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March 15, 2007

Ms. Rachel Rineheart
U.S. Environmental Protection Agency
Region 5
77 W. Jackson Blvd.
Chicago, IL 60604

Subject: **Impacts Assessment Data for Archer Daniels Midland (ADM)
Company's Proposed Decatur, Illinois Glycols Plant**

Dear Ms. Rineheart:

Attached to this letter is a memorandum from Dr. Steve Zemba of Cambridge Environmental, Inc. This memo was prepared as a follow-up to our March 1, 2007 meeting at which, Mr. Michael Coffey of the U.S. Fish and Wildlife Service (FWS) requested some additional assessment in relation to four chemicals of potential concern (COPCs) – chromium, lead, mercury, and polychlorinated dibenzo(p)dioxins and furans (PCDD/PCDFs) associated with ADM's Glycols Plant Project in Decatur, Illinois. Steve has addressed the requests made, and has concluded that there is no likely cause for concern regarding threatened and endangered species due to the increased emissions of ADM's proposed project.

I hope this additional analysis provides U.S. EPA and the FWS with the information needed to complete your review of this project. If you have any questions or need additional information, please contact me or Staci Bogue-Buchholz of ADM.

Sincerely,

Jack M. Burke, P.E.
Senior Project Manager

c: Mike Coffey, U.S. Fish and Wildlife Service
Staci Bogue-Buchholz, Archer Daniels Midland Company
Steve Zemba, Cambridge Environmental, Inc.

MEMORANDUM

To: Jack Burke – RTP Environmental Associates, Inc.
Staci Bogue-Buchholz – Archer Daniels Midland Company

From: Stephen G. Zemba, Ph.D., P.E. – Cambridge Environmental, Inc.

Subject: Further Ecological Consultation support ADM's proposed Glycols production facility

Date: March 14, 2007

I write to provide further information regarding potential impacts to threatened and endangered wildlife species associated with the proposed construction of a Glycols Production Plant at the Archer Daniels Midland (ADM) facility in Decatur, Illinois. This information supplements the calculations previously described in my February 15, 2007 memo, and addresses requests made at our recent meeting with Ms. Rachel Rineheart (U.S. EPA Region 5) and Mr. Michael Coffey (U.S. Fish and Wildlife Service, U.S. F&WS) on March 1, 2007. Specifically, I provide modeling information on four chemicals of potential concern (COPCs) – chromium, lead, mercury, and polychlorinated dibenzo(*p*)dioxins and furans (PCDD/PCDFs) – although the project's emissions of these COPCs are expected to increase existing ambient air concentrations by less than the criterion initially applied for COPC screening (an increase of 2%). I also consider foodchain analyses for the Indiana Bat for two of these COPCs (mercury and PCDD/PCDFs) based on spreadsheet models provided by U.S. F&WS.¹

As I noted at our March 1, 2007 meeting, my screening-level calculations are very conservative. In fact these calculations are too conservative to conclude that project-related impacts for mercury and polychlorinated dibenzo(*p*)dioxins and furans (PCDD/PCDFs) are sufficiently negligible. The supplemental calculations in this memo emphasize the extreme conservatism built into the surface water and sediment modeling in which I assume that all plume emissions enter and mix into Lake Decatur. As such, I have developed an alternate (yet still conservative model) to assess potential impacts to surface water and sediment.

These further screening-level models indicate that emissions from ADM's proposed glycols production facility are not likely to result in adverse impacts to threatened and endangered species. The projected worst-case concentration of lead in soil is very slightly greater than the U.S. EPA Region 5 Ecological Screening Level (ESL), though the ESL is many times smaller than typical background levels of lead in soil. The Indiana Bat dietary exposure model for mercury predicts a conservative exposure level about twice the level shown not to cause adverse effects, but only about 40% of the exposure level at which adverse effects have actually been observed. Given the likely conservatism in the simple fate-and-transport models and the initial

¹ The Indiana Bat is one of two threatened and endangered species of concern for which dietary pathways are potentially relevant (the other is the Bald Eagle). The Indiana Bat is evaluated per the request of U.S. F&WS as screening-level dietary intake models have been developed specifically for this species.

finding that the projected concentrations of these COPCs in ambient air are all less than 1% of background levels, I find no likely cause for concern regarding threatened and endangered species due to the increased emissions of ADM's proposed project.

The following text and tables describe my supplemental calculations and analyses.

