Public Comment
Agricultural Expert Panel Draft Report
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(of 19 pages)

NITRATES: PRODUCTION WITHOUT POLLUTION

Comments on Conclusions of the Agricultural Expert Panel

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Laundry List of G/W BMP's

40 CFR 131.12(a)(2) "Further, the State shall assure that there shall be achieved the highest statutory and regulatory requirements for all new and existing point sources and all **cost-effective** and **reasonable** best management practices for nonpoint source control..." [Clean Water Act]

The term "laundry list" is the term used in the panel's ***Conclusions***, see page 22, e.g.

I. **Point-source** pollution [G/W]
   - A. Wellhead-capping/sealing
   - B. Backflow devices
   - C. Well-bore piping
   - D. Yard ["operatons yard"] management of nitrogen-laden petroleum products
   - E. Spill and hazmat management

II. **Nonpoint** pollution from agriculture [G/W]
   - A. Input accountability
     1. fertilizer management/nutrient management plan
     2. irrigation water management, irrigation system, microdrip/sprinkler,etc.
     3. biodigestion: e.g., tile drainage lagoon for nutrient removal from tile water
   - B. Management of the Biocomplexity of the living soil
     1. Increase "storage bank" and lengthen "hydraulic residency"
        - a. Soil organic carbon/nutrient management plan
        - b. Humic acid/nutrient management plan
     2. Manage rhizosphere, root size and micorrhizal presence; N-transformation
        - a. Inoculants
        - b. Humic substances/nutrient management plan
        - c. No-use BMP: minimal use of synthetics

d. Non-Nitrate forms of organic carbon [manure, wood chips]

3. Manage infiltration to and evaporation from the soil
   a. Mulch
   b. Intercropping
   c. Dry-farming techniques/rain-fed agriculture
   d. Constructed wetland for capture & biodigestion of nitrates
   e. Placement of well pump away from streambed
   f. Cover crop, perennial cover, buffer strips

AM: adaptive management: In its most basic form, adaptive management means do/monitor/&adjust. EPA-style AM is ***measures*** and ***practices.*** Management measures are environmental goals; best management practices [BMP's] are the objectives. As a general rule, the difference between goals and objectives is that objectives are measurable. In the EPA scheme of things, *measures + BMP's + monitoring & adjustment = environmental protection.* The EPA's regulatory scheme is detailed in its textbook for regulators: ***MANAGEMENT MEASURES FOR THE CONTROL OF NONPOINT POLLUTION FROM AGRICULTURE.***

AM is applied to everything at EPA: timber harvests, GMO releases, construction sites and is applied to air quality and water quality alike.

In the realm of water quality, the Water Quality Control Board [hereafter, "the Region"] sets the environmental goals, or "management measures," as EPA would call them. These come in the form of Basin standards of water quality or TMDL's, per the Porter-Cologne Act, as well as federal laws like CZARA.

In summary, the Region sets the water quality standards through Basin plans and TMDL's, and the farmer innovates a suite of BMP's to meet these water quality goals.

New Revolution in Regulation

AM is a new revolution in organizing society. In its earliest times, tribal behavior was controlled by myth, legend and ritual. For example, the old Nordic notion that a nesting stork brought prosperity to the farm was the equivalent of a game law that preserved the population of storks in Northern Europe. Storks were good-eating, and a stork nesting on a chimney was a "sitting duck" for the farmer's table.

Storks nesting on chimneys would be wiped out for food. But farmers were superstitious and they believed that nesting stork blessed the household with prosperity and brought children – children being a form of social security in the Farmer's old age. No less a health & safety law is the Biblical prohibition against eating pork. Swine carried trichinosis, as of 2013, hepatitis E. No pork meant no exposure to these diseases.

Enacted laws replaced myth and legend. The DO's and the DON'T's of law came with modicum of enforcement. Whereas the Bible says, "Thou shalt not suffer a witch to live," the religious community of Salem, Massachusetts enacted laws against witchcraft and sorcery and held trials to determine who was a witch. Laws were one-size-fits-all, unless a loophole was provided by law – hence, the U.S. tax code is 36,000 pages of loopholes.

Conservation tools have to be sited, and a 360,000 page conservation code would be impossible to manage. EPA developed the new model of regulation called ***adaptive management or AM.*** With ***AM***, all farmers do not have to march to the same tune as they do with a code of laws. Two peach farmers can sit side by side in the same watershed with the same soil type and one use suite X of BMP's and the other use suite Y of BMP's – X and Y differ in BMP's to accomplish the same environmental goals. What works, works, and the proof is in the monitoring. That's how the science of **do-monitor-adjust** establishes itself. There is no one-size-fits-all principle, BMP's come in all sizes, figuratively speaking.

