Rhode Island Stormwater Design and Installations Standards Manual

Public Workshop
Recap of Practices
March 24, 2011

Water Quality BMPs

Community Planning

LID Site Design

LID BMPs

Larger Conventional BMPs

Receiving Waters

3.2.3 Minimum Standard 3: Water Quality

- The WQv must be treated by at least one of the structural BMPs listed in Chapter Five at each location where a discharge of stormwater will occur.
- Minimum average pollutant removal efficiencies: 85% removal of total suspended solids (TSS), 60% removal of pathogens, 30% removal of total phosphorus (TP) for discharges to freshwater systems, and 30% removal of total nitrogen (TN) for discharges to saltwater or tidal systems.
- Excludes LID credits allowed under Section 4.6

Acceptable BMPs

- 5.2 Wet Vegetated Treatment Systems (WVTS)
- 5.3 Stormwater Infiltration Practices
- 5.4 Permeable Paving
- 5.5 Filtering Systems
- 5.6 Green Roofs
- 5.7 Open Channel Systems


A
WVTS


B
Sand Filters


Permeable Pavements
C


Open Channels
D


Bioretention
A


B
Green Roofs


Infiltration Practices
C


Storage Practices
D

#1. Land Use

The land use of the contributing drainage area influences the stormwater strategy:

- Rural areas
- Residential sites
- Roads/highways
- Commercial sites
- LUHPPLs
- Urban sites (e.g., redevelopment)

Cul-de-Sac Application


Commercial Application


Municipal Application

Retrofit Application

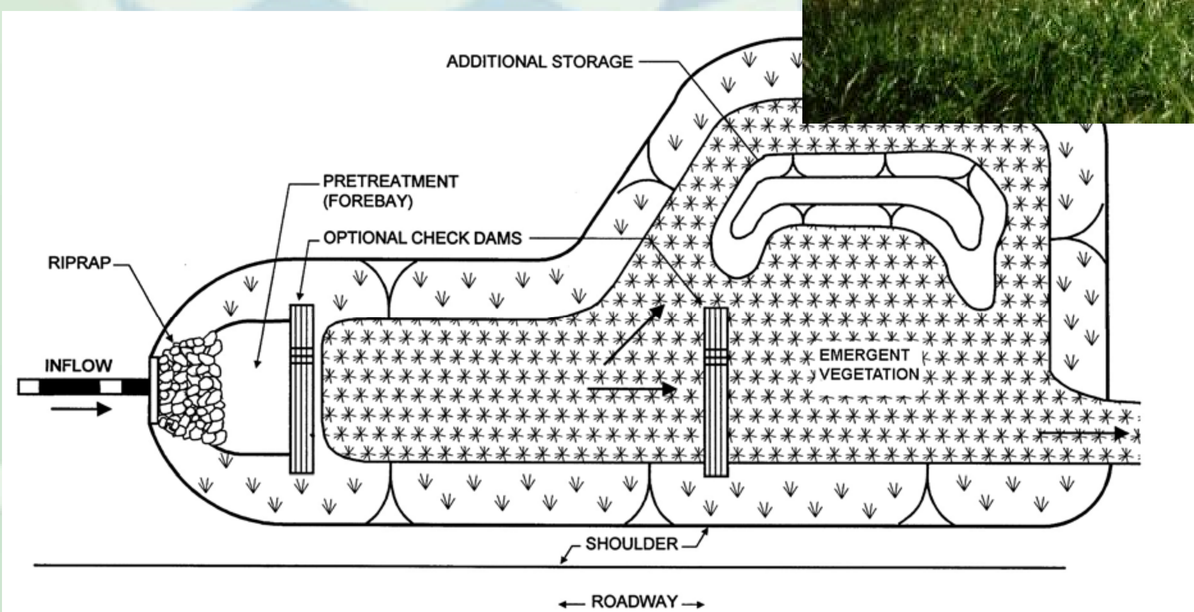
2. Physical Feasibility

Some Practices Cannot Be Used Because of Site Constraints:

- Soils
- Groundwater
- Drainage Area
- Minimum Surface Area
- Slope Restriction
- Head

Wet Swale

- Used when water table is close to surface



#3. Watershed Factors

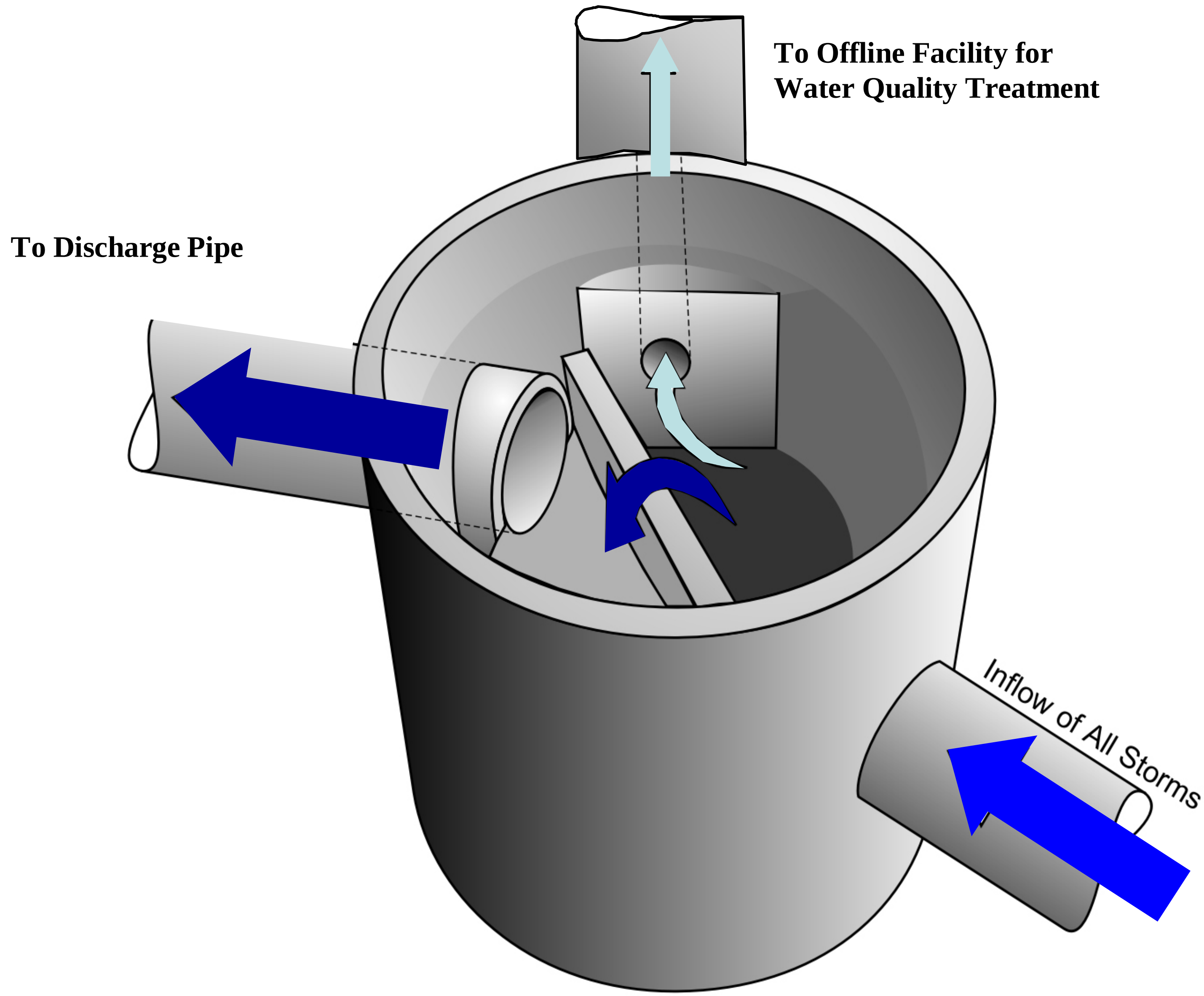
Different Receiving Water Management Objectives Shape Stormwater Strategies:

- Groundwater (Aquifer protection)
- Freshwater streams and Rivers
- Other Freshwaters (Ponds/Lakes/Wetlands)
- Coastal Waters (shellfish/beach areas

#4. Stormwater Management Capability

No single practice achieves all stormwater management objectives. A combination of practices is often needed to provide desired level of:

- Groundwater recharge
- Water quality treatment
- Channel protection
- Flood control
- Ability to treat LUHPPLs


To Offline Facility for
Water Quality Treatment
To Discharge Pipe
Inflow of All Storms

#5. Community and Environmental Impacts

Other community and environmental impacts should be considered when selecting BMPs:

- Ease of maintenance
- Affordability
- Community acceptance/ aesthetics
- Safety
- Habitat

Stormwater Practice Maintenance Burden

Maintenance Burden is a function of the type of facility as well as the design and implementation

- WVTS ---------- Medium to Easy
- Infiltration* --------- Medium to Difficult
- Filters -------------- Medium to Difficult
- Green Roofs --------- Medium
- Open Channels ------------ Medium to Easy

*Except drywells - Easy

Pollutant Removal Capability

Important when higher removals are required (see list in Section 3.2.3). **Table H-3/H-4** compares removal efficiencies for:

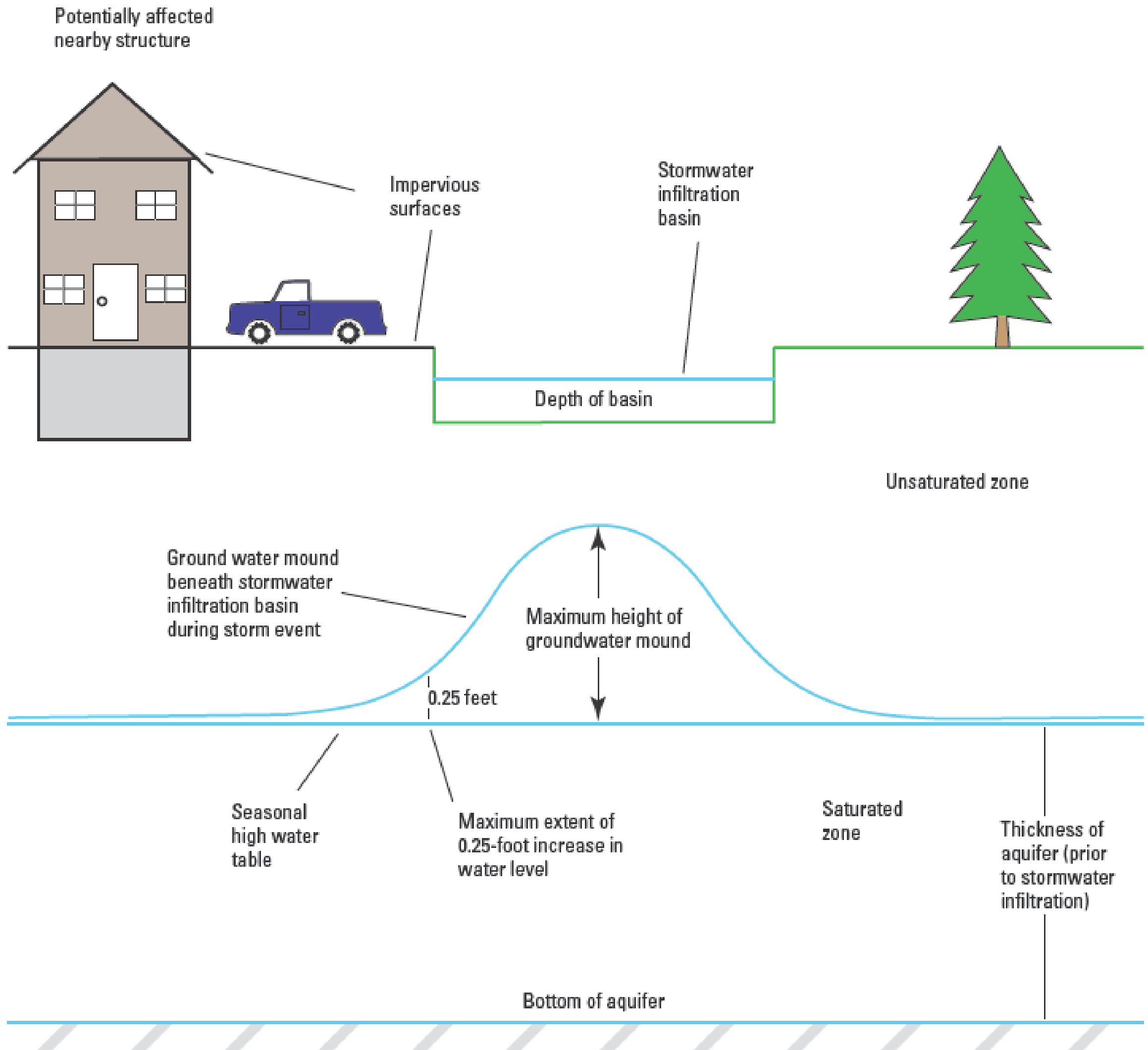
- Total Suspended Solids
- Total Phosphorus
- Total Nitrogen
- Bacteria

