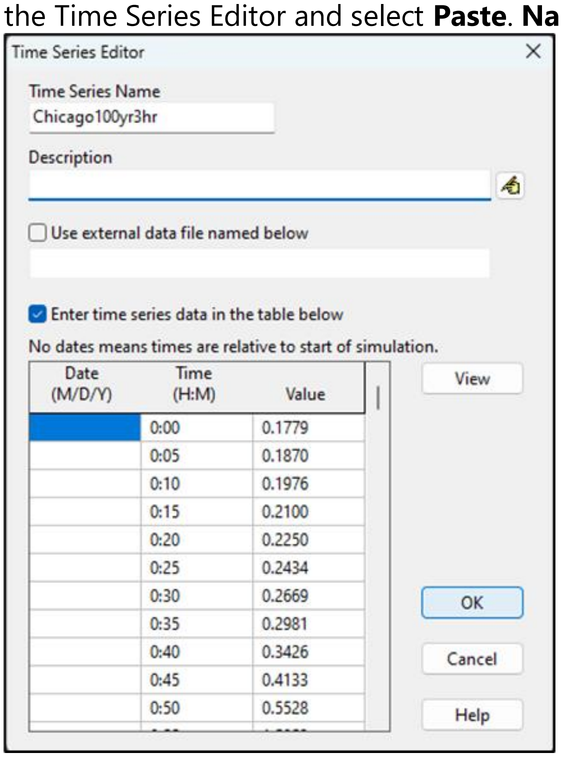
**2-9** **Run** the simulation and **plot the runoff hydrograph** for the subcatchment (select Report | Graph | Time Series from the Main Menu, or the Time Series Plot icon on the Main toolbar). Note the peak computed runoff is 2.3 cfs, reflecting the peak rainfall intensity of with a runoff coefficient of 1.



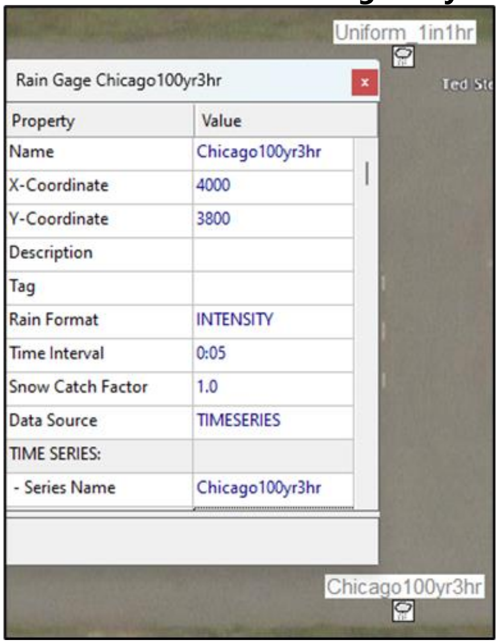
**2-10** In Dstorm, click the **Back** button three times to return to the Design Storm Distribution editor and then select the **Chicago IDF**-based method. Select **Next**. Set the design storm parameters by selecting the **100-year** return period, **3-hour** duration, **5-minute** interval, a **Time to Peak/Duration factor of 0.33** (this will center the peak rainfall at a time of 1 hour in the 3-hour hyetograph), and then **Next**. **Copy** the hyetograph to the clipboard and select **OK**.




**2-11** In SWMM5.2, **Open "ANC1_Chicago100yr3hr.inp"**, and **Add a new Time Series** (under Time Series in the Project panel, select the Add icon at the bottom). **Right-click** in the data table at the bottom of the Time Series Editor and select **Paste**. **Name** the timeseries "**Chicago100yr3hr**" and select **OK**.

