CE 3372 WATER SYSTEMS DESIGN LESSON 21: DETENTION/RETENTION BASIN HYDRAULICS

PURPOSES

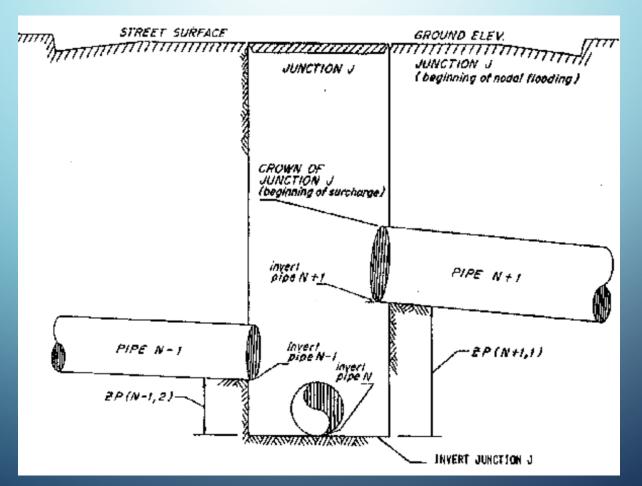
- Detention Basin
 - Mitigate peak discharge(s)
 - Provide water quality benefit

JUNCTION (NODE)

- Ordinary junction connects hydraulic elements (links)
- Junction attributes are:
 - Invert elevation (elevation of the bottom of the node)
 - Max elevation (elevation of top of node)
 - Set to land surface to plot profile grade line in SWMM
 - Set to land surface + added depth for dual (surface+subsurface drainage)
- When program runs, depth at the node is computed, but there is no storage (node has zero area)

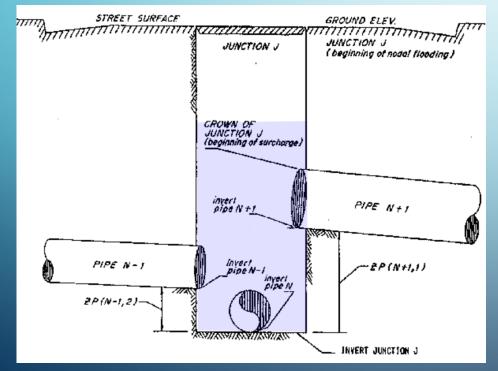
JUNCTION (NODE)

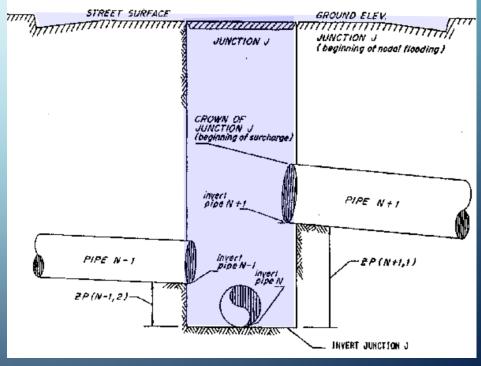
Ordinary junction just connects pipes N-1, N, and N+1



JUNCTION (NODE)

