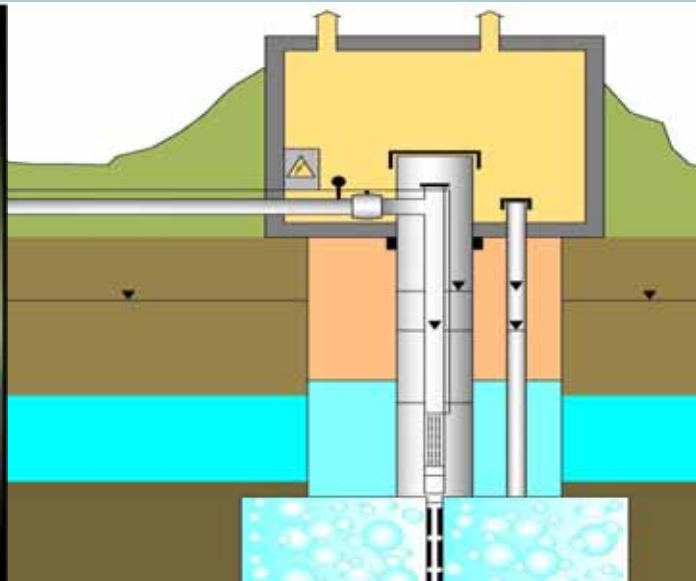
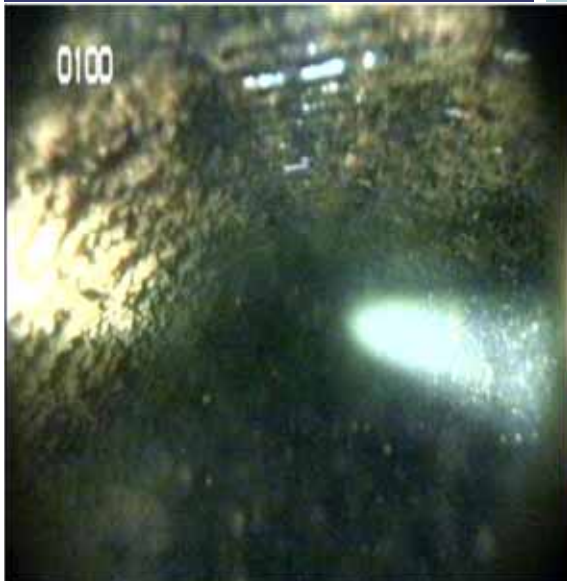


## Water Well Going Dry...Re-drill or Rehab?

2014 Clean & Safe Drinking Water Workshop, Gander, NL

Gil Violette, M.Sc.E., P.Eng., AMEC



## Wilmot Park Wellfield – Fredericton, NB

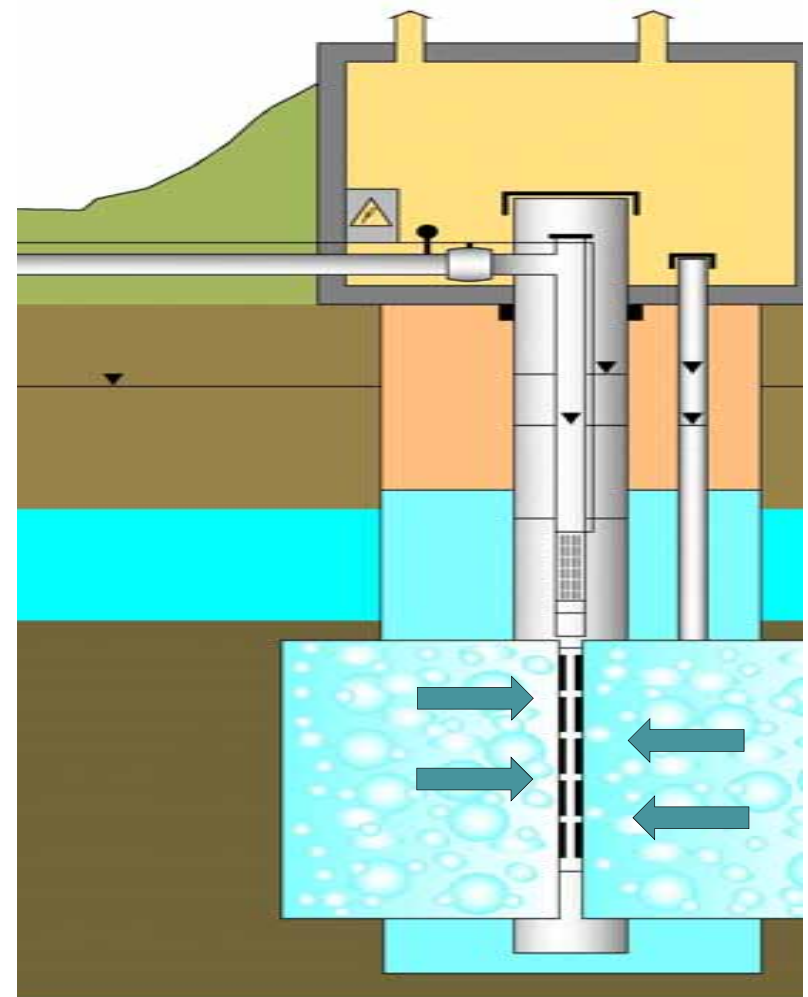


## Outline

- *Near-well aquifer conditions*
- *Well Performance Issues*
- *Decision, Decision: What should be done? Cost of re-drilling?  
Cost of Treatment?  
...Re-drill or Rehab?*

