# WA CAFO Permit Fact Sheet

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# CAFO Fact Sheet 13: The Need for Groundwater Monitoring

Hundreds of thousands of chickens, pigs, & cows, kept in small areas produce hundreds of thousands of tons of manure[1]. Disposal is a major problem. How much nitrogen, phosphorous, potassium, sodium, etc., leaches from the manure to the aquifer? The answer depends on how the manure is managed, and the hydrogeology of the land where a CAFO is located. The only way to measure leaching is through groundwater testing.

The WA State Dept. of Ecology (Ecology) states[2]:

> *Any type of wastewater impoundment, whether it is lined or unlined, has a potential to contaminate ground water. All liners leak to some extent. The amount of leakage is dependent upon the permeability of the liner material, the thickness of the liner, the depth of the water in the impoundment and the surface area of the liner.*

## Models versus Groundwater Testing

To save money scientists develop models for estimating the quantity of pollutants that reach the aquifers in different situations. Model variables include

[1] U.S. General Accounting Office. https://www.gao.gov/assets/gao-08-944.pdf

[2] WA Ecology. Implementation Guidance for Groundwater Monitoring. 2005. https://ecology.wa.gov/research-data/monitoring-assessment/groundwater-quality-assessment/active-studies-index/nitrates-and-groundwater-quality-tool

soil type (poorly drained to excessively well drained), depth to groundwater, direction of groundwater flow, microbial reactions in the soil and water, annual precipitation, and other.

Models have limitations. Many are quite crude when we look at all the possible variables that influence leaching. For example: What happens to water in the vadose zone[3]? How rapidly does pore water[4] move? Does it move vertically or horizontally? What microbial processes are in play? Numbers vary within a single field of land, or even within one acre of land.

The best reality check is groundwater monitoring. WA Ecology states, "The models should be used in conjunction with actual groundwater field sampling."[5]

## Soil Testing versus Groundwater Testing

Currently CAFO nutrient management plans require soil testing to evaluate whether manure & fertilizers have been applied at agronomic rates[6,7].

In wetter climates soil testing is required in the fall after harvest at a depth of twelve inches. In drier climates fall soil testing is required to twenty four inches. Based on test results Ecology classifies fields as:

- Low risk – nitrate tests at 15 parts per million (ppm)
- Medium risk – nitrate tests at 15 – 30 ppm
- High risk – nitrate tests at 31 – 45 ppm
- Very high risk – nitrate tests at greater than 45 ppm

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[3] The area between the land surface and the top of the aquifer

[4] Water contained in pores in the soil and rocks

[5] WA Ecology. Estimating Nitrate Groundwater Impacts. https://ecology.wa.gov/research-data/monitoring-assessment/groundwater-quality-assessment/active-studies-index/nitrates-and-groundwater-quality-tool

[6] WA Ecology. NPDES General Permits for Concentrated Animal Feeding Operations. https://ecology.wa.gov/Regulations-Permits/Permits-certifications/Concentrated-animal-feeding-operation

[7] Agronomic rate means application of fertilizer in amounts that promote optimal plant growth but add no surplus that might leach to groundwater

There are increasingly stringent limitations on the amount of fertilizer/manure to be applied as the risk levels increase. There are currently no application requirements in the NPDES general permits for CAFOs related to elevated phosphorous levels in the soil.

One of the problems related to over reliance on soil testing is that there is no required soil testing on compost areas, pens & corrals[8,9,10], or beneath manure lagoons & ponds[11]. Studies in the Yakima Valley demonstrate significant leaching from these parts of the dairy production areas.

A second problem with soil testing is the variability of results in any single field. Washington geology is not layer upon layer. There are ridges and gullies in much of the Washington landscape. Some areas have a Karst or Pseudo Karst geology with fissures and cracks that become conduits to underlying aquifers[12, 13].

Some large CAFO dairies in Washington perform minimal soil sampling to comply with their dairy nutrient management plans. There is a dairy in Yakima County with 4,700 to 5,699 milk cows and 1,000 to 1,999 calves, with 301 to 550 acres owned and 901 to 1,300 acres leased. According to publicly available data

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[8] Yakima Soil Testing beneath compost areas, pens & corrals http://www.friendsoftoppenishcreek.org/cabinet/data/GWMA%20MR%20Attachment%2013%20Pens%20&%20Corrals.pdf

[9] Yakima Soil Testing beneath compost areas, pens & corrals http://www.friendsoftoppenishcreek.org/cabinet/data/GWMA%20MR%20Attachment%2014%20Pens%20&%20Corrals.pdf

[10] Yakima Soil Testing beneath compost areas, pens & corrals http://www.friendsoftoppenishcreek.org/cabinet/data/GWMA%20MR%20Attachment%2015%20Pens%20&%20Corrals.pdf

