FLUTe® Quintet for Ground Water Measurements

Presented by

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The “quintet” is:

1. The Blank Liner

   Seals the borehole with liner installation

2. The NAPL FLUTe

   For mapping pure product on the hole wall

3. The Felt Activated Carbon Technique (FACT)

   Maps the dissolved phase in the pore space and fractures

4. The Transmissivity Profiler

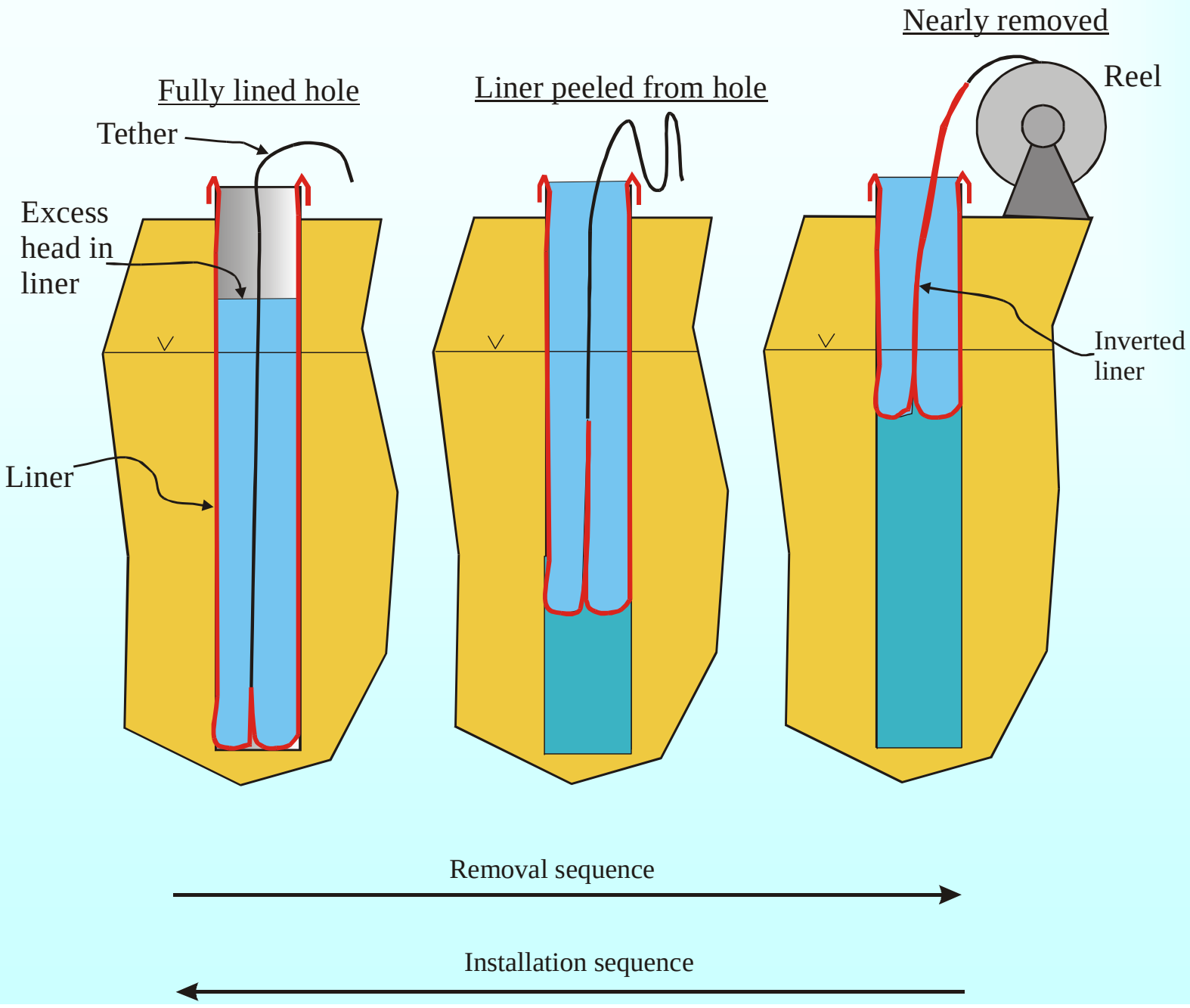
   Maps the borehole transmissivity during the

   sealing liner installation

5. The Water FLUTe

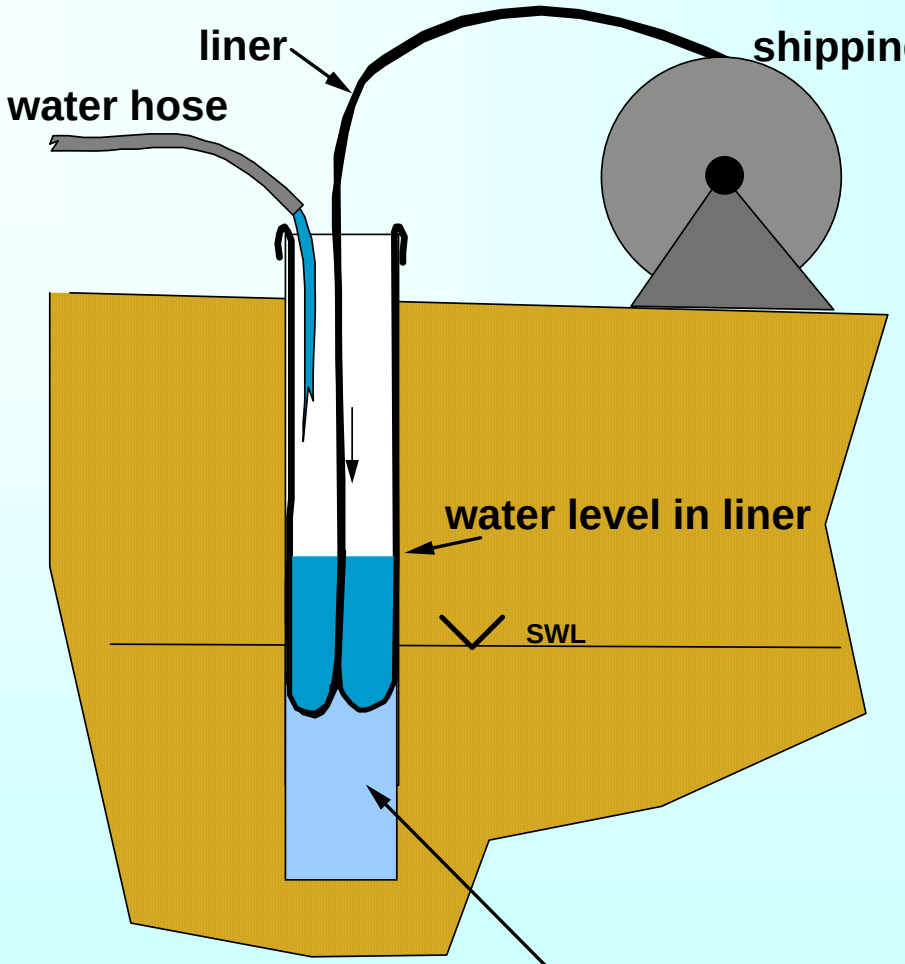
   A Multi-level ground water sampling and head measurement system

