Ministry of **Forests, Lands and Natural Resource Operations**

Groundwater concepts and methods for assessing sustainability




Nanoose Community Workshop

July 6, 2015

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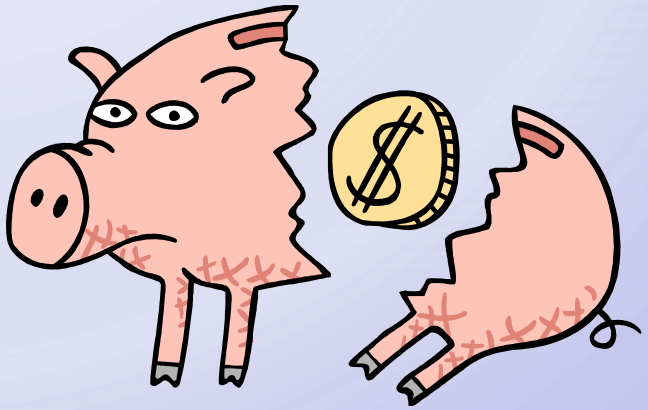
What is sustainability?

"Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs"

(First defined at the World Commission on Environment and Development, the Brundtland Commission (1983) and the UN report "Our common future" (1987))



Need for water sustainability

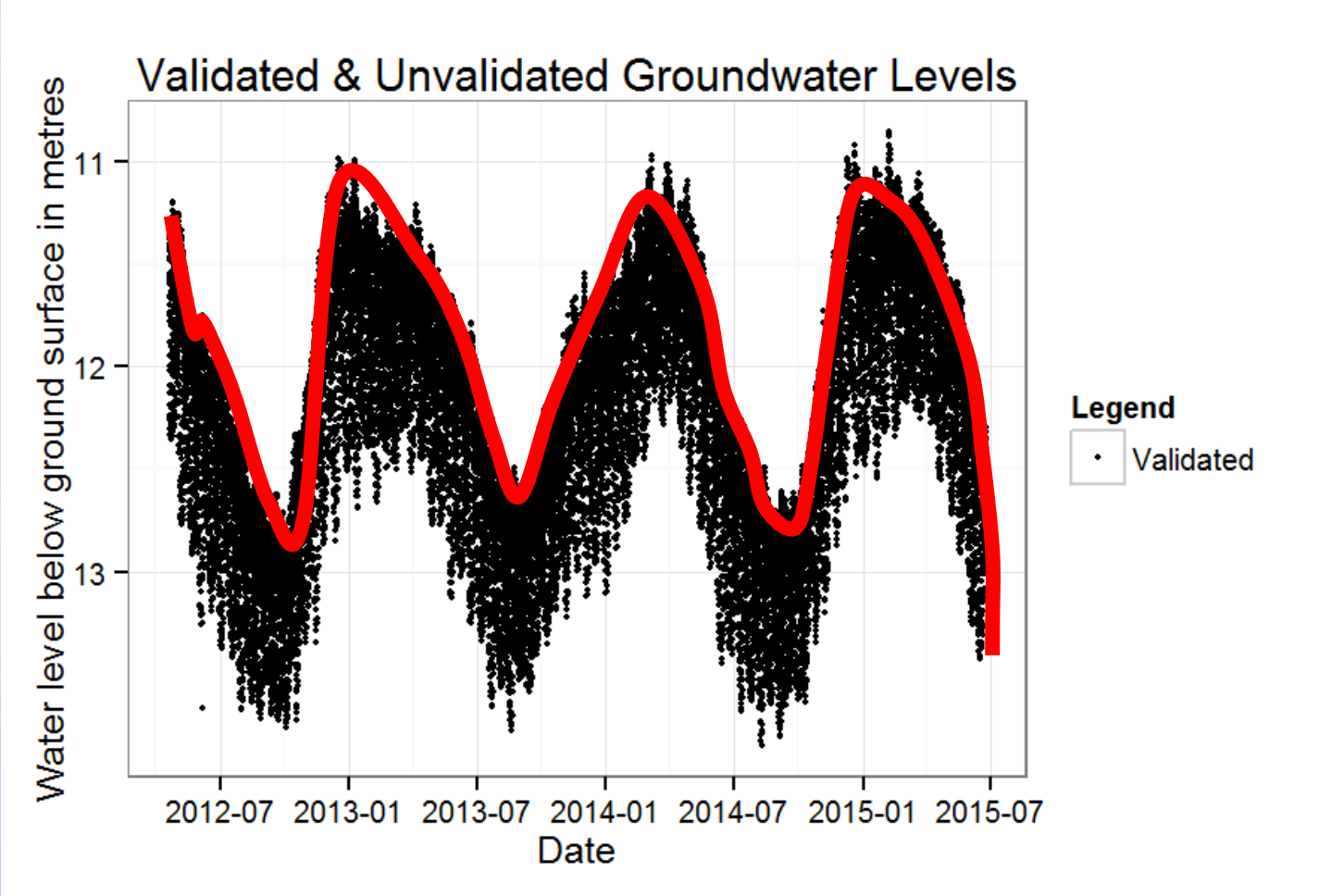
Key information gaps/questions for long-term groundwater protection and management

- Aquifer characterization- How much groundwater is available?
- Linkages to surface water
- Saltwater interface and seawater intrusion risk
- Water budgets- how much is used and can we use sustainably?
- Impacts of climate change? Urban and rural development?

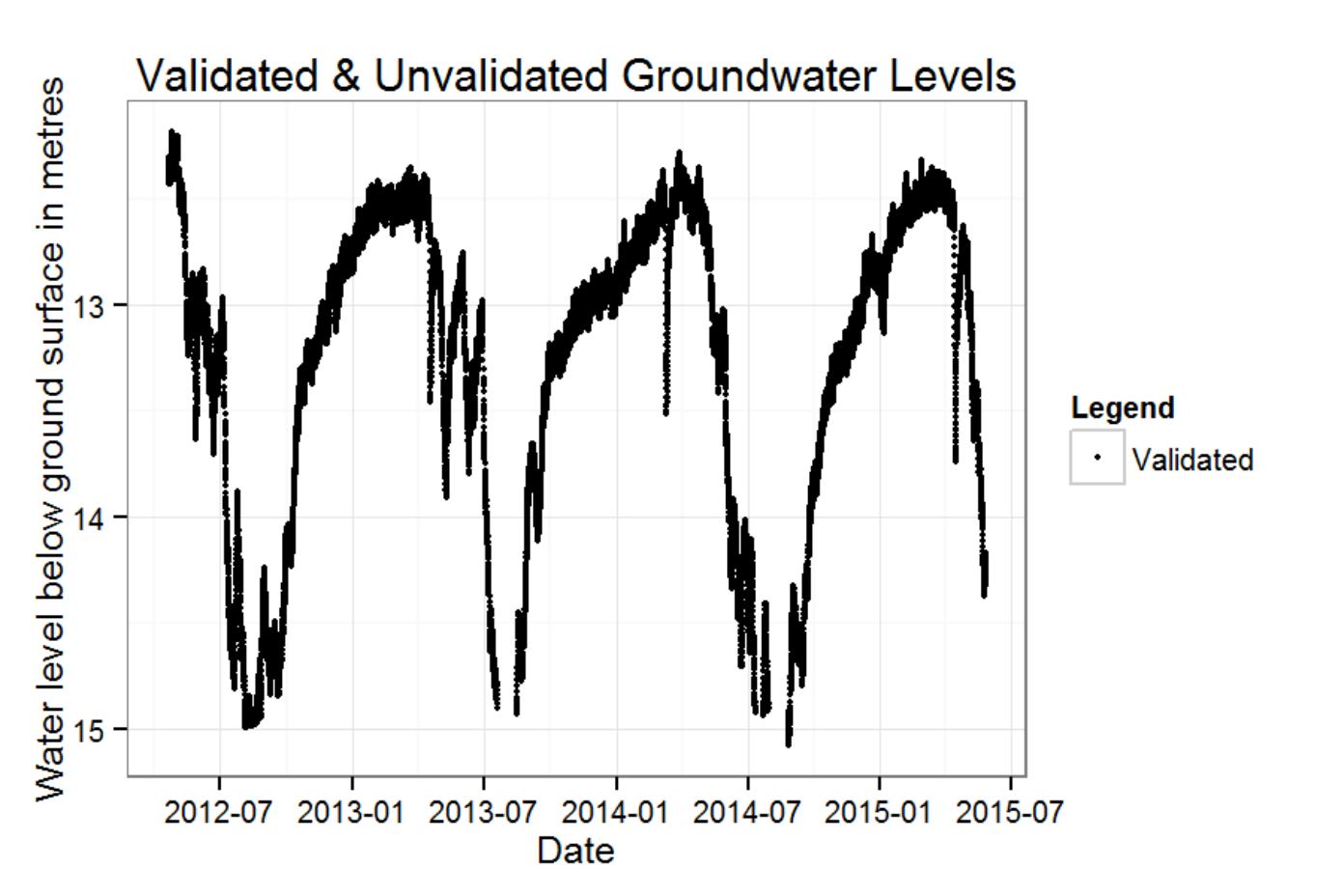
How do we evaluate whether groundwater use is sustainable?

