Occurrence of Nitrate in Aquifer Systems of the Umatilla Basin

WESTERN OREGON UNIVERSITY
Geology & Earth Science

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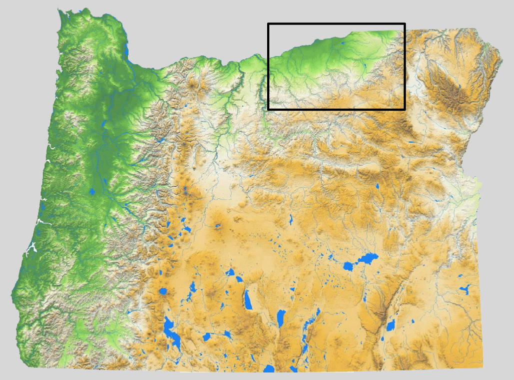

Abstract

Groundwater nitrate levels in the lower Umatilla Basin commonly exceed 10 to 20 mg/L and present a notable public health hazard. Regional land-use activities that contribute to the high nitrate concentrations include agriculture, food processing, livestock production, domestic sewage, and military operations. This project provides an overview of a 550-square-mile study area located in northern Morrow and Umatilla Counties. Water-bearing hydrostratigraphic units are primarily associated with the Miocene Columbia River Flood-Basalts (CRBs) and related sedimentary interbeds. The upper part of the CRBs forms an unconfined aquifer that is in hydraulic communication with overlying alluvial zones. This paper examines the occurrence of high nitrate concentrations in the ground water and explores remediation options. The Umatilla Basin comprises an important component of the greater Columbia River region, and is an area of groundwater concern in the state of Oregon.

Introduction

Nitrate levels in the Umatilla basin exceed 10 mg/L in some areas and is harmful to infants if the groundwater is consumed. High nitrate levels can cause gastrointestinal cancer and heart disease. The problem is that the groundwater nitrate levels cannot be fixed in a short time and the only solution to the problem is mitigation of the nitrogen that is being added to the aquifer at the source.

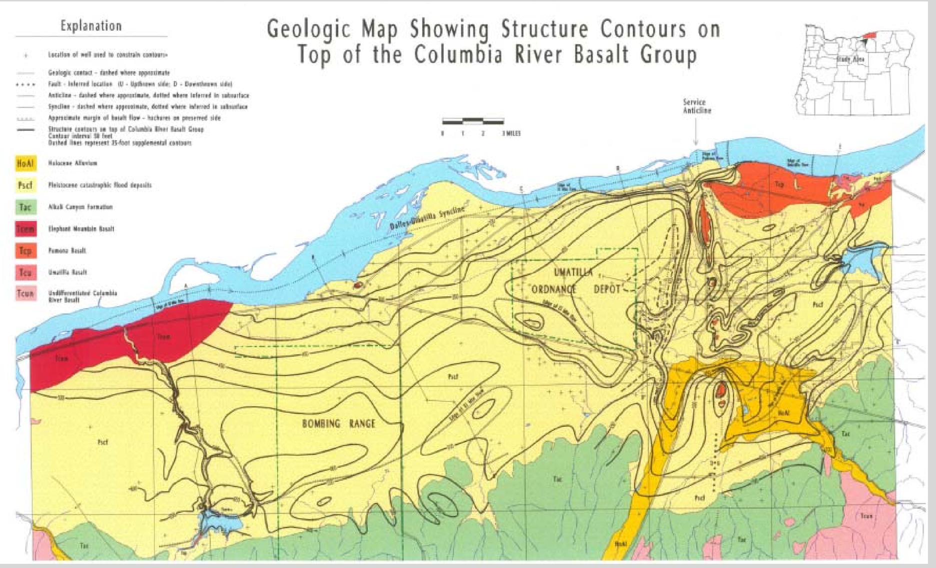

Figure 1. Geologic map of the study area with structure contours on top of Columbia River Basalt Group.

