

CE 374 K – Hydrology



Introduction to HEC - HMS

Daene C. McKinney

Hydrologic Engineering Center

- **U.S. Army Corps of Engineers (USACE)
Hydrologic Engineering Center (HEC)**
 - Formed 1964 to institutionalize the technical expertise in hydrologic engineering
 - L. Roy Beard founding Director (Professor Emeritus, Dept. of Civil Engr., UT Austin)
 - Development well-known family of HEC software
 - HEC-1 (watershed hydrology, now HEC-HMS)
 - HEC-2 (river hydraulics, now HEC-RAS)
 - HEC-3 (reservoir analysis, now HEC-ResSim)

HEC-Hydrologic Modeling System (HEC-HMS)

- Simulation of runoff hydrographs resulting from design storms and other precipitation events
- Primary function
 - quantifying rainfall losses into the soil (computing rainfall excess)
 - converting excess rainfall to runoff
 - routing flows
- Obtaining
 - Program: <http://www.hec.usace.army.mil/> 
 - Data: <http://www.ce.utexas.edu/prof/mckinney/ce374k/Homework/waller.zip> 

Start the Program



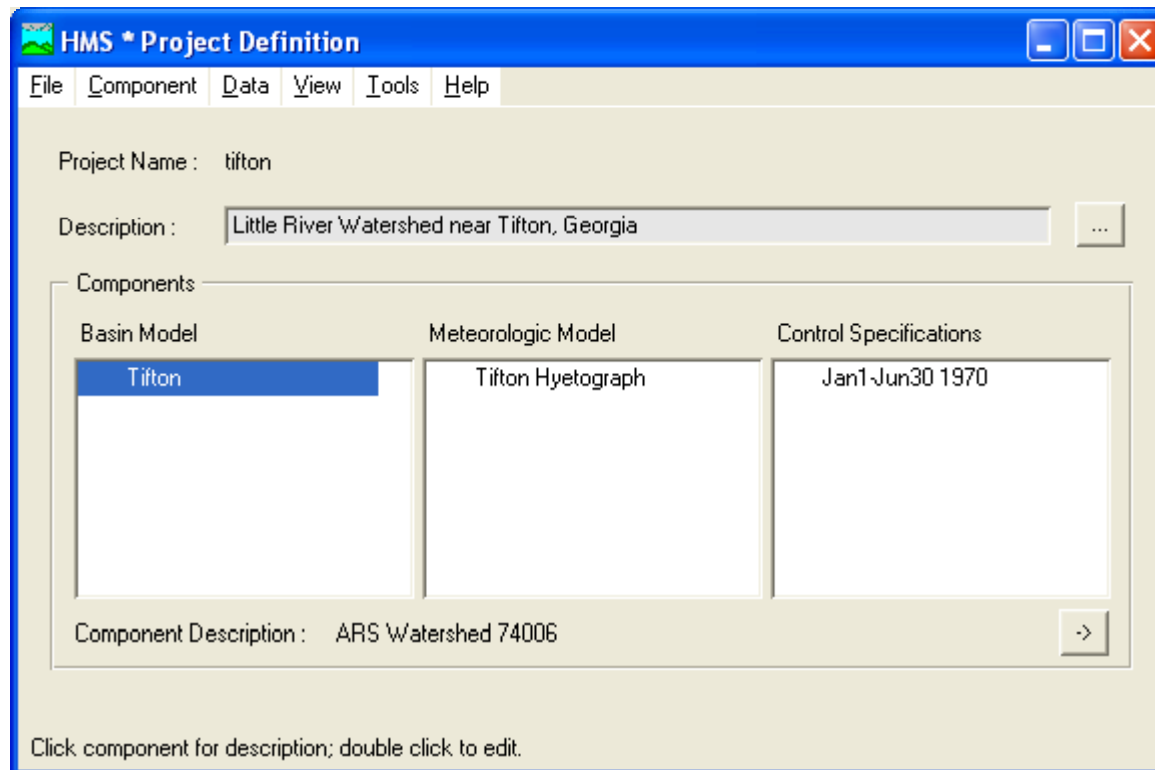
Components:

Basin Model

Meteorologic Model

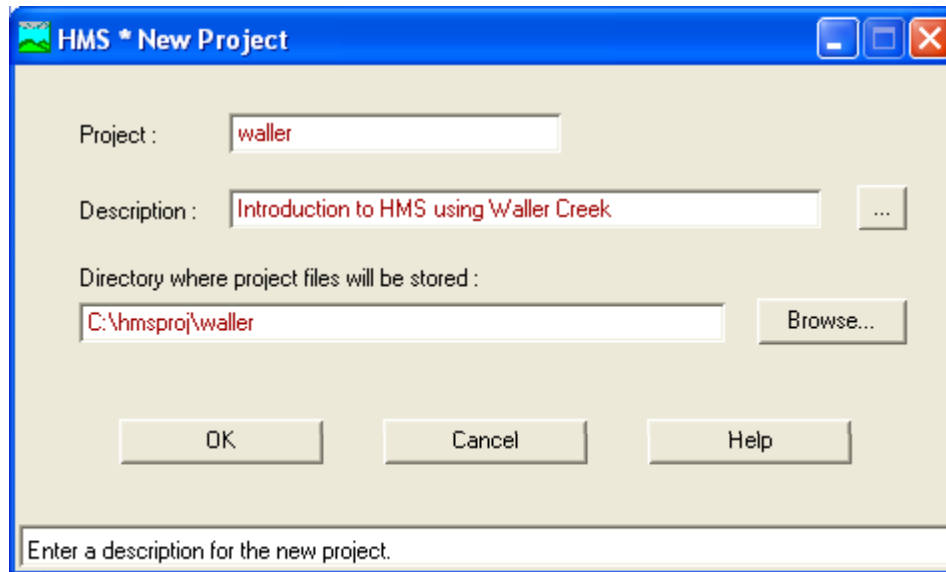
Control Specifications

Project Definition Screen



Import Waller Creek Model

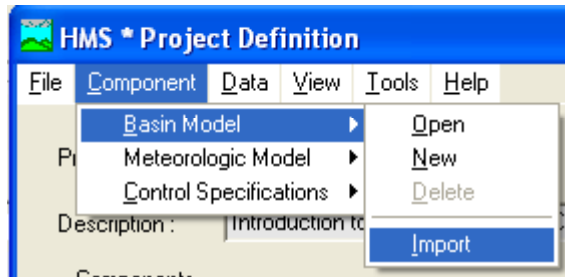
File/New Project



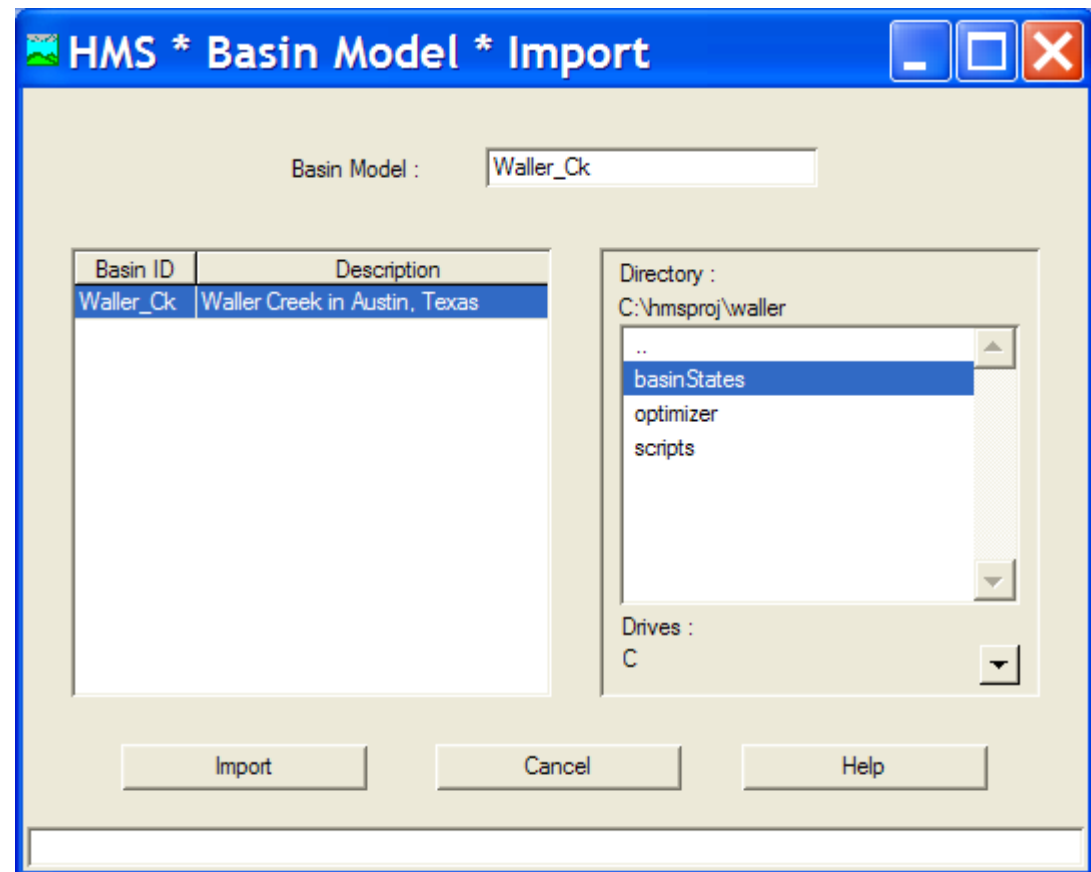
Creates: C:\hmsproj\waller

Copy:
Waller_Ck.basin and
Hms.map
to C:\hmsproj\waller

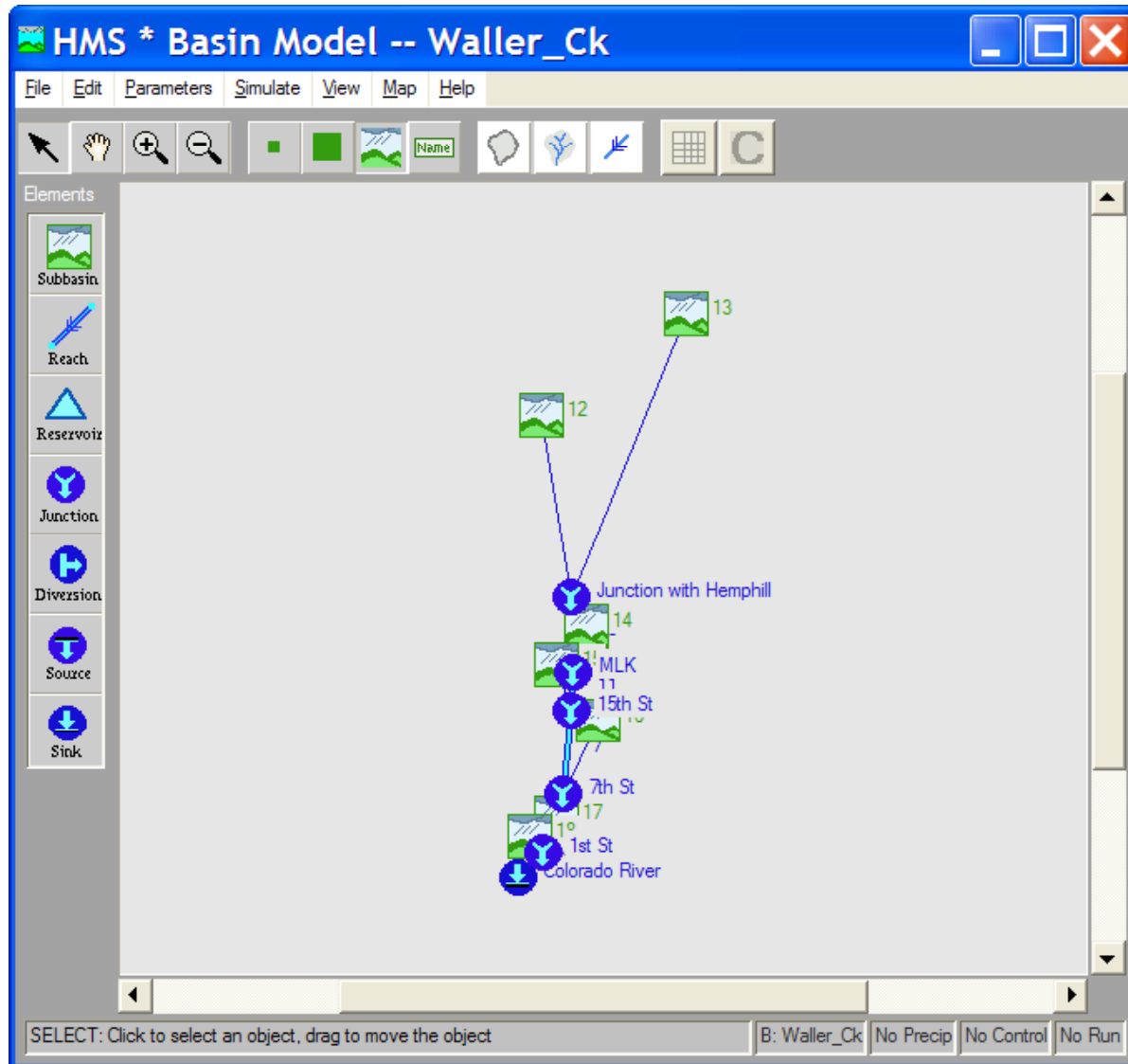
Import Basin Model



Component/Basin Model/Import:
Import basin model file Waller_Ck.basin

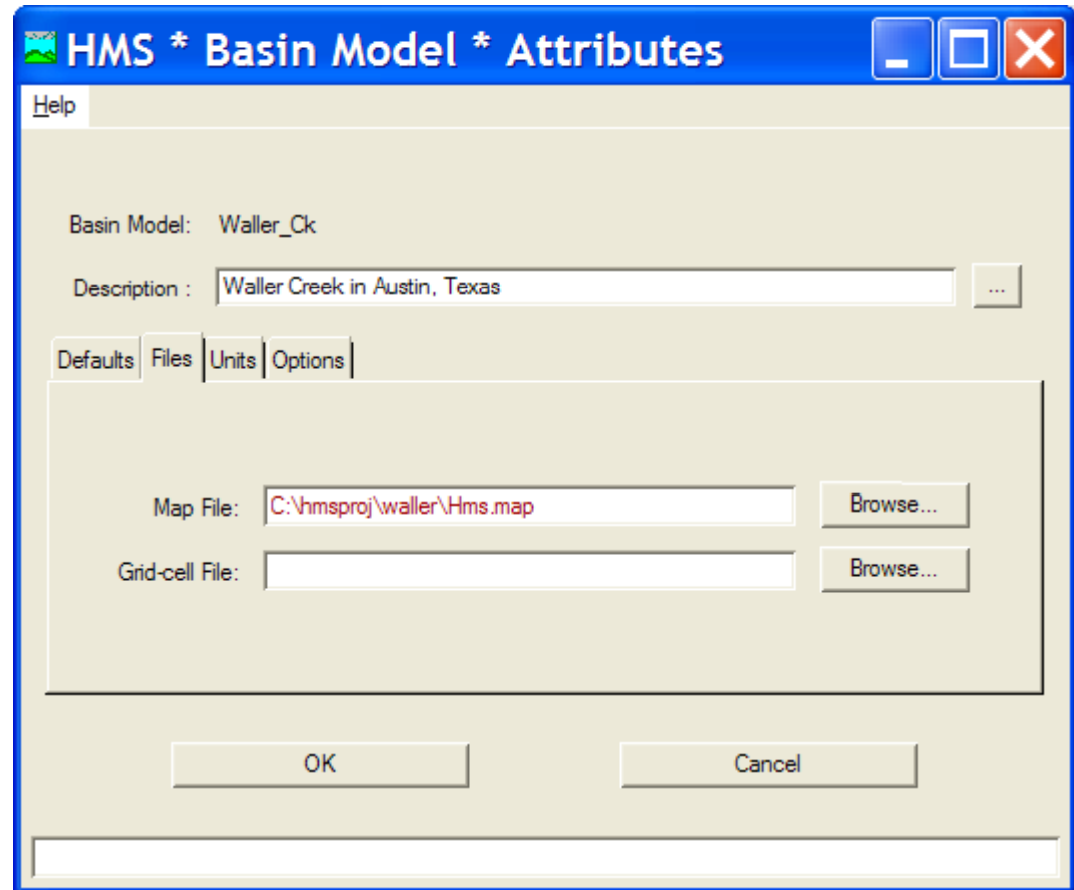


Basin Model

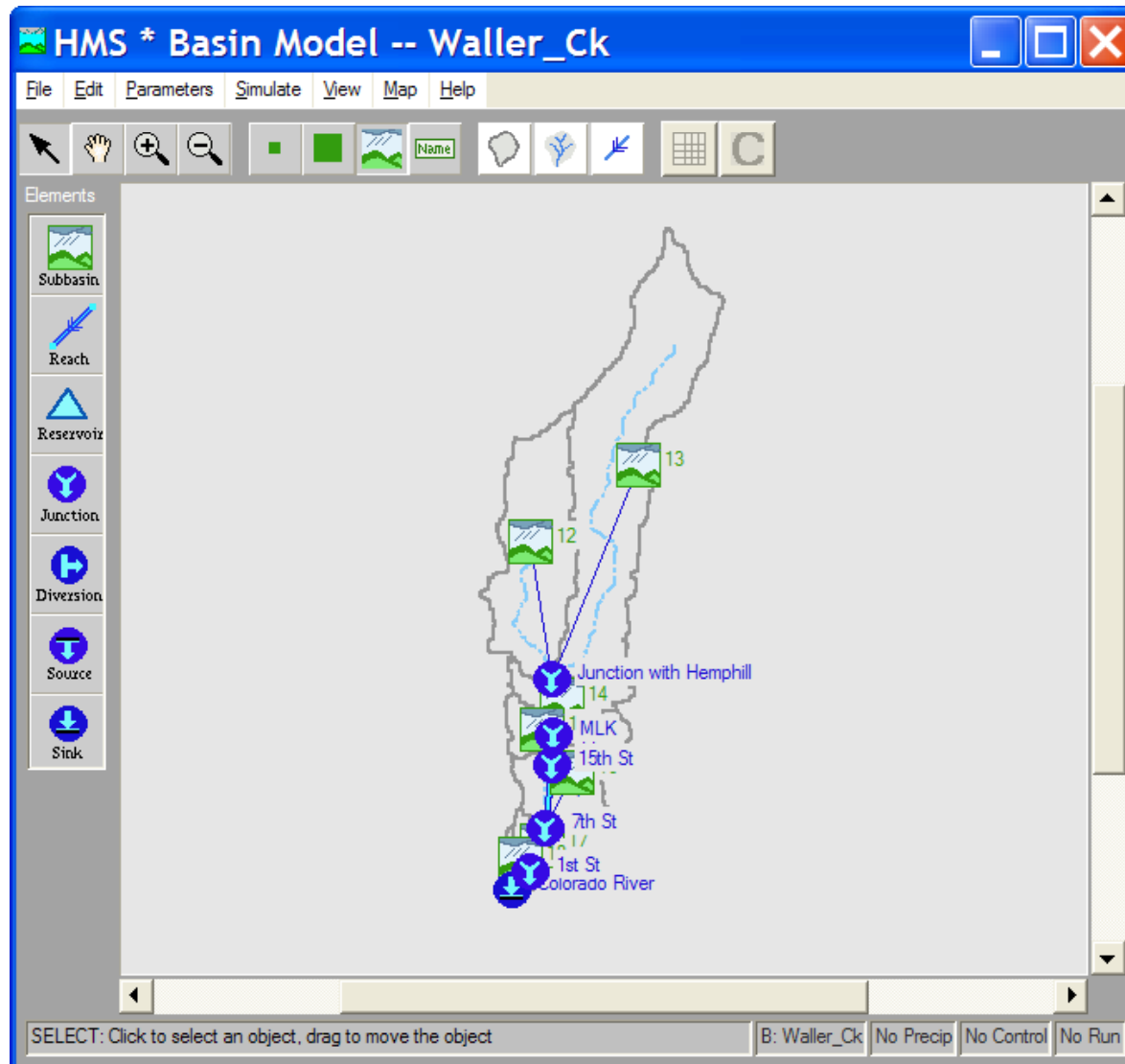