AM works with surface water to control water quality; **AM** does not work to protect groundwater, not in a reliable way. The actions taken by farmers today to stop groundwater contamination do not present in the aquifer pool for 5, 10 or 50 years. Hence, the only reasonable thing to do is to monitor groundwater BMP's, not monitor the pool of groundwater itself for water quality. The key to adaptive management is effectiveness – effectiveness of BMP's – if a farmer can't monitor the effectiveness of his/her BMP's, who's to say they work? ***AM*** alone without monitoring and adjustment – without the hard data to back it up - will not protect groundwater quality.

This is rather straightforward logic. The lag time between the activities that pollute and the contamination of the source water is too long – half a decade, half-a-century – so that the groundwater that dies in 2030 may be killed off in 2015, unawares Imagine being shot in the heart with a bullet and not dying for 12 years. Hence, groundwater protection rests on proven BMP's, not monitoring. Law may have to dictate BMP's to farmers, because the feedback from monitoring is so delayed that ***AM*** is futile, because we forgo the self-correcting feedback process of monitoring and adjustment.

In summary, ***AM*** works in protecting surface water; ***AM*** is a somewhat useless exercise in protecting groundwater, due to hurdles of time and logistics of sampling water that can't be seen. One other characteristic of groundwater deserves mention: When we empty a bottle of bottled water, we get another bottle; when we empty an aquifer of groundwater, there's no recourse. The "built" environment, including farms, eats away at the natural recharge areas and over the span of 50 or a 100 years, we have already reduced the recharge capacity of the land more than half. Say good-bye to groundwater.

Correct BMP's

Scientific agriculture falls into two general categories, Liebig-style and Steiner-style. Liebig was a giant of chemistry who first laid down the principle that a nutrient deficiency is the weakest link in a cropping system and that a plant's growth is limited to the limiting nutrient or mineral. If water is the limiting mineral, the plant's growth with limited water is stunted. Conventional, industrial farming irrigates and fertilizes out of deficient states of the land.

Steiner-style is agroecological farming. Such notions as "feed the soil, not the plant" take into account the biological web of soil life. Fungus called mycorrhizae sheath the roots of the plants and double the roots' ability to take up nutrients such as nitrates. Humic substances in the soil act as root-growth hormones and as storage banks for nutrients, making phosphates more readily available and nitrates less likely to leach. Organic, ecological and biodynamic farming are the popular trends of Steiner-style agriculture that grew out of reactions to the pure Liebig notions..

The expert panel is saddled with the mission of stopping nitrate pollution of groundwater. To do this, the panel has recommended two blanket BMP's: nutrient management and irrigation management, taking a "balanced budget" approach for both Liebig and Steiner styles. The thinking revolves around the unspoken principle that nitrates should abound in the root zone but absent from below it. In other words, nitrates go where water goes, and gravitational water pollutes groundwater with nitrates. Hence, the equation where we subtract uptake from the application.; application minus uptake = gravitational water; and, application of N minus uptake of N = N-laced gravitational water, which is zero in an ideal system. Hence, the aim is input = output, or "balanced budget." The primary role of fertilizer is to supply nitrates, and nitrates are largely synthetic, made by the Bosch-Haber process that uses 3% of the world's energy. Nitrates are soluble and travel with water, and gravitational water moves nitrates beyond the root zone. Therefore, if water and nitrates are rationed to what the crop uptakes, no excess water or NO3 will escape into the groundwater. The "balanced budget" approach matches inputs with uptakes. The idea is to dole out water to meet evapotranspiration needs, and to have none in superfluous excess to seep prodigally into the groundwater, and, in course, water sufficient to supply a crop with nitrates sufficient to its needs but no more. With full bio-utilization of nitrates and irrigation water, the groundwater remains unscathed and untainted. No gravitational water moves nitrates beyond the root zone. The theory is logical, if not fantastical, and the question remains, is it achievable?

The ***Conclusions*** report of the expert panel does not admit of a margin of error, and does not attempt to compute the involved guesswork. Where are the probability and the statistics? How do you determine the root zone? How you determine if the root zone is wet and below it is dry? How you determine the transpiration when the same plant in a humus has double the root size? How accurate are the calculations? – "close" only counts in horseshoes and handgrinades.

In theory, the "balanced budget" approach curbs the ***sieve effect***, to coin a phrase, and effectively turns the topsoil into a self-contained dipper rather than a sieve. Organic farming aims at capturing and holding nitrogen in nonsoluble forms and releasing it through the soil's bioactivity such that the release corresponds to crop needs and uptake. NO3 is not lost to groundwater, in theory. Organic farmers fend off leaching by enriching the soil's carbon content, in theory.

In practice, the Region adopted "1.4 times the expected harvest uptake" as the fertilizer guideline. 1.4 comes from the Hepperly-Pimentel study of Rodale's Organic Farm where side-by-side trials of conventional and organic farming take place and have taken place for 30 years. In the results of their famous study, both fields, conventional and organic, leached the same amount of nitrates in runoff, as it was measured, but the Organic system started out with 1.4 times as much bulk nitrogen in Rodale's enriched amended soil. Hence, 1.4 is the magic number. 1.4 is supposed to make the "balanced budget" approach function flawlessly for all irrigators in the state, conventional or otherwise – including Organic.