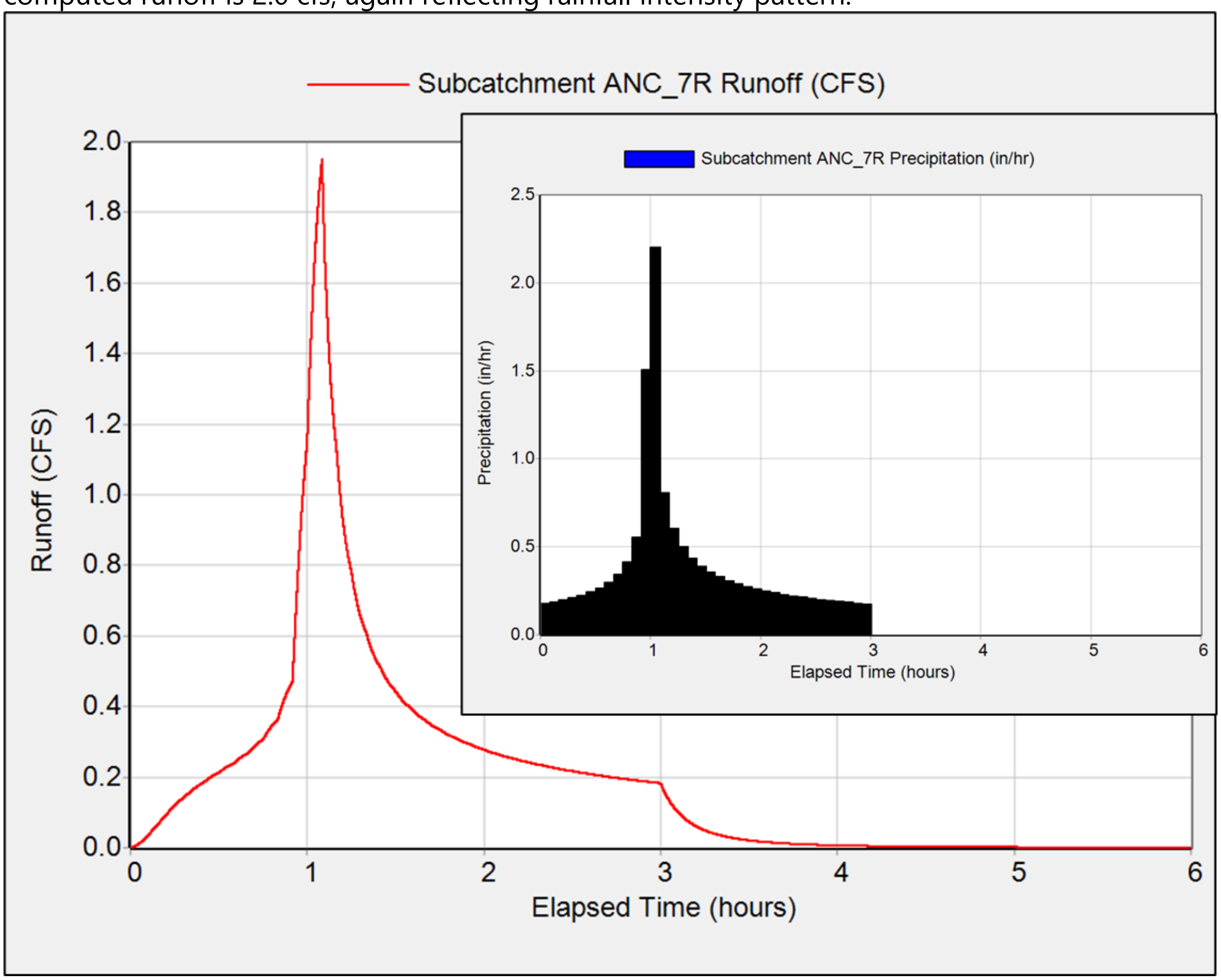



**2-12** **Add a new Rain Gage** (under Hydrology | Rain Gages in the Project panel, select the Add icon at the bottom). **Click** any location in the Study Area Map and a Rain Gage object will be added to the model. **Open** the Rain Gage object, change the **Name to "Chicago100yr3hr"**, the **Time Interval to 0:05**, and select the **timeseries Chicago100yr3hr** from the dropdown list. **Close** the Rain Gage editor.




**2-13** **Open** the Subcatchment object and change the **Rain Gage to "Chicago100yr3hr"** from the dropdown list. **Close** the Subcatchment editor.

**2-14** **Run** the simulation and **plot the runoff hydrograph** for the subcatchment. Note the peak computed runoff is 2.0 cfs, again reflecting rainfall intensity pattern.