Basin Map

File/Basin Model Attributes
Files tab



Basin Model With Map



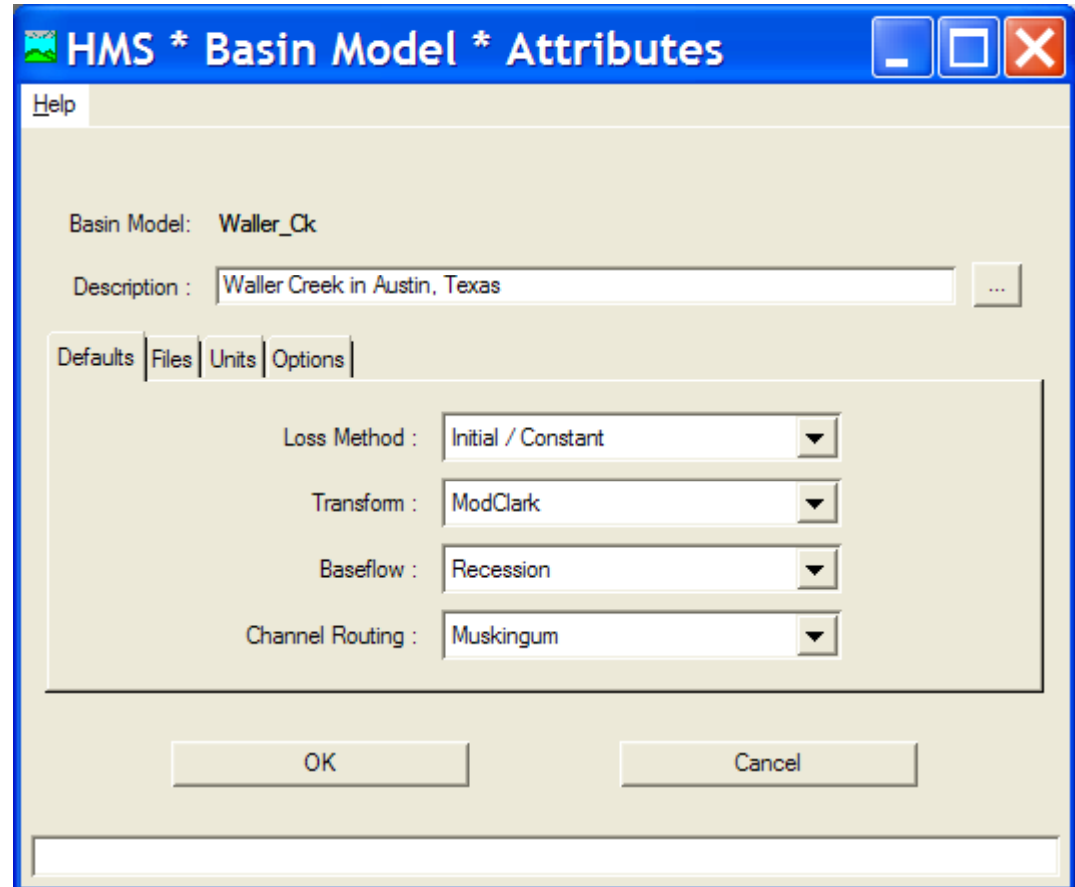
Hydrologic Elements



- **Subbasin** - Outflow calculated from precipitation by subtracting losses, transforming excess precipitation and adding baseflow
- **River Reach** - Inflow from other elements, Outflow computed from flow routing methods
- **Reservoir** - Outflow computed from storage - outflow relations and level water surface assumption
- **Junction** - combine flows from upstream reaches and subbasins
- **Diversion** - Two outlets, main and diverted
- **Source** - inflow from outside the modeled region
- **Sink** - outflow leaving the modeled region

Basin Model Attributes

- Basin Model window
 - File/Basin Model Attributes
- Loss Rates
 - rainfall losses absorbed by the ground
- Transform
 - how to convert excess rainfall to direct runoff
- Baseflow
- Routing
 - routing a hydrograph through a river reach



The screenshot shows a Windows-style dialog box titled "HMS * Basin Model * Attributes". The dialog has a blue title bar with standard window controls (minimize, maximize, close). Below the title bar is a "Help" button. The main area contains the following fields:

- Basin Model: Waller_Ck
- Description: Waller Creek in Austin, Texas (with a browse button "...")
- Tabbed interface with "Defaults" selected, and "Files", "Units", and "Options" tabs.
- Loss Method: Initial / Constant (dropdown menu)
- Transform: ModClark (dropdown menu)
- Baseflow: Recession (dropdown menu)
- Channel Routing: Muskingum (dropdown menu)

At the bottom of the dialog are "OK" and "Cancel" buttons. A status bar is visible at the very bottom of the window.

