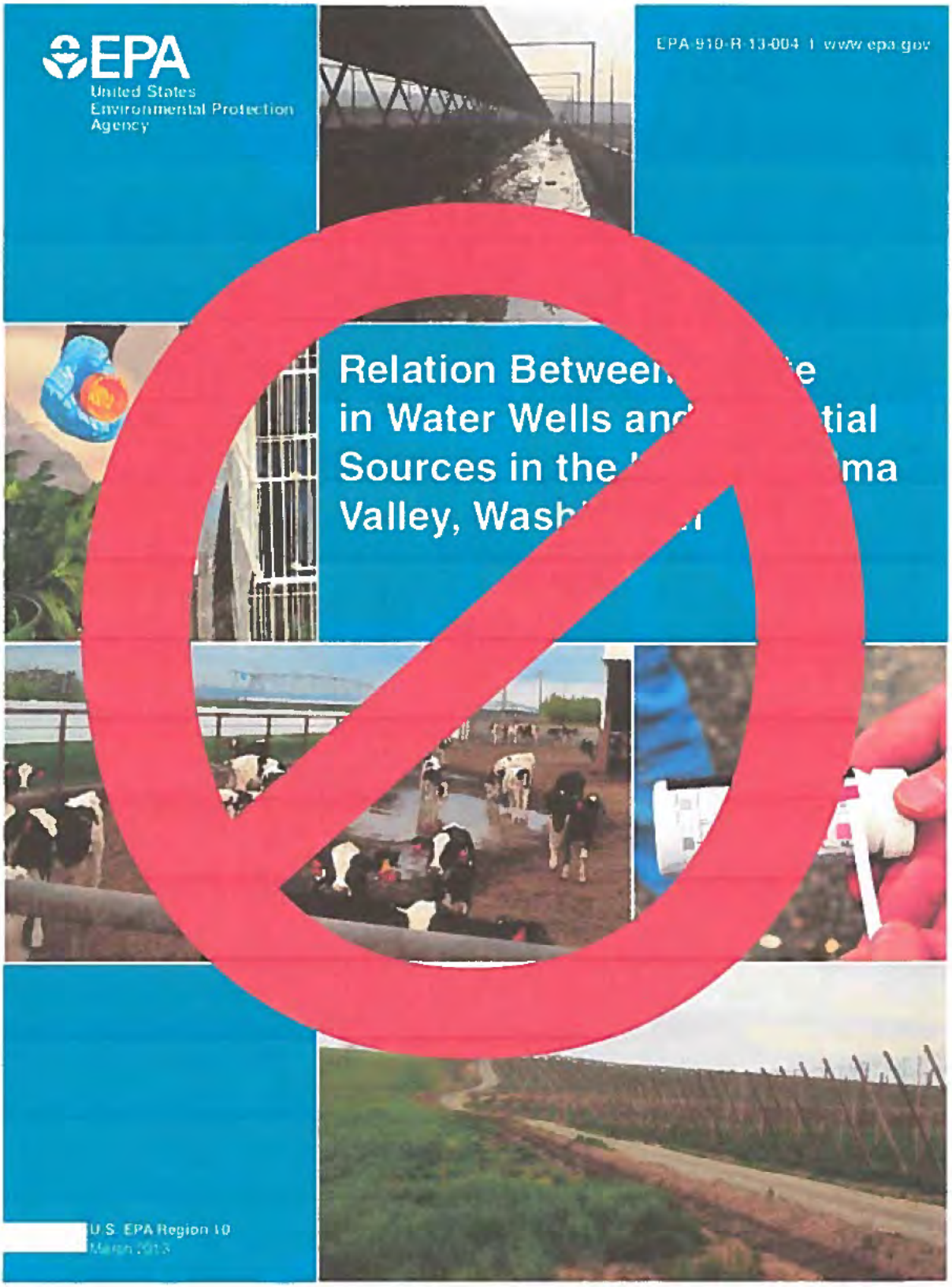

DOCUMENTATION OF FALSIFIED EPA "SCIENCE" REPORT
2012 TO 2018
SAVE FAMILY FARMING

USEPA REG
0000290

Save Family Farming

Washington State Dairy Federation | Idaho Dairymen's Association |

Oregon Dairy Farmers Association

EPA Yakima Nitrate Report

Summary of Concerns
(Including technical analysis by former NRCS Agronomist Richard Fasching)

February 2019

Background

On November 1, 2018 four dairy farmers and the Executive Director of Save Family Farming met with US EPA Region 10 Administrator Christopher Hladick and three EPA staff members. After hearing of the strong concerns of the farming community about the 2012-2013 Yakima Nitrate Report published by the EPA, the Administrator requested farm representatives meet with staff led by Edward Kowalski to discuss concerns about the Report and review recent monitoring results.

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Save Family Farming with the support of the Washington State Dairy Federation is submitting this summary of concerns in order to expedite these important discussions. Our concerns are that EPA Region 10 is failing to recognize extremely serious flaws in both process and substance with the 2012-2013 Lower Yakima Nitrate Study and Report. This report was listed as "important and highly influential" yet it did and does not meet EPA standards for that designation. The report peer review process failed to follow numerous EPA and Federal peer review guidelines and policies. Even more troubling is the substantial content differences between the draft report that was reviewed in early 2012 and the published report that was released in the fall of 2012. The report failed to produce credible and reliable scientific results according to virtually every outside reviewer. The report should be recognized as flawed and withdrawn until, or unless, a properly conducted, independent peer review establishes its validity.

Save Family Farming and Washington State Dairy Federation have retained Richard Fasching to conduct an analysis of the Report and the peer review. He served as Regional Agronomist for the US Department of Agriculture Natural Resource Conservation Service (USDA NRCS) in the Western US. His responsibilities included the technical development and implementation of the Nutrient Management Waste Utilization standards as well as technical training to states for Comprehensive Nutrient Management Planning. Mr. Fasching's in-depth analysis is provided to help inform EPA Region 10 leadership and staff of the serious faults with this study. His analysis includes this summary:

"In 2012 EPA concludes that their screening analysis showed that about 65 percent of the nitrogen generated in Yakima County comes from livestock predominantly as dairy cattle, about 30 percent from fertilizers applied to irrigated crops, about 3 percent from septic and wastewater systems, and the rest, less than two percent, from other relatively minor sources. They particularly investigated the Yakima Valley Dairy cluster and concluded that the dairy producers were causing groundwater contamination in wells miles away from their application and lagoon sites location...In their 2012 investigation of the Yakima Valley Dairy cluster EPA made numerous errors in data collection, therefore raising doubt and distrust in the conclusions."

Summary of Concerns

This Report and the scientific methodology employed to generate the results failed to meet EPA and federal peer review policies for important and influential information. The dairy farming community believes that if EPA, during the EPA sponsored peer review in early 2012, had allowed objective, independent peer reviewers the opportunity to actually examine the full report, including methodology, data collection and subsequent conclusions drawn by EPA staff this Report would never have been published. Those experts who did review the published Report during the public comment period in late 2012 were in full agreement regarding the errors. This includes experts from Texas A&M, Washington State University, the Yakama Nation, Washington Department of Agriculture and the USDA and many others. The scientific errors are so obvious and substantial that government leaders, public and private entities and ordinary citizens question if the report reveals not just incompetence but an intention to intentionally and fraudulently place blame on dairies for nitrate contamination.

Please refer to the Technical Analysis for details substantiating the summary of concerns. Topics addressed:

1) Peer review
2) Soil testing
3) Manure sampling
4) Lagoon storage
5) Manure application and irrigation water management
6) Legacy nitrate
7) Nitrate source identification
8) Updated data

1. Peer Review

The study and Report did not meet federal or EPA policies for peer review required for important and highly influential science and information. Such information is used for agency decisions that affect policies and enforcement action. EPA generated this information for enforcement purposes and used it as the basis for inducing dairy farmers into signing an extremely costly and punitive Administrative Order on Consent. The supporting document will detail the failings of the peer review used. In summary:

- The reviewers were provided limited data and information and asked to only respond to seven questions
- Only two reviewers provided uncritical comments and both those

were EPA officials
- The USGS reviewer submitted comments consistent with other experts who reviewed it but who were not part of the EPA peer review process
- The expert from the USDA Agricultural Research Service (ARS) that was asked to review it, Dr. David Tarkalson, requested his name be removed after he saw the published Report; citing the failure of EPA to provide him with the complete report and therefore the information needed to review the study.

The public comment included numerous critiques from recognized experts from agricultural science, the NRCS and academia. All noted the Report failed in its goal to identify sources of nitrate in groundwater. The EPA produced a "Responsiveness Summary" that while acknowledging many of the science critiques as legitimate, nevertheless and despite this, EPA found no reason and took no action to alter their conclusions.

2. Soil testing protocol/technique

EPA's methodology for securing soil samples to determine nitrate loading in soil demonstrates the study was flawed from the outset. These flaws are found from the directions instructing the science team to follow an inappropriate process of collecting soil samples from fields where manure had recently been applied, then using a teaspoon to extract samples to a depth of one inch. Mr. Fasching's analysis provides details on numerous problems in the soil testing regime including:

- sample timing
- sample management
- sample handling
- number of samples or cores

His conclusion: *"The resultant analysis and conclusions derived from these improper sampling techniques are significantly erroneous."*

3. Manure sampling

As with proper soil sampling, manure sampling is an essential part of managing nutrients to protect water. Regarding manure sampling Mr. Fasching concluded: *"In addition to improper soil testing, EPA also erred in their attempts at collecting representative lagoon samples. Their improper collection methods resulted in erroneous results that*

grossly misrepresent the total amounts of nitrogen produced and consequently applied to fields."

The technical analysis explains the proper procedure for collecting manure samples that accurately determine the amount of nutrients that will be applied. These include collecting samples in the field just before applying, not directly from the lagoon. Collecting samples from the lagoon or too far in advance of application will lead to erroneous results because such samples would not reflect the 70% to 80% loss of nitrogen to ammonia through handling and storage. The samples must also be taken immediately to a lab or frozen prior to delivery to ensure accurate results.

Mr. Fasching concludes: "*EPA did not follow either of those standard procedures and fraudulently reported the analysis results anyway.* "

4. Lagoon storage

EPA made numerous errors in predicting seepage rates from the lagoons they were investigating. Mr. Fasching points out four:

- improper use of lagoon construction guidelines (an abuse that the reviewer from the Yakama Nation said represented "borderline recklessness.")
- gross overestimation of lagoon storage volumes and therefore leakage
- storage design
- storage losses

Misusing a planning field guide, using aerial photography to determine storage volumes, failing to consider construction and condition of lagoons being studied and failing to include very significant losses of nutrients from storage and handling all led EPA to grossly overestimate leakage from lagoons.

It is well established that lagoons built to NRCS standards are protective of water. The errors made by EPA in establishing leakage rates negate their conclusions about leakage and contributions to water quality concerns. However, these faulty conclusions were nevertheless used to coerce farmers into installing liners that will do little to nothing to protect water but are severely impacting the

ability of these farms to continue operation. If EPA's existing and unjustified demands are promulgated more broadly, as the litigation industry is attempting to do using this false report, this one faulty finding alone will potentially put many family dairy farms in Washington state and across the western U.S. out of business.

5. Manure application and irrigation water management

It is well understood that protecting water and growing crops depends upon applying nutrients at agronomic rates. The numerous errors made by the EPA in this study contribute to a severe miscalculation of the contribution of nitrate to groundwater through field application. That miscalculation is based on:

- failure to recognize timing of nutrient uptake
- improper soil testing
- improper manure sampling
- inappropriate means of calculating lagoon volumes and therefore application rates
- failure to consider nitrogen losses from storage and handling

These errors are compounded so that the conclusions reached by EPA about over application bear little to no relation to reality. Fortunately, farmers have kept and are keeping excellent records and the technical analysis provides great detail of how these farms are and were applying at the appropriate rates to allow crop production while protecting water.

6. Legacy nitrate

The inability admitted in the report to determine the presence of legacy nitrate is one of the most significant failings. The technical analysis refers to a section in the report that plainly states that EPA was not able to determine when the nitrate entered the water. This is a crucial issue given the prevalence of legacy nitrate.

The dairy farms included in the study, like most larger dairies in the Valley, are relatively recent. But the Yakima Valley has been a highly productive farming area for many generations. Much of the current land used to grow forage crops for dairy cows was used to grow sugar beets, potatoes and other crops.

In the years following World War II when commercial fertilizer became available at very low-cost farmers were told that more was better. Over application was often accompanied by flood or rill irrigation systems which drove excess nutrients into groundwater. In some areas, Whatcom County for example, nitrate levels in farming areas are decreasing especially near dairy farms. A good indication that farmer stewardship, the use of nutrient management plans and appropriate regulations are helping repair the damage from the past.

If the EPA's conclusions are correct, how do they explain that most other farming areas in eastern Washington have nitrate in groundwater similar to or greater than Yakima? This includes Benton and Franklin counties where little to no dairies or other animal agriculture exists (a nitrate map showing this is also included in the technical analysis). A study from Canada shows that legacy nitrate requires 30 to 50 years to improve with improved protection including better farm practices.

7. Nitrate source identification

Despite the comment made by Mr. Winnicke in the November 1 meeting that all sources of potential nitrate contamination were thoroughly investigated, most reviewers of the Report noted that readily available information about other potential sources was simply ignored or discounted. We mentioned legacy nitrate above. Another well-established source, demonstrated in multiple areas in rural areas that include suburban development, is On-Site Sewage Systems. The EPA has provided detailed information on the contribution of these systems to water contamination. Failing systems combined with specific levels of concentration are known to be significant issues.

Mr. Fasching identifies in the technical analysis additional potential sources that were not adequately investigated.

8. Updated data

In the November 1 meeting, Mr. Kowalski stated that the current data coming from the dairies under the AOC demonstrate the Report was correct and, if anything, too conservative. He specifically referred

to manure lagoon leakage data.

We have attempted to identify the data he is referring to. The analysis provided by Mr. Fasching demonstrates the erroneous nature of EPA's lagoon leakage conclusions. We are not aware of any soil tests or test wells directly below lagoons that can substantiate and justify Mr. Kowalski's conclusion. As we have seen in the testing beneath the Haak decommissioned lagoon, the ammonium and nitrate levels in seepage from the lagoon drops to background levels - due to biological processes - in two to three feet beneath the liner. This background level is maintained except for a small ammonium increase at 5-7 feet then back to background levels to 45 feet. This potentially suggests the presence legacy nitrogen, not lagoon leakage. These results are consistent with other studies, including a more recent evaluation beneath a decommissioned lagoon in Western Washington and studies conducted by the Department of Ecology in the 1990's. Further, page 80 of the March 2013 report states that the EPA was not able to determine the age of the water thereby confirming they cannot determine whether nitrate in the groundwater is legacy or from recent farm activities. This acknowledgement undermines conclusions about source of the nitrate, including those made by Mr. Kowalski in the November 1 meeting.

In short, there is nothing in the updated data that suggests the report is justified or correct.

Richard Fasching Technical Analysis

Introduction

Sound management practices are essential to maximize the agronomic and economic benefits of manure while reducing the risk of adverse environmental consequences. Livestock producers do not intentionally put water quality at risk. Virtually every regulatory and voluntary manure management approach calls for producers to develop a Comprehensive Nutrient Management Plan (CNMP). The plan documents how much manure is produced and how it will be managed. At the core of these plans is the concept that manure and commercial fertilizers will be applied at agronomic rates to crop land and hay land.

The agronomic rate is a nutrient application rate based upon a field-specific estimate of crop needs and an accounting of all N and P available to that crop prior to manure (and/or fertilizer) application. Implicit within the agronomic rate concept is an application rate that does not lead to unacceptable nutrient losses. The agronomic rate is not something that can be directly obtained from a textbook or tables. Rather, it must be evaluated for each farm and field. Knowledge of manure or effluent nutrient content and residual soil nutrients is critical to determining how much can be safely applied so that the agronomic rate is not exceeded.

While producers across the US were encouraged in the past to fertilize for maximum crop yields, now they also consider the environmental risk of nutrient losses in determining how much manure or fertilizer to apply. By knowing the relationship between manure nutrient content, residual soil nutrients, and crop needs, wise decisions are made such as where to spread manure, and how much needs to be spread.

In 2010, the USEPA conducted a study generated primarily due to concerns of ground water contamination and high levels of nitrates in water wells in the Lower Yakima Valley. The nitrate in these wells was consistent with nitrate levels in other similar farming areas throughout the nation and Southeast Washington. In an effort to determine the source of the nitrate in groundwater, dairy producers in proximity to the wells were identified by EPA as potential sources. To validate their claim, EPA collected a limited amount of

data and performed various tests attempting to pinpoint the sources of nitrates. The final published report concludes that the dairy producer's facilities and their associated crop and hay fields were the principal sources of high nitrates in the wells.

Concerns

1. Peer Review

In late 2011 EPA solicited peer reviewers for their report. The peer review process began in January 2012 with four selected individuals that were to provide an independent third-party review. However, the process ended with three of the selected individuals US EPA employees ("We would like to acknowledge the following individuals who provided an independent third party review of the report: Megan Young, PhD, U.S. Geological Survey; Stephen Kraemer, PhD, U.S. EPA Office of Research and Development; Roger Burke, PhD, U.S. EPA Office of Research and Development; and Lorraine Edmond, U.S. EPA Region 10" - ref. 2013 Final EPA report, Acknowledgements). It should be noted that Dr. David Tarkalson, USDA Agricultural Research Service, was one of the initial selected reviewers but asked to have his name removed from the report in December 2012 before final publication. He concluded that he was given a draft report that when compared to the fall 2012 published report was missing numerous pages of introductory statements as well as conclusions. Dr. Roger Burke replaced him on the review team.

It is almost certain that the significant information missing from the materials provided to Dr. Tarkalson was also missing in the information provided to other reviewers thereby limiting the value of their response. It is further understood that rather than seeking a full review of the study and report, the EPA limited the input by asking the reviewers to answer seven specific questions. We further note that Dr. Young's response included detailed concerns about groundwater flow directly and adjacent to non-dairy crop fields which undermine some of the critical assumptions and conclusions of the Report.

The peer review process utilized by EPA violates numerous versions of their own peer review policy, some enacted in 1994 and later updated in December 2004 and January 2006. The 2006 Peer Review and Peer Involvement policy specifically established policy requiring "*peer*

review of scientifically and technically based work products, including economic and social science products, that are intended to inform Agency decisions. Peer review, a form of peer involvement, is one process through which EPA staff augment their capabilities by inviting independent subject-matter experts to provide evaluation of the work product." - ref. Peer Review and Involvement, US EPA, Jan. 31, 2006

The 2006 Peer Review policy further explains that, to ensure that the scientific and technical bases of its decisions meet two important criteria: (1) they are based upon the best current knowledge from science, engineering, and other domains of technical expertise; and (2) they are credible. The policy goes on to reiterate the importance of appropriate peer review: *"peer review is central to sound science and helps the Agency meet important criteria."* By EPA policy, peer review occurs when scientifically and technically based work products are evaluated by relevant experts who were not involved in creating the product. The policy also states that agency managers are accountable for ensuring that Agency policy and guidance are appropriately applied. *"For influential scientific assessments, external (External, in which the reviewers are independent experts from outside EPA) peer review is the expected procedure."* EPA policy requires that peer review be completed prior to public dissemination of any report.

In September 2012 US EPA simultaneously released their report and delivered a consent decree to four Yakima Valley dairy producers (Haak, De Ruyter (2 farms), Cow Palace (Dolsen family) and Bosma) requiring immediate action. It wasn't until the Washington State Dairy Federation and Congressman Doc Hastings got involved that the EPA acquiesced to allow a short "public comment" period ending November 2012 (outside the official pre-publishing peer review process). The public comment period generated substantial feedback to EPA identifying numerous critical technical problems and mistakes with the report. EPA did acknowledge some errors in their report and prepared an errata sheet summarizing any corrections (or lack of). However, in most cases, even though many comments pertaining to lack of science-based integrity in the study were made by recognized experts during the post peer review, EPA ignored the stated concerns or dismissed the comments entirely. Only minor insignificant edits to the content of the report were made.

EPA's own policy was not followed in publishing this report. Because

it was not followed, there are numerous technical errors and mis-diagnosis of data that grossly misrepresents the causes of groundwater and residential drinking water degradation. According to the published report this contamination is caused directly by the dairy producers of the Yakima Valley. Due to the lack of appropriate peer review, violating federal guidelines established by the Office of Management and Budget as well as EPA's own policy related to peer reviews, **the report is not based on science.**

2. Soil Testing Protocol/Technique

Soil testing serves as the foundation for crop nutrient and environmental responsible nutrient applications. Soil sampling has been an important part of agriculture since the 1800's. Land grant universities across the nation began conducting research already in the early 1900's that undergirds soil sampling and analysis programs in use today. Science based soil sampling techniques and analysis have been around since the 1940's developed by land grant universities in nearly every state in the US. The ultimate goal of soil sampling is to properly characterize the nutrient status of a field or zone accurately. Nutrient characterization and fertilizer recommendations are based upon proper soil and tissue tests and depend upon three factors: representative sampling, accurate analysis and proper interpretation of the analytical results. A soil sample must correctly represent an area of soil or a field. The resulting data obtained is only worthwhile if the tested soil sample accurately represents the sampled field. Sampling a zone or field at the depth of one inch does not follow any land grant university guidelines or recommendations for crop land nutrient sampling in the State of Washington or anywhere else in the US.

Below are explanations of proper soil testing which, if followed, would have produced significantly different results than what EPA reported. The sampling protocol which included targeting fields where manure had recently been applied, then using a teaspoon to extract a sample at a depth of one inch demonstrates either an exceptional level of scientific incompetence or a willful effort to deceive.

-Sample Timing

Timing of soil sampling is extremely important. The best time to sample is as close to planting time as possible for determining growing season nutrient availability. Sampling to diagnose poor crop

growth or environmental issues should be taken while problem areas are delineated (when problems are occurring). Samples should never be taken shortly after application of organic or inorganic fertilizer applications as nutrient results will be dramatically inaccurate. For example, manure can dramatically increase nitrate results if applied to the soil surface.

-Management

Translation of soil test data into meaningful characterization involves the integration of all available pertinent information. Sampling should be completed by experienced agriculturalists who understand the principles of fertility and plant nutrition and who are familiar with the soils, crops, and management in the area being sampled. For example, it is extremely important to know the cropping and tillage history of the area being sampled to be able to diagnose potential nutrient availability. Additionally, areas within a field including headlands, turn rows, or areas that received recent applications of organic or inorganic fertilizers should be avoided as soil test results will not be representative of the entire field. The soil sampling procedures utilized by EPA to characterize crop land and hay land fields of the dairy farms did not meet standard operating procedures established in Washington. The resultant analysis and conclusions derived from these improper sampling techniques are significantly erroneous.

-Handling

Samples intended for nitrate-N analysis should be stored in ice chests/coolers during transport. Moist samples subjected to heat will result in N release through microbial mineralization, and the soil test N values will dramatically increase during transport and storage. Samples intended for nitrate-N analysis must be air-dried immediately after collections to prevent alterations of nitrate-N concentrations due to microbial activity. EPA did not follow these guidelines which resulted in analysis that were not representative of the area.

-Number of Samples or Cores

The accuracy of, and confidence in, a measured soil test level is positively related to the number of soil samples collected per field or zone. "Accuracy" measures how close the soil test value is to the actual field average, whereas "confidence" is how often the level of accuracy can be repeated. To have the greatest confidence and highest

accuracy in a particular soil sample, a larger number of subsamples is required.

EPA should have collected at least 25 subsamples down to the crop rooting zone to ensure 90% confidence that their nitrate analysis was within +- 15% of the measured results. Because sampling was completed incorrectly and at an improper depth (the highest amounts of N are typically located in the top 0-6 inches of soil are found in reduced amounts as you sample deeper into the soil profile), the sample(s) collected represent fraudulent results that do not accurately represent the characterization of the area sampled of any field of the dairies.

3. Manure sampling

In addition to improper soil testing techniques, EPA erred in their attempts at collecting representative lagoon samples. Their lack of proper collection methods resulted in significant misrepresentations in the total volume, characteristics, and concentration of nitrates found in the manure storage systems. A representative manure sample is essential to provide an accurate reflection of nutrient content. Manure nutrient content is NOT uniform within storage structures so obtaining representative samples is *vital*. Proper mixing and sampling strategies are required to ensure that samples accurately simulate the type of manure that will be applied.

Sampling manure prior to application(s) does not give a completely accurate measure of nutrient content if the sampling is collected too long in advance of application due to handling and storage losses or when liquid storage structures are not adequately agitated. EPA's storage sample collection and estimated volumes and nitrate concentrations based on sampling did not account for storage losses (i.e., a liquid manure lagoon will lose 70-80% of its nitrogen as ammonia during handling and storage. MWPS-18, Livestock Waste Facilities Handbook).

There are really ONLY two ways to properly collect liquid manure samples, one from the storage facility itself and one in the field. THE BEST samples are collected in the field as liquid manure is applied by an irrigation system.

To sample directly from a storage facility, a sample must be collected with a sampling probe or tube. The tube should be longer than the depth of the facility. The tube should be slowly inserted into the entire depth of the lagoon. Each tube full of liquid should be placed into a bucket. Repeat this process at least 3 times in differing locations of each storage facility or lagoon to make a composite sample from each lagoon. Important - if the samples cannot be mailed or transported immediately to a lab within a few hours, they must be frozen to maintain accurate analysis results.

EPA did not follow either of these standard procedures yet reported and based conclusions on the erroneous analysis results anyway.

4. Lagoon storage

- Seepage Predictions

Using generalized recommendations contained in the USDA NRCS Animal Waste Management Field Handbook (AWMFH) to predict seepage loss contributions from individual farms is misleading and incorrect use of the guidelines. AWMFH is well supported by research and field experience throughout the US however, they are "planning" guidelines and are generalized recommendations that are adjusted to accommodate on site variables during installation phases of construction. AWMFH seepage rates cannot be used to predict leakage losses from multiple dairies distributed randomly in a watershed. The generalized seepage rates are strictly used for planning purposes to anticipate the potential for loss and the need for additional practices that provide adequate protection of localized water resources. EPA did not access important on farm sites or data that could have allowed for more accurate estimates of possible water degradation. The use of planning guidelines to estimate actual degradation is improper use of the AWMFH and the resultant estimates are incorrect.

- Storage volumes

The use of aerial photography to determine storage volumes grossly over estimates each operations manure storage capacity and therefore also over estimates seepage losses (if any). EPA did not measure the capacity of the lagoons on site. Every lagoon is built with specific side slopes and depth to hold appropriate amounts of effluent. In an attempt to calculate the total effluent holding capacity of the dairy lagoons in this study, EPA simply utilized aerial photography to measure the length and width of each lagoon and then assign a nominal

depth. They did not consider side slopes nor differing depths. They also did not take into consideration the amount of free-board allowed in each lagoon (free board is designed into each lagoon for safety measures). This lack of detail grossly over-estimates the total amount of effluent stored in lagoons at any time.

Producers keep extremely detailed records of their lagoons. The total capacity of their lagoons varies tremendously. One producer's lagoons total 25,000,000 gallons (two farms), another 62,500,000 gallons, and the third's totals 39,000,000 gallons. Capacity as such is not the only detail that is needed. Records showing the actual amount of effluent applied to fields is critical when attempting to discern if agronomic rates were being applied and whether possibility of groundwater contamination is possible. Additionally, amounts of manure transferred off site is critical when assessing total quantity of nutrients. EPA did not collect any effluent field application data in their study nor did they collect offsite manure transfer data. Again, the dairy producers keep excellent detailed records showing one producer transferring 100,000 tons of wet manure off site annually to a private composting facility, and another recorded exporting 13,123,900 gallons off site (in 2012).

EPA in their report concluded the dairies were the direct source of nitrate contamination in the groundwater specifically due to the large quantities of effluent leaking lagoons that allowed effluent to seep many feet below the lagoons, and over application of effluent onto cropland. Their conclusions are based on extremely limited tests that were incorrectly collected resulting inaccurate analysis. In the case of nitrogen contained in the storage lagoons, EPA attempted to estimate the total amount of manure by measuring the surface area of the lagoons with no measured data pertaining to depth, side slopes, or free-board (or data on how full each lagoon is typically due to emptying and filling cycles). This lack of consideration grossly overestimates the quantity of effluent and thus the total amounts of nitrogen that might be contained in the storage facilities. Additionally, EPA failed to consider natural nutrient losses from storage, handling, and land application which are significant!

- Storage design

Storage facilities are designed following rigid engineering standards (NRCS standards or private industry) and local code usually requires monitoring for failure. EPA does not know if the storage structures were designed per code or if engineering guidelines were followed. Yet, there are many factors that could lead to a leaking storage

facility. Yet, EPA targeted all operations upgradient of contaminated wells and unfairly focuses attention on well-managed operations. EPA collected only limited data from lagoons pertaining to seepage or leakage and cannot be used to surmise that all lagoons are leaking.

EPA did not determine whether the storage facilities were designed to handle the number of animals confined.

- Storage losses

Plant roots take up nitrogen in the form of nitrate (NO3) and *ammonium-N* (NH4). Major losses of N to the environment occur when ammonia gas (NH3) is lost to the air. Manure that contains large amounts of ammonium-N contain much PAN (plant available nitrogen) that is subject to volatilization to the atmosphere shortly after application. EPA failed to consider these storage losses in their attempts to quantify nutrient loads. Under the climatic conditions found in the Yakima Valley, ammonium (NH4) is readily transformed into ammonia (NH3) and is lost as a gas. Nitrogen lost as ammonia reduces plant available nitrogen that might be supplied by manure. The estimated fraction of manure ammonium-N *lost* after application from the dairy lagoons is high, approximately 45%.

PAN is released from manure organic N through microbial activity in soil in a process called mineralization. Organic N mineralizes most rapidly during the first months after application. The mineralization rate decreases over time. The dairy lagoons have approximately 1-5% dry matter (95-99% wet) classified as "thin slurry". Accordingly, only 40% of the organic N mineralizes into PAN the first year, 15% the next year, 7% the next year, etc. EPA did not differentiate slow release mineralization but simply assumed all N leaches or is available to crops.

5. Manure Application and Irrigation Water Management

Animal manure has long been used as a source of nutrients for crop growth. Livestock manure or mixtures of manure and related organic by-products make excellent fertilizers and soil amendments. Manure provides benefits to the soil, as well as offsetting the amount of nutrients needed in the form of commercial fertilizers.

Manure contains necessary plant nutrients including nitrogen,

phosphorus, potassium and a variety of micro-nutrients. Additionally, the high organic content of manure can readily improve soil quality by enhancing tilth, leading to better water and nutrient holding capacity.

- Nutrient Availability

Organic nutrients in manure are typically *not* available to a crop immediately upon application. **A producer can reasonably expect up to half of the nitrogen content to be available to a crop in the first season (range from 25-50%), the other half divided between residual value for the next year and volatilization (loss to the atmosphere).** The application method also significantly affects the amount of nitrogen available to a crop. EPA did not consider N availability due to timing.

The method of manure application is determined by the type of manure collection system you are dealing with. Solids are typically broadcast from a box type spreader. Slurries, a mix of solid and liquid, are applied with a tanker or a big gun irrigator. Low solid liquids (like those from dairy lagoons) are normally applied using irrigation pivots or similar irrigation system. Applying manure liquids through a pivot or big gun system **will volatilize 50-70% of the analyzed nitrogen in the sample**. EPA did not accommodate for these losses in their calculations.

Application rates for any fertilizer must be based on accurate recent soil tests and the particular crop's nutrient needs. To do this, you simply take the crop nutrient needs, subtract what is present in the soil and, then calculate a rate based on manure nutrient content taking into consideration first year availability and all other losses. Timing of applications are particularly important. Nitrogen can easily be lost to the atmosphere through volatilization. Nowhere does EPA attempt to calculate appropriate agronomic rates.

- Miscalculation of agronomic rates

In 2012 EPA concludes that their screening analysis showed that about 65 percent of the nitrogen generated in Yakima County comes from livestock predominantly as dairy cattle, about 30 percent from fertilizers applied to irrigated crops, about 3 percent from septic and wastewater systems, and the rest, less than two percent, from

other relatively minor sources. They particularly investigated the Yakima Valley dairy cluster and concluded that the dairy producers were causing groundwater contamination in wells miles away from their application and lagoon sites location. A well-designed nutrient management program includes multiple components to maintain fertility for crop growth and development. A well-designed soil sampling plan, including proper soil test interpretations along with manure sampling, manure nutrient analysis, equipment calibration, appropriate application rates and methods are all critical components. EPA, in their investigations of the Yakima Valley dairies in 2012, concluded that groundwater is being contaminated with nitrates due to improper application and too many nutrients (non-agronomic rates). However, EPA makes their conclusions from incorrectly collected soil sampling, waste sampling, and without adequate basic facts pertaining to cropping or irrigation systems to make such conclusions. To accurately determine what the needs of a crop are consideration *must* be given as to the proper rate, proper timing, the proper source, and the proper placement of nutrient applications including manure. Ignoring any of these while diagnosing an environmental issue or production problem will result in inaccurate conclusions. **In their 2012 investigation of the Yakima Valley dairy cluster EPA made numerous errors in data collection and fraudulently arrived at their conclusions.**

To make clear the serious errors made by the EPA, it is valuable to look at the nutrient application and uptake levels from the farms as revealed in their detailed records. Nutrient needs must be calculated to determine whether there is potential environmental harm occurring. There are two ways to address agronomic rate. One is to develop a nutrient budget based on land grant university crop nutrient recommendations and realistic yield goals. The other is to simply apply nutrients based on crop removal rates. A nutrient budget is typically developed for each individual field based on residual soil nutrient concentrations determined from soil tests, crop rotational needs, and realistic yield goals.

Although the Yakima Valley dairy producers differ somewhat in their crop rotations and yields, they each generally follow a rotation of alfalfa, and double-cropped triticale/corn silage. Based on the number of acres of each crop produced and projected yields, the total amount of nutrients a crop will remove in any one year can easily be calculated. When we know the amounts of nutrients removed by a crop, we can then get a good idea, based on water application (effluent) requirements to grow a crop, if agronomic rates are being followed.

To demonstrate the degree to which EPA erred in their estimates of nutrient below are the calculations for the nutrient budgets based on the detailed records provided by the indicated farms. Available records go back to 2008, however this information is from 2012 and therefore useful in determining whether the farms in the dairy cluster were applying at agronomic rates at the time of the study.

Producer 1: (Bosma)

Crop	Crop Removal Rate		Yield		Acres		Total NO3 Removed
Alfalfa	50.39 lbs/ton	x	25 t/ac	x	372	=	468,627 Lbs
Triticale	20.53 lbs/ton	x	7 t/ac	x	1191	=	171,159 Lbs
Corn silage	7.75 lbs/ton	x	35 t/ac	x	1191	=	323,059 Lbs
					Total removed		**962,844 Lbs**

Producer 2: (Dolsen)

Crop	Crop Removal Rate		Yield		Acres		Total NO3 Removed
Alfalfa	50.39 lbs/ton	x	12 t/ac	x	228	=	137,867 Lbs
Triticale	20.53 lbs/ton	x	6 t/ac	x	305	=	37,570 Lbs
Corn silage	7.75 lbs/ton	x	35 t/ac	x	305	=	82,731 Lbs
					Total removed		**258,168 Lbs**

Producer 3: (DeRuyter)

Crop	Crop Removal Rate		Yield		Acres		Total NO3 Removed
Alfalfa	50.39 lbs/ton	x	12 t/ac	x	2300	=	1,390,764 Lbs
Triticale	20.53 lbs/ton	x	6 t/ac	x	6500	=	800,670 Lbs
Corn silage	7.75 lbs/ton	x	35 t/ac	x	6500	=	1,763,125 Lbs
					Total removed		**3,954,559 Lbs**

Grand Total for all 3 producers 5,175,571 Lbs of NO3 needed per year

Producer 1: (Bosma)

Crop	Irr water applied	Total N Lbs/1000 gal	Acres	Total NO3 Applied
Alfalfa	17,856,000 gal	5.46	372	97,494 Lbs
Triticale/ Corn silage	58,359,000 gal	5.46	1191	318,640 Lbs

(note-triticale and corn silage are double cropped)

Total NO3 Applied 416,134 Lbs

Producer 2: (Dolson)

Crop	Irr water applied	Total N Lbs/1000 gal	Acres

	Total NO3 Applied			
Alfalfa	11,637,000 gal	3.76	228	
	43,755 Lbs			
Triticale/	38,000,000 gal	3.76	305	
	142,880 Lbs			
Corn silage				

(note-triticale and corn silage are double cropped)

Total NO3 Applied 186,635 Lbs

Producer 3: (DeRuyter)

Crop	Irr water applied	Lbs/1000 gal	Acres	
	Total NO3 Applied			
Alfalfa	117,390,789 gal	4.77	2300	559,954
Lbs				
Triticale/	809,836,066 gal	4.77	6500	
3,862,918 Lbs				
Corn silage				

(note-triticale and corn silage are double cropped)

Total Applied 4,422,872 Lb

These producers apply nutrients to their crops mostly via effluent application from their dairy lagoons along with some supplemental commercial fertilizers, it is fairly easy to determine how much nutrient is being applied as recorded in their application records. The following does not include fresh water added.

If you compare the amount of nitrate each farm requires just to grow their crops with the amount of nutrients it is applying, you can see that two of the farms are removing more nitrate than they are applying (producer 1 & 2). The third producer under-supplies nutrients on his alfalfa but slightly over applies on his double cropped triticale/corn silage (applies approx. 594 Lbs/acre versus the required 394 Lbs/ac). It should be noted that these are *crop removal rates only*. Typically, land grant university nutrient *recommendations are higher* than crop removal rates. If producers only applied nutrients at the crop removal rate, the soil would eventually be depleted of nutrient reserves that help in building the soil, improves organic matter breaks down crop residues. The conclusion is clear: these farmers in 2012 were applying at or below agronomic rates demonstrating that EPA's conclusions about contamination from over application are erroneous.

EPA's report states that irrigated cropland is expected to be a likely source of nitrates in drinking water wells (ref. ES-9). However, the only pathways that nitrate contaminants can enter well

water is through a). leaching through the soil profile below the crop/forage rooting zone into ground water and subsequent movement underground to a well, or
b). through surface water flow off of a field and directly into a recharge area that feeds the well itself.

- Hydraulic Conductivity

The report attempts to characterize the soils on a majority of the fields receiving manures as "well drained" and that they have "saturated hydraulic conductivity" characteristics that are considered high (ref. EPA-910-R-12-003, surface soils, page 35 and Appendix B) citing the USDA NRCS soil survey and its associated reports. Saturated Hydraulic Conductivity, according to the USDA NRCS Soil Survey Manual (Ag Handbook 18) is described as "saturated flow occuring ONLY when soil water pressure is positive, that is, when the soil metric potential is zero (satiated wet condition)." This means that, if the soil remains saturated for a prolonged period (several months or longer), the percent of total pore space filled with water may approach 100 percent. Therefore, "saturated hydraulic conductivity" CANNOT be used to describe water movement under unsaturated conditions (ref. USDA Soil Survey Manual, Soil Survey Division Staff, Ag handbook 18, October 1993, page 103.

- Drainage Class

Drainage class, according to the USDA Soil Survey Manual, refers to the frequency and duration of wet periods under conditions similar to those under which the soil is developed (natural conditions). Under anthropogenic conditions, the drainage class cannot be used to characterize or depict potential leaching. EPA misinterprets the definition of "well drained" tying nitrate leaching to the natural drainage classification of the soil. There is no documentation of any kind that would lead to the conclusion that, based on the natural drainage classification of the soil, leaching or subsurface water contamination occurred in the lower Yakima Valley.

- Irrigation water management

EPA did not collect irrigation water management details (i.e. irrigation water application, irrigation applied manure effluent, irrigation timing, etc.) in the field or from producers. Because there is no data pertaining to irrigation management, EPA cannot substantiate that the simple (mis) classification of hydraulic conductivity precludes leaching pertaining to land treatment where

manures and fertilizers are applied.

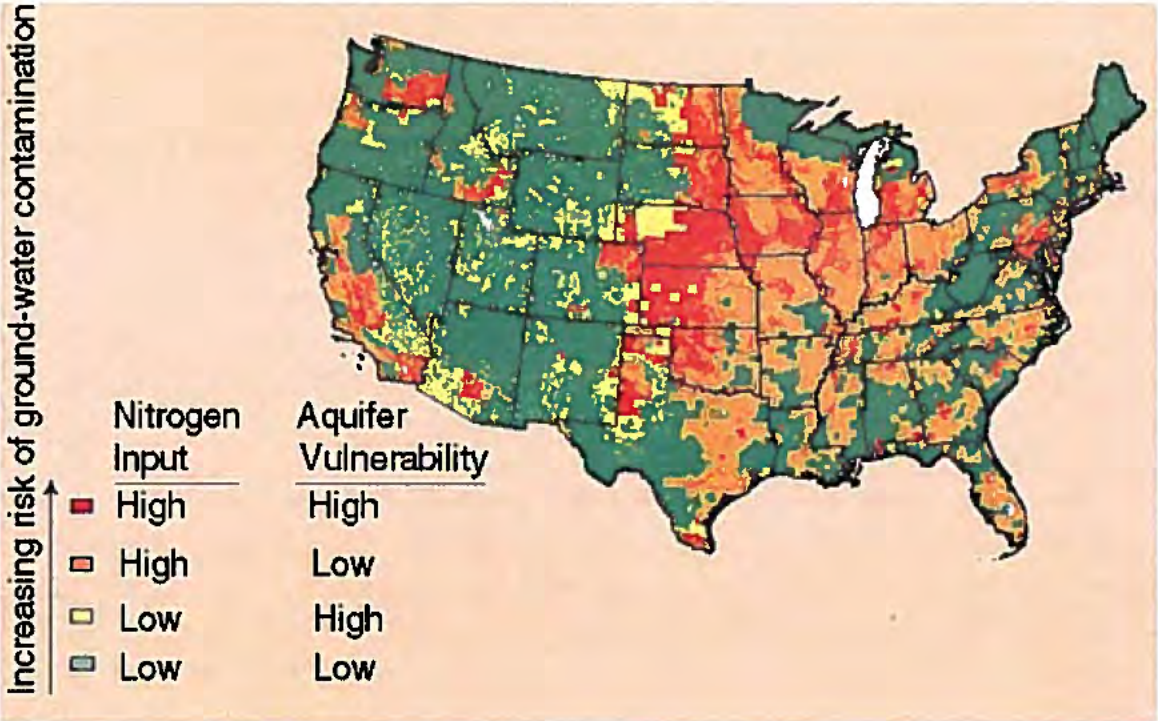
6. Legacy Nitrate Levels in the Soil and/Groundwater.

EPA erred in not sufficiently investigating the possibility of legacy nitrate levels in the soil or the groundwater. Because of this significant failing, EPA cannot conclude that the nitrate degradation throughout the watershed has been caused by the Yakima dairy producers without much more refined and detailed information, data collection, and proper analysis. EPA admits the water age data element of the study did not yield reliable results necessary to establish the presence of legacy nitrate in Yakima groundwater. On page 80 of the March 2013 report it states: "The age dating results were not useful to determine when the nitrate contamination was introduced into the well." Given the presence of legacy nitrate throughout the nation and state, this comment should be seen as sufficient to undermine confidence in the report.

Legacy nitrates are a well-established issue throughout the country where historic agricultural activities have occurred. Nitrate in groundwater above the EPA MCL is in 24% of wells in farming areas of high vulnerability. The map and chart from USGS makes clear this concern is not unique to the Yakima Valley. Note the significant portions of southeast Washington state with soil conditions considered vulnerable. The map below that shows nitrate in groundwater in areas throughout southeast Washington where traditional farming activities have occurred but where there are few if any dairy farms.

Prior to the establishment of the dairy farms in the Yakima Valley, much of the cropland was used to produce row crops including sugar beets and potatoes. Additionally, irrigation systems often included flood irrigation, furrow irrigation, or somewhat antiquated hand lines (sprinkler irrigation) and rolling lines, which typically applied too much water due to their inefficiencies. Nutrient management was not as technically advanced then as it is now. Because of the relatively cheap costs of commercial fertilizers, the typical producer was taught to apply adequate amounts of N-P-K to ensure high yields to make an economic return. Often, due to the lower efficiency

of older irrigation systems, irrigation water was over applied which drove water soluble nitrate through the root zone prior to being utilized by the crops. To counter this, additional nitrogen would be applied, and the cycle would continue. Because of the antiquated irrigation systems and nutrient management ideals, there is a strong possibility that "legacy nitrate levels" can be found below the root zone in much of the Yakima Valley.



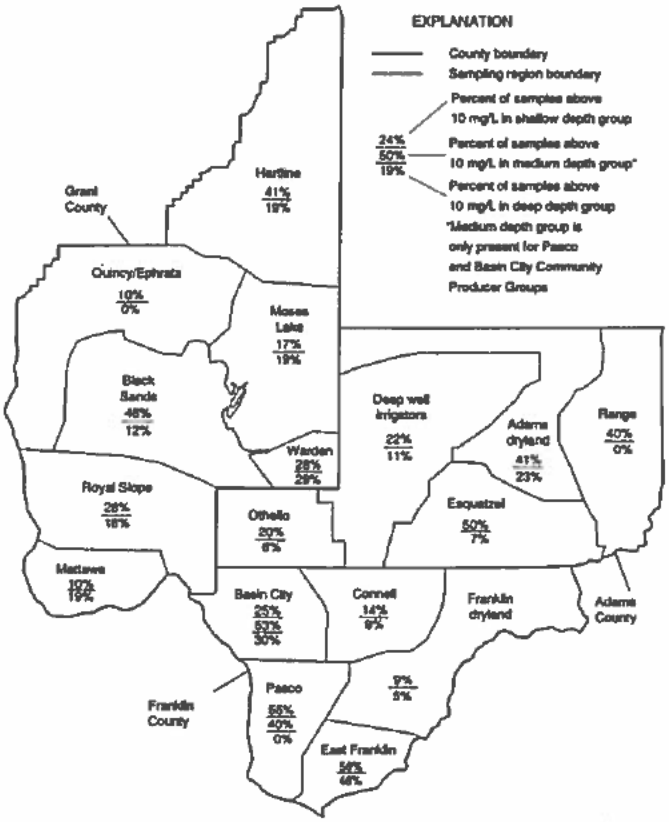
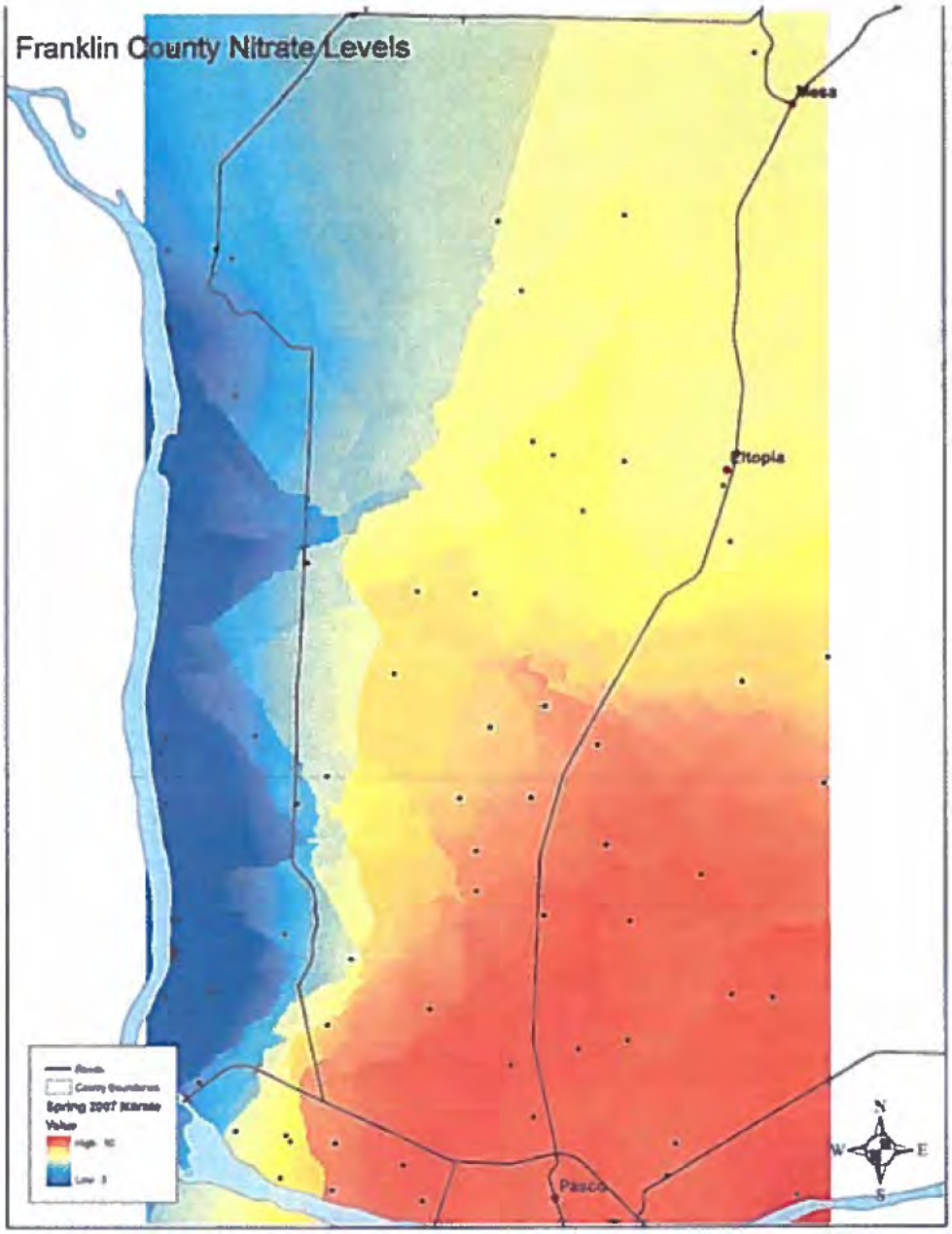


Figure 4. The percentage of samples exceeding the U.S. Environmental Protection Agency maximum contaminant level (MCL) for nitrate in drinking water (10 milligrams per liter of nitrate as nitrogen) for each sampling region and the category of well depths sampled.



There are very few dairy farms or animal agriculture operations in Franklin County.

7. Investigation of Other Potential Sources of Nitrate

Additional items needing investigation to accurately determine sources that were not considered:

- was a nutrient management plan followed including proper irrigation water management, proper waste application/timing?
- are animals fenced out of streams/watercourses?
- are nutrients being applied too close to unbuffered streams?

- potential contributions from non-dairy animals including migrating winter waterfowl?
- do irrigation delivery ditches leak (water and nutrients)?
- are there abandoned wells improperly sealed?
- what contributions come from improperly built and maintained On-site Sewage Systems?
- how much legacy nitrate exists from previous crop farming and earlier dairy practices?
- what do naturally occurring nitrates contribute?
- what do crops add, such as alfalfa during plow down?
- how much is contributed by non-dairy nutrient applications?

As an example of the last item about non-dairy nutrient applications: EPA found detectable levels of the antibiotic tetracycline/oxytetracycline. There are about 40,000 acres of tree fruit crops that have tetracycline applied at up to 2 pounds per acre annually to prevent fire blight. Tetracycline has been legal for this purpose for perhaps 40 years. Some or all of the wells upgradient showed tetracycline which EPA gives a brief reference to this in the report. However, it appears this is a strong indicator of upgradient sources that are NOT dairy. Tetracycline use on dairies is limited mostly to calves and at a very small rate. This EPA data - discounted in the report - is one example of non-dairy sources identified without serious consideration.

8. Updated Data

As mentioned above, we have not seen in any of the current data from the farms under the AOC that would suggest the conclusions in the report are accurate or too conservative as Mr. Kowalski reported. The admitted failure of EPA to determine the age of the water and thereby the time when the nitrate entered the groundwater undermines the conclusions that current farm operations are responsible.

Public Input Index
Relation Between Nitrate in Water Wells and Potential Sources in the Lower Yakima Valley, Washington
Document No. EPA-910-R-12-003

Item No.	Date Received	Name	Affiliation - General	Affiliation - Specific	Attachments
1.0	11/27/2012		Private Citizen		
2.0	11/21/2012		Private Citizen		
3.0	11/23/2012		Private Citizen	RBD, Inc.	
4.0	11/26/2012		Private Citizen		
5.0	11/27/2012		Private Citizen		
6.0	11/29/2012		Private Citizen	Chamberlain Dairy Inc.	
7.0	11/29/2012		Private Citizen		
8.0	11/29/2012		Private Citizen		
9.0	11/29/2012		Private Citizen		
10.0	11/29/2012		Private Citizen	J&K Dairy, LLC	
11.0	11/30/2012		Private Citizen	J&K Dairy, LLC	
12.0	11/30/2012		Private Citizen	J&K Dairy, LLC	
13.0	11/30/2012		Private Citizen	Smeenk Brothers Dairy	
14.0	11/30/2012		Private Citizen	Haringa Dairy	
15.0	11/30/2012		Private Citizen	J&K Dairy, LLC	
16.0	11/30/2012		Private Citizen		
17.0	11/26/2012		Private Citizen		
18.0	10/5/2012	Landon Schilperoort	Regional Agency	South Yakima Conservation District	
19.0	11/29/2012	Joseph H. Harrison	Academia	Washington State University	19.1 - J. Harrison (WSU)
20.0	11/28/2012	Saqib Mukhtar	Academia	Texas A&M University	20.1 - S. Mukhtar (Texas A&M)
21.0	11/21/2012	Jay Gordon	Association - Dairy/Ag	Washington State Dairy Federation	20.1 - Saqib Mukhtar (Texas A&M) 42.1 - Glorieta Geoscience
22.0	11/29/2012	Kathryn Walker	Association - Dairy/Ag	Oregon Dairy Farmers Association (ODFA)	22.1 - K. Walker (ODFA)
23.0	11/29/2012	Jay Gordon	Association - Dairy/Ag	Washington State Dairy Federation (WSDF)	23.1 - Jay Gordon (WSDF) 23.2 - Mark A. Wasemiller, P.E. 23.3 - Stuart Turner (Turner & Co.)
24.0	11/29/2012	Steven E. George	Association - Dairy/Ag	Yakima County Farm Bureau	
25.0	11/5/2012	Jean Mendoza	Association - Environmental	Friends of Toppenish Creek	
26.0	11/30/2012	Denise S. Luk	Association - Environmental	Friends of Family Farmers	26.1 - D. Luk (Friends of Family Farmers)

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Relation Between Nitrate in Water Wells and Potential Sources in the Lower Yakima Valley, Washington
Document No. EPA-910-R-12-003

Item No.	Date Received	Name	Affiliation - General	Affiliation - Specific	Attachments
27.0	11/16/2012	David Tarkalson	Federal Agency	United States Department of Agriculture (USDA) - Agricultural Research Service (ARS) NW Irrigation & Soils Research Lab	
28.0	12/7/2012	Bonda Habets	Federal Agency	USDA - Natural Resource Conservation Service (NRCS)	28.1 - B. Habets (NRCS) Cover Sheet 28.2 - Washington State NRCS 29.1 - Richard Fasching (NRCS) 30.1 - John Russell Davis (NRCS)
29.0	11/30/2012	Richard Fasching	Federal Agency	USDA - NRCS - West National Technology Support Center	29.1 - Richard Fasching (NRCS)
30.0	11/30/2012	John R. Davis	Federal Agency	USDA - NRCS - Ecological Sciences Division	30.1 - John Russell Davis (NRCS)
31.0	12/4/2012	Kirk V. Cook	State Agency	Washington State Department of Agriculture (WSDA)	
32.0	12/20/2012	Robert Duff	State Agency	Washington State Department of Ecology (Ecology)	
33.0	10/23/2012, 11/5/12, 11/27/12	Dr. Steven Wangemann	Federal Agency	Bureau of Indian Affairs, Yakama Agency	
34.0	11/29/2012	Philip Rigdon	Tribal Agency	Yakama Nation	34.1 - Philip Rigdon (Yakama Nation)
35.0	12/3/2012	J. Rand Elliott	Regional Agency	Yakima County	

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Relation Between Nitrate in Water Wells and Potential Sources in the Lower Yakima Valley, Washington
Document No. EPA-910-R-12-003

Item No.	Date Received	Name	Affiliation - General	Affiliation - Specific	Attachments
36.0	11/29/2012	W. Hugh O'Riordan Debora K. Kristensen	Law Firm	Givens Pursley	31.0 - K.V. Cook (WSDA) 36.1 - W.H. O'Riordian (Givens Pursley) 36.2 - Peer Review and Peer Involvement at the USEPA 36.3 - Michael Murray (HDR Engineering), includes attachment 36.4 - U.S. v Fleet Management, LTD., 332 Fed.Appx. 753, 2009 WL 1483143 (C.A.3 (Pa.)) 36.5 - Michael Backe (Olympus Technical Services), includes attachment 36.6 - Lower Yakima Basin Nitrate Treatment Program, Yakima County Public Services 36.7 - Pacific Groundwater Group, Request for Identification Lower Yakima Valley Groundwater Management Area (GWMA) 36.8 - Dave Bjorneberg (USDA) Nitrate Research Proposal 36.9 - Yakima County GWMA Groundwater Resource Library
37.0	11/29/2012	Lori Terry Gregory Patrick W. Ryan	Law Firms	Foster Pepper Perkins Coie	31.0 - K. V. Cook (WSDA) 37.1 - L.T. Gregory (Foster Pepper) 37.2 - Michael Murray (HDR Engineering) 40.1 - K.M. Freeman (Arcadis) 41.2 - Intertox Technical Memorandum 42.1 - Glorieta Geoscience
38.0	11/30/2012	David Haggith	Consultant	N3 Consulting	38.1 - N3 Consulting
39.0	11/26/2012	Kevin Lindsey, PhD, LHG Kenny Janssens	Consultant	GSI	
40.0	11/30/2012	Kevin M. Freeman	Consultant	Arcadis	40.1 - K.M. Freeman (Arcadis)
41.0	11/29/2012	Gretchen Bruce, DABT	Consultant	Intertox	41.1 - G. Bruce (Interox) Cover Sheet 41.2 - Intertox Technical Memorandum
42.0	11/29/2012	Jay Lazarus	Consultant	Glorietta Geoscience	42.1 - Glorieta Geoscience
43.0	11/9/2012	Bob Crider	Press	Yakima Herald-Republic	

ARCADIS
Infrastructure · Water · Environment · Buildings

ARCADIS U.S., Inc.
695 North Legacy Ridge Drive
Suite 200
Liberty Lake
Washington 99019
Tel 509 929 3369
Fax 509 928 3075
www.arcadis-us.com

ENVIRONMENT

Carol Harrison
Office of Environmental Assessment
U.S. EPA, Region 10
1200 Sixth Avenue, Suite 900
Mail code: OEA-095
Seattle, WA 98101

Subject:
Comments to EPA Report *Relation Between Nitrate in Water Wells and Potential Sources in the Lower Yakima Valley, Washington* (EPA Report EPA-910-R-12-003), dated September 2012

Date:
November 28, 2012

Contact:
Kevin M. Freeman, PG

Extension:
211

Email:
Kevin.Freeman@
arcadis-us.com

Our ref:
SK030280.0001
SK030282.0001
SK030326.0000

Dear Ms. Harrison:

ARCADIS U.S., Inc. (ARCADIS) provides the following comments regarding the U.S. Environmental Protection Agency (EPA) Region 10 Office of Environmental Assessment (OEA) September 2012 report entitled "Relation Between Nitrate in Water Wells and Potential Sources in the Lower Yakima Valley, Washington", EPA Report Number EPA-910-R-12-003 (the "Report"). The comments reflect ARCADIS' observations and concerns based on our review of the Report, reference material associated with the Report, and ancillary documents and information as provided via the EPA internet website for "Lower Yakima Valley Groundwater", located at http://yosemite.epa.gov/r10/water.nsf/gwpu/lyakimagw.

The following sections present general comments and observations for the Report. ARCADIS' specific comments to the Report are presented in Attachment A of this letter.

Purpose and Study Design

The Report states that "The primary purpose of this study was to investigate the contribution from various land uses to the high nitrate levels in groundwater and residential drinking water wells, which is the predominant source of drinking water for many residents in the Lower Yakima Valley." However, in the April 2012 *Quality Assurance Project Plan for Yakima Basin Nitrate Study, Phase 3 – Comprehensive Analytical Source Tracer Sampling, April 2012 Sampling Event, Yakima County, Washington* (the "QAPP"), the objective of the study " is to conduct

research/sampling under a RARE grant to test techniques which may improve our abilities to link specific human practices to high nitrate levels in groundwater and private wells." Based on work conducted in Phase 1 of the study, three specific human practices ("land uses") were identified for investigation (1) rural residential septic systems, (2) agricultural crop land sites, and (3) animal feeding operations. The Phase 3 QAPP identified a number of "potential tracing or linking compounds which may be traveling with the nitrate" including estrogens, androgens, veterinary and human antibiotics, agricultural chemicals, personal care products and human medications and compounds. Analysis of these compounds, particularly at "very-low" detection limits, was intended to provide information for a Phase 4 study that would " determine next steps to better control nitrate contamination including potential enforcement actions." The data presented in the Report derived only from the Phase 3 sampling effort; no Phase 4 study was designed or implemented.

The data generated by the Phase 3 study was not designed to investigate the contribution from various land uses as stated in the Report. The sampled media, sampling locations, number of samples, sampling techniques, and selected analytes and analytical methods were designed only to investigate the ability to link observed nitrate contamination to various selected land uses based on the presence or absence of potential tracing or linking compounds. The data would " then be used in determining flow within the aquifer and source characterization." The stated purpose of the Report extends beyond and is not supported by the study design and data quality objectives (DQOs) presented in the Phase 3 QAPP. Any conclusions regrading contribution of nitrate from various human practices/land uses to groundwater are not supported by the study design and lead to untenable assertions regarding contribution of nitrate to groundwater from specific sources. Specific comments regarding the Purpose and Study Design are presented in Attachment A.

Study Limitations and Uncertainties

EPA presents a number of significant limitations and uncertainties for the study, including:

- Water well samples were collected from existing wells and information on the depths and screened intervals of the wells is known only for about a third of the wells that were sampled.

- Local groundwater flow direction, including upgradient and downgradient conditions, is based on regional groundwater flow data from the United States Geological Survey (USGS).

- EPA lacks complete information regarding the dairies in this study. EPA referenced general information regarding dairy operations, and specific information regarding the dairies in the Yakima Valley to the extent it was available.

- EPA has limited information about the irrigated crop fields in this study. EPA included information about the crop fields to the extent it was available.

- The irrigated crop fields are surrounded by similar agricultural uses, and many are situated downgradient of dairies, making more difficult EPA's ability to discern the source of nitrate in drinking water wells downgradient of the irrigated crop fields.

Specific comments regarding the Limitations and Uncertainties of the Study are presented in Attachment A; however ARCADIS identified the following (but not limited to) additional major limitations and uncertainties:

- The selection of wells, and thus the areal and vertical limits of the hydrogeological investigation, were "targets of opportunity" and not selected based on hydraulic, geologic, or hydrogeologic conditions of the study area. Limited information regarding well construction and completion depth does not allow for consistent or accurate comparison of groundwater quality or chemistry data within the underlying aquifer or aquifers. While it is acceptable to use regional groundwater flow directions to evaluate and describe general conditions, this information cannot be used to evaluate or assign contribution from potential specific sources, particularly when localized groundwater conditions can be affected by specific conditions such as canal infiltration, irrigation, and withdrawal from groundwater wells.

- Significant limitations exist with respect to the nitrate budget determined via soil sampling from irrigated fields. The collection depth of the samples (zero to 1 inch) is more indicative of field application amounts than nitrate concentrations passing though and beyond the root/uptake zone. These concentrations should not be used to calculate or extrapolate a nitrate application infiltration budget for the area as they are still subject to uptake by seasonal cropping.

- The inferences made regarding dairy operations based on EPA's general reference information do not appear to be consistent with full conclusions of the utilized reference material.

- No analysis was made regarding absorption or degradation of organic compounds, particularly veterinary pharmaceuticals and hormones, analyzed as part of the study or the relationship of absorption and degradation effects on organic compound concentrations observed in sampled wells.

- Significant limitations and uncertainties are present in the study regarding investigation and analysis of nitrate contribution from onsite wastewater treatment systems (OWTSs), specifically residential septic tanks, to residential drinking water wells. These uncertainties are related to lack of construction information for the drinking water well, location and condition of the OWTS, and quantity and quality of the effluent produced by the OWTS. Lack of this information does not allow for full or accurate evaluation of the residential septic system human practice/land use contribution.

- Limitations and uncertainties with respect to key analytical data are present, including:

  - USGS National Water Quality Laboratory (NWQL) – Trace organics reported values should be used only as a screen. Data reported can only be used for information purposes.
  - University of Nebraska, Lincoln (UNL) Water Sciences Laboratory – Data should be considered for informational purposes only (not enforcement) and biased high for veterinary pharmaceuticals and steroid/hormone analyses.
  - USGS Chlorofluorocarbon Laboratory (Reston) – SF_6 data may be compromised by the volcanic terrain and sediments present in the local aquifer area.
  - EPA Robert S. Kerr Environmental Research Center (Kerr) – Significant differences between Kerr analytical results and UNL analytical results for same hormone compounds in same samples at same locations.

The Report contains significant and serious uncertainties and limitations (as noted by EPA, by ARCADIS above, and in the specific ARCADIS Report comments), yet the Report presents definitive conclusions regarding specific human practice/land use nitrate sources and the nitrate contribution to groundwater from these specific sources. This unqualified linkage of sources and contribution is made in the Report regardless to how these conclusions are affected by the limitations and uncertainties.

Specific comments regarding limitations and uncertainties of the Report are presented in Attachment A.

Study Results

ARCADIS presents the following general comments with respect to study results presented in the Report. Specific comments are presented in Attachment A.

Dairy Facilities

- EPA either dismisses or makes no effort in the Report to evaluate upgradient conditions and potential sources of nitrate as related to the dairy facilities. These actual possible sources are either not quantified or ignored. The effect of this lack of evaluation is clearly demonstrated when information regarding the presence of "tracer" compounds in upgradient wells for the dairy facilities is presented, particularly when these compounds are either (1) present in greater concentrations or (2) not observed in wells downgradient of the facilities.

- Site-specific hydrology, geology, hydrogeology is not given any consideration in evaluating the location and types of sources. The facilities are bounded on the inferred hydrogeologic upgradient and downgradient boundaries by irrigation canals. These canals likely provide a significant source of groundwater recharge to the shallow aquifer and influence the local groundwater flow regime. Additionally, investigation of water quality in the canals has demonstrated that the canal water does contain nitrate at concentrations varying seasonally during irrigation and non-irrigation time periods.

- The Data Quality Objectives (DQOs) as presented in the report do not meet those stated in the Phase 3 QAPP.

- The calculations of lagoon leakage presented by EPA are not reproducible.

- Given the presence of upgradient nitrate sources and other potential nitrate sources adjacent to the facilities, the inference that all or a significant amount of the nitrate contribution to the shallow groundwater system is related to the dairy facilities is unsupportable based on the information contained in the Report.

Irrigated Croplands

- EPA did not make any effort to collect or analyze data that would provide information regarding conditions upgradient of the irrigated croplands included in the study.

- EPA did not collect samples below the root zone of the planted crops. Information related to nitrate concentrations in surficial soils cannot be extrapolated to deeper effects, based on application of a year-round cropping methodology.

- The collected data indicated further issues regarding the tracer use relationship, particularly when examining the presence of veterinary pharmaceuticals and hormones in soil samples when only synthetic fertilizer was used as the nitrate source for field fertilization.

Residential Septic Systems

- EPA did not make any effort to collect or analyze data that would provide information regarding conditions upgradient of the residential septic systems included in the study.

- Four wells (WW-19 through WW-22) were identified and sampled to evaluate if high nitrate concentration could be related to residential septic systems. All four sampled wells contained nitrate in excess of 10 milligrams per liter (mg/L), and two wells (WW-19 and WW-21) contained nitrate in excess of 35 mg/L. EPA collected wastewater <u>influent</u> samples from three Public Wastewater Treatment Plants (WWTPs). The WWTP influent samples were collected by EPA "to serve as surrogates for septic systems by providing a characterization and quantification of compounds that are found in rural septage." EPA further states that the " WWTPs sampled serve rural communities and are sufficiently similar to residential septic systems for the purposes of this study." EPA's approach was intended to determine " whether compounds detected in wells with high nitrate concentrations in areas with a high density of septic systems are similar to the compounds detected in WWTP influent or whether these wells are affected by other sources."

- ARCADIS assumes that EPA is equating "septage" with "effluent"; Typically, "septage" denotes the "liquid, solid and semisolid material that results from

wastewater pretreatment in a septic tank, which must be pumped, hauled, treated and disposed of properly" while "effluent" refers to the "sewage, water, or other liquid, partially or completely treated or in its natural state, flowing out of a septic tank, subsurface wastewater infiltration system, aerobic treatment unit, or other treatment system of system component."

