CE 3372 WATER SYSTEMS DESIGN

LESSON 17: STORM SEWERS CONDUIT DESIGN (SIZE SELECTION) BY RATIONAL EQUATION METHOD FALL 2020

PURPOSES

- Conduits convey Flow from one location to another
  - Pipes
  - Culverts
  - Open channels

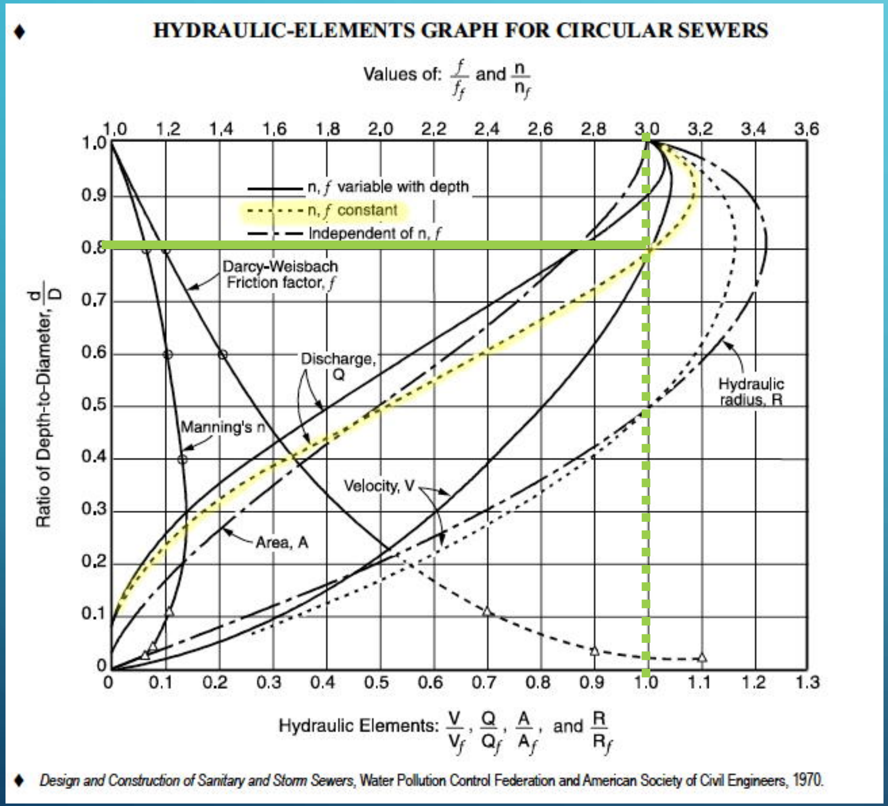
CONDUIT DESIGN

- Select size, material, and slope
  - Storm sewer – usually desire to operate with free surface (as an open channel)
  - Sanitary sewer – similar usually want a free surface
  - Size (diameter) is dictated by
    - Flow required
    - Burial depth relative to drop available

METHODS

- A good preliminary design can be obtained using a combination of the rational equation and manning’s equation
  - Done without regard to downstream boundary conditions
  - Needs to be checked using a hydraulic model (like SWMM)

PRELIMINARY DESIGN

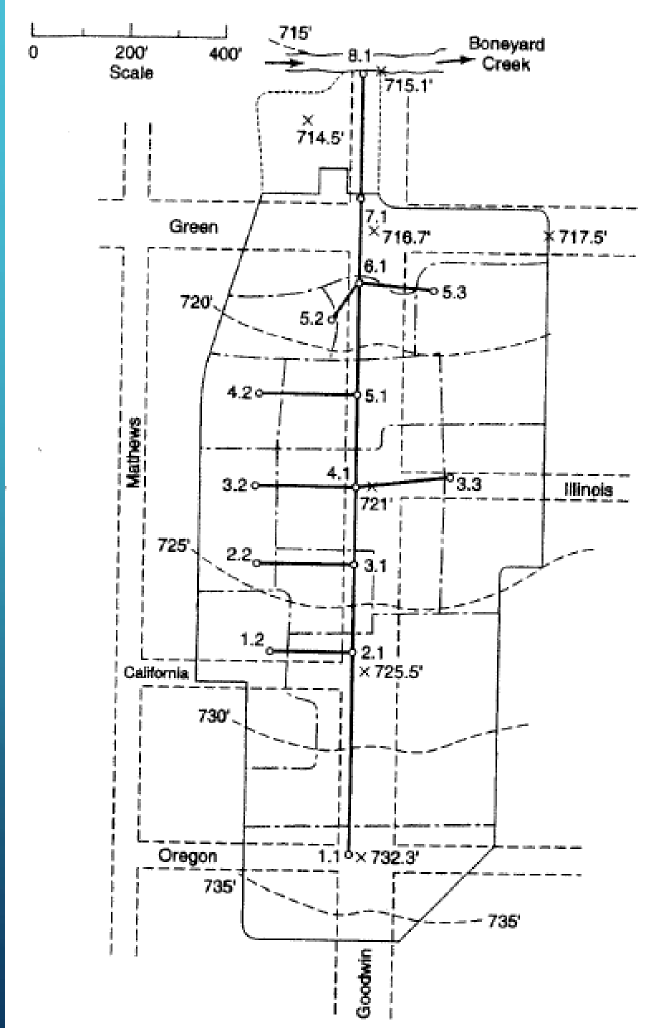


- Determine discharge in each pipe.
- Size using manning's equation (… in us customary)

$$D = 1.333\left(\frac{Qn}{S^{1/2}}\right)^{3/8}$$

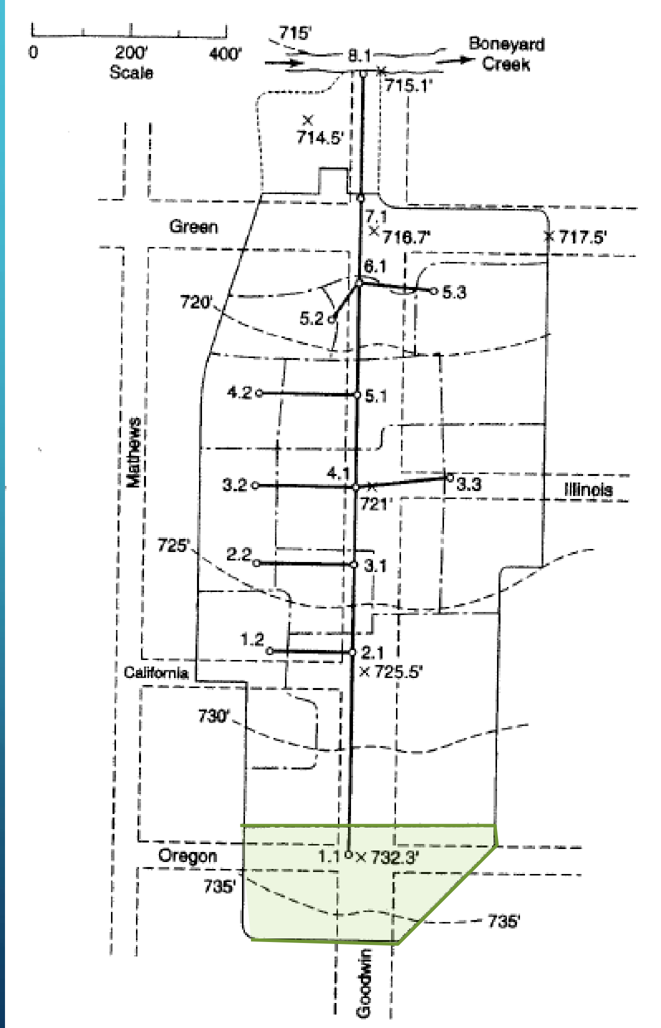
- Assumes full, but pipes will have free surface

PRELIMINARY DESIGN



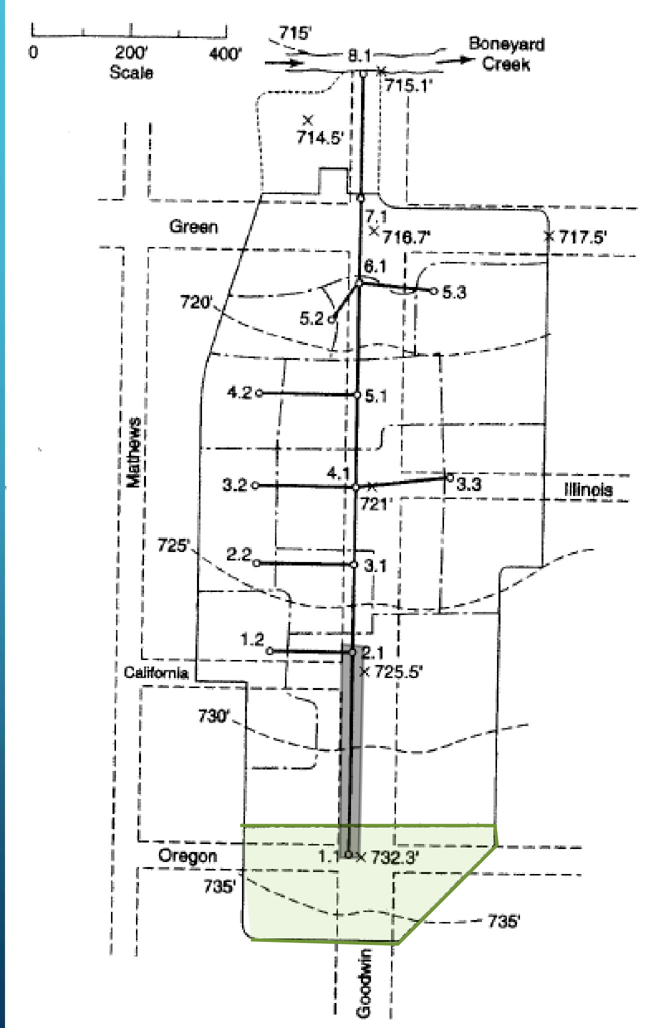
- Layout of system
  - Drainage area and Inlets
  - Pipes
  - Outfall
  - elevations

PRELIMINARY DESIGN



- Drainage areas and inlets
  - Determine inlet time of concentration
  - Determine drainage area runoff coefficient

PRELIMINARY DESIGN



- Pipes (Start upstream)
  - Select pipe size
    - Design guidelines
    - Discharge criteria

$$D = 1.333\left(\frac{Qn}{\sqrt{S}}\right)^{3/8}$$

Adjust

    - Velocity criteria

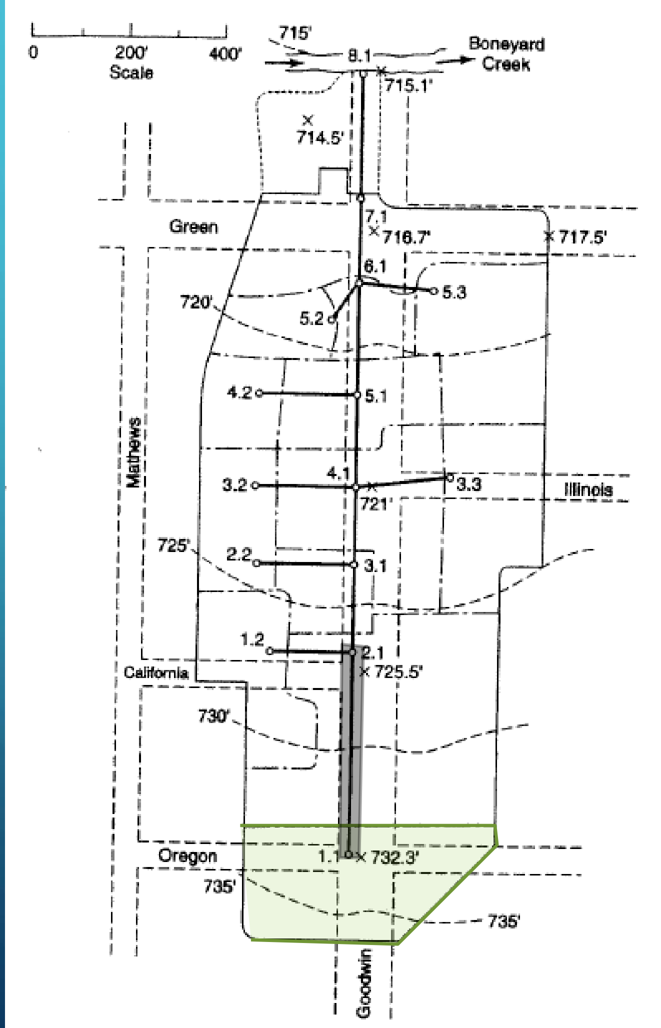
From criterion →

$$V = \frac{1.49}{n}\left(\frac{D}{4}\right)^{2/3}\sqrt{S}$$

  - Determine pipe travel time

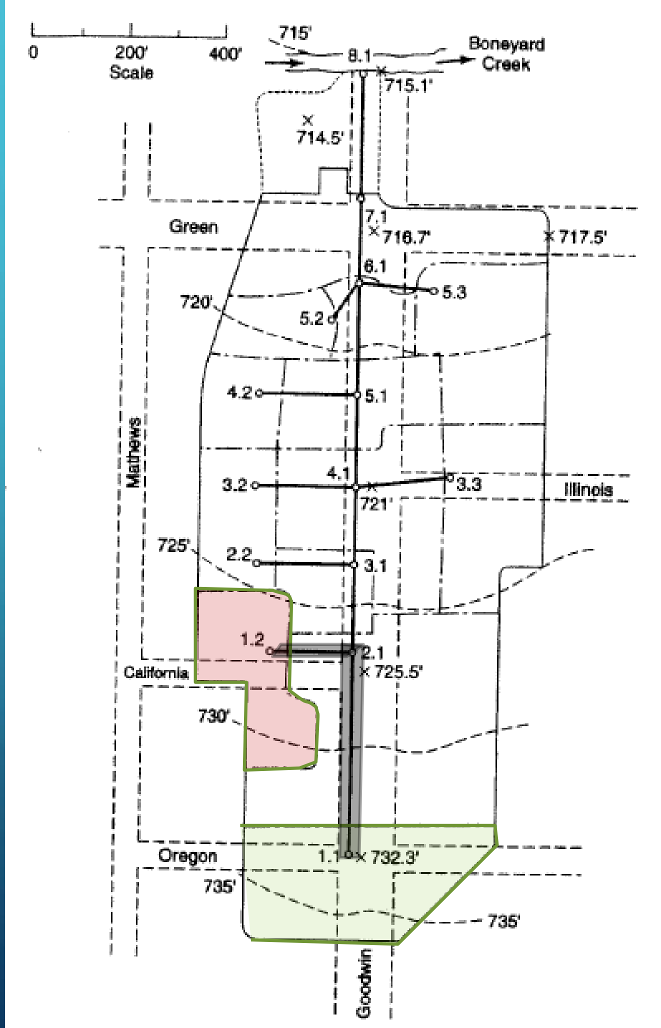
$$t = \frac{distance}{V}$$

PRELIMINARY DESIGN



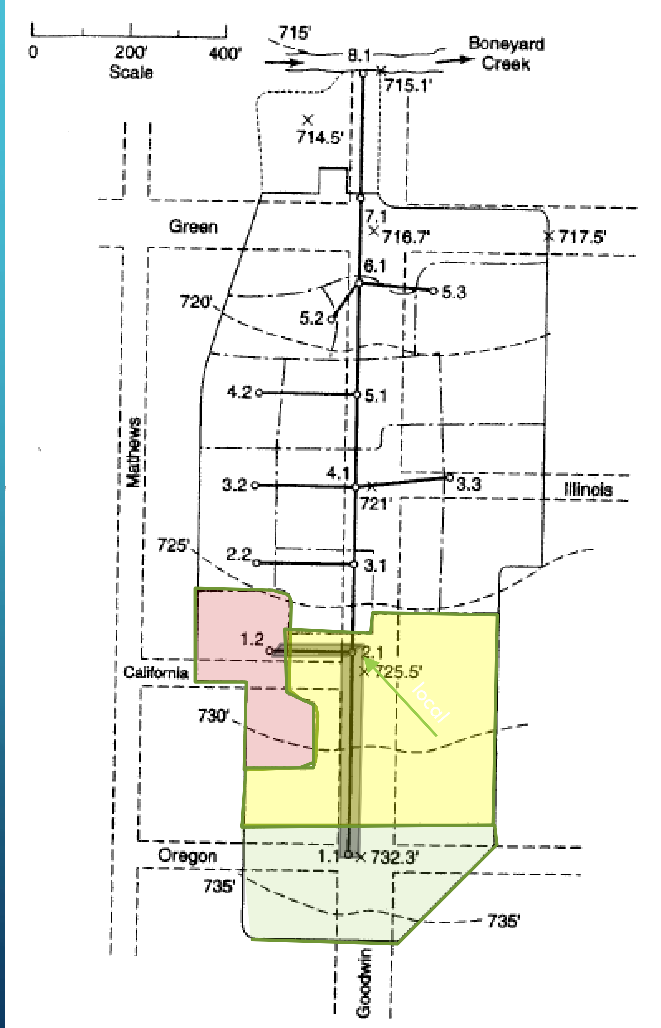
- At most upstream inlet
  - Compute Q_P=CiA to the inlet from inlet time
  - Size pipe from this inlet to hold Q_P
  - ADD pipe travel time to inlet time
  - Move to next node

PRELIMINARY DESIGN



- At NEXT upstream inlet
  - Compute Q_P=CiA to the inlet from inlet time
  - Size pipe from this inlet to hold Q_P
  - ADD pipe travel time to inlet time
  - Move to next node

PRELIMINARY DESIGN

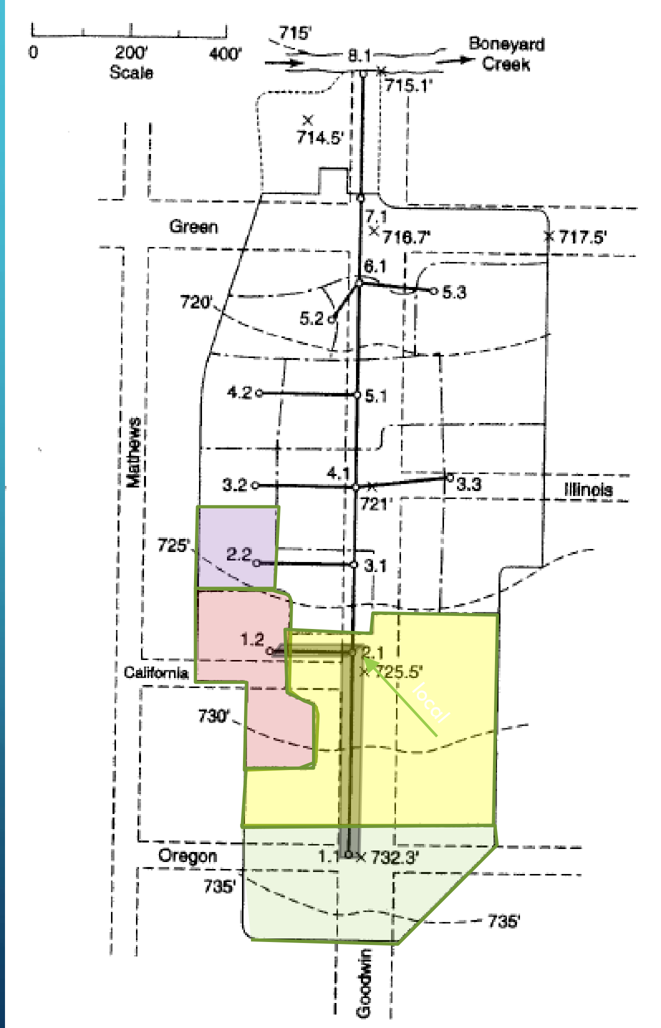


- AT JUNCTION AND INLET
  - Choose largest of:
    1. Local inlet time
    2. Upstream node+travel time
- Compute Q_p LEAVING THE JUNCTION FROM:

$$Q_p = \left(CA_{local} + \sum CA_{upstream} \right) i_{T_c}$$

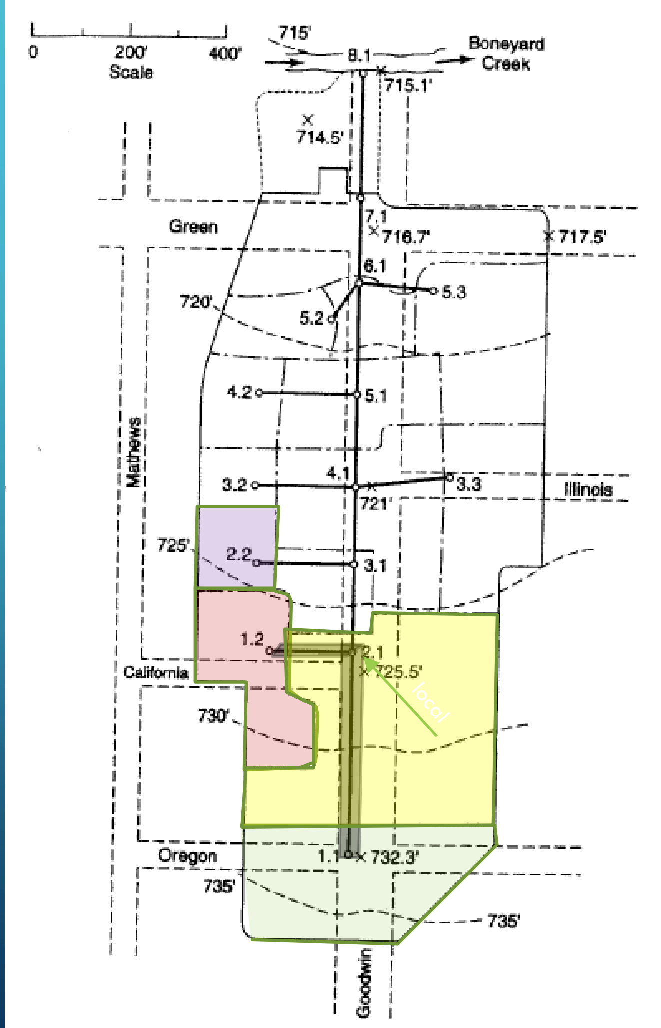
- SIZE next pipe from this q_p

PRELIMINARY DESIGN



- Continue downstream in same fashion (from upstream to junction) until reach outlet
- Accumulate CA values and Tc as move downstream
- Checks include that all areas add up to total area
- T_c should be increasing in value as move downstream

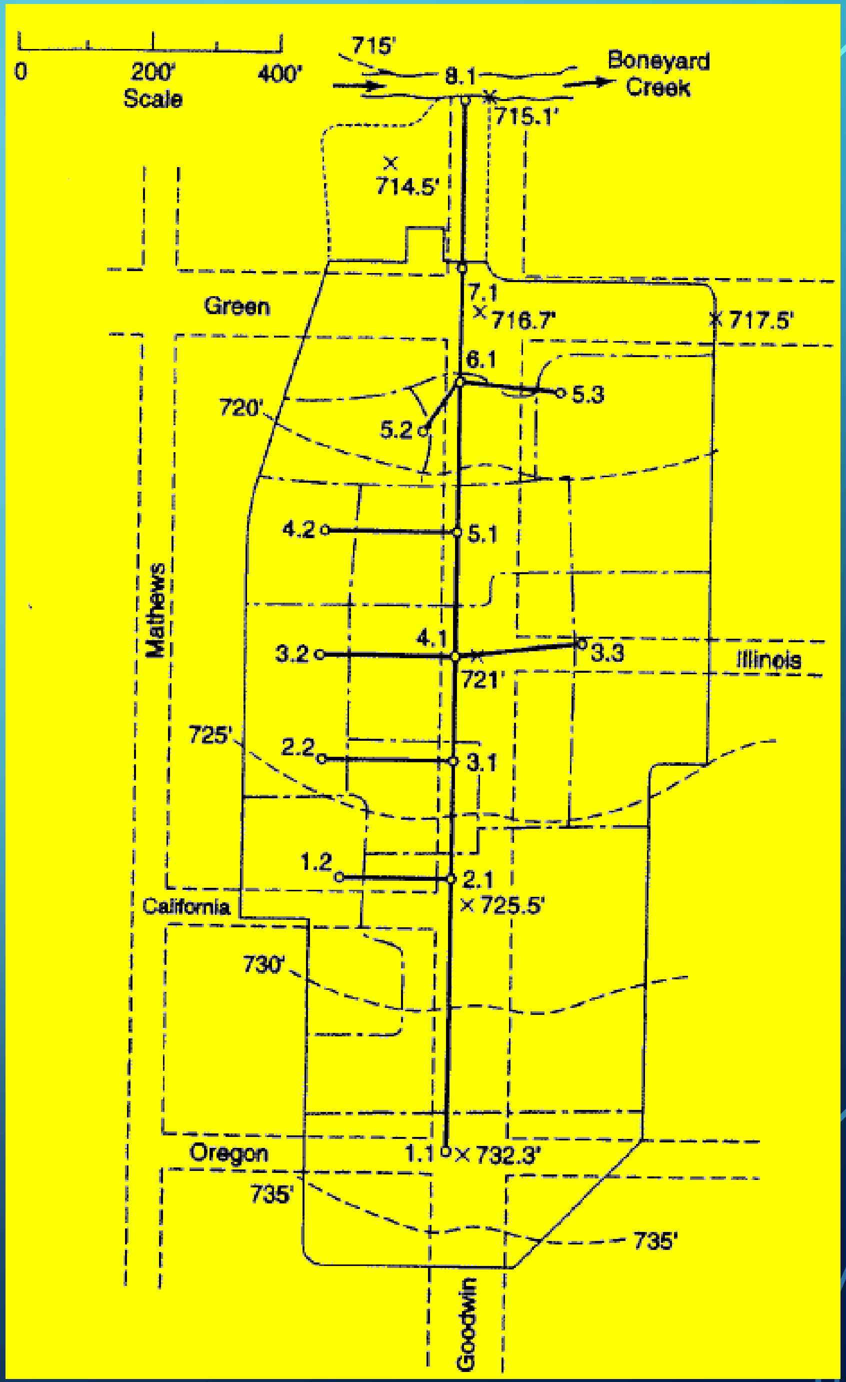
PRELIMINARY DESIGN



- At outlet should have:
  - Pipe sizes
  - Pipe discharges
- Next check hydraulics
  - SWMM – enter Q_{INLET} directly and check pipe hydraulics
  - SWMM – Approximate rational in SWMM to check a design hyetograph
  - Use SWMM results to adjust design and produce a HGL drawing

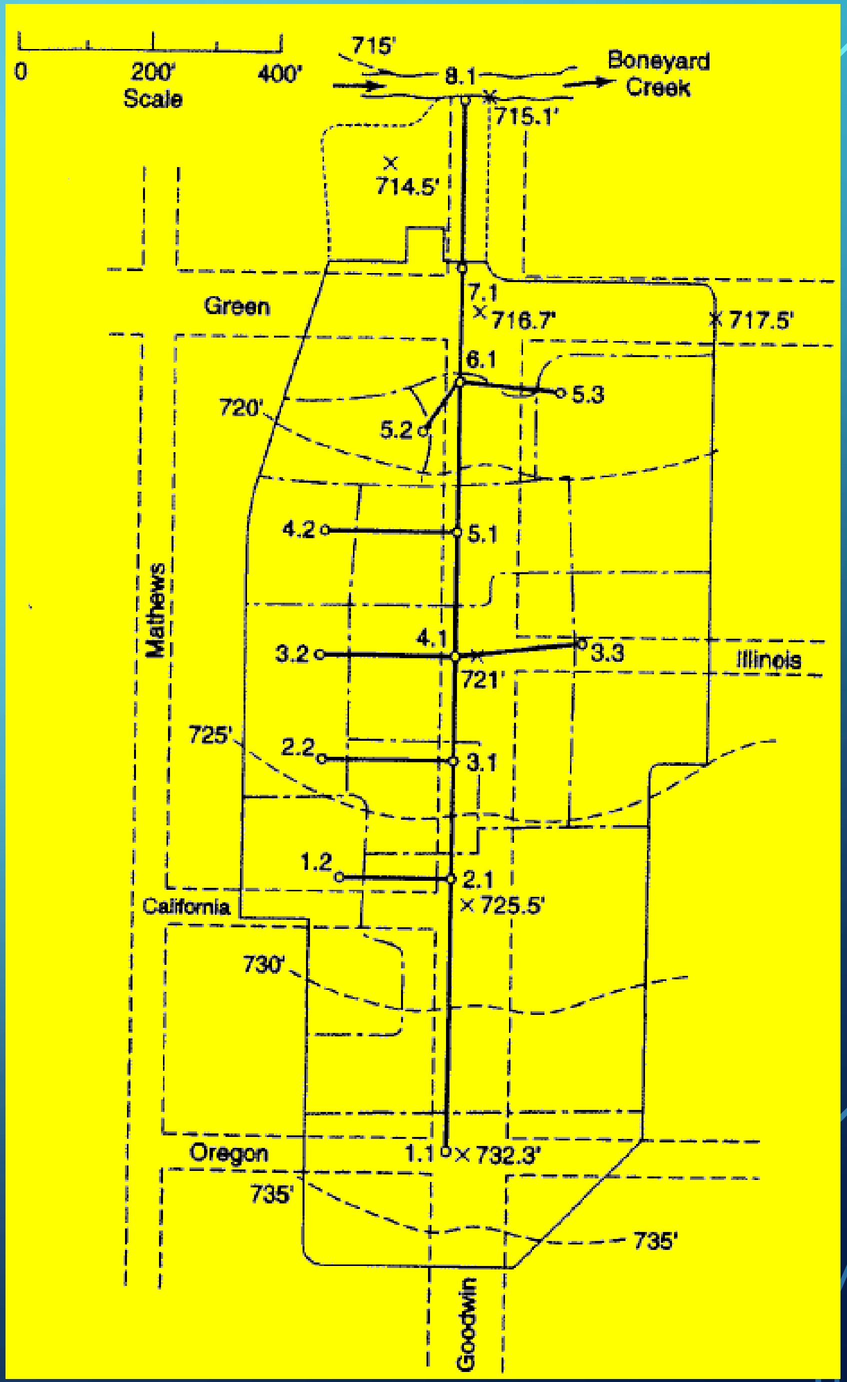
DESIGN STORM SEWER FOR GOODWIN STREET

- "Rational Method Storm Sewer Design" in Mays, L. W. (2008) Water Resources Engineering. Pearson-Prentice Hall (pp. 613-635)
- Method: Rational Equation Design Method to make initial design for subsequent hydraulics analysis