This solution is very problematic, because nitrates and nitrites leach readily and other forms of nitrogen do not – or leach less. The residence time of nitrogen and water is so much greater in biological soils than in depauperate, carbon-less mineral soils. In fact, the main attribute of Steiner-style agriculture is soil. Organic farmers make soil, conventional farms use up their fertility. Conventional Iowa cornfields lose 7-10 times the soil that is regenerated naturally, exhibiting a huge net loss through erosion. For every ear of corn marketed for feed, 7-10 ears in the soil's chemical entropy are lost to erosion. In a natural system of ecology, soil is made, seldom lost and biological soil accrues naturally over time. There is a net gain over time in soil quality and quantity. Liebig-style agriculture wastes this ecosystem service, and if the ecology is removed from the farm, the cropping system is not sustainable and the lost "ecosystem service" must be replaced – hence, synthetic fertilizers, soil in a sack or tank. The goal of Organic agriculture is zero-loss of soil and water quality, see 7 CFR 205 for the statement.

Not borne out in the panel's ***<u>Conclusions</u>*** is the critical point of difference. Soluble nitrates flow with the water that gravity moves into the ground. Other forms of nitrogen tend to be less soluble and therefore, immobile in the soil. They have residency. Complex organic molecules are stable and are banked in the soil until a biological transformation takes place – the molecule is broken down – decomposed – into smaller mineral nitrogen – the commonest mineral form being nitrates or the gaseous elemental dinitrogen. The alternative approach to "balanced budget" is the "residency" approach of a well-nourished soil. If amendments are manure, green manures, wood chips, compost or humus, the complex nitrogen resides in the soil and not in the water. When temperatures spurt, plants grow and the plants' demand for nitrates grows. Simultaneously, bioactivity in the soil spurts and releases nitrates from the complex organic matter to meet the growing plants' need. It's simply another form of balanced budget.

I think the two approaches have equal merit – the "balanced budget" approach and the "residency" approach. Study after study in Europe has validated the residency approach that is incorporated into Organic, ecological and biodynamic farming. But do remember this! Neither of these approaches is an exact science, and no one knows for sure which will work!

Science may make this level of sustainability possible someday for both Steiner & Liebig styles, but the jury is still out on the possibilities. The evidence favors Organic production, but there is no scientific consensus on that. I am wondering what the **Conclusions of the Agricultural Expert Panel** might have been, had Steiner proponents been impaneled instead of Liebig advocates. The Panel gives one answer to questions that may have had two possible answers apiece, one "balanced budget" and another "residency." Perhaps this reflects the built-in bias of the Liebig-leaning panel.

The expert panel relies on a "balanced budget" approach, but I want to suggest an alternative approach which I will label "biocomplexity budgeting." The object of this approach is to control soil carbon enrichment rather than water & nitrate utilization. I am offering a different answer to the same questions, and there is no right or wrong answer here. The decree of science as to workability is still moot and to be decided; either style may be perfected, perhaps both will be, and the Waterboard will have taken agriculture a step toward sustainability.

First, though, I want to establish that "balanced budget" is a Liebig-style approach and that Liebig-style agriculture has been biased. I am talking about ***scientific bias***. I want to showcase the evidence of this insidious bias, and by inference, I show that Steiner-style agriculture is short-strawed by the overwhelming bias effect on BMP's.

To show bias, the three topics I hit on are mycorrhizology, the position appearing in the **Journal of Ecological Chemistry** and by inference, a phenomenon called "national bias" in medicine. Taken together, the collected evidence would make a substantial case of bias. There's more, but I visit but three. I'm not arguing the case; I'm briefly and merely pointing out the strategy for proving the bias of the expert panel. The specter of this lurking bias authenticates the need for an alternative approach for Steiner-style agriculture.

BIAS

Topic #1: The Liebig "style" of farming focuses on mineral inputs, whereas "Steiner" style centers on the soil's biology and maintaining its intricate web of life – "feed the soil, not the plant" is an all-too-familiar slogan. ***MYCORRHIZA***, volume 16, number 4, page 281, 1996 tabulated the number of mycorrhizologists working in the various nations in support of agriculture. India had a ratio of one mycorrhizologist per 10 million people. The U.S. scored one per million. Sweden had one mycorrhizologist per less than half a million of its population, inasmuch as Canada and Australia had one per quarter-million, actually slightly better ratios. The number of root-fungus scientists per given population reflects the Liebig or Steiner focus on the soil. The US & California ratios have an undeniable Liebig tilt in these numbers.

Topic #2: Peer-reviewed Journals will often remark on the biases of agriculture. Here's an example of one comment that appeared in a recent peer-reviewed article in the ***JOURNAL OF CHEMICAL ECOLOGY***, March 2014, 40(3): 220-221 "Plant Chemical Ecology Finally Gets to its Roots" by Nicole van Dam PhD. "Initially, plant chemical-ecological studies focused mainly on above-ground interactions. One can only speculate about what caused this focus, … roots have a life of their own below the ground and may have as many, or even more, interactions with other organisms as the shoots …" Soil science has been decidedly delinquent in studying these beneath-the-soil interactions that determine the success of any harvest. Again, bias reigns over science, and the panel's thinking is a product of this biased science.

