Perched Water Table Mounding Between Subsoil Drains in Sand Fill over Guildford Formation

Written by:

Jim Davies (PhD, FIEAust, Member IPWEA, SIA WA Member)
Alex Rogers (BE(Env), MIEAust)
Gregorio Serafini (BE(Env))
JDA Consultant Hydrologists
Previous Work

A talk on this data was given by Alex Rogers, JDA Consultant Hydrologists, at the *SIA Hydropolis 2010*.

New work presented includes:

- Modflow modelling on a daily time step (previous talk was about the Kraijenhoff Van De Leur–Maasland's method).
- Modflow includes evaporation from shallow water table.
- Modflow analyses soil in layers (i.e. Sand over Clay).
StormTech® Trial Site Location

Southern River

DWMS Area

SUBSOIL DRAINAGE TRIAL

T120 (O) DOW BORE
Subsoil Test Site

Lab Hydraulic Conductivity Results:
91, 93 & 96% Max Dry Density Ratio – 5.1 / 4.6 / 2.7 m/day
Monitoring Layout

Legend
- Stormtech Trial Bores
  - Monitoring Bores
- Shallow Bores With Data Logger
  - P50/38W
  - P50S
- Control Deep Bore
  - C50D

2 x 100m StormTech Drains

40 m
Bore P50S Data Loggers Hydrograph and Daily Rainfall

JDA Consultant Hydrologists

Period: 1 Year  Plot Start: 00:00_01/01/2010
Interval: 1 Day  Plot End: 00:00_01/01/2011

Visit 18/8/10 drain unblocked - 26.50
Manual water level reading
26.44

See Fig 8 & 9 Cross Section

Missing data (interpolated)

22/3/10 Hail Storm

Total Jan - Oct 2010 - 526.8mm
Total Jan - Oct 2002 to 2009 (av) - 771.6mm

HYLOT V132  Output: 01/11/2010
Water Level Decline
15 July to 20 Oct 2010
Calibration on Pre-Dev Scenario

R-Squared = 0.94
Evaporation Effects

- Natural Surface of the Imported Sand-Fill Layer
- Sand-Clay Interface

Rainfall

- mAHD
- K=12, Sy=0.16 No Evap
- K=12, Sy=0.16 With Evap

Graph showing rainfall from 03/2010 to 10/2010 with daily rainfall in mm.
Calibration Acceptance Measure
Pre-Dev Max Mounding 3D Plot

Max Mounding at 26.74 mAHD

- Mounding Elevation [mAHD]
  - 26.9-27
  - 26.8-26.9
  - 26.7-26.8
  - 26.6-26.7
  - 26.5-26.6
  - 26.4-26.5
  - 26.3-26.4
  - 26.2-26.3
  - 26.1-26.2
  - 26-26.1
  - 25.9-26
  - 25.8-25.9
  - 25.7-25.8
  - 25.6-25.7
  - 25.5-25.6

Please note:
- Maximum mounding occurred on stress period #134 which corresponds to 12/07/2010
- Sand-fill layer surface (i.e. 27.5 mAHD circa) not displayed for enhanced mounding stratification
Post-Dev Scenario

Max Mounding:
2/8/2008 at 26.52 m AHD

Model parameters:
- $K = 12$ m/day
- $S_y = 0.16$
- $R = 0.4$
Max Mounding at 26.51 mAHD

Please note:
- Maximum mounding occurred on stress period #155 which corresponds to 2/08/2008
- Sand-fill layer surface (i.e. 27.5 mAHD circa) not displayed for enhanced mounding stratification
Conclusions

• First set of data on subsoil mounding in Perth.
• Perched water table develops in sand fill above a natural clay surface.
• Mounding develops progressively over the winter period.
• Max mounding is dependent upon recharge rate/amount, top soil conditions, hydrological soil properties (e.g. K, S_y), discharge coefficient and drain spacing.
• Modflow is an appropriate tool for modeling and estimating mounding height.
• When appropriately designed, subsoil drains can be an effective vector to obtain a Controlled Groundwater Level (CGL)
• Evaporation from shallow water table is negligible.
• Minimum sand-fill requirements should be flexible and based upon local weather and environmental conditions.