# Well Components

- Several mechanical and electrical components
- Ongoing maintenance required
- Well screen and beyond also require maintenance
- Flow of water entering the well should be as easy as possible

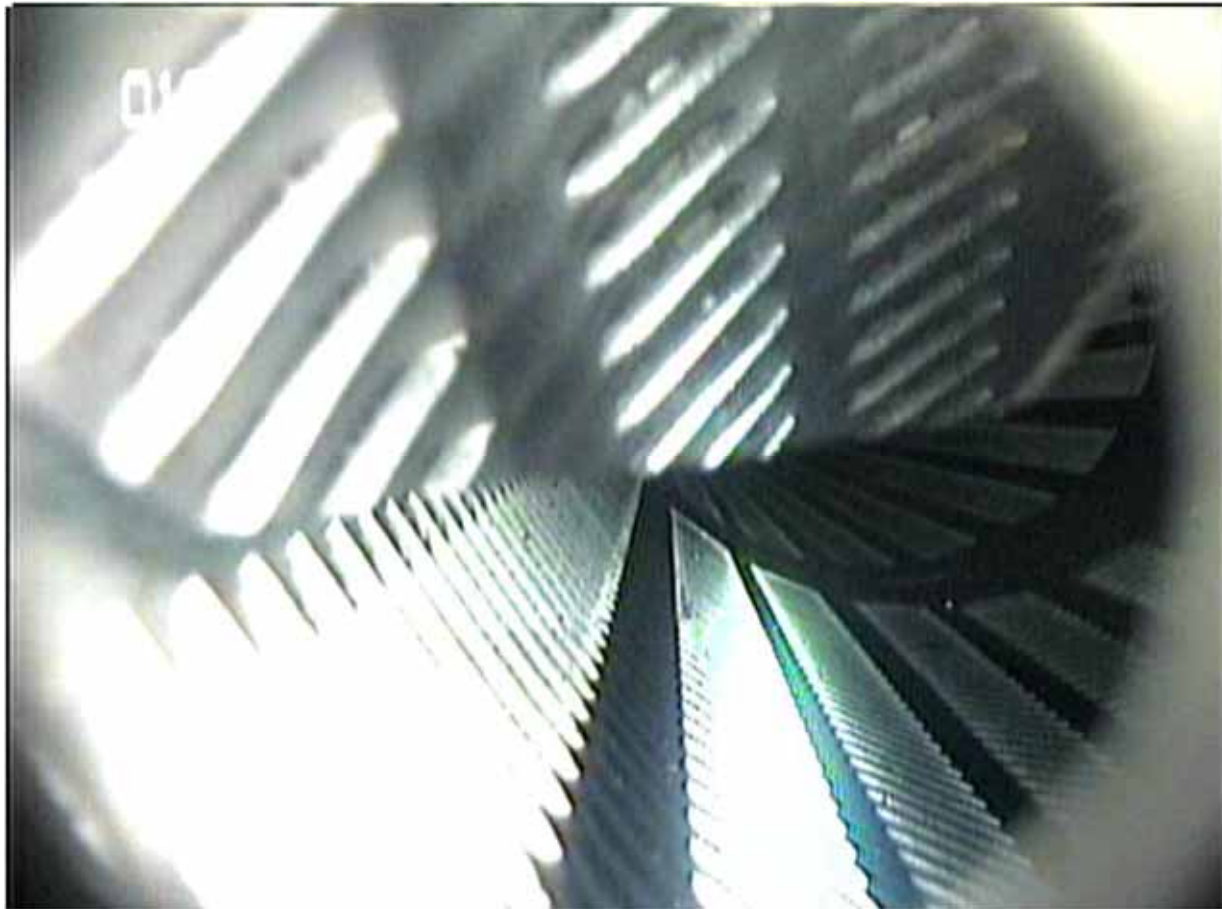