Questions?

Mounding Analysis

- When is it required?
  - Infiltration of stormwater (except for residential rooftops ≤ 1,000sf
  - Separation to SHGT < 4’
  - On-line practice accepting runoff from the 10-year storm event and greater
- What does it tell us?
  - Feasibility of proposed BMP
  - Effect on nearby structures, OWTSs, etc.
- How is it done?
  - Hantush Method or equivalent

Simulation of Groundwater Mounding Beneath Hypothetical Stormwater Infiltration Basins



http://pubs.usgs.gov/sir/2010/5102/

Scientific Investigations Report 2010–5102

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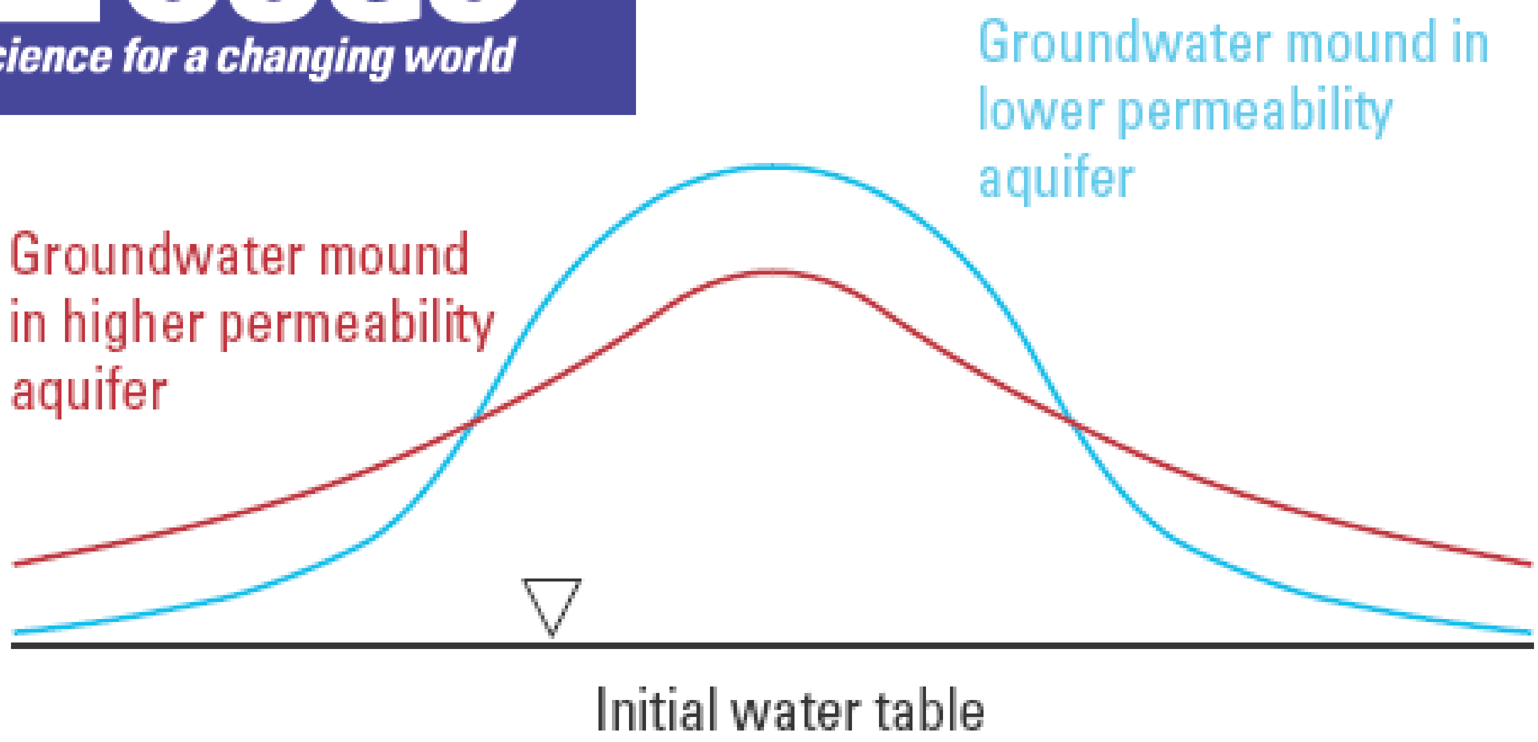
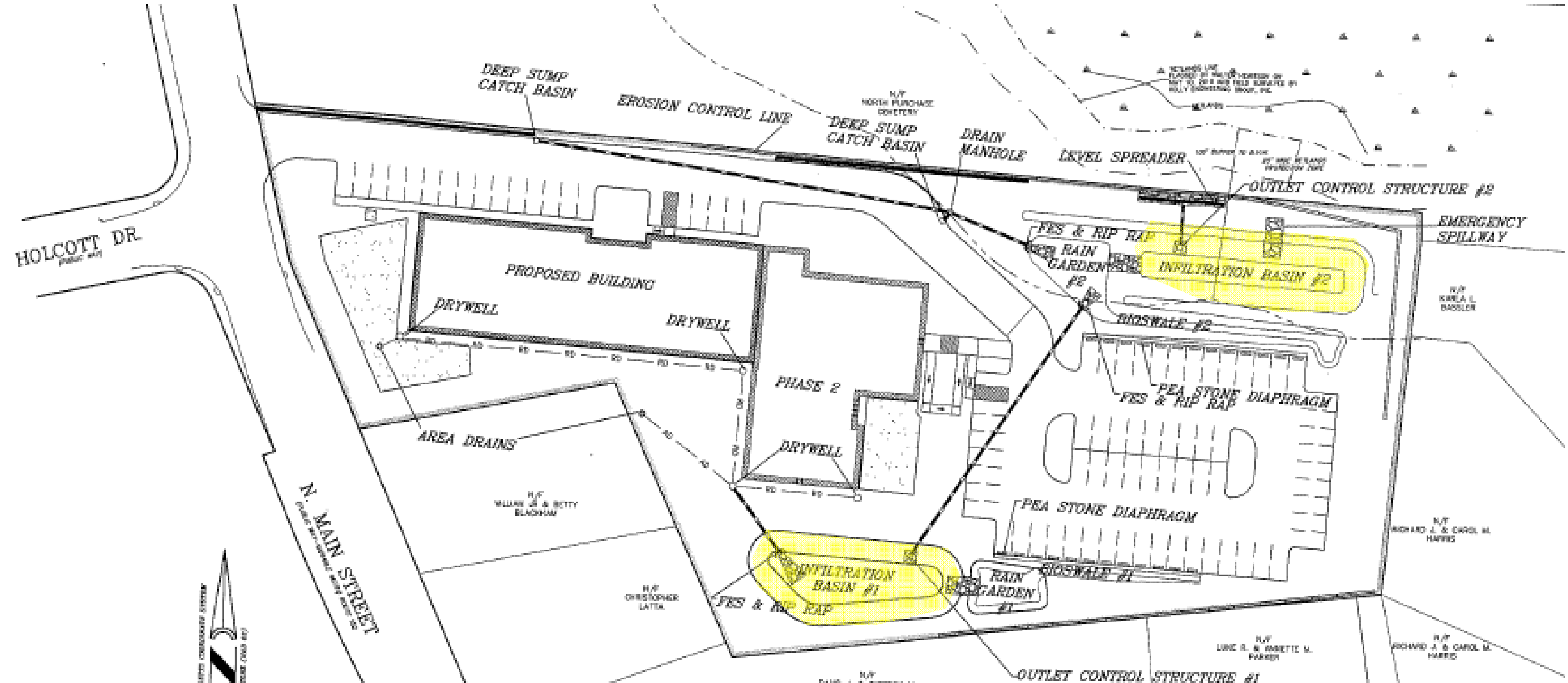