Basin Model Parameters

- Basin Model Screen
 - Parameters/Loss Rate/Initial Constant
- Enter values
 - initial loss
 - constant loss rate
 - % imperviousness

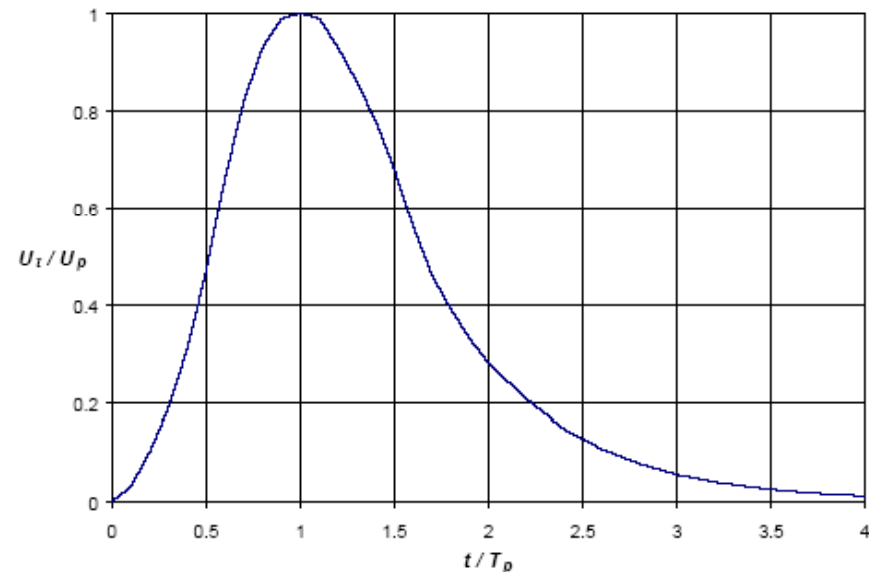
Basin Model ID: Waller_Ck

Subbasin Name	Initial Loss (mm)	Constant Loss Rate	Imperviousness (%)
12	5	2	0.0
13	5	2	0.0
14	5	2	0.0
15	5	2	0.0
16	5	2	0.0
17	5	2	0.0
18	5	2	0.0

Buttons: OK, Apply, Cancel

SCS Dimensionless Hydrograph

- SCS developed a parametric UH model based on averages of UHs from a large number of small agricultural watersheds in the US.
 - A – watershed area
 - C – conversion factor for unit system
 - T_p – time to peak
 - Δt – excess precip duration
 - t_{lag} – basin lag, time between center of rainfall excess and UH peak



Given ER hyetograph and time lag, then solve for time of UH peak, then UH peak

$$U_p = C \frac{A}{T_p}$$

$$T_p = \frac{\Delta t}{2} + t_{lag}$$

Transform Method

- Basin Model Screen
 - Parameters/Transform/SCS UH

Basin Model ID: Waller_Ck

Time Units : Minutes

Subbasin Name	SCS Lag (min)
12	199
13	321
14	67
15	58
16	105
17	49
18	43

OK Apply Cancel

Reach Routing Method

- Basin Model Screen
 - Parameters/Reach/Muskingum

Basin Model ID: Waller_Ck

Reach Name	Muskingum K (hrs)	Muskingum X	Number of Subreaches
7	0.9579	0.15	2
8	0.7032	0.15	2
9	0.4484	0.15	1
10	0.8583	0.15	2
11	0.5643	0.15	2

