

# WELLS AND SURFACE WATER: INTERACTION AND INFLUENCE



# PRESENTATION OUTLINE

- **ISSUES FACING WELL USERS**
- **INCREASED PUBLIC AWARENESS AND UNCERTAINTY**
- **FUNDAMENTAL CONCEPTS**
- **GROUNDWATER VIEWPOINT (“The Well”)**
- **SURFACE WATER VIEWPOINT**
- **PRACTICAL SCREENING TOOLS**
- **SUGGESTED RECOMMENDATIONS TO CLIENTS**

**ISSUES FACING WELL USERS**



**INCREASED PUBLIC AWARENESS  
AND UNCERTAINTY**

# ISSUES FACING WELL USERS

- **INCREASING DEMAND FOR WATER SOURCES**
  - Urban Development, First Nation and Private Rural Subdivisions
  - Agriculture
  - Industry
- **COMPETING INTERESTS FOR GROUNDWATER**
  - Domestic (Municipal vs. Private Utility vs. Residential)
  - Irrigation
  - Fisheries and Environment
  - Industry
- **RAPID PACE OF GROUNDWATER DEVELOPMENT**
  - Explosion of new well construction
  - Limited regulation of development (excl. large-scale and/or Federal Grants)
  - Lack of follow-up monitoring to confirm sustainability of groundwater development and impacts on surface water
  - Lack of follow-up water quality monitoring (groundwater and surface water)

# INCREASED PUBLIC AWARENESS

- **IMPROVED UNDERSTANDING OF HOW SURFACE WATER AND GROUNDWATER INTERACT**
  - Groundwater is typically not “isolated” from nearby surface waters
  - Soils may not adequately “filter” surface water before it recharges groundwater
  - Microorganisms can be transferred from surface water to groundwater
- **INCREASED AWARENESS OF WATER QUALITY ON PUBLIC HEALTH**
  - Walkerton (May 2000: 2300 sick and 7 deaths) resulted from E.Coli contamination of a well due to manure spreading on a local farm (farmer followed approved guidelines)
  - Frequency of Water Advisories in BC (number in 100's)
- **SURFACE WATERS AND GROUNDWATERS ARE VULNERABLE TO CONTAMINATION AND DEPLETION FROM A VARIETY OF SOURCES (NOT JUST HUMAN IMPACTS)**
- **PUBLIC IS BETTER INFORMED BUT UNCERTAIN...**
  - Is there enough to go around ? Who is protecting their water ? What can they do to help ? How much will it cost ?