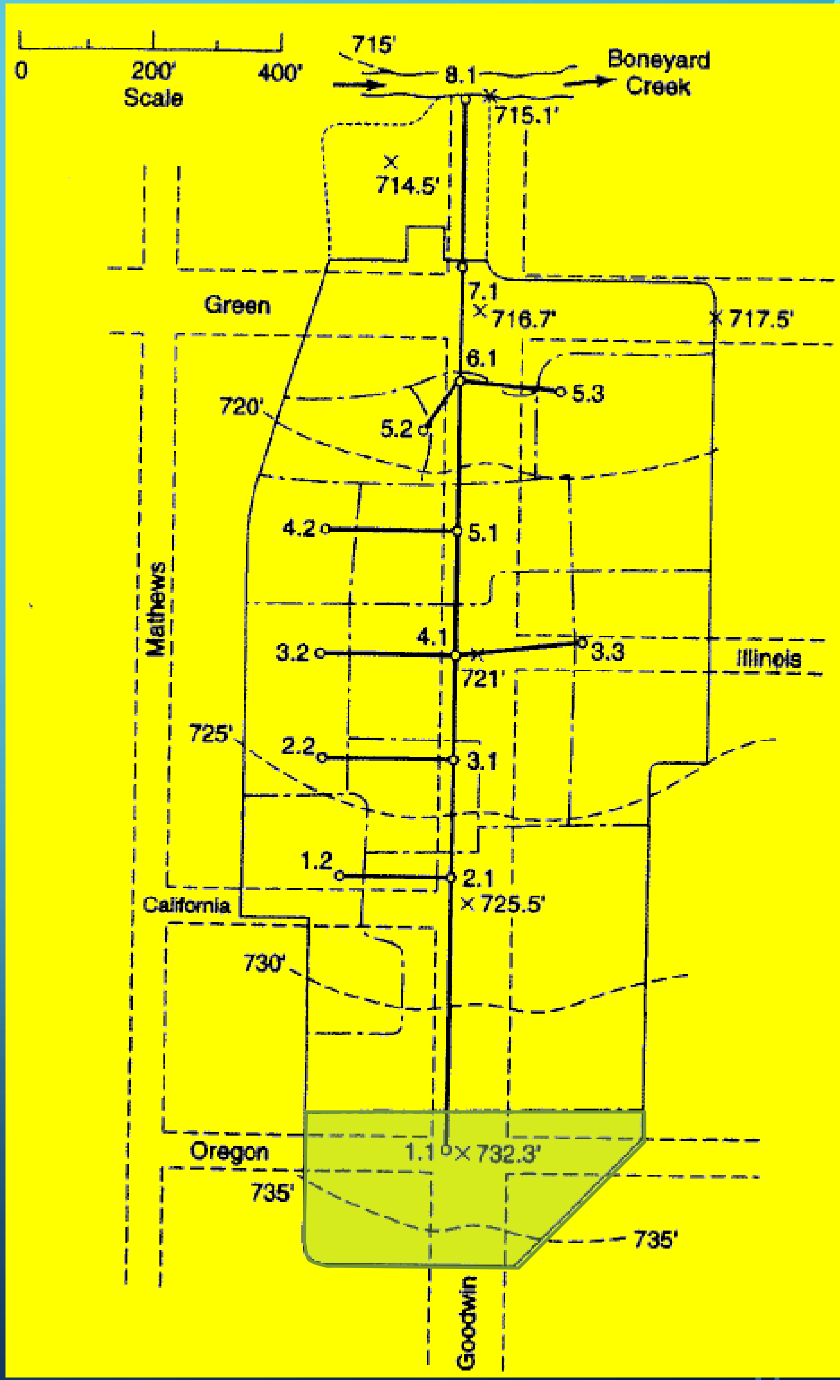
PREPARATION STEPS

- Identify the individual drainage areas.
- Determine the area of each contributing area, in acres. (ENGAUGE, PLANIMETER, etc)
- Determine the rational runoff coefficient for each area (TABLE LOOKUP)



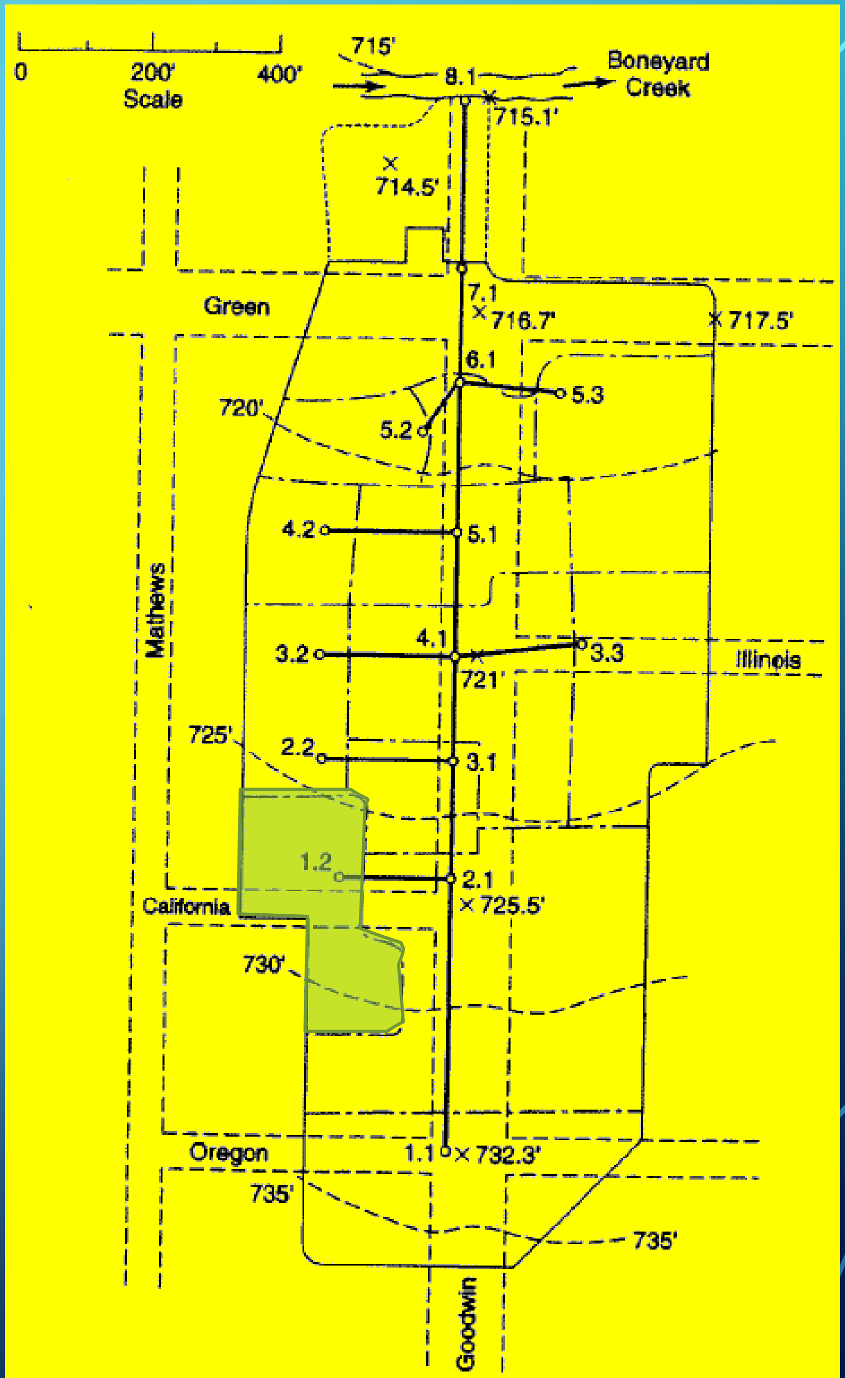
DRAINAGE AREA 1.1

- Identify the individual drainage areas.



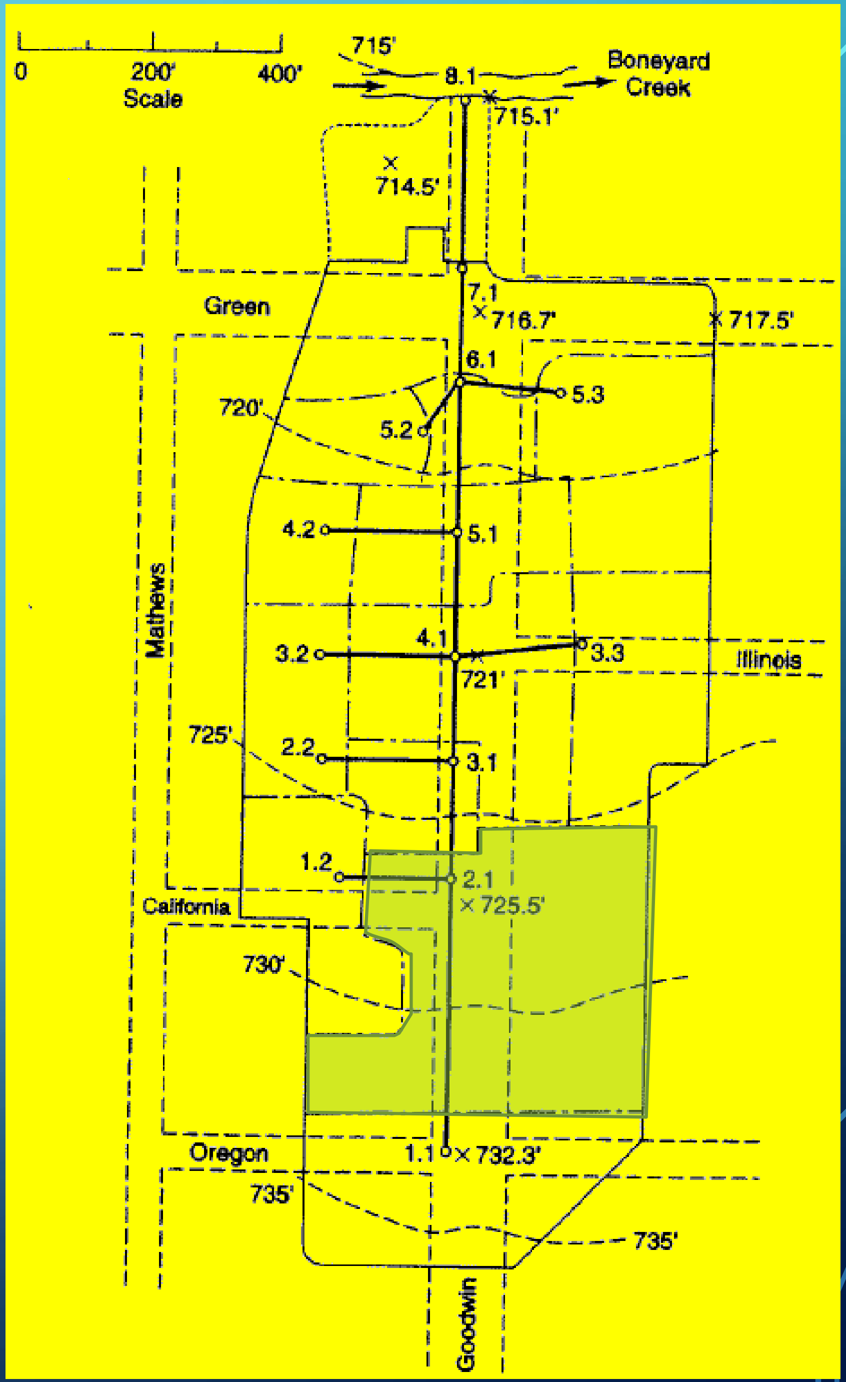
DRAINAGE AREA 1.2

- Identify the individual drainage areas.



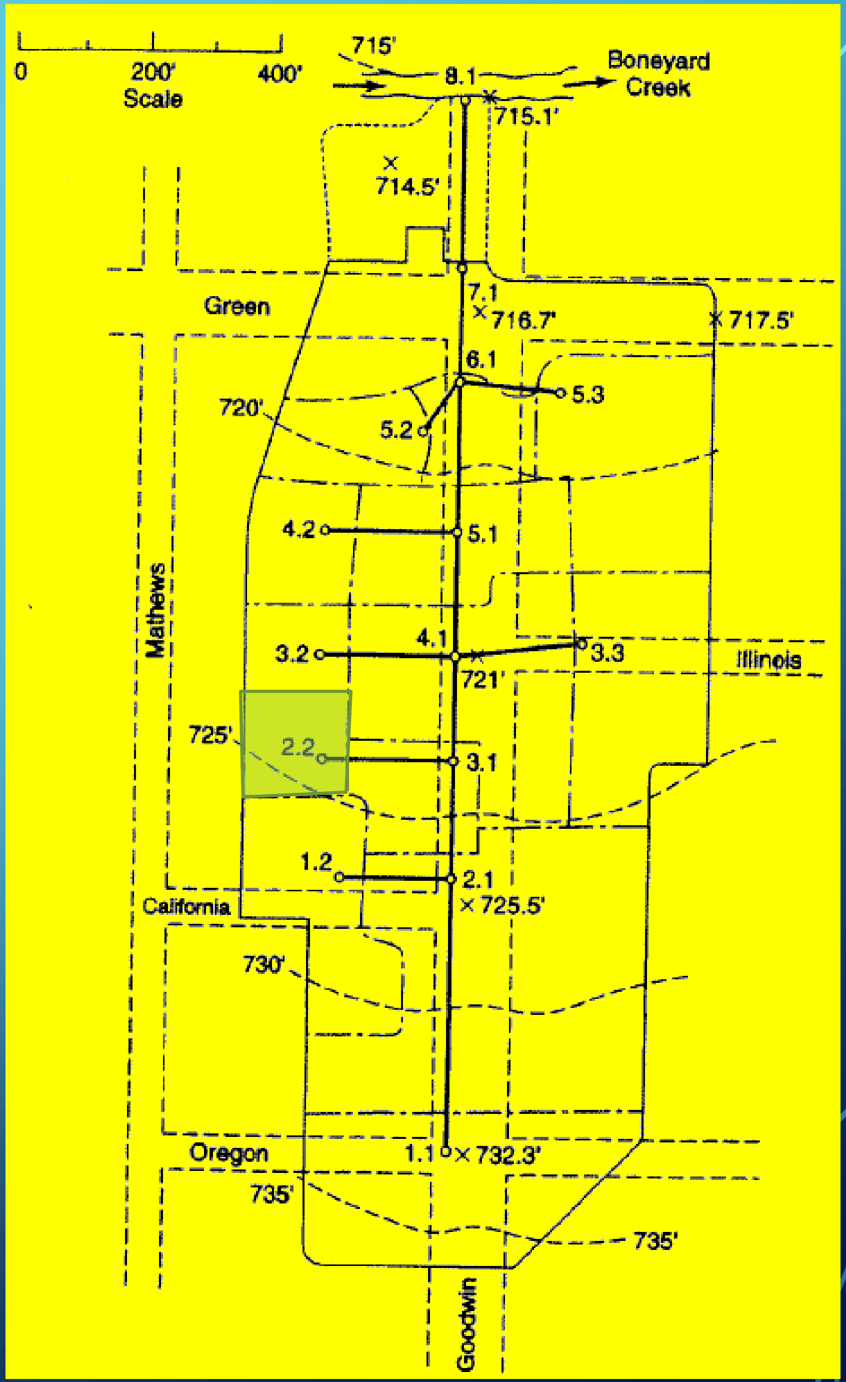
DRAINAGE AREA 2.1

- Identify the individual drainage areas.



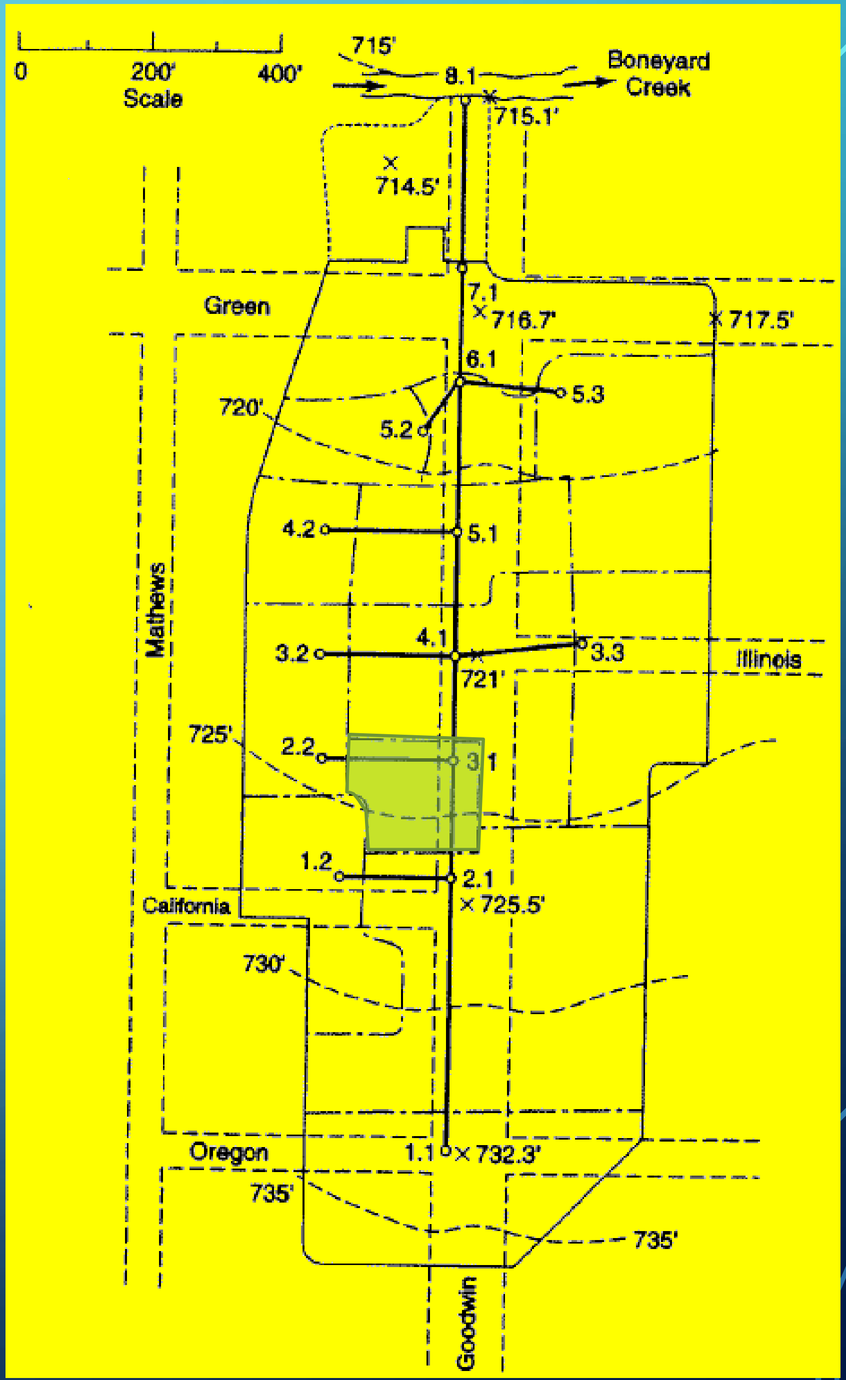
DRAINAGE AREA 2.2

- Identify the individual drainage areas.



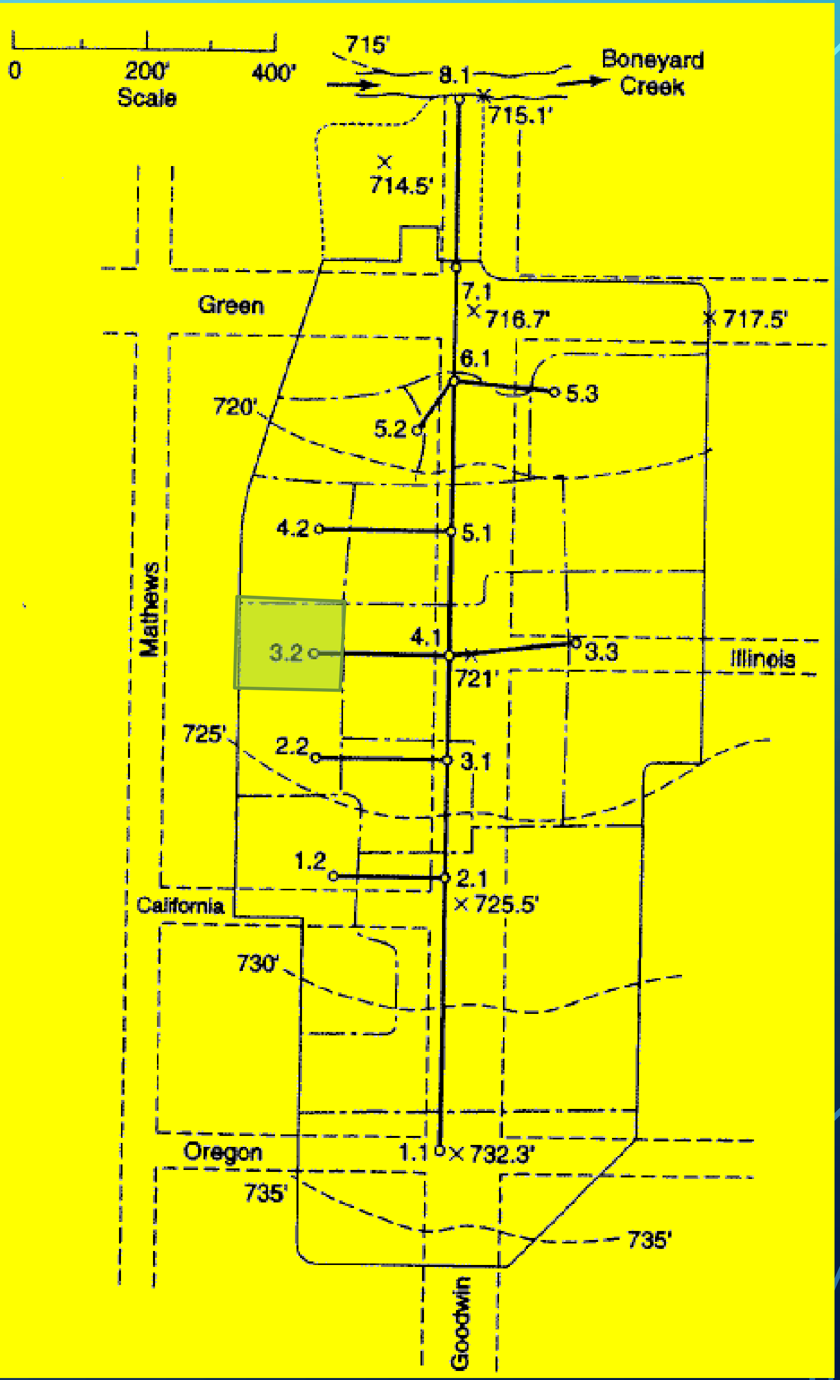
DRAINAGE AREA 3.1

- Identify the individual drainage areas.



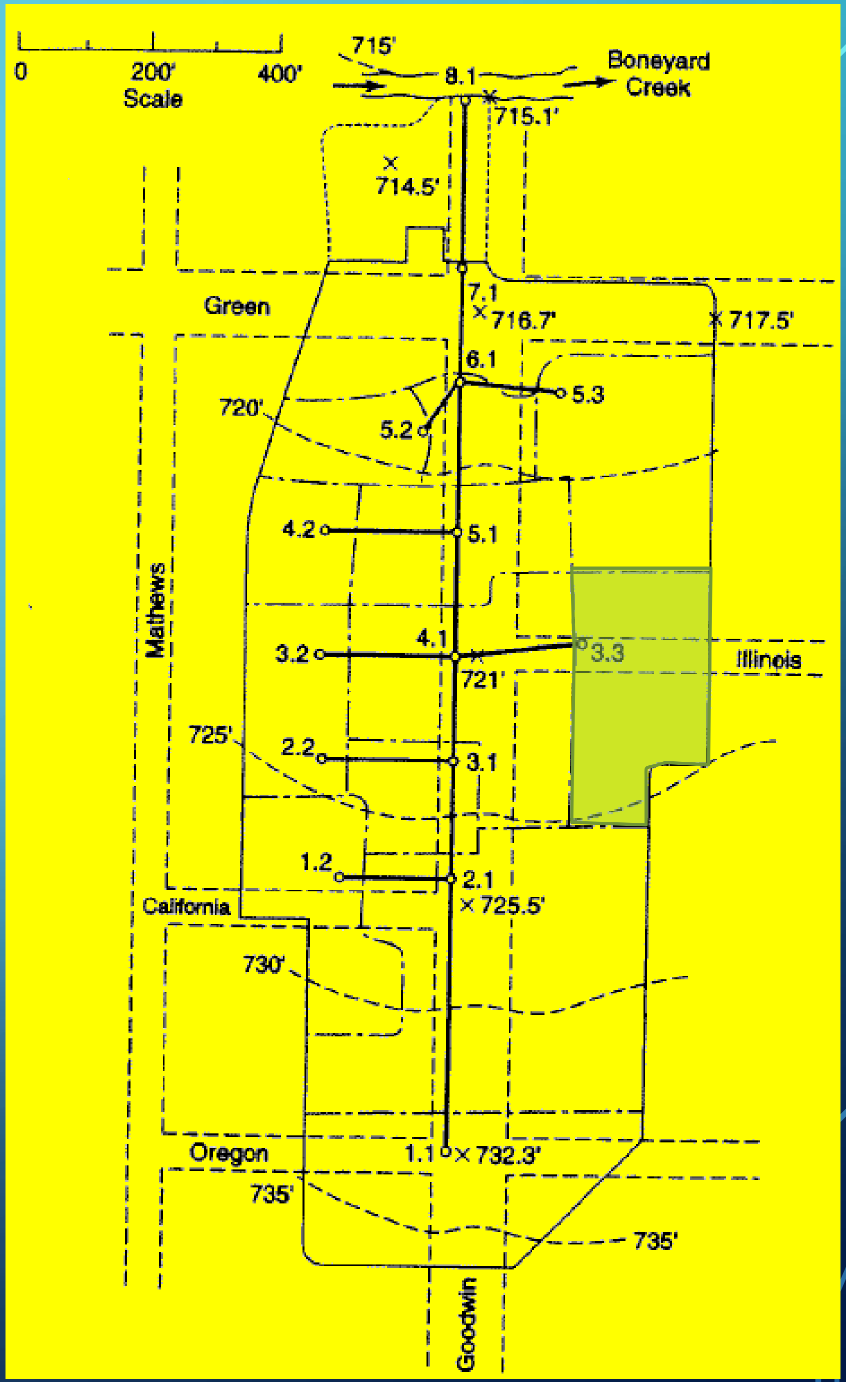
DRAINAGE AREA 3.2

- Identify the individual drainage areas.



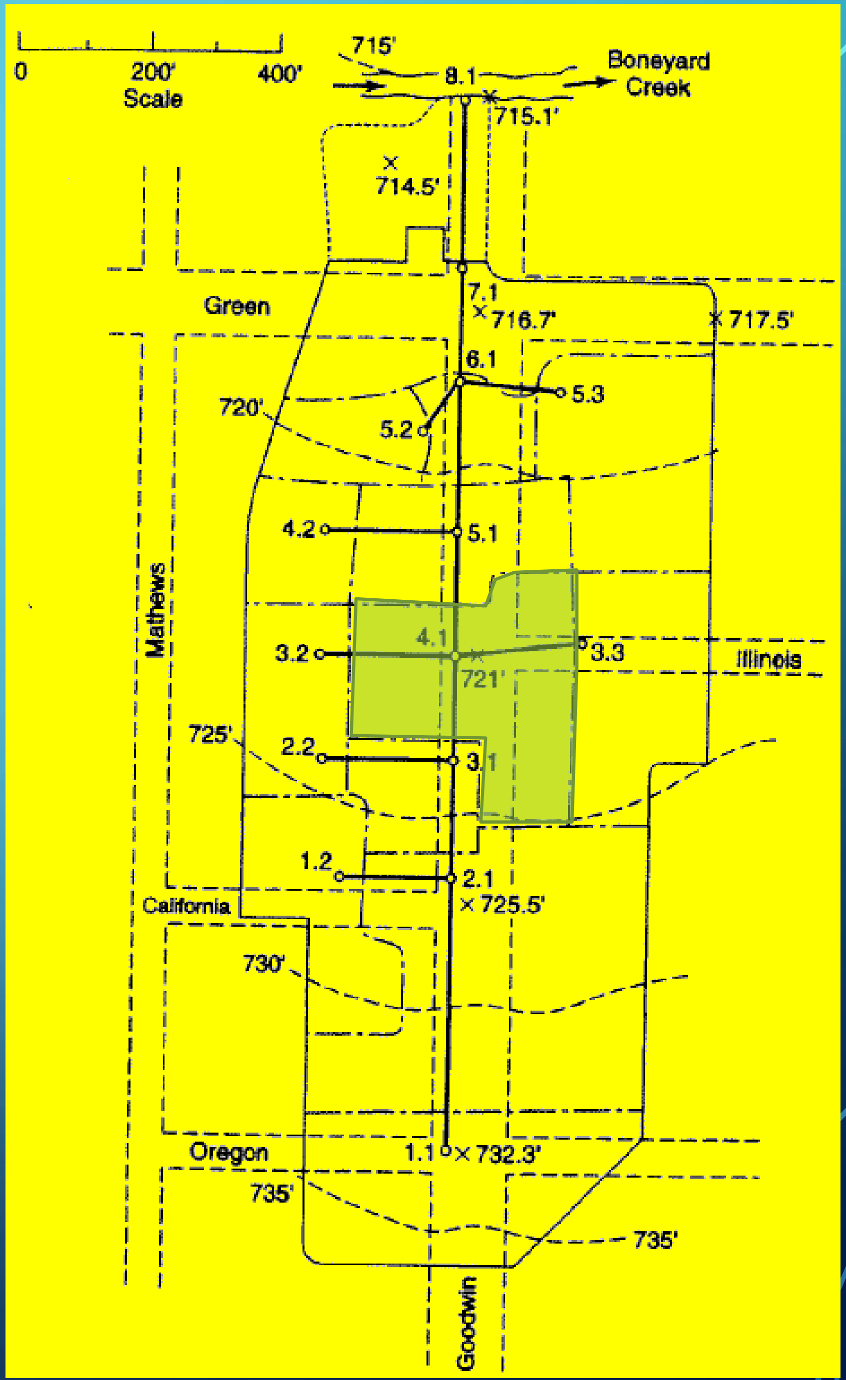
DRAINAGE AREA 3.3

- Identify the individual drainage areas.