- A number of references are available for OWTS, their use, management, and performance; a summary is available in EPA's February 2002 *Onsite Wastewater Treatment Systems Manual* (EPA/625/R-00/008). Information provided in the manual states that there is a significant difference in character between sources (influent) of wastewater, particularly residential and non-residential sources. Additionally, these is a significant difference in character between residential wastewater influent and residential wastewater effluent, based on the design, condition, and loading of the system. Based on available literature, it is expected that functional residential septic tank system effluent produces nitrate concentrations up to 39 mg/L at the tank system location and that these concentrations extend through the soil column. The effects of a non-functioning residential septic system were not evaluated. EPA did not take into account this available and documented information regarding nitrate loading from residential septic systems when evaluation possible contribution from these sources.

- As with other potential sources, EPA made no effort to evaluate the type, construction, condition, location, or other characteristics of the residential septic systems evaluated during the study.

Conclusions

EPA has made a number of conclusions in the report that are unsubstantiated by the presented data. Regardless of the overall data quality or applicability as produced for the Report, these conclusions are not supported by the information obtained. ARCADIS makes the following general comments regarding the conclusions presented in the report; specific comments are included in Attachment A.

- Water well samples were not only collected from existing wells and well head and surrounding conditions were not fully evaluated, but also that water samples were collected from taps within the residence. There is a potential for significant changes in water quality between the groundwater bearing formation and the tap in a residential water system.

- Unknown groundwater flow and direction in the local vicinity of a well and potential source areas results in a confounding condition when attempting to ascribe sources of contamination and their associated contribution. This is a significant issue and has an impact on all conclusions that have been developed based on data interpretations and inferences included in this report.

- The stated objective of the study goes beyond the objective stated in the project QAPPs. If the full objective as stated in this report were also stated in the QAPP, it is likely that the data quality objectives and systematic planning processes would have resulted in a significantly different study and data collection design than what was actually performed.

- A significant shortcoming of the isotopic analysis is the inability to differentiate between human and non-human (animal) waste. This significantly impacts the ability to determine if sources are being adequately identified and evaluated or if other currently unrecognized or unstudied sources of contamination may be present that have a more significant impact on nitrate concentrations observed in wells. Additionally, the perchlorate data collected to augment the isotopic analysis does not appear to have been used to adjust or refine the isotopic analysis.

- While age dating may appear to differentiate between shallow and basaltic aquifer wells, the data are not presented in a manner that allows this conclusion to be fully evaluated. Further, geochemical information suggests that WW-06 identified in this report as an upgradient shallow aquifer well is actually more representative of the bedrock aquifer.

- The EPA relies on elevated concentrations of some major ions while others with significant concentrations in the inferred source area are not detected. This conclusion uses minimal evidence to identify dairies as a source of nitrate contamination while not fully elucidating how it was developed and explaining discrepancies in other major ion concentrations.

- The understanding and evidence used to determine groundwater conditions upgradient and within the Dairy Cluster are flawed. The well selected to represent upgradient groundwater conditions in the shallow aquifer, WW-06, actually appears to be more representative of a well completed and sourcing water from the bedrock aquifer based on geochemical analysis using data presented in this report. Further, the Dairy Cluster is bounded on the north by an irrigation canal that

has been shown to have significant concentrations of nitrate. The relative contribution of potential nitrogen sources within the Dairy Cluster with respect to all other potential nitrogen sources in the vicinity of the Dairy Cluster that may be contributing nitrate to the shallow groundwater system was not evaluated or considered.

- Pharmaceutical and hormone data generated by the UNL laboratory did not meet DQOs for the study and were identified for screening use only. The presence of detected concentrations of pharmaceuticals and hormones in "upgradient" wells at or above concentrations observed in downgradient wells coupled with detections of hormones that were not detected in the same water samples by the EPA Kerr laboratory brings into question the validity of using this data to draw conclusions and assign contributions to potential sources.

- There is insufficient information to justify the isotopic data break points and interpretation used for attributing source types. In addition, perchlorate data collected to augment the isotopic data does not appear to have been taken into consideration. The issues associated with the break points and attempts to classify sources based on them is elucidated by the last sentence in this paragraph that states: "Isotopic data for the other residential drinking water wells downgradient of the Dairy Cluster indicate that the source of nitrate could be animal waste, fertilizer, or derived from the atmosphere, or some combination of these sources." This statement includes all possible sources of nitrated identified for the purposes of this study and also includes the possibility that there may be a combination of sources.

- EPA asserts that there is insufficient information from this study to support the conclusion that residential septic systems could be a source of nitrate in drinking water wells. The study contained an element designed specifically to evaluate possible contribution of nitrate from septic systems to drinking water wells. Nitrate concentrations in all four wells exceeded the nitrate MCL, and two of the wells contained nitrate in excess of 35 mg/L. Information exists reporting that residential septic systems are capable of producing effluent with nitrate concentrations in this range. Often, less evidence was used to assign nitrate contamination to other sources presented in this study.

- The EPA states within the report "The high nitrate levels in residential drinking water wells in the Lower Yakima Valley are likely coming from several sources. This study attempted to identify those sources. In some cases it was possible to

identify likely or possible sources of the nitrate contamination." Allowing for the proposition that EPA has identified likely or possible sources of nitrate contamination in the area, EPA has made no determination on the type and amount of contribution from these sources, nor proven that one sources is the primary or exclusive source of nitrate detected in downgradient wells.

- The EPA states within the conclusions that "Evaluating actions to reduce nitrate concentrations in residential drinking water wells to safe levels is beyond the scope of this report. Although actions to reduce nitrate are needed, it may take many years to reduce the nitrate levels in residential drinking water wells to safe levels because of the extent of the nitrate contamination in the Lower Yakima Valley and the persistence of nitrate in the environment." ARCADIS agrees with this statement.

Closing

ARACDIS appreciates the opportunity to provide EPA comments for this critical document. Should you have questions regarding this submission, please contact Kevin Freeman at (509) 928-3369, extension 211.

Sincerely,

ARCADIS U.S., Inc.

Kevin M. Freeman, PG
Principal Hydrogeologist

Steven L. Hicks, PE
Principal Engineer

Copies:
Ms. Lori Terry Gregory – Foster Pepper PLLC
Mr. Patrick Ryan – Perkins Coie PLLC
Mr. Henry Bosma – Liberty Dairy LLC
Mr. Dan DeRuyter – George DeRuyter & Sons Dairy LLC
Mr. William Dolsen – Cow Palace Dairy LLC

Attachments:
Attachment A – Specific Comments to the Report
Attachment B – Stiff Diagrams for Attachment A, Comment 49

ARCADIS Specific Review Comments on *Relation Between Nitrate in Water Wells and Potential Sources in Lower Yakima Valley, Washington* Report, Prepared by U.S. Environmental Protection Agency Region 10, Dated September 2012 (EPA-910-R-12-003)

1. **Purpose of the Report. Section I, 1st Paragraph, 1st Sentence (Page 1)** states: "This report presents the results for sampling conducted from February through April 2010 by the U.S. Environmental Protection Agency (EPA) in the Lower Yakima Valley in central Washington State." The sampling conducted from February through April 2010 refers to sampling activities described and covered by the following Quality Assurance Project Plans (QAPPs):
    a. *Yakima Basin Nitrate Study Phase 2 – Initial Nitrate/Coliform Screening of Domestic Water Wells February 2010 Sampling Event*, prepared by EPA Region 10, January 27, 2010.
    b. *Yakima Basin Nitrate Study Phase 3 – Comprehensive Analytical Source Tracer Sampling April 2010 Sampling Event*, prepared by EPA Region 10, April 8, 2010.

    The objective of the Phase 2 study is stated in its QAPP (Section 1.2.2, 2nd Paragraph) as: "The objective of Phase 2 was to evaluate if, down gradient of potential nitrate contaminant sources, there are drinking water wells with nitrate levels over the MCL and/or total coliform." Further, in the Phase 2 QAPP, Section 1.2.2, 2nd Paragraph states that: "This (Phase 2) will help us better select potential nitrate sources and sampling sites for further source characterization in Phase 3, and will help management evaluate whether there is a basis for enforcement action."

    The objective of the Phase 3 study is stated in its QAPP (Section 1.3.2, 3rd Paragraph) as: "The objective of Phase 3 is to conduct research/sampling under a RARE grant to test techniques which may improve our abilities to link specific human practices to high nitrate levels in groundwater and private wells." Later in in the Phase 3 QAPP (Section 1.3.2, 5th Paragraph), the objective of Phase 3 is further identified as: "Phase 3 is attempting to demonstrate the potential to use low concentrations of trace organic compounds to link land use to observed nitrate contamination."

    Section I, 1st Paragraph, 2nd Sentence on Page 1 states: "The primary purpose of this study was to <u>investigate the contribution of various sources from nearby land uses</u> to high nitrate levels in groundwater and residential drinking water wells." (emphasis added).

    The statement of the primary purpose of this study does not align with the purpose and objectives for Phase 2 and Phase 3 stated in their respective QAPPs, which was to determine if

nitrate levels in residential wells downgradient of potential sources exceed the MCL (Phase 2) and to evaluate the potential to use various sampling and analysis techniques to link specific human activities to elevated nitrate levels (Phase 3).

Per EPA guidance (such as, EPA QA/R-5, EPA QA/G-4, and EPA QA/G-5) systematic planning using the data quality objectives (DQOs) process is used to identify DQOs and develop sampling plans and identify analysis methods that ensure that the appropriate types, quantity, and quality of data required to answer the principal study questions are obtained. There are significant differences between the objectives used for planning the study and the state objective/purpose of the report.

While the types, quantity, and quality of data collected as identified in the Phase 2 and Phase 3 QAPPs may be appropriate to address their QAPP-stated objectives, there is no demonstration of this contained in this report other than the identification of elevated nitrate concentrations at some locations within the Yakima Valley. Throughout the report, there can be found no evaluation of the applicability to link sources with observed downgradient contamination using the "tracer" sampling results. Rather, there is an unstated assumption that the use of the "tracers" is applicable and no basis for their use is provided other than reference to studies performed by others at other locations that indicate that additional evaluation is required to more fully understand and defensibly use this type of data to link sources and downgradient conditions.

Given that no evaluation or evidence regarding the applicability of the "tracer" data to meet the Phase 3 objective is present within the report, the use of the data to support allocation of contribution from specific or even generalized sources is inappropriate and not supported. This is a significant shortcoming of this report that is discussed in more detail in later comments.

2. **Section II, 1st Paragraph, 2nd Sentence (Page2)** states: "To accomplish this, EPA sampled and analyzed sources of nitrate (dairies, irrigated croplands, and residential septic systems) and private residential drinking water wells for a variety of chemicals to evaluate whether chemicals, including nitrate could be used to link the nitrate contamination in groundwater and drinking water wells to the sources." This statement more closely aligns with the Phase 3 QAPP-stated objective, but the results of this effort are not fully communicated or elucidated in this report. Rather, in later sections of the report, an assumption is made that the above hypothesis is true and the data is then used for a purpose beyond its intended scope and usability.

3. **Section II, 1st Paragraph, 3rd Sentence (Page 2)** - This sentence states that the chemicals analyzed are expected to be associated with the sources, but no further evaluation of these chemicals and their presence is presented in this report. Rather, it is plainly assumed that these chemicals are a result of operations at dairy facilities and other land uses even when the chemicals are consistently detected in areas located "upgradient" of the potential sources.

4. **Section II, 3rd Paragraph, 4th Sentence (Page 2)** - The sources listed in this sentence are potential sources of nitrogen and none of the sampling or analysis performed as part of this study are capable of fully characterizing the potential relative contribution (main sources).

5. **Section II, 6th – 8th Paragraphs (Page 3)** – Data quality issues associated with laboratory data collected and analyzed as part of the study should be included in the limitations section. While EPA takes the time to point out other limitations, it fails to mention data quality limitations until much later in the report (Section VIII) and then only by reference to Appendix E. This gives the impression that data quality objectives for the study were met and only insignificant variations occurred. It is extremely important to note that many of the key data points used to develop and support inferences regarding sources of nitrogen presented in the report are based on data that was qualified for screening-level purposes only by EPA chemists and carries a caveat that users should be made aware of the screening level-status.

6. **Section II, 6th Paragraph (Page 2)** – It is appreciated that regional groundwater flow directions developed by USGS and other studies were used to support inferences on upgradient and downgradient locations on a smaller site-specific scale and that this is recognized as a significant limitation for conclusions and inferences presented in this report. However, the use of regional groundwater flow directions as the sole indicator of upgradient and downgradient locations is not acceptable for the interpretation and evaluation of environmental data on the scale presented in this report where there are several physical conditions which could greatly confound these inferences. Specifically, the presence of production wells, irrigation canals, irrigation systems, and other hydrologic features can have a significant impact on site-specific groundwater flow directions and potential infiltration patterns that must be accounted for before determining potential sources and fate and transport of chemicals in the environment. While this is recognized with one sentence later in the report (Section V, C, 5th Paragraph, Last Sentence) when discussing the overall study area setting, a similar treatment is not given to site-specific areas where inferences of potential source areas and contributions are performed later

in the report. This gives the reader the impression that the inferences of sources and potential contribution are more scientifically supported and defensible than the available data allows.

7. **Section III, 1st Paragraph, 2nd Sentence (Page 3)** - The use of the 1.1 mg/L nitrate concentration as background for the Yakima Basin using the results of the study by Nolan and Hitt (2003) is not appropriate. While 1.1 mg/L is presented by Nolan and Hitt (2002) as a nation-wide relative background concentration, they also present relative background nitrate concentration values that are more applicable to various regions and land use types within the United States. The relative background nitrate concentration of 1.1 mg/L presented in Nolan and Hitt (2002) is based on evaluation of combined forest and rangeland data sets. Nolan and Hitt (2002) demonstrate that relative background nitrate concentrations for forest areas are significantly lower than for rangeland areas because the relative background concentration of nitrate is variable and depends, in part, on land use, hydrogeology, and climate which further identifies the importance of establishing local background conditions. Fortunately, Nolan and Hitt (2003) identified one subset within their study based on the Wisconsinan loess unit (Figure 7 from Nolan and Hitt 2003) which coincides with the Yakima Basin area. In fact, Nolan and Hitt (2003) identify that the 5 samples used to evaluate relative background nitrate concentrations for the Wisconsinan loess are from samples collected in southeastern Washington. In Nolan and Hitt (2003), the median nitrate concentration for the Wisconsinan loess was 1.7 mg/L and for rangeland as whole ranged from 1.4 to 2.7 mg/L. The 75th percentile relative background concentration of nitrate for the full data set (forest and rangeland) was 1.1 mg/L while the 75th percentile relative background concentration for rangeland presented in Nolan and Hitt (2002) is 2.3 mg/L. Therefore, the relative background concentration presented in this section should be revised to 2.3 mg/L.

8. **Section III, 1st Paragraph, 3rd Sentence (Page 3)** - The relative background concentration as defined by Nolan and Hitt (2003) "represents predominantly background concentration plus an extraneous component from low-level influence of human activities."

9. **Section VI, 1st Paragraph, 3rd and 4th Sentences (Page 9)** - The objective stated in Sentence 3 aligns with the Phase 3 QAPP-stated objective for the study, but no evaluation, analysis, or findings related to this objective are presented in the report other than an assumption that chemicals other than nitrate can be associated with specific sources and used to link sources and nitrate contamination. In the 4th sentence, it is implied that MST, isotopic analysis, and age dating will be used to evaluate the contribution of various sources. There is no explanation of

how this was performed or presentation of the results of the contribution evaluation in this report.

10. **Section VI, A, 2nd Paragraph, 2nd Sentence (Page 10)** – It is unclear what is meant by "estimates for different sources" and how these were used to compare with other source estimates. Is there an example that can be included?

11. **Section VI, A, 3rd Paragraph, 3rd Sentence (Page 10)** – "Livestock are prevalent throughout the Yakima Valley study area and accounted for about 65% of the nitrogen." This statement seems random and does not have supporting documentation to substantiate the claim. However, the next paragraph states that EPA is working with the USGS to further evaluate nitrogen fate and transport and a report will be issued in the winter of 2012. This additional report should be reviewed for content to ensure that the above statement aligns with data.

12. **Section VI, A, 2, 3rd Paragraph, 1st Sentence (Page 12)** – "EPA estimates that about 18.5 million pounds of nitrogen are applied to irrigated cropland each year in Yakima County." At the time of review, the nitrogen budget developed by EPA that produced this number was not available for review. This is a significant number that should be kept in mind when generating conclusions regarding contribution of nitrate to groundwater and the methodology to develop the number should be carefully considered.

13. **Section VI, 4, B, 2nd Paragraph (Page 13)-** Section 2.2.4.C of the Phase 2 QAPP states that well head information for the residential drinking water wells would be collected, but this information is not included in the report nor are references to well head conditions that may possibly contribute to elevated nitrate concentrations discussed.

14. **Section VI, 4, B, 7th Paragraph (Page 14)** – The focus of Phase 2 sampling stated earlier in this section focused on areas where elevated nitrate levels had been observed in the past and was not conducted using a random or other sampling design process. Therefore, it is rightly assumed that the percentage of water wells exhibiting nitrate concentrations above the MCL would be higher than if a basin-wide random or other systematic sampling program was employed to select sampling locations. However, the author later in the paragraph also seeks to attribute the increase in the percentage of sampling locations exceeding the MCL to other factors such as potential sources and increasing nitrate levels over time. These types of inferences are not data or scientifically based and the results are most likely the result of biasing resulting from the

sample program design that focuses on areas where elevated nitrate concentrations had been previously observed. Unless there was some sort of data analysis using data collected from previous studies at the same location to evaluate trends over time, there is no basis for inferring that nitrate concentrations are increasing over time in the basin based on the Phase 2 and 3 sampling results.

15. **Section VI, 4, B, 8th Paragraph (Page 14)** - If, as posited in the 7th paragraph of this section, that potential sources of nitrate are indeed sources, then why would other measures indicating the presence of sources actually show decreases from the previous study? As noted in the 7th paragraph, there was an anticipated increase in the percentage of wells with nitrate concentrations greater than 10 mg/L because Phase 2 focused on areas where historic information indicated elevated nitrate concentrations (increase from 12% to 20% in Phase 2). However, what is a plausible explanation for the significant decrease in wells exhibiting fecal coliform (20% in past studies to 2% in Phase 2)? Where are the 2% of wells that exhibited fecal coliform contamination located? Can this be shown on the nitrate concentration figure (Figure 10)?

16. **Section VI, 4, C, 1st Paragraph (Page 14)** - As noted earlier, the Phase 3 objective presented here is not consistent with the Phase 3 QAPP-stated objective to determine <u>if it is possible to link sources to downgradient nitrate using tracer compounds</u> not to "investigate the contribution of various sources." These are clearly different objectives as one is attempting to infer contribution and the other is attempting to develop a suite of analysis methods that could potentially be useful to demonstrate the provenance of contaminants using tracer compounds to augment sampling of the contaminant itself.

17. **Section VI, 4, C, 3rd Paragraph and Table 1** - The fact that no "upgradient" samples were collected for crop field or septic systems severely limits the ability of the authors to evaluate data for the three potential source areas identified in this report in an even-handed, although outside of scope and objective, manner. How can the objective of the study be evaluated without information regarding the presence or absence of proposed tracer constituents without this information? If this information isn't necessary to address the principal study question(s) for the study, then why was "upgradient" information deemed necessary and collected for the potential dairy sources? As shown later in the report, inferences are freely made regarding contaminant conditions in wells downgradient of dairies that could potentially be made

regarding crop fields and septic systems if "upgradient" data were collected, analyzed, and available for evaluation.

18. **Section VI, 4, C, 1st Bullet and Footnote 18 (Page 16)** – What was the rationale for not including WW-22103 and WW-22085 in the Phase 3 study? Is it reasonable for EPA to assume that groundwater, nitrate, and "tracer" conditions observed in WW-06 are representative of conditions upgradient of the Dairy Cluster in the shallow alluvial aquifer?

19. **Section VI, 4, C, 3rd Bullet (Page 16)** - The use of WWTP influent as a representative surrogate for septic tank effluent is not appropriate. This assumes that all septic systems are equal when a number of different factors can have significant impacts on the effectiveness and effluent quality emanating from individual septic systems.

20. **Section VI, 4, C, 1 – Criteria for Selection of Dairies and Associated Sampling Locations, 3rd Bullet (Page 17)** - How was "Relatively consistent direction of groundwater flow from season to season." determined? This question also applies to Irrigated Cropland Areas and Septic System Areas (Page 18).

21. **Section VI, 4, C, 1 – Criteria for Selection of Dairies and Associated Sampling Locations, 1st Paragraph after bullets (Page 17)** - How were lagoon samples collected? Was there a standard protocol used that was repeatable at all locations and representative of conditions within the lagoon? Did lagoon sampling conform to the standard methods identified in Midwest Plan Service MWPS-18 reference?

22. **Section VI, 4, C, 1, Criteria for Selection of Dairies and Associated Sampling Locations, Last Paragraph, Last Sentence (Page 17)** – Collection and analysis of samples from a tap are indicative of exposure but cannot be considered to be indicative of underlying groundwater conditions. This is particularly true when site-specific groundwater flow directions and rates, near-well hydraulic conductivity, nearby hydrologic controls, physical and contaminant conditions in the immediate vicinity of the well head, and other factors that may impact water quality and quantity are unknown.

23. **Section VI, 4, C, 1, Criteria for Selection of Irrigated Cropland Areas and Associated Sampling Locations (Pages 17 and 18)** - What is the rationale for only considering the top inch of the soil column within the fields versus other sampling techniques? This is not clearly identified in either

the Phase 3 QAPP or in this report. Soil samples collected from the 0 to 1-inch interval are likely to be indicative of surface applications of fertilizers and soil amendments. However, the use of these values to infer potential sourcing of chemicals to groundwater is not appropriate. Several factors are present that can confound this inference including, but not limited to, root uptake and losses to the atmosphere.

24. **Section VII, A, 1 (Page 20) –** Discussion and the impact of nitrate and nitrogen compound analysis from EPA MEL for samples that did not meet preservation requirements should be mentioned in this section along with differences in the analytical method used, particularly when discussing agreement between nitrate analyses conducted by EPA MEL and other laboratories at the end of the section. In addition, when discussing comparability of data in this section, note should be made of the lack of duplicate and triplicate sample collection that was identified in the QAPP.

25. **Section VII, A, 1, Second Paragraph, 1st Sentence (Page 20) –** The description of how total nitrogen is calculated is incorrect. However, the correct concentrations are presented in the tables.

26. **Section VII, A, 2 – Major Ions (Page 21) -** In the 1st paragraph of this section, it is stated that the purpose of major ion sampling is to track the chemical evolution of migrating groundwater. The Phase 3 QAPP states that this will be performed using Piper diagrams and other methods. Was any of this type of evaluation attempted? If so, why is it not presented in this report?
In the 4th paragraph of this section, it states that contribution from sources will be determined based on the presence/concentration of major ions in potential source materials. However, the only source materials sampled for major ions were liquids from the dairy lagoons. Why were no major ion samples collected from septic effluent, field soils, manure piles, or other potential sources? Similar to the lack of upgradient groundwater samples for some potential source types, the lack of appropriate information from potential sources limits the ability to attribute contribution and identifies an area where data collection based on the QAPP-stated objectives does not align with the objectives of the study identified in this report.

27. **Section VII, A, 3 (Page 21) -** If organic carbon is a significant control/indicator, why wasn't it sampled either in lieu of or in addition to minor and trace inorganics? It is also not clear why crop fields and manure piles were exclude from analysis given that they may represent significant sources of organic carbon and as noted later in the report are inferred to be potential

sources. Because they are collocated with many of the other inferred sources, they should have been sampled and analysis and evaluation should take these inferred sources into consideration.

28. **Section VII, C, 2 (Page 23)** – The stated purpose of the trace organics sampling is to differentiate water wells affected by septic systems from water wells influenced by other potential sources. "The compounds analyzed include many that can be associated with human usage..." Why would trace organics that are not associated with human usage be included in the analyte list? Was the list of analytes developed using the systematic planning and DQO process to ensure that the appropriate data was collected and extraneous information was not collected? In addition, discussion should be added to this section similar to Section VII, A, 3, regarding the usability and quality of the trace organic data. In particular, it is important to note that as a result of laboratory processes and procedures that the data should only be considered for screening or information purposes and act as a starting point to evaluate potential future sampling. In addition, discussion of field blank contamination and potential impacts on other samples and data should be included.

29. **Section VII, C, 3 (Pages 24 – 26)** – Several of the references used in this section include significant caveats regarding the use of wastewater and veterinary pharmaceuticals as tracers. In particular, an understanding of the degradation of the compounds over time and their fate and transport properties must be understood as many have significantly short half-lives or have a strong affinity to sorb to the aquifer matrix to preclude their use for downgradient evaluation if they are present.

30. **Section VII, C, 4 (Pages 26-28)** – In this section, it is important to note the issues associated with UNL-generated data and its qualification for screening use only as a result of calibration issues and blank contamination. Further, significant differences between hormone data analyzed at the EPA ADA laboratory and UND Laboratory are present in the data when common constituents are compared.

31. **Section VII, E, Last Paragraph (Page 30)** – The conclusion that elevated SF6 observed in some samples is the result of "localized human-caused releases" is contrary to supporting information included in Appendix E and Table C-16. Appendix E, 6, 2nd Paragraph, Last Sentence (Page E-13) states: "Alternatively, volcanic rocks can contain more SF6 than the average atmospheric concentrations of SF6 and the volcanic terrain and mineralogy of the sediments in the local

aquifer may be the source of SF6." The footnote on table C-16 states "Aquifer materials in volcanic areas such as the basalts under the Yakima Valley are known to host naturally-occurring SF6. No anthropogenic source of SF6 is known in the area of the Dairy Cluster." These statements suggest that age dating data may overestimate the ages presented in the report. There is no mention about this potential issue within the report and ages estimated using the SF6 analysis is presented as complete. Additional evaluation or explanation of the potential issues associated with elevated SF6 concentrations associated with the geologic environment should be included in the report and inferences drawn using the age dating results should be qualified accordingly.

32. **Section VIII, Last Sentence (Page 30)** – This sentence is somewhat misleading as review of Appendix E indicates that significant issues were identified and limitations placed on the quality and usability of some of the data collected during the Phase 3 sampling. This statement does not clearly elucidate the gravity and potential impact that data quality and usability issues associated with portions of the Phase 3 data set have on inferences and conclusions drawn in this report. The data limitations and usability issues need to be clearly identified and presented up front rather than hidden in appendices and downloadable data quality reports. Some of the more significant data quality issues include:
    a. Change of relative percent difference (RPD) limits to fit laboratory standards. Were the changes in RPD evaluated to determine if data quality was impacted versus DQOs.
    b. Lack of duplicate samples for water well and lagoon samples. What impact did this have on the ability to validate and qualify the data generated for these samples?
    c. Trace Organics – Qualified as screening level data. Inferences and conclusions based on this data should be identified and caveated appropriately.
    d. UNL Data – A significant amount of the data generated using the UNL laboratory was identified as screening level data. Inferences and conclusions based on this data should be identified and caveated appropriately within the body of the report.

33. **Section IX, 1st Paragraph, 3rd Sentence (Page 30)** – "In addition, one well was sampled that was not related to a specific dairy or crop field (WW-18)..." Could this well then be determined to be representative of septic systems? What is the purpose of the well and sampling if it was not related to one of the potential sources identified in the study?

34. **Table 7, Page 33 –** Lagoon leakage rates calculated and presented in the document could not be reproduced. Additional information regarding assumptions used is necessary to complete the calculations identified in Ham 2002.

35. **Section IX, A, 1, Haak Dairy Nitrate and Other Forms of Nitrogen, 2nd Paragraph (Page 36) –** The description of how total nitrogen is calculated is incorrect. However, the correct concentrations are presented in the table.

36. **Section IX, A, 1, Haak Dairy: Minor and Trace Inorganic Elements, 4th Sentence (Page 38) –** In this section, it is inferred that because barium and zinc were detected in dairy lagoons and in downgradient water wells that the source of barium and zinc in the water wells is the dairy lagoons. However, other metals that were detected in the dairy lagoons (chromium, copper, iron, and manganese) were not detected in the downgradient water wells. If the inference is that if a chemical is detected at a potential source and in a downgradient well, then the chemical comes from the potential source is true, then it would be anticipated that all chemicals detected in the source would be present at some concentration in downgradient wells unless there is a specific, scientifically-based reason why it would not be present.

37. **Section IX, A, 3 (Page 39-42) -** As noted in previous comments regarding data suitability and usability, the preface to this section should indicate that data presented and used to draw inferences are suitable only for screening purposes and do not represent data of a consistent quality that could be used to draw defensible conclusions.

38. **Section IX, A, 3, Haak Dairy Pesticides, 3rd Paragraph (Page 39) –** The assertion that the Haak Dairy is a likely source of atrazine in downgradient groundwater is not supported by the data. While the authors recognize the potential presence of atrazine in the upgradient monitoring well as an indicator of the presence of an upgradient source, attributing the potential presence of atrazine in the downgradient well is not supported by the analytical data and the upgradient detection of atrazine.

39. **Section IX, A, 3, Haak Dairy Trace Organics (Page 40) –** Phthalate was detected in an upgradient well. Phthalate is the second most common laboratory false positive (acetone is the most common). No discussion on the data quality of the trace organics data is provided.

40. **Section IX, A, 3, Haak Dairy Pharmaceuticals (Pages 40-41)** – As noted in previous comments regarding data suitability and usability, the preface to this section should indicate that the data presented and used to draw inferences are suitable only for screening purposes and do not represent data of a consistent quality that could be used to draw defensible conclusions.

41. **Section IX, A, 3, Haak Dairy Pharmaceuticals, 4th and 5th Paragraphs (Pages 40-41)** – The assertion that the Haak Dairy is a source of tetracycline and monensin are not supported by the available data given the quality issues associated with the data set and the estimated presence of monensin at concentrations at or above potentially downgradient concentrations.

42. **Section IX, A, 3, Haak Dairy Hormones (Pages 41-42)** – As noted in previous comments, the data from the UNL analysis is not of sufficient quality for uses other than screening. This is further supported by comparing common hormone results generated by the EPA Kerr laboratory that were qualified as usable. Testosterone results show elevated concentrations in upgradient wells, no detections in all but one dairy location, and concentrations less than upgradient concentrations in downgradient wells. These results are counter to the inferences presented in the report that the dairy is the source of testosterone.

43. **Section IX, A, 4 (Pages 42-43)** – The rationale for selection of isotopic interpretation break points presented in the report and Appendix D do not provide a sufficient level of detail or certainty regarding the use of isotopic data to make inferences regarding potential nitrate sources. This is clearly seen in inferences presented at the end of the section where the dominant sources for WW-03 are identified as all potential sources. In addition, the perchlorate data does not appear to have been used to adjust any of the isotopic data.

44. **Section IX, A, 6 (Pages 44-47)** – The inferences and conclusions presented in this section are confounded by several factors including unknown direction and flow characteristics of groundwater, data quality issues that limit the usability of the data to support conclusions, and inconsistencies in constituent concentrations in analytes (both usable and screening level data) that do not follow patterns similar to those used to base conclusions of potential source contribution.

45. **IX, B, Definition of Dairy Cluster (Pages 47-48)** – It is not clear how the D&A Dairy has been included with the Dairy Cluster other than by virtue of sharing ownership and property boundary with the DeRuyter Dairy. Further, from the inferred direction of groundwater flow

shown on Figure 14, D&A is not located upgradient of the downgradient monitoring wells identified for the Dairy Cluster. Based on preliminary review of Figure 10 (without precise locations of the dairy with respect Phase 2 water wells), it does not appear to be upgradient of any Phase 2 wells with nitrate concentrations greater than 10 mg/L. Please provide the rationale for including this facility with the Dairy Cluster.

46. **Table 18, Page 50 –** Lagoon leakage rates calculated and presented in the document could not be reproduced. Additional information regarding the assumptions used by EPA is necessary to complete the calculations identified in Ham 2002.

47. **IX, B, Surface Soils, 3rd Paragraph, Last Sentence (Page 51)** – "However, agronomic nitrogen application rates are not necessarily protective of drinking water." Agronomic nitrogen application rates are by definition the application rate required for plant growth to support yield projections and assume that N will be removed from the field by crop harvest.

48. **Section IX, B, Application Fields, Figures –** Figures do not match text description and need to be revised. Figures 12 and 13 are for the Haak Dairy, Figure 14 shows the Dairy Cluster boundary. Figures 11, 15, 16(a, b, and c) show Dairy Cluster sampling locations.

49. **Section IX, B, Application Fields, 1st Bullet (Page 53)** – WW-06 is not representative of groundwater in the shallow aquifer upgradient of the Diary Cluster and should not be used to provide a basis for changes to shallow aquifer groundwater quality changes as a result of potential sources between its location and downgradient wells. Major ion data presented in Table C6 of Appendix C were used to develop the attached Stiff plots for water wells sampled as part of the Dairy Cluster during the Phase 3 sampling event. These analyses show that the geochemistry of groundwater measured in WW-06 closely aligns with the geochemistry of groundwater from WW-07, WW-09, and WW-10. In Appendix A, the depths of WW-07, WW-09, and WW-10 are reported as 470, 482, and 345 feet below ground surface. These wells are likely completed and represent groundwater quality in the bedrock aquifer. Further, a hydrologic divide may be present between WW-06 and the northern boundary of the Dairy Cluster represented by the irrigation canal. No only may the irrigation canal represent a hydrologic divide, but it may also be a potential source of nitrogen to underlying groundwater. However, the nitrate concentration in the irrigation canal water is unknown. A number of other potential sources of nitrate are present between WW-06 and the northern boundary of the Dairy Cluster. In order to make inferences regarding the contribution of nitrate to underlying groundwater

resulting from potential sources within the Dairy Cluster, it is important that upgradient groundwater quality is understood.

50. **Section IX, B, Application Fields, 2nd Bullet (Page 53)** – Were efforts made to sample the supply well at the Liberty and Bosma dairies prior to the water treatment system similar to sampling conducted at residential wells? If not, why were standard protocol used at residential wells used at this location?

51. **Section IX, B, Application Fields, 3rd Bullet (Page 53)** – Sample SO-03 is labeled on Figure 15 as an application field sample but is labeled as a manure pile sample.

52. **Section IX, B, Application Fields, 6th Bullet (Page 53)** – While it is understood that downgradient wells represent "targets of opportunity" to estimate groundwater conditions downgradient of the Dairy Cluster, care should be taken and explanation provided regarding the setting of wells selected as "downgradient." For example, it should be noted that WW-15 is located within the outlined boundary of the Dairy Cluster and is not completely downgradient. WW-12 is located on the south side of the irrigation canal south of the Dairy Cluster boundary. The irrigation canal may represent a hydrologic and groundwater quality divide that needs to be considered in this evaluation. Care should also be taken to consider and account for potential sources of nitrogen between the Dairy Cluster boundary and WW-11, WW-12, WW-13, and WW-14 when discussing and evaluating groundwater conditions.

53. **Section IX, B, 1, Dairy Cluster: Nitrate and Other Forms of Nitrogen, 2nd Paragraph, 3rd Sentence (Page 54)** – As noted earlier, WW-06 is not representative of upgradient groundwater conditions in the shallow aquifer and the background concentration used in this report is not representative and does not align with information presented as a reference for this value (Nolan and Hitt, 2002).

54. **Section IX, B, 1, Dairy Cluster: Nitrate and Other Forms of Nitrogen, 2nd Paragraph, Last Sentence (Page 54)** – Nitrate concentrations greater than the MCL (10 mg/L) are present in 7 of the 8 wells identified in the report as downgradient and not in all wells (WW-10, not detected). As noted earlier, the usability and representativeness of WW-12 (located south of the irrigation canal) should be reconsidered and explained. The presence of a number of potential sources between the southern Dairy Cluster boundary and wells WW-11, WW-12, WW-13, and WW-14

should be considered and addressed in the report rather than simply assuming that the Dairy Cluster is the only potential source of nitrogen for these wells.

55. **Section IX, B, 1, Dairy Cluster: Major Ions (Page 54) and Dairy Cluster: Minor Ions and Trace Organics (Page 55) –** It should be noted that the highest total phosphorous (0.0664 mg/L) and zinc concentrations (0.471 mg/L) concentrations were observed in the Dairy Cluster well grouping was observed in the "upgradient" well WW-06 that is representative of groundwater conditions. Zinc concentrations for all other Dairy Cluster wells was less than 0.017 mg/L with the exception of downgradient wells WW-11 (0.0669 mg/L) and WW-15 (0.0538 mg/L). The order of magnitude decrease in zinc concentrations between "upgradient" and "downgradient" in the vicinity of the Dairy Cluster should be evaluated and explained.

56. **Section IX, B, 1, Dairy Cluster: Perchlorate (Page 56) –** This section states that perchlorate analysis was conducted to augment the isotopic data as an indicator of potential accumulation of atmospherically derived nitrate associated with caliche soils. However, there is no further discussion of the results in this section or in the isotopic analysis section (IX, B, 4). What do the perchlorate results tell us? The presence of perchlorate in downgradient wells ranging from 0.915 to 3.08 µg/L suggests that at least a portion of the nitrate observed in these wells may be associated with atmospherically derived nitrate. Were any attempts to quantify the atmospherically derived contribution or at least estimate the potential impact of atmospherically derived nitrate on nitrate concentrations in the study area conducted? There should be some discussion of this within the report beyond a simple data summary since the data was collected for an intended purpose to support the study.

57. **Section IX, B, 2, Dairy Cluster: Microbiology, 1st Paragraph (Page 56) –** The well with a detected level of total coliform is the "upgradient" well. Was the condition of the well head, location of upgradient septic system, or other potential sources of coliform evaluated for this "upgradient" location? What are the potential sources of coliform that could be impacting this "upgradient" well but not having any impact on downgradient locations? Additional explanation regarding the coliform detection in the "upgradient" well is needed. The presence of coliform in "upgradient" well WW-06 is an additional line of evidence that WW-06 is not an appropriate surrogate for conditions shallow aquifer groundwater upgradient of the Dairy Cluster and upgradient to downgradient comparisons between WW-06 and other wells are not valid.

58. **Section IX, B, 3, Dairy Cluster: Pesticides, 4th Paragraph, 3rd Sentence (Page 57)** – None of the pesticides detected in the water wells were detected in application field or manure pile samples. If the dairy application fields or manure from the dairies were sources of these chemicals as stated in this sentence, it would only be logical that they would be detected in them. The supposition that the dairies are the source of these chemicals solely because the chemicals are used in corn production and the dairies have been known to grow corn is not supported by any of the data collected as part of this study. Further, the presence of one of these chemicals in the "upgradient" well further suggests that the source of the pesticides observed in groundwater during this study is not associated with the dairies and is more likely a result of a potential source located "upgradient" of the Dairy Cluster.

59. **Section IX, B, 3, Dairy Cluster: Trace Organics, 1st Paragraph after bullet list (Page 58)** – While DEHP was detected in 1 dairy lagoon sample (LG-10), it was also detected in the "upgradient" well (WW-06). **Last Paragraph (Page 58)** – It is unclear what the detections of trace organics in the dairy lagoons and not in the downgradient water wells tells us. Does this indicate (similar to other "tracer" chemicals analyzed for during this study) that trace organics are not an appropriate tracer (Objective of Phase 3 study) or that chemicals from the dairy lagoons are not migrating to the downgradient monitoring wells? Similarly, because pesticides detected in application fields were not detected in downgradient water wells, does this show that pesticides are not appropriate tracers (Objective of Phase 3 study) or those chemicals from the application fields are not migrating to downgradient water wells?

60. **Section IX, B, 3, Dairy Cluster Pharmaceuticals, 3rd Paragraph, 4th Sentence (Page 60)** - This sentence states that the dairies are the likely source of monensin detected in downgradient wells WW-10 and WW-14. Watanabe and others (2008) (cited as a source for this report) found that monensin was rarely detected downgradient of dairy facilities and that detections of monensin were limited to the actual footprint of the dairy facility as a result of the relatively short half-life of monensin (laboratory – 13.5 days, field – 3.3 to 3.8 days). Because of this monensin is not an effective indicator of downgradient impacts from potential sources. Given this, how are the downgradient detections of monensin in WW-10 and WW-14 reconciled? As noted earlier, WW-10 is representative of groundwater conditions and exhibited no detectable nitrate concentration. If the dairies are in fact the source of the monensin observed in WW-10, and if as inferred in this report the Diary Cluster represents a significant source of nitrate, wouldn't nitrate also be present as significant concentrations in this well? Further, review of data validation information presented in Appendix E suggests that there may be issues

associated with the pharmaceutical data analyzed at the UNL laboratory and that constituents to be analyzed were detected in blank samples. The quality and usability of this data and the basic understanding of hydrogeology of the site should be taken into consideration when making inferences regarding the presence and sources of chemical constituents measured in various wells within the Dairy Cluster vicinity.

61. **Section IX, B, 3, Dairy Cluster: Pharmaceuticals, 5th Paragraph (Page 60)** – A number of other pharmaceuticals were detected in dairy lagoons and manure piles that were not detected in any of the downgradient water wells. If, as the objective of the Phase 3 study suggested, pharmaceuticals are a representative tracer for this study and can be used to identify sources, then designation of a source would be based on the detection of chemicals in both the source and downgradient waters. A majority of the chemicals detected in the source were not detected in downgradient wells and therefore would suggest that the proposed sources are in fact not sources. There is little information or discussion of potential breakdown products, half-lives, or transport characteristics of the chemicals that are being used as the basis for determining contribution from various sources. This limits the ability and validity of assigning contributions from potential sources to conditions observed downgradient.

62. **Section IX, B, 3, Dairy Cluster: Hormones (Pages 60-62)** – There are significant differences between the EPA Kerr and UNL hormone analyses both in terms of analytes detected and not detected between the two as well as reported concentrations. This is illustrated by comparing the 5 common constituents that were analyzed by both laboratories. There does not appear to be a systematic difference between the two for three of the constituents. Detected concentrations, non-detects, and differences between concentrations are random and do not exhibit a pattern. Given issues associated with this data noted in the data validation reports for the UNL laboratory and narrative information provided in Appendix E, the use of UNL hormone data should be used with great caution and issues and caveats should be presented and discussed in this section. Basing assumptions and drawing inferences regarding the potential sources of these chemicals observed in downgradient wells should be tempered by the fact that issues are associated with the UNL analyses and that analytes were detected in the "upgradient" location at concentrations greater than those observed downgradient.

63. **Section IX, B, 4 (Pages 62-63)** – As noted earlier, there is no discussion of how the perchlorate concentrations observed in Dairy Cluster wells was applied to this analysis. The source of nitrate for WW-13 and WW-14 is identified as animal waste. While it is noted in the footnote to Table

23 that animal waste may be either human, non-human, or both, this should also be included in the text in the first sentence of the second paragraph. WW-13 and WW-14 are collocated near the downgradient boundary of the Dairy Cluster and may also be subject to influences from septic systems in this area.

64. **Section IX, B, 5 (Page 63)**– As noted in previous comments and in Appendix E, elevated SF6 concentrations may be present in this area as a result of the geologic environment. Discussion needs to be added to this section to explain this and how this may affect results and inferences drawn from the SF6 analysis. Were groundwater travel times estimated using USGS regional geology and hydrogeology information to determine if the travel time estimates presented in the report are representative?

65. **Section IX, B, 6, 1st Paragraph, Last Sentence (Page 64)** – It is not clear how age dating and well depth information correlate and what this indicates about hydrologic conditions in the vicinity of the Dairy Cluster. As noted in previous comments and using geochemical data collected from the wells, the wells selected to represent hydrogeologic conditions in the vicinity of the Dairy Cluster are a combination of bedrock aquifer and shallow aquifer wells. However, no distinction has been drawn between these two distinct groups when making inferences regarding nitrate sources using "tracer" analyte data.

66. **Section IX, B, 6, 3rd Paragraph (Page 64)** – This paragraph is correct in stating that nitrate concentrations observed in water wells selected to represent the Dairy Cluster area do increase along the inferred direction of regional groundwater flow direction. However, additional information should be included in this paragraph that relate the impacts of uncertainties and limitations associated with the data collected and current level of understanding of the hydrogeologic regime in the vicinity of the Dairy Cluster:
    a. WW-06, selected, identified, and represented as the upgradient location representative of groundwater conditions in the shallow aquifer upgradient of the Dairy Cluster is likely completed in the bedrock aquifer based on evaluation of major ion data collected during the Phase 3 sampling event.
    b. Potential sources of nitrogen are present between WW-06 and the Dairy Cluster boundary and above the Dairy Cluster as a whole. The presence of these potential sources and their impact on nitrate concentrations in shallow aquifer groundwater are not discussed or accounted for in the report.

c. The Dairy Cluster is bounded to the north and south by irrigation canals. Information presented in *Water Quality Conditions in Irrigation Waterways within the Roza and Sunnyside Valley Irrigation Districts, Lower Yakima Valley, Washington, 1997-2008* (Roza-Sunnyside Board of Joint Control, 2009) for the Granger Drainage (where the Dairy Cluster is located) showed median annual concentrations of nitrate + nitrite as N for the 1997 to 2008 time period in canals to range from 5 to 7 mg/L and 2 to 4 mg/L during the irrigation and non-irrigation time periods respectively. It is likely that a significant amount of leakage occurs from the irrigation canals that could have an impact on shallow aquifer groundwater conditions. The potential contribution from the irrigation canals both in terms of water quality and quantity should be taken into consideration and discussed in further detail in this report.

67. **Section IX, B, 6, 4th -7th Paragraphs (Page 64)** – Discussion of pesticides, trace organics, and pharmaceuticals presented in this summary section should be caveated based on limitations associated with the data, ability to define groundwater flow pathways, presence of target analytes in "upgradient" locations, and general data quality.

68. **Section IX, B, 6, 8th Paragraph (Page 68)** – As noted in previous comments, the hormone data used to support statements in this paragraph (hormone data generated by the UNL laboratory) is not consistent with hormone data generated by the EPA Kerr laboratory and significant issues associated with the data quality are noted in Appendix E and data validation reports. The use of this data to draw significant inferences regarding sources of contamination should either be removed or additional explanation regarding the limitations of the inferences should be included in this discussion.

69. **Section IX, B, 6, 9th Paragraph (Page 68)** – As noted in previous comments, the term animal waste should be explained to include both human and non-human waste. In addition, the impact of detected perchlorate concentrations on the isotope data and assumptions should be explained and included in this report.

70. **Section IX, B, 6, 10th Paragraph (Page 68)** – The broad, sweeping conclusion presented in this paragraph should also include discussion of additional sources of nitrogen that may be present. As presented in previous comments, there are potentially significant sources of nitrogen located upgradient of the Dairy Cluster boundary including other livestock facilities, agricultural fields, septic systems, and irrigation canals that exhibit high levels of nitrogen. While an increase from

"upgradient" to downgradient is noted, it is important to consider that WW-06 is likely screened in the bedrock aquifer and therefore is not representative of upgradient conditions in the shallow aquifer.

71. **Section IX, B, 6, 11th Paragraph (Page 68)** – See previous comments regarding monensin and other veterinary pharmaceuticals. In general, there is evidence that the data presented to support linkage between the dairies and downgradient detections of veterinary pharmaceuticals is suspect based on data quality information presented in Appendix E and data validation reports as well as chemical property and half-life information for veterinary pharmaceuticals presented in references used in the report (Watanabe and others 2008, and other report references for pharmaceuticals).

72. **Section IX, B, 6, 12th Paragraph (Page 68)** – Similar to other comments, the evidence used to identify the dairies as the potential source of testosterone is not supported by the data and current level of knowledge. The presence of testosterone in downgradient wells at concentrations less than those observed in "upgradient" wells suggests that the source of testosterone is either upgradient or the Dairy Cluster or that testosterone concentrations are a more localized condition.

73. **Section IX, C, 1st Paragraph (Page 68)** – Unlike sampling conducted at the dairy facilities, no upgradient groundwater information was collected for irrigated cropland areas. This results in confounding the already difficult task of evaluating potential sources of nitrate and their contribution. Similar to observations about conclusions regarding the Dairy Cluster earlier in this report, additional information regarding upgradient conditions both in groundwater and land use activities are required to ascertain the potential impact of irrigated cropland on underlying groundwater conditions.

74. **Section IX, C, 1st Paragraph (Page 68)** – As noted earlier, sampling of the soils in the fertilizer application zone (0-1 inches) is not indicative of potential nitrogen levels after plant uptake in the root zone.

75. **Section IX, C, 2nd Paragraph (Page 69)** – As noted earlier, fertilizer application rates to production fields are typically determined based on soil sampling to determine the appropriate agronomic rate of fertilizer application rates required to achieve yields. Determination of agronomic fertilizer application rates are designed to reduce costs associated with fertilization

by matching plant uptake rates to achieve yields with application rates. Over-fertilization can have significant negative impacts on crop yields and quality.

76. **Section IX, C, 1 (Page 70)** – Similar to over-fertilization, overwatering crops results in significant negative impacts on crop yields and quality in addition to costs associated with water application.

77. **Section IX, C, 3, Irrigated Cropland: Pesticides (Page 70)** – Similar to discussion of the dairy facilities, without upgradient groundwater quality, gradient, and flow direction, it is difficult/impossible to infer that common detections of a compound between an irrigated crop field and a drinking water well are linked. For example, atrazine was found in upgradient wells at both the Haak Dairy and Dairy Cluster areas. An assumption would be that atrazine would likely be found in groundwater upgradient of the irrigated cropland, if it was analyzed.

78. **Section IX, C, 3, Irrigated Cropland Hormones (Page 72)** – As discussed in previous comments and shown in this section, analysis of hormones from the EPA Kerr laboratory met data quality objectives for the project identified in the QAPP and exhibited non-detect concentrations for the 5 hormones analyzed. UNL laboratory data was determined to be of use for screening purposes only as a result of issues with the data and exhibited detected concentrations for compounds that were found to be non-detect by the EPA Kerr laboratory (17-a-estradiol). Therefore, data from the UNL laboratory should be used with extreme caution when making inferences and caveats regarding the data should be included when inferences are drawn.

79. **Section IX, C, 6 (Page 74)** – The conclusions regarding irrigated cropland as a potential source of nitrate presented in the last 2 paragraphs of this section are not supported by data collected as part of this study and level of understanding of the hydrologic and hydrogeologic system in the vicinity of the irrigated cropland. The lack of upgradient information in the vicinity of the irrigated cropland evaluated as part of this study further confounds the ability to draw inferences regarding the potential for irrigated cropland to act as a source of nitrogen. This is further complicated by the detection of analytes in upgradient wells in the vicinity of dairies evaluated as part of this study.

80. **Section IX, D (Page 76)** – Review of figures provided with the report suggest that wells WW-18 and WW-30 should both be included and evaluated in this section as neither appear to be located in a potential area of influence from crop fields or dairies.

81. **Section IX, D, 2nd Paragraph, 1st Sentence (Page 76)** – As noted previously, WWTP influent does not provide a good surrogate for septic tank effluent. EPA's February 2002 *Onsite Wastewater Treatment Systems Manual* (EPA/625/R-00/008) states that there is a significant difference in character between sources (influent) of wastewater, particularly residential and non-residential sources. Additionally, these is a significant difference in character between residential wastewater influent and residential wastewater effluent, based on the design, condition, and loading of the system. For example, total nitrogen in typical residential wastewater influent ranges from 26 to 75 mg/L per day (OWTS Manual, p. 3-11). Total nitrogen in typical residential wastewater effluent ranges from 40 to 100 mg/L per day (OWTS Manual, p. 3-29). Residential septic tank effluent contained 0.01 to 0.16 mg/L of nitrate (NO3-N); however at two feet and four feet below ground surface, the measured nitrate in soil water ranged from 1.7 to 39.0 mg/L and 2.0 to 29.0 mg/L, respectively (OWTS Manual, p. 3-28). Based on available literature, it is expected that functional residential septic tank system effluent produces nitrate concentrations up to 39 mg/L at the tank system location and that these concentrations extend through the soil column. Additionally, most local state environmental agencies (Idaho Department of Environmental Quality, Oregon Department of Environmental Quality, and Washington State Department of Ecology/Washington State Department of Health) assume nitrate loads ranging from 30 to 60 mg/L per day from a functioning residential septic system. The effects of a non-functioning residential septic system were not evaluated. EPA did not take into account available and documented information regarding nitrate loading from residential septic systems when evaluation possible contribution from these sources.

82. **Section IX, D, 3, Septic Systems Organic Compounds (Pages 77-80)** - Similar to observations for dairies and cropland, the quality and limitations of the data generated should be discussed as the data are presented. The presence of unanticipated chemicals in residential wells needs to be evaluated in tandem with potential data quality issues. Similar to dairy and cropland results, hormone analyses conducted by the EPA Kerr laboratory (data qualified as usable) and UNL laboratory (screening level) do not correspond for common constituents.

83. **Section IX, D, 4, Last Paragraph, Last Sentence (Page 80)** – "The probable sources of nitrate for these water wells match the variety of land uses surrounding these highly scattered wells." Based on the information provided we assume that the author is confirming that the animal waste contribution to these wells is attributable to septic systems.

84. **Section IX, D, 6, First Paragraph, 3rd Sentence (Page 81)** – "Although microbial contamination is often observed in situations where septic systems contaminate residential wells, no microbial contamination was found in the downgradient wells." The intent of this statement is not clear. Is the author suggesting that the lack of microbial contamination is an indicator of a source other than septic systems? Is this also true for dairies where significantly greater microbial contamination would be expected? What does this say about the results of the high nitrate targeted Phase 2 study where only 2% of the wells exhibited microbial contamination down from 20% in previous studies. Does this indicate that a nitrate source other than dairies or septic systems is the main driver for elevated nitrate observed in the Yakima Basin?

85. **Section IX, E (Page 83)** – WW-18 exhibited the highest nitrate concentration of any water well in the entire study area (72.2 mg/L) (the units in Table 38 for nitrate are incorrect). Review of figures in the report indicates that WW-18 is not in an area that would be anticipated to be impacted by dairies or cropland. Does this suggest that septic systems may be a very significant issue in this area?

86. **Section X, 1st Paragraph, 2nd Sentence (Page 84)** – It should be noted that water well samples were not only collected from existing wells and well head and surrounding conditions were not fully evaluated, but also that water samples were collected from taps within the residence. There is a potential for significant changes in water quality between the groundwater bearing formation and the tap in a residential water system.

87. **Section X, 1st Paragraph, Last Sentence (Page 84)** – Unknown groundwater flow and direction in the local vicinity of a well and potential source areas results in a confounding condition when attempting to ascribe sources of contamination and their associated contribution. This is a significant issue and has an impact on all conclusions that have been developed based on data interpretations and inferences included in this report.

88. **Section XI, 1st Paragraph (Page 84)** – Similar to previous comments, the stated objective of the study in this paragraph goes beyond the objective stating in the project QAPPs. If the full objective as stated in this report were also stated in the QAPP, it is likely that the data quality objectives and systematic planning processes would have resulted in a significantly different study and data collection design than what was actually performed.

89. **Section XI, 2nd Paragraph (Page 84)** – A significant shortcoming of the isotopic analysis is the ability to differentiate between human and non-human waste. This significantly impacts the ability to determine if sources are being adequately identified and evaluated or if other currently unrecognized or unstudied sources of contamination may be present that have a more significant impact on nitrate concentrations observed in wells. Additionally, the perchlorate data collected to augment the isotopic analysis does not appear to have been used to adjust or refine the isotopic analysis.

90. **Section XI, 3rd Paragraph (Page 85)** – While age dating may appear to differentiate between shallow and basaltic aquifer wells, the data are not presented in a manner that allows this conclusion to be fully evaluated. Further, geochemical information suggests that WW-06 identified in this report as an upgradient shallow aquifer well is actually more representative of the bedrock aquifer.

91. **Section XI, Haak Dairy, 2nd Paragraph (Page 85)** – As noted in earlier comments concerning major ions downgradient of the Haak Dairy, the authors rely on elevated concentrations of some major ions while others with significant concentrations in the inferred source area are not detected. This conclusion uses minimal evidence to identify the Haak Dairy as a source of nitrate contamination while not fully elucidating how it was developed and explaining discrepancies in other major ion concentrations.

92. **Section XI, Haak Dairy, 3rd and 4th Paragraphs (Page 85)** – Pharmaceutical data collected to support the study did not meet data quality objectives for the study and were qualified for screening level and study development use only. In the vicinity of the Haak Dairy, tetracycline and monensin were detected in dairy facility samples and downgradient water wells. In addition, monensin was detected in the upgradient monitoring well. Despite the upgradient detection of monensin and the screening level designation of the data, the author infers that because tetracycline and monensin are present downgradient that the source is the Haak Dairy. This is counter to what the data show and reference material indicate (Watanabe and others, 2008).

93. **Section XI, Haak Dairy, 5th Paragraph (Page 85)** – As noted in earlier comments regarding the isotopic data, there is insufficient information to justify the break points used for attributing source types. This is further characterized by the last sentence in this paragraph that states: "Isotopic data for the other two residential drinking water wells downgradient of the Haak Dairy

indicate that the source of nitrate could be animal waste, fertilizer, derived from the atmosphere, or some combination of these sources." This statement includes all possible sources of nitrate identified for the purposes of this study.

94. **Section XI, Dairy Cluster, 2nd Paragraph (Page 86)** – As noted in previous comments, the understanding and evidence used to determine groundwater conditions upgradient and within the Dairy Cluster are flawed. The well selected to represent upgradient groundwater conditions in the shallow aquifer, WW-06, actually appears to be more representative of a well completed and sourcing water from the bedrock aquifer based on geochemical analysis using data presented in this report. Further, the Dairy Cluster is bounded on the north by an irrigation canal that has been shown to have significant concentrations of nitrate. The relative contribution of potential nitrogen sources within the Dairy Cluster with respect to all other potential nitrogen sources in the vicinity of the Dairy Cluster that may be contributing nitrate to the shallow groundwater system was not evaluated or considered.

95. **Section XI, Dairy Cluster, 3rd - 5th Paragraphs (Page 86)** – As noted earlier, pharmaceutical and hormone data generated by the UNL laboratory did not meet DQOs for the study and were identified for screening use only. The presence of detected concentrations of pharmaceuticals and hormones in "upgradient" wells at or above concentrations observed in downgradient wells coupled with detections of hormones that were not detected in the same water samples by the EPA Kerr laboratory brings into question the validity of using this data to draw conclusions and assign contributions to potential sources.

96. **Section XI, Dairy Cluster, 6th Paragraph (Page 86)** – As noted in earlier comments regarding the isotopic data, there is insufficient information to justify the break points and interpretation used for attributing source types. In addition, perchlorate data collected to augment the isotopic data does not appear to have been taken into consideration. The issues associated with the break points and attempts to classify sources based on them is elucidated by the last sentence in this paragraph that states: "Isotopic data for the other residential drinking water wells downgradient of the Dairy Cluster indicate that the source of nitrate could be animal waste, fertilizer, or derived from the atmosphere, or some combination of these sources." This statement includes all possible sources of nitrated identified for the purposes of this study and also includes the possibility that there may be a combination of sources.

97. **Review of Data Validation Memoranda Provided on the FTP Site for the Project** – The EPA posted data validation memos describing the data validation process performed on the analytical results. Based on the posted information, the data validation followed the procedures described in the QAPP. The purpose of the data validation was to verify that the laboratories produced defensible results. Data which did not meet the criteria were qualified as either estimated or rejected. The data validation acceptance criteria were consistent with EPA data validation guidance. A data validation report was written for each type of analysis on each chain-of-custody. Two levels of data validation evaluation were performed, referred to as Stage 2 and Stage 4. The Stage 2 summaries verify holding times, sample preservations, and internal spike recoveries.

    The summary memos provided minimal information on the actual data validation. The reports stated which data were validated and noted if noncompliance with either the QAPP or laboratory methodologies were observed. The typical details provided in most data validation reports were not included. Also, EPA protocol dictates that internal quality control samples be analyzed for every 20 field samples. EPA analytical protocols include analyzing the method blanks and continuing calibration standard on the same day as the field samples. No information was provided to verify that these criteria were met.

    In addition, the EPA performed their own data validation, even when the samples were collected by EPA personnel and analyzed at the EPA laboratory. EPA guidance clearly states that an independent party should perform the data validation. The purpose for using an independent third party reviewer is to avoid potential conflict of interest. The combination of the EPA performing their validation and the minimal information provided in their validation reports ultimately produces ambiguity in the data defensibility. The EPA does not include sufficient information in their data validation report to strongly support the data defensibility.
    Soil and water samples were analyzed for pharmaceuticals, herbicides, hormones, organic waste indicators such as caffeine, hormones, and inorganic compounds such as nitrates.

    A summary of the data validation ambiguities is provided below:

    Pharmaceuticals – 63 samples were collected from lagoons, soil, and waste water and were analyzed for veterinary pharmaceuticals at the University of Nebraska, Lincoln – Water Science Laboratory. The defensibility of the data precision and accuracy is reduced based on the following statements included in the data validation report:

"Due to the complexity of the liquid matrices (water, lagoon, and WWTP) and chromatographic interferences, internal standard used for calculating the concentrations of target compounds were affected resulting in a potentially high biased associated data. Data users are warned to use the reported values with caution as the concentrations of the compounds in the samples may be lower than reported."

In addition, the veterinary pharmaceuticals report states, "Approximately 9% of the total data points were qualified as unusable and an additional 18% were qualified estimated concentrations with a high bias due to out of control internal standards and/or calibration. Five lincomycin and three monensin results in the water samples were detected above the reporting limits but were flagged non-detects due to contamination in the associated field blank, WW-29." The overall data quality for the veterinary pharmaceuticals results is reduced because of analytical performance issues with the internal standards spiked in the field samples and interferences produced on the individual chromatograms. Based on the information in the data validation reports prepared by the EPA, the entire pharmaceutical data set is suspect and, in the EPA's own words, should be used with "caution" because the reported values "may be" too high.

Herbicides – Sixteen soil and 30 water samples were analyzed for herbicides. The water samples were reportedly evaluated using the EPA's level 4 data validation method.

Water Samples – The laboratory noted that "experimental method" was used for the water samples and no holding time would be applied. The actual holding time used for the samples was not presented in the data validation report. Several quality control issues were identified which caused the detected and nondetected results for the following analytes to be qualitfied:

- *2,3,6*-trichlorophenol
- 2-4-D, clopyralid
- dacthal-DCPA
- dicamba
- picloram
- 4-nitrophenol
- chloramben
- fenhexamid

Based on the identified quality issues with the laboratory control samples and the matrix spike samples, the result for these analytes should not be used.

Soil Samples – The soil samples were analyzed for an equivalent EPA method 8151. The data validation report states that since no holding times were identified in the QAPP for frozen samples, no holding times apply. The holding times listed in the EPA analytical method guidance document do not differentiate between frozen and non-frozen sample preservation. Based on the EPA guidance, holding time is 40 days. The samples were analyzed eight months after collection.

Several quality control issues were identified which causes the detected and nondetected results for the following analytes to be qualified:

- Dinoseb
- Acifluoren
- 2,3,6-trichloropheno
- 2-4-D, 4-nitrophenol
- chloramben.

Based on the identified quality issues with the laboratory control samples and the matrix spike samples, the result for these analytes should not be used.

Hormones – The September 2011 data validation report discussed 16 soil samples and 48 water samples. Limited information was presented in the report. No information was provided on whether individual sets of data quality control samples for each 20 field samples criterion was compliant. No information was provided discussing whether the QC samples were analyzed the same day as the field samples, surrogate recoveries compliance, matrix spike recoveries compliance, calibration or holding time compliance.

The September 2011 report has the following statement concerning the overall data quality. "Due to the calibration results, the detected results and/or reporting limits for androstanedienedion, a-methyltestoserone, androsterone, progesterone, caffeine, estrone,

a-zearalanol, a-zearalenol, b-zearalonol for samples associated with the calibration run on 01/18/2011 were qualified estimated J/UJ."

The report also states that approximately 15 percent of the total data points were flagged estimated due to calibrations. The report also states that additional qualifications were applied due to blank contamination. However, the report does not state which samples are qualified or whether soil or water samples are affected. The data validation report states that data quality issues were identified, but does not provide sufficient information to understand the full ramifications of the quality issues.

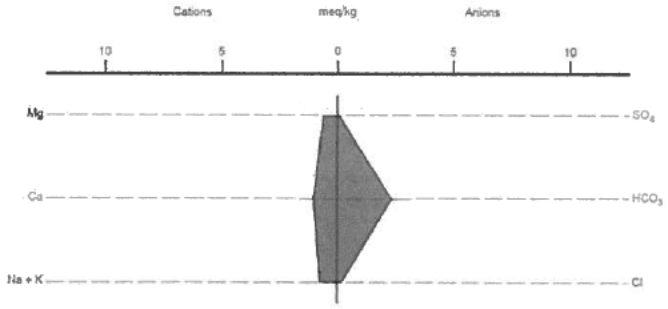
Nitrates – A January 2011 data validation report discusses the data quality for 108 water samples collected in two phases. The report states that the samples were evaluated using EPA stage 4 criteria. However, the details of the review are not included in the report. The report qualified the results for six samples based on quality control noncompliance.

- A March 2011 report discusses the data quality for 30 water samples. Limited information is provided. Missing information includes if sufficient data quality samples were analyzed and whether they were analyzed on the same days as the field samples.
- A September 2011 report discusses the data quality for 43 water samples. Limited information is provided. The report states that data were not qualified. Missing information includes if sufficient data quality samples were analyzed and whether they were analyzed on the same days as the field samples.
- A November 2011 report discusses the data quality for 10 soil samples. Limited information is provided. The report states that data were not qualified. Missing information includes if sufficient data quality samples were analyzed and whether they were analyzed on the same days as the field samples.

Data Quality Summary – As discussed above, the EPA does not include sufficient information in their data validation report to strongly support data defensibility. The EPA performed their own validation despite EPA guidance stating that an independent reviewer should be used. In addition, the data validation report for pharmaceuticals stated that due to data quality issues, caution should be used in reviewing the results. The minimal information provided in the validation reports and the potential conflict of interest reduces the data defensibility.