# **FUNDAMENTAL CONCEPTS**



**Surface Waters**

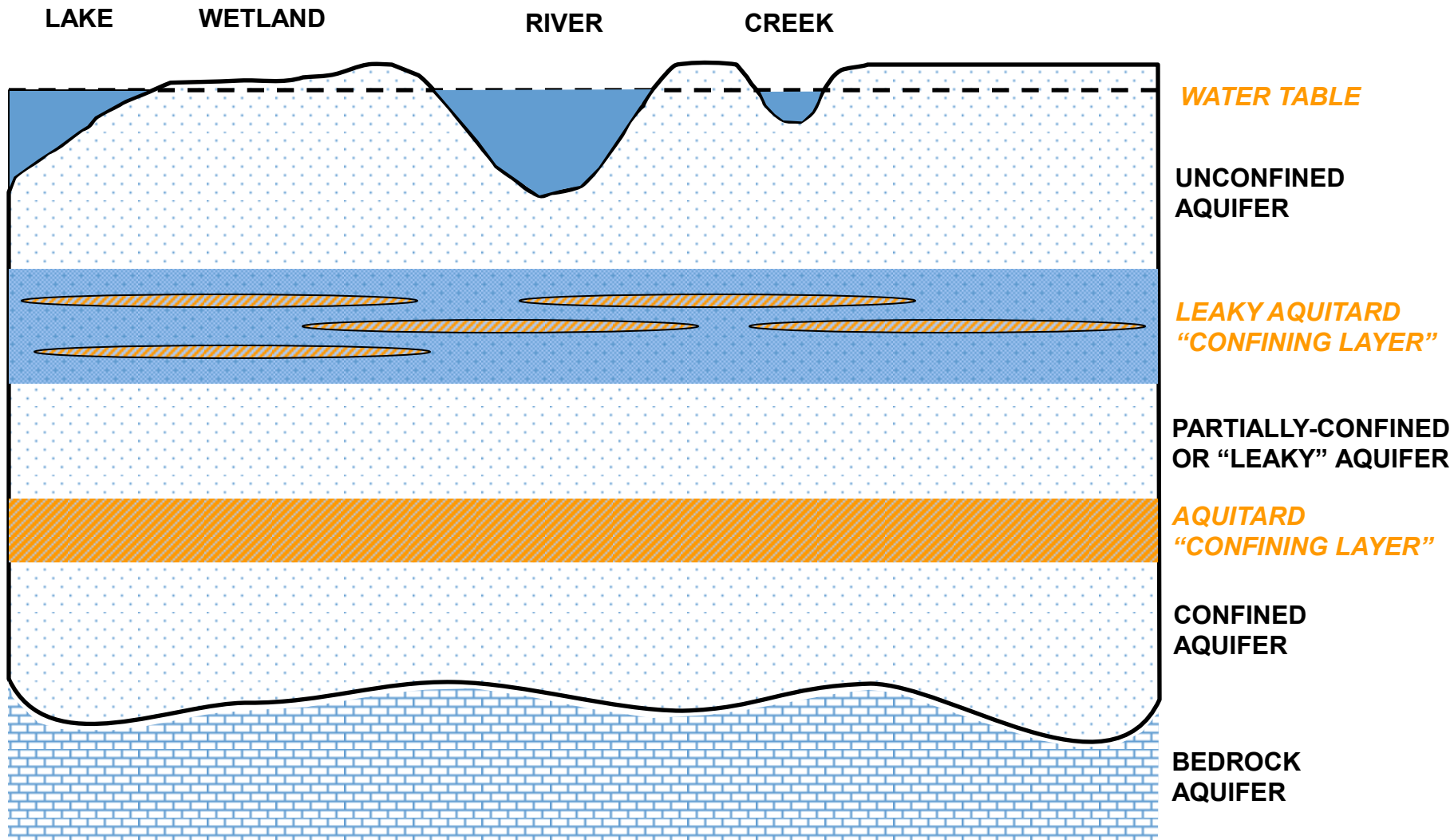
**Aquifers**

**Interaction**

**Ground Water Under Direct Influence**

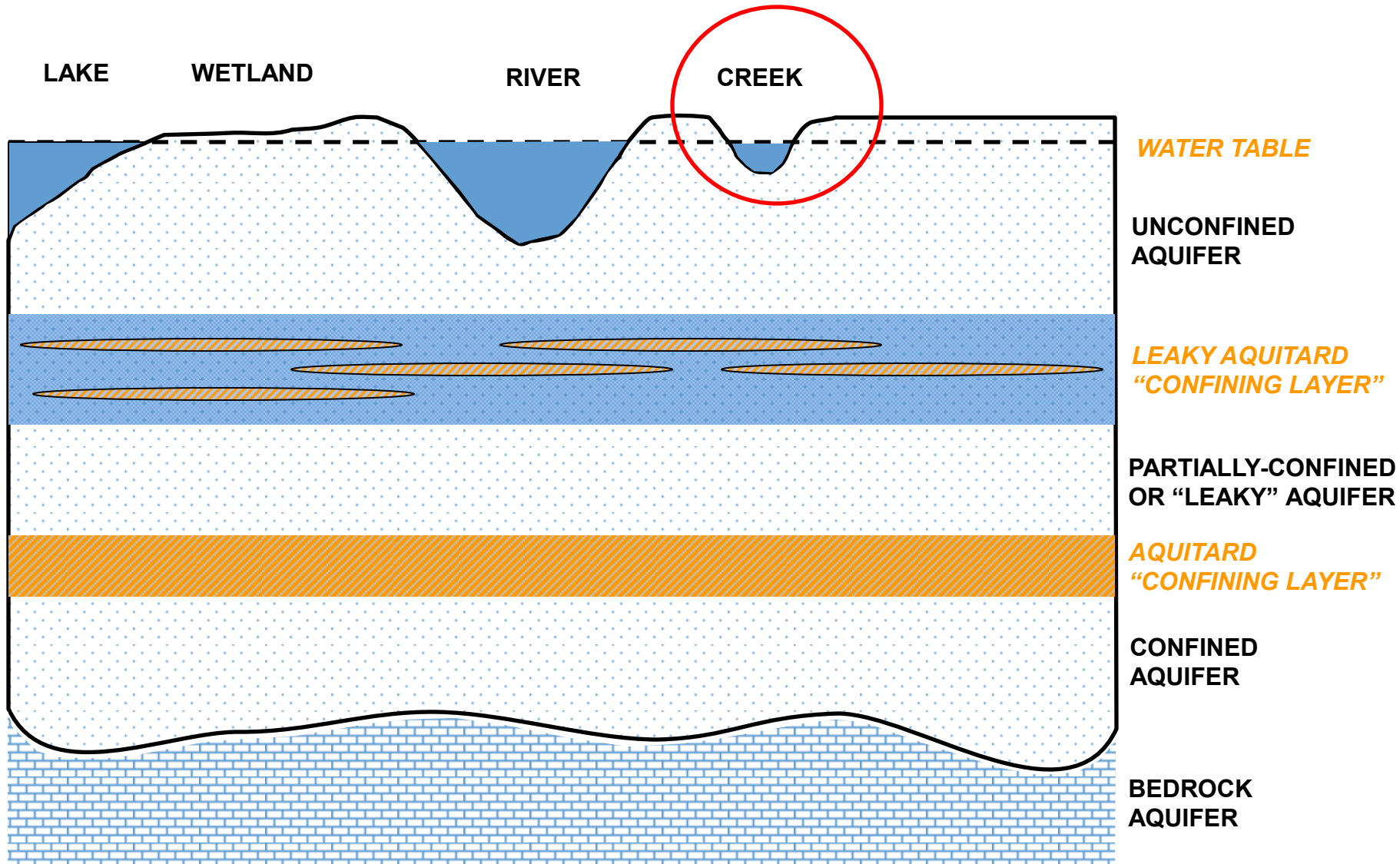
# FUNDAMENTAL CONCEPTS

## - Surface Waters and Aquifers -



# FUNDAMENTAL CONCEPTS

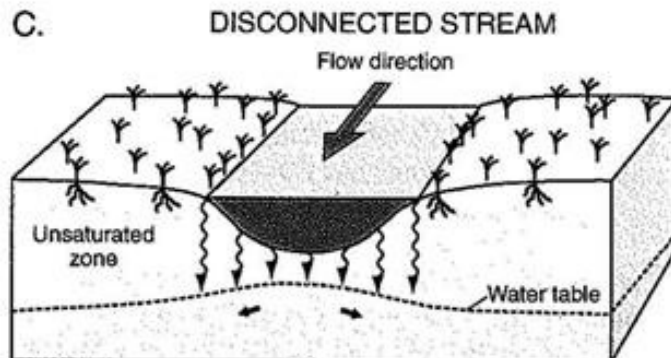
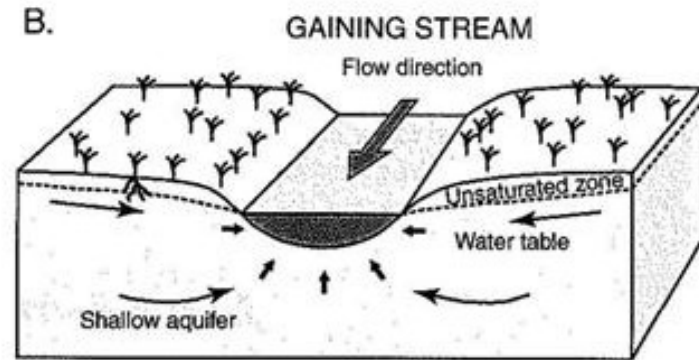
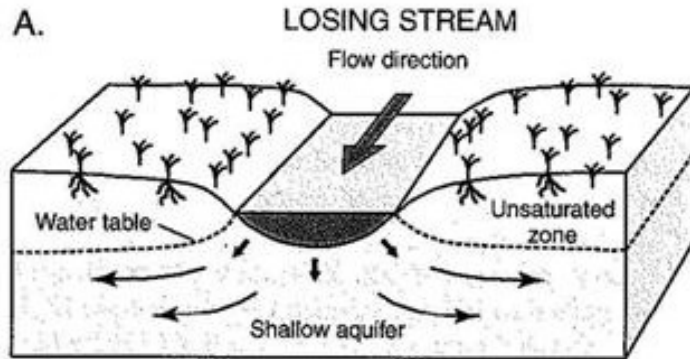
## - Surface Water / Groundwater Interaction (Creek) -



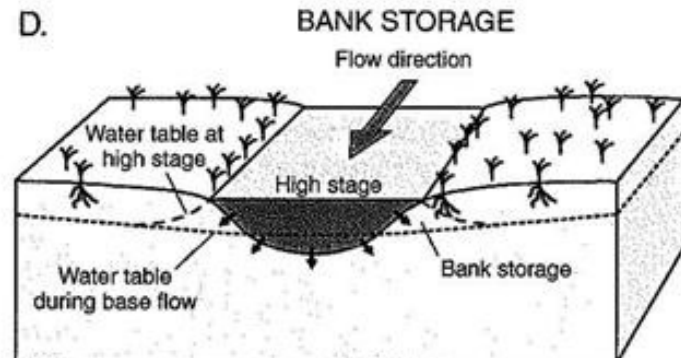


# FUNDAMENTAL CONCEPTS

## - Surface Water / Groundwater Interaction -



Disconnected streams are separated from the ground-water system by an unsaturated zone.

