BEFORE THE ILLINOIS POLLUTION CONTROL BOARD

IN THE MATTER OF:)
)
PROPOSED AMENDMENTS TO)
TIERED APPROACH TO CORRECTIVE)
ACTION OBJECTIVES)
(35 Ill. Adm. Code 742))
)

R09-9
(Rulemaking-Land)

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NOTICE

Dorothy Gunn, Clerk
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James R. Thompson Center
100 W. Randolph, Suite 11-500
Chicago, Illinois 60601
(Via First Class Mail)

Bill Richardson
Chief Legal Counsel
Illinois Dept. of Natural Resources
One Natural Resources Way
Springfield, Illinois 62702-1271
(Via First Class Mail)

Matt Dunn
Environmental Bureau Chief
Office of the Attorney General
James R. Thompson Center
100 W. Randolph, 12th Floor
Chicago, Illinois 60601
(Via First Class Mail)

Richard McGill
Hearing Officer
Illinois Pollution Control Board
James R. Thompson Center
100 W. Randolph, Suite 11-500
Chicago, Illinois 60601

Participants on the Service List
(Via First Class Mail)

PLEASE TAKE NOTICE that I have today filed with the Office of the Clerk of the Illinois Pollution Control Board the Illinois Environmental Protection Agency's ("Illinois EPA") Errata Sheet Number 1 and the Pre-filed Testimony of Gary King, Thomas C. Hornshaw, Tracey Hurley, and Atul Salhotra a copy of each of which is herewith served upon you.

ILLINOIS ENVIRONMENTAL
PROTECTION AGENCY

By: Kimberly A. Geving
Kimberly A. Geving
Assistant Counsel
Division of Legal Counsel

BEFORE THE ILLINOIS POLLUTION CONTROL BOARD

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ERRATA SHEET NUMBER 1

NOW COMES the Illinois Environmental Protection Agency ("Illinois EPA") through one of its attorneys, Kimberly Geving, and submits this ERRATA SHEET NUMBER 1 to the Illinois Pollution Control Board ("Board") and the participants listed on the Service List. Gary King, Tracey Hurley, and Thomas C. Hornshaw will provide testimony in support of these changes at the hearing on January 27, 2009.

Section

742.410(b) ~~Area background shall be determined according to one of the following approaches:~~

~~1) Prescriptive Approach:~~

~~A) If more than 15% of the groundwater sampling results for a chemical obtained in accordance with subsection (a) of this Section are less than the appropriate detection limit for that chemical, the Prescriptive Approach may not be used for that chemical. If 15% or less of the sampling results are less than the appropriate detection limit, a concentration equal to one half the detection limit shall be used for that chemical in the calculations contained in this Prescriptive Approach.~~

~~B) The groundwater sampling results obtained in accordance with subsection (a) of this Section shall be used to determine if the sample set is normally distributed. The Shapiro-Wilk Test of Normality shall be used to determine whether the sample set is normally distributed, if the sample set for the background well(s) contains 50 or fewer~~

~~samples. Values necessary for the Shapiro-Wilk Test of Normality shall be determined using Appendix A, Tables C and D. If the computed value of W is greater than the 5% Critical Value in Appendix A, Table D, the sample set shall be assumed to be normally distributed, and the Prescriptive Approach is allowed. If the computed value of W is less than 5% Critical Value in Appendix A, Table D, the sample set shall be assumed to not be normally distributed, and the Prescriptive Approach shall not be used.~~

~~C) If the sample set contains at least ten sample results, the Upper Tolerance Limit (UTL) of a normally distributed sample set may be calculated using the mean (x) and standard deviation(s), from:~~

~~UTL = x + (K · s);~~

~~Where K = the one-sided normal tolerance factor for estimating the 95% upper confidence limit of the 95th percentile of a normal distribution. Values for K shall be determined using Appendix A, Table B.~~

~~D) If the sample set contains at least ten sample results, the UTL shall be the upper limit of the area background concentration for the site. If the sample set contains fewer than ten sample results, the maximum value of the sample set shall be the upper limit of the area background concentration for the site.~~

~~E) This Prescriptive Approach shall not be used for determining area background for the parameter pH.~~

(b) Area background shall be determined by using a statistically valid approach appropriate for the characteristics of the data set that is approved by the Agency.

742.1210(c)(4)	Remove this subsection from the proposal.
Appendix A, Table A	For the chemical 2-Chlorophenol (ionizable organic) change 1.00E+05 to 1.00E+04 and change 7.00E+04 to 7.10E+03. For the chemical Dichlorofluoromethane change the spelling to Dichlorodifluoromethane and change the 8.70E+04 to 8.70E+02. For the chemical Mercury (elemental) in the Soil Component of the Groundwater Ingestion Exposure Route column change the 3.10E+00 to NA.

	For the chemical Vinyl acetate change the 2.26E+03 to 2.60E+03.
Appendix A, Table F	Under the category of the Respiratory System add 1,3-Dichloropropene (*cis* + *trans*)(inhalation only) just before p-Dioxane (inhalation only).
Appendix A, Table L	For the chemical 2-Chlorophenol (ionizable organic) change 4.90E+04 to 4.90E+03.
	For the chemical Mercury (elemental) change 4.50E-01 to 1.05E+00.
Appendix B, Table A	For the chemical 2-Butanone (MEK) change the Outdoor Inhalation value from 13,000[b] to 25,000[d].
	For the chemical 2-Chlorophenol change the Outdoor Inhalation value from 100,000[d] to 10,000[d].
	For the chemical 1,4-Dichlorobenzene (p-Dichlorobenzene) change the Ingestion value from 120[e] to 5,500[b].
	For the chemical 1,3-Dichloropropene (1,3-Dichloropropylene, *cis* + *trans*) change the Class I value from 0.003[e] to 0.0052[e] and change the Class II value from 0.015 to 0.026.
	For the chemical Methoxychlor change the Class I value from 14[d] to 4.5[d] and change the Class II value from 14[d] to 4.5[d].
	For the chemical 2,4-Dichlorophenol change the Class II value from 3.3[i] to 17[i].
	For the chemical 2,4,6 Trichlorophenol change the Outdoor Inhalation value from 430[e] to 330[e].
	For the chemical Cobalt change the Ingestion value from 1,600[b] to 23[b] and change the Outdoor Inhalation value from 1,100[e] to 360[e].
Appendix B, Table B	For the chemical Bromoform change the footnote under the Construction Worker Ingestion column from an "e" to a "b".

For the chemical 2-Butanone (MEK) change the Industrial/Commercial Outdoor Inhalation value from 21,000[b] to 25,000[d] and change the Construction Worker Outdoor Inhalation value from 140[b] to 730[b].

For the chemical Chloroform change the Construction Worker Ingestion value from 2,000[b] to 4,000[c].

For the chemical 2-Chlorophenol change the Industrial/Commercial Outdoor Inhalation value from 100,000[d] to 10,000[d], change the Construction Worker Ingestion value from 10,000[b] to 1,600[b], and change the Construction Worker Outdoor Inhalation value from 100,000[d] to 10,000[d].

For the chemical Dalapon change the Construction Worker Outdoor Inhalation value from 120,000[d] to 11,000[aa].

For the chemical DDD change the Construction Worker Outdoor Ingestion value from 360[c] to 520[c].

For the chemical 1,2-Dibromo-3-chloropropane change the Construction Worker Outdoor Inhalation footnote from "b" to "e".

For the chemical Di-*n*-butyl phthalate change the Class I value from 1,100[r] to 880[d] and change the Class II value from 5,600[r] to 880[d].

For the chemical 1,4-Dichlorobenzene (*p*-Dichlorobenzene) change the Industrial/Commercial Ingestion value from 1,100[c] to 140,000[b], change the Industrial/Commercial Outdoor Inhalation value from 6.2[c] to 20,000[b], and change the Construction Worker Outdoor Inhalation value from 8.8[c] to 320[b].