Stiff Plots for Attachment A, Comment 49

Stiff Diagram: WW-06



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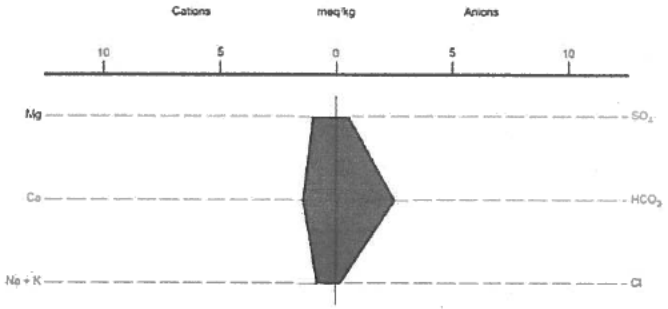

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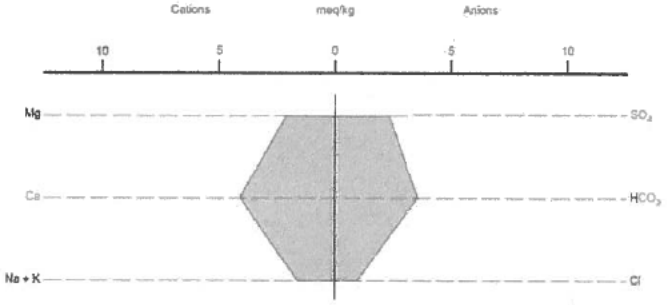
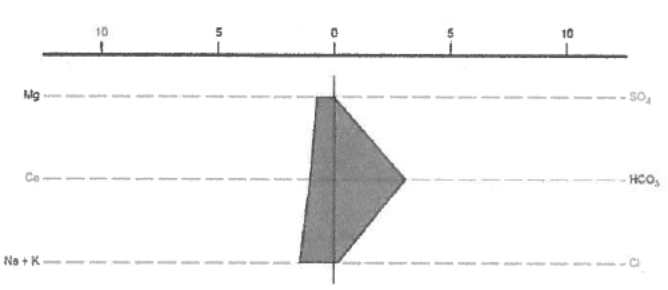


Stiff Diagram: WW-09



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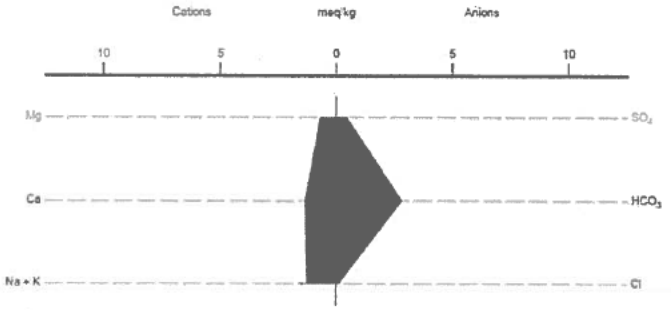
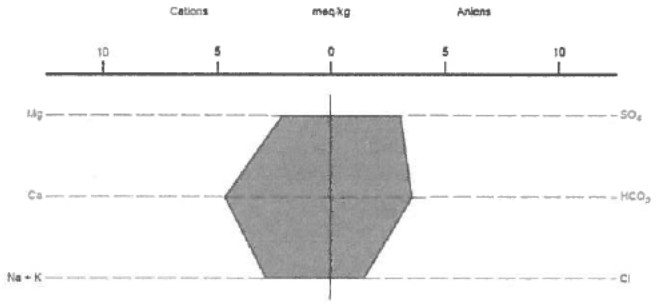
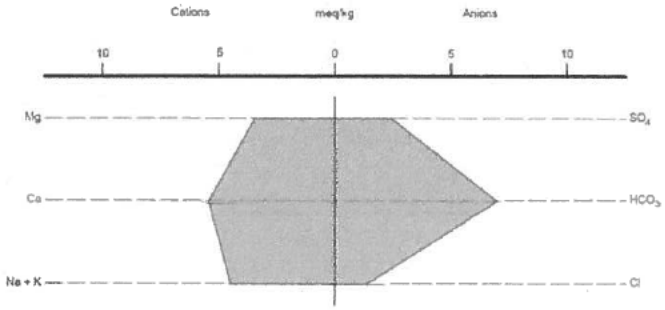


Stiff Plots for Attachment A, Comment 49

Stiff Diagram: WW-11



Stiff Diagram: WW-12



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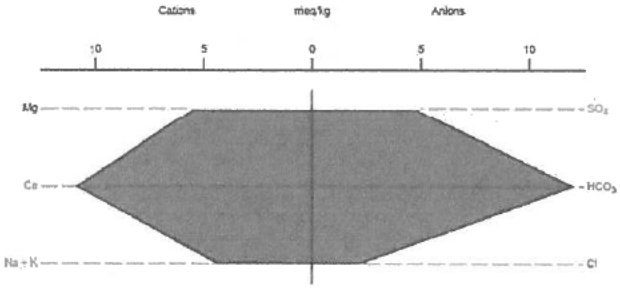

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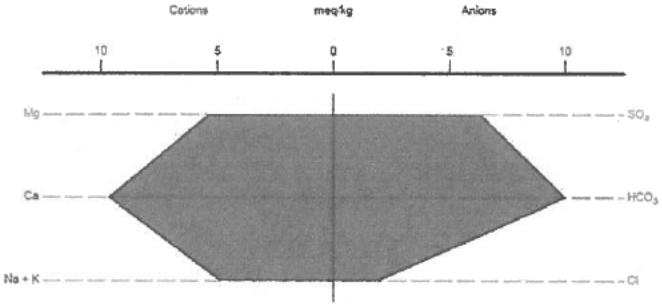

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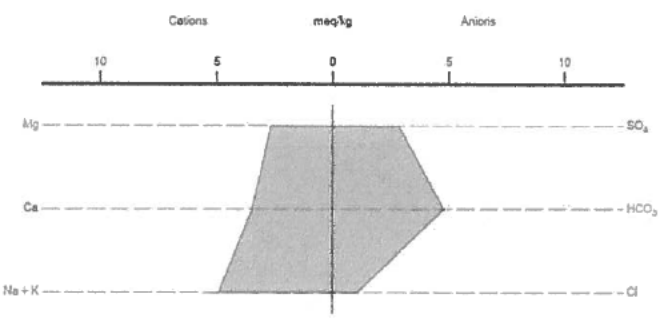
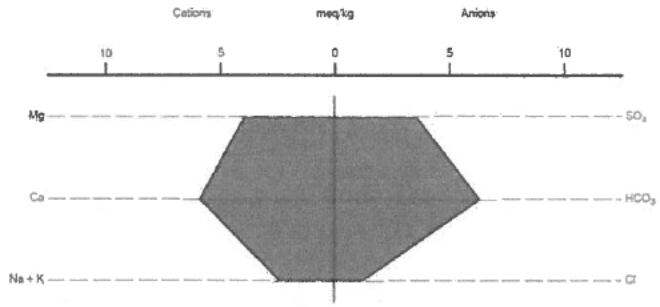
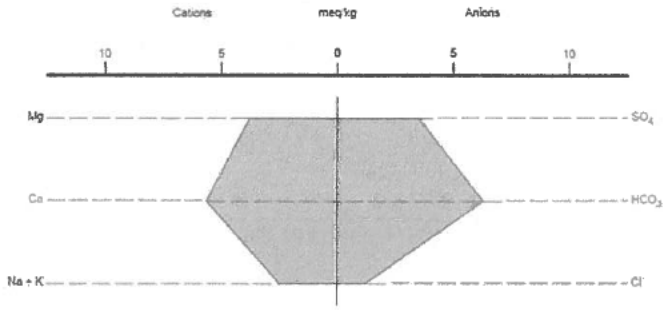


Stiff Plots for Attachment A, Comment 49

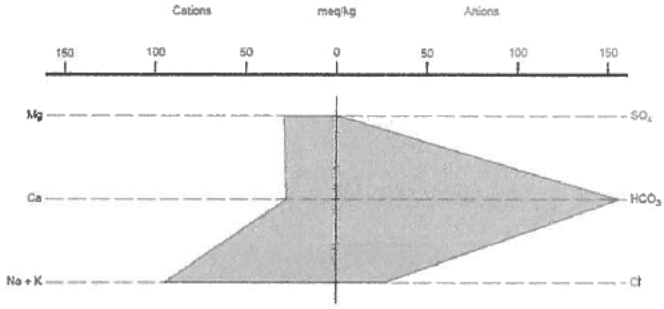
Stiff Diagram: WW-16



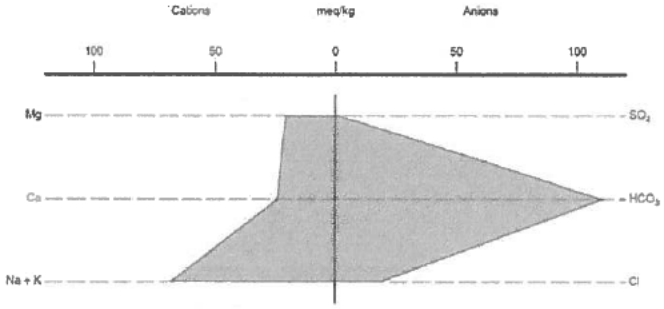
Stiff Diagram: WW-17



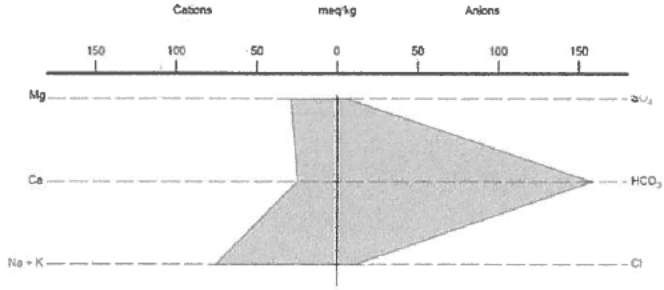
Stiff Diagram: LG-04-06-AVG



Stiff Diagram: LG-07-09-AVG

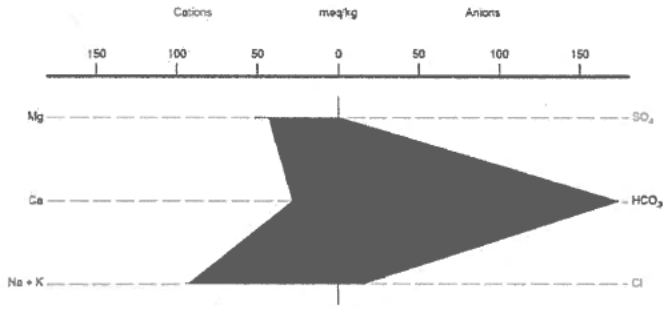


Stiff Diagram: LG-10-12-AVG

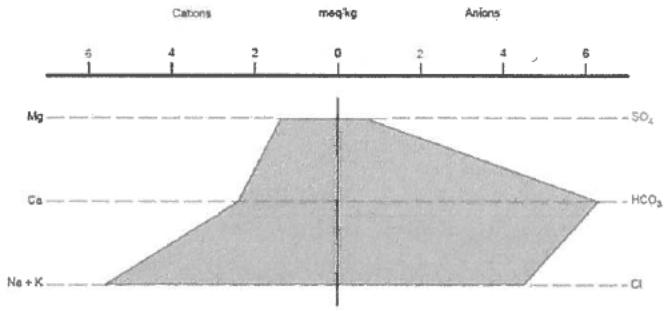


Stiff Plots for Attachment A, Comment 49

Stiff Diagram: LG-13-15-AVG



Stiff Diagram: SP-01-04-AVG



PRELIMINARY TECHNICAL EVALUATION OF THREE REPORTS BY U.S. ENVIRONMENTAL PROTECTION AGENCY REGION 10 ON NITRATE IN WATER WELLS, YAKIMA RIVER BASIN, YAKIMA COUNTY, WASHINGTON

Prepared for: Washington State Dairy Federation
Dairy Producers of New Mexico

GLORIETA GEOSCIENCE, INC.

Prepared by: Glorieta Geoscience, Inc.
PO Box 5727
Santa Fe, NM 87502
505-983-5446
www.glorietageo.com

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INTRODUCTION

At the request of the Washington State Dairy Federation and Dairy Producers of New Mexico, Glorieta Geoscience, Inc. (GGI) conducted a preliminary technical evaluation of the following reports prepared by U.S. Environmental Protection Agency Region 10 (EPA):

1. Quality Assurance Project Plan, Yakima Basin Nitrate Study Phase 2 – Initial Nitrate/Coliform Screening of Domestic Wells February 2010 Sampling Event, Yakima County, Washington, U.S. EPA Region 10, January 27, 2010 (QAPP2)
2. Quality Assurance Project Plan For Yakima Basin Nitrate Study Phase 3 – Comprehensive Analytical Source Tracer Sampling April 2010 Sampling Event, Yakima County, Washington, U.S. EPA Region 10, April 27, 2010 (QAPP3)
3. Relation Between Nitrate in Water Wells and Potential Sources in the Lower Yakima Valley, Washington, EPA-910-R-12-003, September, 2012 (Report)

In the remainder of this report we will refer to these documents as QAPP2, QAPP3, and Report, respectively.

Access to EPA's GIS tool, field notes, water well data, reference maps and other relevant data are critical to a proper technical review of the report and its findings. Multiple requests have been made to EPA under the Freedom of Information Act; however requests for this information have not been fulfilled. Due to the unavailability of these data, GGI's technical evaluation of the three reports is preliminary only, and GGI reserves the right to revise and update this preliminary report once the EPA makes the information available.

In the following sections, we will first evaluate the overall study design/site selection as described in the QAPPs and Report documents followed by specific data collection concerns and finally the results and conclusions drawn from the data as described in the main body of the Report.

OVERALL STUDY DESIGN AND SITE SELECTION

The Report and QAPPs describe a three-phased study of nitrate in groundwater of the Yakima Valley. Phase 1 was based on compiling historic groundwater nitrate data into a GIS database. Based on these data, the Phase 2 data collection focused on areas that had shown high nitrate levels in the past. Phase 3 represents an additional subset of sites where EPA collected samples for extensive groundwater analyses together with potential source analyses for the same analytes. Thus EPA made the choice of focusing on groundwater chemistry, assuming that indicators such as pesticides and other trace organic compounds will tie the groundwater nitrate to a specific source. As we will discuss below, this strategy failed to yield clear indicators pointing to specific sources. Since EPA did not collect any data to gain a detailed understanding of aquifer properties at the Phase 3 sites, no defensible argument can be made regarding the source(s) of groundwater nitrate.

The Yakima Valley is a large agricultural area where there are multiple potential sources of nitrate in groundwater. These potential sources are intermingled, i.e., homes with septic systems are on the same properties as or immediately adjacent to farms (see aerial photo on the cover of this report). Because none of the potential sources are isolated, source tracking requires an in-depth knowledge of

aquifer properties such as thickness, flow direction and hydraulic conductivity in addition to localized effects of ditches, drains and production wells on groundwater flow. EPA did not collect any data to evaluate aquifer properties.

EPA acknowledges these shortcomings on Page 3 of the Report:

First, water well samples were collected from existing wells. No new wells were installed for this study. Information on the depths and screened intervals of the water wells is known for about a third of the wells that were sampled. In this report, designations of upgradient and downgradient are based on regional groundwater flow data from the United States Geological Survey (USGS). ***Lack of complete well information limits our ability to verify if the wells upgradient and downgradient of the sources draw water from the same water bearing zone.*** (bold highlights added)

This means that if designated upgradient and designated downgradient wells are screened into different zones, the designated upgradient well is not a valid baseline. Further, because no water levels were measured as part of the study, the identification of a well as upgradient is an unsubstantiated assumption based on the regional groundwater flow direction rather than site-specific ground water elevations calculated from surveyed well heads and measured water levels (see discussion on Report Pages 7-8). Also: "Flow directions can vary locally due to canal/lateral leakage, irrigation, drains, streams, pumpage, variations in recharge, spatially varying hydraulic characteristics, and topographic setting (USGS 2009)" (Report Page 17). Given these limitations, no definitive conclusions regarding the source of contamination can be drawn even if the designated upgradient well has lower contaminant concentrations than the designated down-gradient well.

To accurately calculate ground water flow direction(s), EPA should have sampled several upgradient wells based on measured water levels and calculated ground water elevations from professionally surveyed well heads. Further, periodic mapping of groundwater flow direction would be necessary to verify that groundwater flow is consistent through seasonal changes in farming practices and regional stream/ditch flow. The only accurate means of determining true upgradient and downgradient sampling points would require surveyed horizontal and vertical coordinates, water level measurements, well completion logs showing screened intervals, hydrogeologic cross-sections and mapping of groundwater elevations on an area map that would include all surface water, domestic and production wells and locations of all area septic tanks.

Below are specific comments GGI wishes to highlight to further address deficiencies in the overall study and QAPP 2 and QAPP3:

EPA states in QAPP2, Page 3: "*The objective of Phase 2 was to evaluate if, down gradient of potential nitrate contaminant sources, there are drinking water wells with nitrate levels over the MCL and/or elevated total coliform.*" EPA states in QAPP2, Page 4: "*Phase 3 attempts to demonstrate the potential to use low concentrations of trace organic compounds to link land use to observed nitrate contamination.*" And "*These compounds include estrogens, androgens, veterinary and human antibiotics, agricultural chemicals, personal care products and human medications and compounds such as caffeine.*"

EPA states in QAPP2, Page 4: *The use of private domestic water supply wells required contacting many individual home owners and requesting access to sample their drinking water. It further involved using wells installed for another purpose as windows into what is happening in the groundwater. These wells may not be screened at horizons where they optimally intersect what we seek to monitor.*

EPA's site selection criteria include sites where "*ground-water flow can be expected to be consistent from season to season and is predictable in direction. Select sites which present as little as possible up-gradient contributing sources of nitrate*." QAPP2, Page 5.

EPA has presented no data supporting the assumed ground water flow directions in the selected study locations, nor have they demonstrated that directions are consistent from season to season. Knowledge of upgradient nitrate sources is critical in determining potential sources. Since the direction of ground water flow was estimated and not adequately mapped for purposes of this study, all uses of 'upgradient' and 'downgradient' references should be qualified with "designated."

EPA presents no data comparing demographics from one community to another. Influent and effluent compositions at a Waste Water Treatment Facility (WWTF) can differ substantially from those for a septic system. Composition of WWTF influent and thus effluent fluctuates from weekdays to weekends, seasonally in areas of specific tourism and throughout any given day. Why did the EPA not sample directly from septic tanks or leach fields?

Well selection was based on: "*Select sites with a linear array of homes using individual domestic water supply wells along the downgradient side of...*" QAPP2, Page 5.

Because homes in the rural part of Yakima Valley all have septic systems, these need to be mapped and evaluated as sources in all investigations of groundwater nitrate. For example, ground-water contamination from on-site septic systems is a widespread problem in New Mexico (McQuillan, 2004) and septic tank effluent has contaminated more water supply wells and more acre-feet of ground water, than all other sources in the state combined (McQuillan, 2005).

Phase 3 was conducted "*to collect data to investigate the contribution of various sources from nearby land uses to the high nitrate levels in groundwater and residential drinking water wells*" (Report Page 2).

EPA used a "GIS tool" to select sites from Phase 1 for Phase 2 (Report Page 10) and from Phase 2 for Phase 3 (Report Page 13). No other information is given on how this "tool" works and why certain areas with high groundwater nitrate were chosen to be sampled and not others (see Report Figures 10 & 11). This tool has been requested from EPA via the FOIA process, but has not been provided.

While the study is supposed to identify all sources of nitrate impacting private water supply wells, a different sampling design was employed for evaluation of potential impacts from farming and septic than for dairy sources. Dairy sites were located close to the northern edge of the Valley farming area, while the other sources were sampled within a matrix of other uses (see Report Figure 11). No designated upgradient wells were sampled for potential farming and septic sources, but a designated upgradient well was included in the dairy sampling network (see Report Table 1). EPA claims "Minimal upgradient nitrate sources" (Page 18) for the non-dairy sites, but provided insufficient data to

substantiate this claim. This discredits any conclusions drawn for the latter sources due to the sampling program as implemented.

Hydrogeology

The study area is underlain by an alluvial aquifer overlying a semiconfined (does EPA mean leaky-confined?) basalt aquifer, with a possible non-continuous shallow saturated zone originating from irrigation return-flow that is situated over the true alluvial aquifer. The well network selected to be sampled for this study includes both alluvial completions and semiconfined basalt completions. No well completion data or aquifer identification data are provided within the report. A key component of the study is collecting ground water quality samples from designated upgradient and designated downgradient wells, completed into the same aquifer. Although the report assumes that ground water flow direction in both aquifers is the same, the report also states "locally, the flow direction may be modified by geologic structures and by irrigation practices, drains, ditches, canals, and other hydrologic features" (Report Page 17). Tables in the report do not provide a description of into which aquifer specific wells are completed. No measured heads or ground water elevations from sampled wells are provided in the report. Three (3) potentiometric surface maps with data based on surveyed well head data should have been constructed for: 1) alluvial aquifer; 2) basalt aquifer; 3) composite potentiometric surface for wells completed into both aquifers. These potentiometric surface maps should be constructed quarterly using quarterly ground water level measurements, and groundwater flow direction should be evaluated for a minimum of one-year before upgradient and downgradient designations are made.

Although the basalt is characterized by EPA as semiconfined, mixing of producing zones in wells completed across both aquifers can transport nitrogen downward from the alluvial aquifer into the semiconfined basalt aquifer. Well completion information is critical to assess the potential for vertical transport through the gravel pack or casing.

QUALITY ASSURANCE PROJECT PLAN – PHASE 2 SCREENING, FEBRUARY 2010

Phase 2 Property Access QAPP2, Page 5

EPA Sampling Teams will collected a GPS location from the well, and fill in an access permission form developed by the EPA team (in Spanish and English. If the homeowner is unwilling to sign the form, but is willing to have a sample taken, just note the unwillingness on the form and go ahead and collect the sample as long as verbal permission is obtained.

EPA's wording assumes that the occupants of the residences will be the owners. Did EPA research County Clerk files to determine who the owners are and specifically contact these owners? Did EPA determine if the occupants are renters or owners? How many renters consented to give access to their well without permission of the owner? EPA has provided no property access forms or notes identifying which properties are owner-occupied or which properties gave signed or verbal permission for EPA to sample onsite wells, or which properties had Spanish-speaking residents. GGI requests the opportunity to review actual access permission forms for each home EPA contacted.

Sample Collection Activities QAPP2, Page 16:

At this time, examine the well for the integrity of the sanitary seal/ surface seal. If the well is open to surface contamination (collapse around the well pad, no well pad, no seal, open seal) to the extent that material from the surface such as run-on water or organisms could fall into the well, then note that on the data form, take a photo of the installation with the Home ID number on it and plan to collect a Coliform bacteria sample at this home.

Using wells with poor surface completions skews results towards contamination from surface sources not associated with septic systems, AFOs or irrigated agriculture. Were wells with inadequate surface seals sampled, or are they eliminated from the study? GGI requests the opportunity to review all intake forms, field notes and photographs of each well EPA evaluated and sampled.

QUALITY ASSURANCE PROJECT PLAN – PHASE 3 APRIL 2010

Phase 1 Soil Sampling QAPP3, Page 25:

For sampling the agricultural field, you might plan a diagonal course through the field attempting to reach at least 1/3 of the way across. You could head for the center pivot point if the field has one. When you get to 20 of 40 subsamples, turn 90 degrees and you should re-intersect the boundary of the field at your last sample. For example – you select a direction across the field and plan on collecting a small sub-sample every 25 steps. Where ever your 25th footstep lands, take your sampler (prepared spoon or syringe) and insert it at the ball of your foot. Try to recover about 1 teaspoon or so of soil centered about 1-inch below the surface. Not too deep and not just at the surface. Place the soil into the prepared stainless steel bowl. Take 25 more steps and repeat until you have collected 40 subsamples.

Soil sampling at CAFOs nationwide is conducted in conformance with NRCS 590 Nutrient Management Standards. The 590 Standards for Washington are currently being developed and the most recent draft states: "Soil, Manure, and Tissue Sampling and Laboratory Analyses (Testing); Nutrient planning must be based on current soil, manure, and (where used as supplemental information) tissue test results developed in accordance with land-grant university guidance, or industry practice, if recognized by the university." Industry standards and NRCS 590 standards in other States recommend collection of composite soil samples at 0-12 inches, 12-24 inches and 24-36 inches.

EPA's plan provides no scientific rationale for collecting soil samples from 1 inch below the soil surface, especially when sampling for nitrates. There is no industry or land grant university standard for EPA's soil sampling methodology that suggests soil sampling only the first inch at CAFO spray fields for either environmental or agronomic purposes is valid and the soils data should be disregarded.

Lagoon Sampling:

QAPP3, Page 11 specifies *"1 sample from freshest source in the lagoon system and 2 samples from the last lagoon prior to pumping onto fields."*

QAPP3, Page 21 specifies *that Liquids from Lagoons or Sewer Plant Influent Streams (16 bottles per location). Locations are identified as LG01 to LG15 and SP01 to SP03.*

No field data on lagoon sampling procedures is currently available. It is unknown if these samples are grab samples or composite samples. If these are composite samples, how many sub-samples per composite? Anecdotally, GGI was informed that "lagoon sampling" occurred in an alley draining from the milking parlor to the lagoon. If the alley was the actual sample location, these samples should be disregarded as not representative of blended lagoon samples. Perhaps this is the reason that matrix effects precluded proper analysis of green water by EPA's Manchester Laboratory?

Page 27 of the QAPP3 specifies that *"we are attempting to integrate our sample across the accessible depth of the lagoon."*

At what depth were the samples collected? Were the lagoon samples collected from the surface, 1 foot below the surface or from deeper layers?

GGI samples more than 25 green water lagoons quarterly as required by the New Mexico Environment Department Ground Water Discharge Permits. Appendix A presents GGI's SOP for green water lagoon sampling.

REPORT ON RELATION BETWEEN NITRATE IN WATER WELLS AND POTENTIAL SOURCES IN THE LOWER YAKIMA VALLEY, WASHINGTON

Site-specific study design

As mentioned above, EPA has not demonstrated that the designated upgradient and downgradient wells are valid reference points for determining sources of nitrate in domestic wells. In addition, we have the following concerns with respect of the specific sampling sites in Phase 3.

Haak Dairy Site: The selected designated upgradient well is not upgradient from the potential dairy sources given the groundwater flow direction indicated (Report Figure 12), thus (see also comments under Study Design), conclusions based on the designated upgradient and designated down-gradient comparisons are not valid.

Dairy Cluster Site: Given the indicated groundwater flow direction, the designated upgradient well is at best upgradient from Cow Palace and Liberty/Bosma dairies. Thus (see also comments under Study Design), conclusions based on the designated upgradient and designated down-gradient comparisons are not valid for DeRuyter and D&A Dairies. Conclusions based on a designated upgradient and designated down-gradient comparisons may or may not be valid for Cow Palace and Liberty/Bosma Dairies.

Crop and septic sites: No detailed maps are provided showing the locations of the wells and associated fields/septic systems and presumed groundwater flow directions. Also no designated upgradient wells were sampled. Therefore, the validity of the results/conclusions cannot be evaluated.

Volume of Manure and Green Water

EPA highlights under the Report Analytical Results and Discussion section (Report Page 30 onward) how much manure and green water is produced by the Phase 3 dairies and compare volumes to people and

swimming pools. These statistics are irrelevant as long as a dairy uses these nutrients in accordance with its nutrient management plan and crop needs.

Age Dates

Reported age dating results indicate a mixing of older and younger waters. It is likely that production wells completed into the lower basalt aquifer are pumping water that is older than water in the overlying shallow alluvial aquifer throughout the valley. Surface water supplies younger water for irrigation. Some irrigation water percolates downward and recharges the shallow alluvial aquifer, thus mixing waters from 3 sources: 1) surface water, 2) the alluvial aquifer, and 3) the basalt aquifer. Mixing of waters of different ages precludes use of the age dating data for definitive source identification. Again, without specific information on well completion, samples cannot be legitimately evaluated for the objectives of the study.

Further, aging of the groundwater at best gives a maximum age of nitrate – old groundwater could have a nitrogen contribution from years ago or yesterday.

Soils

As discussed above, EPA's soil sampling plan for nitrate, consisting of pacing off sample points and collecting only the top one-inch of soil, is not found in any agriculture, industry or land grant university standard. To obtain valid data deeper samples need to be composited. For this reason the soils data should be disregarded.

Nutrient Management

EPA provides a generalized picture of cropping patterns and crop nitrogen requirements in the valley. The dairies being evaluated are all operating under NMPs which require nitrogen and phosphorus to be applied to crops at agronomic rates. EPA provided no nutrient application, soils, tissue samples or crop production data to indicate dairies have over applied manures or green water to land application fields.

General Chemistry

Results from major ions and trace inorganic elements show a range of concentrations in these elements that does not allow source tracking (Report Table C6). For example, in the discussion for Haak Dairy, EPA contends that elevated concentrations of Barium and Zinc in the designated downgradient wells is indicative of dairy groundwater contamination, yet the designated upgradient Dairy Cluster well (WW-06) has the highest Zinc concentration of all wells analyzed. Barium is found at concentrations similar or higher in the residential wells (WW-18, WW-22) compared to the wells designated downgradient of the Dairy Cluster.

Given that the dairies are located in a matrix of farming and septic systems and the shortcomings in the study design, none of the major ions and trace inorganic elements provide conclusive evidence regarding the source of nitrate in the wells designated downgradient from the dairies.

Isotopes

$\delta^{18}O$ values for nitrate derived from the reduced sources (ammonium, urea) can be estimated using a 1:2 mix of atmospheric oxygen to water oxygen during nitrification (Böttcher et al. 1990). Shallow groundwater in the Yakima valley has a $\delta^{18}O$ of -13 to -14.5‰ (McCarthy & Johnson 2009), while air has a $\delta^{18}O$ of 23.8‰. This should result in a $\delta^{18}O$ near 0‰, although Xue et al. (2009) note that $\delta^{18}O$ values up to 5‰ higher than the upper limit for nitrate produced by this mechanism can occur due to microbial processes and evaporation in the soil column. Analyzed perchlorate data do not correlate with $\delta^{18}O$ (see Figure A, below), thus casting doubt that atmospheric deposition is a likely cause for the high $\delta^{18}O$ values reported. Nitrate fertilizer can have a $\delta^{18}O$ signature of $\delta^{15}N$ = 0 to 5.6‰ and $\delta^{18}O$ = 18-26‰ (e.g., Mengis et al., 2001; Roadcap et al., 2002; Vitòria et al., 2004, Deutsch et al., 2005, Rock and Ellert, 2007, Xue et al., 2009). This means that the high values of $\delta^{18}O$ in the EPA study, which are well outside the range of a previous USGS study in the valley ($\delta^{18}O$ of nitrate: -8 to +10‰, McCarthy & Johnson 2009), cannot be readily explained.

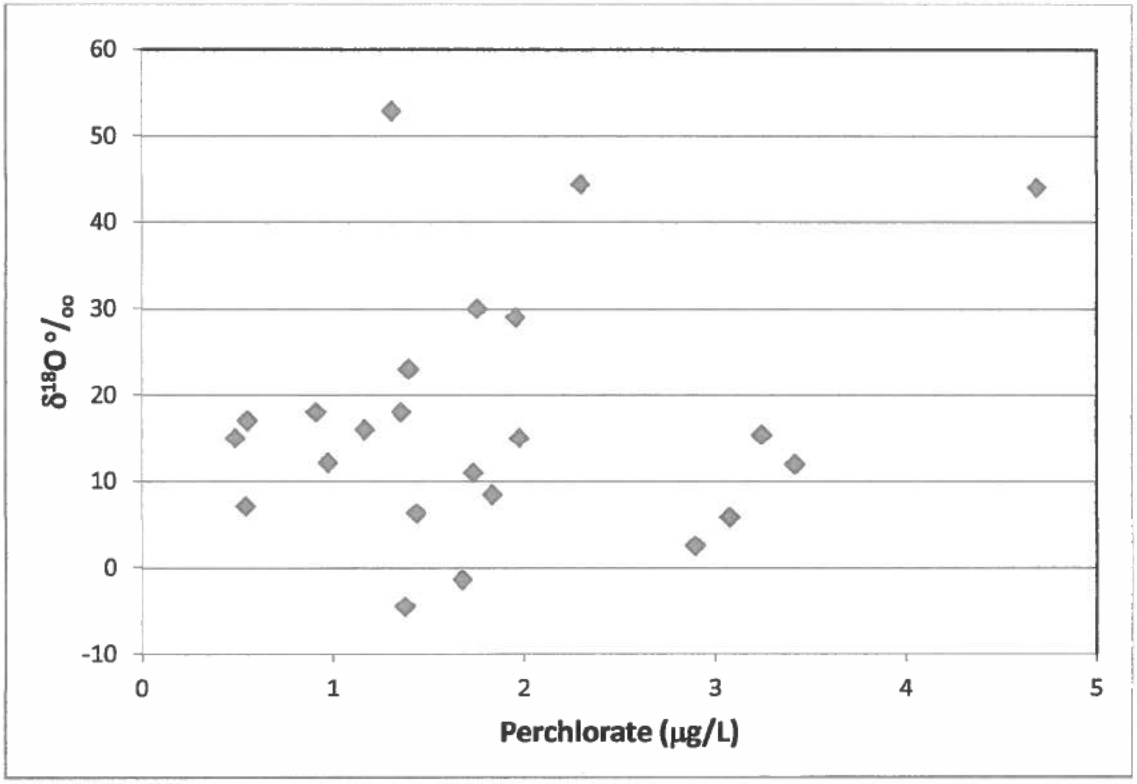

Figure A: Relationship between perchlorate and $\delta^{18}O$ in Phase 3 wells based on data in Report Tables C7 and C15.

$\delta^{15}N$ values in the human and dairy sources examined show a wide range of values (2-14‰), with both sources overlapping, but being distinct from ammonium and urea based fertilizers (-1.5 to -0.4‰, Wassenaar, 1995; Vitòria et al., 2004; Xue et al., 2009).

Overall, the isotope data provide no ability to distinguish between human and dairy sources. It must be noted that domestic wells were sampled in an area where human wastes are disposed of by septic systems in the vicinity of the domestic wells, i.e. homes that have their own wells also have septic systems on the property. As stated already, without detailed knowledge of all potential contributors and groundwater flow direction, the isotope data are meaningless for distinguishing human vs. dairy sources. Only nitrate from synthetic fertilizer that has undergone no nitrification (which would be an assumption) can be distinguished based on $\delta^{15}N$.

Organic Compounds

EPA highlights the results of Atrazine (pesticide) in the Haak Dairy section (Report Table 11), yet all values are either non-detects or estimates. Similarly, all values for the Dairy Cluster well are also estimates. This does not allow for any conclusions, especially since both upgradient wells were already contaminated (Report Table C9). Other pesticides were detected in isolated wells without any clear pattern.

As detailed in the Report, trace organics, hormones, and microbiology also did not yield any patterns. However, it is worth mentioning that the designated upgradient well at the Dairy Cluster was the only well that had detectable levels of total coliform, suggesting that the aquifer in which it is screened is receiving bacteria from non-dairy sources.

Pharmaceuticals were detected in both designated upgradient wells at the dairy study sites indicating non-dairy sources. Specifically, at Haak Dairy, Monesin was detected in the designated upgradient well in the same concentrations as in the designated downgradient wells. The same was true for Tetracycline at the Dairy Cluster site. It is difficult to address conclusions regarding pharmaceuticals since the EPA's lab (see discussion in QA/QC section) does not stand by its results. Even if we analyze these poor quality pharmaceutical sample results, no consistent trend was observed using pharmaceuticals, thus these compounds, even if used at the dairies and detected in lagoons, manure or soils, do not help identify the source(s) of nitrate in downgradient wells.

Miscellaneous

On page 29 the Report states: "The ^{18}O values are reported as ^{18}O-NO3 (for nitrate)." GGI assumes that values are reported as $\delta^{18}O$ as indicated in the Report tables.

On page 48 the Report states: "A difference lies in the fact that human waste is treated before discharge into the environment, but animal waste is either not treated at all or minimally treated before discharge into the environment (EPA 2004)." This is incorrect, human waste is only treated in waste water treatment plants, septic systems are little more than settling systems with leach fields that are designed to leach untreated septic waste into the soil. In contrast, dairy lagoons have been constructed according to National Resources Conservation Service standards with clay liners (Jay Gordon, pers. comm., Nov 2012).

Appendix E Quality Assurance and Quality Control

There are numerous instances where the participating analytical laboratories state that their results do not meet the level of the QAPP and may also have problems meeting third-party review. However, the EPA report still utilizes these data for comparison and development of conclusions. Our comments correlate to the summary analysis by the laboratories presented in Appendix E. Additionally, GGI reviewed the Corrective Action Forms.

EPA's Manchester Environmental Laboratory, Port Orchard, Washington

Nitrate and Nitrogen Compounds

Report Exception: *Nitrogen compounds included ammonia, TKN, and nitrate nitrites. Samples 10154251, 10154252, 10154253, 10154254, 10154255, 10154256, 10154257, 10154258, 10154259, 10164260, 10164261, 10164262, 10164263, 10164264 and 10164265 did not meet the required preservation when they were received at the laboratory. Nitrate/nitrites, TKN, and ammonia results for these samples were qualified estimated with a possible low bias. Thirty one (31 percent) of the data points (147) were qualified estimated.*

All of these samples (10154251 through 10154529 and 10164260 through 10164265) are "LG" or lagoon samples. These samples contained pH preservation levels above the stipulated pH value of 2 when measured at the laboratory. This indicates an increase of pH during shipment to the laboratory. Based on GGI field experiences and the recommendation of NMSU research (Ulery et al., 2004), the amount of sulfuric acid added to the lagoon samples should have been doubled to insure proper preservation. Additionally, there are concerns regarding protocols for the lagoon samples that do not address stratification within the lagoons and the homogeny of the final sample volume that is distributed among the numerous sample kits.

The precision of the results is suspect due the failure to obtain a triplicate (duplicate sample) from one the lagoons as determined in the QAPP and noted in the Corrective Action Form dated August 1, 2012. All of these factors impact the quality of the analytical results producing a lower level of confidence for their use in assessing impacts to land application areas and shallow ground water.

Mercury and Alkalinity

Report Exception: *Thirty nine percent (39 percent) of the total mercury data points were qualified estimated based on out of control sample spike and blank spike recoveries. Alkalinity results met all the QC criteria. The mercury and alkalinity data, as reported and qualified, are acceptable for use for all purposes.*

The Data Validation Report for the Inorganic Analyses of the Water Samples Collected from the Yakima Basin Nitrate Study Phase 3 (USGS Memorandum dated February 10, 2011) by this laboratory notes: 1) the laboratory fortified blank (LFB) associated with at least 12 mercury results were outside the recovery acceptance criteria; and 2) The matrix spike and/or matric spike duplicate were outside the recovery requirements. As a result, the mercury data is qualified as acceptable for identification (a

determination of presence) but the value is an estimate and cannot be used for quantitative assessments. Again, most of the samples are used to characterize lagoons and land application areas.

Pesticides and Herbicides

Report Exception: *The project data quality goals for precision and accuracy for numerous target analytes were not met for dairy lagoons and WWTPs. As stated above, all of the pesticides and herbicide results for the dairy lagoons and WWTPs could not be quantified and are considered unusable because of (1) the complexity of the sample matrices, (2) holding times that were exceeded, (3) recurring QC failures, and (4) the limitations of modified Method 8270D for detecting pesticides and herbicides at the project reporting levels. However, the pesticides for water and soil, as qualified, are usable for all purposes.*

As identified in prior methods, the green water/lagoon samples continue to be the most difficult to analyze and are undependable for correlation. The status of the pesticides results are presented, but the herbicide results for water and soil are not clarified.

Anions

Report Exception: *As a result of matrix interferences, the dairy lagoon and WWTP biosolids samples collected were analyzed at 50x dilutions for bromide, fluoride, and sulfate. The reporting limits for these bromide, fluoride, and sulfate were elevated and did not meet the project goals. As qualified and reported, the analytical results for water and soil are acceptable for use for all purposes.*

See prior comments regarding the waste samples. It is apparent that the sampling protocols as presented in the QAPP have resulted in poor results for characterization of the lagoon chemistry. This impacts the quality objective goal for showing correlations in application of lagoon waters on land applications areas.

Cascade Analytical Laboratory, Wenatchee, Washington

Nitrate and Other Forms of Nitrogen

The identification of analytical methods for nitrogen species in the QAPP did not include methods commonly used to quantify wastewater, namely those found in *Standard Methods for the Examination of Water and Wastewater*. The QAPP should have identified this potential (with information provided by the participating laboratory) and provided the necessary information to sustain quality control for the sampling program (i.e. providing proper holding times, appropriate container and preservation).

Bacteria

Report Exception: *For bacterial analyses, a holding time of 30 hours must be met for drinking water samples and a holding time of 6 hours must be met for wastewater samples. All samples met these requirements, except for the following dairy lagoon and wastewater treatment plant samples: 10154251, 10154252, 10154253, 10154271, 10164263 and 10164264. The fecal coliform results for these samples were qualified estimated based on holding time exceeded.*

For bacteria samples, 20 percent (or 6 of 30) samples, all wastewater samples, exceeded holding time. Without knowing the number of fecal coliform colonies in the original sample, estimates of fecal coliform concentrations in samples that exceeded holding times are meaningless. See previous comments regarding wastewater sample qualifications.

USGS National Water Quality Laboratory, Denver, Colorado

Trace Organics

Report Exemption: *Data users are advised to consider the values reported as a screen. For full usability, data need further confirmation for the following reasons: (1) data were not thoroughly verified by the validator because of the absence of the instrument raw data output at the time of review, and (2) the laboratory followed their in house SOP and the recurrence of results out of SOP QC control limits indicates that the data may not be reproducible by a third party. The data reported can only be used for information purposes and a good starting point in determining sample locations for confirmatory analyses.*

The trace organics results should be considered as not qualified for use in the report for any quantifying applications based on the unresolved quality control issues presented in the exemption.

University of Nebraska Lincoln – Lincoln Water Science Laboratory (UNL)

General QA Observations and Wastewater Pharmaceuticals

Report Exemption: *UNL data sets may not meet the third party reproducibility criterion set forth by EPA's information Quality Guidelines (EPA /260R02008 October 2002) for the following reasons: (1) there is no established or standard analytical method for the analysis of the target compounds, and the analytical methods used are for research purposes only, (2) the recurrence of out of control QC results; (3) variability in duplicate runs; and (4) compound identification and calculations were not verified at the time of review because the instruments' raw data output was not available.*

The exemption continues to identify that 55 percent of the total data points were assigned as being estimates. The use of this data as a correlation tool to determine source is suspect since concentrations of these species are used as the basis of the correlation.

Veterinary Pharmaceuticals

See prior discussion regarding wastewater pharmaceuticals.

USGS Laboratory, Reston, Virginia

Recharge Age Dating

The selected method for age dating followed the SF_6 procedure. The dependency on the single procedure to determine groundwater recharge age does not provide for any comparative test. An

additional method such as the CFC (chlorofluorocarbons) procedure should have been considered to provide a comparative result.

CONCLUSIONS

EPA States the following objectives for the study:

- *EPA hopes to assess which activities on the landscape are contributing excess nitrate to shallow ground water.* QAPP2, page 3
- *In addition, the sampling from this project will provide enforcement-quality data that could be used in later enforcement actions.* QAPP2, page 3

EPA did not achieve these objectives because the aquifer properties such as groundwater flow direction were not evaluated, not all potential sources at each study site were evaluated and mapped and trace organic compound analyses did not yield reliable data or were inconclusive. As a consequence, EPA did not produce a study with reproducible results that supports its conclusions that specific sources of nitrate in domestic wells the Yakima Valley can be identified. Specifically:

1. Overall the Report provides a significant lack of supporting technical information for EPA to arrive at the conclusions presented in the report.
2. Locally the ground water flow direction may be modified by geologic structures and by irrigation practices, drains, ditches, canals, and other hydrologic features.
3. Very limited data on well completion, screened intervals, pump setting, casing diameter, presence or absence of surface/sanitary seals is presented.
4. Lack of well completion information severely limits EPA's ability to verify if the wells identified as upgradient and downgradient of potential sources produce water from the same water bearing zone.
5. No water levels were measured and converted to ground water elevations with which to construct seasonal potentiometric surface maps in each aquifer to determine temporal changes in both localized and valley-wide ground water flow directions.
6. The dairies and other sites are located in a matrix of farming and septic systems, which makes source tracking impossible without detailed knowledge of aquifer and well properties.
7. The selected upgradient well at Haak Dairy is not upgradient from potential dairy sources given the groundwater flow direction indicated in Report Figure 12, and conclusions based on upgradient and down-gradient comparisons are therefore not valid.
8. Given the indicated groundwater flow direction, conclusions based on an upgradient and down-gradient comparisons are not valid for DeRuyter and D&A Dairies because no upgradient well was sampled for these dairies.
9. The designated upgradient well at the Dairy Cluster was the only well that had detectable levels of total coliform, indicating that the aquifer in which it is screened is receiving bacteria from non-dairy sources.
10. No upgradient wells were sampled at septic sites or farm fields, and therefore the validity of the results/conclusions cannot be evaluated against data for dairies.
11. Since EPA did not collect any data to gain a detailed understanding of aquifer properties at the Phase 3 sites, EPA has no defensible argument regarding the source(s) of groundwater nitrate.

12. Mixing of waters of different ages precludes use of the age dating data for definitive source identification.
13. EPA's soil sampling methodology does not follow any accepted NRCS or land grant university soil sampling standard for either agronomic or environmental investigations. All soils data should be disregarded.
14. EPA has provided no historical land-use, nutrient application, soils, tissue samples or crop production data to indicate dairies have over-applied nutrients to land application fields.
15. The EPA states it selected WWTF effluent samples as "representative" of septic system effluent, however this claim cannot be supported by available studies. The effluent composition of WWTF is not necessarily representative of septic system effluent.
16. None of the major ions and trace inorganic elements provides conclusive evidence regarding the source of nitrate in the wells downgradient from the dairies.
17. High values of $\delta^{18}O$ in the EPA study, which are significantly outside the range of a previous USGS study in the valley, cannot be readily explained.
18. The isotopic data provide no basis by which to distinguish between human and dairy sources.
19. The quality of much of the laboratory data indicates many of these data will not pass the third party reproducibility criterion set forth by EPA's Information Quality Guidelines.
20. A full 20% (6 of 30) of samples for fecal coliform bacteria exceeded holding time at Cascade Analytics.
21. EPA's Manchester Laboratory reported 15 nitrogen samples out of 49 (31 percent) were not properly preserved and did not achieve required holding times.
22. EPA's Manchester Laboratory reported that project data quality goals for precision and accuracy for numerous target analytes were not met for dairy lagoons and WWTPs.
23. EPA's Manchester laboratory reported that all of the pesticide and herbicide results for the dairy lagoons and WWTPs could not be quantified and are considered unusable.
24. The reporting limits for bromide, fluoride, and sulfate were elevated due to matrix effects and did not meet the project goals.
25. The USGS laboratory followed their in house SOP for trace organics and the recurrence of results out of SOP QC control limits indicates that the data may not be reproducible by a third party.
26. UNL data sets may not meet the third party reproducibility criterion set forth by EPA's information Quality Guidelines (EPA /260R02008 October 2002) for hormones, wastewater pharmaceuticals, veterinary pharmaceuticals, isotopic nitrogen, isotopic oxygen, ammonia, and nitrate; soil and manure for hormones, wastewater pharmaceuticals, and veterinary pharmaceuticals.
27. EPA did not produce enforcement-quality data from this study.

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Appendix A

Lagoon Sampling Protocol

Collect a composite sample from each lagoon using a sample dipper. A composite sample shall consist of six sub-samples taken from eight different locations distributed evenly throughout the lagoon.

Collect the sub-samples in a clean bucket thoroughly mix and take a composite sample from the bucket to fill in the sampling bottles.

Make sure you collect each sub-sample from 1 foot below the water line by dipping the sample dipper.

A sample "dipper" can be constructed by attaching a clean, plastic container with a wide opening to a length of light-weight wooden pole or pipe, such as PVC. This dipper must either be a one-use sampling device that is disposed of after each sample location or must be decontaminated between each lagoon with a solution of Alconox (or equivalent non-phosphate cleaning product) and clean water. The Alconox solution should be prepared as directed on the label.

Precautions

Special care should be used regarding personal safety when obtaining samples directly from the edge of lagoons, as the footing in these areas can be dangerous and could cause falls into the lagoon.

Samples should be obtained with a container that will provide a composite or mixed representative sample of the lagoon water.

Do not collect a sample from the top layer, make sure you dip the sample dipper to 1 foot below the water line before you collect the sample.

Sample Handling and Shipping

Samples should be examined for accurate labeling for both the individual sample bottles and the Chain-of- Custody Document supplied by the analytical laboratory. The preservation of the sample includes the refrigeration with either clean ice in sealed bags or freezer packs such as Blue Ice. The laboratory may provide freezer packs with a prepared sample kit. The laboratory will provide directions regarding shipping companies (FedEx or bus lines), and notify the laboratory of the shipment of the samples.

Packaging of the samples in a cooler must be completed so that the cooler will not be opened (such as wrapping with shipping tape and some tamper-proof tape). The samples have to be packed such that the bottles will not leak or break if the container is bumped during transit. Generally, it is recommended to seal sample bottles in Zip-lock (or similar) bags and pack clean newspaper or bubble-wrap around bottles and ice packs to prevent them from moving during transit.

INTERTOX

600 Stewart St.
Suite 1101
Seattle, WA 98101
U.S.A.

Tel 206.443.2115
Fax 206.443.2117

TECHNICAL MEMORANDUM

To: U.S. EPA, Region 10

From: Richard Pleus and Gretchen Bruce, Intertox, Inc.

Re: Comments on *Relation Between Nitrate in Water Wells and Potential Sources in the Lower Yakima Valley, Washington*, released by U.S. EPA, September, 2012

Date: November 27, 2012

EXECUTIVE SUMMARY

U.S. EPA released its document, *Relation Between Nitrate in Water Wells and Potential Sources in the Lower Yakima Valley, Washington* in September, 2012 (U.S. EPA, 2012a). The document summarizes results of sampling conducted by the Agency to

> ...investigate the contribution from various land uses to the high nitrate levels in groundwater and residential drinking water wells, which is the predominant source of drinking water for many residents in the Lower Yakima Valley (U.S. EPA, 2012a, p. ES-1).

These sampling results represent Phase 3 of U.S. EPA's assessment of nitrate sources in the Lower Yakima Valley. In this phase, U.S. EPA sampled drinking water wells and potential sources of nitrate contamination in the Lower Yakima Valley from February to April 2010. U.S. EPA conducted multi-parameter sampling on 29 water wells (26 residential drinking water and 3 dairy supply wells), 12 dairy lagoons, 11 soil samples, 5 dairy manure pile samples, and 3 wastewater treatment plant (WWTP) influent samples.

Considering that U.S. EPA's document contains influential information[1], we reviewed the report to assess whether it adequately meets a minimum level of scientific reliability to support valid conclusions. We examine a number of components of U.S. EPA's work presented in the document, including sampling and analytical program design and data quality issues, data presented for specific sample types and locations, the U.S. EPA-commissioned peer review of the Phase 3 report, and U.S. EPA's conclusions.

We find that a number of issues with the design of the sampling and analytical program result in data that are of insufficient quality to support a scientifically reliable assessment of the potential source of contaminants. Specifically:

- Well sampling locations were selected in a biased manner, such that only those with the highest nitrate concentrations measured during the Phase 2 investigation were

[1] "Influential," when used in the phrase "influential scientific, financial, or statistical information," means that the Agency can reasonably determine that dissemination of the information will have or does have a clear and substantial impact (i.e., potential change or effect) on important public policies or private sector decisions (U.S. EPA, 2002; p. 19)

selected for sampling in Phase 3. This bias towards higher concentrations can result in invalid conclusions about the extent of contamination.

- Only two well water samples were collected upgradient of the dairy sources, one upgradient of each area, providing inadequate information on background conditions and making it impossible to determine whether concentrations measured downgradient are statistically similar to or different from background.
- U.S. EPA relied on existing residential wells as the source of sampled groundwater, and did not establish that upgradient and downgradient wells sampled the same aquifers.
- Review of nearby land use suggests there are other uncharacterized sources of contamination upgradient of the dairy areas, including livestock activities, cropland, and septic systems.
- Water samples were grab samples that reflect concentrations at a single point in time, and it is unknown how measured results reflect longer term conditions.
- Cropland sampling was limited to sampling of corn, hop, and mint fields, and contributions from other types of crops (e.g., alfalfa, wheat, hay, tree fruit, grapes) were not assessed.
- A substantial percentage of the analytical data are "J qualified"—i.e., reported concentrations are estimated. These concentrations can be biased low or high such that direct quantitative comparison of samples is not appropriate without case-by-case evaluation.
- U.S. EPA had difficulty analyzing both trace organics and wastewater pharmaceuticals, and indicated that results of these analyses should be considered screening level and not fully usable for quantitative evaluations.
- U.S. EPA's Water Science Lab reported that monensin and lincomycin were detected in the well water field blank sample, such that any detects of these analytes in well water samples should be qualified.
- U.S. EPA did not meet preservation requirements for about one-third of the nitrate analyses, which could bias sample results.
- U.S. EPA did not collect field duplicate samples for well water or lagoon samples due to an oversight and so cannot establish the reproducibility (precision) of sampling and analytical methods applied to these samples.
- Detection limits for some analytes, especially wastewater pharmaceuticals, appear elevated.
- Differential movement of contaminants through soil and groundwater, due to different fate and transport properties, makes it impossible to establish "fingerprints" for these compounds and determine the source of contaminants.
- Nitrate isotopic ratios for synthetic fertilizer and animal waste sources can vary beyond the ranges assumed to by U.S. EPA, and their methodology cannot distinguish between human and other animal sources.

Given the data do not meet a minimum level of reliability, the assessments of Haak Dairy and the Dairy Cluster as well as the assessments of irrigated cropland, wells downgradient of residential septic systems, and WWTP influent cannot be used to make reliable determinations about the source of contaminants. Specifically:

- None of the detected pesticides, trace organics, wastewater pharmaceuticals, or hormones can be reliably attributed to the dairies because of detection in upgradient sources and/or WWTP samples, or data quality issues.
- Veterinary pharmaceuticals can have multiple sources including other agricultural sources and human use, such that downgradient detections cannot be attributed to dairies. In addition, the detection of monensin in the field blank samples indicates that it cannot validly be reported as detected in downgradient samples.
- At the Dairy Cluster, some downgradient concentrations of barium are lower than the upgradient concentration, and some directly adjacent downgradient wells have very different concentrations. In addition, U.S. EPA does not support its assertion that barium is used at the dairies and therefore that the dairies are a potential source.

Regarding the peer review process for the Phase 3 document, U.S. EPA did not conduct an appropriately rigorous peer review in accordance with the spirit of the peer review process as described in U.S .EPA's own guidance. Specifically,

- U.S. EPA's selection of peer reviewers was not transparent, and all four peer reviewers were drawn from federal agencies, potentially limiting the perspectives of provided comments.
- Aside from one peer reviewer, most of the peer review comments received were extremely brief and not adequately rigorous to provide U.S. EPA with sufficient information on the quality of the science presented in the Phase 3 document.
- Of the more rigorous comments received, concerns presented were similar to those we discuss, including the lack of appropriate characterization of contributions from mixed land use, absence of evidence that wells sampled the same aquifers, and misrepresentation of the overlapping ranges of isotopic ratios contributed by different nitrate sources.

In summary, because of the numerous sampling design and analysis issues in the Phase 3 program as well as the potential impact of highly mixed local land uses, we conclude there is insufficient information to determine with scientific certainty whether and how much any of the sources could have contributed to contamination in downgradient wells. In particular, because of the numerous issues highlighted above, no particular location can be implicated as a source of any of the contaminants measured.

1.0 BACKGROUND

U.S. EPA released its document, *Relation Between Nitrate in Water Wells and Potential Sources in the Lower Yakima Valley*, Washington in September, 2012 (U.S. EPA, 2012a). The document summarizes results of sampling conducted by U.S. EPA to

> ...investigate the contribution from various land uses to the high nitrate levels in groundwater and residential drinking water wells, which is the predominant source of drinking water for many residents in the Lower Yakima Valley (U.S. EPA, 2012a, p. ES-1).

Nitrate is both natural and a product of human activities. For human related activities, particularly in this area of Washington, the potential sources of contamination the U.S. EPA evaluated include dairies, irrigated cropland, and residential septic systems. Media sampled include water from drinking water wells and dairy sources, dairy lagoons, soils from dairy

application fields and irrigated croplands, and wastewater treatment plant (WWTP) influent. Analytes include various forms of nitrogen, major ions, isotopes of nitrogen, pharmaceuticals (veterinary and human), steroids and hormones, pesticides, and microbes.

The study was conducted in three phases. The goal of Phase 1 was to identify major sources of nitrogen in the study area, based on historical records and available information. The goal of Phase 2 was to evaluate nitrate contamination of groundwater downgradient of dairies, irrigated cropland, and residential septic systems, and identify sampling locations for Phase 3. The goal of Phase 3 was to further evaluate nitrate contamination and evaluate whether chemicals other than nitrate are associated with specific sources and can be used to link nitrate contamination in groundwater and drinking water wells to those sources. The U.S. EPA (2012a) report focuses primarily on the Phase 3 sampling.

In Phase 3, U.S. EPA sampled drinking water wells and potential sources of nitrate contamination in the Lower Yakima Valley from February to April 2010. U.S. EPA collected 331 samples from residential drinking water wells for nitrate and bacteria, and conducted multi-parameter sampling on 29 water well samples (26 residential drinking water and 3 dairy supply wells), 12 dairy lagoon samples, 11 soil samples, 5 dairy manure pile samples, and 3 WWTP influent samples. U.S. EPA published a Quality Assurance Project Plan (QAPP) in April 2010, which describes the objectives of the sampling and analytical program and the methods to be followed (U.S. EPA, 2010).

The Agency released its report describing the results of the Phase 3 sampling in the fall of 2012.

2.0 INTERTOX'S REVIEW

Intertox reviewed the scientific reliability of the work conducted by U.S. EPA, focusing on the Phase 3 results including the U.S. EPA (2012a) report and supporting documents [e.g., the Phase 3 QAPP (U.S. EPA, 2010); QAPP deviations Corrective Action Form (CAFs) and Sample Alteration Forms (SAFs)[2]; Quality Assurance Validation Memos[3]; and Phase 3 data[4]]. Based on our review, we have prepared these comments.

In reviewing this work, Intertox considered the fundamental tenets of scientific investigation. Specifically, we considered the experimental design of Phase 3, the measurement methods, the quality of the data, and the conclusions reached based on these data. To support our evaluation, we considered a number of relevant guidance documents.

Overall, in our assessment of the U.S. EPA (2012a) document, we have found that a number of experimental design and data quality issues, including selection of biased sample locations, lack of proper background (upgradient) samples, and analytical problems resulting in a large percentage of unusable or qualified sampling data, result in data that cannot be used to draw scientifically valid conclusions about the source of nitrate or other contaminants measured downgradient of dairies. In addition, while U.S. EPA has issued guidance for designing and conducting sampling and analytical studies of this type, it does not follow its own guidance in many cases.

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[2] QAPP deviations Corrective Action Form (CAFs) and Sample Alteration Forms (SAFs) available at ftp://ftp.epa.gov/reg10ftp/sites/yakima/QAPP_Deviations_SAFs_and_CAFs/

[3] Quality Assurance Validation Memos available at ftp://ftp.epa.gov/reg10ftp/sites/yakima/YV_Validation_Memos/

[4] Phase 3 data available at ftp://ftp.epa.gov/reg10ftp/sites/yakima/groundwater_data/

The following sections summarize our comments on (1) the sampling and analytical program design and data quality issues, (2) results for specific sample types and locations, (3) the U.S. EPA-commissioned peer review of the Phase 3 report, and (4) U.S. EPA's conclusions.

3.0 REQUIREMENTS FOR INTEGRITY OF INFLUENTIAL SCIENTIFIC DATA

In the case of the Phase 3 sampling and analytical program, U.S. EPA is both a collector and generator of scientific data, and a user of this information to support decisions about sources and implications of nitrate contamination in the Lower Yakima Valley. In this capacity, U.S. EPA has stated that "EPA must rely upon information of appropriate quality for each decision we make" and that it is "...dedicated to the collection, generation, and dissemination of high quality information" (U.S. EPA, 2002).

To maximize the quality of information they disseminate, U.S. EPA has published policy and procedural guidance. This policy and guidance is found in a number of different documents, but one of the foundational documents is entitled *Guidelines for Ensuring and Maximizing the Quality, Objectivity, Utility, and Integrity of Information Disseminated by EPA* (U.S. EPA, 2002). [5]

In regards to the quality of information it uses to make decisions, the Agency states that it issues these guidelines to:

> ...ensure and maximize the quality, including objectivity, utility and integrity, of disseminated information... "Objectivity" focuses on whether the disseminated information is being presented in an accurate, clear, complete, and unbiased manner, and as a matter of substance, is accurate, reliable, and unbiased. "Integrity" refers to security, such as the protection of information from unauthorized access or revision, to ensure that the information is not compromised through corruption or falsification. "Utility" refers to the usefulness of the information to the intended users (U.S. EPA, 2002).

Regarding the situations to which these guidelines apply, U.S. EPA (2002) states:

> These Guidelines apply to "information" EPA disseminates to the public. "Information," for purposes of these Guidelines, generally includes any communication or representation of knowledge such as facts or data, in any medium or form.

Thus, U.S. EPA's guidelines for data quality would apply to information collected in the Phase 3 program.

U.S. EPA emphasizes the particular importance of ensuring the quality of "influential" information, indicating that such information "should meet a higher standard of quality" (U.S. EPA, 2002). U.S. EPA defines "influential information" as follows:

> "Influential," when used in the phrase "influential scientific, financial, or statistical information," means that the Agency can reasonably determine that dissemination of the information will have or does have a clear and substantial impact (i.e., potential change or effect) on important public policies or private sector decisions (U.S. EPA, 2002; p. 19);

[5] U.S. EPA developed this guidance in response to guidelines issued by the Office of Management and Budget (OMB)1 under Section 515(a) of the Treasury and General Government Appropriations Act for Fiscal Year 2001 (Public Law 106-554; H.R. 5658).

and:

> For disseminated influential original and supporting data, EPA intends to ensure reproducibility according to commonly accepted scientific, financial, or statistical standards. It is important that analytic results for influential information have a higher degree of transparency regarding (1) the source of the data used, (2) the various assumptions employed, (3) the analytic methods applied, and (4) the statistical procedures employed (U.S. EPA, 2002; p. 21).

U.S. EPA has also emphasized the importance of peer review in ensuring the quality of its scientific data, stating in its *Peer Review Handbook* (U.S. EPA, 2012c) that:

> Science is the foundation that supports all of our work here at EPA. Strong, independent science is of paramount importance to our environmental policies. The quality of science that underlies our regulations is vital to the credibility of EPA's decisions and ultimately the Agency's effectiveness in protecting human health and the environment. One important way to ensure decisions are based on defensible science is to have an open and transparent peer review process.

Regarding the peer review process, U.S. EPA states:

> Peer review is a documented critical review of a specific Agency scientific and/or technical work product. Peer review is conducted by qualified individuals (or organizations) who are independent of those who performed the work, and who are collectively equivalent in technical expertise (i.e., peers) to those who performed the original work. Peer review is conducted to ensure that activities are technically supportable, competently performed, properly documented, and consistent with established quality criteria. Peer review is an in-depth assessment of the assumptions, calculations, extrapolations, alternate interpretations, methodology, acceptance criteria, and conclusions pertaining to the specific major scientific and/or technical work product and of the documentation that supports them. Peer review may provide an evaluation of a subject where quantitative methods of analysis or measures of success are unavailable or undefined such as research and development… Regardless of the timing of peer review, the goal is ensuring that the final product is technically sound (U.S. EPA, 2012c; p. 12).

Using U.S. EPA's guidelines as well as other standard scientific guidelines, we assessed whether the work, data, process, and procedures of U.S. EPA's Phase 3 assessment meet accepted data quality standards.

4.0 COMMENTS ON U.S. EPA'S PHASE 3 SAMPLING AND ANALYTICAL PROGRAM

4.1 General Concerns about Sampling and Analytical Program Design and Data Quality Issues

The following summarizes our comments related to the sampling and analytical program design and data quality issues.

In their Quality Assurance Project Plan (QAPP) for Phase 3, U.S. EPA (2010) stated their goal for the sampling program as follows (p. 6-7):

> With this study, EPA proposes an even-handed assessment of potential sources of nitrate by working to analytically detect trace concentrations of compounds released with the nitrate. We will also look at other chemical changes which have been used to

> link up-gradient land use to effects in drinking water wells. EPA hopes to assess which activities on the landscape are contributing excess nitrate to shallow ground water. In this way we can determine which practices or activities are protective of continuing ground-water quality, and which activities are threats to the ground-water resource. In addition, the sampling from this project will provide enforcement-quality data for nitrates and bacteria that could be used in later enforcement actions…
>
> In order to develop a linkage between the high nitrate observed in a private drinking water well and the land use which is adversely affecting ground-water quality it will be necessary to look beyond nitrate. Analytical methods are available to detect a wide range of organic compounds which originate with the nitrate and which may provide a linkage back to the source. By looking at the agricultural chemicals, the hormones or the personal care products traveling with nitrate, we hope to link and identify the farming practice, the confined animal feeding operation or the rural residential septic system which is the source of the nitrate, respectively. Many of these trace organics can be detected at exquisitely low concentrations – some as low as single digit parts per trillion.

However, because of numerous deficiencies with the program design as well as analytical problems that resulted in unusable or estimated data, the resulting data set was insufficient to support scientifically valid conclusions about the sources of contaminants to downgradient wells. General issues with the dataset are discussed below.

4.1.1 U.S. EPA selected groundwater well sampling locations in a biased manner

In Phase 3, groundwater well sampling locations were chosen from those locations expected to have the highest nitrate concentrations. This has at least two implications: (1) wells with lower concentrations that might provide a more complete picture of contaminant presence and behavior were not sampled, and (2) reported concentrations likely overestimate average concentrations at downgradient sites. Thus, sampling bias may lead to invalid conclusions about the nature and extent of contamination.

Specifically, U.S. EPA selected the wells that had the highest nitrate concentrations in Phase 2 for more extensive sampling and analysis in Phase 3 (U.S. EPA, 2012a; p. 14). U.S. EPA (2010) stated this intention in its Phase 3 QAPP, indicating, "Phase 3 will include revisiting the domestic wells which tested highest for nitrate in Phase 2" (p. 8).

In addition, the Phase 2 sampling results were themselves biased high: U.S. EPA (2012a) states with regard to the Phase 2 sampling (p. 13), "The sampling team also used nitrate colorimetric test strips (Hach® test strips) as a field screening tool to provide an indication of whether the water exceeded the MCL [maximum contaminant limit] of 10 mg/L for nitrate. The Hach® test strips measure nitrate concentrations in increments of 0, 1, 2, 5, 10, 20, and 50 mg/L. If the Hach® test strip indicated the water may exceed the MCL (10 mg/L), samples were collected for analysis by EPA's Manchester Environmental Laboratory…" In total, in Phase 2, 331 homes were screened (between February 22–March 6, 2010), and the lab received 189 samples for analysis of which 102 were analyzed for nitrate and chloride, 2 for nitrate and nitrite, and 123 for total Kjeldahl nitrogen (TKN) (p. 13). Samples for 67 of those homes, or about 20%, were found to exceed the MCL of 10 mg/L for nitrate.

U.S. EPA (2012a) acknowledges the sampling bias, stating (p. 14), "The percentage of homes with nitrate levels in wells above the MCL in this study were higher than the 12 percent from earlier studies because the homes sampled in Phase 2 were selected based on their proximity

to likely sources. This method of selection would be expected to bias the results compared with a study where the sampling locations were selected randomly." Thus, sampling results obtained during Phase 3 cannot be interpreted as giving a scientifically valid picture of the nature and extent of contamination in the sampled areas.

4.1.2 U.S. EPA collected insufficient upgradient samples to discern measured downgradient levels from background

In Phase 3, U.S. EPA (2012a) states that they collected and analyzed samples from "representative" residential drinking water wells upgradient of the dairies (p. ES-3, p. 14), i.e., at locations not expected to be impacted by dairy activities. However, they do not specify what makes these wells "representative," and they only collected samples from two upgradient locations, one upgradient of each dairy sampling area (WW-01 upgradient of Haak Dairy, sampled April 13, 2010, and WW-06 upgradient of the Dairy Cluster, sampled April 15, 2010).

Two additional wells upgradient of the Dairy Cluster were sampled during Phase 2 but not Phase 3 (U.S. EPA, 2012a, footnote, p. 16). Table C1 (U.S. EPA, 2012a) indicates that "nitrate as N" was measured in each of these wells and concentrations at both were 5 mg/L (in wells WW-22085 and WW-22103). U.S. EPA does not indicate why these wells weren't evaluated further in Phase 3. Evaluating only one upgradient well from each site results in a dataset that is inadequate to conduct statistically valid comparisons of upgradient and downgradient concentrations.

In any experiment conducted to determine the nature and source of environmental contamination, collection of sufficient background samples is critical. Per U.S. EPA (1989a), "Background sampling is conducted to distinguish site-related contamination from naturally occurring or other non-site-related levels of chemicals." Specifically, when sampling groundwater, the intent of collecting samples from upgradient wells is to provide information on background conditions hydraulically upgradient of a site, for comparison to wells suspected of being impacted by site-related activities. For example, non-point sources such as agricultural practices as well as industrial or commercial activities may influence background water quality and should be distinguished from site-related contamination (Aller et al, 1991).

U.S. EPA's *RCRA Ground-Water Monitoring Technical Enforcement Guidance Document* (U.S. EPA, 1986) elaborates on principles for appropriate design of sampling programs to characterize background in groundwater monitoring programs. U.S. EPA (1986) states (p. 67):

> There are at least three main questions that the technical reviewer should ask when reviewing the decisions the owner/operator has made regarding the placement of the background monitoring wells:
>
> - Are the background wells far enough away from waste management areas to prevent contamination from the hazardous waste management units?
> - Are enough wells installed and screened at appropriate depths to adequately account for spatial variability in background water quality?
> - Are well clusters used at sampling locations to permit comparisons of background ground-water data with downgradient ground-water data obtained from the same hydrologic unit?

They further state that, by regulation, "the owner/operator must install as a minimum one background well." Indeed, 40 CFR 265.91 (Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities, Subpart F: Ground-Water Monitoring, 265.01– Ground-water monitoring system) states that a groundwater monitoring program to support investigations to meet the goals of the Resource Conservation and Recovery Act (RCRA) must consist of at least four wells: one upgradient from the unit and three hydraulically downgradient. The upgradient wells are intended to collect samples that are representative of background ground-water quality in the uppermost aquifer near the facility and that are not affected by the facility. The "number, locations, and depths must ensure that they immediately detect any statistically significant amounts of hazardous waste or hazardous waste constituents that migrate from the waste management area to the uppermost aquifer." However, while the regulations state that one upgradient well is sufficient, they are clear that monitoring at the upgradient well(s) must take place quarterly for a full year to establish background parameters indicating the suitability of the ground water as a source of drinking water (40 CFR 265.92(c)(1))—in other words, sampling once at a single upgradient well is insufficient.

With regard to numbers of wells, U.S. EPA (1986) (p. 67) further cautions that one background well may be insufficient:

> ...a facility that uses only one well for sampling background water quality may not be able to account for spatial variability. It is, in fact, a very unusual circumstance in which only one background well will fully characterize background ground-water quality...In most cases, the owner/operator should install multiple background monitoring wells in the uppermost aquifer to account for spatial variability in background water quality data.

They elaborate (p. 132):

> The inclusion and exclusion of various components of variability in background ground-water data have a substantial impact on the performance of the statistical test. When a background sampling program includes data from only one upgradient well, there is no component of spatial variability in the background data.

Because only one upgradient sample was collected for comparison to samples collected downgradient of each dairy sampling area, there is insufficient statistical power to determine whether concentrations measured downgradient are similar to or different from background. As such, there is no scientific certainty about any conclusions drawn in this regard. Because of the deficiency in upgradient/background data, the following assertion by U.S. EPA (2012a), for example, is not valid (p. 21), "...if chloride is detected at high levels in a dairy lagoon and the concentrations of chloride in a water well downgradient of the dairy lagoon are higher than in a well upgradient of the dairy lagoon, it indicates the dairy lagoon is a likely source of chloride to the downgradient well."