The blank liner installation seals the hole



To install a blank sealing liner,

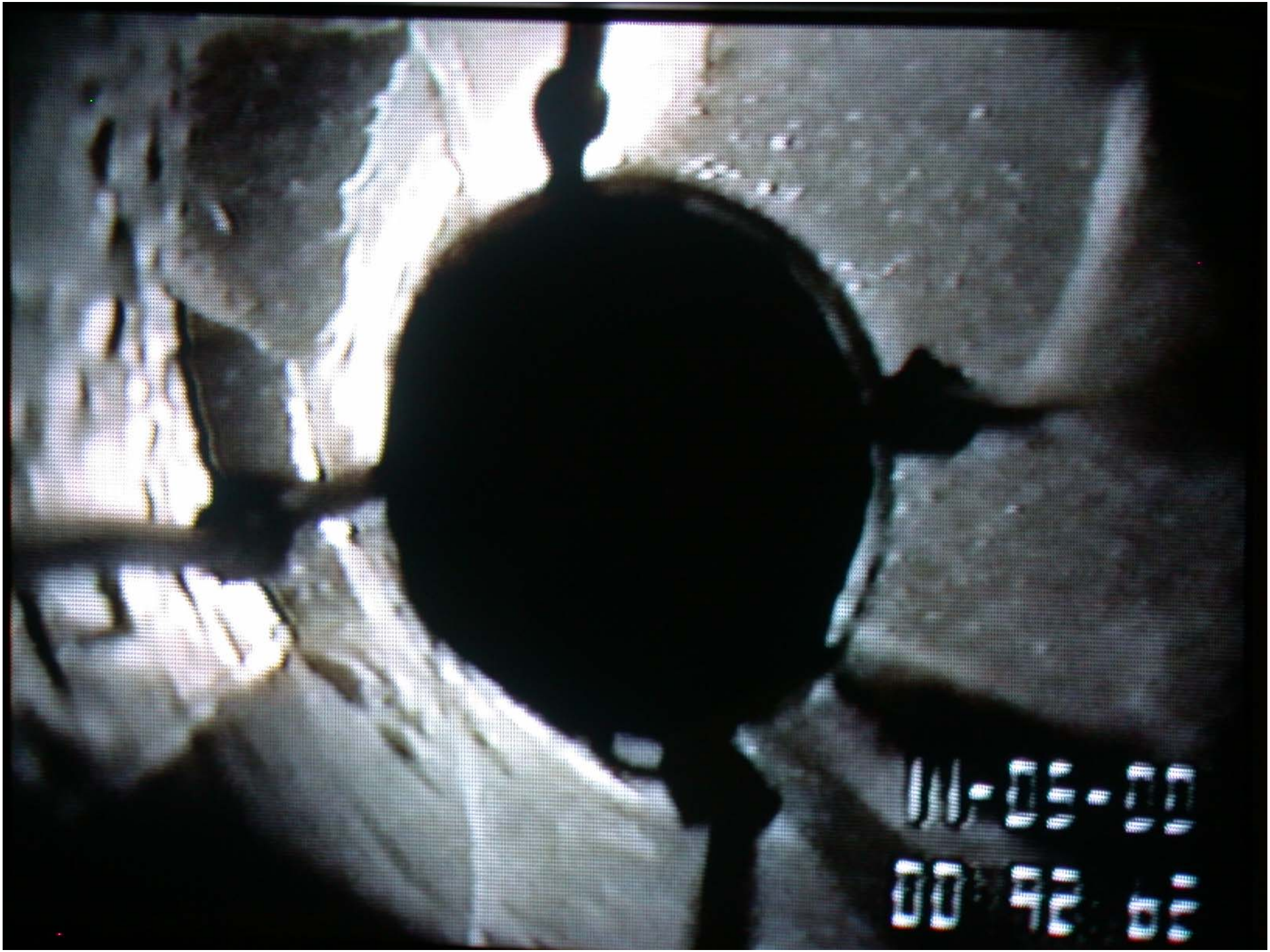
Just Add Water!



Original water in hole is displaced or, it can be removed by pumping during the installation

How well does the liner seal the hole?

- The following photo was taken inside a 6” diameter 328 ft hole at Cambridge, Ontario by Peter Pemhe.
- The liner is a 400denier urethane coated Nylon fabric. The liner is about 6.5 inches in diameter with about 40 ft of excess head.
- In the lower left hand corner is a 1” wide welded seam tape. This is the typical blank liner.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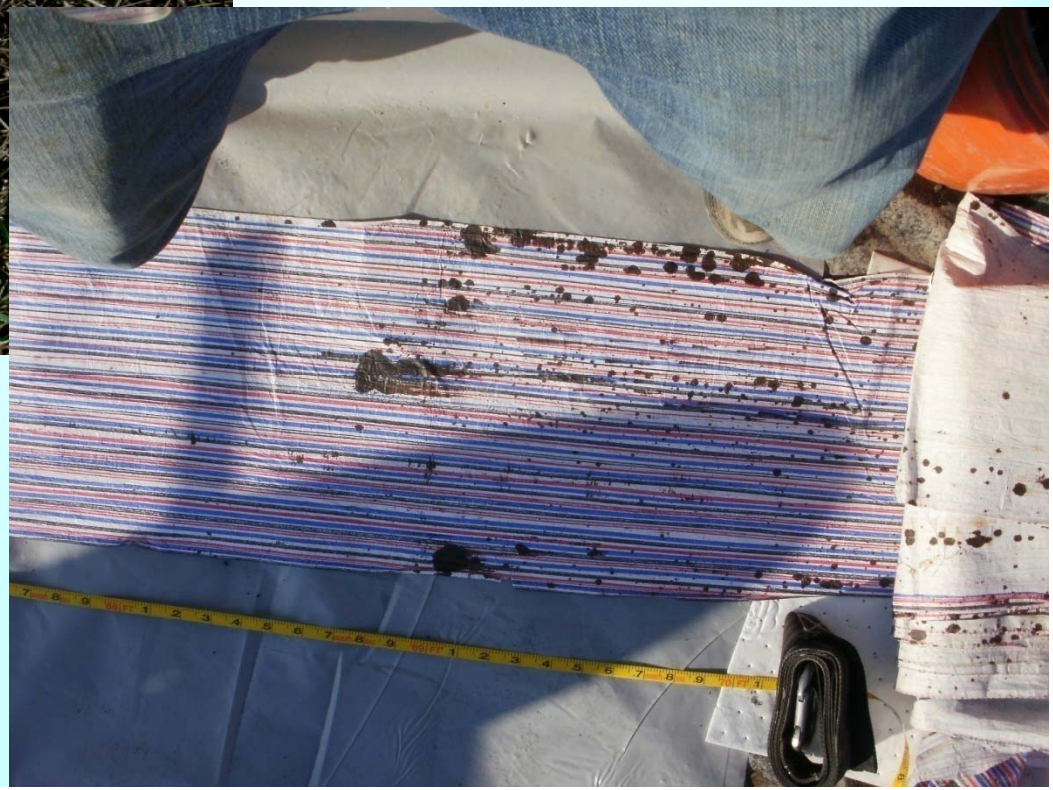
A color reactive cover on the liner maps NAPL