Ambient Air Background Comparison

The four COPCs of interest were not carried through the initial fate and transport modeling because the predicted worst-case concentrations in ambient air are only a small fraction of background concentrations. As indicated in Table 1 (and excerpted from my March 12, 2007 memo), the predicted concentrations in ambient air are all less than 1% of existing background levels for the four COPCs. An important implication to consider with respect to fate and transport modeling is that background can be expected to contribute more than one hundred times as much as the project to all media. In cases for which the potential incremental effects of some COPCs due to ADM emissions seem to be high, the implied effects due to the background COPC presence in air is unrealistically high (i.e., at least 100 times greater than the project's effects), pointing to a high level of model conservativeness.

Soil, sediment, and surface water comparisons

Tables 2 through 4 present estimates of pollutant concentrations in soil, sediment, and surface water, based on the same models described in my February 16, 2007 memo. In addition, Tables 2 through 4 provide representative background concentrations (where available), and values of the U.S. EPA Region 5's Ecological Screening Levels (ESLs, see <http://www.epa.gov/reg5rcra/ca/edql.htm>).

Concentrations of COPCs in soil (Table 2) are estimated with a simple mixing model that assumes pollutants deposit from the atmosphere over a period of thirty years of facility operation and remain within a shallow (1 cm deep) layer of soil (of bulk density 1.5 g/cm³) near the surface. This soil deposition/concentration model is recommended in the U.S. EPA's multi-pathway risk assessment protocol guidance for untilled soils. A high-end deposition velocity of 1 cm/s is used to estimate deposition based on modeled ground-level concentrations in air.

Observations for the four inorganic COPCs relative to background concentrations in soil and ecological screening benchmarks include:

- The predicted worst-case incremental soil concentrations of three of the four COPCs (chromium, mercury, and PCDD/PCDFs) are well below both background levels and ecotoxicity benchmarks;

- The predicted worst-case incremental soil concentration of lead is slightly above (approximately 2% above) the ecotoxicity benchmark, but only a small fraction (approximately 0.2%) of the cited background level.

Sediment modeling and comparisons

As in my 2/15/07 memo, sediment concentrations are initially estimated under the assumption that all ADM stack emissions deposit within Lake Decatur and remain in the bottom sediment. Estimated worst-case COPC concentrations in sediment (Table 3) are thus calculated as the projected facility emission rates (Table 1) divided by the rate of sediment deposition. A recent study estimates that 8.3 acre-ft of sediment are deposited within Lake Decatur each year at an average density of 1,056 tons/acre-ft,² which equates to an annual sediment deposition rate of 8,765 tons/yr. Table 3 compares worst-case sediment concentrations based on these estimates (column 2) to background levels (as measured in Lake Decatur sediments) and benchmark concentrations.

Preliminary observations concerning predicted concentrations of the four COPCs in sediments include:

- For chromium and lead, estimated worst-case incremental concentrations in sediments are lower than both background concentrations and screening-level benchmark concentrations; and
- For mercury and PCDD/PCDFs, however, estimated worst-case incremental concentrations in sediments are greater than both background concentrations and screening-level benchmark concentrations.

Given that the predictions of mercury and PCDD/PCDFs in ambient air from the project are small fractions of background levels (Table 1), the simple model of mixing all plume emissions into Lake Decatur appears to be a gross and extremely conservative oversimplification for mercury and PCDD/PCDFs. If sediment concentrations are assumed to scale with concentrations in air, the ratios of facility impacts to background levels in air (Table 1) imply sediment concentrations of 780 mg/kg and 0.0076 mg/kg, respectively, for mercury and PCDD/PCDFs (based on scaling the incremental concentrations predicted by the plume mix-in model). These values are implausibly large given actual background concentrations observed in sediments (which exist coincidentally with the background concentrations in air).

² Bogner, W., *Sedimentation Survey of Lake Decatur's Basin 6, Macon County, Illinois*, Illinois State Water Survey Champaign, IL, Contract Report 2001-07. The average sediment density of 1,056 tons/acre-ft is calculated as the total sediment weight (1,421,437 tons) divided by the accumulation volume (1,346 acre-ft) (see Table 3 of the Water Survey report).

Another perspective on the degree conservatism in the initial plume mix-in model can be obtained by considering the deposition model used to estimate concentrations in soil. If the maximum modeled COPC deposition rate (evaluated at the point at which the concentration in air is predicted to be the highest) is assumed to occur over the entire 938 mile² (2,430 km²) Lake Decatur watershed,³ the total deposition over this area accounts for only 20% of the stack emissions of mercury and PCDD/PCDFs. Thus, if mercury and PCDD/PCDFs deposit at their maximum modeled rates over the entire watershed and all of it enters Lake Decatur, the COPC fluxes into the lake would be five times smaller than the full stack emission rate assumed in the simple plume mix-in model. Further, the average deposition rate over the entire watershed is expected to be considerably smaller than the maximum rate. Averaged over the 36 km² modeling domain, the modeled dry deposition rate is a factor of four smaller than the maximum rate. Expanding the modeling domain over the entire watershed would yield an even greater ratio between the maximum and average deposition rates. Thus, even without significantly more extensive modeling, it is easy to see that the plume mix-in model overestimates sediment concentrations by at least a factor of twenty (and probably much more).