In addition to the insufficient number of upgradient samples near the dairies, U.S. EPA collected *no* well water samples upgradient of the other types of potential contaminant sources evaluated in the program, including residential septic systems and irrigated crop lands. Consequently, U.S. EPA cannot draw valid conclusions about the type and extent of contamination contributed from these sources as opposed to other potentially confounding sources.

Finally, U.S. EPA collected no background soil samples from any location, to characterize concentrations of constituents in soil in the Lower Yakima Valley from such sources as atmospheric deposition, or from other nonpoint residential or urban/industrial sources.

4.1.3 U.S. EPA does not demonstrate that the upgradient and downgradient wells sampled the same hydrologic units

When assessing whether a potential source could have impacted a drinking water aquifer, it is critical to confirm that sampling data intended to characterize upgradient and downgradient conditions are drawn from the same hydrologic unit. Water collected from different units would be expected to have different characteristics and concentrations. Without confirmation of this, U.S. EPA cannot support conclusions based on comparisons between these wells—differences in measured upgradient and downgradient concentrations could be due to sampling of different aquifers rather than the introduction of a contaminant source between the upgradient and downgradient wells.

For example, U.S. EPA (1986) cites RCRA requirements for groundwater sampling that state with regard to sampled aquifers (p. 66):

> The upgradient wells must be located and constructed to provide representative samples of groundwater in the same portion of the aquifer monitored by the downgradient wells to permit a comparison of groundwater quality (40 CFR 265, Subpart F, 265.92(a)(1)).

They further elaborate (p. 67):

> The owner/operator should also install enough background monitoring wells to allow for depth-discrete comparisons of water quality. This means simply that for downgradient wells completed in a particular geologic formation, the owner/operator should install upgradient well(s) in the same portion of the aquifer, so that the data can be compared on a depth-discrete basis…

In its QAPP for Phase 3, U.S. EPA (2010) acknowledged that sampling from domestic drinking water wells might result in collection of samples from different water horizons, but determined that time and resource limitations outweighed this concern (p. 8):

> The use of private domestic water supply wells requires contacting individual home owners and requesting access to sample their drinking water. It further involves using wells installed for another purpose for use as groundwater monitoring wells. These wells may not be screened at horizons where they optimally intersect the water we seek to monitor. However, the alternative of either direct-push geoprobe style investigatory soil borings or dedicated well installations is not feasible given our interest in timely collection of this data and the resources available.

Despite their lack of knowledge about the horizon monitored, U.S. EPA proceeded to collect samples from these wells and attempted to draw conclusions based on these data without verifying that samples from locations of interest were collected from the same aquifers.

U.S. EPA (2012a) makes a number of statements that demonstrate, post sampling, they still lacked critical information about the aquifers that were sampled. For example:

- When U.S. EPA collected samples from drinking water wells, they "sampled residential drinking water from a tap and depth to water was not measured" (p. 17).

- U.S. EPA (2012a) acknowledges (p. ES-3, p. 3) that "Lack of complete well information limits our ability to verify if the wells upgradient and downgradient of the sources draw water from the same water bearing zone."
- With regard to Haak Dairy, U.S. EPA (2012a) states (p. ES-5), "Information on the construction and depth of the upgradient and one downgradient well would be helpful to provide additional certainty regarding the likely sources." They further state (p. 36), "Available information about the construction and depth of WW-03 and WW-04, the downgradient wells, suggest they are completed in the alluvial aquifer at depths of 95 feet and 88 feet. Information about the upgradient well, WW-01, is limited."
- With regard to the Diary Cluster, U.S. EPA (2012a) states (p. ES-6), "As with the Haak Dairy, information on the construction and depth of the upgradient well and five of the downgradient water wells sampled during Phase 3 would be helpful to clarify the contribution of sources to the increased concentrations measured in the downgradient wells."
- U.S. EPA (2012a) suggests that the dairy supply wells may draw from a different aquifer than downgradient residential wells, stating (p. 85), "The water in the dairy supply wells that are known to be screened in the deeper basaltic aquifer is older than in the downgradient residential wells which are commonly screened in the shallower alluvial aquifer."

Regarding the complex groundwater flow in the Lower Yakima Valley, U.S. EPA (2012a) acknowledges that without more complete information, they cannot draw definitive conclusions about the basis of concentration differences reported in upgradient vs. downgradient study wells. For example, they state (p. 8):

> The Lower Yakima Valley is filled with sediments shed by the ridges at the margins of the study area and those deposited in the valley bottom by the Yakima River. These sediments have an internal structure that strongly controls groundwater movement. As the water moves through these sediments, it tends to follow preferential flow paths composed of coarser sediments.
>
> Very frequently, there are 10- to 100-fold differences in groundwater velocities among aquifer materials of such contrasting grain size (Freeze and Cherry 1979). These different preferential flow paths can have different water chemistry, depending on their location below a source of contamination. A well that is located along a preferential flow path may draw a substantial portion of its water from a particular source. A well located on an adjacent, but different, preferential flow path may have markedly different chemistry. For this reason, it is anticipated that upgradient sources of nitrate could produce different downgradient effects in groundwater (such as nitrate in water wells), even in wells from neighboring homes.

Without confirming that upgradient and downgradient samples are drawn from the same aquifers, U.S. EPA cannot make valid conclusions that differences in upgradient and downgradient concentrations are due to the contribution of an intervening source. An example of a conclusion drawn by U.S. EPA (2012a) that cannot be reliably and scientifically supported without more complete hydrologic information is as follows (p. 38):

> Based on the observed concentrations, chloride and other ions are being introduced to the aquifer between the upgradient and downgradient wells at the Haak Dairy. One explanation for the observed increase in these major ions is that the dairy lagoons are

> introducing these ions to the groundwater. As with total nitrogen, this indicates that the Haak Dairy is a likely source of the major ions in the three downgradient residential drinking water wells at the Haak Dairy.

Likewise, U.S. EPA's conclusions with regard to the Dairy Cluster can also not be supported, for example where they state (U.S. EPA, 2012a; p. 54):

> The figures show a similar pattern to that observed at the Haak Dairy, with elevated concentrations in the downgradient wells (WW-10 to WW-17) compared with the upgradient wells (WW-06) and the supply wells (WW-07 to WW-09), with the highest concentrations in the lagoons. Alkalinity also showed a similar pattern. The increase in the concentrations ranges from up to: seven-fold for sodium; nine-fold for magnesium; 10-fold for calcium; and more than 30-fold for chloride. Potassium showed a slight increase. As with the Haak Dairy, sulfate showed the largest increase in concentration between the upgradient and downgradient wells. As with the Haak Dairy, the dairy sources are a likely source of major ions in the downgradient water wells.

4.1.4 U.S. EPA does not acknowledge other land uses that could contribute contamination upgradient of dairy, cropland, and residential septic sources

Overall, because of the large number of potential sources to groundwater contamination in the Lower Yakima Valley, without a more carefully controlled sampling program, it is impossible to assign measured contamination to a given source. Multiple potential groundwater contaminant sources exist in the Lower Yakima Valley, including agricultural, industrial, and human wastewater sources.

For example, U.S. EPA (2012a) states that sampled dairies were selected in part because of "minimal upgradient nitrate sources to the extent possible" (p. 17). However, examination of the Haak Dairy and Dairy Cluster locations, including the information provided in Figure 7 (Lower Yakima Valley Dairy Locations), Figure 8 (Lower Yakima Valley Crop Inventory), and Figure 9 (Lower Yakima Valley Septic System Distribution) suggests that additional uncharacterized sources could contribute to concentrations measured in these wells. Specifically:

- Figure 8 juxtaposed with Figure 7 suggests that some other types of crops (including tree fruit and corn) are grown north of Haak Dairy, some croplands are north and northeast of the Dairy Cluster, and some septic systems are north and northeast of Haak Dairy and the Dairy Cluster.
- A large livestock facility and what appears to be an adjacent application field are located to the northeast of Haak Dairy (not shown in Figure 7, but visible on Google Earth).

In addition, based on Figure 12 and the illustrated groundwater flow direction, WW-01 does not appear to be truly upgradient of wells WW-03, WW-04, and WW-05 at Haak Dairy—the "upgradient" well appears to be further to the west of the other wells. The impact of this discrepancy on comparisons between upgradient and downgradient concentrations is uncharacterized.

The sampling locations intended to reflect irrigated cropland and septic sources may also be impacted by additional sources. U.S. EPA (2012a) indicated that the irrigated cropland sampling locations were selected in part because of "minimal upgradient nitrate sources" (p.

18), and that residential septic system sampling locations were selected in part because of "minimal upgradient nitrate sources other than septic" (p. 18). However, the cropland locations near Mabton are located downgradient of populated areas where septic systems would be expected (some are indicated in Figure 9), and examination of satellite views (e.g., Google Earth) as well as Figure 7 shows a number of dairies or other livestock facilities in this area including upgradient. In fact, regarding these locations, U.S. EPA acknowledges (p. 84), "the irrigated crop fields are surrounded by similar agricultural uses, and many are situated downgradient of dairies, making more difficult EPA's ability to discern the source of nitrate in drinking water wells downgradient of the irrigated crop fields." The impact of these uncharacterized sources on conclusions about irrigated cropland and septic system sources is unknown, particularly given that background groundwater or soil samples are not collected upgradient of the "irrigated cropland" and "septic system" locations, as discussed in Section 4.1.2. Because of inadequate control of these sampling programs, no scientific conclusions can be drawn about the nature or contribution of any of these sources to contamination of soil or groundwater in the Lower Yakima Valley.

4.1.5 U.S. EPA collected grab samples, which are insufficient to characterize long term conditions

All of the samples collected by U.S. EPA (2012a) were grab samples, i.e., single samples that represent conditions at a discrete location and time. However, it is recognized that groundwater concentrations, in particular, can fluctuate over time. The relationship between concentrations measured in the groundwater samples (collected between February through April 2010) and average or longer term conditions is not known, i.e., whether measured concentrations are higher or lower than average.

Barcelona et al. (1989) describe a number of factors that can cause temporal variability in measured groundwater concentrations, including "'natural' causes, physical-chemical transport properties or sampling-related variables:"

> Examples of natural causes are inhomogenous spatial distributions of the constituents superimposed on the local and regional ground-water flow field, temporal variability in recharge, and inhomogeneities in aquifer properties (e.g., transmissivities). Physical-chemical transport properties may include dispersitivities, sorptive interactions or chemical reactions. Sampling-related variables are well design, sampling devices, and field sampling and laboratory analysis protocols. Other sources of temporal variability in water-quality data which are often attributed to natural effects include hydrologic transience, the time and space variations in contaminant source, strength and composition, and the interactions between reactive chemical, biochemical and mineral constituents in recharge or flowing ground water.

Regarding the design of sampling programs to capture the variability of groundwater concentrations, it is concerning that U.S. EPA (2012a) does not conform to its own recommendations. A U.S. EPA research document, *Sampling Frequency for Ground-Water Quality Monitoring* (U.S. EPA, 1989b), suggests that "quarterly sampling frequency is a good initial starting point for ground-water quality monitoring network design, though bimonthly frequency may be preferred for reactive chemical constituents."

Concentrations of some of the analytes included in the U.S. EPA (2012a) program are expected to show seasonal variations. For example, concentrations of fertilizers and pesticides in soil are expected to be higher immediately following application; without more

careful sampling, it is not known how these temporal variations affect groundwater concentrations. In addition, time of irrigation or precipitation could impact surface soil concentrations and rates of movement of compounds through soil.

U.S. EPA (2012a) acknowledges the potential effect of temporal factors on pesticide levels, stating (p. 23), "Many of the pesticides are used on specific crops and during specific times of the year. This pattern of usage can be an advantage, as it can assist to identify the specific crop where the pesticide was applied. At the same time, it is possible that a particular pesticide, though used in the area, was not applied before the time of sample collection and may not have been detected in the soil samples collected by EPA." However, U.S. EPA (2012a) does not provide any information on the time of application of pesticides or fertilizers compared to the dates of soil sampling that might allow an assessment of whether sampled results are biased low or high relative to average.

Several of the well sampling locations appear to be in close proximity to one another; one would expect similar concentrations to be measured in samples from these wells. For example, collocated samples were collected at a lagoon at D and A Dairy (samples LG-08 and LG-09) and at a lagoon at Cow Palace (samples LG-11 and LG-12) (U.S. EPA, 2012a; p. 53). However, there were wide variations in some parameters from LG-08 and LG-09, particularly concentrations of trace organics, wastewater pharmaceuticals, and veterinary pharmaceuticals (e.g., in these samples, reported trace organic concentrations varied by about four to five fold between the two samples, and two wastewater pharmaceuticals were reported detected in LG-08 at concentrations about 10-fold higher than their detection limits, but were nondetect in LG-09). The range of concentrations reported for samples collected at nearly the same location and time illustrate the heterogeneous nature of the sampled media and the potential variability in repeated sample measurements. Without further experimentation and investigation to quantify this variability, the potential for erroneous conclusions about similarities and differences in contaminant concentrations based on very small sample sizes is significant.

4.1.6 U.S. EPA did not demonstrate that "irrigated crop" samples are representative of contributions from cropland in the Lower Yakima Valley

U.S. EPA collected samples at and near six irrigated crop locations, including two fields each of corn, hops, and mint, to assess the potential contribution of cropland to nitrate and other constituents in well water. They selected these types of crops because "they require significant quantities of nitrogen to produce the large amounts of plant biomass for yield in contrast with other crops such as tree fruit" (U.S. EPA, 2012a; p. 17). In the Phase 3 QAPP, they stated (U.S. EPA, 2010), "For crop land, three crops were selected based on fertilizer application rates and pesticide usage. Corn fields, hop yards and mint fields were selected based on the amount of fertilizer used in their culture" (p. 16).

However, numerous other types of crops grown in the Lower Yakima Valley were not sampled to determine their contribution to nitrate and other constituents in groundwater. Thus, while a key objective of the sampling program was "attempting to use linking or tracer compounds to evaluate linkage between up-gradient land uses to nitrate in down-gradient drinking water wells" (U.S. EPA, 2010; p. 15), U.S. EPA did not attempt to comprehensively determine the sources of these "linking or tracer" compounds in the Lower Yakima Valley. Lack of data on these contributions reduces scientific certainty about possible sources of contaminants to groundwater.

U.S. EPA (2012a) stated that they initially considered irrigated cropland to be a potential source of nitrate to groundwater due to synthetic fertilizer application (which they assumed they could distinguish from fertilizers of animal waste origin using isotopic analysis), but admit that "through this study, it became clear that several of the irrigated crop fields sampled had also received manure applications" (p. 2). Consequently, U.S. EPA has demonstrated that potential cropland and livestock operation sources of nitrate cannot be reliably distinguished.

In addition to nitrate, the Phase 3 sampling program included numerous other analytes "to evaluate whether chemicals other than nitrate can be used to identify likely sources of the nitrate contamination in the groundwater and drinking water wells." However, other crop types can contribute to these contaminant types and may influence conclusions based on these analytes. For example, numerous pesticides are applied to tree fruits (Table 1) and grapes (Table 2) in Washington State. Other crops grown on significant acreage in Yakima County that were not considered in the U.S. EPA sampling program include alfalfa, winter wheat, and hay (U.S. EPA, 2012a; Appendix G).

Further, soil samples collected at each crop field were collected from 30 shallow (1 inch) soil samples per field that were composted to give a "representative" soil sample (U.S. EPA, 2012a; p. 17). Thus, soil data cannot be used to discern variations in concentrations across the crop fields; compositing makes it impossible to determine whether contamination was relatively homogeneous or whether localized hot spots biased average concentrations upward.

Table 1. Examples of Tree Fruit Pesticides Used in Washington State

Fungicides/Bactericides	Herbicides	Insectides and Miticides	
A-506 pseudomonas	2,4-d	Abamectin	Hydrochloride
Fluorescens	Carfentrazone-ethyl	Acequinocyl	Imidacloprid
Azoxystrobin	Clopyralid	Acetamiprid	Indoxacarb
Bacillus pumilus	Dichlobenil	Azadirachtin	Kaolin clay
Bacillus subtilis	Diuron	Azinphos methyl	Lambda-cyhalothrin
Boscalid	Fluazifop	Bacillus thuringiensis	Lime sulfur/calcium
Captan	Fluroxypyr	Bifenazate	Malathion
Chlorothalonil	Glufosinate-ammonium	Buprofezin	Methidathion
Copper hydroxide	Glyphosate	Carbaryl	Methomyl
Cyprodinil	Isoxaben	Chlorantraniliprole	Methoxyfenozide
Dodine	Isoxaben	Chlorpyrifos	Novaluron
Fenarimol	Napropamide	Clofentezine	Oxamyl
Fenbuconazole	Norflurazon	Clothianidin	Permethrin
Fish oil	Oryzalin	Deltamethrin	Petroleum oil
Fixed copper	Oxyfluorfen	Diazinon	Pheromone
Flutriafol	Paraquat	Dicofol	Phosmet
Iprodione	Pendimethalin	Diflubenzuron	Polysulfide
Kaolin clay	Pronamide	Dimethoate	Potassium salts of fatty acids
Kresoxim-methyl	Pyraflufen-ethyl	Emamectin benzoate	Propargite
Lime sulfur/calcium polysulfide	Rimsulfuron	Endosulfan	Pyrethrins
Mancozeb	Sethoxydim	Esfenvalerate	Pyridaben
Metconazole	Simazine	Etoxazole	Pyriproxyfen
Metiram	Terbacil	Fenbutatin oxide	Rosemary/peppermint oil
Myclobutanil	Trifluralin	Fenpropathrin	Spinetoram
Oxytetracycline		Fenpyroximate	Spinosad
Petroleum oil		Fish oil	Spirodiclofen
Potassium bicarbonate		Flonicamid	Spirotetramat
Potassium salts of fatty acids		Flubendiamide	Sulfur
Propiconazole		Formetanate	Tebufenozide
Pyraclostrobin		Gamma-cyhalothrin	Thiacloprid
Quinoxyfen		Granulosis virus	Thiamethoxam
Streptomycin sulfate		Hexythiazox	
Sulfur			
Tebuconazole			
Thiophanate-methyl			
Thiram			
Trifloxystrobin			
Triflumizole			
Ziram			

Source: WSU Extension (2011).

Table 2. Examples of Grape Pesticides Used in Washington State

Fungicides	Herbicides	Insectides and Miticides	
Azoxystrobin	2,4-D	Acetamiprid	Abamectin
Boscalid	Carfentrazone-ethyl	1,3-dichloropropene	Bifenizate
Captan	Clethodim	Beta-cyfluthrin	Fenpyroximate
Cyprodinil	Dichlobenil	Bifenthrin	Propargite
Difenconazole	Diuron	Buprofezin	
Fenarimol	Flumioxazin	Carbaryl	
Fenhexamid	Fluazifop	Chlorantraniliprole	
Iprodione	Glufosinate	Cyfluthrin	
Kresoxim-methyl	Glyphosate	Dinotefuran	
Metrafenone	Napropamide	DiTera	
Micronized flowable sulfur	Nonionic surfactant	Dormant oil	
Myclobutanil	Norflurazon	Fenpropathrin	
Paraffinic oil	Oryzalin	Imidacloprid	
Potassium bicarbonate	Oxyfluorfen	Malathion	
Pyraclostrobin	Paraquat	Metham sodium	
Pyrimethanil	Pendimethalin	Potassium salts	
Quinoxyfen	Pronamide	Promax	
Sulfur	Pyraflufen ethyl	Spineoram	
Sulfur dust	Rimsulfuron	Spinetoram	
Tebuconazole	Sethoxadim	Spinosad	
Tetraconazole	Simazine	Sodium tetrathiocarbonate	
Trifloxystrobin	Trifluralin	Thiamethoxam	
Triflumizole		Zeta-cypermethrin	

Source: WSU Extension (2012)

4.1.7 U.S EPA's Phase 3 results for a large percentage of analyte types and matrices are unusable or qualified due to analytical difficulties

U.S. EPA (2012a) reported problems with conducting analyses for a number of the analyte groups and media. As a result, some data were identified as unusable whereas other analyses were not conducted. In addition, a large percentage of the remaining data was characterized as qualified. The lack of complete and high quality data sets for all compound types in all media diminishes the ability to draw reliable scientific conclusions about possible sources of these contaminants.

As a result, for many of the parameters, U.S. EPA does not meet its Completeness criterion specified in its Phase 3 QAPP (U.S. EPA, 2010), specifically, "Completeness is the percentage of valid results obtained compared to the total number of samples taken for a parameter. Since sampling from inspections are usually grab and limited in number of samples, the number of valid results obtained from the analyses are expected to be equal or better than 85%" (p. 14).

Specific data quality problems are described below.

First, a large proportion of the analytical results in all media are "J qualified." For example, approximately 64% of the pesticides measurements in well water are J qualified, as are 47% of the wastewater pharmaceuticals measurements in well water. A large proportion of other sample types are also J qualified (e.g., 52% of trace organics and 20% of wastewater pharmaceuticals measurements in lagoons; 21% of pesticides measurements in soils; and 52% of trace organics, 26% of wastewater pharmaceuticals, and 37% of veterinary pharmaceuticals measurements in WWTP samples). Per U.S. EPA (1996), the J qualifier indicates,

> ...the analyte was positively identified- the associated numerical value is the approximate concentration of the analyte in the sample. The "J" qualifier indicates

> that one or more QA/QC requirements have not met contact required acceptance criteria but the instrumentation was functioning properly during the analysis. For example, a "J" qualifier may indicate that the sample was difficult to analyze or that the value may lay near the low end of the linear range of the instrument. "J" data are considered biased, but provide definitive analyte identification.

While a J qualifier does indicate positive identification of an analyte, U.S. EPA (1996) emphasizes that "All qualified data should be carefully evaluated to determine if the data are biased…qualified data should always be carefully reviewed on a case-by-case basis prior to use…" They further elaborate,

> It is important to understand the direction of bias associated with "J" qualified data before using the data to document an observed release. Qualified data may have high, low, or unknown bias. A low bias means that the reported concentration is likely an underestimate of the true concentration. For example, data may be biased low when sample holding times for volatile organic compounds (VOCs) are moderately exceeded or when recovery of QA/QC compounds is significantly less than the amount introduced into the sample. Low surrogate recovery would also indicate a low bias. A high bias means the reported concentration, is likely an overestimate of the true concentration. For example, data may be biased high when recovery of QA/QC compounds is significantly higher than the amount in the sample. A bias is unknown when it is impossible to ascertain whether the concentration is an overestimate or an underestimate. For example, an unknown bias could result when surrogate recoveries exceed method recovery criteria and matrix spike/matrix spike duplicate compounds below method recovery criteria fail the relative percent difference (RPD) criteria in the same sample.

Thus, the uncertainty associated with J qualified data limits the validity of any quantitative comparisons between samples that have this qualifier. In our review of U.S. EPA's Phase 3 assessment, all J qualified data appear to be evaluated as if reported concentrations represent true concentration values, without considering the potential bias in the data on a case-by-case basis.

Second, U.S. EPA indicates that pesticide results from dairy lagoon and WWTP samples are unusable. Specifically, U.S. EPA (2012a) states (p. 23),

> EPA's Manchester Laboratory reported that the sample matrices provided significant interferences that made pesticide analysis difficult for dairy lagoons and WWTP influent samples. Because of this problem, the pesticide concentrations could not be quantified in the dairy lagoons or WWTP influent samples. The laboratory attempted to develop an extraction and cleanup procedure for the dairy lagoon and WWTP sample matrix; however, a procedure to resolve the matrix interference could not be developed within the maximum holding time specified for these samples. The maximum sample holding times would have been exceeded by the time the laboratory could have developed and tested an effective and reliable procedure. Therefore, the pesticide results for the dairy lagoon and WWTP samples are considered unusable for all purposes.

Regarding these pesticide data, U.S. EPA (2012a) summarized (p. E-8),

> The project data quality goals for precision and accuracy for numerous target analytes were not met for dairy lagoons and WWTPs. As stated above, all of the pesticides

> and herbicide results for the dairy lagoons and WWTPs could not be quantified and are considered unusable because of (1) the complexity of the sample matrices, (2) holding times that were exceeded, (3) recurring QC failures, and (4) the limitations of modified Method 8270D for detecting pesticides and herbicides at the project reporting levels.

This limits the size of the dataset that U.S. EPA can use in their efforts to trace contaminant sources.

Third, due to quality control issues, U.S. EPA advises data users to consider trace organics results as a "screen," i.e., to be used "only for information purposes" and requiring "confirmatory analyses." Regarding the trace organics measurements, U.S.EPA (2012a) (p. 23) states that they

> ...believed the trace organics would help to differentiate water wells affected by septic systems (humans) from water wells influenced by other sources such as dairy lagoons or irrigated cropland. The compounds analyzed include many that can be associated with human usage, including caffeine, bisphenol A, cholesterol, menthol, phenol, various flame retardants, acetophenone (fragrance in detergent), benzophenone (fixative for perfumes), camphor (flavor, oxidant), isoborneol (fragrance in perfume), and many others.

However, regarding these data, U.S. EPA (2012a) states (p. E-10):

> USGS NWQ Laboratory analyzed fifteen dairy lagoons, three WWTP plant influent, and 30 water samples for trace organic chemicals following the SOP for the "Analysis of Waste Water Samples by Gas Chromatography/Mass Spectroscopy" – USGS SOPs 1433 and 4433. ...
>
> Data users are advised to consider the values reported as a screen. For full usability, data need further confirmation for the following reasons: (1) data were not thoroughly verified by the validator because of the absence of the instrument raw data output at the time of review, and (2) the laboratory followed their inhouse SOP and the recurrence of results out of SOP QC control limits indicates that the data may not be reproducible by a third party. The data reported can only be used for information purposes and a good starting point in determining sample locations for confirmatory analyses.
>
> Samples were analyzed following the technical specifications of the analytical method. Approximately 6 percent of the total data points were qualified unusable based on extremely low surrogate recoveries. Approximately 32 percent of the total data points were qualified estimated due to chromatographic interference and QC results that did not meet the specified criteria.

Thus, because the trace organics results are considered to be screening-level only, U.S. EPA cannot validly use any of these data to support conclusions about potential sources of contaminants in drinking water wells.

Fourth, U.S. EPA (2012a) indicates that the wastewater pharmaceuticals data from the University of Nebraska—Lincoln Water Science Laboratory (UNL) should also be considered a "screen." In addition, all reported well water results for two wastewater pharmaceutical compounds (naproxen and triclosan) are rejected ("R qualified") as are all reported dairy lagoon results for two compounds (amphetamine and methamphetamine).

Specifically, regarding the wastewater pharmaceuticals data, U.S. EPA (2012a) states (p. E-12):

> Data users are advised to consider the values reported as a screen. For full usability, data needs further confirmation for the following reasons: (1) data were not thoroughly verified by the validator because of the absence of the instrument raw data output at the time of review, and (2) there is no established standard analytical method for the analysis of the target compounds and the recurrence of out of control QC results and big variability in the duplicate runs indicated that the data may not be reproducible by a third party. The data reported can only be used for informational purposes only and a good starting point in determining sample locations for confirmatory analyses.

Yet even within U.S. EPA's own report, they do not fully acknowledge these data qualifications. On the same page, U.S. EPA (2012a) states regarding the wastewater pharmaceutical results (p. E-12), "Approximately 10 percent of the wastewater pharmaceutical data points were qualified unusable because of extremely low spike and surrogate recoveries (less than 10 percent). An additional 55% of the total data points were qualified estimated due to out of control recoveries in the associated QC runs. The rest of the data as qualified are usable for all purposes." U.S. EPA does not reconcile how they can characterize 35% of the wastewater pharmaceutical data as "usable for all purposes" when they clearly state that sample results should only be considered a "screen." These inconsistencies in U.S. EPA's qualifications of the data further erode confidence in the overall data usability.

Fifth, a significant portion of the veterinary pharmaceuticals data are either qualified as unusable or estimated. For example, all detected concentrations for the dairy lagoons are either rejected as unusable ("R qualified"), or estimated ("J qualified") (U.S. EPA, 2012a; Table C12).

Regarding the limitations of the veterinary pharmaceuticals data, U.S. EPA (2012a) states (p. E-12),

> Most of the liquid samples (dairy lagoons, well water, and WWTP) underwent multiple analyses because of concentrations of some of the target compounds in the field blank and also because of matrix interferences. Approximately 9 percent of the total data points were qualified unusable and an additional 18 percent were qualified estimated concentrations with a high bias because of out of control internal standards or calibration. Five lincomycin and three monensin results in the water samples were detected above the reporting limits but were flagged nondetects based on contamination in the associated field blank, WW29. The concentrations reported were calculated using internal standard techniques. Most of the internal standards did not meet minimum area requirements when compared with the daily calibration standards. Therefore, the associated results may be biased high.

In addition, U.S. EPA's Water Science Lab (U.S. EPA, 2011) warned that much of the veterinary pharmaceutical data are biased and should be used with caution, stating,

> Due to the complexity of the liquid matrices (water, lagoon and WWTP) and chromatographic interferences, internal standards used for calculating the concentrations of the target compounds were affected resulting in a potentially high biased associated data. Data users are warned to use the reported values with caution

as the concentrations of the compounds in the samples maybe lower than what were reported.

Approximately 9% of the total data points were qualified unusable and additional 18% were qualified estimated concentration with a high bias due to out of control internal standards and or calibration. Five Lincomycin and 3 monensin results in the water samples were detected above the reporting limits but were flagged non-detects due to contamination in the associated field blank, WW29.

U.S. EPA's interpretation of the detected veterinary pharmaceutical in the field blank introduces additional uncertainties: U.S. EPA's Water Science Lab (U.S. EPA, 2011) indicates that three monensin detects in well water samples were flagged as non-detect due to contamination of the field blank WW29 by monensin (although Table C12 of U.S. EPA, 2012a does not indicate that monensin was detected in the field blank—this discrepancy must be addressed). Since sample WW29 was the only field blank collected and analyzed for veterinary pharmaceuticals in water, all compounds detected in the field blank should be labeled as qualified when detected elsewhere. However, as discussed in Sections 4.3.2 and 4.3.3, below, U.S. EPA reported positive detections of monensin in several other well water samples: they report that monensin was detected in the sample upgradient of the Haak Dairy and all three of the wells downgradient of the Haak Dairy, and in two of eight wells downgradient of the Dairy Cluster. It is not apparent why all these reported detects weren't also qualified as nondetects, since the single field blank sample WW29 should be applicable to all of the well water samples.

Sixth, U.S. EPA did not meet preservation requirements for many of the nitrate samples. U.S. EPA (2012a) indicates that 31% of the 147 samples for nitrate/nitrites, TKN, and ammonia were qualified estimated with a possible low bias because the samples did not meet the preservation requirements when they were received at the laboratory (p. E-8). It is not known if or how not meeting the preservation requirement may have differentially affected measured concentrations in upgradient and downgradient samples, but this preservation issue further erodes confidence in the data.

Thus, because of numerous data quality issues, it is invalid to use much of the pesticides and veterinary pharmaceuticals well water data or any of the trace organics or wastewater pharmaceuticals well water data in quantitative comparisons or to assess potential sources of contaminants to downgradient wells.

4.1.8 U.S. EPA did not collect field duplicate samples

In addition to the analytical and data quality issues described above, U.S. EPA (2012a) did not collect field duplicate or triplicate samples for water wells or lagoons "due to an oversight" (p. E-5). This discrepancy is noted in the U.S. EPA laboratory corrective action form.[6] Per the Phase 3 QAPP, the rate of field duplicate collection was to be 1 in 10 samples (U.S. EPA, 2010; p. 35). U.S. EPA indicates that the measure taken to correct this issue is, "Laboratory analytical duplicate quality control samples were analyzed." However, field and laboratory duplicates are not equivalent.

Field duplicates are independent samples collected as close as possible to the same point in space and time. They represent separate samples taken from the same source and analyzed

[6] F Corrective Action form for the Phase 3 Yakima Valley Nitrate Study, dated August 1, 2012. ftp://ftp.epa.gov/reg10ftp/sites/yakima/QAPP_Deviations_SAFs_and_CAFs/YV_CAF_no_field_duplicates.pdf

independently. They are useful in documenting the reproducibility (precision) of the sampling and analytical process. In general, U.S. EPA recommends that field duplicates be included at a frequency ranging from one per day per matrix to 10% of all field samples per matrix (U.S. EPA, 1992; U.S. EPA, 2007). If field duplicate results are highly variable and fall outside of quality objectives established in the project Sampling and Analytical Plan (SAP) or QAPP, then potential sources of the variability (e.g., sampling or analytical issues, or heterogeneity of the sampled matrix) can be investigated to determine the overall impact on data quality.

In contrast, a laboratory duplicate is typically an interlaboratory split of one sample; it is used to document the precision of the analytical method (U.S. EPA, 1992). It does not capture any influences introduced by the sampling protocol (e.g., sample collection, sample storage/transfer) or the in-field heterogeneity of the sampled matrix.

U.S. EPA's failure to collect field duplicates further reduces confidence in the quality of the collected data.

4.1.9 U.S. EPA's detection limits for some analyses are high

In general, a detection limit is the lowest amount of a chemical that can be "seen" above the normal, random noise of an analytical instrument or method. A chemical present below that level cannot reliably be distinguished from noise (U.S. EPA, 1989a). However, in some cases, the detection limits reported by U.S. EPA (2012a) for certain compound types in well water are higher than typically achieved. Consequently, lack of detection of these compounds can lead to erroneous conclusions about whether particular sources are contributing to groundwater concentrations.

For example, U.S. EPA's detection limit for wastewater pharmaceuticals in well water (0.2 μg/L) is higher than typically achieved for drinking water sources. USGS (2009) cites much lower reporting levels in drinking water for a number of the same compounds, including:

- Acetaminophen: 0.036 μg/L
- Azithromycin: 0.004 μg/L
- Cotinine: 0.014 μg/L
- Diphenhydramine: 0.015 μg/L
- Ibuprofen: 0.042 μg/L
- Thiabendazole: 0.011 μg/L

U.S. EPA (2012a) interprets the wastewater pharmaceutical data as follows, "Detection of these compounds in water wells may provide evidence that septic systems are a likely source of nitrate…If the compounds are detected in the WWTP influent, they can be compared with detected compounds in water wells to evaluate whether septic systems may contribute to the presence of these compounds in well water" (p. 24). Conversely, if these compounds are not detected, U.S. EPA may erroneously conclude that septic systems are not contributing to well contamination when in fact the detection limits are simply too high to detect the contribution.

4.1.10 U.S. EPA cannot validly apply chemical fingerprinting techniques because, in addition to other issues, fate and transport properties of the analyzed compounds differ

A primary purpose of U.S. EPA's Phase 3 investigation was to analyze wells "for a variety of chemicals to evaluate whether chemicals other than nitrate can be used to identify likely

sources of the nitrate contamination in the groundwater and drinking water wells" (U.S. EPA, 2012a; p. ES-1). U.S. EPA described this objective in more detail in the QAPP for Phase 3 (U.S. EPA, 2010), stating:

> Phase 3… will analyze for a wide range of potential tracing or linking compounds which may be traveling with the nitrate. These compounds would then potentially identify, or link back to, the land use from which the nitrate came. These compounds include estrogens, androgens, veterinary and human antibiotics, agricultural chemicals, personal care products and human medications and compounds such as caffeine or ibuprofin. (p.8)

One technique that is sometimes used to characterize the source of a contaminant plume or to monitor the migration of a leachate in the environment is "chemical fingerprinting" (Plumb, 2004). However, detection of contaminants in groundwater can be influenced by the analytical and sampling program design (discussed elsewhere in this Section) as well as chemical-specific factors that affect their fate and transport through soil and other subsurface media. For fingerprinting to be most effective, chemicals should be similar and behave in a similar manner (e.g., fingerprinting has been effectively applied to dioxins/furans and polychlorinated biphenyl compounds (PCBs)). Compounds that are dissimilar may behave in different ways; e.g., some may be relatively immobile, while others may volatilize and others move readily through the subsurface. However, because of the widely different chemical types evaluated in the U.S. EPA (2012a) program, it is impossible to establish a relationship between patterns of detection downgradient and in source (e.g., dairy, septic system, or cropland) samples.

U.S. EPA (2012a) acknowledges the potential impact of differences in chemical properties and behavior on interpreting the sampling and analytical data to determine source allocation, stating for example (p. 8-9):

> In addition to the variability caused by the physical characteristics of the aquifer, many compounds react with the silts, sands, and gravels of the aquifer in a way that slows their transport. Some compounds, such as nitrate and ions like chloride, tend to minimally adsorb and are transported nearly as fast as the water flows in the aquifer. Nitrate does not break down unless it encounters denitrifying bacteria and organic carbon, resulting in a low oxygen or anoxic environment. Other compounds, such as iron or manganese, often participate in chemical reactions and can create relatively immobile minerals, which can change their concentrations as measured in water wells (Fetter 1980).
>
> Organic compounds, which are any gaseous, liquid, or solid chemical compounds containing carbon, are typically less mobile in water than inorganic compounds. Organic compounds tend to adsorb to organic carbon in the aquifer and may be degraded by bacteria and either disappear entirely or may be greatly reduced in concentrations. Even if not broken down, most organic compounds will move much slower than nitrate because they tend to adsorb to other organic matter in the aquifer. As a result, in general, they are unlikely to be transported as far or as fast as the nitrate (Stumm and Morgan 1996);

and (p. 22):

> Organic compounds are subject to a number of factors that affect their fate and transport properties and would cause them to travel differently from nitrate in

> groundwater. Organic molecules are much more likely to sorb to materials in the aquifer, which could retard their migration compared to nitrate. In addition, organic compounds are subject to microbial degradation, which would reduce their concentration in groundwater over time.

Yet, U.S. EPA analyzes certain compound types that are unlikely to be detected in groundwater and will contribute little to understanding of contaminant sources. For example, U.S. EPA (2012a) analyzes synthetic hormones, stating (p. 28):

> Some of the synthetic hormones analyzed could be indicative of specific animal sources. For example, 17-α-ethynyl-estradiol is a synthetic analogue of 17-α-estradiol and is used in hormonal contraception exclusively in humans. This compound would not be expected to be found in dairy lagoons, unless the lagoons also receive human waste, but could be found in WWTP influent and septic systems.

However, estrogenic compounds and other hormones (including estrone, 17 β-estradiol, 17α-ethynlestradiol, and testosterone) tend to strongly sorb to soil (Snow et al., 2007) and studies have demonstrated that endocrine disrupting compounds tend to biodegrade in the environment (Snow et al., 2007). In fact, 17-α-ethynyl-estradiol was not detected in any of the U.S. EPA (2012a) drinking water wells. However, lack of detection of these compounds does not necessarily mean that human (e.g., septic) waste sources did not contribute other contamination to these wells.

U.S. EPA recognized that analyses for many of the compound types it included in the sampling program would result in data unlikely to be useful for tracing chemical movement, stating in the Phase 3 QAPP (U.S. EPA, 2010; p. 8):

> Phase 3 is attempting to demonstrate the potential to use low concentrations of trace organic compounds to link land use to observed nitrate contamination. These organic compounds are subject to microbial degradation. Further, they tend to sorb to the organic carbon in the porous media of the aquifer matrix. This can significantly retard the movement of the organic molecules with respect to the movement of groundwater or nitrate. The specification of very low detection limits for many of the organic analyses in this project are hoped to overcome these limitations. Phase 3 will also provide enforcement-quality data.

Nonetheless, they proceeded to collect these data, which were subsequently plagued by data quality issues and were largely unusable for conducting a valid scientific assessment.

4.2 Validity of Location- and Compound-Specific Results

Section 4.1 provides comments on general study design and data quality issues. The following sections consider location- and compound-specific results and conclusions presented in the U.S .EPA (2012a) report. The study design issues noted above (e.g,. insufficient upgradient samples to allow statistical comparisons to background, insufficient time points to assess temporal variability, unusable and qualified data) apply to the results discussed here such that these data cannot be used to draw scientifically valid conclusions about the contribution of dairies or other sources to measured contamination.

4.2.1 Isotopic analyses

In addition to analysis of inorganic and organic compounds, hormones, and pathogens, U.S. EPA submitted samples from well water to the UNL Laboratory for isotopic analysis of

nitrate (NO_3), and samples from the lagoons for isotopic analysis of ammonium (NH_4). As described by U.S. EPA (2012a; p. 28), "Stable isotopes of the various nitrogen species that make up dissolved inorganic nitrogen (nitrate, nitrite, and ammonium) in water can indicate the general source, or combination of sources, or dominant processes acting on nitrogen in groundwater." For nitrogen, the most common isotope is ^{14}N (the "light" isotope) which comprises 99.636% of total nitrogen in the atmosphere, and ^{15}N (the "heavy" isotope) makes up the rest of total nitrogen in the atmosphere, or about 0.364%. The ratio of the heavy isotope to the light isotope can provide an indication of the source of the nitrogen.

U.S. EPA applied isotopic analysis of nitrogen to identify the possible origin of nitrate (NO_3) in water wells and lagoons, i.e., whether it is from synthetic fertilizer, animal sources, the atmosphere, or a combination of sources. U.S. EPA did isotopic analysis of samples from 24 wells as follows: 3 dairy supply wells (1 at Haak Dairy and 2 at the Dairy Cluster), 10 downgradient of dairy wells (3 at Haak Dairy and 7 at the Dairy Cluster), 1 background residential well, 4 downgradient of septic wells, and 6 downgradient of crop field wells. They did not do isotopic analysis of the two upgradient wells. U.S. EPA also did isotopic analysis of ammonium (NH_4) in the 15 lagoon samples.

U.S. EPA (2012a) summarized its methodology and assumptions in Appendix D, and the isotopic signatures and interpreted dominant source of nitrogen in Table D2. They assert that $\delta^{15}N\text{-}NO_3$ well water values below 2% indicate a synthetic fertilizer source, values greater than 8.4% indicate an animal waste source, and intermediate values ($\geq$2% and $\leq$ 8.4%) indicate a synthetic fertilizer and/or animal waste source. Based on these analyses and assumptions, U.S. EPA identified seven of the residential wells as having one dominant source: six with "animal waste" and one with "fertilizer" identified as the only source. They list 14 other wells for which a less definitive declaration is made (the source indicated is a combination of fertilizer and/or animal waste and/or atmospheric).[7] U.S. EPA also asserted that $^{18}O\text{-}NO_3$ values greater than 20% reflect an atmospheric source.

However, our review of U.S. EPA's assumptions about isotopic ratios associated with specific sources indicates that $\delta^{15}N$-NO3 values attributable to synthetic fertilizer and animal waste sources can vary beyond the ranges assumed to by U.S. EPA, and that rain water can also influence $\delta^{15}N$-NO3 values. Further, $\delta^{18}O\text{-}NO^3$ ratios reflecting atmospheric contributions can also vary outside the range U.S. EPA assumed. Additionally, U.S. EPA's methodology cannot distinguish between human and other "animal" sources. Overall this approach is inadequate to conclude that the animal wastes are the predominant source of nitrate in the downgradient wells or residential wells.

Fertilizer sources

With regard to assignment of specific isotope measurements to certain sources, U.S. EPA (2012a) suggests that $\delta^{15}N\text{-}NO_3$ well water values below 2% should signify that "synthetic fertilizers are the likely dominant source of nitrate in water wells" since "the lowest $\delta^{15}N\text{-}NH_4$ value from the dairy lagoons was 2.0%" (p. D-6). In other words, they assume that since dairy lagoons reflect animal waste, the range of isotope values for nitrogen (in

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[7] Regarding the isotopic data, U.S. EPA states (p. 84) "The isotopic data provide some indication of the likely nitrate sources for seven of the 25 residential wells tested (six animal waste and one synthetic fertilizer). Although the isotopic analysis identified animal waste as the source of the nitrate in six wells, this analytical technique cannot differentiate between human and nonhuman waste." However, U.S. EPA only did isotopic analysis of 21 "residential" wells.

ammonium) measured here reflects possible nitrogen isotopic values associated with animal wastes.

However, the U.S. EPA study "did not directly evaluate the isotopic values for [synthetic] fertilizer used in the study area" (p. D-6) and it therefore is unknown what the actual synthetic fertilizer $\delta^{15}N\text{-}NO_3$ values are in the study area. U.S. EPA states that the "ratios for synthetic fertilizers are often within a range of -4.0 to +4.0%," and provides several references. Table 3 lists the ranges of $\delta^{15}N\text{-}NO_3$ values reported from analyses of a number of fertilizer types, including the references cited in the report. $\delta^{15}N\text{-}NO_3$ values for fertilizers vary based on fertilizer type (Kendall 1998). In general, for fertilizers not explicitly identified as organic fertilizers (i.e., synthetic fertilizers), these data show that $\delta^{15}N\text{-}NO_3$ values range from about -8 to 8%.

TABLE 3. Ranges of $\delta^{15}N\text{-}NO_3$ values obtained from various fertilizers

Reference	Low end of range (%)	High end of range (%)	Comments
Report-Appendix D		<2	
Kreitler, Ragone et al. (1978)	-8	6.2	90% of samples ranging from -3‰ to 2‰
Heaton (1986)	-5	7	Fertilizers from: US, France, Germany, Australia, South Africa
Komor and Anderson (1993)	-4	4	Commercial fertilizers
Aravena, Evans et al. (1993)	-2	4	Commercial fertilizers
Herbei and Spalding (1993)		1.5[b]	Single fertilizer analyzed
Macko and Ostrom (1994)	-3	2	Chemical fertilizers
Battaglin, Kendall et al. (1997)	-5	5[a]	Values based on combined references
Battaglin, Kendall et al. (1997)	-5	0[b]	Values based on combined references
Kendall (1998)	-4	4	Values based on combined references
Kendall (1998)	2	30[c]	Organic
Becker, Peter et al. (2002)	-4 (mean=2.75)	4	Synthetic fertilizers
Townsend, Young et al. (2002)	-5	8[a]	Unspecified commercial fertilizer
Townsend, Young et al. (2002)	2	8[b]	Anhydrous ammonia
Townsend and Macko (2007)	-2	2	Values based on combined references
Kendall, Elliott et al. (2007)	-8	7	Values based on combined references

[a] Nitrate based fertilizers; [b] Ammonia based fertilizers; [c] Organic fertilizers

U.S. EPA acknowledges that reported local $\delta^{15}N\text{-}NO_3$ ranges can differ from world-wide reported values, stating (p. D-3):

> local end-members specific to a particular study region often have a smaller isotopic range in comparison to worldwide reported values, and therefore measuring the isotopic compositions of local end-members can sometimes help better constrain and interpret nitrate isotope values within a specific data set.

Since local fertilizer samples were not analyzed in this study, it is uncertain how these values compare to reported world-wide $\delta^{15}N\text{-}NO_3$ values. In general, nitrate based fertilizers have slightly higher $\delta^{15}N\text{-}NO_3$ values than ammonia-based types, with even higher values reported for organic fertilizers (Kendall 1998). Nonetheless, based on reported $\delta^{15}N\text{-}NO_3$ values for inorganic fertilizers, the highest reported value was 8% and the average high end of the range was approximately 5% (Table 3). Thus, $\delta^{15}N\text{-}NO_3$ values up to 8% could be associated with synthetic fertilizers (U.S. EPA assumes values between 2 and 8% could reflect a mixed synthetic fertilizer and animal waste source).

Figure 1 illustrates the range of comparative $\delta^{15}N$ values that have been reported for fertilizer as well as rain, animal waste, and soils (Kendall 1998). These data are a compilation of various data sources and portray other $\delta^{15}N$ sources in addition to fertilizers and animal waste that may contribute to nitrate compositions in surface and ground waters. This figure suggests that for fertilizer, $\delta^{15}N\text{-}NO_3$ values may range up to about 6.5% and $\delta^{15}N\text{-}NH_4$ values may range up to 4% (in other words, $\delta^{15}N\text{-}NO_3$ values are slightly higher). "Soil" (fertilized and natural) and rain water are additional sources of $\delta^{15}N$ (with values up to about 14% for natural soil and 25% for fertilized soil, and up to about 18% for rain water) that can influence $\delta^{15}N\text{-}NO_3$ values in surface and ground water. Indeed, U.S. EPA states that "for $\delta^{15}N\text{-}NO_3$ values between 2.0% and 8.4% the source of nitrate in the water wells cannot be confidently attributed to a single source" as "atmospheric contribution, other sources could be solely animal waste, solely synthetic fertilizer, or a mixture of all three with an atmospheric contribution" (p. D-6). The authors of the Report did not question if $\delta^{15}N\text{-}NO_3$ values <2% or >8.4% were also influenced by other contributions including soil and rain water and with that uncertainty it is not apparent whether their $\delta^{15}N\text{-}NO_3$ cutoff values accurately reflect actual source contributions.

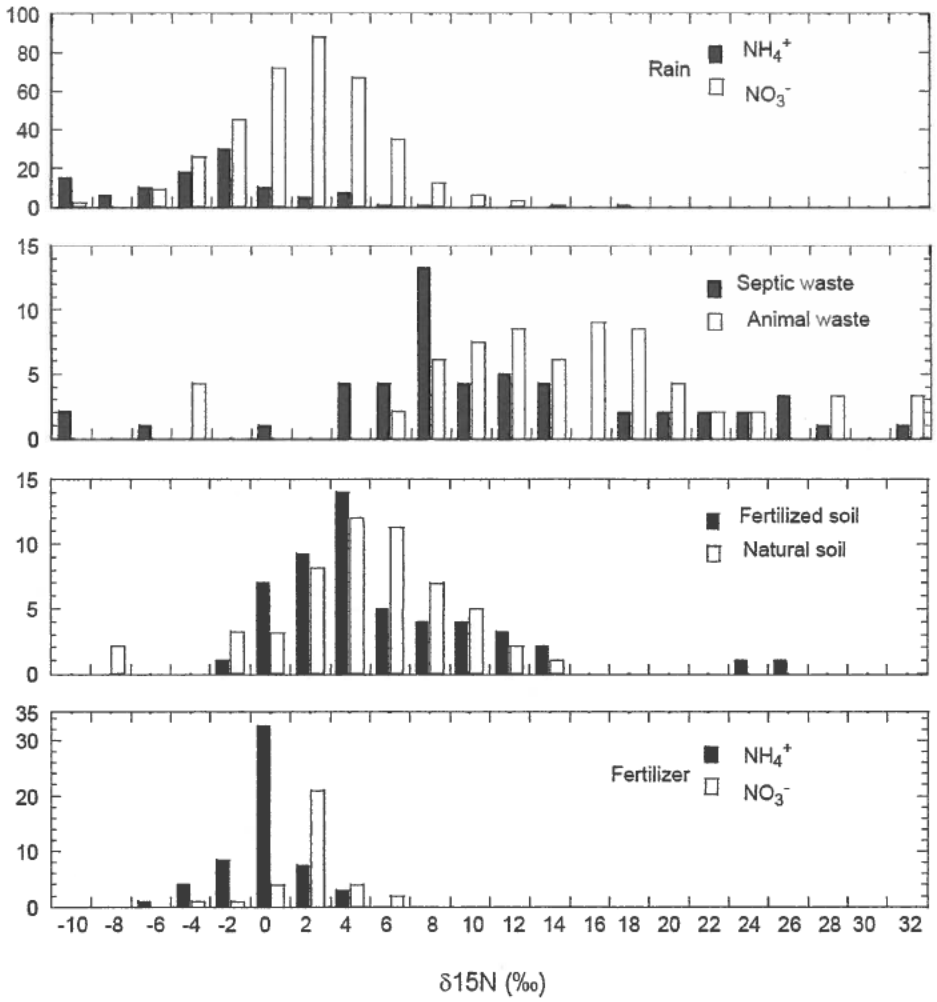

Figure 1. $\delta^{15}N$ Values Obtained from Major Sources of Nitrogen in the Hydrosphere (from Kendall, 1998)

Applications used to determine the source of nitrates based on $\delta^{15}N\text{-}NO_3$ values can be complicated by biogeochemical reactions such as ammonia volatilization, nitrification and denitrification (Kendall 1998). The Report notes that "denitrification will result in a coupled linear increase of both $\delta^{15}N\text{-}NO_3$ and $\delta^{18}O\text{-}NO_3$ values" and "this combined isotope and concentration pattern was not observed in the water wells, which indicates that the nitrate isotope compositions measured in the water wells are primarily controlled by mixing of one or more nitrate sources." Results from groundwater studies using $\delta^{15}N\text{-}NO_3$ values to identify relative contributions by fertilizers and or/animal wastes are difficult to interpret in clayey soils when denitrification cannot be ruled out or if the nitrate level in the soil organic matter is significant (Gormly and Spalding 1979; Kendall 1998). The Report does not provide data regarding the nitrate level in the soil organic matter or evidence that it may leach out under certain conditions.

<u>Animal waste sources</u>

The Report states that "a $\delta^{15}N\text{-}NO_3$ ratio above 8.4% was used to indicate that the likely dominant source of the nitrate in the water wells was animal waste" (p. D-5). This value was

chosen because "the average $\delta^{15}N\text{-}NH_4$ ratio at the discharge end of the lagoons was 8.4% and this ratio forms the lower end of the expected range for the weights of nitrogen that, after microbial conversion to nitrate, would be transported in groundwater to drinking water wells" (p. D-5). However, based on a review of the literature, the lower range limit for $\delta^{15}N\text{-}NO_3$ values that suggest an animal waste source of nitrate by most authors or studies is 10% (Table 4).

Table 4. Ranges of $\delta^{15}N\text{-}NO_3$ Values from Animal Waste

Reference	Low end of range (‰)	High end of range (‰)	Comment
Report- Appendix D	>8.4		
Kreitler and Jones (1975)	10	22	Barnyard waste soil
Heaton (1986)	8	23	Manure, barnyards soils, sewage-contaminated soil
Komor and Anderson (1993)	10	22	Reference: Heaton 1986
Aravena, Evans et al. (1993)	10	20	Values based on combined references
Herbei and Spalding (1993)		>10	
Kendall (1998)	10	25	Reference: Kreitler 1975
Becker, Peter et al. (2002)	10	20	Values based on combined references
Townsend, Young et al. (2002)	10	20	Values based on combined references
Townsend and Macko (2007)		>10	Values based on combined references
Kendall, Elliott et al. (2007)	10	20	Reference: Kreitler 1975

U.S. EPA also states that "values of $\delta^{15}N\text{-}NO_3$ below 8.4% do not rule out animal waste as a source" and that "the tendency for the $\delta^{15}N\text{-}NH_4$ value to continue to increase is why 8.4% is considered a lower bound for identifying animal waste as a source of nitrate in the water wells" (p. D-5).

Only one author (Heaton, 1986) sets the low end of the range below 10% (8%) for a $\delta^{15}N\text{-}NO_3$ value that is representative of animal waste while the rest of the authors use 10% as the lower bound. The cutoff value of 8.4% for $\delta^{15}N\text{-}NO_3$ used in the study is not consistent with the 10% that is widely used in the literature—U.S. EPA indicates that the 8.4% value is actually the average $\delta^{15}N\text{-}NH_4$ ratio at the discharge end of the lagoons. The $\delta^{15}N\text{-}NH_4$ values at the discharge ends reported in Table D1 range from 2.0% to 13.9%. However, the data presented in Tables 3 and 4 and Figure 1, above, suggest that the lower end of this range may reflect contributions from synthetic fertilizer sources. The spread in the data suggests that the isotopic analyses provide no definitive evidence regarding the source of nitrate in the wells.

Further, U.S. EPA (2012a) does not acknowledge that "animal" sources can include human, e.g., septic sources—i.e., even if the measured $\delta^{15}N\text{-}NO_3$ value is suggestive of animal waste, the measurement cannot distinguish between an animal (i.e., cattle) or human source. U.S. EPA did not measure $\delta^{15}N\text{-}NO_3$ values in septic systems, thus they did not determine local septic system values for this parameter. Thus, rather than assigning any $\delta^{15}N\text{-}NO_3$ measurement to an "animal waste" source, it would be more valid to assign it to an "animal and/or human" waste source.

Atmospheric contribution

U.S. EPA states that "ratios above 20.0% for $\delta^{18}O\text{-}NO_3$ were considered to have some contribution from atmospherically derived nitrate" based on the literature which states "that $\delta^{18}O\text{-}NO_3$ ratios from synthetic fertilizer, soil cycling, and animal wastes are typically below 15.0%" (p. D-6). Table 5 lists the range of $\delta^{18}O\text{-}NO_3$values (18-75%) that suggest a contribution from atmospheric sources.

Table 5. Ranges of $\delta^{18}O\text{-}NO_3$ Values from Atmospheric Sources

Reference	Low end of range (%)	High end of range (%)	Comment
Appendix D		>20	
Kendall (1998)	55	75	Precipitation (Bavaria, Germany)
Kendall (1998)	18	70	Precipitation (Colorado, New York, Vermont)
Kendall (1998)	23	58	Precipitation (Muensterland, Germany)
Kendall (1998)	28	51	Precipitation (East-Central Canada)
Battaglin, Kendall et al. (1997)	23	75	Values based on combined references

Figure 2 shows a histogram of the frequency of data distribution and the world-wide ranges of $\delta^{18}O\text{-}NO_3$ measured in precipitation from all the data sources referred to in Kendall (1998).

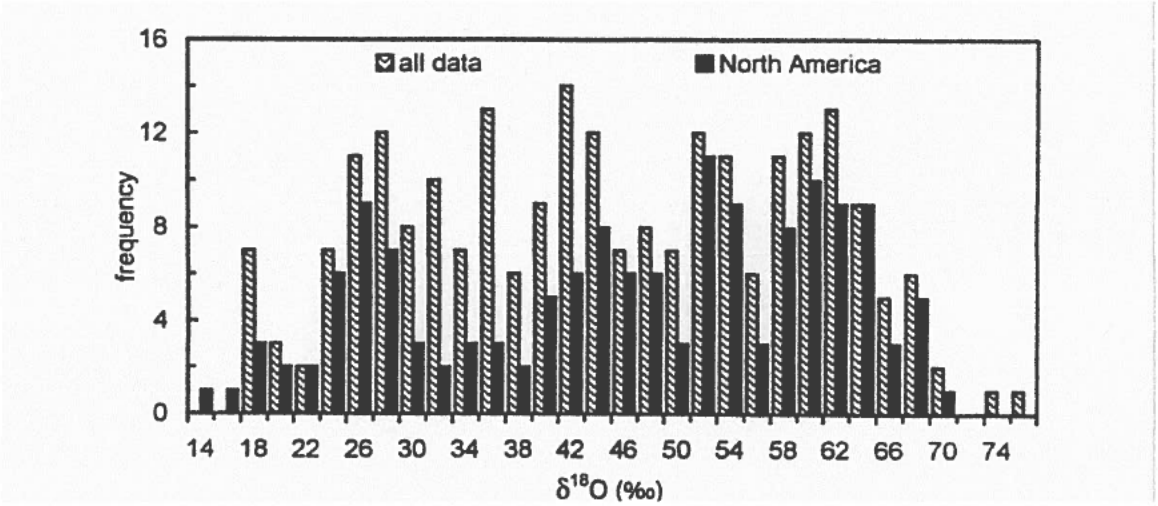

Figure 2. Histogram illustraing the range of values and the frequency of observations of δ18O-NO3 in nitrate from precipitation samples collected world-wide as compiled and presented in Kendall, 1998. Data are from numerous sources with North American values presented with solid bars.

U.S. EPA states "values of $\delta^{18}O\text{-}NO_3$ below 20.0% could have an atmospheric contribution, but it becomes indistinguishable from other sources" (p. D-6). They did not explain why water in one well would be influenced by atmospheric contribution while another is not. Given that U.S. EPA assumes that atmospheric contribution (rain) could increase $\delta^{18}O\text{-}NO_3$

in well water, rain could also increase the percentage of $\delta^{15}N\text{-}NO_3$ in the same sample, as suggested in Figure 1. However, U.S. EPA states, "If the nitrate in any given water sample has a significant component of atmospheric nitrate, then the $\delta^{18}O\text{-}NO_3$ value will be higher than the $\delta^{18}O\text{-}NO_3$ values reported for other sources such as fertilizers and animal waste" (p. D-6).

U.S. EPA acknowledges "since the major nitrate sources have ranges of $\delta^{18}O\text{-}NO_3$ values, the exact contribution of each end-member cannot be determined, but a qualitative evaluation can be made" (p. D-6). As with $\delta^{15}N\text{-}NO_3$, the fertilizers used in the area were not analyzed for $\delta^{18}O\text{-}NO_3$ therefore it is unclear what the potential contribution to the $\delta^{18}O\text{-}NO_3$ value is from fertilizers compared to atmospheric sources. U.S. EPA states, "Ratios above 20.0% for $\delta^{18}O\text{-}NO_3$ were considered to have some contribution from atmospherically derived nitrate. This ratio was selected because the literature based on multiple studies of various nitrate sources suggests that $\delta^{18}O\text{-}NO_3$ ratios from synthetic fertilizer, soil cycling, and animal wastes are typically below 15.0% (Kendall et al. 2007)" (p. D-6).

However, review of the literature indicates that the range of $\delta^{18}O\text{-}NO_3$ values that have been reported for fertilizers ranges from -5 to 58%, and varies considerably based on their composition (Table 6). The high end of these reported $\delta^{18}O\text{-}NO_3$ ranges for synthetic (25%) and natural (58%) fertilizers are above the 15.0% stated by U.S. EPA as the upper level for $\delta^{18}O\text{-}NO^3$ ratios. Since actual $\delta^{18}O\text{-}NO_3$ value for fertilizers used in this area was not obtained makes the source determination identification based on $\delta^{18}O\text{-}NO_3$ values difficult.

Table 6. Ranges of $\delta^{18}O\text{-}NO_3$ Values for Different Fertilizer Types

Reference	Low end of range (%)	High end of range (%)
Aravena, Evans et al. (1993)	18	22[a]
Kendall, Elliott et al. (2007)	17	25[a]
Kendall, Elliott et al. (2007)	-5	15[b]
Kendall, Elliott et al. (2007)	46	58[c]

[a]Synthetic fertilizer; [b] Nitrate from ammonia-based fertilizer; [c] Natural fertilizer

Summary of Isotopic Analysis Review

Overall, $\delta^{15}N\text{-}NO_3$ values attributable to synthetic fertilizer and animal waste sources can vary beyond the ranges assumed to by U.S. EPA, and that rain water can also influence $\delta^{15}N\text{-}NO_3$ values. Further, $\delta^{18}O\text{-}NO^3$ ratios reflecting atmospheric contributions can also vary outside the range U.S. EPA assumed. Also, even if the assumptions U.S. EPA used to derive the source signature ranges are accurate, this methodology cannot distinguish between human and other "animal" sources. Finally, if one compares the "supply" well results to downgradient results, they are generally similar (although statistical analysis is not possible due to the small number of samples, and results for downgradient samples are highly variable). Overall this approach cannot be used conclude that the dairy farm wastes are the predominant source of nitrate in the downgradient wells or residential wells.

4.2.2 Assessment of samples collected at and near Haak Dairy

In Table 16 (p. 44-45), U.S. EPA (2012a) summarizes detections in wells downgradient of Haak Dairy, and also identifies which of these were detected in "dairy sources" on the dairy

site. However, this summary is misleading in that it does not present other important data that puts these results in perspective, including concentrations and detection limits, detections in WWTP influent, and statements made by U.S. EPA indicating that certain analytical results should be considered qualified or "screen" values.

Specific results and U.S. EPA's conclusions are discussed below.

Pesticides Table 16 (U.S. EPA, 2012a) reports that atrazine (the only pesticide detected) was detected in two of three wells downgradient of the Haak Dairy and in the upgradient well. In addition, atrazine was detected in "dairy sources" (one dairy application field sample). Regarding these results, U.S. EPA (2012a) states (p. 39), "The detection of atrazine at a higher concentration in one of the downgradient wells compared with the upgradient well indicates that there likely is a source from a crop field associated with the Haak Dairy; however, the presence of atrazine in the upgradient well indicates that the Haak Dairy is not the only source."

Some missing information puts these results in context:

- While atrazine was detected at a slightly higher concentration in one downgradient well (0.11 µg/L) compared to the upgradient well (0.015 µg/L), in the other two downgradient wells, atrazine was not detected in one sample [Table 16 mistakenly identifies atrazine as detected in WW-03 when it was not detected in this well] and was detected at 0.015 µg/L in the other. Thus concentrations are variable across the aquifer, and only one of three downgradient wells was in excess of the upgradient concentration. Further, "background" detection of atrazine is expected since it is widespread in the environment in agricultural areas (U.S. EPA, 2012b).
- Atrazine was also detected in the well upgradient of the Dairy Cluster at 0.051 µg/L (J qualified; see Section 4.2.3).
- The atrazine quantitation limit ranges from 0.095 to 0.1 µg/L— two of the three detected concentrations are below this range, and the other only slightly exceeds it. Further, all detected concentrations are reported as "estimated" (J qualified).

In addition, as discussed in Section 4.1.2, a single upgradient sample is insufficient to determine whether there is a statistical difference in upgradient and downgradient concentrations. Thus, one cannot conclude that the concentrations of atrazine measured in the upgradient and downgradient wells are different, and U.S. EPA can draw no valid conclusions about the possible contribution of Haak Dairy to these concentrations in well water.

Trace organics Table 16 (U.S. EPA, 2012a) reports that one trace organic (DEHP) was detected downgradient of Haak Dairy. It was detected in one downgradient well at 5.26 µg/L, but was also detected in the upgradient well at 2.66 µg/L. It was also detected upgradient of the Dairy Cluster (at 1.74 µg/L, J qualified) and in 2/10 wells downgradient of the Dairy Cluster (at 2.77 (J qualified) and 1.03 µg/L). In addition, DEHP was also detected in 3/3 WWTP samples and, in general, was not detected in dairy lagoons (it was detected in only 1/15 lagoon samples, at 4.58 µg/L in LG-10). Further U.S. EPA reported that the trace organic concentrations should be interpreted as "screen" values (see Section 4.1.7).

DEHP is commonly detected in treatment plant influent. For example, ATSDR (2002) reported that "DEHP was present in 48% of the influent and 12% of the effluent samples taken from New York City sewage treatment plants during 1989–1993" (p. 188). It is "a widely used chemical that enters the environment both through disposal of industrial and

municipal wastes in landfills and by leaching into consumer products stored in plastics." Regarding this compound, U.S. EPA states (p. 58) that "DEHP is a common plasticizer and could come from a variety of sources." Together, these data suggest that dairies were not a source of DEHP to groundwater, but that human waste water is a possible source.

Veterinary Pharmaceuticals Table 16 reports that three veterinary pharmaceuticals were detected in water wells downgradient of Haak Dairy: chlortetracycline, monensin, and tetracycline.

Monensin was detected in the upgradient well (at 0.027 µg/L) and all three of the downgradient wells (at 0.022, 0.023, and 0.028 µg/L). However, monesin was detected in only one downgradient well at a concentration that exceeded the upgradient concentration. Thus, while monensin was also detected in the Haak Dairy lagoons, manure sample, and application field sample, there is no evidence that the dairy is contributing to increased levels of monensin in the well water. According to U.S. EPA (2012a; p. 49),

> The detection of monensin in the upgradient well indicates there is an upgradient source of this compound. The high concentrations of monensin seen in the Haak Dairy lagoon samples, manure pile, and application field sample indicate that it is used at the Haak Dairy. The data indicate that the Haak Dairy is a possible source of monensin in the three downgradient residential drinking water wells. Given the presence of monensin in the upgradient well, another source of monensin is likely.

Further, as discussed in Section 4.1.7, U.S. EPA states that monensin was detected in the field blank for the well water samples and, as such, monensin should have been qualified as nondetect in other well water samples.

Chlortetracycline was detected in one downgradient well (at 0.049 µg/L), but not in the upgradient well (detection limit 0.02 µg/L). Tetracycline was detected in two of the downgradient wells (at 0.041 and 0.075 µg/L) but not in the upgradient well (detection limit 0.02 µg/L), and in the dairy lagoon, dairy manure pile, and dairy application field samples. According to U.S. EPA (p. 40), "The detections in all the dairy supply sources provides a good indication that tetracycline is used at the Haak Dairy. These data indicate that the Haak Dairy is a likely source of tetracycline in the two downgradient residential water wells." However, tetracycline is also used as a human pharmaceutical (Drugs@FDA.com, 2012), and was also detected in one of three WWTP influent samples. Further, tetracycline compounds (oxytetracycline) are used as a fungicide and bactericide on tree fruit in Washington State for the control of fire blight on apples and pears (WSU Extension, 2011). Thus, other sources of tetracycline to groundwater cannot be ruled out. Further, because of a number of issues discussed in Section 4.1 (including small number of samples, lack of evidence that aquifers are connected), these data cannot be used to conclude that Haak Dairy is the source of tetracycline to the downgradient wells.

Hormones Testosterone was detected in all three downgradient drinking water wells downgradient of Haak Dairy (at 0.007, 0.009, and 0.012 µg/L) and in dairy sources. However, it was also detected in the upgradient well, at a higher concentration then downgradient (at 0.021 µg/L). In addition, though not shown in Table 16 (U.S. EPA, 2012a), testosterone was detected in 3/3 WWTP influent samples. Regarding these results, U.S. EPA (2012a; p. 61) states, "The dairies are a possible source of the testosterone in the downgradient wells; however, given the concentration in the upgradient well, another source for the testosterone is likely." Based on these observations, there are clearly other contributions to contaminant concentrations in the downgradient wells. Overall, none of the

organics or hormone sampling results demonstrate that the dairy is contributing to contaminant concentrations in the drinking water wells.

