Significance of Nitrogen Emissions and Atmospheric Deposition for the Lower Yakima Valley – A Briefing

J. Mendoza – November 1, 2018

This paper addresses the assessment and evaluation of nitrogen emissions from agricultural operations and the subsequent atmospheric deposition of reactive nitrogen in the Lower Yakima Valley. There are major errors in the Lower Yakima Valley Groundwater Management Area's 2017 *Nitrogen Availability Assessment (NAA)* regarding atmospheric deposition.

The Science

If you open a bottle of ammonia and measure the concentration of ammonia six inches above the bottle with a test strip you will get a positive response. If you measure the air 15 feet away from the bottle you may not see a response at all. The concentration is higher at the source. This is a scientific experiment that has been replicated over and over. It is a fact.

Nitrogen compounds are essential components of commercial fertilizers and manure. When exposed to air these compounds volatilize and enter the atmosphere. This is especially true for ammonia. The rate of volatilization, also called emission, depends on temperature, wind, nitrogen concentration in the source, etc. Ammonia by itself is lighter than air and rises. Ammonia in the air readily combines with other chemical compounds to form ammonium nitrate and ammonium sulfate which are classified as fine particulate

matter. (Hristov, 2011; WA Dept. of Ecology, 2014) Most ammonium compounds are heavier than air and stay close to the surface.

When nitrogen compounds in the air fall back to earth this is called atmospheric deposition. Atmospheric deposition of reactive nitrogen contributes to eutrophication, increased fine particulates in the ambient air and climate change. (Sutton et al, 2011)

The relationship between the amount of ammonia in the air and deposition rates is not linear. The rate of deposition also depends on multiple factors including temperature, wind, and nitrogen concentrations at the land surface and in the air. (Personal Communication, Dr. Ranil Dhammapala, October, 2018)

Estimation of Atmospheric Deposition in the GWMA Nitrogen Availability Assessment

The GWMA Nitrogen Availability Assessment (NAA) estimates that, on average 2.05 lbs of nitrogen deposit on every acre in the GWMA target area every year. (WSDA, 2017)

WSDA and Ecology base this estimate, in part, on data from the only place in Washington where wet and dry deposition is measured. The station is on the top of Mt. Rainier and it was chosen because even small amounts of reactive nitrogen in the air damage the alpine plant life. The air over Mt Rainier is a Class I Air Space. This means it is a pristine area with special protections under the Federal Clean Air Act, 42 U.S.C. §7472.

The National Atmospheric Deposition Program (2018) states that atmospheric deposition of nitrogen compounds on Mt. Rainier is near 1.53 lbs per acre. WSDA and Ecology used this number as the low estimate for the LYV. They added 0.52 lbs per acre and arrived at an average deposition of 2.05 lbs N per acre. (WSDA, 2017)

Here is the NAA rationale:

> *The lowest number used is the combination of the most recently available annual wet and dry deposition data from the NADP Mt. Rainier station. Deposition reported includes dry nitric acid, dry ammonium, dry nitrate, wet ammonium, and wet nitrate (EPA 2016).* *This is believed to be a good surrogate for low deposition due to the considerable transportation corridor along I-5 in western Washington mimicking farm-related emissions and deposition seen in eastern Washington.* *(Emphasis added)*
>
> (WSDA, 2017, page 68)

You decide, is this real science?

Emissions from animal agriculture are a major source of reactive nitrogen in the ambient air. Research from California, where the concentration of dairies is similar to that in the Yakima Valley, says that nitrogen deposition averages 9 lbs per acre in the Tulare Lake Basin and 5 lbs per acre in the Salinas Valley.

WSDA rationalizes that:

> *In addition, the scale of animal agriculture in the Central Valley is an order of magnitude greater than that found in Yakima County (approximately 640 dairies compared to about 50 in the GWMA)*

In fact, California's Central Valley covers ten times more land area than the GWMA target area. The concentration of cows is approximately equivalent. The Lower Yakima Valley actually has a slightly higher number of cows per acre.

Reasons Why the NAA Estimate of Atmospheric Deposition Should Be Higher

WSU Modeling of Nitrogen Deposition: On the ground measurement of atmospheric deposition is difficult. Washington State University has developed a program, AIRPACT-5,

that models nitrogen deposition for Washington, Oregon and Idaho. This program is based on the EPA's Community Multiscale Air Quality Modeling System (CMAQ) and is endorsed by Ecology.

Monthly estimates are published at http://lar.wsu.edu/airpact/monthly_depo_ap5.php# According to FOTC's reading pf the maps the average monthly nitrogen deposition in the Lower Yakima Valley is about 1 kg per hectare which equals .89 lbs per acre. Over twelve months this equals about 10 lbs per acre. WSU mapping clearly shows a correlation with similar areas in Whatcom County, Jerome County, Idaho and Morrow County, Oregon.