Developing more accurate estimates of sediment and surface water concentrations demands more detailed consideration of impacts to the watershed. As one option, watershed algorithms could be implemented such as those described in the U.S. EPA's Human Health Risk Assessment Protocol (HHRAP), which considers the various potential loadings to water bodies. Our experience with the HHRAP algorithms in similar settings indicates that soil erosion can be expected to contribute the bulk of the COPC loading to Lake Decatur. As a simplification, if one assumes that soil erosion is responsible for COPC loading to Lake Decatur, then an alternate worst-case model of the potential concentrations of COPCs in sediment is that they equal worst-case modeled concentrations in surficial soil.

Adopting an alternate worst-case model of setting the COPC concentrations in sediment equal to the worst-case modeled concentrations in soil, the sediment/soil concentrations of COPCs listed in Table 3 (column 3) are considerably lower than those predicted by the plume mix-in model, and similarly lower than both representative background concentrations and screening-level benchmark concentrations.

Surface water modeling and comparisons

As described in my 2/15/07 memo, the initial screening-level model to estimate worst-case concentrations in surface water assumes that all stack emissions are mixed within Lake Decatur (a widened portion of the Sangamon River), the most significant surface water feature near the ADM facility. Concentrations are calculated by dividing the emission rate of each COPC (Table 1) by the measuring flow rate of the lake/river. The longest running stream gaging station

³ The watershed area of 938 mile² corresponds to the U.S. Geological Survey's stream gaging station located at the outlet of Lake Decatur (39°49'52", longitude 88°58'35", NAD27).

is located at the outlet of Lake Decatur, near where it is crossed by State Route 48 (latitude 39°49'52", longitude 88°58'35", NAD27). Streamflow at this location averaged from 1983 to 2005 is 699.3 cfs (http://il.water.usgs.gov/annual_report/data/disl_86/indices0/index.htm). This streamflow rate likely underestimates the amount of water that enters Lake Decatur, which serves as a drinking water supply to the City of Decatur (which actively withdraws water). Surface water concentrations of contaminants calculated by this simple mixing model are provided in Table 4 (column 2) along with bounding-level background concentrations (sampling typically fails to detect these COPCs) and ecological screening benchmarks.

Applied to the four COPCs of concern, predictions of the simple plume mix-in model for surface water shares similar tendencies as that of the comparable sediment model:

- For chromium and lead, estimated worst-case incremental concentrations in surface water are lower than screening-level benchmark concentrations;
- For mercury and PCDD/PCDFs, however, these bounding estimates of incremental concentrations in surface water are greater than screening-level benchmark concentrations; and, additionally,
- The analytical detection limits of background concentrations of lead and mercury available for local monitoring data do not permit reliable judgments with respect to benchmark concentrations.

An alternate model to estimate worst-case surface water concentrations is based on an assumed equilibrium between COPC concentrations in bottom sediment (C_{BS}) and surface water (C_{dw}). The equilibrium equation depends on the sediment/water partition coefficient (Kd_{BS}) and is used as a fundamental equation in the U.S. EPA's Human Health Risk Assessment Protocol model for partitioning COPC concentrations in a water body:

$$C_{dw} = \frac{C_{BS}}{Kd_{BS}}$$

This equilibrium model is a conservative estimate of the concentration of the COPC that could dissolve into the water column from a sediment source, as the equilibrium equation is a predictor of the COPC concentration in sediment pore water, and extrapolating this concentration to the entire water column likely overestimates the COPC concentration in open lake water. The partitioning coefficients and estimates of C_{dw} using this model (Table 4, column 5) are calculated using the alternate sediment concentrations provided in Table 3 (the sediment = soil model). The predicted concentrations of chromium and lead are higher than those predicted by the plume mix-in model, and are hence unrealistically high as mass conservation is violated by allowing the river to transport COPCs at a higher rate than emitted from the ADM facility. The predicted mercury and PCDD/PCDF concentrations in surface water, however, are lower than those of the plume-mix-in model as the equilibrium model better accounts for the tendency of these COPCs

to remain in sediment (a reflection of their higher Kd_{BS} values). Conservative estimates of COPC concentrations in surface water, taken from the combined use of the plume mix-in and sediment equilibrium models, are indicated as bold entries in Table 4.

