UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	
CROW BUTTE RESOURCES, INC. ,	)	Docket No. 40-8943
	)	ASLBP No. 08-867-02-OLA-BD01
(License Renewal for the	)	
In Situ Leach Facility, Crawford, Nebraska)	)	May 1, 2015

EXPERT OPINION TESTIMONY OF LINSEY MCLEAN

I, Linsey McLean, do hereby swear that the following written testimony is true to the best of my knowledge:

I. Basis for Testimony as Expert in Field.

As an environmental biochemist working with toxic exposures in both animals and humans for the last 40 years, I have collected the largest databank for hair analysis of metals and minerals of anyone in the world since 1977. This databank follows the continuing increase in environmental toxins in air, water and food residues over the last 50 years, and correlates with disease and health compromise symptoms and syndromes. To date, I have one Canadian and 7 U.S Patents for products and protocols addressing health compromises from environmentally driven diseases in both humans and animals, including one for the only diet protocol that has ever earned a U.S Patent. This diet program resulted from my research from the 1970's, 1980's and 1990's, and underlies all the popular and effective diets of today featuring low carbohydrate, high protein, and high monounsaturated healthy vegetable oils, including the Atkins Diet, the South Beach Diet, the Zone Diet, the American Diabetes Association Diet, the Mediterranean Diet, etc. The foundation of this revolutionary approach is designed to fuel biochemical energy pathways while supporting compromised biochemical pathways, including hormone pathways, and also addressing detox of the interfering environmental chemicals, so that normalization of biochemistry is achieved. I have served in Michigan as an expert witness in state courts in environmental pollution and dumping cases and as expert witness in South Dakota in state and federal (NRC) hearings in the Dewey Burdock case for ISL uranium mining. My complete CV is attached.

II. Expert Opinions and Testimony Concerning Contentions #A, 12.

Opinion: **Contaminants associated with the current mining operations produce non-radiological health effects on humans, animals and plants.**

Basis: The Principles of Chemistry and Toxicology that apply to all of the Referenced Metals below:

Slide 1 describes a heavy metal

Slide 2 shows which elements on the periodic chart of elements are metals and which are not

Slide 3 lists the heavy metals that are toxic to the living body - plants, animals and man

Slide 4 lists which heavy metals are generated by ISL mining

All metals/minerals have a relationship to each other in Nature. They balance each other. Too much of one will have a negative effect on the other. For good health, they all need to be in proper balance. Heavy metals generated from mining are many, and will compromise many essential minerals for health. When one mineral or metal is too high, it will exert a repressive effect upon its counterpart metal or mineral, causing a deficiency or imbalance. Since minerals are known to fuel enzyme systems in the body, and the living body is dependent upon enzymes for life itself, compromise of any enzyme system can cause severe health consequences and even death. The toxic heavy metals generated in ISL mining are shown in an overlay to accurately depict the interference of those toxins on the natural system and their impact to all living things, even plants.

Slide 5 shows the “mineral wheel” and how each metal and mineral has an inter relationship with others

Slide 6 shows the overlay of what mineral inter relationships are most affected by metals from ISL mining

The difference between inorganic and organic compounds:
Organic compounds always contain carbon, while most inorganic compounds do not contain carbon. Also, almost all organic compounds contain carbon-hydrogen or C-H bonds. Organic chemistry is “The Chemistry of Life”. Metals in an inorganic form have significantly different chemistry and chemical activity in the living body from organically bound minerals/ organic forms of minerals and metals.

Inorganic salts of metals most prominent in aquifers, also have different toxicities, and any monitoring of aquifers should include speciations of these different forms so that proper toxicity evaluation can be done. Simply giving the absolute levels of a metal does not tell the whole story. All metallic "salts" are not equal. They can have different solubilities, different melting points, different Ph, different conductivity affecting the central nervous system that relies on electrical signals, and totally different chemistry within the living body. Further, any discussion to the general lay public needs to distinguish between a chemical metallic salt and ordinary table salt, that the public is led to believe will be created as "salt" in a mined aquifer.

Slide 7 shows the many species/chemical forms that a metal like selenium can take upon exposure to oxidation/reduction reactions typical within an ISL mining aquifer. Typically, speciation testing, even if monitored by the mining company, is not made available to the public.

When metals and minerals are bound to organic compounds, they become more bioavailable and more biochemically active in the living body. Whether this action is favorable or not will depend on the toxicity of the original metal in question. In the case of metals like lead, cadmium and arsenic, where no beneficial activity and only toxicity has been recognized, these organically bound heavy metals are increased in toxicity over their inorganic counterparts generally. However, by bonding the essential minerals to organic compounds, especially amino acids and small peptides, they form a higher health promoting molecule.

25 controlled studies by different authors in five different countries adverse array of data is presented. These data validate the effectiveness of mineral nutrients presented as amino acid chelates when compared with the ionic forms derived from the inorganic salts. These studies further support the results of numerous laboratory experiments showing increased absorption, assimilation and reduced toxicity of the forms of minerals chelated to amino acids. With little cost and effort animals can be supplemented with amino acid chelates which will promote, with little risk of overdose, a fuller genetic potential achievement as far as mineral requirements are concerned. Results of this supplementation are reflected in increased growth, immunological integrity and more consistent reproduction increased ovulation and conception after first service as a result of increased bioavailability of these chelated forms.

Slide 8 shows the benefits of these chelates, organically bound essential minerals over their inorganic salt counterparts.

Reference:
Chelated Minerals in Animal Nutrition
Rajendran, C.Kathirvelan and V.Balakrishnan, Madras Veterinary College, Chennai, INDIA

Inorganic forms of metals are changed to organic forms through the process of biotransformation, upon the action of simple forms of life like bacteria and algae.

This process happens in Nature mostly in the sediments of ponds, lakes and rivers where these elemental forms of life exist.

Slide 9 shows the path elemental and inorganic forms of arsenic take in biotransformation to organic forms

Slide 10 shows the path that elemental and inorganic forms of selenium take to the formation of organic forms of selenium

Slide 11 Shows the results of a study on mercury, and the increased toxicity of biotransformed/organified mercury from a mining site

Slide 12 shows the path that cadmium takes to organification in Nature

Organic forms of uranium as well as other toxic metals have also been shown to exist in mining areas and they are not known to be recoverable by the ion exchange method of ISL recovery, since it is already bound organically and will not bind to the organic synthetic resins. Organic forms of any heavy metal are known to be much more toxic and much more bioavailable, so that they are able to penetrate the lining of the digestive tract much easier than ionic and inorganic salts that are blocked by their electrical charges. Organic metals have their electrical charges spread over the organic ligand they are bound to, so that they act as a "chelate", something that the health industry does to minerals to significantly improve absorption of essential minerals, and also make them much more able to enter into direct biochemical reactions in the living body. Organically bound metals under this circumstance, and there is plenty of organic carbon naturally existing with ISL mining sites to make this a complication, will continue to increase in the waste water of the ISL mine as they are **not recoverable, adding to the metal burden of the wastewater and also the toxicity of such beyond what would be it the metals remained in an inorganic and ionic form.**
This problem is not currently recognized or addressed in the ISL mining industry. The only testing that is regularly done is elemental screening for all chemical forms. Sometimes there is speciation done for inorganic ions, but those numbers are not ever published to the public. There is no testing for organics, and little to no studies have been done on organic forms of toxic metals on living systems. Organic forms of heavy metals are just now being recognized.

