Exploring connections between teacher and student conceptions of groundwater through drawings

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Overview

- Research Question
- Review of student conceptions about groundwater
- Learning Progressions
- Student Drawings of Groundwater
- Teacher Drawings of Groundwater
- Conclusions

Groundwater Drawing

We get water out of the ground using a well. Draw a picture of what it looks like under the ground where there is water. Label the things that you draw. Also, draw how we get water out of the ground.

Question

Many researchers have examined students' drawings to understand their common conceptions and errors in students' mental models of groundwater.

How are teachers' drawings similar and different from students' drawings?

Methods

- Replicated the prompt used with students
- Collected drawings from 44 elementary, middle and high school teachers during a professional development workshop
- Classified the teacher drawings according to a rubric previously used to analyze student drawings.

Student Conceptions of Water Cycle

- Water Cycle is portrayed in mountain and coastal processes (Shepardson et al., 2009).
- Water Cycle is primarily focused on surface processes (Shepardson et al. 2009).
- Atmospheric parts of the water cycle are not connected to underground water systems (Assaraf & Orion, 2005)
- Students do not connect the water cycle models they learn in schools to their daily lives (Assaraf & Orion, 2005)

Student Conceptions of Surface Water

- Rivers flow through rural landscapes (Dove et al., 1999; Shepardson et al., 2009)
- Students identify river sources as the mountains (Shepardson et al., 2009)
- Student identify where rivers empty but can not necessarily identify their source (Dove et al., 1999)

Student Conceptions of Groundwater

- Groundwater is a sub-surface lake, disconnected from the water cycle with no relationship with the surrounding rock (Assarf & Orion, 2005)
- Groundwater comes from deeper than 10,000ft (Dickerson, 2005)
- Groundwater storage in: pores and cracks, pipes, streams and rivers, pools and lakes (Dickerson, 2005)
- Scale– pools and lakes: microscopic to pencil eraser; pores and cracks: basketball to beach ball (Dickerson, 2005)

Learning Progressions

"Learning Progressions are descriptions of the successively more sophisticated ways of thinking about a topic that can follow one another as children learn about and investigate a topic of a broad span of time."

Taking Science to School, National Research Council, 2007

Learning Progressions

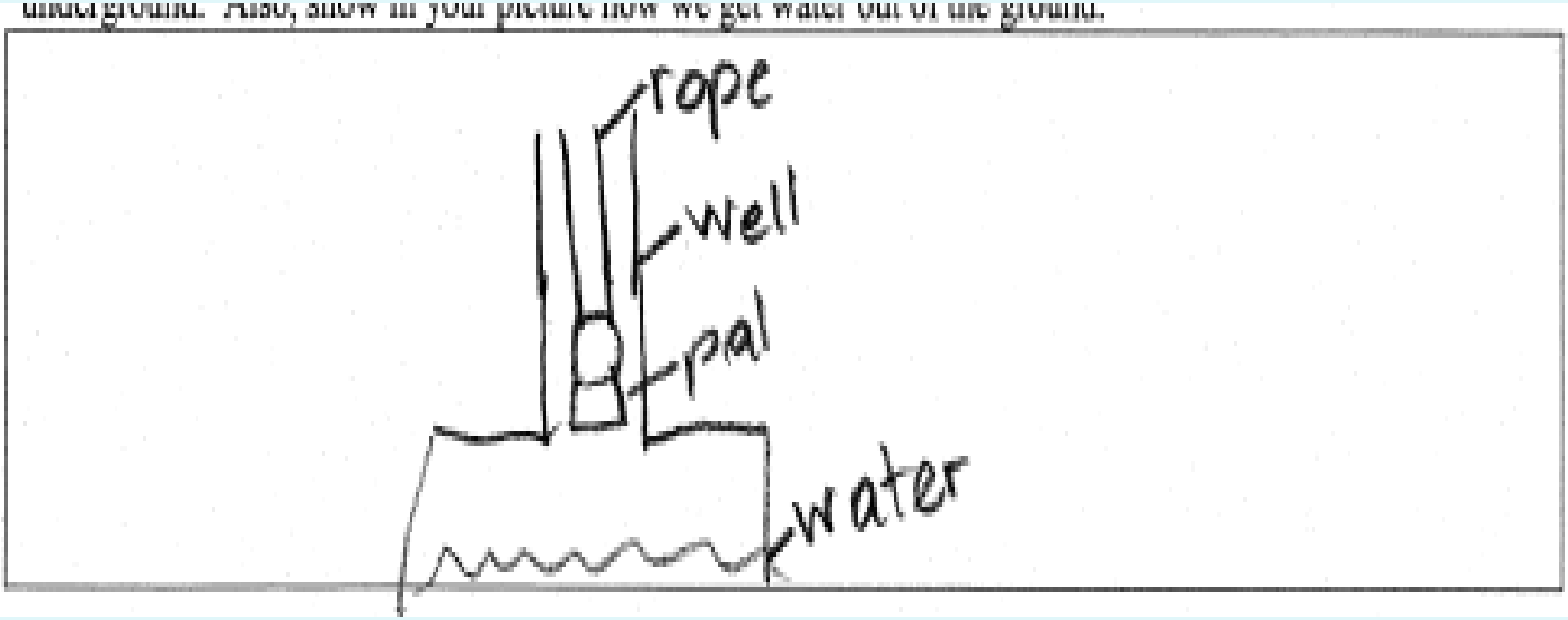
- Low Anchor: Students' concepts and reasoning about a topic when they enter school
- Upper Anchor: Knowledge and practice about that topic in the science discipline
- Includes a framework for the development of these ideas and intermediate steps
- Based on research on students about their conceptions

(NRC, 2007)

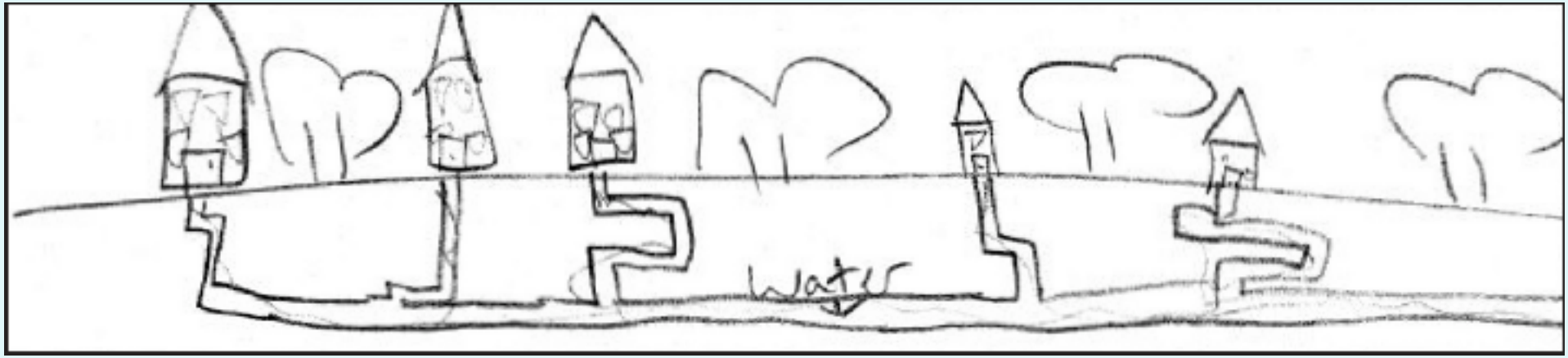
Learning Progression Levels (after Gunckel et al. 2009)

Level	Key Characteristics	Student Thinking
4	Shows water exists in all porous spaces in the ground and shows layers, including impermeable layers. Drawing represents particle size of materials.	**Scientific reasoning: Complete Atomic to Landscape Features**
3	Shows layer detail, including composition of layers. Identifies water in pore spaces in sand and gravel. May include errors on location of water (such as in unconfined sand but not unconfined gravel).	**School-based Narratives; Connected Natural Systems; Microscopic Features**
2	Shows water is in underground river or lake.	**Actors as Agents of Change; Some Natural Processes**
1	Shows water is in pipes or tanks underground.	**Mechanisms of Change are Absent; Visible Features**