1. Monitoring e.g. observation wells measuring groundwater levels over time (seasonal variation, pumping interference, long-term trends)
2. Pumping test – monitor water levels in test well and adjacent wells during pumping - response is used to predict water availability over time
3. Water budget – analysis of inputs and outputs

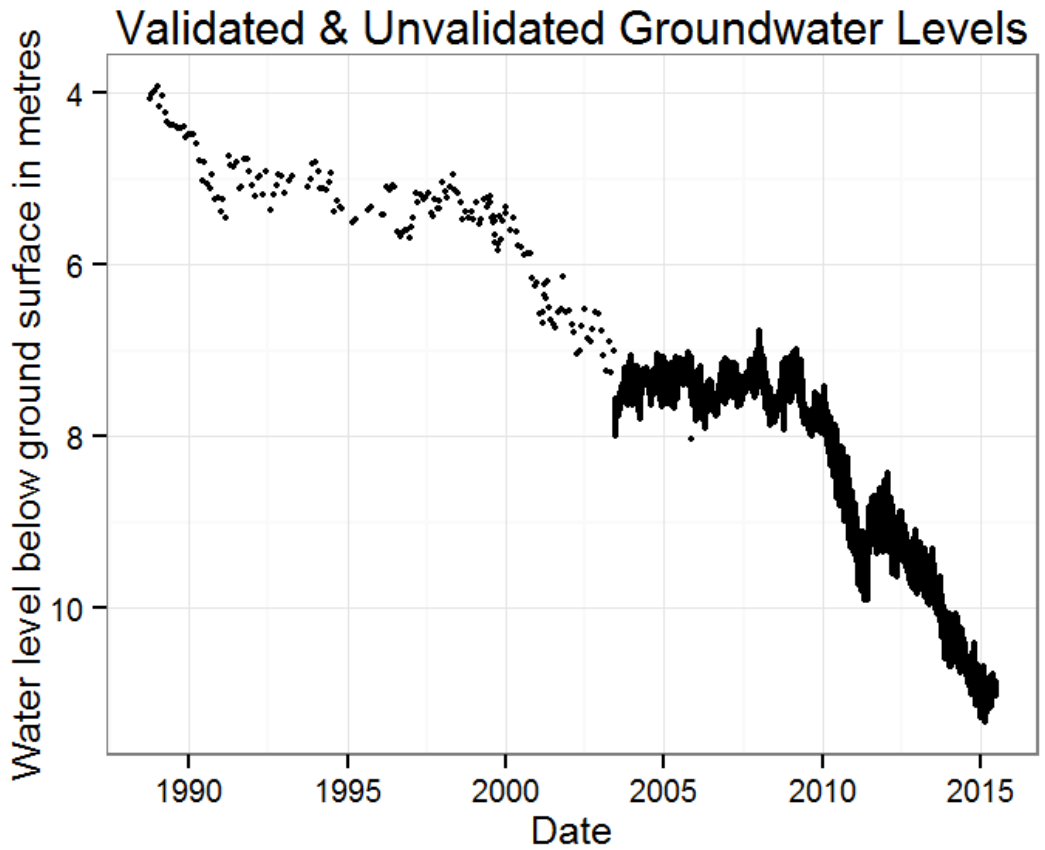
Observation well 394 Nanoose (Nuttal Dr)



Observation well 395 Nanoose (Rivers Edge Dr)



Observation well 304 Parksville (Despard Rd)



Sustainable?