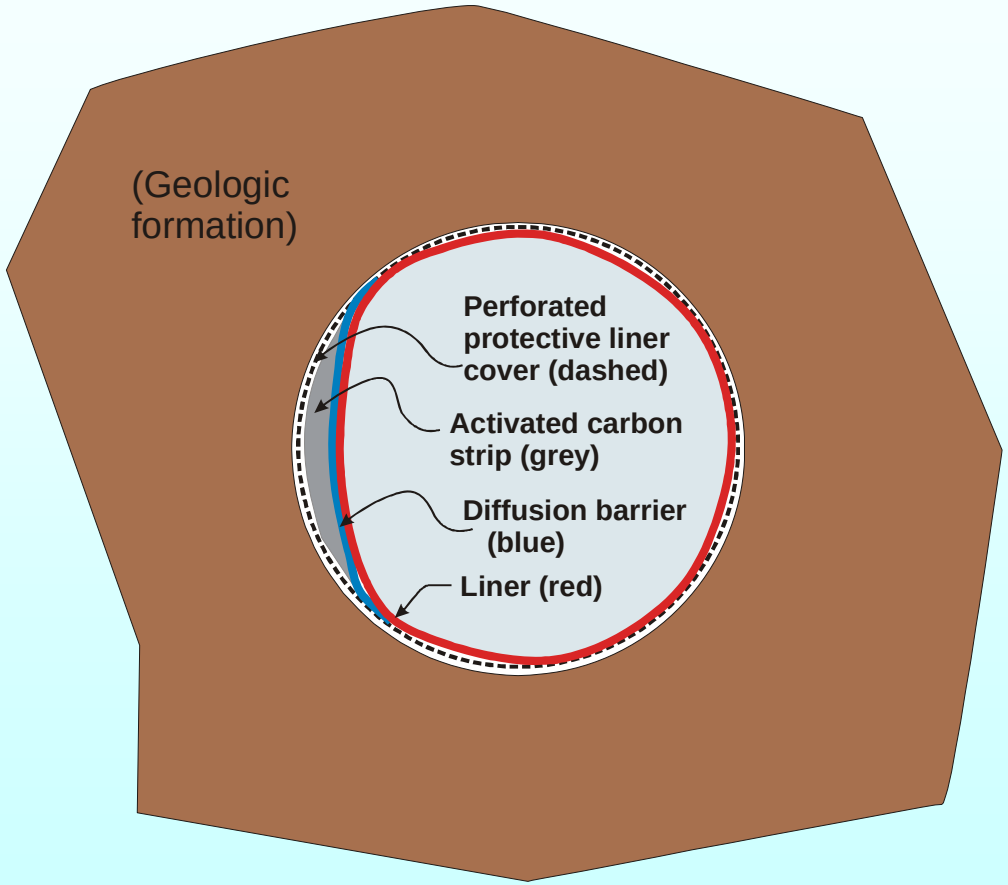
Still bottoms

Coal tar



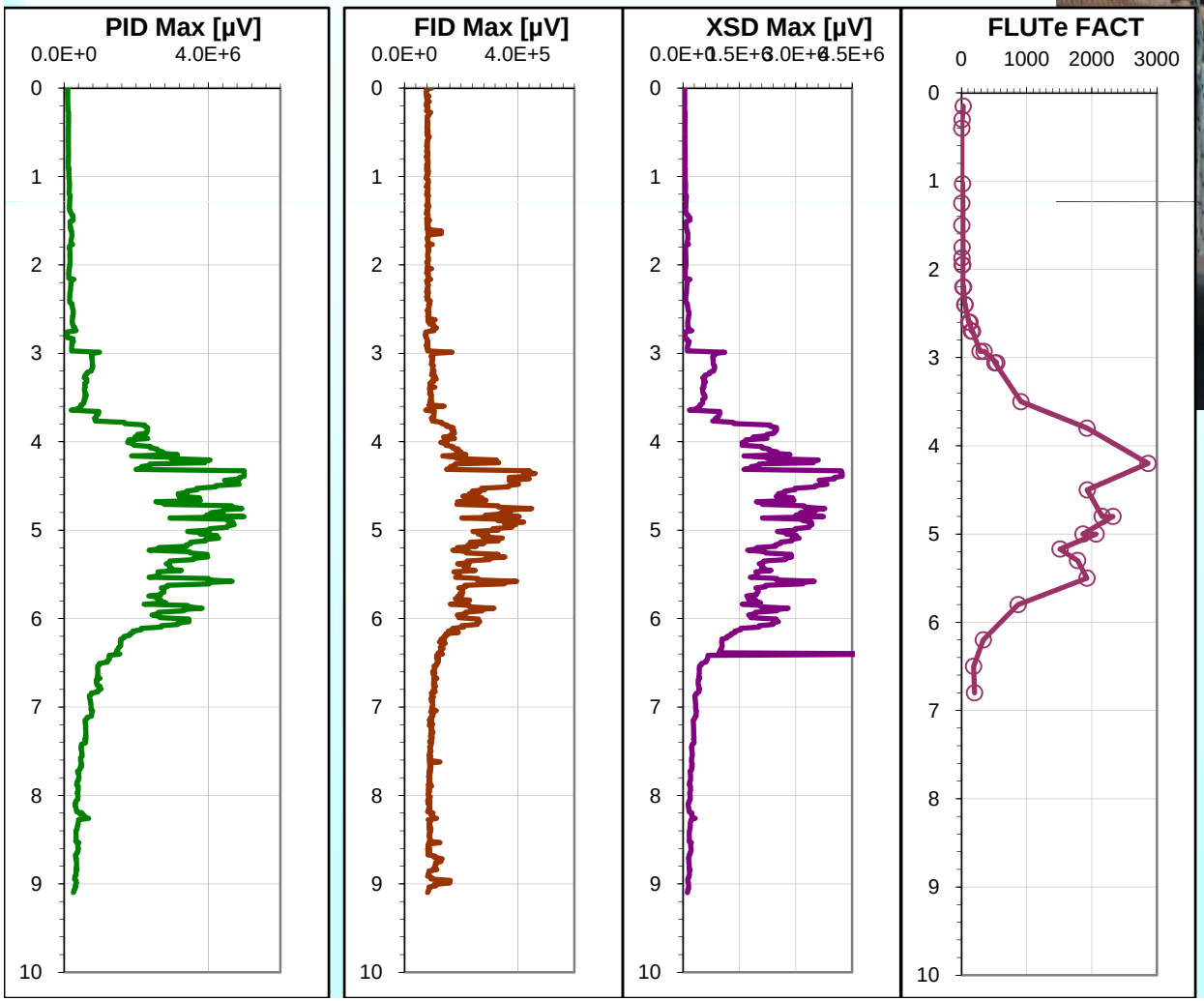
FLUTe FACT: a carbon felt absorber is pressed against the hole wall

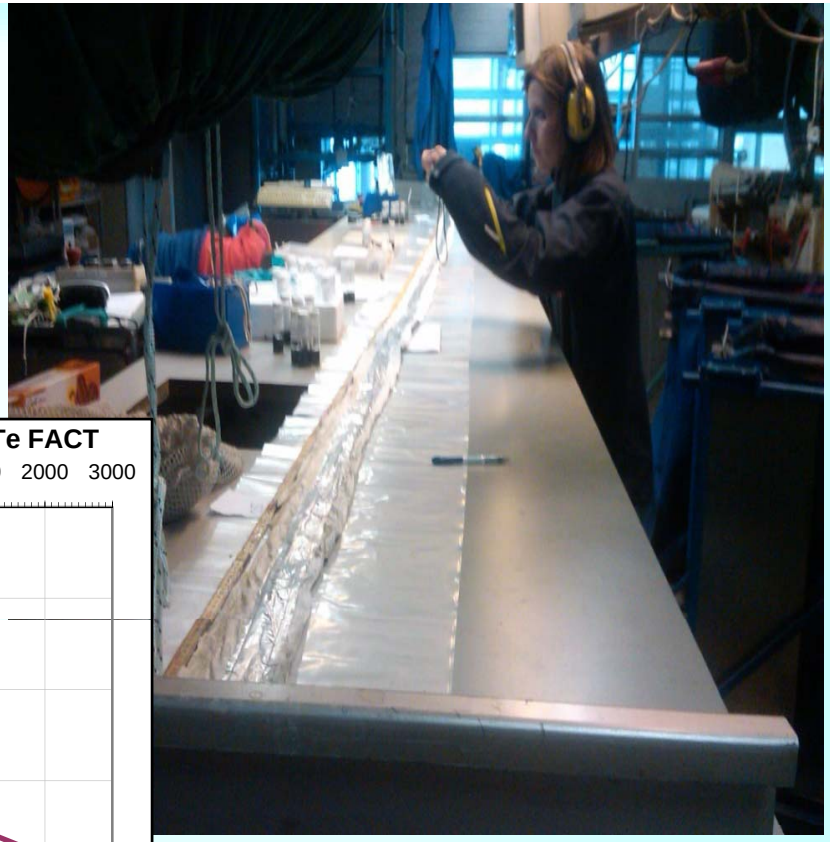
Borehole cross section
showing carbon felt absorber



The activated carbon felt maps the dissolved phase

MIP profiles





Inverted cover showing silver diffusion barrier

<u>Circumstances of FACT:</u>

Direct push installation to 8 M in clay till in Denmark.

