The case for longer duration of pumping tests and confined aquifer well deep well seals



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Consultants in Hydrogeology and Water Resources Management

Presentation Topics

- Pumping test duration
  - Perspectives
  - What the experts say
  - Time of year - significance
  - Pumping test examples
  - Why "volume" tests are not pumping tests
- Effective casing seals in confined aquifer wells
  - Where and when
  - Regulatory examples from other areas

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Pumping tests: how long is long enough?

- Client's perspective – keep costs low
- Hydrogeologists's perspective – need data to support conclusions
- Purpose / use of the well and the test
- Yield of well versus yield requirement
- Possible interference or "boundary" effects
- Concerns of neighbouring well owners
- Specific regulatory requirements

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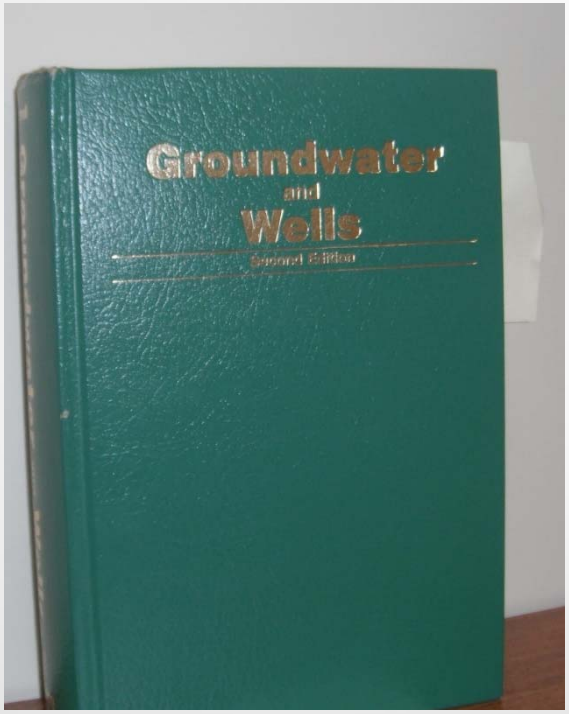
When in doubt, consult the bible



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'GROUNDWATER AND WELLS' (Driscoll 1986)

- **Pumping test duration:**

  Confined aquifer: 24 hours

  Unconfined aquifer: 72 hours

  …in B.C. the unpredictable nature of fractured bedrock aquifers suggests durations of 48 to 72 hours

"In no event should pumping tests be terminated prematurely, because the limited data collected may not reveal the true nature of the aquifer" ***p. 554 Driscoll 2nd ed.***

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BC's own CPCN Guidelines and "Guide to Conducting Well Pumping Tests"

- **Pretty much the same as Driscoll:**

Unconfined aquifer: 48-72 hours

Confined aquifer: 24 hours

Bedrock: 72 hours

(note: new GW Protection Reg. Div. 4, #32 does not specify duration)

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Time of year

- Test analysis assumes ‘no recharge’
- Therefore, in coastal settings best to test in late summer/early fall
- Interior settings, fall to mid winter
- Given the above, with appropriate analysis, tests can be done throughout the year
- Important to have pre-test and recovery data

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Pumping Test Examples

- To illustrate how often a brief four-hour test is nowhere near long enough
- Sometimes, 24 hours is not sufficient
- Even longer tests lasting > 1 week can reveal surprises

