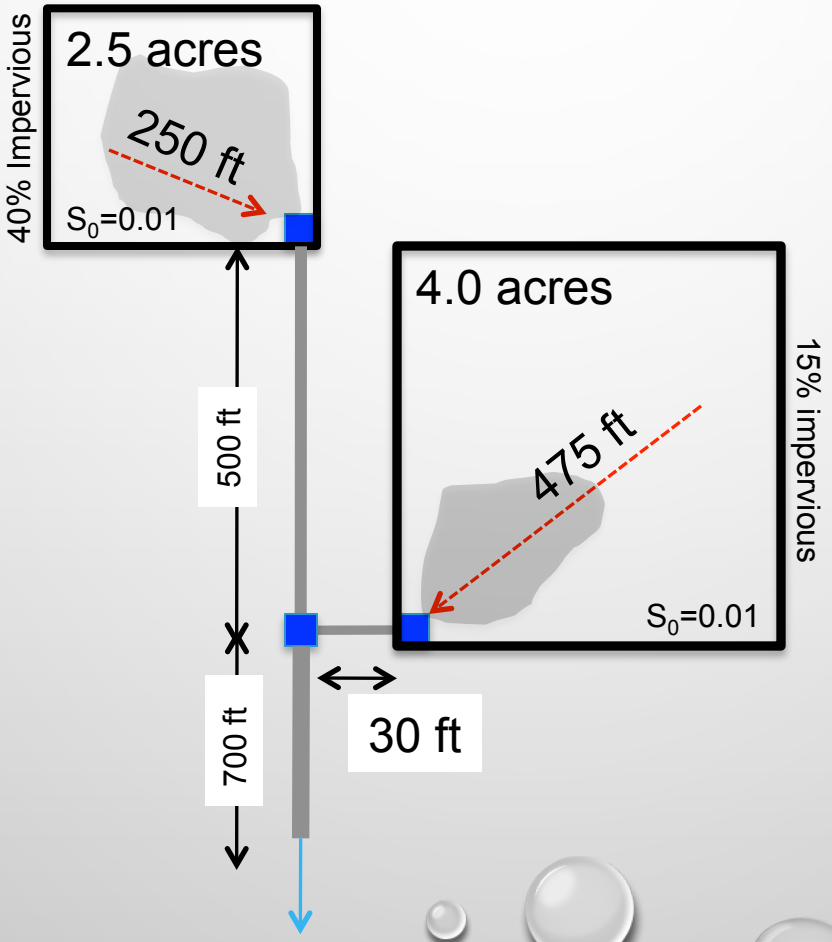
CE 3372 WATER SYSTEMS DESIGN

LECTURE 19: SWMM HYDROLOGY

SWMM AS HYDROLOGIC MODEL

- SUB-CATCHMENTS
  - INFILTRATION MODEL (RUNOFF GENERATION)
- RAINGAGES
  - TIME-SERIES OF RAINFALL (HYETOGRAPH)