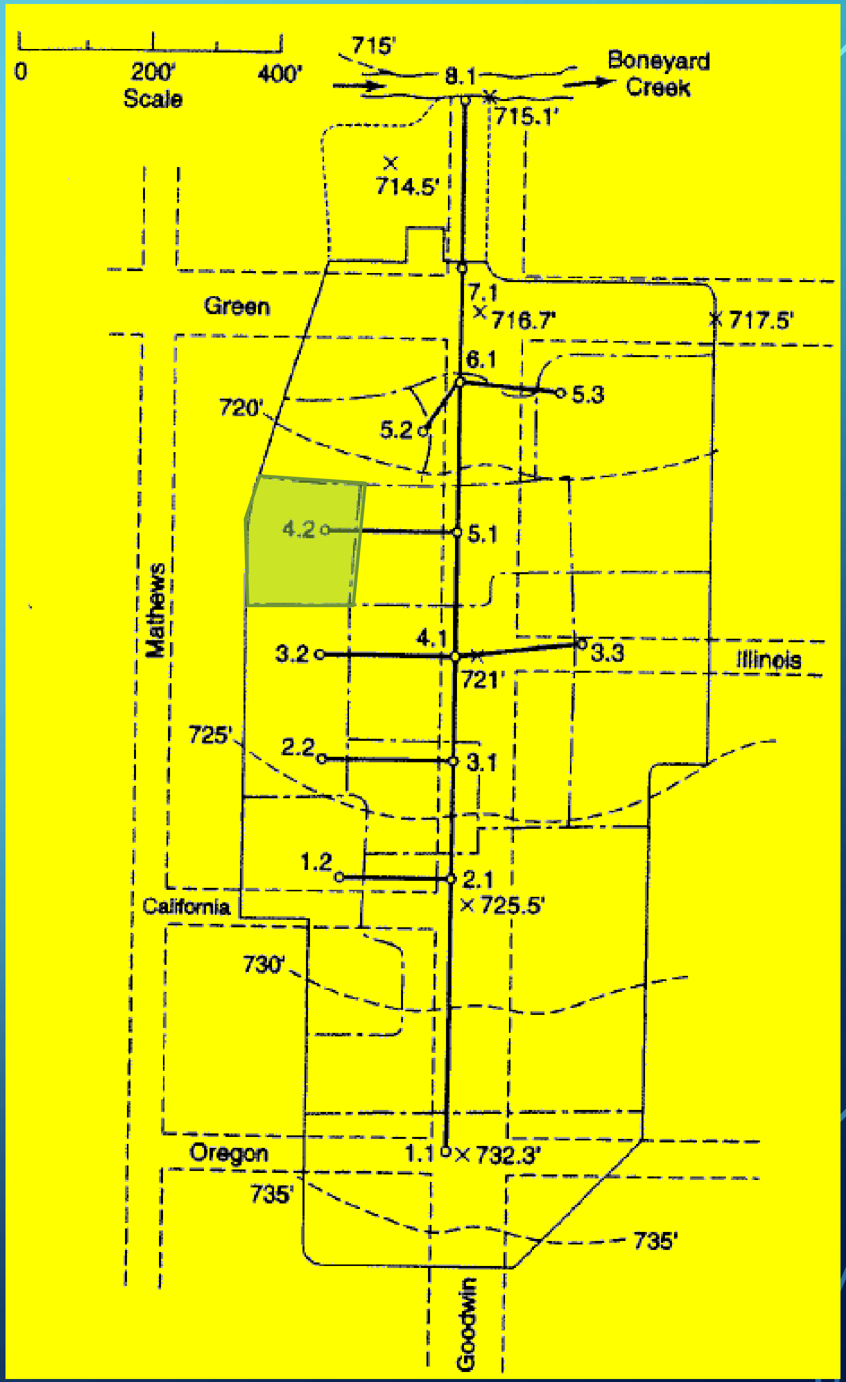
DRAINAGE AREA 4.1

- Identify the individual drainage areas.



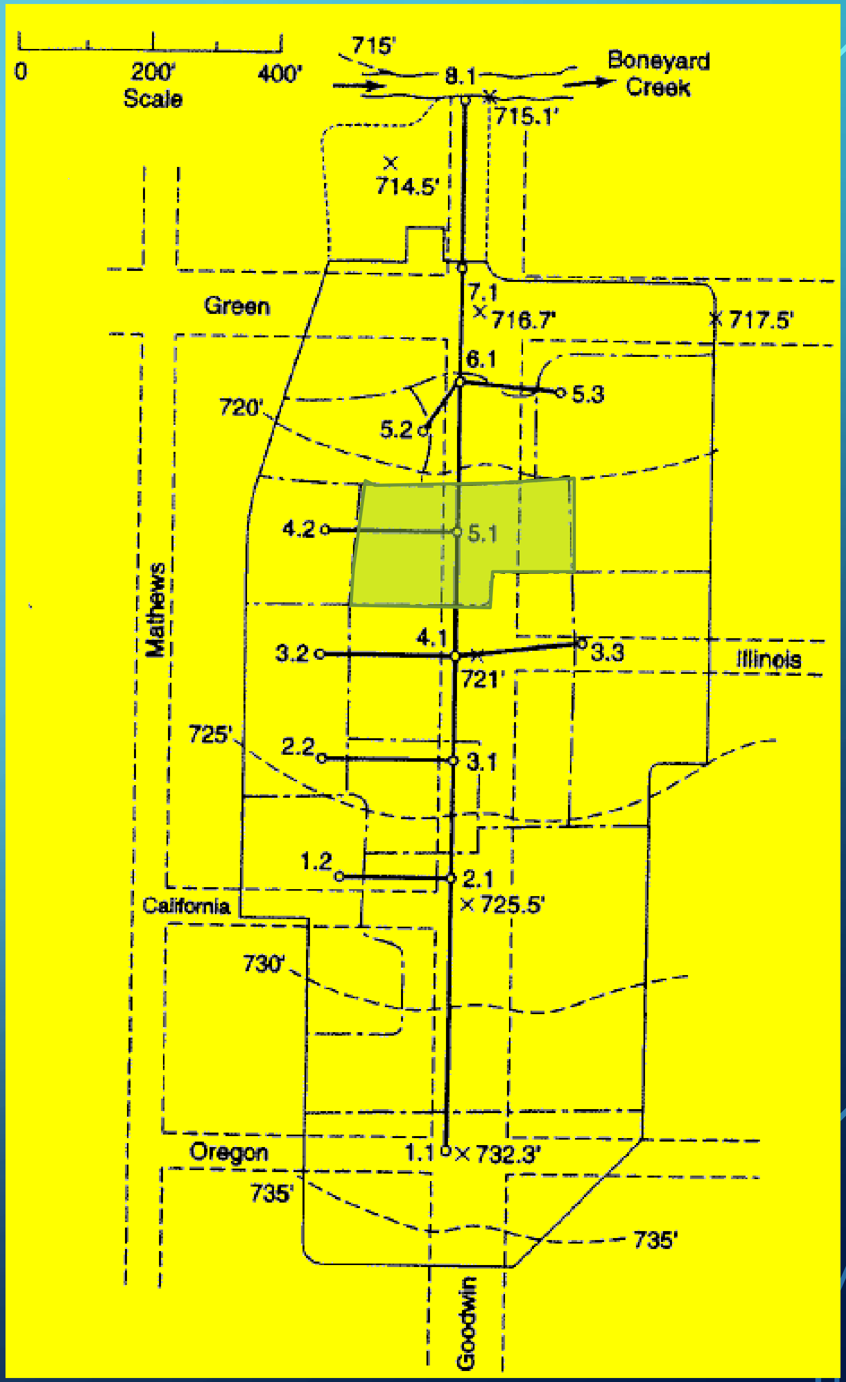
DRAINAGE AREA 4.2

- Identify the individual drainage areas.



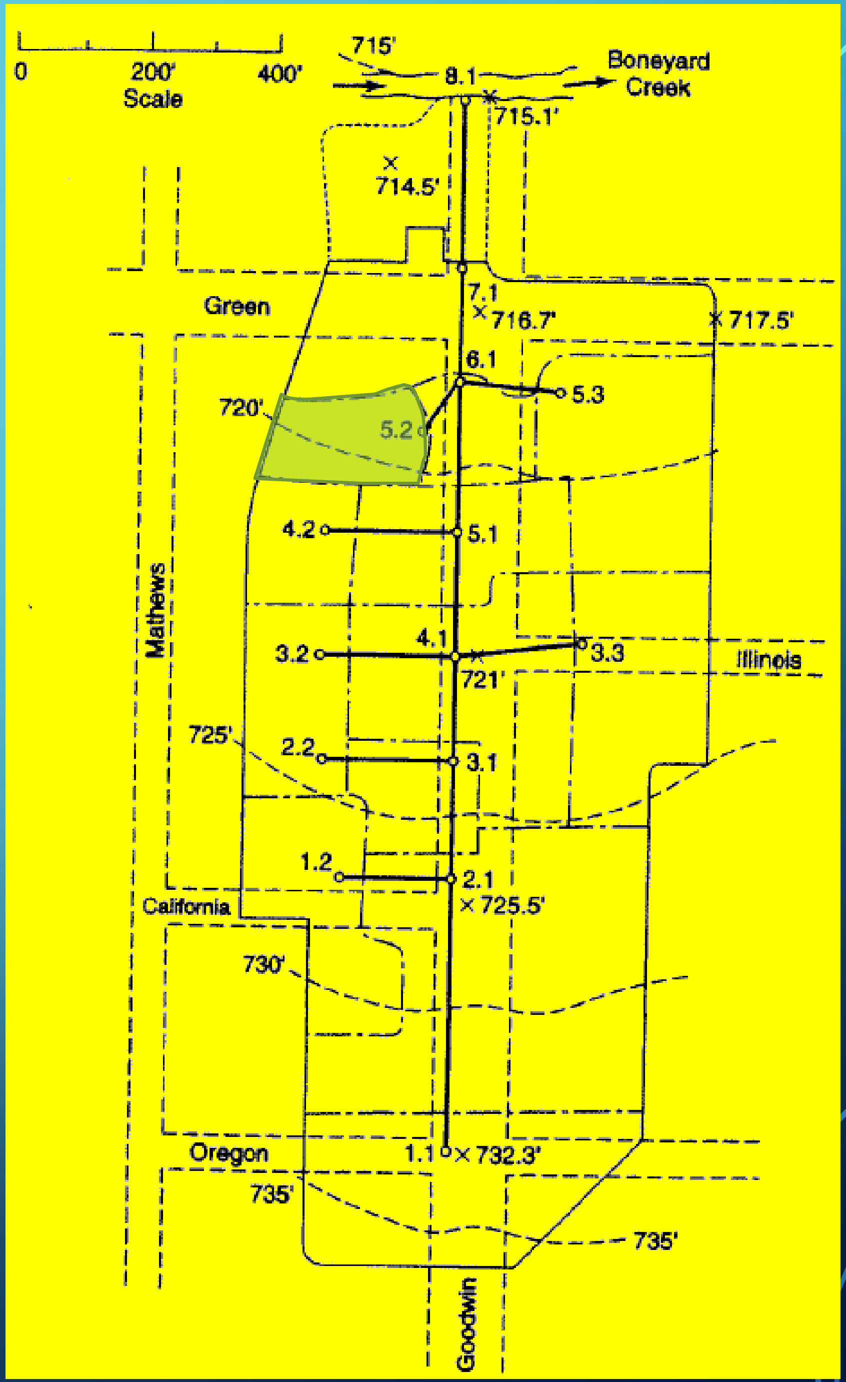
DRAINAGE AREA 5.1

- Identify the individual drainage areas.



DRAINAGE AREA 5.2

- Identify the individual drainage areas.



DRAINAGE AREA 5.3

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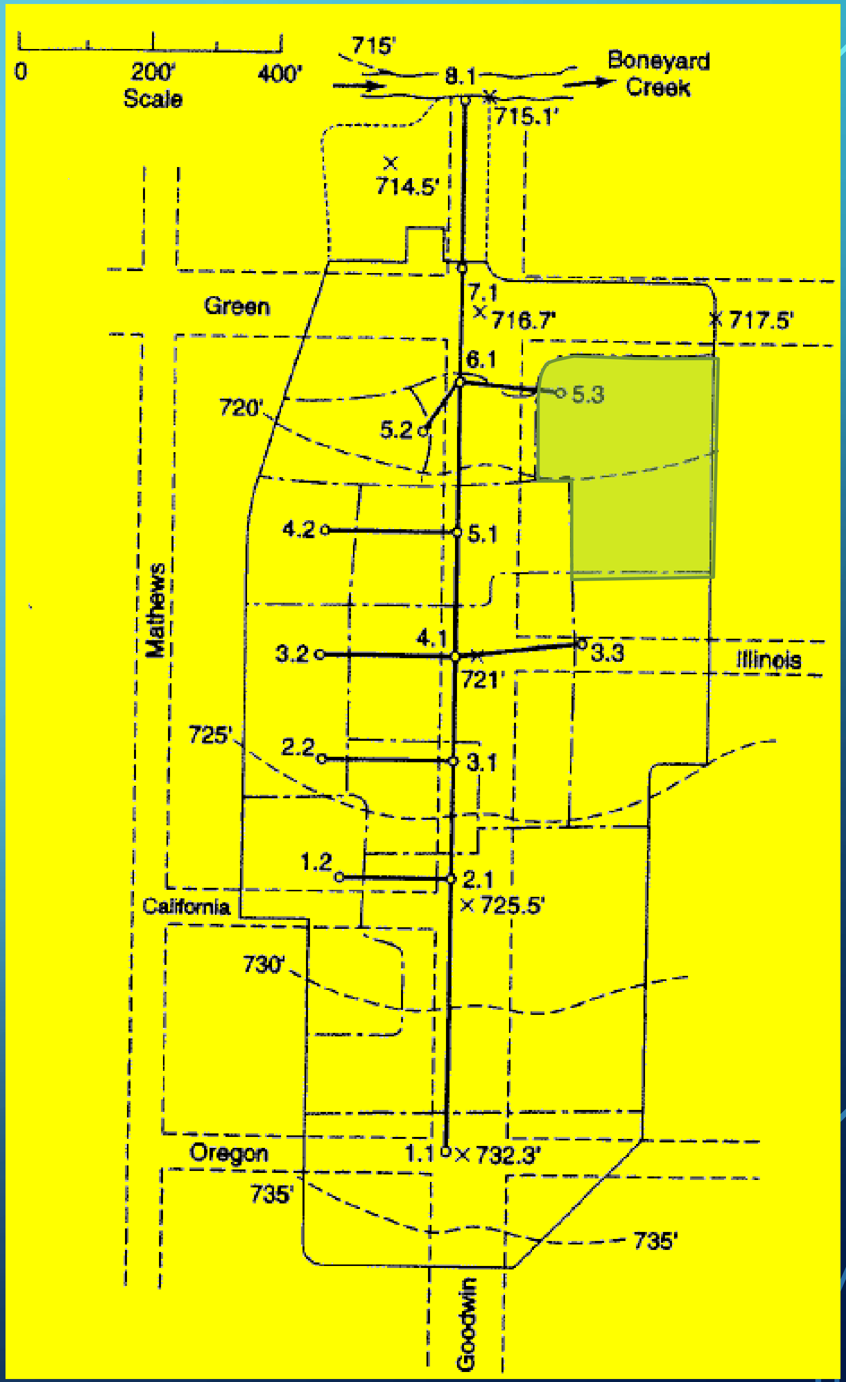
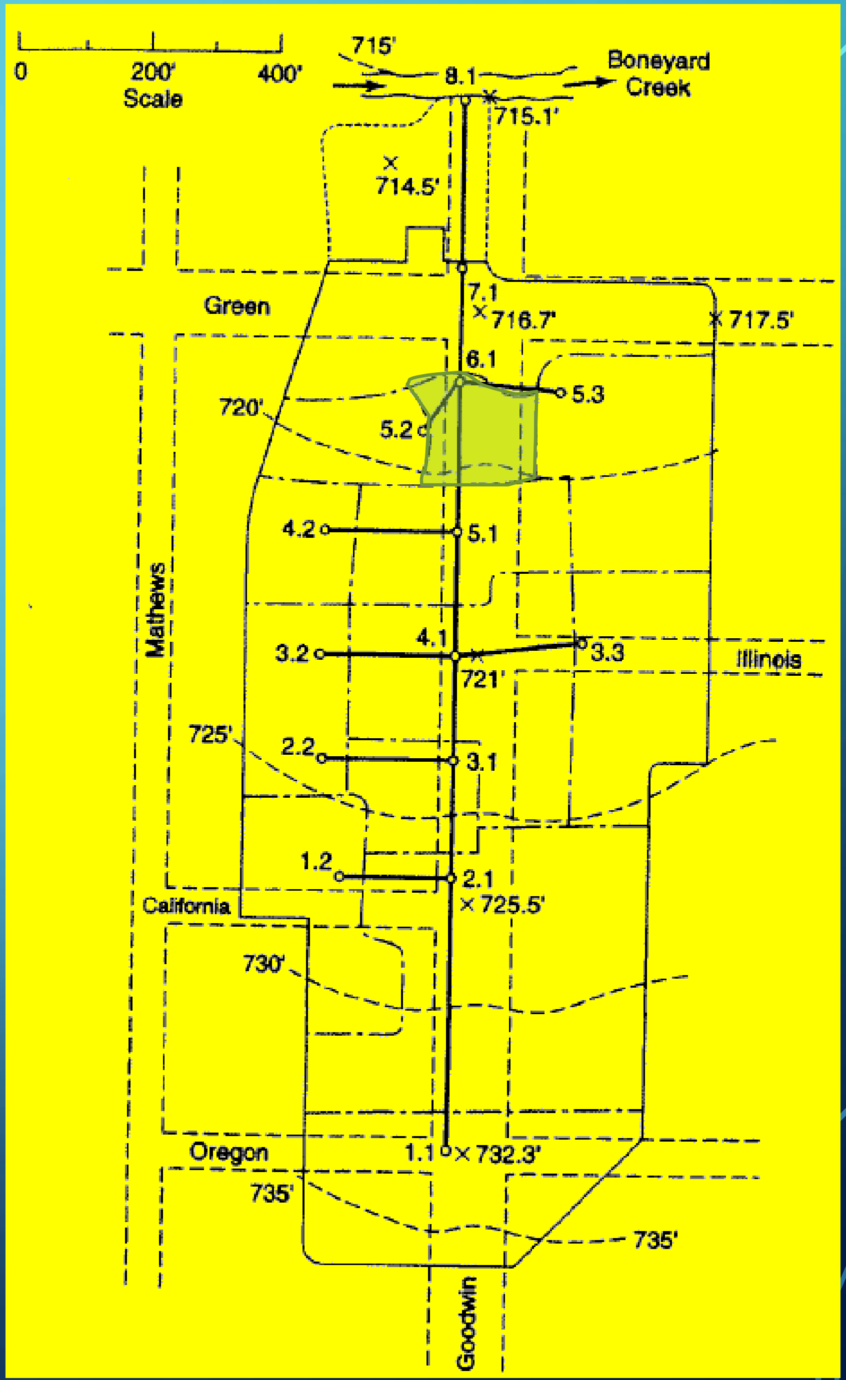


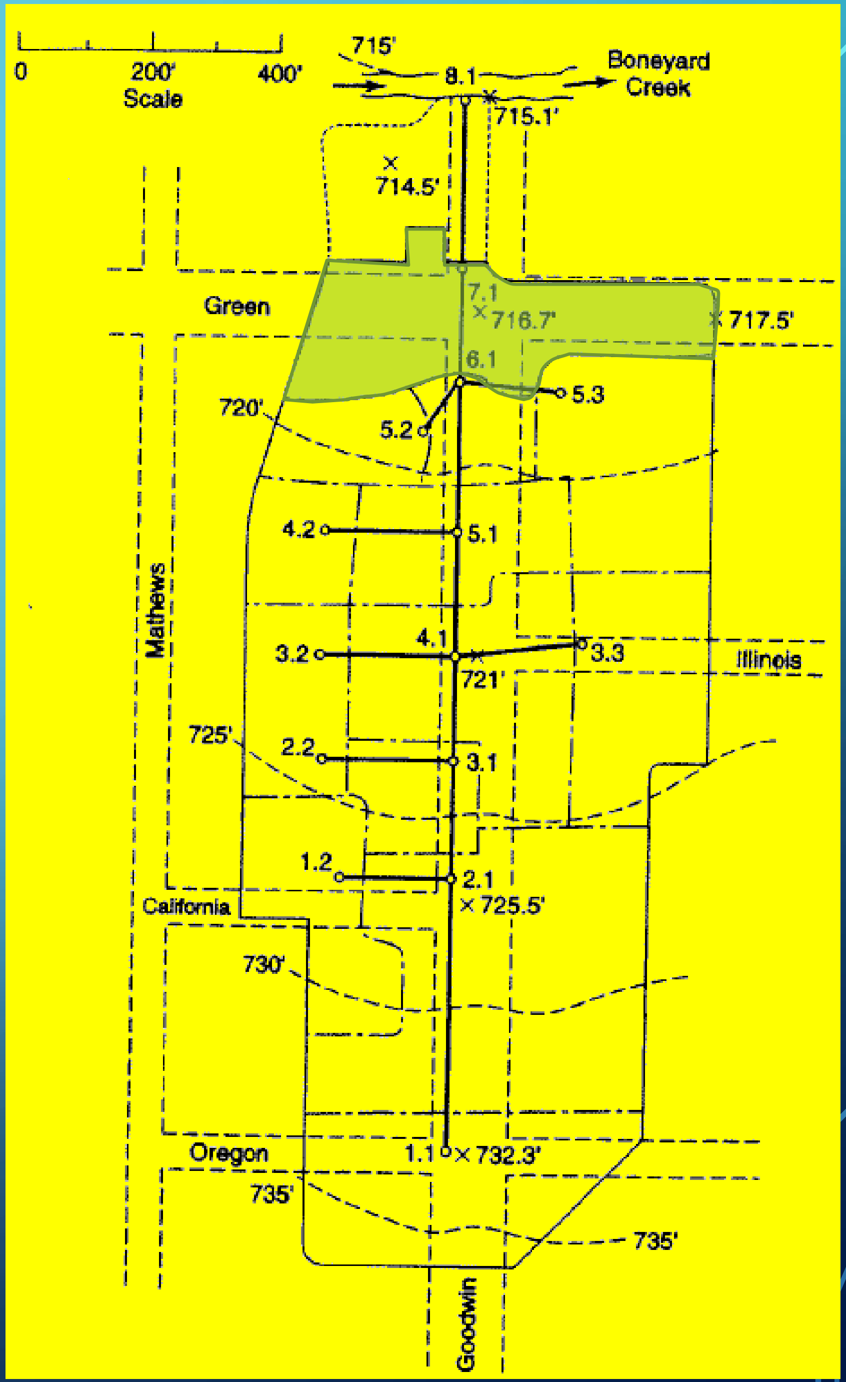
DRAINAGE AREA 6.1

- Identify the individual drainage areas.



DRAINAGE AREA 7.1

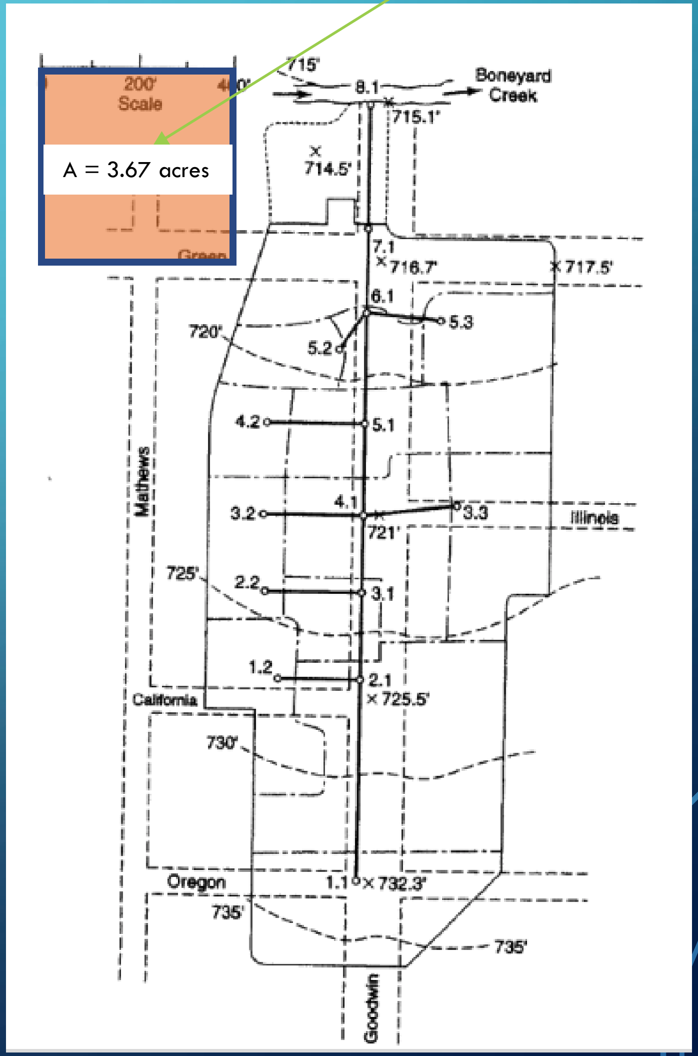
- Identify the individual drainage areas.



CALIBRATE AREA MEASUREMENT TOOL

Area =400X400/43560
= 3.67 acres

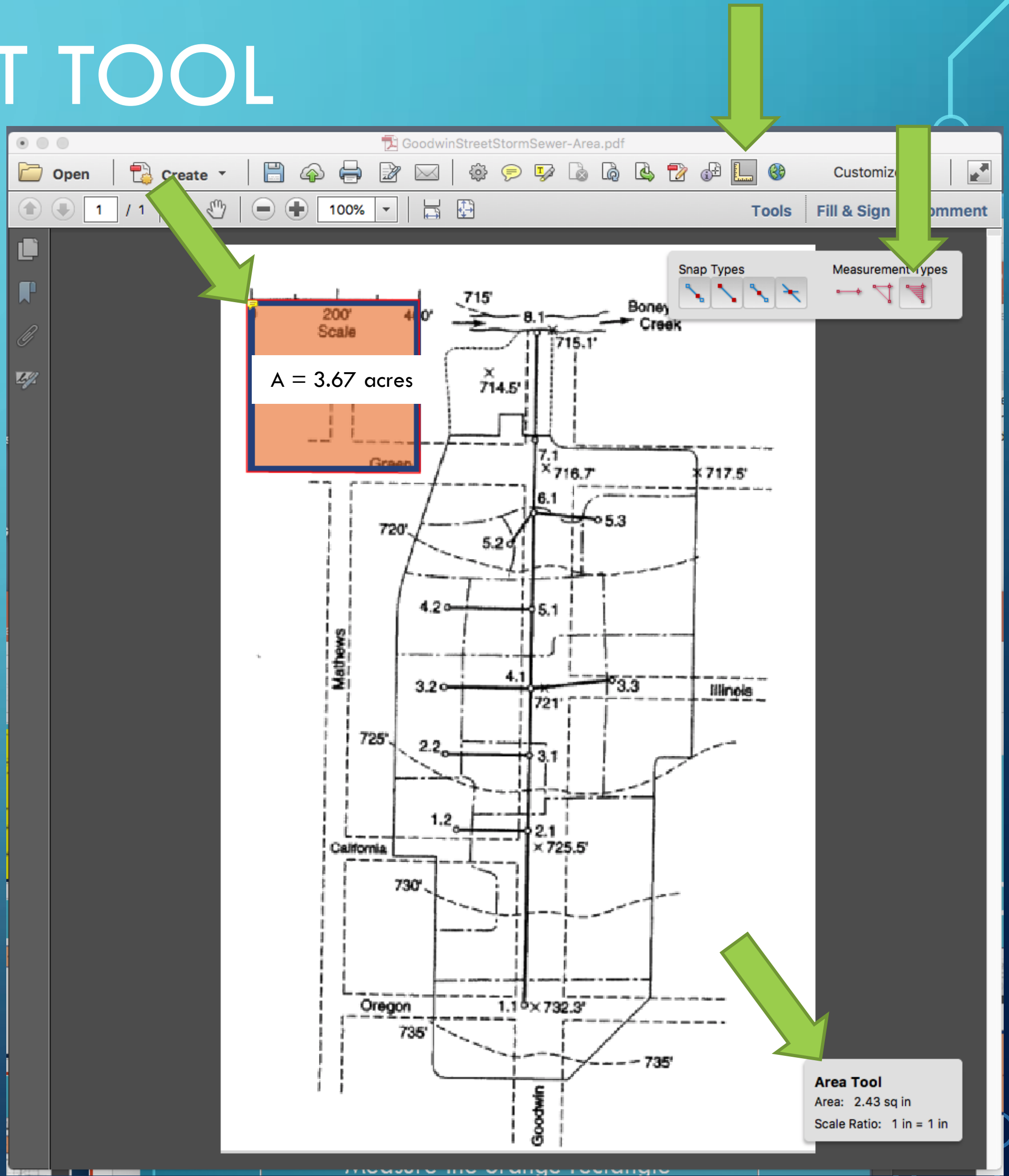
- Measure areas using appropriate tools
  - E.g. Acrobat Pro
    - Need to measure a known area
    - Save the conversion factor



CALIBRATE AREA MEASUREMENT TOOL

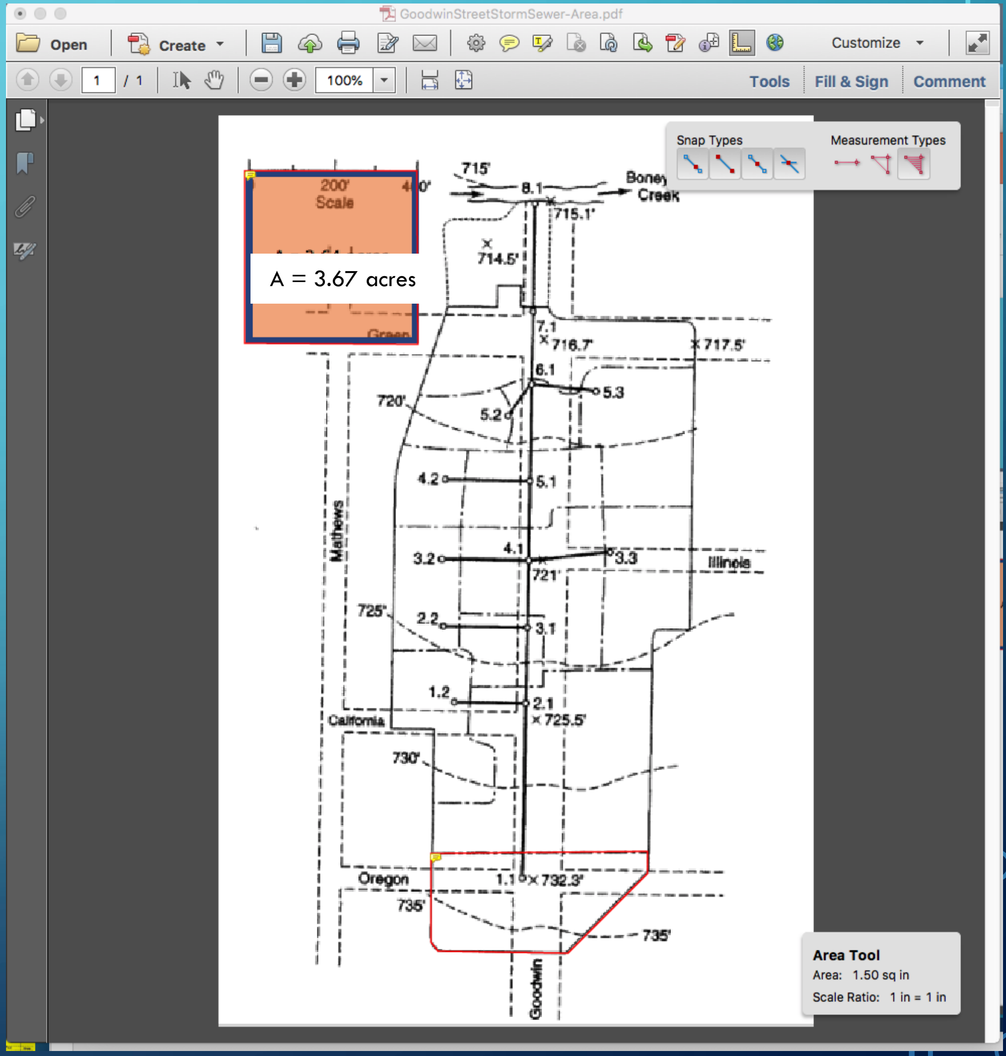
- Measure areas using Acrobat Pro
  - Activate the measurement toolkit
  - Select Area
  - Measure the orange rectangle
  - Save the conversion factor:

    2.43 sq.in. == 3.67 acres



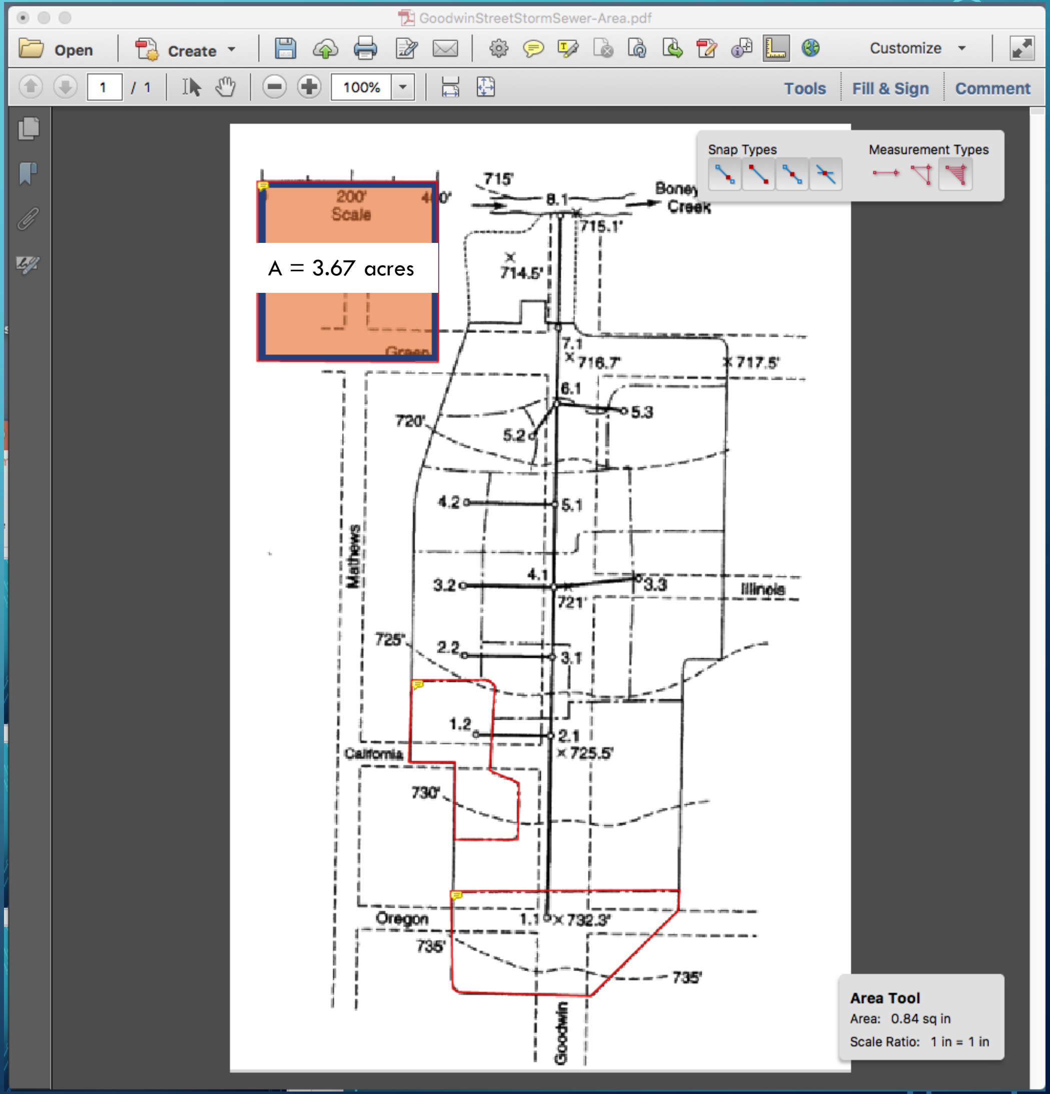
DRAINAGE AREA 1.1

- Identify the individual drainage areas.
- Determine the area of each contributing area, in acres. (G3DATA; PLANIMETER, etc)
- Area = 1.50*3.67/2.43 = 2.26 acres



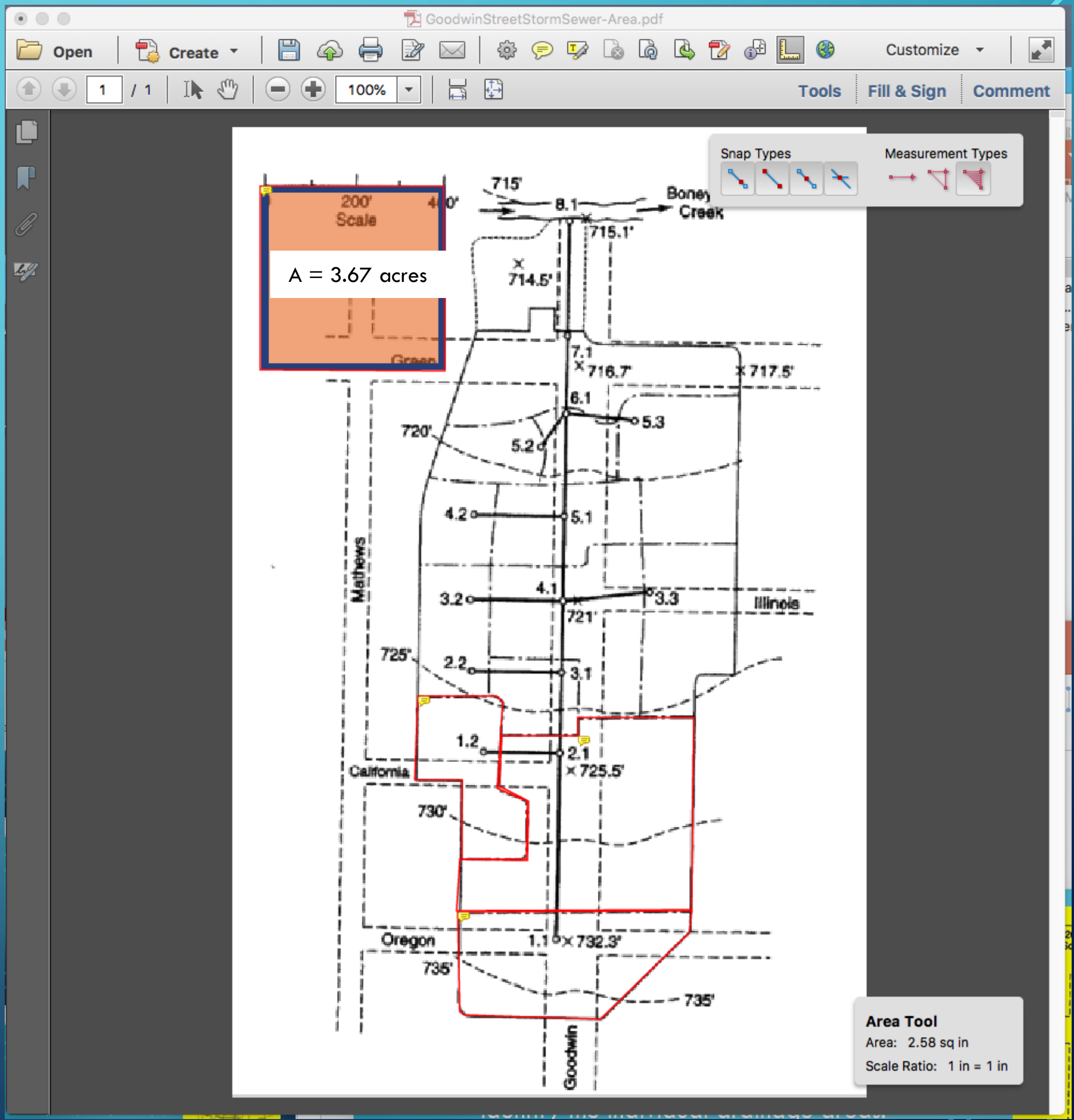
DRAINAGE AREA 1.2

- Identify the individual drainage areas.
- Determine the area of each contributing area, in acres. (ENGAUGE, PLANIMETER, etc)
- Area = 0.84*3.67/2.43 = 1.26 acres



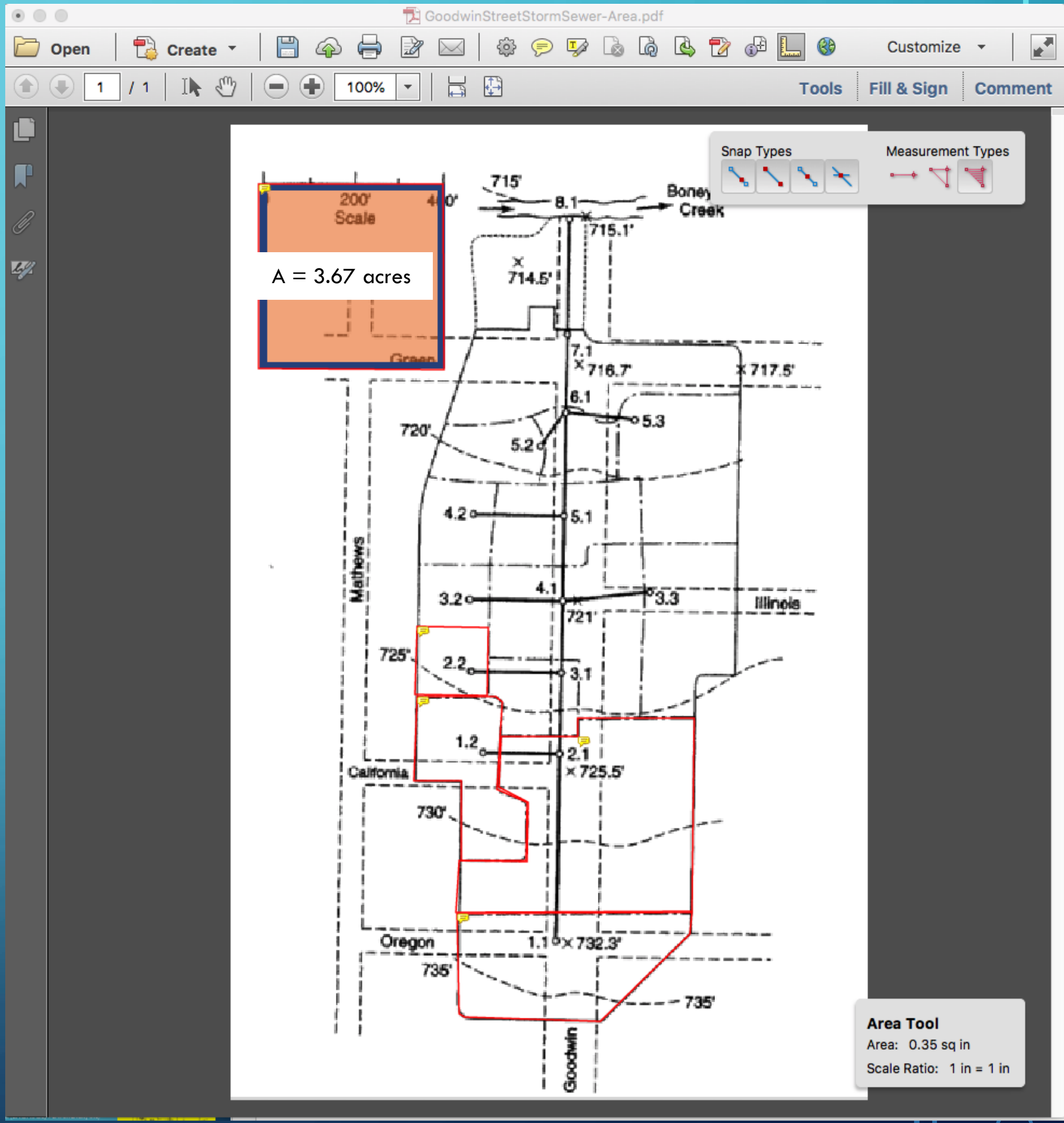
DRAINAGE AREA 2.1

- Identify the individual drainage areas.
- Determine the area of each contributing area, in acres.
- Area = 2.58*3.67/2.43 = 3.89 acres



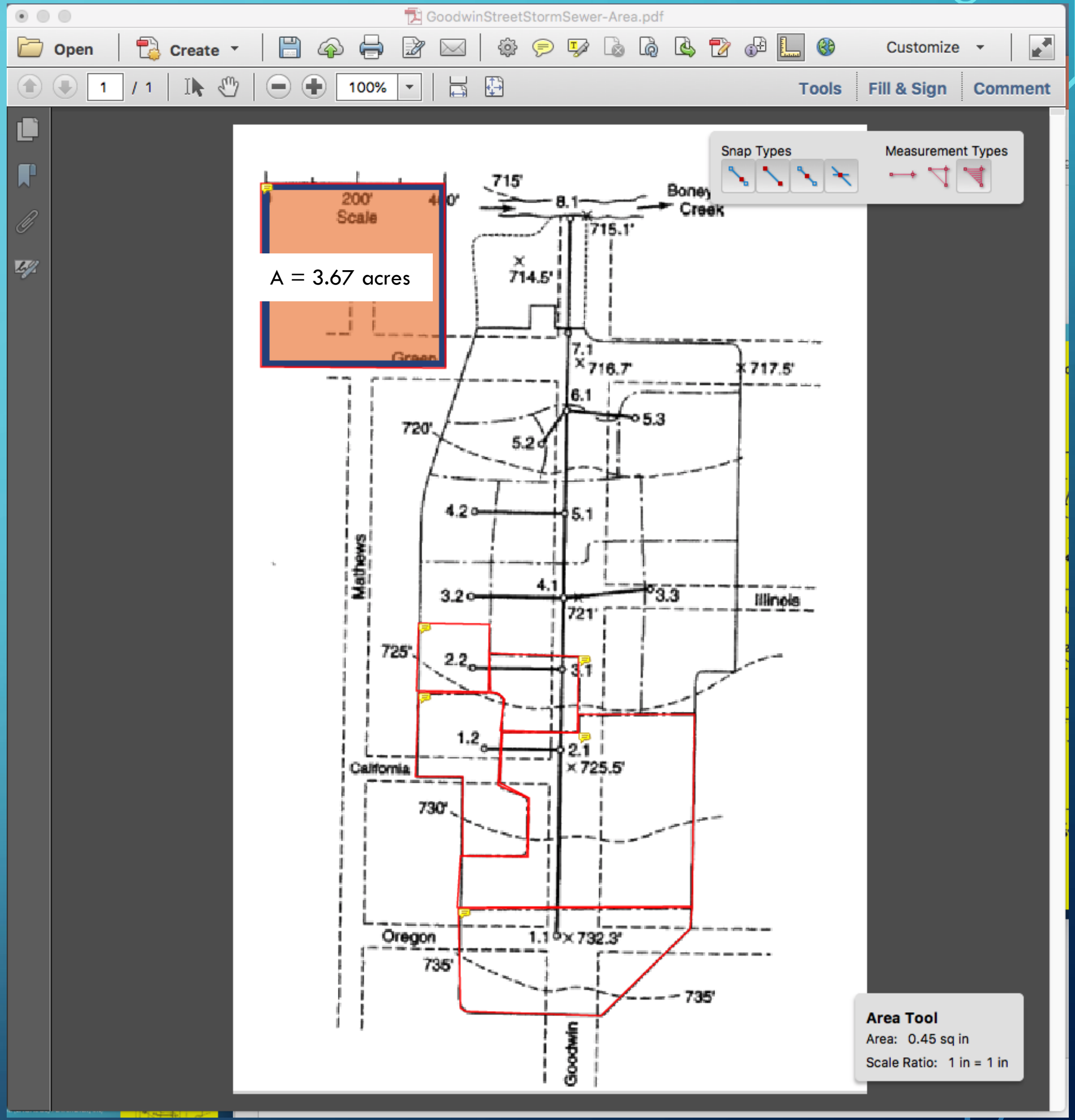
DRAINAGE AREA 2.2

- Identify the individual drainage areas.
- Determine the area of each contributing area, in acres.
- Area = 0.35*3.67/2.43 = 0.53 acres



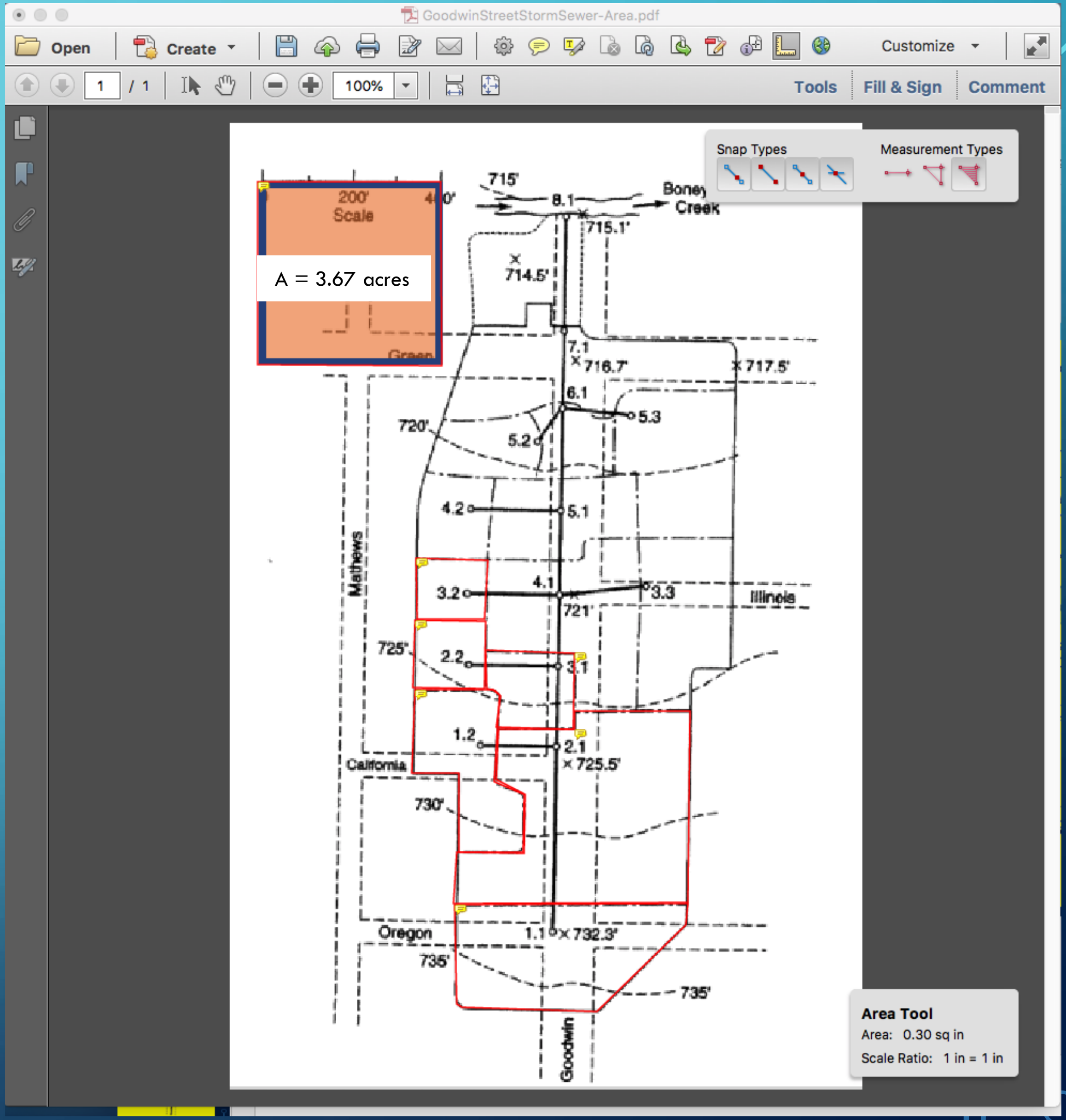
DRAINAGE AREA 3.1

- Identify the individual drainage areas.
- Determine the area of each contributing area, in acres.
- Area = 0.45*3.67/2.43 = 0.68 acres



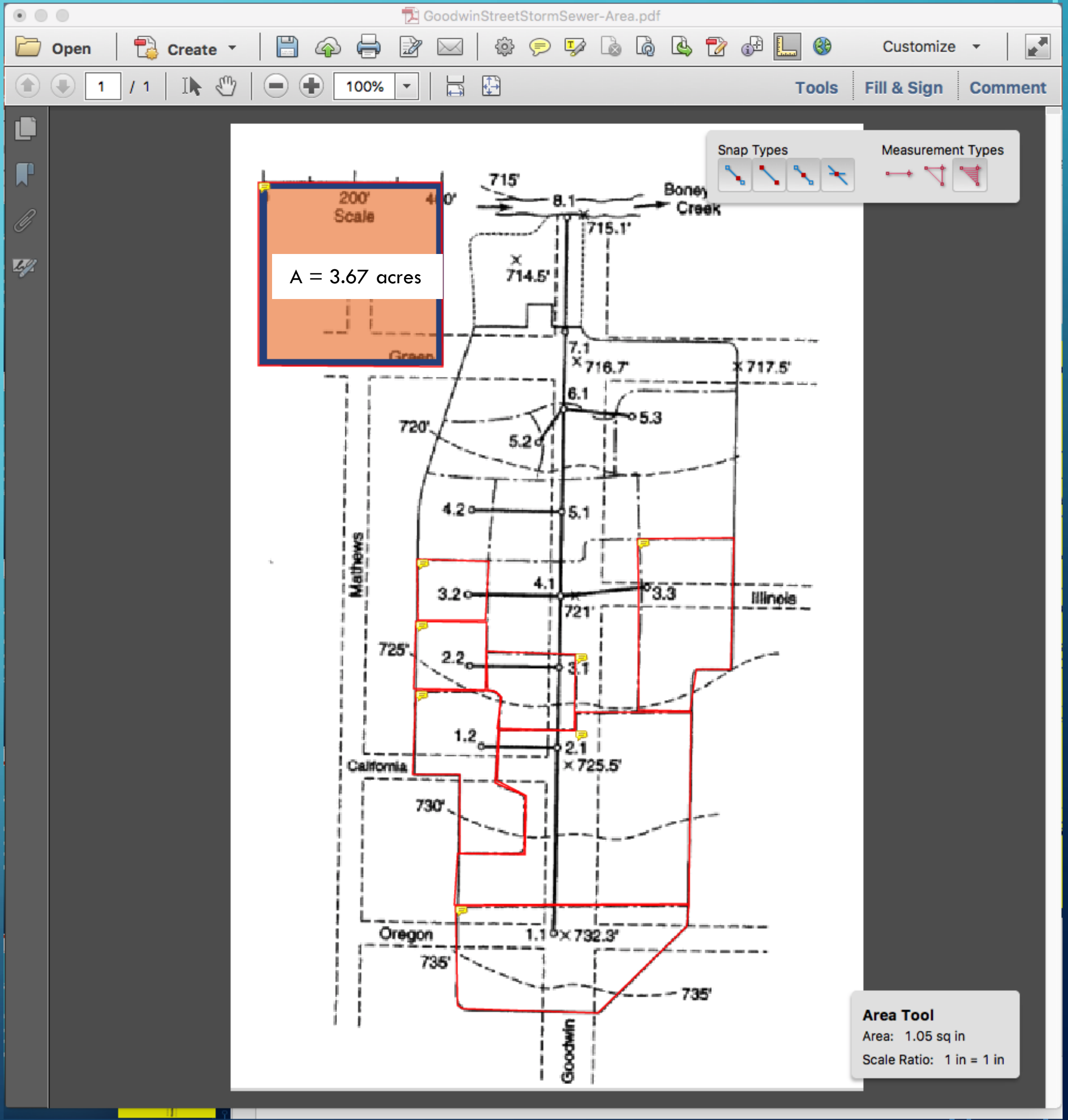
DRAINAGE AREA 3.2

- Identify the individual drainage areas.
- Determine the area of each contributing area, in acres.
- Area = 0.30*3.67/2.43 = 0.45 acres



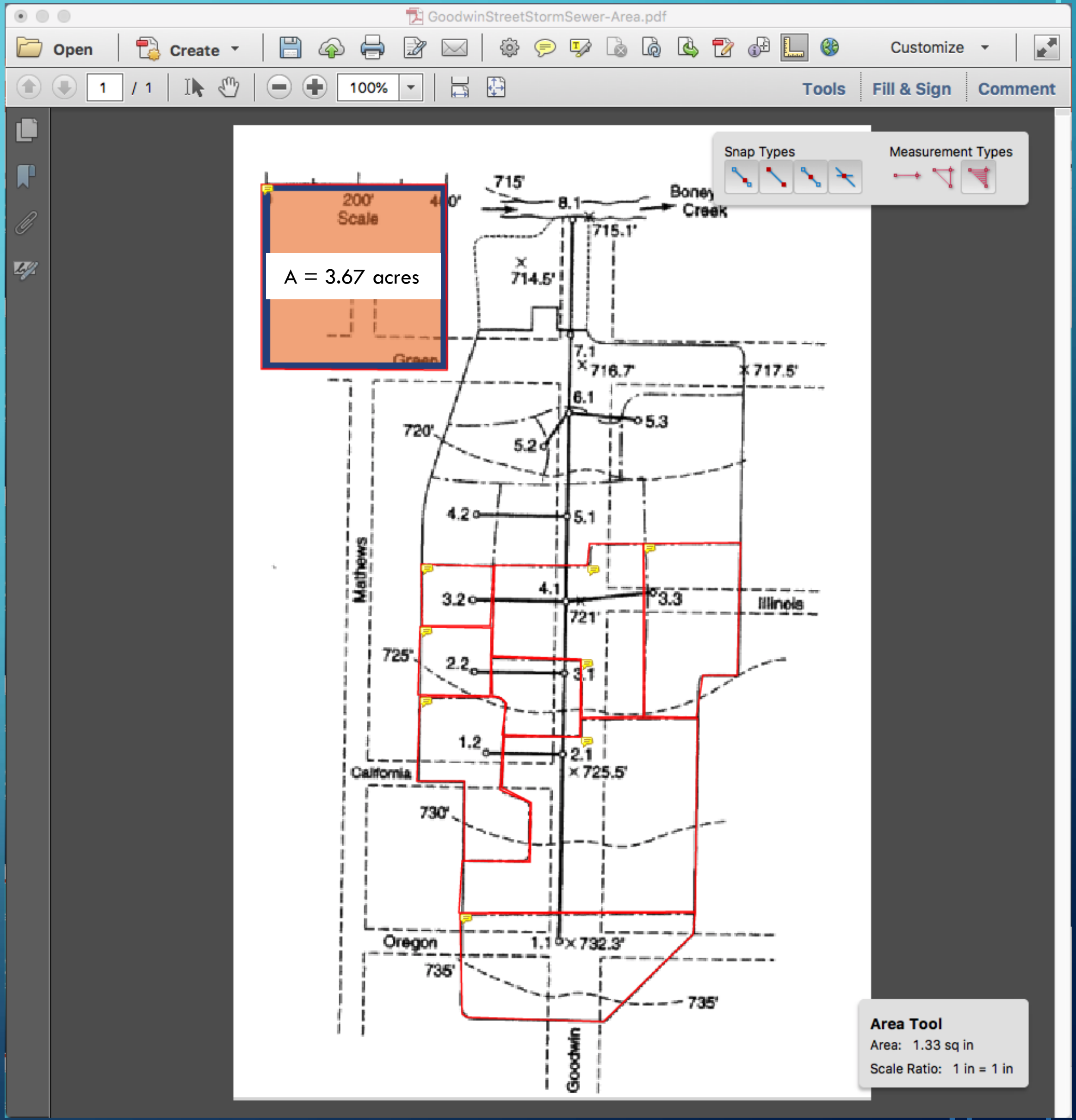
DRAINAGE AREA 3.3

- Identify the individual drainage areas.
- Determine the area of each contributing area, in acres.
- Area = 1.05*3.67/2.43 = 1.58 acres



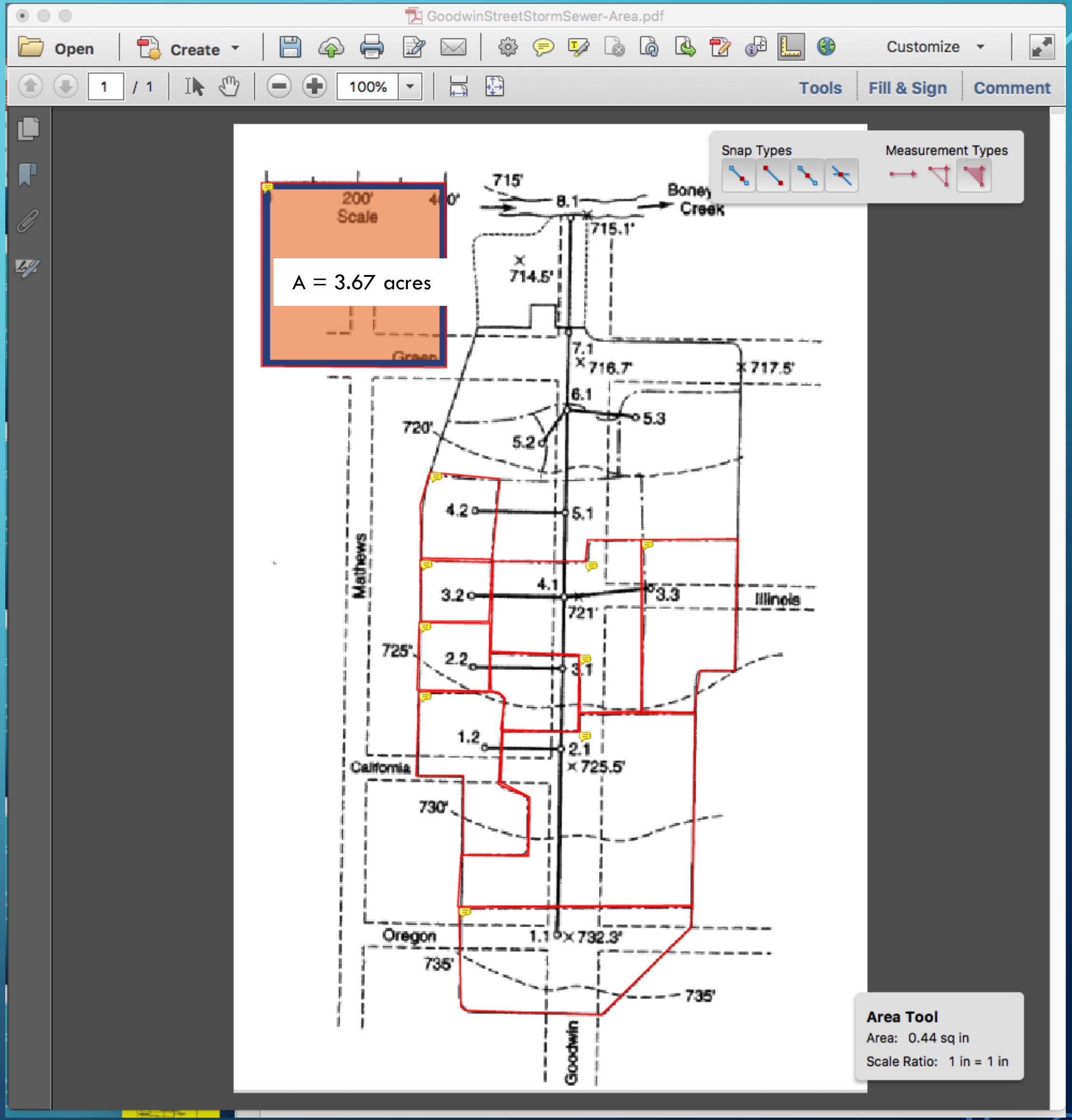
DRAINAGE AREA 4.1

- Identify the individual drainage areas.
- Determine the area of each contributing area, in acres.
- Area = 1.33*3.67/2.43 = 2.01 acres