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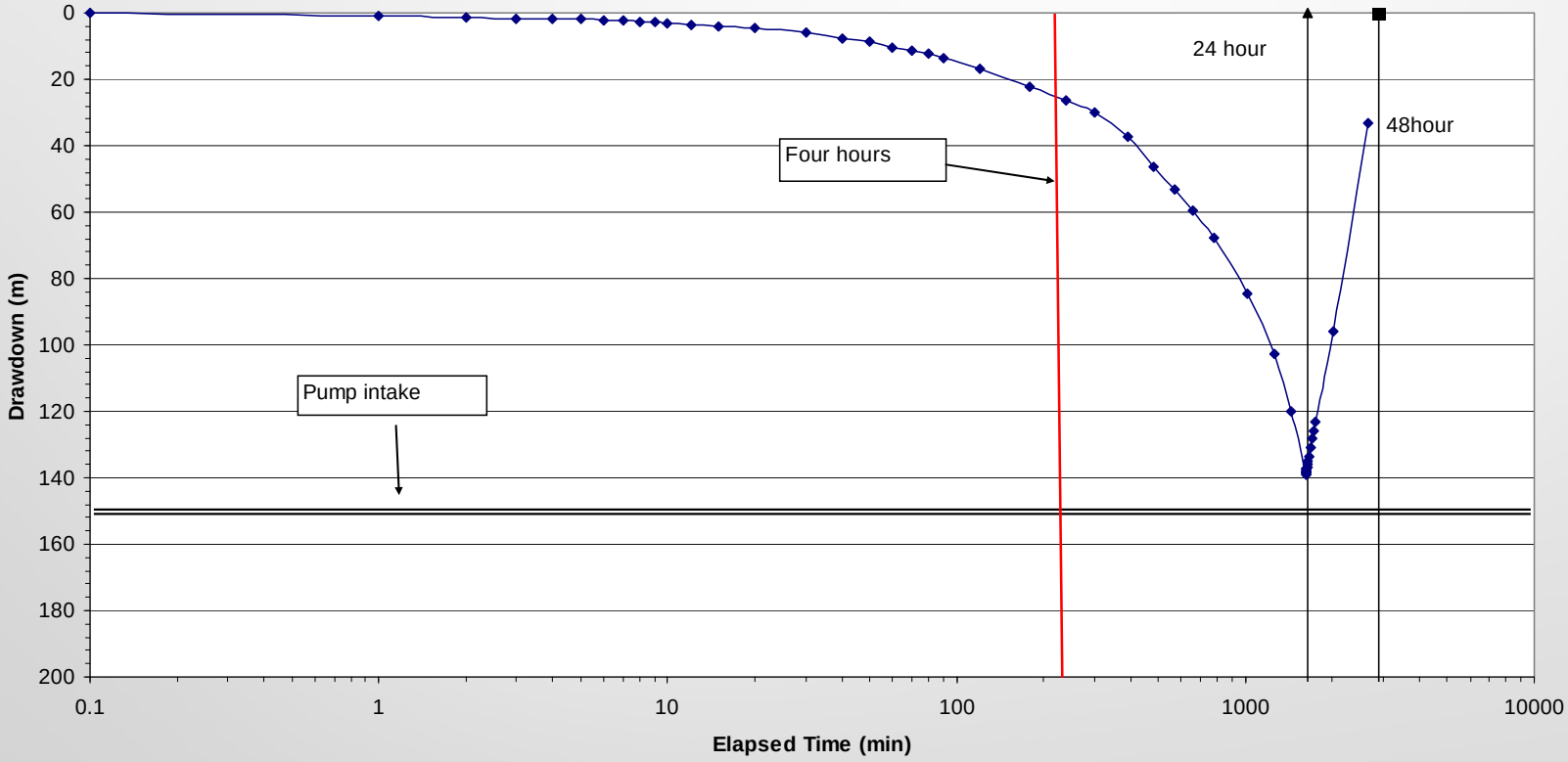
When is 4 hours long enough?

Figure 2: Semilogarithmic Plot of Drawdown
Pumping Test
Pumping Rate - 1 lgpm, Nov, 2006



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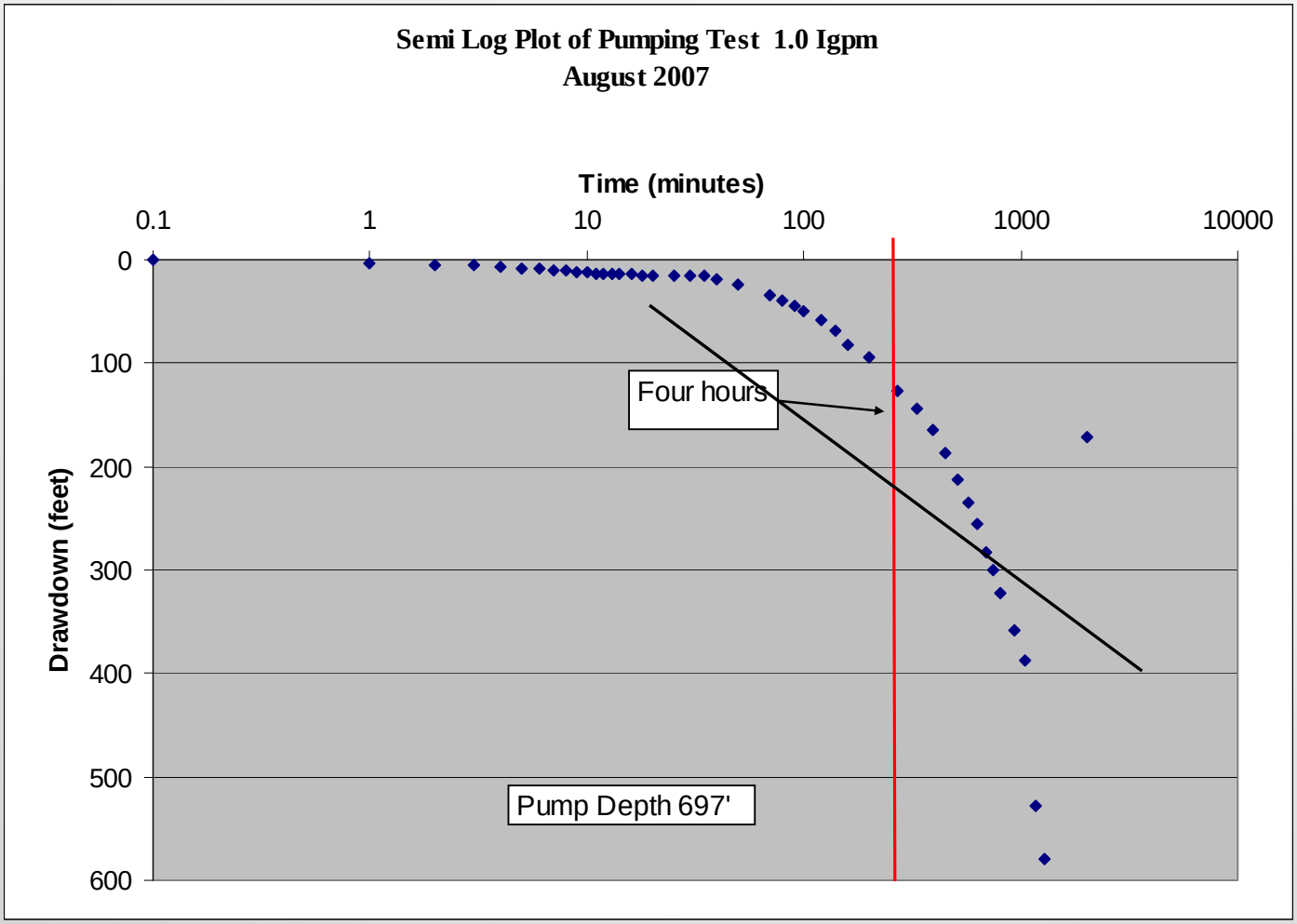
Look what happens after 4 hours….