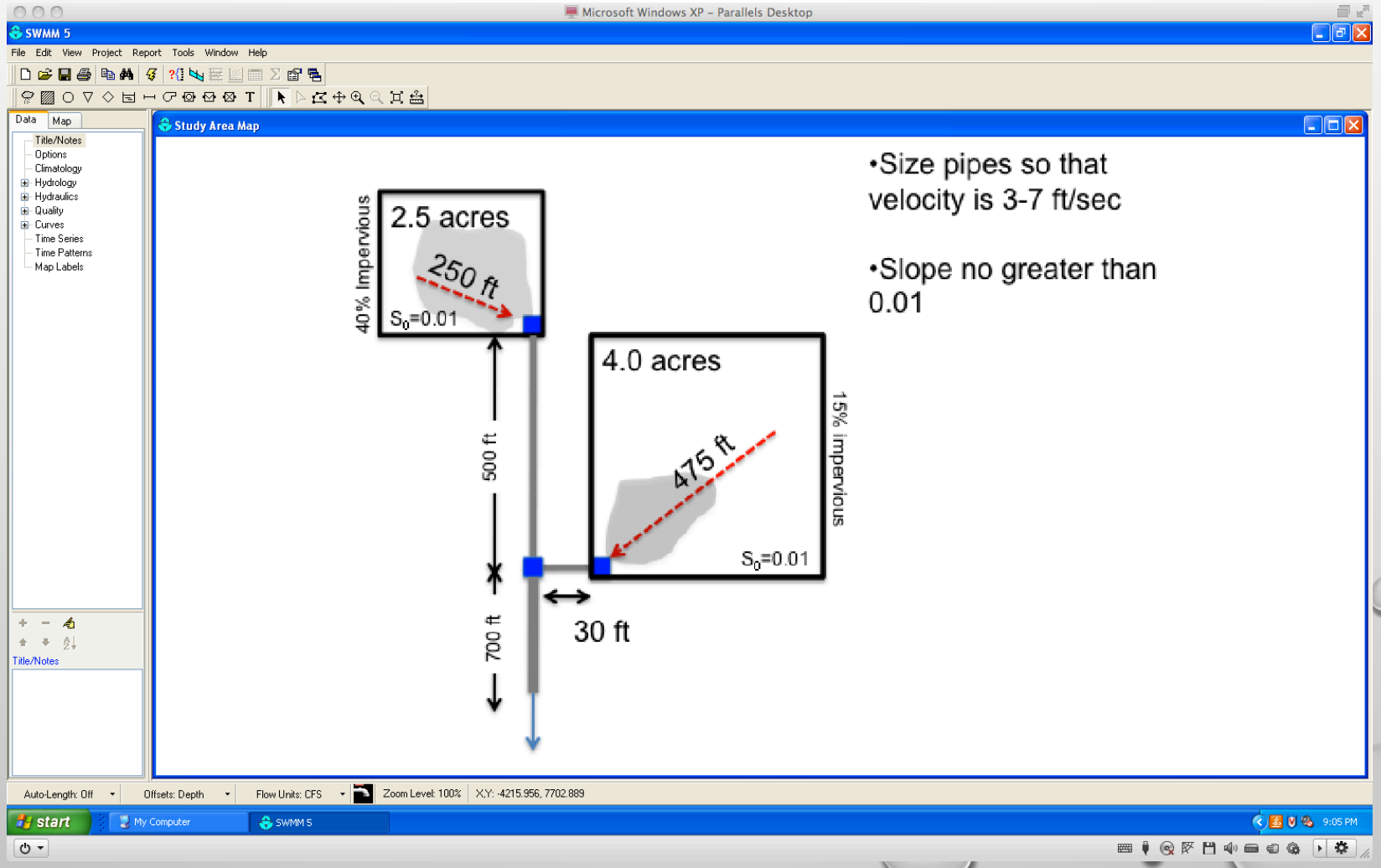
SWMM AS HYDROLOGIC MODEL



- Size pipes so that velocity is 3-7 ft/sec
- Slope no greater than 0.01

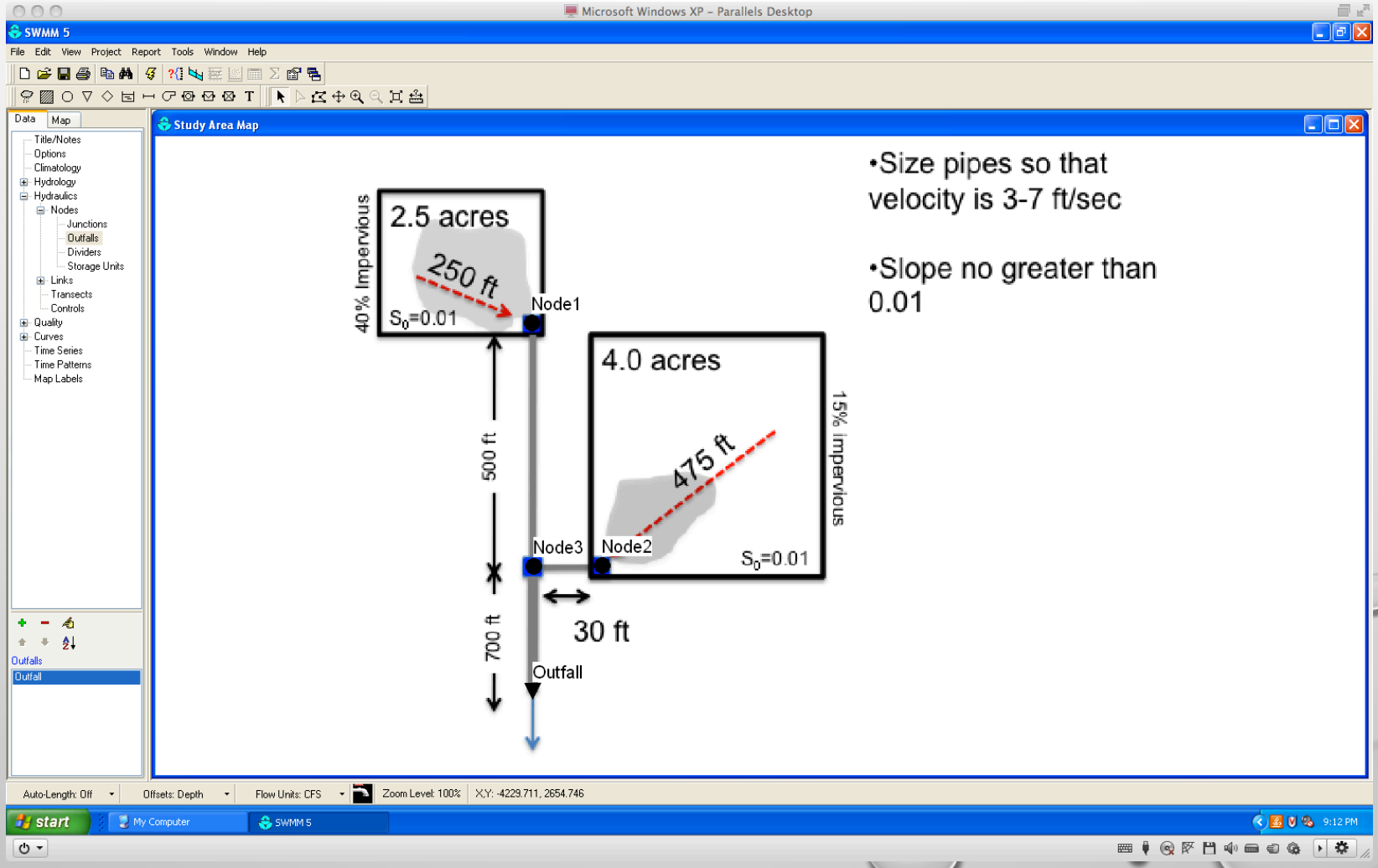
SWMM AS HYDROLOGIC MODEL

- LOAD THE PICTURE INTO SWMM



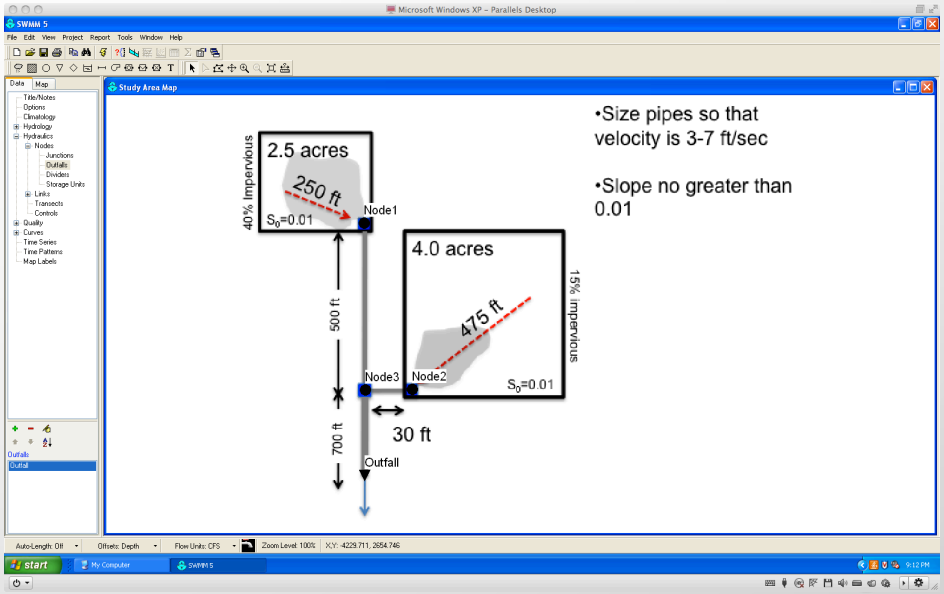
SWMM AS HYDROLOGIC MODEL

- 3 NODES + OUTFALL



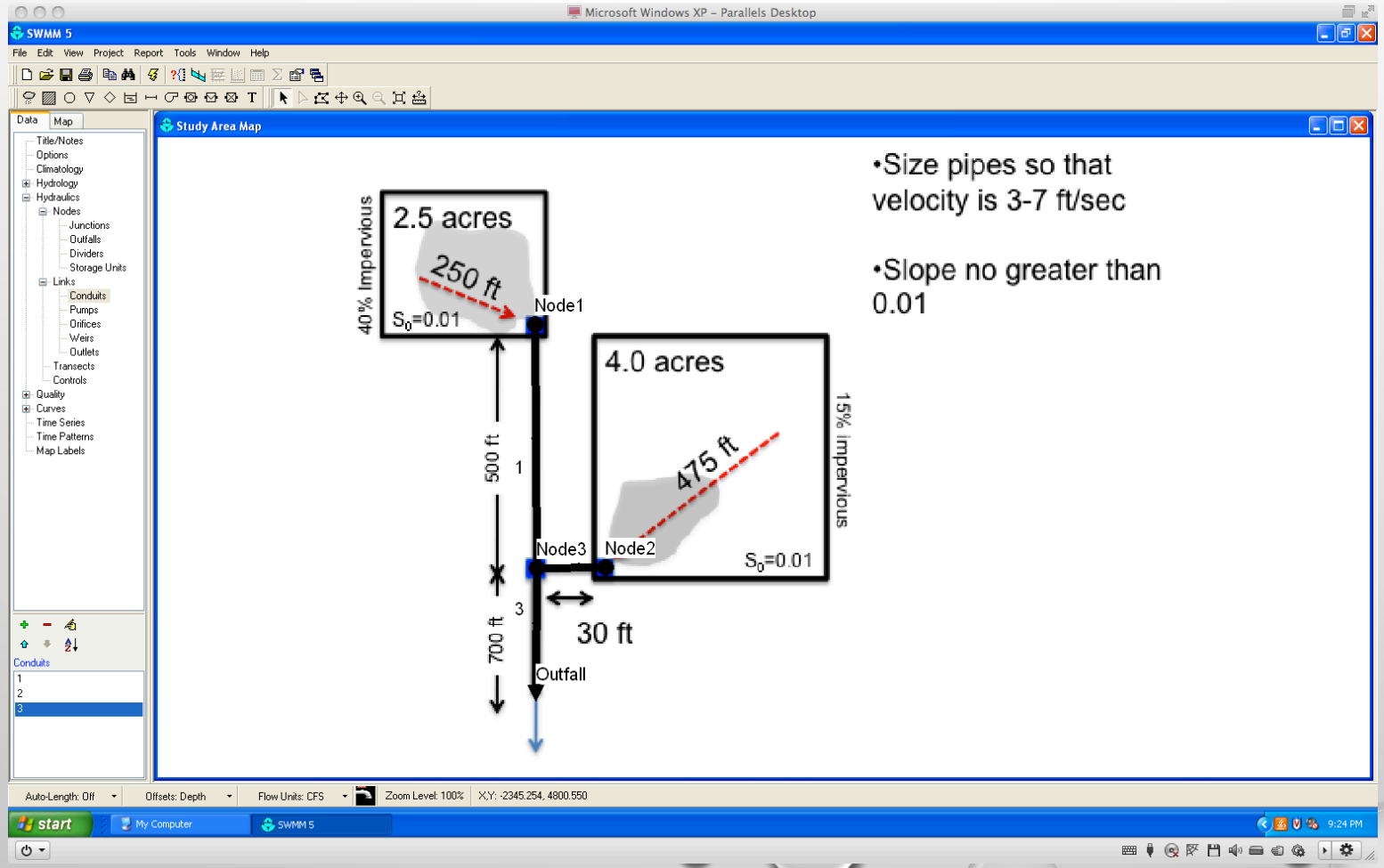
SWMM AS HYDROLOGIC MODEL

- INVERT ELEVATIONS
  - (EXAMPLE, THESE WOULD BE DESIGN VALUES, EXCEPT FOR OUTFALL, ADJUST TO GET VELOCITY)
    - OUTFALL = 0
    - NODE 3 = 700*(0.01)=7 FT
      - OFFSET OF 2 FT
    - NODE 2 = 7+2+0.01(30) = 9.3
    - NODE 1 = 7+2+0.01(500) = 14



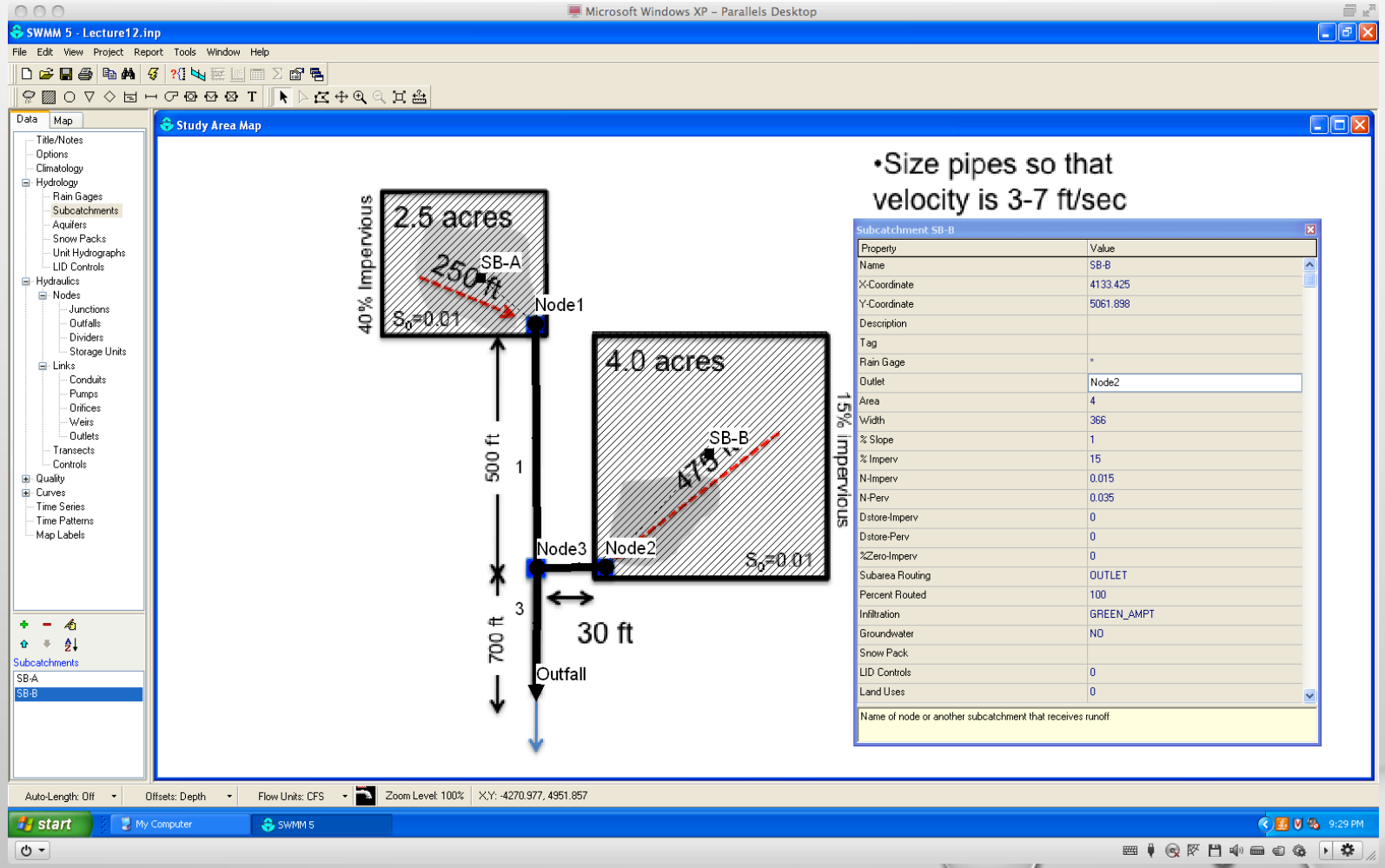
SWMM AS HYDROLOGIC MODEL

- 3 PIPES, 24” DIAMETER, CONCRETE (N=0.013)



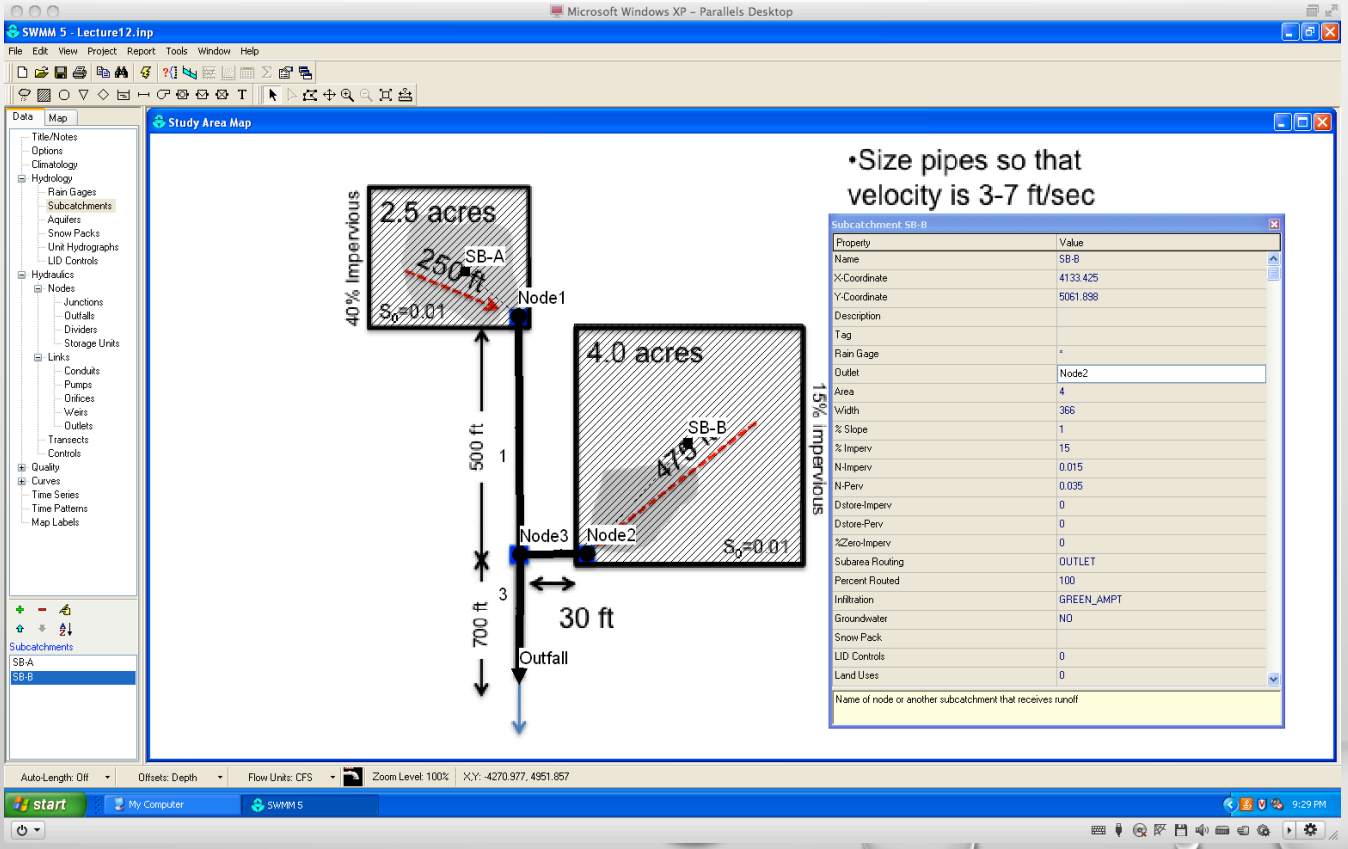
SWMM AS HYDROLOGIC MODEL

- 2 SUB-CATCHMENTS



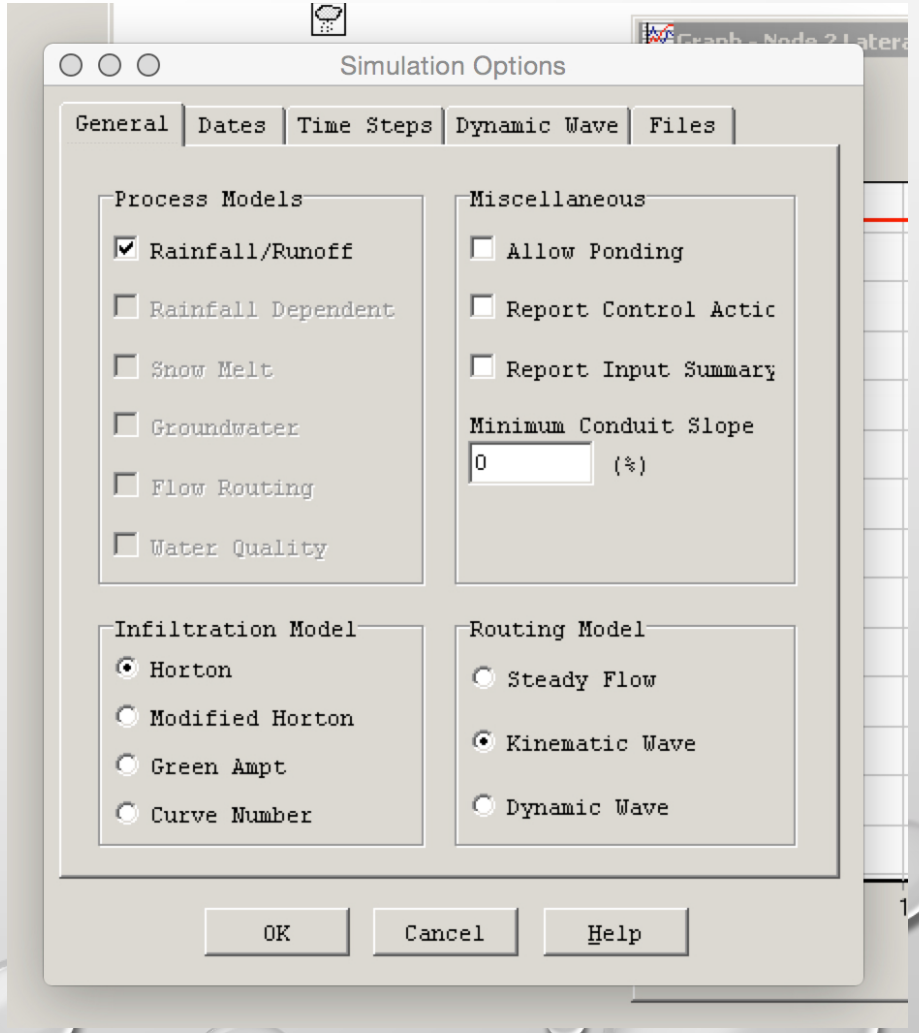
SWMM AS HYDROLOGIC MODEL

- CHOOSE A RUNOFF GENERATION MECHANISM!
  - FOR THIS SCALE RATIONAL IS LOGICAL, BUT NOT PART OF SWMM – NEED A HACK!