OK Apply Cancel

Meteorological Model

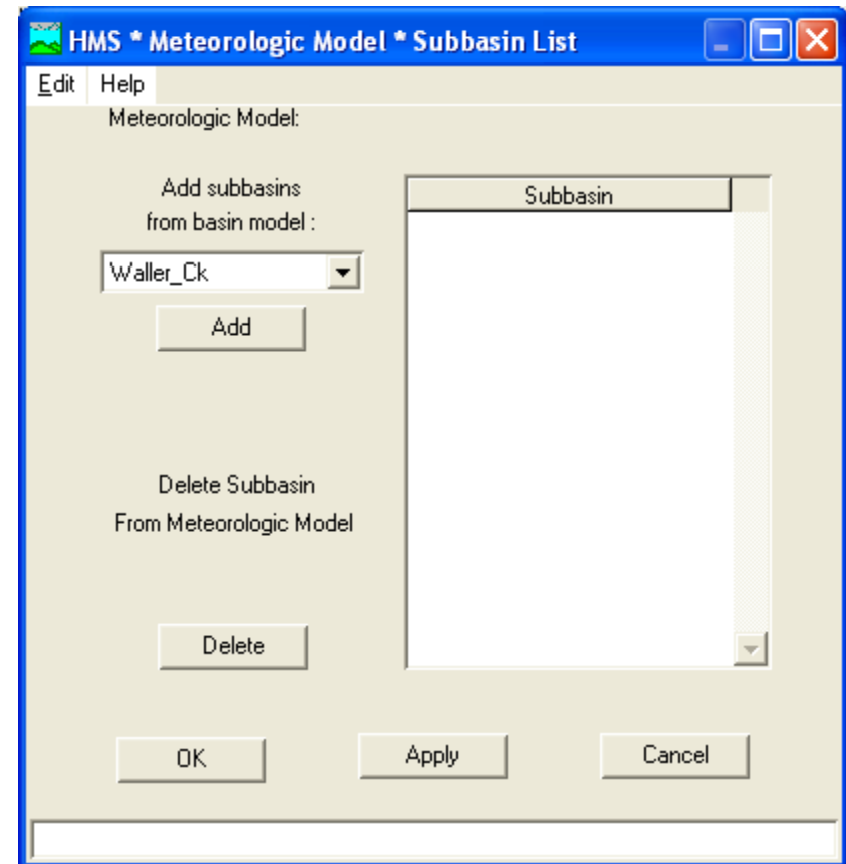
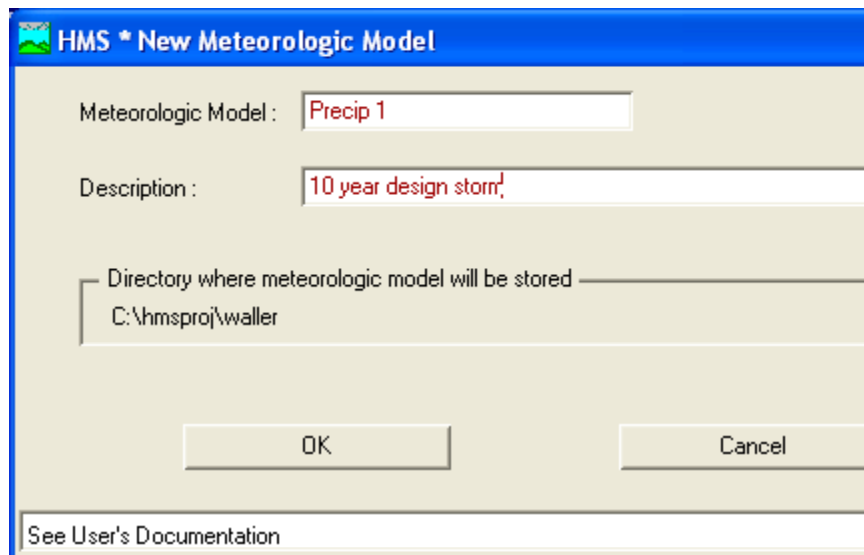
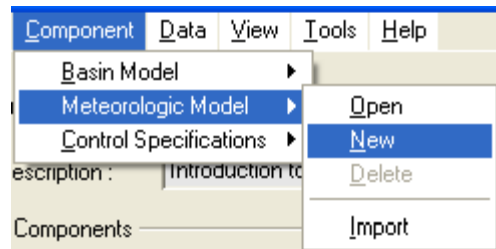
- Precipitation and evapotranspiration data necessary to simulate a watershed
- Precipitation depth expected as function of return period and the storm duration

Design Precipitation Depths for Travis County, Texas (in.)

Duration (min)	Return Period (yr)					
	2	5	10	25	50	100
5	0.60	0.75	0.85	0.98	1.07	1.24
15	1.15	1.47	1.66	1.93	2.12	2.43
60	1.94	2.55	2.91	3.41	3.80	4.31
120	2.35	3.13	3.57	4.21	4.74	5.35
180	2.60	3.47	3.98	4.71	5.34	6.02
360	3.05	4.11	4.75	5.65	6.45	7.28
720	2.54	4.87	5.57	6.71	7.75	8.69
1440	4.06	5.67	6.52	7.94	9.26	10.39