Foodchain analyses based on the F&WS Indiana Bat models

Spreadsheet-based models to assess dietary intakes of mercury and PCDD/PCDFs were provided by the U.S. Fish and Wildlife Service (F&WS, personal communication from Michael Coffey) and adapted to project-specific modeled COPC concentrations and background data. Food intake rates, bioconcentration/bioaccumulation factors, and dietary assumptions were retained in the spreadsheets as received from F&WS. Area and seasonal use factors were set to one (the spreadsheet defaults).

Two changes have been made to the spreadsheets to correct inaccurate or inappropriate parameters. First, in the mercury spreadsheet, a piscivorous wildlife criterion of 6.41×10^{-10} mg/l has been changed to 6.41×10^{-7} mg/l (in cell M8) to reflect the proper conversion of units from the referenced value of 641 pg/l provided in the U.S. EPA's 1997 Mercury Report to Congress (<http://www.epa.gov/mercury/report.htm>, Volume VII). Second, in the PCDD/PCDF spreadsheet, the sediment to invertebrate bioaccumulation factor (cell F11) has been changed to a value of 0.9 l/kg, reflecting the high-end value of the range of values (0.5 l/kg to 0.9 l/kg) for 2,3,7,8-tetrachlorodibenzo(p)dioxin recommended by the U.S. EPA in a review of contaminant bioaccumulation literature (<http://www.epa.gov/waterscience/cs/biotesting/>). The 0.9 l/kg biota-to-sediment accumulation factor (BSAF) for invertebrates replaces a spreadsheet default value of 19,576 that is not supported by published/available values.

The following project-specific data were entered into the F&WS mercury model:

- Future emissions enrichment – soil: 0.00886 mg/kg (Table 2);
- Past emissions enrichment – soil: 0 mg/kg (has not been modeled);
- Background soil concentration: 0.033 mg/kg (Table 2);
- Future emissions enrichment – sediment: 0.00886 mg/kg (Table 3);
- Past emissions enrichment – sediment: 0 mg/kg (has not been modeled);
- Background sediment concentration: 0.12 mg/kg (Table 3);
- Future emissions enrichment – water: $0.00000018 = 1.8 \times 10^{-7}$ mg/l (Table 4);
- Past emissions enrichment – water: 0 mg/l (has not been modeled); and
- Background water concentration: $0.00000066 = 6.6 \times 10^{-6}$ mg/l (value in original F&WS spreadsheet).

No modeling of past facility emissions was developed in conjunction with the project. The background measurement in sediment, taken recently in Lake Decatur, probably reflects local

conditions (including any past contributions from the ADM facility). The local representativeness of the background soil and water concentrations, however, cannot be determined. The soil concentration derives from a regional study throughout central and southern Illinois, and the concentration in water is the value provided in the F&WS spreadsheet, as local measurements were not sufficiently sensitive to detect the levels of mercury present in Lake Decatur.

The mercury model predicts a NOAEL-based hazard quotient of 1.8 and a LOAEL-based hazard quotient of 0.36. Background mercury concentrations entered into the model account for about 90% of the risk estimates. A spreadsheet printout of the F&WS mercury model is provided in Figure 1.

The following project-specific data were entered into the F&WS PCDD/PCDF model:

- Future soil concentration: 4.77×10^{-9} mg/kg (Table 2);
- Existing soil concentration: 0 mg/kg (value in original F&WS spreadsheet);
- Future sediment concentration: 4.77×10^{-9} mg/kg (Table 3);
- Existing sediment concentration: 0 mg/kg (value in original F&WS spreadsheet); and
- Future water concentration: 3.11×10^{-14} mg/l (Table 4).

The PCDD/PCDF model predicts a NOAEL-based hazard quotient of 0.003 and a LOAEL-based hazard quotient of 0.0003. These values are many times smaller than one, the point at which projected dietary intake becomes as large as the ecotoxicity threshold. A spreadsheet printout of the F&WS PCDD/PCDF model is provided in Figure 2.

Conclusions and Observations

These additional calculations illustrate an important point concerning bounding-level fate-and-transport models: the model predictions are known to conservatively estimate environmental impacts and must be interpreted accordingly. My original calculations (as described in my 2/15/07 memo) eliminated the four COPCs considered in these supplemental calculations because the worst-case modeled concentration in air due to facility emissions is projected to be less than 2% of the existing background concentration in air (actually, less than 1% for these four COPCs). Simple screening-level models for sediment and surface water, however, were not able to demonstrate that project impacts will be less than ecological benchmark concentrations. It is counterintuitive to have one model suggest indiscernible impacts and then have follow-on models indicate cause for concern, as there should be some general correspondence to the relative presence of COPCs in air and their subsequent behavior in the environment. Either background air quality is very dangerous (since it contains concentrations a hundred-fold greater than projected facility impacts) or there is distortion in relative impacts induced by the screening

level multi-pathway fate-and-transport models that simulate the deposition and potential accumulation of COPCs from air into soil, surface water, and sediment.

