Time span=0.00-72.00 hrs, dt=0.01 hrs, 7201 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Reach 1S: 1% Swale Avg. Flow Depth=1.19' Max Vel=3.82 fps Inflow=30.64 cfs 2.198 af
n=0.030 L=100.0' S=0.0100 '/' Capacity=52.71 cfs Outflow=30.57 cfs 2.198 af

Reach 2R: 1% Swale Avg. Flow Depth=1.17' Max Vel=3.79 fps Inflow=29.51 cfs 2.117 af
n=0.030 L=100.0' S=0.0100 '/' Capacity=52.71 cfs Outflow=29.44 cfs 2.117 af

Reach 3R: 8% Swale Avg. Flow Depth=0.73' Max Vel=8.20 fps Inflow=29.51 cfs 2.117 af
n=0.030 L=100.0' S=0.0800 '/' Capacity=149.09 cfs Outflow=29.49 cfs 2.117 af

Reach 4R: 1% Swale Avg. Flow Depth=0.86' Max Vel=3.17 fps Inflow=14.75 cfs 1.058 af
n=0.030 L=100.0' S=0.0100 '/' Capacity=52.71 cfs Outflow=14.70 cfs 1.058 af

Reach 342R: 8% Swale Avg. Flow Depth=0.53' Max Vel=6.83 fps Inflow=14.75 cfs 1.058 af
n=0.030 L=100.0' S=0.0800 '/' Capacity=149.09 cfs Outflow=14.74 cfs 1.058 af

Reach S8: 8% Swale Avg. Flow Depth=0.88' Max Vel=9.11 fps Inflow=44.26 cfs 3.175 af
n=0.030 L=100.0' S=0.0800 '/' Capacity=149.09 cfs Outflow=44.24 cfs 3.175 af

Pond 324P: 1% 12" Culvert Peak Elev=100.34' Inflow=14.75 cfs 1.058 af
Primary=4.69 cfs 0.874 af Secondary=10.07 cfs 0.184 af Outflow=14.75 cfs 1.058 af

Pond 325P: 1% 12"x2 Culvert Peak Elev=100.46' Inflow=29.51 cfs 2.117 af
Primary=9.60 cfs 1.757 af Secondary=20.29 cfs 0.359 af Outflow=29.51 cfs 2.117 af

Pond 326P: 1% 12"x3 Culvert Peak Elev=100.44' Inflow=30.64 cfs 2.198 af
Primary=9.50 cfs 1.806 af Secondary=21.58 cfs 0.392 af Outflow=30.64 cfs 2.198 af

Pond 327P: 8% 12" Culvert Peak Elev=100.55' Inflow=14.75 cfs 1.058 af
Primary=4.74 cfs 0.875 af Secondary=10.01 cfs 0.183 af Outflow=14.75 cfs 1.058 af

Pond 328P: 8% 12"x2 Culvert Peak Elev=100.66' Inflow=29.51 cfs 2.117 af
Primary=10.00 cfs 1.766 af Secondary=19.50 cfs 0.351 af Outflow=29.51 cfs 2.117 af

Pond 329P: 8% 12"x3 Culvert Peak Elev=100.74' Inflow=44.26 cfs 3.175 af
Primary=15.53 cfs 2.665 af Secondary=28.73 cfs 0.510 af Outflow=44.26 cfs 3.175 af

B4. HydroCAD 100-Year Storm Analysis

Time span=0.00-72.00 hrs, dt=0.01 hrs, 7201 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Reach 1S: 1% Swale Avg. Flow Depth=1.51' Max Vel=4.40 fps Inflow=53.44 cfs 3.796 af
n=0.030 L=100.0' S=0.0100 '/' Capacity=52.71 cfs Outflow=53.34 cfs 3.796 af

Reach 2R: 1% Swale Avg. Flow Depth=1.48' Max Vel=4.36 fps Inflow=51.46 cfs 3.655 af
n=0.030 L=100.0' S=0.0100 '/' Capacity=52.71 cfs Outflow=51.37 cfs 3.655 af

Reach 3R: 8% Swale Avg. Flow Depth=0.94' Max Vel=9.47 fps Inflow=51.46 cfs 3.655 af
n=0.030 L=100.0' S=0.0800 '/' Capacity=149.09 cfs Outflow=51.44 cfs 3.655 af

Reach 4R: 1% Swale Avg. Flow Depth=1.10' Max Vel=3.66 fps Inflow=25.73 cfs 1.828 af
n=0.030 L=100.0' S=0.0100 '/' Capacity=52.71 cfs Outflow=25.66 cfs 1.828 af

Reach 342R: 8% Swale Avg. Flow Depth=0.69' Max Vel=7.92 fps Inflow=25.73 cfs 1.828 af
n=0.030 L=100.0' S=0.0800 '/' Capacity=149.09 cfs Outflow=25.71 cfs 1.828 af

Reach S8: 8% Swale Avg. Flow Depth=1.13' Max Vel=10.51 fps Inflow=77.19 cfs 5.483 af
n=0.030 L=100.0' S=0.0800 '/' Capacity=149.09 cfs Outflow=77.16 cfs 5.483 af

