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Nitrate in Drinking Water and Human Health

**Are the concerns about nitrate in drinking water justified?
Is it correct to blame dairy farmers for nitrate in groundwater?**

Nitrate in drinking water is a contaminant that according to the EPA can cause health problems. A few activists, including an Oregon lawyer, claim that dairy farms are contributing massive amounts of nitrate to groundwater through manure storage lagoons and application of manure to fields. They claim dairy contamination poses a very significant risk to human health. However, the facts do not support these claims.

The EPA established a maximum of 10 parts per million of nitrate in drinking water. This was based on a 1940s study that related some cases of infant methemoglobinemia (IM) – also called “blue baby syndrome” to newborn infants fed formula using well water high in nitrate. That study has since been fully discredited by numerous more recent studies as we will show. It has even been discredited by EPA scientists who researched the assumed link. One of the most recent studies by eminent medical researchers concludes that given a much improved understanding of the causes, *“perhaps the current MCL for nitrate in drinking water of 10 mg/L (or 10 ppm) should be revisited.”*

We challenge these activists to produce science studies that refute the conclusion of all recent studies we have seen that show the causal link between nitrate in groundwater and blue baby syndrome is wrong. Since we have been publicly presenting this documentation for nearly three years, we believe activists and their attorney are choosing to ignore current science as it interferes with their fundamental claim against farmers.

In this document we will first show that nitrate levels are actually declining in areas of intensive dairy farming. This brings into question the effort of activists to end dairy farming because of the claim that these farmers are “killing our country.” Second, we show that nitrate levels above the EPA level are widespread in wells across the nation where farming has occurred for

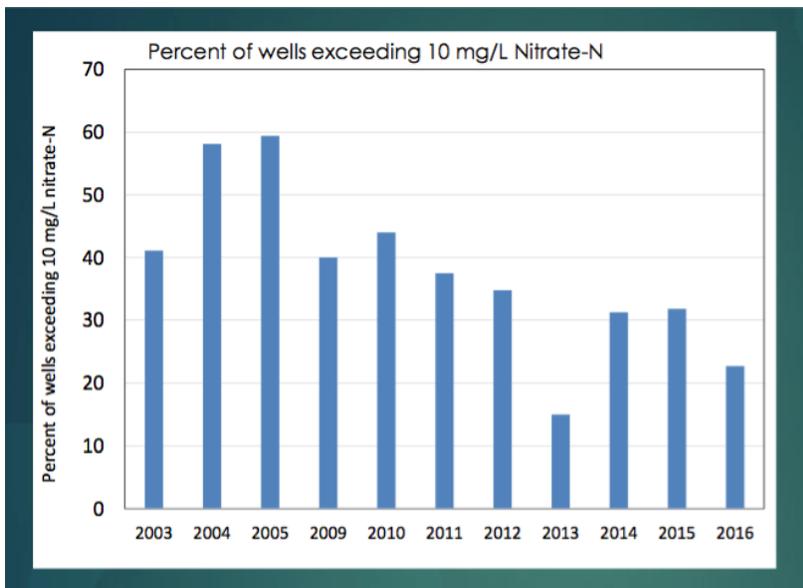
generations. In Eastern Washington, there is significant nitrate levels in groundwater where there are no dairy farms.