In this case, the apparent gap between relative impacts in air and subsequent terrestrial/aquatic impacts stems largely from the overly conservative nature of the screening-level models that assume all facility emissions enter and mix into Lake Decatur. A second set of conservative models, based on the assumption that sediment is not likely to accumulate greater concentrations of COPCs than soil, was able to demonstrate lower projections of facility impacts. Other factors also contribute to the conservatism of these screening assessments. For example, benchmark concentrations are sometimes considerably smaller than background levels, perhaps due to the safety factors incorporated in the calculation of the benchmarks. The soil benchmark concentration of 0.0537 mg/kg for lead (Table 2) is far lower than typical background levels that are (in my experience) rarely lower than 10 mg/kg. The issue of background levels exceeding benchmark concentrations is potentially relevant to many COPCs.

Screening-level models are thus useful if they can eliminate COPCs, but perhaps raise more questions if they cannot. The degree of appropriate model refinement necessary to reach confident conclusions is not always clear. For example, the mercury dietary exposure analysis for the Indiana Bat results in ambiguous hazard quotients. If viewed from the basis of a no observed adverse effects level (NOAEL), the hazard quotient of 1.8 is perhaps a cause for concern, as adverse effects have been observed at an exposure level about two times smaller than tested. However, the projected exposure level does not exceed the level at which adverse effects have actually been observed (the LOAEL). In this model, the predicted concentration in soil is the single most important factor in deriving the risk estimate, as it also serves as the basis for estimating concentrations in sediment and surface water. The mercury concentration in soil is based on an estimate of mercury deposition at the worst-case point, and not an average over the Lake Decatur watershed, and hence likely overestimates aquatic impacts. The estimates of mercury in sediment and surface water could be refined by using the AERMOD dispersion model to predict location-specific deposition and the HHRAP algorithms to simulate COPC loadings and watershed dynamics. If this were done, I would expect that a lower concentration would be predicted. This lower concentration, however, would still embody a likely (and difficult to assess) degree of conservatism.

I note that tentative consideration of background concentrations has a dramatic effect on the F&WS PCDD/PCDF model. As obtained from F&WS, the model lacks background concentrations of PCDD/PCDF in environmental media. Although I could not locate background data for PCDD/PCDFs measured near the site, these compounds are ubiquitous in soil and sediment. The U.S. EPA's recent dioxin reassessment document suggests that 5 ppt, or 5 ng/kg = 5×10^{-6} mg/kg, is a typical background concentration in sediments (see <http://www.epa.gov/ncea/pdfs/dioxin/nas-review/>, Volume 2, Chapter 3). This background value is about one thousand times greater than the projected site-specific impact, about forty times

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greater than U.S. EPA's benchmark concentration (1.2×10^{-7} mg/kg, Table 3), and by itself produces hazard quotients of more than 0.3 (NOAEL-based) and 0.03 (LOAEL-based) in the F&WS spreadsheet.

In my opinion, a more complex analysis for the ADM facility is not warranted. Rather, recognizing (1) the likely conservatism in the simple fate-and-transport models described above and (2) the initial finding that the projected concentrations of these COPCs in ambient air are all less than 1% of background levels, I find no likely cause for concern regarding threatened and endangered species due to the increased emissions of ADM's proposed project.



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Table 1 Projected Ambient Air Impacts for Select Air Pollutants

Air Pollutant (non-HAPs <i>italicized</i>)	Emission Rate (lb/hr)	Highest Predicted Increment to Ambient Air ($\mu\text{g}/\text{m}^3$)	Background Concentration ($\mu\text{g}/\text{m}^3$) ^A	Worst-case percentage increase to existing background
Chromium	3.74E-03	2.60E-05	4.29E-03	0.6%
Lead	6.13E-03	8.66E-05	2.20E-02	0.4%
Mercury	1.35E-02	1.40E-05	1.63E-03	0.9%
PCDD/PCDF TEQs ^B	7.64E-09	7.57E-12	1.50E-08	0.1%

Notes:

A National Air Toxics Assessment modeling study for the census tract in which the ADM facility is located (<http://www.epa.gov/ttn/atw/nata1999/nsata99.html>). Concentrations followed by parenthetical percentages reflect measured values in Decatur, IL in 2005 based on speciation of fine particle (PM_{2.5}) samples. Since PM_{2.5} constitutes only a portion of total suspended particulate matter, the measured values underestimate background, and the degree of underestimation is likely substantial for chemicals such as magnesium that typically derive from crustal sources and hence are predominantly found on coarse particles. The percentage values that follow the background concentrations indicate frequency of detection with respect to analytical detection limits. Since the background concentrations of infrequently detected chemicals influence the reported annual average concentrations (non-detects are included in averages at ½ of reported detection limits), background estimates for some chemicals are uncertain, and hence barium, magnesium, and molybdenum are retained as Chemicals of Potential Concern even though projected incremental concentrations are smaller than 2% of background.