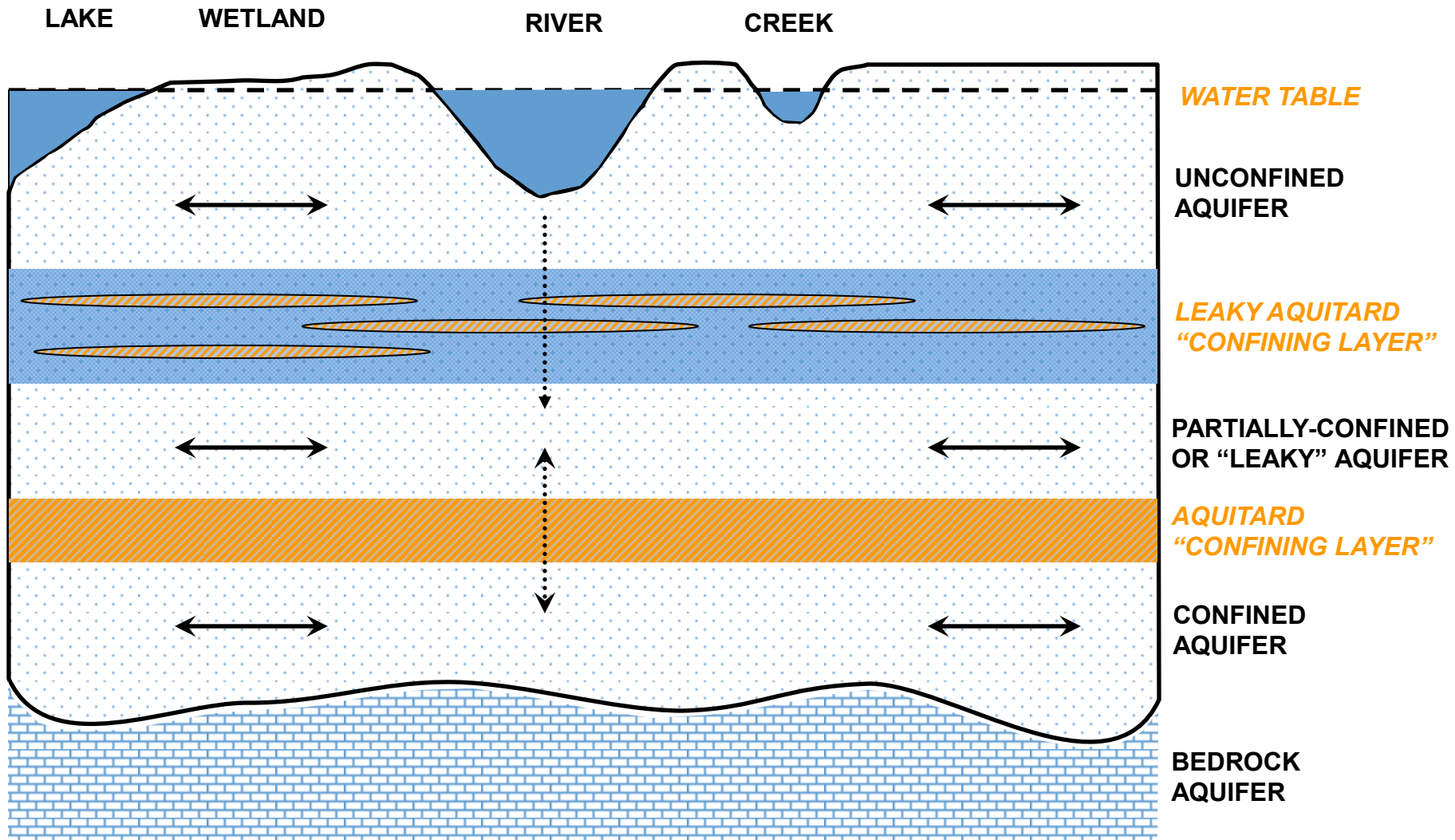


If stream level rises higher than adjacent ground-water levels, stream water moves into the streambanks as bank storage.

**SW/GW INTERACTION IS A NATURAL PROCESS**

# FUNDAMENTAL CONCEPTS

## - Natural Groundwater Movement (No Wells) -



# FUNDAMENTAL CONCEPTS

## - Ground Water Under Direct Influence (GWUDI) -

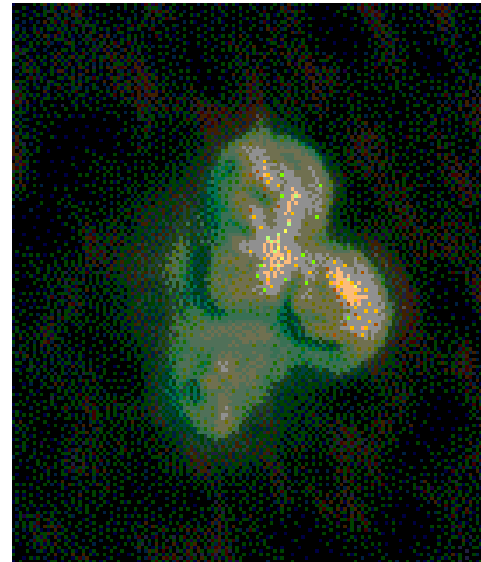
- **WHAT IS IT ?**

- Groundwater containing insects, algae and pathogens found in surface water
- Suggests increased potential for occurrence of Pathogens in untreated groundwater
- Pathogen = “that which produces suffering” (Greek)
- Babies, youth and seniors are most at risk due to weaker immune systems
- Chemotherapy, HIV and antibiotic use stresses immune system causing increased susceptibility to effects of pathogens

**Giardia (“Beaver Fever”)**



**Cryptosporidium**

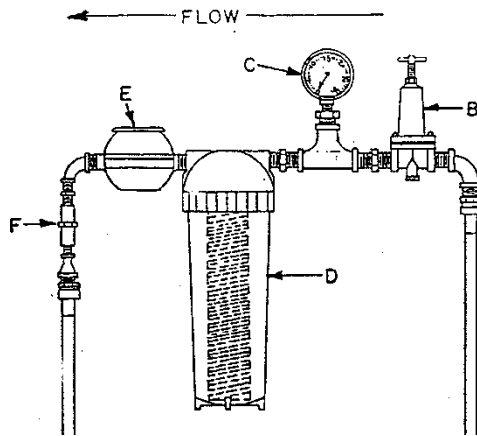


# FUNDAMENTAL CONCEPTS

## - Ground Water Under Direct Influence (GWUDI) -

- HOW IS IT DETECTED ?

- Microscopic Particulate Analysis ("MPA") and Risk Ranking

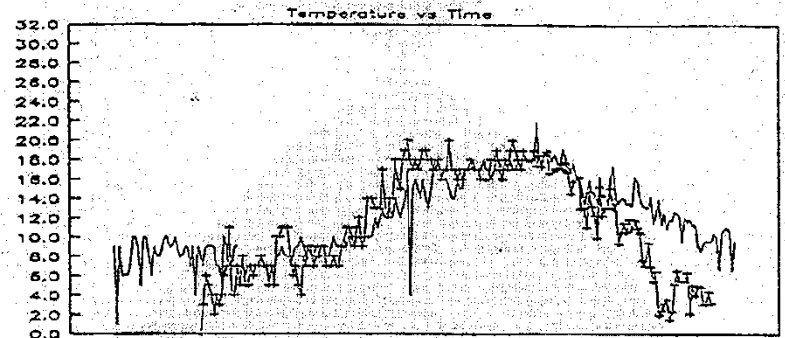
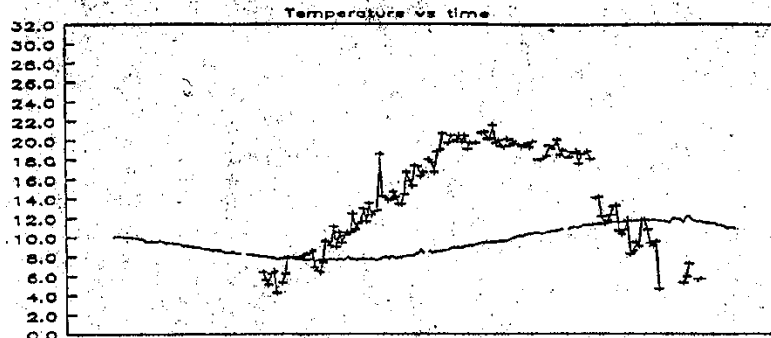