Reference:
Arabian Journal of Chemistry
Volume 4, Issue 4, October 2011, Pages 361–377

Problems with Ion Exchange in Water Purification

> "Ion exchange is another method used successfully in the industry for the removal of heavy metals from effluent. An ion exchanger is a solid capable of exchanging either cations or anions from the surrounding materials. **Commonly used matrices for ion exchange are synthetic organic ion exchange resins. The disadvantage of this method is that it cannot handle concentrated metal solution as the matrix gets easily fouled by organics and other solids in the wastewater.** Moreover ion exchange is nonselective and is highly sensitive to the pH of the solution." (Kurniawan et al., 2006).

The 'Jekyll and Hyde' personalities of minerals

Even the minerals that we consider necessary for the living body will have different biochemical actions and tissue and organ destinations in the living system. Common case in point: selenium. Selenium is known to have wonderful health effects, preventing cancer, converting the storage form of the storage thyroid hormone T4, to the active form T3 by virtue of fueling an enzyme glutathione peroxidase. This biochemical reactions is absolutely essential to life. Glutathione also doubles as the most powerful antioxidant in the body. Inorganic selenium, as is the form generated in ISL mining, is known to cause birth defects of the highest severity. However, in the inorganic state, selenium as a consequence of mining, is severely toxic, producing severe deformities. The higher evolved animals above micro organisms are not able to convert quantities of the inorganic forms of minerals, even essential ones like selenium, into the bio compatible organic forms.

Bioaccumulation of organified heavy metals rises quickly in the living systems and the environment, rising up the food chain.

Elemental inorganic forms of metals and minerals are "organified", bonded with carbon compounds to become organic forms by micro organisms, which are then eaten by simple life forms, which are then eaten by higher animals, and so on, all the way up to man and other top predators at the top of the food chain. As these metals and minerals pass from one body to the next, they are known to concentrate as they move up, with humans and other top predators then suffering the worst consequences from the highest concentration in their tissues and organs. There can be formed many different kinds of organic metal compounds, however, all are not equally bio essential, some are even more toxic as the living body cannot convert them. This will depend on which micro organisms are organifying the metals into which compounds.

Slide 13 depicts the process of bioaccumulation up the food chain, with the increased concentration of a toxin at each level

Epigenetics, a newly recognized toxic compromise of DNA by heavy metals shows that heavy metals can and do influence the extrusion of genes to the negative. Epigenetics is a new study looking at how heavy metals and other environmental toxins can and do affect the gene expression of DNA to cause potentially serious ill health compromises, even death. DNA is actually a set of switches which are found to be controlled by chemical signals from the cell membrane of each cell, which are generated in response to the cell membrane's sensing of the environmental characteristics in the fluid surrounding it. Every living cell is actually floating in a body fluid called lymph. If the cell membrane senses that something is wrong, it sends a chemical signal to the cell nucleus and DNA there to adjust by turning on or off certain genetic switches. This is the living body's way of adapting to its surroundings for survival. This is evolution in progress.

Heavy metals have been found to both up regulate and down regulate DNA switches, and these switches tripped by epigenetic toxins can remain tripped into up to 5 generations hence, even if the original cause or toxin has been removed in the first generation. The implications for health and humanity for future generations considering epigenetics is mind blowing.

Slides 14 - 18 tell the story of epigenetics and the impact on DNA expression, all the way to cancer.

Heavy metals are also known to denature protein and negate the biochemical activities of protein based enzymes and hormones, as well as cause effects in skeletal muscles. Protein makes up a full 90% of the dry weight of the living animal body. Any living animal body, any species. Protein is an organic compound composed of long chains of amino acids.

Each protein has its own distinct combination of amino acids and also its unique three dimensional shape, and it is the shape that gives it its unique biochemical activity, not simply the chemical formula of its amino acid composition. **This is the most important concept in protein, hormone and enzyme biochemistry.**

Slide 19 shows the formation of three dimensional protein strands from long chains of amino acids

"Denaturation" is a process in which proteins lose their three dimensional structure/shape which is present in their native state, causing them to unwind and deform, by application of some external stress or compound such as a strong acid or base, a concentrated inorganic salt, an organic solvent (e.g.,

alcohol or chloroform), radiation or heat. If proteins in a living cell are denatured, this results in disruption of cell activity and possibly cell death. Denatured proteins can exhibit a wide range of characteristics, from conformational change and loss of solubility to communal aggregation to form a solid.

Slide 20 shows the process of denaturation of a three dimensional protein

Heavy metal inorganic salts act to denature proteins in much the same manner as acids and bases. Heavy metal salts usually contain Hg+2, Pb+2, Ag +1 Tl+1, Cd+2 and other metals with high atomic weights. Since salts are ionic they disrupt salt bridges in proteins. **The reaction of a heavy metal salt with a protein usually leads to an insoluble metal protein salt, meaning that it forms a solid and becomes inactive biochemically. This will affect all tissues and organs as well as blood at the microscopic level.**

A common example that we all understand and that is epidemic in the human and pet animal population today, is that of insulin. Insulin is a three dimensional folded protein that acts also as a hormone, regulating blood sugar but escorting glucose in the blood into the tissues for storage. If the insulin cannot accomplish this process, then the blood sugar rises to dangerous levels and the patient is diagnosed with Diabetes.

Non-Insulin Dependent Diabetes, or Diabetes Type 2, is the result of such a compromise in the body, with the insulin not able to perform its designated function. It is also called Insulin Resistant Diabetes, because simply giving the affected patient more insulin does not cure the problem. Typical blood testing of insulin reveals the presence of adequate insulin or even higher than normal levels, but conventional blood testing is not capable of viewing the actual three dimensional shape of the molecules to properly asses their actions or lack of. So we typically see the Type 2 diabetic having both high blood glucose along with high insulin levels that are not working effectively. The insulin has been denatured in the blood, and any new insulin that would be still functional when administered to the type 2 diabetic with toxic blood sporting effective levels of some denaturing toxin, will just further deform any new and functional insulin given. Such is the naming of “Insulin Resistance”.

The same scenario is commonly born out with thyroid testing and other natural hormones such as estrogen, testosterone, progesterone, DHEA, cortisol, pregnenolone, etc. We call this scenario in medicine “euthyroid hypothyroid” for thyroid, and appropriately such for the other hormones, where the blood levels show normal levels but the patient manifests hypo hormone symptoms, because the hormones present have been denatured and

rendered ineffective. This is a serious problem for medicine today. This is a serious problem in assessing the real toxicity of any environmental toxin that has been shown to denature protein, such as heavy metals. Conventional blood testing does not accurately reflect the true health compromise of the sick individual.