Topic #3: The National Library of Medicine observed that American medical journals cite American [peer-reviewed] articles more than foreign [peer-reviewed] articles written by scientists in other countries, noting something called "national bias" in the field of medicine. No thorough accounting has been done of bibliographical materials in the area of agricultural science, but Europe pays more attention to Steiner-style agriculture, while the U.S. is fixated on Leibig-style, and a quick check of peer-reviewed bibliographies substantiates that bias. The evidence of bias is fairly ample, and the panel's expertise is a product of this biased agriculture, and the panel's answers to the questions reflect this onerous bias. My contention is that California agriculture is biased to Liebig-style agriculture, and that the Liebig bias is reflected in the ***Conclusions*** of the expert panel – particularly in choice of BMP's for nitrate control and groundwater protection.

While California's productivity is the envy of the world, the question of sustainability looms ineluctably. SAREP at UC-Davis defines "sustainability" in agriculture by three components: ecology, economy and equity. Equity can be a bit hard to define but it is the inveterate foundation for civilization and social interaction, from the principle of "an eye for an eye" to "love thy neighbor as thyself" to "all men are created equal" to the underpinning of our buy-and-sell economy "willing seller, willing buyer," all of which are equitable principles that we live by. In 1902 Joseph Conrad wrote, "To tear treasure out of the bowels of the land was their desire, with no more moral purpose at the back of it than there is in burglars breaking into a safe." Does this describe the over-arching priority of economics in agriculture? Economics has bottlenecked the science of agriculture and led us down the blind alley where we only now barely discern the complex constellation of impacts of the world's most stellar agriculture.

Here's a few observations on our bottleneck direction in agriculture:

"We are using an agriculture that probably doesn't work in terms of soil." John Jeavons

"While the soil thins, the human population grows." Colin Tudge

"We save our topsoil like we save our crude oil." John Wiebe

"Agriculture is doing just that – it's costing us the earth." Michael Rhoades

In 1992 *The AMERICAN BIOLOGY TEACHER* documented the shortcoming of Liebig-style agriculture: 1950: one ton of fertilizer increased the grain yield to 46 tons; 1965: one ton of fertilizer increased the grain yield to 23 tons; 1985: one ton of fertilizer increased the grain yield to 13 tons. This is a downward spiral, it's not resource sustainability, and it suggests that Liebig-style agriculture doesn't work sustainably, neither in terms of soil nor in terms of water. The expert panel answers questions that shore up in business-as-usual manner. Ideally, in an ideal world of agriculture, we could provision the soil to grow crops without the addition of irrigation water altogether. Fertilizer would come in the form of recycled nutrients, as in any ecosystem.

The Panel has been dealt a hand of cards that plays a green restoration on the Green Revolution. In the greater picture of things, in an era of conscious sustainability, tractors are supposed to depreciate, resources like soil and water are stable like climate has been for 200 years. The Panel has chosen to take a technological stab at fixing the false accounts – namely, balancing the Liebig budget. To be fair, the Panel ought to acknowledge the secondary approach of Steiner-style farming in preserving the resources. This would be equitable – for the Panel to give Steiner-style farming a level playing field with Liebig-style agriculture in terms of their selected BMP's.

I say give the many manifestations of Steiner agriculture a chance too. BMP's for Steiner-style agriculture differ inherently from those of Liebig-style, though farms may deploy some of both styles. There has to be a way to eliminate the bias from agricultural science and not to stifle trends in the field of Organic agriculture. The ***CONCLUSIONS OF THE AGRICULTURAL EXPERT PANEL*** sought only one right answer when the opportunity for two right answers to each question persists.

The "balanced budget" approach reflects the NRCS BMP's of nutrient management and irrigation management [e.g. NRCS codes 447, 443, 441, 442, 449 for irrigation practice standards]. In effect, "balanced budget" monitors the Liebig-style inputs – with the fatuous remark on page 26 of the ***Conclusions*** calling it "a major advancement for most farmers." The truth is that the Centers for Disease Control elevates "rain-fed agriculture" on their website because irrigation tends to contaminate the topsoil and the food chain. The major advancement is dry-farming - no irrigation at all – and farmers will have to prop up the soil quality to achieve this raptured endpoint. The ***Conclusions*** pretends to make their Balanced Budget BMP work on both Steiner and Liebig styles with the Waterboard's "1.4" flourish. The thinking is unmistakable: one size fits both styles, and nitrate application allowed is 1.4-times whatever is needed by the crop for the expected harvest. 1.4 is the monumental magic number and 1.4 was chosen because it relates to the Hepperly/Pemintel study of nitrate leaching on the

Rodale farm near Emmaus, PA. The half-life of ammonium nitrate fertilizer in crop field is days, so farmers of the cornbelt split their delivery – sidedressing knee-high corn after the seed was injected with fertilizer. The half-life of manure incorporated into the soil has been documented to be 5 years; wood chips last much longer. The Panel's gold-plate answer of "1.4"will stymie and stifle the scientific research in Organic agriculture; I urge the Panel to revise its ***Conclusions*** so that the flexibility of adaptive management is preserved with alternative BMP's – give two answers to an official question rather than one answer, albeit one one-size-fits-all answer. The "balanced budget" as the lone approach to both styles is basically biased and needs revision.