HACKING RATIONAL METHOD IN SWMM

- RUNOFF GENERATION
  - NO EXPLICIT RATIONAL METHOD FOR RUNOFF GENERATION
  - HORTON, GREEN-AMPT, AND CN.

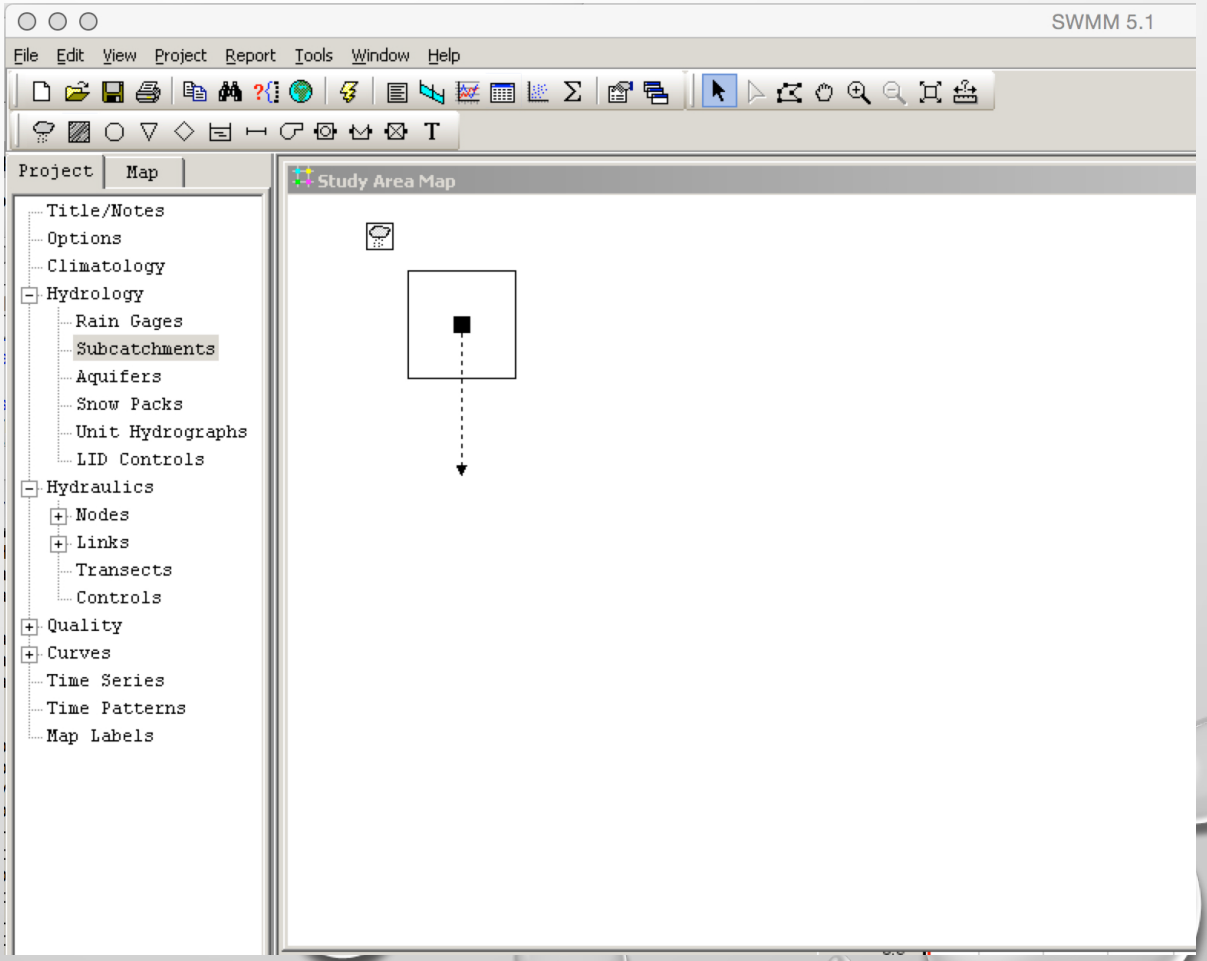


HACKING RATIONAL METHOD IN SWMM

- SUPPOSE WE WANT TO SIMULATE A 10.9 ACRE DRAINAGE AREA, WITH TC =49 MINUTES, AND C=0.32 AND APPLIED RAIN DEPTH IS 0.87 INCHES.
  - I = 0.87INCHES/49MIN X 60 MIN/HR = 1.06 IN/HR
  - QP = (0.32)(1.06)(10.9) = 3.7 CFS