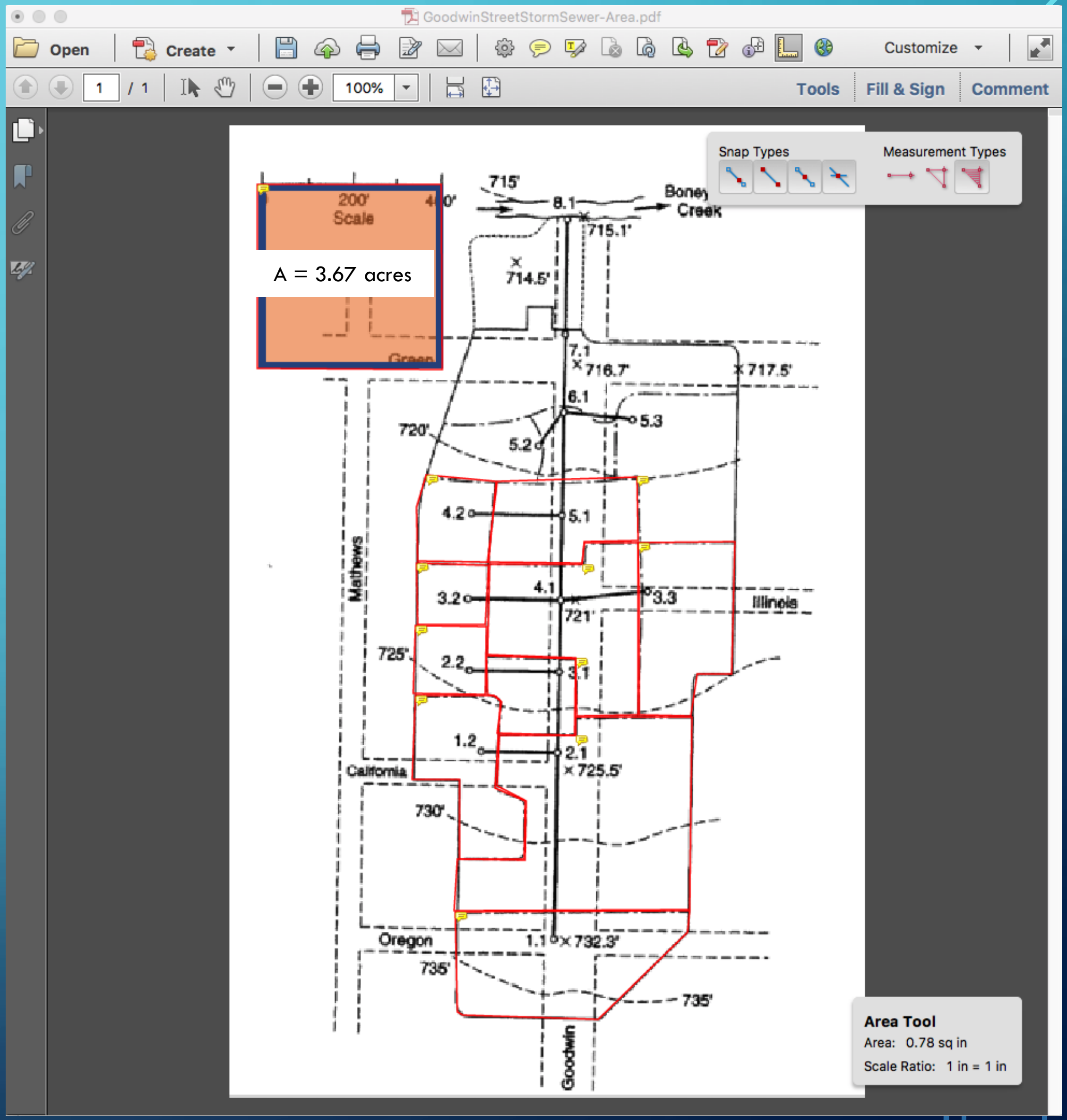
DRAINAGE AREA 4.2

- Identify the individual drainage areas.
- Determine the area of each contributing area, in acres.
- Area = 0.44*3.67/2.43 = 0.66 acres



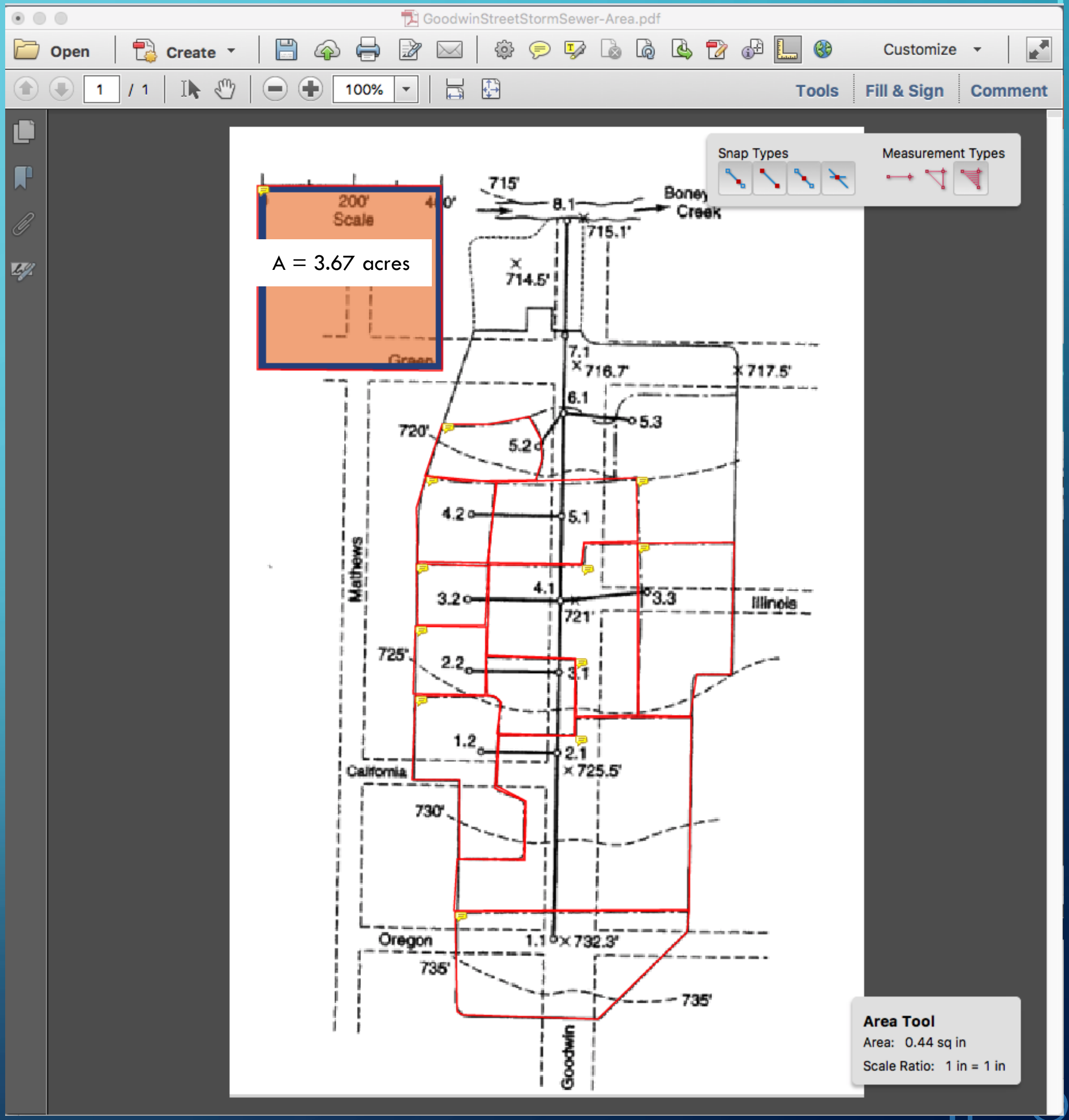
DRAINAGE AREA 5.1

- Identify the individual drainage areas.
- Determine the area of each contributing area, in acres.
- Area = 0.78*3.67/2.43 = 1.17 acres



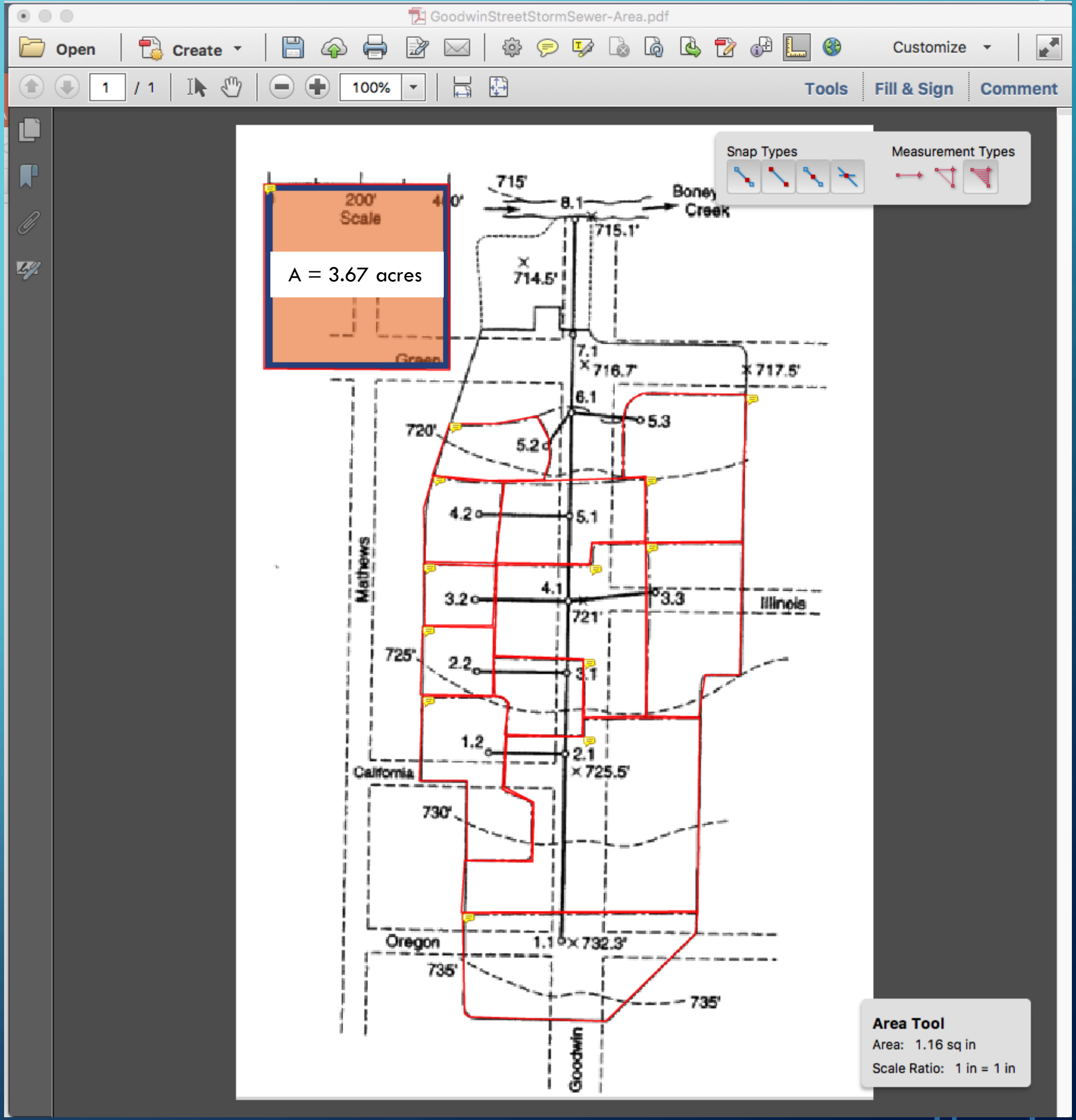
DRAINAGE AREA 5.2

- Identify the individual drainage areas.
- Determine the area of each contributing area, in acres.
- Area = 0.44*3.67/2.43 = 0.66 acres



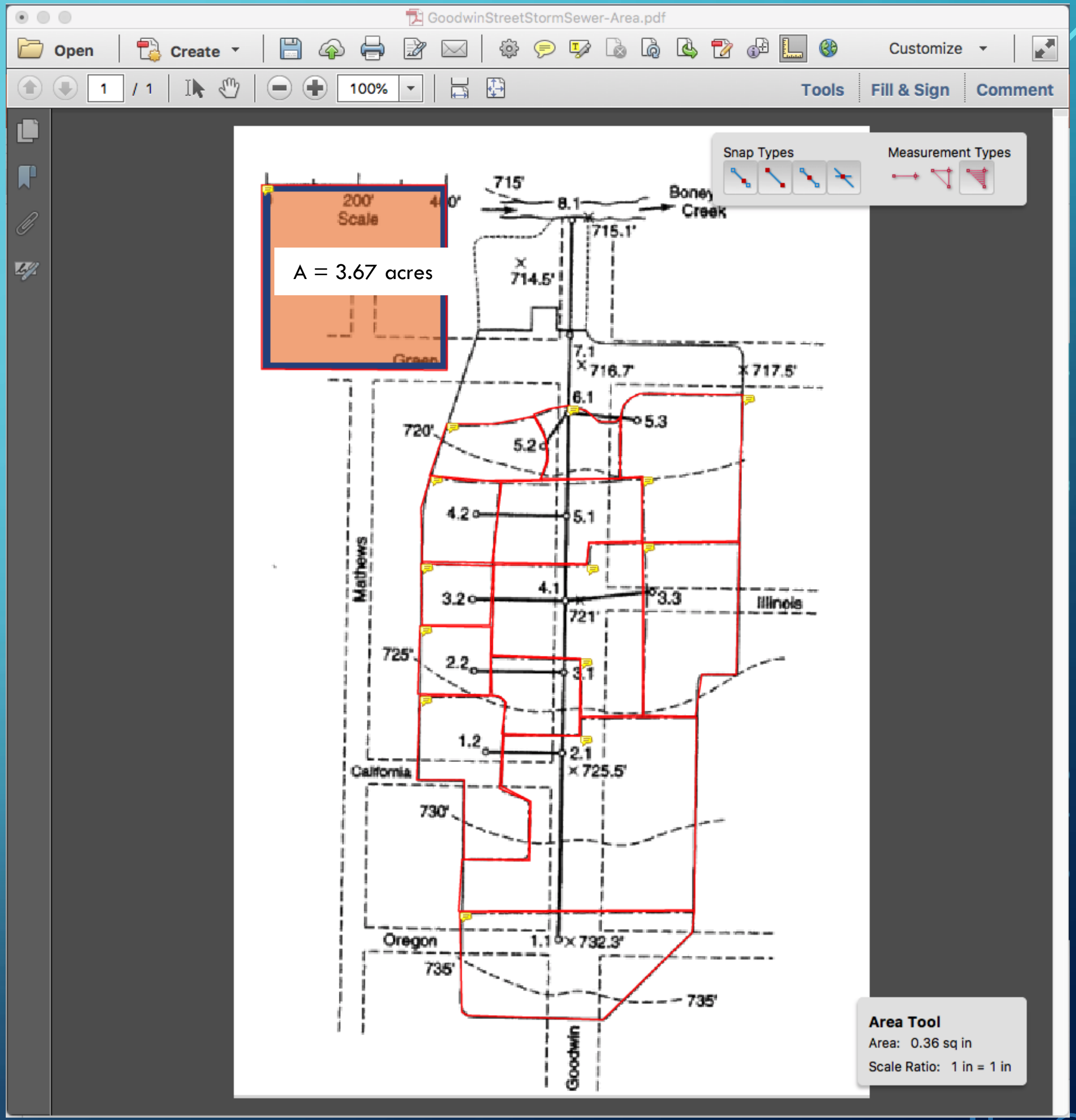
DRAINAGE AREA 5.3

- Identify the individual drainage areas.
- Determine the area of each contributing area, in acres.
- Area = 1.16*3.67/2.43 = 1.75 acres



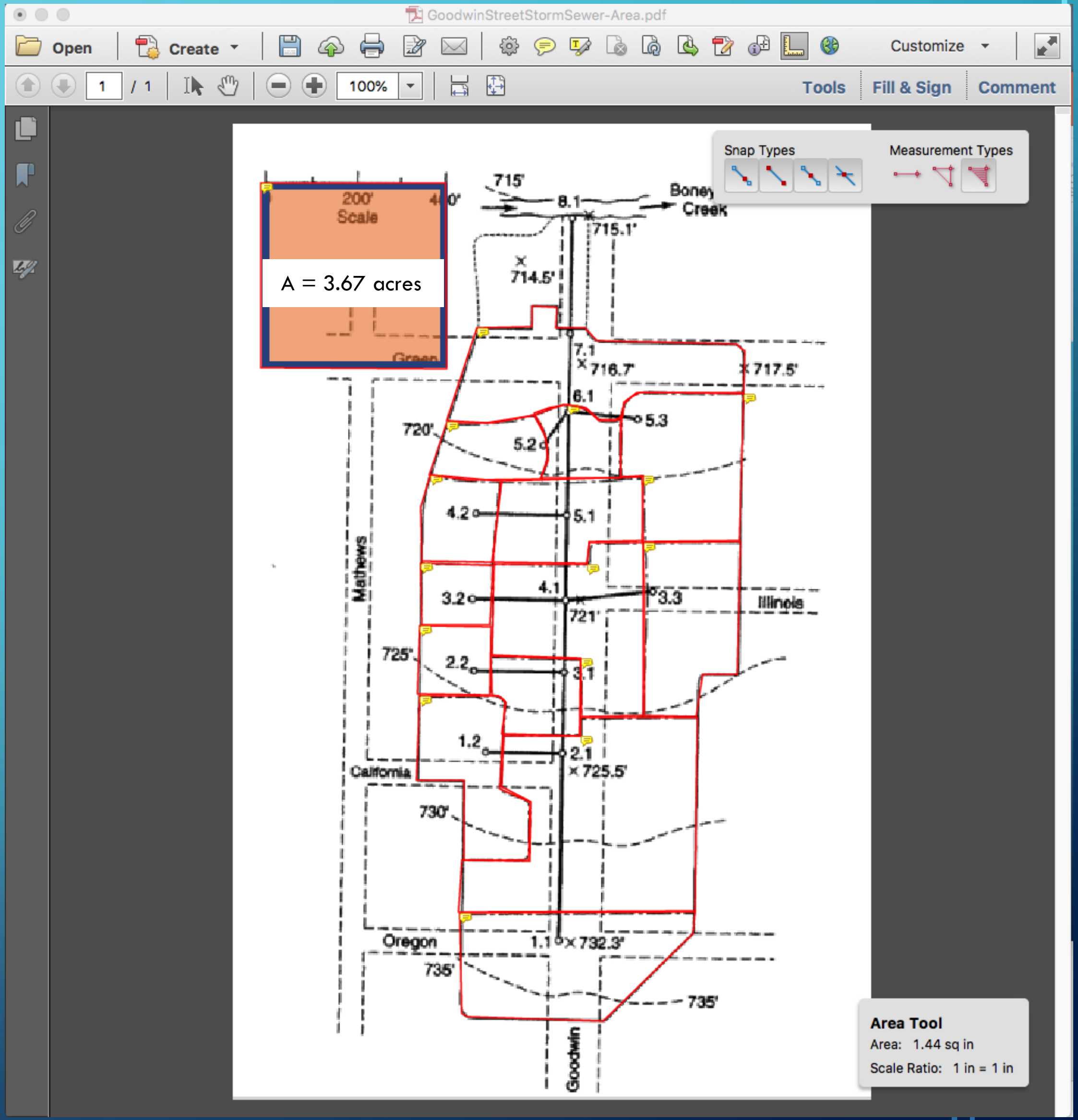
DRAINAGE AREA 6.1

- Identify the individual drainage areas.
- Determine the area of each contributing area, in acres.
- Area = 0.36*3.67/2.43 = 0.54 acres



DRAINAGE AREA 7.1

- Identify the individual drainage areas.
- Determine the area of each contributing area, in acres.
- Area = 1.44*3.67/2.43 = 2.17 acres



ESTIMATE RUNOFF COEFFICIENTS

- For each area estimate a runoff coefficient
- Usually based on a table lookup and surface description

Table 1 Runoff Coefficients for the Rational Method

	FLAT	ROLLING	HILLY
Pavement & Roofs	**0.90**	**0.90**	**0.90**
Earth Shoulders	0.50	0.50	0.50
Drives & Walks	0.75	0.80	**0.85**
Gravel Pavement	**0.85**	**0.85**	**0.85**
City Business Areas	0.80	**0.85**	**0.85**
Apartment Dwelling Areas	0.50	0.60	0.70
Light Residential: 1 to 3 units/acre	0.35	0.40	0.45
Normal Residential: 3 to 6 units/acre	0.50	0.55	0.60
Dense Residential: 6 to 15 units/acre	0.70	0.75	0.80
Lawns	0.17	0.22	0.35
Grass Shoulders	0.25	0.25	0.25
Side Slopes, Earth	0.60	0.60	0.60
Side Slopes, Turf	0.30	0.30	0.30
Median Areas, Turf	0.25	0.30	0.30
Cultivated Land, Clay & Loam	0.50	0.55	0.60
Cultivated Land, Sand & Gravel	0.25	0.30	0.35
Industrial Areas, Light	0.50	0.70	0.80
Industrial Areas, Heavy	0.60	0.80	**0.90**
Parks & Cemeteries	0.10	0.15	0.25
Playgrounds	0.20	0.25	0.30
Woodland & Forests	0.10	0.15	0.20
Meadows & Pasture Land	0.25	0.30	0.35
Unimproved Areas	0.10	0.20	0.30

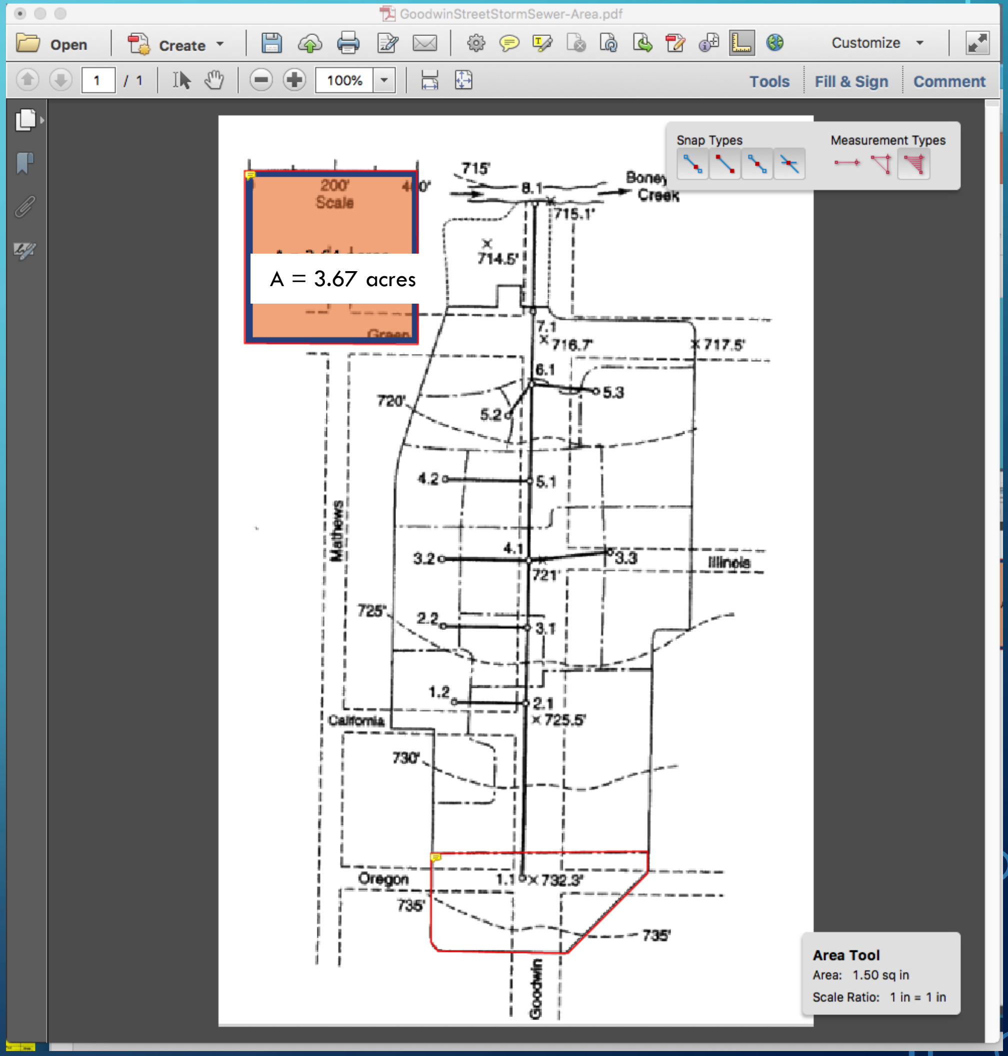
Note:

- ***Impervious surfaces in bold***
- *Rolling = ground slope between 2 percent to 10 percent*
- *Hilly = ground slope greater than 10 percent*

from "Oregon Hydraulics Manual (Chapter 7, Appendix F), 2014."

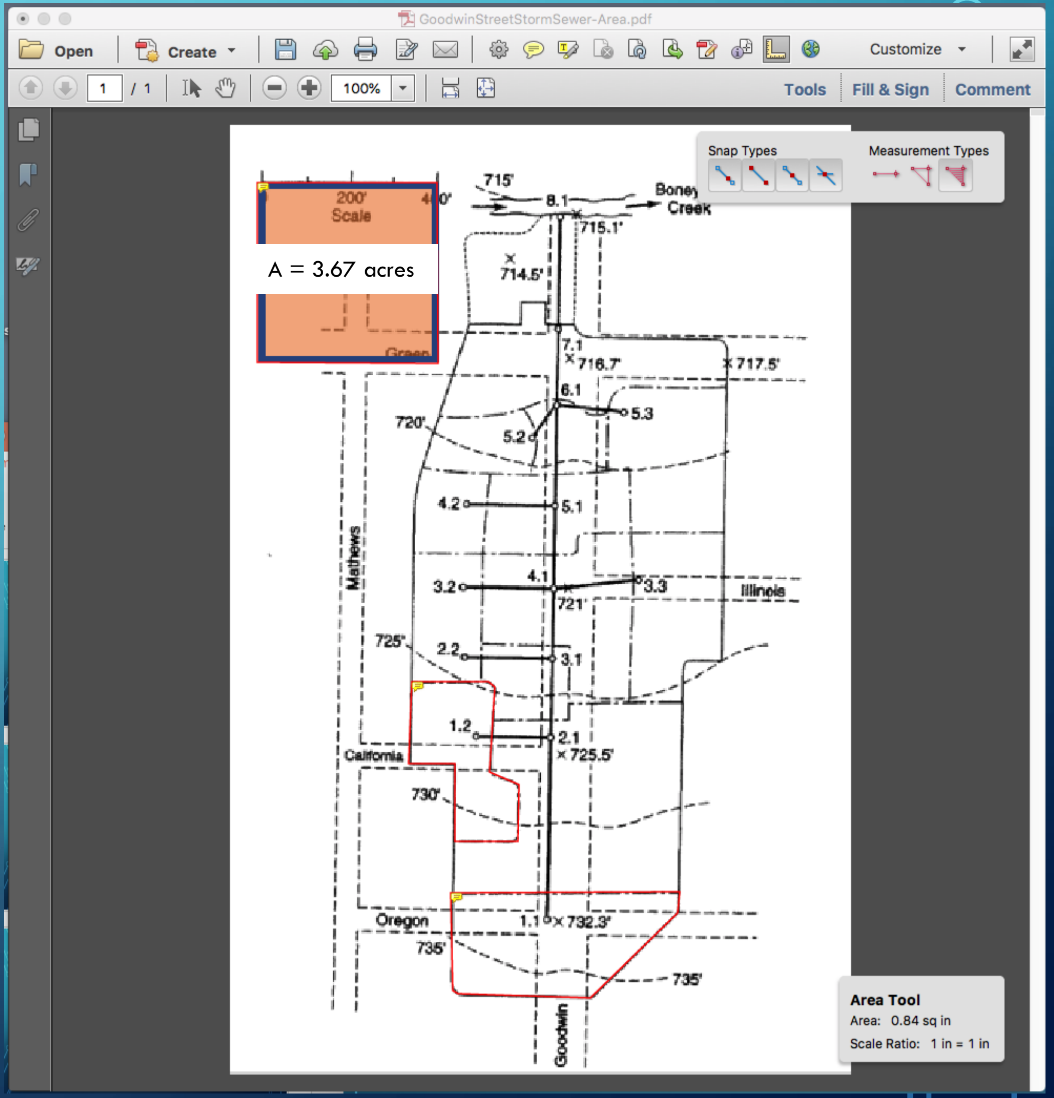
DRAINAGE AREA 1.1

- Identify the individual drainage areas.
- Determine the area of each contributing area, in acres. (ENGAUGE, PLANIMETER, etc)
- Area = 1.50*3.67/2.43 = 2.26 acres
- C = 0.65



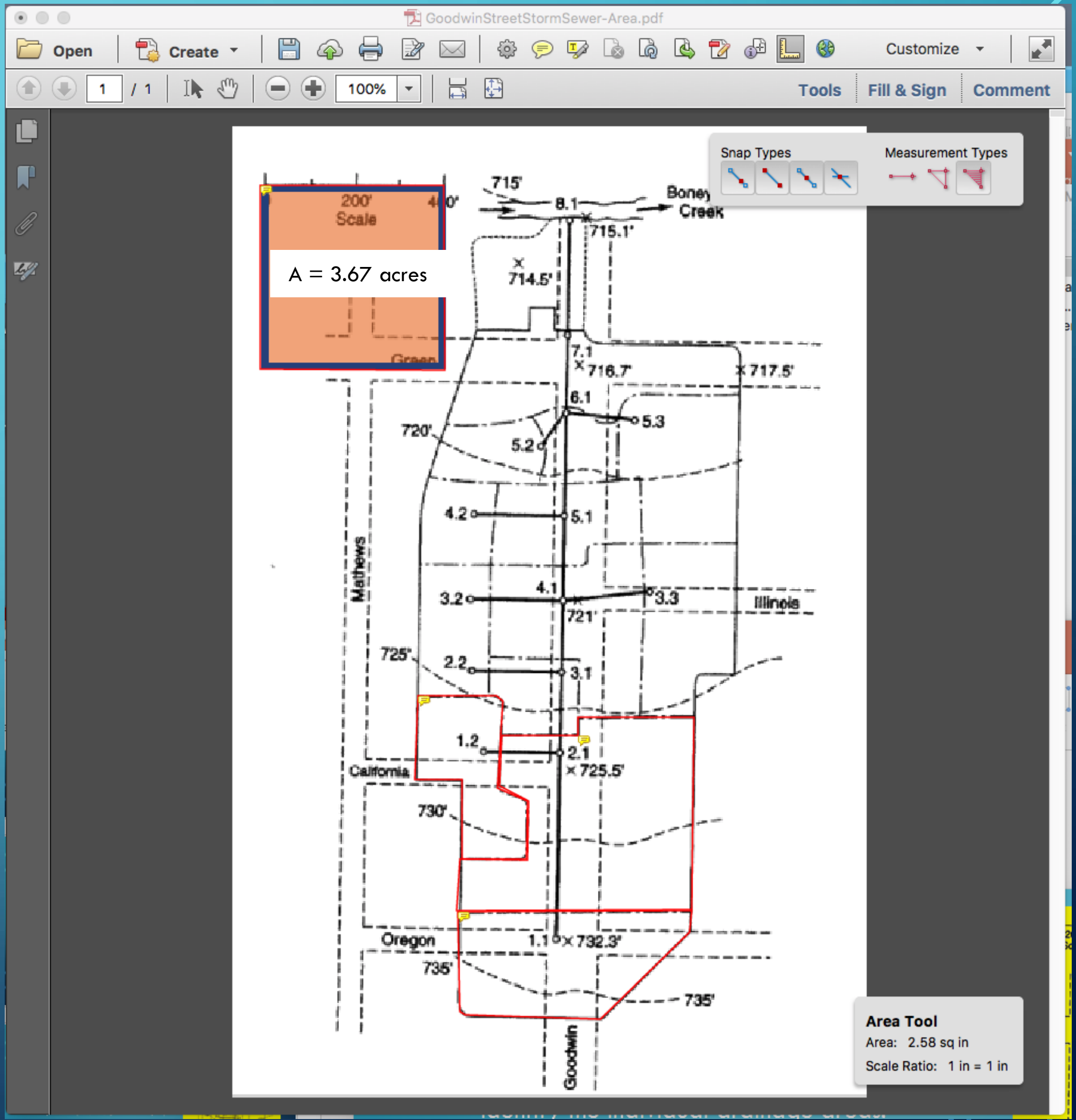
DRAINAGE AREA 1.2

- Identify the individual drainage areas.
- Determine the area of each contributing area, in acres. (ENGAUGE, PLANIMETER, etc)
- Area = 0.84*3.67/2.43 = 1.26 acres
- C = 0.80