• If flooding occurs, it is only considered when HGL is above node Max. Depth





Node not flooded; pipes are surcharged

Node flooded; pipes are surcharged

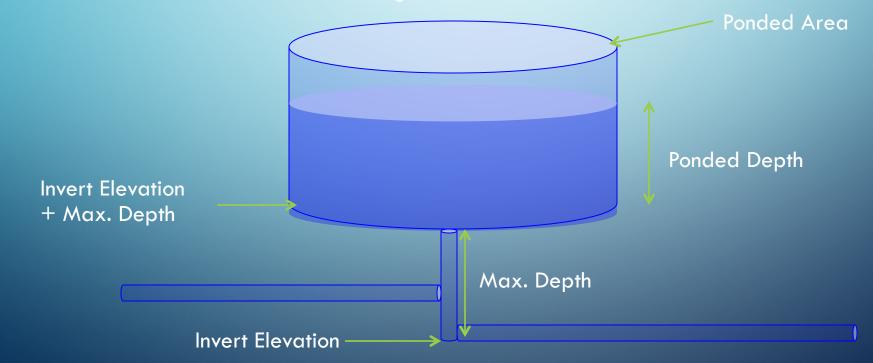
FLOODING OPDINIARY N Water Elevation Profile: Node 80408 - 16109 160-Conduit 8060 158 82309 Node Rim Elevation Value Property 156-Name 8060 154-The Node Surchage Depth and Flooded Area Inlet Node 80608 152 are only used when the Node Water Surface 150 Outlet Node 82309 Elevation is above the Node Rim Elevation 148-Description 112.30 146 8060 Tag 42.70 Max. Depth 144 Shape CIRCULAR Initial Depth 142-Max. Depth 4.0 Surcharge Depth 10 140-80408 2075.0 Length Ponded Area 100 138 Roughness 0.015 ``- 80608 136 Inlet Offset € 134-Outlet Offset 114,500 <u>5</u> 132 Initial Flow 0.0 <u>8</u> 130 Maximum Flow 128-**Pipe Crown Elevation** Entry Loss Coeff. 0 124 Conduit length (ft) 122-120-118-116-Node Invert Elevation 114-112 Pipe Offset Elevation 110 108-106-104 8,500 8,000 7,500 7,000 6,500 6,000 5,500 5,000 4,500 4,000 3,500 3,000 2,500 2,000 1,500 1,000 500

Distance (ft)

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- How deep is the flooding allowed (surcharge depth) above the top of the node
- What is the ponded area during surcharge treats the node as a vertical wall storage tank



STORAGE UNIT (NODE)

- A storage node explicitly considers storage in the node including (if data are correctly supplied) the sub-grade portion of the node
- Storage Node Attributes
 - Same as an ordinary node +
 - Depth-Area relationship
 - Tabular
 - Functional

STORAGE UNIT (NODE)

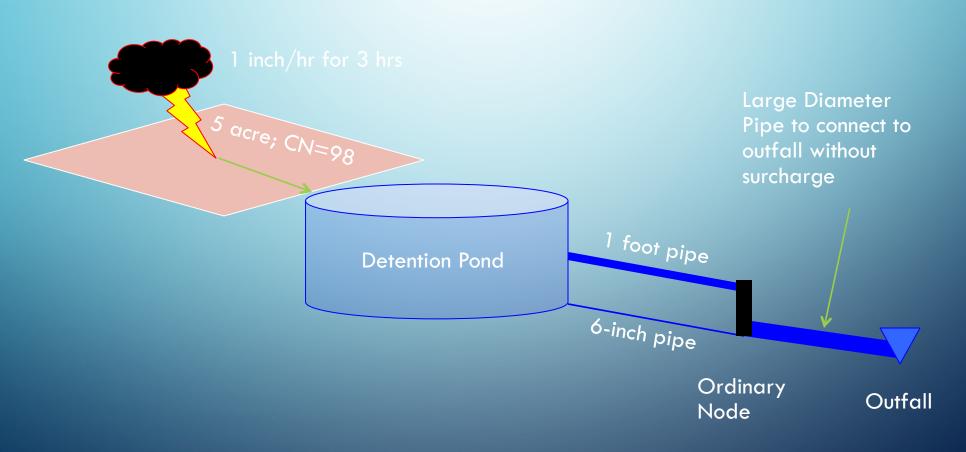
- Useful for:
 - Detention ponds
 - Modeling multiple level inlet/outlet hydraulics
 - Riser inlet
 - Outlet that has portion through a pipe, a portion over a weir (or another pipe at different elevation)

EXAMPLE

- Consider a detention pond that drains a 5-acre parking lot, then discharges to a nearby receiving stream
- Use SWMM to approximate the hydraulics
 - Sub-catchment, high CN (98) to represent the parking lot
 - 1-inch/hour storm for 3 hours
 - All flow passes through the detention pond before exiting to a stream through a 6-inch pipe at the inverts, and a 1-foot pipe at 2-feet above basin bottom

