MEMORANDUM

TO: Allan Brouillet, Sue Kaelber-Matlock, and Brenda Brouillet (MDEQ)

FROM: Hector Galbraith (GES)

DATE: July 22, 2004

SUBJECT: GES analyses of data in Entrix (2004) Wild Game Study Report

1. INTRODUCTION

As requested by Allan Brouillet of Michigan DEQ, I have reviewed the report: *Evaluation of PCDDs and PCDFs in Wild Game Taken From the Floodplain Along the Tittabawassee River* (Entrix, 2004). This study reports organochlorine contaminant concentrations in game species collected on Tittabawassee River floodplain in the winter of 2003/2004. These data were collected to support the evaluation of risks posed to human health, rather than ecological risks, by polychlorinated dibenzo-*p*-dioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs).

In a previous memorandum (GES 2004a), I evaluated the general utility and limitations of the Entrix (2004) study methods and data for ecological risk assessment (ERA) in general, and, in particular, for two ERAs already performed for the aquatic and terrestrial environments of the Tittabawassee River and its floodplain (GES 2003 and 2004, respectively). The GES (2004a) memorandum showed that the Entrix (2004) data confirmed one of the two major predictions of the terrestrial ERA, that floodplain terrestrial food chains are contaminated with PCDDs/PCDFs to above background levels. In this memorandum, the data reported in Entrix (2004) are examined more closely to determine the extent to which they support the second major prediction, that risks to floodplain wildlife species due to PCDD and PCDF contamination cannot be discounted.

1.1 Caveats

It is important to note that the sampling methods and data reported in Entrix (2004) were intended to support the evaluation of human health risks, not ecological risks. Because of this, the data set has limitations regarding how it can be used in the evaluation of ecological risk (Galbraith 2004a). Specifically:

- The sampling was confined to organisms (white-tailed deer, fox squirrels and wild turkeys) which, because of their vegetarian diets, are unlikely to bioaccumulate PCDDs and PCDFs to the extent that other organisms would.

- The carcass handling procedures resulted in a likely underestimation of the magnitudes of the PCDD/PCDF whole-body burdens to which predators and scavengers may be exposed.

- The comparative lack of wild turkey data from Imerman Park almost certainly results in an underestimation of the PCDD/PCDF body burdens of wild turkeys in the lower sections of the floodplain, and, hence, in the potential exposures to their predators and scavengers.

- Not unexpectedly, there is a positive relationship between PCDD/PCDF concentrations in soil and those in deer, turkeys and squirrels, with the lowest tissue concentrations at the relatively uncontaminated reference area, greater concentrations at the more contaminated Smith's Crossing, and the highest concentrations at Imerman Park, where soil concentrations are highest. It is important to note that the soil concentrations at Imerman Park are not the highest reported from the floodplain; they are lower than those in areas further downriver (MDEQ, 2003). TCDD-Equivalent (TEQ) soil concentrations closer to the confluence of the Titabawassee and Saginaw Rivers are more than double than those at Imerman Park (MDQ, 2003). Thus, Imerman Park tissue concentrations probably underestimate the concentrations and risk to biota further downriver.

The net result of the above limitations is that using the data reported in Entrix (2004) probably results in an underestimate of ecological risk. Nevertheless, until better data become available, they provide an opportunity to begin to further evaluate the occurrence of risk to ecological receptors.

The main question addressed in this analysis is: does the body residue data reported in Entrix (2004) provide any support for the prediction that PCDDs and PCDFs may pose risks to wildlife on the flood plain of the Tittabawassee River? To evaluate this, the analyses focuses on the dietary pathway and exposure to the red fox, a scavenger and predator that occurs on the flood plain and one of the receptors included in the original terrestrial ERA. Because of their varied diet, it would be expected that red foxes in the assessment area could be exposed to contaminants in the three prey species (Chapman and Feldhamer, 1982; GES, 2004). Potential risks posed to the red fox by each of the three prey/carrion species are considered separately below.

2. RED FOX CONSUMPTION OF WILD TURKEYS

A limitation of the Entrix (2004) study is that it failed to collect adequate numbers of wild turkeys from the furthest downriver sampling site at Imerman Park. Thus, we have no definitive estimate of body burdens in that area. However, mean TEQs (calculated using World Health Organization mammalian Toxicity Equivalence Factors) in the white-tailed deer and fox squirrels obtained by Entrix (2004) at Imerman Park exceed the concentrations in animals obtained at the closest upriver sampling site, Smith's Crossing, by factors of between 3.1 and 5.8. So, assuming a downriver multiplier of 4, and using the mean skin-on turkey conc. of 10.2 ng/kg ww (nanograms/kilogram wet weight) that Entrix measured at Smith's Crossing, the skin-on turkey TEQ concentration at Imerman Park may be extrapolated to be 10.2 x 4 = 40.8 ng/kg ww, or 40,800 pg/kg (picograms/kilogram). The TEQ Toxicity Reference Value (TRV) developed for the red fox in GES (2004b) is 2,050 pg/day. This is a NOAEL-based threshold and

represents the daily intake above which adverse impacts may begin to occur. This translates into an estimated daily maximum allowable wild turkey intake of 2,050/40,800 = 0.050 kg or 50 g (skin-on and wet weight). More than 50 g of wild turkey being consumed by red foxes would result in an exceedence of the TRV and the possibility of risks being incurred. At a daily food intake rate of 400 g (GES, 2004), this represents only 12.5% of the red fox daily intake of food.