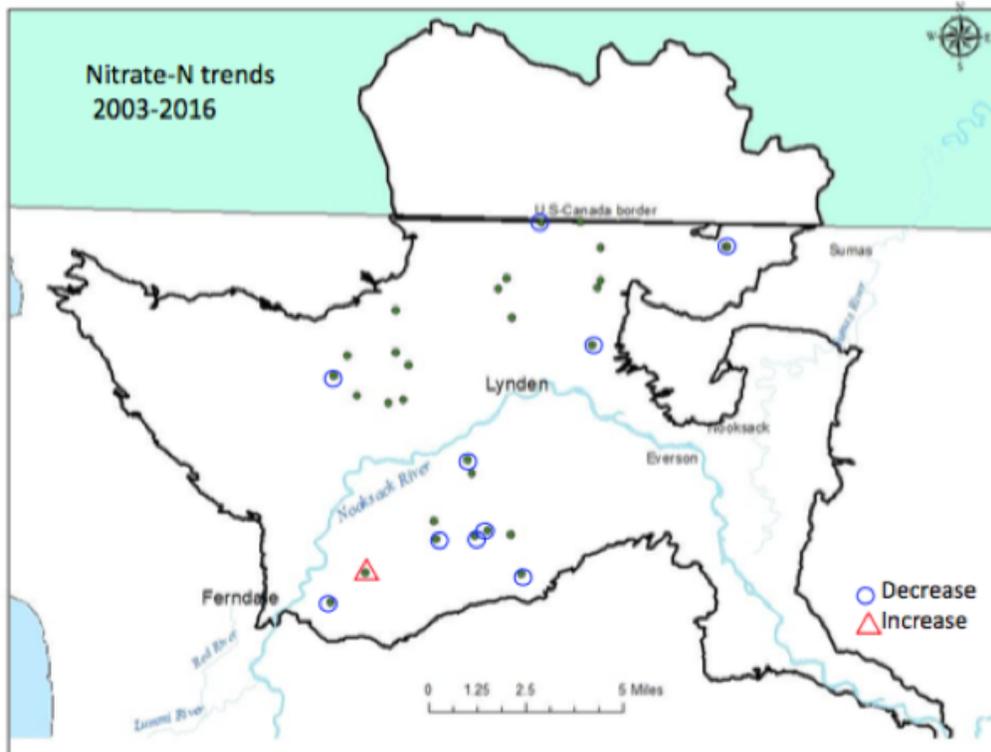
In addition to demonstrating that recent science shows the basis for the EPA limit is false, we also provide detailed information on the health benefits of nitrates in diets. The DASH diet, promoted by the National Institutes of Health, is beneficial for cardiac performance because it is high in vegetables that contain about 2500 times the nitrate allowed in drinking water. We simply note the vast difference in position of these two federal agencies to point out that the claims about urgent health risks activists claim are caused by dairy pollution are not credible. Farmers fully recognize that as long as the EPA holds to the current limit, it is their obligation to do all they can to limit or eliminate nitrate contamination. The information provided above about protective measures and farmer stewardship show that while the EPA standard stands farmers will do all they can to limit or eliminate contamination.

1. Nitrate levels in areas of intensive dairy farming are declining.

Claims of a water quality crisis by anti-farm activists lose credibility when confronted by the facts of improving water quality. Whatcom County, with about 90 dairy farms, is a favored target of these activists who go so far as to claim the aquifer shared with Canada is “closed” presumably to public consumption. Nothing could be further from the truth as the Department of Ecology has shown.

NITRATE REDUCTIONS IN WHATCOM COUNTY DAIRY COUNTRY





(From an October 2016 report and presentation by B Carey of the Department of Ecology)