EXAMPLE

Schematic of the system



Grab File Edit Capture Window Help \$\$ \$\sim 16\% □ \tau 5:18 PM \text{ cleveland } \Q \cdots \equiv \equiv \text{ \text{\text{\text{Tue}}}} \text{\$\\$}}}}\text{\$\text{\$\text{\$\text{\$\text{\$\text{\$\text{\$\text{\$\text{\$\text{\$\text{\$\e 000 SWMM 5.1 $\underline{\text{File}} \quad \underline{\text{Edit}} \quad \underline{\text{V}} \text{iew} \quad \underline{\text{Project}} \quad \underline{\text{R}} \text{eport} \quad \underline{\text{Tools}} \quad \underline{\text{W}} \text{indow} \quad \underline{\text{H}} \text{elp}$ Project Map Study Area Map 11/17/2015 04:30:00 Themes Subcatchment 1 Runoff (CFS) - Link UpperPipe Flow (CFS) Subcatchments Link LowerPipe Flow (CFS) Link OutfallPipe Flow (CFS) None 000 Storage Curve Editor Nodes 5.0 None 4.5 Curve Name DetentionPond Links 4.0 None 3.5 Description 3.0 Time Period 2.5 Depth Area <u> </u>View... (ft) (ft2) 2.0 11/17/2015 1.5 Load... 0.5 10890 1.0 15246 Time of Day <u>S</u>ave... 04:30:00 23958 30492 10 12 14 16 18 20 4.5 39204 Elapsed Time Elapsed Time (hours) 0.04:30:00 0K 5.5 52272 80586 Profile - Node 2 - 4 Profile - Node 2 -Cancel -Animator-Water Elevation Profile: Node 2 - 4 Water Elevation Profile: Node 2 -10 H 4 **□** → Help Functional Curve Coefficient Exponent Constant 0 50 100 150 200 250 300 350 400 450 500 550 600 650 Tabular Curve 200 700 Distance (ft) Distance (ft) 11/17/2015 04:30:00 11/17/ Name of storage curve to use Auto-Length: Off T Offsets: Depth T Flow Units: CFS T Zoom Level: 100%

EXERCISE ES 15

 Use SWMM to model a detention basin (Harris County Permit 8-262-4)

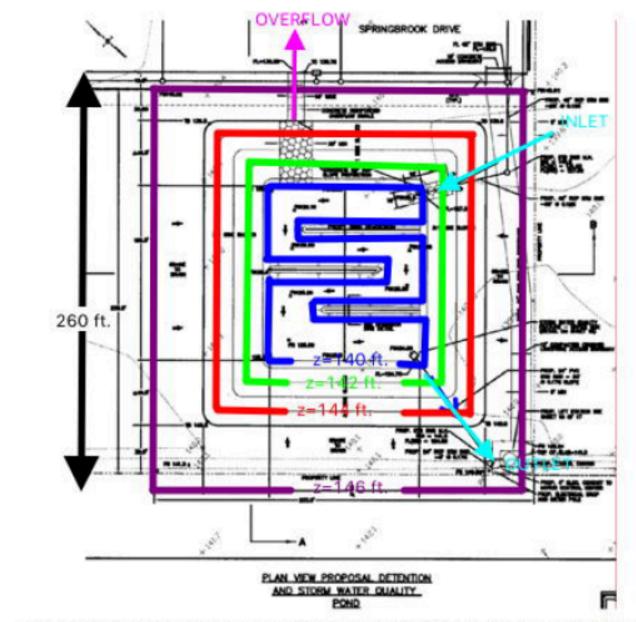


Figure 5. 36 Engineering Drawing for Permit 8-262-4 (Harris County) SWQ Pond

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 Use SWMM to model a detention basin (Harris County Permit 8-262-4)