Indicators of surface water <sup>1</sup>	Relative Risk Factor <sup>3</sup>				
	EH <sup>2</sup>	H	M	R	NS
<i>Giardia</i> or <i>Cryptosporidium</i>	40	30	25	20	0
Coccidia	35	30	25	20	0
Diatoms	16	13	11	6	0
Other Algae	14	12	9	4	0
Insects/Larvae	9	7	5	3	0
Rotifers	4	3	2	1	0
Plant Debris	3	2	1	0	0

≥20 - high risk      10-19 - moderate risk      ≤9 - low risk

Key      EH = extremely heavy      H = Heavy      M = Moderate  
           R = Rare                                      NS = not significant

- Correlation of water chemistry trends in surface water and groundwater



# **GROUNDWATER VIEWPOINT (THE “WELL”)**

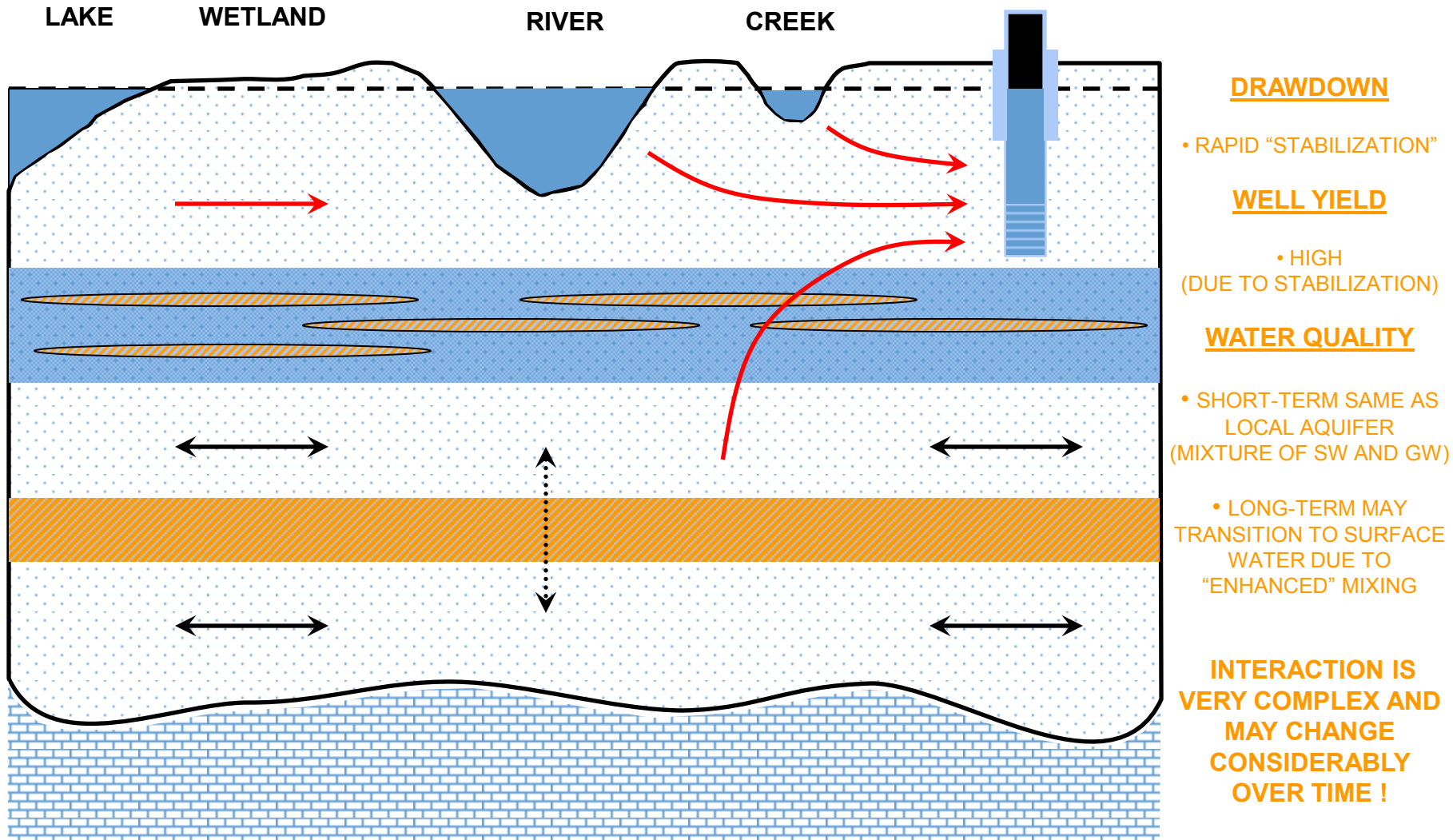


**Effects of Well Depth  
Bedrock Wells**

**Ground Water Under Direct Influence**

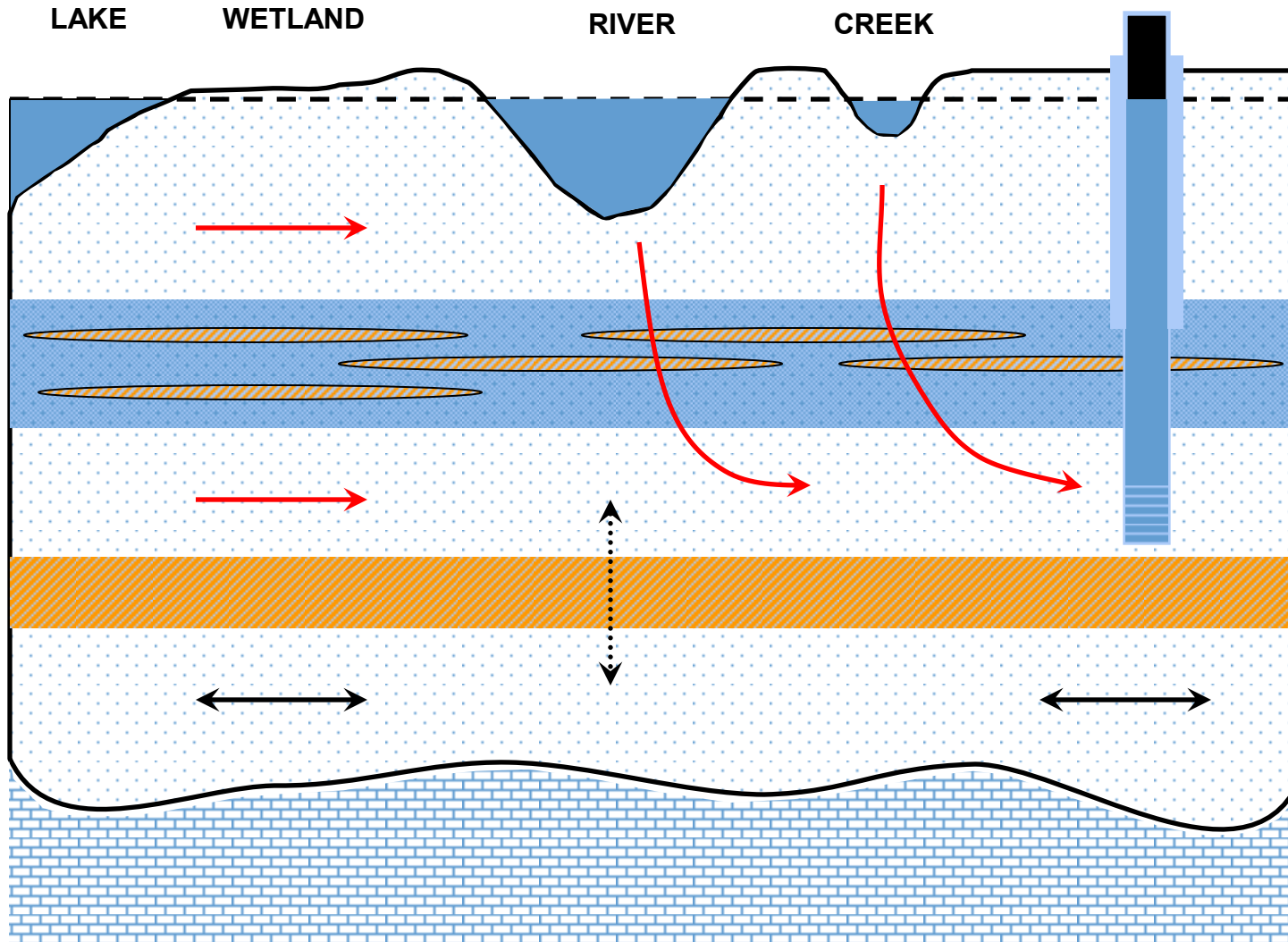