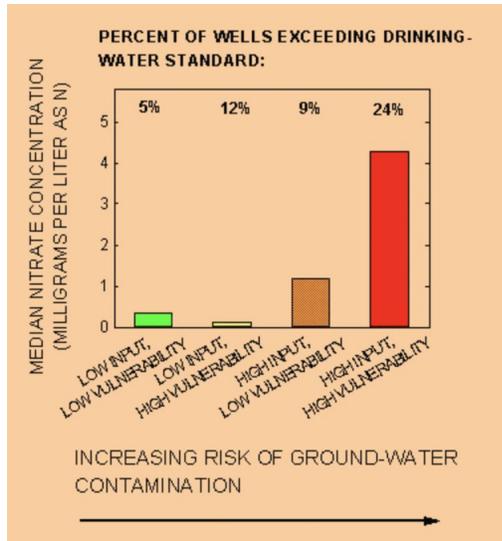
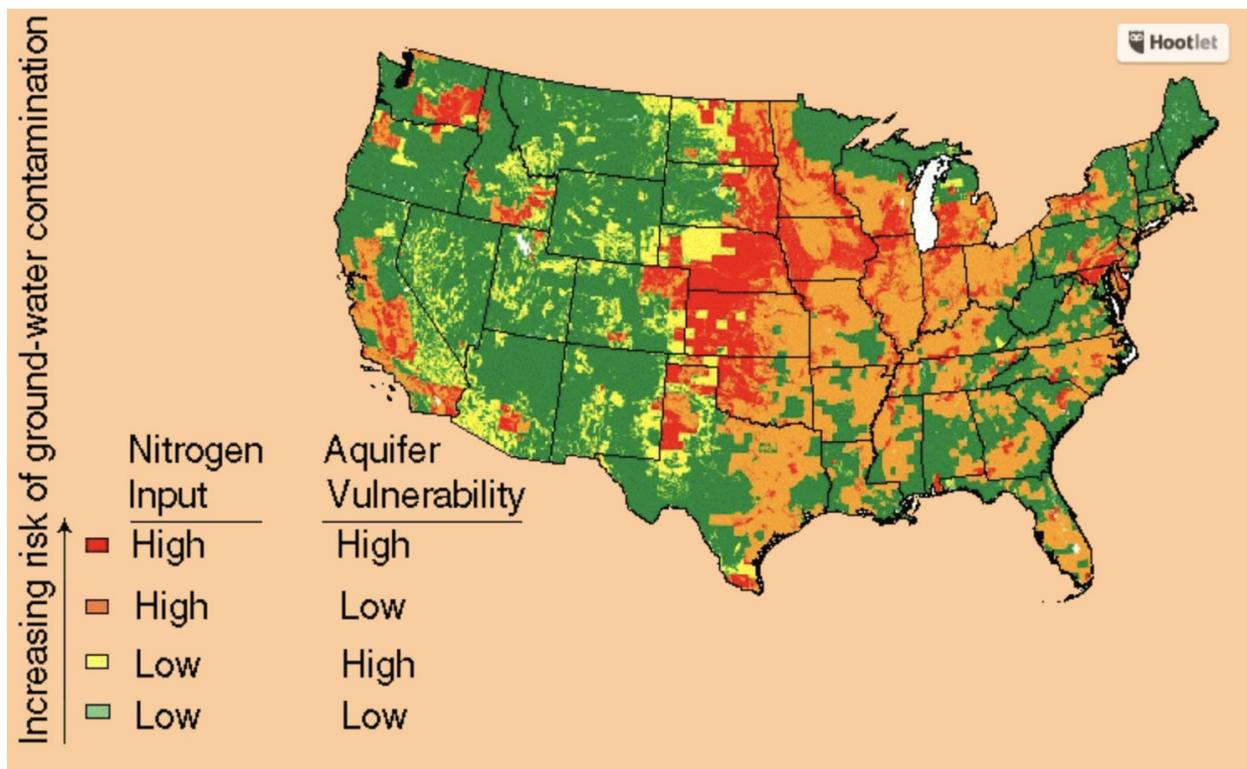
2. Nitrate levels above EPA limit are widespread in farm country -- even without dairy farms

There is intense focus on dairy farms as the alleged cause of nitrate contamination, including in a discredited EPA 2012 science report on causes of nitrate contamination in the Yakima Valley. These actions ignore the level of nitrate in groundwater in almost all areas of intensive farming across the nation.

This federal government website provides information on the location of wells likely to have nitrate in groundwater above the EPA limit:

https://water.usgs.gov/nawqa/nutrients/pubs/wcp_v39_n012/

It shows that 24% of wells have nitrate above the EPA limit. The accompanying map shows that vulnerability is based on nitrogen input combined with soil conditions. The map of Southeast Washington demonstrates that high nitrate in this area is common in farming areas regardless of the presence of dairy farms.