For the chemical 1,3-Dichloropropene (1,3-Dichloropropylene, *cis* + *trans*) change the Class I value from 0.003[c] to 0.0052[c] and change the Class II value from 0.015 to 0.026.

For the chemical 2,4-Dimethylphenol change the Construction Worker Ingestion value from 41,000[b] to 10,000[b].

For the chemical 2,6-Dinitrotoluene change the Class II value from 0.0006[r] to 0.0018[r].

For the chemical Di-*n*-octyl phthalate change the Industrial/Commercial Ingestion footnote from a "d" to a "b".

For the chemical Hexachlorocyclopentadiene change the Class II value from 130[d] to 44[d].

For the chemical Isopropylbenzene (Cumene) change the Construction Worker Ingestion value from 82,00[b] to 82,000[b].

For the chemical Methoxychlor change the Class I value from 14[d] to 4.5[d] and change the Class II value from 14[d] to 4.5[d].

For the chemical 2-Methylphenol (*o*-Cresol) add a footnote "a" after the value in the Construction Worker Outdoor Inhalation column.

For the chemical *N*-Nitrosodiphenylamine change the footnote "e" to "b" in the Construction Worker Ingestion column.

For the chemical *N*-Nitrosodi-*n*-propylamine change the Industrial/Commercial Outdoor Inhalation value from 1,900[d] to 0.22[e] and change the Construction Worker Outdoor Inhalation value from 1,900[d] to 0.31[e].

For the chemical 2,4,5-TP (Silvex) change the Construction Worker Ingestion value from 160,000[b] to 1,600[b].

For the chemical 2,4-Dichlorophenol change the Class II value from 3.3[i] to 17[i].

For the chemical 2,4,5-Trichlorophenol change the Construction Worker Ingestion value from 200,000[b] to 61,000[b].

For the chemical 2,4,6-Trichlorophenol change the Industrial/Commercial Outdoor Inhalation value from 820[c] to 630[c], change the Construction Worker Ingestion value from 11,000[c] to 2,000[b], and change the Construction Worker Outdoor Inhalation value from 1,200[c] to 890[c].

For the chemical Antimony change the Construction Worker Ingestion value from 41[b] to 82[b].

For the chemical Chromium, ion, hexavalent change the footnote in the Construction Worker Outdoor Inhalation column from a "b" to an "e".

For the chemical Cobalt change the Industrial/Commercial Ingestion value from 41,000[b] to 610[b], change the Industrial/Commercial Outdoor Inhalation value from 1,800[c] to 560[c], and change the Construction Worker Ingestion value from 12,000[b] to 610[b].

Add a new footnote "aa" at the end of the footnotes to read: [aa] Calculated values correspond to soil concentrations that should not result in air concentrations that exceed criteria for workplace air.

Appendix B, Table G

For the chemical 2-Butanone (MEK) change the Soil Gas Residential value from 440,000 to 380,000[g] and change the Soil Gas Industrial/Commercial value from 2,700,000 to 380,000[g].

For the chemical 2-Chlorophenol change the Soil Residential value from 49,000[c] to 4,900[c], change the Soil Industrial/Commercial value from 49,000[c] to 4,900[c], change the Groundwater Residential value from 220,000[h] to 22,000[h], and change the Groundwater Industrial/Commercial value from 220,000[h] to 22,000[h].

For the chemical 1,4-Dichlorobenzene change the Soil Residential value from 1.3[d] to 130[c], change the Soil Industrial/Commercial value from 9.8[d] to 130[c], change the Groundwater Residential value from

	0.85[d] to 79[h], change the Groundwater Industrial/Commercial value from 6[d] to 79[h], change the Soil Gas Residential value from 317[d] to 8,400[g], and change the Soil Gas Industrial/Commercial value from 270[d] to 8,400[g].
	For the chemical Mercury change the Soil Residential value from 0.45[c,i] to 1.05[c,i] and change the Soil Industrial/Commercial value from 0.45[c,i] to 1.05[c,i].
	Change footnote "i" by deleting "Mercury is measured in mg/L." and replace it with "Value for the inhalation exposure route is based on Reference Concentration for elemental mercury (CAS No. 7439-97-6). Inhalation remediation objectives only apply at sites where elemental mercury is a contaminant of concern."
Appendix C, Table E	For the chemical 2-Chlorophenol change the Solubility in Water entry from 2.20E+05 to 2.2E+04.
	For the chemical 2,4,5-Trichlorophenol change the Solubility in Water entry from 8.00E+02 to 1.20E+03 and change the Dimensionless Henry's Law Constant (H')(25°) entry from 3.53E-04 to 1.78E-04.
	For the chemical 2,4,6-Trichlorophenol change the Solubility in Water entry from 1.20E+03 to 8.00E+02 and change the Dimensionless Henry's Law Constant (H')(25°) entry from 1.78E-04 to 3.53E-04.
Appendix C, Table J	In the pH header row change Hg to Hg(+2) for the entire table.

Respectfully submitted,

ILLINOIS ENVIRONMENTAL
PROTECTION AGENCY

By: Kimberly A Geving
Kimberly A. Geving
Assistant Counsel
Division of Legal Counsel

DATE: November 12, 2008

1021 North Grand Ave. East
P.O. Box 19276
Springfield, Illinois 62794-9276

(217) 782-5544

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IN THE MATTER OF:)
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PROPOSED AMENDMENTS TO) R09-9
TIERED APPROACH TO CORRECTIVE) (Rulemaking-Land)
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(35 Ill. Adm. Code 742))

PRE-FILED TESTIMONY OF THOMAS C. HORNSHAW

Qualifications

My name is Thomas C. Hornshaw. I am a Senior Public Service Administrator and the Manager of the Toxicity Assessment Unit of the Illinois Environmental Protection Agency ("Agency"). I have been employed at the Agency since August of 1985, providing expertise to the Agency in the area of environmental toxicology. Major duties of my position include development and use of procedures for toxicity and risk assessments, review of toxicology and hazard information in support of Agency programs and actions, and critical review of risk assessments submitted to the Agency for various cleanup and permitting activities.

I was a member of the Agency's Cleanup Objectives Team until February of 1993, when that Team's responsibilities were assumed mainly by the Toxicity Assessment Unit. I was also a member of the Groundwater Standards Technical Team during the development of the Groundwater Quality Standards. These two teams have looked in depth at the problems involved with determining acceptable residual concentrations of chemicals in soil and/or groundwater. I have also participated in the development of the original 35 Ill. Adm. Code Part 742 rule, Tiered Approach to Corrective Action Objectives ("TACO"; R97-14) and subsequent amendments to this rule.

I received Bachelor of Science (with honors) and Master of Science degrees in Fisheries Biology from Michigan State University, East Lansing, Michigan. I also received a dual Doctor of Philosophy degree from Michigan State University, in Animal Science and Environmental Toxicology. I am a member of the Society of Environmental Toxicology and Chemistry and Sigma Xi, the Scientific Research Society. I have authored or co-authored six papers published in peer-reviewed scientific journals, one report issued through the U.S. Environmental Protection Agency, and have written or co-written six articles which have appeared in trade journals. I have also presented twenty-one posters and/or talks describing facets of my graduate work and my work at the Agency at various regional and national meetings. A more descriptive account of my work and educational background and a list of publications, posters, and talks is included in a Curriculum Vitae presented as Exhibit 1 to this testimony.

Testimonial Statement

It has recently come to the Agency's attention that the procedure specified in TACO currently for the determination of area background for groundwater at Section 742.410(b)(1), the "Prescriptive Approach," is now out of date and must be updated. In the current approach, if the data set for a background well has no more than 15% non-detect results for the chemical of interest, is normally distributed, and has at least 10 sample results, then the area background concentration for that chemical is calculated as the 95% Upper Tolerance Limit ("UTL") using the calculation specified in Section 742.410(b)(1)(C). The Agency selected this approach at the time TACO was first proposed because this was the approach recommended by the United States Environmental Protection Agency ("USEPA") for establishing groundwater background levels at RCRA sites in "RCRA Facility Investigation Guidance, Interim Final," EPA 530/SW-89-031 (May 1989), and its follow-up document "Statistical Training Course for Ground-water Monitoring Data Analysis," EPA 530-R-93-003 (1992).

