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

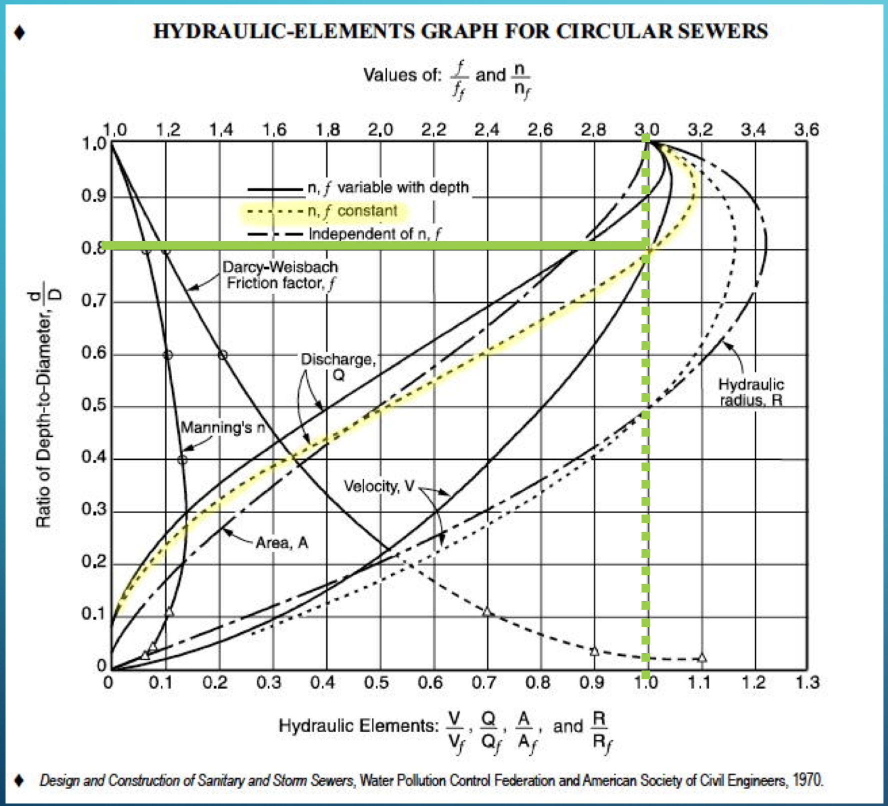
CONDUIT DESIGN

- 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

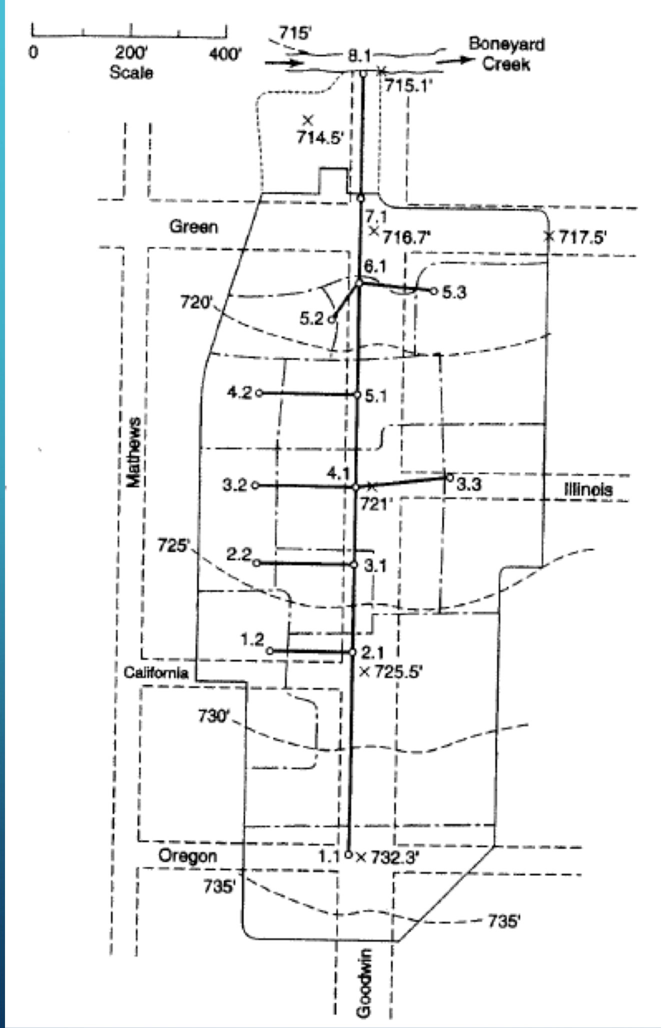


- Determine discharge in each pipe.
- Size using manning's equation
  (… in us customary)