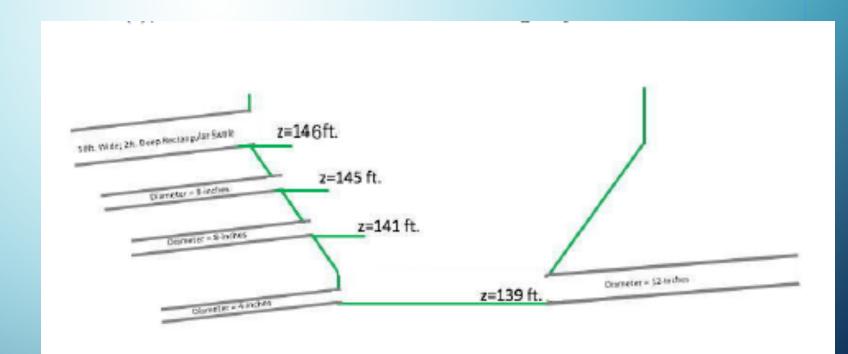
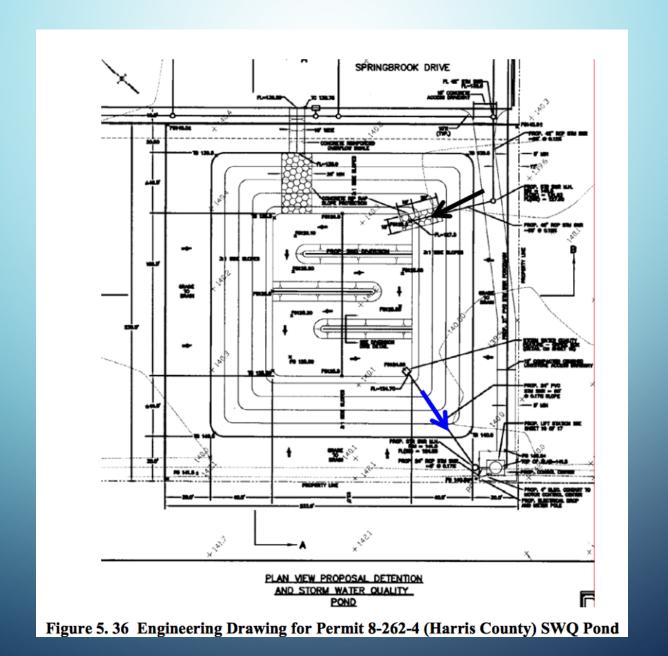


Figure 2: Schematic elevation-view sketch of pond.

DETENTION POND DRAWING



DEPTH-AREA

- Use the drawing to determine the depth-area of the pond
 - Pick an elevation (depth)
 - Find pool area for that elevation (depth)
 - Record the depth and the area (in acres usually)