Slide 21 shows the hormone insulin with its characteristic folded nature, that is unfolded in Type 2 diabetes by denaturing agent exposure.

Heavy metals themselves also act as xenohormones and hormone disruptors in the living body.

Our hormones are all stereoisomers, meaning atoms are arranged differently in 3 dimensional space, and are subject to the toxic effects of xenohormone environmental toxins. Heavy metals have been shown to act as xenohormones, entering into the cellular receptor sites and skewing the hormone biochemical pathways for Estrogen, Testosterone, Progesterone, Cortisol, Pregnenolone, Thyroid, DHEA, Insulin and more. Since hormones are key initiators, regulators and intermediary metabolites of virtually every biochemical reaction in the living body, the protection of their integrity is crucial for their actions. Heavy metals, environmental chemicals and industrial chemical wastes can act as “xenohormones”, and interfere with natural hormones, enzymes, etc., and cause cancer and other severe ill health compromises.

Further, heavy metals are known to be “xenoestrogens”, a hormone mimic of estrogen, the female and growth hormone. Estrogenic toxicity causes cancer, skin lesions, obesity, fertility problems, accelerated aging, liver problems, learning problems, mood disorders, metabolic syndrome, blood sugar irregularities, blood fat irregularities, increase in breast tissue and size in both males and females, smaller or even undeveloped male genitalia and higher anger and anxiety responses to daily life situations. Mineral imbalances caused by high levels of toxic heavy metals themselves, also are known to cause hormone imbalances of insulin, thyroid, testosterone, progesterone, estrogen and cortisol.

We see those very problems exemplified in the most toxic areas of the world, and in increasing statistics overall in the world, as environmental pollution moves around the world. All of the heavy metals studied so far, that are common exposures to man, have shown to be “xenoestrogens”, including those that are generated from the rock strata at Crowe Butte. The increase in obesity of animals and humans over the last several decades is directly correlated to the increase of environmental toxins that are known to be fat soluble and deposited in body fat, including heavy metals.

Reference: J Toxicol Environ Health B Crit Rev. 2009 Mar;12(3):206-23. doi: 10.1080/10937400902902062.

The effects of metals as endocrine disruptors.

Iavicoli I[1], Fontana L, Bergamaschi A.

"This review reports current knowledge regarding the roles that cadmium (Cd), mercury (Hg), arsenic (As), lead (PB), manganese (Mn), and zinc (Zn) play as endocrine-disrupting chemicals (EDCs). The influence of these metals on the endocrine system, possible mechanisms of action, and consequent health effects were correlated between experimental animals and humans. Analysis of the studies prompted us to identify some critical issues related to this area and showed the need for more rigorous and innovative studies. Consequently, it was recommended that future studies need to: (1) identify the mechanisms of action, because at the present time only a few have been elucidated-in this context, the possible presence of hormesis need to be determined, as currently this was reported only for exposure Cd and As; (2) study the possible additive, synergistic, or antagonistic effects on the endocrine system following exposure to a mixture of metals since there is a lack of these studies available, and in general or occupational environments, humans are simultaneously exposed to different classes of xenobiotics, including metals, but also to organic compounds that might also be EDCs; (3) assess the potential adverse effects on the endocrine system of low-level exposures to metals, as most of the information currently available on EDCs originates from studies in which exposure levels were particularly high; and (4) assess the effects on the endocrine and reproductive systems of other metals that are present in the general and occupational environment that have not yet been evaluated."

PMID: 19466673 [PubMed - indexed for MEDLINE]

The toxicity of inorganic metals has been well studied.

Inorganic forms of minerals, especially selenium and uranium, as well as other heavy metals referred to in this testimony, which consistently test high in aquifers post mining, have shown to be toxic to living systems of plants, animals and humans in very low levels. Uranium toxicity at low levels has shown in population statistics of exposed population such as Native Americans on contaminated and exposed reservations downwind and downriver from old exposed uranium mines to be more predisposed to chronic conditions such as: metabolic syndromes, diabetes, behavior and sleep problems, obesity and heart disease, fertility, and morbidity and mortality compromises. These are non-radiological effects of uranium discussed, in that uranium as a metal actively incorporates itself into the biochemistry of the body. The radiological effects are another subject, not involving the actual chemical reactions such are described here.

Reference

Heavy metal uranium affects the brain cholinergic system in rat following sub-chronic and chronic exposure

> "Previous studies have shown that uranium is present in the brain and alters behavior, notably locomotor activity, sensorimotor ability, sleep/wake cycle and the memory process, but also metabolism of neurotransmitters. The cholinergic system mediates many cognitive systems, including those disturbed after chronic exposure to uranium i.e., spatial memory, sleep/wake cycle and locomotor activity."

Helene Bensoussan[a], Line Grancolas[a], Bernadette Dhieux-Lestaevel[b], Olivia Delissen[b],Claire-Marie Vacher[c], Isabelle Dublineau[a], Philippe Voisin[a], Patrick Gourmelon[a], Mohammed Taouis[c], Philippe Lestaevel[a]

Uranium is known to travel through the blood to virtually every tissue and organ system in the living body through active transport by blood. It will reduce and for solid precipitates in the hard tissues of the body like bone and also cause kidney stones and kidney disease and the precipitates enlarge with time and chronic exposure. Binding with bicarbonate in the body will also compromise the body's ability to neutralize acids, predisposing to gastric ulcers as well as various muscle pains, cramps and spasms. Highly acidic bodies with compromised acid neutralization abilities, such as contamination with compromising uranium ions, will have higher agitation levels and volatility of behavior. Uranium ions in the liver will compromise blood sugar regulation, causing increased cravings for sugars in the diet, leading to diabetes, metabolic syndromes and obesity, as carbohydrate metabolism is compromised. Further, as blood sugar lacks internal regulation, alcohol and drug use is elevated in statistics, as the body struggles to "just feel good for a little while". Increased cancer rates are observed with uranium exposure as well as reproductive toxic effects with DNA breakage observed. Compromise to the connective tissues of the body, that cover virtually every surface in the entire body, produce autoimmune diseases such as crippling Lupus. This is exactly what we are seeing in population health statistics on the reservations affected. Further, the toxic effects of uranium are greatly enhanced in the presence of calcium ions, which are known to be generated in ISL mining as well as in runoff waters of the Rocky Mountains over old uranium open pit mines. The Rocky Mountains are high reservoir of calcium carbonate, so ISL mining waters containing uranium as they are known to do, will have even more toxic effects in synergy than what would be expected and predicted of each separately. In addition, the forms of uranium that are referred to as "unfilterable" and very biochemically active, are likely to be the organic forms, known to be unrecoverable in ion exchange units of minefields as ISL sites. These uranium compounds are known to be bound to proteins and therefore act as a chelate, with high toxicity and high bioavailability organic forms. This study further demonstrates the increased toxicity of organic forms of heavy metals over their counterpart inorganic salt forms, and affects the

living body in different ways. This is yet another reason that any environmental monitoring for metals needs to include not only total elemental screening but also inorganic speciation as well as analysis of organic forms to best asses the true toxicity to the living system that all these forms affect.

