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August 8, 2016

Statement to ND Health Council Regarding Proposed Changes to TENORM Waste Disposal Regulations

"The facts are really not at all like fish on the fishmonger's slab. They are like fish swimming about in a vast and sometimes inaccessible ocean; and what the historian catches will depend partly on chance, but mainly on what part of the ocean he chooses to fish in and what tackle he chooses to use---these two factors being, of course, determined by the kind of fish he wants to catch. *By and large, the historian will get the kind of facts he wants."*
Edward Hallett Carr [What is History? 1961]

Bio Summary. I am Robert E. Moran, a hydrogeologist / geochemist with more than 44 years of domestic and international experience in conducting and managing water quality, geochemical and hydrogeologic work for private investors, industrial clients, tribal and citizens' groups, NGO's, law firms, and governmental agencies at all levels. Much of this technical expertise involves the quality and geochemistry of natural and contaminated waters and sediments as related to mining, nuclear fuel cycle sites, industrial development, geothermal resources, hazardous wastes, and water supply development. I have significant experience in the application of remote sensing to natural resource issues, development of resource policy, and litigation support. I have often taught courses to technical and general audiences, and have given expert testimony on numerous occasions. Countries worked in include: Australia, Greece, Bulgaria, Mali, Senegal, Guinea, Gambia, Ghana, South Africa, Iraqi Kurdistan, Oman, Pakistan, Kazakhstan, Kyrgyzstan, Mongolia, Romania, Russia, Papua New Guinea, Argentina, Bolivia, Chile, Colombia, Guatemala, Haiti, Honduras, Mexico, Peru, El Salvador, Belgium, France, Canada, Great Britain, Netherlands, Spain, United States.

Recommendation. Because of the numerous weaknesses discussed below (TENORM data inadequacies; uncertainties regarding actual, documented long-term impacts to human health and the environment; inadequate oversight by the State agencies; inadequate screening of TENORM wastes prior to disposal, etc.), I recommend that the Health Council not approve the proposed increase in the TENORM radiation standard at this time. Instead, it would seem wiser to slow down this process, and direct the NDDH to respond to the inadequacies described here and in the public comments prior to revisiting the TENORM radiation standard at a future date.

Introduction.

Dear Mr. Peterson and Other Health Council Members:

I have been asked by *Dakota Resource Council and the North Dakota Energy Industry Waste Coalition* to review the scientific underpinnings of the Health Department's recommendation to adopt proposed regulations governing TENORM radioactive waste presented to you almost one year ago.

The Health Council is caught in the dilemma of being asked to rule on an extremely complex public issue while much of the most relevant information was previously *mischaracterized or was never presented to you*. Also, your ruling involves two of the most controversial public interest arenas---*oil & gas and radiation***.** Thus, while the NDDH may wish to say that this determination is based purely on *scientific "facts"*, it is also heavily influenced by *political and economic pressures*—as is routine in such situations.

The Federal government has published documents on NORM (naturally-occurring radioactive materials) and TENORM (Technologically Enhanced Naturally-Occurring Radioactive Materials) since at least the mid-1970s. The various federal agencies have argued over these issues for decades, yet have never decided how to regulate TENORM at the federal level. *Hence, they have kicked the can down the road to you.*

Ground waters below and adjacent to North Dakota special waste sites are already being contaminated by oilfield wastes, and likely also by TENORM wastes. This is substantiated by the findings in a recent (July 2016) study at IHD Solids Management Facility conducted for the McKenzie County Board of Commissioners (Torstenson, 2016).

My comments are presented in the following sections:

I-Science-based Criticisms of the Argonne (ANL) Study.
II-Inadequate TENORM Waste Information / Data (publicly-available) in ND
  -Self-monitoring, etc.
  -Fate of TENORM Wastes? Volumes?
  -Contamination in ND
III- Waste Screening Concerns
IV- Ground Waters Near Present Special Landfills
V-Unprepared to Enforce Regulations
VI- General TENORM Comments

I.Science-based Criticisms of the Argonne (ANL) Study.

As you know, the Health Department relied almost entirely on the Argonne National Laboratory Report (ANL,2014) when telling you that changing the limit on radioactive waste from 5 to 50 pCi/g was safe. Further, the Health Department told you on August 11, 2015 that "there was not any significant scientific data presented [during the comment period] to show that the proposed limit of 50 pCi/g should be changed."