Student: Level 1



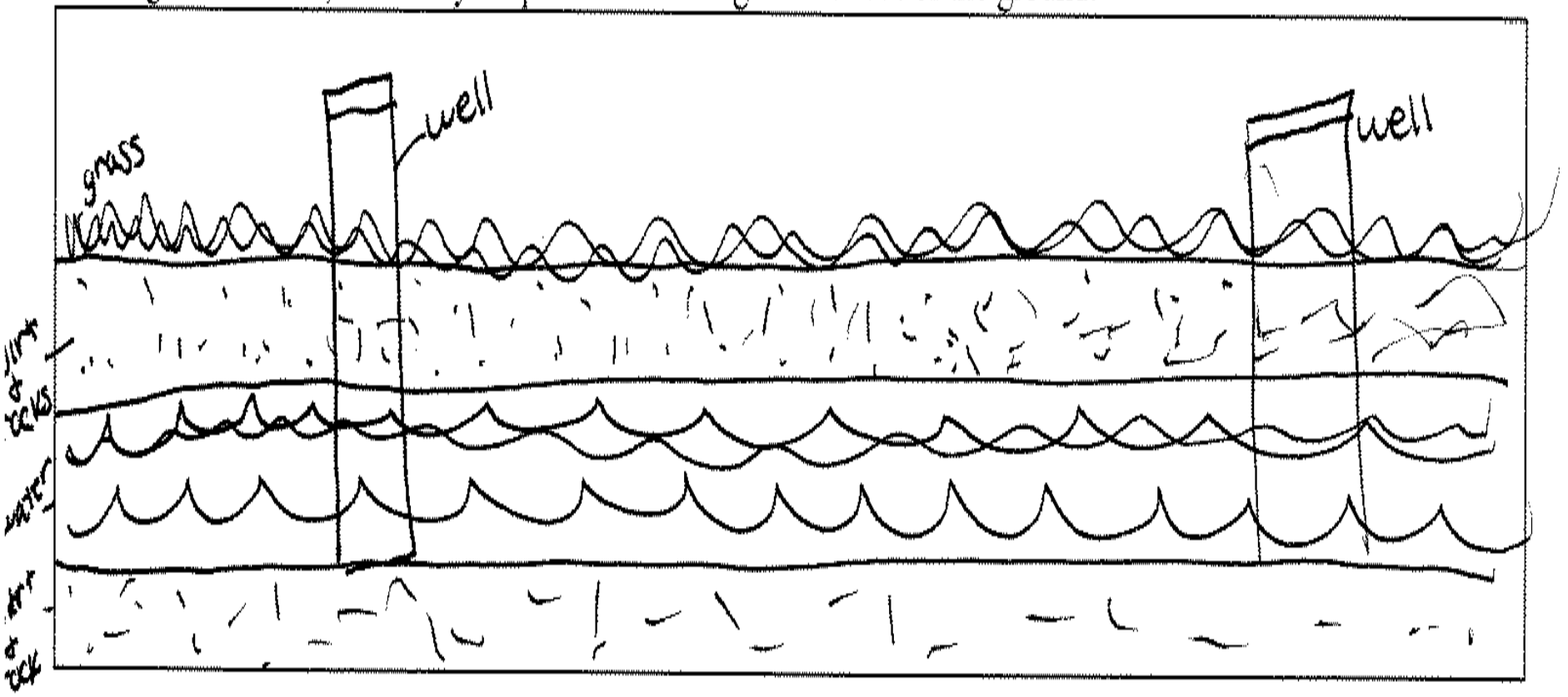
Student – Level 1



Middle School Student Drawing. Fig. 7 Covitt, Gunckel, and Anderson, 2009.

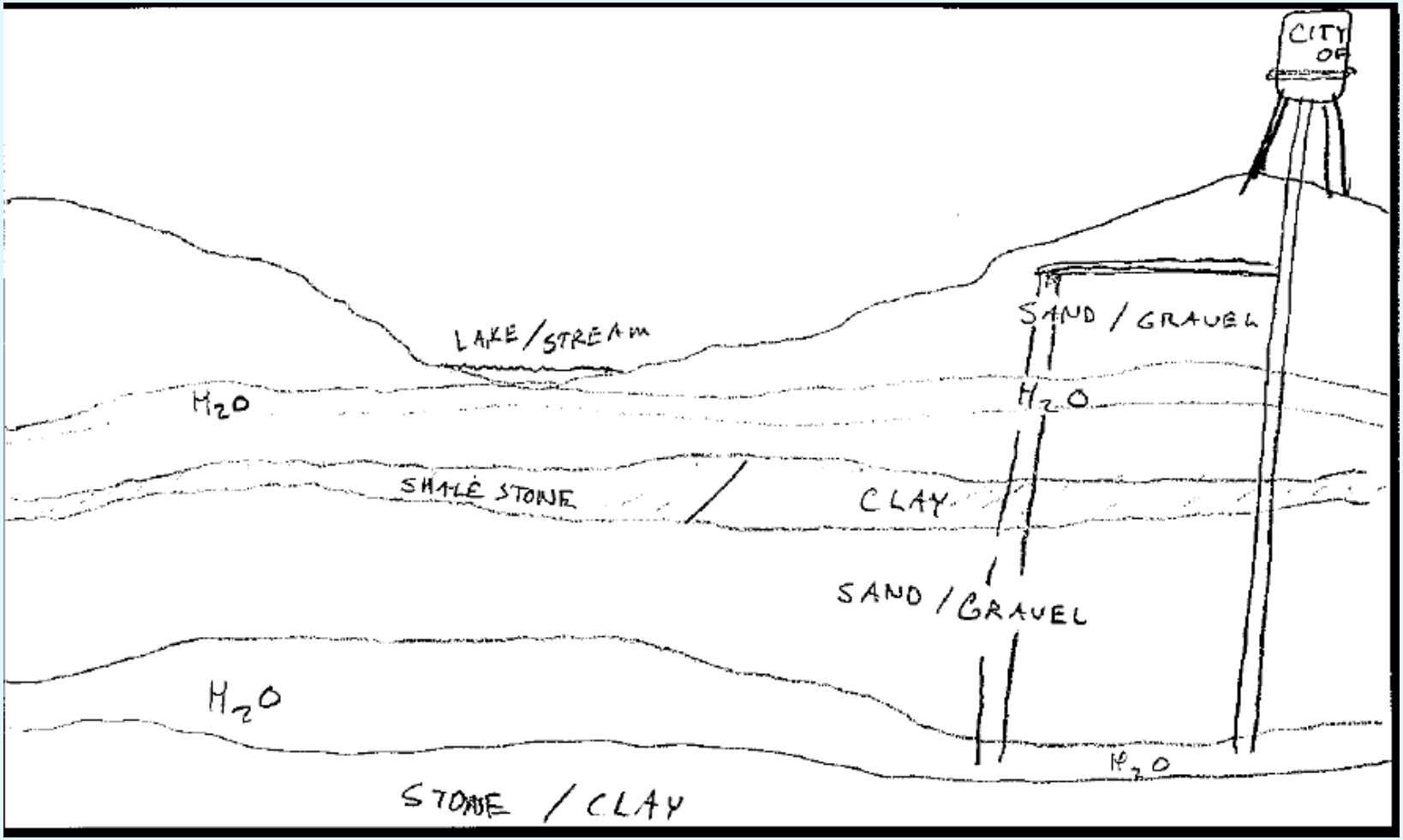
Student – Level 2

underground. Also, show in your picture how we get water out of the ground.