Repeating the above calculations, but using the upper 95th percentile of the skin-on wild turkey TEQ data (23.2 ng/kg ww), shows that the estimated 95th percentile at Imerman Park is 23.2 x 4 = 92.8 ng/kg or 92,800 pg/kg, and the maximum allowable daily intake is 22g or 5.5% of the estimated red fox daily food intake.

In summary, both methods of calculation suggest that a red fox consuming wild turkeys from the Imerman Park area would have to limit its consumption to a very low level (a few percent of its total diet) if it was to avoid risk from PCDDs/PCDFs. In the context of the screening-level ecological risk assessment that has already been performed for the area (GES, 2004), the 95th percentile-derived result may be the more appropriate one on which to base regulatory decisions.

It should be noted that the consumption levels calculated above may still not be adequately protective. There are three reasons for this: first the calculation of the "allowable" daily intake rates (12.5% and 5.5%) assumes that everything else that the foxes eat is free of PCDDs/PCDFs. Even to approach this state is highly unlikely and would require that the foxes obtain the balance of their diet outside of the flood plain. Second, the Entrix data probably underestimate the total body residues in wild turkeys since they discarded the internal organs (including major PCDD/PCDF storage sites such as the liver) and analyzed only muscle and skin. Last, as already noted (Section 1.1), the PCDD/PCDF concentrations in tissues of turkeys further downriver, in more contaminated floodplain areas, may be even higher than those estimated for Imerman Park.

3. RED FOX CONSUMPTION OF WHITE-TAILED DEER

Using the Imerman Park white-tailed deer concentrations reported in Entrix (2004) and similar calculations to those in Section 2, it can be extrapolated that foxes feeding on deer carrion could eat up to 919 g/d, providing they ate only muscle (based on the mean muscle TEQ concentration from Imerman Park). If, however, the fox ate only the liver it could consume only 32 g/day. If the upper 95th percentile data are substituted for the means in the muscle and liver (1 and 149 ng/kg ww, respectively), the maximum "allowable" intake rates become 487g and 13.7g, respectively. Thus red foxes would be less at risk from consuming deer carrion than from turkeys. However, much of the carrion that may be available to foxes on the floodplain might be due to hunters discarding the internal organs of their quarry, including the livers. Consuming such carrion could put red foxes at greater risk. Also as with the wild turkey diet it should be noted that the PCDD/PCDF concentrations in tissues of deer further downriver, in more contaminated floodplain areas, may be even higher than those estimated for Imerman Park. Thus the estimated "allowable" intake rates given above may not be protective enough.

4. RED FOX CONSUMPTION OF FOX SQUIRRELS

Using the Imerman Park fox squirrel concentrations reported in Entrix (2004) and similar calculations to those in Sections 2 and 3, it can be extrapolated that foxes feeding on fox squirrels could eat up to 1.55 kg of squirrel/day, providing they ate only muscle (based on the mean muscle TEQ concentration from Imerman Park). If the upper 95th percentile value is used in this calculation the corresponding figure becomes 500 g. At face value, these data suggest that foxes could safely feed on fox squirrels. However, these values certainly underestimate the exposure of foxes to TEQs in fox squirrels because in preparation of their samples, Entrix (2004) discarded the skin and internal organs, which are major storage sites for PCDDs and PCDFs. It is possible that red foxes feeding on whole squirrels on the floodplain could incur higher risks due to exposure to PCDDs and PCDFs. Also, as with the deer and wild turkey diets it should be noted that the PCDD/PCDF concentrations in tissues of fox squirrels further downriver, in more contaminated floodplain areas, may be even higher than those estimated for Imerman Park. Thus the estimated "allowable" intake rates given above may not be protective enough.

5. SUMMARY AND CONCLUSIONS

A previous review of the Entrix (2004) report (GES, 2004a) has shown that the Wild Game Study data supports the first of two major predictions of the Michigan DEQ terrestrial ecological risk assessment (GES, 2004), that biota and food chains on the Tittabawassee River floodplain downriver of Midland are contaminated by PCDDs and PCDFs. The results reported in this memorandum extend the GES (2004a) analysis to show that the data reported in Entrix (2004) also support the second major prediction, that risk to floodplain wildlife cannot be discounted. At least one floodplain food chain (soil – vegetation – herbivore – predator/scavenger) may be contaminated to levels that could result in risks to some ecological receptors, specifically red foxes depredating or scavenging wild turkeys and/or deer. Furthermore, it is important to note that we have no empirical data regarding tissue concentrations and risk levels among terrestrial organisms that should, given the environmental behavior of PCDDs and PCDFs, be even more exposed than the deer, turkeys, and squirrels reported in the Entrix (2004) study.

6. REFERENCES

Chapman, J.A. and G.A. Feldhamer. 1982. *Wild Mammals of North America: Biology, Management, Economics*. The Johns Hopkins University Press. Baltimore.

Entrix. 2004. *Evaluation of PCDDs and PCDFs in Wild Game Taken From the Floodplain Along the Tittabawassee River.* Report to Dow Chemical Company, Midland, Michigan.

GES. 2003. Tittabawassee River Aquatic Ecological Risk Assessment**.** Report to Michigan DEQ.

GES. 2004. Tittabawassee River Floodplain Screening-Level Ecological Risk Assessment. Report to Michigan DEQ.

GES. 2004a. Memorandum to MDEQ: *GES Comments on Entrix (2004) Wild Game Study Report*, dated July 15, 2004.

MDEQ. 2003. *Final Report. Phase II Titabawassee/ Saginaw River Dioxin Flood Plain Sampling Study, June 2003*. Michigan Department of Environmental Quality, Remediation and Redevelopment Division, Bay City, MI.