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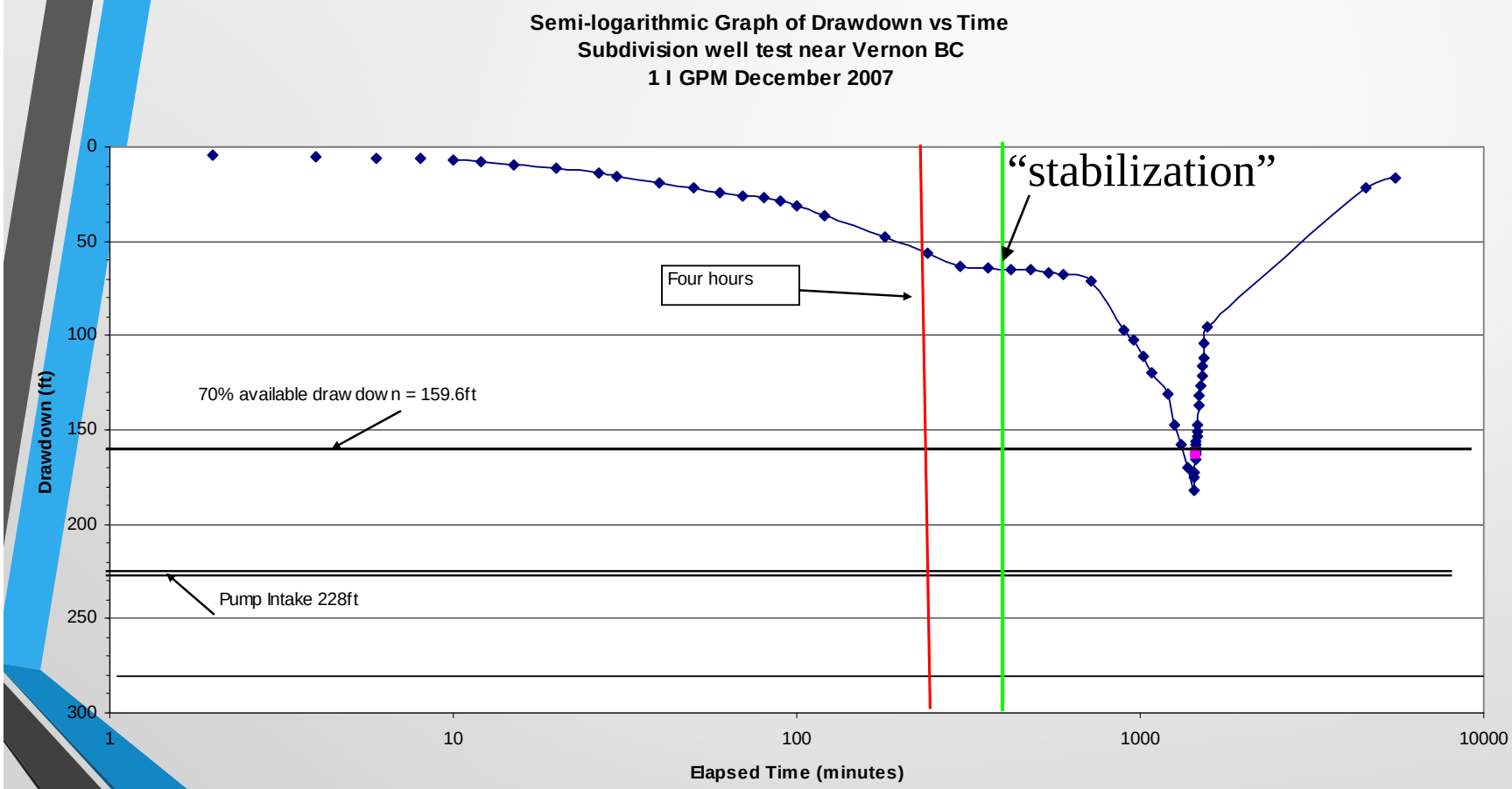
So is 12 hours long enough?