Figure 6. Schematic diagram showing relative shape of groundwater mounding in aquifers of higher and lower soil permeability.

GW Mounding Evaluation By Hantush Method (1967) - Input Parameters:

- Recharge Rate – Design infiltration rate.
- Hydraulic Conductivity – Property of aquifer. Should be determined by in-situ testing (e.g., pumping test or slug test on a well).
- Initial Saturated Thickness – Field-determined (soil boring) - the distance from water table down to first restrictive boundary.
- Specific Yield (Storage) – Estimate from literature values.
- Infiltration Basin Area – From design plans.
- Infiltration Time – Time required to infiltrate design storm volume at design infiltration rate.



Two Infiltration Basins ~ 350 ft apart

- Design Infiltration Rate = 4.82 ft/day (2.41 in/hr for loamy sand)
- Surface Areas:
  - Basin 1 = 2,180 ft
  - Basin 2 = 1,800 ft
- 10-Year Storm Volumes:
  - Basin 1 = 17,552 cf
  - Basin 2 = 13,622 cf

Example Mounding Analysis

Horsley Witten Group, Inc.

POND 1 – 10 YEAR Storm GW Mound

½ Basin Size !

Ignore These #'s

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)

use consistent units (e.g. feet & days or inches & hours)

Input Values		
4.8200	R	Recharge (infiltration) rate (feet/day)
0.200	Sy	Specific yield, Sy (dimensionless, between 0 and 1)
50.00	K	Horizontal hydraulic conductivity, Kh (feet/day)*
45.000	x	1/2 length of basin (x direction, in feet)
7.500	y	1/2 width of basin (y direction, in feet)
1.700	t	duration of infiltration period (days)
20.000	hi(0)	initial thickness of saturated zone (feet)
42.002	h(max)	maximum thickness of saturated zone (beneath center of basin at end of infiltration period)
22.002	Δh(max)	maximum groundwater mounding (beneath center of basin at end of infiltration period)