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

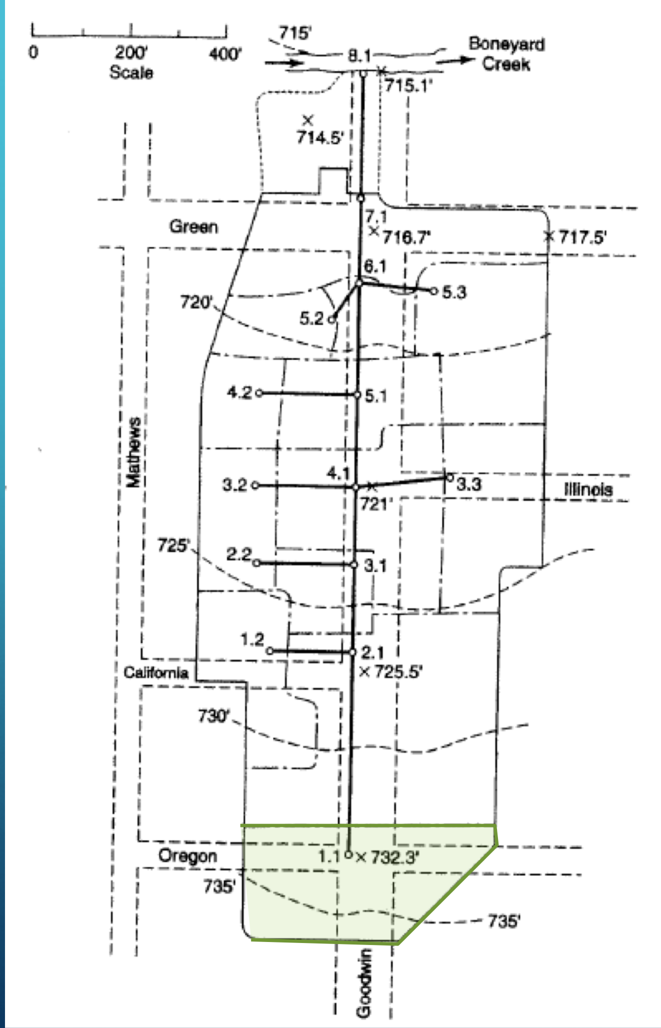
- Assumes full, but pipes will have free surface

PRELIMINARY DESIGN



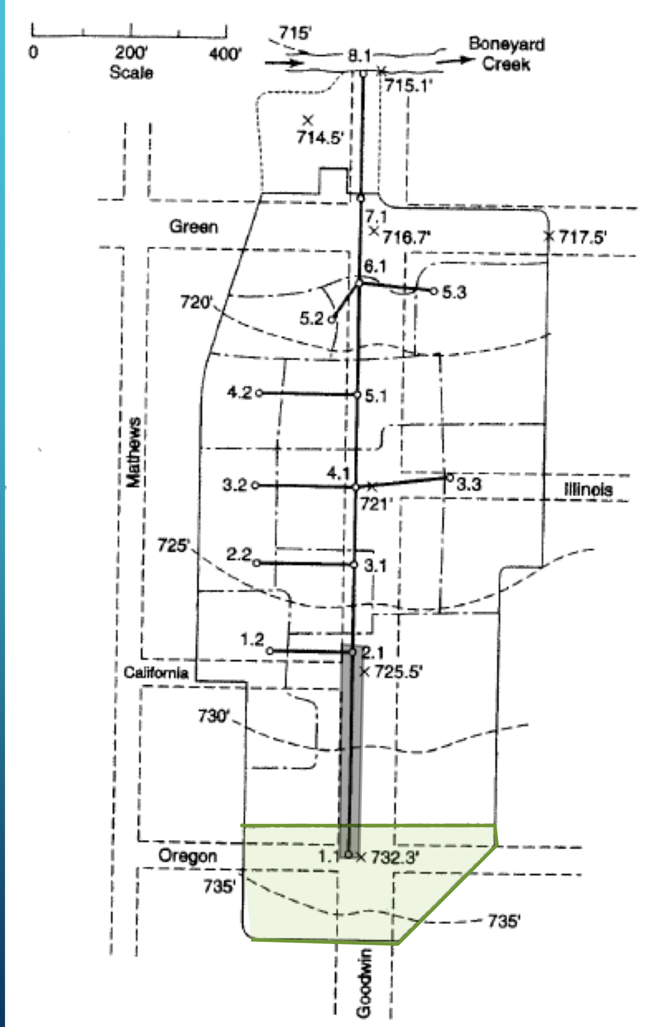
- Layout of system
  - Drainage area and Inlets
  - Pipes
  - Outfall
  - elevations