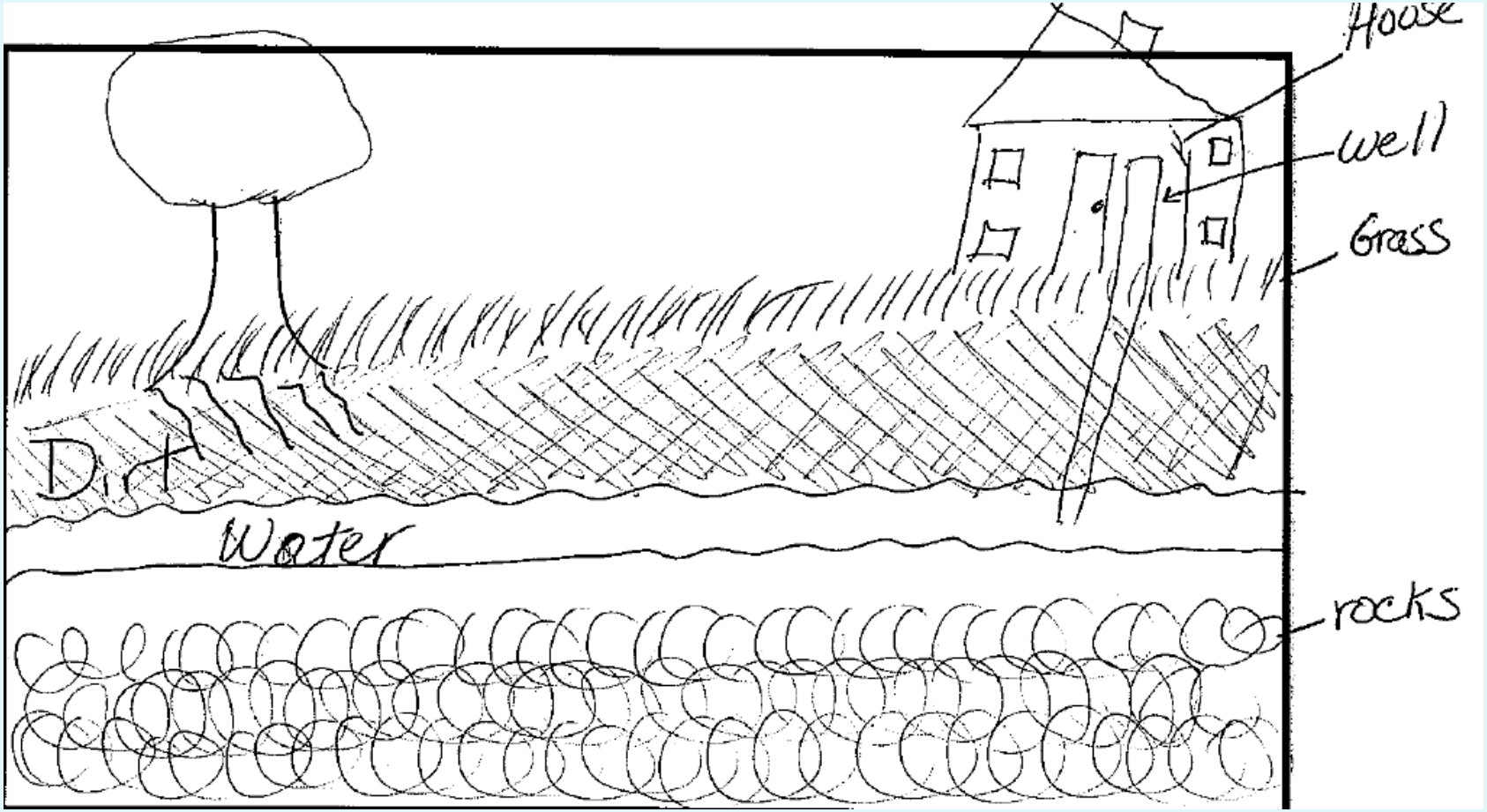


14. Can a landfill (garbage dump) cause water pollution in a well? (Circle one) YES NO

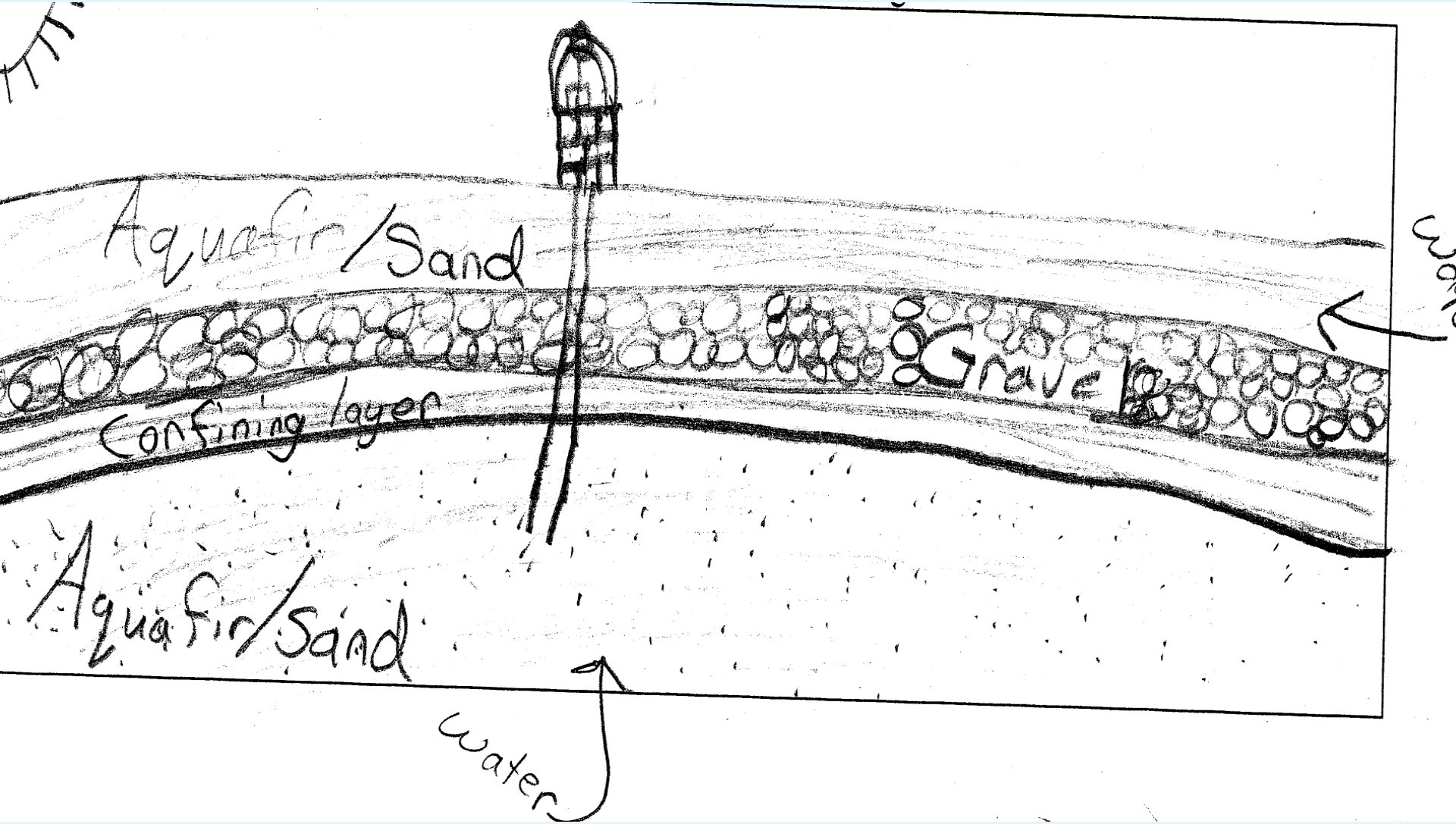
Teacher – Level 2



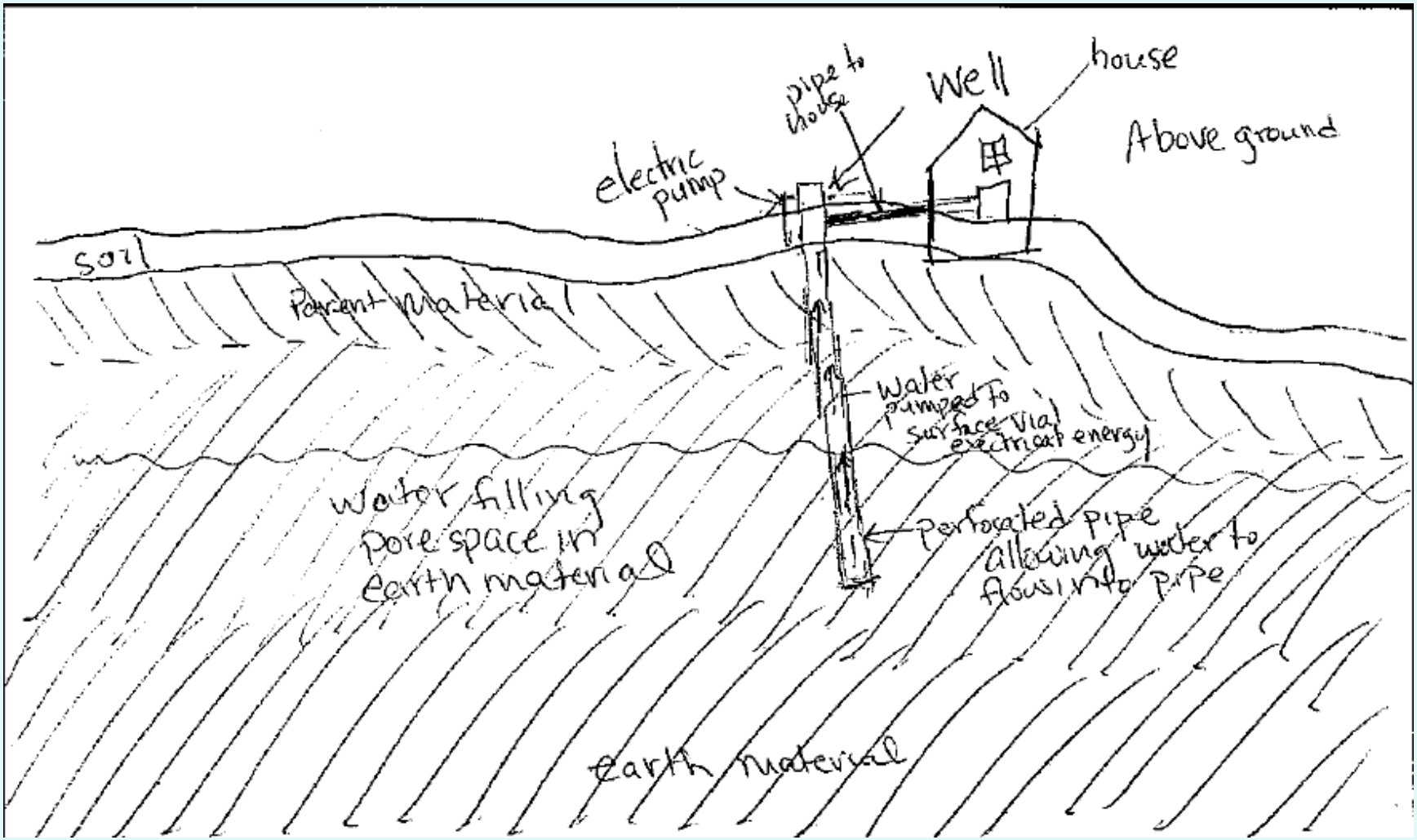
Teacher – Level 2



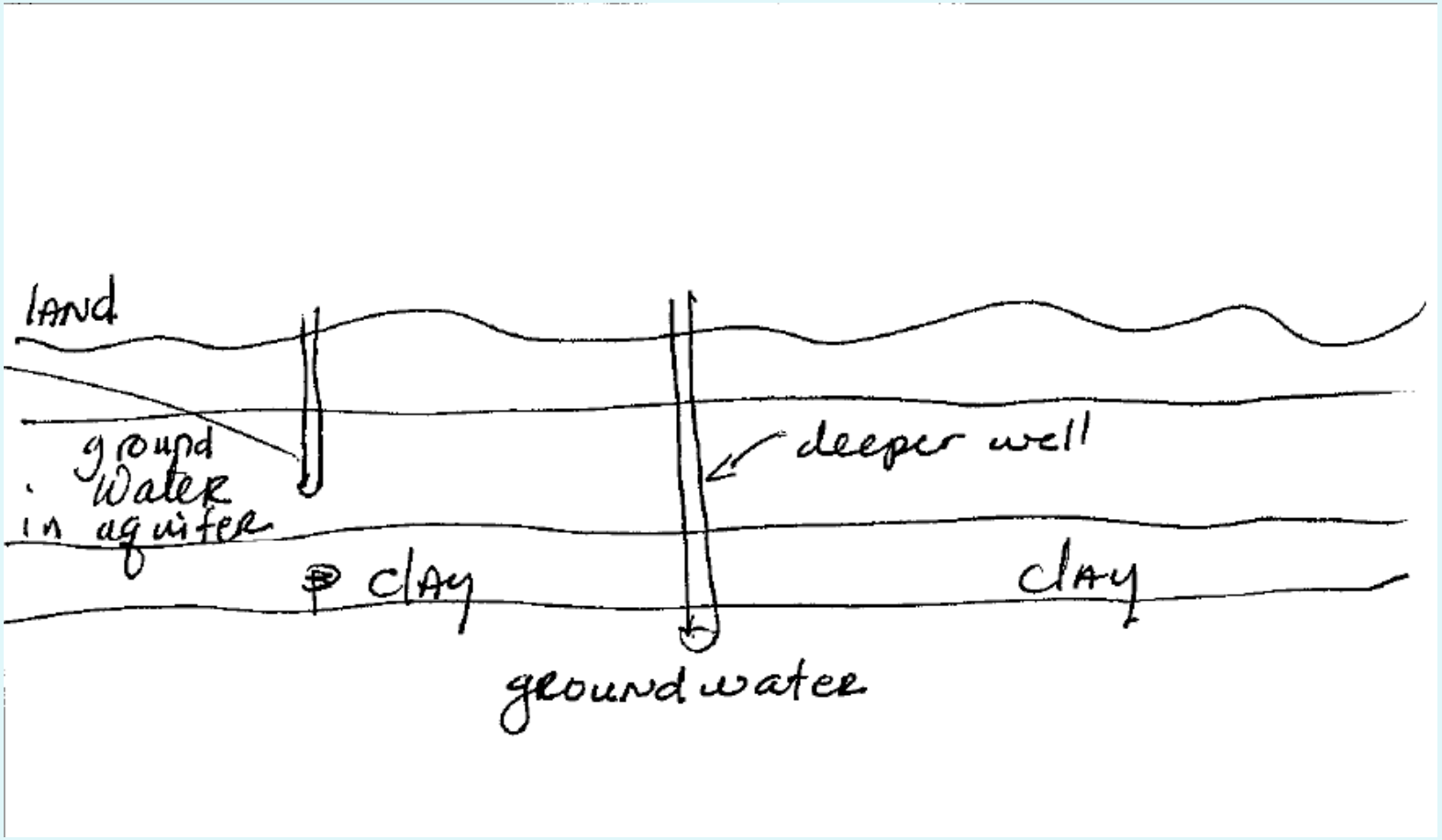