# Corrosion / Biofouling – Pump Column

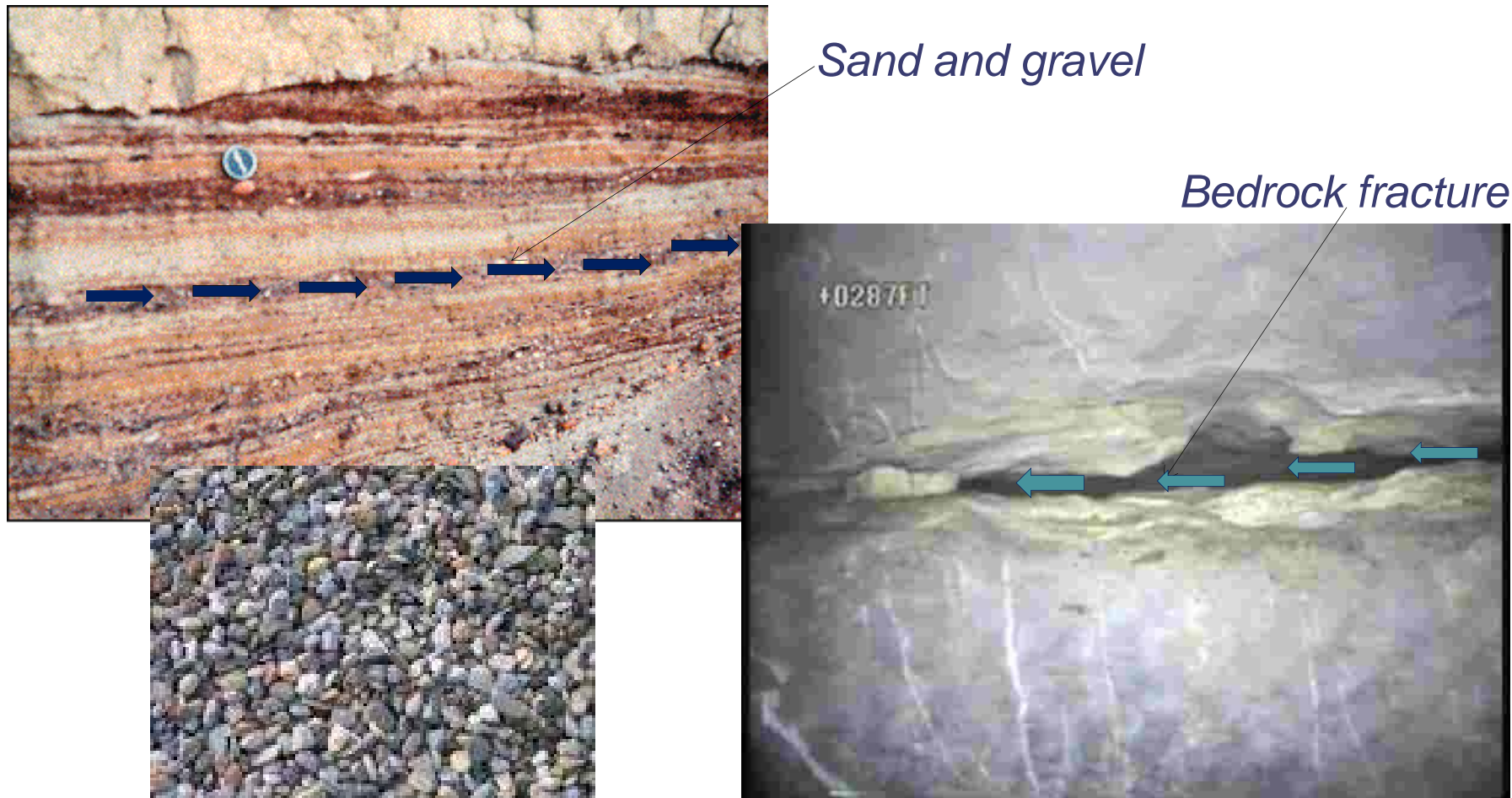
nodules



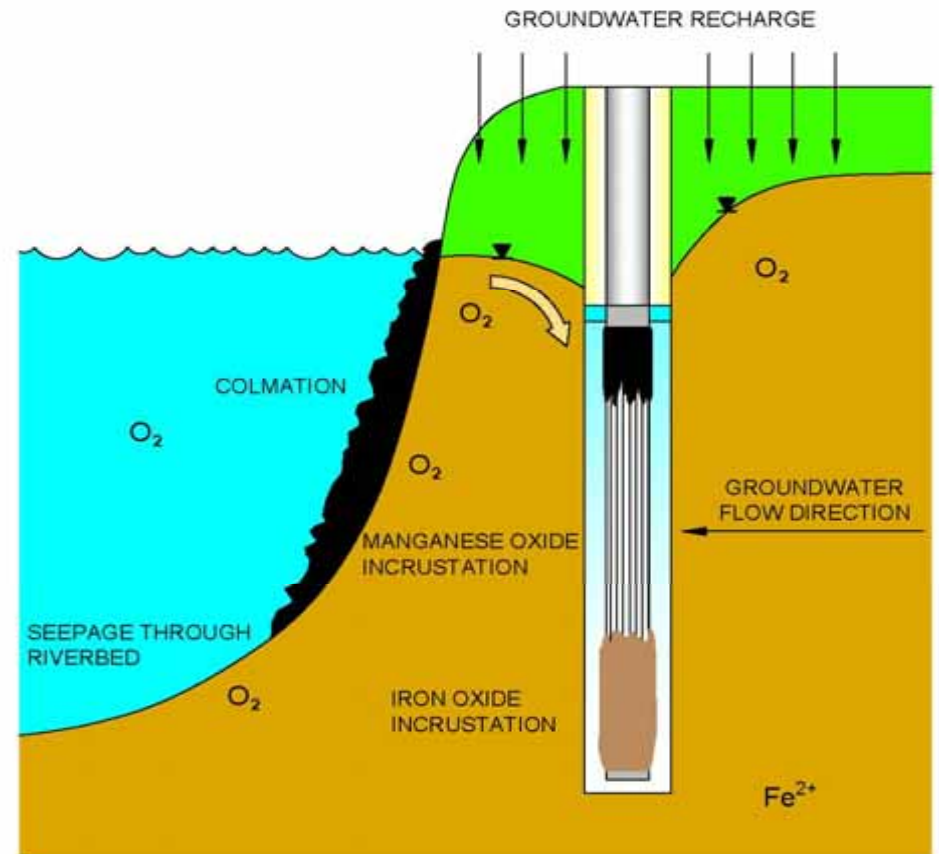
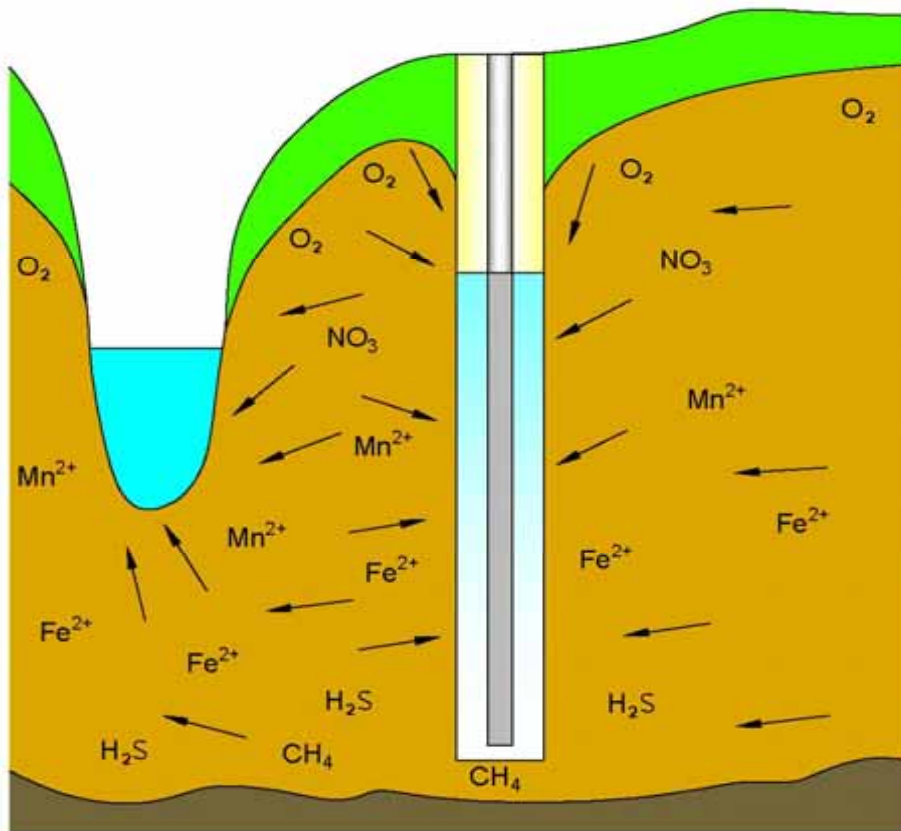
# Encrustation / Clogging – growth in well