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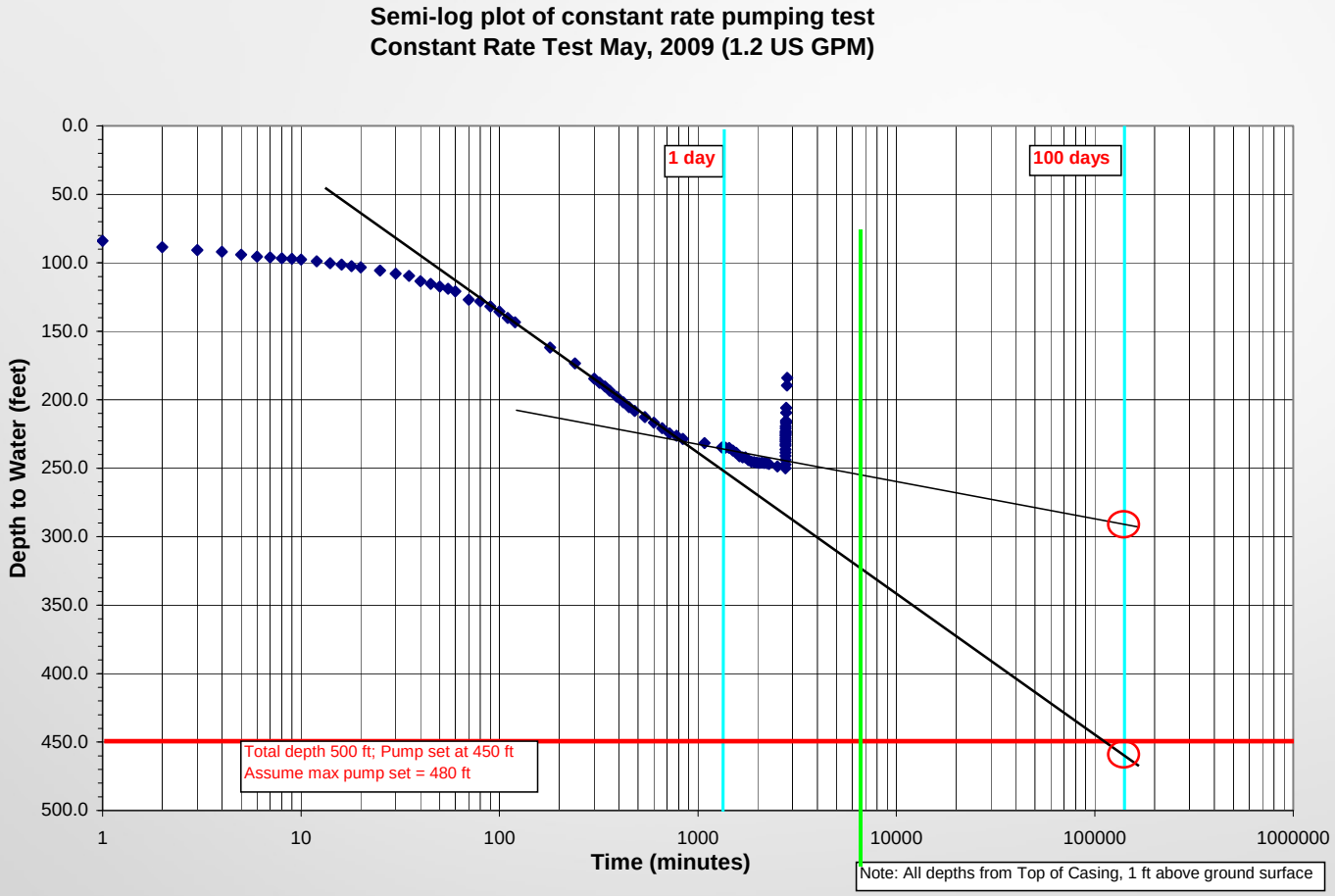
How about 24 hours?



