COLLEGE OF ENGINEERING

Small-scale Aquifer Storage and Recovery

Julianne Robinson, Desirée Tullos, Todd Jarvis

Background

In the face of increasing demand for water and a changing climate that can decrease water supply, methods to augment water supply and storage capacity are becoming increasingly important. In some areas, this has taken the form of aquifer storage and recovery (ASR), which involves injecting water into a well during a time of water surplus (i.e. winter) and storing it for later recovery when water is more scarce (i.e. summer), essentially using the aquifer as an underground reservoir. Although groundwater and surface water-sourced ASR has been implemented on a large scale for industrial, municipal, and agricultural uses (Embleton 2012), its potential as a tool for domestic well owners, particularly in utilizing spring water, is largely unexplored.

Objective

This study will develop and apply criteria for investigating the feasibility of ASR on a small scale, using water from a natural spring.

Study site

The study site is located on private land outside of Toledo, Oregon. A natural spring exists on the property and produces water continuously throughout the winter and spring, but dries up in the summer. A borehole well was recently drilled nearby the spring and produces approximately 1 pint of water/minute. The goal of ASR is to store spring water in the well during the winter, and then use that water in the summer as a buffer for water supply.

Above: study site location.
(Google Maps)

Figure 1. Proposed ASR schematic.

Water is pumped from the spring/ shallow well in the winter.

Well on top of ridge provides storage for injected water…

…which is then recovered in the summer months when other sources of water are unavailable.

Methods

The block diagram below depicts the geology and geography of the study site. It was drawn using readily available geologic maps published by the State of Oregon and the U.S. Geological Survey.

Key points of interest are the spring, the Wiley well (recently drilled, proposed injection well for ASR), and the Davenport well. These points help identify the location of the water table, and the direction of flow.