B PCDD/PCDF TEQs represent the sum of polychlorinated dibenzo(*p*)dioxin and furan congeners weighted by toxicity equivalency factors relative to the 2,3,7,8-tetrachlorodibenzo(*p*)dioxin congener. Derivation of the emission rate is described in a 2/15/07 memo from Stephen Zemba, Cambridge Environmental Inc., to Jack Burke, RTP Environmental Associates Inc. The background concentration of 15 fg/m³ (1.5E-08 $\mu\text{g}/\text{m}^3$) is a representative background concentration for rural areas in Illinois derived from the National Dioxin Air Monitoring Network (see http://www.epa.gov/ncea/pdfs/dioxin/dei/NDAMN_PAPER3a.pdf and http://esm.versar.com/pprp/features/Atmosdep/national_site_links/NDAMN-2002.ppt).

Table 2 Estimated impacts of facility emissions to soil

Chemical of Potential Concern	Concentrations in Soil (mg/kg)		
	Worst-case modeled increment due to proposed facility emissions ^A	Background	Benchmark ^E
Chromium	1.64E-02	1.62E+01 ^B	4.00E-01
Lead	5.46E-02	3.60E+01 ^B	5.37E-02
Mercury	8.86E-03	3.30E-02 ^C	1.00E-01
PCDD/PCDF TEQs	4.77E-09	#N/A ^D	1.99E-07

Notes: A Concentrations in soil are calculated with the deposition/surface mixing model.
B Background values from a statewide survey of soils located within Metropolitan Statistical Areas (see <http://www.ilga.gov/commission/jcar/admincode/035/03500742ZZ9996agR.html>).
C Average concentration in recent surface soils collected in central and southern Illinois (Dreher, G.B. and Follmer, L.R., Mercury Content of Illinois Soils, *Water, Air, and Soil Pollution* **156**: 299–315, 2004).
D Rachel Rineheart, U.S. EPA Region 5, personal communication.
E Benchmark concentrations are U.S. EPA Region 5 Ecological Screening Levels (ESLs)

Table 3 Estimated impacts of facility emissions to sediment

Chemical of Potential Concern	Concentrations in Sediment (mg/kg)			
	Worst-case modeled increment due to proposed facility emissions ^A		Background ^B	Benchmark ^D
	Based on plume-mix in model used in 2/15/07 memo	Based on assumption of worst-case modeled concentration in surface soil (Table 1)		
Chromium	1.87E+00	1.64E-02	2.20E+01	4.34E+01
Lead	3.06E+00	5.46E-02	2.05E+01	3.58E+01
Mercury	6.76E+00	8.86E-03	1.20E-01	1.74E-01
PCDD/PCDF TEQs ^B	3.82E-06	4.77E-09	#N/A	1.20E-07

Notes:

- A Concentrations in sediment are worst-case estimates that assume 100% of the proposed emission increases mix into Lake Decatur bottom sediments
- B Unless noted, background values from sampling conducted in Lake Decatur in 2003, unless noted. Values represent the averages of two samples. Values obtained from the U.S. EPA's STORET database (<http://www.epa.gov/soret>).
- C Background values sampled and reported in 1996 by the U.S. Geological Survey for bed sediment in the Sangamon River near Monticello, IL, the main tributary that feeds Lake Decatur. See http://pubs.usgs.gov/wdr/2005/wdr-il-05/data/swq_m_96/alt_1.htm for data.
- D Benchmark concentrations are U.S. EPA Ecological Screening Levels (ESLs) (see <http://www.epa.gov/RCRIS-Region-5/ca/ESL.pdf> for ESL descriptions)

Table 4 Estimated impacts of facility emissions to surface water

Chemical of Potential Concern	Concentrations in Surface Water ($\mu\text{g/l}$ unless noted); values in boldface indicate appropriately conservative estimates					
	Worst-case modeled increment from facility emissions based on plume mix-in model (as described in 2/15/07 memo) ^A	Sediment concentration based on alternate soil/sediment model (C_{BS} , mg/kg) ^B	Sediment/water partition coefficient (Kd_{BS} , l/kg) ^C	Worst-case modeled concentration in water based on assumed equilibrium with bed sediment C_{dw} (based on sediment/soil concentrations) ^D	Background	Benchmark ^F
Chromium	2.4E-02	1.64E-02	1.90E+01	8.6E-01	< 5.0E+00 ^E	4.20E+01
Lead	3.9E-02	5.46E-02	9.00E+02	6.1E-02	< 5.0E+00 ^E	1.17E+00
Mercury	8.6E-02	8.86E-03	5.00E+04	1.8E-04	< 0.05 ^E	1.30E-03
PCDD/PCDF TEQs	4.9E-08	4.77E-09	1.56E+05	3.1E-11	#N/A	3.00E-09