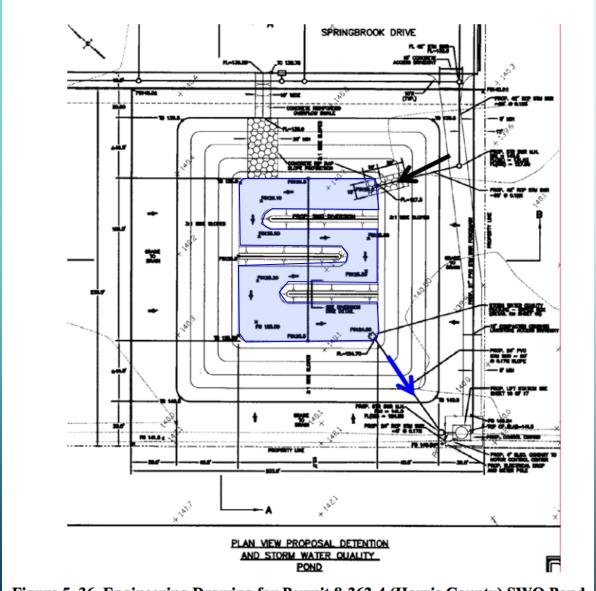
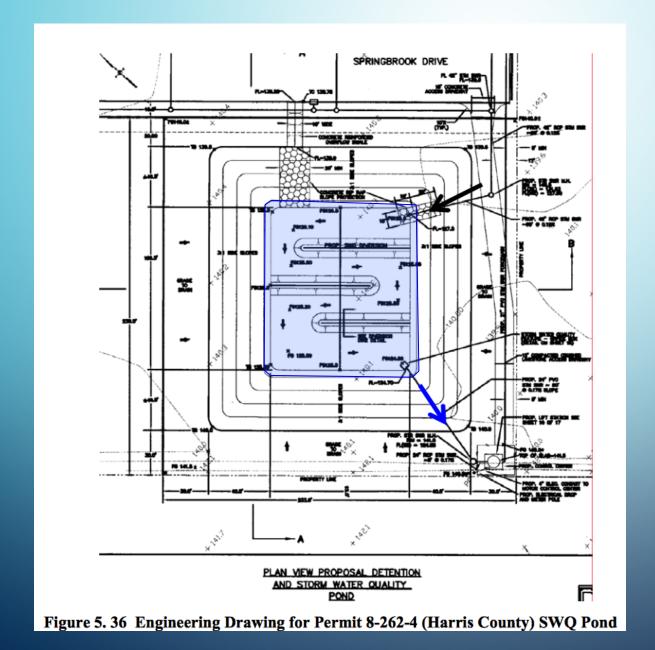
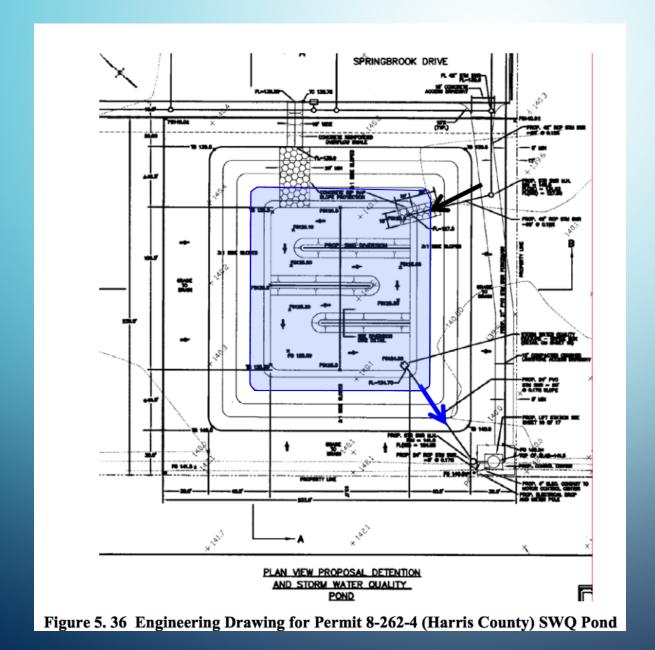


Figure 5. 36 Engineering Drawing for Permit 8-262-4 (Harris County) SWQ Pond

- Pool elevation = 140 ft.
- Pool Area = 0.25 acres



- Pool Area = 0.35 acres



- Pool elevation = 142 ft.
- Depth = 2.5 ft.
- Pool Area = 0.55 acres

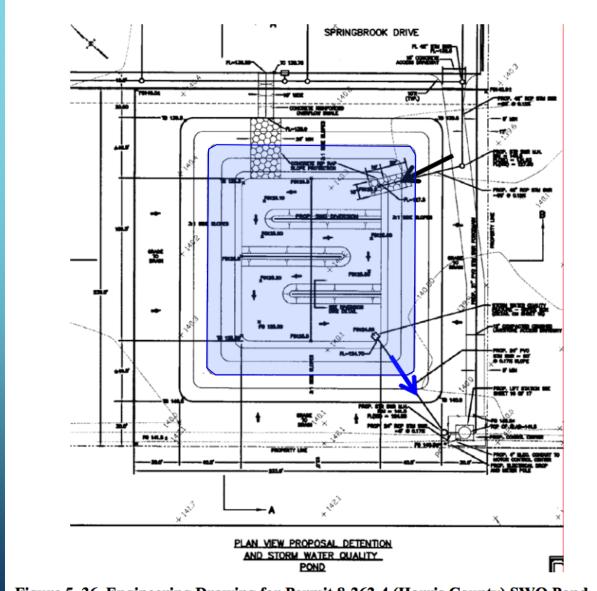
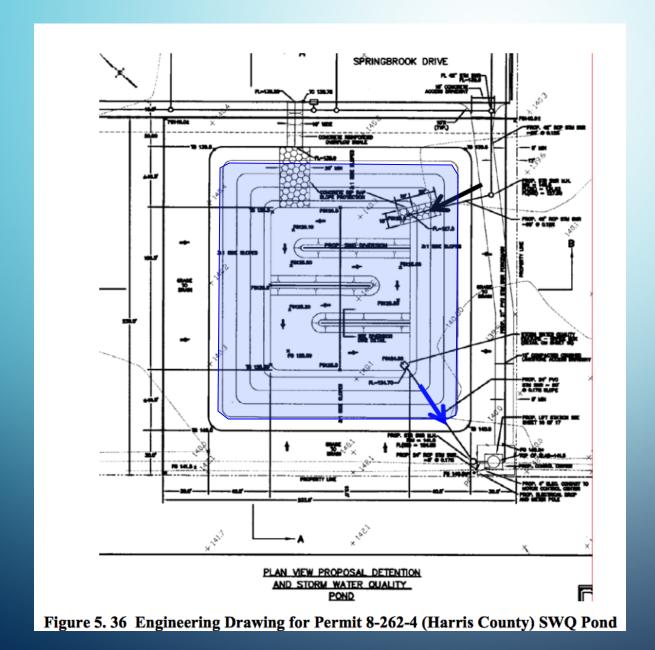