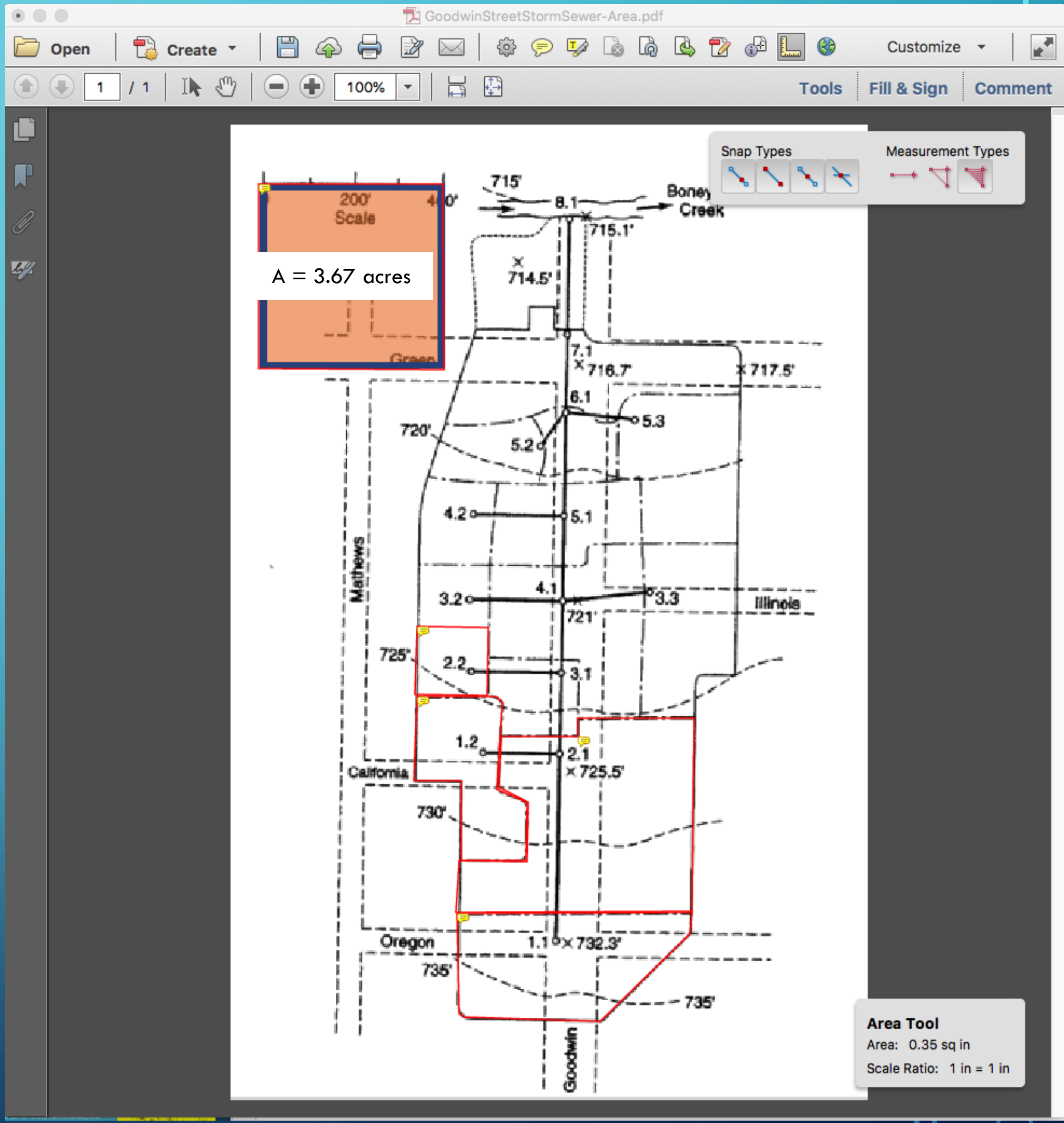
DRAINAGE AREA 2.1

- Identify the individual drainage areas.
- Determine the area of each contributing area, in acres.
- Area = 2.58*3.67/2.43 = 3.89 acres
- C= 0.70



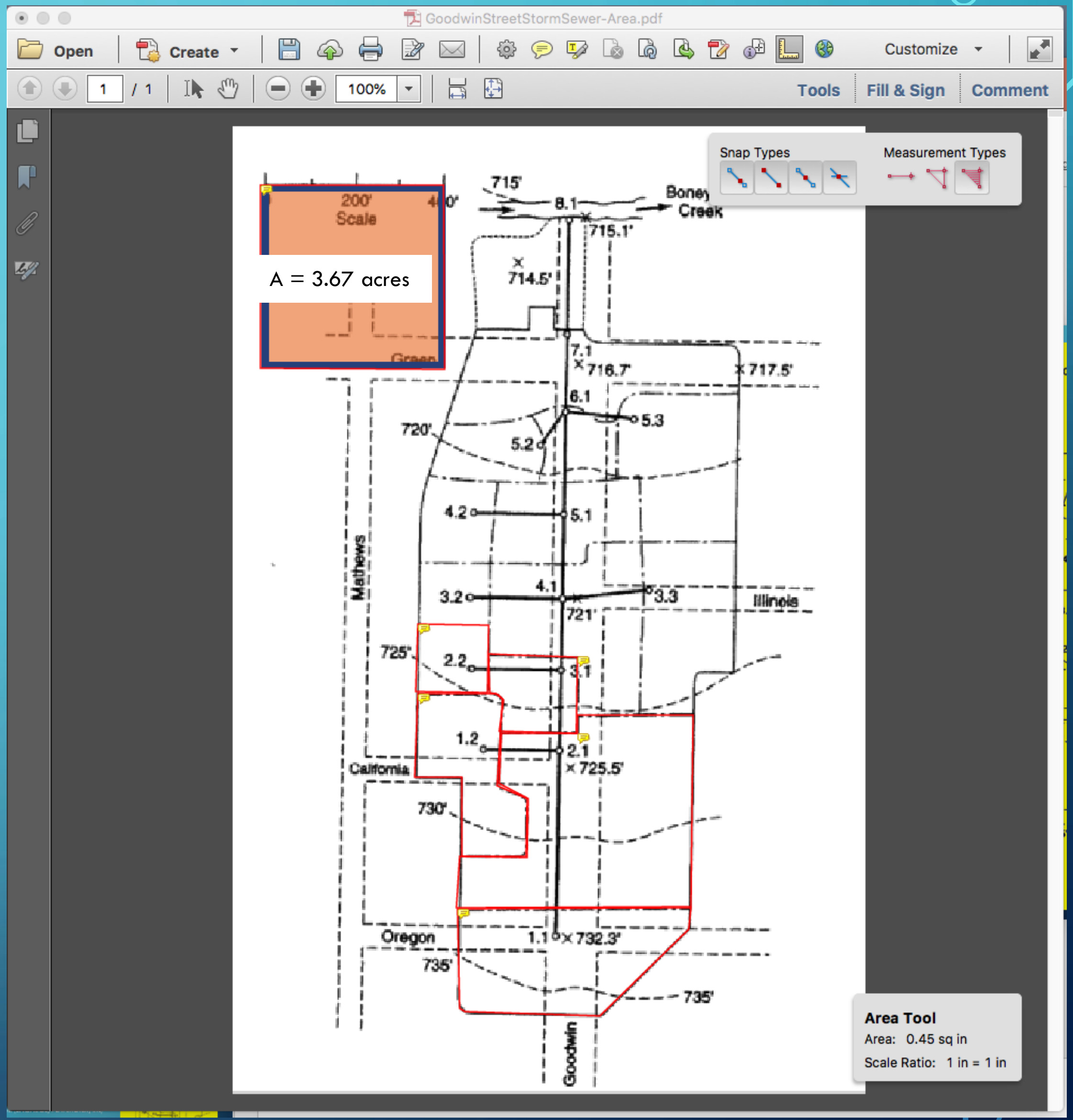
DRAINAGE AREA 2.2

- Identify the individual drainage areas.
- Determine the area of each contributing area, in acres.
- Area = 0.35*3.67/2.43 = 0.53 acres
- C = 0.80



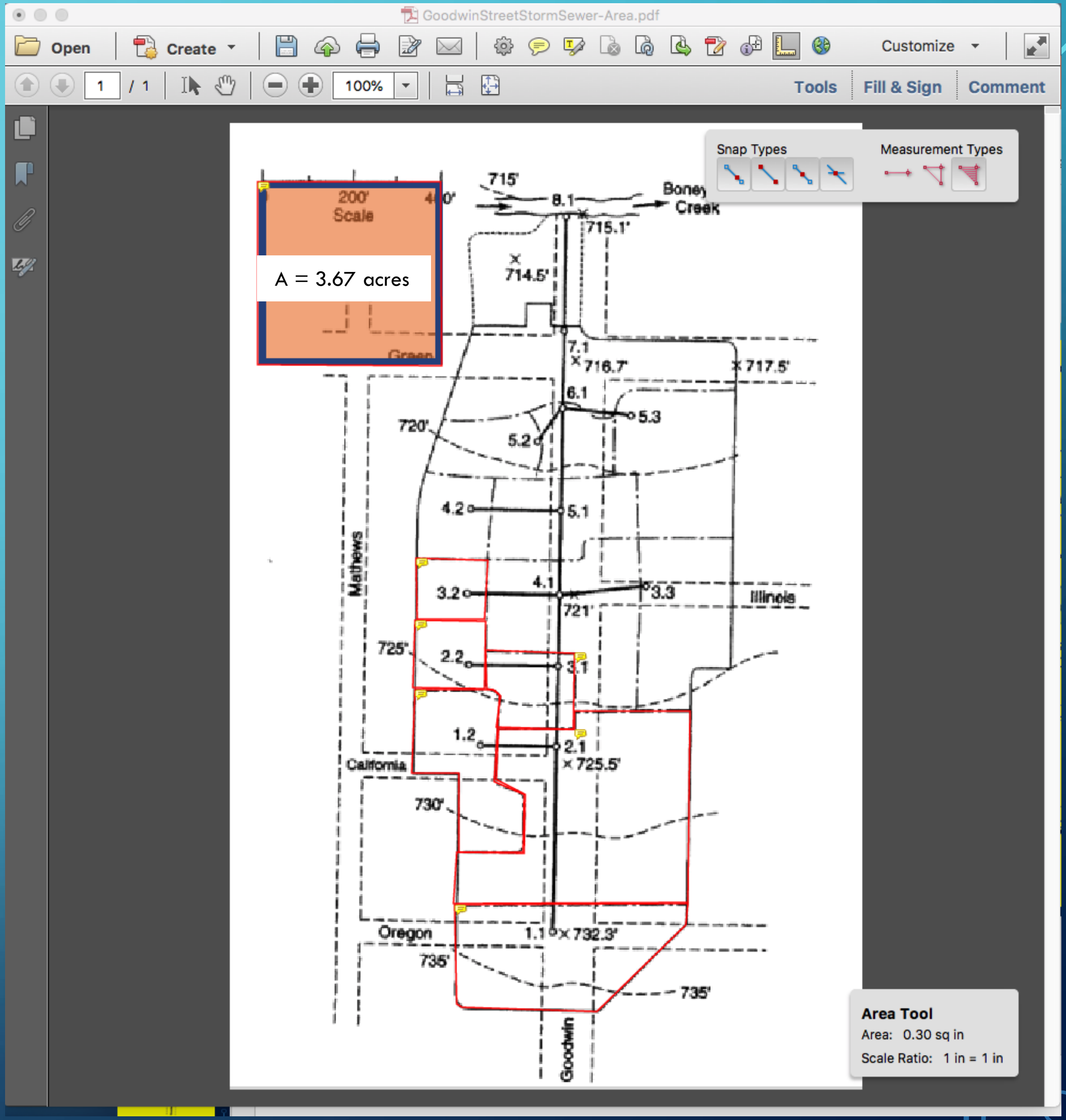
DRAINAGE AREA 3.1

- Identify the individual drainage areas.
- Determine the area of each contributing area, in acres.
- Area = 0.45*3.67/2.43 = 0.68 acres
- C = 0.70



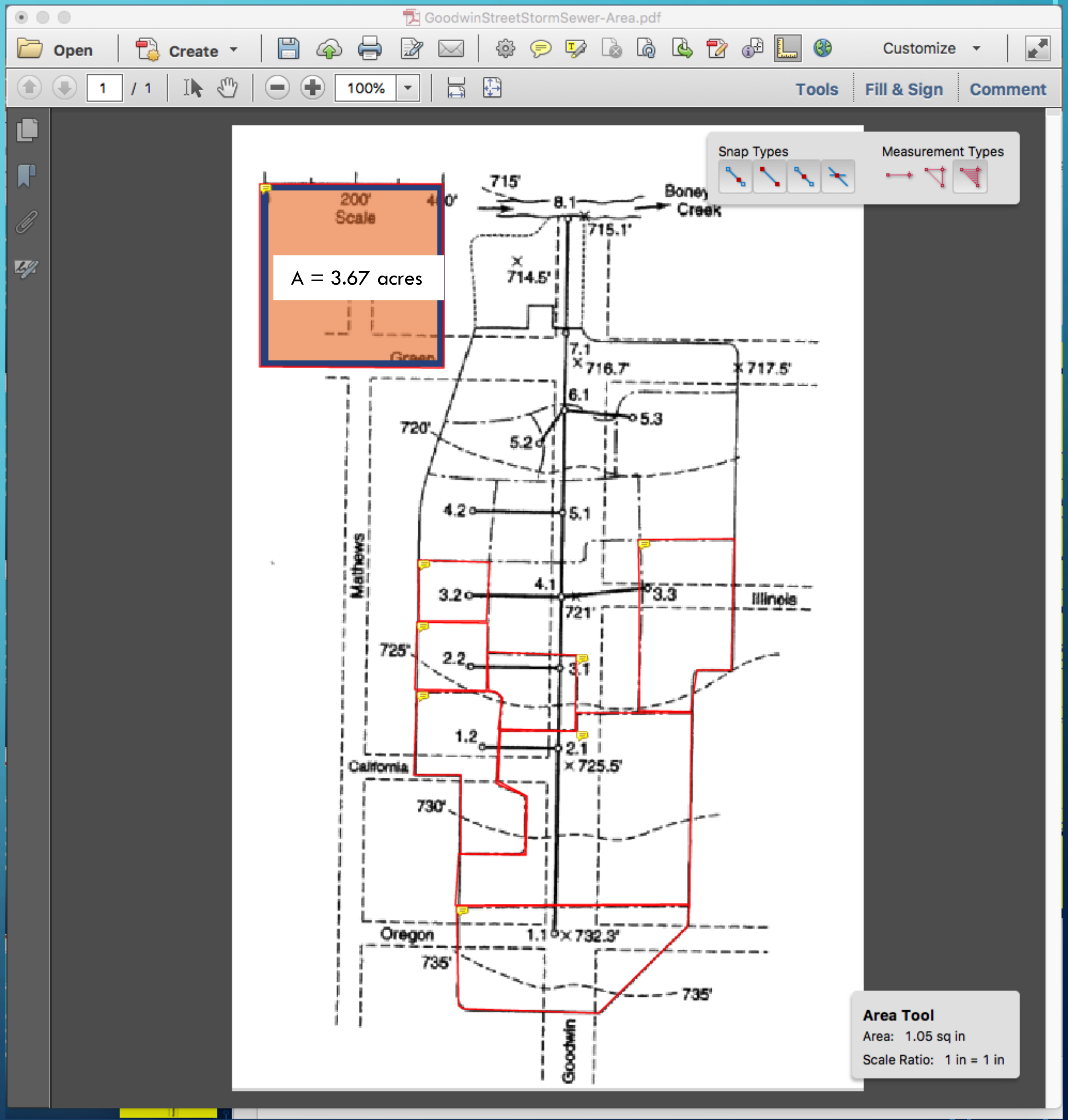
DRAINAGE AREA 3.2

- Identify the individual drainage areas.
- Determine the area of each contributing area, in acres.
- Area = 0.30*3.67/2.43 = 0.45 acres
- C = 0.85



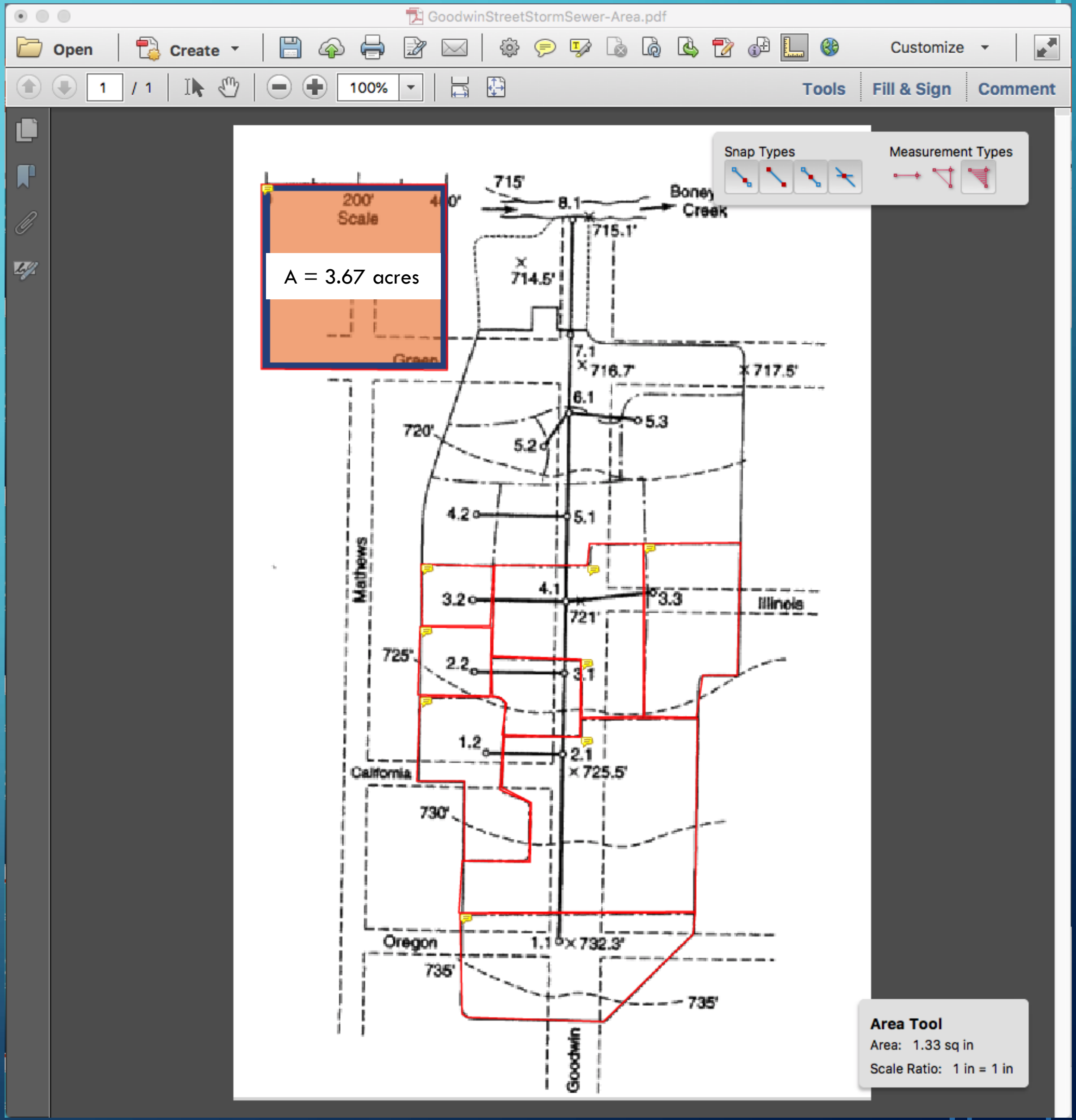
DRAINAGE AREA 3.3

- Identify the individual drainage areas.
- Determine the area of each contributing area, in acres.
- Area = 1.05*3.67/2.43 = 1.58 acres
- C = 0.65



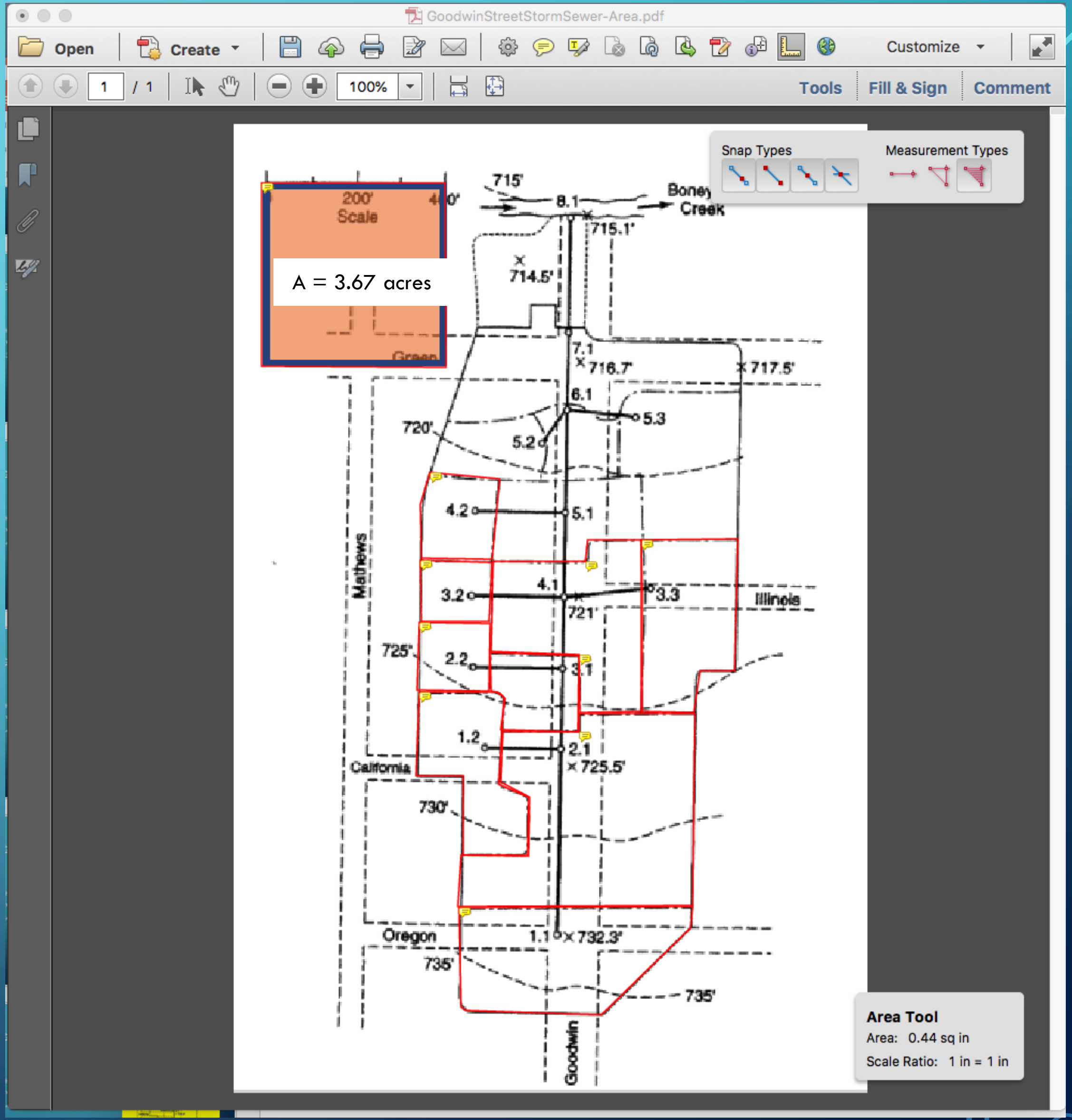
DRAINAGE AREA 4.1

- Identify the individual drainage areas.
- Determine the area of each contributing area, in acres.
- Area = 1.33*3.67/2.43 = 2.01 acres
- C = 0.75



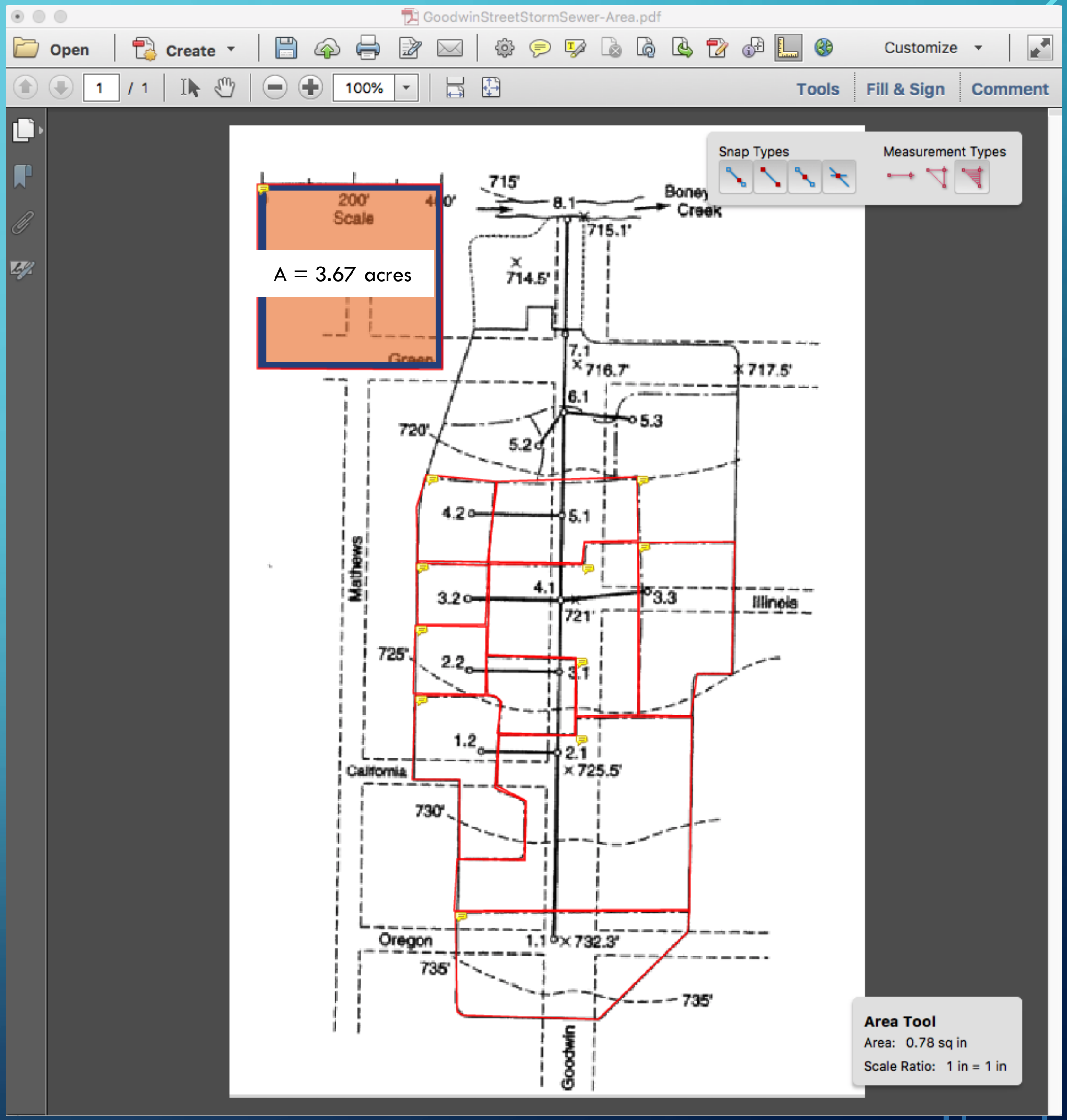
DRAINAGE AREA 4.2

- Identify the individual drainage areas.
- Determine the area of each contributing area, in acres.
- Area = 0.44*3.67/2.43 = 0.66 acres
- C = 0.85



