Groundwater Mounding
Causes, Issues and Prevention

WCOWMA - Onsite Wastewater
Association of BC
2017 Annual Convention and Tradeshow
March 11, 2017

Presented by
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INTRODUCTION

– What is groundwater mounding and why is it important?
– Basics of effluent and groundwater behavior in soil
– How is it related to vertical separation?
– Problematic site characteristics and how to recognize them
– Ways to manage and/or mitigate potential GW mounding
– When to call a professional?
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• KEY part of site assessment, soil evaluation and system design process
  – Setbacks and potential breakout locations
  – Soil properties
  – Limiting layers
  – Seasonal effects

• Possible system constraint per SPM

• May significantly affect your system design
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Groundwater Flow Basics

- In general, effluent and shallow GW flows downhill
- Many factors involved, but key factors are ground slope and soil permeability
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!!NOT TRUE*!!
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In almost all situations, GW is contained within pores within sediments, and within fractures within bedrock.
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Effluent Behavior in Soil

• Unsaturated Flow
  – Water moves over surface of soil particles
  – Slow, lots of time for oxygenation, chemical and biological treatment

• Saturated Flow
  – Water/effluent moves through pore spaces
  – Little oxygen available
  – Much faster compared to unsaturated flow
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- Groundwater mounding will occur when effluent reaches limiting layer or,
- Effluent is discharged into soil faster than it can migrate away

Key Issue – How to maintain sufficient vertical separation
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• **What is Vertical Separation?**
  – Distance between infiltration area and limiting layer
  – Bedrock, dense or low permeability soil, hardpan, or **groundwater**

• **Why do we need VS anyway?**
  – Critical to system performance
  – Most effluent treatment here
  – Water table surface is where biological treatment is supposed to be essentially complete

• **Common Standards**
  – Depends on soil characteristics and jurisdiction
  – Generally vary between 0.3 and 1.2 m
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**Groundwater Mounding**

- **Thin Aerated Soil**
- **Insufficient Treatment**
- **Anaerobic Conditions**
- **Very Limited Treatment**
- **Limiting Layer**

*Need to maintain this*
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More Considerations

• HLR = water dumped daily onto the same piece of land, every day, for a long time
  – Values in SPM based on soil infiltration characteristics, need to consider underlying materials
  – Too much will saturate soil, reduce or eliminate unsaturated flow, may cause GW mounding

Key Relevant Information

– Ground surface slope direction, and slope steepness
– Depth to groundwater or limiting layer
– Soil properties: hydraulic conductivity, structure, texture, compactness
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Consequences Of Failure To Recognize Potential Gw Mounding
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AVOID AREAS WHERE SURFACE FLOWS CONVERGE

GOOD LOCATION

965' 964' 963' 962' 961' 960' 959'
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Infiltration area

No limiting layer

Basement

Tank
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- Infiltration Area
- Limiting layer
- Basement
- Groundwater Mound
- Tank

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Avoid areas where surface flows converge.
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Tank

Infiltration area

No Limiting Layer
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- Tank
- Groundwater Mound
- Limiting Layer
- Infiltration Area
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- Well
- Tank
- Infiltration area
- No limiting layer or High K soil
- Groundwater Flow
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Important - Water well can be any direction from infiltration area for this to happen
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How To Identify Where Mounding May Be An Issue

• Three Levels of Assessment
  – Area-wide Assessment
  – Lot Scale - Test Pit Assessment
  – Hand-Sample Characterization
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• Area- Wide Assessment
  – Make sure potential impacts from mounding are identified and accounted for
  – Make sure system design is appropriate for entire area, not just the individual lot
  – Identify potentially limiting factors that may be evident on adjacent lands
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Area-wide Observations

- Standing water, wetland / swampy areas
- Hydrophilic vegetation (willows, alders/poplars, ferns, skunk cabbage, etc)
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Area-wide Observations

- Topographic Slope (shallow GW flow direction)
- Exposed bedrock, large rocks at the ground surface
- Nearby GW seepage, potential breakout locations
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More Area-wide Considerations

- Effects of location / season / climate / weather on field observations
- Temporary standing water
- Abundant precip vs limited precip
- Abundant evaporation vs limited evaporation

*Identify where effluent could go and what could be affected*
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Lot Scale - Test Pit Profiles
– Focus on proposed disposal area
– Test pits are better than auger holes
– More than 2 may be required

– Test pits are THE best way to identify potential mounding conditions
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Test Pit Profiles

A (THE?) KEY INDICATOR OF POTENTIAL PROBLEMS
PERMEABLE SOIL (HIGH HLR) OVER LOW PERMEABILITY SOIL / LIMITING LAYER (WATER, BR, TILL/HARDPAN, SILT, CLAY)
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Test Pit Profiles

• Increasing soil density with depth (harder digging, penetration resistance)
• Digging artifacts - smearing
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Test Pit Profiles

- Digging artifacts - bucket teeth marks
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Test Pit Profiles
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Test Pit Profiles

• Barriers to vertical flow
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Test Pit Profiles

- Increasing rocks, cobbles and boulders with depth
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Test Pit Profiles
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Test Pit Profiles

- Lack of soil structure
- Stiff / smeared sidewalls
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Test Pit Profiles

- Soil color changes – generally darker with depth (gray, olive brown)
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Test Pit Profiles