3. Nitrate in Yakima area is mostly from non-human natural causes according to a 2017 study

[A 2017 study presented as a Master's Thesis](#) by Central Washington University study Dallin Jensen, titled ISOTOPE INVESTIGATION OF NITRATE IN SOILS AND AGRICULTURAL

DRAIN WATERS OF THE LOWER YAKIMA VALLEY, WASHINGTON, demonstrated that naturally occurring nitrate in Yakima is a major contributor. He compared soil studies in Yakima area to a study near the Hanford site and found that soil samples show the nitrate comes from non-human sources. However, irrigated agriculture likely helped desposit the natural nitrate to the shallow groundwater aquifers:

The groundwater nitrate [in an EPA report] was largely attributed to a mixture of manure and fertilizer. However, isotope signatures in this study also overlapped with isotopic values attributed to naturally occurring soil nitrate from a study at the nearby Hanford Site, Washington. A mass balance calculation based on $\Delta^{17}\text{O}$ data suggests that there is a ~9% atmospheric contribution to nitrate in soil accumulations below caliche layers at several locations. This atmospheric input was iii consistent across multiple sites. We argue that the consistent atmospheric component implies the nitrate in these soil samples at depth appears to have a largely predominately non-anthropogenic origin, because a significant anthropogenic input would dilute and cause variation in this atmospheric signature. We suggest the flushing of naturally occurring soil nitrate to groundwater during land use conversion to irrigated agriculture may represent a previously overlooked, significant, nitrate input to shallow alluvial aquifers in this region.

4. Residential septic systems are major contributors of nitrate to groundwater according to the EPA, particularly when a large number are located in a condensed region.

EPA documents show that residential septic systems, otherwise known as On-site Sewage Systems or OSS, can be significant contributors to nitrate in groundwater. In fact, government and academic scientists report that just five septic systems can contribute as much as 10 times more nitrate than a one acre manure lagoon. A closer look at the data shows that that number is likely considerably higher.

Given the propaganda by activists about manure lagoons, it may be difficult to accept until one understands the science behind nitrogen, nitrates, nitrification and denitrification. A detailed but non-technical explanation can be found on the Save Family Farming website. The key difference is design and purpose. A manure lagoon using federal standard soil and cured manure liners is specifically designed to prevent the small amount that seeps through the liner from converting into nitrate. This has to do with the lack of oxygen, water and microbes in the soil beneath the liner. Septic systems with a septic tank that leads to a drainfield is designed to convert the nitrogen in the human waste to nitrate through its exposure to loose soil that percs and the air, water and microbes it contains. So, lagoons prevent nitrification while septic systems are designed to generate nitrate.

Isolated septic systems represent a very minor risk. However, when concentrated, that risk increases significantly according to a number of studies and the EPA. The town of Outlook in the lower Yakima Valley features a number of dairy farms which have been accused by their location

near test wells of major nitrate contributions. But no one has investigated the high density of septic systems near Outlook and its impact on wells testing high in nitrate in that area.

[A 2019 report out of Wisconsin](#) shows the impact of septic systems on water quality. Water testing in a three county area in rural Wisconsin showed that wells above health limits ranged from 27% to 42% (compare the 12% to 15% of Yakima area wells). When they tested the wells for the source of the microbes, they found that the primary source was human.:

The first round of source sampling in April found 32 out of 35 wells had fecal contamination. Thirty wells had human microbes, 17 wells had cattle microbes and five had pig microbes.

Here is a more detailed explanation of the comparison between septic systems' and manure lagoons' contributions to nitrate in groundwater:

<https://savefamilyfarming.org/easternwashingtonfamilyfarmers/2019/06/18/386/>

5. The link between nitrate in well water and “blue baby syndrome” was shown to be based on a mistaken 1947 science report

Statements about the public health risk by anti-dairy activists are often extreme, such as this statement from the discredited What's Upstream campaign: [nitrates are] *“acute contaminants that produce immediate (within hours or days) health effects upon exposure.”* This is clearly intended to frighten the uninformed but when the facts about health risks are known, these statements seriously diminish the credibility of those making those claims.