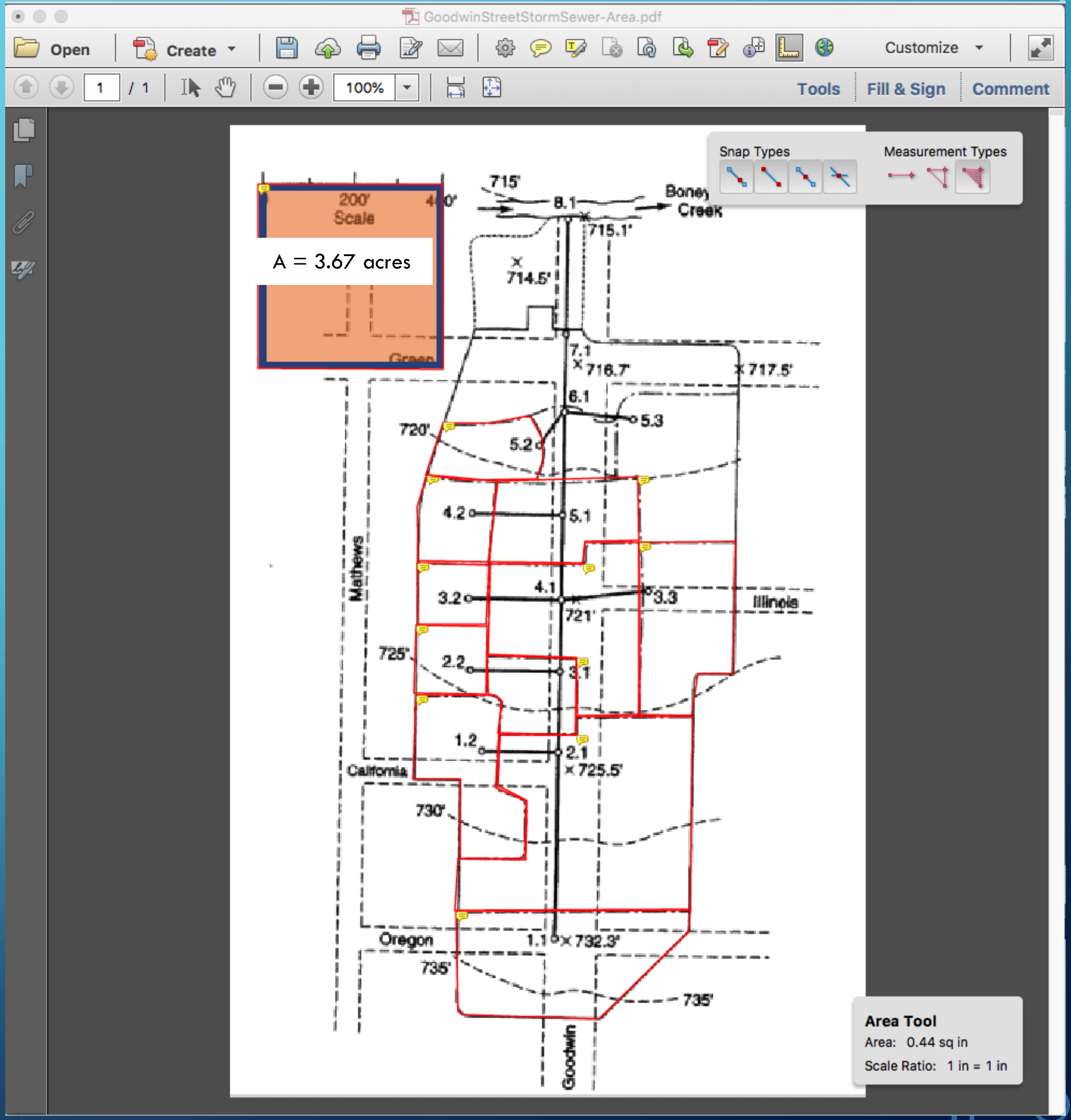
DRAINAGE AREA 5.1

- Identify the individual drainage areas.
- Determine the area of each contributing area, in acres.
- Area = 0.78*3.67/2.43 = 1.17 acres
- C = 0.70



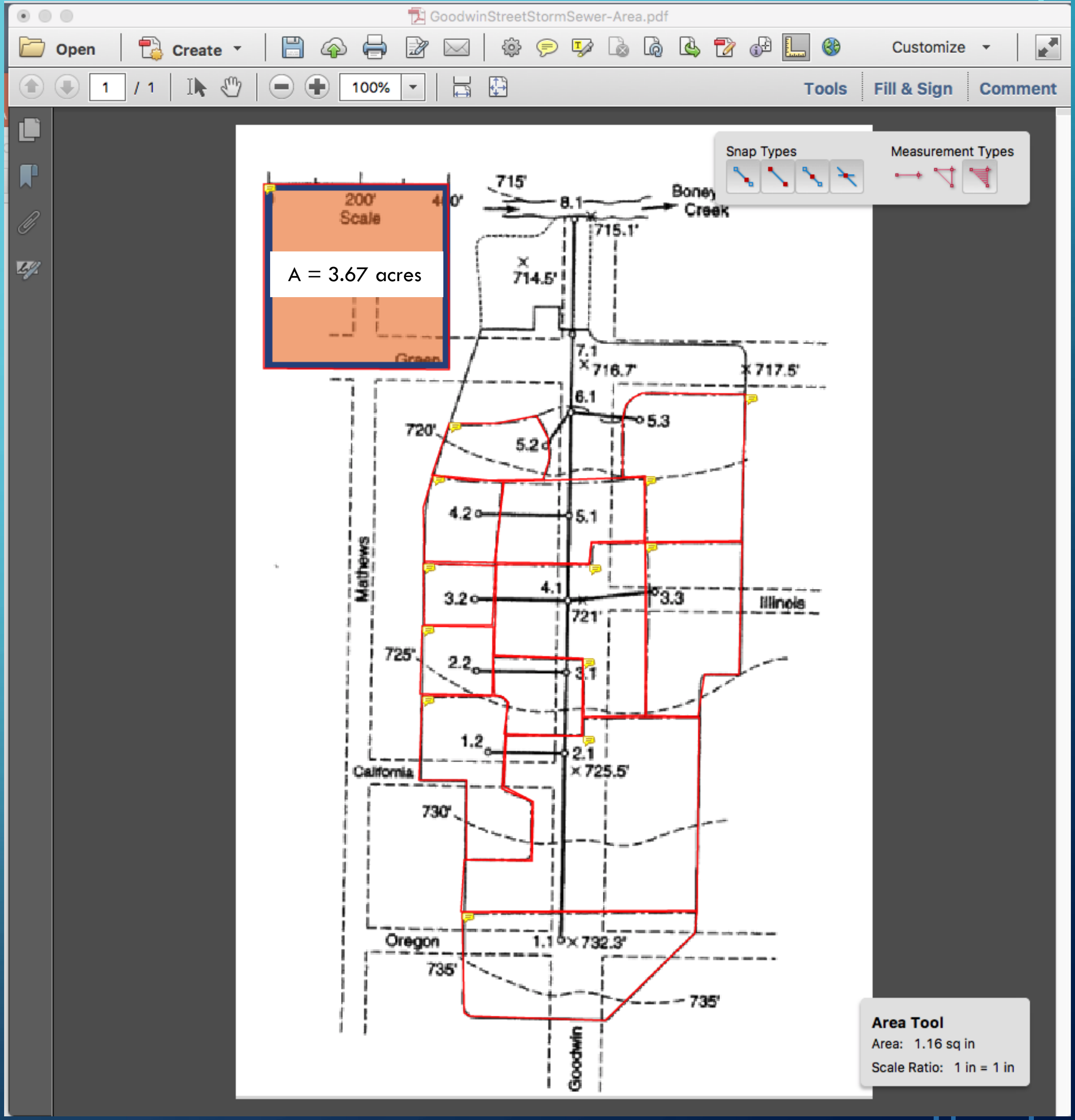
DRAINAGE AREA 5.2

- Identify the individual drainage areas.
- Determine the area of each contributing area, in acres.
- Area = 0.44*3.67/2.43 = 0.66 acres
- C = 0.65



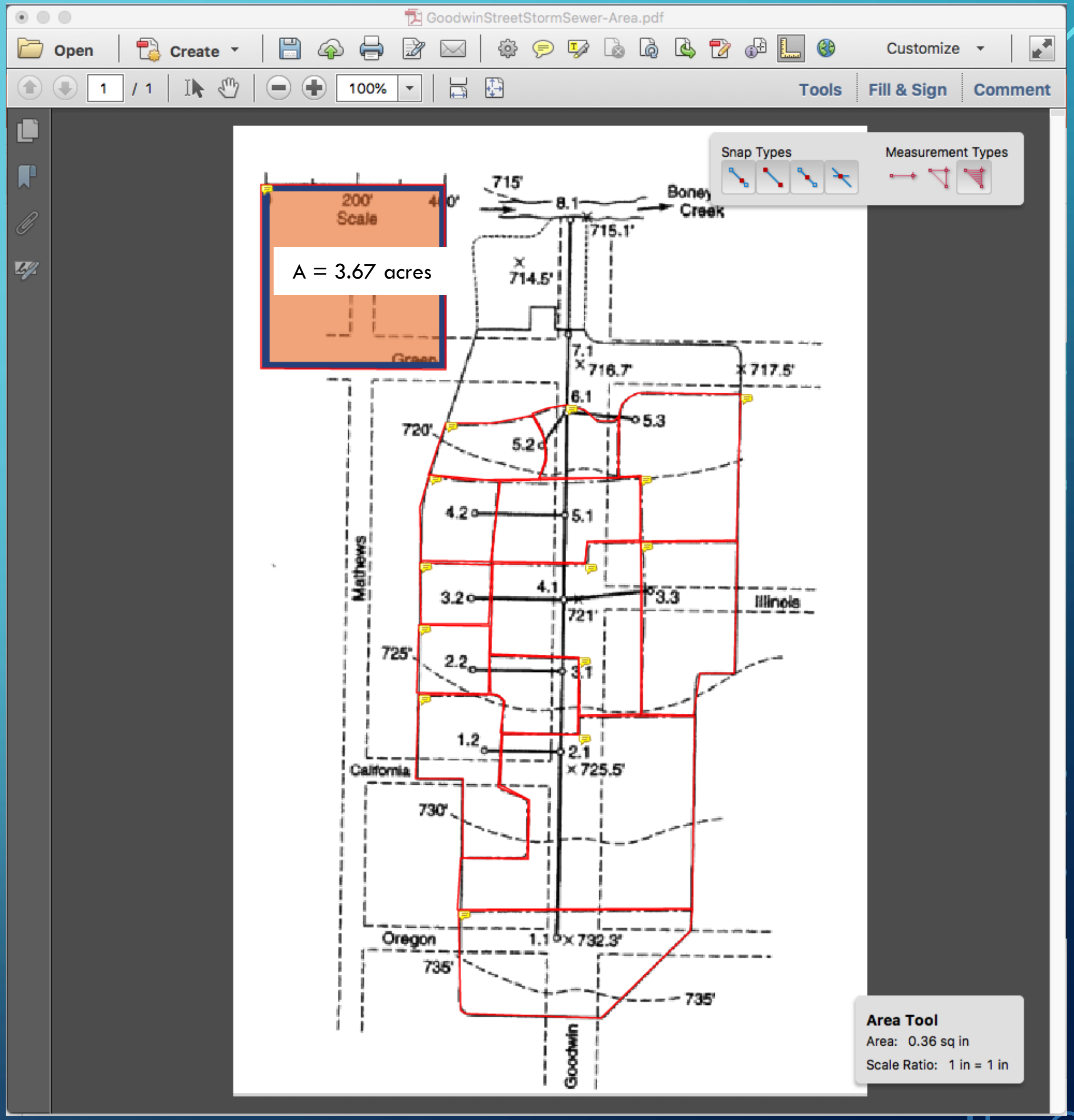
DRAINAGE AREA 5.3

- Identify the individual drainage areas.
- Determine the area of each contributing area, in acres.
- Area = 1.16*3.67/2.43 = 1.75 acres
- C = 0.55



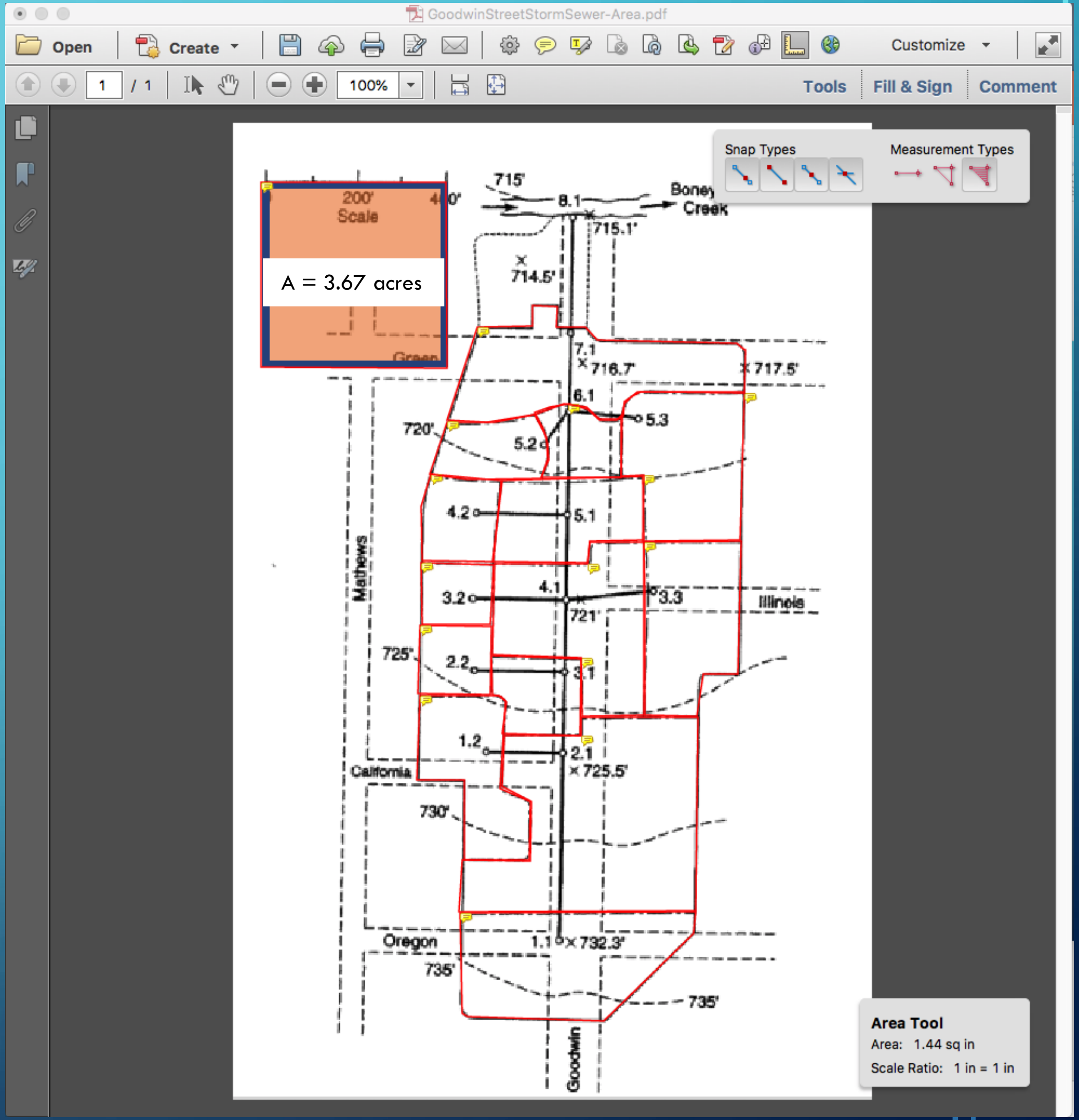
DRAINAGE AREA 6.1

- Identify the individual drainage areas.
- Determine the area of each contributing area, in acres.
- Area = 0.36*3.67/2.43 = 0.54 acres
- C = 0.75



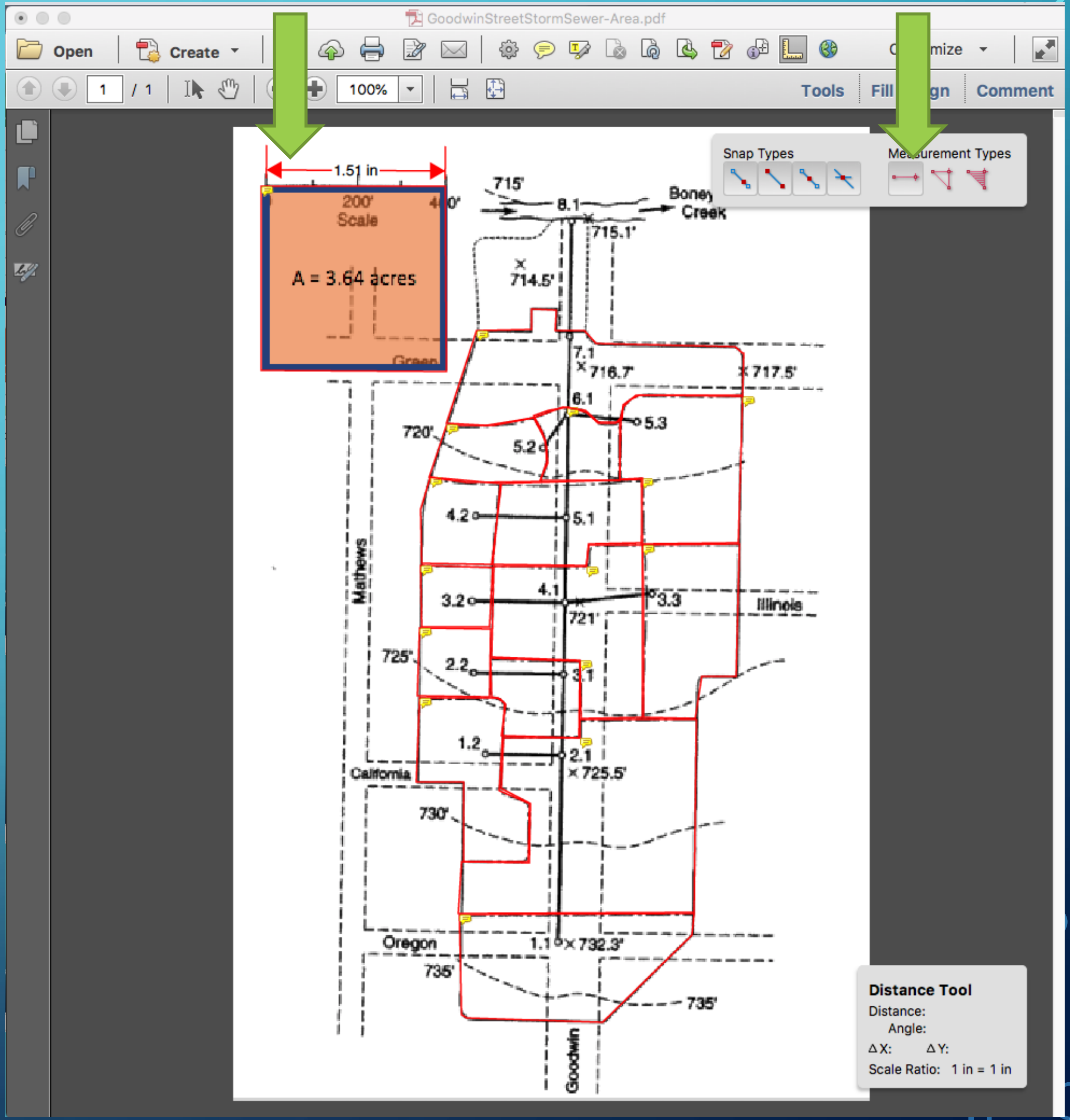
DRAINAGE AREA 7.1

- Identify the individual drainage areas.
- Determine the area of each contributing area, in acres.
- Area = 1.44*3.67/2.43 = 2.17 acres
- C = 0.70



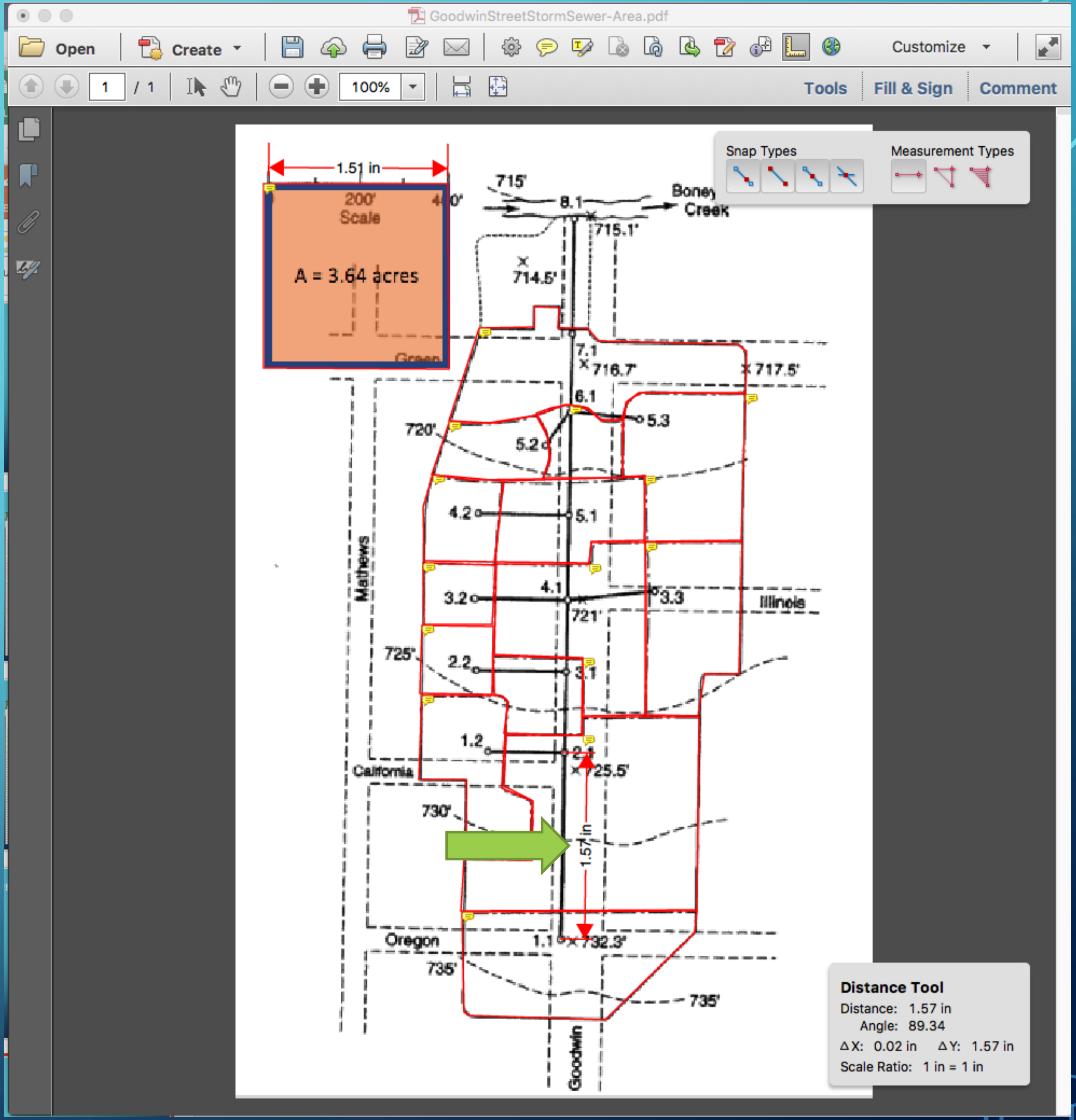
IDENTIFY AND MEASURE CONDUIT LENGTHS

- Use ACROBAT to measure distances between Node ID
- Select distance tool
- Measure the 400 foot scale
- Save scale factor
  1.51 in == 400 feet



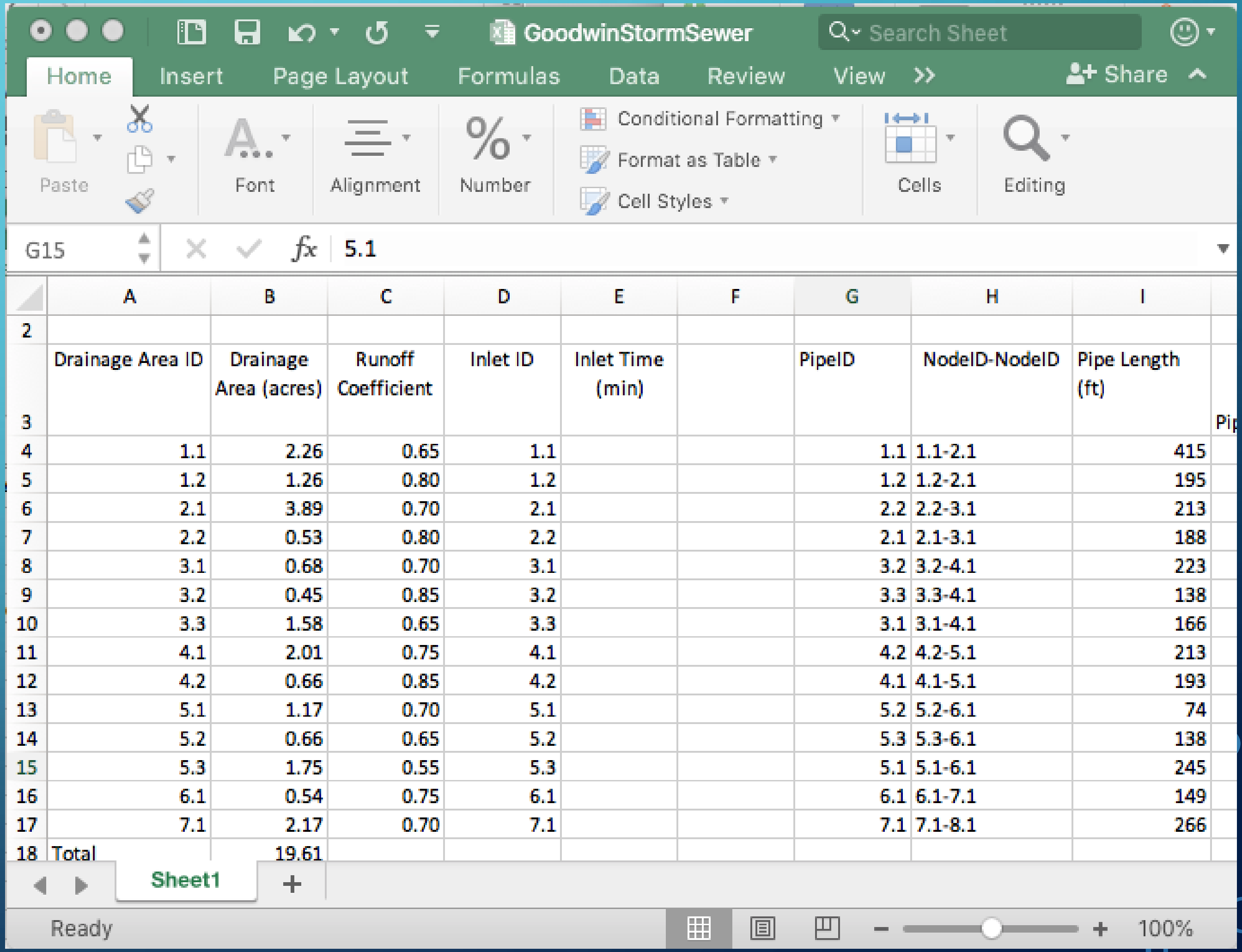
PIPE 1.1

- Connects 1.1 to 2.1
- Length = 1.57*400/1.51
  = 415 ft
- Repeat for all the other pipes



GATHER THE INFORMATION INTO A SPREADSHEET

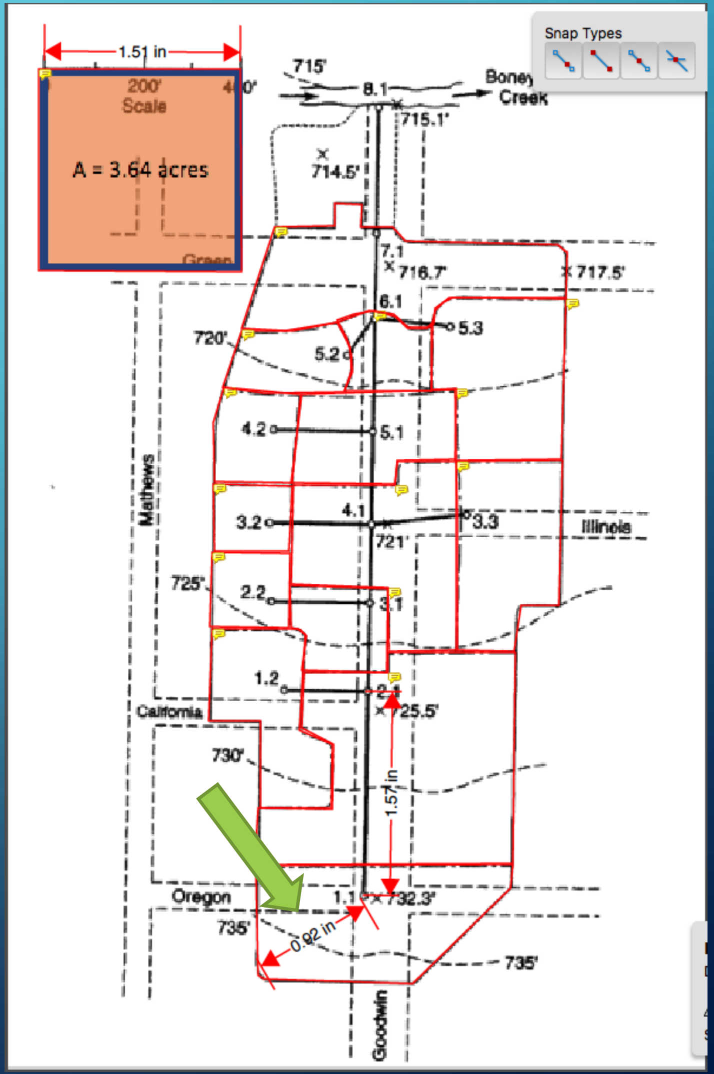
- Build a sheet with the information
- Note the naming convention (a bit awkward, but faithful to the original example)



Drainage Area ID	Drainage Area (acres)	Runoff Coefficient	Inlet ID	Inlet Time (min)		PipeID	NodeID-NodeID	Pipe Length (ft)
1.1	2.26	0.65	1.1			1.1	1.1-2.1	415
1.2	1.26	0.80	1.2			1.2	1.2-2.1	195
2.1	3.89	0.70	2.1			2.2	2.2-3.1	213
2.2	0.53	0.80	2.2			2.1	2.1-3.1	188
3.1	0.68	0.70	3.1			3.2	3.2-4.1	223
3.2	0.45	0.85	3.2			3.3	3.3-4.1	138
3.3	1.58	0.65	3.3			3.1	3.1-4.1	166
4.1	2.01	0.75	4.1			4.2	4.2-5.1	213
4.2	0.66	0.85	4.2			4.1	4.1-5.1	193
5.1	1.17	0.70	5.1			5.2	5.2-6.1	74
5.2	0.66	0.65	5.2			5.3	5.3-6.1	138
5.3	1.75	0.55	5.3			5.1	5.1-6.1	245
6.1	0.54	0.75	6.1			6.1	6.1-7.1	149
7.1	2.17	0.70	7.1			7.1	7.1-8.1	266
Total	19.61							