Reference:
Medical Effects of Internal Contamination with Uranium
Croatian Medical Journal v.40, n.1, Mar99 Asaf Durakoviæ
Department of Nuclear Medicine, Georgetown University School of Medicine, Washington D.C., USA

"**Uranium as a heavy metal is of particular importance as a complex of uranium and bicarbonate ions, which increases the solubility of uranium in serum.** This compound is rather insoluble in water due to the complex ion formation between uranium and bicarbonates. This mechanism determines the transport of ultrafilterable uranium from the sites of contamination to the tissues and target organs (8). In blood, the uranium-bicarbonate complex establishes an equilibrium with non-filterable protein-bound uranyl ions, with 60% of uranium bicarbonate-formed and 40% protein-formed (9). In other studies, 74% of uranium in blood was present in the inorganic compartment of plasma, 32% was protein-formed, whereas 20% was associated with red blood cells (10). Uranyl salt complexes with bicarbonates are less stable than uranous salt complexes. Reduction of uranium in plasma is not probable, while the uranous salts can be reduced in the intracellular environment (11). Uranous (IV) retention sites are the bone and kidney, whereas uranyl (VI) ions accumulate in the liver and spleen prior to their redistribution in the renal and skeletal system."

"Each of the uranyl ions are complexed by two phosphate ions on the surface of bone crystals, with simultaneous release of two calcium ions. The uranous ion produces a toxic effect on the living cells by inhibiting the processes of metabolism of carbohydrates by the inhibition enzyme systems. A uranyl ion replacing a magnesium ion binds the ATP molecule to hexokinase. ATP-uranyl-hexo- kinase complex blocks the release of phosphate to glucose, inhibiting its first step of metabolic utilization with non-metabolized glucose in the extracellular environment (12). The toxic effects of uranium were shown to be enhanced by the administration of calcium (33). The effects of uranium on the nervous system have been described as paralysis of the hind legs, blindness, and loss of coordination in rabbits in the terminal phase of intoxication (52). Most recent studies indicate significantly higher prevalence of malignant diseases in uranium workers (59), with increased mutations in underground miners (60) and connective tissue disease, including lupus erythematosus (61). Reproductive toxicity of uranium in a recent Chinese study includes chromosome aberrations in spermatogonia, causing DNA alterations in the spermatocytes and strand breakage in sperm (62)."

Slide 30 shows blood abnormalities from selenium toxicity

Selenium is another poorly regulated heavy metal, and difficult to regulate as far as toxicity and allowable levels are concerned, because of the myriad chemical forms that it can exist in, each with different toxicity.

Selenium can exist in many chemical forms and many inorganic ionic species, as well as organic forms, and some forms are more toxic for the amount of selenium exposure than others. Symptoms of selenosis, selenium toxicity, include a garlic odor on the breath, gastrointestinal disorders, hair loss, sloughing of nails, (hooves and claws in animals), fatigue, irritability, thyroid compromise, thyroid chemistry compromise, and neurological damage.

Selenium in certain organic chemical forms, is not only non-toxic but absolutely essential to life. It fuels the enzyme that converts T4, the storage form of thyroid hormone to T3, to the active form, that regulates the speed of all biochemical reactions in the body at the cell level. However, the inorganic selenium salts generated at ISL mining sites are extremely toxic, causing mutations and deformities that are shown to be carried down many generations, even after the toxic exposure has been removed. Extreme cases of selenosis can also result in cirrhosis of the liver, pulmonary edema, and death.

Selenium is not a mineral to ignore. The living body can only deal safely with certain forms of selenium, and does not have the ability generally, to convert high exposures of this trace mineral from a toxic inorganic form to a safe and essential organic form. And some organic forms are even toxic. Locoweeds are plants that sequester selenium in a toxic organic form. Selenium has more “mineral personalities” than any other trace mineral.

Slide 22 shows the mutagenic effects

Slide 23 shows the mutagenic birth defects effects of selenium on ducks that had access to evaporation and holding ponds in mining.

Slide 24 shows horse hooves affected by selenium toxicity

Slide 25 is a picture of sheep with selenium poisoning and cattle hooves

Slide 26 shows the effects of selenium in a mining exposure on duck exposed to a holding pond

Slide 27 shows the toxic effects in muscles of animals
This is a paralyzing disease.
Slide28 shows the toxic effects of chronic selenium exposure from mining

Slides 29 and 30 show the mutagneic effects of selenium from a mining exposure. Studies of effects in amphibians are important as they are really the "canaries in the coal mine" for being the first to show toxic effects of some environmental toxin as they go through a metamorphosis different from higher animals.

Slide 22 shows the incongruencies between actual toxicities of some chemical forms of selenium and the regulatory levels. Most toxicity level charts fail to take into consideration the chemical forms of metals and minerals, which is absolutely critical in assessing any toxicity status. Care for patients suffering from selenium poisoning is usually aimed at treating symptoms. There is no specific antidote or treatments for selenium poisoning.

Arsenic is another major pollutant. Unlike selenium, which has a value in certain chemical forms as a health and life biochemistry promoter, arsenic has not been found to have any health value outside of its use as a parasiticide, and even that use can have toxic metabolic consequences.

Slide 32 shows the major health effects of arsenic exposure.

Arsenic opposes iodine on the mineral wheel of life, and will cause a physiological iodine deficiency by its opposing actions even if there is enough iodine in the diet to counteract general deficiency. Such is the case with all opposing metals and minerals of nutritional minerals. This is how things work in Nature and the living body. Metals like arsenic have their own set of compromising chemistries, and the opposition and interference chemistries of opposing metals and minerals presents a whole new set of pathways for health compromise, independent of the individual roles of the individual metals in actual biochemical reactions. So, with its opposing action on iodine, arsenic can precipitate a whole hypothyroid overlay on the living body, complete with all the health compromises that a hypothyroid body will manifest.

Slide 33 shows the different LD 50 doses for different chemical forms of arsenic. LD 50 represents the level at which 50% of the animals are killed from the toxin presented. So this again shows the importance of different toxicities of different chemical forms.

Slide 34 shows the comparison of the toxicity of arsenic relative to other common toxins.

Slides 35 - 39 show arsenic effects in humans.

Arsenic is extremely dangerous in the world today, and especially in North America, because arsenic opposes iodine on the mineral wheel, meaning that high arsenic causes iodine deficiency. Current research has shown that we need far more iodine than we thought we did for health, and we are not getting it in food or water, even as we used to decades past, when iodine was used in food processing and water purification.

Arsenic has been rising in our environment and food supply because of the legal dumping of it into commercial fertilizers from mining and ore smelting waste since 1976 when it became legal to do so. In the 1980's President Reagan increased to legal limit of arsenic in public drinking water because the levels were rising so high, and arsenic is both difficult and expensive to remove from water, as mining reclamation efforts have shown.