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

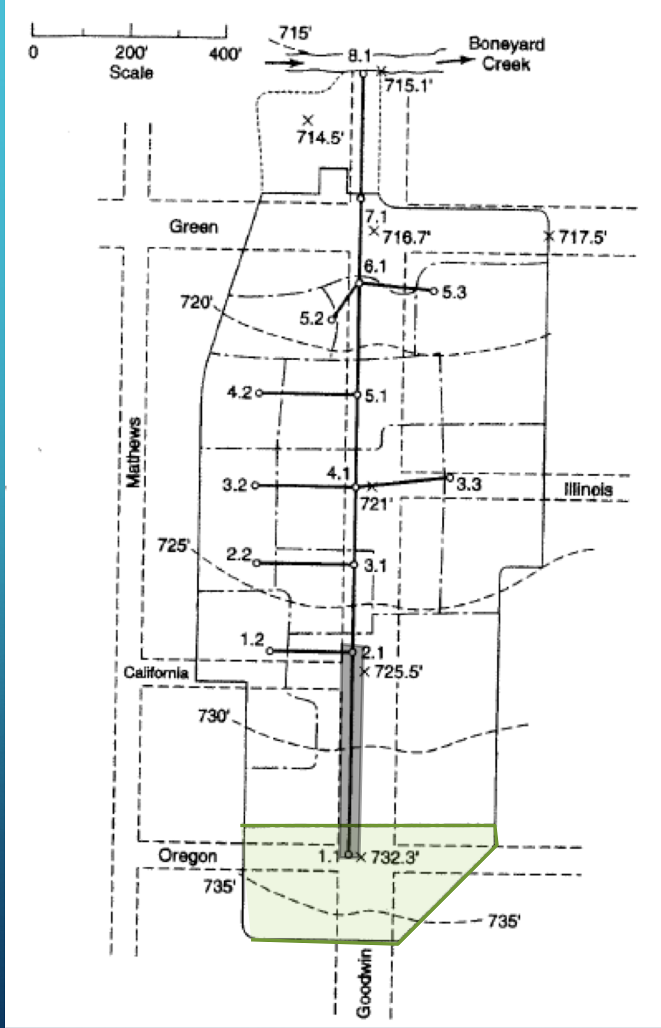
- Velocity criteria

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

- Determine pipe travel time

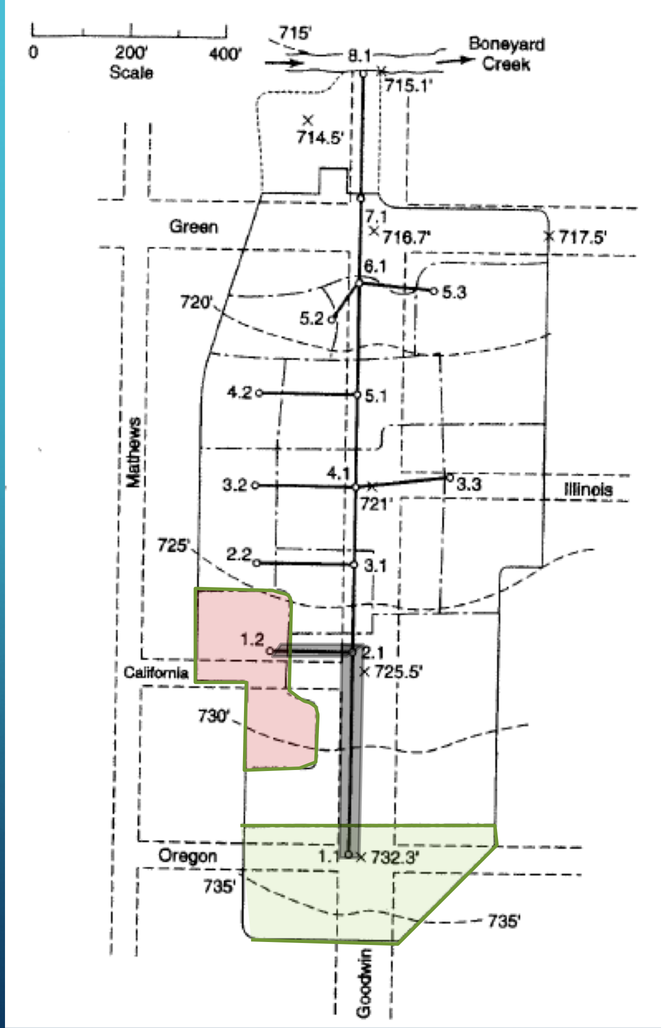