National Atmospheric Deposition Program: South Central Idaho has a concentration of dairies and cows, economy, geography and climate that closely resembles the GWMA target area. The National Atmospheric Deposition Program has measured average ammonia concentrations in the Twin Falls region at 8.8 micrograms per cubic meter and average ammonia concentrations in Tulare County, CA at 3 micrograms per cubic meter. (NADP, 2018) This should suggest the importance of ammonia emissions in Yakima County and prompt a more realistic analysis. (The ammonia concentration in the air at Mt. Rainier averages 0.18 micrograms per cubic meter).

Ecology's Emissions Inventory: The Washington State Department of Ecology has estimated that 24% of all Washington State ammonia emissions from livestock in 2014 came from Yakima County. These Yakima emissions totaled about 3,890 tons of atmospheric ammonia in that year. (WA Dept of Ecology, 2018)

National Air Emissions Monitoring Study (NAEMS): In 2010 scientists from Washington State University conducted emissions studies at two dairy barns in the Lower Yakima Valley as part of the National Air Emissions Monitoring Study (NAEMS). They found that an average Yakima milk cow produces 56 grams per day per cow of ammonia. (Ramirez-Dorronsoro et al, 2010)

The 100,000 milk cows in Yakima County will produce 5,600,000 grams = 5,600 kilograms = 12,320 lbs = 6.16 tons of ammonia every day. This equates to 2,190 tons per year which fits well with Ecology's estimate of 3,890 tons per year from all animal agriculture in Yakima County.

> Caveat 1: This high rate of ammonia production is the result of mixing urine and feces. There is a chemical reaction when the two combine and this does not occur to such a high degree when animals are not kept in confined quarters.
>
> Caveat 2: This estimate does not account for manure and urine that is stored in lagoons, for manure that is composted or for emissions from land application of manure.

Doing the Math:

- 2,190 tons or 4,380,000 lbs of nitrogen from milk cows is emitted every year in the GWMA target area
- Around 13% or 569,400 lbs redeposits on 179,346 acres of the target area
- This is a deposition rate of 3.17 lbs N per acre, just from the milk cows

NRCS Research - Emissions from crop fertilization: The Natural Resources Conservation Service (NRCS) estimates that an average 2.3 lbs of nitrogen per year is deposited on every acre of cropland in the western states. When the land is planted in silage corn the average deposition is 2.6 lbs N per acre per year. About 13% of the nitrogen that volatilizes from agriculture in the western states redeposits on farm land. (US NRCS, 2006)

Ammonia containing fertilizers and manures are the source and this process is highly dependent on temperature, wind, and time to incorporation in the soil. Volatilization rates range from 0% when fertilizers and manures are directly injected into the ground to 100% when fertilizers and manures are not incorporated and the weather is hot and dry. (Shaw, 2015)

Contribution from Composting: Steve George from the Yakima Farm Bureau and Laurie Crowe from the South Yakima Conservation District have shared their expert opinions with the GWMA regarding nitrogen flows from dairies. (Attachment 1) They state:

> *75% of manure generated is composted which reduces the volume by 50%. Over 50% of this compost is exported out of Yakima County.*

A significant portion of the 50% loss is volatilization of water and nitrogen from the compost.

Historical Data from Whatcom County:

Nitrogen balance has been studied much more intensely in Whatcom County compared to Yakima County. In their study of that area Cox & Kahle (1999, page 104) state:

> *However, additional dry deposition is expected in areas where substantial amount of manures are present due to volatilization of a large fraction of the ammonia in manures (Ivens and others, 1988). Sanderson and La Valle (1979) found that bulk deposition (combined wet and dry) at six farm sites in southern Ontario was 30 to 37 pounds of nitrogen per acre. In the dairy and agricultural region of southern Ontario, Barry and others (1993) estimated that dry deposition of nitrogen ranged from 5.9 to 15 pounds per acre and made up 44 to 55 percent of the bulk atmospheric nitrogen across the region. Similar rates were found by Goulding (1990) on adjacent farm lands in southern England. Barry and others (1993) suggest that nitrogen deposition on farms where large volumes of manure are susceptible to volatilization should include from 13 to 19 pounds of nitrogen per acre for dry redeposition of nitrogen resulting from manure volatilization.*

Almasri & Kaluarachchi (2003) estimated atmospheric deposition of 7.3 lbs N per acre in Whatcom County. This comprised 8% of the input in the nitrogen balance for that area. They attributed most of this input to the 53,000 milk cows in Whatcom County at that time and noted the differences in wet and dry deposition for different climates.