Mother Nature, of course, does not necessarily agree that so much arsenic is safe! Arsenic compromises thyroid. Thyroid disease has escalated epidemically in the last 50 yrs since iodine was reduced in our food and water supplies. And today, as relevant for accelerated aging, each generation is not expected to live as long as its parents, and higher and higher statistics of formerly "old age" ailments are evident in younger and younger segments of the population, severely compromising our health care.

Reference: **Combined Toxic Exposures and Human Health: Biomarkers of Exposure and Effects**
Int. J. Environ. Res. Public Health 2011, 8, 629-647; doi:10.3390/ijerph8030629

There is no specific treatment for chronic arsenic poisoning. Once it has been identified further exposure should be avoided. Recovery from the signs and symptoms may take weeks to months from when exposure is stopped. In particular, effects on the nervous system may take months to resolve and in some cases a complete recovery is never achieved.

Cadmium, another toxic metal, has no known biological function in higher organisms, and is extremely toxic to life. Cadmium is said to be 10 times more toxic than lead. Cadmium will bind with many organic compounds, and the structures of many cadmium complexes with nucleobases, amino acids and vitamins

have been determined. Thus, cadmium will and can affect genetic expression negatively.

Reference:
Carballo, Rosa; Castiñeras, Alfonso; Domínguez-Martin, Alicia; García-Santos, Isabel; Niclós-Guttiérrez, Juan (2013). "Chapter 7. Solid state structures of cadmium complexes with relevance to biological systems". In Astrid Sigel; Helmut Sigel; Roland K. O. Sigel. *Cadmium: From Toxicology to Essentiality*. Metal Ions in Life Sciences 11. Springer. pp. 145–189. doi: 10.1007/978-94-007-5179-8_7.

Therefore, cadmium, with no known beneficial activity in the living body, is found to be able to enter into, and to interfere and corrupt normal biochemical pathways critical to the living body, and the highest concentration of cadmium has been found to be absorbed in the kidneys of humans, causing kidney disease. Cadmium can substitute for zinc and so will be uptake by the living body at a greater level in the presence of a zinc deficiency and also will create a physiological deficiency of zinc even when adequate levels of zinc are present, if the levels of cadmium are sufficiently elevated. Such is the case with all metals in opposition or relation to each other ion the mineral wheel in Nature. cadmium has been designated as a carcinogen.

The ingestion of highly soluble cadmium compounds can cause significant toxicity to humans and animals. Cadmium has also shown activity as a xenoestrogen/ estrogen mimic and causing breast cancer.

Reference:

Morrow, H. (2010). "Cadmium and Cadmium Alloys". *Kirk-Othmer Encyclopedia of Chemical Technology*. John Wiley & Sons. pp. 1–36. doi: 10.1002/0471238961.0301041303011818.a01.pub3. ISBN 978-0-471-23896-6.

IARC Monographs on the Evaluation of Carcinogenic Risks to Humans, Volume 58

Cadmium works as an endocrine disruptor and experimental studies have shown that it can interact with different hormonal signaling pathways. Cadmium can bind to the estrogen receptor alpha, and affect signal transduction along the estrogen and MAPK signaling pathways at low doses. Since estrogen is actually the major hormone activity in the living body for both males and females, any interference, down or up regulation of this hormone can cause skewing of the other major hormone cycles and feedback loop cycles that regulate both the production of

hormones as well as their biochemical activity and influence in the living body. These affected hormones are: progesterone, pregnenolone, thyroid hormone, testosterone, cortisol and insulin, DHEA and estrogens estradiol, estriol and estrone. The types of cancers most driven by xenoestrogens such as cadmium are endometrial, breast, ovarian and prostate cancers. Osteoporosis in humans is also documented as cadmium directly opposes calcium on the mineral wheel and in the living body,

References:

Fechner, P; Damdimopoulou, P; Gauglitz, G (2011). "Biosensors paving the way to understanding the interaction between cadmium and the estrogen receptor alpha". *PloS one* 6 (8): e23048. doi:10.1371/journal.pone.0023048. PMC 3149063. PMID 21829690.

Stoica, A; Katzenellenbogen, B. S.; Martin, M. B. (2000). "Activation of estrogen receptor-alpha by the heavy metal cadmium". *Molecular endocrinology (Baltimore, Md.)* 14 (4): 545–53. doi:10.1210/mend.14.4.0441. PMID 10770491.

Ali, I; Penttinen-Damdimopoulou, P. E.; Mäkelä, S. I.; Berglund, M; Stenius, U; Akesson, A; Håkansson, H; Halldin, K (2010). "Estrogen-like effects of cadmium in vivo do not appear to be mediated via the classical estrogen receptor transcriptional pathway". *Environmental health perspectives* 118 (10): 1389–94. doi:10.1289/ehp.1001967. PMC 2957917. PMID 20525538.

Ali, I; Damdimopoulou, P; Stenius, U; Adamsson, A; Mäkelä, S. I.; Åkesson, A; Berglund, M; Håkansson, H; Halldin, K (2012). "Cadmium-induced effects on cellular signaling pathways in the liver of transgenic estrogen reporter mice". *Toxicological sciences : an official journal of the Society of Toxicology* 127 (1): 66–75. doi:10.1093/toxsci/kfs077. PMID 22314386.

Johnson, M. D.; Kenney, N; Stoica, A; Hilakivi-Clarke, L; Singh, B; Chepko, G; Clarke, R; Sholler, P. F.; Lirio, A. A.; Foss, C; Reiter, R; Trock, B; Paik, S; Martin, M. B. (2003). "Cadmium mimics the in vivo effects of estrogen in the uterus and mammary gland". *Nature medicine* 9 (8): 1081–4. doi:10.1038/nm902. PMID 12858169.

Cadmium is one of six substances banned by the European Union's Restriction on Hazardous Substances (RoHS) directive, which bans certain hazardous substances in electrical and electronic equipment but allows for certain exemptions and exclusions from the scope of the law.

Reference:

"European Commission Decision of 12 October 2006 amending, for the purposes of adapting to technical progress, the Annex to Directive 2002/95/EC of the European Parliament and of the Council as regards exemptions for applications of lead and cadmium (notified under document number C(2006) 4790)". Journal of the European Union. 14 October 2006.

Cadmium exposure is a risk factor associated with early atherosclerosis and hypertension, which can both lead to cardiovascular disease.

Reference:
Cadmium Exposure can Induce Early Atherosclerotic Changes, Medinews Direct, 7 September 2009

In Nature, we have observed toxicology in fish and other aquatic animals as described below:

Environ Toxicol Chem. 2005 Jun;24(6):1483-95.
Biochemical effects of lead, zinc, and cadmium from mining on fish in the Tri-States District of northeastern Oklahoma, USA.
Schmitt CJ1, Whyte JJ, Brumbaugh WG, Tillitt DE.
Author information

"We assessed the exposure of fish from the Spring and Neosho Rivers in northeast Oklahoma, USA, to lead, zinc, and cadmium from historical mining in the Tri-States Mining District (TSMD). Fish (n = 74) representing six species were collected in October 2001 from six sites on the Spring and Neosho Rivers influenced to differing degrees by mining. Additional samples were obtained from the Big River, a heavily contaminated stream in eastern Missouri, USA, and from reference sites.