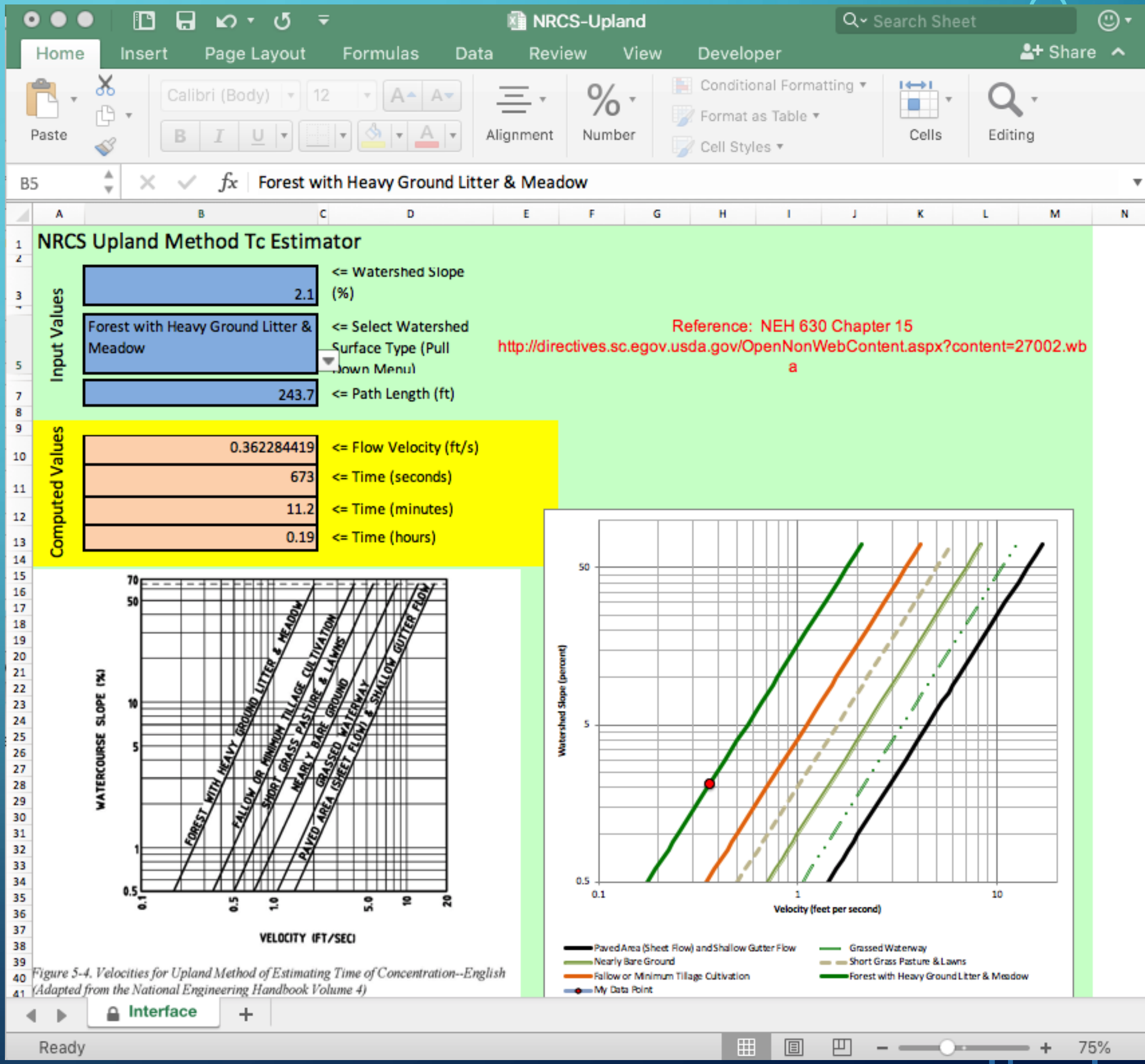
DETERMINE INLET TIMES FOR EACH DRAINAGE AREA

- Measure actual best-guess flow path
  - Find Slope (737.5 – 732.3)/(0.92*400/1.51) = 5.2ft/243.7 ft = 0.021 (2.1%)
  - Determine some kind of cover
  - Apply NRCS Velocity, NRCS Upland, or Kerby-Kirpich
  - Use method that makes most sense



DETERMINE INLET TIMES FOR EACH DRAINAGE AREA

- NRCS Upland Method
- Measure actual best-guess flow path
  - Path = 243.7 ft
  - Slope = 0.021 (2.1%)
- Inlet Time ~ 11 minutes
- Repeat for each drainage area, populate spreadsheet



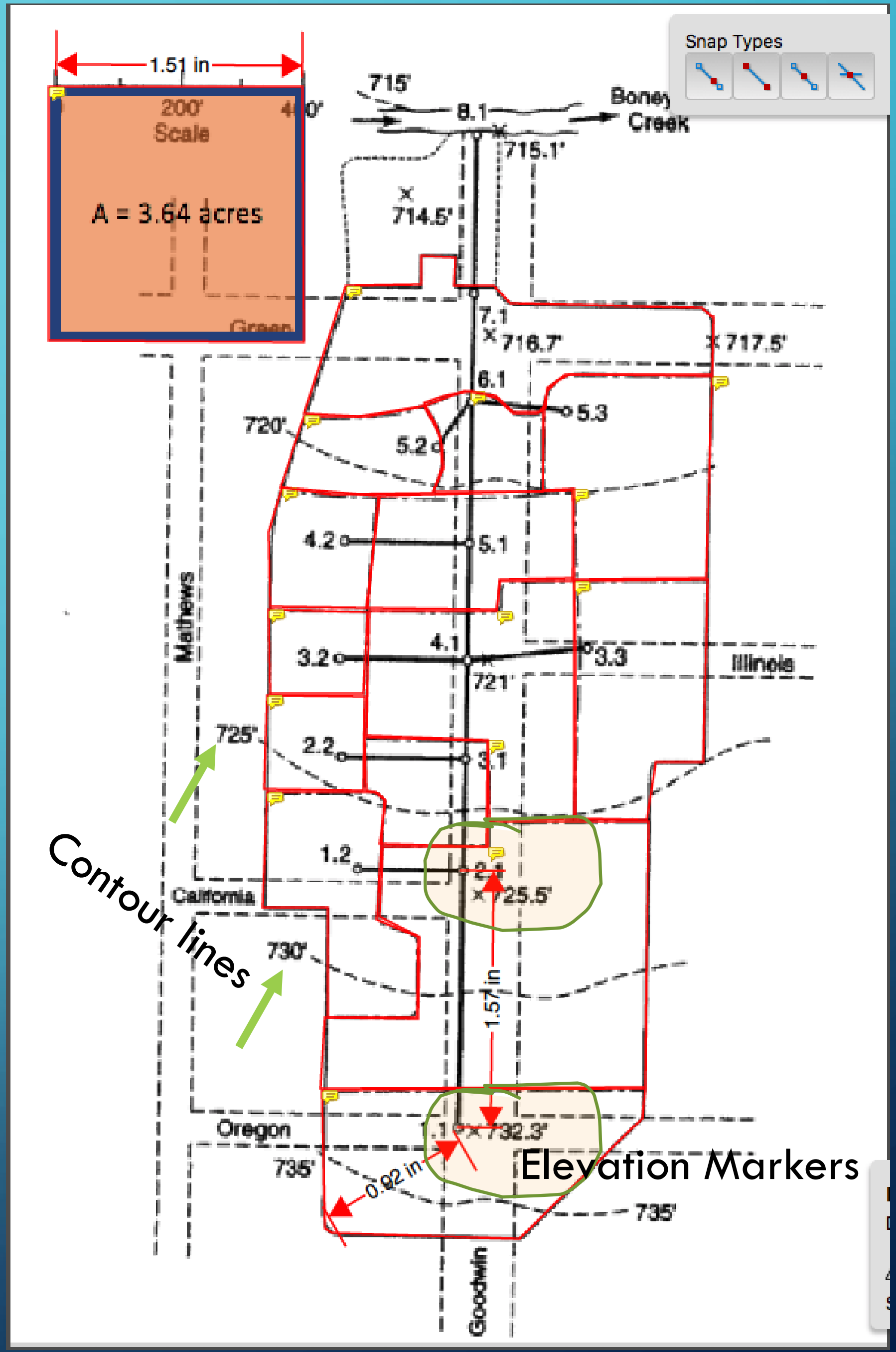
DETERMINE INLET TIMES FOR EACH DRAINAGE AREA

- Repeat for each drainage area, populate spreadsheet

Drainage Area ID	Drainage Area (acres)	Runoff Coefficient	Inlet ID	Inlet Time (min)		PipeID	NodeID-NodeID	Pipe Length (ft)
1.1	2.26	0.65	1.1	11		1.1	1.1-2.1	415
1.2	1.26	0.80	1.2	9.2		1.2	1.2-2.1	195
2.1	3.89	0.70	2.1	13.7		2.2	2.2-3.1	213
2.2	0.53	0.80	2.2	5.2		2.1	2.1-3.1	188
3.1	0.68	0.70	3.1	8.7		3.2	3.2-4.1	223
3.2	0.45	0.85	3.2	5.9		3.3	3.3-4.1	138
3.3	1.58	0.65	3.3	11.8		3.1	3.1-4.1	166
4.1	2.01	0.75	4.1	9.5		4.2	4.2-5.1	213
4.2	0.66	0.85	4.2	6.2		4.1	4.1-5.1	193
5.1	1.17	0.70	5.1	10.3		5.2	5.2-6.1	74
5.2	0.66	0.65	5.2	11.8		5.3	5.3-6.1	138
5.3	1.75	0.55	5.3	17.6		5.1	5.1-6.1	245
6.1	0.54	0.75	6.1	7.3		6.1	6.1-7.1	149
7.1	2.17	0.70	7.1	14.5		7.1	7.1-8.1	266
Total	19.61							

ESTIMATE PIPE SLOPES

- Use the node elevations and topographic map to estimate pipe slopes



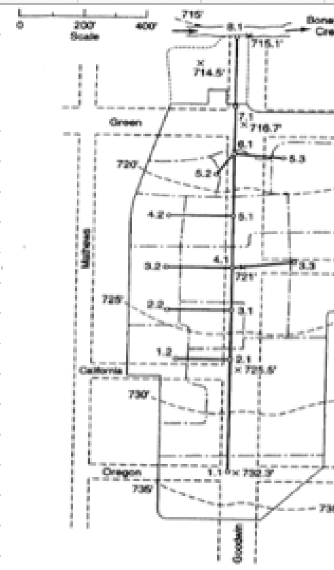
ESTIMATE PIPE SLOPES

- Use the node elevations and topographic map to estimate pipe slopes
- Populate the spreadsheet

GoodwinStormSewer

E4 | fx 11

	A	B	C	D	E	F	G	H	I	J
2										
3	Drainage Area ID	Drainage Area (acres)	Runoff Coefficient	Inlet ID	Inlet Time (min)		PipeID	NodeID-NodeID	Pipe Length (ft)	Pipe Slope
4	1.1	2.26	0.65	1.1	11		1.1	1.1-2.1	415	0.0200
5	1.2	1.26	0.80	1.2	9.2		1.2	1.2-2.1	195	0.0041
6	2.1	3.89	0.70	2.1	13.7		2.2	2.2-3.1	213	0.0180
7	2.2	0.53	0.80	2.2	5.2		2.1	2.1-3.1	188	0.0245
8	3.1	0.68	0.70	3.1	8.7		3.2	3.2-4.1	223	0.0175
9	3.2	0.45	0.85	3.2	5.9		3.3	3.3-4.1	138	0.0300
10	3.3	1.58	0.65	3.3	11.8		3.1	3.1-4.1	166	0.0104
11	4.1	2.01	0.75	4.1	9.5		4.2	4.2-5.1	213	0.0026
12	4.2	0.66	0.85	4.2	6.2		4.1	4.1-5.1	193	0.0041
13	5.1	1.17	0.70	5.1	10.3		5.2	5.2-6.1	74	0.0250
14	5.2	0.66	0.65	5.2	11.8		5.3	5.3-6.1	138	0.0060
15	5.3	1.75	0.55	5.3	17.6		5.1	5.1-6.1	245	0.0028
16	6.1	0.54	0.75	6.1	7.3		6.1	6.1-7.1	149	0.0030
17	7.1	2.17	0.70	7.1	14.5		7.1	7.1-8.1	266	0.0030
18	Total	19.61								

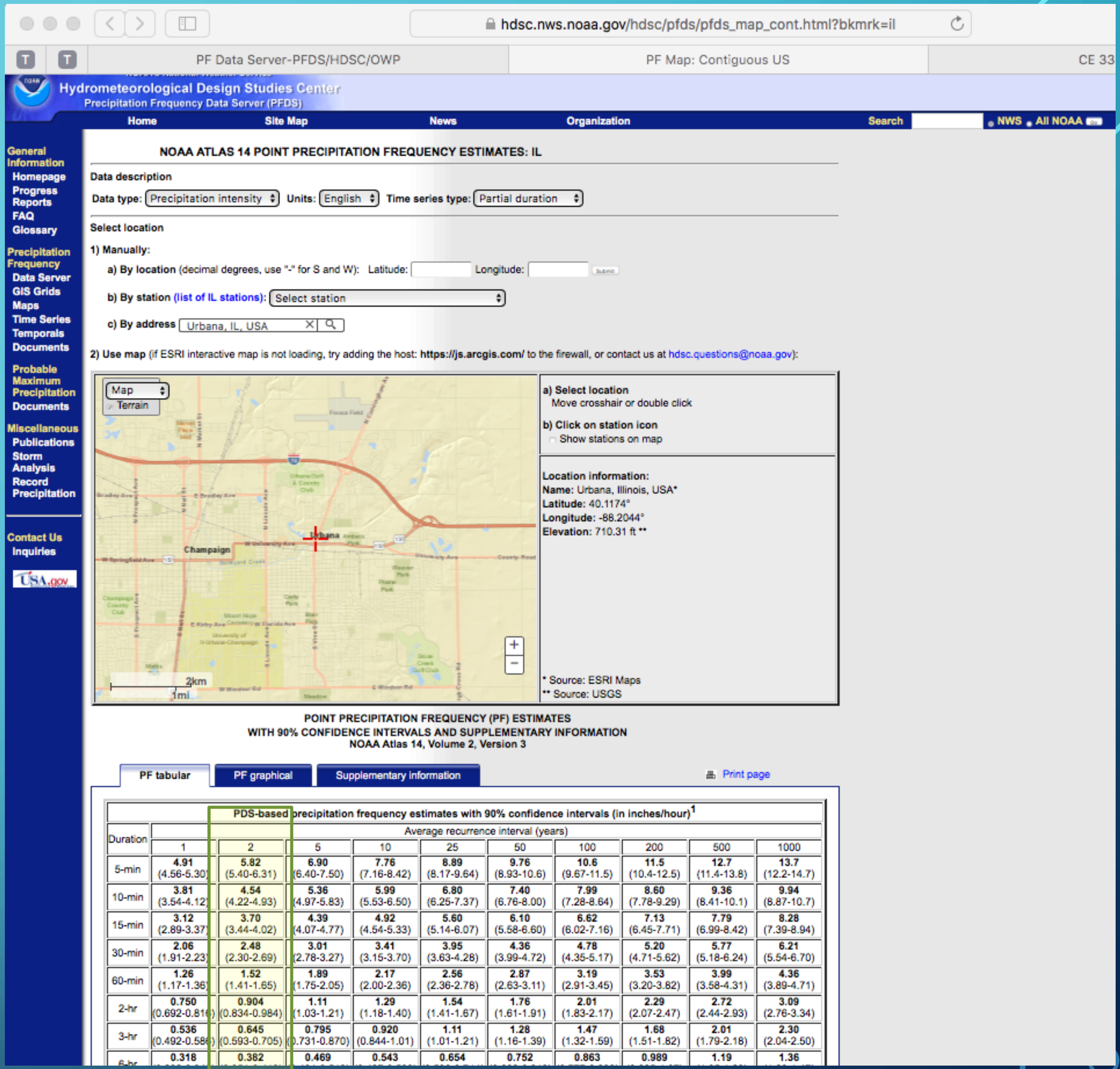


Sheet1

Ready Average: 10.19285714 Count: 14 Sum: 142.7

INTENSITY EQUATION

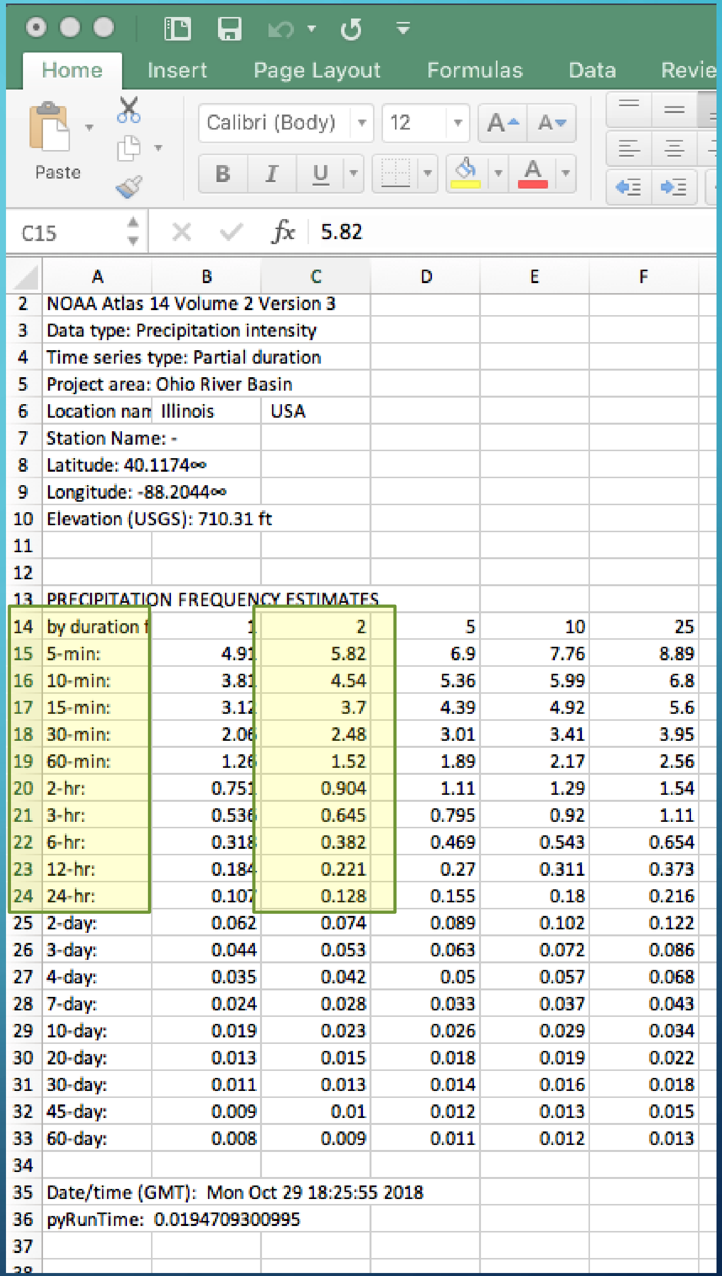
- Next we will need to precipitation information for the design.
- Easiest for this example is to build an IDF curve for the location.
- The basin in the example is in Urbana, Illinois – Use NOAA Atlas 14
- For the example use a 2-yr ARI



Duration	1	2	5	10	25	50	100	200	500	1000
5-min	4.91 (4.56-5.30)	5.82 (5.40-6.31)	6.90 (6.40-7.50)	7.76 (7.16-8.42)	8.89 (8.17-9.64)	9.76 (8.93-10.6)	10.6 (9.67-11.5)	11.5 (10.4-12.5)	12.7 (11.4-13.8)	13.7 (12.2-14.7)
10-min	3.81 (3.54-4.12)	4.54 (4.22-4.93)	5.36 (4.97-5.83)	5.99 (5.53-6.50)	6.80 (6.25-7.37)	7.40 (6.76-8.00)	7.99 (7.28-8.64)	8.60 (7.78-9.29)	9.36 (8.41-10.1)	9.94 (8.87-10.7)
15-min	3.12 (2.89-3.37)	3.70 (3.44-4.02)	4.39 (4.07-4.77)	4.92 (4.54-5.33)	5.60 (5.14-6.07)	6.10 (5.58-6.60)	6.62 (6.02-7.16)	7.13 (6.45-7.71)	7.79 (6.99-8.42)	8.28 (7.39-8.94)
30-min	2.06 (1.91-2.23)	2.48 (2.30-2.69)	3.01 (2.78-3.27)	3.41 (3.15-3.70)	3.95 (3.63-4.28)	4.36 (3.99-4.72)	4.78 (4.35-5.17)	5.20 (4.71-5.62)	5.77 (5.18-6.24)	6.21 (5.54-6.70)
60-min	1.26 (1.17-1.36)	1.52 (1.41-1.65)	1.89 (1.75-2.05)	2.17 (2.00-2.36)	2.56 (2.36-2.78)	2.87 (2.63-3.11)	3.19 (2.91-3.45)	3.53 (3.20-3.82)	3.99 (3.58-4.31)	4.36 (3.89-4.71)
2-hr	0.750 (0.692-0.816)	0.904 (0.834-0.984)	1.11 (1.03-1.21)	1.29 (1.18-1.40)	1.54 (1.41-1.67)	1.76 (1.61-1.91)	2.01 (1.83-2.17)	2.29 (2.07-2.47)	2.72 (2.44-2.93)	3.09 (2.76-3.34)
3-hr	0.536 (0.492-0.586)	0.645 (0.593-0.705)	0.795 (0.731-0.870)	0.920 (0.844-1.01)	1.11 (1.01-1.21)	1.28 (1.16-1.39)	1.47 (1.32-1.59)	1.68 (1.51-1.82)	2.01 (1.79-2.18)	2.30 (2.04-2.50)
6-hr	0.318	0.382	0.469	0.543	0.654	0.752	0.863	0.989	1.19	1.36

INTENSITY EQUATION

- Download the table
- Use the 2-nd column



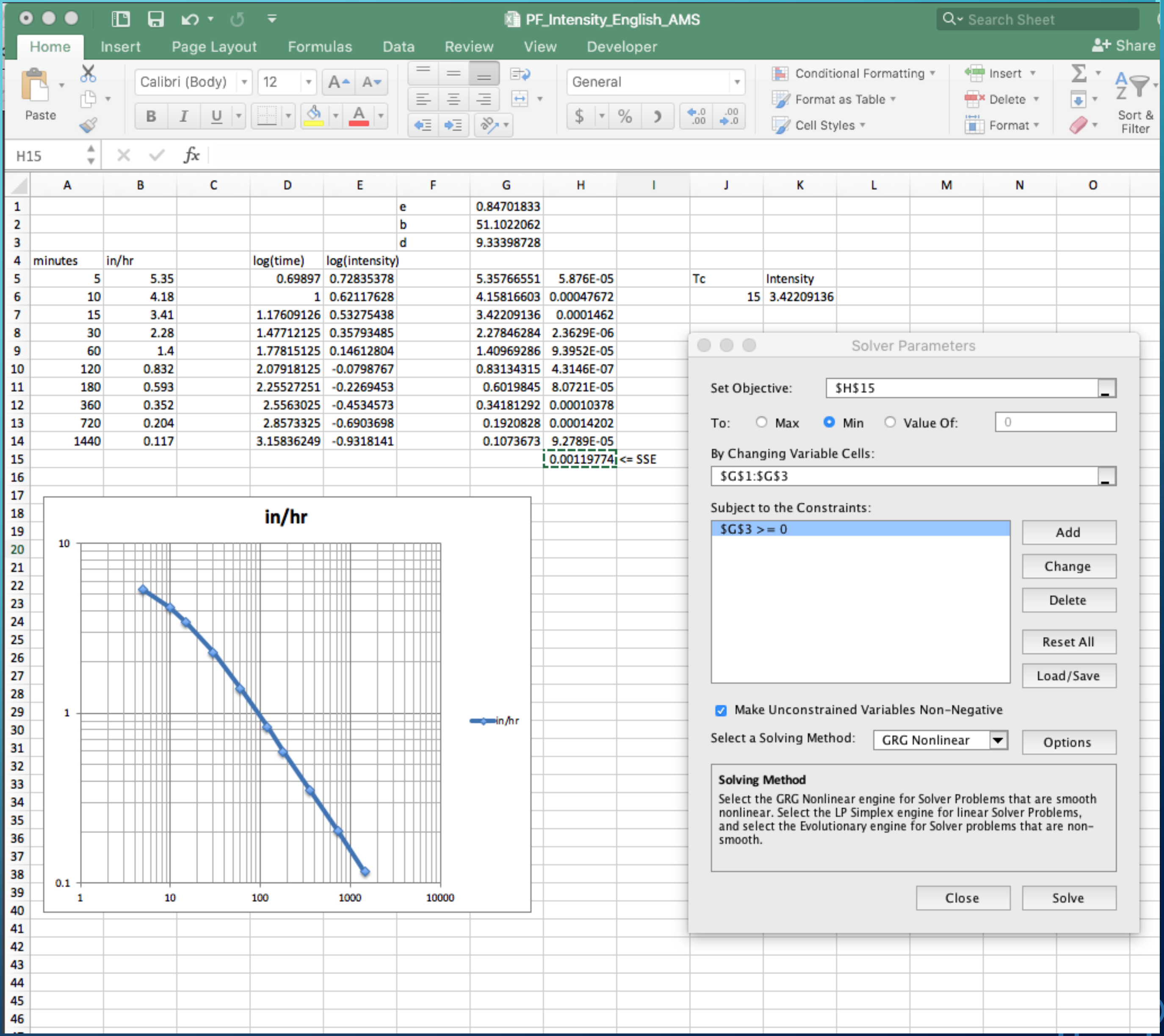
	A	B	C	D	E	F
2	NOAA Atlas 14 Volume 2 Version 3					
3	Data type: Precipitation intensity					
4	Time series type: Partial duration					
5	Project area: Ohio River Basin					
6	Location nam	Illinois	USA			
7	Station Name: -					
8	Latitude: 40.1174∞					
9	Longitude: -88.2044∞					
10	Elevation (USGS): 710.31 ft					
11						
12						
13	PRECIPITATION FREQUENCY ESTIMATES					
14	by duration f	1	2	5	10	25
15	5-min:	4.91	5.82	6.9	7.76	8.89
16	10-min:	3.81	4.54	5.36	5.99	6.8
17	15-min:	3.12	3.7	4.39	4.92	5.6
18	30-min:	2.06	2.48	3.01	3.41	3.95
19	60-min:	1.26	1.52	1.89	2.17	2.56
20	2-hr:	0.751	0.904	1.11	1.29	1.54
21	3-hr:	0.536	0.645	0.795	0.92	1.11
22	6-hr:	0.318	0.382	0.469	0.543	0.654
23	12-hr:	0.184	0.221	0.27	0.311	0.373
24	24-hr:	0.107	0.128	0.155	0.18	0.216
25	2-day:	0.062	0.074	0.089	0.102	0.122
26	3-day:	0.044	0.053	0.063	0.072	0.086
27	4-day:	0.035	0.042	0.05	0.057	0.068
28	7-day:	0.024	0.028	0.033	0.037	0.043
29	10-day:	0.019	0.023	0.026	0.029	0.034
30	20-day:	0.013	0.015	0.018	0.019	0.022
31	30-day:	0.011	0.013	0.014	0.016	0.018
32	45-day:	0.009	0.01	0.012	0.013	0.015
33	60-day:	0.008	0.009	0.011	0.012	0.013
34						
35	Date/time (GMT): Mon Oct 29 18:25:55 2018					
36	pyRunTime: 0.0194709300995					
37						

INTENSITY EQUATION

- Download the table
- Use the 2-nd column
- Use solver to fit

$$I = \frac{B}{(T_c + D)^E}$$

- Use this equation for estimating intensity and runoff

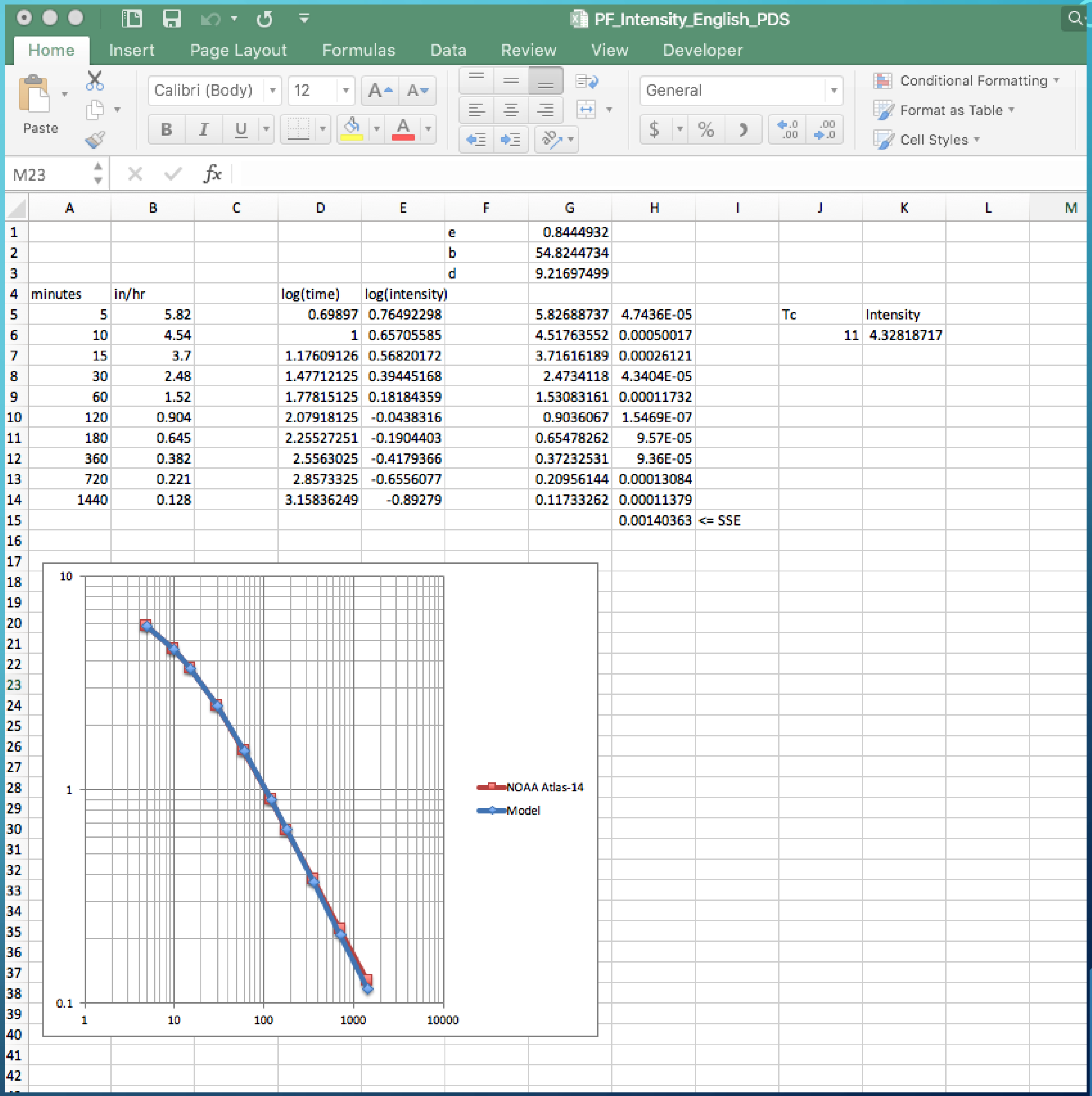


INTENSITY EQUATION

- Intensity function for the example:

$$I = \frac{54.82}{(T_c + 9.21)^{0.844}}$$

- This can be coded into an analysis spreadsheet directly



	A	B	C	D	E	F	G	H	I	J	K
1						e	0.8444932				
2						b	54.8244734				
3						d	9.21697499				
4	minutes	in/hr		log(time)	log(intensity)						
5	5	5.82		0.69897	0.76492298		5.82688737	4.7436E-05		Tc	Intensity
6	10	4.54		1	0.65705585		4.51763552	0.00050017		11	4.32818717
7	15	3.7		1.17609126	0.56820172		3.71616189	0.00026121			
8	30	2.48		1.47712125	0.39445168		2.4734118	4.3404E-05			
9	60	1.52		1.77815125	0.18184359		1.53083161	0.00011732			
10	120	0.904		2.07918125	-0.0438316		0.9036067	1.5469E-07			
11	180	0.645		2.25527251	-0.1904403		0.65478262	9.57E-05			
12	360	0.382		2.5563025	-0.4179366		0.37232531	9.36E-05			
13	720	0.221		2.8573325	-0.6556077		0.20956144	0.00013084			
14	1440	0.128		3.15836249	-0.89279		0.11733262	0.00011379			
15								0.00140363	<= SSE		

BEGIN WITH MOST UPSTREAM NODE

- Intensity Equation
- Rational Method
- Discharge to Inlet