Conversion Table

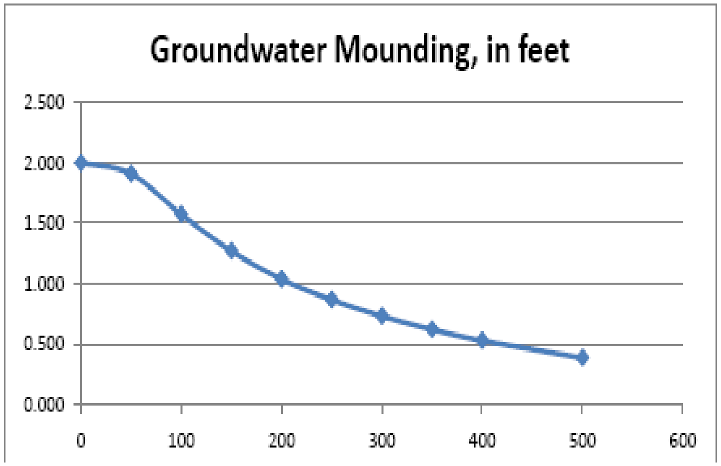
inch/hour	feet/day
0.67	1.33
2.00	4.00

hours	days
36	1.50

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

Ground-water Mounding, in feet	Distance from center of basin in x direction, in feet
2.002	0
1.910	50
1.576	100
1.273	150
1.039	200
0.868	250
0.734	300
0.623	350
0.531	400
0.387	500

Re-Calculate Now



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POND 2 – 10 YEAR Storm GW Mound

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.
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use consistent units (e.g. feet & days or inches & hours)

Input Values

4.8200	*R*	Recharge (infiltration) rate (feet/day)
0.200	Sy	Specific yield, Sy (dimensionless, between 0 and 1)
50.00	K	Horizontal hydraulic conductivity, Kh (feet/day)*
60.000	x	1/2 length of basin (x direction, in feet)
7.500	y	1/2 width of basin (y direction, in feet)
1.600	t	duration of infiltration period (days)
20.000	hi(0)	initial thickness of saturated zone (feet)

Conversion Table

inch/hour	feet/day
0.67	1.33
2.00	4.00

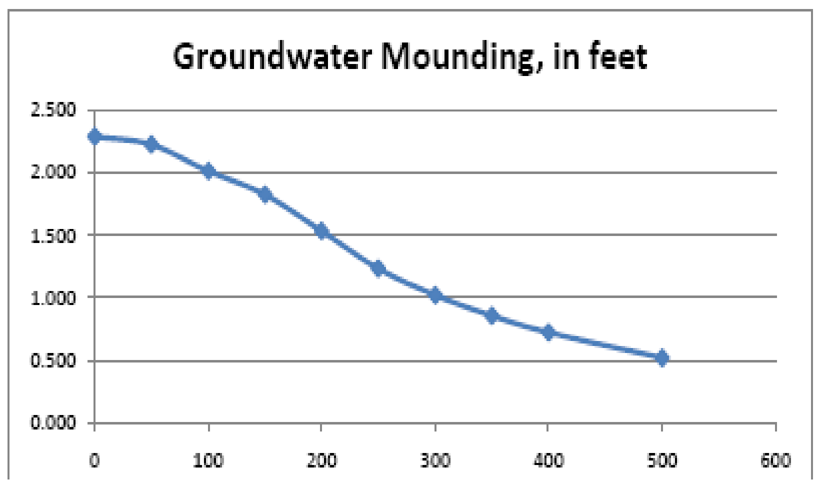
hours	days
36	1.50

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

42.290	h(max)	maximum thickness of saturated zone (beneath center of basin at end of infiltration period)
22.290	Δh(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
2.290	0
2.227	50
2.014	100
1.826	150
1.535	200
1.234	250
1.020	300
0.855	350
0.721	400