[11] Leaking Manure Lagoons in the Yakima Valley http://www.friendsoftoppenishcreek.org/cabinet/data/Manure%20Lagoons%20Leak%20LYV.pdf

[12] U.S. Geological Survey. Characterizing Regional Karst Types Under the Framework of the New National Karst Map. 2020. https://pubs.usgs.gov/sir/2008/5023/07weary.htm

[13] U.S. Geological Survey. Karst Aquifers: Pacific Northwest Pseudokarst Aquifers. 2021. https://www.usgs.gov/mission-areas/water-resources/science/karst-aquifers-pacific-northwest-pseudokarst-aquifers

from this dairy's most recent inspection soil testing was only performed on three fields.[14]

## Test for What?

Generally speaking groundwater quality in Washington and most other states is measured by testing for nitrate-n, or nitrate-n plus nitrite–n. This terminology means that the lab only measures the nitrogen component of the molecule – the N in $NO_3$, or the N in $NO_2$. It is possible to test for the entire nitrate or nitrite molecule, in which case safe drinking water levels are 45.45 mg/L and 3.29 MG/L rather than 10 mg/L and 1.0 mg/L.

There are other drinking water contaminants but testing for everything would be costly.[15] Nitrate is a common contaminant associated with organic waste. When nitrate is present in the water there is a good chance that other organic pollutants are present as well. Regulators expect a reduction of other contaminants when nitrate levels decline.

The situation for bacteria is similar but even more complex. There are thousands of classes of microorganisms in manure and the soil. So testing is usually done for coliform bacteria or for the more specific Escherichia coli with the assumption that detection of coliform bacteria indicates that other pathogens may be present as well.

### *Public Health*

Testing for nitrate in ground and drinking water is important because intake of nitrate above certain amounts in mg per kg of body weight brings health risks that include death in the extreme. In the 1940's public health officials became aware of a condition called blue baby syndrome or methemoglobinemia in babies given formula that was reconstituted with well water that had high levels of

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[14] Copy of this Dairy Inspection Report available on request

[15] In Washington State municipal water providers must test for nitrate, nitrite, arsenic, chromium, cadmium, cryptosporidium, disinfection bi-products, lead, and other contaminants as appropriate. WA State Dept. of Health. Drinking Water Systems. https://doh.wa.gov/community-and-environment/drinking-water

nitrates/nitrites[16]. Some babies died. Later cases of miscarriage were associated with nitrates/nitrites in well water[17].

It is unethical to conduct prospective experiments on human populations, but there is a wealth of evidence to support the belief that nitrates/nitrites impact mammals. Cows die when their intake of nitrate is too high[18]. There is a direct relationship, a dose response relationship, between nitrates in drinking water and methemoglobin levels in babies[19]. National research confirms increases in certain cancers and thyroid conditions when nitrate intake is too high[20]. Blood pressure decreased and pulse increased in subjects given measured doses nitrite[21].

### *Groundwater Testing for CAFOs*

Ecology's current National Pollutant Discharge Elimination System (NPDES) general permits for concentrated animal feeding operations (CAFOs) require groundwater testing for CAFOs located in "nitrate priority areas"[22] Testing is for

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[16] Cyanosis in Infants Caused by Nitrates in Well Water. H.H. Comly. 1987. https://jamanetwork.com/journals/jama/article-abstract/366259

[17] Spontaneous Abortions Related to Ingestion of Nitrate Contaminated Well Water. CDC. 1996. https://www.cdc.gov/mmwr/preview/mmwrhtml/00042839.htm

[18] Nitrate Poisoning of Livestock. North Dakota State University. 2020. https://www.ndsu.edu/agriculture/extension/publications/nitrate-poisoning-livestock

[19] Dose Response of Nitrate and Other Methemoglobin Inducers. VanderSlice. 2008. https://www.yakimacounty.us/DocumentCenter/View/9490/VanderSlice_Meth-Inducers-in-Infants_cfpub-epa-gov?bidId=

[20] Work Group Report: Nitrate and Health. Ward et al. 2005. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1310926/

[21] Nitrate and Nitrite Profile. ATSDR. 2017. Page 13. https://www.atsdr.cdc.gov/ToxProfiles/tp204.pdf

[22] WA Ecology. NPDES General Permits for Concentrated Animal Feeding Operations. Pages 40 and 74. https://ecology.wa.gov/Regulations-Permits/Permits-certifications/Concentrated-animal-feeding-operation

depth to water, pH[23], conductivity[24], temperature, dissolved oxygen, total nitrogen, Nitrate-N plus Nitrite-N, total Kjeldahl Nitrogen[25], and Escherichia coli.