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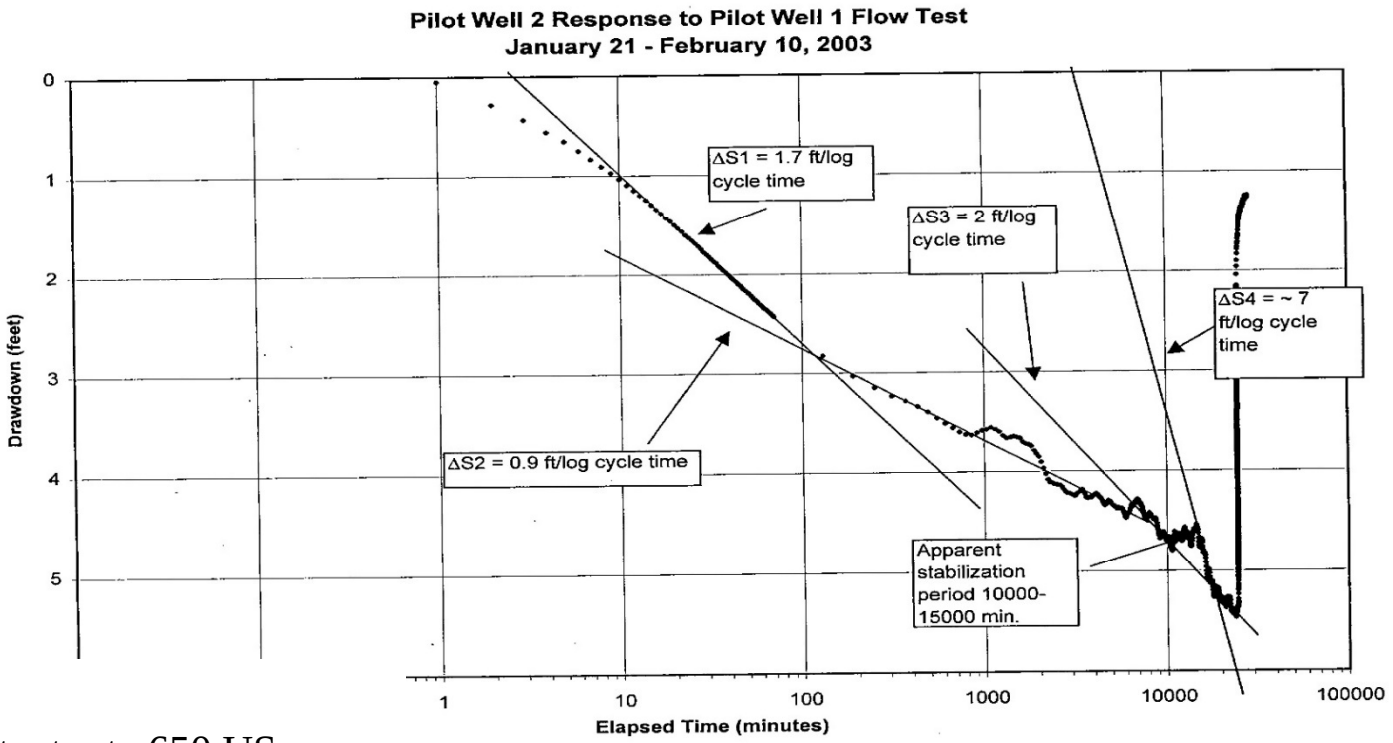
How about 20 days?



Constant rate 650 US gpm

Five distinct drawdown slopes (semilog)