I've also read those comments and the ANL report, and I *strongly disagree*. There was a lot of valid and significant scientific criticism of the assumptions, estimations and methodology of the Argonne Risk Assessment.

I will highlight some of these significant scientific concerns so that you can independently weigh the validity of the Health Department's dismissal of those criticisms.

1-NDDH neglected to tell the you that outside experts on radioactive wastes and the related computer simulations made several intelligent and knowledgeable criticisms of NHL simulation approaches and conclusions.

One is Robert Morris, a Principal Health Physicist with the firm of MH Chew, a national **firm that specializes in** radiation protection and nuclear safety, and in conducting such modeling**,** sent detailed comments to NDDH (Letter: R. Morris to Scott Radig; Mar. 2, 2015, 6pg.). While supporting the new TENORM standard, MH CHEW cited many **weaknesses in the ANL model simulations**, many of which are summarized in the NDDH COMMENTS at pg. 30 through 36.

All of the MH CHEW technical comments were significant, knowledgeable comments, yet all were dismissed by the NDDH.

Another radiation expert that sent detailed criticisms of the ANL study is Daniel Shrum [Letter from Treesa Parker of Energy Solutions to Scott Radig, containing comments of Dan Schrum; Jan. 26, 2015].

Daniel B. Shrum, is Sr. V.P. for regulatory affairs of Energy Solutions, a nuclear services company that owns and operates radioactive waste transportation, processing, recycling and disposal facilities throughout the US and Canada, **strongly disagreed with the use of the 100-mrem/year dose limit** (NDDH, 2015-- Review and Response to Public Comments, p.70-71).

"Shrum of Energy Solutions recommends that North Dakota regulation should re-evaluate the disposal concentration limits, with the new limits being based upon <1 mrem/year RESRAD and TSD- Dose modeling. The risk based models should examine both non-radworker landfill worker/disposal dose pathways and also dose pathways to affected members of the public consistent with NRC, Agreement State, and IAEA International protocols. **The current proposition to establish nuclide disposal concentrations limits derived from a 100 mrem/year modeling is 100 times higher than all accepted nuclear exemption regulation and should be reconsidered prior to promulgation.** (Energy Solutions)" (NDDH, 2015-- Review and Response to Public Comments, p.70-71).

Thus, the use of the 100-mrem/year dose limit—the basis for both the ANL study and the NDDH justification of the proposed 50 pCi/g radium Standard---has also been questioned by a nuclear services company, Energy Solutions.

NDDH dismissed the Energy Solutions comments.

2-The ANL study failed to consider and discarded numerous pathways and factors which operate in the real world.

-**Produced waters: excluded** from risk assessment (electr. p.25-26)

-TENORM- **contaminated equipment**: "Data describing the potential volume of this waste stream **have not been collected in North Dakota**. **This waste stream was not included** in the scope of this risk assessment." **(**electr. p. 27)

-**contaminated Soils pathway was not considered**.

-disposal of proppants was not considered.

3-The Argonne (ANL) TENORM Study (Harto, and others, 2014) results <u>do not</u> support raising the North Dakota TENORM waste disposal standard from 5 pCi/g to 50 pCi/g of total radium.

The ANL report is a purely **theoretical modeling exercise**. No actual data or measurements (radiation levels, doses, concentrations, activities) from any North Dakota TENORM materials were used in conducting the study. Instead all ANL predictions were purely theoretical, based on estimations and assumptions, and computer-derived simulations.

None of the *industry-generated* TENORM data provided in ANL Table 2.1 (electronic p.24) were used in the ANL computer simulations. Apparently these were included to give the casual reader the impression that actual data were used.

Yes, ANL has created some **theoretical, mathematical, computer simulations** of Risk Assessment and Dose Calculations—all based on theoretical assumptions. Now let's see some studies to show that such predictions have any relevance to the real world. **Where are the real world data to show what relationship exists between these predictions and any observed risks and doses?**

ANL has operated since 1946. Surely they have had ample time to collect real world data to allow reliable comparisons between predicted and actual (measured) Risk Assessment and Dose Calculations.

After consulting several radiological experts, **none knew of any studies which demonstrate that such predictions are reliable**, or the extent to which they are unreliable.

3-NDDH has neglected to consider several sources of natural radioactivity when proposing the revised TENORM standard of 50 pCi/g of total radium. The ANL study also neglected to consider the majority of these other TENORM sources, known to be present in oilfield waters.

