

To: People In Need of Environmental Safety

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Subject: Comments on the Arsenic Bioavailability Report

On behalf of People in Need of Environmental Safety (PINES), Geo-Hydro, Inc. (GHI) has reviewed the results of the Arsenic Bioavailability study that was prepared by the Respondents on the Pines Area of Investigation. The purpose of this review was to identify important issues contained in the documents that should be highlighted and explained to PINES, and, through PINES, to the general public.

Bioavailable arsenic is that portion of the total arsenic content of a material that is absorbed by an organism, as opposed to that which simply passes through the gut and is eliminated. For example, arsenic that occurs in tiny un-weathered spheres of glass in CCB may simply move through the gut without being absorbed, whereas arsenic from weathered (devitrified) glass spheres or from arsenic oxides may readily be absorbed.

The purpose of the bioavailability study was to evaluate the relative amount of arsenic that may be absorbed into the system of juvenile swine upon ingestion of Coal Combustion Byproducts (CCB). By extension, the study may be viewed as reason to allow using a reduced estimate of arsenic bioavailability (allowing higher total arsenic concentrations) in the human health risk assessment than would be used under standard procedures.

The test was performed over a 14-day period using seven groups of juvenile swine. Two groups of juvenile swine received doses of sodium arsenate (a soluble form of arsenic), two groups received Test Material 1 (CCB1) and two groups received Test Material 2 (CCB2). Test materials 1 and 2 contained total arsenic at concentrations of 217 and 80 micrograms per gram (ug/g), respectively. A seventh group was fed no arsenic-containing material as a control. The

amount of arsenic absorbed by each animal was evaluated by measuring the amount of arsenic excreted in the urine (collected over 48-hour periods beginning on days 6, 9, and 12).

Results of this testing indicated that absorption of test materials 1 and 2 were approximately 72% and 50%, respectively, of the absorption rates of the comparable sodium arsenate doses. The CCB values are lower than the default absorption values of 80% –100% that are assumed in risk assessments when bioavailability test data are not available. The following observations are provided to the Pines group in order to help them more fully understand the results of this study.

### Selection of Test Materials

The report provides detailed descriptions of the test protocols, results and conclusions from the testing that was performed. It does not however, indicate on what basis the soil samples tested (TP026, TP041) were selected for testing or how these samples were identified as CCBs. The ability to distinguish CCBs in the field has been a topic of many discussions over the years of investigation at Pines. The Respondents have repeatedly asserted that visual classification, as CCB or other materials could not be reliably done.

PINES, and through PINES the public has a legitimate need to understand how the Respondents reliably identified as CCB the material chosen for use in this testing. Have the Respondents now established visual characteristics that can be used to characterize a material as CCB in the field? If not, on what basis were these materials classified as CCBs?

### Result Variation

The reported results of the two samples tested were 50% and 72% RBA. The 22% difference between represents substantial variation in relative bioavailability (RBA) in addition to the compositional variation between these two samples and, by extension, among all various materials disposed in Pines. It also indicates that the full range of RBA from Pines area CCBs has not been established and that the highest RBAs could easily be in the 80% to 100% range. On the basis of only two samples with such widely varying results, approving a reduced RBA in the human health risk assessment would be very questionable.

### Pre-Leaching of Test Materials

PINES and the public should understand that the most soluble waste components may have already been leached from the waste prior to this testing. The materials used in the tests had presumably been exposed to infiltration of precipitation or migration of groundwater for a period of potentially many years. Water moving through CCW has the capacity to leach many contaminants, including soluble arsenic. CCB-derived compounds that leach from surface or subsurface CCBs may accumulate in adjacent or nearby soils by precipitating or absorbing into the soils in response to various geochemical gradients. This accumulation of CCB-derived contaminants in nearby soil is the natural and inevitable result of the soil particles removing contaminants from impacted groundwater as it flows through the soil, mechanisms that are collectively termed attenuation. As discussed in Section 3.6.3 of the SMS on page 3-24, arsenic is relatively easily mobilized from CCB but has a “high potential” for attenuation from groundwater. That high potential for attenuation means a high potential for arsenic that leaches from CCBs to concentrate in soils near the CCB source. CCB-derived contaminants that leach from CCB, migrate and accumulate in nearby soils demonstrate mobility under naturally occurring geochemical conditions; they are clearly not bound in the CCB matrix. As such, they are potentially more injurious to human health and the environment than the portions that remain in the CCBs and are subject to these kinds of testing.

The bioavailability study evaluates only the bioavailability of the less mobile fraction of the CCB arsenic that remains in place, not that of the more mobile fraction that has already been leached from the CCB. The more soluble arsenic fraction, and, therefore, the arsenic of more potential concern to human health, may have already been leached from the CCB and now reside in surrounding soils that have not been characterized and were not included in this study.

#### Uncertainty in Application of Results

On the basis of these tests we now know that juvenile swine are not likely to be adversely affected short-term by consuming the particular materials tested. Testing of the materials on juvenile swine was conducted because this method is generally considered to be a good physiological model for gastrointestinal absorption in children. The report states that there is

uncertainty in the extrapolation of RBA values measured in juvenile swine to young children or adults. It goes on to say, “even though the immature swine is believed to be a useful and meaningful animal model for gastrointestinal absorption in children, it is possible that there are differences in physiological parameters that may influence RBA and, so, RBA values in swine may not be identical to values in children.” Thus, the authors recognize that absorption of arsenic in humans may be different than in swine, and, therefore, the results should not be interpreted as meaning that the derived bioavailability values should necessarily be applied to human uptake of arsenic.

The report is silent on the potential that there could be other populations such as adults, senior citizens, or anyone with gastrointestinal conditions or on medications that may be more susceptible to oral adsorption of arsenic. The report also does not address the impacts of future weathering of CCB, particularly devitrification of any remaining glass, on arsenic availability years or decades hence. While such discussion is perhaps outside the scope of this report of a specific laboratory exercise, it is something that rightly, and presumably, will be part of any regulatory decisions of how, if at all, these results will be allowed to impact the human and environmental risk assessments.

[Note: In the graphs presented in the appendices there is an erroneous referral to arsenate as arsenite and of arsenite as arsenate. This presumably represents a dual typographical error and does not reflect a fundamental lack of understanding of arsenic chemistry. PINES may wish a formal confirmation of this presumption, however.]