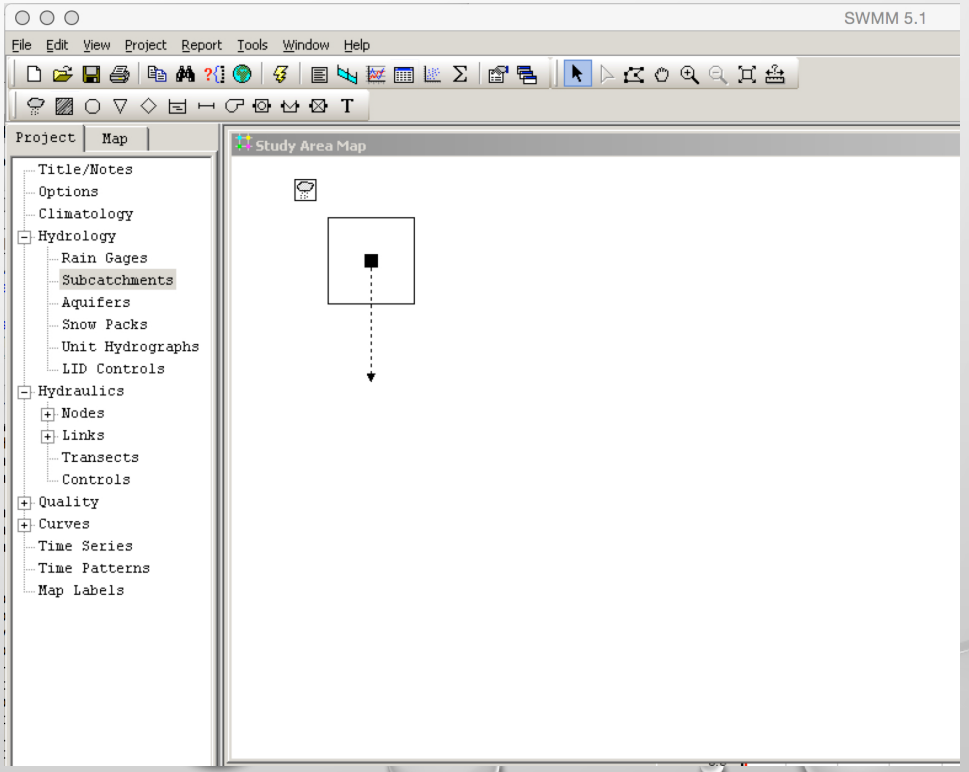
HACKING RATIONAL METHOD IN SWMM

- EQUIVALENT SWMM MODEL:
  - RAINGAGE
  - CATCHMENT
  - OUTLET



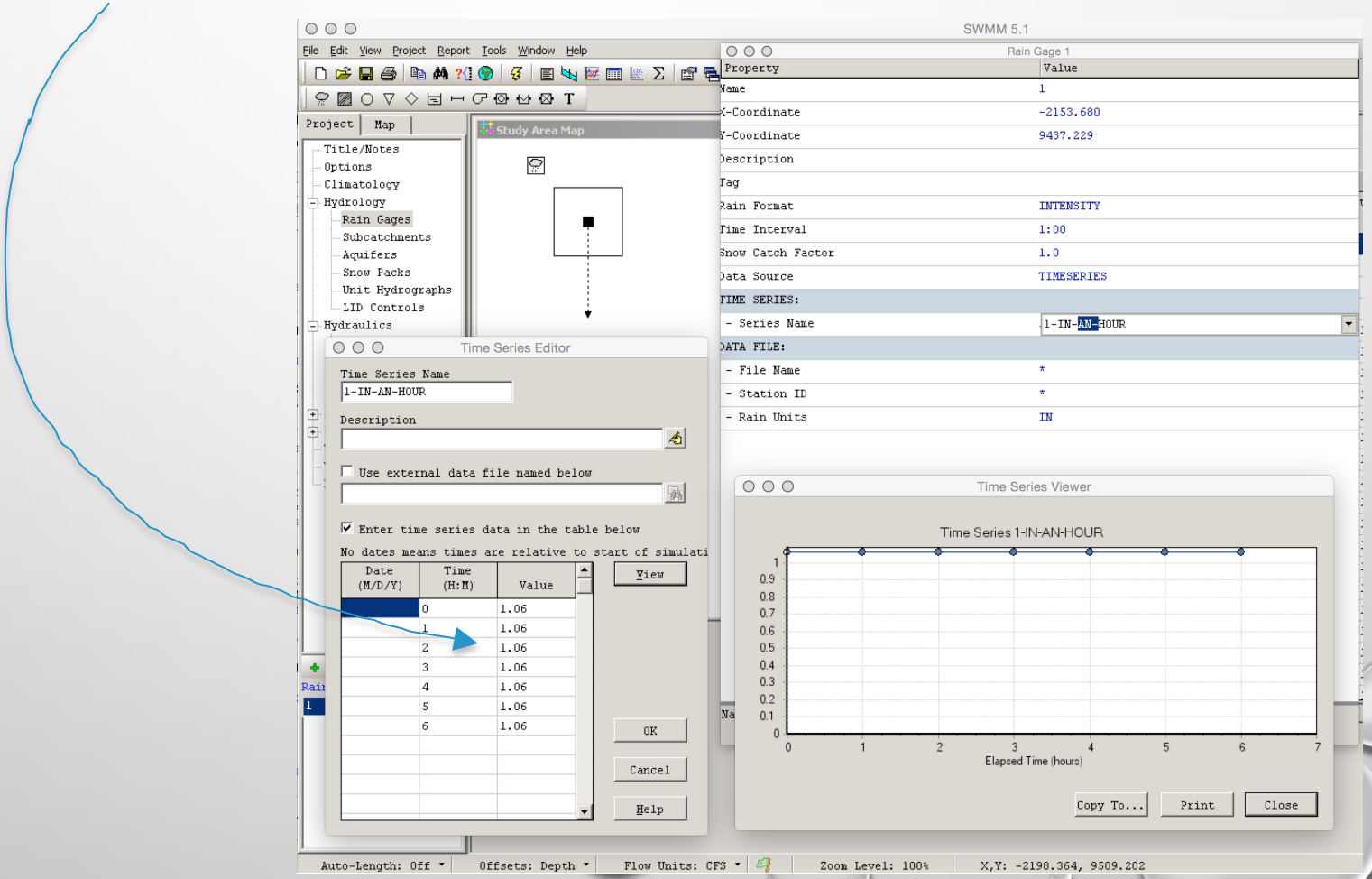
HACKING A RATIONAL METHOD IN SWMM

- EQUIVALENT SWMM MODEL:
  - RAINGAGE ➔ CONSTANT INTENSITY OF 1.06 IN.HR
  - CATCHMENT ➔ AREA = 10.9 ACRES
  - OUTLET



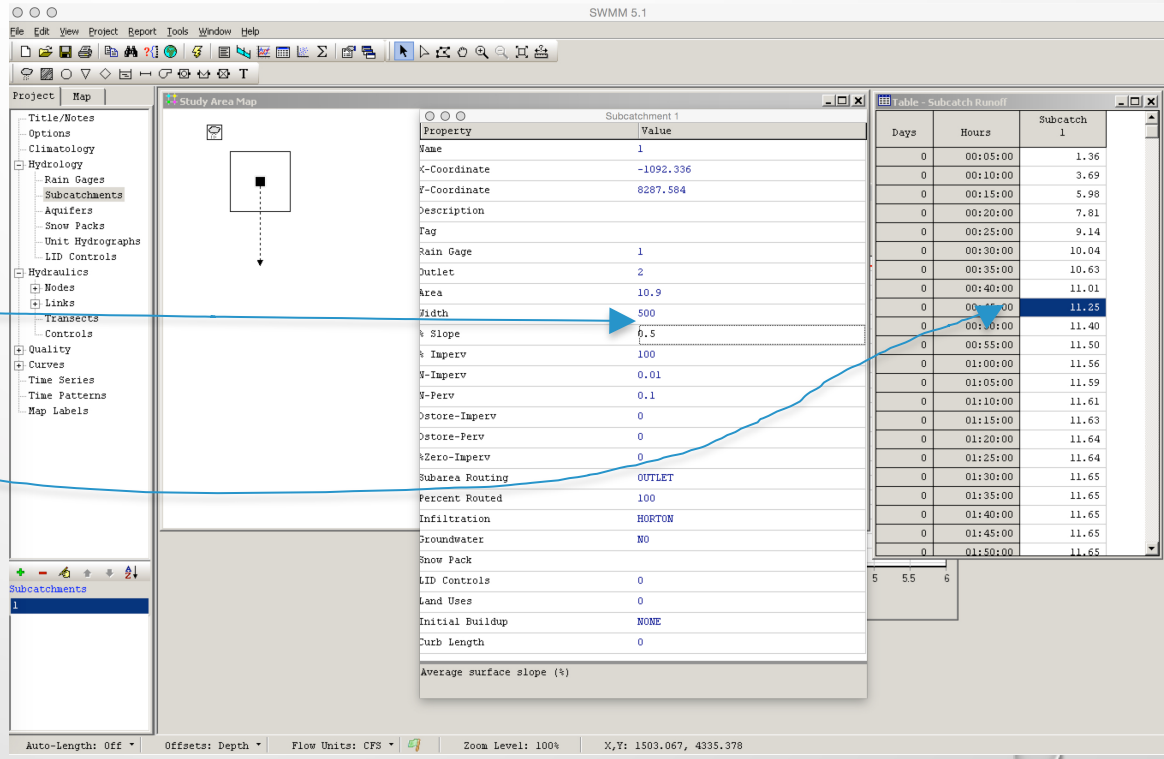
HACKING A RATIONAL METHOD IN SWMM

- RAINGAGE ➔ CONSTANT INTENSITY OF 1.06 IN/HR



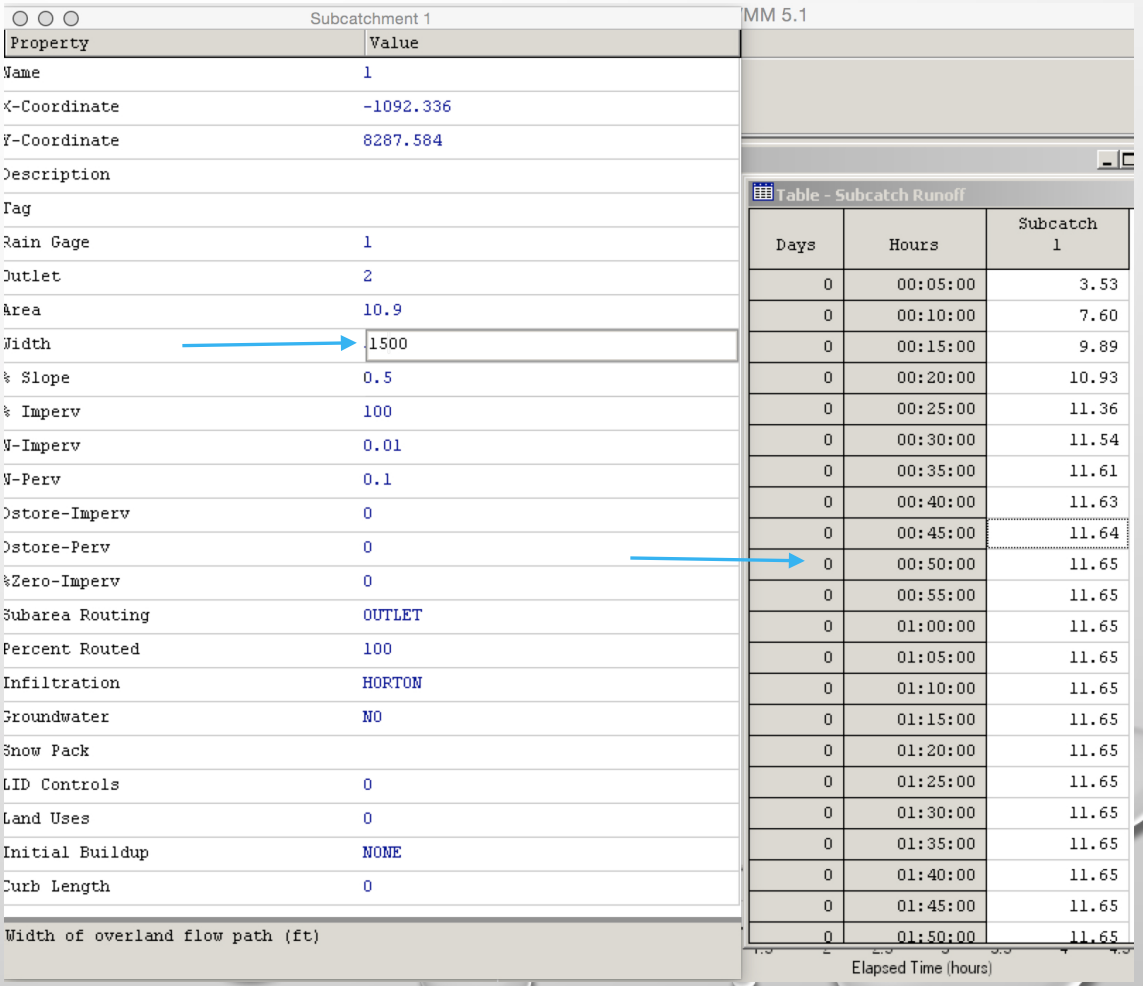
HACKING RATIONAL METHOD IN SWMM

- CATCHMENT ➔ SET SIZE, SET TO 100% IMPERVIOUS
  - RUN TO ADJUST WIDTH & SLOPE
    - ARRIVAL TIME OF QP AT 50 MINUTES
    - QP = 11.65 CFS (C=1)



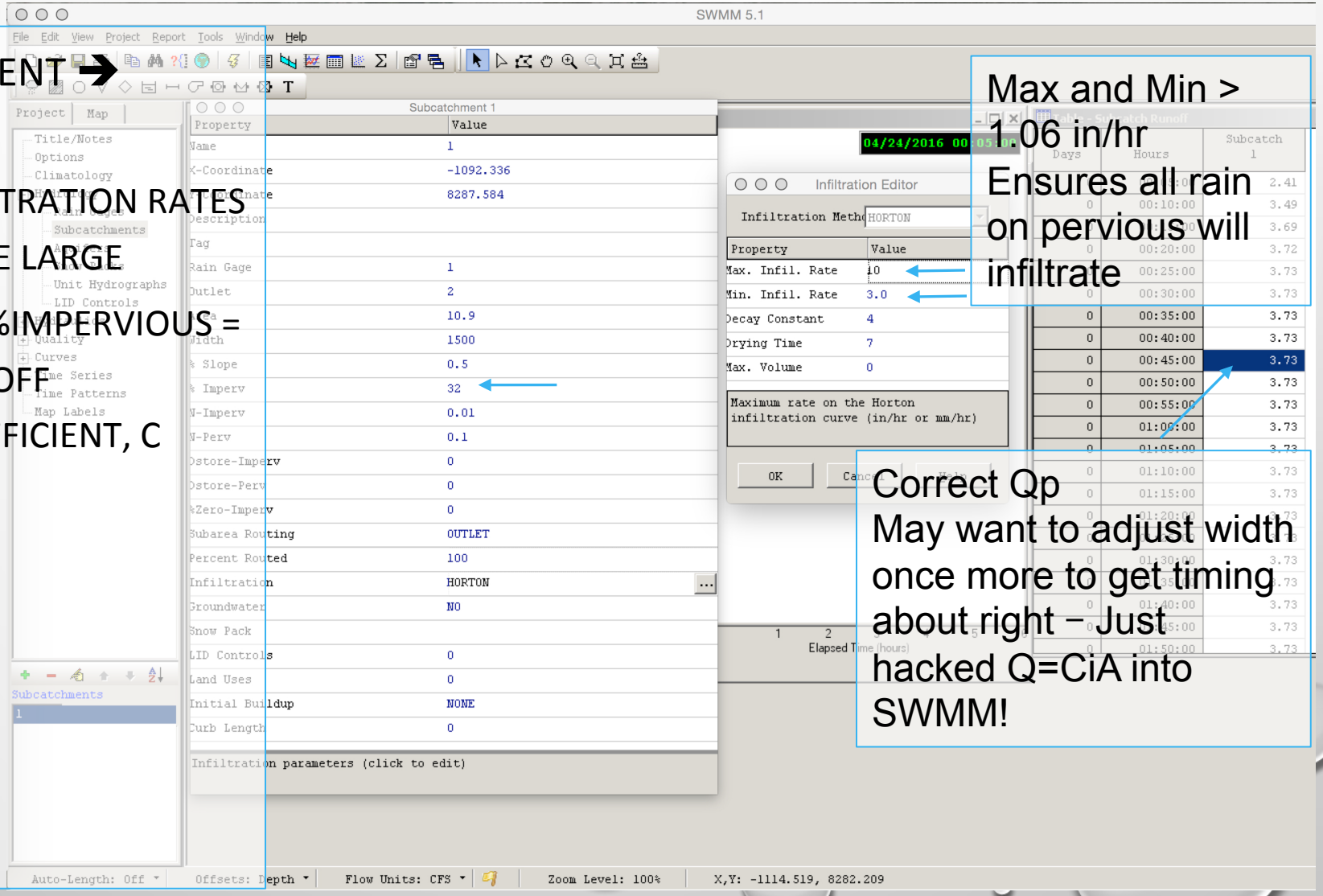
HACKING A RATIONAL METHOD IN SWMM

- CATCHMENT ➔ SET SIZE, SET TO 100% IMPERVIOUS
  - WIDTH = 1500
    - ARRIVAL TIME OF QP AT 50 MINUTES
    - QP = 11.65 CFS (C=1)



HACKING A RATIONAL METHOD IN SWMM

- CATCHMENT ➔ ADJUST
  - INFILTRATION RATES TO BE LARGE
  - SET %IMPERVIOUS = RUNOFF COEFFICIENT, C

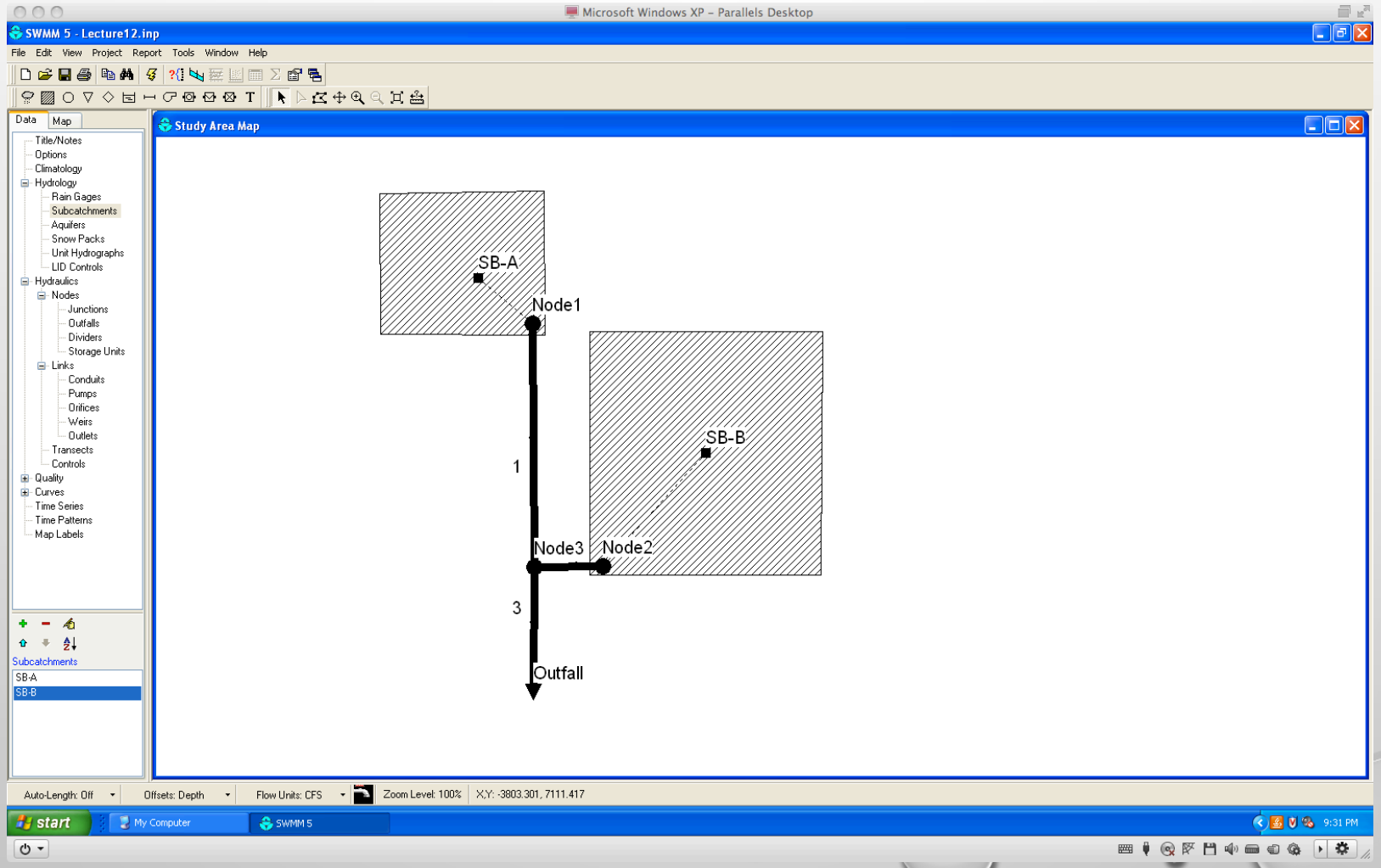


Max and Min > 1.06 in/hr
Ensures all rain on pervious will infiltrate

Correct Qp
May want to adjust width once more to get timing about right – Just hacked Q=CiA into SWMM!