Project Overview

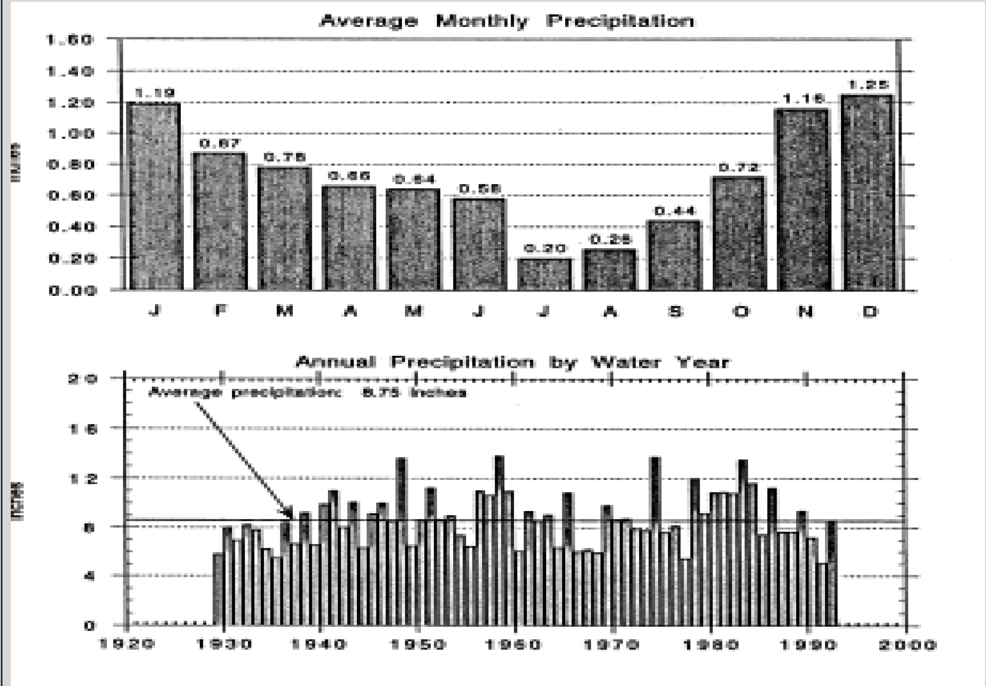

Figure 2. Average monthly and annual rainfall for the study area.

The purpose of the study was to monitor nitrate levels in the groundwater and decipher what factors play the biggest part in the contribution of nitrates in the groundwater.

Figure 3 represents the increase in groundwater elevation with the increase of nitrates in the groundwater.

Figure 2 shows the monthly and annual rainfall for the study area . Most of the rainfall that is this area receives is during the winter months; therefore, during the growing season all of the irrigation water is applied with fertilizer.

Reconnaissance sampling allowed for a basic understanding of the aquifer and the extent of the contamination in the area. Bimonthly sampling on a specific set of 35-40 basin wells provided a seasonal and long term nitrate and other constituent concentration trends at different locations and along selected groundwater flow paths. Synoptic sampling was done once during June and July 1992 and it provided enough data for basin-wide analysis.(Grondin, 1995)