A major concern raised is the supposed link between nitrate levels in groundwater and infant methemoglobinemia or “blue baby syndrome” The suggestion was that this risk was considerable even at or near the EPA level of 10 parts per million. Farmers understand that the EPA Maximum Contamination Level or MCL on nitrate continues in effect and continue to make progress in limiting or eliminating nitrate contributions. But there is clear and compelling evidence that the current limit, set by a now discredited science study of 1945, is not supported by the preponderance of more current studies.

Federal agencies, with the exception being the EPA, are making it clear that science studies relating to the role of nitrate in human health are pointing away from the outdated reports. The Public Health statement of the Agency for Toxic Substances and Disease Registry (ATSDR) states:

*“Most people are not exposed to levels of nitrate and/or nitrite that would cause adverse health effects. Young infants (<6 months of age) appeared to be particularly sensitive to the effects of nitrite on hemoglobin after consuming formula prepared with drinking water that contained nitrate at levels higher than recommended limits; some of these infants died. **The cause of methemoglobinemia (a change to hemoglobin that decreases the ability to***

transport oxygen to tissues) in many of these infants may have been gastroenteritis from bacteria or viruses in the drinking water or from other sources not related to nitrate. [Emphasis added]

In 2013 Dr. Bruce Macler from EPA Region 9 presented a summary of studies of health risks from nitrate in drinking water. After noting the EPA limit was set based on the 1940s study, Dr. Macler stated: “Clinical studies of nitrate exposure alone showed little or no methemoglobinemia.” Perhaps most interesting is Dr. Macler’s review of a study of methemoglobinemia in California completed in 2000. He notes that 42 cases in California over 13 years were studied. **“None specifically associated with nitrates.”** “Only four of the 42 cases were in areas where there were wells.” Dr. Macler was referring to data from an EPA California study of 2000 which indicated the areas with the highest incidence of Blue Baby Syndrome were all urban areas: Pasadena, San Francisco, San Fernando, La Puente and Colton. Agricultural areas with untreated well water did not have the highest incidence rates in California. Macler stated, “Methemoglobinemia [Blue Baby Syndrome] in infants is typically associated with diarrhea and suggests a fecal association.” He further suggested that improper use of Benzocaine by parents of newborn infants may be a cause of blue baby syndrome.

The error made by the original study in [1945 by Hunter Comly](#) that linked methemoglobinemia to nitrate in drinking water is now quite well understood and is widely reported in the literature. The researcher only considered the high levels of nitrate in the drinking water which was also contaminated by bacteria. Subsequent studies compounded the error by failing to consider the role of bacteria, genetics and other factors. Numerous studies since then have pointed out that error, which is [succinctly summarized here](#):

“Methaemoglobinaemia is a side-effect of gastroenteritis and is not caused by nitrate but by nitric oxide, which is produced in a defensive reaction stimulated by gastroenteritis. The latter may be caused by a bacterium or a virus. The association of methaemoglobinaemia with nitrate may have arisen because early cases of the condition were often associated with wells polluted with bacteria, and the same pollution increased the nitrate concentration.”

An article from Environmental Health Perspectives by Mary H. Ward, et al., from 2005 and published on the [NIH website provides evidence](#) that factors other than nitrate contribute to methemoglobinemia.

“Methemoglobinemia in infants fed formula made with well water with high nitrate levels was first reported in 1945 by [Comly \(1945\)](#). The regulatory level for nitrate in drinking-water supplies was determined after a survey of infant methemoglobinemia case reports in the United States indicated that no cases were observed at drinking-water nitrate levels < 10 mg/L nitrate-N ([Walton 1951](#)). Because an estimated 22% of domestic wells in agricultural regions of the United States exceed the nitrate MCL (U.S. Geological Survey, unpublished data), it is likely that significant numbers of infants are given water containing > 10 mg/L nitrate-N.

Nevertheless, few cases of methemoglobinemia have been reported since the MCL was promulgated.”