env.gov.bc.ca/wsd/data_searches/obswell/map/index.html

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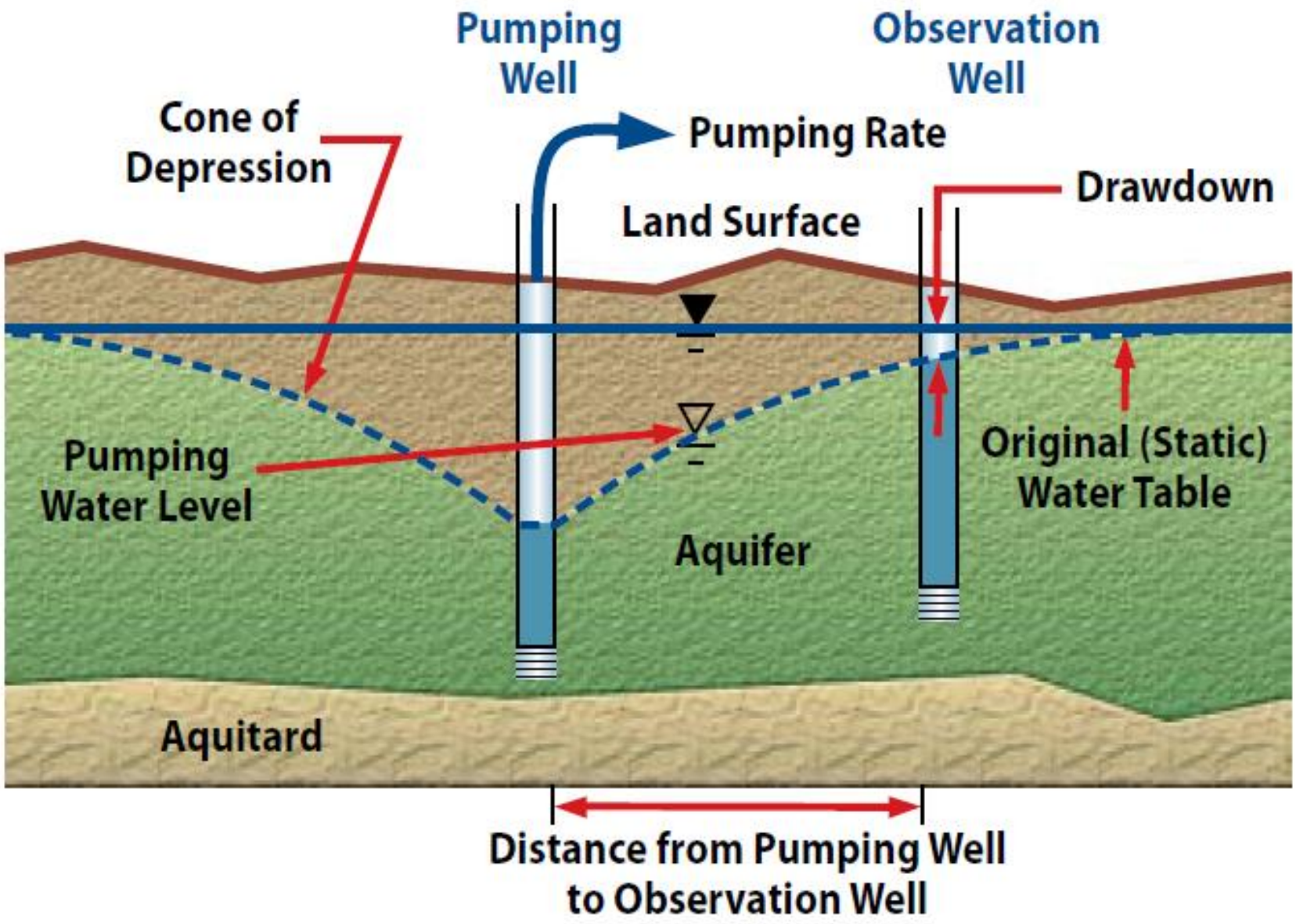
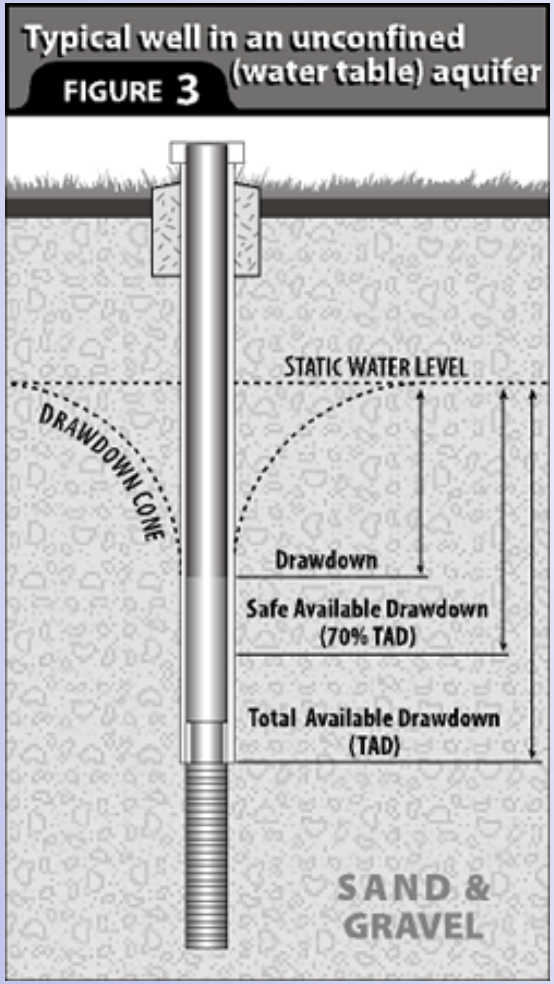
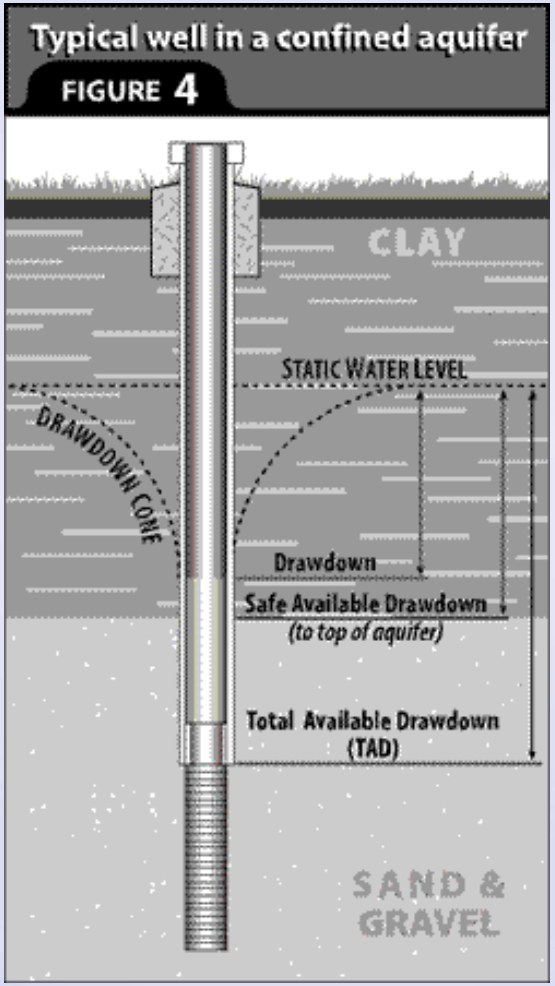
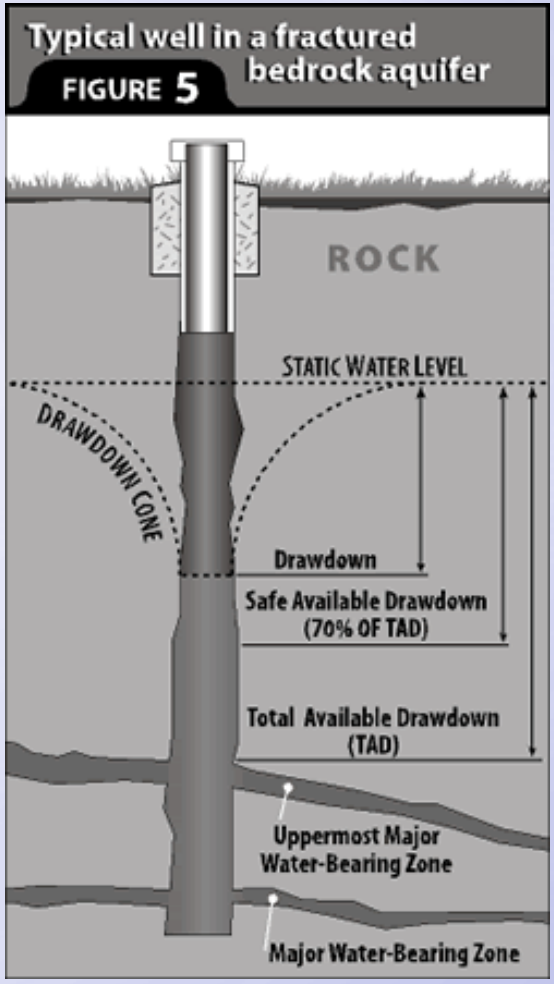
Well pumping concepts & terms