# Biofouling – Aquifer Formation



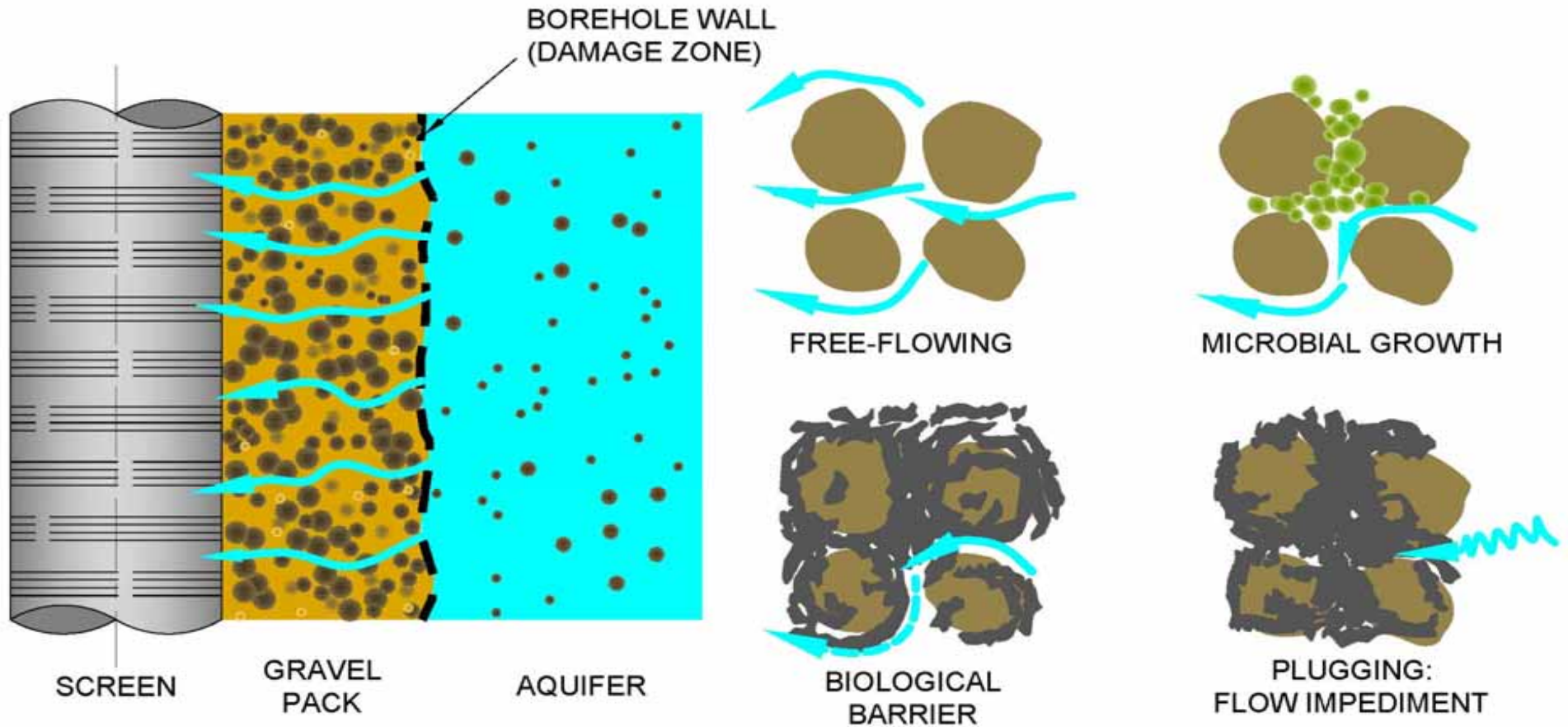
## Aquifer/Screen Plugging/Clogging



Images adapted from Droycon Bioconcepts

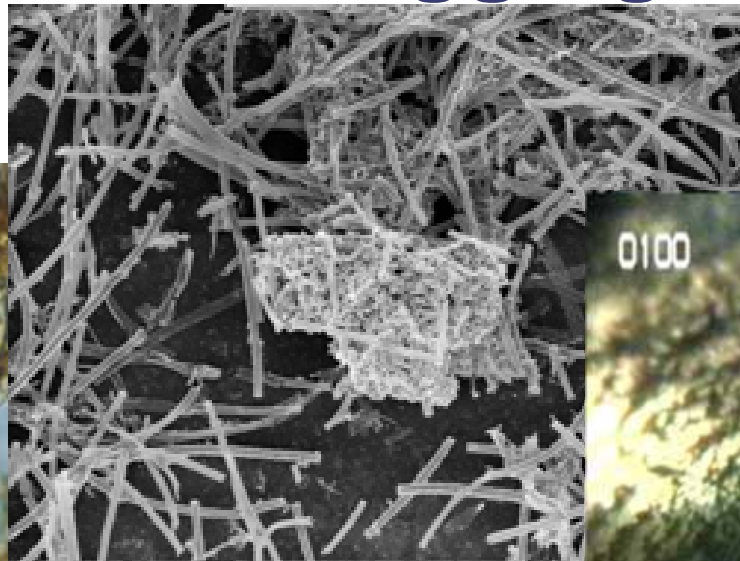


## Aquifer/Screen Plugging/Clogging

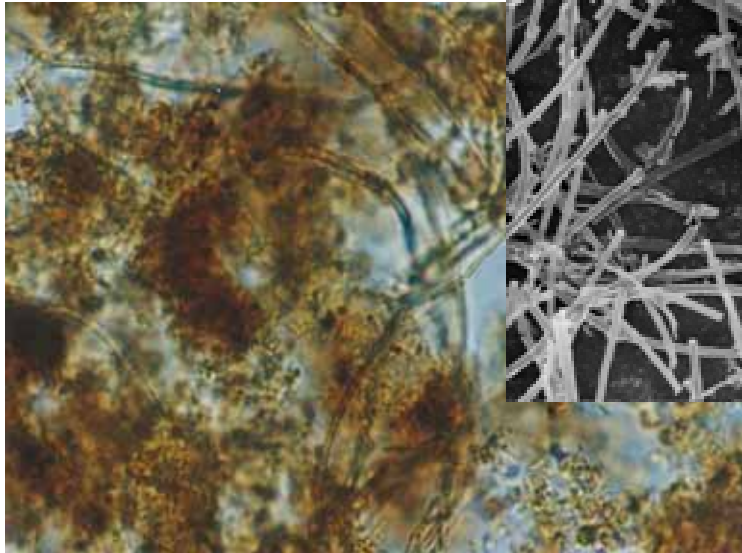


Images adapted from Droycon Bioconcepts

# Aquifer/Screen Plugging/Clogging



*Filamentous  