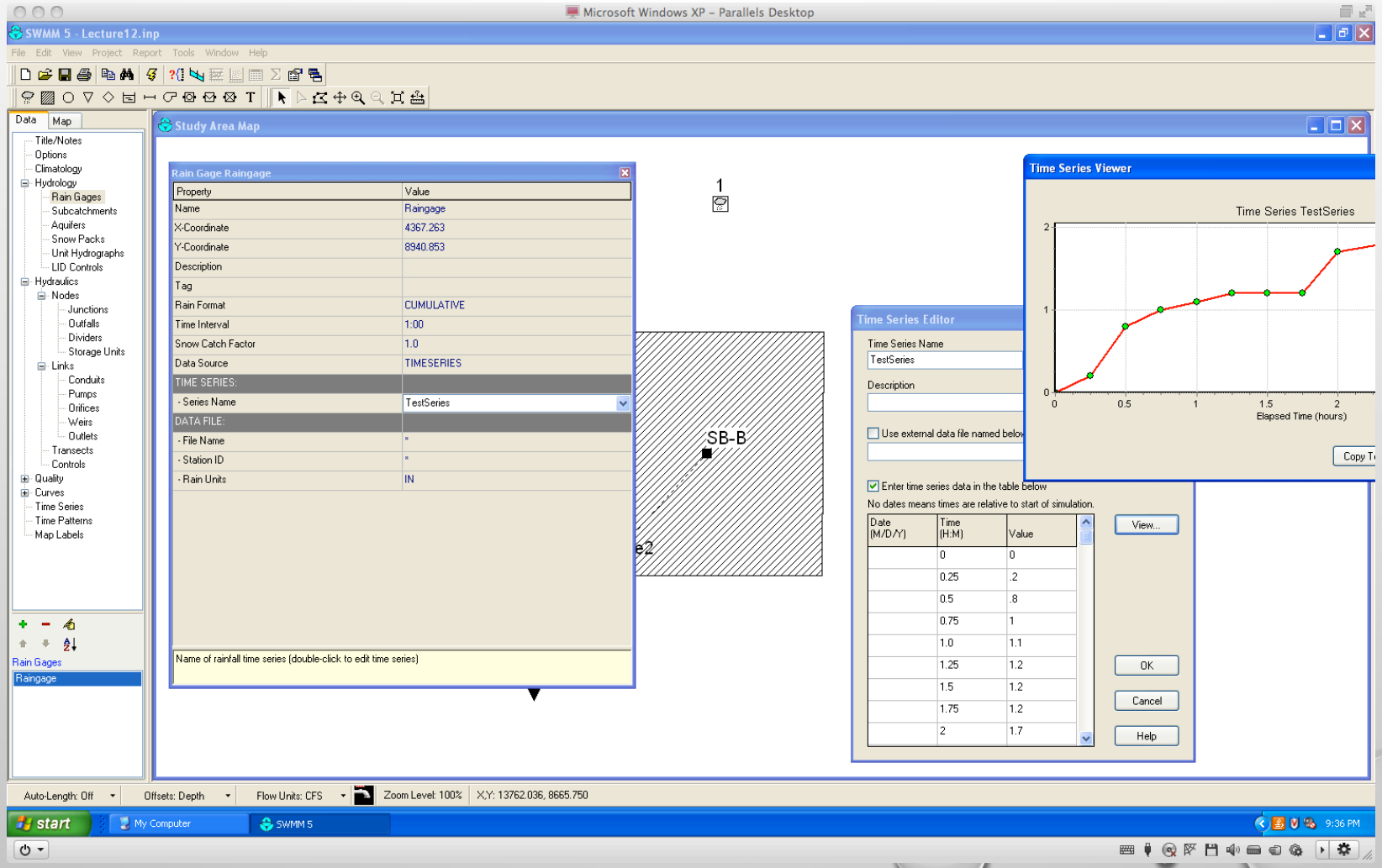
SWMM AS HYDROLOGIC MODEL

- SUPPRESS BACKGROUND, CHECK LAYOUT



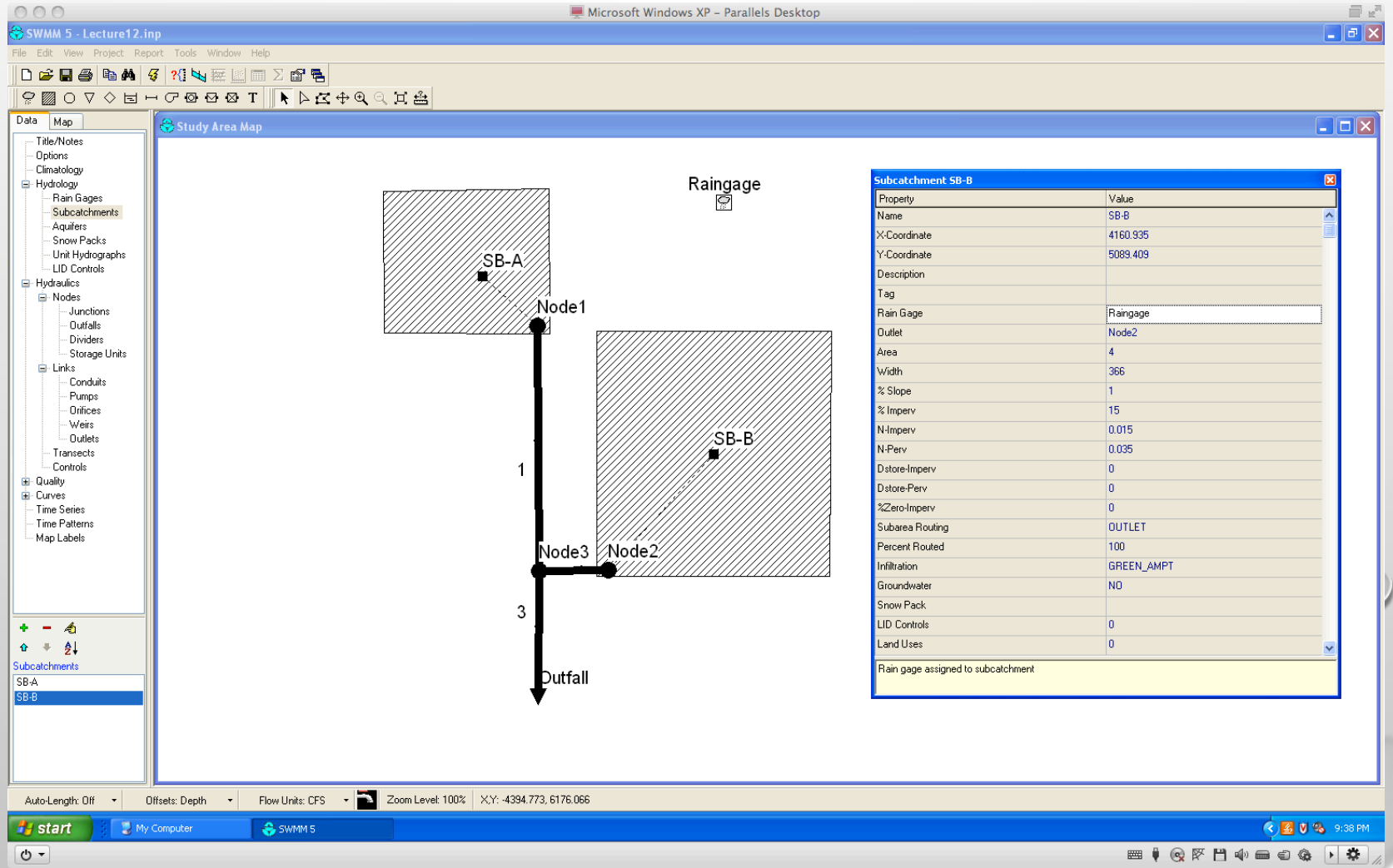
SWMM AS HYDROLOGIC MODEL

- INSERT A RAINGAGE



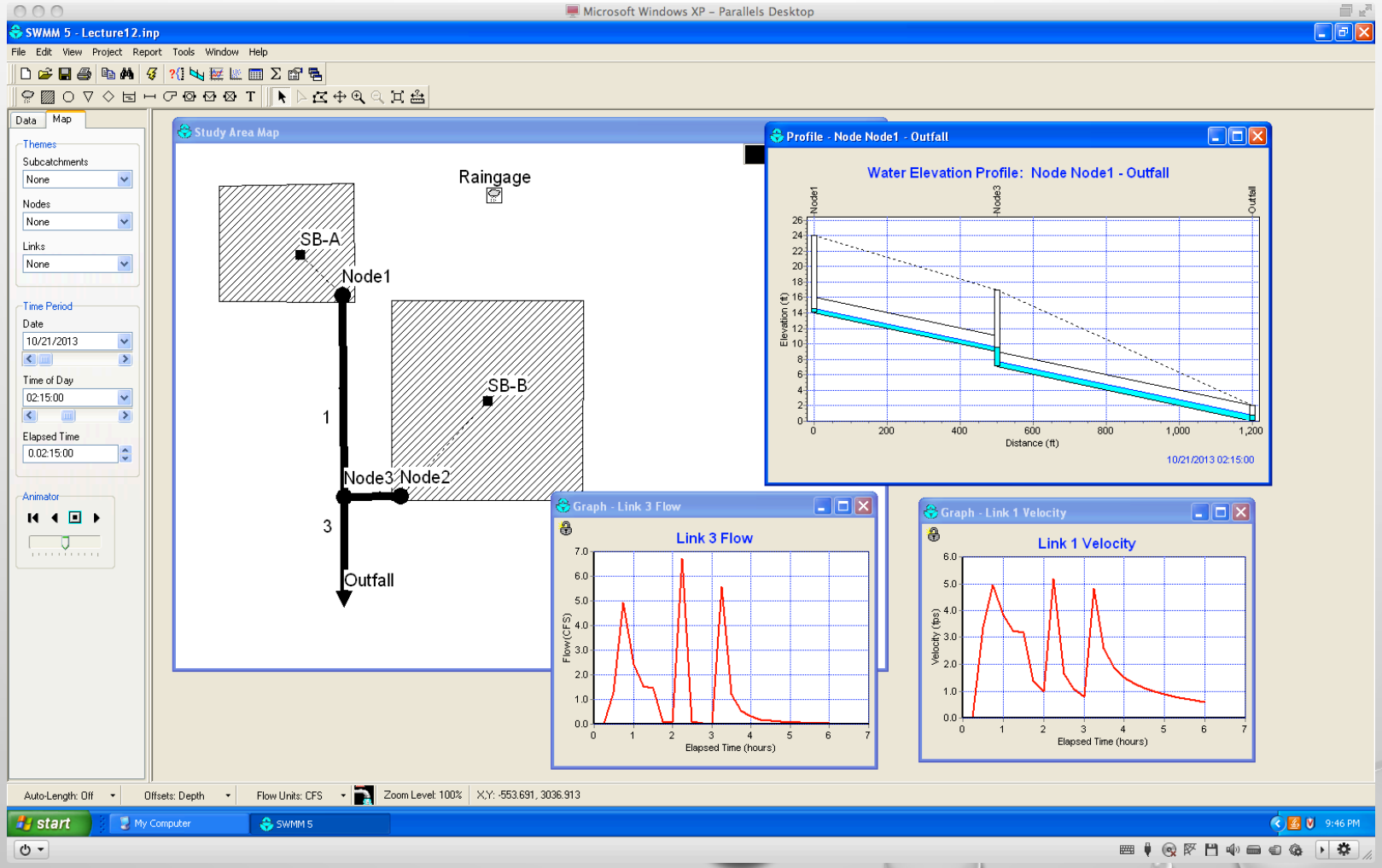
SWMM AS HYDROLOGIC MODEL

- APPLY THE RAINGAGE TO THE SUB-CATCMENTS



SWMM AS HYDROLOGIC MODEL

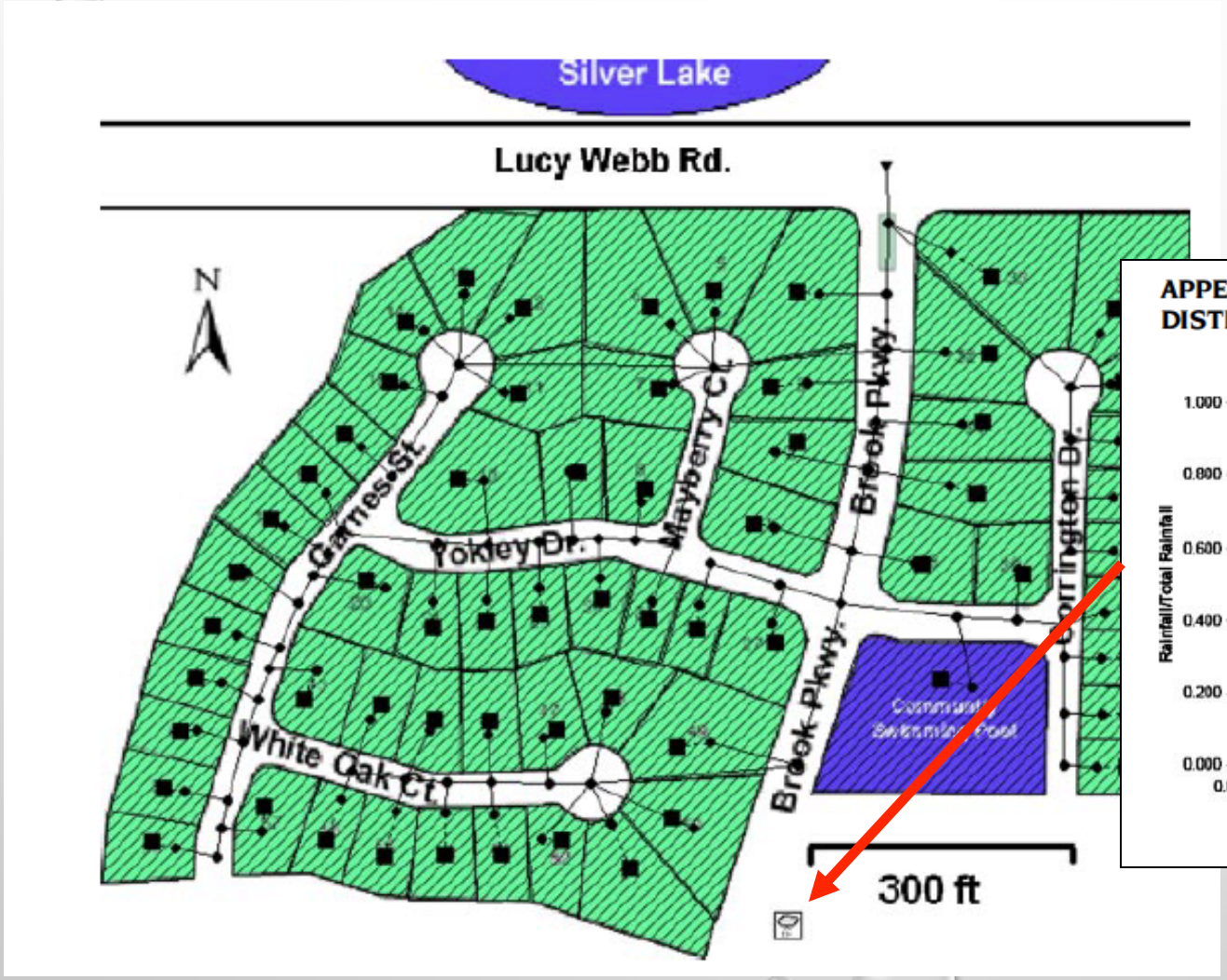
- SET THE TIME WINDOW, AND RUN THE MODEL

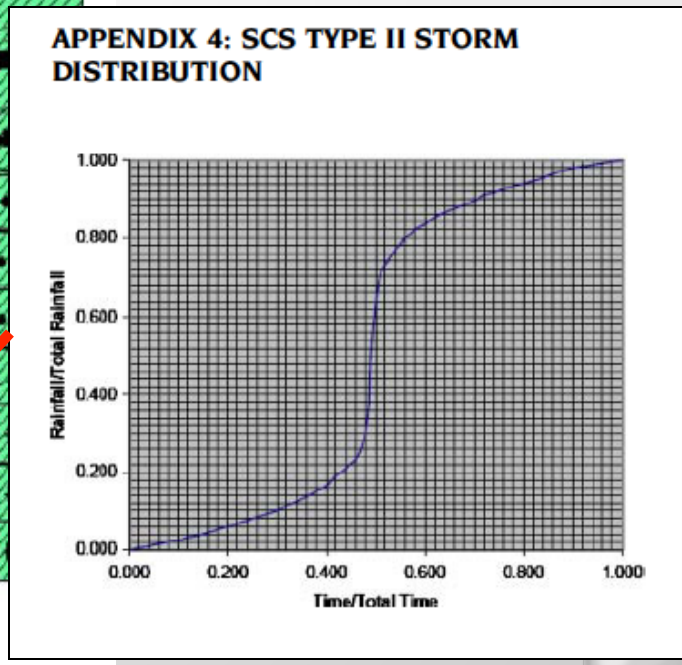


SWMM AS HYDROLOGIC MODEL

- FOR LARGER SCALE (LOTS OF SMALL CATCHMENTS) THERE WILL BE A DESIRE TO USE SCS STORMS OR EVEN HISTORICAL EVENTS TO EVALUATE THE DESIGN.
- THE NEXT EXAMPLE ILLUSTRATES HOW TO USE HEC-HMS AS A TOOL TO GENERATE RAINFALL FOR USE IN SWMM.

SWMM AS HYDROLOGIC MODEL





SWMM AS HYDROLOGIC MODEL

- ASSIGN A STORM TO A RAINGAGE
  - SUPPOSE INSTRUCTED TO USE SCS-TYPE II STORM AND PARAMETERIZE FOR SAN ANTONIO, TEXAS
  - SCS STORMS ARE BUILT-IN TO HEC-HMS, SO TAKE ADVANTAGE OF THAT TO GENERATE A RAINFALL TIME SERIES FOR SWMM

SWMM AS HYDROLOGIC MODEL

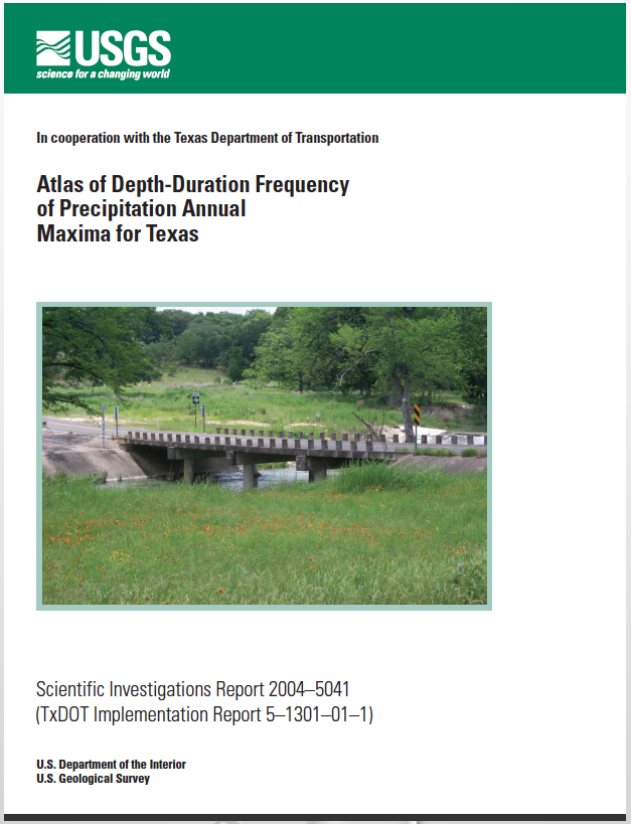