Blood from each fish was analyzed for Pb, Zn, Cd, Fe, and hemoglobin (Hb). Blood also was analyzed for delta-aminolevulinic acid dehydratase (ALA-D) activity. The activity of ALA-D, an enzyme involved in heme synthesis, is inhibited by Pb. Concentrations of Fe and Hb were highly correlated ($r = 0.89$, $p < 0.01$) across all species and locations and typically were greater in common carp (Cyprinus carpio) than in other taxa. Concentrations of Pb, Zn, and Cd typically were greatest in fish from sites most heavily affected by mining and lowest in reference samples. The activity of ALA-D, but not concentrations of Hb or Fe, also differed significantly ($p < 0.01$) among sites and species. Enzyme activity was lowest in fish from mining-contaminated sites and greatest in reference fish, and was correlated negatively with Pb in most species. Statistically significant ($p < 0.01$) linear regression models that included negative terms for blood Pb explained as much as 68% of the total variation in ALA-D activity, but differences among taxa were highly evident. Positive correlations with Zn were documented in the combined data for channel catfish (Icralurus punctatus) and flathead catfish (Pylodictis olivaris), as has been reported for other taxa, but not in bass (Micropterus spp.) or carp. In channel catfish, ALA-D activity appeared to be more sensitive to blood Pb than in the other species investigated (i.e., threshold concentrations for inhibition were lower). Such among-species differences are consistent with previous studies. Enzyme activity was inhibited by more than 50% relative to reference sites in channel catfish from several TSMD sites. Collectively, our results indicate that Pb is both bioavailable and active biochemically in the Spring-Neosho River system."

PMID: 16117126 [PubMed - indexed for MEDLINE]

Cadmium toxicity was first described and observed in 1950 in Japan as Itai-Itai disease. This study is important as it describes the effects of ca mium as the principal metal involved in this disease. being highly toxic even at low levels, causing a flu like syndrome initially, known as "The Cadmium Blues", and quickly poisoning both liver and kidneys. Its initial toxic activity is that of a metal substitution for zinc, poisoning all of the enzyme and other biochemical reactions in the body in which zinc is involved, because of its similarity to zinc, acting as a metal mimic. again I refer back to the Mineral Wheel: slides 5 and 6.

Reference: Metals in medicine and the Environment
http://faculty.virginia.edu/metals/cases/rasnake1.html

Cadmium has been shown to exist in both inorganic and organic forms and to quickly bioaccumulate up the food chain.

Slide 40 shows the common known biochemical pathways that are compromised by cadmium in the living body. "TCA" is the tricarboxylic acid pathway, often called the "citric acid cycle" or the "Krebs Cycle", and often thought to be the most important energy producing pathway in the body.

Slides 41 - 42 show the most commonly affected areas of the body and the associated diseases caused by cadmium. Slide 42 is actually a video presentation of the toxicity explained.

Slide 43 shows the toxic effects of a purely inorganic form of cadmium salt, documented in the lab, important because ISL mining is known to produce quantities of metals salts such as this in an inorganic state.

Reference:**Upper Human Limits for All Minerals and Metals**
http://iom.edu/Activities/Nutrition/SummaryDRIs/~/media/Files/Activity%20Files/Nutrition/DRIs/ULs%20for%20Vitamins%20and%20Elements.pdf

Lead is another heavy metal that has no known function in the living body. Therefore, it has only toxic effects and those can be measured even at low levels. Lead levels are known to increase over time as radioactive elements degrade into lead at the end of their metallic lives. Lead is known to be present in wastewater and ISL mined aquifers in toxic levels. Lead toxicity has been known for a long time, and so is now recognized as a toxin in conventional wisdom.

Slide 44 shows the most common physiological effects of lead on both children and adults

Slide 45 shows the correlation between blood levels and clinical symptoms of lead poisoning. Keep in mind, that blood levels are normally much lower than the total toxic body burden for many metals, including lead, because the body is actively storing toxins away in different tissues and organs, to get it out of active metabolism for survival. So blood levels will only reflect the actual levels left circulating and not the storage levels. for this reason, hair analysis is commonly implemented, as it more accurately records tissue levels because hair is a continually growing tissue, and has been correlated in both humans and animals by tissue biopsy to be accurate for total body tissue levels.

Slide 46 shows the pathway in the body for lead and the health manifestations it causes with exposure and time with resulting toxicity symptoms

Slide 47 shows the effects of inorganic lead on different levels of exposure

Slide 48 shows the classification of different naturally occurring metals by toxicity and hydrologic availability. Note that the metals we are referring to here are found in the highest toxicity category. ISL mining exacerbates this list greatly in that even higher quantities of these metals in all categories are generated, increasing the toxicity of all of them.

Opinion: The impacts of selenium on humans and wildlife if Crow Butte uses land application of mining wastes are material, adverse and potentially fatal to humans and wildlife exposed to selenium.

Basis: **Heavy metals, most notably: High levels of Selenium, as well as Molybdenum, Lead, Radium, Cadmium and Arsenic, will be generated in soluble forms that are highly toxic to all living things, and are able to be concentrated even further by bioaccumulation up the food chain.**
Reclamation of the affected land is not physically or economically feasible.The land application for wastewater is destined for environmental contamination that will never be able to be remediated. Heavy metals never degrade into harmless substances. Those lixiviant solubilized toxic heavy metals, will eventually migrate into groundwater aquifers or surface water via streams, floods, melting snow runoff and storms.

Selenium is a well known as a common mining pollutant in Crowe Butte and elsewhere, and using studies done at the Smith Ranch and the Highlands Uranium Mine in Converse County, Wy, selenium was found to bioaccumulate in the environment and wildlife of the area where in situ wastewater was used to irrigate grasslands. In this case, the in situ wastewater was applied to grasslands as irrigation water.

> Reference:
> http://link.springer.com/article/10.1007/s00244-001-0037-y#page-2
>
> In this study, mean selenium concentrations in grasses, grasshoppers, red-winged blackbirds eggs and livers were 5.8 to 30 times higher at the study area than at the reference site. Elevated selenium collected from soil, water, and wildlife demonstrate that selenium is being mobilized and is bioaccumulating in the food chain. This can eventually affect livestock grazing in the area and can then enter the human food chain.

Fish and aquatic organisms are especially sensitive to selenium levels and grasshoppers and other insects, salamanders and crayfish are key parts of the food chain at risk.