"1.4" derives from the Hepperly/Pemintel Study where comparison trials of Organic and conventional farming played out side by side. In the study, the estimated loss of nitrates was roughly equal, but the Organic system had 40% more nitrogen to utilize at the outset – mostly stored in the soil as organic matter – hence, the 1.4. The "balanced budget" approach works if and only if "1.4 times expected need" works. How do we figure ***need***?

The July 2014 ***ACRES U.S.A.*** interviewed Bob Castisano on page 52. Bob comments on page 56, "...the grape industry is ridiculously dependent on irrigation. A number of clients and friends, who haven't irrigated wine grapes in normal years for 30 or 40 years, are producing large high-quality fruit, while operating next door to wine growers irrigating three times a week. You tell me what the need for water is on those grapes, other than a difference of philosophy on the part of the people doing the dry-farming and those addicted to water to make up for other farming deficiencies." The Panel seems hard-headed about this message – we talk about "biocomplexity building" as an alternative, but the notion of ***resilience*** is fundamental to a sustainable operation. Ecosystems are sustainable, agrosystems depreciate. The difference is resilience. UCCE & Berkeley professor Miguel A Altieri illustrates resilience in his video ***Using agroecological practices to enhance the resilence of organic farms to drought,*** on Web at UC ANR.

A certified nutrient/irrigation plan is fine for Liebig-style agriculture; but as an alternative, especially to benefit small Organic farms, the practical BMP could be "registered Organic with CDFA or certified Biodynamic, both with a written OSP that includes cover crops plus soil tests that show improvement in the parameter of soil organic matter." The reality is that some types of farming pollute more, and some less. There is no incentive to pollute less or to irrigate less in a balanced budget system – only to trim excess. The Panel is stuck on one answer to each question, a question that has multiple BMP answers.

Specific criticisms

Please listen: "The organic matter in soil acts like a sponge, providing water reserves to plants during drought periods and preventing water from running off the soil surface in times of heavy rains … the more we rely on our soil rather than our *hoses*, the better off we'll be." Quoted, Rita Seidel, agroecologist and scientist with the Rodale Institute's research farm.

The Panel's ***Conclusions*** are ***hose-heavy***.

I.

Conclusions, page 19, section 3.2.1.ii "The concept of risk … 1. Human health risks … associated with the ingestion of drinking water with nitrate-N concentrations exceeding the MCL of 10 mg/L."

Let me be blunt: this is wrong. There is a California standard and there is a federal standard, and the Federal standard differs and dictates. See the accompanying page for the details. The U.S. standard for drinking water is nitrate-N + nitrite-N is less than the mcl of 10 mg/L. I recommend clarification of the standards.

II

Conclusions, generally – N uptake by plants

Plants make their food: sugars [CHO] and proteins **[CHON]** Ectomycorrhizae that sheath the roots determine how much nitrate is taken up and utilized by the crop. During drought, mycorrhizae shape the plant's metabolism in favor of sugars. Less nitrate is removed and used to make protein.

Technical Factsheet on: NITRATE/NITRITE

List of Contaminants

As part of the Drinking Water and Health pages, this fact sheet is part of a larger publication:
National Primary Drinking Water Regulations

Drinking Water Standards (in mg/L)

Nitrate- MCLG: 10; MCL: 10; 10-day HAL: 10
Nitrite- MCLG: 1; MCL: 1; 10-day HAL: 1
Total (Nitrate+Nitrite)- MCLG: 10; MCL: 10; 10-day HAL: 10

Health Effects Summary

Acute: Excessive levels of nitrate in drinking water have caused serious illness and sometimes death. The serious illness in infants is due to the conversion of nitrate to nitrite by the body, which can interfere with the oxygen-carrying capacity of the child's blood. This can be an acute condition in which health deteriorates rapidly over a period of days. Symptoms include shortness of breath and blueness of the skin.

Drinking water levels which are considered "safe" for short-term exposures: For a 10-kg (22 lb.) child consuming 1 liter of water per day, a ten-day exposure to 10 mg/L total nitrate/nitrite.

Chronic: Effects of chronic exposure to high levels of nitrate/nitrite include diuresis, increased starchy deposits and hemorrhaging of the spleen.

Cancer: There is inadequate evidence to state whether or not nitrates or nitrites have the potential to cause cancer from lifetime exposures in drinking water.