FOTC Requests

FOTC has asked the GWMA advisory Committee (GWAC) to recommend modeling in order to refine a nitrogen balance for the GWMA target area. How can we assess the nitrate problem if we do not understand the nitrogen pathways; if we do not know where the nitrogen goes?

In response to our request for an alternative solution that addresses atmospheric deposition of nitrogen, Yakima County advised that this work would be "inconsequential" with "cost disproportionate to benefits". The county described the proposal as "big and expensive". (Yakima County, 2018, page 58). None of the agencies informed us about the WSU AIRPACT-V program.

FOTC believes this is a conscious and deliberate effort to avoid documentation of the significant problem we have with loss of nitrogen to the atmosphere in Yakima County.

Efforts to Confuse and Deceive

Casual readers who study the document, *Estimated Nitrogen Available for Transport in the Lower Yakima Valley Groundwater Management Area,* will likely look at charts and graphs to learn how much reactive nitrogen is deposited on the 280 square miles that make up the GWMA. They will read, and justifiably assume to be true, the statement that on average 76 tons of nitrogen are deposited in the GWMA every year. (WSDA, 2017, page 69)

Serious scholars will discover that this calculation only covers deposition on 73,976 acres of non-agricultural land. Atmospheric deposition on agricultural land was folded into calculations for irrigated agriculture and animal agriculture. Thus the authors were able to say that atmospheric deposition only accounts for 2% of the available nitrogen in the GWMA. If atmospheric deposition, even at the ridiculously low rate of 2.05 lbs per acre is calculated for all 179,346 acres in the GWMA, then the percentage due to atmospheric deposition is closer to 5%.

Conclusion

It is vitally important to publish accurate information and data so that students, scholars, policy makers, other experts and the general public can analyze the material and draw useful conclusions. The LYV GWMA's 2017 Nitrogen Availability Assessment is false and misleading with respect to atmospheric deposition. It should be withdrawn from dissemination to the public.

Respectfully,

The Friends of Toppenish Creek

References:

Almasri, M. N., & Kaluarachchi, J. J. (2003). Regional variability of on ground nitrogen loading due to multiple land uses in agriculture dominated watersheds. In *Proceedings of the Seventh International Conference on Diffuse Pollution and Basin Management, Dublin, Ireland*. Available at https://www.researchgate.net/profile/Jagath_Kaluarachchi/publication/242351619_REGIONAL_VARIABILITY_OF_ON-GROUND_NITROGEN_LOADING_DUE_TO_MULTIPLE_LAND_USES_IN_AGRICULTURE-DOMINATED_WATERSHEDS/links/02e7e536a6b7eaf07d000000.pdf

Cox, S. E., & Kahle, S. C. (1999). *Hydrogeology, ground-water quality, and sources of nitrate in lowland glacial aquifers of Whatcom County, Washington, and British Columbia, Canada* (No. 98-4195). US Geological Survey. Available at https://pubs.usgs.gov/wri/1998/4195/report.pdf

Hristov, A. N. (2011). Contribution of ammonia emitted from livestock to atmospheric fine particulate matter (PM2. 5) in the United States. *Journal of dairy science*, *94*(6), 3130-3136. Available at https://kundoc.com/pdf-technical-note-contribution-of-ammonia-emitted-from-livestock-to-atmospheric-fin.html

National Atmospheric Deposition Program (2018) Maps & Data – AMON Data. Available at https://nadp.slh.wisc.edu/data/AMoN/

Ramirez-Dorronsoro, J.C., H.S. Joo, P. Ndegwa, and A.J. Heber. 2010. National Air Emissions Monitoring Study: Data from Two Dairy Freestall Barns in Washington WA5B, Final Report. Purdue University, West Lafayette, IN, July 30.

Shaw, B.H. (2014) Expert Testimony in CARE versus Cow Palace. Available at http://charlietebbutt.com/files/CP/237-2%20-%20Expert%20Report%20of%20Byron%20Shaw.pdf

Sutton, M. A., Howard, C. M., Erisman, J. W., Billen, G., Bleeker, A., Grennfelt, P., ... & Grizzetti, B. (Eds.). (2011). *The European nitrogen assessment: sources, effects and policy perspectives*. Cambridge University Press. Available at http://www.nine-esf.org/node/204/ENA.html

U.S. Natural Resources Conservation Service (2010) Model Simulation of Soil Loss, Nutrient Loss, and Change in Soil Organic Carbon Associated with Crop Production. Available at https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs143_013138.pdf