## 3 Apply Continuous Simulation

Inputting precipitation (and other meteorologic variables) with long-term measurements is commonly used for model calibration, long-term water budget analysis, or model applications related to snowmelt, water quality, surface-groundwater interactions, and environmental assessments. In this exercise, the local 30-year hourly precipitation record will be downloaded using the U.S. EPA National Stormwater Calculator.

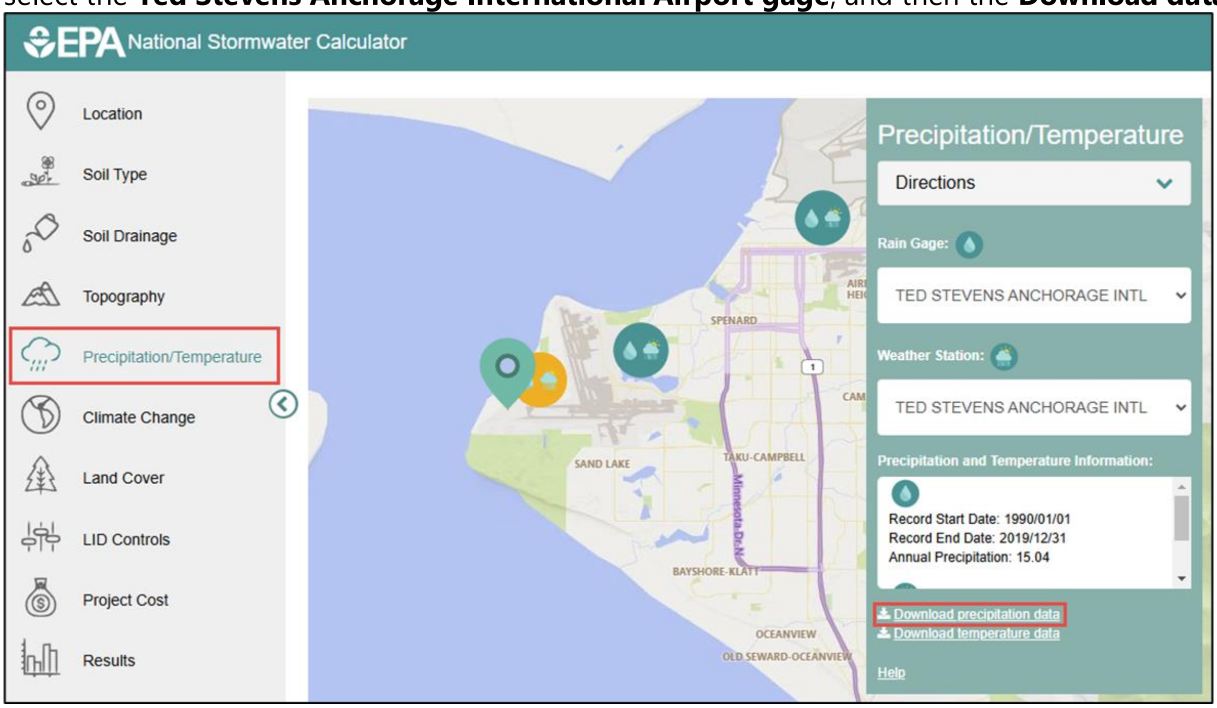
There are important considerations when setting job control parameters for model applications involving long-term continuous simulation. The design storm hyetographs in earlier steps were input without dates and so rainfall was applied relative to the Start/End Analysis Dates specified in the Simulation Options. With observed precipitation/meteorologic data however, it is important to set the Start/End Analysis Dates to match the recorded dates in the input timeseries.

Further, continuous simulation implies long simulation periods, and it is therefore critically important to be aware of how the Reporting timestep affects the output file size and how the Routing timestep affects the computation time. With the design storms earlier in this exercise, a 1 second Reporting timestep was useful, allowing the modeler to "see" (i.e., graph, tabulate, or statistically analyze) all of the computed results at a Routing timestep of 1 second. The time it takes to run a given model depends on the Routing timestep, and the size of the binary output (i.e., the *.out file, which is used by the SWMM5.2 interface to graph, tabulate, or statistically analyze model results) depends on the Routing timestep. For example:

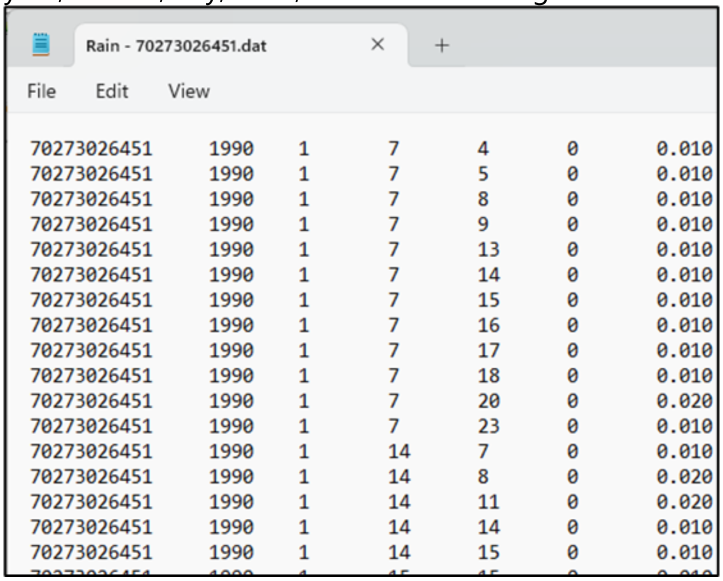
- A model with a Reporting timestep of 1 second will produce an output file that is approximately 300X larger than a model with a Reporting timestep of 5 minutes.
- A model with a Routing timestep of 0.1 second will take approximately 50X longer to run than a model with a Routing timestep of 5 seconds.

**3-1** In **SWMM5.2**, **Open** the file **"ANC1_1in1hr.inp"** and then **Save As "ANC1_Hourly1990-2019.inp"**.

**3-2** In a **web browser**, **Open the National Stormwater Calculator**, which can be accessed at https://swcweb.epa.gov/stormwatercalculator/. **Pan** over to Alaska and **Zoom** into the Anchorage area on the map, and then **Click** on a location near the airport. Select the **Precipitation/Temperature** item, select the **Ted Stevens Anchorage International Airport gage**, and then the **Download data** button.



**3-3** In **Notepad** (or another text editor), **Open** the downloaded file "**Rain - 70273026451.dat**". Note that it contains nearly 16,600 records of hourly precipitation, recorded at the airport for the 30-year period from January 1990 through December 2019. The first column shows the station ID, the next five columns indicate the time stamp, and the last column shows the rainfall depth in inches. The time stamp gives the year, month, day, hour, and minute during which the accumulated rain fell.