Left in place one day.

Mass spectrometer assessment of carbon felt.

FACT uses:

Install via direct push rods or via sonic casing in sediments.

Install by eversion on a blank liner into open boreholes such as fractured rock.

Assess carbon felt concentrations via mass spectrometer with methanol extraction.

Or, assess carbon felt similar to MIP method of heating with gas collection.

Use two felt strips, one for coarse assessment followed by fine subdivision of the second strip for the contaminated sections.

Use in conjunction with the NAPL FLUTe color reactive system or separately.

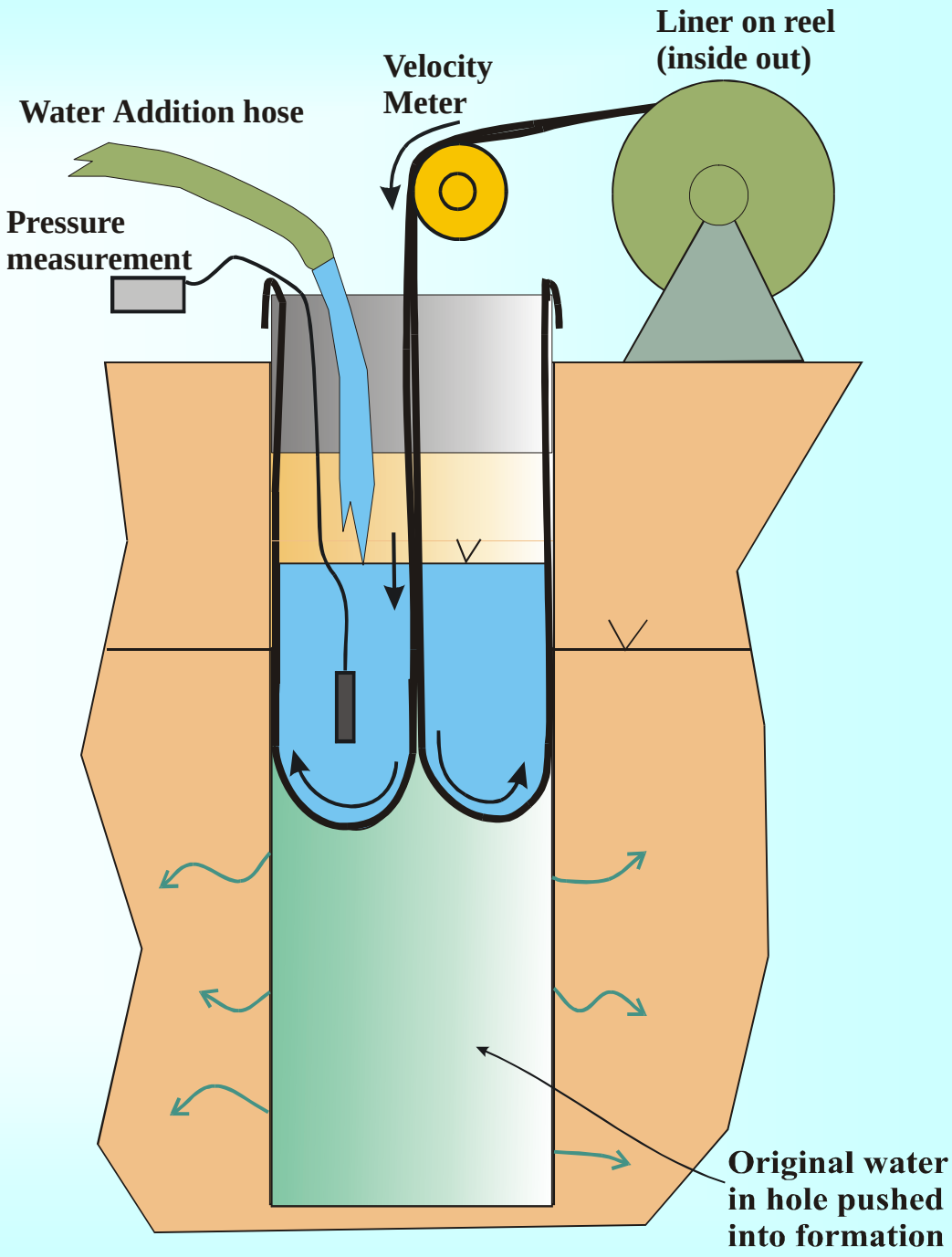
Result: qualitative distribution of contamination in pore and fracture fluids.

The transmissivity distribution can be measured with the blank liner

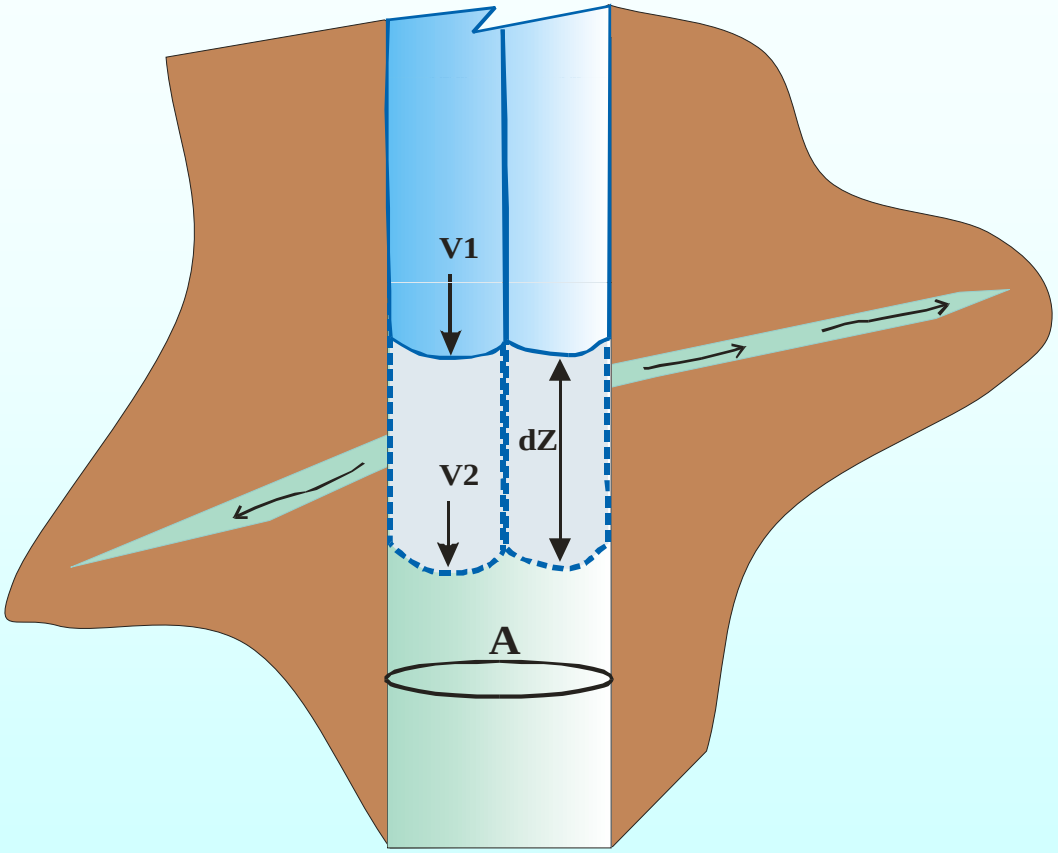
- The liner descent rate and other parameters are carefully measured and recorded
- Significant parameters not measured are carefully controlled to be constant
- The result is a very detailed map of the location and flow capacity of all significant flow paths in the borehole.