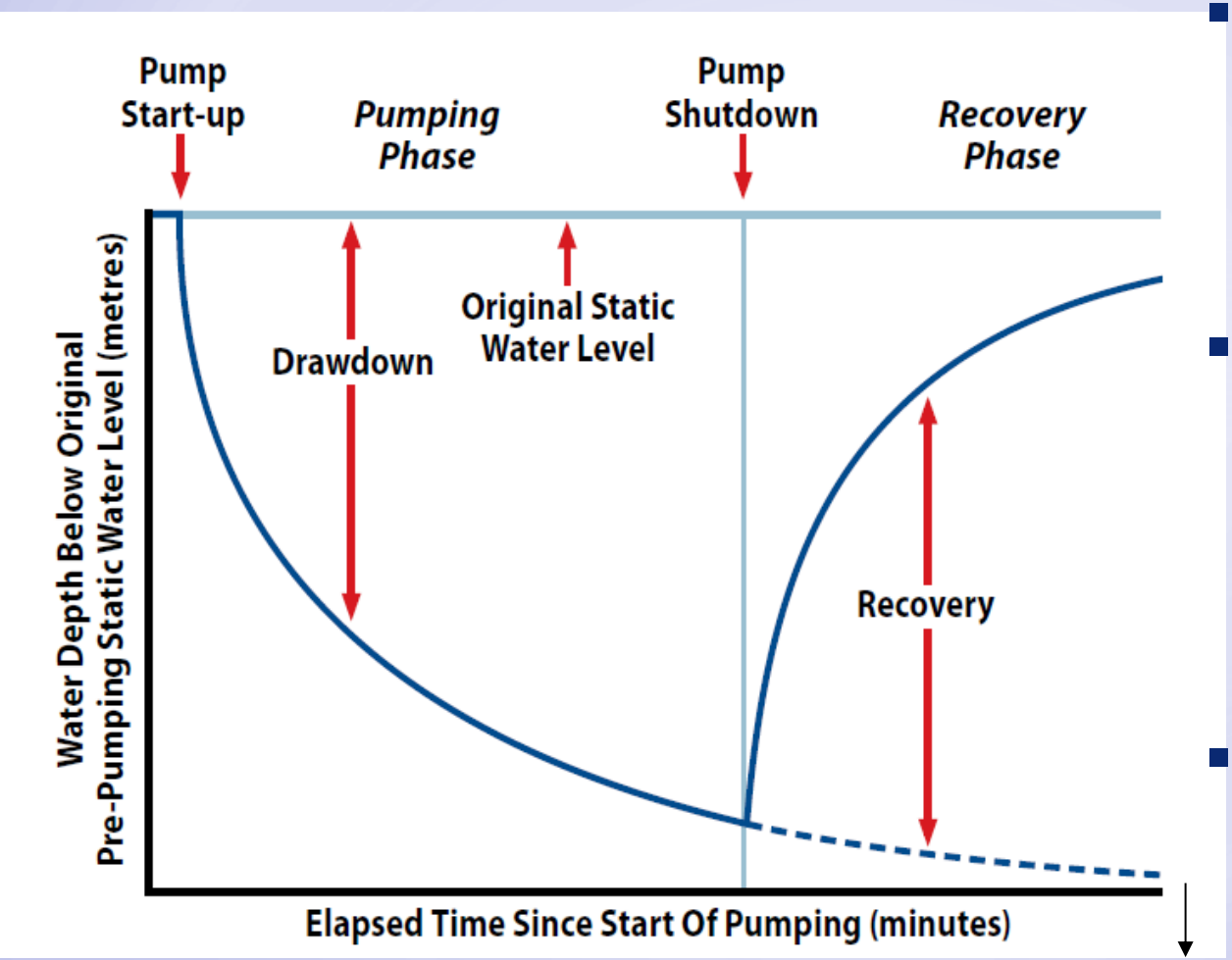






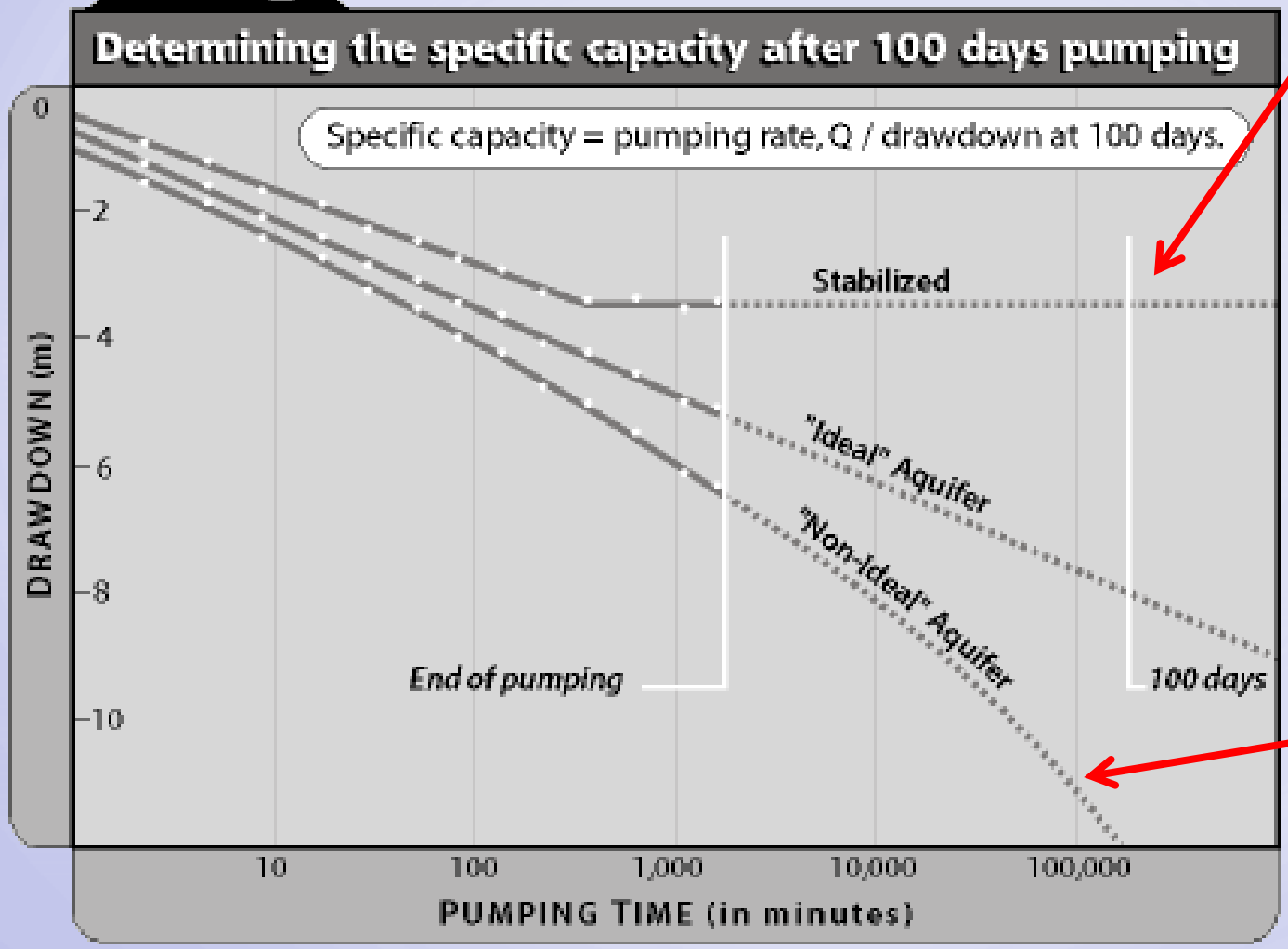
env.gov.bc.ca/wsd/plan_protect_sustain/groundwater/library/eval_well/index.html

Pumping tests



- Well is pumped for an extended period e.g. 24 to 72 hours
- Water levels monitored in pumping well and nearby observation wells
- Monitoring continues after pump stops

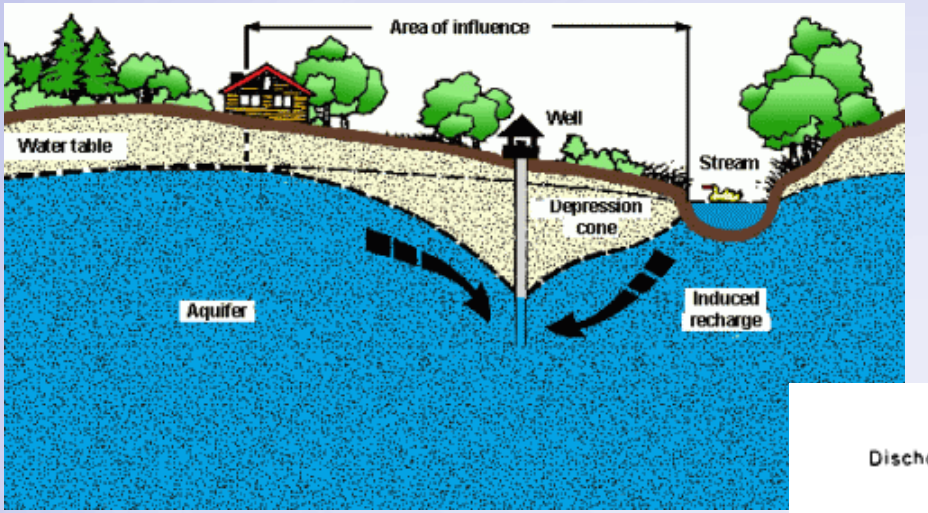
FIGURE 2



Greater aquifer capacity than pumping rate? Positive boundary condition (e.g. interception with source of recharge, leaking from other aquifers)?