# GROUNDWATER VIEWPOINT (THE "WELL")

## - Surface Water "Influence" on a "Shallow" Well -



# GROUNDWATER VIEWPOINT (THE "WELL")

- Surface Water "Influence" on a Well of "Moderate" Depth -



## DRAWDOWN

- DELAYED OR NO "STABILIZATION"

## WELL YIELD

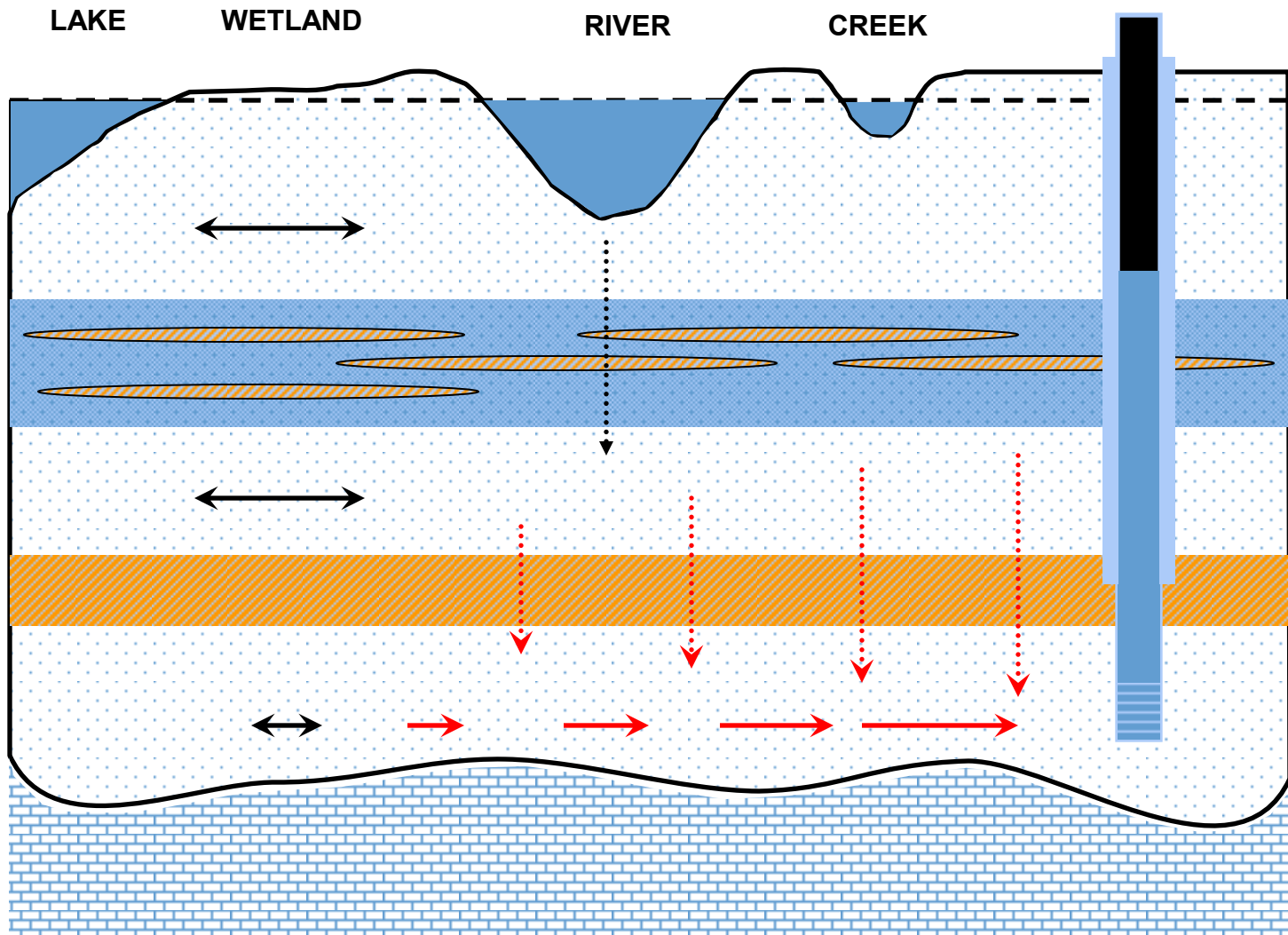
- MODERATED BY DELAYED STABILIZATION AND AQUITARD

## WATER QUALITY

- SHORT-TERM IS SAME AS LOCAL AQUIFER (DIFFERENT FROM SURFACE WATER ?)
- LONG-TERM REDUCED POTENTIAL OF SIGNIFICANT SURFACE WATER MIXING DUE TO AQUITARD ?
- INTERACTION STILL COMPLEX BUT MORE PREDICTABLE AND CONSISTENT OVER LONG-TERM

# GROUNDWATER VIEWPOINT (THE “WELL”)

## - Surface Water “Influence” on a “Deep” Well -



### DRAWDOWN

- NO “STABILIZATION”