This is how it works:

Measuring the installation rate and driving head yields a transmissivity profile



The liner velocity drops when each fracture is sealed

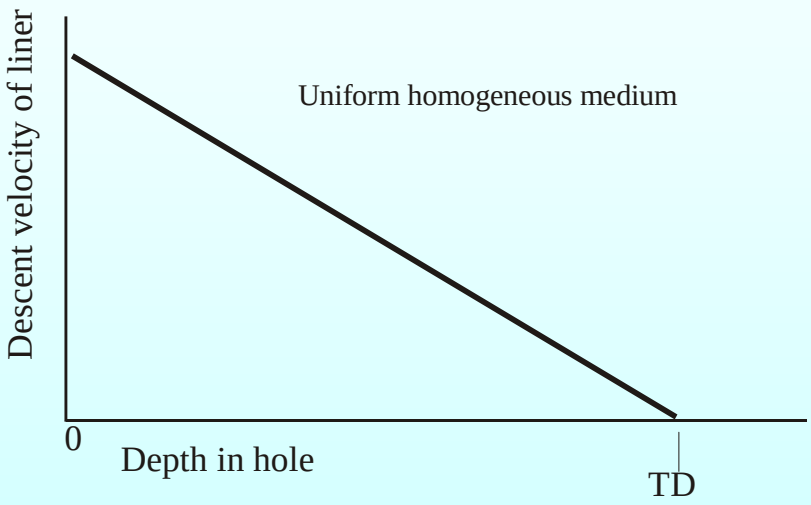


Flow rate into the fracture, Q, is A(V1-V2) , where V1>V2

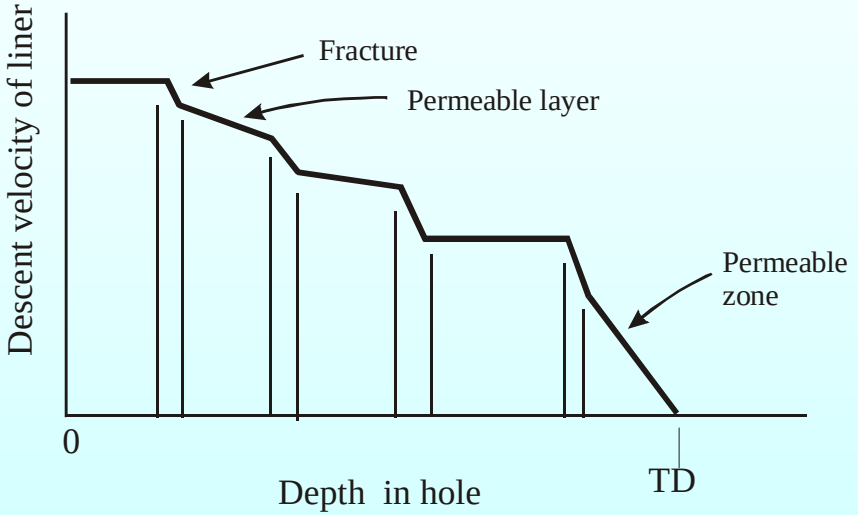
Average flow rate into the hole wall over the interval dZ is:
$Q/(dZ\ \pi\ D)$ = fctn(C,dP, D,..)