The authors point out that numerous recent studies show that exposure to nitrate alone does not result in the infant disease: “*Recently, the role of nitrate exposure alone in causing methemoglobinemia has been questioned ([Avery 1999](#); [Fewtrell 2004](#); [Hanukoglu and Danon 1996](#)).*” They concluded:

“Clearly, we need to better understand the interaction of factors that lead to methemoglobinemia to assess the relative importance of each factor and to identify the conditions under which exposure to nitrate in drinking water poses a risk of methemoglobinemia.

The need to better understand the factors contributing to methemoglobinemia was answered by a 2014 [medical report published on the National Institutes of Health Website called *Reexamining the Risks of Drinking-Water Nitrates on Public Health*](#) authored by Alyce M. Richard, MD, James H. Diaz, MD, DrPH, and Alan David Kaye, MD, PhD. Dr. Richard is now with Harvard Medical School. The report examines in-depth the medical issues surrounding this disease and concludes:

Because research refutes exogenous nitrate-to-nitrite sources as causes of IM [infantile methemoglobinemia] and supports endogenous nitrite production secondary to genetic abnormalities or nitric oxide generation in an inflamed infant gut as causative mechanisms for IM, perhaps the current MCL for nitrate in drinking water of 10 mg/L (or 10 ppm) should be revisited.

Those promoting the link between nitrate in drinking water and blue baby syndrome frequently refer to Eastern European countries that have had much higher levels of incidence of this disease than Western European nations or the US. The paper referred to above by Ward et. al., states “*in Romania, 20% of 2,000 wells had nitrate levels > 23 mg/L as nitrate-N ([Jedrychowski et al. 1997](#)).* Studies from other countries, including China, Botswana, Turkey, Senegal, and Mexico, report private well water levels that exceed the WHO guideline, in some instances at levels > 68 mg/L nitrate-N ([WHO 2004a](#)).”

Another researcher from the [UK, Lorna Fewtrell](#) reported: “*In 1985, WHO reported that > 1,300 cases of methemoglobinemia (with 21 fatalities) occurred in Hungary over a 5-year period. Indeed, up until the late 1980s methemoglobinemia was a serious problem in Hungary ([Hill 1999](#)).* Although there are reports of high nitrate concentrations in drinking water (i.e., > 50 mg/L nitrate) from around the world ([Hoering and Chapman 2004](#)), these are rarely paralleled by reports of methemoglobinemia. Where illness has been reported, many of the cases predate the early 1990s, and [Hanukoglu and Danon \(1996\)](#) have proposed that the apparent decline in the incidence of methemoglobinemia is suggestive of an infectious etiology.”

Much of the focus of activism and litigation on dairy farms and nitrate is in the Yakima Valley in central Washington state. Activists and their lawyer use compliant media reporters to create a sense of health crisis. They repeatedly claim that the nitrate levels in drinking water represents a serious and imminent health crisis. If so, we might expect reports of illness or deaths related to nitrate. But, the Yakima Health Department has no record of blue baby syndrome or, as far as we know, any illness linked to nitrate in drinking water. Given the science studies discussed here, this lack of reported illnesses is understandable.

6. EPA: nitrate in groundwater does not cause cancer

A Washington state government official reported in a public meeting that even very low levels of nitrate in drinking water cause cancer. This accusation has also been made frequently by some activists. They reference the [Iowa study published in the 2001 issue of Epidemiology](#) which concludes that low levels of nitrate in drinking water are associated with increased incidence of some forms of cancer. This study generated the expected news headlines and has been used extensively by activists to ramp up concerns about nitrate and cancer. The study was done on the basis of a survey mailed to Iowa residents. The authors note: *“There are several important limitations to our exposure assessment that require comment.”* Those limitations provide adequate reason why the study results are inconsistent with and not supported by a number of other studies that show no link to low levels of nitrate in drinking water and cancer. Dr. Macler, the EPA Region 9 scientist referenced above, also noted in his presentation that since 2002 the EPA has determined that nitrate was not a carcinogen. This was after the Iowa study was published. Dr. Macler’s 2013 presentation offered this conclusion: *“Net effect = zero.”* This was because of the admitted weakness of the study and the numerous other studies that show no link.