Biofilm*



*Iron Bacteria*



*Moss-like cover on well screen*

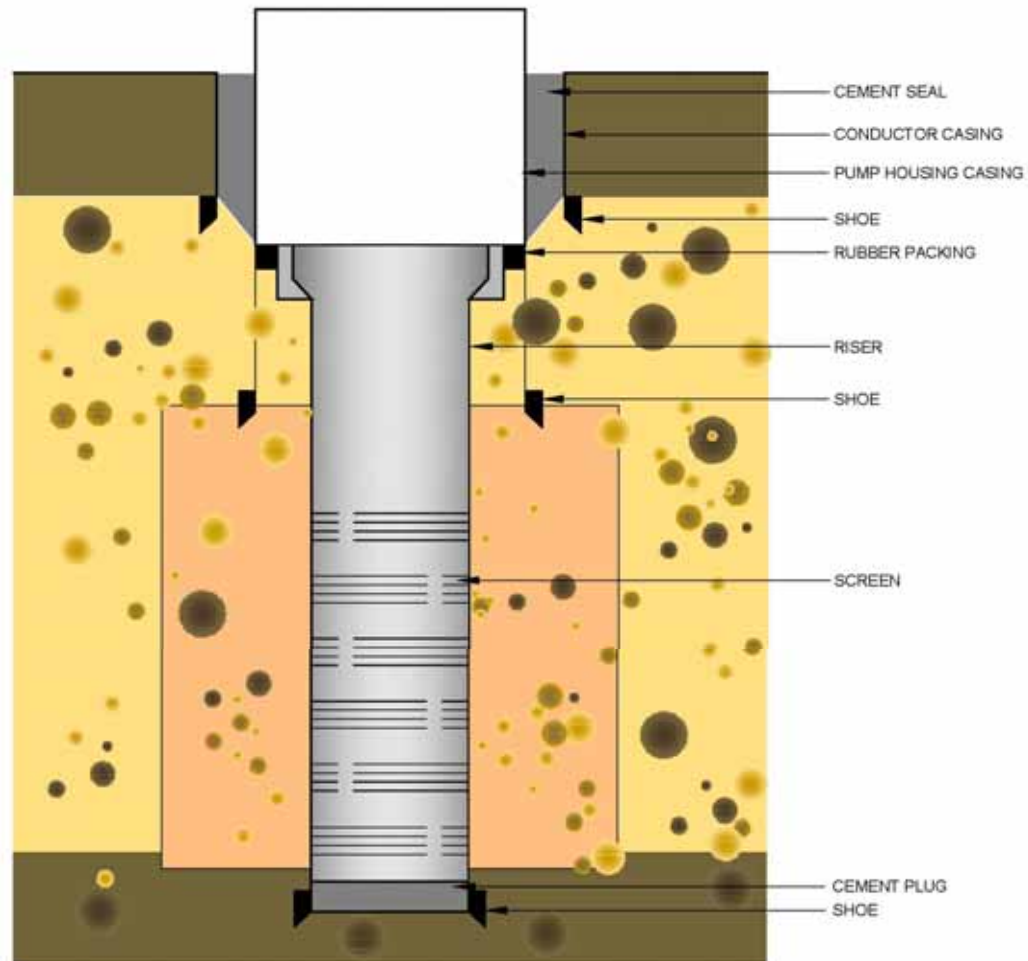
Photos from Groundwater Science, City of Fredericton

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***Biofouling :***  
***Most common type of bacteria***

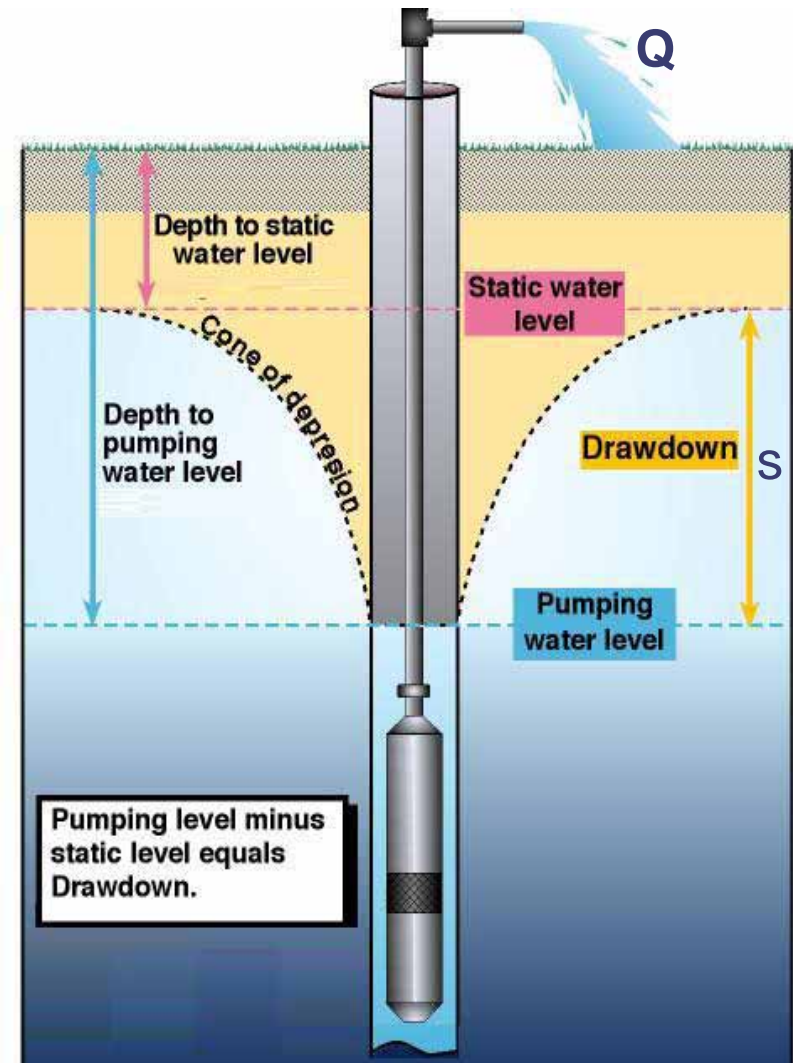
- Iron Bacteria (IRB)
- Sulphate Reducing Bacteria (SRB)
- Heterotrophic Aerobic Bacteria (HAB)
- Slime Forming Bacteria (SLYM)

## Aquifer/Screen Plugging/Clogging



## Key Well Performance Indicators

- Factors leading to loss of performance
  - Discharge (Q)
  - Drawdown (s)
  - Specific Capacity ( $SC=Q/s$ )
  - Well Efficiency
  - Geochemistry, microbiology
- Require historical measurements