### WELL YIELD

- MODERATED BY CONTINUOUS DRAWDOWN AND AQUITARD

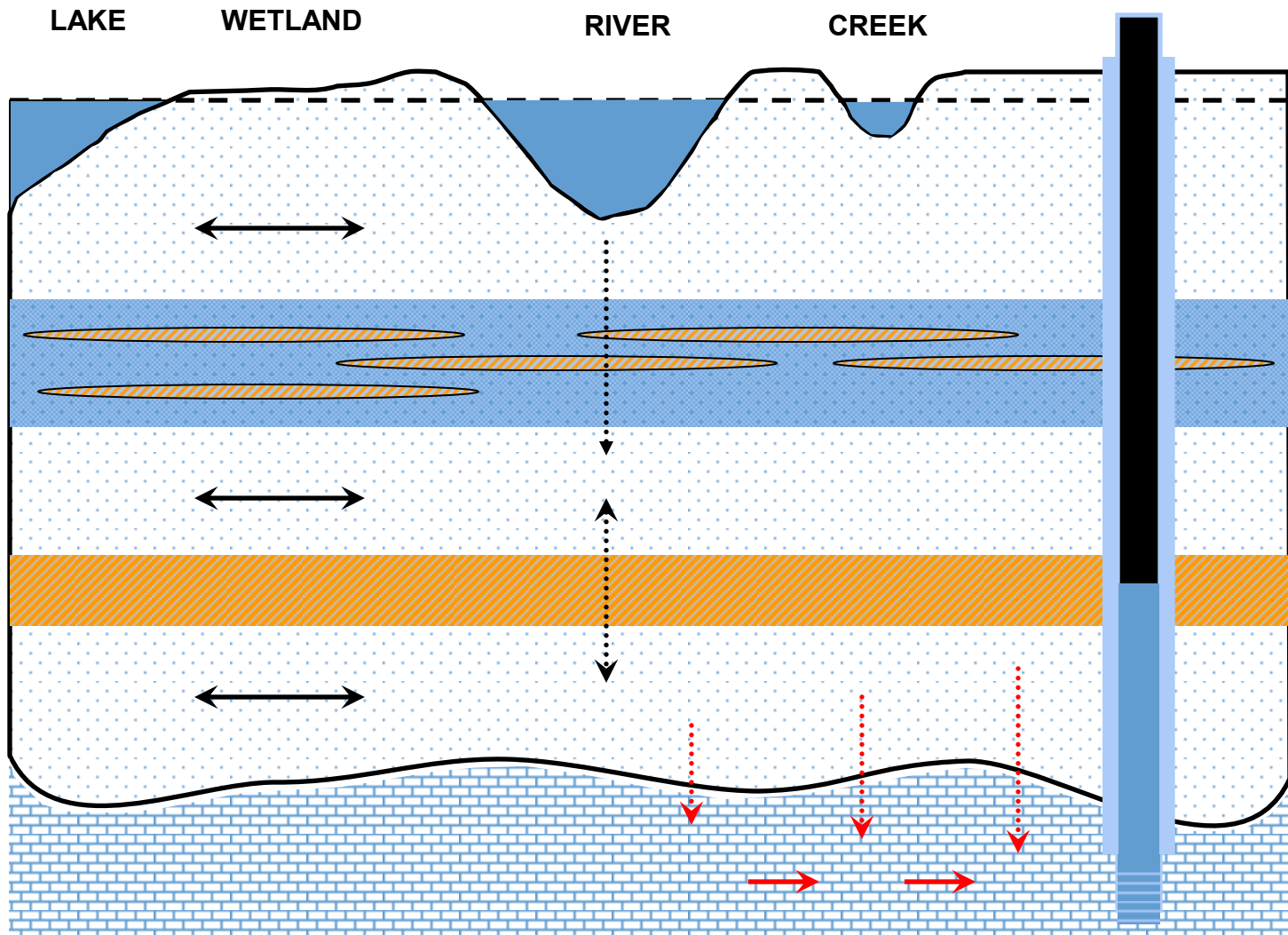
### WATER QUALITY

- SHORT-TERM IS SAME AS LOCAL AQUIFER (DIFFERENT FROM SURFACE WATER)
- LONG-TERM REDUCED POTENTIAL OF SURFACE WATER MIXING DUE TO MULTIPLE AQUITARDS
- INTERACTION IS PREDICTABLE AND CONSISTENT OVER LONG-TERM



# GROUNDWATER VIEWPOINT (THE "WELL")

## - Surface Water "Influence" on a "Bedrock" Well -



### DRAWDOWN

- COMPLEX WITH NO "STABILIZATION"

### WELL YIELD

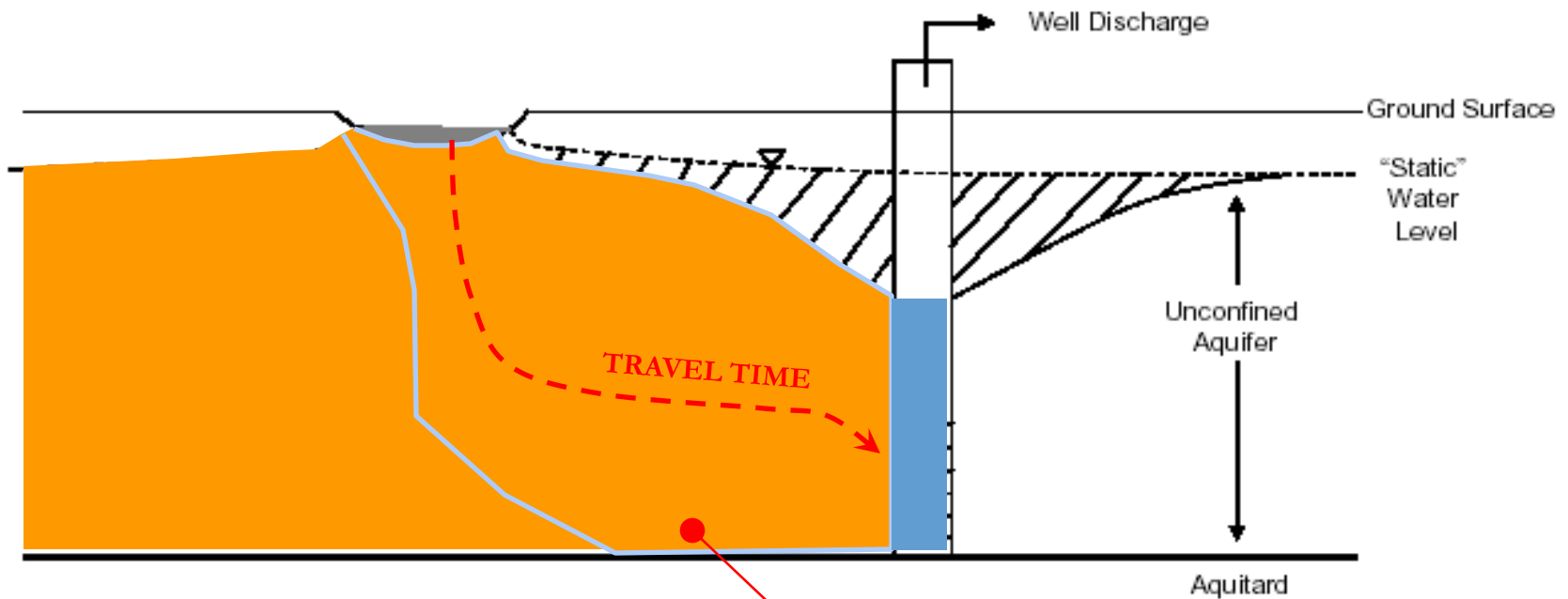
- LOW DUE TO FORMATION AND AQUITARDS

### WATER QUALITY

- SHORT-TERM SAME AS LOCAL AQUIFER (DIFFERENT FROM SURFACE WATER)
- LONG-TERM REDUCED POTENTIAL OF SURFACE WATER MIXING DUE TO MULTIPLE AQUITARDS
- INTERACTION IS PREDICTABLE AND CONSISTENT OVER LONG-TERM