Rain - 70273026451.dat

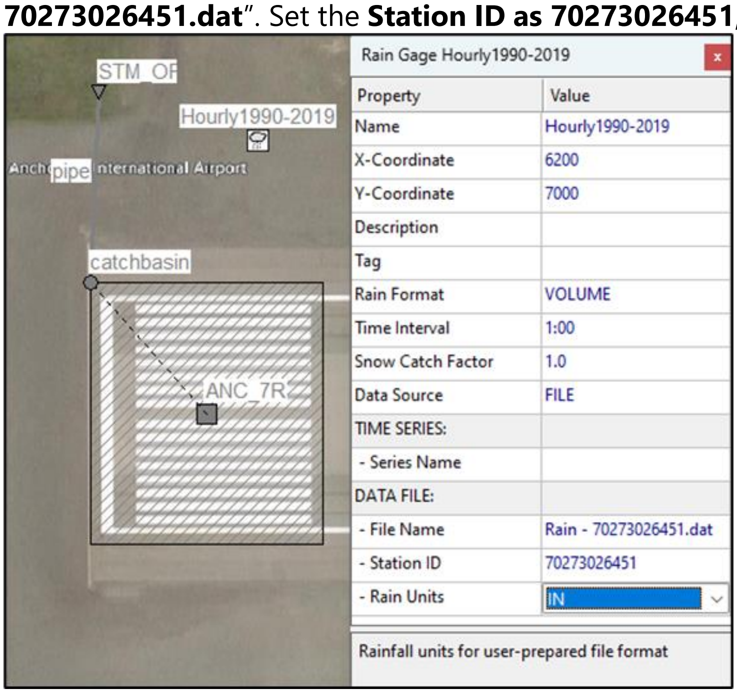
File Edit View

| | | | | | | |
|---|---|---|---|---|---|---|
| 70273026451 | 1990 | 1 | 7 | 4 | 0 | 0.010 |
| 70273026451 | 1990 | 1 | 7 | 5 | 0 | 0.010 |
| 70273026451 | 1990 | 1 | 7 | 8 | 0 | 0.010 |
| 70273026451 | 1990 | 1 | 7 | 9 | 0 | 0.010 |
| 70273026451 | 1990 | 1 | 7 | 13 | 0 | 0.010 |
| 70273026451 | 1990 | 1 | 7 | 14 | 0 | 0.010 |
| 70273026451 | 1990 | 1 | 7 | 15 | 0 | 0.010 |
| 70273026451 | 1990 | 1 | 7 | 16 | 0 | 0.010 |
| 70273026451 | 1990 | 1 | 7 | 17 | 0 | 0.010 |
| 70273026451 | 1990 | 1 | 7 | 18 | 0 | 0.010 |
| 70273026451 | 1990 | 1 | 7 | 20 | 0 | 0.020 |
| 70273026451 | 1990 | 1 | 7 | 23 | 0 | 0.010 |
| 70273026451 | 1990 | 1 | 14 | 7 | 0 | 0.010 |
| 70273026451 | 1990 | 1 | 14 | 8 | 0 | 0.020 |
| 70273026451 | 1990 | 1 | 14 | 11 | 0 | 0.020 |
| 70273026451 | 1990 | 1 | 14 | 14 | 0 | 0.010 |
| 70273026451 | 1990 | 1 | 14 | 15 | 0 | 0.010 |

**3-4** **Copy** the file "**Rain - 70273026451.dat**" into your working folder (i.e., the same folder where your "ANC1_Hourly1990-2019.inp" input file is located).

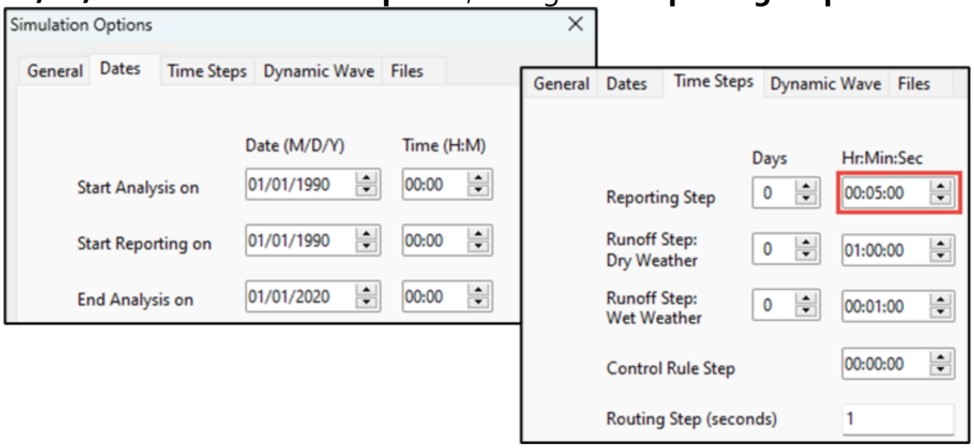
**3-5** In **SWMM5.2**, **Open** the file **"ANC1_Hourly1990-2019.inp"** and **Add a new Rain Gage** at any location in the Study Area Map.

**3-6** **Open** the Rain Gage object, change the **Name to "Hourly1990-2019"**, the **Rain Format to Volume**, and select the **Data Source as FILE** from the dropdown list. In the DATA FILE section of the Rain Gage Editor, click the ellipse button in the File Name input box and browse to the file "**Rain - 70273026451.dat**". Set the **Station ID as 70273026451**, **Rain Units of IN**, and then **Close** the editor.