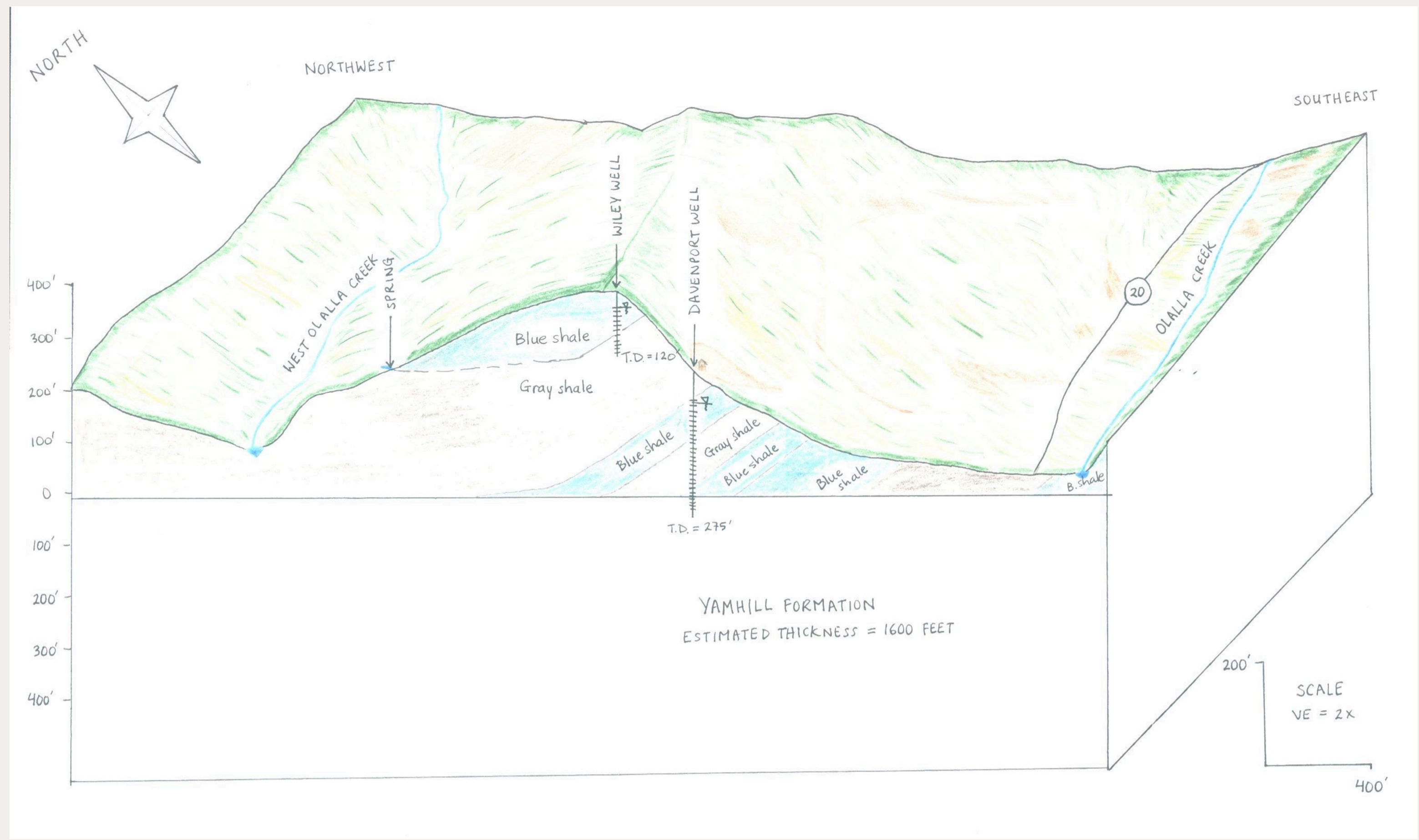
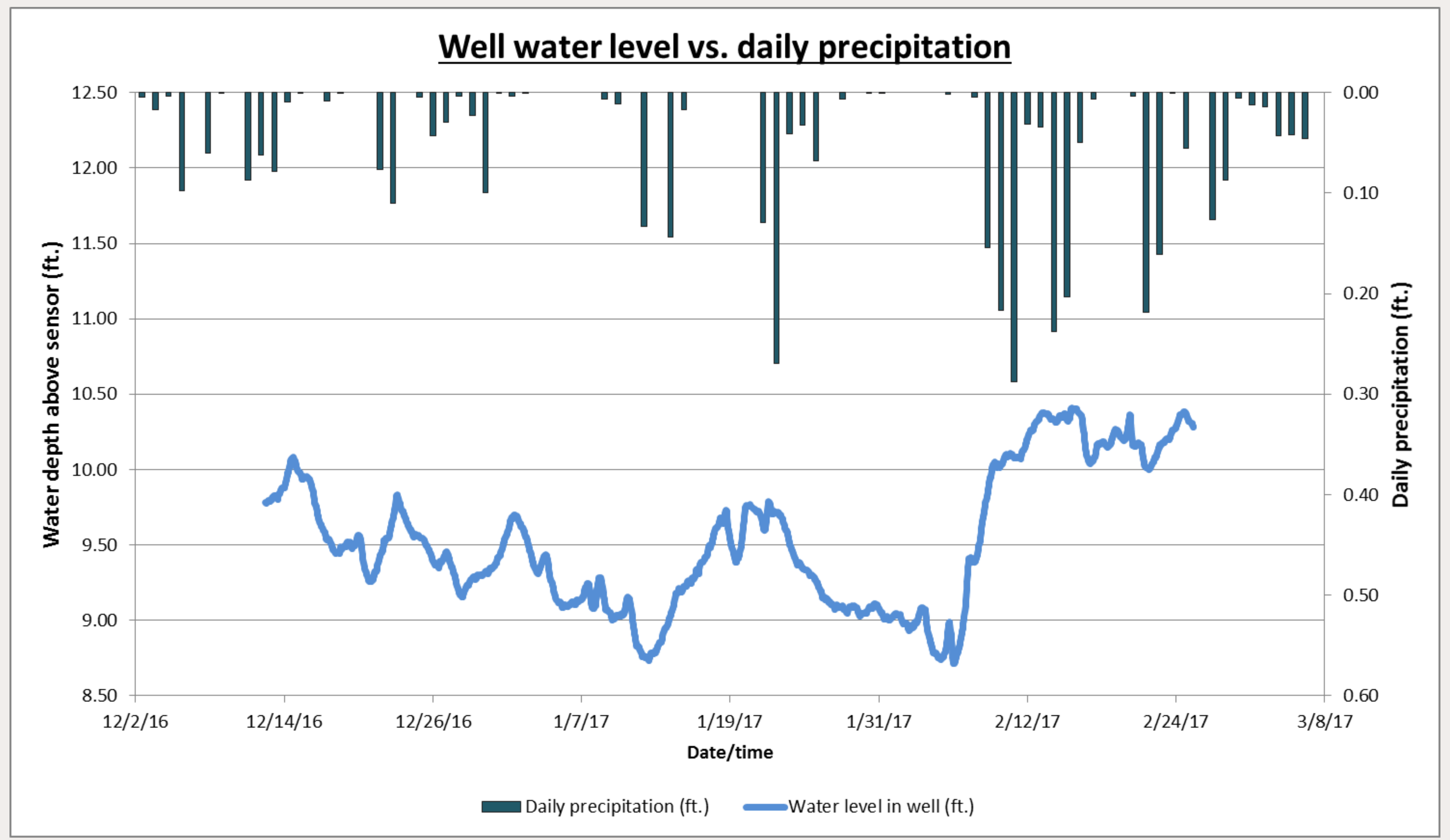