Slides 22 - 31 show the toxic and mutagenic effects of selenium from onld mining areas

Selenium can exist in many chemical forms, and some forms are more toxic for the amount of selenium exposure than others. Symptoms of selenosis, selenium toxicity, include a garlic odor on the breath, gastrointestinal disorders, hair loss, sloughing of nails, (hooves and claws in animals), fatigue, irritability, thyroid compromise, thyroid chemistry compromise, and neurological damage. Selenium in certain chemical forms, is not only non-toxic but absolutely essential to life. It fuels the enzyme that converts T4, the storage form of thyroid hormone to T3, to the active form, that regulates the speed of all biochemical reactions in the body at the cell level. Extreme cases of selenosis can also result in cirrhosis of the liver, pulmonary edema, and death.

The same result of toxic bioaccumulation occurs for other known pollutants and products of ISL mining, such as arsenic. So that everything stated above for selenium can also be said for arsenic, manganese, chromium, copper, vanadium, and other heavy metals.

No ISL mines have ever have proven to be safe and free of excursions, or been able to be properly decommissioned with the mined aquifer restored to baseline chemistry levels, so that the water is drinkable in quality.

Humanity has continuously failed to clean up our mining messes throughout history, as evident from all the superfund sites of total and complete loss of any use all over the country and the world, not to mention the over 10,000 other old uranium mines that should be super funds and are not, due to lack of funding for remediation/burial.
The more dangerous the mined materials, the more toxic the residual mess left. In this case, mining of uranium, a toxic heavy metal in itself, also brings an additional risk of radiation from radon gas and lixiviant solubilized radioactive heavy metals of vanadium, thorium, strontium and radionuclides.

> Reference: Large amounts of contaminated wastewater are generated, according to a report on ISL mining prepared for the Larimer County Commissioners by The Larimer County Environmental Advisory Board, in WY, they say:
>
> “Due to the nature of ISL mining, quite large volumes of wastewater are created, which are often highly saline and contain toxic levels of heavy metals, process chemicals, and radionuclides. Excess ISL process water that is not re-injected is typically either directed to an evaporation pond, or injected into a

deep disposal well to an aquifer below the uranium deposit and domestic aquifers."

Slides 5 and 6 show the Mineral Wheel - a graphic of how minerals and metals interact with each other. You can see that, following the arrows from one to another, that an excess of one will create a deficiency of another. This is important in the health of all life, as minerals both fuel and direct enzymatic biochemical reactions in the living body.

Heavy metals will not only create deficiencies of essential minerals but also exhibit toxicity by their very presence in the living body. Thus they are doubly toxic. Selenium affects directly 11 other minerals and metals by direct competition and opposition, including some essential minerals.

A low concentration of selenium in water has the potential to increase by several orders of magnitude by the time it reaches fish and wildlife. For example, a water concentration of 10 ug/L (micrograms per liter or parts-per-billion) can increase to over 5,000 times that amount in fish tissues. Bioaccumulation causes otherwise harmless concentrations of selenium to reach toxic levels. This same principle applies to other heavy metals as well.

Slides 13 shows a graphic of how bioaccumulation works. The substance that exists in a low level amount in the environment, that was formerly thought to be so low as to be safe, is taken up by small and simple organisms such as algae, then eaten by animals, which in turn are eaten by other animals up the food chain, and the substance is further concentrated as it travels up the food chain, increasing its toxicity. Man, as the top predator, will suffer the most from bioaccumulation as we eat the animals in the food chain below us.

"Although fish do take up some selenium directly from water, most of it comes from their diet. Therefore, in order to protect fish from selenium poisoning it is essential to keep waterborne selenium below levels that cause bioaccumulation in the food chain "(Lemly and Smith 1987).

Slide 10 is a graphic that shows how inorganic selenium from mining wastes is biotransformed into organic forms that are far more bioavailable and can be more toxic depending on what it is bound with. Locoweeds are plants that bioaccumulate high levels of selenium that are toxic as organic forms not compatible with living animal bodies.

Metals cannot be broken down to other elements in Nature or the living body, and in fact, toxin exposure in continuous low levels, formerly thought to be

safe, have now been shown to have additive or synergistic effects, where the end effects of a combination of toxin exposure produces more severe health compromises than those that would be expected from each toxin. The common example is that 2 +2 now equals 8. Since different chemical forms of minerals and metals can and do exist, and some are more toxic than others, and travel up the food chain at different rates. Different chemical forms of minerals and metals target different organs and tissues of the body.

Additionally, each individual toxin is shown to enter the body at levels under the body's detoxification radar of liver detoxification, thus allowing toxic levels of the pollutant to build up over time, until the body becomes so sickened that it cannot help itself anymore in a detox and elimination protective method.

These toxic metals will be concentrated in the area of waste water discharge for time immemorial and due to the large volume of wastewater generated and also the large surface area contaminated, no effective and safe economical method of remediation and reclamation of the land's original purpose is possible. Substantial disposition of sediment in stream or lake beds, landslides, or water pollution cannot feasibly be prevented.

Application of wastewater to grasslands from this uranium mine is not a good idea, and not a safe and efficacious solution for disposal of this highly contaminated waste water. **The subsequent plants grown, if they are able to grow at all from the toxicity, would be far too contaminated to be used for any feeding.**

Containment of toxic wastewater load is not feasible in a leach pond designed to be large enough to be a lake bed, contrary to a plan to fence out Nature. No fence will last the lifetime of the toxins being contained here: ie; the lifetime of radiation left behind and accumulation of heavy metals that never die or degrade, in sediments of a pond. **It is not possible to adequately fence off Nature**. Fencing plans are to fence off mammals, however, there is no fence for the rest of Nature, insects and other small crawly things, small mice, salamanders, snails, etc., at the bottom if the food chain, that would leave the pond and be eaten by their predators, to have their toxins then bioaccumulate up the food chain.

Seasonal weather changes bringing heavy rains, winds, blizzards and floods will cause the borders of the pond to be overrun, taking toxins away from the pond, toward streams and rivers, and giving access to Nature, the environment and wildlife.

Further, seasonal drying in summer and drought conditions will allow exposure to the winds of dried sediments on the pond's edge, adding to air

pollution which can be carried for miles. Migrating birds and other animals will carry toxins to far away places, while it damages their bodies for survival, and contaminates game birds that are hunted and eaten by man.

Further, with the high drainage capabilities of areas of Crowe Butte, such that domestic leach beds for septic systems often drain too fast, this water with its toxins will permeate the Earth and eventually contaminate the waters below. This is how Nature works to recharge its aquifers, after all. And gasses produced like radon, will be taken by the wind with other by toxic byproducts yet to be seen.

The problem with ponds

1. Ponds are shallow design, not more than 12 or so feet deep. This allows for more contact between the highly chemically active waste water and the plastics in the liners, facilitating faster degradation. **And all plastics do degrade over time, even without this chemical exposure. The high levels of oxidizing chemicals will speed degradation dramatically**. This is what these chemicals do and why they are used in the ISL process to degrade rocks.

2**.The plastics used in the liners are polypropylene and polyethylene, common plastics we use every day. These plastics are so easily degraded that they are the principle plastics used in the food and bottled water industry and easily recycled by adding chemicals to degrade and disintegrate, and hence the ones we recycle.**

The warranty by the manufacturer is only 1 yr for the polypropylene and 2 yr for the polyethylene, and the project is supposed to last 20 yrs. And the strips of plastics will be bonded together by seams of heat and or glue, and these have been shown in other EPA tests to leak.