Student – Level 3



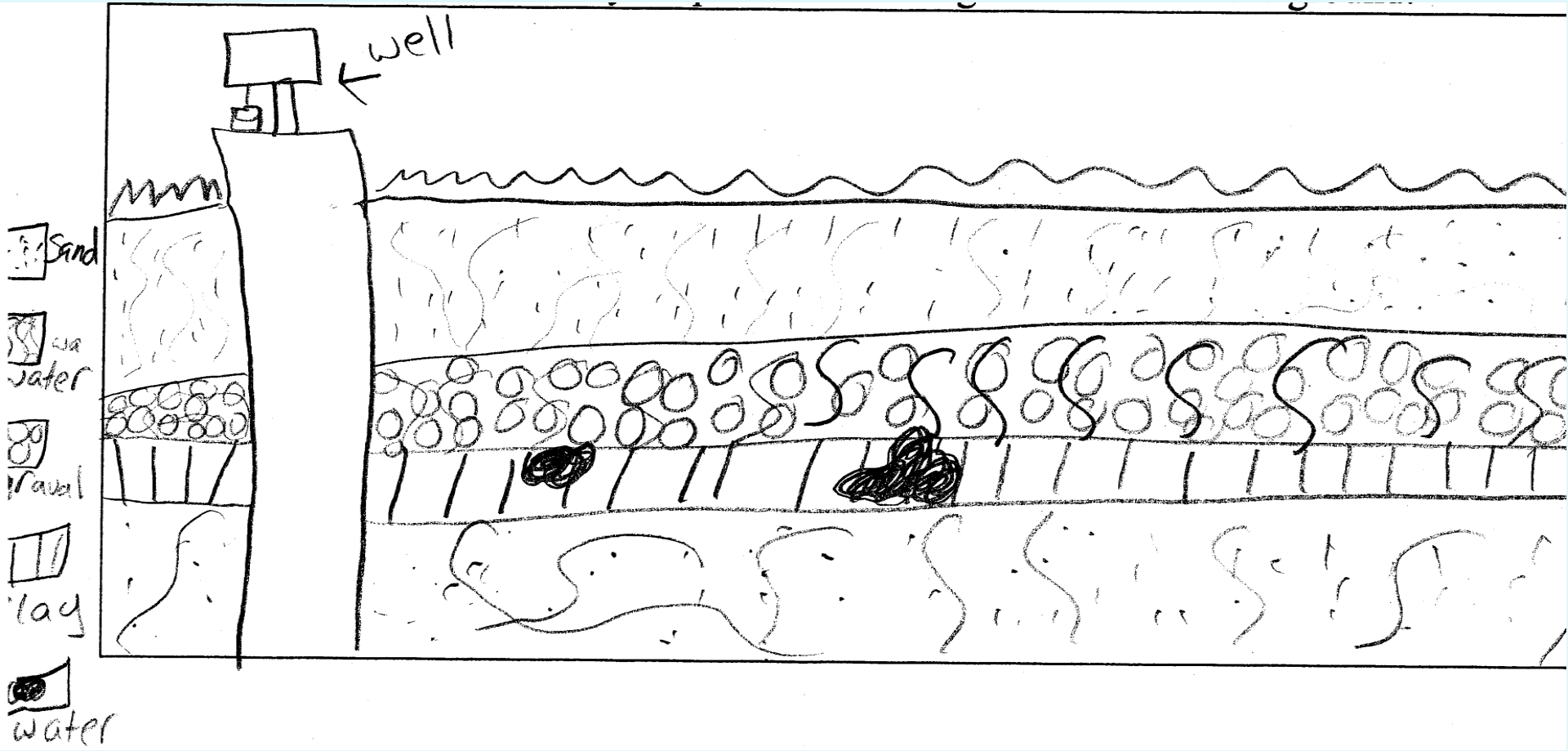
Teacher – Level 3



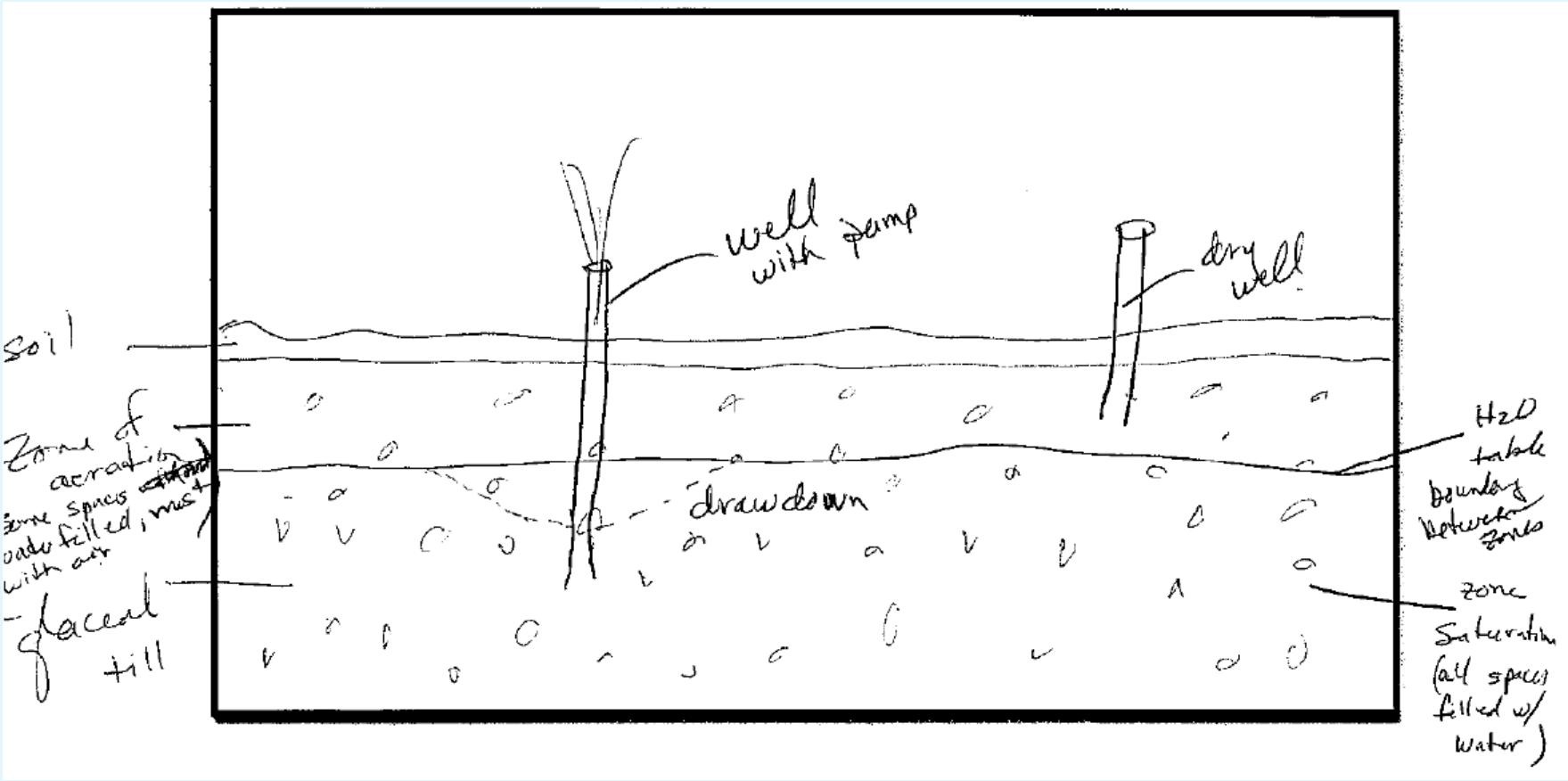
Teacher – Level 3



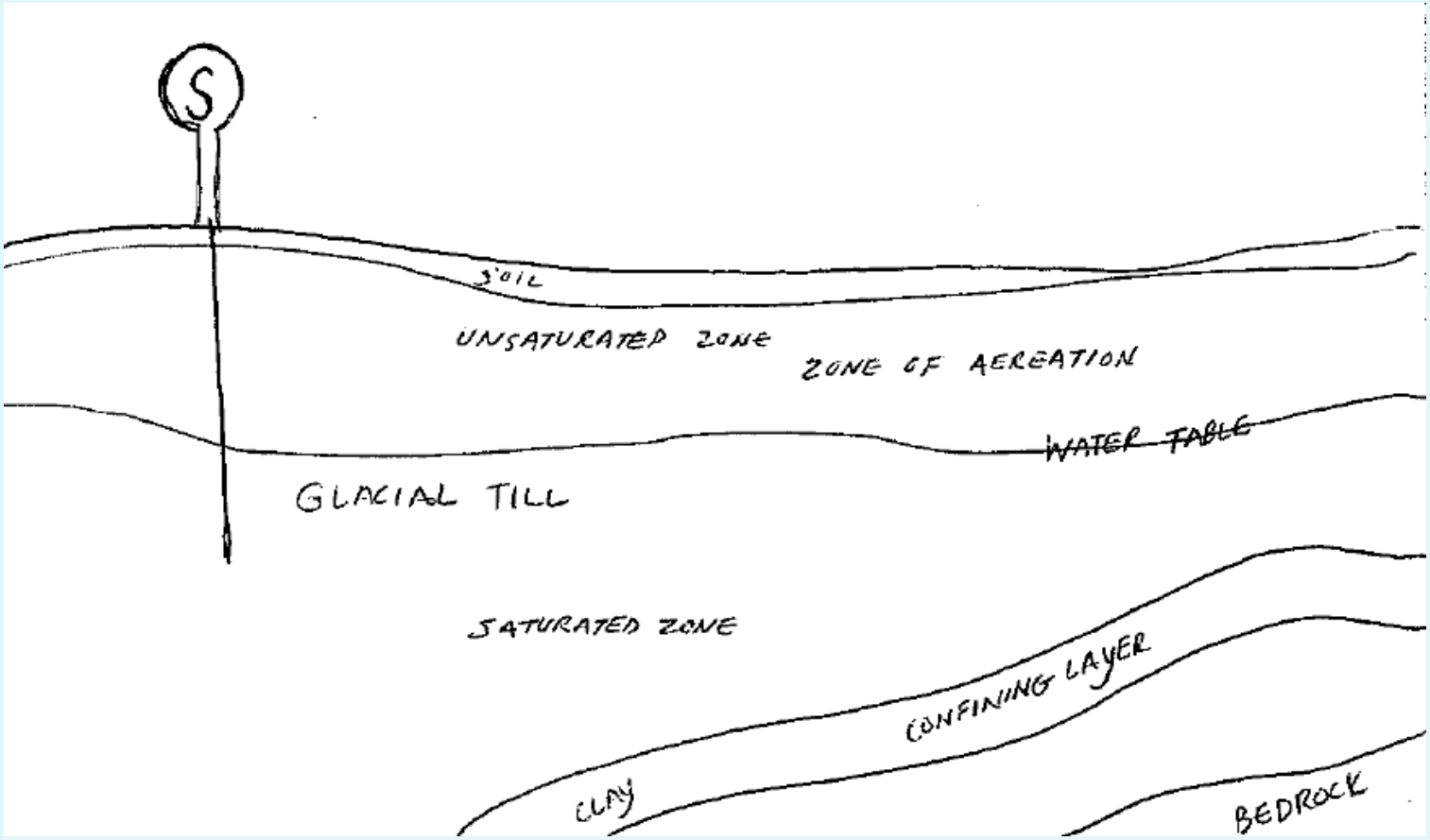
Student – Level 4



Teacher – Level 4



Teacher – Level 4



Themes in Teacher Drawings