Notes:

- A Concentrations in surface water are worst-case estimates that assume 100% of the proposed emission increases mix into Lake Decatur.
- B Input for alternate surface water model based on alternate sediment concentration model (Table 3) that assumes worst-case sediment concentrations are equal to maximum modeled soil concentrations (Table 2).
- C Sediment/water partition coefficients obtained from the on-line database of the U.S. EPA's Human Health Risk Assessment Protocol (http://www.epa.gov/earth1r6/6pd/rcra_c/protocol/protocol.htm). Mercury Kd_{BS} value selected for mercuric chloride (the most prevalent species in surface water).
- D Calculated as the sediment concentration divided by the sediment/water partition coefficient.
- E Neither lead nor chromium was detected in five dissolved (unfiltered) samples collected in Lake Decatur in 2003 (U.S. EPA's STORET database – <http://www.epa.gov/storet> – detection limit: 5 $\mu\text{g/l}$). Additional samples were collected from the Sangamon River just downstream of Lake Decatur near Niantic, IL from 1994 to 1997 (USGS National Water Quality Assessment Data Warehouse. <http://infotrek.er.usgs.gov/traverse/f?p=NAWQA:HOME:1516752920773994>). Chromium and lead were detected infrequently: dissolved chromium in 1 of 24 samples (at 5 $\mu\text{g/l}$), total chromium is 2 of 26 samples (at 5 $\mu\text{g/l}$ and 7 $\mu\text{g/l}$), dissolved lead in 1 of 25 samples (at 7.3 $\mu\text{g/l}$), and total lead in 2 of 26 samples (at 6.9 $\mu\text{g/l}$ and 8.7 $\mu\text{g/l}$). The detection limit in these samples was 5 $\mu\text{g/l}$. Total mercury was not detected in any of 24 samples at the Niantic location at a detection limit of 0.05 $\mu\text{g/l}$.
- F Benchmark concentrations are U.S. EPA Ecological Screening Levels (ESLs) unless noted (see <http://www.epa.gov/RCRIS-Region-5/ca/ESL.pdf> for ESL descriptions).

Clean Air Act permit Endangered Species Act consultation
 Indiana bat (*Myotis sodalis*) food exposure pathway risk calculations
 Chemical: Total Mercury
 DRAFT

Future Emissions Enrichment -Soil	0.0088600000	mg/Kg dw	Soil enrichment percent background	26.8 %
Past Emissions Enrichment -Soil	0.0000000000	mg/Kg dw	Water enrichment percent background	2.7 %
Background Soil Concentration	0.033	mg/Kg dw	Sediment enrichment percent background	7.4 %
Soil to Invert Bioaccumulation Factor	8.5	unitless	Water enrichment HQ USEPA wildlife criteria	0.3
Future Emissions Enrichment - Sediments	0.00886	mg/Kg dw	Water enrichment HQ Mich. wildlife criteria	0.1
Past Emissions Enrichment -Sediments	0	mg/Kg dw		
Background Sediment Concentration	0.12	mg/Kg dw	Sediment concentration is an actual baseline measurement	
Sediment to Invert Bioaccumulation Factor	0.48	unitless		
Future Emissions Enrichment - Water	0.000000180000	mg/L	piscivorous wildlife water criteria 0.000000641 mg total mercury / L (USEPA 1997)	
Past Emissions Enrichment - Water	0.000000000000	mg/L	piscivorous wildlife water criteria 0.0000013 mg total mercury / L (Michigan numeric)	
Background Water Concentration	0.0000066	mg/L		
Water to Invert Bioaccumulation Factor	55000	unitless		
Normalized Food Ingestion Rate	0.333	Kg/Kg-bw/d ww		
Percent terrestrial insects	0.33	%		
Percent infaunal aquatic insects	0.33	%	These three values must be ≤ 1	
Percent epifaunal aquatic insects	0.34	%		
Normalized Water Intake Rate	0.16	L/Kg-bw/d		
Area Use Factor	1	unitless		
Seasonal Use Factor	1	unitless		
Safety Factor	1	unitless		
Incidental Exposures (e.g on insects)	0.01	% of food rate		
Methyl Mercury	0.65	% of total Hg		
Body Weight	0.0075	Kg		
Toxicity Reference Value NOAEL	0.032	mg/kg-bw/d		
Toxicity Reference Value LOAEL	0.16	mg/kg-bw/d		
Soil to invertebrate burden	0.35581	mg/kg		
Sediment to invertebrate burden	0.0618528	mg/kg		
Water to invertebrate burden	0.3729	mg/L/		
Normalized Food dose	0.088116703	mg/kg-bw/d		
Drinking water dose	0.00000002880	mg/kg-bw/d		
Normalized Food & Water Dose	0.088997899	mg/kg-bw/d		
Hazard Quotient NOAEL	1.8078	unitless		
Hazard Quotient LOAEL	0.3616	unitless		