For decades, industry and government studies have reported on the wide range of TENORM constituents known to be present in oil and gas operational wastes. These include: e.g. radioisotopes of uranium (U-235, 238), thorium (Th-232), radium (Ra-226 / 228), radon (Rn-222), potassium (K-40), lead (i.e. Pb-210), polonium (Po-210), strontium, rubidium, thallium (numerous), and their decay products.

ANL also focused their theoretical model simulations on radium. However, the ANL study recommended that the North Dakota TENORM standard be based on total radium (Ra-226 plus Ra-228) activity concentrations, but also "taking into consideration the presence of Th-232 and the relative concentrations of Th-232 and total radium in the waste samples measured." (ANL, 2014, electronic pg. 18).

Nevertheless, the NDDH has proposed a TENORM standard based only on the presence of radium (Ra-226 / 228).

In the 2-page TENORM Information Sheet, NDDH (2014, Dec.) stated:
"The study found that the highest level of exposure in the various disposal scenarios would be to a worker employed at an active landfill. If the landfill were accepting TENORM at a concentration of 51.6 picocuries per gram, that worker could potentially reach an exposure level of 100 mrems/year, which is the maximum recommended public exposure. This maximum exposure scenario identifies the acceptable upper limit of TENORM, and the NDDH used this data to propose a new disposal limit of 50 picocuries per gram."

The author of these responses fails to tell the reader how difficult it is to obtain reliable (precise, accurate, statistically-representative) TENORM data based on field sampling followed by any sort of analysis. Numerous factors contribute to wide ranges of normal error in such data, so that the results routinely have **error** bars (or confidence limits) that are **often plus or minus 10, 50, or even 100 percent of the reported value**. Such routine errors (the sum of sampling, handling and analytical errors) obviously mask any attempt to reliably interpret data down to a few picocuries per gram. Yet, the ANL authors claim their theoretical modeling results are that precise (see 51.6 picocuries per gram in paragraph above).

II. Inadequate TENORM Waste Information / Data (publicly-available) in ND.

1-**Industry Generated Data**. Almost all data relating to TENORM or special wastes disposed of in ND come from industry sources. These categories include data on:
-fate of TENORM wastes;
-volumes of TENORM wastes;
-all environmental monitoring data;

-estimations of radioactivity in wastes;
-presence of TENORM contamination in air, soils, ground or surface waters;
-composition of wastes.

Thus, it is clear that the industry is essentially **self-monitoring**.

2-No Baseline Data. All of the reports and or data I have reviewed relating to TENORM wastes in ND, indicate that **no actual**, **pre-operational baseline data have been collected** at any relevant landfill sites.

Many of the North Dakota TENORM-related documents I have reviewed, including numerous authored by the NDDH, seem to consider "baseline" to be synonymous with "background", which is incorrect and misleading. Rose, Hawkes & Webb (1979, p.30) state the following: "The normal abundance of an element in unmineralized earth materials is commonly referred to as **background**." Baseline data are the data (soils, water, air, vegetation, aquatic biota, etc.) collected before an actual project or activity begins operations. It is imperative that detailed **baseline** data be collected at all landfill sites prior to the initiation of operations, or one has no "yardstick" against which to tell whether the disposal practices have caused changes or not.

3-Oil and gas production activities have been exempted from Federal regulation regarding TENORM. For decades, the **oil & gas industry has been exempt** from any NORM OR TENORM regulation at the federal level. They are essentially **self-monitoring** when it comes to revealing TENORM and other chemical information to regulators. Hence, they do not routinely collect and make public such data, which would "load the regulatory gun" for their opponents. So, the NDDH and other regulatory agencies **lack the technical data** to reliably regulate such matters.

A recent article in Science discusses these problems with respect to oilfield waters, and cites the original research findings from Nelson and others (2015). The paper can be found at:
Brown, Valerie, 2015, Study raises questions about measuring radioactivity in fracking wastewater; Science Magazine.
http://www.sciencemag.org/news/2015/04/study-raises-questions-about-measuring-radioactivity-fracking-wastewater

4-**Monitoring Data from ND Special Oilfield Waste Facilities**
North Dakota has 13 special oil field waste facilities that currently accept a variety of waste forms from oil and gas production. If the new radioactivity standard is approved, these facilities would be eligible to accept TENORM wastes after receiving the appropriate permit (WORC 2015, p.37-38).