Isotopic analysis Regarding the isotopic data, U.S. EPA (2012a) states (p. 85), "The isotopic data provide strong evidence that animal waste (human or non-human) is the likely dominant source of the nitrate contamination in at least one of the residential water wells (WW-05) downgradient of the Haak Dairy. However, since isotopic analysis cannot differentiate between human and non-human waste, both could be sources of the nitrate in the downgradient well. Isotopic data for the other two residential drinking water wells downgradient of the Haak Dairy indicate that the source of the nitrate could be animal waste, fertilizer, derived from the atmosphere, or some combination of these sources." However, as discussed in Section 4.2.1, isotopic ratio signatures are broader than assumed by U.S. EPA, and this methodology cannot reliably assign nitrate detected in wells to any given source.

4.2.3 Assessment of samples collected at and near the Dairy Cluster

In Table 25 (p. 65-67), U.S. EPA (2012a) summarizes detections in wells downgradient of the Dairy Cluster, and also identifies which of these were detected in "dairy sources" on the dairy site. However, as with the results presented for Haak Dairy, this summary is misleading in that it does not present other important data that put these results in perspective, including concentrations and detection limits, detections in WWTP influent, and statements made by U.S. EPA that indicate certain analytical results should be considered "screen" values.

Specific results and U.S. EPA's conclusions are discussed below.

Pesticides Regarding pesticides, Table 25 (U.S. EPA, 2012a) reports:

- Three pesticides (atrazine, alachlor, and ioxynil) were detected in the upgradient or downgradient water wells associated with the Dairy Cluster. The three pesticides detected in the water wells were not detected in the dairy manure pile or dairy application field samples.
- One of these (atrazine) was detected upgradient (at 0.051 µg/L) and in six of eight downgradient wells (at concentrations ranging from 0.011 to 0.19 µg/L). However, atrazine is widespread in the environment in agricultural areas (U.S. EPA, 2012b) and background detection is expected, as indicated by the detection in the upgradient well. Further, all detected concentrations were J qualified (i.e., estimated), and all but two of the reported concentrations were below the quantitation limit of 0.1 µg/L.
- Alachlor was only detected in two of eight downgradient wells (at 0.011 and 0.057 µg/L). It was not detected upgradient or in any other well (quantitation limit 0.1 µg/L). Both reported concentrations were below the quantitation limit and were J qualified (estimated).
- Ioxynil was detected in only one of eight downgradient wells (at 0.0063 µg/L). The reported concentration was well below the quantitation limit (0.1 µg/L) and was J qualified (estimated).

Further, as discussed in Section 4.1.2, only one upgradient sample was collected. This is insufficient to determine whether there is a statistical difference in concentrations. Nonetheless, regarding the pesticide concentrations, U.S. EPA (2012a) states (p. 57), "Given the historical use of these pesticides and the detection of these compounds in other studies, it is likely that these pesticides are from the current and historical use of pesticides for

agriculture, which could include application by the dairies on the associated fields." U.S. EPA provides no evidence to support this assertion. Based on the data, U.S. EPA can draw no valid conclusions about the possible contribution of the Dairy Cluster to pesticide concentrations in well water.

Trace organics Table 25 (U.S. EPA, 2012a) reports that one trace organic (DEHP) was detected downgradient of the Dairy Cluster, in two of eight wells (at 1.03 and 2.77 μg/L; both J qualified). In all of the other wells it was not detected (<2 μg/L). It was detected in eight lagoons in the Dairy Cluster. It was also detected in 3/3 WWTP samples. Further, per U.S. EPA, the trace organic concentrations should be interpreted as "screen" values (see Section 4.1.7).

As discussed in Section 4.2.2, DEHP is commonly detected in treatment plant influent. For example, ATSDR (2002) reported that "DEHP was present in 48% of the influent and 12% of the effluent samples taken from New York City sewage treatment plants during 1989–1993" (p. 188). It is "a widely used chemical that enters the environment both through disposal of industrial and municipal wastes in landfills and by leaching into consumer products stored in plastics." Regarding this compound, U.S. EPA states (p. 58) that "DEHP is a common plasticizer and could come from a variety of sources." Together, these data suggest that dairies were not a source of DEHP to groundwater, but that human waste water is a possible source.

Wastewater pharmaceuticals Table 25 (U.S. EPA, 2012a) reports that one wastewater pharmaceutical was detected in water wells downgradient of the Dairy Cluster: DEET, in one of eight wells (at 0.67 μg/L). In all other drinking water wells, DEET was not detected (quantitation limit = 0.2 μg/L). DEET was detected in 8/12 lagoons at the Dairy Cluster. DEET can be used to protect livestock form biting flies (Blume et al., 1971). However, it is also used by humans and was detected in 3/3 WWTP samples. Further, U.S. EPA specifies that wastewater pharmaceutical results are only to be considered as screening level values and therefore should not be used in quantitative comparisons.

Veterinary pharmaceuticals Table 25 (U.S. EPA, 2012a) reports that five veterinary pharmaceuticals were detected in water wells downgradient of the Dairy Cluster: monensin, chlortetracycline, tetracycline, tylosin, and virginiamycin.

Monensin was detected in two of eight downgradient wells (at 0.033 and 0.0499 μg/L); in all other wells including the upgradient well, it was nondetect (at <0.02 μg/L). It was also detected in two dairy supply wells, dairy lagoons, manure piles, and application fields. Per U.S. EPA (2012a; p. ES-7, p. 86), "The Dairy Cluster is a likely source of monensin because this antibiotic is used in dairy cows but not people. Monensin was not detected in samples from the WWTP influent samples that were collected as surrogates for residential septic systems, providing further support that the dairies are a likely source." However, as discussed in Section 4.2.2, monensin was also detected in the well upgradient of Haak Dairy (at 0.027 μg/L). With regard to the detection upgradient of Haak Dairy, U.S. EPA (2012a) concluded (p. 49), "Given the presence of monensin in the upgradient well, another source of monensin is likely." Because the number of background samples upgradient of the Dairy Cluster was so severely limited (i.e., one sample, collected at a single location and point in time), it is impossible to definitely conclude that monensin was not present upgradient of the Dairy Cluster as well. Further, as discussed in Section 4.1.7, U.S. EPA states that monensin was detected in the field blank for the well water samples and, as such, monensin should have been qualified as nondetect in other well water samples.

Chlortetracycline was detected in one downgradient well (at 0.119 μg/L), but not in the upgradient well (detection limit 0.02 μg/L). Tetracycline was detected in the upgradient well (at 0.051 μg/L, J qualified) and in two of eight downgradient wells (at 0.038 and 0.049 μg/L), which had lower concentrations than the upgradient well. Tetracycline was detected in all of the dairy lagoon samples, dairy manure pile samples, and dairy application field samples, which according to U.S. EPA (2012a; p. 60), indicates that "...tetracycline is used at the dairies. It is possible that the dairy sources are one of the sources of the tetracycline in the downgradient wells. However, given that the concentrations in the upgradient well are higher than the downgradient wells, another source for the tetracycline is likely" (p. 60). Further, as discussed in Section 4.2.2, tetracycline is used as a human pharmaceutical, and was detected in one of three WWTP influent samples. In addition, tetracycline compounds (oxytetracycline) are used as a fungicide and bactericide on tree fruit in Washington State for the control of fire blight on apples and pears (WSU Extension, 2011). Thus, other sources of tetracycline to groundwater cannot be ruled out. Because of a number of sampling plan design and data quality issues discussed in Section 4.1, these data cannot be used to conclude that the Dairy Cluster is a source of tetracycline to the downgradient wells.

Tylosin was detected in one of eight downgradient wells at a concentration of 0.029 μg/L. All other concentrations were below the quantitation limit of 0.02 μg/L. It was also detected in five lagoons, two manure piles, and one application field sample. Virginiamycin was detected in one of eight downgradient wells at a concentration of 0.023 J μg/L, just slightly above the quantitation limit of 0.02 μg/L. It was also detected in six lagoons. However, for the reasons stated previously (i.e., insufficient upgradient samples, samples collected at only one point in time, lack of confirmation that samples were collected in the same aquifer), these data are insufficient to conclude that the Dairy Cluster is the source of these detected compounds.

Hormones Three hormones were detected in downgradient wells: androsterone, androstadienedione, and testosterone. Of these:

- Androsterone was detected in three of eight downgradient wells (at 0.008, 0.018 , and 0.019 μg/L; all J qualified). It was not detected in any of the other wells (detection limit 0.002 μg/L) or in any of the dairy source samples. It was detected in 3/3 WWTP influent samples.
- Androstadienedione was detected in one of eight downgradient wells (at 0.004 μg/L; J qualified). It was not detected in any of the other wells (detection limit 0.002 μg/L) but was detected in three lagoons and four manure samples. It was also detected in 3/3 WWTP influent samples.
- Testosterone was detected in one of eight downgradient wells (at 0.004 μg/L) and in the upgradient well (at 0.005 μg/L). It was also detected in one residential well (at 0.003 μg/L, in well WW-18, west of Mabton, not located near the dairies), in one of four wells downgradient of septic systems (at 0.001 μg/L), and in one of the wells downgradient of the hops field (at 0.004 μg/L), as well as in 3/3 WWTP influent samples.

Because these hormones were detected in all of the WWTP samples and at other locations not near the dairies but in only some of the dairy source samples, these data do not demonstrate dairies as a source of hormones to the wells.

Isotopic analysis Regarding the isotopic data, U.S. EPA states (p. 86), "The isotopic data provide strong evidence that animal waste (human or non-human) is the likely dominant source of the nitrate in at least two of the residential water wells downgradient of the Dairy Cluster. Because isotopic analysis cannot differentiate between human and non-human waste, both could be sources of the nitrate in these downgradient wells. Isotopic data for the other residential drinking water wells downgradient of the Dairy Cluster indicate that the source of the nitrate could be animal waste, fertilizer, or derived from the atmosphere, or some combination of these sources." However, as discussed in Section 4.2.1, isotopic ratio signatures are more ambiguous than assumed by U.S. EPA, and this methodology cannot reliably assign nitrate detected in wells to any given source.

Trace inorganics Overall, regarding the trace inorganics data downgradient of the Dairy Cluster, U.S. EPA states (p. 56): "Barium was detected in all 11 wells, iron was detected in five wells, manganese was detected in four wells, mercury was detected in one well, and zinc was detected in eight wells. Barium was the only trace inorganic element that increased between the upgradient well and the downgradient wells, with the highest concentrations in the lagoons." Possible reasons why barium was the only element that increased are not discussed. Some reasons could be differences in fate and transport behavior and the lack of other sources between the upgradient and downgradient wells. Also, it is interesting to note that barium concentrations downgradient are not consistent: wells WW-13 and WW-14, downgradient of the Liberty/Bosma dairy and close to a lagoon (sampled as LG-15) appear to be directly adjacent to each other. However, the concentration of barium in WW-13 is 8.7 μg/L, and the concentration in WW-14 is 35.9 μg/L. By comparison, the concentration of barium in the upgradient well is 11.2 μg/L, greater than the concentration in WW-13.

These comparisons show that comparison a single upgradient measurement to the downgradient measurements is scientifically invalid and produces no meaningful information, and that concentrations downgradient are highly variable. Note also that while U.S. EPA (2012a) assumes that dairies are a source of barium, stating for example (with regard to Haak Dairy, p. 38), "Two metals, barium and zinc, which may be used at dairies, were detected in both the water wells and dairy lagoons," they provide no supporting data in this regard, such as a discussion of how barium is used at dairies. Barium can be found in fertilizers and soil amendments (ATSDR, 2007); however, the barium seems to be found in those fertilizers originating from natural rocks and salt deposits (Senesi et al., 1983).

4.2.4 Assessment of samples collected at and near irrigated cropland

In Table 32 (p. 75), U.S. EPA (2012a) summarizes detections in the six wells downgradient of irrigated croplands and also identifies which of the detected compounds were detected in the composited soil samples at each of the six fields. Again, additional detail on reported concentrations and detections at other locations relative to those measured at and near the croplands would help put the results in perspective. Further, detection of many of the same contaminants in soil and downgradient wells near the croplands demonstrates the difficulty in assigning contaminants detected in wells at any location to any particular source type due to the highly mixed land use.

Specifically:

- U.S. EPA (2012a) states (p. 87), "Nitrogen-rich fertilizers, such as inorganic synthetic fertilizer and manure, are applied to irrigated crop fields and are a possible source of nitrate in drinking water wells…The six water wells downgradient from the

irrigated crop fields and sampled by EPA during Phase 3 all had nitrate levels greater than the MCL."

- U.S. EPA (2012a) states (p. 87), "The isotopic data provide strong evidence that synthetic fertilizer is a dominant source in one residential drinking water well downgradient of a mint field [WW-24] and that animal waste (human and non-human) is a dominant source of the nitrate in one well downgradient of a hops field [WW-27]. Isotopic analysis cannot differentiate between human and non-human waste. Isotopic data for the other residential drinking water wells downgradient of the crop fields indicate that the source of the nitrate could be animal waste or fertilizer, with some contribution from the atmosphere." However, as discussed in Section 4.2.1, isotopic ratio signatures are more ambiguous than assumed by U.S. EPA, and this methodology cannot reliably assign nitrate detected in wells to any given source.
- Two pesticides were detected in the downgradient wells: atrazine and bentazon. Atrazine was detected in 1/2 samples downgradient of the mint field (at 0.017 µg/L, J qualified) and 1/2 samples downgradient of the hops field (at 0.025 µg/L, J qualified). Atrazine was not detected in the associated soil samples, and as discussed in Sections 4.2.2 and 4.2.3, it was detected in wells upgradient of the dairies and is ubiquitous in agricultural environments. Bentazon was detected in two wells at 0.028 and 0.033 µg/L (both J qualified), downgradient of the mint field. It was also detected in the soil sample at the mint field.
- Several veterinary pharmaceuticals (erythromycin, lincomycin, monensin, ractopamine, sulfamethazine, sulfathiozole, tiamulin, and virginiamycin) were detected in one well downgradient of the hops field. Only monensin was detected in the associated soil sample. It is not clear why these compounds were detected here; however, the well is located in an area with heavy agricultural use, and these results illustrate the difficulty in parsing out sources of groundwater contaminants based on limited sampling data. Per U.S. EPA (2012a; p. 74), "Possible manure application to the hop field could account for the monensin detected in the downgradient residential well." Note that one of these (sulfamethazine) was also detected in WWTP influent samples.
- Bentazon was detected in two water wells and the associated mint field soil samples. These results indicate that bentazon was applied to the crop field and is likely migrating to the groundwater and water wells.

Overall, regarding these data, U.S. EPA (2012a) states (p. 87), "Given the historic and current application of nitrogen-rich fertilizers in the Lower Yakima Valley, it is expected that irrigated crop fields would be a likely source of high nitrate levels in downgradient drinking water wells. The data collected in this study provide some corroboration that irrigated crop fields are a likely a source of nitrate in groundwater. The data supporting this conclusion is not as strong for the crop fields as it is for the dairies. The reasons for this include: lack of upgradient well data; the irrigated crop fields sampled are situated amongst other agricultural uses, including upgradient dairy operations; fewer analytes detected in both the crop field samples and the corresponding downgradient wells; more limited information about crop field operations; and the crop fields' positions on the landscape relative to other potential sources."

Of note, however, the arguments U.S. EPA (2012a) makes to support its assertion that data linking irrigated croplands to nitrate in well water is "not …strong" would also apply to the data associated with the dairies, specifically:

- There is also a "lack of upgradient well data" for the dairies (only one upgradient well at each location).
- Dairies are also "situated amongst other agricultural uses."
- Few analytes were "detected in both" the dairy samples and corresponding downgradient wells.
- Conclusions about the dairies are also influenced by their "positions on the landscape relative to the other potential sources."

Nonetheless, using the data that were collected, direct statistical comparison of levels of nitrogen measured in soil and water at and near the irrigated croplands to levels measured at and near the dairies shows there is no significant difference in the concentrations for irrigated cropland vs. dairy samples (Tables 7 and 8).

Table 7. T-test Results (two independent samples t-test) Comparing Nitrogen Measurements in Soil Samples Collected at Dairy vs. Irrigated Cropland Locations

Nitrogen Measurement	General Location and Sample Count	Mean (SD) (mg/kg)	T-test Result
Total Nitrogen/Solid	Dairy (n = 5) Crop (n = 6)	2,492 (1,009) 2,195 (915)	No difference (p = 0.621)
Nitrate-N/Nitrite	Dairy (n = 5) Crop (n = 6)	117.5 (80.0) 96.1 (99.4)	No difference (p = 0.707)
Ammonium-N	Dairy (n = 5) Crop (n = 6)	5.74 (1.9) 44.4 (81.3)	No difference (p = 0.320)

Table 8. T-test Results (two independent samples t-test) Comparing Nitrogen Measurements in Water Samples Collected at Locations Downgradient of Dairies vs. Downgradient of Irrigated Croplands

Nitrogen Measurement	General Location and Sample Count	Mean (SD) (mg/L)	T-test Result
Nitrite-N (Cascade Analytical Laboratories)	Dairy-Downgradient Well (n = 11) Crop-Downgradient Well (n = 6)	29.2 (15.3) 28.3 (22.2)	No difference (p = 0.921)
Nitrate+Nitrite as N (Manchester Environmental Laboratory)	Dairy-Downgradient Well (n = 11) Crop-Downgradient Well (n = 6)	30.7 (16.2) 30.4 (23.6)	No difference (p = 0.974)

Soil samples were collected from sixteen locations: 10 associated with dairies (two at Haak dairy, consisting of one manure and one soil sample; and eight at the Dairy Cluster, consisting of four manure and four soil samples), and six associated with irrigated crop land (two soil samples from each of mint, corn, and hops fields). No background soil samples were collected; therefore, measured concentrations cannot be compared to local background conditions and the contribution from other sources (e.g., atmosphere) cannot be assessed.

Each soil sample was analyzed for nitrogen species using three methods; however, a total of six different methods were used so that the methods/results are not directly comparable across all samples. Specifically:

Of note, however, the arguments U.S. EPA (2012a) makes to support its assertion that data linking irrigated croplands to nitrate in well water is "not …strong" would also apply to the data associated with the dairies, specifically:

- There is also a "lack of upgradient well data" for the dairies (only one upgradient well at each location).
- Dairies are also "situated amongst other agricultural uses."
- Few analytes were "detected in both" the dairy samples and corresponding downgradient wells.
- Conclusions about the dairies are also influenced by their "positions on the landscape relative to the other potential sources."

Nonetheless, using the data that were collected, direct statistical comparison of levels of nitrogen measured in soil and water at and near the irrigated croplands to levels measured at and near the dairies shows there is no significant difference in the concentrations for irrigated cropland vs. dairy samples (Tables 7 and 8).

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Soil samples were collected from sixteen locations: 10 associated with dairies (two at Haak dairy, consisting of one manure and one soil sample; and eight at the Dairy Cluster, consisting of four manure and four soil samples), and six associated with irrigated crop land (two soil samples from each of mint, corn, and hops fields). No background soil samples were collected; therefore, measured concentrations cannot be compared to local background conditions and the contribution from other sources (e.g., atmosphere) cannot be assessed.

Each soil sample was analyzed for nitrogen species using three methods; however, a total of six different methods were used so that the methods/results are not directly comparable across all samples. Specifically:

- "Kjedahl Nitrogen/Solid" was measured in only one sample (SO-01, Haak Dairy manure sample) so the results were not comparable to any other data.
- "Ammonia Solid" and "NO3N/Total Solid" were only measured at the dairies (in manure samples) so the results are not comparable to irrigated crop soil samples.
- The other three nitrogen types ("Total Nitrogen/Solid", "Nitrate-N/Nitrite", and "Ammonium-N") were measured at each general location (Haak Dairy, Dairy Cluster, and the three irrigated cropland types), so the results are comparable.

Independent samples t-tests were conducted to compare nitrogen soil sampling results for samples collected at dairies and the irrigated crop fields, for each of the three types. Based on these analyses, there was no significant difference in the concentrations for dairies and irrigated crop samples, for any of the three nitrogen measurements (Table 7).

Likewise, independent samples t-tests were conducted to compare nitrogen water sample results for samples collected downgradient of the dairies vs. downgradient of the irrigated crop fields. Based on these analyses, there was no significant difference between the concentrations measured downgradient of the dairies vs. downgradient of the croplands, for either nitrite-N or nitrate+nitrite as N (Table 8).

4.2.5 Assessment of samples collected downgradient of residential septic systems

U.S. EPA (2012a) reports that "As of 2009, there were about 22,000 septic systems registered with Yakima County" (p. 12). To assess the potential contribution of nitrate and other contaminants from septic systems, U.S. EPA sampled four residential wells downgradient of domestic septic systems in Mabton (well WW-21), Harrah (well WW-19), and Sunnyside (wells WW-20 and WW-22). Chemicals detected in these wells were compared to chemicals detected in samples collected from the influent to three wastewater treatment plants (WWTPs) located in Toppenish, Mabton, and Zillah.

Regarding the sampling of WWTP influent and downgradient of septic system wells, the Phase 3 QAPP stated (U.S. EPA 2010, p. 16):

> For rural residential septic characterization, samples will be taken from the influent stream to 3 different small sewer treatment plants in the lower valley. These plants will be selected so as to have a similar demographic in the contributing area as the adjacent non-sewer area. In this way it is not necessary to sample from a specific drain field and a wider range of potential linking organic compounds will be encountered. Four home locations down-gradient of significant concentration of septic systems and which provided high nitrate samples in Phase 2 will be re-sampled in Phase 3 for the same wide range of trace organic compounds, age dating gases and general chemical analytes to provide the strongest basis for comparison with the AFO [animal feeding operation] and crop-land associated wells.

The objective of this sampling was to "help differentiate water wells affected by septic systems (humans) from water wells influenced by other sources such as dairy lagoons or irrigated cropland" (U.S. EPA, 2012a; p. 23). That is "Detection of these compounds in water wells may provide evidence that septic systems are a likely source of nitrate. If detected in the influent to the WWTPs, it can establish whether these compounds are being excreted by humans and ending up in municipal sewage waste. If the compounds are detected in the WWTP influent, they can be compared with detected compounds in water wells to

evaluate whether septic systems may contribute to the presence of these compounds in well water" (p. 24). U.S. EPA further elaborated (p. 76),

> The treatment plant influent samples were collected to serve as surrogates for septic systems by providing a characterization and quantification of compounds that are found in rural septage. EPA recognizes that these WWTPs may receive substances that are not found in residential septic systems (for example they may also receive commercial and industrial waste streams). The WWTPs sampled serve rural communities and are sufficiently similar to residential septic systems for the purposes of this study. This approach was used to determine whether the compounds detected in wells with high nitrate concentrations in areas with a high density of septic systems are similar to the compounds detected in WWTP influent or whether these wells are affected by other sources.

In Table 37 (p. 82), U.S. EPA (2012a) summarizes detections in the four wells downgradient of septic systems. Table 37 reports detections of two pesticides (atrazine and bentazon), 10 veterinary pharmaceuticals (erythromycin, lincomycin, monensin, ractopamine, sulfamethazine, sulfamethoxazole, sulfathiazole, tetracycline, tiamulin, and virginiamycin), and 8 hormones (11-keto testosterone, 17β-estradiol, 17α-estradiol, androstadienedione, β-zearalanol, estrone, testosterone, and epitestosterone).

Samples collected downgradient of the septic systems suffer from many of the same problems as the samples collected downgradient of the dairies, specifically that inadequate (in this case, no) samples were collected upgradient of the septic systems to assess area background exclusive of the contribution from the putative source, samples were grab samples collected at a single point in time and do not reflect potential temporal/seasonal variability or the possibility of a heterogeneous matrix, and many of the analytical results were qualified. Further, U.S. EPA reported no efforts to confirm that these "downgradient of septic system" samples were in fact relevantly located to capture the contribution from septic systems—e.g., did the sampled aquifers intersect the septic systems? Were they truly downgradient?

While U.S. EPA collected three samples of WWTP wastewater influent in Zillah, Mabton, and Toppenish, they did not confirm that these samples are representative of what might be found in septic systems upgradient of the residential "septic system" wells or in septic systems located near the dairies, though U.S. EPA (2012a) did state (p. ES-8) "The WWTP influent had no actual or potential hydrogeological connection with the residential wells." Further, in attempting to analyze these samples, U.S. EPA encountered numerous matrix interference issues such that results for some chemical classes (pesticides) were declared unusable. Overall, the data collected in these wells and the WWTP influent do not contribute scientifically valid information to this assessment. Nonetheless, these data show that diverse agricultural and human sources, exclusive of dairy sources, contribute to contaminant concentrations in groundwater in the Lower Yakima Valley.

Independent samples t-tests were conducted to compare nitrogen water sample results for samples collected downgradient of the dairies vs. downgradient of the septic systems. Based on these analyses, there was no significant difference between the concentrations measured downgradient of the dairies vs. downgradient of the septic systems, for either nitrite-N or nitrate+nitrite as N (Table 9).

Table 9. T-test Results (two independent samples t-test) Comparing Nitrogen Measurements in Water Samples Collected at Locations Downgradient of Dairies vs. Downgradient of Septic Locations

Nitrogen Measurement	General Location and Sample Count	Mean (SD) (mg/L)	T-test Result
Nitrite-N (Cascade Analytical Laboratories)	Dairy-Downgradient Well (n = 11) Septic-Downgradient Well (n = 4)	29.2 (15.3) 26.9 (12.9)	No difference (p = 0.797)
Nitrate+Nitrite as N (Manchester Environmental Laboratory)	Dairy-Downgradient Well (n = 11) Septic-Downgradient Well (n = 4)	30.7 (16.2) 28.7 (14.0)	No difference (p = 0.836)

4.3 Review of the U.S. EPA's Peer Review Process for the Phase 3 Assessment

As part of its evaluation, U.S. EPA solicited a peer review of the Phase 3 document. U.S. EPA provides a discussion of the intent of peer review in its *Peer Review Handbook* (U.S. EPA, 2012c):

> Peer review is intended to uncover any technical problems or unresolved issues in a preliminary (or draft) work product through the use of independent experts. This information is then used to revise that draft product so that the final work product will reflect sound technical information and analyses. Peer review is a process for enhancing a scientific or technical work product so that the decision or position taken by the Agency, based on that product, has a sound, credible basis...
>
> Peer review is intended to uncover any technical problems or unresolved issues in a preliminary (or draft) work product through the use of independent experts. This information is then used to revise that draft product so that the final work product will reflect sound technical information and analyses. Peer review is a process for enhancing a scientific or technical work product so that the decision or position taken by the Agency, based on that product, has a sound, credible basis.

U.S. EPA developed a Peer Review Plan for the Phase 3 project prior to October 2012 (U.S. EPA, 2012d). In terms of its potential impact on public policy or the private sector, the project was characterized by an Office of Management and Budget (OMB) Category of "influential." However, in our review of the Peer Review Plan, the charge to the peer reviewers, and the submitted comments from the peer reviewers[8], we find that the peer review did not achieve the level of transparency and rigorous analysis necessary to adequately inform U.S. EPA of the limitations of the Phase 3 document.

First, while the peer review request was for "independent experts" in the area of chemical-biogeochemistry, public nominations were not solicited, nor does it appear that public, scientific societies were asked to nominate peer reviewers. Per U.S. EPA's *Peer Review Handbook* (U.S. EPA, 2012c):

> An independent peer reviewer is an expert who was not associated with the generation of the specific work product either directly by substantial contribution to its development or indirectly by significant consultation during the development of the specific product....Independence is freedom from institutional or ideological bias

[8] U.S. EPA presents the Peer Review Plan, the identity of the Peer Review Panel, the Charge to the Third Party Reviewers, and the submitted Peer Reviewer comments on their website at: http://cfpub.epa.gov/si/si_public_pra_view.cfm?dirEntryID=242089

> regarding the issues under review and is necessary for objective, fair, and responsible evaluation of the work product. If a selected reviewer has a particular scientific or technical perspective, it may be desirable to balance the review with peer reviewers with other perspectives. In addition to being independent, ideally, peer reviewers should be free of real or perceived conflicts-of-interest.

However, U.S. EPA was not transparent about the process they used to select the peer reviewers (e.g., no information in this regard is presented on their website) nor do they present information demonstrating the independence of the peer reviewers from conflicts-of-interest.

Second, the peer review group was small in number (4)[9], which limits the breadth of technical capability offered by the group. Only three peer review response reports were found on U.S. EPA's website.[10] While it can be argued that all of the peer reviewers are independent, in that they are drawn from outside the U.S. EPA office that conducted the Phase 3 work, all are either U.S. EPA, USGS, or USDA employees.[11] While U.S. EPA's *Peer Review Handbook* (U.S. EPA, 2012c) states, "Peer reviewers can come from EPA, another Federal agency, or from outside of the Federal government," one might wonder how the inclusion of nonfederal employees might have broadened the perspective of the provided comments. It is also not clear when the peer reviewers were convened and how much time was provided to them to conduct their review. If the allotted time was brief, the peer reviewers might not have had sufficient time to conduct a thorough assessment.

Third, the comments by a majority of the peer reviewers were short and lacking in rigor. While Dr. Young provided nine pages of detailed comments, the other response documents are no more than two pages long and some responses are a single word (e.g., Q. "Are the uncertainties adequately addressed and clearly articulated?" A. "Yes."). Given the length of the Phase 3 document and the size of the sampling and analytical program, it is surprising that the reviewers did not have more extensive observations about the program.

Fourth, some of the comments provided are consistent with what we observed. For example, Dr. Young comments on the uncertainties in determining contaminant sources introduced by the mixed land use:

> (p. 1) I don't see anything within the data that could more strongly link the nitrate contamination to specific sources. Based on the age dating results, isotope results, and fairly widespread occurrence of atrazine and a few other compounds, the nitrate in many of the wells is most likely from a mix of sources which would be challenging to tease apart, probably requiring a much more extensive sampling campaign and more knowledge of well depth and screen lengths;
>
> (p. 3) Approximately how long have the dairies been in operation? The age dating results suggest that many of the wells are probably sampling mixed older and younger water, so I'm still unsure about whether the upgradient vs. downgradient wells can be used to directly identify dairy-related impacts. I think this is addressed well in Section X, but I think the uncertainties associated with mixed land use need to be mentioned throughout the report;

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[9] While there are five separate names listed on U.S. EPA's website, Dr. Lorraine Edmond's report was not provided on the website as of date of these comments.

[10] Stephen Kraemer, Ph.D and Roger Burke, Ph.D., are co-authors of a single report.

[11] Lorrain Edmonds, Stephen Kramer, and Roger Burke are affiliated with the U.S. EPA, Megan Young is affiliated with the USGS, and David Turkalson is affiliated with the USDA.

(p. 4) Pg 15. How certain is it that the dairy areas only contain dairy-related sources? The aerial photos seem to show surrounding fields- are these all dairy fields? Maybe state that within the mixed septic & irrigated cropland areas, these sources were all within X kilometers of the sampled wells, while in the dairy areas, only dairy-related fields were located within X kilometers of the sampled wells;

(p. 5) Pg 17: In the criteria for selection of septic systems, there needs to be further explanation about how well the selected wells met the criteria of "minimal upgradient nitrate sources other than septic." Maybe an approximate distance away from any irrigated and fertilized fields? On page 15, it is mentioned that the three other areas contain both septic systems and irrigated cropland sources.

She also comments on the possibility that wells sampled different aquifers:

(p. 4) Pg 9 Study Area- what is the possibility that some/ any of the wells sampled in this study are within the deeper aquifer? This section goes into detail about the uncertainties, but in the sections on the different well results, the report makes it sound like there is reasonable certainty that the upgradient and downgradient wells are tapped into an aquifer with a known and somewhat rapid flow direction. Since approximate depth to the confined aquifer isn't mentioned in the Study Area section, I can't evaluate the likelihood that any of the wells might be in a deeper aquifer with an unknown flow direction.

She also comments on the overlapping isotopic compositions contributed by different nitrate sources:

(p. 5) Pg 26. Second paragraph in Isotopic Analysis. I would suggest changing the phrasing of this paragraph to state that multiple studies have shown that various dominant nitrate sources can have overlapping isotopic compositions, and that unless the range of isotopic values for nitrate source end-members within the local study area has been well measured (and have distinct isotope values), nitrate which falls into the isotopic range in which the sources overlap cannot be distinguished based on isotopes alone.

She also comments on the contribution of other land uses to some of the specific detected contaminants:

(p. 6) Pg 33-34. Since atrazine was found in the upgradient well and the downgradient wells, it seems like you should mention that the atrazine could also be from other surrounding land uses, the occurrence of atrazine in the application fields doesn't provide a very strong link to the downgradient wells, particularly since it seems to have been found in wells with different land uses as well;

(p. 8) Pg 67. I think the complications associated with mixed land uses should also be mentioned here, particularly because the detections of some compounds in the various upgradient wells indicates the presence of different sources of various compounds within the study areas. You can emphasize that sites were selected to try and minimize mixed land use, but it will always be close to impossible to find areas with only a single land use.

Overall, we find that U.S. EPA did not conduct an appropriately rigorous peer review that embraces the spirit of the peer review process as described in U.S .EPA's own guidance (U.S. EPA, 2012c).

5.0 CONCLUSIONS

U.S. EPA (2012a) emphasizes a number of results in order to support its conclusion that dairies are contributing significantly to well water contamination. However, it downplays results that both suggest other sources also contribute significantly and that demonstrate the difficulty in allotting contamination to any source without a more detailed and careful sampling and analysis program. U.S. EPA also does not adequately emphasize the numerous data quality concerns.

A number of issues with the design of the sampling and analytical program are apparent, resulting in data that are insufficient to conduct scientifically reliable assessments of the potential source of contaminants. Specifically:

- Well sampling locations were selected in a biased manner, such that only those with the highest nitrate concentrations measured during the Phase 2 investigation were selected for sampling in Phase 3. This bias towards higher concentrations can result in invalid conclusions about the extent of contamination.
- Only two upgradient well water samples were collected, one upgradient of each dairy sampling area. As a result, there is little information on "background" conditions (i.e., conditions unimpacted by the sites), and it is impossible to determine whether concentrations measured downgradient are statistically similar to or different from background. Consequently, there is no scientific certainty about any conclusions drawn with regard to these data. Further, U.S. EPA did not collect well water samples upgradient of the other types of sources it evaluated, including septic systems and irrigated crop lands, such that conditions unimpacted by these sites are not known.
- U.S. EPA did not collect background soil samples to assess concentrations of contaminants in soil in the lower Yakima Valley from such sources as residential, urban, or industrial sources. Thus, the contribution from these sources is not known.
- U.S. EPA does not demonstrate that upgradient and downgradient wells are measuring the same aquifer, since U.S. EPA relied on existing residential wells and had limited information on the depth of many wells. Regarding this, U.S. EPA states, "Lack of complete well information limits our ability to verify if the wells upgradient and downgradient of the sources draw water from the same water bearing zone."
- U.S. EPA had little information on groundwater flow and acknowledges that "Very frequently, there are 10- to 100-fold differences in groundwater velocities among aquifer materials of such contrasting grain size…A well that is located along a preferential flow path may draw a substantial portion of its water from a particular source. A well located on an adjacent, but different, preferential flow path may have markedly different chemistry. For this reason, it is anticipated that upgradient sources of nitrate could produce different downgradient effects in groundwater (such as nitrate in water wells), even in wells from neighboring homes."
- Review of nearby land use suggests there are other uncharacterized sources of contamination upgradient of the dairy areas, including livestock activities, cropland, and septic systems.
- Water samples are grab samples reflecting concentrations at a single point in time. Groundwater conditions and water conditions can fluctuate seasonally and it is not known how measured results reflect longer term conditions. In addition,

concentrations of some of the analytes such as soil fertilizer and pesticides are also expected to show seasonal variations in concentrations depending on application time.

- Cropland sampling was very limited. Contributions from other types of crops (e.g., alfalfa, wheat, hay, tree fruit, grapes) were not assessed. Interpretation of crop field data is also complicated by the fact that some are located near other possible source areas (e.g., near septic systems) and crop fields were treated with both synthetic and animal fertilizers.
- A substantial percentage of the analytical data are "J qualified"—i.e., reported concentrations are estimated. These concentrations can be biased low or high such that direct quantitative comparison of samples is not be appropriate without case-by-case evaluation.
- U.S. EPA had difficulty analyzing both trace organics and wastewater pharmaceuticals, and indicated that results of these analyses should be considered screening level and not fully usable for quantitative evaluations. However, these two analyte types would be most useful in supporting efforts to assess whether human wastewater sources contribute to concentrations detected in downgradient wells. The lack of quality data for these parameters limits the usefulness of this investigation.
- U.S. EPA's Water Science Lab reported that monensin and lincomycin were detected in the well water field blank sample, such that any detects of these analytes in well water samples should be qualified.
- U.S. EPA did not meet preservation requirements for about one-third of the nitrate analyses, which could bias sample results.
- U.S. EPA did not collect field duplicate samples for well water or lagoon samples due to an oversight and so cannot document the reproducibility (precision) of the sampling and analytical methods applied to these samples, reducing confidence in the quality of the well water data.
- Detection limits for some analytes, especially wastewater pharmaceuticals, appear elevated. Consequently, it is inappropriate to conclude that human waste did not contribute to concentrations in corresponding wells, since lack of detection could be due simply to elevated detection limits.
- Differential movement of contaminants through soil and groundwater due to different fate and transport properties makes it impossible to establish "fingerprints" for these compounds and determine the source of contaminants.
- Nitrate isotopic ratios for synthetic fertilizer and animal waste sources can vary beyond the ranges assumed to by U.S. EPA, and their methodology cannot distinguish between human and other animal sources.

Given the data do not meet a minimum level of reliability, the assessments of Haak Dairy and the Dairy Cluster as well as the assessments of irrigated cropland, wells downgradient of residential septic systems, and WWTP influent cannot be used to make reliable determinations about the source of contaminants. Specifically:

- None of the detected pesticides can be reliably attributed to the dairies. Atrazine was detected in both upgradient wells and at variable concentrations downgradient. All reported concentrations are "J qualified" (estimated), and atrazine is largely ubiquitous in agricultural areas. Alachlor was only detected in two downgradient

wells, and reported concentrations are J qualified. Ioxynil was detected in only one downgradient well at a concentration well below the quantitation limit and reported concentrations were J qualified.

- The only detected trace organic (DEHP) cannot be reliably attributed to the dairies. DEHP was detected in three downgradient wells, as well as one upgradient well. Although it was detected in some dairy source samples, it was also detected in all of the WWTP influent samples. Further, per U.S. EPA, the trace organic concentrations should be interpreted as "screen" values. Finally, DEHP is widely detected in the environment due to its use as a plasticizer.
- The only detected wastewater pharmaceutical (DEET) cannot be reliably attributed to the dairies. DEET was detected in one downgradient well. Although it was detected in some dairy source samples, it was also detected in all of the WWTP influent samples. Further, per U.S. EPA, the wastewater pharmaceutical concentrations should be interpreted as "screen" values.
- The five detected veterinary pharmaceuticals can have multiple sources (monensin, chlortetracycline, tetracycline, tylosin, and virginiamycin). Tylosin and virginiamycin were detected infrequently. Monensin was detected both upgradient and downgradient, and U.S. EPA concluded, "The detection of monensin in the upgradient well indicates there is an upgradient source of this compound." In addition, the detection of monensin in the field blank samples indicates that it cannot validly be reported as detected in downgradient samples.

  Tetracycline was detected in both upgradient and downgradient wells, is used as a human pharmaceutical, and was detected in one WWTP influent samples. In addition, tetracycline compounds (oxytetracycline) are used as a fungicide and bactericide on tree fruit in Washington State. Regarding tetracycline, U.S. EPA states "given that the concentrations in the upgradient well are higher than the downgradient wells, another source for the tetracycline is likely." U.S. EPA further states, "Given the results, septic systems are a possible source of tetracycline and sulfamethoxazole, both of which can be used by humans, in the residential drinking water wells."
- The three detected hormones (testosterone, androsterone, and androstadienedione) cannot be reliably attributed to the dairies. All three hormones were detected in all three of the WWTP influent samples. Regarding testosterone, U.S. EPA states, "The dairies are a possible source of the testosterone in the downgradient wells; however, given the concentration in the upgradient well, another source for the testosterone is likely." Androsterone and androstadienedione were detected downgradient only in J qualified samples.
- Barium was the only trace inorganic element that increased between the upgradient well and downgradient well at the Dairy Cluster. However, some downgradient concentrations are lower than the upgradient concentration, and some directly adjacent downgradient wells have very different concentrations. These assessments show that comparison a single upgradient measurement to the downgradient measurements is scientifically invalid and produces no meaningful information. In addition, U.S. EPA does not support its assertion that barium is used at the dairies and therefore that the dairies are a potential source.

Regarding the peer review process for the Phase 3 document, U.S. EPA did not conduct an appropriately rigorous peer review in accordance with the spirit of the peer review process as described in U.S .EPA's own guidance. Specifically,

- U.S. EPA's selection of peer reviewers was not transparent, and all four peer reviewers were drawn from federal agencies, potentially limiting the perspectives of provided comments.
- Aside from one peer reviewer, most of the peer review comments received were extremely brief and not adequately rigorous to provide U.S. EPA with sufficient information on the quality of the science presented in the Phase 3 document.
- Of the more rigorous comments received, concerns presented were similar to those we discuss, including the lack of appropriate characterization of contributions from mixed land use, absence of evidence that wells sampled the same aquifers, and misrepresentation of the overlapping ranges of isotopic ratios contributed by different nitrate sources.

In summary, because of the numerous sampling design and analysis issues in the Phase 3 program as well as the potential impact of highly mixed local land uses, we conclude there is insufficient information to determine with scientific certainty whether and how much any of the sources could have contributed to contamination in downgradient wells. In particular, because of the numerous issues highlighted above, no particular location can be implicated as a source of any of the contaminants measured.

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RICHARD C. PLEUS, PH.D.
BIOGRAPHICAL SKETCH

RICHARD C. PLEUS, PH.D., Intertox managing director and toxicologist, is an expert in neurological and reproductive toxicology with over 25 years' experience assessing the risk to humans exposed to chemical and biological agents via food, consumer products, therapeutic agents, and the environment.

Dr. Pleus' current research has focused on emerging contaminants in water, such as endocrine disruptors (EDCs), pharmaceuticals, and personal care products (PPCPs). He has recently been involved with a number of research projects focusing on PPCPs and EDCs in drinking water with the Water Research Foundation (formerly American Water Works Association Research Foundation (AwwaRF)), and the WateReuse Foundation (WRF).

Dr. Pleus' credentials include a B.S. in Physiology, with honors, from Michigan State University, an M.S. in Environmental Health and a Ph.D. in Environmental Toxicology from the University of Minnesota, and postdoctoral research in neuropharmacology at the University of Nebraska Medical Center.

GRETCHEN BRUCE, DABT
BIOGRAPHICAL SKETCH

Gretchen Bruce, DABT, Intertox Director of Toxicology, and has over 20 years of professional experience as a toxicologist and risk assessor assessing risks to human health posed by a wide range of compounds in different media. Areas of particular expertise include the assessment of pharmaceuticals and endocrine disrupting compounds (EDCs) in source and drinking water; characterizing the state of knowledge regarding the toxicity of metals, organics, and nanomaterials; and establishing risks of leachables, extractables, and excipients in consumer drug products.

As a risk assessor, Ms. Bruce has managed and conducted risk assessments for industrial and residential sites in accordance with federal CERCLA/RCRA, state, and local guidance for more than a dozen states. Project experience includes assessing fate and transport and establish site cleanup levels; negotiating with regulatory agencies; designing and conducting field sampling programs and laboratory QA/QC reviews; conducting detailed evaluations of the validity of default assumptions for site-specific assessments; and designing multipathway probabilistic exposure models to characterize the uncertainty and variability in estimated doses.

Ms. Bruce holds a Bachelor of Science degree in Environmental Toxicology from the University of California, Davis, and is certified as a Diplomate of the American Board of Toxicology.

JOHN DAVIS - NRCS

Thank you for the opportunity to provide comments on the EPA- Relation Between Nitrate in Water Wells and Potential Sources in the Lower Yakima Valley, Washington study.

At the request of NRCS Washington State leadership, NRCS National Science and Technology staff has reviewed the report and submits the following comments and observations:

1) The use of generalized recommendations contained in the NRCS Animal Waste Management Field Handbook (AWMFH) to predict the seepage loss contribution from individual farms is misleading. AWMFH recommendations and data are well supported by research and field experience throughout the US. However, they are generalized recommendations that typically get adjusted to accommodate site conditions during the planning and/or installation phases of storage facility construction. Site specific testing and on-site evaluations are usually necessary to assure adequate design for a given site. Planning for an adequate structure requires detailed information about anticipated manure volumes, manure type and consistency, climate, and production area runoff, etc.

2) The generalized AWMFH seepage rates should not be used to predict leakage losses from multiple dairies distributed randomly in a major watershed. Generalized seepage rates are used by planners/installers to anticipate the potential for loss and the need for additional conservation practices that will provide adequate protection of local water quality. Recent Mississippi River Basin and Chesapeake Bay Watershed CEAP studies have established the effectiveness of installed NRCS conservation practices at protecting water quality. Practices were most effective when they were coordinated as a suite of practices designed to deal with a site-specific water quality issue.

3) NRCS funded waste storage structures must be constructed following engineering conservation practice standards that are maintained by state-based NRCS technical experts. To receive USDA funding, producers must sign a contract that requires compliance with design, oversight/maintenance, and other criteria established by the practice standard. The contract is permanently tied to the state's official practice standard when the contract was signed by the producer, i.e., lagoons built 15-20 years ago are not associated with contracts that enforce criteria for the current official practice standard.

4) EPA's restricted access to important sites or data made it difficult to estimate the pollution contribution from individual farms. Farm specific information would have helped the researchers isolate site/management issues contributing contaminants to the environment.

5) The use of aerial photography to determine storage volumes can grossly over estimate each operation's manure storage capacity and therefore your estimate of seepage losses.

6) A storage facility is typically designed following rigid engineering standards, and local code usually requires routine monitoring for failure. EPA does not know if the structures were designed per code or if competent engineers were involved in the work. There are many factors that could lead to a leaking storage facility. Targeting all operations upgrade of a contaminated well may unfairly focus attention on well managed operations.

7) EPA does not know if the operations have storage facilities that were designed to handle the number of animals confined. If not, the lagoons may lack sufficient capacity to accommodate the manure/wastewater volumes generated, making them vulnerable to discharge. Has a nutrient management plan been followed to assure adequate facilities to handle mortality, spoiled feed, contaminated runoff, medical wastes, etc? Are animals fenced out of streams; are nutrient being applied too near unbuffered streams? These factors were not considered by the study.

8) Every AFO deals with a unique set of circumstances that define how to best manage large volumes of potentially polluting materials. Site factors, e.g., soil, topography, climate, animal type/number, period of confinement, confinement facility type, field hydrology, storage design/volume, spreadable acres available, and management styles change significantly from farm to farm. A leaking lagoon may not always be the principal problem, and oftentimes additional conservation practices, or better management of installed practices, may significantly reduce losses.

9) It appears that the high levels of nitrate found in drinking water wells in the Yakima Valley are coming from multiple sources. More information is needed to help focus attention on site/management issues contributing pollutants.

10) NRCS acknowledges the need to encourage producers to install sufficient conservation measures to minimize the movement of potential contaminants off-site. Accordingly, NRCS manages approximately 190 conservation standards that can be used to protect air, soil and water quality. Structural practices are available to help the producer keep air and water clean in the confinement (production) area, and land treatment practices (cropland, hayland, pasture) help growers minimize non-point source losses associated with erosion, leaching, volatilization, denitrification and surface flow.

11) Livestock growers enrolled in USDA programs are strongly encouraged to manage their manure handling, storage and field allocation activities following a Comprehensive Nutrient Management Plan (CNMP). The CNMP is developed based on site conditions and is designed to help farmers safely apply stored manure to their available land base.

12) The NRCS Nutrient Management Conservation Practice Standard (CPS 590) provides the minimum nutrient management planning criteria for the application of nutrients (synthetic or organic) to agricultural lands enrolled in USDA programs.

13) In January 2012, NRCS released a revised nutrient management policy and CPS 590. The new policy encourages improved nitrogen and phosphorus risk assessment tools, precision and enhanced efficiency fertilizer technologies, suites of coordinated conservation practices, and adaptive nutrient management strategies. Improved nutrient use efficiency saves the producer money and also reduces the potential for loss to the environment.

14) NRCS is committed to working with farmers to help them minimize the impact that farming operations can have on local water quality, including drinking water.

A review of EPA Report 910-R-12-003

Entitled "Relation Between Nitrate in Water Wells and Potential Sources in the Lower Yakima Valley, Washington"

Provided by Joe Harrison
Livestock Nutrient Management Specialist
Washington State University, Puyallup

This review was conducted at the request of the Washington State Dairy Federation

My comments will be focused on study methodology of the EPA report and based on my field-research experience during the past 8 years. I have conducted collaborative research with the Washington State Dairy Industry (WSDF) and Washington State Department of Ecology (WDOE) Environmental Assessment Division to evaluate the relationship between forage and manure application management, and shallow ground water nitrate concentrations on a commercial dairy. (Nitrate in Groundwater, Soil, and Grass in a Manured Field Overlying the Sumas-Blaine Aquifer)

The EPA study has several design elements that are of concern:

1) Lack of replication of samples (water, manure, soil) overtime

Published research and multi-year studies conducted by WSU in collaboration with WSDF and WSDOE have demonstrated seasonal and yearly variability for the types of samples collected when evaluating the relationship between forage and manure application management, and shallow ground water nitrate concentrations on a commercial dairy.

2) Soil samples collected at 1 inch of depth

When conducting environmental studies (manure storage and application and ground water) it is common to take samples at a depth of 1 ft or multiples of 1 ft depths to determine the concentration of a constituent of interest, particularly when trying to inter-relate the concentration of a constituent and ground water. At best, a shallow (1 inch) soil sample might be appropriate when evaluating the relationship between the constituent and surface water contamination.

3) Relating aged water (16 to 42 years) to: 1) contemporary (2010) analytes in soil, water, and manure, and 2) contemporary dairy management factors

Samples of soil, water, and manure were collected in 2010 and analyzed for specific components. The soil and manure samples were of contemporary time (2010) while the water was aged, 16 to 42 years old. In addition, the report summarized current (2010) management aspects of the farms, for instance animal numbers and acreage used for crop production. It is well known that the dairies have increased in size over the past few decades, but no effort was made to factor this into the calculations. No evidence was cited that would suggest what the transport rate is of the analytes of interest from soil to ground water.

4) Lack of specific data on ground water flow direction

General reference was made in the report of the flow of groundwater in the region of interest. No indication is given if the flow of ground water is affected by seasonal precipitation, snow melt, and irrigation practices. Studies we have conducted in Whatcom County suggest seasonal flow changes during the course of a given year and can impact the recharge of shallow ground water. If changes in the flow of ground water do change throughout the year in the region of interest, then the groundwater could be influenced by multiple sources of nitrogen from different direction.

General Summary Comments

Due to the concerns mentioned above, and the lack of information confirming the integrity of the wells from which water was obtained, the report does not accomplish its goal of providing information on "the contribution from various land uses to the high nitrate levels in groundwater and residential drinking water wells".

J H Harman
11/29/2012

2606 W Pioneer, Puyallup, WA 98371-4998
253-445-4501 • Fax: 253-445-4571 • TDD: 1-800-833-6388

MUKHTAR TEXAS A&M

A Review of the U.S. EPA Region 10 Report entitled, "Relation Between Nitrate in Water Wells and Potential Sources in the Lower Yakima Valley, Washington.

Review Comments

Review comments and observation for this report that describes the sampling, analyses, results and findings during the phase 3 of the Lower Yakima Valley study are provided in this section. A summary of the review is provided in the "Conclusions" section. Most comments are related to sampling and results for nitrate from potential sources and sinks in the study area.

Lack of replicated and representative sampling

Statistically, due to the lack of replicated samples of soil, well water, manure, lagoon effluent and septic system influent collected during the study, results do not represent the "population" of potential sources of nitrate and other analytes.

For example, on page 36 (Haak Dairy General Chemistry) it is indicated that five well samples, one from one upgradient water well and one each from four downgradient water wells, were collected and analyzed for different analytes including nitrate. Not taking multiple samples per well presents a major challenge for assessing sample to sample variability within one well and among different wells. Statistically, the normality and independent distribution of just one sample per source cannot be examined for sampling errors, experimental errors, handling, processing and analysis of samples because mean and standard deviation for one sample cannot be calculated. Therefore, the confidence level in comparing results of one upgradient well sample with one downgradient sample per well is low and the differences in results for nitrate and other analytes cannot be compared using standard statistical procedures. Similarly, lack of replicated samples from only one upgradient well of the Dairy Cluster and one sample each from all the downgradient wells (page 55, Table 20) significantly decreases the level of confidence in the results and increases the uncertainty of comparison for nitrate and other analytes from one sample of the upgradient well with one sample each of the 11 downgradient wells.

Another such example is soil sampling in Irrigated Croplands. On page 12 of the study, paragraph 1 describes that there are more than 240,000 acres of cropland in Yakima County.

However, only six samples (page 15, Table 1), each one a composite of 30 sub-samples per crop field of an undisclosed number of acres, were collected upgradient from six water wells. It is not known from the study how many total acres of cropland existed upgradient of these wells and why only one composite sample per field was considered a reasonable number of sample to represent the entire field. Therefore, the variability in soil sample results (page 70, Table 28) for different N species including nitrate in Table 28 cannot be explained due to the lack of number of samples per field, per crop, and fertilizer type.

In addition to these examples, results of only one sample from manure pile per dairy and one application field per dairy do not provide statistically sound estimates of actual concentrations of nitrogen and its species including nitrate (page 55, Table 20) or any other analytes.

One consequence of the lack of a representative number and replicated samples is provided as an example from the data provided in this report. On page 44, second paragraph below Table 15, it is stated, "Sample LG01 was taken from liquid waste in a ditch just before entering the lagoon system and contained sulfate. Sulfate was not detected in co-located samples LG-02 and LG-03, likely because of anoxic conditions in the lagoon." On the other hand, as shown in Table C6, sulfate was detected in lagoon sample LG 14. One would expect anoxic conditions in the lagoon where sample LG-14 was collected yet sulfate was detected in this sample but not in samples LG-02 and LG-03.

Lack of strategic sampling of potential sources of nitrate and other analytes

In addition to the lack of replicated sampling and as a result, expected deficiencies described above, the lack of strategic sampling for different N species and other analytes was observed in the report and examples of those deficiencies are provided here.

During early spring of 2010 (February through March) soil samples from one inch depth were collected from an application field or a crop field (Page 15 Table 1). These samples most probably represented the greatest accumulation of N and other analytes during spring when no active utilization of N fertilizer, from organic or inorganic sources, occurs due to absence of crops or due to early growth stage of crops, if growing during early spring. A high accumulation of N at shallow depths (one inch in this case) does not infer that there is movement of nitrate from the soil surface to the groundwater through the vadose zone. A sampling plan should have included to sample soil cores from depths much greater than one inch and to collect water samples from greater depths by installing piezometers (observation wells) in these fields, as well as upgradient and downgradient of these fields.

Additionally, soil samples from one inch depth should also have been taken during the growing season and after the harvest season to assess availability of soil surface N and its species. Soil

moisture content at shallow and deeper soil profiles should also have been measured during different seasons of the year to investigate porosity and saturation conditions of soil and to assess how, if any, organic N was converting to nitrate/nitrite due to unsaturated or saturated conditions below the soil surface of these application fields or crop fields.

On page 14, last paragraph, it is stated that no drinking water wells upgradient of the crop fields or septic systems were sampled. Therefore, no upgradient versus down gradient comparisons could be made for analytes measured from the dwongradient wells.

One influent sample per waste water treatment plant (WWTP) was collected "to serve as surrogates" for rural septic systems. On page 76, paragraph 4, it is stated, "Although four wells were selected for this evaluation, all of the residential wells were compared with the WWTP data to determine whether septic systems are a likely source of the nitrate found in any Phase 3 well in the study." However, no assessment (and sampling) of sites with failing septic systems in the study area was conducted or reported. Poorly constructed and failing/failed septic systems (including leach fields) may potentially have contributed to contaminants including nitrate and bacteria to shallow drinking wells in the vicinity.

In a 1993, in a WWTP inspection report (Glenn, 1993) in the Lower Yakima Valley area by the Washington State Department of Ecology it was concluded, "The most frequent problems, each occurring at about half the plants, were:

- potential for chlorine toxicity in the receiving water;
- potential for ammonia toxicity/nutrient enrichment in the receiving water;
- wasteload to WWTP exceeds design criterion(a);
- potential for violation of weekly/monthly average fecal counts; and
- flow measuring instrumentation needs calibration."

It was also observed that "Several plant sites need better maintenance practices; several are understaffed. Two of the WWTPs have considerably more problems than the remaining seven, namely Zillah and Mabton."

According to the phase 3 EPA report, Page 80, last paragraph, age dating (defined as the number of years since the water infiltrated from the surface to the aquifer) method used in this study can determine the age of water up to about 40 years, or approximately up to 1970. Potential contributions of contaminants in the receiving waters of the study area from WWTPs (DOE, 1993 report above) may have been the potential cause of well water contamination due to infiltration of water from surface to the shallow aquifer.

levels of nitrate in observation wells had declined to near those measured before loading. Sealing of the lagoon with dairy manure was cited for this decrease.

Conclusions

This review document discusses the lack of replicated and statistically deficient sampling of potential sources and sinks of nitrate and other analytes in the Lower Yakima Valley. Other observations pointing out to study assumptions are also provided. This phase 3 report by EPA also points to limited or non-existent information (page 84, Section X) on several important aspects including incomplete information on well parameters and realistic groundwater flow direction specific to the study sites. Lack of historical information and production and management data on dairies and irrigated crop fields also were cited. Additionally, nonexistent or insufficient information on presence of livestock, possible wildlife presence, use of synthetic and organic fertilizers in the vicinity of the residential drinking well water sites further dilute the validity of results shown and conclusions made in this study.

Based upon the data and results provided in this report, no direct correlations can be made between nitrate in water wells and any one specific potential source of nitrogen in the Lower Yakima Valley.

References

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USDA-NRCS. 2009. Agricultural Waste Management System Component Design, Chapter 10, Agricultural Waste Management Field Handbook, Part 651 Publication number 210–VI–AWMFH, amend. 31, August 2009.

Yakima Valley Nitrate Study

Comments/Input
Submitted by Richard Fasching
USDA Natural Resources Conservation Service
Portland, Oregon

The following is being provided in response to the USEPA report, EPA-910-R-12-003, entitled *Relation between Nitrate in Water Wells and Potential Sources in the Lower Yakima Valley, Washington.*

Introduction. This EPA study was generated primarily due to the concerns by many pertaining to the high levels of nitrate in water wells in the Lower Yakima Valley, WA. In an effort to determine the source of those high nitrates, dairy farms (along with other minor sources) located within proximity to the wells, were identified as potential sources, specifically dairy farms in operation there. The report concludes that dairy producer's facilities and their associated lands are the principal sources of high nitrates in the wells. To validate their claim, EPA collected much data and performed numerous tests attempting to pinpoint the source of the nitrates.

After reading the report and reviewing the numerous data and conclusions derived from it, I am highly skeptical of their conclusions based on their testing methods, procedures, and interpretations of these recorded throughout the report. The report is filled with considerable errors in calculations and interpretations that, based on the performed tests, methods and interpretations, cannot be scientifically defended to derive at the stated conclusions. I want to acknowledge that high nitrate levels in water wells are a documented health hazard. However, the source and extent of those nitrates must be accurately identified before corrective measures can be implemented or a course of action, pineal or otherwise, is undertaken.

Comments/Input. The study design itself is flawed in that it fully acknowledges that identification of the extent and sources of nitrates did not take into account any losses of nitrates from biological, physical, or chemical processes and also did not account for crop utilization (ref. page 16, Phase 3 Study Results). The conclusions pertaining to the dairies are based on data that does not properly represent the sources or the extent of nitrates. In essence, the study simply collects data on particular sites at particular times and finds nitrogen of various forms and concludes that all these are the cause of the well water contamination or substantially contribute to it.

Anytime animal wastes and fertilizers are utilized to provide the required nutrients for crops and forages, a minimum set of information must be considered to properly provide a management system that simultaneously provides needed plant nutrients as well as protects surface and subsurface waters. To accurately determine what the needs of the crop are consideration *must* be given as to the proper rate, proper timing, the proper source, and the proper place of nutrient applications including fertilizers and manures. Lack of consideration to any of these will lead to potential production and or environmental problems. Additionally, ignoring any of these while diagnosing an environmental or production problem will also result in less than accurate conclusions. In attempting to determine the source and extent of the nitrate problem in the Lower Yakima Valley, this report ignored or misinterpreted vital data and information to derive at their conclusions.

1. The report does not utilize actual design parameters of the waste storage pond for any of their calculations for all the estimates of specific discharge. The only dimension that was measured is the top surface area of the waste storage pond. The size of the top of this pond was measured at 6.175 acres, which is a significant structure.

By NRCS design criteria, written in the Waste Storage Facility, CPS 313 (2004), the storage ponds would have a designed specific discharge as little as 0.07 inches and is equivalent less than 1% of the total annual depth of precipitation in this part of the state.

Given that the basis of concern stated in the EPA report is groundwater quality, there conclusions that the ponds are causing considerable leaching of nitrates into the groundwater is incorrect. Proper calculations would conclude that the ponds are **not** likely the source of nitrates in the wells. This also would suggest that there may be other nitrate sources that have a higher potential to impact groundwater than the waste storage ponds as stated.

2. The EPA report suggests that irrigated cropland is expected to be a likely source of nitrates in drinking water wells (ref. page ES-9). However, the only pathway that nitrate contaminants can enter well water is through either 1). Leaching through the soil profile past the crop/forage rooting zone into ground water and subsequent movement underground to a well, or 2). through surface water flow off of the field and directly into a recharge area that feeds the well itself.

In consideration of leaching, the report attempts to identify that the soils on a majority of the fields that are receiving manures and commercial fertilizer are considered "well drained" and that they have "saturated hydraulic conductivity" characteristics that is considered high (ref. EPA-910-R-12-003, surface soils, page 35 and Appendix B). The report cites the USDA NRCS soil survey and reports generated from the survey to characterize the fields.

Saturated Hydraulic Conductivity. According to the definition that USDA NRCS uses to describe and characterize saturated hydraulic conductivity (Soil Survey Manual, Ag Handbook 18) saturated flow occurs only *when the soil water pressure is positive; that is, when the soil matric potential is zero (satiated wet condition).* This situation takes place when about 95% of the total pore space is filled with water (5% is air). If the soil remains saturated for a prolonged period (several months or longer) the percent of total pore space filled with water may approach 100 percent. "Saturated hydraulic conductivity CANNOT be used to describe water movement under unsaturated conditions" (ref. USDA Soil Survey Manual, Soil Survey Division Staff, Agriculture handbook 18, October 1993, page 103).

Because irrigation water management details were not collected from the producers nor was data collected in the field that measured soil saturation or duration, there is no data that can substantiate that the simple classification of hydraulic conductivity precludes leaching. Therefore, the data that EPA draws upon in this report to suggest the fields were leaching is circumstantial and cannot be used to conclude that leaching is attributed to the land treatment fields where manures and fertilizers were applied.

Drainage Class. Natural drainage class refers to the frequency and duration of wet periods under conditions similar to those under which the soil developed. Alterations of the water regime by man, either drainage or irrigation, is NOT considered unless the alterations have significantly changed the morphology of the soil (ref. USDA Soil Survey Manual, Soil Survey Division Staff, Agriculture handbook 18, October 1993, page 98).

The USDA Soil Survey manual describes "well drained" as *water is removed from the soil readily but not rapidly. Internal free water occurrence commonly is deep or very deep; annual duration is not specified. Water is available to plants throughout most of the growing season in humid regions. Wetness does not inhibit growth of roots for significant periods during most of the*

growing seasons (ref. USDA Soil Survey Manual, Soil Survey Division Staff, Agriculture handbook 18, October 1993, page 98).

The EPA report misinterprets the definition of "well drained" tying nitrate leaching to the natural drainage classification of the soil. Again, there is no documentation of any kind that would lead to the conclusion that, based on the natural drainage classification of a soil, leaching or subsurface water contamination occurred in the Lower Yakima Valley.

3. The report makes substantial conclusions pertaining to the potential for nitrate leaching and runoff based on soil tests that were derived from the top 1 inch of soil (Table ES-1, footnote b). The top 1-3 inches of soil contains a large majority of the soil profile's organic matter, where large amounts of organic matter and mineralization occur. Additionally, depending upon when soil samples were collected and how and when any manures or fertilizers were applied, it is not uncommon to see high quantities of N near the soil surface for certain periods of the year. For example, if manure was broadcast on the soil surface and not incorporated, higher quantities of N-P- and K would be apparent until such time as the manures of fertilizers were incorporated or volatilized. Management techniques have a great deal to do with the location and quantities of nutrients in the soil profile depending upon the characteristics of the nutrient and the management practices utilized.

To accurately ascertain if nitrates were moving through the soil profile, deep soil tests (36-60 inches) should have been collected from fields above gradient and below gradient of affected wells. If nitrates were found below the rooting zone of the crops grown, this may have been an indicator of potential nitrate movement to ground water. A 1 inch soil sample has limited applicability if any.

4. Some of the testing interpretations are also questionable as to their applicability. For example, on page 20 of the report, EPA states that they tested for nitrate, nitrite, ammonia, and TKN. *"Total nitrogen concentration was calculated bu summing concentration of nitrate, nitrite, and TKN"*. The TKN test is used to determine what the potential total of various forms of N are. A TKN test is the measure of organic N (nitrate and nitrite), ammonia N (NH3) and ammonium N (NH4). By adding nitrite and nitrate to the TKN, you essentially are adding quantities of nitrate and nitrite twice, substantially increasing the total. Nitrate and nitrite are ion specific. Additionally, TKN tests include N that has not been mineralized (as nitrates) and assumptions that they will be are erroneous. The nitrogen cycle, as shown in the report, includes mineralization, denitrification, volatilization, etc. Not all nitrite will be nitrate. Not all nitrate will be remain nitrate (denitrification) especially under wet or saturated soil conditions. Summarily, the results of the improper (depth) soil test data is being misinterpreted and cannot be used to draw conclusion as to the source of nitrates in the wells.

Summary. Due to the fact that specific data pertaining to crop management and tillage systems, manure management, irrigation water management, nutrient management, and pest management were not collected or were not available to EPA, utilizing gross or generalized characteristics or data pertaining to soils within the Lower Yakima Valley for purposes of identifying sources of nitrates in well water is not accurate or conclusive.

It is my suggestion that this report be retracted and data collection begin in earnest including the above listed management information and the appropriate tests using proper data collection methods and testing techniques. The results of which should be independently analyzed by non-affected parties to enable proper conclusions as to the source of nitrates in water wells in the Lower Yakima Valley.

November 29, 2012

Office of Environmental Assessment
Attn: Carol Harrison
U.S. EPA, Region 10
1200 Sixth Avenue, Suite 900
Mail code: OEA-095
Seattle, WA 98101

RE: Lower Yakima Valley Nitrate Study

To Whom It May Concern:

I submit these comments on behalf of N3 Consulting. We are an Agricultural Environmental consulting company specializing in Dairy Nutrient Management. We have over 100 dairy clients in Washington State and several of these are in the Yakima Valley. These comments are based on your report: *Relation Between Nitrate in Water Wells and Potential Sources in the Lower Yakima Valley, Washington.*

Our clients are keen to ensure that their impact on the greater environment are minimized wherever possible, ultimately this boils down to three goals: Pollution represents a loss from the system and often avoiding the losses can involve a saving elsewhere in the system; Dairymen are generally long term residents in the counties and communities in which they farm, they are good neighbours and don't like to be branded otherwise; and the cleanup of pollution and the regulation of it can consume a lot of time and energy .

Dairy farmers are the most closely monitored farmers in Washington state, they are the only ones required to have nutrient management plans by the government and they are the only ones who have regular government inspections. They all have Nutrient Management Plans, often written by, but always approved by the government as meeting your required standards. In order to have these plans Approved and Certified the dairies often had to invest heavily (hundreds of millions of dollars in the state) in structures and management techniques, this is usually done with the help of government engineers and often incorporated government cost share. Ultimately the diaries are the sector of farming that has the most contact with and oversight by you, the government. It seems ludicrous therefore that you, the government should come out with a report that ultimately says that you the government have failed in advising and overseeing the dairies and therefore protecting the ground water. I'm sure that all of your fellow "civil servants" (WSDA, DOE, NRCS, CD's and WSU) will be almost as appalled as we, the tax payers, are. If the protective measures recommended and certified by our government representatives are not sufficiently protective of the environment, then the dairies want to know. The Washington State Dairy farmers have been given rules to follow and are doing so in the good faith that you know what you are doing.