TRVs for methylmercury chloride from Sample *et al.* 1996 (rat) - primary reference Verschuuren *et al.* 1976, USEPA 1997 provides chronic NOAEL 0.018 mg/Kg-bw/d
 Food ingestion and water intake rates from Sample *et al.* 1996 for little brown bat
 [Sum (Abiotic Media Concentration X Bioaccumulation Factor) X Ingestion or Intake Rate / Body Weight] X Use Factors = Dose / Toxicity Reference Value = Hazard Quotient
 Modeled on dry weight basis (dw to ww conversion use X 0.2978)

1 ng = 0.001 µg = 0.000001 mg 1.5E-03 = 0.0015
 ppm = mg/Kg = µg/g = ng/mg = 1000 ppb
 ppb = µg/Kg = ng/g = pg/mg 0.001 ppm
 ppt = ng/Kg = pg/g = fg/mg = ng/L
 ppq = pg/L

Last Updated 2/20/2007

Figure 1 Mercury dietary assessment for the Indiana Bat (F&WS model)

Clean Air Act permit Endangered Species Act consultation
Indiana bat (*Myotis sodalis*) food exposure pathway risk calculations
Chemical: TCDD-TEQ
DRAFT

Future Soil Concentration	4.77E-09	mg/Kg dw
Existing Soil Concentration	0	mg/Kg dw
Soil to Invert BAF	1.59	unitless
Future Sediment Concentration	4.77E-09	mg/Kg dw
Existing Sediment Concentration	0.00E+00	mg/Kg dw
Sediment to Invert BAF	0.9	unitless
Future Water Concentration	3.11E-14	mg/L
Water to Invert BAF	1560	unitless
Normalized Food Ingestion Rate	0.333	Kg/Kg-bw/d ww
Percent terrestrial insects	0.8	%
Percent infaunal aquatic insects	0.2	%
Percent epifaunal aquatic insects	0	%
Normalized Water Intake Rate	0.16	L/Kg-bw/d
Area Use Factor	1	unitless
Seasonal Use Factor	1	unitless
Incidental Exposures (e.g. grooming)	0.1	% of food rate
Body Weight	0.007	Kg
Toxicity Reference Value NOAEL	0.000001	mg/kg-bw/d
Toxicity Reference Value LOAEL?	0.00001	mg/kg-bw/d
Soil to bug burden	7.5843E-09	mg/kg/d
Sediment to bug burden	4.293E-09	mg/kg/d
Water to bug burden	4.8516E-11	mg/L/d
Normalized Food dose	2.30637E-09	mg/kg-bw/d
Drinking water dose	4.976E-15	mg/kg-bw/d
Normalized Food & Water Dose	2.53701E-09	mg/kg-bw/d
Hazard Quotient	0.003	unitless
Hazard Quotient	0.0003	unitless

Effects analysis:

Direct affects (chemical): see risk calculation
 Direct affects (physical): see tree removal mitigation plan
 Indirect affects (chemical): see direct tox to invert HQs
 Interrelated affects (physical): powerline construction (not considered)
 Cumulative affects (chemical): Considered in risk calculation

Model considered dw to ww conversion or may use X 0.2978

Did not consider existing water concentration because retention time assumed low

Diet rates from Sample *et al.* 1996 for little brown bat

These three values must be < 1

TRVs from Murray *et al.* 1979 rat multigeneration reproduction

S Weighted (Abiotic Media Concentration X Bioaccumulation Factor) X Food Ingestion Rate/Body Weight X Use Factors = Dose / Toxicity Reference Value = Hazard Quotient

1 ng = 0.001 :g = 0.000001 mg
 ppm = mg/Kg = :g/g = ng/mg = 1000 ppb
 ppb = :g/Kg = ng/g = pg/mg 0.001 ppm
 ppt = ng/Kg = pg/g = fg/mg
 1.5E-03 = 0.0015

Figure 2 PCDD/PCDF dietary assessment for the Indiana Bat