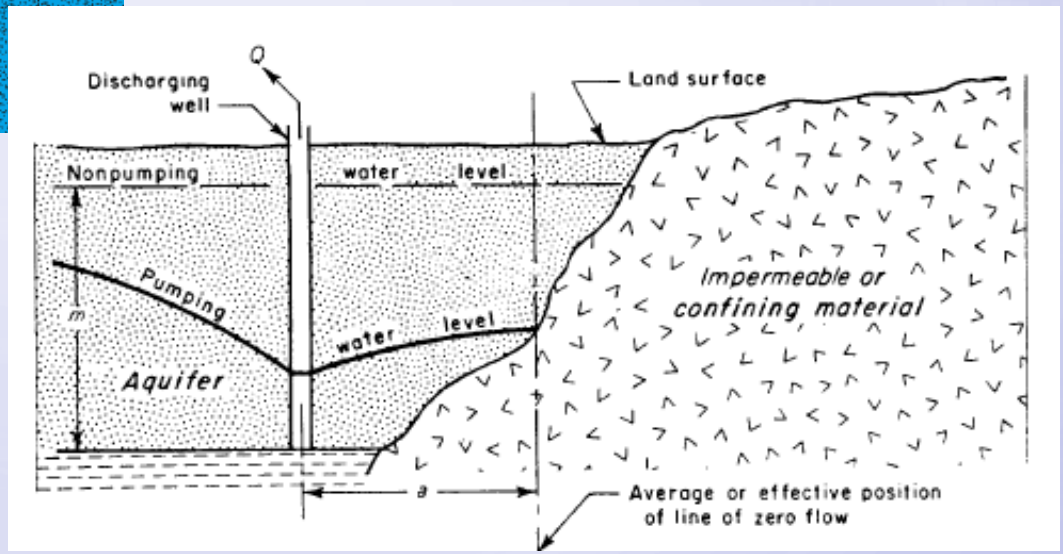
Too high pumping rate? Negative boundary encountered e.g. edge of aquifer?

env.gov.bc.ca/wsd/plan_protect_sustain/groundwater/library/eval_well/index.html



Positive (recharge) boundary

Negative boundary



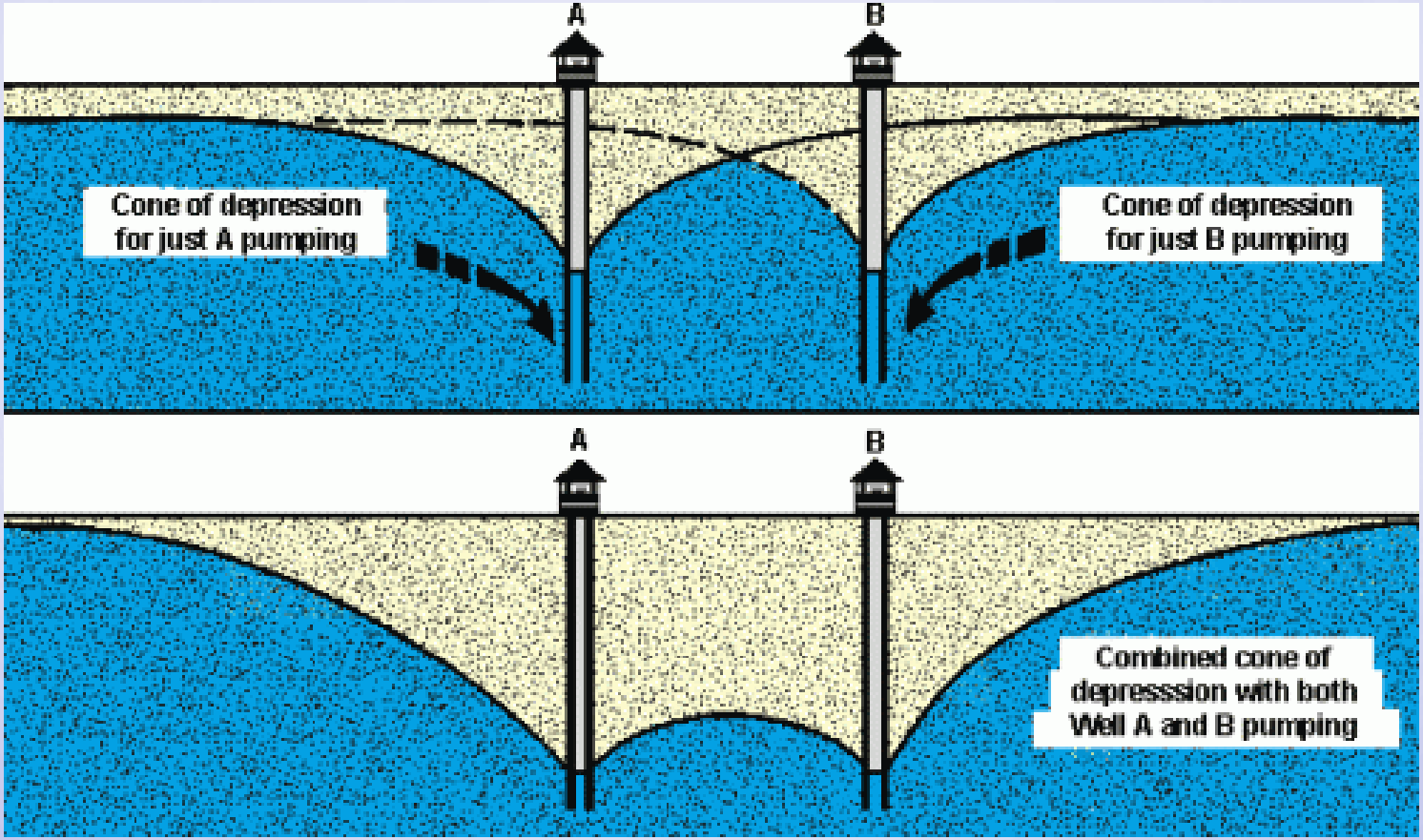
www.aqtesolv.com/pumping-tests/pumping-tests-in-bounded-aquifers.htm