The public should be allowed to see detailed monitoring data for these 13 sites, together with details on their monitoring networks (air, soils, waters), and whether they have adequately defined pre-operational **baseline**.

Obviously TENORM wastes are presently being disposed in ND landfills---based on information in the IHD report (Torstenson, 2016).

-Fate of Rejected TENORM loads:
The NDDH Responses to COMMENTS states (electr. pg.84): V.q. **Comments**： There were a number of comments regarding previously rejected loads and what will happen with rejected loads in the future, such as:

"Second thing I'd like to know is what happens to the radioactive waste? In 2013, I believe in McKenzie County Landfill, **they rejected 1000 loads of oilfield waste** that were coming in because they were measuring it, using a Geiger counter or some kind or another. I would like someone from the health department to tell me what happened to those 1000 loads, and I have asked. I would like to know **where the radioactive waste from North Dakota has been going for the last five years."** (Williston page 6)

Obviously the NDDH does not know the answer to this question.

5- **Radiological Characteristics of TENORM Wastes**
NDDH is clearly **uncertain** about the actual chemical and radiological characteristics of the TENORM wastes to be disposed in the ND landfills, as no detailed summaries have been made public. **All of the TENORM waste data provided in ANL Table 2 (electr. pg. 24)** were supplied by industry sources and many of the waste categories had inadequate samples to be statistically meaningful. Also, there is no way for the public to know if these samples reliably represent the actual spectrum of TENORM wastes. Such sampling should be conducted by a party that is financially and politically separate from the oil & gas industry. As stated above, none of the data in ANL Table 2 were actually used in any of the ANL simulations.

Actual field measurements and lab analyses for all TENORM wastes should be collected BEFORE altering the regulations. Laboratory determinations of Gross, alpha, beta and gamma might be most practical.

How is it possible for NDDH to reliably regulate TENORM wastes if they do not possess detailed information on the forms (alpha, beta, gamma) and quantities of radiation being generated?

III. Waste screening techniques and inadequate methods & descriptions
Numerous technical sources report that oilfield TENORM wastes emit various combinations of **alpha, beta and gamma radiation.** Thus, NDDH should require screening of these wastes for alpha, beta and gamma radiation before they are transported to an approved waste disposal site. In addition, the NDDH should have department staff or independent contractors who periodically make independent field measurements for total radioactivity of TENORM waste loads before disposal.

Clearly there are currently some difficulties in finding portable meters that measure / estimate all three forms of radiation, **but this issue must be overcome before approving the proposed increase in the TENORM radiation standard.**

Several commenters noted that there must be a viable, real-time, field waste screening technique. They also commented on the confusion and lack of detail in the proposed TENORM regulations as regards **screening of wastes prior to disposal**. Interestingly, those quoted below are **operators of commercial waste sites and the ND Petroleum Council.** For example, from COMMENTS, p. 36-38:

"The laboratory methods currently approved by the NDDH do not allow for an immediate or real time result of the level of radioactively of a waste material. A field method and instrument must be approved that demonstrates an equivalency to the laboratory method." (**Clean Harbors**)

"The subject of screening for wastes that may contain levels of radioactivity subject to the regulation was raised by a couple of the speakers at the hearing. I would like to add to those discussions the suggestions that the Department consider adopting a maximum reading on a Geiger counter that would trigger the requirement to test." **(IHD)**

"These regulations create a disposal limit of TENORM as determined in picocuries per gram (pCi/g). There is no rapid field measurement currently available for accurate determinations of pCi/g. The only reliable method is a 21day laboratory analysis. This presents a significant compliance burden, not only for operators, but for disposal facilities receiving TENORM waste. In order for operators to segregate waste economically, and for disposal facilities to accept this waste with confidence, **real-time radiation measurements must be achievable. (ND Petroleum Council)**

The confused and contradictory NDDH response to those screening comments (below) shows that efforts to modify the 5 pCi / g standard are premature and have not been carefully and scientifically evaluated.