When environmentalist conclude consent agreements with dairies the required testing is similar except that Nitrate-N and Nitrite-N are measured separately, and testing includes ammonia, phosphorus[26], inorganic ions (chloride, fluoride, sulfate), and metals (calcium, magnesium, potassium, sodium). The additional chemicals are addressed because manure contains more than nitrogen and phosphorus. Trace metals such as sodium and potassium accumulate in the soil when manure is over applied. This creates a condition in which the soil is too salty, and plants do not grow well[27, 28]. A frequent solution is to flush salts to the aquifer below using irrigation water.

In a recent environmental lawsuit against a Yakima dairy under the Resource Conservation and Recovery Act (RCRA), testing found high levels of ammonia in a shallow aquifer. The likely reason was lack of oxygen in the soil and water. Due to lack of oxygen, ammonia was not converted to nitrate. One of the outcomes of

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[23] A measure of acidity and alkalinity in water. Normal pH is 7.35 to 7.45. Less than 7.35 is acidic and greater than 7.45 is alkaline.

[24] Conductivity is measured with a probe and a meter. Voltage is applied between two electrodes in a probe immersed in the sample water. The drop in voltage caused by the resistance of the water is used to calculate the conductivity per centimeter. Conductivity can tell you how much dissolved substances, chemicals, and minerals are present in the water. Higher amounts of these impurities will lead to a higher conductivity.

[25] Total Kjeldahl nitrogen or TKN is the sum of organic nitrogen, ammonia (NH3), and ammonium (NH4+) in the chemical analysis of soil, water, or wastewater

[26] Phosphorous clings to soil. Once the soil's capacity to retain phosphorous is exceeded then phosphorous leaches to the aquifer where it contributes to eutrophication. Rising phosphorous levels indicate serious over-application of manure or fertilizer. U.S. Geological Survey. Phosphorous and Groundwater. https://pubs.usgs.gov/fs/2012/3004/

[27] Saline and Sodic Soils. North Dakota State University. https://www.ndsu.edu/soilhealth/wp-content/uploads/2014/07/Saline-and-Sodic-Soils-2-2.pdf

[28] Soil testing from a Yakima dairy showing the results of manure over application. http://www.friendsoftoppenishcreek.org/cabinet/data/DeRuyter%20and%20Son%20Soil%20Testing%20with%20highlights.pdf

this litigation is a pilot project to inject oxygen into the aquifer, transform ammonia to nitrate, pump the water and apply to fields as fertigation.

When the EPA tested groundwater on and around five Yakima dairies in 2010-2012, the agency tested for possibly the widest range of contaminants ever addressed[29]. The EPA tested for pharmaceuticals, personal care products, steroids and hormones, pesticides, and herbicides. The results showed significant water contamination from pollutants in addition to nitrates. The take home message is that nitrate in groundwater is an indicator of the potential presence of other chemicals as well.

Interestingly, nitrate levels in monitoring wells at the EPA Yakima site have not decreased as rapidly as anticipated after implementation of mitigation measures. The initial consent decree called for eight years of testing until 2021. Because nitrate levels remain high in many wells the monitoring continues.[30]

## Looking to the Future

The story never ends. The category pharmaceutical includes antibiotics. Over half of all life on earth lives in the soils[31]. This includes ever evolving microorganisms. When these organisms are exposed to antibiotics as they are on CAFOS, in manure lagoons, and in fertilized soils, they develop antibiotic resistance[32]. Evaluating antibiotic resistance in wastewater and manure

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[29] Relation Between Nitrate in Water Wells and Potential Sources in the Lower Yakima Valley, Washington. U.S. EPA. 2013. https://www.epa.gov/sites/default/files/2017-12/documents/lower-yakima-valley-groundwater-report-2013.pdf

[30] U.S. Environmental Protection Agency. Lower Yakima Valley Groundwater. https://www.epa.gov/wa/lower-yakima-valley-groundwater

[31] More than Half of Life on Earth is Found in Soil. 2023. https://theconversation.com/more-than-half-of-life-on-earth-is-found-in-soil-heres-why-thats-important-211455#:~:text=A%20recent%20study%20has%20found,biodiverse%20habitat%20on%20the%20planet.

[32] National Priorities: Evaluation of Antimicrobial Resistance in Wastewater and Sewage Sludge Treatment and Its Impact on the Environment. https://www.epa.gov/research-grants/national-priorities-evaluation-antimicrobial-resistance-wastewater-and-sewage

management systems is a little publicized high priority for the EPA, and really for all of us and our children

Groundwater Testing is essential to minimize leaching of manure contaminants to the aquifers. Groundwater Testing is important if scientists hope to understand all the processes taking place and provide valid recommendations for protecting water.

Thank you for reading.

*Friends of Toppenish Creek*

You have received this Fact Sheet because you are on a list of potentially interested parties. If you do not want to receive further information, please contact Jean Mendoza at jeanrmendoza@icloud.com