# GROUNDWATER VIEWPOINT (THE “WELL”)

- Ground Water Under Direct Influence (GWUDI) -



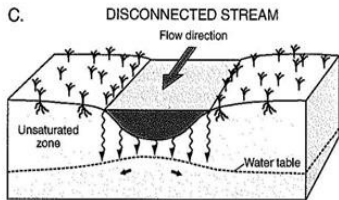
**IS THIS REALLY A  
“FILTRATION” ZONE ?**

**•  
CAN TRAVEL TIME BE ADEQUATE TO  
DEACTIVE PATHOGENS ?**

# GROUNDWATER VIEWPOINT (THE "WELL")

## - Ground Water Under Direct Influence (GWUDI) -

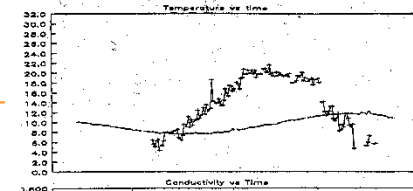
### LOW RISK ?



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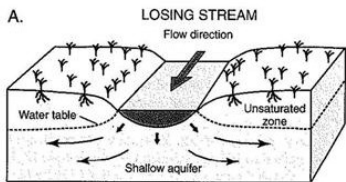
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Diatoms	16	13	11	6	0
Other Algae	14	12	9	4	0
Insects/Larvae	9	7	5	3	0
Rotifers					0
Plant Debris					0

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+ Long travel time > 30 Days ? = Pathogens deactivated before reach well ?

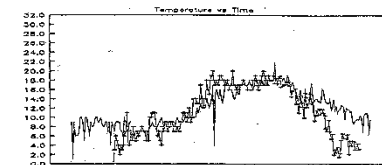
### MODERATE TO HIGH RISK ?



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Indicators of surface water <sup>1</sup>	Relative Risk Factor <sup>3</sup>				
	EH <sup>2</sup>	H	M	R	NS
<i>Giardia</i> or <i>Cryptosporidium</i>					0
Coccidia					0
Diatoms					0
Other Algae					0
Insects/Larvae					0
Rotifers					0
Plant Debris					0

+



+ Short travel time < 30 Days ? = "Live" Pathogens may reach the well ?