- HOW TO GENERATE SCS TYPE STORMS
  - SELECT ANNUAL EXCEEDANCE PROBABILITY (AEP) OR ANNUAL RECURRENCE INTERVAL (ARI)
  - LOOK UP 24 HOUR DEPTH FOR THE ARI AND LOCATION
  - GENERATE 24 HOUR STORM USING SCS TABULATIONS OR HEC-HMS
  - PUT THE TIME SERIES INTO SWMM AND RUN THE HYDRAULICS

SWMM AS HYDROLOGIC MODEL

- HOW TO GENERATE SCS TYPE STORMS
  - SELECT ANNUAL EXCEEDANCE PROBABILITY (AEP) OR ANNUAL RECURRENCE INTERVAL (ARI)
    - GIVEN IN THE PROJECT STATEMENT, A 10% CHANCE AEP OR 10-YEAR ARI (SAME PROBABILITY) IS SPECIFIED.

SWMM AS HYDROLOGIC MODEL

- HOW TO GENERATE SCS TYPE STORMS
  - LOOK UP 24 HOUR STORM DEPTH FOR THE AEP/ARI AND LOCATION



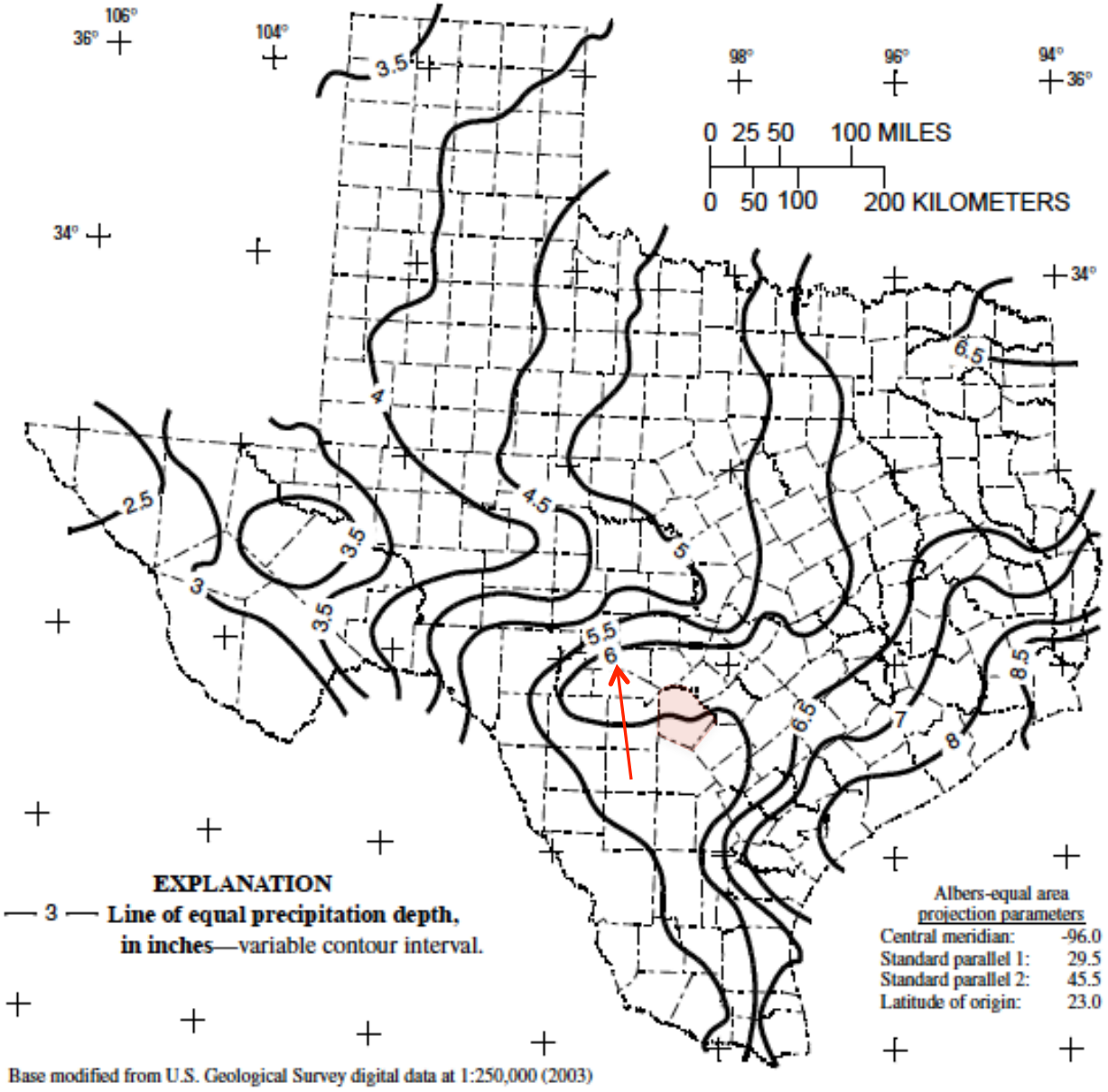


Figure 35. Depth of precipitation for 10-year storm for 1-day duration in Texas.

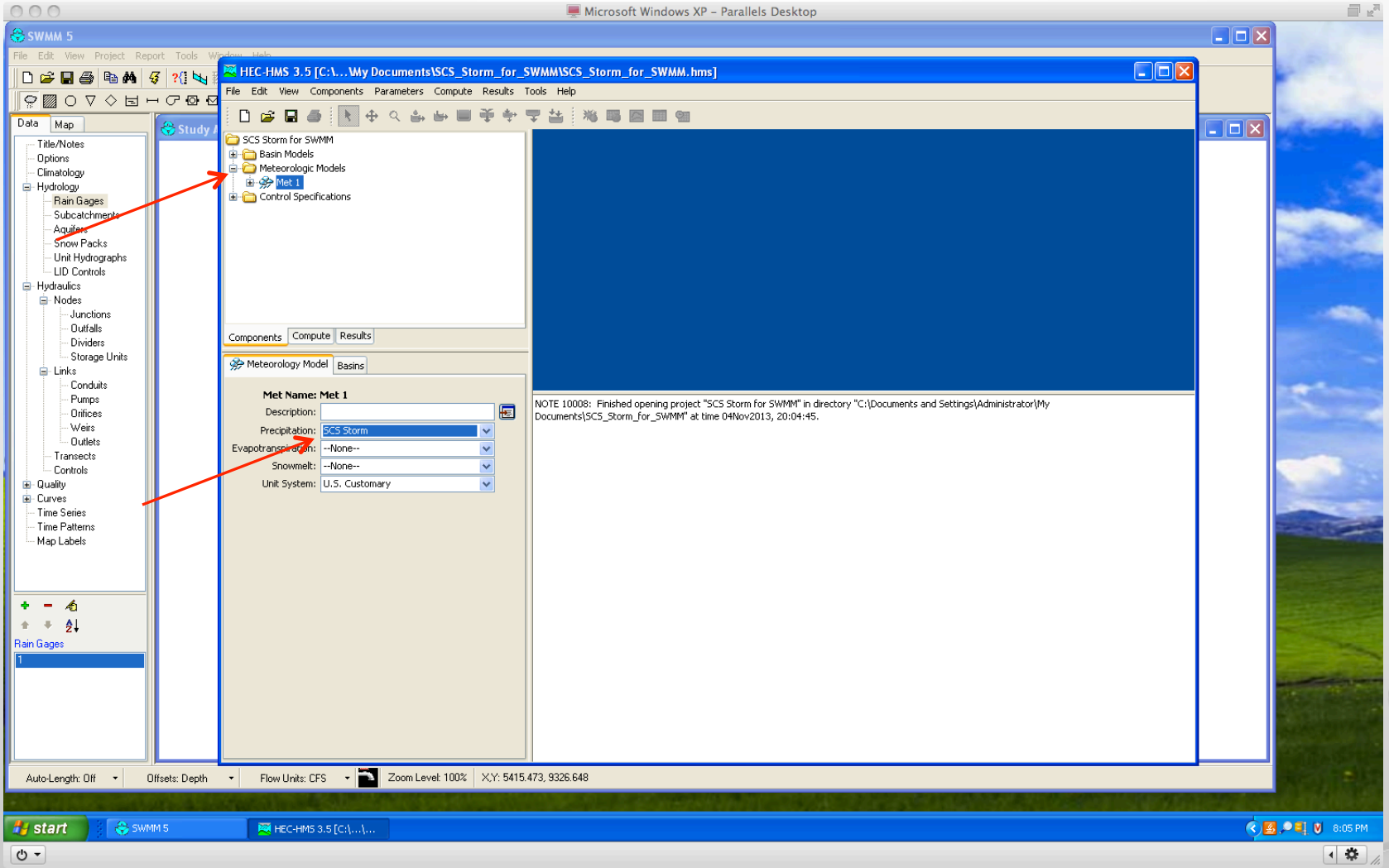
SWMM AS HYDROLOGIC MODEL

- HOW TO GENERATE SCS TYPE STORMS
  - SELECT ANNUAL EXCEEDANCE PROBABILITY (AEP) OR ANNUAL RECURRENCE INTERVAL (ARI)
  - LOOK UP 24 HOUR DEPTH FOR THE ARI AND LOCATION
    - 6 INCHES FOR BEXAR COUNTY, TX