Washington State Department of Agriculture (2017) Estimated Nitrogen Available for Transport in the Lower Yakima Valley Groundwater Management Area. Available at https://agr.wa.gov/FP/Pubs/docs/103-691YakimaGWMANitrogenTransportReport.pdf

Washington Department of Ecology, 2014. The Yakima Air Wintertime Nitrate Study (YAWNS): Final Report. Prepared by the Laboratory for Atmospheric Research, Washington State University. Available at https://ecology.wa.gov/DOE/files/a6/a67789dd-aed4-461e-b138-e77537dd1952.pdf

Washington State Department of Ecology (2018) Air Emission Inventory Summaries. Available at https://ecology.wa.gov/Air-Climate/Air-quality/Air-quality-targets/Air-emissions-inventory

Yakima County (2018) LYV Groundwater Management Area Draft Program, Volume II. Available at http://www.yakimacounty.us/DocumentCenter/View/17731/Volume-II-8-2-2018

Attachment 1:

Confined Animal Feeding Operations (CAFOs)

Water Quality Requirements:

What laws or rules apply to CAFOs in regard to water quality, specifically groundwater protection?

Federal and State regulators and local Conservation Districts have a zero water discharge policy for dairies:

- Federal Clean Water Act
- Washington State Dairy Nutrient Management Plan (DNMP)
- Washington State Water Quality Standards for surface and Groundwater; and
- Washington State Solid Waste Handling Requirements

Federal Clean Water Act:

40 CFR part 122 – defines CAFOs, any size operation that confines animals for more than 45 days on non-growing surface. Facility has to have a permit if they have a discharge or propose discharge to surface waters of the state. The proposed combined permit will encompass groundwater. Discharges must meet criteria and cannot be excessive.

Washington State DNMA:

(WSDA) All dairies must comply (RCW 15.36). In place to protect surface and ground waters (RCW 90.64.026) Dairy producers that have a grade A license to sell milk must develop an DNMP that is approved and certified by conservation district. BMPs must follow NRCS specs. RCW 90.48 does

not allow discharge to surface or groundwater and is much more restrictive than the federal CWA. Dairies must keep application records, perform soil testing and adhere to maximum N levels in their fields.

Washington State Water Quality Standards for Surface and Groundwaters: (Ecology)

Applies to everyone regardless of industry.

Washington State Solid Waste Handling Requirements: (Ecology)

The current solid waste rules are in the process of being updated and may have some impact to dairies and others who generate manure. Currently, ag inputs are exempt from this statute. Ag inputs must be used at agronomic rates.

Practices pertaining to water quality protection in Yakima County:

The following are practices that dairy producers employee to prevent surface or groundwater contamination on the dairy foot print:

1. Sites engineered to have slope to a central collection site location

2. Catch basins for effluent at low spot on dairy

3. Manage effluent in catch basins or piped to lagoon – liquid evaporates, periodic removal of solid materials

4. Corral management: Packed and groomed

A) Grooming to prevent low spots that could accumulate water; fill holes to keep pen surface integrity

B) Haul bulk materials away as needed, generally composted

C) Clean solid material from under fence lines as needed

D) Animals fed on impervious surfaces

5. Feed management: Most feed that has excess moisture is kept on impervious surfaces such as concrete silage bunkers. Any excess moisture fed into catch basins or lagoon. Rations balanced by professional nutrition specialist that prevents excessive intake that reduces animal waste.

6. Lagoon Management: Solids reduction to limit volume and N and P concentrations going into lagoon. New technology includes centrifuge and floating filtration separation that takes out over 90% of solids. Concrete settling basins used in-line with this technology. Better separation reduces lagoon volume that translates into the dairy needing less lagoon space. Lagoons are engineered and most have clay liners. A few newer ones have put in synthetic liners. New permit will require testing of all existing lagoons. After solid separation, left over liquid is pumped or trucked to ag fields. This material generally runs less than 1% N per volume. Bio filter is new technology in testing that would add additional extraction of solids leaving 99% pure water.

7. Compost Areas: 75% of manure generated is composted which reduces the volume by 50%. Over 50% of this compost is exported out of Yakima County. (Information from WSDA, SYCD and Organix). Compost yards are placed on packed surfaces and are continually repacked by the use of large trucks and tractors running over them while hauling material in, out and turning compost. Compost areas do not generate moisture and during the summer must have moisture added to operate properly. Areas are kept smooth and flat to prevent ponding. Water is not applied that ponds up or runs off the compost area, but if water were to run off, it would be captured with the rest of the dairy's water.

This is a verbatim copy of a document that was prepared and shared by Steve George and Laurie Crowe with the Lower Yakima Valley Groundwater Management Area in November 2016.