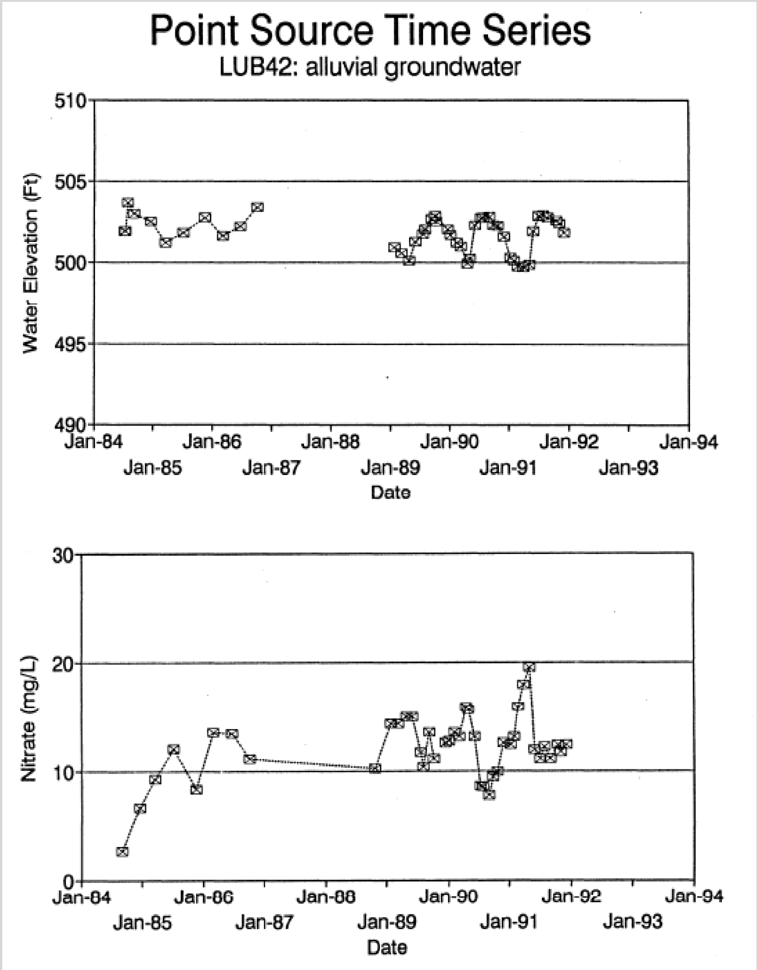

Figure 3. Water level increase generally is followed with increase with nitrates in the groundwater.

Results and Discussion

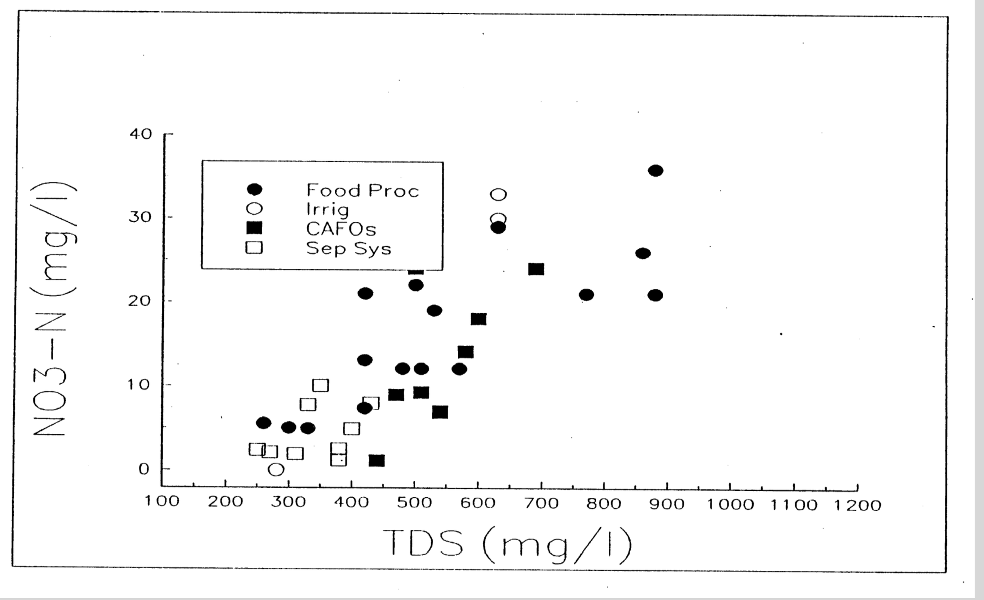

Figure 4. Graph of Nitrate-N levels vs. total solved solids in groundwater.