• Seepage Into Test Pit
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- Obscure / unusual Soils, TP profile
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Test Pit Profiles

- Stiff sidewalls
- Darker soil with depth
- Seepage into test pit
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Test Pit Profiles
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Test Pit Profiles

- Staining, mottles = *Seasonal Saturation*
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Test Pit Profiles

- Mottles
- Gray soil with depth
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Test Pit Profiles

- Staining, mottles
- Seasonal saturation
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Test Pit Profiles

• Opposite of limiting layer –
• Preferential Effluent Flow Pathways

*Beware of utility trenches!*
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Smallest Site Factors – Hand-Held Soil Characteristics

- Use to confirm/support test pit observations, refine estimates of soil infiltration capacity
- Key factors: color, density (consistence), texture (composition) moisture content, clay plasticity, nodules, cementation

![Mason Jar Soil Test](https://www.preparednessmama.com)

- Clay layer – water clears
- Silt layer – 2 hours
- Sand layers – 1 minute

20% Clay
35% Silt
45% Sand

www.PreparednessMama.com

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Smallest Site Factors – Hand-held Soil Characteristics

• If soil is classified silt/silt loam or clay/clay loam, then possible low infiltration potential / permeability problems

Combined with other site characteristics, may indicate potential mounding issues
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Soil Permeability Characteristics

- Continuum between amazingly high (clean sand & gravel) and amazingly low (silt & clay)

- Primary factor which governs effluent and GW flow movement and velocity in soil

<table>
<thead>
<tr>
<th>Type of Soil</th>
<th>Gradation</th>
<th>$k$ Value in mm/s</th>
<th>$k$ Value in m/day (after Schöller, 1962)</th>
<th>Degree of Permeability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gravels</td>
<td>Coarse</td>
<td>10 to 1</td>
<td>1 to $&gt;10^3$</td>
<td>High</td>
</tr>
<tr>
<td></td>
<td>Medium</td>
<td>1 to $10^{-1}$</td>
<td>1 to $2 \times 10^2$</td>
<td>Medium</td>
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<tr>
<td></td>
<td>Fine</td>
<td>$10^{-1}$ to $10^{-2}$</td>
<td>10$^{-1}$ to 10</td>
<td>Very Low</td>
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<tr>
<td>Sands</td>
<td>Coarse</td>
<td>$10^{-2}$ to $10^{-3}$</td>
<td>10$^{-1}$ to 10</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td>Medium</td>
<td>$10^{-3}$ to $10^{-4}$</td>
<td>10$^{-1}$ to 10</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td>Fine</td>
<td>$10^{-4}$ to $10^{-5}$</td>
<td>10$^{-1}$ to 10</td>
<td>Very Low</td>
</tr>
<tr>
<td>Silt and Peats</td>
<td>Coarse</td>
<td>$10^{-4}$ to $10^{-5}$</td>
<td>10$^{-1}$ to 10</td>
<td>Practically Impermeable</td>
</tr>
<tr>
<td>Clays</td>
<td>Coarse</td>
<td>$10^{-6}$ to $10^{-8}$</td>
<td>$10^{-3}$ to $10^{-7}$</td>
<td>Practically Impermeable</td>
</tr>
</tbody>
</table>
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• Groundwater Mounding Considerations
  – Will a mound occur beneath the infiltration area?
  – If so, how big could it become?
    • Horizontal and Vertical Extents
  – What could be affected?
    • Potential breakout
    • Seepage into buildings
    • Impact nearby potable water supply
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If GW Mounding May Occur

- Increase infiltration area – reduce HLR
- Increase VS - construct mound
- Decrease VS requirements – improve effluent quality
- Improve effluent quality and reduce required area
  - Type 2 system can decrease area by up to ±30%
- Decrease dose volume and increase dose frequency
- Other site-specific methods – install GW cut-off wall, etc
- Find new disposal area

If All Else Fails - Obtain Specialized Expertise
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Specialized expertise could include

- Conduct more detailed site assessment
- Identify GW flow direction and potential downgradient receptors
- Identify more suitable disposal locations
- Estimate possible groundwater mounding amount and effects
- Help with upgrading treatment and disposal design
- Interface with owners and regulators
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• Comments??

• Questions???
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• Perc Tests vs Perm Tests vs Soil Profiles
  – All methods to estimate / measure soil permeability
  – Perc tests very simple but fundamentally flawed
    • Disturbed fines often reduces infiltration rate, especially after repeated tests
  – Perm tests more accurate and more consistent
  – Soil profiles alone can be OK, but very subjective
    • Not quantitative – no data to support design or to troubleshoot problems
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Large Site Factors – BC Soil Survey Information

- Soil parent material
- Soil drainage characteristics
- Other useful information

**Hsl – Nahun sandy loam**
- Fine textured surface layer overlying coarse gravelly cobbly sand, can also overly areas of reworked glacial till
- A/B5- Steep irregular slopes
- Well drained
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Once effluent gets into shallow GW, it may travel quite a long ways

- Bacteria and viruses can travel several hundred meters downslope, nitrates even further
- Steep gradient – long narrow contaminant plume
- Flat gradient – wide contaminant plume
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**SSR 30 m Setback Distance**

- “Approved” safe distance from wells, lakes, creeks, etc.
- First required in the **1893 BC Health Act**
- Based on what seemed reasonable at the time
- Is it prudent to apply this to all situations?