Now, however, USEPA has developed updated guidance for determining background groundwater levels, "Statistical Analysis of Ground-water Monitoring Data at RCRA Facilities-Unified Guidance," USEPA, Office of Solid Waste, 1999c (in progress). This guidance specifies a number of statistical approaches for determining background groundwater concentrations, with the approach to be used dependant on the characteristics of the data set. It is noteworthy that the UTL statistic is not among the approaches recommended by USEPA. It is also noteworthy that in a remediation project overseen by the Agency, the responsible party is in the process of determining the area background for nitrate in groundwater, in which the UTL will eventually be calculated to be in the range of 50-55 mg/l. This concentration of nitrate is also in the range at which potentially serious effects might be experienced by infants.

In keeping with the updated guidance, the Agency is proposing in Errata Sheet Number 1 to update the determination of area background for groundwater in Section 742.410. We recommend removing all of the current subsection 742.410(b) and replacing it with a new subsection (b) as follows:

> (b) Area background shall be determined by using a statistically valid approach appropriate for the characteristics of the data set that is approved by the Agency.

This concludes my testimony on Errata Sheet Number 1.

EXHIBIT

1

CURRICULUM VITAE

THOMAS C. HORNSHAW

EDUCATION: Ph.D., Animal Science and Environmental Toxicology, 1985. M.S., 1981, and B.S., 1976, Fisheries Biology, Michigan State University.

EXPERIENCE: Senior Public Service Administrator, Illinois Environmental Protection Agency, 1985 - Present.

Graduate Research Assistant, Department of Animal Science, Michigan State University, 1981 - 1984.

Graduate Research Assistant, Department of Fisheries and Wildlife, Michigan State University, 1978 - 1981.

Student Aide, Water Quality Division, Biology Section, Michigan Department of Natural Resources, 1976 - 1977.

FIELDS OF EXPERIENCE: At the Illinois Environmental Protection Agency, Dr. Hornshaw's major duties include the management of the Toxicity Assessment Unit; development and use of procedures for human and environmental exposure assessments and risk assessments; review of toxicological data and hazard information in support of Agency programs and actions; and critical review of remedial investigation and risk assessment documents submitted to the Agency during hazardous waste site investigations and cleanups. Dr. Hornshaw was a member of the Agency's Cleanup Objectives Team until 1993, when that Team's functions were assumed by the Toxicity Assessment Unit. As a member of Agency work groups, he participated in the development of Illinois= Air Toxics, Groundwater Quality, and Tiered Approach to Corrective Action rules. He is one of the Agency's representatives to the Great Lakes Toxic Substances Control Agreement (member of the Fish Advisory Task Force) and is the Chair of the multi-agency Illinois Fish Contaminant Monitoring Program. Dr. Hornshaw was also a member of the National Advisory Committee for Acute Exposure Guidance Levels, moderated by USEPA, whose task is the development of action levels for use in unplanned air releases of hazardous chemicals. In an earlier assignment at the Agency, Dr. Hornshaw assisted in the development of bioassay protocols and quality assurance procedures for the Biomonitoring Unit.

As part of his duties during his Ph.D. research at Michigan State University, Dr. Hornshaw conducted experiments to develop protocols for mammalian wildlife dietary LC_{50} and reproduction tests, using mink and European ferrets as representative mammalian carnivores. He has published four papers in scientific journals as a result of this research, and the protocols developed from these studies have been published by USEPA.

As part of his duties during his M.S. research at Michigan State, Dr. Hornshaw conducted experiments to assess the suitability of several species of Great Lakes fish for animal feed, testing the fish in reproduction trials with mink. He quantitated levels of polychlorinated biphenyls in fish, mink fat, and mink milk as a portion of this research, and published the results of these studies in a scientific journal. These results were also published in several trade journals serving the fur industry. He has authored or co-authored articles detailing the results of several other studies sponsored by the fur industry in these trade journals.

After receiving his Bachelor's degree from Michigan State, Dr. Hornshaw worked as a student aide in the Biology Section of the Water Quality Division of Michigan's Department of Natural Resources. His duties included assisting staff aquatic biologists in the collection of fish, water, sediment, and benthos samples, in laboratory work, in data handling, and in reporting requirements. His field experience included sample collection and identification from inland lakes, Great Lakes, and rivers and streams.

HONORS: Bachelor of Science, with honors; Member, Sigma Xi, the Scientific Research Society.

AFFILIATIONS: Member, Society of Environmental Toxicology and Chemistry.

THESES:

Hornshaw, T. C. 1984. Development of Dietary LC_{50} and Reproduction Test Protocols Using Mink and Ferrets as Representative Mammalian Carnivores. Ph.D. Thesis, Michigan State University, East Lansing, MI. 212pp.

Hornshaw, T. C. 1981. Renewed Use of Underutilized Species of Great Lakes Fish for Animal Feed. M.S. Thesis, Michigan State University, East Lansing, MI. 45pp.

PUBLICATIONS (Peer Reviewed):

Ringer, R. K., Hornshaw, T. C., and Aulerich, R. J. Mammalian Wildlife (Mink and Ferret) Toxicity Test Protocols (LC_{50}, Reproduction, and Secondary Toxicity). U.S. Environmental Protection Agency Report No. EPA/600/3-91/043. July 1991. NTIS Document # PB91-216507.

Hornshaw, T. C., Aulerich, R. J., and Ringer, R. K. 1987. Toxicity of thiram (tetramethylthiuram disulfide) to mink and European ferrets. Bull. Environ. Contam. Toxicol. 38: 618 - 626.

Hornshaw, T. C., Ringer, R. K., Aulerich, R. J., and Casper, H. H. 1986. Toxicity of sodium monofluoroacetate (Compound 1080) to mink and European ferrets. Environ. Toxicol. Chem. 5: 213 - 223.

Hornshaw, T. C., Aulerich, R. J., and Ringer, R. K. 1986. Toxicity of o-cresol to mink and European ferrets. Environ. Toxicol. Chem. 5: 713 - 720.

Hornshaw, T. C., Safronoff, J., Ringer, R. K., and Aulerich, R. J. 1986. LC_{50} test results in polychlorinated biphenyl-fed mink: age, season, and diet comparisons. Arch. Environ. Contam. Toxicol. 15: 717 - 723.

Bleavins, M. R., Aulerich, R. J., Hochstein, J. R., Hornshaw, T. C., and Napolitano, A. C. 1983. Effects of excessive dietary zinc on the intra- uterine and postnatal development of mink. J. Nutr. 113: 2360 - 2367.

Hornshaw, T. C., Aulerich, R. J., and Johnson, H. E. 1983. Feeding Great Lakes fish to mink: effects on mink and accumulation and elimination of PCBs by mink. J. Toxicol. Environ. Health 11: 933 - 946.

PUBLICATIONS (Trade Journals):

Hornshaw, T. 1992. Illinois' Air Toxics selection process described. National Air Toxics Information Clearinghouse (NATICH) Newsletter. USEPA Office of Air Quality Planning and Standards, Research Triangle Park, NC. January, 1992.

Aulerich, R. J., Napolitano, A. C., and Hornshaw, T. C. 1986. How supplemental copper affects mink kit hemoglobin concentration. In The Fur Rancher Blue Book of Fur Farming. Communications Marketing, Inc., Eden Prairie, MN. pp. 42 - 46.

Hornshaw, T. C., Aulerich, R. J., and Ringer, R. K. 1985. Mineral concentrations in the hair of natural dark and pastel mink. Scientifur 9(3): 216 - 219.

Aulerich, R. J., Napolitano, A. C., and Hornshaw, T. C. 1985. Effect of supplemental copper on mink kit hemoglobin concentration. Fur Farmer's Gazette of the United Kingdom 35(4): 8 - 11.