Meteorological Model

Component/ Meteorologic Model/New



Meteorological Model

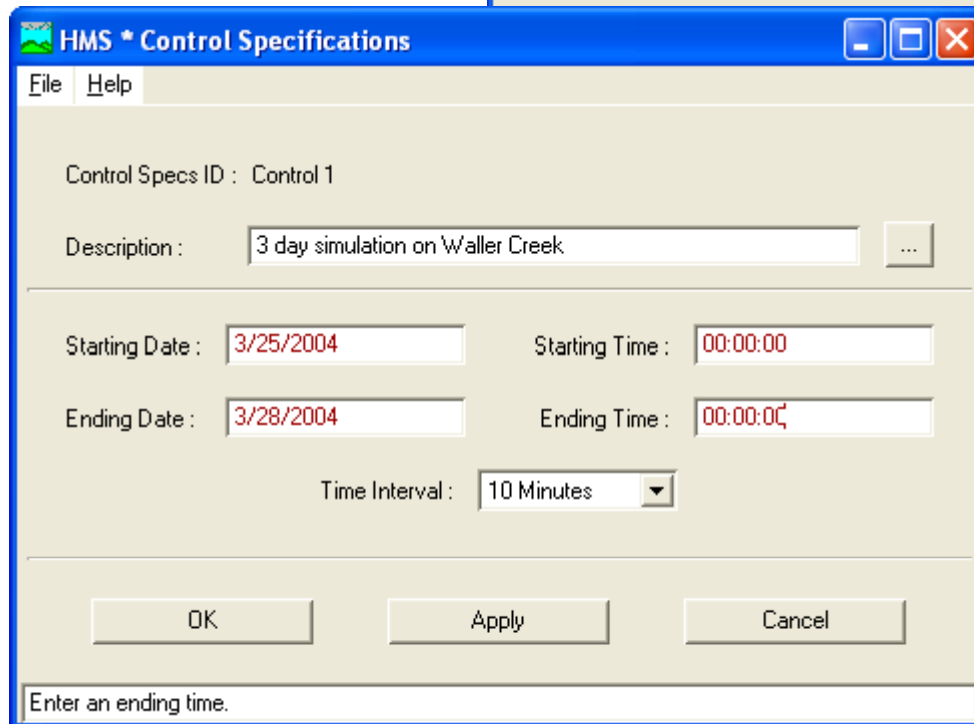
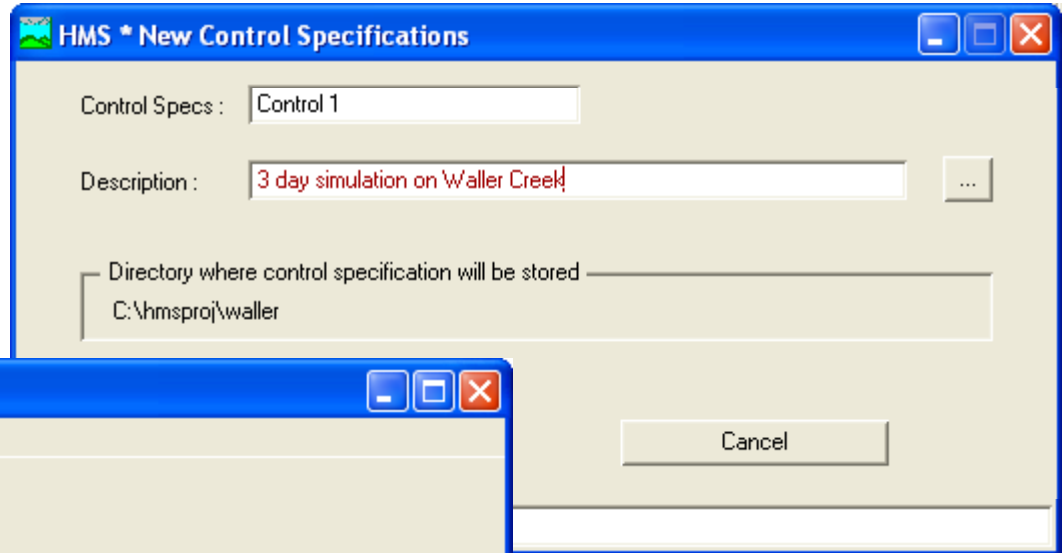
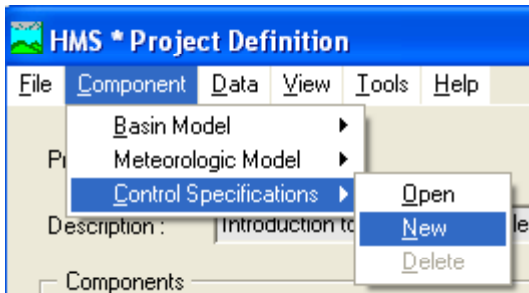
Method: Frequency Storm

The screenshot displays the HMS Meteorologic Model software interface. The main window is titled "HMS * Meteorologic Model" and contains several configuration fields and a table. The "Method" dropdown is set to "Frequency Storm". The "Exceedance Probability" is set to "10 %", "Series Type" to "Annual", "Max Intensity Duration" to "5 Mins", "Storm Duration" to "24 Hr.", and "Peak Center" to "50%". The "Storm Area (sq. mi.)" field is empty. The "Precipitation" tab is active, showing a table of precipitation depths for various durations. The "2 days" row is highlighted in blue.

Duration	Precip Depth (in)
5 minutes	0.85
15 minutes	1.66
1 hour	2.91
2 hours	3.57
3 hours	3.98
6 hours	4.75
12 hours	5.57
24 hours	6.52
2 days	
4 days	
7 days	
10 days	

Control Specifications

Component/ Control Specifications/New



Run it!