p.38: *IV.a.* ***Response****: "The Department's Radiation Control Program has received scientific documentation of short turn-around TENORM screening methods from several vendors. As these methods are approved by the Department, they are posted on the Department's website https://www.ndhealth.gov/AQ/RAD/Licensed_tenorm_testing.htm. All persons requesting approval for a field screening procedure are required to submit split samples to an independent laboratory that uses one of the approved 28 day ingrowth testing methods such as the EPA 901.1(m) or the HASL 300 and submit the results to the Department. The screening results will be compared to the laboratory results to determine they do not deviate by more than two standard deviations from the mean. Some screening testing methods can provide results in as short as one day or less."*

"Survey meters may be used as a screening method to determine whether or not the waste material is radioactive, however, they do not indicate what radioisotopes are present or the amount or concentration. There is no direct correlation between the survey meter reading and the laboratory analysis. The survey meter is measuring how much radiation is being given off and the laboratory analysis is indicating what radioisotopes (i.e. Ra-226 and Ra-228) are present and at what concentrations (i.e. pCi/g).

The Department will not specify an accepted practice regarding "two times background" level because that is a screening procedure, not an analytical method and has no place in the rules. Screening procedures are addressed in the waste acceptance plan as part of the permitting process and is site specific. The radiation monitoring requirements for TENORM waste entering a landfill will be addressed in the specific conditions of the TENORM licenses and landfill permits. Due to a number of variables such as lack of training, improper use of survey meters, lack of calibrations of survey meters, and improper survey techniques, the Department deems this practice to be unacceptable."

IV. Ground Waters Near Present Special Landfills

-The ANL and NDDH TENORM-related documents I have reviewed largely avoid substantive discussions about existing or potential contamination of ground waters near TENORM disposal sites. This is possibly because historically, TENORM impacts to ground waters have been largely exempt from relevant water quality regulations.

This situation raises several questions, which the NDDH must be able to answer:
1-Are aquifers (potentially suitable for drinking water purposes) near the historic Bakken production being contaminated by disposal of TENORM and related wastes?

2-Where are the detailed monitoring data, including baseline data?

Disposal of wastes at the IHD site (McKenzie County) is already causing contamination of local ground waters [elevated and or unusual concentrations / measurements of: conductivity (most wells) = 5000 to 13,000 micromhos/ cm; arsenic, chloride, chromium, DRO (diesel range organics), magnesium, manganese, nitrate, some ammonia, potassium, radium, selenium, sodium, sulfate, total alkalinity, TDS]

Also, the IHD **ground water monitoring network is totally inadequate**, plus no baseline data set has been made public. [Torstenson (2016), Ground Water Monitoring Data: Attachment E]. *Attachment I to this report contains additional detailed notes relating to the Torstenson report.*

V. Unprepared to Enforce Regulations.

My review of the relevant documents (listed below) and my other comments should make clear that the NDDH is not prepared for the problems related to actually managing a viable TENORM program. These include: independent screening of wastes; making independent field measurements of total radioactivity—prior to disposal; preparing

detailed descriptions of sampling and measurement procedures; full knowledge of the actual radioactive contents in TENORM wastes and details regarding their actual monitoring.

-Almost all NDDH responses (in the NDDH COMMENTS) imply that a regulation will magically control the disposal of TENORM---as opposed to implementing some form of independent State oversite and monitoring. Such an approach simply adds more regulations and paperwork, but no REAL enforcement, now or in the future.

-It is clear that the State has been "pressured" into raising the TENORM standard—you decide by whom—and now it needs to appear to have scientific support.

-All sources I have contacted during my review indicate that the State is not enforcing the current TENORM standard.

-State field personnel should actually oversee TENORM disposal practices, as part of unannounced visits. Field measurements for gross alpha, beta and gamma activity of waste loads and areas within the waste facility should be made. Also, State representatives should make field measurements in the relevant surface and ground waters for electrical conductivity, pH, and total radioactivity. If necessary this field information can help determine whether samples should be collected for laboratory analysis of total radioactivity (gross alpha, beta and gamma activity).

VI. General TENORM Comments.

Oilfield brines and cuttings are not defined as TENORM wastes. Both should be—especially where they have been disposed of in landfills such as at IHD. It can easily be argued that the cuttings, at least, are **concentrated** in the landfill.

Cuttings containing NORM materials were originally deposited at depth naturally, but later brought to the surface via oil and gas operations, which have concentrated these materials at the surface, in sites such as landfills. Thus they should be considered and regulated as TENORM.