Figure 5. 36 Engineering Drawing for Permit 8-262-4 (Harris County) SWQ Pond

- Pool elevation = 143 ft.
- Pool Area = 0.70 acres



- Pool elevation = 144 ft.
- Depth = 4.5 ft.
- Pool Area = 0.90 acres

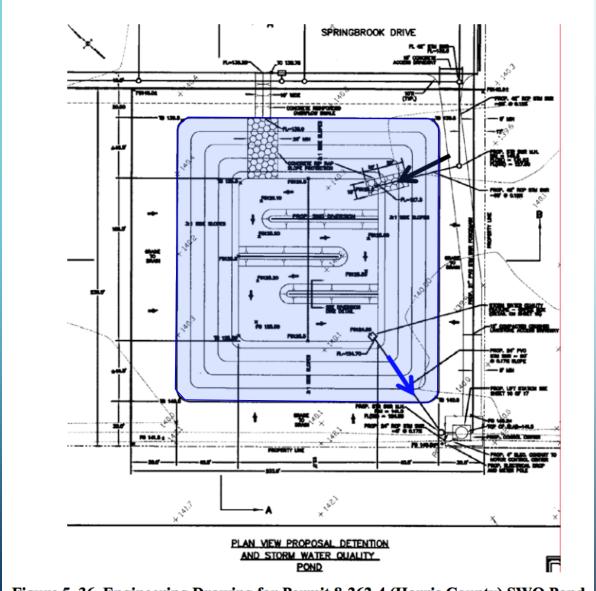


Figure 5. 36 Engineering Drawing for Permit 8-262-4 (Harris County) SWQ Pond

- Pool elevation = 145 ft.
- Pool Area = 1.20 acres

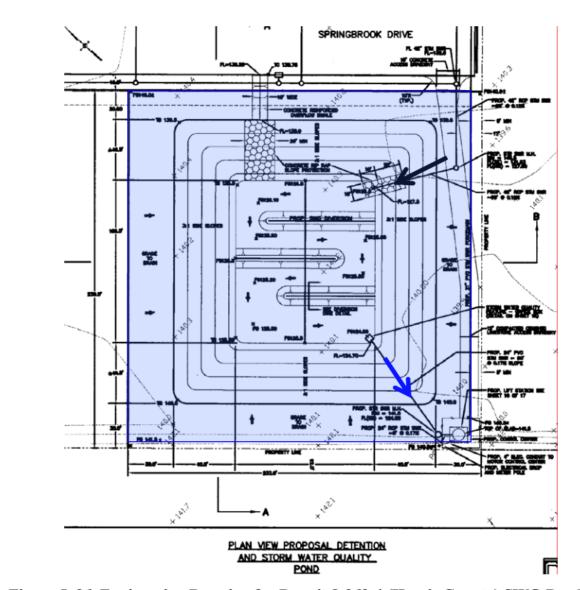


Figure 5. 36 Engineering Drawing for Permit 8-262-4 (Harris County) SWQ Pond

- Pool elevation = 148 ft.

inundating off-site property

ENTER INFORMATION INTO SWMM

- Storage tabular element
- Apply a rainfall (flow)
- Simulate pond fill/drain and outflow hydrograph