Hornshaw, T. C., Aulerich, R. J., Johnson, H. E., and Ringer, R. K. 1982. How suitable are today's Great Lakes fish for use in feeding mink? Fur Rancher 62(9): 21 - 23.

Hornshaw, T. C., and Aulerich, R. J. 1980. Can Great Lakes fish again be fed safely to mink? In The Fur Rancher Blue Book of Fur Farming. Communications Marketing, Inc., Eden Prairie, MN. pp. 48 - 49.

PRESENTATIONS:

Hornshaw, T.C. "The Illinois Fish Contaminant Monitoring Program." Talk presented at the 27th Annual Fall Meeting, Midwest Regional Chapter, Society of Toxicology, November 7, 2008, Downers Grove, IL.

Hornshaw, T.C. "Illinois EPA Pilot Study: PPCPs in Illinois Drinking Water." Talk presented at the Meds with Water...Not in Water Pharmaceutical Summit Conference, October 1, 2008, Springfield, IL.

Willhite, M. and Hornshaw, T. "Illinois EPA Study of Pharmaceuticals in Drinking Water." Talk presented at the Illinois Waste Management and Research Center Symposium on Pharmaceuticals and Personal Care Products (PPCPs) in the Illinois Environment, April 25, 2008, Champaign, IL.

Hornshaw, T.C. "Emerging Contaminants: What Next to Worry About?" Talk presented at the

Illinois Lake Management Association Annual Conference, February 28-29, 2008, Springfield, IL.

Hornshaw, T.C. and Homer, D. "Calumet Ecotox Protocol: Protecting Calumet's Plants and Animals." Talk presented at the Calumet Research Summit, January 10-11, 2006, Hammond, IN.

Hornshaw, T.C. "Background Metals and PAHs – Panel Discussion." Session Chair and Panel Member at the Midwestern States Risk Assessment Symposium, August 25-27, 2004, Indianapolis, IN.

Hornshaw, T.C. "Vapor Intrusion Action Levels – Panel Discussion." Panel Member at the Midwestern States Risk Assessment Symposium, July 24-26, 2002, Indianapolis, IN.

Hornshaw, T. C. AThe Illinois Strategy for Endocrine Disruptors.@ Talk presented at The Endocrine Disruptor Debate: Environmental Chemicals and Reproductive and Developmental Health, October 17, 1997, St. Paul, MN.

Hornshaw, T. C. ARisk Pathways and Exposure Potential as Critical Factors in the Determination of Remedial Objectives.@ Talk presented at the Science for Environmental Professionals and Attorneys Conference, January 8, 1997, Chicago, IL.

Hornshaw, T. C. APotential Health Effects of Triazine Herbicides and Their Metabolites in Community Water Supplies.@ Talk presented at the 1996 Illinois Agricultural Pesticides Conference, January 3-4, 1996, Champaign, IL.

Hornshaw, T. C. "The Illinois Fish Contaminant Monitoring Program." Talk presented at the Biannual Meeting of the Federal-State Toxicology and Risk Assessment Committee (FSTRAC), November 6-8, 1991, Chicago, IL.

Hornshaw, T. C. "Assessing Exposure to Toxic Air Releases from a Chemical Facility: Illinois Acrylonitrile Exposure Assessment." Talk presented at the National Governors' Association Conference on Assessing Exposure to Toxic Contaminants: Issues and Problems Facing State Government, March 29, 1989, Salt Lake City, UT.

Hornshaw, T. C. "Risk Assessment from State Point of View." Talk presented at the 1st Annual Hazardous Materials Management Conference/Central, March 16, 1988, Chicago, IL.

Perino, J. V., Whitaker, J. B., and Hornshaw, T. C. Technical aspects of an aquatic toxicological testing program at a state regulatory agency. Poster presented at the 1st Annual Meeting of the Ozark-Prairie Chapter of the Society of Environmental Toxicology and Chemistry, April 24-26, 1986, Columbia, MO.

Hornshaw, T. C. "Illinois EPA's Aquatic Toxicity Testing Program." Talk presented to the Illinois Environmental Consensus Forum. December 12, 1985. Springfield, IL.

Aulerich, R. J., Bursian, S. J., Nachreiner, R. F., Olson, B. A., Hochstein, J. R., Hornshaw, T. C., and Koudele, K. A. Toxicological manifestations of dietary exposure to 3,4,5,3', 4', 5' - hexachlorobiphenyl in mink. Poster presented at the 24th Annual Meeting of the Society of Toxicology, March 18-22, 1985, San Diego, CA.

Hornshaw, T. C. "Effects of Feeding Great Lakes Fish to Mink." Talk presented at the Great Lakes Commercial Fisheries Workshop, March 12, 1985, Mackinaw City, MI.

Hornshaw, T. C., Safronoff, J., Aulerich, R. J., and Ringer, R. K. Development and validation of dietary LC_{50} test protocols for wildlife mammalian carnivores using mink and ferrets. Poster presented at the 5th Annual Meeting of the Society of Environmental Toxicology and Chemistry, November 4-7, 1984, Arlington, VA.

Hornshaw, T. C., Ringer, R. K., and Aulerich, R. J. Toxicity of thiram to mink and European ferrets. Poster presented at the 23rd Annual Meeting of the Society of Toxicology, March 12-16, 1984, Atlanta, GA.

Hornshaw, T. C., Ringer, R. K., and Aulerich, R. J. Toxicity of sodium monofluoroacetate (Compound 1080) to mink. Poster presented at the 22nd Annual Meeting of the Society of Toxicology, March 6-11, 1983, Las Vegas, NV.

Hornshaw, T. C., Aulerich, R. J., Johnson, H. E., and Ringer, R. K. Suitability of today's Great Lakes fish for animal feed. Poster presented at the International Symposium on PCBs in the Great Lakes, March 15-17, 1982, East Lansing, MI.

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(35 Ill. Adm. Code 742))

PRE-FILED TESTIMONY OF GARY KING

Qualifications

My name is Gary King. I am the Acting Chief for the Bureau of Land at the Illinois Environmental Protection Agency. Since 1990, I have been senior manager for the Illinois EPA site cleanup programs: the voluntary cleanup program, federal and state Superfund cleanup programs, Department of Defense cleanup program, Brownfields assistance program and the Leaking Underground Storage Tank program. I led Illinois EPA's development of the original 35 Ill. Adm. Code Part 742 rule, Tiered Approach to Corrective Action Objectives (TACO, R97-14) and all subsequent amendments.

I also chaired the Association of State and Territorial Solid Waste Management Officials ("ASTSWMO") CERCLA Research Center from January 2001 to October 2008. In that role I had frequent contact with other States and U.S. EPA concerning important issues to State and federal Superfund programs.

Prior to 1990, I managed Illinois EPA land enforcement programs. I am an attorney and hold a B.S degree in civil engineering from Valparaiso University.

Testimonial Statement

I will be testifying in support of the proposed amendments to 35 Ill. Adm. Code 742: Tiered Approach to Corrective Action Objectives. I will present an overview of the pathway evaluation and tiered approach to the indoor inhalation exposure route; describe the derivation of the Tier 1 remediation objectives for the indoor inhalation exposure route, including the recommended parameter values for the modified Johnson and Ettinger (J&E) model; and explain the rationale and requirements for the use of soil gas data and building control technologies.

Subpart A: Introduction

Section 742.115 introduces the exposure routes to be evaluated under this Part, including the indoor inhalation exposure route. Similar to the groundwater ingestion route, the indoor inhalation route has both a soil and groundwater component. In addition, it has a soil gas component. The soil component is the migration of contaminants from soil through soil gas into a building interior. The groundwater component is the migration of contaminants from groundwater through soil gas into a building interior. This pathway is unique in that it involves three types of media: soil, groundwater, and soil gas.