The report states: *"lack of complete well information limits our ability to verify if the wells upgradient and downgradient of the sources draw water from the same water bearing zone."* Surely this is crucial to the investigation and without this any comparison of contamination levels is tenuous at best. In fact it seems that there is very little upgradient water information at all. Admittedly there are a limited number of wells to select from in the area above the dairies but statistical significance requires more than the two questionable wells you have selected.

One of our greatest concerns is the lack of any focused attempt to determine the age of the water. This area has a relatively short history of land use. During that time there have been sweeping changes in the cropping and management of the farmland. Most notably are the changes in relative value of commercial fertilizer to marketable crops. As this ratio has increased, so the use of commercial fertilizer has decreased dramatically in all crops.

The state introduced Dairy nutrient management legislation in 1998 and since then sweeping changes have been made on all the dairies in the state, and particularly the dairies in the study, to bring them into line with government recommendations. I see nothing in your study that references this or even suggests that these changes may have already produced the required water quality improvements. This is of particular concern when the limited aging data you give claims the water variously as 16 to 40 years old and possibly older than 45 years. Anyone who is involved closely with the workings of any of the dairies you have included in your study (and your various government agents have been) will be aware of the massive changes that have occurred on these facilities often at great cost to the dairymen. In particular the escalating commercial fertilizer prices have made manure and composted manure solids valuable commodities in Eastern Washington which has led to huge exports of manure from the larger dairies to crop farmers often dozens of miles away. On one of the dairies included in your study there is now a removal of over ten million gallons of manure and over 2000 tons of composted manure solids which equates to more than 260,000 lbs of nitrogen removed per year. I saw only a cursory note to this in your report. To not give reference to this is inexcusable and shows a blinkered approach on behalf of your researchers.

The report findings indicate that more information is needed for onsite septic systems, wells and cropland fields as well as the dairies. Perhaps this is a good point to work from. The study in fact proves nothing we didn't already know. There is contamination of some drinking water wells and we don't know where it is coming from. The study hypothesizes that the dairy farms are the source of this contamination but has not produced any evidence that scientifically proves that their hypothesis is true. *

The study area has a large number of homes that have onsite septic systems. Onsite Septic studies we have been privy to in Skagit and Whatcom counties have shown between 8 and 26 percent of septic systems to be failing in some form. Since the study area is a similar rural area with a similar, if not older, housing profile, would it not be fair to assume a similar level of failure. Yakima County Department of Health will undoubtedly have some data on the performance of the 22,000 OSS and this could have been included in the report.

On page 34 of your study you say EPA knows of no state requirements for lagoons to meet a standard yet Washington state law requires every Dairy to have an approved farm plan and approval of that plan requires the lagoons to meet NRCS standards.

Soils and Crops

Soils and crop investigations were laughably pathetic. I'm sorry, but this is an area of particular expertise to ourselves and we, the dairy industry, are expected to account for and balance the nutrients applied to our cropland. This is not detailed in your report and neither is the fact that the dairies are the ONLY farm type having to do this. Forage crops such as the Corn, Triticale and Alfalfa grown on the majority of dairy fields have massive nitrogen removal rates when compared with other

farm crops because the whole crop is removed rather than just the grain or fruit (400-500 lbs N/acre per year vs. <100 lbs/acre per year for most annual and orchard crops).

To take soil samples from cropland at a depth of only one inch defies just about every soil sampling protocol in existence. Crops draw their nutrients from the soil through their roots and most of the root mass is in the top three feet of soil. The top inch has almost no significance in this situation as it is the region of the soil where changes happen so rapidly, changes occur from day to day due to both climate (precipitation and temperature) and management actions (cultivation, fertilization, irrigation) and crop growth (both uptake and release). Soil samples in the top foot of soil have been shown to vary in nitrate from week to week by as much as 15ppm, and the top inch of soil is by far the most reactive of the foot. Nitrate in the top inch is often high as this is the area to which most cropland fertilizer is applied, surface feeder roots will absorb some of this, the remainder will be washed deeper down into the soil where it can be accessed by the main root mass. In order for cropland nitrate to have an impact on groundwater it must pass through the root zone unabsorbed by the crop and soil biotia. Soils below the root zone have not been sampled and as a result nothing has been gained from the sampling.

Sampling soils from only two fields of each of Corn, Hops and Mint gives very little information for a study of 300+ pages. Considering that we budget on 20+ fields sampled per man-day during our sampling season (with 30 cores to 12 inches taken per field) then the expenditure of more than the three man-hours it would have taken you to sample these six fields would have produced some results that would at least have been statistically significant.

That being said, nitrate and ammonia are the only leachable forms of nitrate and on the Haak Dairy the levels are equivalent to only 22lbs of N per acre (less than a tenth of the nitrate requirement of a corn crop). At the DeRuyter dairy levels of 247ppm in the top inch still only relate to 74lbs of N per acre (less than a third of the needs of a corn crop). As a crop consultant, I would say that these levels of nutrition in the top inch are within the range I would like to see in a corn or triticale field.

Your manure sampling protocol seems equally flawed. Manure is constantly changing as it is collected and stored. The biology of a manure lagoon is a complicated, ill-understood subject, but what is known is that the only relevant sampling for crop and soil nutrition is of the manure as it is moved out of the lagoon for land application. Manure is often separated before the liquid enters storage and, on larger dairies, wastewater often enters the lagoon from multiple sources in multiple directions. None of this seems to have been considered during your manure sampling.

Your consideration (page 47) of "fecal contamination" of the samples in the manure lagoon is ridiculous. The whole purpose of the lagoons is to store fecal matter. How can it be considered contamination if the purpose of the lagoon is to store it the "contaminant"? This use of language is inflammatory.

On page 11 of your report you state that some of the dairies use "synthetic fertilizer". It seems that this comment was not investigated further. Utilizing synthetic fertilizer is common practice on many dairies as crop yield is limited by the most limiting nutrient. Often the well timed application of a small amount of fertilizer, even a micronutrient, can have a huge impact on crop yield and therefore overall nutrient harvest by the crop. This is particularly the case for Corn which needs phosphate in the early stages of growth (first six weeks) but is almost entirely incapable of absorbing phosphorus from the soil until it establishes its symbiotic relationship with soil fungi. In this case a small application of

phosphorus with the seed will help the crop establish and allow greater uptake of phosphorus from the field.

In Conclusion

Peer review is essential for a study of this scope. Within the government agencies there reside enough experts in the varying sciences to present valid input, there also is the background science to make a study like this truly effective. NRCS have based their lagoon designs and best management practice on sound science yet none of this is referred too, indeed the fact that they were not included in the

The language used in the report is inflammatory and this and the focus of the report highlights the bias to implicate dairymen rather than truly study the problem in order to seek a long term solution that assures both security of food supply and environmental protection. It is disappointing that so little peer review was asked for during the timescale of the study, there are so many steps that could have been improved upon and resulted in a study that was valid and sound. Now you feel unable to allow this document to receive true peer review, but as a government agency I can understand why you would not want to place yourself under that level of ridicule. Perhaps the solution in future is to conduct your explorations of groundwater with a more scientific and professional approach. To think that this document came from the same US government that put men on the moon and split the atom.... How the mighty have fallen.

Thank you for the opportunity to comment and we look forward to answering any questions EPA may have.

Nitrate study comments
Wangemann, Stephen to: R10YVNitrate 11/27/2012 01:54 PM

From: "Wangemann, Stephen" <Stephen.Wangemann@bia.gov>
To: R10YVNitrate@EPA

Please accept this corrected version of my prior comments, which were sent on 11/5/2012.

While large dairy and livestock operations present a significant potential for groundwater contamination, the current study does not provide the level of scientific proof that I believe is needed to implicate individual operators. The one inch soils samples, for example, are an extremely weak circumstantial link to groundwater contamination, because they do not reflect the nitrate component lost from the root zone by leaching. However, I would agree that by-pass flow via the soil macro-pore system, which was not evaluated, could be a significant contributor. Secondly, the crop contribution from alfalfa was non-existent in the study, but could be a major contributor in the lower valley. I fully support the efforts of the Washington State Department of Ecology and the EPA in undertaking the issue of ground water contamination in the lower valley. Unfortunately I cannot entirely support the inferences derived from this study. I hope EPA continues this effort in the lower valley so that all potential sources of groundwater contamination can be definitively dealt with. As an employee with the Bureau of Indian Affairs, I sincerely appreciate EPA's recognition of an underserved lower valley population deserving of Environmental Justice, relative to this matter.

Please include the following comments in the record for the Relation Between Nitrate is Water Wells and Potential Sources in the Lower Yakima Valley, Washington study.

1. A distinction was made between the 15N-NO3 and 18O-NO3 isotopic composition derived from fertilizer versus animal waste, but symbiotic bio-genically derived 15N-NO 3 and 18O-N03 in alfalfa was not examined.
2. In addition, an alfalfa field producing 8 tons to the acre has an approximate root mass of 1 ton. Given a value of 15% crude protein for the root mass, this would contain approximately 50 pounds of nitrogen.
3. Alfalfa is produced in the lower valley on a large number of acres in support of the dairy industry. It is a known fact that significant quantities of nitrogen can leach below the root zone and into the water table, especially if alfalfa is followed by corn. Many dairy operators try to capture this nitrogen leached below the corn root zone by including either a fall or sometimes a spring triticale planting, which sends down roots considerably deeper than corn. It would be a mistake for any study tasked with "Investigating the Contributing sources of Nitrate", to not consider the contribution of

alfalfa in the mass balance.

4. No matter whether organic or inorganic, the potential to leach nitrogen below the root zone also increases, based on the irrigation system. Corn under furrow irrigation has a much higher leaching potential, especially if surge or cut-back methods of furrow irrigation are not used and on farm water metering is not employed. Neither on farm water metering nor water budgeting are common practices within the Wapato Irrigation Project. Page 17 and & 68 both refer to Nitrate-N soil samples that were collected for analysis. Table 28, on page 70, indicated that the nitrate content at the 1 inch soil depth increment was above the MCL for drinking water. I would assert that the nitrate content in the one inch soil depth increment was an extremely poor parameter to use in relation to drinking water contamination. I would expect the Nitrate value at this depth to be high, especially if nitrogen has been applied based on expected crop needs. It is the percent that leaches below the root zone that is important, with respect to groundwater contamination, as such deeper soil samples (6 foot depth) should have been taken.

5. The study did not include up gradient to down gradient well pairing with a specific source separation. As a result flow paths cannot be demonstrated.

6. Nutrient leaching estimates from Agricultural Waste Lagoons contained a very wide spread in the estimated gallons leached per year. No attempt was made to install nested monitoring wells to verify flow paths or nutrient plumes around agricultural waste lagoons. No mass balance was accomplished for liquid entering or leaving the storage lagoons.

7. The wells were not stratified by depth and no long term trend was established for nitrate contamination even though several studies have been completed in the lower valley over the past 30 years. One such study, completed by the Department of Ecology in 2010, included samples from 453 well sites, that were collected between 1990 through June of 2005. This study also included stratification of the data by well depth.

Steve Wangemann
Soil Scientist, Ph.D.
BIA-Yakama Agency

11/28/12 To Marie

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U.S. EPA-WOO

STATE OF WASHINGTON

DEPARTMENT OF AGRICULTURE

P.O. Box 42560 • Olympia, Washington 98504-2560 • (360) 902-1800

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U.S. EPA REGION 10
OFFICE OF WATER

November 9, 2012

Thomas Eaton
Director
EPA Region 10, Washington Operations Office
300 Desmond Dr. SE, Suite #102
Lacey, WA 98503

Dear Mr. Eaton:

The Washington State Department of Agriculture (WSDA) wishes to convey its appreciation to the U.S. Environment Protection Agency in allowing us to provide comments to the recently released *Relation Between Nitrate in Water Wells and Potential Sources in the Lower Yakima Valley, Washington, EPA-910-R-12-003*. The report provides further insight into both the historic and current conditions that have resulted in degraded water quality within the aquifer system underlying the Toppenish and Benton Basins.

It is our hope that this document will provide a foundation on which the recently convened Groundwater Management Area (GWMA) Committee can use to address the long standing issues surrounding nitrate contamination of underground drinking water sources. Recognizing the importance this document may have to the GWMA, WSDA would like to offer the following comments and suggestions.

Overall Comments

The purpose of the study was to investigate the contribution from various land uses to the nitrate levels in groundwater and residential drinking water wells within the lower Yakima Valley. We believe that from an overall perspective, this was accomplished. The results of the study appear to have confirmed the findings of earlier studies/samplings that show that approximately 20% of shallow drinking water wells have been impacted by historical and current land uses. The majority of those land uses have been identified in EPA' report to be agriculturally related. Predominately, agricultural land use is separated into two major areas: livestock operations and irrigated farming. These findings will be helpful in the formulation of a Groundwater Management Area Plan currently under development by Yakima County.

WSDA appreciates the effort made by EPA in attempting to define with greater accuracy the historic and current source(s) of nitrogen that has negatively impacted the underground drinking water source. However, after reviewing the report WSDA is concerned that the report under-emphasizes the degree of uncertainty associated with the identification of specific sources. We are also concerned regarding the over emphasis of the data and the identification of potential sources beyond a reasonable area. The majority of our comments are related to these concerns.

Finally, as an overall comment, the report appears to suffer from a redirection of the study purpose sometime after the initial phase. The study appeared to change from a data collection / research emphasis to a data collection effort with regulatory actions in mind. The result is a report that does not truly satisfy either goal.

Uncertainty Regarding Aquifer Identification and Well Construction

Throughout the study, the authors note their inability to identify the depth to which a majority of the sampled wells were either completed or screened. The lack of this information is critical when comparing water quality data from upgradient wells to those located downgradient from a potential pollution source. The authors are careful to use the term "groundwater flow" rather than aquifer flow direction because of the lack of certainty that an upgradient well is located in the same aquifer as those identified as downgradient. This uncertainty can make it extremely difficult to determine the source(s) of any contamination detected in the downgradient well.

The condition of the wells being sampled is always a factor to consider. Private domestic wells are subject to a higher degree of construction "issues" than are those designed and installed as monitoring wells, or even public water supply wells. Issues regarding casing integrity, adequacy of the surface seal, and screen design can all impact the water quality within the well.

The wells used within the "Dairy Cluster" exhibit many of the uncertainties cited above. The authors are careful to note this in Page ES-5, paragraph one. The uncertainties introduced by the lack of knowledge of the wells and well construction could be a reason for the detection of "contaminants" in upgradient wells thought to be originating from dairy only sources. Statements addressing these findings on pages ES-5 thru ES-7 would indicate the need for further investigation and diminish the data value in a regulatory context.

Additionally, the use of the United States Geological Survey's regional groundwater flow model may not be appropriate for use when characterizing the shallow groundwater movements underlying the subject area of the EPA report. This aquifer(s) is very sensitive to irrigation recharge and in the upper regions may not mirror the regional flow directions. This could prove problematic when determining upgradient and downgradient flow directions. A more comprehensive investigation which includes evaluation of known well logs, and well bore analysis of water levels should be conducted before making pronouncements regarding flow in the shallow aquifer(s).

Irrigated Crop Fields

The findings presented by the authors indicate that the irrigated fields (subject in the report) are sources of nitrate, bentazon, and monensin detected in downgradient wells used for monitoring purposes based on detections within soil samples collected in those fields. The quote is, "*This finding suggests that bentazon and monensin detected in the crop field soil are likely migrating to groundwater and nearby water wells. Possible manure application to the hop field could account for the monensin detected in the downgradient residential well.*"

While the "findings" suggest a source, it does not identify a source. The findings also may open the possibility of other sources different from the mint fields from which samples SO-11 and SO-12 were taken. This is a point that the authors fail to mention and a technique that is used several times in various places in the report. Without the benefit of data from an upgradient well, it is impossible to say if the subject fields are "likely the source". The source very well could be another land use activity somewhere upgradient, other fields upgradient, or leakage from unlined irrigation laterals that may transport contaminants from other locations. The point is that there is sufficient uncertainly (caused by lack of upgradient well data) to identify a "likely" source of the detected contaminants.

Nitrate Estimate

WSDA is concerned that the applied nitrogen value cited on page 12 of the report, fails to represent best available data and may therefore not represent the true current conditions. It is important that when attempting to identify (and therefore quantify) total nitrogen loading for the purposes of characterizing basin conditions that best available data be used. WSDA supplied EPA with its GIS layer that represents the current condition of cropping in the Valley down to the field level. It does not appear that this data was used in the nitrogen loading calculation. WSDA collects this data every two years. Additionally, the irrigation methods used on those fields are included in the WSDA data set, making an irrigation estimate possible. WSDA is concerned that when provided with this far more recent and detailed information (for which the QA/QC plan for collection has been approved by EPA-HQ), EPA Region 10 chose not to use it.

WSDA, has concerns regarding the accuracy of the conclusions presented in section 4, page 13.

Waste Management

WSDA has reviewed the results of EPA estimates of liner leakage contained on pages 33 and 34 and find them to be excessive. The authors fail to specify the head within their lagoon scenario. Additionally, the soil permeably that is assumed appears to be that characterized for the surface soils, which in most cases varies downward at the 60" levels. These two parameters, when considered, yield drastically different leakage rates than those estimated by EPA. Due to the biochemical process underlying most liners, what leakage does exist generally does not contain significant amounts of nitrate. In most cases, there is a much greater potential for nitrate loss to the underlying aquifer through over-application at the surface followed by excessive irrigation.

Data Interpretation and Source Identification

Throughout the report conclusions are made regarding the identification of sources for many of the contaminants identified in shallow drinking water wells. It must be emphasized that the sampling conducted by EPA in this phase of the investigation was only conducted once. As such the results should

be viewed as a snapshot and a possible precursor to subsequent investigations. In the case of the identified dairy and irrigated agriculture source(s), one sampling is not adequate to provide a statistically significant increase over background for any particular contaminant. It should be noted that in both EPA and Department of Ecology site investigation and groundwater guidance, a statistically significant increase of a contaminant in downgradient well(s) over that observed in upgradient well(s) is necessary to establish a cause and effect relationship for regulatory purposes. The EPA data does not support this type of conclusion.

Conclusion

The EPA report *Relation Between Nitrate in Water Wells and Potential Sources in the Lower Yakima Valley, Washington, EPA-910-R-12-003,* provides further verification of earlier findings regarding the status of shallow groundwater in the Yakima Valley. Additionally, the report substantiates earlier theories regarding the overall potential sources of nitrate in the Valley groundwater. The report is limited in its ability to identify specific sources of nitrate. It is effective in identifying areas within the Valley where hydrogeologic and land use conditions interact to more adversely impact groundwater quality.

The report raises many questions that should provide the Groundwater Management Area Committee a technical starting point. The degree of uncertainties raised in the report is limiting as to its use for regulatory purposes. Questions regarding sources and the degree to which these sources may or may not be contributing to groundwater contamination, should be addressed thru further investigation and refinement of estimates presented in the report.

Sincerely,

Kirk V. Cook, LG, LHG
Washington Department of Agriculture
Agency Hydrogeologist
Natural Resource Assessment Section

BOARD OF YAKIMA COUNTY COMMISSIONERS

★ District One
Michael D. Leita

★ District Two
Kevin J. Bouchey

★ District Three
Rand Elliott

November 30, 2012

Office of Environmental Assessment (OEA)
Attn: Carol Harrison
U.S. EPA, Region 10
1200 Sixth Avenue, Suite 900
Mail code: OEA-095
Seattle, WA 98101

Re: Review of EPA's Lower Yakima Valley Nitrate Study

Dear Ms. Harrison:

Yakima County appreciates the opportunity to provide comments regarding EPA's recently published study, "*Relation between nitrate in water wells and potential sources in the Lower Yakima Valley*". Yakima County, as Lead Entity of the Lower Yakima Valley Groundwater Management Area's (GWMA) Groundwater Advisory Committee (GWAC), like EPA, is committed to developing and implementing long-term strategies to reduce nitrate concentrations in groundwater below safe drinking water standards. We believe that this same commitment is shared by the citizens, communities, industries, and commercial enterprises that are located within the Lower Valley.

We were optimistic and hopeful that the study would lay a strong scientific foundation for charting a course of action towards our mutual goal of reducing nitrate concentrations. Disappointingly, after our own review of the study and after careful consideration of comments made by individual and industry representatives along with local, state, and tribal entities, we do not believe that the study provides that strong scientific foundation. Instead, the study has created a considerable amount of confusion, distrust, fragmentation, uncertainty, and skepticism amongst affected communities and parties. We believe this negativity is largely due to the limitations documented in the study - most notably the lack of well data and trend data. If the intent of the study is to draw a direct correlation to the dairies based upon sound scientific information, we believe it failed to do so simply because of the study's stated limitations and questionable assumptions.

On a positive note, we believe that the study is an important first step in defining the scope and likely sources of the nitrate contamination in the Lower Valley - it verifies earlier shallow groundwater findings and supports previous theories regarding the potential nitrate sources in the groundwater. In addition, it presents many questions that will undoubtedly provide the GWAC with a technical starting point for further study.

In summary, we request EPA to seriously consider and address study comments received from all parties and to perform additional investigations and data gathering to minimize the study's limitations and assumptions. We remain optimistic that if EPA is able to do so, the study, revised as appropriate, can and would provide the strong scientific foundation that we believe is essential in charting a future course of action.

Again, thank you for your efforts in addressing our groundwater problems and for offering this opportunity to comment.

Sincerely,

J. Rand Elliott, Chairman
Yakima County Commissioners

128 North Second Street • Yakima, Washington 98901 • 509-574-1500 • FAX: 509-574-1501

Confederated Tribes and Bands
Of the Yakama Nation

Established by the
Treaty of June 9, 1855

November 21, 2012

Office of Environmental Assessment (OEA)
Attn: Carol Harrison
U.S. EPA, Region 10
1200 Sixth Avenue, Suite 900
Mail code: OEA-095
Seattle, WA 98101

Re: Review of EPA's Lower Yakima Valley Nitrate Study

Dear Ms. Harrison:

The Yakama Nation greatly appreciates the strenuous effort on behalf of EPA and the residents of the Lower Yakima Valley towards identifying the sources of groundwater contamination and we thank you for the opportunity to provide input regarding EPA's recently published study, "*Relation between nitrate in water wells and potential sources in the Lower Yakima Valley*".

After a thorough review, we feel that this study may have helped to further define the scope and likely sources of the problem, and is a significant step towards a solution. However, the EPA needs to continue its efforts to more definitively identify the sources and status of the situation to work towards a long term solution. We need to establish trend and determine if current reduction strategies are working, and if not we need to reinvent best management practices that will work in today's environment.

Please see the attached technical assessment of the study. We submit these comments to you with the intent to participate in continued research and development of a more thorough and definitive study.

Thank you for your time and consideration. If you have any questions, please contact Kristina Proszek, Environmental Review Coordinator at kris@yakama.com or Joanne Cornwall, Water Quality Specialist at littlejoe@yakama.com.

Sincerely,

Philip Rigdon
DNR Deputy Director
Yakama Nation

CC: Tom Eaton, Director, EPA Washington Operations

Post Office Box 151, Fort Road, Toppenish, WA 98948 (509) 865-5121

The recent release of the EPA report titled, "*Relation between nitrate in water wells and potential sources in the Lower Yakima Valley*" has created a considerable amount of confusion amongst effected communities and parties. The report, at best, is inconclusive partly because of documented limitations to the study, and partly due to the unexpected lack of bacteria detections. This eliminated the microbial source tracking (MST) element from the study. That portion of the study would have determined, more specifically the sources of contamination. MST testing differentiates between human or ruminant sources of bacterial contamination, clarifying whether the source of bacteria was from septic systems, dairy manure applications, or another mono-gastric animal source. This distinction would have huge implications when coupled with the isotope testing, which cannot differentiate human from any other animal species. Without the MST component of the study no clear line of evidence towards any one source exists. The assumption that the dairies are the most "likely" sources of the contaminants is not definitive enough. "Likely" is not legally defensible verbiage and cannot be interpreted any stronger than potential or possible sources. There is no clear line of evidence here. It is very unfortunate that the MST portion of the study could not be performed.

Study Limitations

The report does acknowledge that the study lacked some important information which would have been helpful to clarify the situation. Of primary importance was the lack of well data. That information is crucial to determining the source water of the wells and if in fact the up gradient and down gradient well locations are accurate. This well data was unavailable for more than just a few wells; in fact it was unavailable for the majority of the wells. Two thirds of the sampled well locations were at indeterminate depths, ages and construction. It may have been possible to get an approximate depth by using a simple range finder. It has been documented that poorly sealed well casing can create a "co-mingling" effect where water drawn from two different aquifers can mix through the casing and cross contaminate or cause one source to dry up.

The other limitations noted were the lack of information provided to the EPA from the dairies in the study, and the inability to locate distinct crop field locations separate from areas that use manure as a fertilizer. This diffusion of fertilizer sources made it impossible to draw conclusions on the effects of commercial fertilizer applications. Conversely, it is just as difficult to clearly define to what extent the surrounding orchards and fertigation stations affected the results from the dairy samples. It is obvious that the area surrounding the "Dairy Cluster" and the Haak Dairy is dominated by orchards in the assumed up gradient locations. These orchards are interspersed with fertigation stations at irrigation water ponds where the fertilizer is injected into the water lines for application. For illustration purposes, a dozen or more were located and marked on "Google Earth" surrounding the "Dairy Cluster" location.

Figure 1 depicts the "Dairy Cluster" surrounded by fertigation stations for the orchards. The report states that the nitrogen source was determined to be too diffuse to accurately assess any impacts from irrigated agriculture. While the report claims that this was due in part because most of the irrigated cropland is associated with dairies either directly or indirectly through the purchasing of organic fertilizers from the dairies, the photo clearly shows that there may be significant influence from fertigation stations. The locations of the stations coupled with the presence of Tetracycline in many wells would be indicative of current orchard management practices.

Study design and methodology

It is important to understand that the study as designed was a "targeted" study, which is very different from a "random" study. While the report does explain to the reader that the sampling locations were selected from the results of Phase I and II, it does not clearly define the differences between a targeted and randomly selected survey.

It is important to remember that EPA "combined information on land use with some simple calculations to estimate the amount of potential nitrogen available from several sources" as the first phase of the study and then selected wells to sample based on the likely hood that they would be impacted. "The objectives of Phase II were to: (1) evaluate nitrate contamination of groundwater at locations downgradient of the three types of sources identified in Phase I"; (2) assist in identifying sampling locations for Phase III sampling and (3) provide residents with information". Essentially the sites that were detected with high nitrate concentrations in Phase II, were the wells used as the downgradient well locations in Phase III. They were not selected randomly, but were targeted for the study because they were already determined to be impacted with high nitrate levels.

"The results of Phases I and II were used in Phase III to identify residential drinking water wells with high nitrate concentrations and potential upgradient sources of nitrogen." The report does touch upon this again on page 14 stating, "The percentage of homes with nitrate levels in wells above the MCL in this study were higher than the 12 percent from earlier studies because the homes sampled in Phase II were selected based on their proximity to likely sources. This method of selection would be expected to bias the results compared to a study where the sampling locations were selected randomly." This statement defines the study design as biased towards locating the impacted wells and should not be viewed as anything other than that.

It is questionable to sample a "cluster" of potential contributors when there is a need to clearly identify the sources of pollution. No positive determination of the responsible party in the "Dairy Cluster" was made. This will only make enforcement efforts more difficult.

There are also issues with the suite of veterinary pharmaceuticals selected. Many are used to treat multiple species, including livestock, humans, and even fruit, making their presence in any sample inconclusive. Specifically mentioned in the report were the several detections of Tetracycline. Tetracycline is an anti-biotic that is used extensively in the area on pears and apples. It is of such economic importance to pear producers that it is approved for broadcast application to certified organic pears.

Also troubling was that both upgradient and downgradient wells were sampled in the dairy areas, but no upgradient wells were sampled above irrigated crop fields or septic systems. This fact makes comparison impossible.

Well information

It may have been beneficial to stratify the study by well depths, types and by soil type. This would have been considerably more work; either requiring a great deal of information gathering or by actually drilling some new wells. If new wells had been established, they could be used over time to establish trend and long term monitoring. This is important as different soils have different characteristics relating to lateral groundwater movement and aquifer recharge.

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Fertilizer
Google earth

Figure 1

Sampling design and methodology

The text on page 16 of the report is not clear as to whether or not multiple upgradient wells were sampled for each of the dairy locations. "In addition one upgradient well was sampled in each dairy area." This statement would indicate that only one well upgradient was sampled, however we know from previous text that the downgradient wells used in Phase III were selected from a larger sampling effort in Phase II as having tested positive for elevated nitrates. It is not clear if the upgradient wells used in Phase III were also selected from a previous sampling effort as having been below the MCL.

Upon further research and personal communications with EPA staff Mike Cox and Tom Eaton it was clarified that two other wells upgradient of the "dairy cluster" were in fact sampled and the results reported in the executive summary as having been below the MCL as well. They are both reported as having been analyzed with only the field test strips and found to be at 5mg/l. A reading of 5, while still well below the MCL of 10 mg/l, would be considered elevated and well above the level found in the upgradient well used in the report, which was reported as 0.73. Statistically speaking, two thirds of the upgradient wells sampled above the dairy cluster were considered elevated above the expected natural nitrate levels. This seems to be indicating that there are definitely some additional sources of nitrate above the "dairy cluster".

The soil samples were reportedly taken from application fields at a depth of one inch. While this may serve to indicate which, if any, pharmaceuticals and chemicals persisted in the environment once removed from the dairy production area, it will not tell us if any nitrate has leached beyond the root zone of the plants and is migrating towards the groundwater. This indication of leaching is imperative to locating the problem application sites and the responsible parties. Without knowing what crops are to be planted and expected yields, nitrogen levels in the top one inch of soil are not an accurate measure of potential to pollute.

Analysis of data

While there is relative certainty that Monensin would be indicative of livestock feeding, it is troubling that, according to the EPA report, it was discovered in higher concentrations in the upgradient well. Upon further review of the data it was determined that the hits for Monensin in the upgradient well were barely above the detection limits of the laboratory methods. In personal communications with EPA's Mike Cox, he has stated that in fact, the chemist that performed the data analysis was slightly hesitant at calling this detection in the first place. The limits of detection for Monensin are at 0.02 ug and the test results were at 0.027ug, seven hundredths' of a microgram different. Not that any chemical in any amount is acceptable, but it needs to be expressed in a manner relative to the risk.

Lagoon seepage applicability

In calculating the range of animal waste lagoon leakage for the Yakima Valley, this report used rates and estimates derived by numerous studies conducted by J.M. Ham and T.M. DeSutter. While these studies signify the forefront of research in nutrient travel associated with animal waste lagoons, concerns reside with the fact that all studies cited in this EPA report were carried out in the Great Plains region.

In the 2002 Ham study, Seepage Losses from Animal Waste Lagoons: A Summary of a four-year investigation in Kansas, which is where this EPA report acquired its applied Seepage Rate Range, the

author states, "Lagoons in other regions of the Great Plains probably have similar seepage". In another study cited in this EPA report (Ham, J.M., and DeSutter, T.M., 2000) Toward site-specific design standards for animal waste lagoons, the authors state "This report argues that lagoon design should be site specific… factors such as soil properties, chemistry of the waste, and depth of water table are used to arrive at lagoon performance standards" and "The framework presented here is most appropriate for the Great Plains". Applying studies to the Yakima Valley in which the authors openly state that the research presented is intended to apply specifically to the region in which it was conducted and that their own research shows that lagoon efficiency should be judged on a site specific basis is not only disconcerting but borderline reckless. That is not to say that research conducted on the Great Plains is completely invalid here, but rather before it is applied to this area it should be scientifically confirmed that it applicably transfers to the local environment before it is used in an attempt to identify individual polluters. That confirmation should be researched and stated within this EPA report.

Conclusion

If government agencies are concerned with protecting human health, holding responsible parties accountable, and protecting the environment, then a long term, more definitive study needs to be initiated. Shallow monitoring wells should be installed downgradient of the lagoons to detect and document the presence or absence of large plumes of lagoon leakage. Additionally, all wells sampled need to be paired with an upgradient control sample.

Most importantly, this study was merely a snapshot in time and does not establish trend. Trend is extremely important in this case because of the potential enforcement activities. It is not known for certain if the nitrate issue in the Lower Yakima Valley is a legacy problem and decreasing under current best management practices or if it is an on-going problem. A long term monitoring effort is required to establish this trend, not only because of temporal variation, but because of hydrological shifts both seasonal and anthropogenic.

While the intent of the study is clearly to draw a direct correlation to the dairies, based upon the findings in the earlier phases of the study, it failed to do so. This was possibly because expectations clouded thorough scientific methodology. In other words; the study was dependent on finding some wells with high bacteria in order to accurately determine the source through microbial source tracking. When the results failed to detect any bacteria in the samples, this MST portion was dropped, leaving gaps in the knowledge obtained. Based upon the absence of bacteria in any of the downgradient well samples, one would have to consider that there may be more influence from chemical fertilizers than expected. Any enforcement capabilities based upon the findings of this report appear to be compromised.

YAKIMA HERALD REPUBLIC
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Nov. 9, 2012

RECEIVED
NOV 14 2012
U.S. EPA REGION 10
OFFICE OF WATER

Marie Jennings
Manager, Drinking Water Unit
Environmental Protection Agency
1200 Sixth Avenue, Suite 900
Seattle, WA 98101

Dear Ms. Jennings:

As a follow-up to your phone conversation on Oct. 12 with City Editor Craig Troianello, the Yakima Herald-Republic seeks formal correction to information contained on Page 1 of the Environmental Protection Agency's report "Relations Between Nitrate in Water Wells and Potential Sources in the Lower Yakima Valley, Washington."

The line reads: "In October 2008, the Yakima Herald-Republic ran a series of articles titled 'Hidden Wells, Dirty Water' that examined a long history of groundwater contamination affecting public and private drinking water wells, primarily in the Lower Yakima Valley. The reporter sent a letter requesting that EPA invoke Section 1431 of the Safe Drinking Water Act (SDWA) to address the problem."

Because the EPA was not quoted as part of the series, Lower Yakima Valley residents asked our reporter after publication whether the EPA had authority to take action under the Clean Water Act. That prompted reporter Leah Beth Ward to write the aforementioned letter with the intent of finding out whether the law was applicable. She did not request that the Act be invoked; unfortunately, the report you released Sept. 27 mischaracterized what she wrote. That was understood by your agency in its Nov. 4, 2008, response by regional administrator Elin D. Miller. In that letter to the reporter, Ms. Miller states, "You specifically asked whether the EPA would consider invoking Section 1431 of the Safe Drinking Water Act to address the groundwater issue." It then went on to explain elements that would be considered.

The Herald-Republic considers your report's error to be serious. The newspaper does not inject itself or take an active role in issues it covers. Doing so would undermine the neutrality critical to maintaining credibility. Stating that the newspaper sought to invoke the act undermines that credibility.

I ask the EPA to correct the statement by amending the report, and that the statement be correct in both printed and electronic reports, including those online.

I also ask the EPA to send a letter to the Washington State Dairy Federation notifying them of the correction, as well as including this letter in the record along with other comments you receive on your report. The Dairy Federation's address is: P.O. Box 1768, Elma, Wash.

Thank you.

Bob Crider

Bob Crider, Editor
Yakima Herald-Republic

CC: Leah Beth Ward, Craig Troianello

Turner & Co., Inc.

STUART A. TURNER
(b) (6)
West Richland, WA 99353

Phone: (b) (6)
Fax: (509) 967-5865
Mobile: (509) 539-5524
E-mail: (b) (6)

November 26, 2012

Mr. Jay Gordon
Mr. Jesse Robbins
Washington State Dairy Federation
575 East Main Street
Elma, WA 98541

For Submittal as Formal Comment to EPA

Re: Formal Public Comment, EPA -910-R-12-03

Scope and Scale of Review and Comment:

These comments are restricted to the limited materials released by EPA on the web in September, 2012. A written offer made to Thomas Eaton by email in late September asking for both additional time for comments, and full access to conduct a complete and rigorous technical audit was formally refused by Thomas Eaton in early November. Access was denied to interview EPA and contract labs about their participation; how and why sampling and testing protocols were selected; why data failed basic QA/QC and reliability standards; why some test data was rejected or not relied upon by EPA upon completion of testing; Actual review of raw lab print outs, data, notes and calculations. This severely limits outside reviewers ability to fully examine and comment on this project. If such materials become available thru FOIA or other means, I will respectfully request an opportunity to provide addition comments following review.

Important Note of Clarification Re: Lower Yakima GWMA

These and other public comments regarding the EPA-910-R-12-003 document titled "Relation Between Nitrate in Water Wells and Potential Sources in the Lower Yakima Valley, Washington" are my personal and professional comments exclusively. Although I am an appointed member of the GWAC for the Lower Yakima GWMA, opinions articulated here and elsewhere are not on behalf of, nor intended to be on behalf of the GWAC or the GWMA. They are made at the request of the Washington State Dairy Federation and its producer family farmers.

Perspective/Professional Qualifications

I am a Board Certified Agronomist, one of fewer than 650 worldwide (ASA/SSSA/CSSA) and approximately 20 currently working primarily in Washington State. I began working in the lower Yakima

Valley in the late 1970's in a variety of capacities in the Ag Chem/Fertilizer business. I obtained a statewide (WA/OR/ID by reciprocity) Pest Consulting License; Operated a soil and plant tissue analysis laboratory, and managed an Ag Chem Dealership. Since 1983 I have worked as an independent consulting Agronomist, providing technical support to the very wide variety of family farming enterprises in the PNW. Tree fruit, grape, row and field crops and dairy producers dominate my professional practice. As regards dairy, I provide technical services to a significant segment of the industry in Yakima, Grant and Franklin Counties. I also work closely with WSDF, Farm Bureau, and WSU; I provided substantial assistance and support for the NAEMS WA5A and WA5B research projects under Dr. Grant (Purdue) and Dr. Ndegwa (WSU). I continue to assist Dr. Ndegwa in the second phase of this CAFO/Dairy air quality research currently underway. In addition, I worked from 2010-2012 as an invited member of the Dairy Work Group chaired by Gary Pruit, manager of the YRCAA, to assist technically in the development of a model Air Emissions Evaluation and Reduction program for Yakima County dairies.

Comments

A. How are research studies constructed? A normal, unbiased study would generally be constructed as follows: After initial scoping work, a scientific hypothesis (theory) would be formed, and the study then designed to use investigation, sampling, literature review, interviews, records reviews, analysis of sampling using both deductive and inductive reasoning to TEST the original hypothesis. In this case it appears this industry standard approach was abandoned either very early on in the scoping process, or was not utilized at all. Instead it appears that the EPA settled very quickly on a single theory – that current and recent dairy operations were the primary source of groundwater nitrates to the exclusion of any other source of significance. In fact, the best way to describe the EPA approach is that it is "reverse engineered" the final product, targeting dairy producers and either not considering or excluding all other sources as insignificant. The report then became a "fill in the blank" type of investigation where only certain questions were asked in specific ways.

   The failure to follow basic, standard scientific protocols, and the early induction of bias doomed any opportunity the study, and any conclusions reached from the study, to be reasonably accepted as being either unbiased or scientifically sound.

B. Bias or Incompetence regarding basic Nitrate loading assumptions -As evidence of this bias, and clearly further compounded by a general ignorance of the basic Nitrogen cycle and Nitrogen forms and uses in agriculture, about three years ago I attended one of the first meetings with the EPA researchers at the USDA Wapato facility. Also in attendance was Bill Wavrin, DVM (Vet, nutrition expert, dairy owner/operator), Tom DeVries (Diary Federation board member), and Laurie Crowe (Nutrient Planner/Expert from the SYCD). We were first shocked, and then horrified when the PowerPoint slide appeared with the draft EPA total Nitrate Loading estimate for the lower Yakima Valley appeared. The level of expertise (lacking), professional work experience with agriculture, and perhaps bias combined and was revealed in this Nitrate (N03-N) loading estimate. After a quick consultation between the experts listed above, we were able to show the EPA research team that they had combined Nitrogen from all sources and all forms into a number they represented as Nitrate N. Since MOST of the nitrogen in the production Ag and dairy industry is in the form of NH3+ or NH4+, this was a huge and fundamental miscalculation. Only N03- Nitrate N is water soluble and able to leach to, and impact

groundwater. This enormous error was an ominous clue to the ultimately flawed final work product. This was the one and only opportunity for industry contact in the preliminary/planning phase. The EPA team failed to present data showing how they quantified the Nitrogen loss by denitrification – instead of converting to Nitrate (N03-) it is converted to N2 and lost to the atmosphere. The recent very extensive California Study (www.groundwaternitrate.ucdavid.edu; technical reports 1-4) concluded that this in total amounted to a 38% loss or reduction of N as it relates to dairies. The EPA study does not "show the math" allowing an understanding about how much total N dairies produce, and the end fate of that N in a total basin Nitrate in groundwater loading. Instead they elected to knowingly use highly inflated and inaccurate numbers. Most baffling of all, why the EPA did also elect to not account for crop removal, the largest of the "losses" of applied nitrogen.

This is either evidence of clear bias, or of gross incompetence. It would appear this was done to inflate, in combination with other decisions by
EPA, to inflate the potential leaching numbers by orders of magnitude while excluding other contributors identified in other peer reviewed and published research. The use of biased or slanted science to advance a political cause or agenda is cruel and deliberate, and very underhanded at best. While I can understand non industry political agenda groups taking this path, I expect much more than this from a public agency living on my tax dollars. This is especially so since EPA presents itself to the taxpayers as an unbiased, scientific driven organization. Based on my review of this report, nothing could be further from the truth.

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C. Scientific value of Water testing -In Phase I of the EPA project, a significant number of wells were screened for Nitrate concentrations using a simple and inexpensive tool, the colorimetric strip test. While it only provides a general guideline to the approximate range of nitrates in a water sample, it is good enough to separate out wells with water low in nitrates with wells with moderate or high levels of nitrates. However, EPA neglected the MOST important element of this initial screening process; they failed to investigate and document the critical details of well depth, static level, construction, surface sealing and distance to potential point sources like rural septic systems. Therefore, the data obtained in the initial screenings, as well as all of the data obtained in Phase II and Phase II is of little value, since it provides no real scientific basis to reach and scientific conclusions about the one piece of information the study authors defined as their goal; a determination of why a given well had good, fair or poor quality water based on nitrate concentrations.

D. Evidence ofbias in selection of sampling sites and intensity of sampling -In the initial screening process of Phase I, there is demonstrably very strong bias in the locations EPA elected to sample (or not sample). Even though the intensively farmed irrigated acreage on the Yakima Indian Reservation is larger than the area across the river to the North, off the reservation, it appears (see EPA Map) that less than 25% of the sample sites were located on the reservation. Even those limited sample sites were not spatially dispersed and random in nature. A higher percentage of the irrigated lands within the Reservation are still irrigated by flood or rill (furrow) irrigation compared to the non-reservation acres to the North which were much more intensively sampled. Research has long demonstrated that Nitrate N leaching losses are typically 30-40% higher on flood or rill irrigated cropland compared to well managed sprinkler or

drip irrigation. What reason could there be for not conducting a more fair, balanced and thorough sampling for nitrate N on Reservation lands? This is especially puzzling as demographics available readily demonstrate that land and housing values, and income on average is much lower on the Reservation compared to similar land just outside the Reservation. If EPA's stated goal for this program under the auspices of "Environmental Justice" is to reach this target demographic, why did they fail to aggressively canvass and sample/analyze the dominant land area? Could it be that since EPA is the sole authority for groundwater quality on the Reservation that they did not want to indict their own environmental stewardship and management?

E. Refusal by EPA to test one of three key sources of Nitrates -In Phase II, the largest land area in the subject study local, the Yakima Reservation, was essentially ignored. Instead EPA chose to do extremely limited tested in a very small area, a place populated by diverse irrigated agriculture and a cluster of medium to large dairies. This area is representative of less than 10% of the total land area in the Lower Yakima Valley. The testing was not spatially at random, but as best as can be determined by examination of Google Earth images, it appears to be specifically targeted to a single segment of agriculture; dairies. This is in contrast to the specific statement on page E-2 of the Executive Summary; "Based on the estimates developed in Phase 1, EPA focused the Phase 2 and 3 sampling on three predominant sources; dairies, irrigated cropland; and residential septic systems". Only the first part of that statement ended up resembling the truth in any way; over 80% of the total testing was targeted exclusively towards the dairies; the balance of the testing was limited to six fields (three crops of the 100+ grown in Yakima County) and six wells considered to be down gradient of these same fields. There was ZERO testing of any rural septic; for reasons not explained there was limited "surrogate" testing of some nearby municipal waste water treatment plants. Anyone with even a passing knowledge of the characteristics of rural septic in comparison with muni plant waste water knows they are not even distant cousins. There was no scientific data or research presented to support the EPA hypothesis that in any way the municipal plant effluent bore any resemblance to rural septic. Rural homes have very little impermeable paved, roofed or concreted areas; do not contain medium or heavy industry, and do not comingle storm runoff. Since most septic systems are pumped every 12-24 months, access is not difficult to obtain; why then would EPA, spending a million or more of our tax dollars, flub this very simple exercise? First they identify rural septic as one of the three leading suspects they intend to sample, analyze and consider as a source of nitrates. At the end of the project we find they have failed to sample and analyze even a single septic system for scientific characterization. This action by EPA, while clearly deliberate, is inexplicable. How can a research project that identified three sources of groundwater nitrate loading be considered complete or viable when NO work is done on one of the three sources?

F. Selection of Pharmaceuticals as "tracers" to dairies -At the bottom of page ES 6, the EPA report states as follows: "The pharmaceuticals tetracycline and monensin were detected in all but one of the dairy samples, which indicate they are used by the dairies in the Dairy Cluster." There are many problems with this statement, some of which are in the following sentence from the EPA report "Tetracycline was detected in two of the down gradient residential drinking water wells,

two dairy supply wells, dairy lagoons, manure piles and application fields". These statements clearly indicate that tetracycline is present in the aquifer, in dairy and domestic wells; why then would there not be an assumption that tetracycline passed through the dairy cows, to be found in the liquid and solid manure, and in fields with receive these recycled nutrients? Not only has EPA not considered this most likely scenario, it appears that they are either severely ignorant or they have willfully disregarded the obvious, real source of Tetracycline: its ubiquitous use on deciduous tree fruits. Yakima County has over 77,000 acres of stone and pome fruits, and has been a leading fruit producer for over 70 years. Had EPA bothered to consult the current (and all past) editions of the annually revised WSU Tree Fruit Spray Guide they would have learned that it is THE recommended pesticide for control of the very serious disease Fire blight (causal organism, bacteria *erwinia*) on apples and pears, and for Bacterial Spot on peach and nectarine. The label for the Tetracycline product Fireline 17 WP lists use rates of 1 to 5 # per acre, depending on crop 5 to 8 applications per year are permitted. Even if we assume a conservative application of 2# per acre on 70,000 acres of tree fruit, that is equal to a potential 140,000# of tetracycline per year in Yakima County from tree fruit use alone. It is fair to assume that use of tetracycline on dairies by comparison is less than 1% of that number. It would appear here that the odds favor the dairies as recipients of their neighbor's use of this pharmaceutical, not the inverse as EPA speculates in this case. Further complicating the situation with EPA's selection and testing for Tetracycline as a tracer pharmaceutical linked to dairies is this important factor apparently not known to EPA; dairy cows are fed substantial quantities of raw and partially processed fruit. This fruit contains in many cases (an allowable, regulated food safety tolerance) of Tetracycline; therefore, it would be expected to be found in manure and fields where that manure was land applied, recycled for nutrient value. In that case the dairy is not the source, merely a thru put for Tetracycline residues, which are essentially ubiquitous in the landscape. This creates yet another concern; this compound was discovered in 1948 as a product of naturally occurring bacteria *Streptomyces* spp. There is no discussion in the EPA or supporting lab summary reports (no raw data provided) as to how their sampling and analysis procedure accounted for, or differentiated between naturally produced and synthetically cultured Tetracycline. Monensin, the other product selected as a tracer for dairy sourced nitrate, was only approved for use on milking cows in late 2004 (see October, 2004 Federal Register). Assuming an aggressive marketing campaign and rapid consumer acceptance, it seems unlikely that in just the few years since this product has migrated in significant quantities to be found in groundwater sampling as reported by EPA in this report. While Monensin was approved years earlier for non milking cows, many dairies raise their heifers and calves on separate facilities out of the area. Further, research published in 1984 (Journal of Animal Science 58:1528-1539) established that Monensin, incorporated in soil with manure (see table 10) was degraded below lab detection limits at one month. This is not an environmental fate profile which points to a persistent, bio-accumulating, leaching pharmaceutical useful as a tracer for dairy sourced Nitrates.

G. Mischaracterization of Nitrogen contenct of organic vs synthetic fertilizers -On page ES 7, under the title Irrigated Cropland the following initial sentence appears: "Nitrogen rich fertilizers, such as inorganic synthetic fertilizer and manure, are applied to irrigated cropland, and are a possible source of nitrate in drinking water wells". This statement is grossly incorrect, as it is wrong in two related dimensions; First and foremost, since liquid manure averages around .16% Total N, it is not and cannot be considered "Nitrogen rich". Since common synthetic fertilizers average

around 28% Nitrogen (range 16-82%) they contain on a per ton basis more than 100 times as much Nitrogen. It is very concerning to see such a basic, sloppy error and to such an extreme extent; again, this is either evidence of bias, or perhaps worse, ignorance. Furthermore, almost all synthetic forms of N are either in the form of Nitrate, or are readily converted by soil microbes to plant available (and leachable) Nitrate N. In manure, much of the N is in an organic complex, and breaks down more slowly, on average only 80% converts in the year of application. By comparison, under most conditions all synthetic forms of N, if not already in the Nitrate form, are converted to Nitrate within 30 to 60 days. There is no scientific basis to use the same assumptions for these very substantially different materials, especially as it relates to potential to leach to groundwater in the form of Nitrate.

H. Incorrect assumptions about the herbicide Bentazon -On this same page, ES-7, EPA links the findings of the herbicide Bentazon in soil samples with findings in nearby wells, and implies that there is a direct and immediate link between application and leaching to groundwater. There is not information provided about well construction, surface seal, depth, etc. as apparently EPA failed to accurately characterize about 70% of the wells they sampled. Assuming the soil analysis is correct, and since soil samples were essentially 0-2" by EPA, a finding there would likely indicate application of this pesticide in the current crop cycle. If one were to assume the finding in the well water of the same pesticide was analytically correct, given well circulated, authoritative published numbers, this assumption of leaching cannot be correct. If that were the case, the application or series of applications subject to leaching would almost certainly be 10-25 years OLD and not current practice as implied. The 9th Edition of the WSSA Herbicide Handbook, considered the most authoritative reference work on environmental chemistry of herbicides, says the following about Bentazon: (Page 46), "**Mobility**: Does not leach below the plow layer". Soil half-life is listed in this same reference work as 20 days; any pesticide with this short a soil half-life and not a leacher, cannot reasonably be expected to reach groundwater as a result of normal use. A simple Google search using the string "Bentazon soil leaching" identifies a wide range of peer reviewed, scientific journal articles supporting this position. An often cited article is published in the journal *Reviews of Environmental Contamination and Toxicology* by Huber and Otto (1994, 137:111-134) which states as follows in the abstract: "...However, several field lysimeter studies unambiguously proved that it does not leach under field situations..." It would seem reckless and unsupported for EPA to conclude the findings in several wells are due to leaching; it is far more probable that it is as a result of using wells with no backflow devices to mix and load sprayers with this chemical resulted in this well contamination. This is but one example of a long and obvious series of incorrect and unsupportable assumptions made by EPA in this report.

I. Speculation about Monensin unsupported by both field studies and EPA sampling and analysis- At the bottom of page ES-7 and the top of the following page are a series of theories offered to explain one finding of the pharmaceutical Monensin in a well and in a soil sample from a single (Hop) field: "Possible manure application to the hop field could account for the monensin detected in the down gradient well. The isotopic analysis indicated that the dominant source of nitrate for one drinking water well was synthetic fertilizer". Given what is known about Monensin (short half-life, degradation enhanced by manure) and the completely unsupported speculation about a "possible" manure application, the known science here would clearly not support such a conclusion. Further proof to the contrary is in the remainder of the EPA

statement; most of the nitrate in this subject well, according to their isotopic analysis, was not of organic, but rather from synthetic origin fertilizer. This isotopic finding then also refutes the theory of leaching of Monensin from excessive manure applications; and rather than suggesting over application of nutrients from manure, this subject site, if ever fertilized with manure, was done so at appropriate, agronomic rates and did not result in leaching nitrate to groundwater.

J. EPA conclusions about source of nitrates completely unsupported by well water sample and analysis-On page ES 9, EPA summarizes their "proof" of likely nitrate contamination by dairy sources by saying that their analysis showed 6 of 25 residential wells tested in Phase 3 were primarily Nitrate sourced from animals. They went on to say they could not differentiate animal from human sources. So, at best, using EPA's own analysis, 76% of the wells tested in Phase 3 did not have Nitrate contamination from any living source. Of the remaining 24%, it was at best a 50-50 whether that source was dairy or human from septic. I don't know if EPA subjected this limited data to any type of scientific statistical analysis; however, I can say that from a purely common sense viewpoint, initially excluding over three quarters of the Phase 3 (intensively tested) wells as having a dairy sourced problem, and then saying that the remaining 24% are at best only 50% likely to be affected by the "Dairy Cluster" source does not, and rationally could not lead any reasonable person to the conclusion EPA has adopted.

K. EPA rejects their own sampling and analysis results as it relates to age dating -There is no explanation offered by EPA to their statement that "The age dating results were not useful to determine when the Nitrate contamination was introduced into the well." Was there a testing problem? Did the data set fail to pass QA/QC? Is this a generally reliable and accepted analytical procedure? All important questions with no answers provided by EPA. We were told initially by EPA that they considered this age dating testing critical to their project; it was the single tool available to definitively understand and separate historic sources and loading from current practices and loading. EPA's complete abandonment of this important tool demands a complete and detailed explanation. Abandonment of this tool so highly promoted initially by EPA after the results were in from the lab prevents EPA from forming any scientific conclusions about one of the most critical issues facing both EPA from an enforcement perspective, and the GWMA from its stated goal of reducing nitrates in groundwater. Nothing can change the nitrate loading by prior generations (many of whom were following then current recommendations from WSU and other Land Grant Sources); but by improving existing nutrient BMP's, and encouraging the development of even better practices we have the opportunity to move beyond the "study" of nitrates, and move progressively towards partnerships with industry, residential, agricultural and municipal leaders to actually reduce nitrates in groundwater.

legacy

L. EPA concludes there are no upgradient nitrate sources of nitrate despite overwhelming historic and physical evidence to the contrary -The EPA assertion that there are no significant up gradient sources of nitrates to the "dairy cluster" is demonstrably false. There are thousands of acres of intensively farmed irrigated fields which are generally up gradient from the "Dairy Cluster"; see Google Earth and related images on the Yakima County GIS data base. Since this area has been farmed for over 100 years, with sprinkler and drip only replacing flood or furrow/rill irrigation in the past 25 years to any significant extent, EPA is turning a blind eye to the obvious; the majority of all nitrates found in current sampling of drinking water wells are of historic origin. Farming practices have changed substantially over the past 25 years and in

particular in the past ten years at an accelerated rate. Since passage of the Dairy Nutrient Management Act (1998, RCW 90.64 and related) dairies in the subject area have been under very different regulations and requirements. All these facilities are currently, and have been under permits from WA DOE and WSDA for some time. Compliance inspections, including site visit/inspection, soil testing and nutrient application records have been inspected on almost an annual basis for the past 14 years. EPA has made no references in this report to consideration of that important data set; instead they make a vague reference to general, second hand reports from WSDA of "high nitrate levels in fields". If that nitrate was in the top 1' of soil, generally that is not an issue; only when it is found in high concentrations in depths below 3' is there a high risk of leaching to groundwater. Recall that EPA decided to use a 0-2" soil sampling protocol; this is not an accepted sampling protocol to evaluate soil nitrates. Since EPA has not considered in their calculations crop removal, and the report generally is very weak on all agronomic issues, let me use a single example to illustrate the folly of their position, stated in this report, in this regard.
Typical Dairy forage double crop system:
Crop 1: Winter Triticale; seeded late September; harvested early May: Crop removal of Nitrogen for a 3 ton (average crop) cut first week of May would average 135#/acre.

Crop 2: Corn Silage direct drilled second week of May; Nitrogen removal for a modest crop of 30 tons/acre would average 185#/acre (WSU estimate 220#).
Total average crop removal N for one year, standard double cropping system: 320#/acre.
This represents the net minimum N that must be available for uptake in a given year. When consideration for other (non leaching, denitrification to the atmosphere) environmental losses are considered, they are estimated in the just published California report (www.groundwaternitrate.ucdavis.edu; Technical report #2) at 38% total; Assuming half those losses occur prior to field application, the amount of Nitrogen that needs to be applied to meet the minimum crop requirement, a total of 380 # N must be applied to achieve realistic, sustainable yields. EPA presents no specific sampling, lab analysis or other data to establish that farming practices on fields provided dairy nutrients are in any way different than synthetic fertilizer supplied fields. In fact, the sampling plan selected by EPA does not lead to any scientifically valid data which even suggests that current practices are contributing in any way to the (dominantly historic in nature) groundwater nitrate contamination. Measuring elevated nitrates in the top inch of soil, and somewhere below in some areas there is elevated nitrate in groundwater provides no scientific causal connection that current practices are contributing significantly to what most research shows is primarily "legacy" nitrate from 20+ years ago. There is no way to change the past; we can change the future, but only with the use of scientifically valid, repeatable and reliable data. Such data does not exist within the subject EPA report.

M. EPA misuse of USGS groundwater modeling to establish up from down gradient on a micro scale
-As it relates to the basic EPA choice to designate "up gradient" vs. "down gradient", this was a designation not based on their sampling and analysis; it was instead a misuse of the USGS computer model useful only on a "macro" scale. It is not a scientifically valid tool to use it on the extreme micro scale that EPA attempts to do in this case. For such very local information, dye or tracer material injection and intensively spaced and sampled test wells are required to

reach reasonable certainty for very local areas. Given the complex terrain and soil variation, the effects of land leveling, irrigation and drainage, the decision by EPA to rely on the computer model crafted by USGS which is intended to be used on a more macro scale, for a very small scale specific sites (5 named dairies) without any verification of actual flow directions, rates, and lateral movement is not scientifically reliable. This is further compounded by the failure of EPA to adequately study, sample (soils to depth, drilling test wells, repeated over time), analyze, take crop histories/nutrient input calculations for surrounding agricultural enterprises and septic as other viable, potential sources. Failure here is in both the inductive (lack of proper sample plan; sampling; analysis, data gathering) and deductive (study, sample plan, sampling, analysis, data gathering to reasonably allow, based on evidence the exclusion of other contributing sources) analysis.

N. EPA ignores key published peer reviewed study which establishes appropriate research requirements to link manure applications to potential for nitrate loading in groundwater. -An intensive, ten year study published in 2005 in the Journal of Environmental Quality (Vol. 34, Sept-Oct 2005 pp. 1672-1681, Ferguson, et al) compared a number of manure application regimes and rates of application, compared to a conventional fertilizer program. Not only were yields measured, but nutrient removal, effect of winter cover crops, and effects on accumulation of Nitrate in soil with depth, and potential for leaching were investigated in detail. When manure was applied at treatment CP (matching crop requirement for P removal, composted manure) the study concluded "...Applications of manure to match crop P removal, and basing application rates on at least 70% of total manure P being available to the crop in the year of application, effectively utilizes nutrient resources from manure and minimize the environmental risk of manure application." This study is the blueprint for the type of study design, sampling, and research over a ten year period which is the optimum scientific approach to determine what the potential is for nitrate leaching, and which manure application rates, timing and field culture result in the lowest potential impact to groundwater quality with respect to nitrate leaching and accumulation. Since this is a 2005 study, it was available for EPA to review and consider if they were in fact committed to gaining a specific understanding of how land application of dairy nutrients can be safely and appropriately recycled. It appears instead that EPA deliberately ignored the standard rule of research; search for and review current peer reviewed journal articles to understand the current state of the science in this particular area. Failure to do so in even a master's thesis would result in automatic rejection of the research presented; many of the EPA people associated with this study have advanced degrees and know full well this is an absolute minimum requirement. It appears that what very limited technical source review took place, at least as it is reported by EPA, was selectively limited to articles and work EPA felt would support the direction they wanted this study to go from the start.

O. You will note in reviewing this study that their sampling took place over a ten year period, with 5 or 6 sample points even spaced out to a depth of 1.37 meters (about 4.5'). This is typical of a standard nitrate leaching study; the 0-2" standard selected by EPA is not recognized as a scientific, accepted method of sampling for nitrates. To further illustrate this point; please review the attached documents from both private and public sources. The A & L labs sampling guide (www.al-labs.west.com) suggests a maximum sample size of 40 acres; there is no information provided by EPA as to the acres in each of the six fields (2 each, Corn, Mint, Hops) but it is likely some fields were larger than 40 acres, in which case the sample area is too large to

be accurately represented. There was no discussion of soil types present in the sampled fields; yet the web soil survey is available online to identify the different soil types; in fields smaller than 40 acres two samples would be the recommended minimum if there were differing soils in these EPA selected fields. More importantly, specifically to address the issue of characterizing Nitrate nitrogen, the mobile form of interest here, A & L labs (recognized as the largest commercial soil lab in the country) recommends sampling in 1' increments down to 3' (3 samples per site). This allows not only an accurate assessment of total Nitrates present, but the level at which the highest nitrates are found will provide a clear indicator if nutrient practices are likely, over the long run, to produce excess leaching on Nitrate to groundwater. Soil sample guides from Oregon State University (bulletin PNW 570-E), and University of Idaho (EB 704, revised) provide similar guidance for appropriate sampling protocols to accurately assay Nitrate nitrogen. The soil sampling protocol utilized by EPA in this case is one used less than 1% of the time, and is only used when looking for freshly surface applied chemicals (like pesticides). This unusual very shallow sample protocol is not recognized anywhere in the great body of literature as an appropriate technique when the research is focused on an assay of Nitrate nitrogen. The odd, deliberate and unacceptable sampling protocol used by EPA negates fully any scientific value of the results obtained. In addition, the number of fields sampled (total of 6) cannot possibly be representative of the variation in crops, cultural techniques, soil rotational history of the Lower Yakima Valley. At least ten fields and ten crops, with full field histories, and sampled in 1' increments to 3' (sampling to further depth would be even better) would be necessary (two consecutive years) at a minimum to provide data which would withstand peer review and scientific journal publication.

P. Missing data not taken by EPA would negate the test results even if the proper sample protocol were followed for Nitrates -EPA presents essentially no data on the fields selected for soil sampling (2 each, corn, hops and mint) other than the current crop at time of sampling. As previously described, the sample plan chosen by EPA is not correct, and based on an extensive literature search has never been used before to study nitrate nitrogen. Missing data necessary to allow any reasonable evaluation of soil test data (assuming an appropriate protocol using sampling to depth of at least 3', 5' better is followed) includes the following:

a. Field history – crop rotation prior 3 years minimum; 5 years better;
b. Field history of all nutrient applications – form of nutrient, when and how applied, amounts;
c. For the three or five year prior rotational crop need yield to calculate nutrient removal in harvested crops, and whether or not it was cover cropped;
d. Based on nutrient applications and crop removal, add expected denitrification and other losses to estimate N balance for each field (net deficiency or removal or addition of nitrate);
e. Irrigation type, amounts, application rates and frequency;
f. Presence of any soil tile or surface waterways thru or adjacent to subject fields;
g. Source and nitrate analysis of irrigation water;
h. Crop residue management;
i. Soil tillage or lack thereof (no till or min till farming);
j. Whether field has protective soil berms to prevent any run on and run off;
k. Historic and current annual soil and any available plant tissue nitrogen analysis;

Without this data, even if EPA had selected and executed an appropriate sampling plan and analysis for nitrates (and NH4-N which converts to Nitrate) the test data is not meaningful for the purpose of evaluating the key question; Are current nutrient management techniques,

including land application of organic or synthetic nutrients likely to contribute to groundwater Nitrate loading in the future?

P. EPA failed to obtain, review and consider the wide body of technical literature, including research within Washington State and Yakima County in particular; instead chose a single 10 year old report from Kansas with only a single dairy basin evaluated -The EPA report relies exclusively on the report by J.M. Ham (Trans ASAE Vol. 45(4): 983-992) in calculating their critical estimate of leaching losses from dairy manure storage basins. It is rather odd that EPA would pick this report, which is ten years old, when there are more current reports in the technical literature; odd that this is a study from the Midwest (Kansas) where the author makes specific reference to extending these findings only to the great plains area; particularly unusual in that of the 20 storage basins studied, only one was a dairy basin. This single dairy basin it should be noted was only 1 year old at the time of the study, and the author acknowledges that initial loss rates are always higher due to the additive effects over time of very fine sedimentation and head pressure increasing the seal by about an order (factor of 10x). In order to select this report above all others, EPA also had to ignore studies conducted by the Washington State DOE on storage basins here in Washington State, some of which were within the EPA/Yakima County study area. In addition, several privately funded studies on site in Yakima County with a combined total of 20 years of data specific to this issue are not available to EPA as a direct result of their enforcement actions pending against five listed dairies in the "cluster" near Outlook identified in their report. With EPA targeting this important segment of the ag economy, this is but one example of a great lost opportunity for cooperative, rather than legal, adversarial based relationships between EPA and family farmers.

Summary of Comments

It is apparent that EPA research group, other than the single meeting previously described over three years ago, sought to internally design and execute their selected plan, and to exclude outside comment and review through the entire process. Science itself has no ideology; it is simply a tool to be used for good or, as in this case, for what appears to be a politically driven, anti-dairy agenda. While there is adequate evidence of incompetence in the design, execution, and conclusions reached by EPA in this final report, perhaps of even greater concern is the perception created. Overall the dominant impression created is of an adverse bias, directed against a single and important element of our food production system; family dairy farming enterprises. This focus by EPA, to the exclusion of the other well know sources, and the relegation of historic practices of generations past to a mere footnote, have resulted in an indictment of EPA in the general scientific community.

The conclusions in the report are simply not scientifically supported by the very limited, biased sampling and flawed analytical data provided. A reading of each labs comments on the limitations of the data which they generated at EPA's behest with samples provided, and how and where it should be used, should have been enough to prevent EPA from using any of it, good, bad or somewhere in between, in their summary and conclusions in this report.

The non-public so called "peer reviews" plan utilized by EPA in this case is almost unbelievable in its form and nature. I have been told that the entire completed plan was not provided to, and was not what was sent to the selected reviewers. If it turns out that important sections, including those where EPA made conclusions from the data in the (partial/draft) report were not provided, then there was no

this was a deliberate and deceptive act. The limited selection of only FEDERAL employees within EPA and affiliated agencies is at best, a badly incestuous idea. At worse, it could be reasonably viewed as a calculated way of controlling the potential for negative feedback of substance. The lack of a real peer review by independent experts, at least some of whom should have had some detailed local knowledge, was a crucial decision point that ultimately led to the release of this mortally flawed research report. The refusal of EPA to cooperate in a joint, true independent peer review process after its public release was compounded severely when the stated reason for the rejection was that the quality of the data was so good there was no point to such an exercise. Within a week of that assertion, I learned that EPA was scouting locations for geo-probe data gathering, seeking new, apparently "better" field and lab data. Folks, you can have it one way or the other, but definitely not both. Either EPA stands by their stated position that the data is of such high quality, and their conclusions unassailable, or there are major defects, errors and omissions which require a substantial "fix", if not a complete do over.

For over three decades I have worked with the EPA, and developed a high level of respect as a result of those many experiences. It is with deep regret that I pass such critical judgment with respective to their report EAP-910-R-12-03. EPA has lost all credibility within the agricultural, rural population that lives and works every day in their "study area". Yakima County is a one pony show economically; it has production ag, processing, storage and distribution as a primary employer. In my over 35 years of direct experience working with family farming enterprises in Yakima County, I have found these producers to be intelligent, progressive, and eager to embrace new technology and BMP's as they are developed. They were strong supporters of the 1998 DNMP, and more recently voluntarily cooperated with EPA in providing critical testing sites for the NAEMES and follow-on research projects, and worked for two years with Gary Pruitt at the YRCAA on identifying and adopting comprehensive BMP's to reduce air emissions. The dairy industry has worked very hard and has been the most committed group of ag producers I have worked with on environmental issues. Given the quality of leadership in the fruit, grape, hop, mint, wheat and potato commodity organizations, that is saying a great deal.

The decision to turn what could have been an even handed, progressive work to assist the GWMA, the group with the real opportunity to make positive long term changes and reducing groundwater nitrate levels into an unscientific, unsupported, targeted attack on one segment of Yakima County agriculture will in my opinion be viewed as a disastrous, watershed moment. EPA has decided that litigious pursuit of a handful of dairies, unsupported by sound science, driven by bias and politics, is more important than really identifying how to solve the problem of nitrates in groundwater. This report, and the actions of EPA against the dairies, represent in my opinion the largest obstacle to be overcome by GWMA in their long term pursuit of sustained and significant reduction in groundwater Nitrate contamination. I respectfully request that EPA consider carefully this brief analysis and critique, and reconsider their commitment to this deeply flawed report.

Yours Very Truly,

Stuart A. Turner, CPAg #02575
Turner & Co., Inc.