One of the most comprehensive analyses of the health impact of nitrate in drinking water was published by the [University of Nebraska-Lincoln in 2008](#):

“About 50 epidemiological studies have been made since 1973 testing the link between nitrate and stomach cancer incidence and mortality in humans, including Forman et al. (1985) and National Academy of Sciences (1981). The Chief Medical Officer in Britain (Acheson, 1985), the Scientific Committee for Food in Europe (European Union, 1995), and the Subcommittee on Nitrate and Nitrite in Drinking Water in the USA (NRC,1995) all concluded that no convincing link between nitrate and stomach cancer incidence and mortality had been established...Based on the above findings showing no clear association between nitrate in drinking water and the two main health issues with which it has been linked [stomach cancer and methemoglobinemia--ed note], some scientists suggest that there is now sufficient evidence for increasing the permitted concentration of nitrate in drinking water without increasing risks to human health (L’hirondel et al., 2006; Addiscott, 2005).”

This comports with the statement by the ATSDR: *“The International Agency for Research on Cancer (IARC) determined that there is inadequate evidence for the carcinogenicity of nitrate in food or drinking water and limited evidence for the carcinogenicity of nitrite in food (based on association with increased incidence of stomach cancer).”* In a concluding slide looking at various studies that purported to link nitrate to cancer, Dr. Macler concluded: *“No smoking gun.”* His presentation along with most of these reports can be found on the Save Family Farming website at: <http://www.savefamilyfarming.org/nitrates-and-human-health.html>

7. Instead of representing a serious health risks, most now agree that nitrate is beneficial.

At a very minimum the health risks previously associated with nitrate in drinking water, particularly at the very low levels set by the EPA, are being seriously questioned if not moving toward a strong consensus of little to no risk. But there is another side to the story: the positive benefits of nitrate in the diet.

In the University of Nebraska-Lincoln study mentioned above, the authors make note of the potential positive benefits: *“On one hand there is evidence that shows there is no clear association between nitrate in drinking water and the two main health issues with which it has been linked, and there is even evidence emerging of a possible benefit of nitrate in cardiovascular health.”*

The DASH diet, based on research from the National Institutes of Health, is a good example as it promotes eating vegetables known to be high in nitrate such as beets, spinach and celery. For example, one serving of spinach contains about 2500 times the 10 parts per million in water that the EPA set as the MCL. The DASH diet website states:

“The healthy DASH (Dietary Approaches to Stop Hypertension) diet plan was developed to lower blood pressure without medication in research sponsored by the US National Institutes of Health. The first DASH diet research showed that it could lower blood pressure as well as the first line blood pressure medications, even with a sodium intake of 3300 mg/day! Since then, numerous studies have shown that the DASH diet reduces the risk of many diseases, including some kinds of cancer, stroke, heart disease, heart failure, kidney stones, and diabetes. It has been proven to be an effective way to lose weight and become healthier at the same time. It is full of fabulous, delicious, real foods. All of these benefits led to the #1 diet ranking by US News & World Report in 2011, 2012, 2013, and 2014.”

Scientific evidence for the health benefits of nitrate in the diet have been established for some time as this 2009 article in the American Journal of Clinical Nutrition, shows: *“As such, the dietary provision of nitrates and nitrites from vegetables and fruit may contribute to the blood pressure–lowering effects of the Dietary Approaches to Stop Hypertension (DASH) diet.”*

This website does a good job of explaining how the science on nitrate and human health is changing and why nitrate in our diets is beneficial:

<http://www.pronutritionist.net/2010/08/nitrates-are-beneficial-where-did-i-get-it-wrong/>

Government officials on the one hand communicate publicly that nitrate represents a very serious health risk but then others recommend that we eat salads or vegetables because of high nitrate. This conflict needs to be resolved. The review of available science will lead to the conclusion that EPA's limit on nitrate in drinking water dating back to the 1960s deserves a re-evaluation.