Subpart B: General

Section 742.200 contains new definitions for the terms "building," "building control technology," "soil gas," and "soil vapor saturation limit." Assigning a specific meaning to "building" will avoid confusion as to whether the indoor inhalation pathway must be evaluated for every structure. The use of "building control technology" describes mitigation systems for indoor inhalation risks and is compatible with the existing term "engineered barriers." "Soil gas" merits a definition now that it has become a medium of interest as does "soil vapor saturation limit," which parallels the definitions of "soil saturation limit" and "solubility." The amended definition of "soil saturation limit" is actually language taken from an original footnote contained in Appendix B, Tables A and B. The footnote offered the better explanation. As for the amended definition of "volatile chemicals," it resulted from a re-examination (and eventual deletion) of the original definitions of "volatile organic compounds" and "volatile chemicals." Today the term is used to define contaminants subject to evaluation under the indoor inhalation exposure route, including elemental mercury.

Section 742.210 contains 19 new incorporations by reference. The most notable of these are U.S. EPA's draft guidance, *Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils*, which established the use of the J&E model, and its companion document, *Users Guide for Evaluating Subsurface Vapor Intrusion into Buildings*, which provided justification for certain parameter values. Other significant publications include ASTM International's *Standard Practice for Assessment for Vapor Intrusion into Structures on Property Involved in Real Estate Transactions* and the Interstate Technology and Regulatory Council (ITRC)'s *Vapor Intrusion Pathway: A Practical Guide*. Additional incorporations have been included to provide soil gas analytical methods, source information for parameter value selection, and techniques for mitigation systems.

Section 742.222 provides methods for determining the soil vapor saturation limit and parallels Section 742.220, which is used for determining the soil saturation limit. The soil vapor saturation limit is the maximum vapor concentration that can exist in the soil pore air at a given temperature and pressure. Section 742.Appendix A, Table K presents the soil vapor saturation limits for volatile chemicals. For the indoor inhalation exposure route, soil gas remediation objectives cannot exceed the soil vapor saturation limit; otherwise, the assumptions of the modified J&E model would be violated. The modified J&E model as well as the existing RBCA and SSL models operate on similar assumptions regarding soil saturation and solubility. These risk-based models assume an equilibrium between contaminant concentrations that exist as vapors in soil pores, contaminants that adhere to soil particles, and contaminants that dissolve into water within soil pores.

In Section 742.225, compositing and averaging of sample results are not allowed to demonstrate compliance with the indoor inhalation exposure route. Compositing of volatile chemicals is already prohibited under this Section (the physical mixing of samples in the field provides a mechanism for the contaminants to volatize and escape into the atmosphere; subsequent sample analyses would underestimate the amount of contamination actually present at a site). As for sample averaging, first, and most important, is the concern that averaging could allow a "hot spot" of contamination to remain beneath a building that could result in a concentrated "slug" of chemicals entering the building in a relatively short period of time. It is possible under such conditions that these short-term, higher-level concentrations could result in odor, irritation, and even central nervous system (headache, nausea, etc.) problems. Second, it is unlikely that a sufficient number of soil and/or groundwater samples will be collected for the indoor inhalation exposure route to allow for the development of statistically valid 95 percent upper confidence limits (UCLs) for this route. Third, an appropriately conducted indoor inhalation exposure evaluation would typically include sampling in two or more seasons, and procedures for deriving the most representative statistic for such data sets can be problematic. For these reasons, Illinois EPA decided that averaging for the indoor inhalation route would not be included, except in Tier 3. Nonetheless, we would be willing to evaluate an averaging methodology if it adequately addressed the concerns we have raised.

Illinois EPA acknowledges that there are likely to be site-specific circumstances in which averaging results would be appropriate, and that an outright prohibition against averaging is not needed. Therefore, Section 742.225(b)(5) allows for averaging in Tier 3 based upon an Illinois EPA-approved plan.

Section 742.227 provides minimal requirements for the collection and analysis of soil gas samples. Ordinarily, sampling locations, quantities and protocol are determined by the program under which the remediation is being performed (LUST, RCRA, Site Remediation Program); however, because the use of soil gas data is not as well understood by site evaluators, Illinois EPA decided to specify the most essential criteria to reduce the likelihood of error, the misrepresentation of actual conditions, and the need for repeat sampling.

Subpart C: Exposure Route Evaluations

Section 742.312 identifies ways in which the indoor inhalation exposure route may be excluded from consideration. Indoor inhalation presents a risk only if volatile chemicals are the contaminants of concern. If a site has none of the 59 chemicals listed in Section 742.Appendix A, Table J or any other contaminants meeting the new definition of "volatile chemicals," then the indoor inhalation pathway does not need to be evaluated.

If volatile chemicals are present, the site evaluator has the option of excluding the pathway by either restricting buildings above contaminated areas or by implementing building control technologies. The general pathway exclusion criteria of existing Sections 742.300 and 742.305 must also be met; these are the "speed bumps" to prevent free product, the leaving behind of materials with the potential impact of hazardous waste, and concentrations of polychlorinated biphenyls above 50 parts per million.

The new building-specific exclusions would need institutional controls as follows:

1. A land use restriction prohibiting a building or man-made pathway above the contaminated soil or groundwater. (The indoor inhalation exposure route is incomplete if a building does not exist.)
2. Operation and maintenance requirements for approved building control

technologies, including sub-slab depressurization, sub-membrane depressurization or membrane barriers. These requirements are contained in the new Subpart L: Building Control Technologies.

The indoor inhalation exposure route cannot be excluded by use of a groundwater ordinance. This exclusion is not allowed because an ordinance restricting the use of groundwater as a source of drinking water would not protect the enclosed air space of a building from the migration of contaminants emanating from the groundwater.

Subpart E: Tier 1 Evaluation

A Tier 1 remediation objective is a numerical chemical concentration that represents a level of contamination at or below which there are no human health concerns. Sites achieving residential Tier 1 remediation objectives are intended to clearly indicate that the property meets an unrestricted land use category for that category of use. Tier 1 requires a determination of either residential or industrial/commercial land use. Generally, equally protective but less restrictive remediation objectives apply to the industrial/commercial sites. [Note: whenever remediation objectives are based on an industrial/commercial land use, an institutional control must be placed on the property in accordance with Section 742.1000(a)(1).]

Early in the rulemaking development, SRAC proposed that indoor air OSHA standards should apply in lieu of TACO at facilities where the chemicals of concern continue to be used or manufactured. Illinois EPA disagreed since vapor intrusion potentially impacts the entire building and all of its occupants. The OSHA standards may be more narrowly applied to a subset of workers and do not account for the future use of the property.

As with the other exposure routes, the indoor inhalation remediation objectives are calculated based on a one-in-a-million individual excess cancer risk for chemicals causing carcinogenic adverse health effects and a hazard quotient of one for chemicals causing noncarcinogenic adverse health effects.

Risk-based indoor inhalation remediation objectives were derived from equations combining exposure assumptions with toxicity data. The steps used to develop the soil, groundwater and soil gas remediation objectives included:

1. Calculating a concentration of the contaminant of concern in indoor air that adequately protects humans who inhale this air (i.e., meets the above mentioned risk criteria);
2. Calculating an acceptable concentration of the contaminant of concern in the soil gas at the source of contamination. This concentration will not cause the contaminant in indoor air to exceed the concentration calculated in Step 1. This calculation was made using an attenuation factor derived from a mathematical model developed by Johnson and Ettinger (J&E). [Note: the ratio of the concentration in the indoor air (Step 1) to the soil gas concentration is called the attenuation factor. Thus the primary use of the J&E model is to calculate the attenuation factor.]
3. Calculating acceptable soil and groundwater remediation objectives using the soil gas remediation objective calculated in Step 2, with the assumption that this contaminant is in three phase equilibrium.

The J&E model is preferred by U.S. EPA and is the most common predictive model used by State environmental agencies in calculating the attenuation of contaminant concentrations from the subsurface to indoor air. The attenuation factor accounts for the following processes:

1. Migration of contaminants from the source upwards through the vadose zone. The source of contaminant concentrations in the subsurface may be either soil or groundwater. If the source is groundwater, the attenuation factor considers the initial migration of contaminants through the capillary fringe.
2. Migration of contaminants through the dirt filled cracks in the slab-on-grade or basement floor.
3. Mixing of the contaminants with air inside the building.