Multiple boundary conditions

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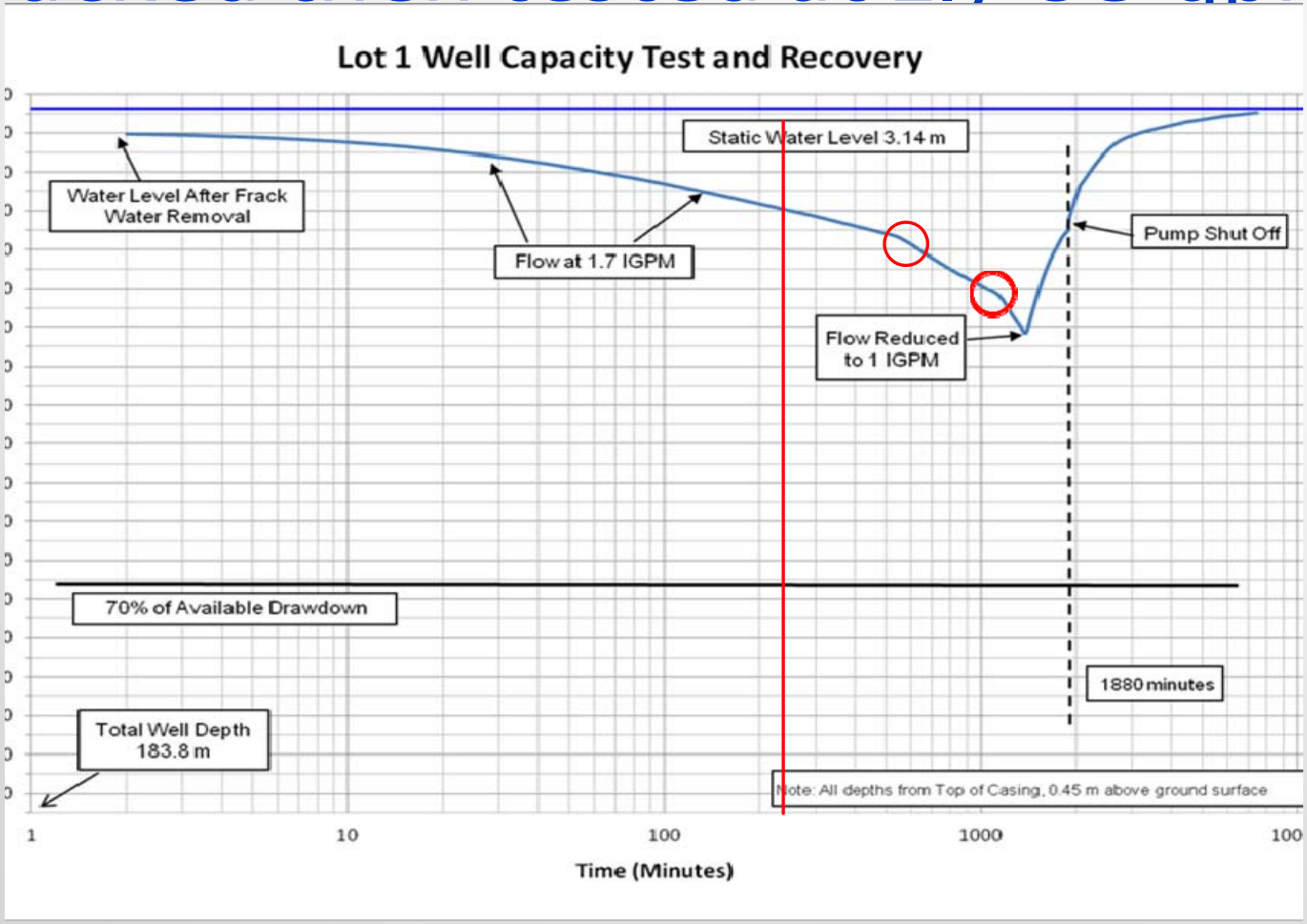
600 ft bedrock well, 0.6 US gpm fracked then tested at 1.7 US gpm