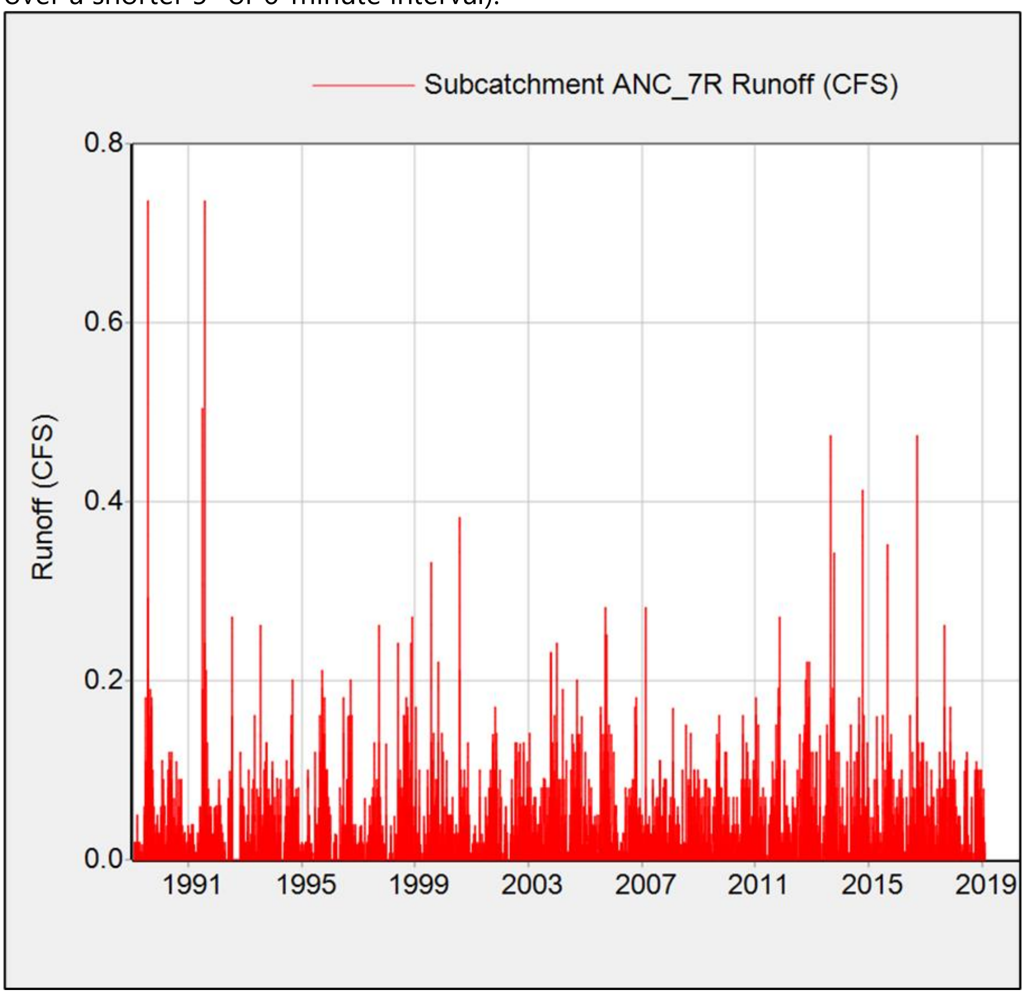

**3-7** In the **Dates tab** of the Simulation Options editor, change the **Start Analysis on** and **Start Reporting on** dates to midnight on **01/01/1990**, and change the **End Analysis on** date to midnight on

**01/01/2020**. In the **Time Steps tab**, change the **Reporting Step to 5 minutes**. <<DON'T MISS THIS!




**3-8** **Open** the Subcatchment object and change the **Rain Gage to "Hourly1990-2019"** from the dropdown list. **Close** the Subcatchment editor.

**3-9** **Run** the simulation (note this could take 15-20 minutes) and **plot the runoff hydrograph** for the subcatchment. Note that since the long-term rainfall intensities are averaged over an hourly interval, the resulting runoff is less peaky than with the design storm events (where rainfall intensities are averaged over a shorter 5- or 6-minute interval).




**3-10** As an option to reduce the computation time, the hydraulic flow routing can be disabled. The advantage is that the model will run in a few seconds. However, the disadvantage is that there will be no computed results in the hydraulic network (i.e., only hydrology timeseries can be plotted, tabulated, or statistically analyzed).