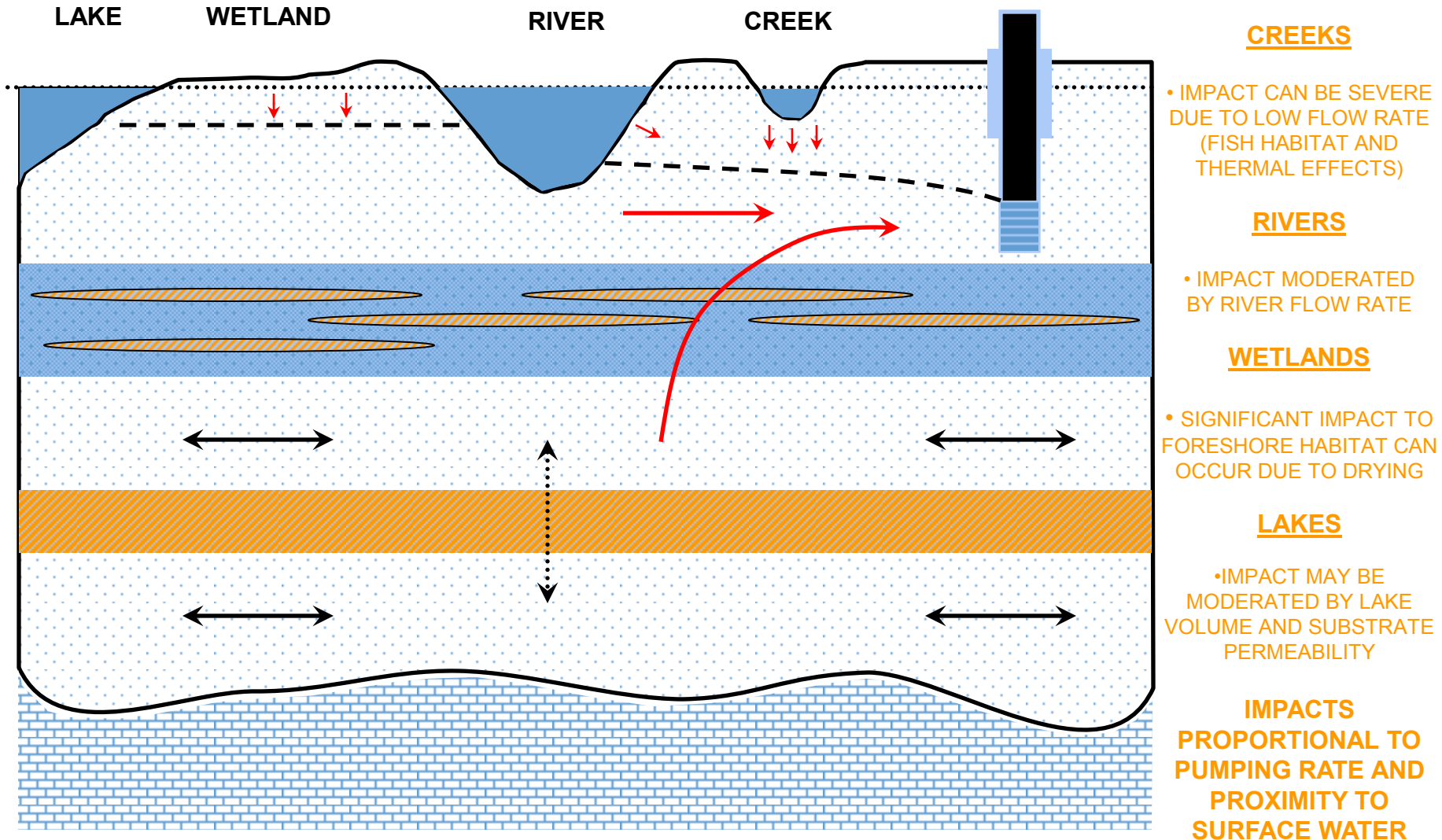
# **SURFACE WATER VIEWPOINT**



## **Surface Water Depletion**

# SURFACE WATER VIEWPOINT

## - Surface Water Depletion and Related Effects -



# SURFACE WATER VIEWPOINT

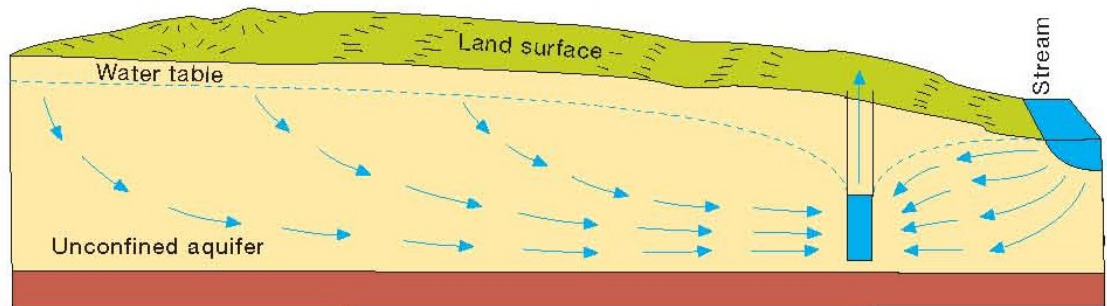
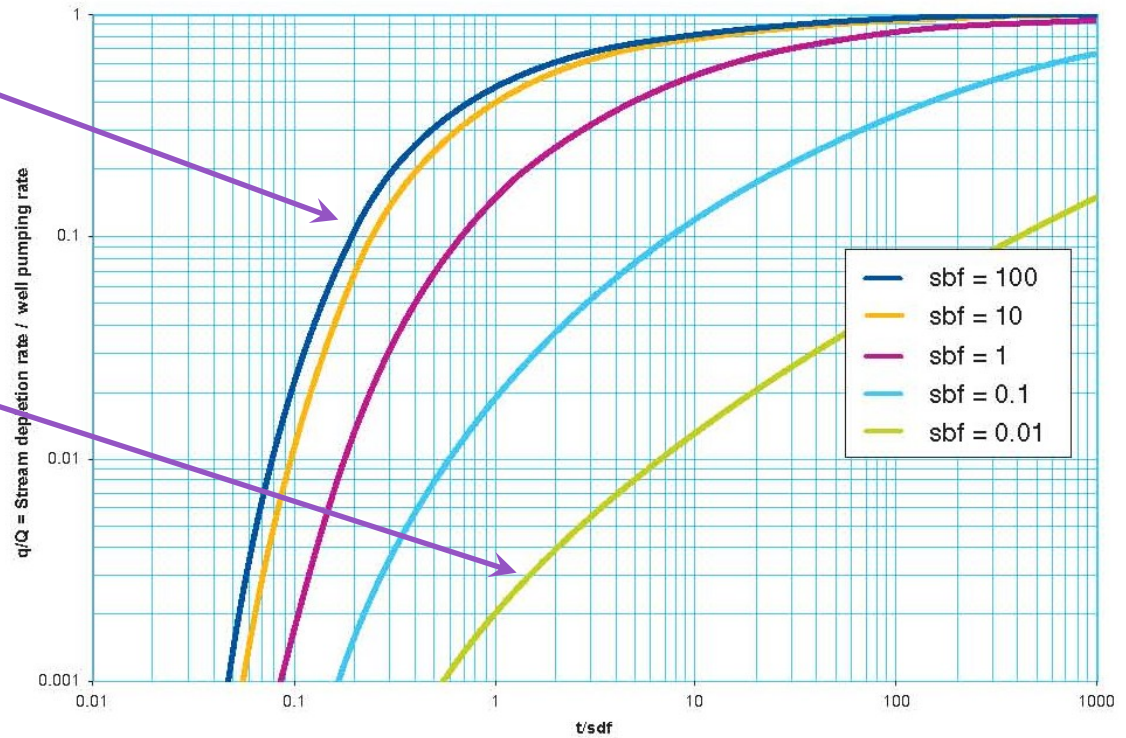
## - Timeline of Surface Water Depletion Effects -

RATE OF DEPLETION MAY  
EVENTUALLY EQUAL PUMPING  
RATE !

RAPID ONSET OF DEPLETION  
(MINUTES TO DAYS) !

RATE OF DEPLETION MAY ONLY  
BE A FRACTION PUMPING RATE

SLOW ONSET OF DEPLETION  
(DAYS TO YEARS)



# **PRACTICAL SCREENING TOOLS**

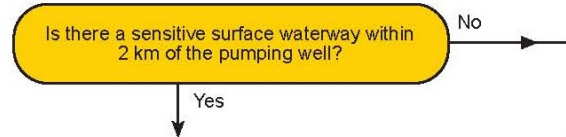


# **RECOMMENDATIONS TO CLIENTS**

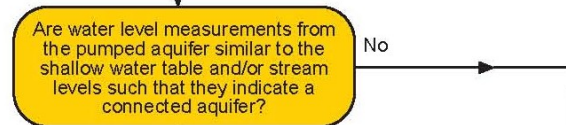
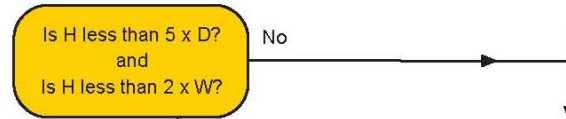
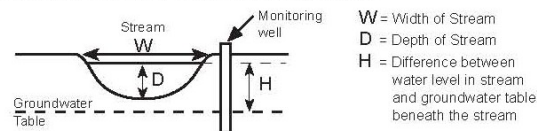
# PRACTICAL SCREENING TOOLS

## - Surface Water Depletion -

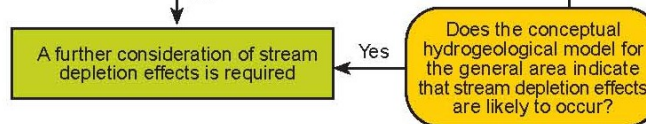
1. Consider the location of the well in relation to nearby surface waterways



2. Consider the water level data for the area.



3. Consider geological data.



A further consideration of stream depletion effects is required

Stream depletion effects are unlikely to be an issue of concern



# PRACTICAL SCREENING TOOLS & RECOMMENDATIONS

## - Public Health and GWUDI -

- **WELLS COMPLETED IN UNCONFINED OR SEMI-CONFINED AQUIFERS AND **ANY** WELLS LESS THAN 30 m DEEP**
  - Potentially vulnerable to GWUDI and infiltration of recharge from the surface
    - May show the presence of pathogens even if not GWUDI (septic fields, livestock, wildlife and decaying matter)
  - Detailed bacteriologic testing considered a necessity for community wells
  - Detailed bacteriologic testing recommended for residential wells
- **WELLS LOCATED LESS THAN 60 m (200') FROM SURFACE WATERS**
  - Statistics clearly show increased susceptibility to GWUDI
  - Detailed GWUDI evaluation considered a necessity for community wells
    - **Consider all community wells near surface water to be GWUDI until proven otherwise !**
    - Work with local Health Authority in conjunction with a qualified Hydrogeologist and Water Treatment Specialist
    - Undertake regular Microscopic Particulate Analysis (“MPA”) and risk ranking
    - Undertake monitoring program to determine correlation of water chemistry trends in surface water and groundwater
  - Detailed bacteriologic testing recommended for residential wells.