## ***Well Efficiency: Multi-Step Pumping Test***

### **Walton's C Factor ( $\text{min}^2/\text{m}^5$ ) for Well Efficiency**

<b>&lt; 0.5</b>	<i>Properly Designed</i>
<b>0.5 to 1</b>	<i>Mild Deterioration</i>
<b>1 to 4</b>	<i>Severely Clogged</i>
<b>&gt; 4</b>	<i>Difficult / Impossible to Restore</i>



# *Changes in the aquifer*

- **Sedimentation:**
  - Fine Particles – silt and sand (**Clogging**)
- **Encrustation:**
  - Chemical Deposits such as Calcite, Gypsum (**Corrosion**)
- **Biofouling:**
  - Growth of Naturally Occurring Bacteria (**Plugging**)

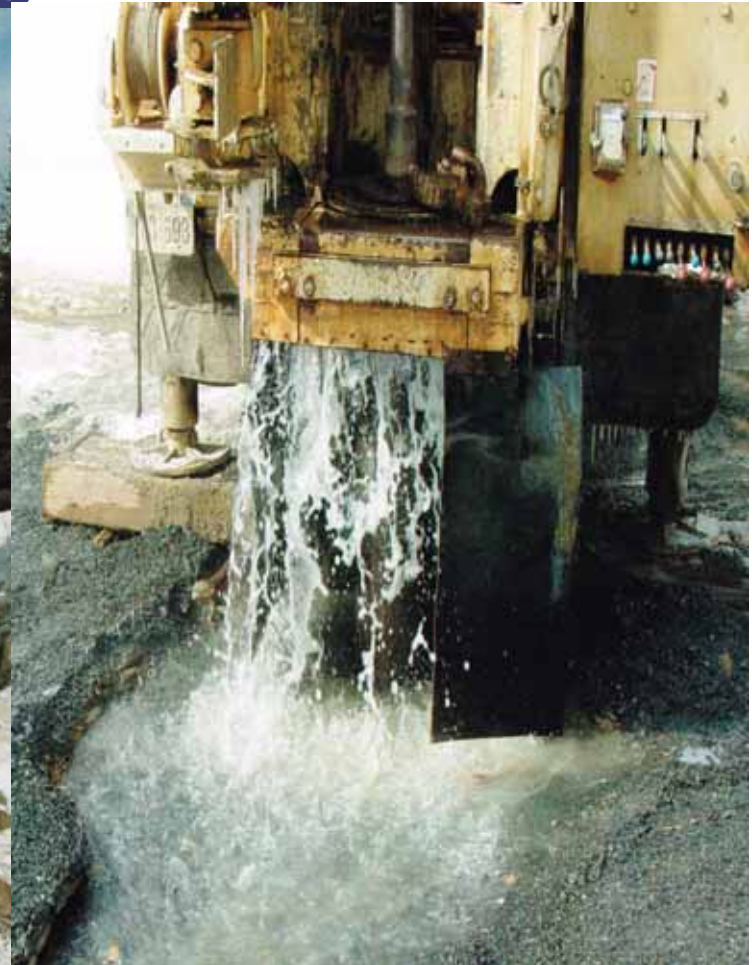
### *Recognizing the signs...*

- Drawdown has increased by 50%? **Action**
- Pumping rate decrease > 50%? **Action**
- Specific Capacity decrease > 25 to 50%? **Action**
- Walton's Well Efficiency (C) > 0.5 **Action**
- Screen area plugged > 50% **Action**
- Nearby wells shown signs of biofouling? **Action**

### ***Do-nothing approach:***

- **Something is still happening...**
- Production issues with well, decrease discharge
- Drawdown issues, changes in pump placement
- Rising power costs due to higher head to pump (>s)
- Issues get worse, cost to rehab increases
- Could lead to permanent loss of well

## *Well Drilling:*



## Re-drill - Pro/Cons:

Pros	Cons
<b>Re-drill at same site</b>	
Regain Q	Problems can return
Small well, costs are low	Large well, costly redo
Re-use infrastructure	
<b>Re-drill at new site</b>	
Issues are gone	Lengthy timeline
Small well, costs are low	Large well, costly redo
	New distribution infrastructure