Dr. Atul Salhotra, RAM Group, will provide testimony on the scientific basis, fundamental concepts and application of the modified J&E model.

Illinois EPA provides 18 J&E equations and 56 default parameter values (Section 742.Appendix C, Tables L and M). Exposure factors are consistent with the values used in the current TACO regulations. Toxicity factors were obtained using U.S. EPA's hierarchy and are chemical-specific. Existing Sections 742.505(b)(3) and (4), which contain the procedures for addressing the additive effects of similar-acting chemicals in developing Tier 1 groundwater remediation objectives, also apply to the indoor inhalation exposure route.

Tier 1 remediation objectives have been developed for a slab-on-grade building. A slab-on-grade building is a more conservative scenario because there is less air available in the building to mix with the contamination. A building with a basement assumes there is mixing of the air between the basement and the first floor. Tier 1 remediation objectives are applicable to both slab-on-grade buildings and buildings with basements.

A slab-on-grade building is one with a concrete floor at about the same level as the grade of the surrounding area; a basement would typically be below the grade of the surrounding area. Tier 1 indoor inhalation remediation objectives calculated for a slab-on-grade building are not much lower than what would be developed for a similar building with a basement. For ease of implementation, Illinois EPA chose to use only one set of Tier 1 remediation objectives.

Building-specific default values for the following parameters were used to develop the Tier 1 remediation objectives: length of building (L_B), width of building (W_B), height of building (H_B), surface area of enclosed space at or below grade (A_B), and building ventilation rate (Q_{bldg}). The same default values must be used for the same parameters when performing Tier 2 calculations. The actual values of these parameters do not have a great impact on the remediation objective; however, the default values are based on a conservative representation of the type of buildings that are or may be present at the site in the future. Without these conservative values, restrictions would be required on the minimum size of a building that can be constructed over the contaminated area.

For the indoor inhalation exposure route, the industrial/commercial remediation objective differs from the residential remediation objective in three ways: exposure duration, building size, and air exchange rate. The air exchange rate (ER) is used to represent the mixing that occurs within a building. The air within a residence is assumed to be flushed out of the building at a rate of 13.8 times per day (0.53 times per hour) and at a commercial location at the rate of 22.32 times per day (0.93 times per hour) based on values listed by Hers et al. (2001) and Murray and Burmaster (1995). These two papers are the source of the recommendations in U.S. EPA's *User's Guide for Evaluating Subsurface Vapor Intrusion into Buildings* (2004).

Tier 1 indoor inhalation remediation objectives assume the vadose zone is composed of sand. The default properties used are consistent with the existing TACO values for sand.

For the J&E equations, Illinois EPA used a chemical-specific value for Dimensionless Henry's Law Constant set to a default system temperature of 13°C. U.S. EPA's draft vapor intrusion guidance – as well as the other exposure routes in TACO – set the system temperature for Dimensionless Henry's Law Constant at 25°C. Illinois EPA decided to use a lower system temperature for the indoor inhalation route in Tiers 1 and 2 because it is more representative of the groundwater temperature in Illinois. The groundwater temperature in Illinois ranges from 8.3° C to 16.7° C; the average within that range is 13.19° C. The lower temperature reduces the Dimensionless Henry's Law Constant, resulting in a less stringent remediation objective. The States of New Jersey and Michigan also apply a state-specific system temperature (13° C and 12.5° C, respectively) for Dimensionless Henry's Law Constant under the indoor inhalation exposure route.

Section 742.Appendix B, Table G provides a Tier 1 table of numerical soil, groundwater and soil gas values for both residential and industrial/commercial receptors. An Acceptable Detection Limit (ADL) column is also part of the indoor inhalation Tier 1 table and applies only to soil remediation objectives. The ADL identifies the lowest practical quantitation limit of any U.S. EPA-approved methodology for any chemical. For most chemicals, the column is noted with an asterisk, meaning the detection limit is less than the remediation objective. Where this is not the case, the ADL is used as the remediation objective. This parallels ADL usage on the existing Tier 1 look-up tables, Section 742.Appendix B, Tables A and B. Remediation objectives are not provided for the construction worker population since this receptor group is not at risk from indoor inhalation exposure. The exposure duration for indoor construction in almost all cases is less than the exposure duration for the residents or commercial workers. Thus the protection of these two receptors will ensure protection of the construction worker during the period of indoor construction.

In addition to describing Section 742.Appendix B, Table G, Section 742.515 explains how Tier 1 remediation objectives for the indoor inhalation exposure route are to be used in regards to the three media (soil, groundwater and soil gas) and in conjunction with the existing Tier 1 tables for the other exposure routes.

During the migration of contaminants from soil and groundwater to a building's interior, the contaminants must pass through soil gas. U.S. EPA, ITRC and individual States generally concur that the measurement of soil gas is the most reliable indicator of a vapor intrusion threat. However, many sites will collect soil and groundwater data in characterizing the other exposure routes and will not want to do further, and potentially unnecessary, field work. For these reasons, Illinois EPA proposes that sites intending to use numerical remediation objectives to demonstrate compliance with the indoor inhalation exposure route must meet <u>either</u> the 1) soil and groundwater remediation objectives, or 2) soil gas remediation objectives.

The use of indoor air data to demonstrate compliance with remediation objectives under Tier 1 or 2 was rejected early by Illinois EPA. Indoor air samples are highly susceptible to bias from occupant sources (smoking, dry cleaning, household chemical use and storage, etc.). They are also invasive, requiring site evaluators to obtain access to indoor space. The rules do not prohibit the use of indoor air data; however, any such request would be a Tier 3 evaluation.

Under Tier 1, separate chemical-specific remediation objectives are calculated for each route, including now the indoor inhalation exposure route. If the respective Tier 1 remediation objective is not exceeded for a route, the user may exclude that route from further investigation (additional exposure routes may be excluded under Section 742.312). Of the exposure routes remaining, the most restrictive or health protective Tier 1 soil and groundwater remediation objective from Section 742.Appendix B, Tables A, B, E, and G is to be compared to the concentrations measured at a site. This practice is consistent with current usage of the Tier 1 tables.

Subpart G: Tier 2 Soil Evaluation

Tier 2 remediation objectives are developed using the J&E equations provided in Section 742.Appendix C, Table L. Illinois EPA is preparing a guidance document for site evaluators that will describe in a more complete narrative how Tier 2 equations for the indoor inhalation exposure route will work.

Tier 2 calculations require information on the physical and chemical properties of the individual contaminants at a site. As in Tier 1, a chemical's toxicological parameters, physical parameters (obtained from Section 742.Appendix C, Table E), and the J&E equations themselves may not be varied. This is also true for Tier 2 evaluations applying the SSL and RBCA models for the other exposure routes.

Section 742.Appendix C, Table M contains all of the parameters used for the J&E equations. These parameters use either default values (i.e., standardized and/or health protective values) or actual site-specific field data. Where default values are provided, they may be used in Tier 2 equations. That is, only partial site-specific information need be obtained and default values may be used for the rest of an equation's parameter inputs. This practice is consistent with Tier 2 evaluations for the other exposure routes.

For the indoor inhalation exposure route, Tier 2 differs from Tier 1 in two ways. First, the additivity of risk from noncarcinogenic contaminants in soil must be taken into account (as required for the other exposure routes). Second, the attenuation factor is based on site-specific soil properties, including: depth to contaminated soil; types of soil present beneath the ground surface and the contamination source; and geotechnical parameters (dry soil bulk density, soil total porosity, water-filled soil porosity, and fraction organic carbon content).

To determine site-specific physical soil parameters, a minimum of one boring per 0.5 acre of contamination must be collected. Each soil sample analyzed for one or more of the applicable contaminants of concern must also be analyzed for water content; at sites where multiple samples from multiple depths are analyzed for contaminants on a dry weight basis and their volumetric water content can be measured based on available data, additional samples solely for analysis of water content may not be necessary.