ATTACHMENT 1

Washington State NRCS comments:

The study does not accurately represent the likely discharge rate occurring from Dairy Waste Storage Ponds (WSP) identified in the report. The assessment utilized by EPA was based on limited site information. Assumed values were utilized for computing the specific discharge, as such the results and findings are erroneous and unreliable. We recommend that EPA take immediate steps to revise the findings taking into consideration the following:

1. Accurate estimates for computing the likely discharge amounts require site specific information of the WSP. The WSP wetted surface soil type and extent is required. If the WSP is lined the liner thickness is required and the seasonal fluctuation of the effluent level acting on the WSP wetted surface must be known. Utilizing the design guidance found in the NRCS Agricultural Waste Management Field Handbook (AWMFH), Appendix 10D, for computing the specific discharge rate from a WSP requires very detailed data. Given that the actual WSP data is not available for any of these calculations, all the estimates for specific discharge rates are erroneous and unreliable.

2. NRCS design methodology for computing WSP specific discharge rates are based on very accurate permeability rate determinations. The procedure for conducting the analysis is found in ASTM D-5084, "Standard test methods for Measurement of Hydraulic Conductivity of Saturated porous Materials using a Flexible Wall Permeameter". EPA should collect multiple undisturbed soils samples from each WSP within the wetted surface area that would be representative of the entire wetted surface of the WSP. The results should be used to revise the seepage rates based on the procedure in the AWFMH, Appendix 10D.

3. The EPA study assumption that the WSP is full year round is invalid for estimating and quantifying the discharge occurring from a WSP. The methodology should be revised to estimate the discharge over a full year as the WSP is being filled and then emptied. To assume a full WSP condition for specific discharge quantification is unrealistic and unfairly overestimates the discharge.

4. The maximum effluent depth over the liner is required for estimating specific discharge rates. EPA should conduct topographical surveys of each evaluated WSP to determine the WSP depth and effluent levels acting on the wetted surface area of the WSP.

5. NRCS recommends that greater consideration and focus be given to other nitrate sources that have a higher potential to impact groundwater than the WSP's. The organic and synthetic material used for fertilizer across all the crop acres if not applied at the right amount, the right time and the right place has a higher chance of impacting the groundwater quality than the WSP specified. NRCS is well equipped to provide technical and financial assistance for the development and implementation of a comprehensive nutrient management plan.

6. The EPA study mentioning a difference in human waste being treated and animal waste is not, is misleading in that treated human waste (biosolids) still poses a great threat for contamination of nitrates and heavy metals when discharged into the environment.

7. The EPA study claiming the amount of waste produced by the cluster was similar to a community of more than 2,827,000, dismissed the fact that 65% of the study area is land application, where the majority of the animal waste is utilized by crops with high nitrogen needs. Only some of the fields were noted in WSDA inspector reports to have elevated levels of nitrogen.

ATTACHMENT 2

Yakima Valley Nitrate Study

Comments/Input

The following is being provided in response to the USEPA report, EPA-910-R-12-003, entitled *Relation between Nitrate in Water Wells and Potential Sources in the Lower Yakima Valley, Washington.*

Introduction. This EPA study was generated primarily due to the concerns by many pertaining to the high levels of nitrate in water wells in the Lower Yakima Valley, WA. In an effort to determine the source of those high nitrates, dairy farms (along with other minor sources) located within proximity to the wells, were identified as potential sources, specifically dairy farms in operation there. The report concludes that dairy producer's facilities and their associated lands are the principal sources of high nitrates in the wells. To validate their claim, EPA collected much data and performed numerous tests attempting to pinpoint the source of the nitrates.

After reading the report and reviewing the numerous data and conclusions derived from it, I am highly skeptical of their conclusions based on their testing methods, procedures, and interpretations of these recorded throughout the report. The report is filled with considerable errors in calculations and interpretations that, based on the performed tests, methods and interpretations, cannot be scientifically defended to derive at the stated conclusions. I want to acknowledge that high nitrate levels in water wells are a documented health hazard. However, the source and extent of those nitrates must be accurately identified before corrective measures can be implemented or a course of action, pineal or otherwise, is undertaken.

Comments/Input. The study design itself is flawed in that it fully acknowledges that identification of the extent and sources of nitrates did not take into account any losses of nitrates from biological, physical, or chemical processes and also did not account for crop utilization (ref. page 16, Phase 3 Study Results). The conclusions pertaining to the dairies are based on data that does not properly represent the sources or the extent of nitrates. In essence, the study simply collects data on particular sites at particular times and finds nitrogen of various forms and concludes that all these are the cause of the well water contamination or substantially contribute to it.

Anytime animal wastes and fertilizers are utilized to provide the required nutrients for crops and forages, a minimum set of information must be considered to properly provide a management system that simultaneously provides needed plant nutrients as well as protects surface and subsurface waters. To accurately determine what the needs of the crop are consideration *must* be given as to the proper rate, proper timing, the proper source, and the proper place of nutrient applications including fertilizers and manures. Lack of consideration to any of these will lead to potential production and or environmental problems. Additionally, ignoring any of these while diagnosing an environmental or production problem will also result in less than accurate conclusions. In attempting to determine the source and extent of the nitrate problem in the Lower Yakima Valley, this report ignored or misinterpreted vital data and information to derive at their conclusions.

1. The report does not utilize actual design parameters of the waste storage pond for any of their calculations for all the estimates of specific discharge. The only dimension that was measured is the top surface area of the waste storage pond. The size of the top of this pond was measured at 6.175 acres, which is a significant structure.

   By NRCS design criteria, written in the Waste Storage Facility, CPS 313 (2004), the storage ponds would have a designed specific discharge as little as 0.07 inches and is equivalent less than 1% of the total annual depth of precipitation in this part of the state.

   Given that the basis of concern stated in the EPA report is groundwater quality, there conclusions that the ponds are causing considerable leaching of nitrates into the groundwater is incorrect. Proper calculations would conclude that the ponds are **not** likely the source of nitrates in the wells. This also would suggest that there may be other nitrate sources that have a higher potential to impact groundwater than the waste storage ponds as stated.

2. The EPA report suggests that irrigated cropland is expected to be a likely source of nitrates in drinking water wells (ref. page ES-9). However, the only pathway that nitrate contaminants can enter well water is through either:

   1). Leaching through the soil profile past the crop/forage rooting zone into ground water and subsequent movement underground to a well, or

   2). through surface water flow off of the field and directly into a recharge area that feeds the well itself.

   In consideration of leaching, the report attempts to identify that the soils on a majority of the fields that are receiving manures and commercial fertilizer are considered "well drained" and that they have "saturated

hydraulic conductivity" characteristics that is considered high (ref. EPA-910-R-12-003, surface soils, page 35 and Appendix B). The report cites the USDA NRCS soil survey and reports generated from the survey to characterize the fields.

Saturated Hydraulic Conductivity. According to the definition that USDA NRCS uses to describe and characterize saturated hydraulic conductivity (Soil Survey Manual, Ag Handbook 18) saturated flow occurs only *when the soil water pressure is positive; that is, when the soil matric potential is zero (satiated wet condition)*. This situation takes place when about 95% of the total pore space is filled with water (5% is air). If the soil remains saturated for a prolonged period (several months or longer) the percent of total pore space filled with water may approach 100 percent. "Saturated hydraulic conductivity CANNOT be used to describe water movement under unsaturated conditions" (ref. USDA Soil Survey Manual, Soil Survey Division Staff, Agriculture handbook 18, October 1993, page 103).

Because irrigation water management details were not collected from the producers nor was data collected in the field that measured soil saturation or duration, there is no data that can substantiate that the simple classification of hydraulic conductivity precludes leaching. Therefore, the data that EPA draws upon in this report to suggest the fields were leaching is circumstantial and cannot be used to conclude that leaching is attributed to the land treatment fields where manures and fertilizers were applied.

Drainage Class. Natural drainage class refers to the frequency and duration of wet periods under conditions similar to those under which the soil developed. Alterations of the water regime by man, either drainage or irrigation, is NOT considered unless the alterations have significantly changed the morphology of the soil (ref. USDA Soil Survey Manual, Soil Survey Division Staff, Agriculture handbook 18, October 1993, page 98).

The USDA Soil Survey manual describes "well drained" as *water is removed from the soil readily but not rapidly. Internal free water occurrence commonly is deep or very deep; annual duration is not specified. Water is available to plants throughout most of the growing season in humid regions. Wetness does not inhibit growth of roots for significant periods during most of the growing seasons* (ref. USDA Soil Survey Manual, Soil Survey Division Staff, Agriculture handbook 18, October 1993, page 98).

The EPA report misinterprets the definition of "well drained" tying nitrate leaching to the natural drainage classification of the soil. Again, there is no documentation of any kind that would lead to the conclusion that, based on the natural drainage classification of a soil, leaching or subsurface water contamination occurred in the Lower Yakima Valley.

3. The report makes substantial conclusions pertaining to the potential for nitrate leaching and runoff based on soil tests that were derived from the top 1 inch of soil (Table ES-1, footnote b). The top 1-3 inches of soil contains a large majority of the soil profile's organic matter, where large amounts of organic matter and mineralization occur. Additionally, depending upon when soil samples were collected and how and when any manures or fertilizers were applied, it is not uncommon to see high quantities of N near the soil surface for certain periods of the year. For example, if manure was broadcast on the soil surface and not incorporated, higher quantities of N-P-and K would be apparent until such time as the manures of fertilizers were incorporated or volatilized. Management techniques have a great deal to do with the location and quantities of nutrients in the soil profile depending upon the characteristics of the nutrient and the management practices utilized.

To accurately ascertain if nitrates were moving through the soil profile, deep soil tests (36-60 inches) should have been collected from fields above gradient and below gradient of affected wells. If nitrates were found below the rooting zone of the crops grown, this may have been an indicator of potential nitrate movement to ground water. A 1 inch soil sample has limited applicability if any.

4. Some of the testing interpretations are also questionable as to their applicability. For example, on page 20 of the report, EPA states that they tested for nitrate, nitrite, ammonia, and TKN. *"Total nitrogen concentration was calculated bu summing concentration of nitrate, nitrite, and TKN"*. The TKN test is used to determine what the potential total of various forms of N are. A TKN test is the measure of organic N (nitrate and nitrite), ammonia N (NH3) and ammonium N (NH4). By adding nitrite and nitrate to the TKN, you essentially are adding quantities of nitrate and nitrite twice, substantially increasing the total. Nitrate and nitrite are ion specific. Additionally, TKN tests include N that has not been mineralized (as nitrates) and assumptions that they will be are erroneous. The nitrogen cycle, as shown in the report, includes mineralization, denitrification, volatilization, etc. Not all nitrite will be nitrate. Not all nitrate will be remain nitrate (denitrification) especially under wet or saturated soil conditions. Summarily, the results of the improper (depth) soil test data is being misinterpreted and cannot be used to draw conclusion as to the source of nitrates in the wells.

Summary. Due to the fact that specific data pertaining to crop management and tillage systems, manure management, irrigation water management, nutrient management, and pest management were not collected or were not available to EPA, utilizing gross or generalized characteristics or data pertaining to soils within the Lower Yakima Valley for purposes of identifying sources of nitrates in well water is not accurate or conclusive.

It is my suggestion that this report be retracted and data collection begin in earnest including the above listed management information and the appropriate tests using proper data collection methods and testing techniques. The results of which should be independently analyzed by non-affected parties to enable proper conclusions as to the source of nitrates in water wells in the Lower Yakima Valley.

ATTACHMENT 3

Thank you for the opportunity to provide comments on the EPA- Relation Between Nitrate in Water Wells and Potential Sources in the Lower Yakima Valley, Washington study.

At the request of NRCS Washington State leadership, NRCS National Science and Technology staff has reviewed the report and submits the following comments and observations:

1) The use of generalized recommendations contained in the NRCS Animal Waste Management Field Handbook (AWMFH) to predict the seepage loss contribution from individual farms is misleading. AWMFH recommendations and data are well supported by research and field experience throughout the US. However, they are generalized recommendations that typically get adjusted to accommodate site conditions during the planning and/or installation phases of storage facility construction. Site specific testing and on-site evaluations are usually necessary to assure adequate design for a given site. Planning for an adequate structure requires detailed information about anticipated manure volumes, manure type and consistency, climate, and production area runoff, etc.

2) The generalized AWMFH seepage rates should not be used to predict leakage losses from multiple dairies distributed randomly in a major watershed. Generalized seepage rates are used by planners/installers to anticipate the potential for loss and the need for additional conservation practices that will provide adequate protection of local water quality. Recent Mississippi River Basin and Chesapeake Bay Watershed CEAP studies have established the effectiveness of installed NRCS conservation practices at protecting water quality. Practices were most effective when they were coordinated as a suite of practices designed to deal with a site-specific water quality issue.

3) NRCS funded waste storage structures must be constructed following engineering conservation practice standards that are maintained by state-based NRCS technical experts. To receive USDA funding, producers must sign a contract that requires compliance with design, oversight/maintenance, and other criteria established by the practice standard. The contract is permanently tied to the state's official practice standard when the contract was signed by the producer, i.e., lagoons built 15-20 years ago are not associated with contracts that enforce criteria for the current official practice standard.

4) EPA's restricted access to important sites or data made it difficult to estimate the pollution contribution from individual farms. Farm specific information would have helped the researchers isolate site/management issues contributing contaminants to the environment.

5) The use of aerial photography to determine storage volumes can grossly over estimate each operation's manure storage capacity and therefore your estimate of seepage losses.

6) A storage facility is typically designed following rigid engineering standards, and local code usually requires routine monitoring for failure. EPA does not know if the structures were designed per code or if competent engineers were involved in the work. There are many factors that could lead to a leaking storage facility. Targeting all operations upgrade of a contaminated well may unfairly focus attention on well managed operations.

7) EPA does not know if the operations have storage facilities that were designed to handle the number of animals confined. If not, the lagoons may lack sufficient capacity to accommodate the manure/wastewater volumes generated, making them vulnerable to discharge. Has a nutrient management plan been followed to assure adequate facilities to handle mortality, spoiled feed, contaminated runoff, medical wastes, etc? Are animals fenced out of streams; are nutrient being applied too near unbuffered streams? These factors were not considered by the study.

8) Every AFO deals with a unique set of circumstances that define how to best manage large volumes of potentially polluting materials. Site factors, e.g., soil, topography, climate, animal type/number, period of confinement, confinement facility type, field hydrology, storage design/volume, spreadable acres available, and management styles change significantly from farm to farm. A leaking lagoon may not always be the principal problem, and oftentimes additional conservation practices, or better management of installed practices, may significantly reduce losses.

9) It appears that the high levels of nitrate found in drinking water wells in the Yakima Valley are coming from multiple sources. More information is needed to help focus attention on site/management issues contributing pollutants.

10) NRCS acknowledges the need to encourage producers to install sufficient conservation measures to minimize the movement of potential contaminants off-site. Accordingly, NRCS manages approximately 190 conservation standards that can be used to protect air, soil and water quality. Structural practices are available to help the producer keep air and water clean in the confinement (production) area, and land treatment practices (cropland, hayland, pasture) help growers minimize non-point source losses associated with erosion, leaching, volatilization, denitrification and surface flow.

11) Livestock growers enrolled in USDA programs are strongly encouraged to manage their manure handling, storage and field allocation activities following a Comprehensive Nutrient Management Plan (CNMP). The CNMP is developed based on site conditions and is designed to help farmers safely apply stored manure to their available land base.

12) The NRCS Nutrient Management Conservation Practice Standard (CPS 590) provides the minimum nutrient management planning criteria for the application of nutrients (synthetic or organic) to agricultural lands enrolled in USDA programs.

13) In January 2012, NRCS released a revised nutrient management policy and CPS 590. The new policy encourages improved nitrogen and phosphorus risk assessment tools, precision and enhanced efficiency fertilizer technologies, suites of coordinated conservation practices, and adaptive nutrient management strategies. Improved nutrient use efficiency saves the producer money and also reduces the potential for loss to the environment.

14) NRCS is committed to working with farmers to help them minimize the impact that farming operations can have on local water quality, including drinking water.

GIVENS PURSLEY LLP

LAW OFFICES
601 W. Bannock Street
PO Box 2720, Boise, Idaho 83701
TELEPHONE: 208 388-1200
FACSIMILE: 208 388-1300
WEBSITE: www.givenspursley.com

W. Hugh O'Riordan
Direct Dial: (208) 388-1255
Email: who@givenspursley.com

Debora K. Kristensen
Direct Dial: (208) 388-1287
Email: dkk@givenspursley.com

Gary G. Allen
Peter G. Barton
Christopher J. Beeson
Clint R. Bolinder
Erik J. Bolinder
Preston N. Carter
Jeremy C. Chou
William C. Cole
Michael C. Creamer
Amber N. Dina
Elizabeth M. Donick
Thomas E. Dvorak
Jeffrey C. Fereday
Justin M. Fredin
Martin C. Hendrickson
Steven J. Hippler
Donald E. Knickrehm
Debora K. Kristensen
Anne C. Kunkel
Michael P. Lawrence
Franklin G. Lee
David R. Lombardi
Emily L. McClure
Kenneth R. McClure
Kelly Greene McConnell
Alex P. McLaughlin
Christopher H. Meyer
L. Edward Miller
Patrick J. Miller
Judson B. Montgomery
Deborah E. Nelson
Kelsey J. Nunez
W. Hugh O'Riordan, LL.M.
Angela M. Reed
Kenton H. Walker
Robert B. White

Retired
Kenneth L. Pursley
James A. McClure (1924-2011)
Raymond D. Givens (1917-2008)

November 29, 2012

VIA EMAIL (R10YVNitrate@epa.gov)
Office of Environmental Assessment
Attention: Carol Harrison
United States Environmental Protection Agency
Region 10
1200 Sixth Avenue, Suite 900
Mail Code OEA-095
Seattle, WA 98101

RE: Comments on EPA report entitled *Relation Between Nitrate in Water Wells and Potential Sources in the Lower Yakima Valley, Washington* (EPA 901-R-12-003) and Request for Independent Third Party Peer Review

Dear Ms. Harrison:

The following comments to the report of the United States Environmental Protection Agency ("EPA") entitled *Relation Between Nitrate in Water Wells and Potential Sources in the Lower Yakima Valley, Washington* ("Report") and request for independent third party peer review are submitted by:

1) The Washington State Dairy Association ("WSDA"), a nonprofit corporation founded in 1892, and the oldest dairy trade association in the United States;

2) The Idaho Dairyman's Association ("IDA"), a nonprofit corporation founded in 1944 to represent the dairy industry in the state of Idaho; and

3) The Independent Dairy Environmental Action League ("IDEAL"), a nonprofit research foundation established in 2003 to represent the dairy industry in Idaho by engaging in independent research on environmental issues, including nitrates in groundwater (collectively "Commenters").

The Commenters' members and families are directly affected by the Report and believe it contains significant technical errors and data gaps which make it unreliable as a basis for enforcement action under the Safe Drinking Water Act, 42 U.S.C. §300 *et seq.* ("SDWA"), by EPA Region 10. The concerns of the Commenters are set forth in detail below.

I. THE NEED FOR INDEPENDENT PEER REVIEWED SCIENCE

Peer review of scientific documents is necessary to ensure objectivity and to provide credibility. At its core, independent peer review by qualified scientists catches and corrects errors and biases in research. It is a good process. That is precisely why the EPA itself insists that peer review of its scientific documents be conducted in a very specific manner as set forth in its *Peer Review Handbook 3rd Edition* (EPA/100/B-06-002). As stated by the EPA, "[p]eer review of all scientific and technical information that is intended to inform or support [EPA] decisions is encouraged and expected." (**Attachment A**).

Despite the EPA's "encouragement and expectation" that a specific peer review process be followed, such a process was not followed in issuing the Report. Instead, the Report followed a "peer review plan" whereby a "data report" was sent to EPA-selected reviewers. Public nominations or comments were not allowed. This review process fails in several significant respects.

First, the supposed "peer review" used in the Report was wholly inadequate in that it merely consisted of the EPA sending a small group (five individuals, of which four responded)[1] a document package with a list of seven questions the EPA sought input on. Such cherry-picked and directed input on the draft Report does not amount to independent third-party peer review since "peer input is not a substitute for peer review." (EPA's *Peer Review Handbook* at § 1.2.5). The EPA has many knowledgeable resources at its disposal in this important process, including the United States Department of Agriculture's ("USDA") Agricultural Research Service ("ARS") and Natural Resources Conservation Services ("NRCS") and the Washington State Department of Agriculture ("WSDA"). Each of these agencies has significant experience and expertise in scientific agricultural research. Nonetheless, none of these entities were used to conduct an independent peer review of the Report (consistent with EPA policies) and, even more surprisingly, none of them were the lead parties in the Report's development.

Despite not using these valuable resources, EPA had reason to question the accuracy of its Report based on the limited comments it did receive. At least one of the EPA's selected reviewers, Dr. Young, submitted detailed concerns regarding groundwater flow directly and adjacent to non-dairy agricultural fields which undermine some of the critical assumptions and conclusions of the Report. It is unclear what, if anything, the EPA did to change the Report in

[1] According to the EPA's website, the following five individuals comprised the Report's "Peer Review Panel:" Lorraine C. Edmond (USEPA), Stephen Kraemer (USEPA-NERL), Roger Burke (USEPA-NERL), Megan B. Young (USGS-Water) and David Tarkalson (USDA). Edmond apparently did not provide comments, because only those provided by Kraemer, Burke, Young and Tarkalson are posted on the EPA's website and noted in the Report.

response to the concerns raised by Dr. Young.[2] Accordingly, even the limited "peer review" process used by the EPA does not appear to support the conclusions of the Report, but instead stresses the uncertainty of its results.

Second, the "peer review" process used in the Report failed to mention to reviewers that the Report's purpose is enforcement under the SDWA. Based on our discovery to date, we understand that the draft Report sent for review did not disclose the intent to identify dairy farms as the source of nitrates in groundwater. This was confirmed by at least one of the EPA's hand-picked reviewers, Dr. Tarkalson, who, we understand, after learning the true purpose of the Report, requested that his name be removed from the Report.

Third, a review of the Report highlights significant technical mistakes with it and its assumptions. For example, the Report begins by stating that nitrate levels in residential drinking water wells above the EPA maximum contaminant level ("MCL") drinking water standard of 10 mg/liter is a problem for only 9-12% of the residential wells in the lower Yakima Valley. Yet, the wells chosen by EPA for the Report (some still undisclosed) were not chosen from a cross-section of residential wells in the Yakima Valley, they were specifically selected for their high levels of nitrates, thereby biasing the Report from its inception. Similarly, the Report implies that nitrogen simply leaches from dairy lagoons to groundwater. Michael R. Murray, Ph.D, an experienced soil scientist with HDR Engineering, reviewed the Report and found that such a conclusion is an over simplification which ignores nitrogen cycle dynamics and, based on available scientific research, is "simply not accurate." (**Attachment B at 1**). Further, and perhaps of most concern, the Report relies upon a limited and selected set of data of well water and soil samples taken one time. In effect, the Report takes a snapshot of groundwater data from wells and selected soil samples while excluding long-term trends in the Yakima Valley. The Report creates confusion by lumping together land application of manure at dairy farms pursuant to the WSDA's approved Nutrient Management Plans ("NMP") with the use of commercial fertilizer not similarly regulated by the State of Washington or EPA. Historic application of commercial fertilizers has significantly different impact on groundwater than manure applied under the terms of a NMP.

Despite its title which claims to discuss the relationship between nitrates in well waters and potential sources in the Lower Yakima Valley, the Report appears designed to look at individual "hot spots" pre-identified as dairy farms surrounding wells with suspected elevated levels of nitrates with the idea of using ". . . analytical techniques to trace the nitrate back to specific sources." The Report does not analyze other obvious sources, such as adjacent farms. The Report needs to be peer reviewed by experts in agricultural sciences to ensure that it studies the entire lower Yakima Valley and not be limited to serving as the basis for an enforcement action against individual dairies.

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[2] The Commenters have sent a request under the Freedom of Information Act for all peer review documents associated with the Report so that we can better analyze the EPA's "peer review" process and the accuracy of the Report's information and conclusions, but we have not yet received them as of the date of this letter.

The Report has not been subject to a rigorous independent third party peer review and, as such, is not valid as a scientific document for purposes of an enforcement proceeding under Section 1431 of the SDWA, 42 U.S.C. § 300i(a). Nor is the Report admissible into evidence in support of any federal court proceeding under the standards set forth in *Daubert v. Merrell Dow Pharms., Inc.*, 509 U.S. 579 (1993). *See, e.g.*, **Attachment C** (*U.S. v. Fleet Management, Ltd.*, 2009 WL 1483143 (3rd Cir. 2009) (expert testimony based on "the best inference" drawn from allegations, which excluded other explanations from consideration, held inadmissible under *Daubert*). While the EPA has allowed public comment on the Report, public comment does not substitute for peer review, and public involvement is not a peer review mechanism. (EPA's *Peer Review Handbook* at § 1.2.8). What is needed is full disclosure by EPA and rigorous public involvement, followed by independent third party peer review.

II. EPA RELIES UPON LIMITED AND NON-REPRESENTATIVE DATA

IDA and IDEAL have been collecting data regarding nitrates in groundwater along the Snake River Plain in Idaho for a number of years. This data establishes that nitrates in groundwater are below MCL standards in areas where dairy farming practices are subject to NMPs (with the exception of a few "hot spots"). (**Attachment D**). The Idaho data seems to be consistent with the situation in the lower Yakima Valley.

In June 2011, Yakima County Public Services issued a final report entitled *Lower Yakima Basin Nitrate Treatment Pilot Program* ("Yakima Final Report"), which summarized the results of its Nitrate Treatment Pilot Program in the Lower Yakima Valley whose goals were to provide "public education, technical assistance and water treatment systems to households with people at high public health risk from nitrate contamination." (**Attachment E at 1**) (report included without Appendix). The Yakima Final Report gives scientific insight on two important issues. First, the Yakima Final Report found that "the percentage of homes with nitrates that exceed the drinking water standard of 10 ppm appears lower than originally estimated. Previous estimates indicated that 21 percent of the wells in the Program area were contaminated; however, the program's in-home testing results indicated only 9 percent were at or above the 10 ppm standard." (**Attachment E at 2 & 12**). This difference may be accounted for by the fact that there has been little analysis of wells with low levels of nitrates in the Yakima Valley. EPA's certified lab results for private wells indicated a 21% rate of contamination exceeding drinking water standards (**Attachment E, Figure 3 at 13**). However, the Yakima Final Report states that this database specifically excluded many wells less than 10 ppm "because households were not eligible for financial assistance [under the Nitrate Treatment Pilot Program]." (***Id.***) This indicates a strong bias to overstate nitrate levels. Second, Figure 2 of the Yakima Final Report shows a geographical concentration of exceedences largely in urban areas with some rural hot spots. (**Attachment E, Figure 2**).

A review of the Report in light of the data from Idaho and the lower Yakima Valley indicates that the Report is a "hot spot" analysis and not a regional approach as the title and EPA press release implies. This fundamental flaw in the Report's overall reliability is compounded by the lack of knowledge about the specific wells EPA selected in the Report which may present

higher levels of nitrates than in fact occur. As EPA's chosen reviewer Dr. Young points out, these selected wells need to be carefully studied and it is unwise to make definitive statements about nitrate sources within the Report given the inherent limitations of the study with respect to data on well location and depth, mixing/flow paths and potential mixed land use.

The Commenters are particularly concerned with the fact that the Report does not indicate what, if any, effort was made to coordinate with the WSDA which is responsible for NMPs at each dairy. This is a significant omission because a NMP is specifically designed to regulate the impacts of dairy farming on groundwater and is the key state legal process to ensure compliance with federal and state drinking water standards. We have sent a public records request to WSDA to determine the extent of EPA consultations. Our conversations with WSDA personnel so far reveal little or no contact by EPA regarding the correctness of the data in the Report.

Washington State and local authorities have acted for years to protect the health of Yakima Valley residents. Indeed, as recently as June 2011, the Washington Department of Ecology and the Yakima County Public Works Department worked together to create a Lower Yakima Valley Groundwater Management Area ("GWMA") specifically to resolve SDWA concerns. (**Attachment F**). EPA has not challenged these local and state efforts to manage groundwater contamination. Instead, EPA has failed to consult with State and local authorities to confirm that any endangerment to public health exists before issuing the Report and using it as a threatened enforcement tool under the SWDA. This failure to consult with the WSDA and local authorities (like the failure to obtain appropriate peer review) is compounded by the EPA's failure to collect adequate data over time. The data collected by EPA and used in the Report is 1) inadequate to determine the source of nitrates in individual wells, and 2) inadequate to determine if NMP are being properly implemented or are effective in controlling dairy farm impacts on groundwater. Oddly, the Report does not even discuss whether the wells tested are regulated as drinking water wells under the jurisdiction of the SDWA and, in fact, the key wells have not been identified to the public.

III. EPA NOT APPROPRIATE GOVERNMENT ENTITY FOR REGIONAL ANALYSIS OF NITRATES IN GROUNDWATER

EPA is not the appropriate governmental entity to prepare the Report or to conduct this study. The ARS has been conducting peer reviewed, scientific studies of agricultural impacts on nitrates in groundwater for years. ARS, as the United States Department of Agriculture's research arm, specializes in issues such as nitrates in groundwater and the impact of agriculture. The ARS was first authorized by Congress by the Organic Act of 1862 to be the premier agricultural science research agency in the United States, if not in the world. Similarly, EPA failed to consult with the NRCS which is the congressionally approved arm of the USDA to provide financial, technical and field office assistance to local communities. NRCS has conducted studies on the transport of nitrogen for years, yet they were not consulted. There seems to be no reason why the EPA Region 10 is conducting independent research that overlaps with ARS and/or NRCS activities.

EPA did consult with one ARS scientist in Kimberly, Idaho (Dr. Tarkalson) without revealing the enforcement purpose of the Report. We understand that this scientist has asked EPA to remove his name from the Report. EPA is, apparently, unaware that IDA, the Idaho Department of Environmental Quality ("IDEQ") and third parties are in the process of contracting with ARS in Kimberly, Idaho to conduct research on the impacts of dairy farms on nitrates in groundwater. (A copy of the proposal is **Attachment G**.) This proposed research will, among other things, study: (1) nutrient budgets for dairy farms; (2) nutrient budgets for crop fields; (3) use simulation models to estimate nitrogen losses from agricultural sources; and (4) monitor water quality in select springs and wells. This is the type of approach that should be taken in the lower Yakima Valley.

IV. THE REPORT IS AN ENFORCEMENT DOCUMENT

The Report seems tailored to bring an enforcement action under Section 1431 of the SDWA and, in fact, EPA is seeking a "voluntary" consent order under threat of unilateral action against individual Yakima area dairies. The Report has also triggered threats of citizen suits against individual dairies. This is hardly indicative of a scientific inquiry and seems to place the Report into the status of a litigation document and not a scientific inquiry. This, to us, is a clear indicator that the EPA document needs to be peer reviewed by the ARS, NRCS or independent third party scientists before it is released in final form.

EPA is seeking to use the Report as the basis for an enforcement order under the emergency provisions of Section 1431 of the Safe Drinking Water Act (42 U.S.C. § 300i(a)). The Section provides:

> PART D—EMERGENCY POWERS
>
> EMERGENCY POWERS
>
> SEC. 1431. (a) ... the Administrator, upon receipt of information that a contaminant which is present in or is likely to enter a public water system or an underground source of drinking water, or that there is a threatened or potential terrorist attack (or other intentional act designed to disrupt the provision of safe drinking water or to impact adversely the safety of drinking water supplied to communities and individuals), which may present an <u>imminent and substantial</u> endangerment to the health of persons, <u>and</u> that appropriate State and local authorities have not acted to protect the health of such persons, may take such actions as he may deem necessary in order to protect the health of such persons. To the extent he determines it to be practicable in light of such imminent endangerment, he <u>shall</u> consult with the State and local authorities in order to confirm the correctness of the information on which

> action proposed to be taken under this subsection is based and to ascertain the action which such authorities are or will be taking.

While Congress intended Section 1431 to confer broad powers to the EPA in emergency situations that pose a substantial and imminent threat to public health, "the EPA's emergency power is not without limitation." *W. R. Grace & Co. v. United States Environmental Protection Agency*, 261 F.3d 330, 339 (3rd Cir. 2001). For instance, the clear intent of Congress in enacting Section 1431 was "that this broad administrative authority not be used when the system of regulatory authorities provided elsewhere in the bill could be used adequately to protect the public health." *Id.* In other words, EPA could not invoke its emergency powers to take action under Section 1431 when, and if, local and state authorities had already identified and were acting to appropriately address the situation. Given this, EPA's proposed enforcement actions in the lower Yakima Valley do not meet SDWA statutory standards.

First, based on our investigation to date, it appears that there has been no consultation with the WSDA, the state agency responsible for enforcing State of Washington groundwater regulations at dairies pursuant to NMPs. Indeed, based on the comments recently submitted by the WSDA, it appears that WSDA takes issue with many aspects of the Report, including the accuracy of some of its fundamental conclusions and its overall purpose:

> After reviewing the report WSDA is concerned that the report underemphasizes the degree of uncertainty associated with the identification of specific sources. We are also concerned regarding the over emphasis of the data and the identification of potential sources beyond a reasonable area. . . . as an overall comment, the report appears to suffer from a redirection of the study purpose sometime after the initial phase. The study appeared to change from a data collection/research emphasis to a data collection effort with regulatory actions in mind. The result is a report that does not truly satisfy either goal.

(Attachment H at 2). Similarly, it appears that EPA has not consulted with local counties which are, as authorized by law, under the local GWMA programs, to protect groundwater from contamination.[3] Thus, a fundamental prerequisite to the invocation of Section 1431 has not been satisfied by EPA.

Second, even if EPA had formally "consulted" with state and local officials "in order to confirm the correctness of" its supposition that dairy farms pose a substantial threat to the public health and safety because of nitrates in groundwater – which it did not – EPA cannot demonstrate that state and local authorities are doing nothing to address and resolve the issue of nitrates in the groundwater of the lower Yakima Valley. Indeed, just the opposite is true. State

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[3] **Attachment I** is a list from the Groundwater Resource Library of Reports and Studies which clearly shows the long-term efforts of local governments to resolve groundwater issues.

and local officials have been working for years to address and resolve this issue, including the creation of a GWMA in the Yakima Valley, which is ready, willing and able to address such concerns. As noted in the WSDA's recent comments to EPA on the Report "[t]he report raises many questions that should provide the Groundwater Management Area Committee a technical starting point." (**Attachment H at 4**).

Third, the "imminent and substantial" threat to public health and safety required by Section 1431 is questionable for at least two reasons. First, EPA has refused to identify the contaminated wells so that alternative water sources, such as available reverse osmosis treatment systems, can be provided at no cost to affected families by local authorities. This indicates no serious or imminent threat to family health. And, second, EPA has taken two and a half years to analyze a well-known problem. Again, this fact alone indicates no imminent threat to public health.

Third, as described above, the EPA study is severely flawed and cannot, properly, form the basis for regulatory action under the SWDA. This fundamental fact is confirmed by the WSDA: "The degree of uncertainties raised in the report is limiting as to its use for regulatory purposes." (**Attachment H at 4**). Commenters believe that EPA efforts to avoid the independent peer review procedure set forth in the EPA's own *Peer Review Handbook* suggest knowledge by the agency of the Reports' technical shortcomings.

In light of the serious concerns raised with the accuracy of the Report's findings and conclusions, coupled with the EPA's inability to meet the statutory requirements necessary to assert regulatory power under Section 1431 of the SWDA, we recommend that EPA immediately withdraw the Report and enter into a careful, independent peer review procedure in consultation with the ARS, NRCS and independent scientists. The WSDA, IDA and IDEAL, among others, are ready to collaborate in this effort to bring about a result that is science-based and accurate.

Thank you for the opportunity to comment on the Report.

Very truly yours,

W. Hugh O'Riordan

Very truly yours,

Debora K. Kristensen

Attachments
1633398_1 [7045-11]

EPA RE PEER REVIEW

PEER REVIEW AND PEER INVOLVEMENT AT THE U.S. ENVIRONMENTAL PROTECTION AGENCY

This document establishes the policy of the United States Environmental Protection Agency (EPA) for peer review of scientifically and technically based work products, including economic and social science products, that are intended to inform Agency decisions. Peer review, a form of *peer involvement*, is one process through which EPA staff augment their capabilities by inviting independent subject-matter experts to provide objective evaluation of the work product.

PEER REVIEW

EPA strives to ensure that the scientific and technical bases of its decisions meet two important criteria: (1) they are based upon the best current knowledge from science, engineering, and other domains of technical expertise; and (2) they are credible. Peer review, a process based on the principles of obtaining the best technical and scientific expertise with appropriate independence, is central to sound science and helps the Agency meet these important criteria. Peer review occurs when scientifically and technically based work products are evaluated by relevant experts who were not involved in creating the product. Properly applied, peer review not only enriches the quality of work products but also adds a degree of credibility that cannot be achieved in any other way. Furthermore, peer review early in the development of work products in some cases may conserve future resources by steering the development along the most efficacious course.

Peer review generally takes one of two approaches:

- Internal, in which the reviewers are independent experts from inside EPA.
- External, in which the reviewers are independent experts from outside EPA.

POLICY STATEMENT

Peer review of all scientific and technical information that is intended to inform or support Agency decisions is encouraged and expected. Influential scientific information, including highly influential scientific assessments, should be peer reviewed in accordance with the Agency's Peer Review Handbook. All Agency managers are accountable for ensuring that Agency policy and guidance are appropriately applied in determining if their work products are influential or highly influential, and for deciding the nature, scope, and timing of their peer review. For highly influential scientific assessments, external peer review is the expected procedure. For influential scientific information intended to support important decisions, or for work products that have special importance in their own right, external peer review is the approach of choice. Peer review is not restricted to the nearly final version of work products; in fact, peer review at the planning stage can often be extremely beneficial.

LEGAL EFFECT

This policy statement does not establish or affect legal rights or obligations. Rather, it confirms the importance of peer review where appropriate, outlines relevant principles, and identifies factors Agency staff should consider in implementing the policy. On a continuing basis, Agency management is expected to evaluate the policy as well as the results of its application throughout the Agency and undertake revisions as necessary. Therefore, the policy does not stand alone; nor does it establish a binding norm that is finally determinative of the issues addressed.

IMPLEMENTATION

The Science Policy Council is responsible for overseeing Agency-wide implementation of this policy, including: promoting consistent interpretation; assessing Agency-wide progress; developing recommendations for revisions of the policy as necessary; and issuing the *Peer Review Handbook*, which provides additional information and procedures on implementing this policy. Assistant Administrators, Regional Administrators, and other senior managers remain ultimately responsible for ensuring the appropriate application of Agency policy and guidance in identifying work products subject to peer review, determining the type and timing of such review, documenting the process and outcome of each peer review, ensuring that the Science Inventory is kept current, and otherwise implementing the policy within their organizational units.

The policy is effective immediately.

APPROVED: _____ DATE: JAN 31 2006
STEPHEN L. JOHNSON, ADMINISTRATOR

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

JAN 31 2006

THE ADMINISTRATOR

MEMORANDUM

SUBJECT: Peer Review Program

TO: Assistant Administrators
General Counsel
Inspector General
Associate Administrators
Regional Administrators
Staff Office Directors

We have made tremendous strides in improving our peer review program at EPA since the Agency's Peer Review Policy was reaffirmed in 1994. Today I am updating the Peer Review Policy to emphasize the critical role that peer review plays in our efforts to ensure that EPA's decisions rest on sound, credible science and data (see attached policy statement).

Peer review at EPA takes several different forms, ranging from informal consultations with Agency colleagues who were not involved in developing the product to the formal, public processes of the Science Advisory Board (SAB) and the FIFRA Scientific Advisory Panel (SAP). In any form, peer review assists EPA's work by bringing independent expert experience and judgment to bear on issues before the Agency to the benefit of the final product.

In 1994 the Science Policy Council (SPC) and its Steering Committee were asked to undertake an initiative to ensure that EPA has a comprehensive Agency-wide program for implementing its Peer Review Policy. I commend the SPC for its diligence and success in meeting this objective. The SPC has made substantial improvements in the Peer Review Handbook, sponsored training of Agency managers and staff in peer review procedures, identified scientific and technical work products that merit peer review, and developed a publicly available data base of the peer review activities across the Agency. EPA has a strong and well-recognized peer review program as a direct result of these efforts.

In 2004 the Office of Management and Budget (OMB) issued a "Final Information Quality Bulletin for Peer Review" that contains provisions for peer review at all federal agencies. The OMB Bulletin applies to influential scientific information and highly influential scientific assessments. The SPC has updated the Agency's Peer Review Handbook, in part to incorporate the provisions of the OMB Bulletin, and to reflect the experience gained from implementing the program over the last decade.

I ask that you continue to implement fully the provisions of our Peer Review Policy, and I expect the Science Policy Council to continue its role in overseeing and strengthening EPA's peer review program. We must ensure that our decisions are based on the highest quality, peer-reviewed scientific and technical information.

Stephen L. Johnson

Attachment

cc: Science Policy Council
Science Policy Council Steering Committee

HDR ONE COMPANY | *Many Solutions*

November 23, 2012

Mr. Hugh O'Riordan
Givens Pursley, LLC
601 West Bannock Street
Boise, ID 83702

Subject: Preliminary Review of EPA-910-R-12-003

Dear Hugh:

At your request, I have conducted a preliminary review of the document, *Relation Between Nitrate in Water Wells and Potential Sources in the Lower Yakima Valley, Washington* (EPA-910-R-12-003). My preliminary comments are focused on nitrogen fate and transport beneath dairy lagoons as the document implies that nitrogen simply leaches from the lagoon to groundwater. This is an over-simplification, ignores nitrogen cycle dynamics, and, based on scientific research on the vadose zone beneath lagoon liners, is simply not accurate. It is my opinion that based on the information provided in the document it is not possible to distinguish between elevated nitrate in groundwater from lagoon seepage and background levels from nitrogen source applications to irrigated agricultural fields. My discussion focuses on research that has been conducted on soils (vadose zone) beneath lagoons that have demonstrated significant atmospheric loses of lagoon nitrogen through coupled nitrification-denitrification mechanisms.

Nitrate Fate and Transport beneath Dairy Lagoons

It is well documented that with the introduction of wastewater to a diary lagoon, the hydraulic conductivity of the earth lining will be reduce by at least an order of magnitude due to a process referred to as "seal formation", which is an organic seal at the bottom of the lagoon that results from a combination of biological, chemical, and physical processes (Tyner and Lee 2004; Tyner et al., 2006). Research shows that after a stable seal forms, which can be as soon as 10-days after wastewater additional to a lagoon, the seal properties, not the sediment or liner properties, are responsible for limiting infiltration (Cihan et al, 2006). Furthermore, studies have demonstrated that the soils beneath the seal (could be clay liner material or native material), becomes partially unsaturated. This soil zone beneath the seal has been shown to have favorable conditions for both nitrification and denitrification (Baram et al., 2012). This condition is termed *coupled nitrification-denitrification* (CND).

For an illustration of the nitrogen cycle please referred to Figure 2 in the document *Relation Between Nitrate in Water Wells and Potential Sources in the Lower Yakima Valley, Washington.* This figure provides a general overview of the nitrogen cycle, except that it leaves out ammonia volatilization, which can be an important nitrogen removal process from lagoon, manure piles, soil systems.

HDR Engineering, Inc.

River Quarry at Parkcenter
412 E Parkcenter Blvd
Suite 100
Boise, ID 83706-6659

Phone: (208) 387-7000
Fax: (208) 387-7100
www.hdrinc.com

For a wastewater lagoon system, the main forms of nitrogen (N) are organic-N, ammonium, and ammonia. Organic nitrogen can be microbially converted to ammonium and ammonia through *mineralization*. Microbial oxidation of ammonium and ammonia to nitrate (*nitrification*) requires the presence of molecular oxygen, which is almost always limiting in manure wastewater.

The overall process is as follows:

$$RNH_2 + H_2 \longrightarrow NH_4^+ + \text{energy}$$

$$2NH_4^+ + 3O_2 \longrightarrow 2NO_2^- + 2H_2O + 4H^+ + \text{energy}$$

$$2NO_2^- + O_2 \longrightarrow 2NO_3^- + \text{energy}$$

where R represents an organic compound.

Nitrification only occurs in oxidizing environments. Factors that influence this microbial reaction include temperature, moisture content, bacterial population, and pH. Nitrate, as an anion, is repelled by clays and is susceptible to leaching. Ammonium is a cation and is adsorbed by clay mineral and negatively charged organic matter. Ammonia is a gas and can exist in solution and as soil vapor, is in equilibrium with ammonium, and its concentration (ratio between ammonia and ammonium) is dependent upon solution pH.

Under low oxygen conditions (anoxic), nitrate can serve as an electron donor for microbial decomposition of organic matter. This reaction is expressed:

$$5C + 4NO_3^- + 2H_2O \longrightarrow 2N_2 + 4HCO_3 + CO_2$$

N_2 is a gas and is lost to the atmosphere. Nitrification does not occur (or minimally occurs) in dairy wastewater because there is not sufficient oxygen.

Baram et al. (2012) found that seal formation at the bottom of a dairy lagoon lead to the development of unsaturated conditions (70 percent saturation) in the underlying vadose zone. The authors describe a desiccation-crack network developing in the unsaturated material allowing air penetration and formation of aerobic conditions with anaerobic niches where CND occurred. Several findings were reported by these researchers:

- The formation of desiccant cracks beneath the seal zone enhanced vadose zone aeration and organic nitrogen and ammonium were completely oxidized to nitrate in the upper 2 feet of the soil beneath the lagoon.
- Ammonium oxidation was coupled with nitrate reduction, removing 90 percent of the leached N, with up to 100 percent N removal under regions of higher water contents.
- While nitrogen loss was near 100 percent complete for soils beneath the lagoon, seepage of wastewater near the lagoon margins (the outer banks of a lagoon that

might get infrequent wastewater overflow) was favorable for nitrate formation and leaching. However, the "margin" areas have infrequent flooding (therefore I would expect the quantity of nitrate leached could be potentially low and could be controlled through best management practices).

In summary, scientific data supports the occurrence of CND zones beneath lagoons that can result in significant removal (loss) of nitrogen. Therefore, caution is warranted when making correlations between the presence of a dairy lagoon and downgradient water quality, especially when the lagoons occur in areas of manure and fertilizer applications to irrigated agricultural lands.

If you have questions, please contact me at (208) 387-7033.

Very truly yours,

HDR ENGINEERING

Michael R. Murray, Ph.D.
Soil Scientist

References:

Baram, S., S. Arnon, Z. Ronen, D. Kurtzman, and O. Dahan. Infiltration mechanism controls nitrification and denitrification processes under dairy waste lagoons. J. Environ. Qual. 41: 1623-1632.

Cihan, A., J. S. Tyner, and W.C. Wright. Seal formation beneath animal waste holding ponds. Trans ASAE 49:1539-1544.

Tyner, J.S. and J. Lee. 2004. Influence of seal and liner hydraulic properties on the seepage rate form animal waste holding ponds and lagoons. Trans. ASAE 47:1739-1745.

Tyner, J.S. W.C., Wright, and J. Lee. 2006. Lagoon sealing and filter cakes. Trans. ASAE. 49:527-521.

Journal of Environmental Quality TECHNICAL REPORTS

VADOSE ZONE PROCESSES AND CHEMICAL TRANSPORT

Infiltration Mechanism Controls Nitrification and Denitrification Processes under Dairy Waste Lagoon

S. Baram,* S. Arnon, Z. Ronen, D. Kurtzman, and O. Dahan

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*Corresponding author (baramsha@bgu.ac.il).
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5585 Guilford Rd., Madison, WI 53711 USA

S. Baram, S. Arnon, Z. Ronen, and O. Dahan, Dep. of Environmental Hydrology & Microbiology, Zuckerberg Institute for Water Research, Blaustein Institutes for Desert Research, Ben-Gurion Univ. of the Negev, Sede Boqer Campus, Israel 84990; D. Kurtzman, Institute of Soil, Water and Environmental Sciences, Agricultural Research Organization, The Volcani Center, Bet Dagan 50250, Israel. Assigned to Associate Editor Jim Miller.

Abbreviations: BLS, below land surface; CAFO, concentrated animal feeding operation; CEC, cation exchange capacity; CND, coupled nitrification–denitrification; FTDR, flexible time domain reflectometry; USS, ultraviolet spectrophotometric screening; VMS, vadose zone monitoring system; VSP, vadose zone sampling port.

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Olympus Technical Services, Inc.

November 27, 2012

Hugh O'Riordan
Givens Pursley, LLP
601 West Bannock Street
Boise, ID 83702

Via: e-mail - who@givenspursley.com

Re: EPA-910R-12-003 Report Comments
Olympus Project A7194-1

Dear Hugh:

Olympus Technical Services, Inc. (Olympus) has been retained by the Washington Dairy Commission and Givens Pursley, LLP (on behalf of the Idaho Dairymen's Association) to review and provide comments regarding the United States Environmental Protection Agency's (EPA) September 2011 *Relation Between Nitrate in Water Wells and Potential Sources in the Lower Yakima Valley, Washington* (EPA-910R-12-003, Report). The Report presents the results of EPA's sampling of drinking water wells, sampling of potential sources of nitrate that could impact groundwater quality in the Lower Yakima Valley, and EPA's attempt to evaluate direct (nitrate analyses) and indirect methods that could be used to link sources of nitrate impact to groundwater.

The Reports states, in part:

> *"...the primary purpose of this study was to collect data to investigate the contribution of various sources from nearby land uses to the high nitrate levels in groundwater and residential drinking water wells. To accomplish this, EPA sampled and analyzed sources of nitrate (dairies, irrigated croplands, and residential septic systems) and private residential drinking water wells for a variety of chemicals to evaluate whether chemicals, including nitrate, could be used to link the nitrate contamination in groundwater and drinking water wells to the sources."*

While the Report focused its study on two specific areas in the Yakima Valley, the Haak Dairy; and the George DeRuyter & Son Dairy, the D and A Dairy, the Cow Palace 1 and 2, and the Liberty and Bosma Dairy (collectively labeled the Dairy Cluster), there is concern within the dairy industry that the EPA could extrapolate the Report's results for use elsewhere. Additionally, we understand that the EPA has used the Report as a basis for threatening to issue an Administrative Order under the Safe Drinking Water Act to the subject dairies.

Figures 1 and 2 show the locations of the Haak Dairy and the Dairy Cluster, and the nitrate concentration in wells the EPA used to evaluate groundwater upgradient and downgradient of the Haak Dairy and the Dairy Cluster. Olympus used figures shown in the Report to better locate the wells shown on Figures 1 and 2.

Olympus' review identified the following concerns with the Report.

- The EPA's definition of upgradient wells in evaluating background conditions is flawed. For both the Haak Dairy and the Dairy Cluster, the wells defined as upgradient of the subject dairies are located upgradient and cross-gradient of the subject areas. Additionally the Report uses regional groundwater flow data to define upgradient and downgradient (of the dairies) wells; the Report did not consider localized groundwater flow directions and gradients, which may be different from regional flows and gradient. The Report acknowledges such, and states, in part:

  > *"Selection of upgradient and downgradient wells for this study was based on groundwater flow direction and gradient data compiled by USGS. According to USGS, the generalized direction of groundwater flow in the study area in both the shallow sedimentary hydrogeologic unit and the deeper basalts is toward the Yakima River (USGS 2009). Flow directions can vary locally due to canal/lateral leakage, irrigation, drains, streams, pumpage, variations in recharge, spatially varying hydraulic characteristics, and topographic setting (USGS 2009). Groundwater flow directions were determined by USGS by measuring depth to water and reflecting these localized influences at the time it was measured. ..."*

  The use of well WW-1 as a Haak Dairy upgradient well fails to consider its location, immediately downgradient of an irrigation canal. Leakage from this canal could result in considerable dilution of groundwater, near this well, with surface water. The potential dilution could result in inaccurately reporting background conditions. There is considerable acreage (at least one square mile) of agricultural land north and east of this well's location. The Report does not address the potential use of nitrate-based chemical fertilizer(s) on this land. Groundwater below these fields may contain nitrate at elevated concentrations, but irrigation canal dilution may mask its presence (as a background condition).

  Additionally, the EPA failed to identify the uncertainty of defining groundwater flow in fractured basalt. Groundwater flow in fractured flow typically flows in a network of fractures (or micro conduits) and may not follow regional flowpaths.

- The EPA's use of existing study area wells, rather than monitoring wells, adds a high degree of uncertainty in its conclusions. The lack of well completion details make it difficult to evaluate the validity of samples collected from the subject wells. Improperly constructed, leaking, or absent well seals could result in localized (around the well intake) groundwater impact from surface leakage down well casings. While the use of existing wells may be acceptable for screening purposes, the EPA could have conducted a more accurate study had it used monitoring wells to better define the nature and extent of nitrates in groundwater.

  Additionally, the Report-referenced downgradient wells for the Dairy Cluster are not adequately located to differentiate potential source areas within the Dairy Cluster area. As discussed above for the Haak Dairy, the accuracy of the Report-defined upgradient well location and groundwater flow direction is also a concern at the Dairy Cluster.

- The EPA reportedly collected soil samples from dairy application fields at a depth of one inch below the ground surface. Collecting samples at a one-inch depth is not adequate for characterization of soil nitrogen. For proper characterization of soil nitrogen, the EPA should have collected soil samples from depths of at least one foot (at a minimum) below the ground surface. To better determine if nitrogen was leaching below the root zone, the EPA should have collected samples to at least the bottom of root zone.

- Laboratories used by the EPA used internally developed methods for some procedures. While these methods may provide acceptable results, the EPA typically requires the use methods which either the EPA or other entities have published guidance.

- The Report's Quality Control/Quality Assurance data validation identified a high number of analytical problems that resulted in qualified and rejected data. While the data used may have been judged valid, the number of qualified and rejected data may be indicative of a poorly designed study.

- As quoted above, the EPA intended to use the Report study to evaluate whether chemicals, including nitrate, could be used to link nitrate contamination in groundwater to sources of nitrate. The EPA's use of assessment methods documented in the Report to issue an Administrative Order of Consent may be an overuse of the Report's conclusions.

On behalf of the Idaho Dairymen's Association, Olympus performed a review of nitrate in groundwater in Jerome and Gooding Counties, Idaho. The subject area is located in the Snake River Plain, on the north side of the Snake River in the Thousand Springs area. The hydrogeologic conditions in this area consist of an overburden of alluvial sediments underlain by basalt flows, with groundwater present in the shallow sediments and in fractures within the basalt flows, similar to the Yakima Valley. We conducted the review in response to Idaho Department of Environmental Quality (IDEQ) concerns regarding dairy operations and IDEQ-reported increasing concentrations of nitrates in groundwater in the subject area. The subject area contains a significant number of dairy operations.

Olympus compiled data for nitrate concentrations in groundwater from the IDEQ, the Idaho Department of Water Resources, and the Idaho State Department of Agriculture into a graphic information system (GIS) database. We used the GIS database to prepare figures showing nitrate concentrations in groundwater on aerial photographs of the subject area. The figures show that in the subject area nitrate concentrations in groundwater generally do not exceed EPA Maximum Concentration Limits for drinking water. The figures did identify nitrate "hot spots", generally in areas near the rim of the Snake River Canyon. The Idaho Dairymen's Association presented the data to the IDEQ Board at its June 29, 2011 meeting.

The source of the "hot spots" is presently being addressed by a study to be conducted by the United States Department of Agriculture, Agricultural Research Service's Northwest Irrigation and Soils Research Lab in Kimberly, Idaho. The study is being conducted with the cooperative support from the Idaho Dairymen's Association, the IDEQ, and other partner organizations. Attachment 1 includes a copy of the printout of the PowerPoint slides presented to the IDEQ Board that proposed the study.

Olympus performed the services reported in this document in a manner consistent with generally accepted principles and practices for the nature of the work completed in the same or similar localities, at the time the work was performed. No other warranty, expressed or implied, is made. Opinions contained in this document apply to conditions existing when the services were performed. All conclusions and recommendations are based on readily available and reasonably ascertainable information on site conditions at the time of the work and for the laws in effect at that time. We are not responsible for any changes in environmental standards, practices, or regulations subsequent to performance of services. This report is not meant to represent a legal opinion. We do not warrant the accuracy of information supplied by others, nor the use of segregated portions of this report.

Thank you for providing Olympus with the opportunity to work with Givens Pursley, the Idaho Dairymans Association, and the Washington Dairy Commission on this project. Please contact me with any questions or comments. I can be reached by telephone at (208) 562-5500 or via e-mail at MBacke@OlyTech.com.

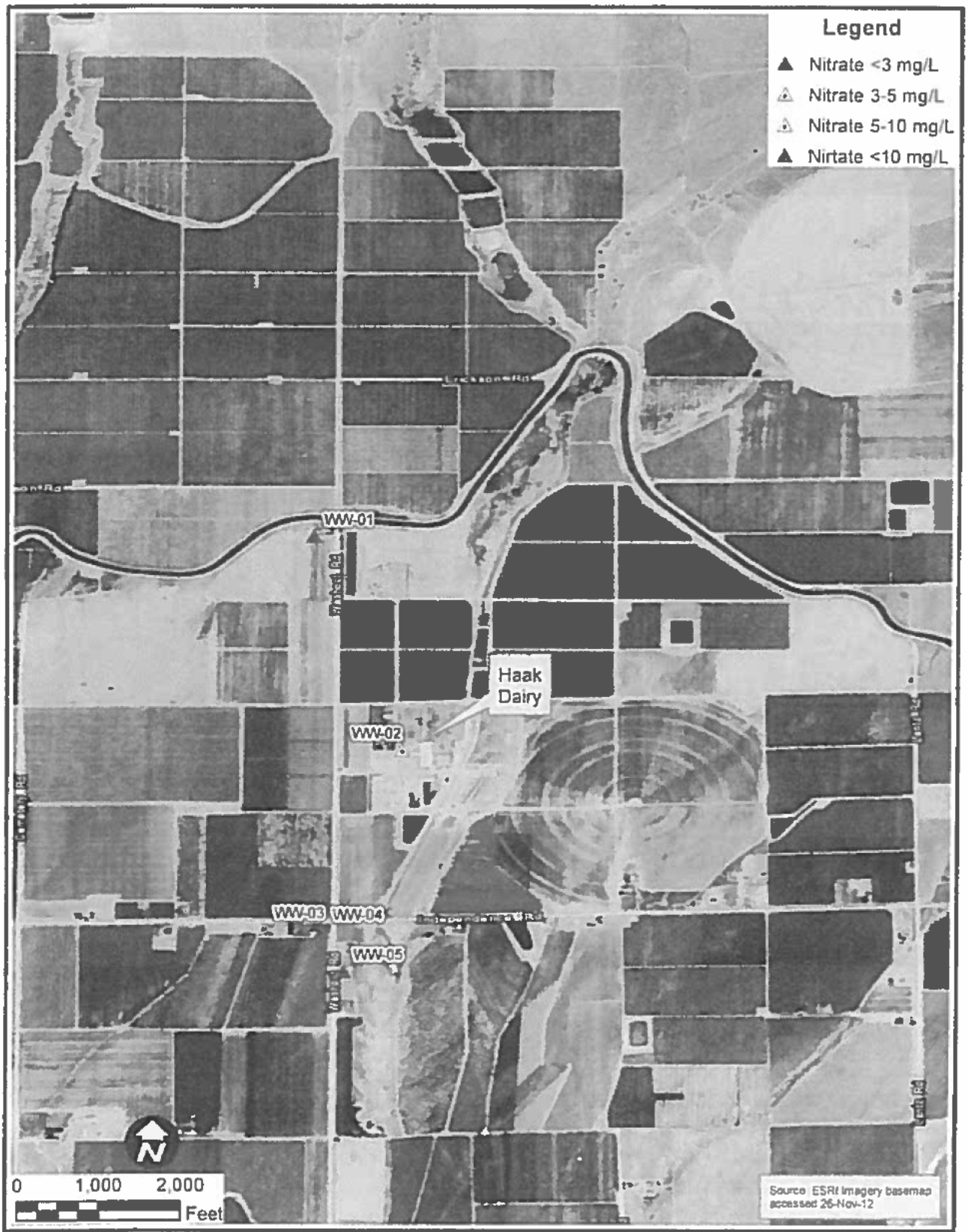
Sincerely,

Olympus Technical Services, Inc.

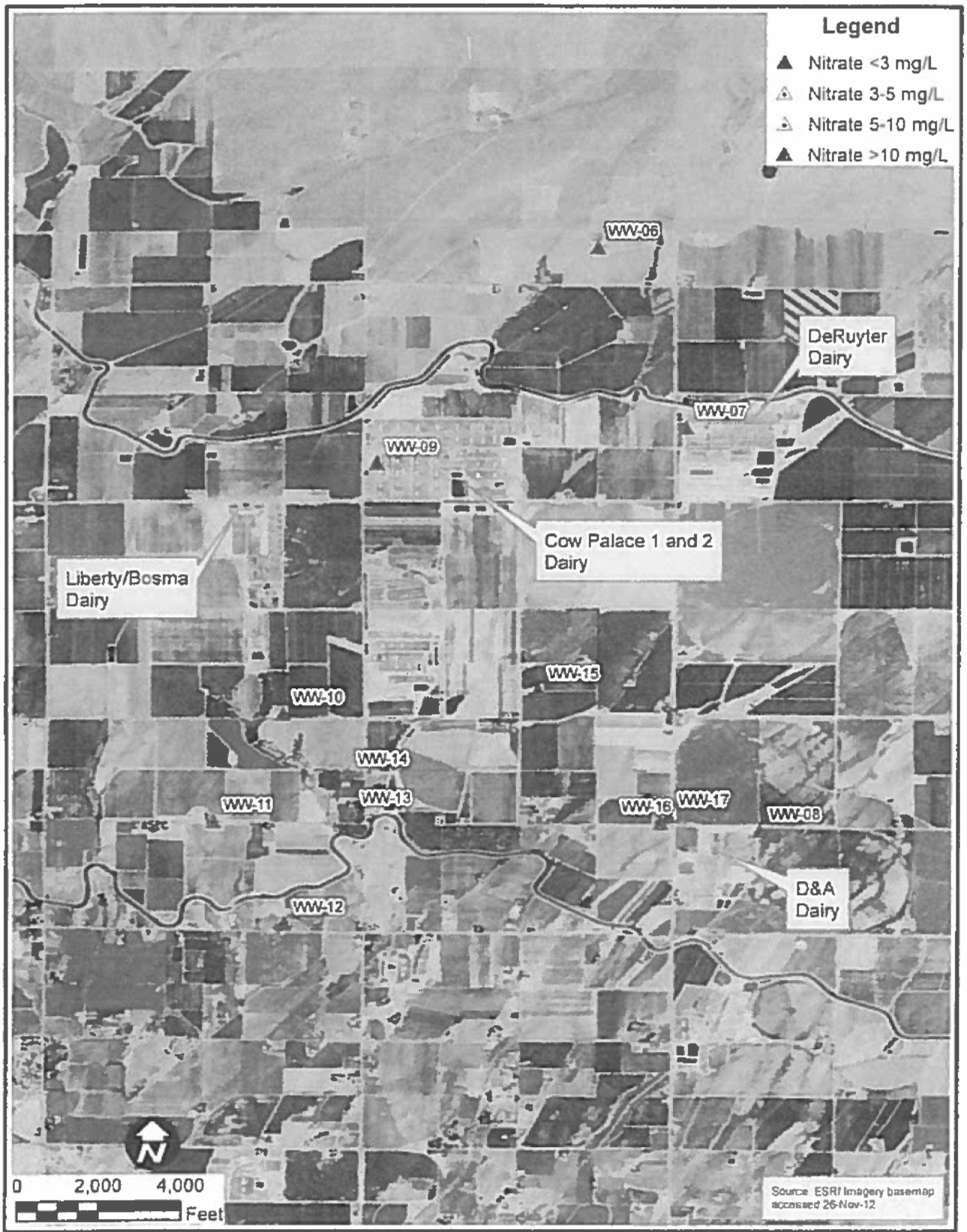
Michael Backe, P.G.

Attachments: Figures 1 and 2
Attachment 1

cc: Bob Naerebout, Idaho Dairymen's Association (via: e-mail)
Jay Gordon, Washington Dairy Commission (via: e-mail)



Olympus Technical Services, Inc.	NITRATE IN GROUNDWATER CONCENTRATIONS Haak Dairy	FIGURE 1



Olympus Technical Services, Inc.

NITRATE IN GROUNDWATER CONCENTRATIONS
Dairy Cluster

FIGURE 2

ATTACHMENT 1

JUNE 10, 2011 POWERPOINT PRESENTATION

Idaho Dairymen's Association

June 29, 2011

Department of Environmental Quality Board Meeting

Air

Soil

Water

Independent Dairy Environmental Action League

IDEAL, LLC.

Proposed Groundwater Nitrate Study

Conducted by USDA Agricultural Research Service

Magic Valley Area

PURPOSE

www.idahoconservation.org

Idaho Conservation League
PO Box 844, Boise, ID 83701
208.345.6933

Regional Administrator Dennis McLerran
Environmental Protection Agency, Region 10
1200 Sixth Avenue, Suite 900
Seattle, WA 98101

February 22, 2011

Re: ICL Petition to Review Certain Projects within the Eastern Snake River Plain Sole Source Aquifer

Dear Regional Administrator,

The Idaho Conservation League submits this petition under the Safe Drinking Water Act and its implementing regulations to review specific projects within the Eastern Snake River Plain Sole Source Aquifer ("ESRP aquifer") that receive federal financial assistance. *See* 42 U.S.C. § 300h-3(c); 40 C.F.R. §149.104.

Since 1973, the Idaho Conservation League has been Idaho's voice for clean water, clean air and wilderness—values that are the foundation for Idaho's extraordinary quality of life. The Idaho Conservation League works to protect these values through public education, outreach, advocacy and policy development. As Idaho's largest state-based conservation organization, we represent over 20,000 supporters, many of whom have a deep personal interest in protecting Idaho's groundwater quality.

The Idaho Conservation League has a long history of working to protect Idaho's groundwater quality. Idaho is an arid state and over 95% of Idahoans get their drinking water from underground sources - mostly from private wells. Although groundwater plays such a significant role in the lives of Idahoans, groundwater quality is not well protected in Idaho and is therefore vulnerable to largescale contamination.

The Idaho Conservation League is particularly concerned with nutrient loading over the Eastern Snake River Plain Sole Source Aquifer. Accordingly, the Idaho Conservation League hereby petitions the Regional Administrator to review nutrient management-related projects slated for federal financial assistance in 2011, 2012, and 2013 within Cassia, Twin Falls, Jerome and Gooding Counties. 40 C.F.R. § 149.104. Specifically, we petition the Administrator to review the projects described below to determine if these projects "may contaminate [the Eastern River Plain Sole Source Aquifer] through a

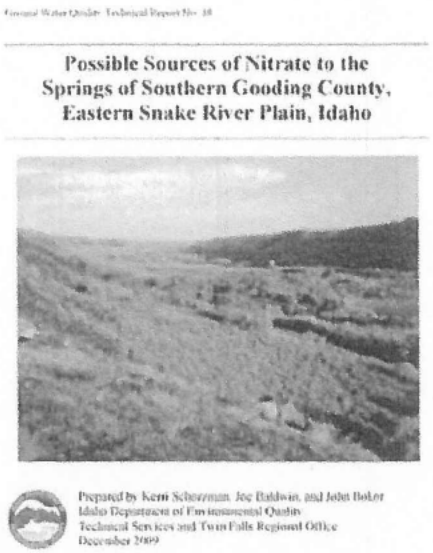
ICL Petition to Review Projects in the ESRP aquifer 1 of 9

ICL petitions EPA to review nutrient management-related projects slated for federal financial assistance
ICL Sites DEQ study

"According to Idaho's Department of Environmental Quality, there are 32 regions in Idaho were nitrate contamination in groundwater is a concern, and almost half of these areas are within the ESRP aquifer flow region.1 The ESRP has a long history of agricultural production and has experienced a dramatic increase in animal feeding operations over the last 15 years. As a result, communities within this area experience nitrate contamination issues within in the sole source aquifer as well as private and public drinking water wells."