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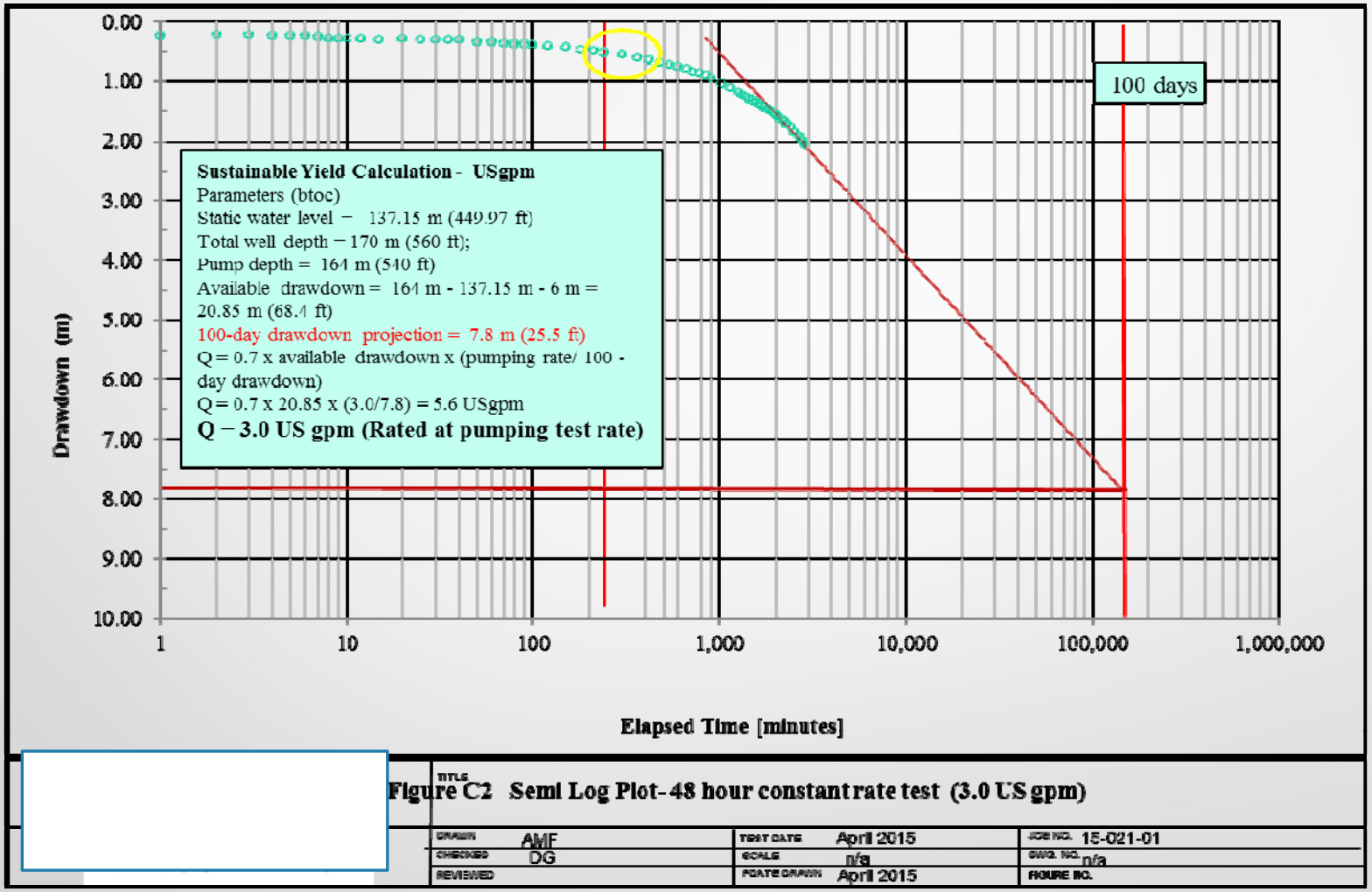
Need another one?



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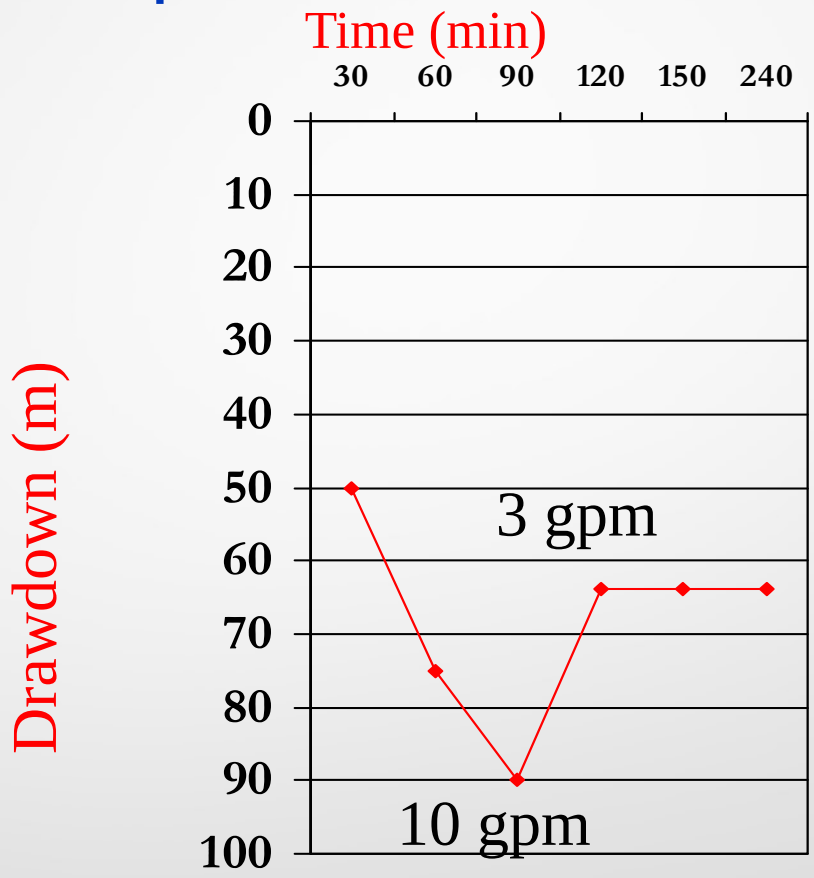
"Volume tests" are not pumping tests
Example #1

- Pump at high rate to maximize drawdown
- Reduce flow rate
- Achieve a stabilized water level
- "Stabilized" level – is reflecting recovery due to flow rate reductions
- It is not stabilization



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"Volume tests" are not pumping tests Example #2