3.**The plasticizers that are integral in all plastics to give them their softness and pliability, are well known endocrine disruptors and hormone mimics, and also are well known to leach into foods. Hence the warnings of plastic bottled juices, foods and waters.**

When these plasticizers are leached from the plastics, the plastics become brittle and will break and then leak. I would expect leaks fairly quickly in the these ponds because of the contact with these highly active oxidative chemical waste waters facilitating that leaching of plasticizers and degradation.

The clay liner underneath will not be impervious to the leakage, as we have found with clay pits of old that are now deemed superfund sites. Clay leaks too.

I have just given numerous reasons that conditions for land reclamation and prevention of contamination cannot be met with Crowe Butte's mining activities.

None of this data or analyses have been considered by NRC in its environmental assessment.

The moral of the story is that once you severely contaminate an environment with radiation and heavy metals, it cannot be taken back. The initial financial rewards enjoyed for a relatively short time become horribly costly in the end, much more so than the initial rewards.

And science now understands that exposure of just one generation of individuals, will have their genetics impacted in a negative way for the next 5 generations, even if that individual is removed from the contamination. This is HUGELY significant! **This means that birth defects from environmental toxins can last up to 5 generations afterward.**

Contamination of our water, land and air with radiation and toxic chemicals released in uranium mining and processing cannot be taken back...not in our lifetime, nor the lifetimes of the next 5 generations. In fact, it cannot be taken back at all.

Civilization has been shaped over time by science and scientific discoveries. Indeed, this is how we grow and develop as humanity. New observations by man are incorporated into the standard paradigm which change our world views, and shape and direct our actions for the future. We learn from our mistakes, or are supposed to.

When new observations come into conflict with the standard paradigm, there is always outrage, resistance and denial, as the status quo is challenged. However, for man to progress forward, these new observations must be incorporated into our learning curve so that civilization can progress forward. We must keep learning about our environment, our surroundings and our place in it, to survive, maintain and improve our quality of life on Earth.

In decades past, we thought that butter was the best treatment for burns. In fact, even hospitals put butter on burns. It wasn't until an oil tanker burned and sank in the north Atlantic, leaving the crew with burns up to 80% of their bodies and floating in the cold ocean for 14 hours until help arrived, that we discovered that cold water was the superior treatment for burns. When the crew was plucked from the cold ocean water, they were in remarkable shape. This new discovery by tragedy, changed our paradigm of burn treatment forever. Yes, it caused the expected denial, resistance and outrage by the traditionalists, but further studies

comparing different treatments of burns proved the new discovery correct, and a paradigm shift was accomplished.

Today, with ISL mining, we are now seeing the same traditionalist beliefs prevailing here, **however history has shown us that ISL mining cannot be contained, aquifers cannot be restored to baseline, and the mining toxic wastes cannot be disposed of in a safe and economical way.** So, we professionals here testifying for you today, from various fields of expertise, are giving you the latest research and information for you to use, for the opportunity for you to right a grave wrong, to upgrade our paradigm for the good. **Understanding that those who came before you, permitted ISL technology with the belief that mining in a totally reduced zone, a condition that other areas exhibit, would safely secure any excursions, that they would just go out and hit the reduced zone and turn back into rock and be contained for safety. However, history has shown us otherwise. Plumes have not been able to be controlled.**

Now, with the experience of history and the research we have given you, you have the opportunity to upgrade our mining scientific paradigm and uphold your agency's commitment to guarding the environment and safety of the American people with your oversight, that is regulating agency mandate, and deny this permit and correct the errors of the past.

Further References:

The Larimer County Environmental Advisory Board, February 12, 2008
Report on In Situ Leach and Open-Pit Mining, Prepared for the Larimer County Commissioners

Stoica A1, Katzenellenbogen BS, Martin MB. Mol Endocrinol. 2000 Apr;14(4): 545-53.
Activation of estrogen receptor-alpha by the heavy metal cadmium.

Choe SY1, Kim SJ, Kim HG, Lee JH, Choi Y, Lee H, Kim Y. Sci Total Environ. 2003 Aug 1;312(1-3):15-21.
Evaluation of estrogenicity of major heavy metals.

Bogdan Georgescu, Carmen Georgescu, Stelian Dărăban, Anca Bouaru, Simona Paşcalău*Georgescu B. et. al./*Scientific Papers: Animal Science and Biotechnologies,

2011, 44 (2)
Heavy Metals Acting as Endocrine Disrupters

Cheryl A. Dyer, PHD eknygos.lsmuni.lt/springer/631/111-133.pdf
5 Heavy Metals as Endocrine-Disrupting Chemicals

P. Ramirez, Jr., B. P. Rogers, **Selenium in a Wyoming Grassland Community Receiving Wastewater from an *In Situ* Uranium Mine**.
Archives of Environmental Contamination and Toxicology,May 2002, Volume 42, Issue 4, pp 431-436

William T. Frankenberger, Richard A. Engberg - 1998 - Technology & Engineering
Ecosystem recovery following selenium contamination in a freshwater reservoir. Ecotoxicol. Environ. Saf. 36:275-281. **Lemly**, A. D., and G. J. **Smith**. **1987**.

"Public Health Statement: Health Effects" (PDF). Agency for Toxic Substances and Disease Registry. Retrieved 2009-01-05.

Wah Chu K1, Chow KL. **Synergistic toxicity of multiple heavy metals is revealed by a biological assay using a nematode and its transgenic derivative.** Aquat Toxicol. 2002 Nov 13;61(1-2):53-64.

Sasadhar JanaMonojit A. Choudhuri. **Synergistic effects of heavy metal pollutants on senescence in submerged aquatic plants.** Water, Air, and Soil Pollution, January 1984, Volume 21, Issue 1-4, pp 351-357

Harvey H. Ashmead, H. Dewayne Ashmead, Darrell J. Graff
Amino acid chelated compositions for delivery to specific biological tissue sites
Patent number: 4863898 Filed: February 6, 1986Issued: September 5, 1989
Assignee: Albion International, Inc.
Inventors: Harvey H. Ashmead, H. Dewayne Ashmead, Darrell J. Graff

Theo Colborn, Dianne Dumanoski, and John Peterson Myers ***Our Stolen Future: Are We Threatening Our Fertility, Intelligence, and Survival?*** 1996

Int. J. Environ. Res. Public Health 2011, 8, 629-647; doi:10.3390/ijerph8030629
Combined Toxic Exposures and Human Health: Biomarkers of Exposure and Effects

http://www.diabetesandenvironment.org/home/mech/genes **Epigenetics and gene expression**

Pursuant to 10 CFR 2.304(d) and 28 USC 1746, I declare under penalty of perjury, that the foregoing is true and correct to the best of my knowledge and belief.

Signed in Rapid City, SD, on April 30, 2015.

Linsey McLean_____
LINSEY MCLEAN