Usage Patterns

Most nitrogenous materials in natural waters tend to be converted to nitrate, so all sources of combined nitrogen, particularly organic nitrogen and ammonia, should be considered as potential nitrate sources. Primary sources of organic nitrates include human sewage and livestock manure, especially from feedlots.

The primary inorganic nitrates which may contaminate drinking water are potassium nitrate and ammonium nitrate. Potassium nitrates are used mainly as fertilizers (85%), with the remainder in heat transfer salts, glass and ceramics, and in matches and fireworks. Ammonium nitrates are used as fertilizers (84%) and in explosives and blasting agents (16%).

Release Patterns

The major environmental releases of inorganic sources of nitrates are due to the use of fertilizers. According to the Toxics Release Inventory, releases to water and land totalled over 112 million pounds from 1991 through 1993. The largest releases of inorganic nitrates occurred in Georgia and California.

Environmental Fate

Due to its high solubility and weak retention by soil, nitrates are very mobile in soil, moving at approximately the same rate as water, and has a high potential to migrate to ground water. Because it does not volatilize, nitrate/nitrite is likely to remain in water until consumed by plants or other organisms. Ammonium nitrate will be taken up by bacteria. Nitrate is more persistent in water than the ammonium ion. Nitrate degradation is fastest in anaerobic conditions.

Chemical/Physical Properties

CAS Number: Nitrate ion: 14797-55-8; Nitrite ion: 14797-65-0

Color/ Form/Odor: Domestic fertilizer grade ammonium or potassium nitrates are in prilled (beaded) or crystalline forms, usually coated with an anti-caking agent and adsorbed fuel oil.

Solubilities: Nitrates and nitrites are highly soluble in water

Soil sorption coefficient: N/A

Bioconcentration Factor: N/A

Trade Names/Synonyms:
Potassium salt: Potnit, Hitec, Niter, Nitrate of potash, Saltpeter.
Ammonium salt: German or Norway saltpeter, Varioform I, Merco or Herco prills, Nitram.

Other Regulatory Information

Monitoring:
-- For Ground Water Sources:
Initial Frequency-Nitrate: 1 sample annually
Nitrite: 1 sample during first 3-year compliance period
Repeat Frequency-Nitrate: 1 sample annually
Nitrite: determined by State
-- For Surface Water Sources:
Initial Frequency-Nitrate: 1 sample each quarter
Nitrite: 1 sample during first 3-year compliance period
Repeat Frequency-Nitrate: 1 sample annually
Nitrite: determined by State
--Triggers - If detect at > 5 mg/L nitrate, sample quarterly.
If detect at > 0.5 mg/L nitrite, sample quarterly.
If detect total nitrate + nitrite > 5 mg/L, sample quarterly

Analysis

Reference Source	**Method Number**
EPA 600/4-79-020	353.1; 353.2; 353.3; 300.0; 354.1
Standard Methods	418C; 418F
ASTM	D3867-85A; D3867-85B

Treatment/Best Available Technologies: Ion exchange; Reverse osmosis; Electrodialysis (nitrate only)

Toxic Release Inventory - Releases to Water and Land, 1987 to 1993 (in pounds):

	Water	**Land**
TOTALS	**59,014,378**	**53,134,805**
Top Fifteen States*		
GA	12,114,253	12,028,585
CA	0	21,840,999
AL	3,463,097	6,014,674

Irrigation is often cut off in sugar beet fields prior to harvest, thereby increasing the sugar content of the root. Sugar corn is sweeter when the available water is limited to the maturing ear.

Adjuvants in the formulation of 2,4-D caused beets to accumulate nitrates in the foliage so that cattle, when fed the foliage, got sick from methemoglobinemia. See, John M Kingsbury, ***POISONOUS PLANTS OF THE UNITED STATES AND CANADA.***

III

Conclusions, page 25 "…Educational programs must address two key groups …"

A third group is equally important and must not be omitted here. ***3. Inspectors, regulators, waterboard staff.***

The EPA's textbook for regulators ***NATIONAL MANAGEMENT MEASURES FOR THE CONTROL OF NONPOINT POLLUTION FROM AGRICULTURE*** contains a laundry list of BMP's in its appendix. The textbook manual further notes BMP's can be found in the USDA-NRCS manual of conservation practice standards, one of which is Code 500, Obstruction Removal.

During the "waiver" era, the waterboard resolutions required an NOI that described BMP's in use on a farm. Code 500 was reported in one NOI, and the waterboard staff who reviewed were unfamiliar with Obstruction removal and did not recognize the BMP. The result was a Waterboard letter threatening to cite and fine the farmer who used the "code 500" BMP..

The Clean Water Act has a provision that requires the states to eliminate duplication of paperwork in their regulatory requirements. Organic Farmers who have an OSP will have to revise and resubmit their OSP to meet the waterboard requirements. The inspectors who certify farms as Organic may have to be trained in two paperworks, and they are part of the third group that has been omitted. They are a key group.