Scientifically Correct:

- More detail than student drawings
- More accurate representations of wells
- Most have multiple layers of material underground

Problems:

- Materials – soil under rock
- Connection between surface and groundwater

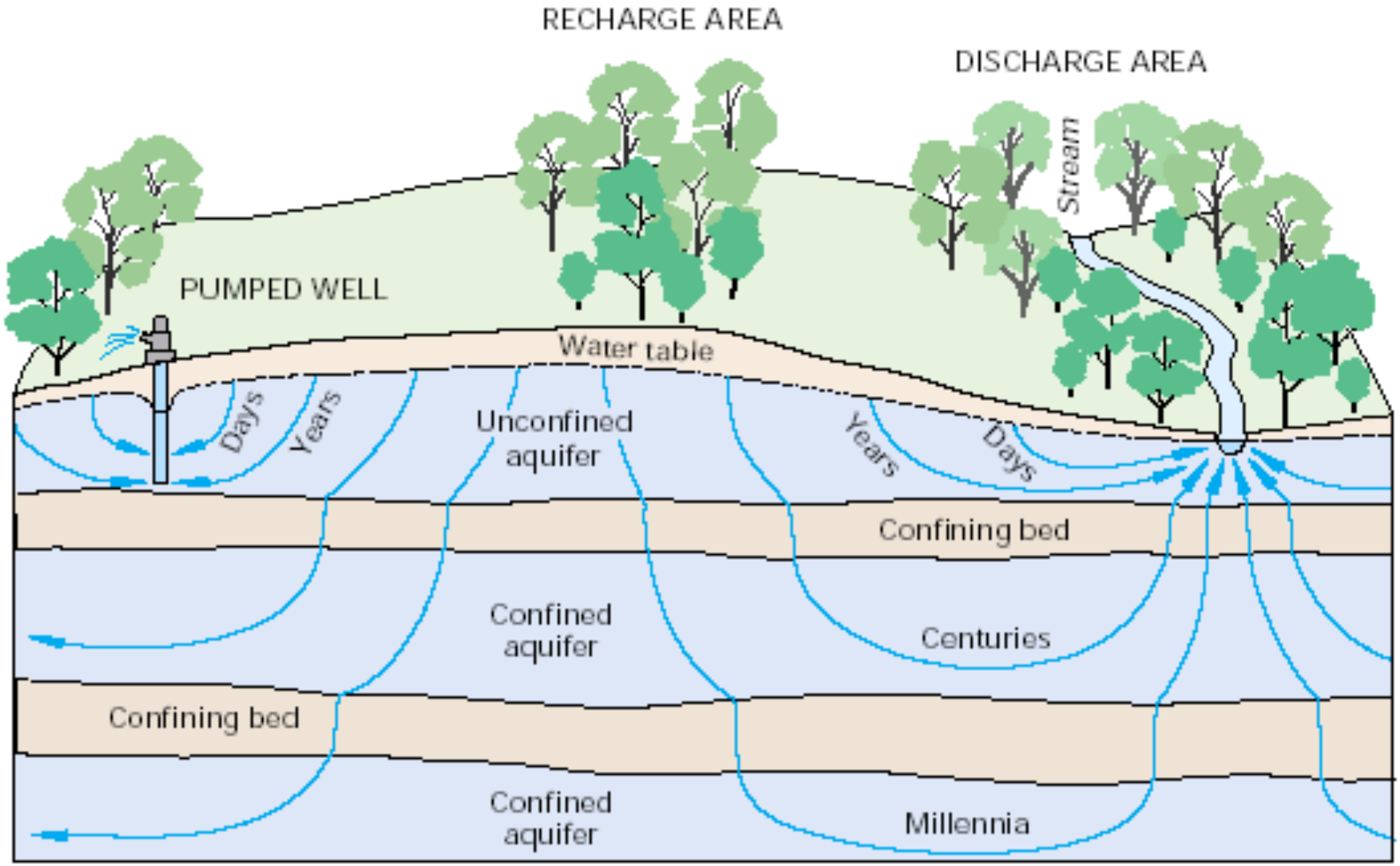
Conclusions

- Interviews are needed to understand if teachers who draw water layers have the alternative conception of underground lakes or rivers.

- Teacher PD should focus on what materials can be found underground (eg. soil profiles) and the permeability of various earth materials.