wellwater.oregonstate.edu/groundwater-and-wells

Considerations in determining long-term well capacity

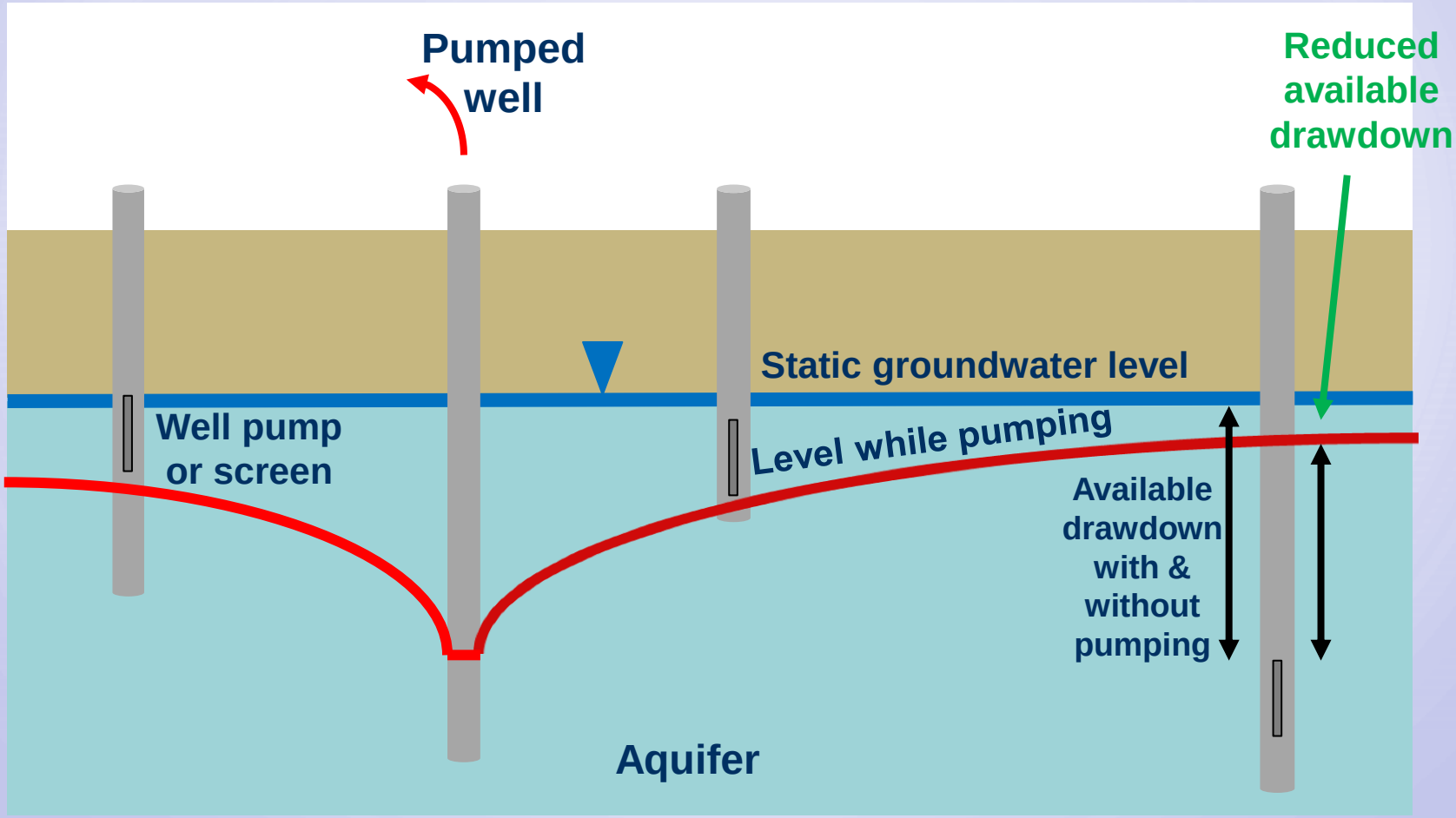
- Well performance and aquifer capabilities – How much can the well provide sustainably (including during periods of no recharge)?
- Well interference – Will this extraction impact other groundwater users?
- Linkages to surface water – Will this extraction impact environmental flows within a nearby stream?
- Saltwater interface – is the well or aquifer at risk of intrusion as a result of well pumping (including cumulative effects of multiple wells)