Pond 324P: 1% 12" Culvert Peak Elev=100.46' Inflow=25.73 cfs 1.828 af
Primary=4.89 cfs 1.328 af Secondary=20.96 cfs 0.500 af Outflow=25.73 cfs 1.828 af

Pond 325P: 1% 12"x2 Culvert Peak Elev=100.63' Inflow=51.46 cfs 3.655 af
Primary=9.57 cfs 2.655 af Secondary=42.90 cfs 1.000 af Outflow=51.46 cfs 3.655 af

Pond 326P: 1% 12"x3 Culvert Peak Elev=100.60' Inflow=53.44 cfs 3.796 af
Primary=9.45 cfs 2.726 af Secondary=45.10 cfs 1.070 af Outflow=53.44 cfs 3.796 af

Pond 327P: 8% 12" Culvert Peak Elev=100.67' Inflow=25.73 cfs 1.828 af
Primary=5.03 cfs 1.331 af Secondary=20.70 cfs 0.496 af Outflow=25.73 cfs 1.828 af

Pond 328P: 8% 12"x2 Culvert Peak Elev=100.82' Inflow=51.46 cfs 3.655 af
Primary=10.71 cfs 2.692 af Secondary=40.75 cfs 0.963 af Outflow=51.46 cfs 3.655 af

Pond 329P: 8% 12"x3 Culvert Peak Elev=100.93' Inflow=77.19 cfs 5.483 af
Primary=16.74 cfs 4.068 af Secondary=60.45 cfs 1.415 af Outflow=77.19 cfs 5.483 af

Appendix C - Mounding Calculations

DiPrete Engineering has prepared groundwater mounding calculations for the proposed infiltration pond F. Pond F has been designed to fully infiltrate the 1 year storm event. To be conservative, all storms beyond the 1 year storm, infiltration is removed in the calculations. Since infiltration will occur during these storm events, the model will be conservative and report higher volume and flow numbers than will occur.

DiPrete Engineering has calculated the groundwater mounding using the USGS Hantush Calculator. The calculator is available online at http://pubs.usgs.gov/sir/2010/5102/. Additional guidance is provided through the New Jersey Stormwater Best Management Practices Manual.

The calculator provided by the USGS requires several variables:

R – Recharge infiltration rate (feet/day):
Recharge rate is the vertical conductivity (Kv) of the soil. The vertical conductivity was determined based on soil texture and table 5-3 in section 5.3.4 of the RISDISM of the RISDISM. Per table 5-3 the soils have an infiltration rate of 2.41 in/hr. To reduce impacts of the stormwater mound, the infiltration rate has been reduced by 4/5. A rate of 0.482 in/hr or 0.964 ft/day has been used in the calculations

Sy – Specific Yield:
Specific Yield is specific to the parent material through which the infiltration occurs. Onsite soil evaluations classified the soils as coarse sand. A value for Sy has been obtained from Table 4.3 of Hydrology and Hydraulic Systems by Ram S. Gupta:

TABLE 4.3 REPRESENTATIVE VALUES OF SPECIFIC YIELD FOR SOILS AND ROCKS

Material	Specific Yield (%)
Gravel, coarse	23
Gravel, medium	24
Gravel, fine	25
Sand, coarse	27
Sand, medium	28
Sand, fine	23
Silt	8
Clay	3
Sandstone, fine-grained	21
Sandstone, medium-grained	27
Limestone	14
Dune sand	38
Loess	18
Peat	44
Schist	26
Siltstone	12
Till, predominantly silt	6
Till, predominantly sand	16
Till, predominantly gravel	16
Tuff	21

Source: Todd, 1980.

HYDROLOGY
&
HYDRAULIC
SYSTEMS

RAM S. GUPTA, Ph.D., P.E.
Roger Williams University, Bristol, RI
Delta Engineers, Inc., Bristol, RI

K – Hydraulic conductivity, Kh (feet/day):
Mounding calculations require the hydraulic conductivity (Kh) value of the soils. According to USGS SIR 2010-5102, Vertical Conductivity is approximately 1/10 of horizontal conductivity. The vertical conductivity was determined based on soil texture and table 5-3 in section 5.3.4 of the RISDISM of the RISDISM. The vertical conductivity is 2.41 in/hr, which equates to a horizontal conductivity of 24.1 in/hr or 48.2 ft/day. Note, even though the vertical conductivity is reduced, the horizontal conducting remains the same. Guidance on this procedure is available within the New Jersey Stormwater Best Management Practices Manual.

x & y – ½ of the basin length:
The x and y variables represent the length and width of the system. The overall system infiltration surface is approximately 95' x 24' and the ½ basin length and width is 47.5' x 12.0'.

t – Duration of infiltration period in (days):
The time of infiltration is calculated from volume infiltrated dived by the square footage of the pond and the infiltration rate (Kv). The infiltrated volume is obtained from the HydroCAD analysis for the 1 year storm.