Potential Confound

- Presentation prior to workshop by hydrologist about groundwater.
- Diagrams shared in slides are robust models of groundwater
- Diagrams have confusing attributes for novices



Winter et al. 1998

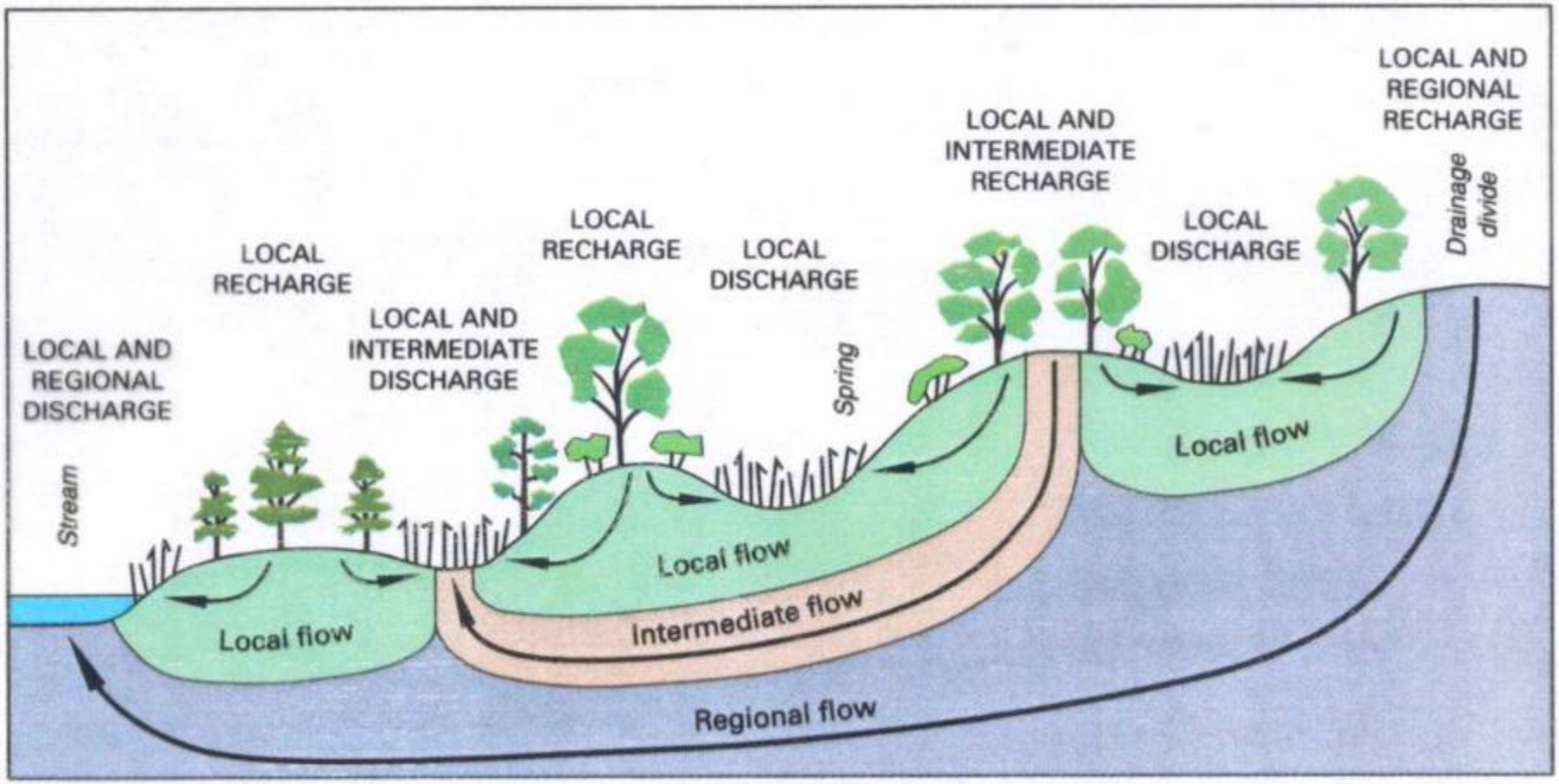
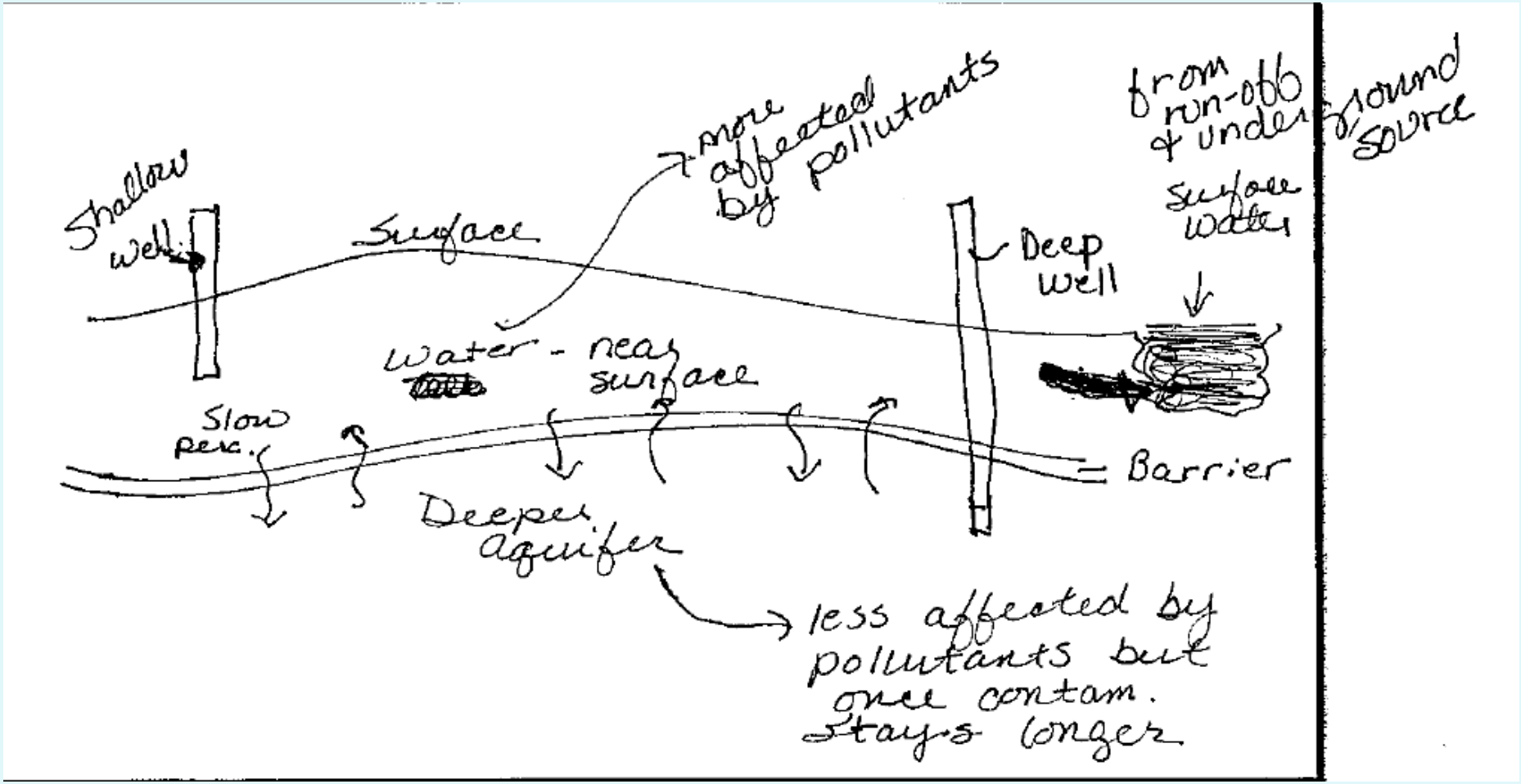
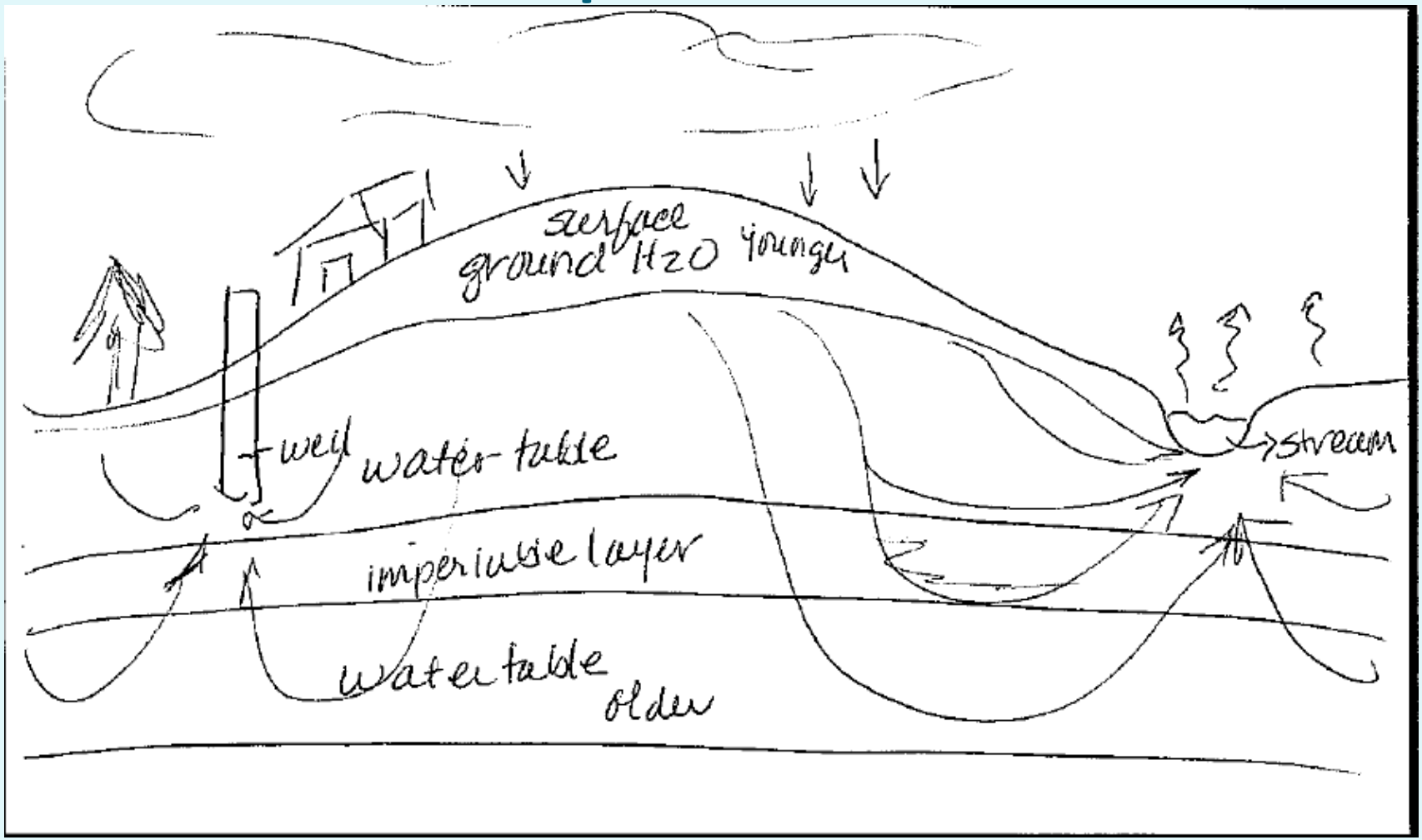