Table 1: ASR Scales and Sources. The table below compares and contrasts different ASR scales and sources, with the proposed framework labeled "Domestic well/spring."

	Domestic Well	Municipal Well	Domestic well/spring
Permitting	Embleton 2012 - Rainwater Recharge - "by rule"	Mansfield 2015 - Older wells recharge OWRD/OWA/ODEQ	Wiley - Springs vs. "shallow well", Recharge capacity
Water Rights	None - exempt	Wells	Spring - TBD
Pre-Engineering Design	Pre-treatment	Injection tests Recovery tests	1) Conceptual model of hydrogeology 2) Gravity feed 3) Pump test 4) Slug test 5) Water quality in spring and well
Engineering	Plumbing from "roof to well"	Existing SCADA	Plumbing from spring-tank-well Measure all that goes in and out
Timing	Winter - storage Summer – recovery	Storage/recovery at will	Winter -testing Winter-storage Summer - recovery

Results



Water elevation response to precipitation. The graph above compares average precipitation in the area to the water level in the proposed ASR injection well.

Ongoing research

The feasibility criteria for small scale ASR, which include transmissivity, source water quality, groundwater quality, hydraulic gradient, and water supply, will be based on site assessment methods modified from Brown's Site Rating System (Woody 2007). Components will include:

Determine the transmissivity and conductivity of aquifer:
1. Formulation of a conceptual model of local hydrogeology
2. Pumping test to measure hydraulic properties of the aquifer
3. Slug test to determine recharge rate

Determine quality of water from the source and surrounding area:
4. Water quality tests for arsenic and nitrates in well and spring water

References

Embleton, David (2012). Use of Exempt Wells As Natural Underground Storage and Recovery Systems. *Journal of Contemporary Water Research & Education, Vol.148(1)*, pp.44-54.

Mansfield, B. (2015). A Second Use: An unsuccessful water supply well proves aquifer storage can be a key to success. *Water Well Journal, December 2015*, pp. 30-32.

Woody, Jennifer (2007). *A preliminary assessment of hydrogeologic suitability for Aquifer Storage and Recovery (ASR) in Oregon.* OSU Libraries Scholars Archive.

Acknowledgements

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Contact information: robinsju@oregonstate.edu

Oregon State UNIVERSITY