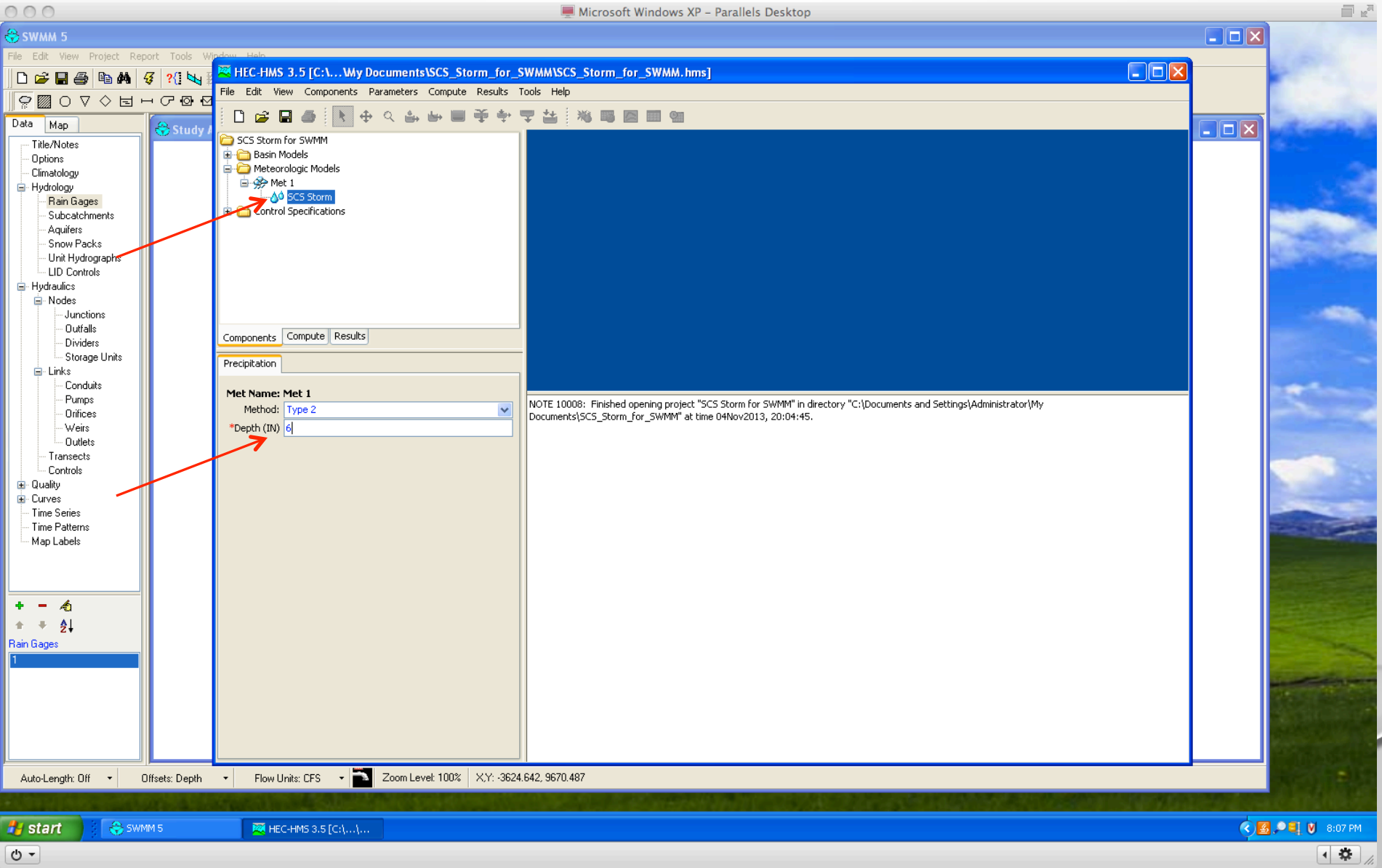
SWMM AS HYDROLOGIC MODEL

- HOW TO GENERATE SCS TYPE STORMS
  - GENERATE 24 HOUR STORM USING SCS TABULATIONS OR HEC-HMS
    - GET THE SWMM MODEL BUILT
    - OPEN HMS AND GENERATE A SCS STORM FROM THE METEROLOGICAL MODEL