- Pump enough to equal a daily volume requirement
- (e.g. "2300 L/day" for some regional districts)
- Record the drawdown
- Measure well recovery
- If well recovers to some arbitrary level, it "passes"

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Part 2 – The case for deep(er) well seals in confined aquifer wells

- Why?
  - Drilling and casing advancement do not ensure a tight seal between formation and well casing
  - Prevent loss of confining pressure in lower aquifer
  - Prevent co-mingling of waters between two aquifers
  - More safely contains potential artesian flow
  - ….and it is standard practice in many areas with complex hydrogeology

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Deep well seals in confined aquifer wells

- When and where
  - Upper unconfined aquifer and lower confined, with an aquitard in between
  - Expected different water levels and water chemistry between upper and lower aquifer(s)
  - Anywhere with known or possible flowing conditions (see Golder's presentation on Coldstream well)
  - Contaminated upper aquifer or contamination threatens shallow zone (e.g. GUDI, nitrates, etc)

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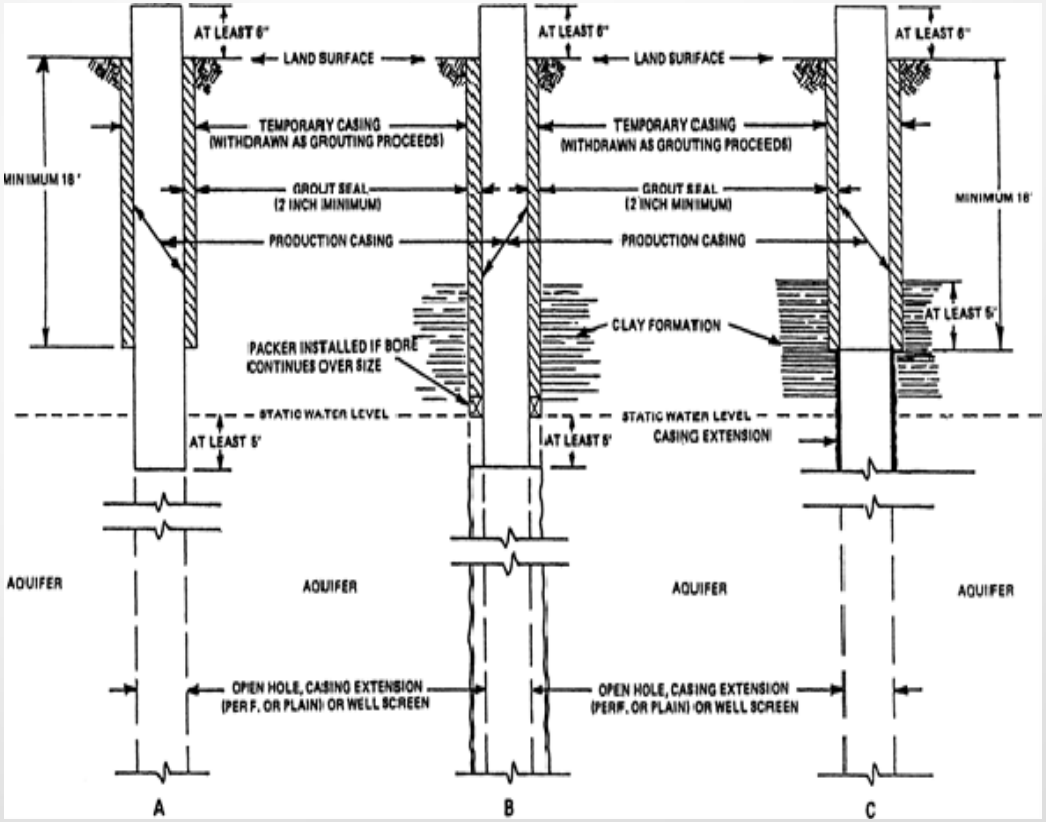
Examples of "full" annular seal regulations

- Ontario Water Resources Act, RRO 1990 Reg 903
- Washington Code (WAC 173-160-241)
- Alberta Water Regulation (Section 48, AR 205/98)

And many other locations



The well casing in the next slide was fully sealed into a confining unit prior to drilling into the aquifer

2,000+ gpm of artesian flow from 500 ft

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Why should our industry promote these standards?

- **Keeping to minimum pumping test durations would**
  - Marginally increase costs of testing
  - Fewer unexpected poor yielding wells
  - Reduce opportunity to "cut corners "
  - Promotes better science and more reliable results for well owners
  - Lower cost in the long run

- **If full annular seals are required in BC this would**
  - Increase well drilling costs especially in deeper confined wells
  - Prevent cross-connection of multiple aquifers
  - Protect gw quality
  - Reduce chances of uncontrolled flowing wells (if casings are sealed in place before drilling through aquitards)
  - .....and lower cost in the long run!

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Thank You!
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