$$t = \frac{distance}{V}$$

PRELIMINARY DESIGN



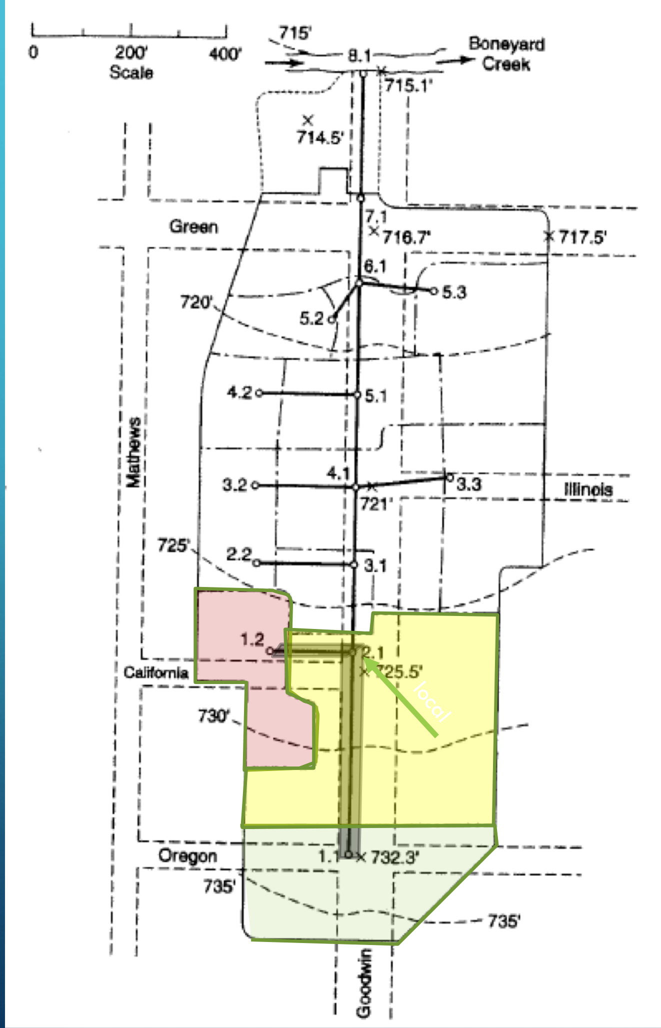
- At most upstream inlet
  - Compute Q_P=CiA to the inlet from inlet time
  - Size pipe from this inlet to hold Q_P
  - ADD pipe travel time to inlet time
  - Move to next node