Well interference



wellwater.oregonstate.edu/groundwater-and-wells

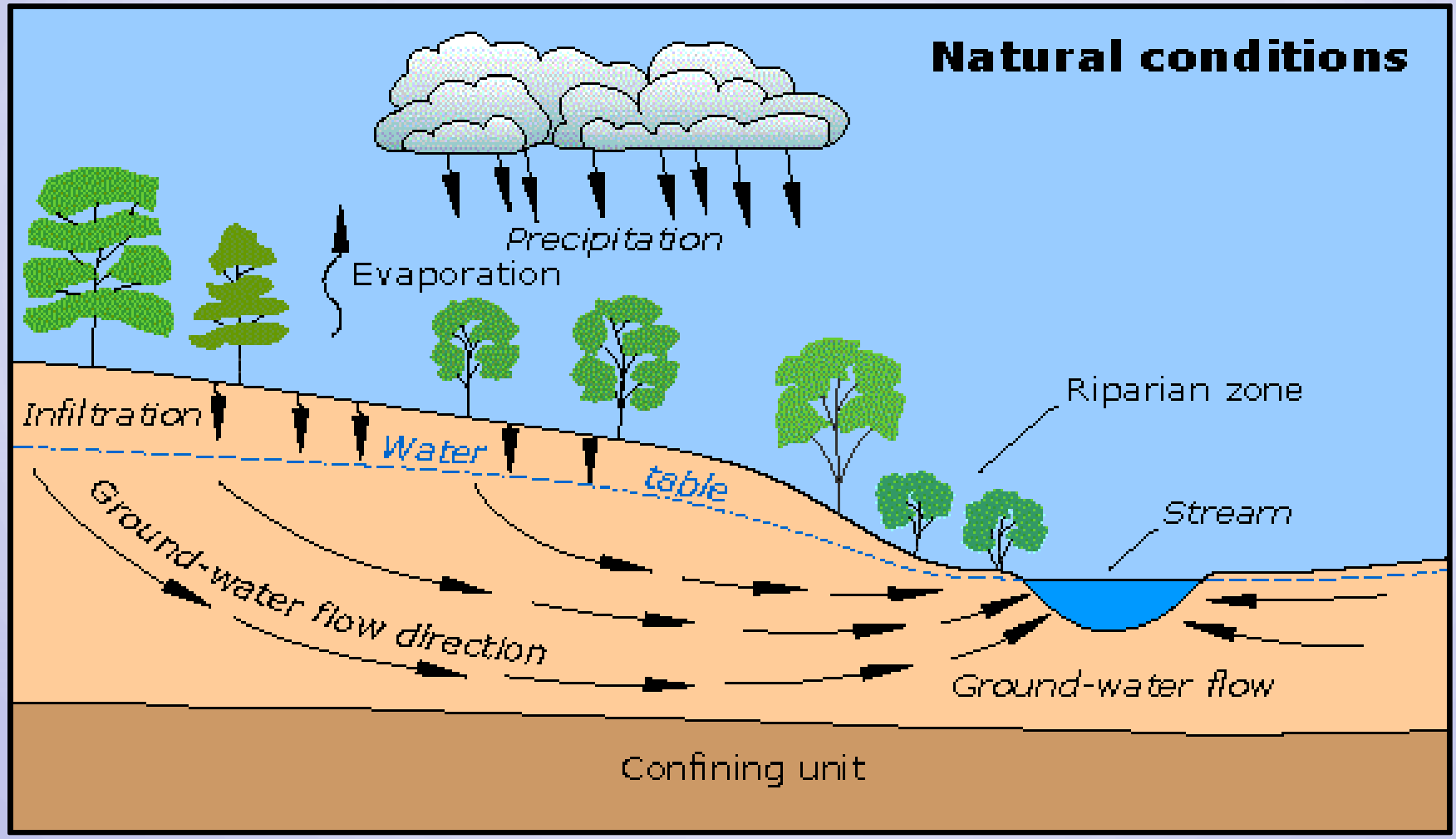
Well interference - examples



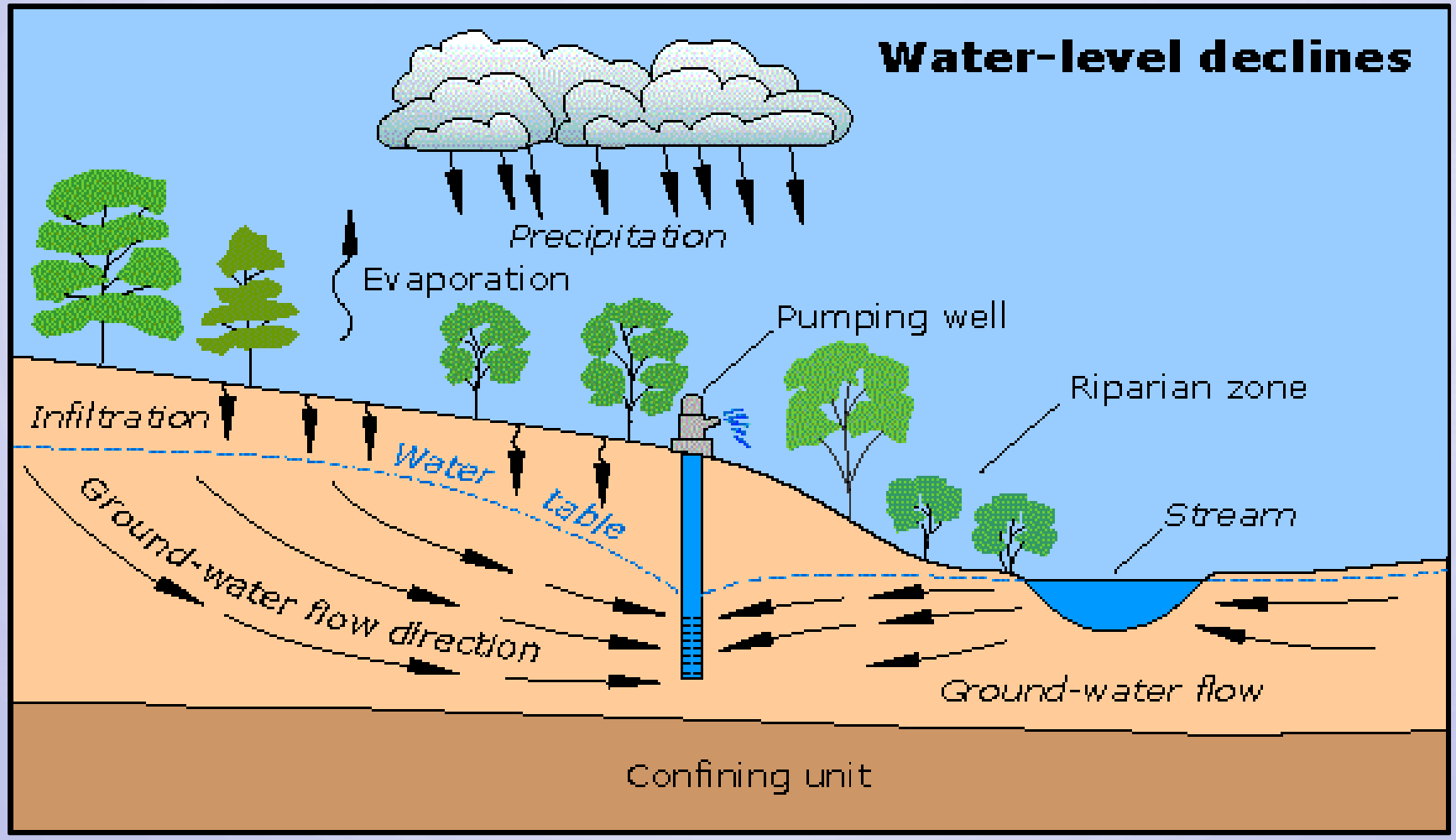
Potential impacts of unsustainable groundwater extraction and well interference

- If depth to water increases → lift distance increases → energy to power pump increases → $$$$
- Groundwater levels may decline below the existing pump → lower pump, deepen well or drill a deeper replacement well → $$$$
- Yield of well may decline below usable rates – dry wells
- Potential water quality impacts – less dilution of dissolved elements

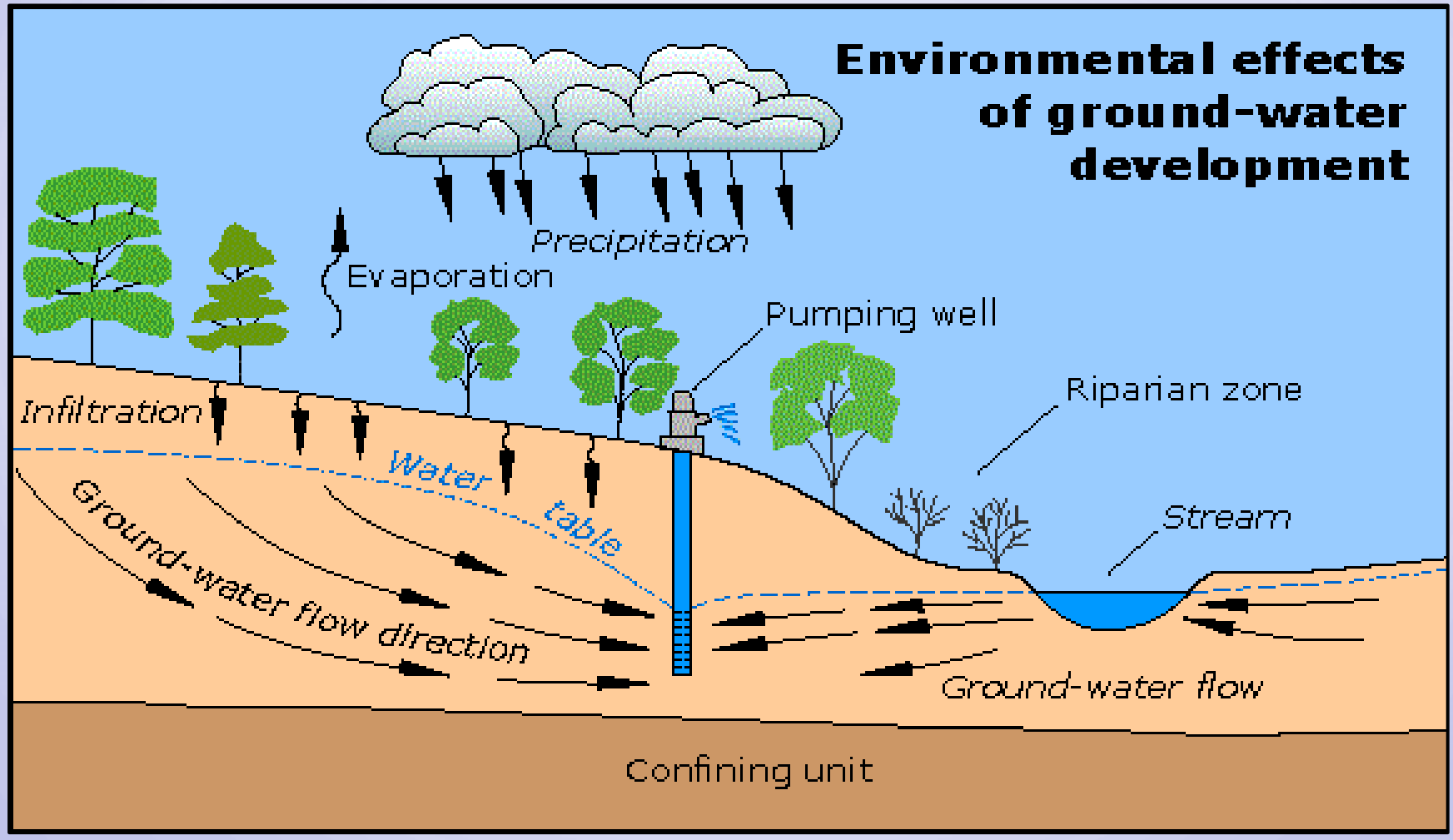
Impacts on environmental flows in streams



Impacts on environmental flows in streams



Impacts on environmental flows in streams



How do we evaluate whether groundwater use is sustainable?

1. Monitoring e.g. observation wells measuring groundwater levels over time (seasonal variation, pumping interference, long-term trends)
2. Pumping tests - use behaviour of well to predict water availability over time and to evaluate how adjacent wells respond to pumping of test wells
3. Water budgets – analysis of inputs and outputs

Groundwater Balance – How much of the "available" water is being taken by a particular taking or takings?