I recognize that the wording of the federal NORM / TENORM definitions come from a source other than the NDDH. However, regulation of TENORM is presently only being done at the state level. North Dakota has the opportunity to define cuttings in a technically and proactively-logical manner.

If ND allows the TENORM standard to become 50 pCi / g, then, obviously, it will be adding total radioactivity—above background-- to all these disposal areas, and to the neighboring soils and ground waters. **These radioactive wastes will remain in North Dakota forever—**except for those mobile forms that become transported out via water, and wind pathways—and those ingested by migrating animals.

Obviously, 5 pCi / g is much more CONSERVATIVE than 50 pCi/g

Documents Reviewed

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Collins, A. Gene, 1975, Geochemistry of Oilfield Waters; Developments in Petroleum Science 1; Elsevier Sci. Publ. Co., Amsterdam, 496 pg.

Granger, Harry Clifford, and Robert Bruce Raup, Reconnaissance Study of Uranium Deposits in Arizona, Issue 1147

Harto, Christopher B., Karen P. Smith, Sunita Kamboj, and John J. Quinn, 2014 (Nov.), Radiological Dose and Risk Assessment of Landfill Disposal of Technologically Enhanced Naturally Occurring Radioactive Materials (TENORM) in North Dakota; prepared by Argonne Nat. Lab, Environmental Science Division; ANL/EVS-14/13, **140 pg.**

Harto, C.B., K.P. Smith, S. Kamboj, and J.J. Quinn, 2015, Assessment of TENORM Disposal in North Dakota Industrial Waste and Special Waste Landfills; Environmental Science Division, Argonne National Laboratory; Public Mtg. Presentations; Williston, Jan. 20 / Bismarck, Jan. 21 / Fargo, Jan. 22; 26 presentation slides.

International Assoc. of Oil and Gas Producers, 2016 (March), Managing Naturally Occurring Radioactive Material (NORM) in the oil and gas industry; Report 412; 68 pg.

ND Dept. Health, 2014 (Dec.), TENORM Information Sheet; 2pg. http://www.ndhealth.gov/ehs/tenorm/informationfactsheets/nddoh tenorm information sheet-v.final.pdf

ND Dept. of Health, 2015 (Aug. 11), Cover Memo: Proposed Rules for Regulation of Technologically Enhanced Naturally Occurring Radioactive Material; memo from Scott Radig to ND State Health Council, 2pg.

ND Dept. of Health, 2015 (Aug. 6), Review and Response to Public Comments Received for the Proposed Administrative Rules Related to TENORM Management and Disposal; **107 pg**.

ND Century Code Chapt. 23-20.1, 2015, Ionizing Radiation Development

North Dakota Petroleum Council (NDPC), 2015 (March 1), Comments to Proposed Rules on TENORM; Memo to Scott Radig, NDDH, 2pg.

Nelson AW, Eitrheim ES, Knight AW, May D, Mehrho MA, Shannon R, Litman R, Burnett WC, Forbes TZ, Schultz MK. 2015. Understanding the Radioactive Ingrowth and Decay of Naturally Occurring Radioactive Materials in the Environment: An Analysis of Produced Fluids from the Marcellus Shale. Environ Health Perspect 123 (July 2015): p. 689–696; http://dx.doi. org/10.1289/ehp.1408855

Resnikoff, Marvin, 2012, RADIOACTIVITY IN MARCELLUS SHALE; CHALLENGE FOR REGULATORS AND WATER TREATMENT PLANTS; WEF Conf., New Orleans; 15 pg.
http://www.rwma.com/radioactivity_in_marcellus_shale.pdf

Rose, A.W., H.E. Hawkes, & J.S. Webb, 1979, Geochemistry in Mineral Exploration, 2nd Edition; Academic Press, 657 pg.

Torstenson, Jared, 2016 (July 28), Assessment of Suitability for Acceptance of TENORM Waste at IHD Solids Management Facility; prepared for McKenzie County, ND, Board of Commissioners, **203 pg.**

Attachment 1.

Additional Notes Relating to the Torstenson (2016) IHD REPORT

Torstenson (IHD) Rept. 2016:

-local ground waters are **already being contaminated**, and many of the chemical contaminants are obviously the result of **oilfield brines and or O&G-contaminated sediments**--which NDDH claims are not being disposed of in liquid forms.

The ground water monitoring well network is totally inadequate to reliably define the extent of the contamination.