Volume Infiltrated (af)	Pond Infiltrating Surface Area (sf)	Infiltration Rate (ft/day)	T (days)
0.158	2,334	0.964	3.050

hi(0) – initial thickness of saturated zone (feet):
The initial thickness of the saturated zone is the depth from the water table to the impervious limiting layer. Test holes performed did not encounter ledge. A value of 5' has been used for this analysis. The ledge could be much deeper. Condition of the ledge is also unknown, the ledge could be fractured thus providing an even greater hi(0). An estimate of 5' below the seasons high groundwater is reasonable.

Conclusion:

System Bottom	System Top	1-Year Mound height (ft)	1-Year Mound Elevation
280	287.1	1.84	279.84

The mounding height is obtained from the USGS Hantush Calculator. The mound elevation is determined by adding the mound height to the average seasonal high groundwater. The mound will have no impact on the system performance. It is important to note that for all storms above the 1year storm, infiltration is not accounted for within the calculations.

This spreadsheet will calculate the height of a groundwater mound beneath a stormwater infiltration basin. More information can be found in the U.S. Geological Survey Scientific Investigations Report 2010-5102 "Simulation of groundwater mounding beneath hypothetical stormwater infiltration basins".

The user must specify infiltration rate (R), specific yield (Sy), horizontal hydraulic conductivity (Kh), basin dimensions (x, y), duration of infiltration period (t), and the initial thickness of the saturated zone (hi(0), height of the water table if the bottom of the aquifer is the datum). For a square basin the half width equals the half length (x = y). For a rectangular basin, if the user wants the water-table changes perpendicular to the long side, specify x as the short dimension and y as the long dimension. Conversely, if the user wants the values perpendicular to the short side, specify y as the short dimension, x as the long dimension. All distances are from the center of the basin. Users can change the distances from the center of the basin at which water-table aquifer thickness are calculated.
Cells highlighted in yellow are values that can be changed by the user. Cells highlighted in red are output values based on user-specified inputs. The user MUST click the blue "Re-Calculate Now" button each time ANY of the user-specified inputs are changed otherwise necessary iterations to converge on the correct solution will not be done and values shown will be incorrect. Use consistent units for all input values (for example, feet and days)

Input Values		use consistent units (e.g. feet & days or inches & hours)
0.9640	***R***	Recharge (infiltration) rate (feet/day)
0.230	Sy	Specific yield, Sy (dimensionless, between 0 and 1)
48.20	K	Horizontal hydraulic conductivity, Kh (feet/day)*
12.000	x	1/2 length of basin (x direction, in feet)
47.500	y	1/2 width of basin (y direction, in feet)
3.050	t	duration of infiltration period (days)
5.000	hi(0)	initial thickness of saturated zone (feet)

Conversion Table

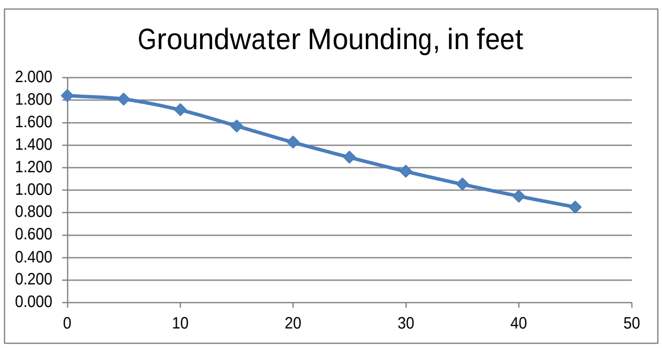
inch/hour	feet/day
0.67	1.33
2.00	4.00
hours	**days**
36	1.50

In the report accompanying this spre
(USGS SIR 2010-5102), vertical soil pe
(ft/d) is assumed to be one-tenth hor
hydraulic conductivity (ft/d).

6.840	h(max)	maximum thickness of saturated zone (beneath center of basin at end of infiltration period)
1.840	**Δ**h(max)	maximum groundwater mounding (beneath center of basin at end of infiltration period)

Ground-water Mounding, in feet	Distance from center of basin in x direction, in feet
1.840	0
1.809	5
1.714	10
1.570	15
1.426	20
1.292	25
1.167	30
1.052	35
0.946	40
0.849	45

Re-Calculate Now



Disclaimer

This spreadsheet solving the Hantush (1967) equation for ground-water mounding beneath an infiltration basin is made available to the general public as a convenience for those wishing to replicate values documented in the USGS Scientific Investigations Report 2010-5102 "Groundwater mounding beneath hypothetical stormwater infiltration basins" or to calculate values based on user-specified site conditions. Any changes made to the spreadsheet (other than values identified as user-specified) after transmission from the USGS could have unintended, undesirable consequences. These consequences could include, but may not be limited to: erroneous output, numerical instabilities, and violations of underlying assumptions that are inherent in results presented in the accompanying USGS published report. The USGS assumes no responsibility for the consequences of any changes made to the spreadsheet. If changes are made to the spreadsheet, the user is responsible for documenting the changes and justifying the results and conclusions.

Watershed Maps