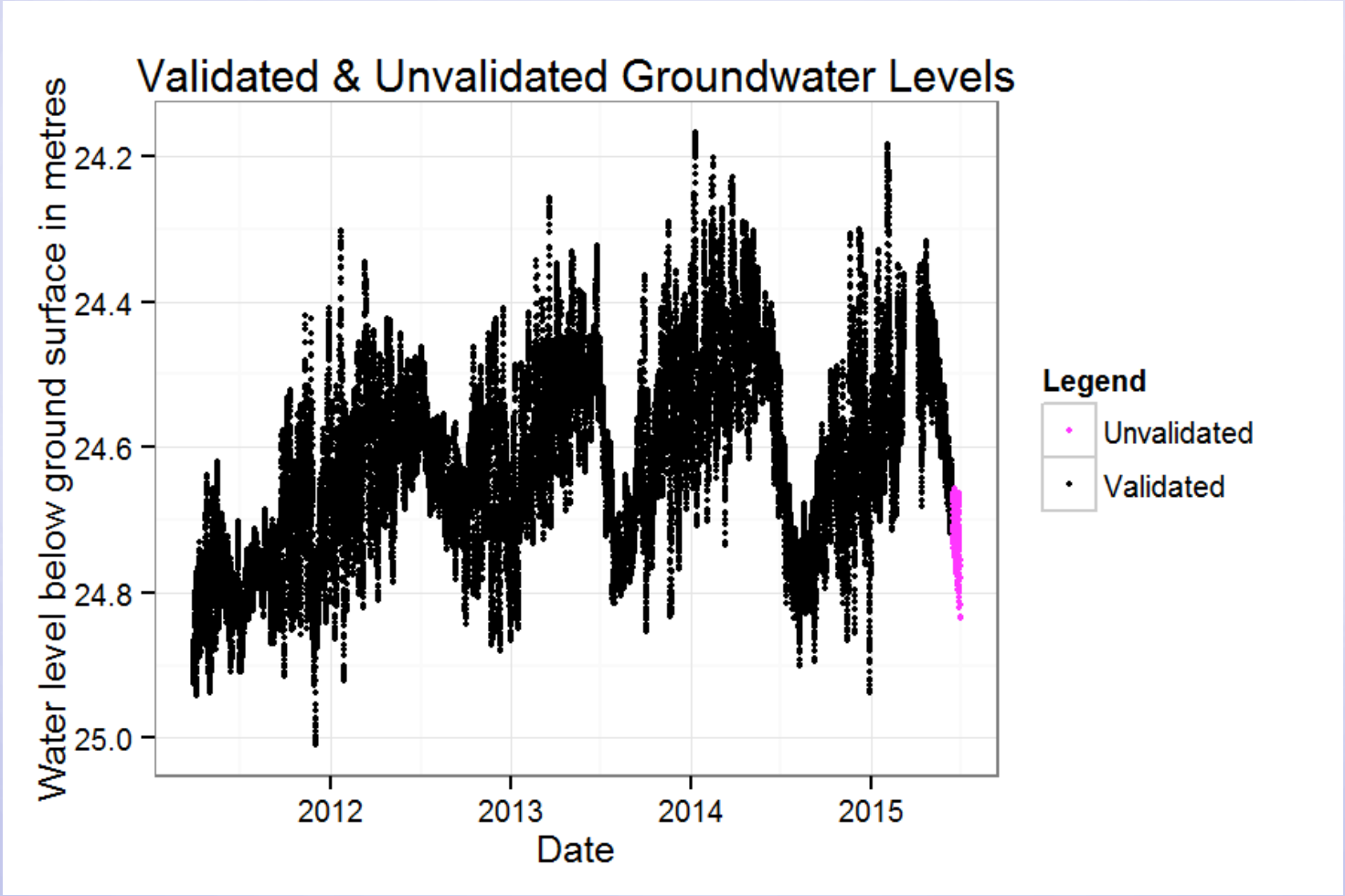
$$\text{Amount of Water Used (\%)} = \frac{\text{Total Volume of groundwater extracted}}{\text{Total Volume of water recharging to aquifer}} \times 100$$

Simple calculation but many assumptions!

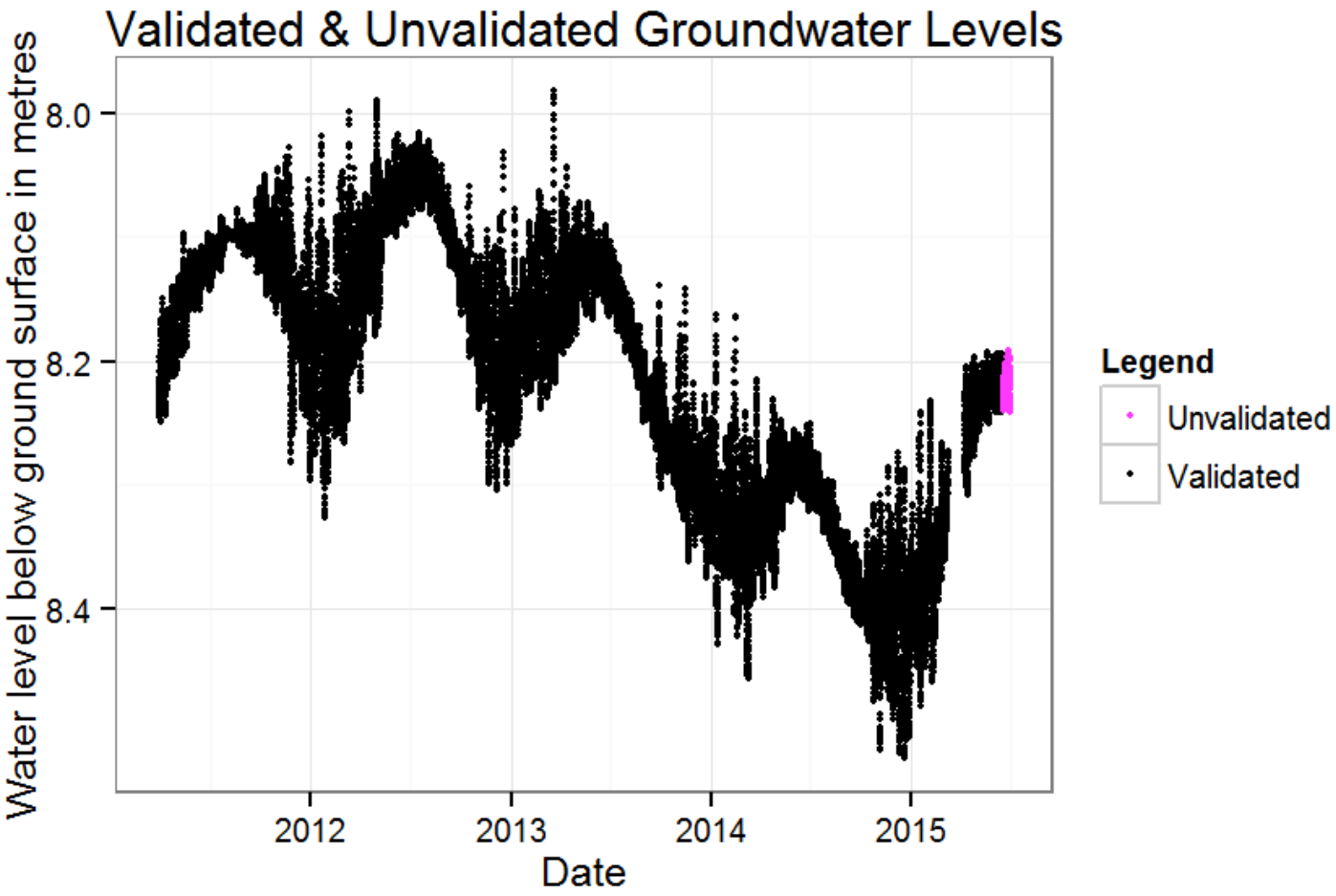
See: rdnwaterbudget.ca/island/waterbudget/region5/

Discussion

Observation well 392 Nanoose (Dawson Rd deep)



Observation well 393 Nanoose (Dawson Rd shallow)



Observation well 396 Nanoose (Ballenas Rd)