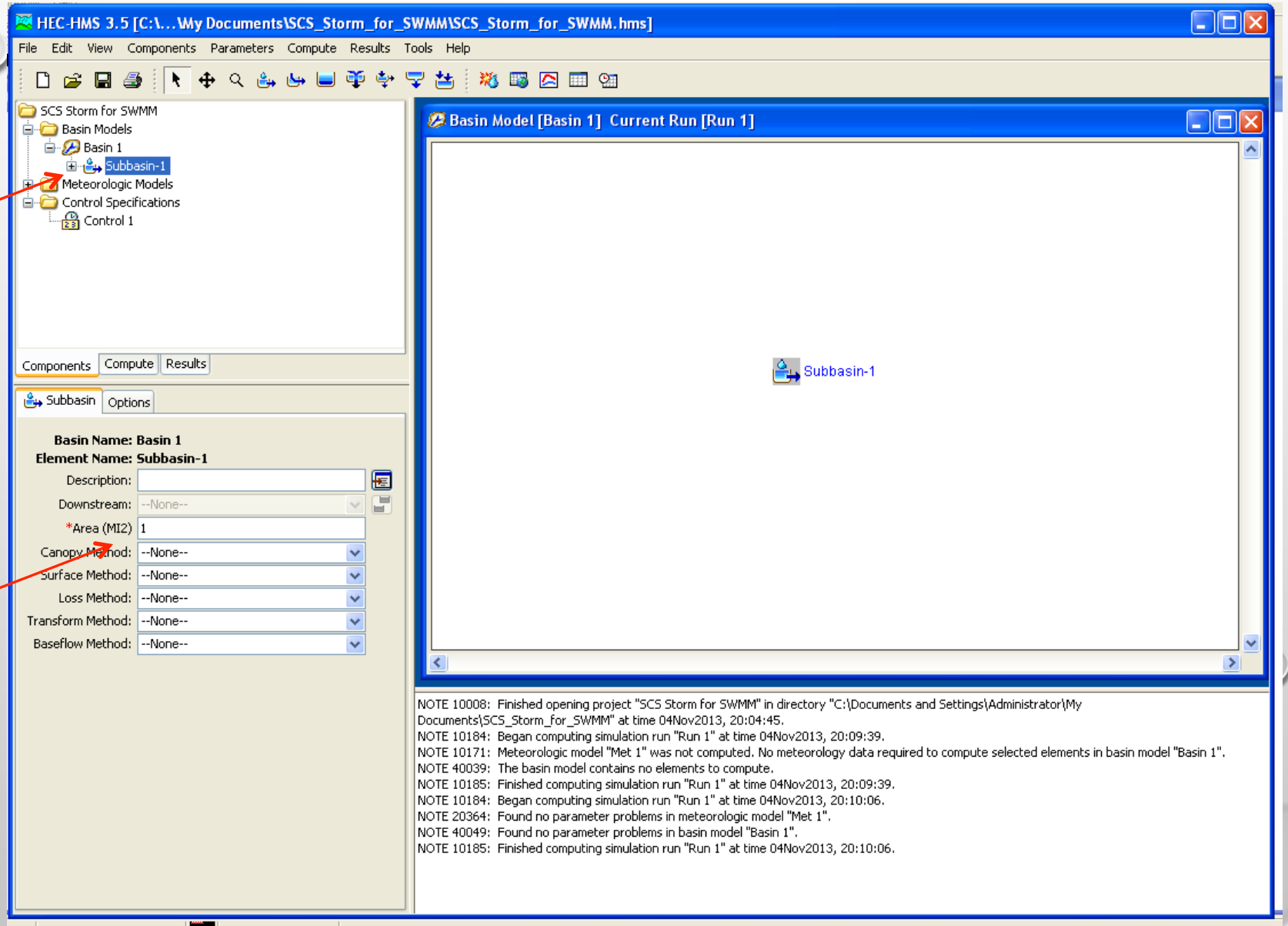
BUILD A MINIMAL HEC MODEL



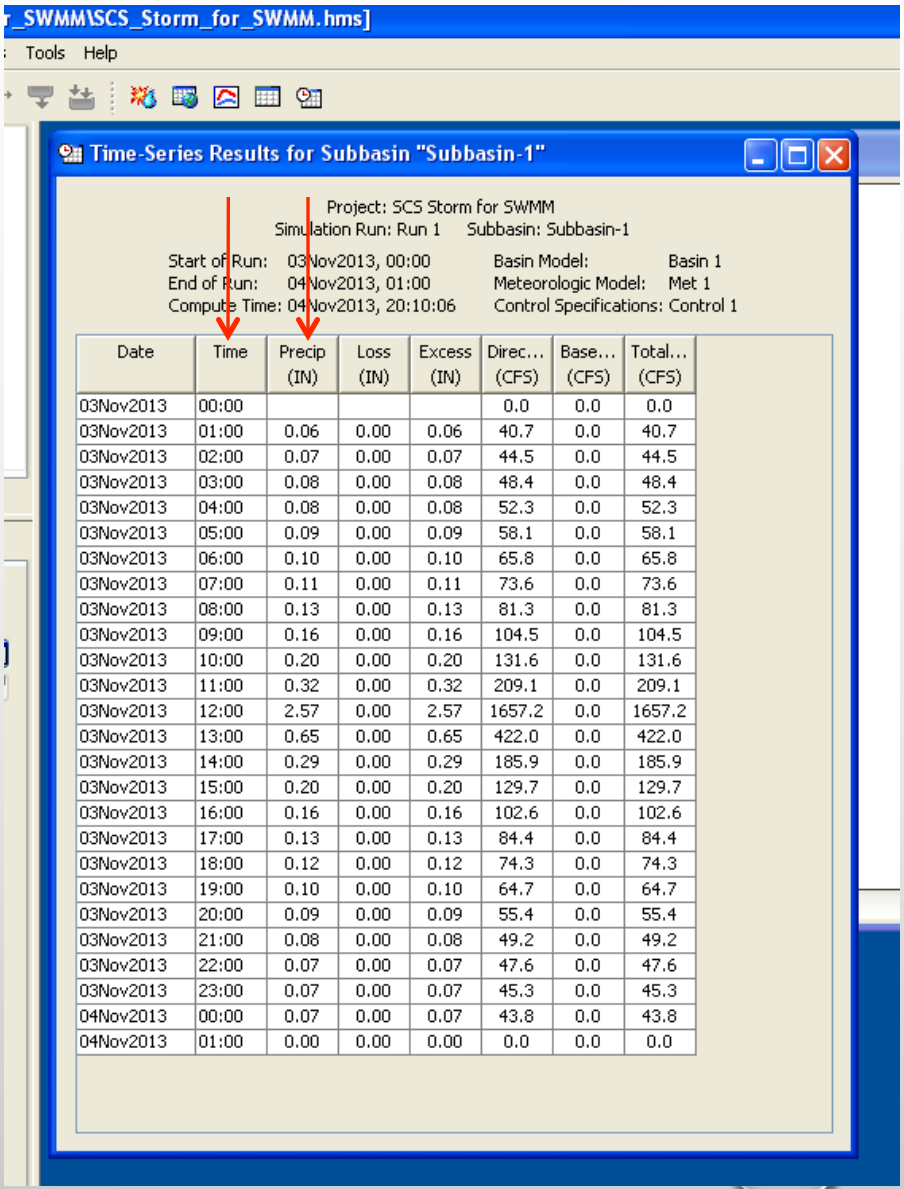
BUILD A MINIMAL HEC MODEL



BUILD A MINIMAL HEC MODEL



RUN THE HEC MODEL



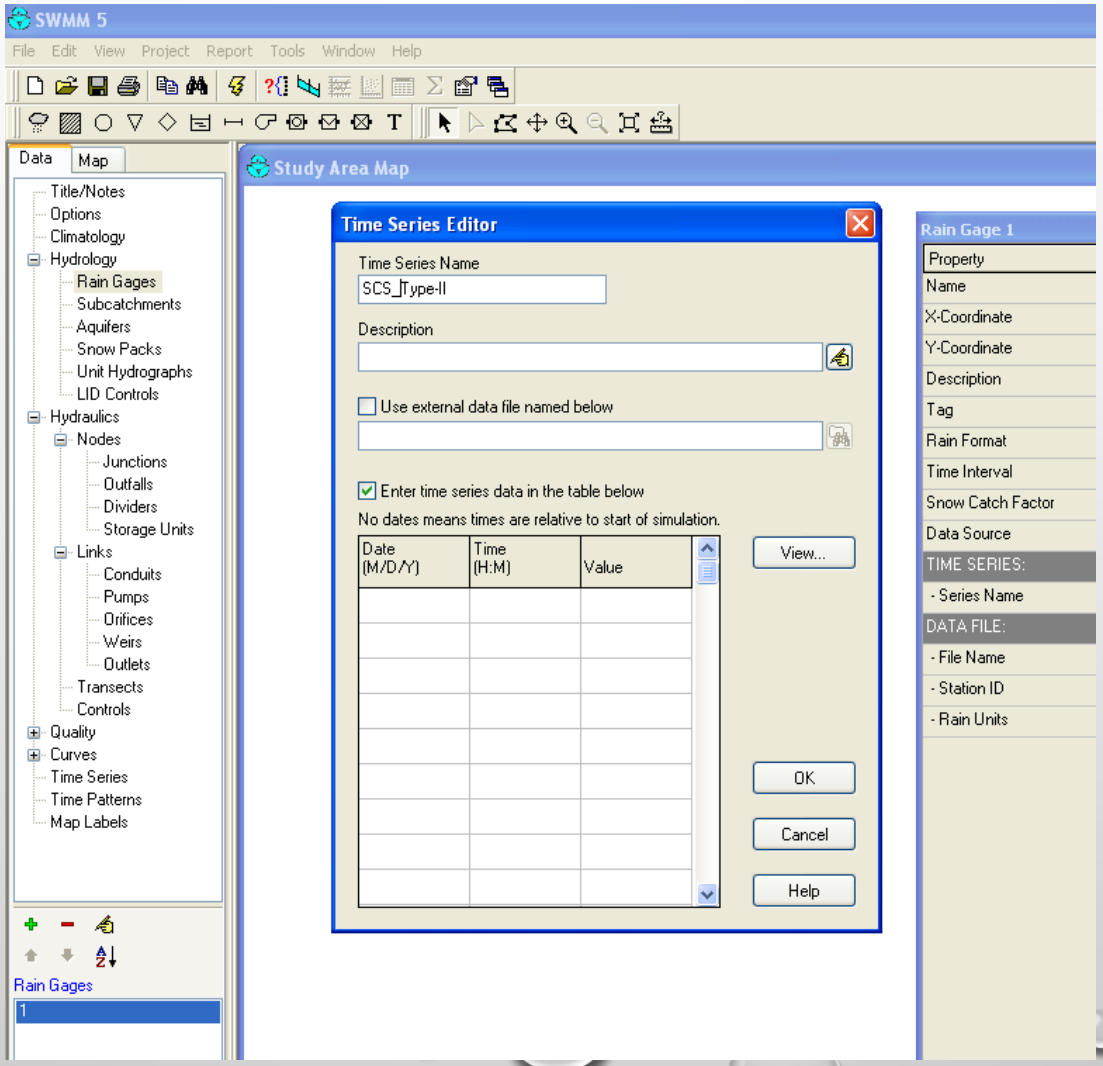
Date	Time	Precip (IN)	Loss (IN)	Excess (IN)	Direc... (CFS)	Base... (CFS)	Total... (CFS)
03Nov2013	00:00				0.0	0.0	0.0
03Nov2013	01:00	0.06	0.00	0.06	40.7	0.0	40.7
03Nov2013	02:00	0.07	0.00	0.07	44.5	0.0	44.5
03Nov2013	03:00	0.08	0.00	0.08	48.4	0.0	48.4
03Nov2013	04:00	0.08	0.00	0.08	52.3	0.0	52.3
03Nov2013	05:00	0.09	0.00	0.09	58.1	0.0	58.1
03Nov2013	06:00	0.10	0.00	0.10	65.8	0.0	65.8
03Nov2013	07:00	0.11	0.00	0.11	73.6	0.0	73.6
03Nov2013	08:00	0.13	0.00	0.13	81.3	0.0	81.3
03Nov2013	09:00	0.16	0.00	0.16	104.5	0.0	104.5
03Nov2013	10:00	0.20	0.00	0.20	131.6	0.0	131.6
03Nov2013	11:00	0.32	0.00	0.32	209.1	0.0	209.1
03Nov2013	12:00	2.57	0.00	2.57	1657.2	0.0	1657.2
03Nov2013	13:00	0.65	0.00	0.65	422.0	0.0	422.0
03Nov2013	14:00	0.29	0.00	0.29	185.9	0.0	185.9
03Nov2013	15:00	0.20	0.00	0.20	129.7	0.0	129.7
03Nov2013	16:00	0.16	0.00	0.16	102.6	0.0	102.6
03Nov2013	17:00	0.13	0.00	0.13	84.4	0.0	84.4
03Nov2013	18:00	0.12	0.00	0.12	74.3	0.0	74.3
03Nov2013	19:00	0.10	0.00	0.10	64.7	0.0	64.7
03Nov2013	20:00	0.09	0.00	0.09	55.4	0.0	55.4
03Nov2013	21:00	0.08	0.00	0.08	49.2	0.0	49.2
03Nov2013	22:00	0.07	0.00	0.07	47.6	0.0	47.6
03Nov2013	23:00	0.07	0.00	0.07	45.3	0.0	45.3
04Nov2013	00:00	0.07	0.00	0.07	43.8	0.0	43.8
04Nov2013	01:00	0.00	0.00	0.00	0.0	0.0	0.0

SWMM AS HYDROLOGIC MODEL

- NOW HAVE SCS TYPE II IN HEC-HMS, ONLY AFTER THE TWO COLUMNS IN THE TIME SERIES

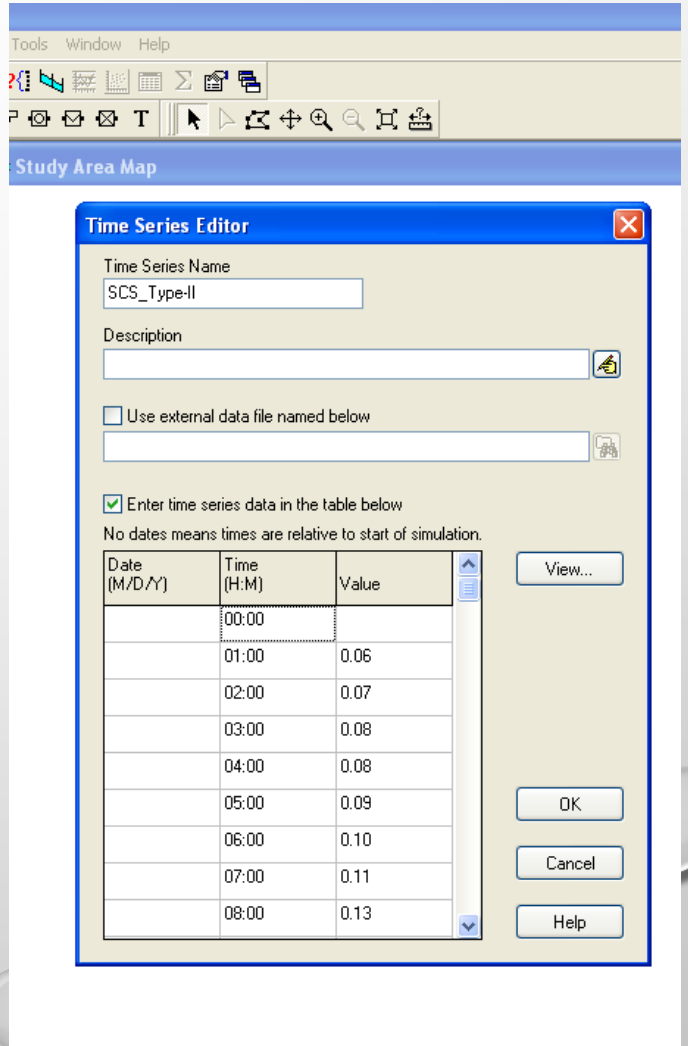
- NOW GO TO THE SWMM MODEL AND BUILD A RAINGAGE TO ACCEPT THE TIME SERIES

SWMM RAINGAGE



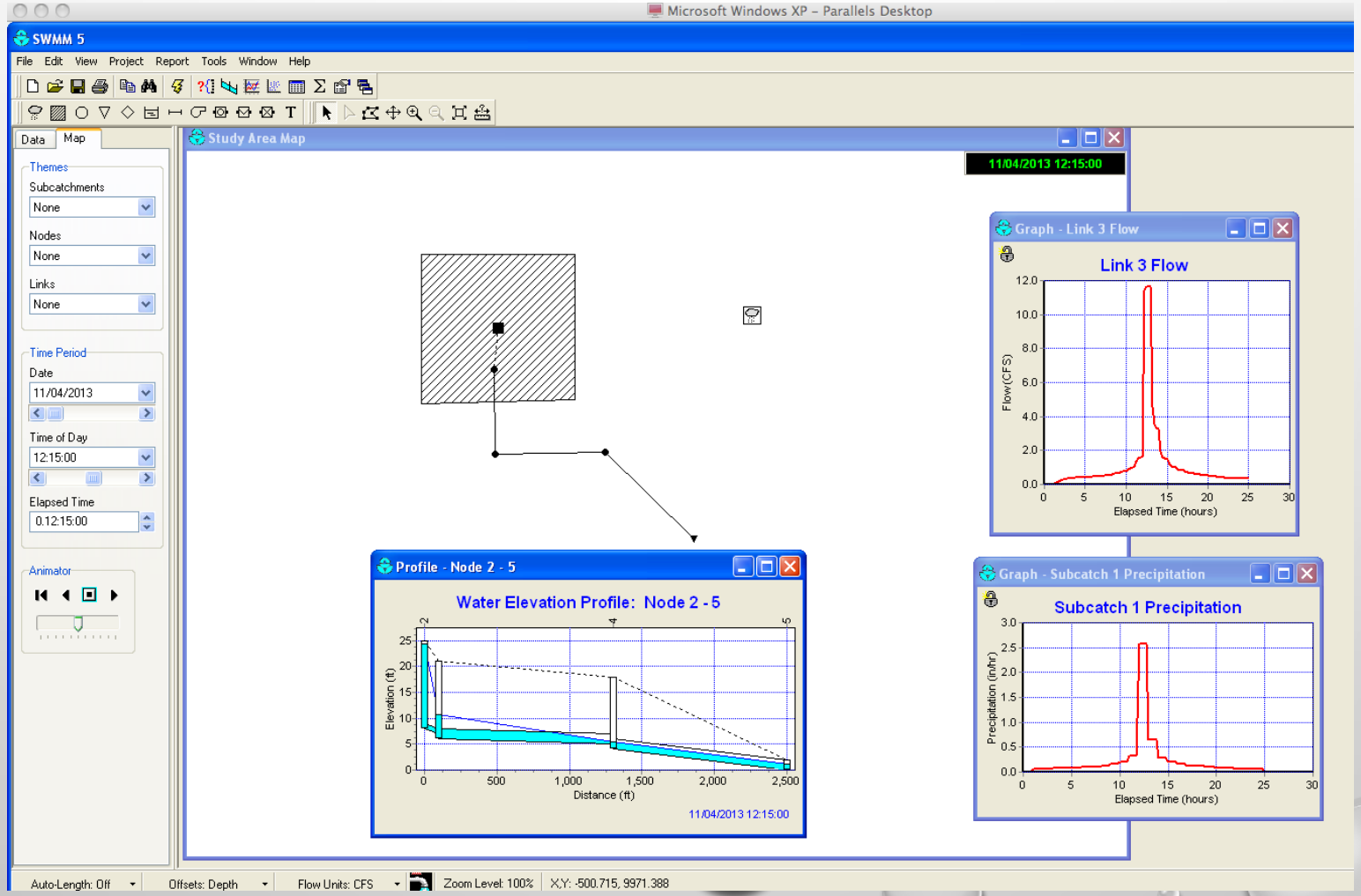
SWMM AS HYDROLOGIC MODEL

- NOW COPY-PASTE FROM HMS TO SWMM THE TWO COLUMNS
  - EDIT TO FIX THE FIRST VALUE
  - EDIT TO FIX THE 24TH AND 25TH HOURS
  - SET THE TIME WINDOW
  - RUN SWMM



SWMM AS HYDROLOGIC MODEL

- DONE! INTERPRET RESULTS



SWMM AS HYDROLOGIC MODEL

- SHOWED HOW TO USE HMS TO GENERATE SWMM INPUT.
- SWMM IS ALSO HANDY FOR GENERATING HMS INPUT
  - THE TIME ARITHMETIC IS MORE DEMANDING!

NEXT TIME

- CONDUITS IN SWMM
  - INVERT ELEVATIONS AND OFFSETS
  - DUAL DRAINAGE SYSTEMS