Samples for geotechnical data are not required from directly under the building. Samples collected adjacent to a building are acceptable. In lieu of sampling the different soil types for geotechnical parameters, use of the default soil parameters provided in TACO is also acceptable. Soil parameters obtained from other literature searches and not from site-specific determinations may be allowed under Tier 3.

The depth to contaminated media (D_{source}) is the shortest distance from the base of any existing or potential building (or man-made pathway into the building) to a location where a sample result exceeds the Tier 1 value for a contaminant of concern for the indoor inhalation exposure route.

It is essential to determine the type of soil between the ground surface and the contamination source, as the contaminants must migrate through this soil before entering a building. If the site stratigraphy varies in this zone, it should be divided into different layers. For each different soil layer, the soil type, thickness, water-filled soil porosity and soil total porosity are necessary to calculate the Tier 2 remediation objectives. Specifically, the water-filled soil porosity and soil total porosity are used to estimate the effective diffusion coefficient for each layer. If the contaminated medium is groundwater, then the capillary fringe is included as one of the soil layers.

The geotechnical parameters – dry soil bulk density, soil total porosity, water-filled soil porosity, and fraction organic carbon content – are used to estimate soil gas concentrations at the source, assuming that the risk being calculated is based on representative soil concentrations. Methods for determining soil parameters for the indoor inhalation exposure route are provided in Section 742.Appendix C, Table F.

The most sensitive parameters are water content and thickness of the capillary fringe. Fraction of organic carbon content (f_{oc}) is also sensitive; increasing f_{oc} increases the remediation objectives. Depth to soil source is not sensitive because the modified J&E model assumes an infinite source with no biodegradation as the vapors migrate through the vadose zone.

Section 742.717 explains how the J&E equations are to be applied when calculating soil or soil gas remediation objectives for the indoor inhalation exposure route. Equations J&E1 through J&E3 are used to calculate the acceptable concentration of the contaminant in indoor air. Equation J&E1 applies only to chemicals that cause carcinogenic health effects, J&E2 applies only to chemicals that cause noncarcinogenic health effects, and J&E3 is used by both types of contaminants to convert from parts per million volume to milligrams per cubic meter. Estimation of indoor air remediation objectives using J&E1 or J&E2 requires two categories of input parameters: toxicological information and receptor-specific exposure factors (exposure frequency, exposure duration and averaging time).

Equation J&E4 calculates a soil gas remediation objective using the appropriate indoor air remediation objective (from either J&E1 or J&E2) and an attenuation factor developed from Equations J&E8b through J&E18. The soil gas remediation objective must be compared to the saturated vapor concentration (C_v^{sat}). Section 742.222 presents the methods by which the C_v^{sat} concentration is obtained; for example, site evaluators may use the list of C_v^{sat} values in Section

742.Appendix A, Table K or calculate a site-specific C_v^{sat} using equation J&E6b. If the calculated soil gas remediation objective is greater than C_v^{sat}, then C_v^{sat} is used as the soil gas remediation objective.

When comparing the calculated soil gas remediation objective to soil gas samples from the site, Section 742.717(k) instructs site evaluators to use soil gas data collected at a depth at least three feet below the ground surface and above the saturated zone. This is to ensure the quality of the soil gas sample. Samples taken less than three feet from the ground surface can be compromised by the influence of barometric pressure fluctuations that may cause an influx of ambient air into the soil, variations in ambient temperature, and precipitation. Samples taken from the capillary fringe or below are unacceptable because of high water saturation.

Equation J&E5 calculates soil remediation objectives using an equilibrium conversion, which assumes that the soil gas is in three phase equilibrium with the contaminated soil at the source. This calculation takes into account soil-specific properties – water-filled soil porosity, the soil-water partition coefficient, the air-filled soil porosity, and the dry soil bulk density – and uses a chemical-specific Dimensionless Henry's Law Constant set at a system temperature of 13°C (as in Tier 1).

The calculated soil remediation objective must be compared with the soil saturation limit (C_{sat}). Site-specific C_{sat} values for the indoor inhalation exposure route may be calculated using equation J&E6a. C_{sat} values for volatile chemicals for the indoor inhalation exposure route are also provided in Section 742.Appendix A, Table L. This table differs from the C_{sat} table in Section 742.Appendix A, Table A because it uses different values for two parameters: the system temperature used to set the chemical-specific Dimensionless Henry's Law Constant and the fraction organic carbon content (f_{oc}). The soil component of the groundwater ingestion exposure route (migration to groundwater pathway) and the outdoor inhalation exposure route use a system temperature of 25°C. The rationale for the difference in system temperature (13° C instead of 25° C) for the indoor inhalation exposure route has already been described. As for differences in f_{oc} values, the migration to groundwater pathway uses an f_{oc} 0.002 (mg/mg) because the contamination is moving into deeper soils with a lower organic carbon content. The outdoor inhalation exposure route uses an f_{oc} value of 0.006 because the contamination is moving up through the soils. Illinois EPA decided to use an f_{oc} value of 0.002 for the indoor inhalation exposure route because basements are below surface; using a lower f_{oc} value results in a more conservative remediation objective. If the calculated soil remediation objective is greater than C_{sat}, then C_{sat} is used as the soil remediation objective. This practice is consistent with the other exposure routes.

Equation J&E8b is used to calculate the attenuation factor. This is the heart of the predictive model, measuring how much contamination from the subsurface is expected to reach the indoor air. The source of the contaminant concentrations in the subsurface may be either soil, groundwater or soil gas. J&E8b assumes that there is no significant pressure difference between the subsurface soil and the building. This means that contaminants emanating from the source do not migrate into the building by advection. Migration by advection is represented by the parameter Q_{soil}, also known as the volumetric flow rate of soil gas into the enclosed space. When Q_{soil} is assumed to equal zero – as is the case in Tiers 1 and 2 – diffusion is the only contaminant transport mechanism. This is analogous to the indoor inhalation model included in the Appendix of the *Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites* that assumes the value of Q_{soil} is negligible (ASTM Designation: E 1739-95). If advection was occurring, site evaluators would use equation J&E8a to calculate the attenuation factor under

Tier 3.

The remaining equations, J&E9a through J&E18, are used to establish the input parameters for application in J&E8b. Equation J&E9a calculates the total overall chemical-specific effective diffusion coefficient. For this equation, each layer of soil (sand, loamy sand, loam etc.) through which contaminant vapors migrate from source to building must be accounted for. The total thickness of the soil layers must equal the distance from the bottom of the slab to the top of the contamination; this relationship is presented in equation J&E9b. The distance, called the source to building separation distance, is calculated by equation J&E10.

Equation J&E11 calculates the chemical-specific effective diffusion coefficient for each soil layer and is used in equation J&E9a. Equations J&E12a and 12b are used to calculate the surface area of the enclosed space at or below grade through which vapors enter into the building. For slab-on-grade buildings, site evaluators must use J&E12a. For buildings with basements, site evaluators must use J&E12b. Equation J&E13 calculates the building ventilation rate using the air exchange rate and the size of the building. For equations J&E12a, J&E12b and J&E13, site evaluators must use the same default values as in Tier 1.

Equation J&E14 calculates the area of total cracks assumed to exist in the portion of the structure below grade through which contaminants migrate into the building; default values from Tier 1 must be used here as well. Contaminants intrude into the building only through cracks that completely penetrate the slab; these cracks are assumed to be filled with dirt. The thickness of these cracks is represented by the slab thickness, which is set at 10 cm for both Tier 1 and Tier 2. Equation J&E15 calculates the effective diffusion coefficient through the cracks using soil parameters representative of the soil within the cracks; as these parameters cannot be measured directly, the default values in Tier 1 apply.