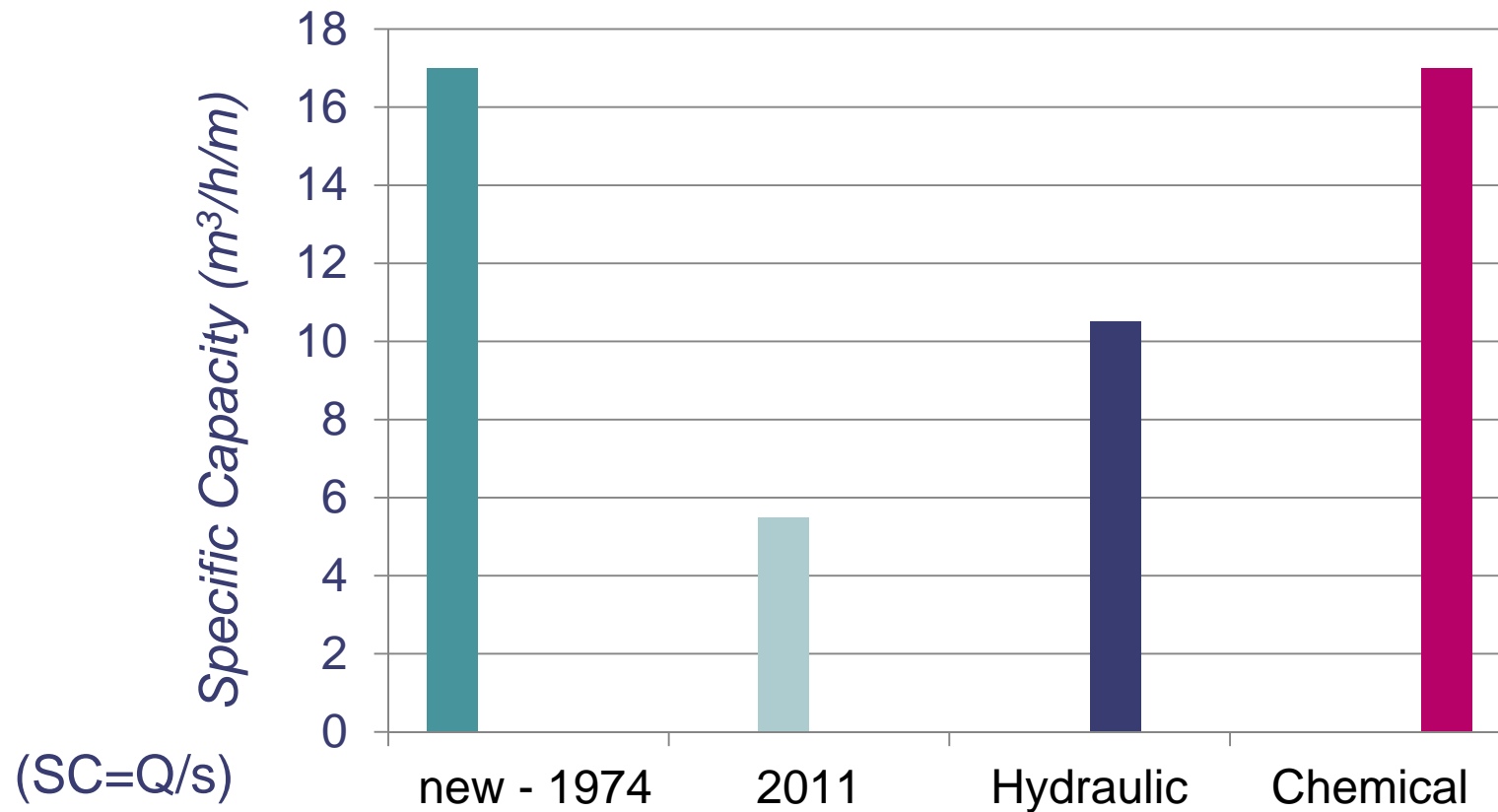
# ***Rehab: many methods available***

- Methods depend on:
  - Type of problem
  - type of well
  - type of aquifer
- Each situation can bring on customized solution
- Method can range from ***inserting 'Javex' down the well ...***  
to a ...  
  
***two week aggressive chemical injection / well re-development***  
approach

## *Rehab - Pro/Cons:*

Pros	Cons
Regain Q very quickly	Preventative program
Low costs	Frequency of treatment unknown
Short well shut-down	Can damage well
Re-use infrastructure	
Can extend life of well indefinitely	

# Hydraulic-Chemical Aquifer Regeneration



Dr. C. Treskatis, Water World Volume 36, Issue 6, December 2013





# *Hydraulic Aquifer Regeneration*

## *Wire Brush / Swab*

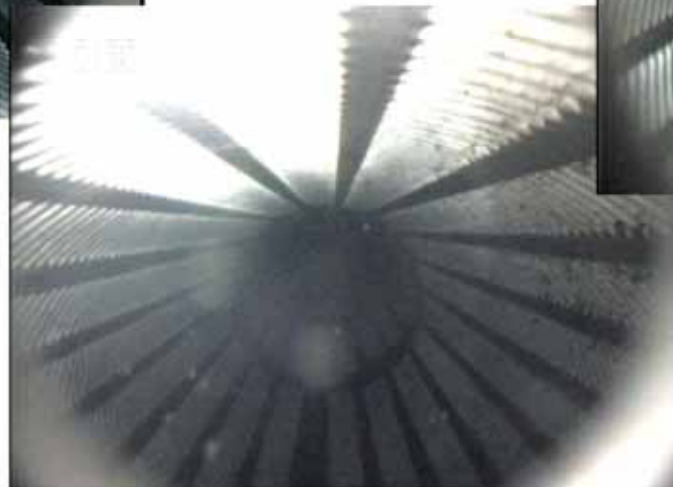


# *Chemical Aquifer Regeneration*



City of Fredericton

# Aquifer Well Screen



Photos from City of Fredericton

## Good connection with aquifer



Photo from City of Fredericton

### *in Conclusion...*

- Water well performance declines with age of well
- Determine cause of loss of Q or increased s, including:
  - *hydraulic tests*
  - *biological tests*
  - *downhole camera visuals*
  - *maintain historic data*
- Evaluate **DO-NOTHING, RE-DRILL OR REHAB** approaches
- If choosing rehab route, **TAKE ACTION**, the longer the issues persist, the more costly rehab becomes
- Water wells are major investment for municipalities, best to have them perform for the longest period possible

## Questions?