NRCS EQUIP monies, and other NRCS programs, give farmers money to pay for installing BMP's. The NRCS has "certified conservation planners" that coordinate and reconcile the BMP's. CCP's and NRCS staff are essential members of this third group omitted from the ***Conclusions.***

IV

Conclusions, page 28 "define the process for certification of 'planners'." I want to both star and rubricate this section – it's very good! However, it is in conflict with and can be irreconcilable with the chart on page C-13 of the ***Conclusions***. I would include a paragraph "i" after "sentence "h" Paragraph i would read: "Training farmers, or professionals, to prepare and self-certify their own plans is the abiding goal." The problem with the chart is **not** that there are too few professionals – there are too few professionals who are even capable of the "planning" work.

Two anecdotes of relevance: I talked to Dennis, the state agronomist with the NRCS, who – with a flair of honesty that I admired – said he'd be hard-pressed to develop a suite of groundwater BMP's for a farm. He is an ASA-certified agronomist, and the chart presumes his expertise.

In the ASA's ***Preparing for the 2014 international Certified Crop Advisor Exam***, published by the IPNI, question 75 on page 41 gave a wrong answer.

"75. Which of the following is **not** part of the purpose of a nutrient management plan…" The answer in the answer key was "C. improve atmospheric conditions." Of course, if one refers to the USDA NRCS "nutrient management' BMP (also called a "conservation practice") one sees the contrary – the NRCS BMP "nutrient management" includes as its stated purpose "improving atmospheric conditions." The chart has the presumption that the ASA professional would get this answer right.

As of right now, there are no good textbooks or manuals on the concepts that lie behind BMP's or "conservation practices." The best textbook is the EPA's manual ***MANAGEMENT MEASURES FOR THE CONTROL OF NONPOINT POLLUTION FROM AGRICULTURE***. Certainly, professionals like landscape architects and agronomists are fitter than most farmers by their education to read and absorb the concepts that lie behind these BMP's.

Otherwise, no one is truly fit in the discipline of BMP's by their education, no one has the over-arching knowledge and experience inculcated inside them. I will share two examples:

Road design can be either **for runoff** and part of the drainage system (artificial tributary of the watershed) or **for infiltration** as part of the recharge system. [See UCCE ANR for details.] A PE will not know this despite his sheepskin; ANR teaches these lessons with a team of a CalFire fire-fighter, a geologist and a UCCE farm advisor. BMP's like inboard design, culverts and ditches favor channelization of the flow; BMP's like crowning or outsloping coupled to infiltration zones favor the filtered recharge of groundwater. Who would know this by their education?

Or, take **armoring** for example. "Armoring" is a conservationist's term for what happens with erosion (splash, sheet, rill & gully) The smaller particles erode leaving behind a surface of gravel – or sand – or on the Valley floor, silt, in streambeds. Hiking trails show natural armoring where water races down the tread removing silt and sand and leaving larger gravel behind. At the dip in the trail, erosive energy slows and silt builds on the trail tread. We "armor" our artificial tributaries: we gravel rural roads, we lay down asphalt, we surface them with "hard-scape." The term "hardscape" appears in California's water code – the sections that incorporate the ***California Water Plan Update***'s 2009 & 2013.

Armoring, hardscapes, artificial tributaries are working concepts that these professionals may never have encountered during their education years. The USDA NRCS has a BMP titled "field access" that requires some of this very knowledge. Someday, universities may offer four-year degrees in the science of BMP's.

BMP's are a new disciplne, a new field of study, altogether, and ***Conclusions*** of the expert Panel fails to make note of that point.

V

Conclusions, page 32 – just a minor point here: "…measuring groundwater was deemed unreliable, because the source of the nitrates cannot be pinpointed." If it could be **pinpointed**, it would **point-source** pollution. The ILRP focuses on nonpoint pollution.

I think the term "legacy nitrate" would be a useful term to use here – and adding "legacy nitrate" to the list of definitions is a good idea.

(Defined) Legacy nitrate: what's in groundwater and may be 5-, 10-, or 50- years old, depending on the time span of translocation.

Conversion nitrate: nitrate is a product of bacterial decomposition of organic matter or other mineral fertilizers [example, potassium nitrite fertilizer yields nitrate through bacterial interaction].

Fertilizer nitrate: what's applied to a field

Legacy-monitoring does not lend itself timely feedback of the effectiveness of BMP's. This is the point that is repeated made in the ***Conclusions***.

Points missed in the ***Conclusions*** report include the following:

Nitrates are soluble and water translocates nitrates as it migrates or moves.

Ammonia fertilizers are rather insoluble, but nitrate is the mobile conversion product of microbial interactions in the soil.

Nitrogenous organic matter in the soil is relatively stable and immobile until microbial decomposition and conversions take place to make it nitrate. Peat moss in permfrost regions is centuries old. I would dub this "the soil's N-reservoir." Soil is a staging area for decomposition and conversion in its role as a nitrogen bank; the pie-chart of inputs and outputs excludes this residency. BMP's that promote a longer residency or make resident nitrogen available to plants on a uptake-timely/need basis will spare groundwater of nitrate contamination too.