Torstenson reports **storm waters** (supposedly diverted around wastes) are also “contaminated”.

Also, the report contains **no** description any **baseline** water quality data set ever being collected prior to the commencement of operations (the State and author repeatedly refer to "background"--which is incorrect here)--so there is no quantitative way to demonstrate changes in water quality through time!----a common industrial ruse.

Whatever **liner was installed is likely leaking**, both because of pinholes, tears, etc., and because **polyethylene liners are degraded when in contact with direct sunlight several organic compounds (such as BTEX (benzene, toluene, ethyl benzene and xylene)**

Not adequately monitored for TENORM constituents: should include Gross alpha, beta, and gamma.

These observations imply that NDDH is not actually acting to "enforce" their regulations. This includes collecting their own samples and making own field measurements.

Site is self-monitoring and self-regulating.

Site waste disposal history: not known for sure.
1998--direct disposal of petroleum impacted soils was discontinued;
2011—soil treatment by composting (and dilution) and disposal was discontinued (Pg.11).

Hydrogeology: site constructed into **extremely permeable, inter-fingering sediments**, which act as **interconnected water-bearing units**. Misleading to think of them as true geologic formations—as in layers of a cake.

Storm waters, supposedly diverted around waste disposal areas show evidence of contamination (p.11). Contained diesel range organics (DRO), etc.

Monitoring wells and water quality.
Locations and number are **inadequate to define water quality and detailed ground water flow directions. (p. 8-9, 14-16,)**

Adequacy of well constructions are questionable, especially the **poor surface casings**—which allow mixture of surface water with ground waters (p. 8,9).

No evidence that an actual, detailed water quality data base was ever compiled to define BASELINE conditions—prior to initiation of disposal operations.

Ground waters contain contaminants, starting at least as of 2015.

Torstenson: Attachment E—Ground Water Monitoring Data:
Elevated / unusual concentrations and measurements:
Most obvious: conductivity (most wells) = 5000 to 13,000 micromhos/ cm
arsenic, chloride, chromium, DRO (diesel range organics, magnesium, manganese, nitrate, some ammonia, potassium, radium, selenium, sodium, sulfate, total alkalinity, TDS

-many analyses lacked radium determinations

-No Air Monitoring program!
-potential to contaminate potable water pipeline.
-No radon barrier; must be constructed

Most detailed comments were only included in the Attachments. For example: Attachment A--Comments. p.4-6:
23. Section 2.1.1 **Special Wastes** – The list of specific Exploration and Production (E&P) waste streams accepted at the facility includes "Other solid waste uniquely associated with Oil and Gas Exploration and Production." **Some such wastes, such as filter socks, will be TENORM waste and will exceed the upper limit of 50 pCi/g radium- 226 plus radium-228.** Any wastes that exceed said limit shall not be accepted at the facility.

25.Section 2.2 Prohibited Waste – Consider adding filter socks to prohibited waste list, as many filter socks can exceed 200 pCi/g gross alpha. Alternatively, propose a rigorous sampling and verification procedure for filter socks to ensure no waste exceeding the TENORM threshold of 50 pCi/g is accepted for disposal at the facility.

26. **Prohibited wastes**: "Please **add "natural gas pipeline pigging waste"** to the list of prohibited waste. **Radon** in natural gas pipelines **decays to polonium-218** which is not represented when expressing radioactivity levels in terms of radium-226 and - 228."

35. Section 3.3.1 Inspection Procedure, page 8 and 9 – In an effort to prevent any unknown TENORM waste from being accepted at the facility, ALL loads of waste

entering the facility **should be screened with an exposure rate meter**. This meter can be fixed to the scale. Any load not characterized as TENORM that exhibits **total radioactivity exceeding background level shall be rejected**. While it is expected that many waste generators will comply with appropriate regulations and facility requirements, the only way for the facility Operator to verify that they have done so is to check all waste loads entering the facility.

39. Section 3.3.2 Random Special Waste Characterization – Special attention should be given to **BTEX (benzene, toluene, ethyl benzene and xylene**) content in waste received at the facility, as **such aromatic hydrocarbons exhibit compatibility issues with polyethylene liners.** It is recommended that firm limits be placed on concentration of aromatic hydrocarbons in waste total volume of waste which contains them. Alternatively, the liner system could be redesigned to minimize or **prevent contact between aromatic hydrocarbons and the polyethylene liner.**