Re-Calculate Now



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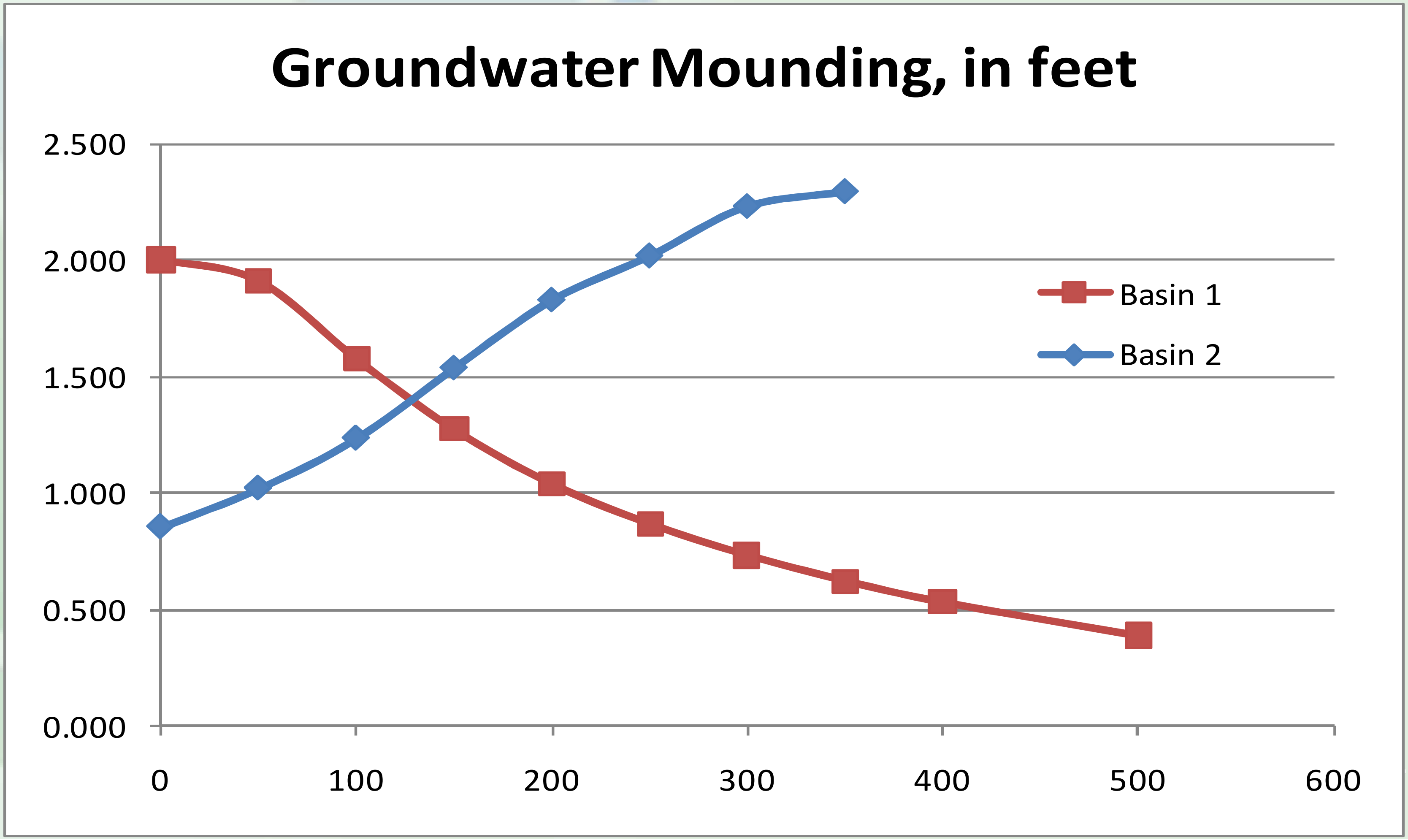
Interpreting Results

- 10-year storm groundwater mounding evaluation for two basins 350 ft apart



Questions?