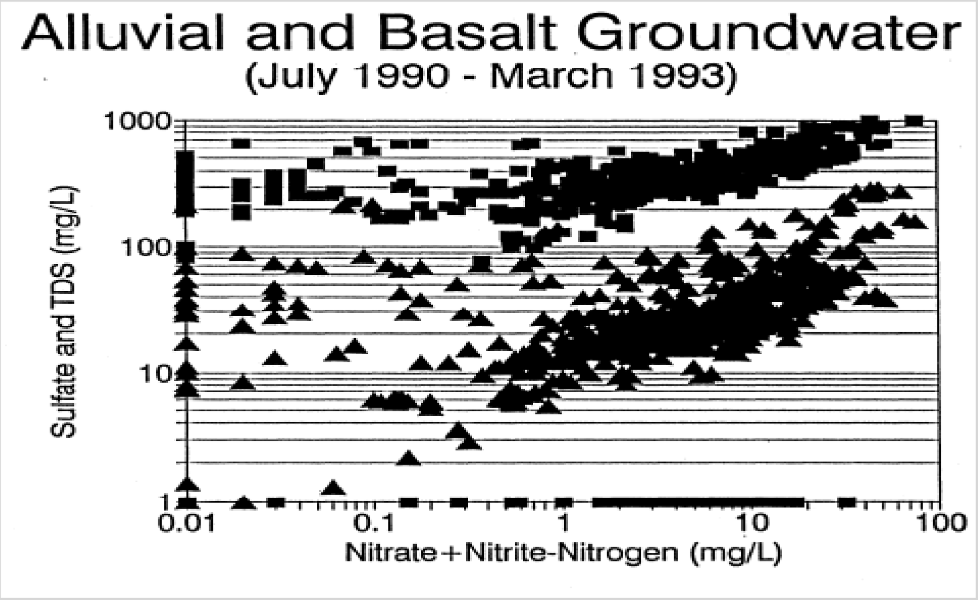

Figure 5. Values < 1mg/L are background conditions for the aquifer and values >1 mg/L are human influence.

Figure 4 shows that there are multiple factors that influence the high levels of nitrogen in the groundwater. The biggest factors were food processing and irrigated agriculture. Figure 5 shows the difference between natural nitrate levels and human influenced nitrate levels. Table 1 shows the amount of nitrogen that was applied and the residual nitrogen that was left in the soil and allowed to infiltrate.

	Alfalfa (hay)	Field Corn, grain	Pasture	Potato-tubers	Water-melons	Winter Wheat (grain)
YIELD	6.5 T	185 Bu	3 T	480 cwt	16 T	123 Bu
N required, lb/A	360	190	190	295		190
N APPLIED/PRESENT:						
N in crop residue, lb/A	40	60	30	90		60
N applied, lbs/A	25	280	110	350	140	195
N released from soil, lb/A	300	60	40	80	80	75
N AVAILABLE, lb/A	365	400	180	520	220	330
N OUTPUT:						
De-nitrification, lb/A	0	25	0	40	10	10
Residue, lb/A	0	50	0	10		50
N Removed, lbs/A	320	130	160	205	130	130
N REMAINING in PROFILE, lb/A	45	195	20	265	80	140

From "Lower Umatilla Basin Water Management Area Crop Production Practices and Groundwater Quality, May 1991; and individual contact with L. Fitch, OSU Hermiston Ag. Research and Extension Ctr, and V. Pumphrey, Retired Professor, OSU.

Table 1. Residual nitrogen remaining after the growing season for each crop type.

Conclusion

Irrigated agriculture and food processing are the major contributors to the high ground-water nitrate concentrations. The only way to remove the nitrates from the system is to allow the system to naturally attenuate. The goal of nitrate mitigation in the future is to reduce the amount of nitrates that seep into the groundwater from irrigated agriculture and food processing. The Umatilla Basin ground-water system is a critical resource in the region.

References

Bauer, H., H., and Hansen, A., J., 2000, Hydrology of the Columbia Plateau Regional Aquifer System, Washington, Oregon, Idaho, pgs. 1-56.

Grondin, G., H., and Wozniak, K., C., and Nelson, D., O., and Camacho, I., 1995, Hydrology, Groundwater Chemistry and Land uses in the Lower Umatilla Basin Groundwater Management Area, pgs. 1-591.