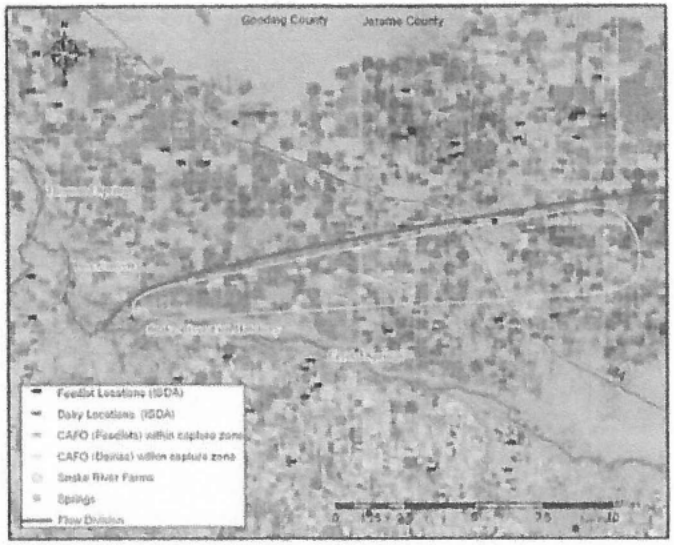
CONCERNS

DEQ-published studies may lead to the perception that the Dairy Industry is the source of Nitrate affecting groundwater quality



Possible Sources of Nitrate to the Springs of Southern Gooding County, Eastern Snake River Plain, Idaho

Prepared by Kerri Scherzman, Joe Baldwin, and John Baker
Idaho Department of Environmental Quality
Technical Services and Twin Falls Regional Office
December 2009



CONCERNS

Geographic Information System Data Sources

- Idaho Department of Environmental Quality

  (Snake River Rim Sampling 2010)

- Idaho State Department of Agriculture

  (Annual Dairy Sampling 2010)

- Idaho Department of Water Resources

  (Annual Water Quality Sampling 2010)

Legend

IDEQ 2010 Sampling
- Nitrate <3 mg/L
- Nitrate 3-5 mg/L
- Nitrate 5-10 mg/L
- Nitrate >10 mg/L

IDWR 2010 Sampling
- Nitrate <3 mg/L
- Nitrate 3-5 mg/L
- Nitrate 5-10 mg/L
- Nitrate >10 mg/L

ISDA 2010 Sampling
- Nitrate <3 mg/L
- Nitrate 3-5 mg/L
- Nitrate 5-10 mg/L
- Nitrate >10 mg/L

0 50 100 150 Miles

GROUNDWATER NITRATE CONCENTRATIONS (Milligrams per Liter)
Southern Idaho

GROUNDWATER NITRATE CONCENTRATIONS (Milligrams per Liter)
Greater Magic Valley Area, Idaho

Legend

IDEQ 2010 Sampling

- Nitrate <3 mg/L
- Nitrate 3-5 mg/L
- Nitrate 5-10 mg/L
- Nitrate >10 mg/L

IDWR 2010 Sampling

- Nitrate <3 mg/L
- Nitrate 3-5 mg/L
- Nitrate 5-10 mg/L
- Nitrate >10 mg/L

ISDA 2010 Sampling

- Nitrate <3 mg/L
- Nitrate 3-5 mg/L
- Nitrate 5-10 mg/L
- Nitrate >10 mg/L

0 1 2 3 4 5 Miles

GROUNDWATER NITRATE CONCENTRATIONS (Milligrams per Liter)
Thousand Springs Area, Idaho

Identify Potential Nitrogen Sources

- USDA Agricultural Research Service Northwest Irrigation and Soils Research Laboratory - Kimberly, Idaho

Lower Yakima Valley Nitrate Study
Tarkalson, David to: R10YVNitrate 11/16/2012 10:11 AM
Cc: "Bjorneberg, Dave"

From: "Tarkalson, David" <David.Tarkalson@ARS.USDA.GOV>
To: R10YVNitrate@EPA
Cc: "Bjorneberg, Dave" <Dave.Bjorneberg@ARS.USDA.GOV>

I would request that my name and affiliation be removed as a reviewer from the final report. The final version of the report contains information that I did not review in the original draft. A couple examples include: 1. the inclusion of quantities of lagoon liquid leakage and 2. differing interpretation of pharmaceutical data.

Thank you

David Tarkalson
Soil Scientist/Systems Agronomist
USDA-ARS NW Irrigation and Soils Research Lab
3793 N. 3600 E.
Kimberly, ID 83341-5076
tel: 208-423-6503
email: david.tarkalson@ars.usda.gov
home page: http://www.ars.usda.gov/pandp/people/people.htm?personid=40544

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STATE OF WASHINGTON
DEPARTMENT OF ECOLOGY
PO Box 47600 • Olympia, WA 98504-7600 • 360-407-6000
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December 20, 2012

Thomas Eaton, Director
EPA Region 10, Washington Operations Office
300 Desmond Dr SE Suite 102
Lacey, WA 98503

Re: EPA report on Yakima nitrates in groundwater

Dear Director Eaton:

The Washington State Department of Ecology has reviewed the recent report from the U.S. Environmental Protection Agency (EPA) entitled "*Relation Between Nitrate in Water Wells and Potential Sources in the Lower Yakima Valley, Washington, EPA-910-R-12-003* " released in September, 2012. We offer the following general comments.

The report continues progress in delineating the extent of groundwater contamination in the Lower Yakima Valley. Identifying sources of nitrate is a complex and difficult task due to the numerous sources and transformations in the environment. All of these factors make it extremely difficult to pinpoint the source of nitrate contamination.

EPA used a variety of indicator parameters and physical characteristics to quantify loading and identify potential sources of nitrate in the area. The use of indicator parameters to identify sources of contamination in groundwater is a standard practice that is well documented in the literature. While many of these indicator parameters by themselves may not be able to definitively identify a specific source, taken together they provide a clearer picture. This study succeeded in identifying likely sources by using a combination of hydrogeologic information, nitrate concentrations, ionic signatures, and the presence of veterinarian pharmaceuticals. Veterinarian pharmaceuticals are an indicator of an animal source, and several of the pharmaceuticals tested are specific to dairy cows. The presence of veterinarian pharmaceuticals in groundwater combined with other factors discussed above indicates that dairies sampled in this study are discharging nitrate to groundwater and contributing to contamination of the resource.

The lack of well construction information on many of the wells is unfortunate. In order to make more definitive conclusions on the sources of nitrate contamination, well depth and the screened interval are essential information. It is our hope that EPA will conduct Phase 4 of their planned study, as originally proposed in their quality assurance project plan, and install monitoring wells to refine the conclusions drawn in this study. These additional steps should reduce uncertainty regarding the findings and more clearly identify sources of nitrate contamination in Lower Yakima Valley groundwater. Ecology would be happy to provide technical review of the Phase 4 monitoring plan.

In summary, EPA's report indicates that dairies are discharging nitrate to groundwater. In order to better define the extent of this discharge, Ecology recommends that EPA conduct Phase 4 of their planned study.

Sincerely,

Robert Duff
Manager, Environmental Assessment Program

cc: Kelly Susewind, Manager, Ecology Water Quality Program

ENVIRONMENTAL HEARINGS
Pollution Control Hearings Board
Shorelines Hearings Board

Telephone: (360) 664-9160
FAX: (360) 586-2253
Email: eluho@eluho.wa.gov
Website: www.eluho.wa.gov

STATE OF WASHINGTON

ENVIRONMENTAL AND LAND USE HEARINGS OFFICE

Mailing Address: PO Box 40903, Olympia, WA 98504-0903 •
Physical Address: 1111 Israel Rd SW, Suite 301, Tumwater, WA 98501 •

October 25, 2018

Sent by Email and US Mail

Connie Sue Martin
Virginia Nicholson
Schwabe Williamson & Wyatt
1420 5th Ave, Suite 3400
Seattle WA 98101

Andrea K Rodgers
Western Environmental Law Center
3026 NW Esplanade
Seattle WA 98117

Andrew Hawley
Western Environmental Law Center
1402 3rd Ave. Ste 1022
Seattle WA 98101

Elizabeth E Howard
Schwabe Williamson & Wyatt
1211 SW Fifth Avenue, Suite 1900
Portland OR 97204

Phyllis J Barney
Assistant Attorney General
Ecology Division
PO Box 40117
Olympia WA 98504-0117

Charles M Tebbutt
Daniel C Snyder
Sarah A Matsumoto
Law Offices of Charles M Tebbutt
941 Lawrence Street
Eugene OR 97401

Katelyn Kinn
Puget Soundkeeper Alliance
130 Nickerson St Ste 107
Seattle WA 98109

Re: **PCHB NO. 17-016c**
WASHINGTON STATE DAIRY FEDERATION, the WASHINGTON FARM BUREAU, PUGET SOUNDKEEPER ALLIANCE, COMMUNITY ASSOCIATION FOR RESTORATION OF THE ENVIRONMENT (CARE), FRIENDS OF TOPPENISH CREEK, SIERRA CLUB, WATERKEEPER ALLIANCE, CENTER FOR FOOD SAFETY, and RE SOURCES FOR SUSTAINABLE COMMUNITIES v. STATE OF WASHINGTON, DEPARTMENT OF ECOLOGY

Dear Parties:

Enclosed is the Pollution Control Hearings Board's Findings of Fact, Conclusions of Law and Order in this matter.

This is a FINAL ORDER for purposes of appeal to Superior Court within 30 days. *See* Administrative Procedures Act (RCW 34.05.542) and RCW 43.21B.180.

You are being given the following notice as required by RCW 34.05.461(3): Any party may file a petition for reconsideration with the Board. A petition for reconsideration must be filed with the Board and served on all parties within ten days of mailing of the final decision. WAC 371-08-550.

If you have any questions, please feel free to contact the staff at the Environmental and Land Use Hearings Office at 360-664-9160.

Sincerely,

Heather C. Francks

Heather C. Francks, Presiding
Administrative Appeals Judge

HCF/le/P17-016c
Encl.

CERTIFICATION

On this day, I forwarded a true and accurate copy of the documents to which this certificate is affixed via United States Postal Service postage prepaid or via delivery through State Consolidated Mail Services to the attorneys of record herein.

I certify under penalty of perjury under the laws of the state of Washington that the foregoing is true and correct.

DATED 10/25/18, at Tumwater, WA.

Morgan Pure

POLLUTION CONTROL HEARINGS BOARD
STATE OF WASHINGTON

WASHINGTON STATE DAIRY FEDERATION, the WASHINGTON FARM BUREAU, PUGET SOUNDKEEPER ALLIANCE, COMMUNITY ASSOCIATION FOR RESTORATION OF THE ENVIRONMENT (CARE), FRIENDS OF TOPPENISH CREEK, SIERRA CLUB, WATERKEEPER ALLIANCE, CENTER FOR FOOD SAFETY, and RE SOURCES FOR SUSTAINABLE COMMUNITIES Appellants, v. STATE OF WASHINGTON, DEPARTMENT OF ECOLOGY, Respondent.	PCHB No. 17-016c FINDINGS OF FACT, CONCLUSIONS OF LAW AND ORDER

I. INTRODUCTION

This appeal involves the Concentrated Animal Feeding Operation (CAFO), National Pollutant Discharge Elimination System (NPDES) and State Waste Discharge General Permit (Combined Permit), and the CAFO State Waste Discharge General Permit (State Only Permit) issued by the Department of Ecology (Ecology) on January 18, 2017, (collectively, the Permits). The Pollution Control Hearings Board (Board) received, and consolidated for hearing, two separate appeals of the Permits. Appellants Puget Soundkeeper Alliance, Community Association for the Restoration of the Environment (CARE), Friends of Toppenish Creek, Sierra

Club, Waterkeeper Alliance, Center for Food Safety and Resources for Sustainable Communities (collectively PSA) were represented by Attorneys Charles M. Tebbutt, Daniel C. Snyder and Sarah A. Matsumoto of Law Offices of Charles M. Tebbutt, PC, Andrea K. Rogers and Andrew M. Hawley of Western Environmental Law Center, and Katelyn J. Kinn of Puget Soundkeeper Alliance. Appellants Washington State Dairy Federation and the Washington Farm Bureau (collectively Dairy Federation) were represented by Attorneys Elizabeth E. Howard and Virginia R. Nicholson of Schwabe Williamson and Wyatt, PC. Assistant Attorney General Phyllis J. Barney represented Respondent Ecology.

The Board conducted a hearing May 21-25, 2018, and June 5-7, 2018, in the Board's office in Tumwater, Washington. The Board was comprised of Chair Joan M. Marchioro and Members Kay M. Brown and Neil L. Wise. Administrative Appeals Judge Heather C. Francks presided for the Board. Andrea Clevenger and Laura Stewart of Capitol Pacific Reporting Inc. of Olympia, Washington provided court reporting services.

The issues identified in the Amended Consolidation and Prehearing Order, which proceeded to hearing were as follows:[1]

2. Whether the permits violate the federal Clean Water Act, 33 U.S.C. § 1251 et seq., Washington water pollution control laws (including but not limited to RCW 90.48 and 90.64), and implementing regulations by failing to require adequate surface water monitoring by permittees.

3. Whether the permits fail to control and monitor discharges to groundwater in violation of the federal Clean Water Act and Washington water pollution control laws (including but not limited to RCW 90.48 and 90.64), and implementing regulations.

[1] Prior to the hearing Ecology and PSA moved for partial summary judgment. The Board dismissed Issues 1, 11, 12, 13, 17 and 18. Order on Motion for Partial Summary Judgment, May 10, 2018. PSA withdrew Issue 15. The remaining twelve issues proceeded to hearing.

4. Whether the permits' soil monitoring requirements and standards are invalid under the federal Clean Water Act and Washington water pollution control laws (including but not limited to RCW 90.48 and 90.64), and implementing regulations.

5. Are the soil sampling requirements of S4.I contrary to best available science and research, unattainable, impracticable, and, thus, arbitrary, capricious and unlawful?

6. Does the failure to account for variances in location, crops, weather, and other conditions in the Fall Soil Test Nitrate Ranges as reflected in Table 3 of the CAFO Permits render the standard unattainable, unsupported by agronomic science and research, arbitrary, capricious and unlawful?

7. Whether the permits fail to require permittees to install and implement all known, available, and reasonable methods of preventing, controlling and treating pollutants prior to discharge as required under the Washington water pollution control laws with respect to: (a) composting; (b) land application of manure; (c) manure storage; (d) animal pens and corrals?

8. Whether the permits fail to establish technology-based effluent limitations and standards as required under the federal Clean Water Act with respect to: (a) composting; (b) land application of manure; (c) manure storage; (d) animal pens and corrals?

9. Whether Ecology illegally relied upon an adaptive management approach that authorizes residual nitrate and phosphorus levels in the soil that are known to result in discharges to waters of the state and fails to sanction permittees for violating the terms of the permit by applying manure in excess of agronomic rates for nitrogen and phosphorus.

10. Whether the permits authorize discharges of pollutants to surface and groundwaters in the state of Washington in violation the federal Clean Water Act, Washington water pollution control laws (including but not limited to RCW 90.48, RCW 90.64) and applicable implementing regulations.

14. Is the permits' failure to establish numeric water quality based effluent limitations or standards for nitrate and phosphorus invalid?

16. Whether the permits violate the federal Clean Water Act, Washington water pollution control laws (including but not limited to RCW 90.48, RCW 90.64) and applicable implementing regulations for Nutrient Management Plans ("NMP").

19. Are the requirements related to lagoons in Conditions S4.B and S7.B inconsistent with NRCS standards, impracticable, lacking a basis in applicable research and science, presented only in the final version and, as such, preventing public comment, and unlawful and wholly disproportionate to the pollution reduction benefits?

Twice during the hearing, PSA made a motion pursuant to Civil Rule 50(a) for judgment as a matter of law on the issue of whether Ecology had determined all known, available, and reasonable methods of preventing, controlling and treating pollutants for existing manure lagoons pursuant to WAC 173-200-100(3). Each time, after deliberation, the Board denied PSA's motion. Based on its full consideration of the eight days of sworn testimony of witnesses, numerous exhibits admitted into the record, argument from counsel representing each of the parties, and supplemental authorities filed by Ecology and PSA, the Board enters the following:

II. SUMMARY OF THE DECISION

The Board concludes that the Permits, taken as a whole, comply with the federal Clean Water Act (CWA) and Washington state water pollution control laws, and are protective of water quality. PSA did not present sufficient evidence to convince the Board that surface water monitoring and groundwater monitoring should be required in the Permits.

The Board affirms the provisions of the Permits that provide for soil sampling and adaptive management of land application fields depending upon nitrate levels revealed by the sampling. The Board concludes that the emergency land application allowed by the Permits avoids a worse alternative outcome from the overtopping of a lagoon and is sufficiently limited by the remaining Permit terms.

The Board concludes that implementing a lagoon assessment program using the National Resource Conservation Service (NRCS) guidelines is appropriate and reasonable with the caveat that measurement of the two foot vertical separation from the water table should also follow the NRCS guidelines and begin from the top of the liner inside the lagoon. The Board remands the Permits to Ecology to revise Conditions S4 and S7 consistent with this decision.

III. FINDINGS OF FACT

1.

CAFOs are agricultural facilities where animals are confined and fed for a total of 45 days or more during a 12 month period in an area that does not support growth of vegetation. 40 C.F.R. §122.23(b). CAFO operations, including their land application areas, animal confinement areas and other production related areas that discharge to surface water are point sources of pollution under the CWA, and therefore subject to regulation under the NPDES permit regulations. 40 C.F.R. §122.23(a). The state Water Pollution Control Act (WPCA), ch. 90.48 RCW, regulates CAFO discharges to both surface and ground waters.

2.

"Potential sources of pollution from CAFOs include manure and litter generated by livestock as well as process wastewater generated from animal product production by the CAFO." Ex. R-3 at 10. Many CAFOs land apply manure, litter, and process wastewater to agricultural fields as crop fertilizer. Manure, litter, and process wastewater generated by CAFOs include nitrogen and phosphorous. In appropriate quantities, nitrogen and phosphorus are beneficial to the growth of crops. However, if discharged to water in elevated concentrations,

nitrogen and phosphorus can have significant consequences to human health and the environment. Jennings Testimony; Ex. R-3 at 13-16.

3.

Nitrate, a form of nitrogen found in manure and also produced from the organic breakdown of manure that is land applied, is of particular concern. When consumed by humans, nitrate is converted to nitrites within the body. Nitrites bind with blood hemoglobin and prevent it from carrying oxygen. Nitrates themselves are not directly toxic to most people and are consumed daily, mostly in vegetables. Nitrates do pose health risks to vulnerable populations. Noted vulnerable populations include pregnant or nursing women and infants under six months old. High nitrate intake in these populations is more likely to cause Methemoglobinemia, or "blue-baby syndrome". Ex. R-3 at 14. Washington's groundwater quality standard for nitrate (as nitrogen) is 10 mg/L. WAC 173-200-040(3).

NITRATE RISKS

4.

Increased levels of nitrates and phosphorus in surface water bodies can lead to algae and macrophyte growth. Decomposition of those aquatic plants reduces dissolved oxygen in the water body. This process can cause harm or death to aquatic organisms, including fish, and lead to the loss of the water body through eutrophication. Ex. R-3 at 14, 16.

5.

PSA contends that the Permits do not protect water quality. Although PSA presented evidence of water quality issues related to dairies around the state, the evidence focused primarily on the Yakima Valley and the Sumas-Blaine aquifer in Whatcom County.

6.

PSA presented the testimony of Helen Reddout and David Erickson concerning nitrate contamination of the groundwater aquifer in the Lower Yakima Valley. Ms. Reddout, the President of CARE and a longtime resident of the Lower Yakima Valley, testified regarding her experience with nitrate contaminated groundwater and litigation initiated by CARE against local dairies to address that contamination. Ms. Reddout testified that water from her groundwater well contains nitrates in excess of ten parts per million and she has installed a reverse osmosis system in her kitchen sink to treat her water. Ms. Reddout testified that the litigation brought by CARE against local dairies, referred to as the "dairy cluster"[2] resulted in consent decrees establishing a clean drinking water program for local residents and the requirement that the cluster dairies study groundwater contamination in the Lower Yakima Valley aquifer. Reddout Testimony.

7.

Mr. Erickson, a Principal Hydrogeologist with Water & Environment Technologies, PC, testified regarding groundwater monitoring in the Lower Yakima Valley conducted under the consent decrees from the CARE litigation. As part of a quality assurance plan in the dairy cluster consent decrees, Mr. Erickson and his team performed monitoring of groundwater wells and collected soil samples in and near the dairy cluster. They collected soil samples (10 feet in depth) from 10-12 of the land application fields, as well as the dairies' pens and corrals. Under

[2] The dairies that comprise the dairy cluster are the Cow Palace Dairy, Bosma Dairy, DeRuyter Dairy, Liberty Dairy and D&A Dairy. Erickson Testimony.

the compost area they took samples (20 feet in depth). Mr. Erickson testified that his assessment of nitrogen loading sources prepared for the Cow Palace Dairy litigation showed that the dairy cluster contributed 99.9% more loading than any of the other sources in that area. Erickson Testimony. Mr. Erickson participated in the installation of double-lined lagoons with leak detection systems at the Cow Palace Dairy. Soil samples collected from one of the lagoons showed high organic nitrogen and very high ammonia concentrations at approximately 12-15 feet below the bottom of the lagoon. *Id.*

8.

The dairy cluster dairies were not permittees under the previous CAFO general discharge permit, were not following their nutrient budgets, and were not properly maintaining their lagoons. Erickson Testimony. The dairy cluster operations had high levels of land application of manure. Harrison Testimony.

9.

The northwestern portion of Whatcom County is an area of high-intensity agricultural production. The main agricultural businesses in Whatcom County are dairy farming and berry production. Whatcom County has the second highest number of dairy cows in the state. Ex. R-15 at xxi.

10.

Groundwater supply in this area is derived almost exclusively from the Sumas-Blaine aquifer, an unconfined aquifer occurring in the unconsolidated glacial deposits that blanket the region. "Over the last 30 years, this area has had one of the highest percentages of water supply

wells in the state failing to meet the drinking water standard for nitrate (29% of wells tested had concentrations greater than 10 mg/L as nitrogen). Groundwater is the only source of drinking water for residents living in the northern, rural part of the county. As of 2010, the population living over the Sumas –Blaine aquifer not on city water systems was 18,000 to 27,000 people." Ex. R-15 at xiii.

11.

Factors that make groundwater in Whatcom County particularly sensitive to water quality impacts from intensive agricultural production include:

- Shallow depth from land surface to groundwater.
- Relatively permeable character of the aquifer deposits.
- Long periods of heavy rainfall each year.

Combined with the high mobility of nitrate in the environment, these characteristics enable rapid transport of nitrate from surface soils to the water table. *Id.*

12.

Sue Joerger, Field Director for PSA, testified that she had observed and photographed dairy practices in Whatcom County that she believed were negatively impacting water quality in the area. Joerger Testimony; Exs. A-33, A-43, A-47 and A-50.

13.

Ecology and the Washington State Department of Agriculture (WSDA) jointly administer programs related to protecting water quality from livestock activities under the authority of the state WPCA, ch. 90.48 RCW, the Dairy Nutrient Management Act, ch. 90.64 RCW, and under

an inter-agency Memorandum of Understanding (MOU) that identifies the responsibilities of each agency.

14.

Under the MOU, Ecology is responsible for administering, developing and processing CAFO discharge permits; WSDA inspects unpermitted dairies and permitted CAFOs and provides technical support to the operators of CAFOs. Harrison Testimony. Dairies are inspected approximately every 18 months. *Id.* The previous CAFO general discharge permit developed by Ecology was issued in 2006 (2006 CAFO Permit). Ex. R-18.

Permit Development and Relevant Provisions

15.

Pursuant to ch. 173-226 WAC, Ecology elected to develop general discharge permits for the CAFO industry. General permits are designed to meet the applicable requirements of the CWA (33 U.S.C. § 1251) and WPCA (ch. 90.48 RCW). When developing general permit conditions, Ecology shall apply and ensure compliance with "all known, available, and reasonable methods of prevention, treatment, and control" (AKART). WAC 173-226-070(1).

16.

The Permits were developed by an internal Ecology permit team using the 2006 CAFO Permit as a starting point. Jennings Testimony; Ex. R-18. Ecology's lead permit writer was Jonathan Jennings. *Id.* Melanie Redding, a Licensed Hydrogeologist with Ecology, performed a literature review of peer reviewed journals to research the science for the Permits. Redding Testimony; Ex. R-4 (Manure and Groundwater Quality Literature Review). In August 2015,

Ecology issued a preliminary draft permit and solicited comments from the public. Jennings Testimony; Ex. A-11. In 2016, Ecology issued formal draft permits and solicited public comments, receiving approximately 4,600 comments. Jennings Testimony. Both the Dairy Federation and PSA submitted comments on the formal drafts. Exs. R-16, A-8, A-69. The United States Environmental Protection Agency reviewed the Permits. Jennings Testimony.

17.

On January 18, 2017, Ecology issued the final Permits regulating discharges from CAFOs. Exs. R-1, R-2. The Permits took effect on March 3, 2017, and will expire in five years on March 2, 2022. Exs. R-1 at 1, R-2 at 1.

18.

For purposes of determining which operations must obtain permit coverage, the Permits separate CAFOs into two groups. CAFOs that stable or confine more than a defined number of animals and discharge to surface or ground water are required to obtain Permit coverage. Small CAFOs, which stable or confine a smaller number of animals and have been designated by Ecology as significant contributors of pollutants to surface or groundwater, must also obtain coverage under the appropriate Permit. Exs. R-1 at 6, R-2 at 6.

19.

The threshold number of animals for a CAFO or small CAFO varies depending upon the type of animals stabled or confined. Exs. R-1 at 6 (Table 2), R-2 at 6 (Table 2). For example, for mature dairy cows, a CAFO contains 200 cattle or more. *Id.* A small CAFO of swine contains less than 750 swine of 55 pounds or more. *Id.* Most, but not all, CAFOs in Washington

are dairies. There are 377 dairies in Washington. Wood Testimony. In 2018, between 200 and 250 dairies had more than 200 mature dairy cows and therefore satisfied the size criteria of a CAFO. Jennings Testimony. At the time of the Board hearing there were 23 CAFOs covered under the Permits. Jennings Testimony; McGowan Testimony. These included four non-dairy beef operations, one heifer raising operation and one poultry operation. In addition, approximately 10-12 CAFOs were in the permit application process. Jennings Testimony.

20.

General discharge permit conditions are intended to prevent permittees from exceeding discharge limits and violating water quality standards. WAC 173-226-070. The Permits accomplish this through the use of technology-based requirements for preventing and controlling discharges. The Permits' technology-based requirements include the implementation of AKART and best management practices (BMPs). Jennings Testimony; Ex. R-3 at 39. Under the Permits, discharges from a CAFO must not cause or contribute to an exceedance of the state surface or ground water quality standards. Ex. R-3 at 39-40.

21.

Ecology chose to issue two permits because some CAFOs may have discharges to both surface and ground water, while other CAFOs may only discharge to groundwater. Jennings Testimony. The Combined Permit regulates discharges from CAFOs to both surface and ground water under the NPDES program and the WPCA. Ex. R-1. The State Only Permit regulates discharges to groundwater under the WPCA. Ex. R-2.

22.

The Combined Permit is a statewide general permit for handling manure, litter, process wastewater and organic by-products resulting from operating a CAFO. Ex. R-1 at 6. The Combined Permit conditionally authorizes the discharge of pollutants to both surface and ground water from the production area[3] and land application fields.[4] Ex. R-1 at 7.

23.

Discharges conditionally authorized by the Combined Permit must not cause or contribute to a violation of water quality standards. Ex. R-1 at 12 (Condition S3). With one exception, the Combined Permit prohibits all discharges to surface water. A discharge to surface water is permitted in the event of an overflow from the production area from a waste storage facility designed, maintained and operated to contain runoff and precipitation from a 25-year, 24-hour rainfall event. Such discharge is only allowed if the production area is otherwise in compliance with the Combined Permit. Ex. R-1 at 12 (Condition S3.C.1).

24.

Discharges from land application areas are prohibited unless the discharge meets the definition of agricultural stormwater. Ex. R-1 at 13 (Condition S3.D). A precipitation related discharge is agricultural stormwater only where the discharge was due to precipitation, was not

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[3] The Permits define "production area" as "[t]he locations making up a CAFO facility that are used for animal confinement, manure, litter, feed, and process wastewater storage, product processing facilities (e.g. milking parlor, egg washing, feed mixing), and other areas used for the storage, handling, treatment, processing, or movement of raw materials, products, or wastes. This includes manure stockpiled on fields." Exs. R-1 at 49, R-2 at 45.

[4] The Permits define "land application fields" as "[a]n area of land, including management units, under the control of the CAFO (excluding the production area) to which manure, litter, process wastewater, or other organic by-products are added as a fertilizer or soil amendment." Exs. R-1 at 48, R-2 at 43.

from the production area, was not caused by human activities, and the permittee is in compliance with all permit conditions and has land applied nutrients in accordance with site specific field nutrient budget and other relevant permit conditions. Ex. R-1 at 45. Congress explicitly exempted agricultural stormwater from the definition of point source. *See* 33 U.S.C. §1362 (14). Therefore, a discharge meeting the definition of agricultural stormwater is not regulated by the Combined Permit.

25.

The State Only Permit is a statewide general permit for handling manure, litter, process wastewater, and other organic by-products from the operation of a CAFO. Ex. R-2 at 6. The State Only Permit conditionally authorizes the discharge of pollutants to groundwater from the production area and land application fields, provided that the permittee is operating in compliance with the Permit. Ex. R-2 at 7 (Condition S1.A). The State Only Permit does not authorize any discharges to surface water from the CAFO. Ex. R-2 at 12 (Condition S4).

Nutrient Management Plan/Manure Pollution Prevention Plan

26.

Federal water quality regulations contain permit requirements for specified categories of NPDES Permits. 40 C.F.R. § 122.42. The regulations identify specific requirements that must be included in NPDES permits for CAFOs (federal CAFO Rule). 40 C.F.R. § 122.42(e). Federal regulations require, as part of the NPDES permit application process for CAFOs, that permit applicants must develop and submit a Nutrient Management Plan (NMP) for Ecology's

review, public comment, and approval. The NMP is required to contain nine elements identified in 40 C.F.R. § 122.42(e)(1). Ex. R-3 at 40-41.

27.

Under the 2006 CAFO Permit, Ecology required applicants to submit a NMP with their Notice of Intent requesting permit coverage. Once Ecology approved the NMP, permit coverage was granted. Jennings Testimony. Ecology found that the iterative process for review and approval of NMPs was time consuming and inefficient. To address this issue, through Conditions S4 and S5, Ecology incorporated the federal regulatory requirements for NMPs into the Permits as enforceable effluent limits. Jennings Testimony; Exs. R-1 at 13-33, R-2 at 12-30. As described in the Permits' Fact Sheet, Ecology incorporated the federal CAFO Rule requirements, including the nine elements of 40 C.F.R. § 122.42(e)(1), into the Permits as enforceable conditions. Jennings Testimony; Ex. R-3 at 41-43.

28.

Under the current Permits, once coverage has been obtained, permittees must prepare Manure Pollution Prevention Plans (MPPP). MPPPs are site specific plans documenting how the Permits' effluent limitations, Conditions S4.A-Q, are being met at a permitted facility. Ex. R-3 at 59. MPPPs are expected to be updated as the facility makes changes. Jennings Testimony; Exs. R-1 at 28, R-2 at 25 (Condition S4.Q).

29.

Permit Condition S4.J.1 requires each permittee to submit yearly field nutrient budgets for each field they own, operate, lease or otherwise control based on spring soil and manure

sample nutrient analysis, planned crops and other factors. Exs. R-1 at 20, R-2 at 19. The nutrient budgets include measurement of nitrogen and phosphorus levels. *Id.* This information will be used by Ecology for future permit development. Ex. R-3 at 54.

Lagoon Permeability and Assessment

30.

One source of nitrate in groundwater is seepage from CAFO manure lagoons. A lagoon is a "structure designed for storage of liquid manure, process wastewater, other organic by-products, or other liquids or slurries." Ex. R-1 at 48. Earthen lagoons are composed of compacted earth and clay. Jennings Testimony. Some lagoons have synthetic liners and leak detection systems. Erickson Testimony. "All lagoons have a seepage rate based upon the structure's permeability. This rate is how much liquid and dissolved materials escape out of containment during a period of time per unit area." Ex. R-3 at 32. The seepage rate is dependent upon the engineering properties of the materials used to construct the lagoon as well as lagoon maintenance activities and the presence of preferential flow paths. *Id.*, at 32-33. Lagoon construction is variable, which leads to variable seepage rates and variable impacts to groundwater. *Id.*, at 68.

31.

Limiting seepage from a storage lagoon has two primary goals. The first is to prevent any virus or bacteria from migrating out of the storage lagoon to an aquifer or water source. The second is to prevent the conversion of ammonia to nitrate in the vadose zone. Exs. I-6 at 41, R-6 at 10D-2. The vadose zone is the area between the ground surface and the water table which is

in a predominantly unsaturated condition. Lindsey Testimony. In a saturated condition, all the spaces between the soil particles are filled with water. *Id.* In an unsaturated state, there is also air in the spaces. *Id.* In Eastern Washington, the vadose zone will be comprised of sands and gravels and intermixed fine grain deposits. *Id.* Western Washington has silty, sandy, gravelly and clay vadose zones. *Id.*

32.

Seepage from a lagoon is calculated using Darcy's Law. Ex. R-3 at 33.[5] Assuming steady state conditions, the amount of seepage will vary based upon head pressure (depth of liquid, which varies) soils, compaction and permeability. Ex. R-3 at 33-34. Conditions that allow greater seepage will increase the risk of discharge. Ex. R-3 at 34.

33.

NRCS is an agency of the United States Department of Agriculture responsible for providing technical assistance to farmers. One aspect of the technical assistance provided by NRCS is lagoon construction. Ex. I-6 at 35. NRCS's most current guidance on the subject is included in Part 651 of the agency's Agricultural Waste Management Field Handbook as "Appendix 10D Design and Construction Guidelines for Waste Impoundments Lined with Clay or Amendment-treated Soils" (Appendix 10D). Exs. R-6, I-6 at 29-30. Based on its review of NRCS's guidance and calculations using Darcy's Law, Ecology concluded that manure lagoons built consistent with the standards of Appendix 10D would still have a seepage rate. Ecology

[5] The Darcy's law equation in Ecology's implementation guidance is incorrect because the units used do not match. Lindsey Testimony; Ex. R-5 at 27. If the equation is not corrected, seepage from a lagoon would be overestimated. Lindsey Testimony. Ecology agreed that there is a typographical error in the equation. Redding Testimony.

further concluded that "[t]his seepage rate along with other risk factors indicate that those covered under either of the permits have a discharge to groundwater based on a preponderance of the evidence." Ex. R-3 at 68; Redding Testimony.

34.

Ecology also determined that available information did not support a conclusion that seepage from all lagoons was resulting in the contamination of groundwater. Ex. R-3 at 68. To address this information gap, Permit Condition S7 requires permittees to conduct an assessment of their existing manure lagoons using Washington NRCS Engineering Technical Note 23 (NRCS Assessment Procedure for Existing Waste Storage Ponds). Exs. R-1 at 35-36, R-2 at 32-33.

35.

Among other requirements, permittees are to determine the vertical separation between the bottom of the lagoon liner and the water table.

> If the lagoon assessment determines that there less than two feet of vertical separation from the bottom of the lagoon liner (as measured from the outside of the liner) and the water table (including seasonally high water tables), the Permittee has six months from completion of the lagoon assessment to develop a plan to address this deficiency.

Exs. R-1 at 36, R-2 at 33. The plan shall include a description of how the permittee will ensure the two foot vertical separation, timelines for work required to address the deficiency, and a groundwater monitoring plan. *Id.*

36.

The Permits also include requirements for permeability and proximity to the water table for new and modified lagoons. Condition S4.B establishes permeability and vertical separation requirements for lagoons and other liquid storage structures built, expanded, or undergoing a major refurbishment after issuance of the Permits. Such structures "must achieve a permeability of $1x10^{-6}$ cm/s without consideration for manure sealing and there must be a minimum of two feet of vertical separation between the bottom of the lagoon (measured from outside of the earthen liner) and the water table, including the seasonal high water table." Exs. R-1 at 13, R-2 at 13. With manure sealing, lagoons constructed according to this condition will have a permeability of $1x10^{-7}$ cm/s. Redding Testimony. Vertical separation is defined as the distance between the bottom of the lagoon liner and the top of the water table, at its highest level during the season. Ex. R-4 at 70. Maintaining a two foot aerobic unsaturated environment beneath the lagoon is important to the attenuation and destruction (inactivation) of bacteria and viruses. Redding Testimony; R-4 at 70.

37.

PSA argued that the Permits' standards for lagoon liners was insufficient to protect groundwater and was not AKART. Mr. Erickson opined that earthen lagoons with a permeability of $1x10^{-7}$ cm/s are designed to leak. Because earthen lagoons, even those built to NRCS's standards, will leak, there is no need to perform the assessment required by the Permits. According to Mr. Erickson, the only way to protect groundwater is to install a liner that is designed not to leak. Mr. Erickson testified regarding his experience installing synthetic double-

liners in lagoons at Cow Palace Dairy. The cost of the liners, including installation, was $400,000 to $600,000. Mr. Erickson testified that, in his opinion, AKART for lagoons is a synthetic double liner or a two-foot clay liner with a geosynthetic top. Erickson Testimony.

38.

The Dairy Federation argued that the Permits' lagoon conditions conflict with NRCS's construction standards. The Dairy Federation contended that the point from which to measure the two foot vertical separation from the water table is contrary to NRCS's Conservation Practice Standard (CPS) 313, pursuant to which many dairies have constructed their lagoons. Harrison Testimony. According to the Dairy Federation, under NRCS CPS 313 the appropriate point from which to measure the two foot vertical separation is from inside the lagoon liner. Exs. I-6 at 67, R-9 at 313-CPS-3, I-13 at 313-4. Dr. Harrison testified that, contrary to Ecology's assertion, the additional amount of separation provided by measuring from the outside of the liner is not needed for the attenuation of pathogens or viruses. Harrison Testimony.

39.

The Dairy Federation contended that by including the measurement location only in the final Permits, Ecology failed to provide the public the opportunity to review the condition and submit comments. Dan Wood, Executive Director of the Washington State Dairy Federation, testified that he participated in several meetings with Ecology during development of the Permits. Requiring the measurement of vertical separation from the water table to be from the bottom of the liner was never discussed. Wood Testimony.

40.

The Dairy Federation also asserted that the lagoon conditions are contrary to AKART because they require actions that are not economically reasonable. For purposes of the lagoon assessment, measuring the depth to the water table from the outside of the liner could require modification of lagoons that had been constructed consistent with NRCS's standards. Wood Testimony. The cost of lagoon repair or replacement could be several hundred thousand dollars. Ex. I-10 at 10. The costs associated with installation of synthetic liners as recommended by Mr. Erickson were far in excess of what dairy farmers could afford. Neibergs Testimony; Ex. I-10. Many farmers obtain funding from NRCS to make improvements to their facilities. Haggith Testimony. NRCS imposes a lifetime cap of $450,000 on its lending to farmers. *Id.* Dr. Neibergs testified that dairies currently face financial pressures and this additional cost could cause dairies to close down. Neibergs Testimony; Ex. I-10.

41.

Appendix C to NRCS Technical Note 716 illustrates the two different locations for measurements labeled point 1 and 2. Ex. R-7 at Appendix C. Pursuant to CPS 313, NRCS measures from the bottom of the lagoon (inside the lagoon above the liner) or the impoundment bottom at point 1. Exs. I-6 at 67, R-9 at 313-CPS-3, I-13 at 313-4. Ecology measures from point 2, which is below the outside of the liner. Ex. R-7 at Appendix C; Redding Testimony. The

Dairy Federation presented excerpts of the deposition of William Reck, NRCS's National Engineer. Mr. Reck discussed the figure in Appendix C.[6]

42.

Ecology stated that Ecology added the parenthetical "(as measured from the outside of the liner)" to Conditions S4.B and S7.B of the final version of the Permits in response to public comment on the draft Permits. Moore Testimony. Ecology contended that the parenthetical simply explains Ecology's longstanding position that measurement starts below the lagoon. Jennings Testimony; Moore Testimony.

43.

Ecology argues that the Permits do not require retrofit if a lagoon is found not to have two foot vertical separation from the water table. Under Condition S7.B, the Permits require permittees to develop a plan to address any deficiencies identified in their lagoon assessment. Exs. R-1 at 36, R-2 at 33. Mr. Jennings testified that, given the potential cost associated with addressing noted deficiencies, the Permits provide permittees with a reasonable amount of time to return a lagoon to proper condition.

44.

Ecology determined that AKART for new and modified lagoons was the construction of a liner with a permeability of $1x10^{-6}$ cm/s without consideration for manure sealing. Jennings

[6] Because Mr. Reck's testimony was provided through deposition transcript, the Board lacked the ability to fully explore the science behind the two different measurement locations. Because Mr. Reck's deposition was scheduled to occur after the discovery cutoff and shortly before hearing, PSA declined to participate in the deposition. As a result, the Board did not have the benefit of PSA's potential cross examination in the transcript.

Testimony; Redding Testimony. Because of the lack of information regarding existing lagoons, the Permits do not provide a specific AKART requirement. Rather, the lagoon assessment required by Condition S7.B will provide information on the range of impacts from existing lagoons and assist Ecology in future permit development. Jennings Testimony; Ex. R-3 at 68-69.

Soil sampling

45.

Under Condition S4.I, permittees are required to take spring and fall soil samples from all land application fields and have those samples analyzed for nutrient content. Exs. R-1 at 18-19, R-2 at 17-18. The spring soil sample is required to be taken prior to starting land application after T-SUM 200.[7] Exs. R-1 at 18, R-2 at 17. The spring soil sample provides information regarding the amount of plant-available nitrogen present in the soil at the start of the growing season. Jennings Testimony; Ex. R-4 at 40. The fall soil sample provides information or a "report card" on the effectiveness of the manure management practices of the previous season. *Id.*

46.

Under Condition S4.I.2, "[f]all soil samples must be taken by October 1st, after harvest of annual crops, and before heavy rain begins in the fall or before any irrigation water is used on the field after harvest." Exs. R-1 at 18, R-2 at 18. The timing of the fall sample, October 1st, was taken from a publication discussing the "use of post-harvest soil nitrate testing as a tool for

[7] T-SUM 200 is defined as "[a] sum of the daily heat units above zero for each day since January 1 until 200 heat units are reached. Heat units are the average of each day's low and high temperatures in degrees Celsius." Exs. R-1 at 50, R-2 at 45.

assessment of nitrogen (N) management in manured cropping systems west of the Cascade Mountains in Oregon, Washington, and south coastal British Columbia." Ex. R-12 at 1, 2.[8]

47.

The Permits dictate the depth at which a soil sample is to be taken depending on the amount of annual precipitation. Exs. R-1 at 19, R-2 at 18. In areas with less than 25 inches of annual precipitation, the sample must be taken from the 0-12 inch depth and 13-24 inch depth. In those areas with greater than 25 inches of annual precipitation, a composite sample must be taken from the 0-12 inch depth. *Id.* If a fall soil sample is taken after October 1st, the sample is required to be taken at a greater depth in order to account for nutrient leaching. *Id.*

48.

The Dairy Federation contended that the Permits' soil sampling requirements are inconsistent with AKART. David Haggith, Agricultural Consultant with N3 Consulting, testified that the spring soil samples are not supported by available science, are time-consuming and costly, and provide little useful information. Haggith Testimony; Ex. I-4. Mr. Haggith testified that the October 1st fall sample deadline is unattainable because not all crop harvests are completed by that date. *Id.* Mr. Haggith also opposed the use of T-SUM 200, testifying that it is not the best tool for minimizing the risk of early season land application. *Id.*

[8] D.M. Sullivan & C.G. Cogger, *Post-Harvest Soil Nitrate Testing for Manured Cropping Systems West of the Cascades,* Oregon State University Extension Services, May 2003.

49.

PSA argued that the depth of all soil samples should be greater. PSA asserted that samples should be taken up to three feet deep in order to evaluate whether nitrate or phosphorus has travelled below the crop root zone. Keeney Testimony. PSA also argued that the Permits should monitor phosphorus in addition to nitrate. *Id.*

50.

Under Conditions S5.B and S5.C, permittees are required to report both nitrogen and phosphorus levels in nutrient sources and post-harvest soil samples. Exs. R-1 at 31-33; R-2 at 29-31 (Conditions S5.B. C, and S6.B).

51.

T-SUM 200 is a tool used to determine when to start land application. Jennings Testimony. It is a measure of the sum of daily heat units above zero for each day since January 1 until 200 heat units are reached. Exs. R-1 at 50, R-2 at 45. Heat units are the average of each day's low and high temperatures in degrees Celsius. *Id.* When the total reaches 200 degrees Celsius, the plants will begin growing and require nutrients. Ex. R-4 at 55. Ecology added T-SUM 200 to the Permits based on comments received during permit development. Jennings Testimony. The draft permit used the term "spring green up" as the trigger for the spring soil sample. In its comments on the draft permits, the Dairy Federation stated that it did not understand the term "spring green up" and requested that Ecology replace spring green up with T-SUM 200 as it is a standard timing guideline. Wood Testimony; Ex. R-16 at 14.

52.

The Dairy Federation now contends that instead of T-SUM 200, the Permits should use Application Risk Management (ARM), a process that is currently being used in several Western Washington counties and recommended by WSDA. Haggith Testimony; Ex. I-4 at 17-18. ARM, which was designed for British Columbia and Western Washington, looks at a wider set of site specific characteristics such as weather forecast, soil conditions, and proximity to surface and ground water. *Id.* Citing results of recent water quality sampling from Whatcom County where ARM is being used, Mr. Haggith testified that that in his opinion ARM is more protective of surface and ground water than T-SUM 200. *Id.;* Ex. I-46.

Adaptive Management

53.

Under Condition S4.J.1, permittees are required to develop a yearly field-specific nutrient budget for each land application field they control and at which they plan to apply manure, litter, process wastewater, or other organic by-products. Exs. R-1 at 20, R-2 at 19. "The yearly nutrient budget specifies the maximum amount of nutrients that may be land applied to the field during the year unless "the permittee is double cropping, or growing winter cover or perennial crops. *Id.* "Yearly nutrient budgets must be developed before the first land application of the calendar year." *Id.* The yearly nutrient budget will depend upon the results of the fall soil samples. The yearly nutrient budget considers what nutrients are present in the field and the nutrients the proposed crop will require during the growing season. Jennings Testimony.

54.

Condition S4.K requires permittees to use adaptive management techniques on land application fields in order to prevent the build-up of excess nutrients. Exs. R-1 at 22-24, R-2 at 22-23. Table 3 in Condition S4.K establishes Field Risk Levels (Low, Medium, High, Very High) based upon the nitrate levels reported from the fall soil tests. For each risk level, Table 3 specifies "Required Actions" and "Required Actions Based Upon Trends". The goal of adaptive management is "to reduce land application field fall soil nitrate concentrations to a Risk Level of Medium or less." *Id.*

55.

PSA contended that the quantities of nitrate expressed in Table 3 as action triggers are too high and create a risk of nitrate leaching into groundwater. Keeney Testimony. Dr. Keeney testified that some residual nitrate in soil is acceptable for crop production but higher levels pose a problem. In his opinion, land application of manure should be discontinued on fields with nitrate levels in the High to Very High ranges until such time as those levels are in the Low or Medium ranges. Keeney Testimony.

56.

The Dairy Federation argued that the nitrate thresholds in Table 3 are inappropriate as they do not take into account the need for high nitrate levels in the fall when a cover crop or double crop is planned for the land application field. Harrison Testimony; Haggith Testimony. Winter crops frequently take up significant quantities of nitrogen over the winter. Mr. Haggith testified that the nitrate levels in Table 3 will result in less nitrogen in soil when crops need

nutrients, leading to lower yields and utilization of less nutrients during the growing season. Haggith Testimony; Ex. I-4 at 11.

57.

Ecology noted that the risk categories in Table 3 were taken from WSDA, which has been using those ranges for a number of years. The Manure and Groundwater Quality Literature Review also supported the ranges reflected in Table 3. The timeframes in Table 3 for adaptive management actions reflect changing conditions, such as a crop failure or drought, which may affect nutrient uptake by crops. Jennings Testimony; Redding Testimony. Addressing the need for higher nitrate levels in soils where a cover or double crop is planned, the Permits provide that in those instances a second nutrient budget must be calculated for the second crop. Exs. R-1 at 21, R-2 at 21 (Condition S4.J.4). Ecology asserted that Table 3 cannot be viewed in isolation, instead, all conditions of the Permits must be followed. Moore Testimony.

PSA remaining permit challenges

58.

PSA contended that the Permits are not sufficiently protective of surface and ground water quality. According to PSA, the Permits should have required surface and ground water monitoring. PSA argued that the Permits do not require AKART or establish technology-based effluent limitations and standards for composting, land application, and animal pens and corrals.

Surface water monitoring

59.

PSA challenged the Permits' failure to require surface water monitoring. Emeritus Professor Dennis Keeney, appearing on behalf of PSA, testified that surface water monitoring is necessary because runoff from agricultural fields contains nitrates from a variety of sources, including land application of manure and fertilizers, and high nitrates in drinking water pose health risks. Discharges from tile drains and runoff from fields receiving winter land applications should be monitored before reaching surface waters. According to Dr. Keeney, this monitoring will allow farmers to determine if their crop management or winter land applications are contributing to water quality violations. Keeney Testimony; Ex. A-4 at 3.

60.

Under Condition S4.J.5, the Permits allow the land application of manure, litter, process water, or other organic by-products in winter to address emergency conditions. Emergency winter land application of such materials is permitted when land application is necessary to protect public health and safety. Exs. R-1 at 22 (Condition S4.J.5), R-2 at 21-22 (Condition S4.J.5). An example of an emergency condition is when a manure lagoon is in danger of failing or overtopping. Jennings Testimony. Mr. Jennings testified that Ecology provided the option for emergency winter land application in the Permits because the threat to public health and safety is greater from lagoon overtopping than the threat from application to the land. Jennings Testimony. In the event that a permittee conducts emergency winter land application, the permittee is required to maintain records of the land application and report the application to

Ecology within 24 hours. The permittee must also account for the application in its field budget and follow all the remaining permit requirements. *Id.*; Exs. R-1 at 22, R-2 at 21-22.

61.

Mr. Jennings testified that surface water monitoring is not required under the Combined Permit because the only permitted discharge to surface water is limited to precipitation events that are difficult to predict. Jennings Testimony. Under the Combined Permit, a facility may discharge from the production area to surface water under two circumstances: (1) the facility must be operating in compliance with all permit conditions governing the production area; and (2) the production area must have been "designed, constructed, operated and maintained to contain all manure, litter, feed, process wastewater, and other organic by-products including the contaminated runoff and the direct precipitation from a 25-year, 24-hour rainfall event." Ex. R-1 at 12-13 (Condition S3.C.1).

Groundwater monitoring

62.

Through the testimony of Dr. Keeney and Mr. Erickson, PSA contended that, in order to protect groundwater from contamination as has occurred in the Yakima Valley and the Sumas-Blaine aquifer, the Permits should require groundwater monitoring. PSA argued that, absent information that can be garnered from monitoring, Ecology cannot ensure that permittees are operating in compliance with the state's anti-degradation requirement. Erickson Testimony; Keeney Testimony; Exs. A-1 at 31-33, A-4 at 3-4.

63.

Mr. Jennings testified that Ecology did not require groundwater monitoring under the Permits because the practicalities of land application do not support the investment required to install monitoring wells. Because the fields used for land applications are often leased, a permittee's ability to use the land may be of limited duration. Jennings Testimony. Responding to PSA's claims that monitoring is necessary to ensure groundwater is protected, Ecology contends that the requirements of the Permits as a whole provide the required protection. *Id.* By its very nature, groundwater monitoring is backward looking as it measures what happened at the surface some time before. *Id.* According to Ecology, groundwater monitoring does not provide feedback with sufficient time to affect surface activities. *Id.*

64.

Professor Joseph Harrison, appearing on behalf of the Dairy Federation, testified regarding the study he participated in with Ecology evaluating the Sumas-Blaine aquifer. Harrison Testimony; Ex. R-15. Dr. Harrison testified that the study demonstrated that groundwater monitoring was not necessary to be protective of groundwater and he was not aware of any scientific report or study to the contrary. According to Dr. Harrison, the Sumas-Blaine aquifer study showed that when the producer managed land so that the nitrogen loading was at crop removal levels, nitrogen in the groundwater was generally below 10 mg/L-N. Harrison Testimony; Ex. R-15 at xi.

65.

Groundwater monitoring under the Permits may be triggered by: (1) the adaptive management actions in Condition S4.K; or (2) the Existing Lagoon Assessment in Condition S7.B. Jennings Testimony; Exs.R-1 at 24, 36-37; R-2 at 23, 32-33. If triggered, Condition S5.D provides the required protocols for groundwater monitoring. Exs. R-1 at 33, R-2 at 29-30.

66.

The parties presented expert testimony concerning the costs associated with groundwater monitoring. PSA's expert, Mr. Erickson described a "simple" monitoring system of eight wells for a total installed cost of approximately $40,000 to $50,000. Erickson Testimony. Water sampling from the monitoring wells would also include laboratory and labor costs. *Id.* Professor J. Shannon Neibergs, appearing on behalf of the Dairy Federation, testified regarding the costs of permit compliance for dairies in Washington. Dr. Neibergs testified that the cost of installing groundwater monitoring wells could be a significant expense to a dairy. Such an expense may be unaffordable, especially for smaller dairies. Neibergs Testimony; Ex. I-10.

AKART and technology-based effluent limits for composting, land application, manure storage, and animal pens and corrals

67.

PSA argued that the Permits failed to require permittees to comply with AKART and did not impose technology-based effluent limits for composting, land application of manure, manure storage, and animal pens and corrals. PSA asserted that Ecology should have required the use of moisture sensors on land application fields as part of adaptive management. Keeney Testimony.

Mr. Erickson testified that management techniques should be required to prevent contaminated water leaching into groundwater from animal pens and corrals, and compost areas. He testified that with the dairy cluster operations, he has worked on reducing the permeability of the soil under the compost and lined stormwater ditches conveying water from the compost. While stating that animal pens are a potential source of pollution, Mr. Erickson did not offer any management techniques to address that potential.

68.

Mr. Jennings testified that the Permits, taken as a whole, constitute AKART and require the implementation of technology-based limitations. Mr. Jennings pointed out specific conditions implementing AKART for those CAFO features identified by PSA: (1) composting – Conditions S4.A, S4.B, S4.C, and S4.D; (2) land application – S4.H, S4.J, S4.L and S4.M; and (3) animal pens and corrals – Conditions S4.A, S4.D, and S4.E.[9] Permit conditions implementing technology-based effluent limits are: (1) composting – S4.A, and S4.D; (2) land application – S4. H, S4.I, S4.J, S4.L, and S4.M; (3) manure storage – S4.B; and (4) animal pens and corrals – S4.A, S4.B, S4.C, S4.D, S4.E and S4.F.

69.

Any Finding of Fact deemed to be a Conclusion of Law is hereby adopted as such.

[9] AKART for manure storage (lagoons) is discussed above.

IV. CONCLUSIONS OF LAW

1.

The Board has jurisdiction over the subject matter and the parties pursuant to RCW 43.21B.110 (1) (c). Findings of fact are based on a preponderance of evidence standard. WAC 371-08-485(2). Appellants have the burden of proof in this proceeding. WAC 371-08-485(3). The Board considers the matter *de novo*, while giving deference to Ecology's expertise in administering water quality laws and on technical judgments, especially where they involve complex scientific issues. *Port of Seattle v. Pollution Control Hearings Bd.*, 151 Wn.2d 568, 593-94, 90 P.3d 659 (2004). Similarly, Ecology's interpretations of water quality statutes and its own regulations are entitled to great weight, unless such interpretation conflicts with the statute's plain language. *Id.* at 593-94. Pursuant to WAC 371-08-540(2), "[i]n those cases where the board determines that the department issued [an NPDES] permit that is invalid in any respect, the board shall order the department to reissue the permit as directed by the Board and consistent with all applicable statutes and guidelines of the state and federal governments."

2.

The CWA was enacted with the broad policy objective of restoring and maintaining the chemical, physical, and biological diversity of the nation's waters. Congress created the NPDES permit program to further this goal. *Puget Soundkeeper Alliance v. Ecology*, 102 Wn. App. 783, 788, 9 P.3d 892 (2000). To serve those ends, the CWA prohibits the discharge of any pollutant by any person unless done in compliance with some provision of the Act and/or in compliance with an NPDES permit. 33 U.S.C. §§ 1311(a) and 1342. Pursuant to RCW 90.48.260, the

legislature authorized Ecology to implement and enforce all programs necessary to comply with the CWA, 33 U.S.C. § 1251. Such powers include the authority to administer the NPDES permit program (ch. 173-220 WAC) and to establish water quality standards for both surface water and groundwater (ch. 173-201A and ch. 173-200 WAC).

3.

Like the broad goals of the CWA, the State's Water Pollution Control Act (WPCA), ch. 90.48 RCW, declares the public policy of the State is "to maintain the highest possible standards to insure the purity of all waters of the state consistent with public health and public enjoyment thereof. . . ." RCW 90.48.010. The WPCA also makes it unlawful for any person to discharge into the waters of the state, or to permit or allow the discharge of any organic or inorganic matter that shall cause or tend to cause pollution of such waters. RCW 90.48.080. Waters of the state include both surface and ground water. RCW 90.48.020. Any commercial or industrial operation that discharges solid or liquid waste material into waters of the state is required to obtain a State Waste Discharge Permit from Ecology. RCW 90.48.160.

4.

The WPCA requires that all state and federal discharge permits incorporate permit conditions requiring AKART. RCW 90.48.520; 90.58.010; *see also* RCW 90.52.040 and RCW 90.54.020(3)(b). Ecology's rules define AKART as "the most current methodology that can be reasonably required for preventing, controlling, or abating the pollutants associated with a discharge." WAC 173-201A-020. The Washington Court of Appeals has further clarified that the "reasonableness" prong of AKART limits Ecology "to requiring a system that is both

economically and technically feasible." *Puget Soundkeeper Alliance v. State of Washington,* 102 Wn. App. 783, 792-793, 9 P.3d 892, 897 (2000).

5.

Through ch. 173-226 WAC, Ecology established a state general permit program to address the discharge of pollutants, wastes and other materials to waters of the state. WAC 173-226-010. General permits developed under ch. 173-226 WAC satisfy the requirements of the CWA and the WPCA. WAC 173-226-010.

6.

Ecology has developed general permits to cover multiple dischargers rather than requiring individual permits for each discharger. WAC 173-226-030(13). General permits issued by Ecology are required to "apply and insure compliance with . . . whenever applicable . . . [t]echnology-based treatment requirements and standards reflecting all known, available, and reasonable methods of prevention, treatment, and control" or AKART. WAC 173-226-070; *see also* WAC 173-200-030(2)(c)(ii); WAC 173-201A-020.

7.

The Board recognizes each water quality discharge permit should build on the previous permit as knowledge is gained, uncertainties reduced and technology developed. *Crown Resources Corp. v. Ecology et al.,* PCHB No. 14-018 at 42 (July 30, 2015); *Port of Seattle v. Ecology*, PCHB Nos. 03-140, 03-141,03-142 at COL 6 (Oct. 18, 2004). The Board finds and concludes that terms and conditions in this iteration of the Permits is an advancement from those contained in the 2006 CAFO Permit.

Water and Soil Monitoring (Issues 2, 3, 4, 5 and 6)

8.

PSA challenged the Permit's lack of surface and ground water monitoring, and the sufficiency of the soil monitoring conditions. The Dairy Federation contested the need for spring soil sampling and the requirements for when fall and spring samples are to be taken.

9.

The Board concludes that PSA failed to prove that surface water monitoring is necessary. The only discharges to surface water allowed by the Combined Permit in Section S4.C.1 are extremely limited. The discharge is allowed only from direct precipitation from a 25-year, 24-hour rainfall event and all the other permit requirements must be met. Similarly, the Board concludes that an emergency land application is only allowed to avoid a worse public health or safety result. Ex. R-1 at 22, S4.J.5.

10.

The Board concludes that PSA failed to prove that groundwater monitoring is necessary. The Board agrees that there has been groundwater contamination in the Yakima Valley as demonstrated in the dairy cluster litigation. However, the dairies involved were not permitted under the 2006 CAFO Permit. Erickson Testimony. PSA was not able to show that groundwater contamination would have not occurred had the cluster dairies been complying with the terms of the Permits. Similarly, the Board concludes that there has been groundwater contamination in Whatcom County. Again, PSA was not able to show that the dairies were operating under the

terms of either the current or previous Permit terms. The Board concludes that the evidence presented at hearing demonstrated that the Permits as a whole are protective of groundwater.

11.

The Dairy Federation challenged the permit requirement of spring soil sampling and the adaptive management process set forth in Table 3 related to nitrate levels found in fall soil samples. The Dairy Federation claimed that the requirement to take fall soil samples by October 1st was unworkable. The Dairy Federation argued that soil sampling is not AKART because it is unreasonable and unknown. The Board concludes that there is a sufficient level of flexibility in the Permits to allow soil sampling to be accomplished if all the Permits' terms are followed. For example, the Permits require fall sampling after harvest but no later than October 1st. If a particular harvest occurs after October 1, the Permits require a deeper sample. Ex. R-1 at 19, S4.I.3 or 4. The October 1st date comes from the Sullivan and Cogger publication and is supported by the literature review. Ex. R-12 at 2; Ex. R-4 at 40-43.

12.

Dairy Federation argues that spring soil samples are unnecessary because the nitrate levels remaining in the soil in the spring result from mineralization and that field budgets take that into account in the calculations. The Board concludes that spring soil sampling is necessary to verify the nitrate levels remaining in the soil after the winter. Incorporating spring nitrate levels make nutrient budgets more accurate. The Board concludes that if the Permits are taken as a whole, the soil sampling and adaptive management process is known and reasonable and therefore AKART.

Manure Pollution Prevention Plans as Nutrient Management Plans (Issue 16)

13.

PSA argues that the Permits violate the CWA, state water quality laws and implementing regulations by not requiring permit applicants to submit a completed NMP with their Notice of Intent requesting permit coverage. According to PSA, Ecology's election to incorporate NMP requirements into the Permits as enforceable effluent limits is unlawful as it eliminated public review of and comment on the NMPs, and the permittee's site-specific NMP is not incorporated into the Permit. PSA contends that, as with the 2006 CAFO Permit, permittees should have been required to prepare NMPs for Ecology's review and approval before being granted Permit coverage.

14.

The Board concludes that Ecology's decision to incorporate the federal NMP requirements into the Permits as enforceable effluent limits is not contrary to applicable law. As Ecology explained, the MPPPs are not intended as a substitute for the previous NMPs. Rather, the MPPPs are site-specific plans intended to demonstrate how a facility will comply with the effluent limitations. Based on its prior experience, Ecology elected to incorporate the effluent limitations required by federal law into the Permits in order to avoid the time-consuming NMP approval process that the 2006 CAFO Permit entailed. The evidence presented demonstrated that the Permits' conditions address each applicable federal regulatory requirement, including the nine elements of the federal CAFO Rule, 40 C.F.R. § 122.42(e)(1). Jennings Testimony; Ex. R-3

at 41-43. The Board concludes that the Permits comply with applicable legal requirements regarding NMP contents, recordkeeping, and enforceability.

AKART, effluent limitations, discharges to ground and surface water (Issues 7, 8, 10, 14)

15.

PSA argues that the Permits fail to require AKART and to establish technology based effluent limitations and standards with respect to (a) composting, (b) land application of manure, (c) manure storage, and (d) animal pens and corrals. PSA also asserted that the Permits fail to include numeric water quality based standards and allow unauthorized discharges to surface and ground water.

16.

An effluent limitation is any restriction on timing, quantities, rates, and concentrations of pollutants discharged into the waters of the state. Exs. R-1 at 46; R-2 at 42; *see* 33 U.S.C. § 1362(11). In order to meet applicable water quality standards, permit conditions may implement technology based (AKART and/or BMPs) or water quality based limits. Ex. R-3 at 19. AKART represents the most current methodology that can be reasonably required for preventing, controlling, or abating the pollutants associated with a discharge. WAC 173-201A-020. Technology based effluent limitations are implemented through technology, which can consist of infrastructure or monitoring. Jennings Testimony.

17.

The Board finds that the Permits include conditions requiring the implementation of AKART and conditions establishing technology-based effluent limits. Permit conditions

implementing AKART for those CAFO features identified by PSA are: (1) composting – Conditions S4.A, S4.B, S4.C, and S4.D; (2) land application – S4.H, S4.J, S4.L and S4.M; and (3) animal pens and corrals – Conditions S4.A, S4.D, and S4.E. Permit conditions implementing technology-based effluent limits are: (1) composting – S4.A, and S4.D; (2) land application – S4.H, S4.I, S4.J, S4.L, and S4.M; (3) manure storage – S4.B; and (4) animal pens and corrals – S4.A, S4.B, S4.C, S4.D, S4.E and S4.F.

18.

In developing the Permits, Ecology chose not to impose numeric effluent limits because there are significant variables outside of the permittee's control, such as amount of rainfall or irrigation water available, disease, drought and weather. Jennings Testimony. The sections of the Permits that apply to water based effluent limitations are Conditions S3, S4.G, J, K and the adaptive management Table 3. *Id.* The Board concludes that, in this instance, it will defer to Ecology's expertise in administering water quality laws and its technical judgments in NPDES permit development. *Port of Seattle v. Pollution Control Hearings Bd.*, 151 Wn.2d 568, 593-94, 90 P.3d 659 (2004).

19.

The Board finds and concludes that the Permits do not permit unauthorized discharges to waters of the state. The Permits conditionally authorize discharges to groundwater when a permittee is operating in compliance with all Permit conditions. With one exception, the Combined Permit prohibits all discharges to surface water. Under the Combined Permit, a discharge to surface water is permitted in the event of an overflow from the production area from

a waste storage facility designed, maintained and operated to contain runoff and precipitation from a 25-year, 24-hour rainfall event, and only when the production area is otherwise in compliance with the Combined Permit. Ex. R-1 at 12 (Condition S3.C.1). The State Only Permit conditionally authorizes the discharge of pollutants to groundwater from the production area and land application fields, provided that the permittee is operating in compliance with the Permit. Ex. R-2 at 7 (Condition S1.A). The State Only Permit does not authorize any discharges to surface water from the CAFO. Ex. R-2 at 12 (Condition S4).

Adaptive management (Issue 9)

20.

PSA argued that the Permits' adaptive management provision allows high nitrate levels to remain in the soil for an extended period of time, thereby increasing the risk of leaching to groundwater. PSA also asserted that, in addition to nitrate, the Permits' soil sampling should include phosphorous. The Dairy Federation contended that the nitrate action levels in Table 3 did not adequately account for the need for high nitrate levels in land application fields where a fall cover crop or double crop is planned. Condition S4.J.4 of the Permits addresses double cropping, winter cover crops, and perennial crops.

21.

The Board finds and concludes that the evidence presented established that Ecology, applying its technical expertise and permitting experience, developed reasonable adaptive management conditions to address excessive nitrates in land application fields. The Board further concludes that the adaptive management provisions are not contrary to law.

Lagoon standards (Issue 19)

22.

The Dairy Federation challenged the lagoon standards set forth in Conditions S4.B and S7.B of the Permits. The Dairy Federation argued that the starting point for measuring the two foot vertical separation is contrary to NRCS standards, was not presented to the public for review and comment, and is not AKART. Requiring two-feet of vertical separation from the bottom of the lagoon liner will cause dairies to incur significant costs well beyond what they can reasonably afford.

23.

The Board concludes that Ecology's clarification of the measurement point in the final Permits was not improper. Changes in a final NPDES permit are permissible if in character with the original proposal and a logical outgrowth of the notice and comments received. *BNSF Railway Co. v. Dep't. of Ecology,* PCHB 12-062c at 12 (Order on Motions for Partial Summary Judgment, May 28, 2013.) Ecology testified that the parenthetical was added due to comments received on the formal draft permit. Jennings Testimony; Moore Testimony. When establishing this requirement, Ecology was aware that the NRCS employed a different point from which to measure the two foot vertical separation from the seasonal high water table. Redding Testimony.

24.

Although Ecology testified its long-held position was that the measurement of the two foot separation began from the outside of the bottom of the liner, the Board concludes that Ecology failed to provide sufficient evidence to support the need to measure from that point.

The Board finds that the evidence established that a two foot vertical separation measured from the top of the liner inside the lagoon to the water table is sufficient for attenuation of pathogens and viruses. Harrison Testimony. The evidence did not convince the Board that a two foot vertical separation from the outside of the lagoon liner to the water table is necessary. Based on these findings, the Board concludes that the measurement required by Conditions S4.B and S7.B.1 should follow the NRCS recommendation and commence from the top of the liner inside the lagoon or point 1 in the illustration in Appendix C of NRCS Technical Note 716. Ex. R-7 at Appendix C. On remand, the Board directs Ecology to revise the Permits to address this issue.

25.

With the exception of the measurement of the two foot vertical separation from the seasonal high water table in Condition S4.B and Condition S7.B.1, the Board affirms the Permits.

26.

Any Conclusion of Law deemed to be a Finding of Fact is hereby adopted as such.

V. ORDER

The Concentrated Animal Feeding Operation National Pollution Discharge Elimination System and State Waste Discharge Permit and the Concentrated Animal Feeding Operation State Discharge General Permit issued by Ecology January 18, 2017, are AFFIRMED with the exception of permit conditions S4.B and S7.B.1 relating to the measurement of the two foot vertical separation from the water table. The Board REMANDS the Permits to Ecology to be modified and reissued consistent with this Order, specifically: Condition S4.B and Condition

S7.B.1 shall be modified, as necessary, to make the conditions consistent with the measurement location number 1 as described in Appendix C of Natural Resource Conservation Service Technical Note 716. Ex. R-7 at Appendix C.

SO ORDERED this 25th day of October, 2018.

POLLUTION CONTROL HEARINGS BOARD

JOAN M. MARCHIORO, Board Chair

KAY M. BROWN, Member

NEIL L. WISE, Member

HEATHER C. FRANCKS, Presiding Administrative Appeals Judge