Therefore, the liner descent velocity is controlled by the flow paths

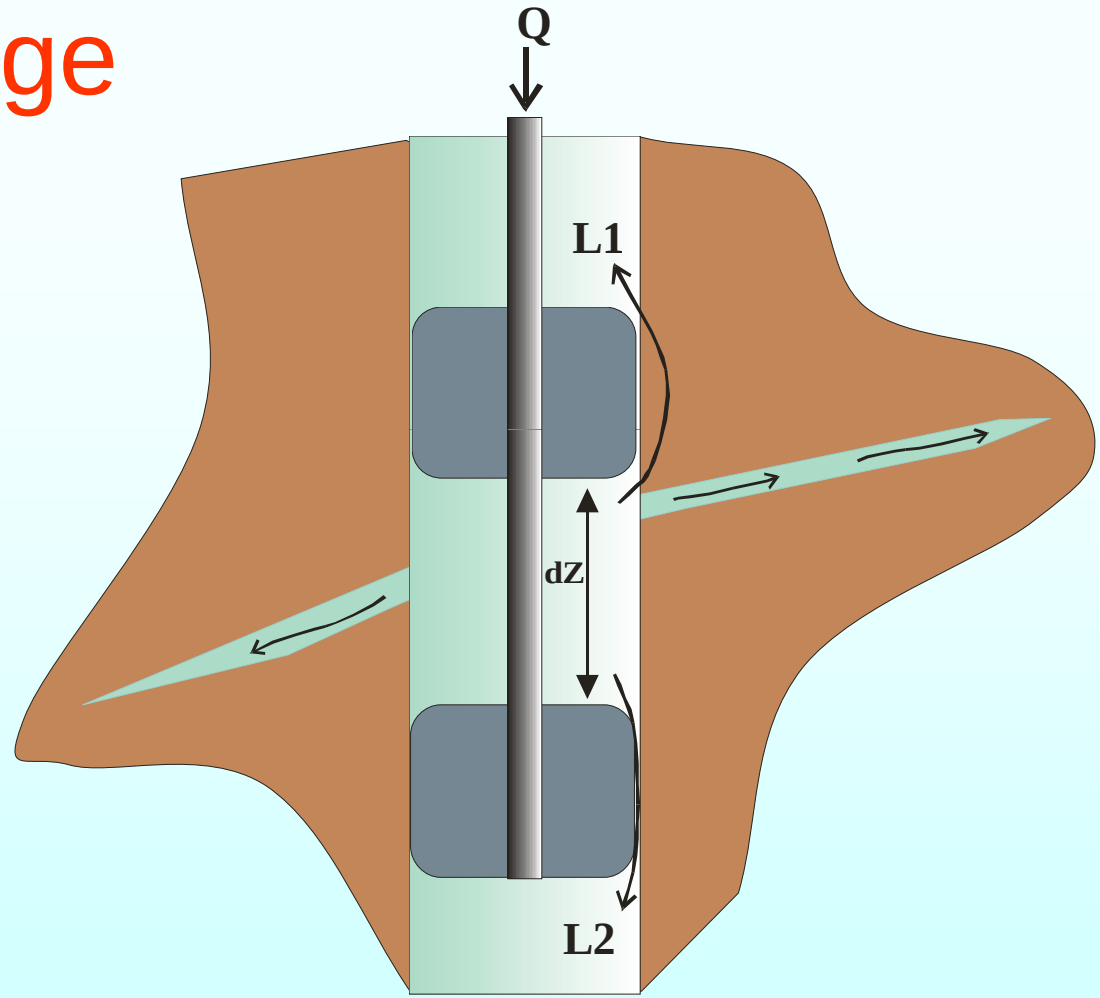
Velocity of liner in uniform medium



Possible velocity profile in fractured medium

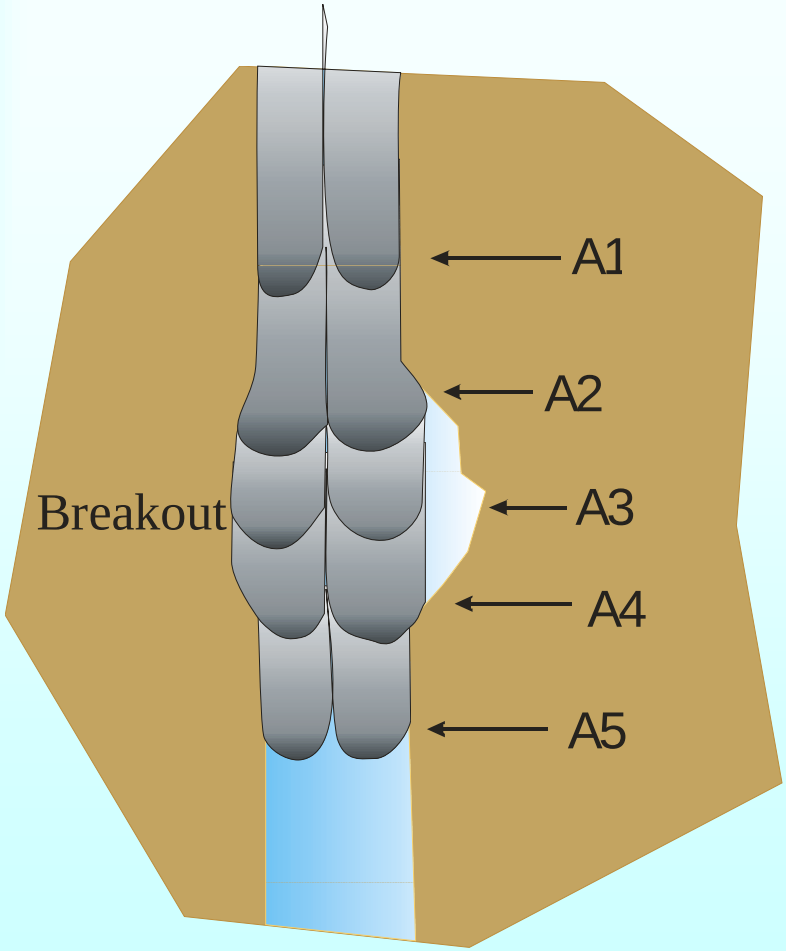


Straddle packers have more or less leakage



Flow rate into the fracture is Q-L1-L2.
Average flow rate into the hole wall over the interval dZ is:
$(Q-L1-L2)/(dZ\ \pi\ D) = fctn(C,dP, D, L,..)$

In a breakout, a liner slows and then accelerates as it exits



$$V_i = Q/A_i$$

Hence, only a breakout with flow paths causes a persistent drop in the velocity

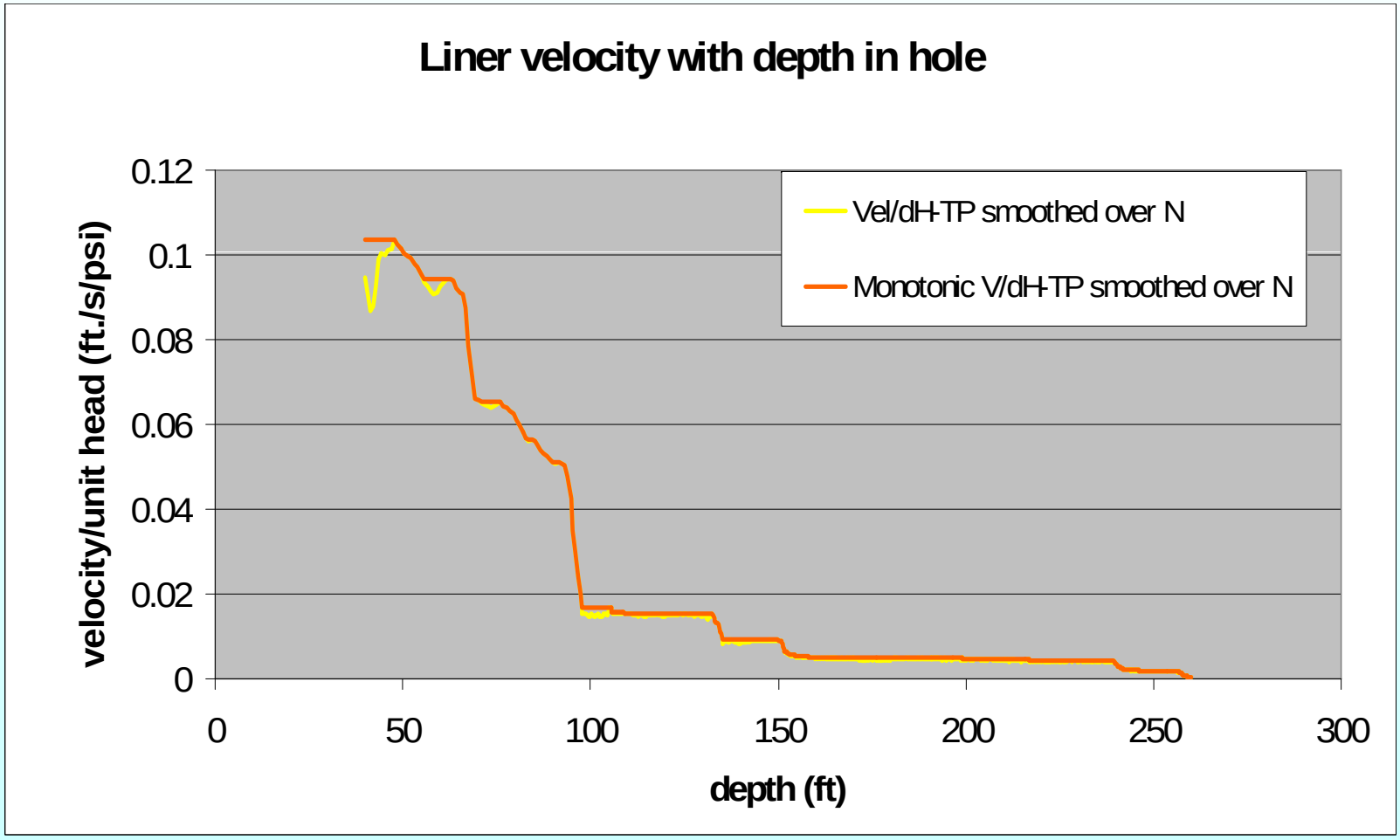
This machine collects the data to a laptop and controls the tension (8” hole)

Data are collected every 1-2 seconds:

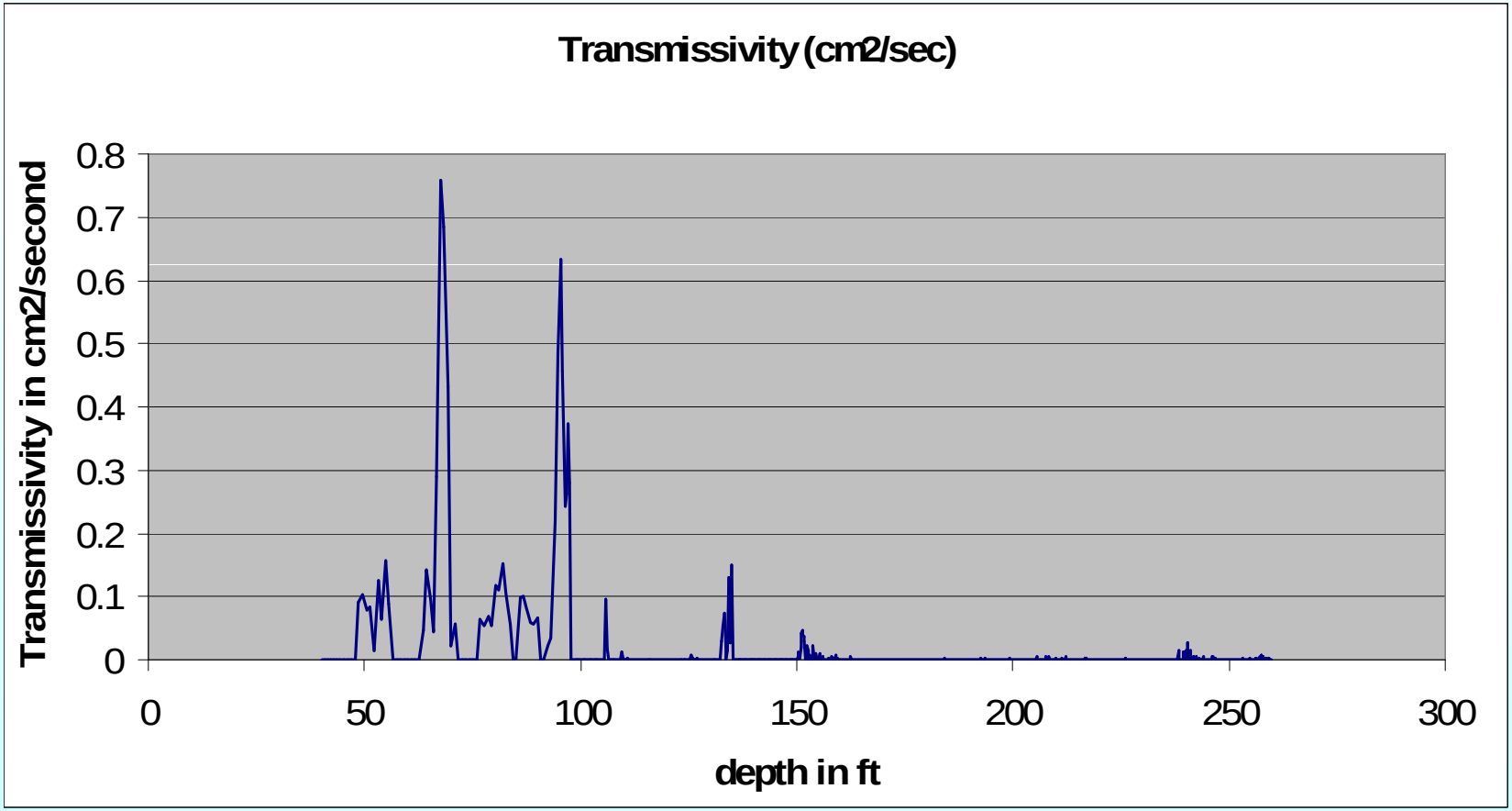
- Position
- Time
- Head inside the liner
- Tension on the liner

And, the tension on the liner is controlled at an essentially constant value.

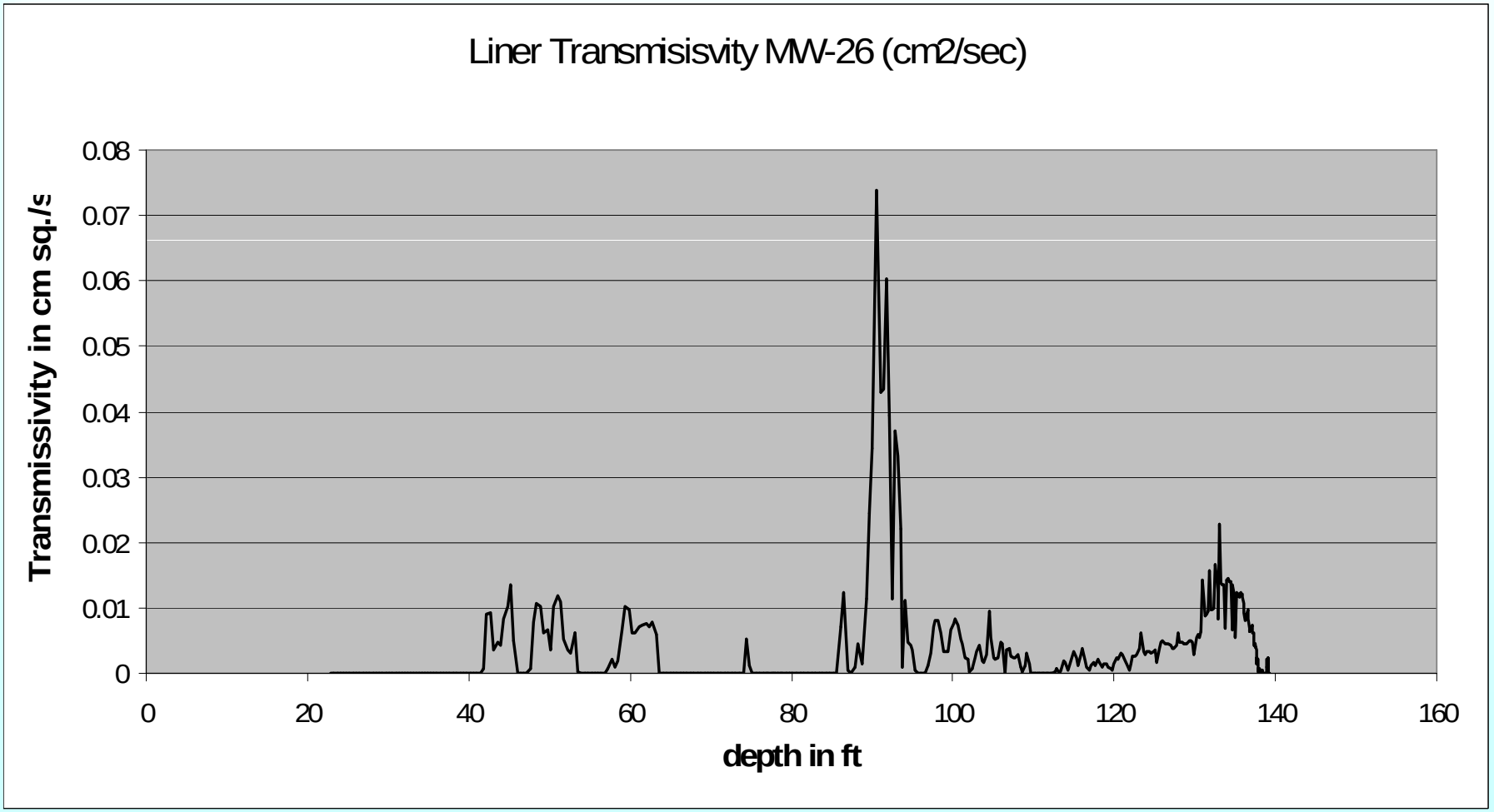
Typical liner result



The resulting liner profile



Another liner transmissivity profile



The blank liner is then swapped for the multi level sampling system:

1. First, the sampling intervals are defined by the customer

2. Then, the multi level “Water FLUTe” system is fabricated and shipped to the site on a reel.

3. The blank liner is removed.

4. The Water FLUTe liner is installed

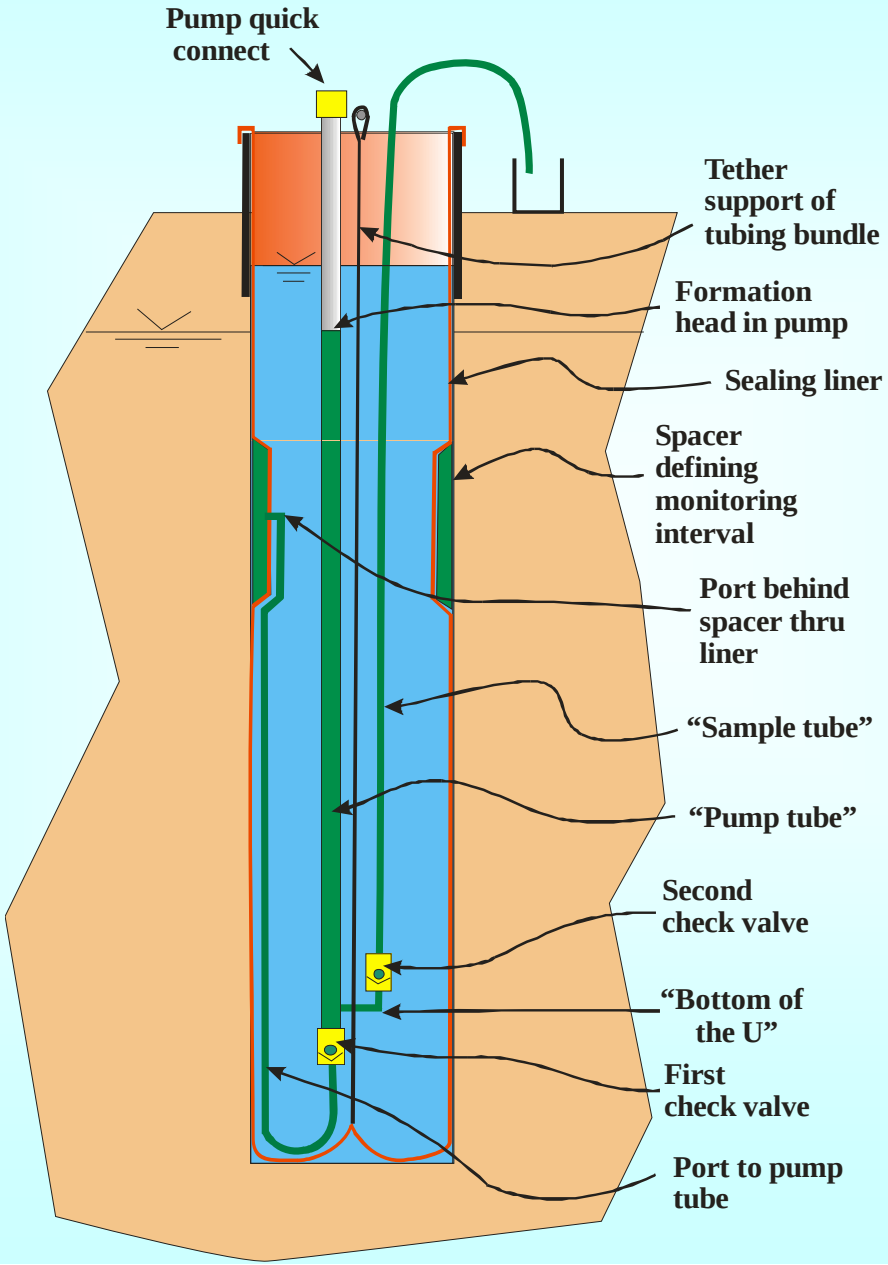
The Water FLUTe Installation

15 Ports
installed
to 328 ft
in 2 hrs

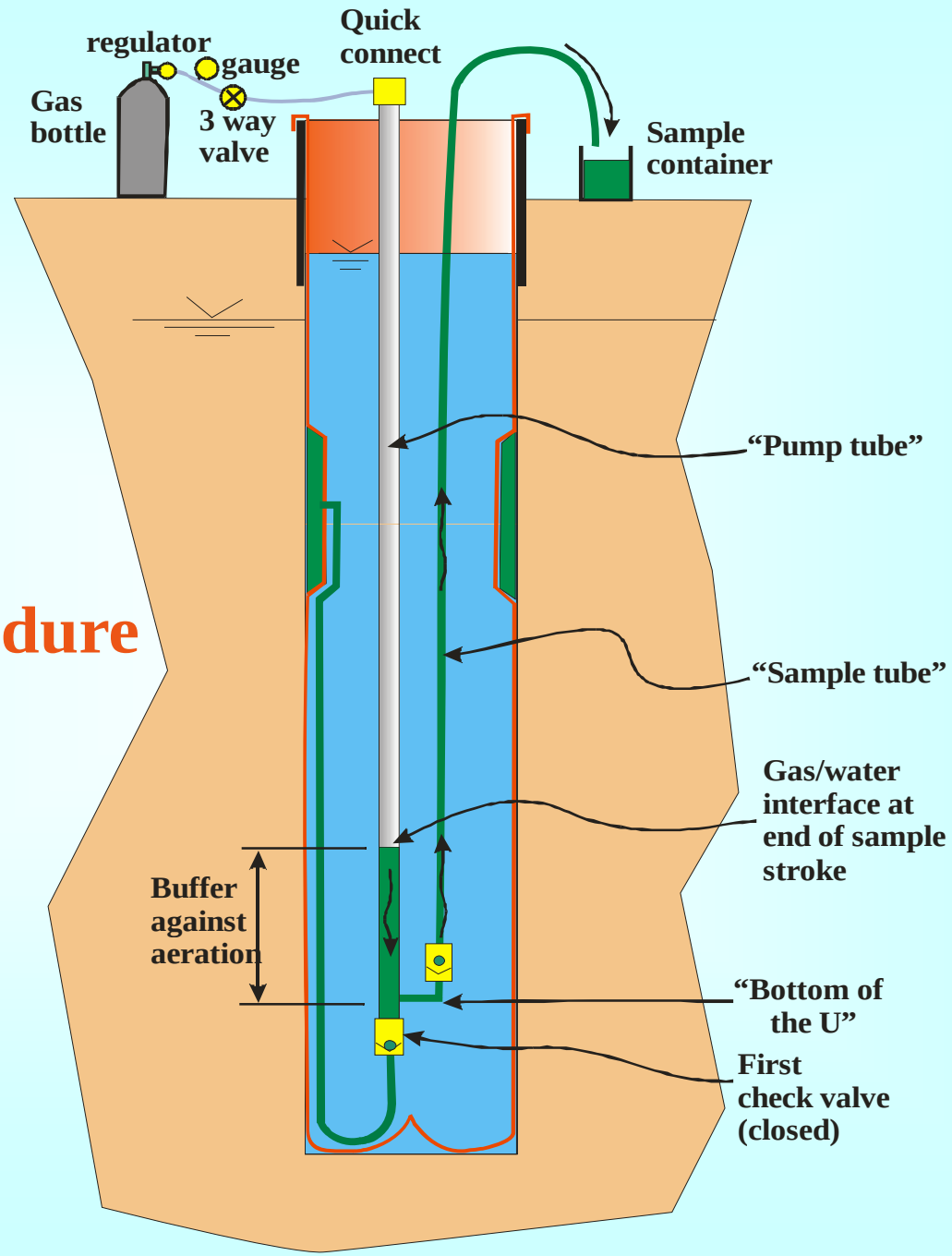
(Cambridge, Ontario)

Water FLUTe liner system in place

(Single port system shown for clarity)



Pumping Procedure



The sampling procedure

1. Each port is purged twice at the purge pressure, a pressure sufficient to expel all of the water from each pump.
2. Then the pressure is lowered to the sampling pressure which can not expel all of the water.
3. The sample is collected after the first flow on the sampling stroke.

- The typical flow volume per stroke of the pump is 1.5-2 gallons.
- The sample is drawn directly from the formation

Purging
15 ports
simultaneously

The unique Water FLUTe characteristics are:

- Seals the entire hole against flow
- Easy to install (typically, 1-4 hr.)
- Draws each sample directly from the formation
- Is easily removed
- Produces a large sample volume per port
- Pressure tested fully assembled in the factory to 300 psi

The other attractive characteristics

- Allows many ports in one hole (1 - 30+)
- Allows a head measurement for each port
- Easy to purge and sample (e.g., 30 min./5 ports)
- Relatively inexpensive for life cycle costs
- Recording pressure transducers can be added at each port with no conflict with sampling or manual head measurements

In summary

1. Blank liners are used to quickly and completely seal the borehole
2. Adding unique FLUTe covers to blank liners adds very useful additional capabilities
3. The transmissivity distribution can be measured for the entire borehole in less than two hours, typically.
4. The multi level sampling system allows a reliable and easy assessment of water quality and head at each port.

Summary continued:

5. The flexible liner combination can be done with less than 6 hours total open hole time
6. The combination can reduce drilling costs and the need for several traditional methods such as packer testing and some geophysics. Ask us for details.

Note: FLUTe™ methods are covered by numerous US and foreign patents

Thanks for your attention

Questions?

More information is available at our website:
www.flut.com