Figure 22. Ground-water flow systems. Local ground-water flow systems are recharged at topographic highs and discharged at immediately adjacent lows. Regional ground-water flow systems are recharged at the major regional topographic highs and discharged at the major regional topographic lows. Intermediate flow systems lie between the other two systems. *(Source: Modified from Winter, 1976.)*

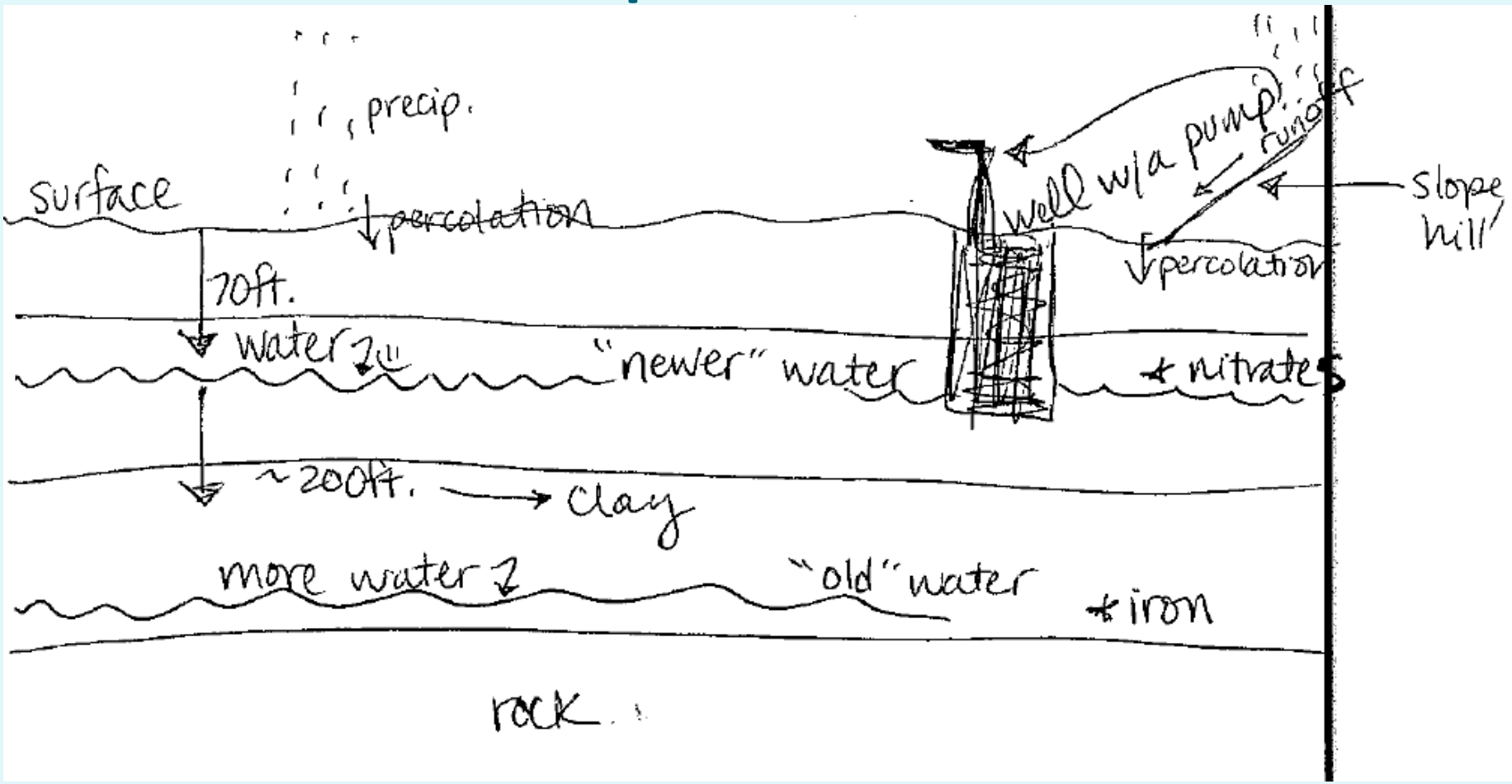
Influence of Expert Model



Influence of Expert Model



Influence of Expert Model



Influence of Expert Model