I want to thank the Panel for their excellent work in preparing the ***Conclusions***, and I trust my comments will be given fair, impartial and judicious consideration.

Sincerely,

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Technical Factsheet on: NITRATE/NITRITE

List of Contaminants

As part of the Drinking Water and Health pages, this fact sheet is part of a larger publication:
National Primary Drinking Water Regulations

Drinking Water Standards (in mg/L)

Nitrate- MCLG: 10; MCL: 10; 10-day HAL: 10
Nitrite- MCLG: 1; MCL: 1; 10-day HAL: 1
Total (Nitrate+Nitrite)- MCLG: 10; MCL: 10; 10-day HAL: 10

Health Effects Summary

Acute: Excessive levels of nitrate in drinking water have caused serious illness and sometimes death. The serious illness in infants is due to the conversion of nitrate to nitrite by the body, which can interfere with the oxygen-carrying capacity of the child's blood. This can be an acute condition in which health deteriorates rapidly over a period of days. Symptoms include shortness of breath and blueness of the skin.

Drinking water levels which are considered "safe" for short-term exposures: For a 10-kg (22 lb.) child consuming 1 liter of water per day, a ten-day exposure to 10 mg/L total nitrate/nitrite.

Chronic: Effects of chronic exposure to high levels of nitrate/nitrite include diuresis, increased starchy deposits and hemorrhaging of the spleen.

Cancer: There is inadequate evidence to state whether or not nitrates or nitrites have the potential to cause cancer from lifetime exposures in drinking water.

Usage Patterns

Most nitrogenous materials in natural waters tend to be converted to nitrate, so all sources of combined nitrogen, particularly organic nitrogen and ammonia, should be considered as potential nitrate sources. Primary sources of organic nitrates include human sewage and livestock manure, especially from feedlots.

The primary inorganic nitrates which may contaminate drinking water are potassium nitrate and ammonium nitrate. Potassium nitrates are used mainly as fertilizers (85%), with the remainder in heat transfer salts, glass and ceramics, and in matches and fireworks. Ammonium nitrates are used as fertilizers (84%) and in explosives and blasting agents (16%).

Release Patterns

The major environmental releases of inorganic sources of nitrates are due to the use of fertilizers. According to the Toxics Release Inventory, releases to water and land totalled over 112 million pounds from 1991 through 1993. The largest releases of inorganic nitrates occurred in Georgia and California.

Environmental Fate

Due to its high solubility and weak retention by soil, nitrates are very mobile in soil, moving at approximately the same rate as water, and has a high potential to migrate to ground water. Because it does not volatilize, nitrate/nitrite is likely to remain in water until consumed by plants or other organisms. Ammonium nitrate will be taken up by bacteria. Nitrate is more persistent in water than the ammonium ion. Nitrate degradation is fastest in anaerobic conditions.

Chemical/Physical Properties

CAS Number: Nitrate ion: 14797-55-8; Nitrite ion: 14797-65-0

Color/ Form/Odor: Domestic fertilizer grade ammonium or potassium nitrates are in prilled (beaded) or crystalline forms, usually coated with an anti-caking agent and adsorbed fuel oil.

Solubilities: Nitrates and nitrites are highly soluble in water

Soil sorption coefficient: N/A

Bioconcentration Factor: N/A

Trade Names/Synonyms:
Potassium salt: Potnit, Hitec, Niter, Nitrate of potash, Saltpeter.
Ammonium salt: German or Norway saltpeter, Varioform I, Merco or Herco prills, Nitram.

Other Regulatory Information

Monitoring:
-- For Ground Water Sources:
Initial Frequency-Nitrate: 1 sample annually
Nitrite: 1 sample during first 3-year compliance period
Repeat Frequency-Nitrate: 1 sample annually
Nitrite: determined by State
-- For Surface Water Sources:
Initial Frequency-Nitrate: 1 sample each quarter
Nitrite: 1 sample during first 3-year compliance period
Repeat Frequency-Nitrate: 1 sample annually
Nitrite: determined by State
--Triggers - If detect at > 5 mg/L nitrate, sample quarterly.
If detect at > 0.5 mg/L nitrite, sample quarterly.
If detect total nitrate + nitrite > 5 mg/L, sample quarterly

Analysis

Reference Source	Method Number
EPA 600/4-79-020 353.1; 353.2; 353.3; 300.0; 354.1	
Standard Methods 418C; 418F	
ASTM D3867-85A; D3867-85B	

Treatment/Best Available Technologies: Ion exchange; Reverse osmosis; Electrodialysis (nitrate only)

Toxic Release Inventory - Releases to Water and Land, 1987 to 1993 (in pounds):

	Water	Land
TOTALS	**59,014,378**	**53,134,805**
Top Fifteen States*		
GA	12,114,253	12,028,585
CA	0	21,840,999
AL	3,463,097	6,014,674