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

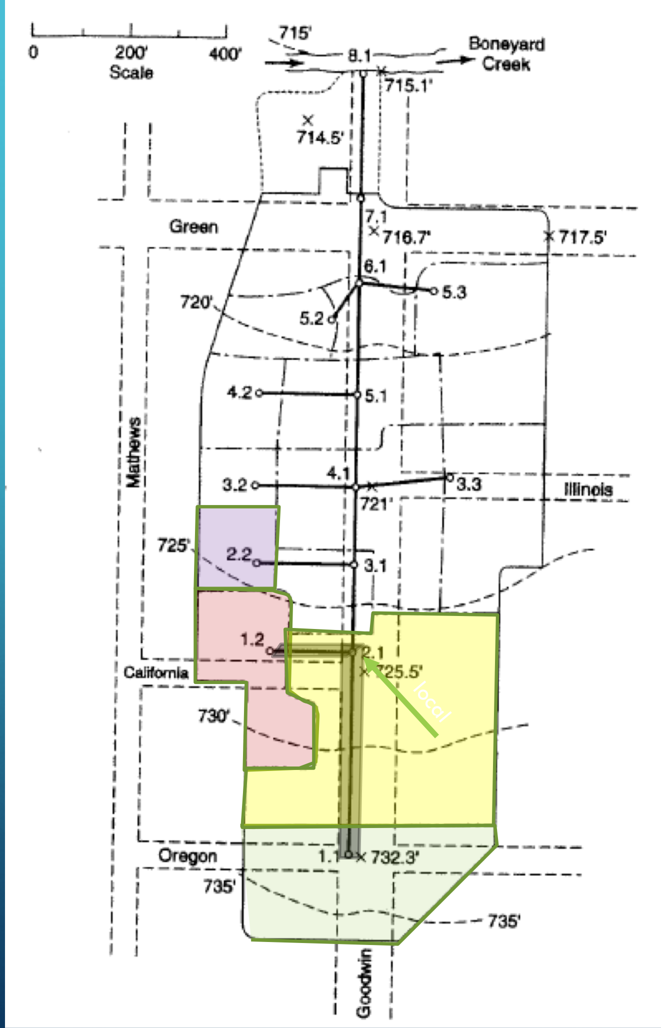


- AT JUNCTION AND INLET
  - Choose largest of:
    1. Local inlet time
    2. Upstream node+travel time
- Compute Q_p LEAVING THE JUNCTION FROM:

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

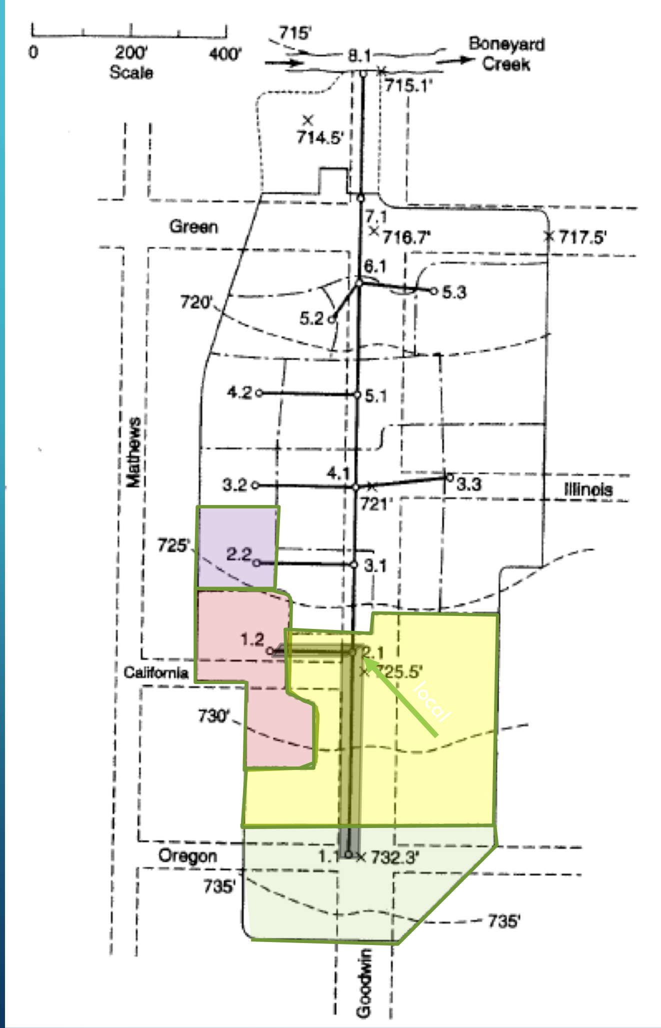
- SIZE next pipe from this q_p

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

NEXT TIME

- Introduction to SWMM
    - Used to perform hydraulic simulations
    - Similar interface to EPANET, more complicated tool