Equations J&E16 through J&E18 calculate site-specific geotechnical parameters. J&E16 gives the total porosity, which is the ratio of the volume of voids to the volume of soil sample. J&E17 gives the water-filled soil porosity, which is the ratio of the volume of water to the volume of soil. J&E18 gives the air-filled soil porosity, which is a measure of the total porosity minus the water-filled porosity. Porosity values representative of the soil layer at the source of contamination as well as each soil layer through which contaminants migrate are needed to calculate the effective diffusion coefficient (J&E11). Additional methods for determining the physical soil parameters are presented in Section 742.Appendix C, Table F.

It is possible to calculate a Tier 2 soil remediation objective more stringent than the Tier 1 soil remediation objective for the indoor inhalation pathway; in such cases, the Tier 1 remediation objective applies. This practice is consistent with the other exposure routes in TACO.

Subpart H: Tier 2 Groundwater Evaluation

Section 742.805(e) requires site evaluators to follow Section 742.812 in calculating groundwater remediation objectives for the indoor inhalation exposure route.

Under Section 742.812, site evaluators follow the J&E equations presented in Section 742.717, only equation J&E7 is used instead of equation J&E5, and when determining the attenuation factor, the capillary fringe must be considered one of the layers in equation J&E9a.

The capillary fringe is the zone immediately above the saturated zone where capillary attraction causes upward movement of water molecules from the saturated zone into the soil above; it contains more water than the rest of the soil above the water table. This zone is distinct in that it has characteristics of both the vadose and saturated zones. Because the capillary fringe impacts the migration of contaminants from the water table, it must be considered as a separate soil layer when developing remediation objectives for groundwater and a default thickness of 17 cm must be used. This value comes from the U.S. Soil Conservation Service soil texture classification table, which is also used by U.S. EPA for determining soil-dependent properties for the J&E model. In addition, the default water-filled soil porosity of the capillary fringe is assumed to be 90 percent of the total porosity of the soil that comprises the capillary fringe. The thickness of the capillary fringe and its water-filled soil porosity cannot be measured accurately in the field on a site-specific basis, which is why site-specific values are not allowed.

Subpart I: Tier 3 Evaluation

Section 742.900(c)(10) identifies the use of building control technologies – different from those presented in Subpart L – as a situation eligible for a Tier 3 evaluation. Site evaluators wanting to perform a Tier 3 evaluation for reasons of impractical remediation (Section 742.920) or exposure route exclusion (Section 742.925) for the indoor inhalation pathway are directed to follow Section 742.935.

Under Section 742.935, site evaluators may propose to use calculations and modeling to establish remediation objectives; use soil gas data, such as sub-slab sampling; and use building control technologies different from those presented in Subpart L.

In Section 742.935(a), the indoor inhalation pathway may be excluded through calculations and modeling to account for contaminant transport from soil, groundwater or soil gas into a building. Unlike Tiers 1 and 2, the calculation of Tier 3 remediation objectives for the indoor inhalation exposure route must take into account the possible migration of chemicals caused by both diffusion and advection. If the contamination is more than five feet from an existing or potential building or man-made pathway, a value of zero for the volumetric flow rate of soil gas into the enclosed space (Q_{soil}) must be used. A Q_{soil} value of zero means that the controlling mode of contaminant transport is diffusion and not advection. If the contamination is within five feet of an existing or potential building or man-made pathway, then a Q_{soil} value of 83.33 cm^3/sec must be used in calculating the attenuation factor (equation J&E8a), unless additional site-specific information indicates a different remediation objective is reasonable and appropriate. A Q_{soil} assessment under Tier 3 is a balancing factor to make sure these alternative evaluations remain health-protective.

In Section 742.935(b), site evaluators may propose to establish remediation objectives using soil gas data in lieu of the requirements of Section 742.227. One such difference is the use of sub-slab samples collected directly beneath a building foundation. Section 742.227 applies to exterior samples collected near the building, which is Illinois EPA's preferred approach as it is the least invasive. However, because sub-slab sampling is an accepted methodology nationwide, Illinois EPA decided to reference it specifically under Tier 3. This section identifies what information a site evaluator must submit to Illinois EPA to demonstrate the validity of alternative soil gas data in calculating indoor inhalation remediation objectives.

Section 742.935(c) must be used when site evaluators propose a mitigation system that deviates from the building control technology requirements presented in Subpart L. This section identifies what information a site evaluator must submit to Illinois EPA to demonstrate the effectiveness of an alternative building control technology to prevent or mitigate indoor inhalation exposure risks.

Subpart J: Institutional Controls

Section 742.1000(a)(7) requires the use of institutional controls whenever remediation objectives are based on a building control technology. Section 742.1015(j) prohibits the use of a groundwater ordinance to exclude the indoor inhalation exposure route. As described previously, this is because an ordinance restricting the source of drinking water would not protect the enclosed air space of a building from the migration of contaminants in the groundwater. The other institutional controls available in TACO for land use restrictions and engineered barriers may still be used, though Highway Authority Agreements will likely not apply to the indoor inhalation exposure route.

Subpart L: Building Control Technologies

Building control technologies are designed to prevent the migration of volatile chemicals into enclosed spaces. They control unacceptable health risks due to vapor intrusion by reducing or eliminating the concentrations in the indoor air without necessarily reducing the residual concentrations in soil, groundwater, or soil gas. The objective of these measures is to make the indoor inhalation exposure route incomplete by preventing the migration of chemicals into a building.

Section 742.1200 establishes the use of building control technologies as an acceptable final corrective action and requires that the site evaluator also comply with the provisions of Subpart J regarding institutional controls. This Section allows for no further remediation determinations to be made on building control technologies for buildings not yet constructed, provided that the approved technology is in place and operational before human occupancy. Site owners and operators are required to maintain building control technologies; specific maintenance duties will be contained in the institutional control. In the event that the system shuts down, site owners and operators are required to notify building occupants and workers and implement protective measures to prevent exposure to the contaminants of concern. System inoperability may occur during routine maintenance or power failures. Contingency measures will be contained in the institutional control; this practice is consistent with provisions in place for engineered barriers used by the other exposure routes. Lastly, this Section states that the no further remediation determination may be voided if the building control technology is not maintained as stipulated in the institutional control.

Section 742.1205 lists the information to be submitted in a proposal to use any of the three mitigation systems under Subpart L.

Section 742.1210 defines the specific requirements for three common mitigation systems: sub-slab depressurization, sub-membrane depressurization, and membrane barrier systems. This Section specifically prohibits natural attenuation, access controls and point of use treatment from use as building control technologies. Also, building control technologies cannot be used as part of a Tier 1 evaluation.

Sub-slab depressurization is an active venting system that draws contaminated soil gas from beneath the building and expels it to the atmosphere. Sub-slab depressurization systems can be used for existing and new buildings. Sub-membrane depressurization is similar to the sub-slab depressurization system, but used for existing buildings with crawl spaces.

Membrane barrier systems are used for new building construction and serve to physically block the entry of contaminants into interior air space.

This concludes my testimony.

Errata Sheet Number 1

Illinois EPA would like to remove Section 742.1210(c)(4) from the proposed rules. This section contains the building control technology requirements for a barrier made of geologic materials. This language was added early on in the rulemaking development when it made sense to offer a barrier parallel to the engineered barriers available for the ingestion and outdoor inhalation exposure routes. Instead of specifying a depth requirement as for the other two pathways (three and 10 feet, respectively), Illinois EPA stated that the depth was to be determined using either Tier 2 or Tier 3.

We have since tested the practicality of a geologic barrier for the indoor inhalation exposure route by calculating the depth needed to meet the requirements of 742.1210(c)(4) using data from an actual site. It turns out the J&E model can't answer the question. Illinois EPA knew that depth to source is one of the least sensitive parameters in determining remediation objectives, but didn't fully appreciate the implications. Because the model assumes an infinite source of contamination without degradation, no depth of geologic materials would be sufficient to exclude the pathway.

Site evaluators have reasonable, cost-effective options for exclusion using the remaining three BCTs, and should a site evaluator want to propose a geologic materials barrier using an alternative methodology for determining a depth protective of building occupants, that option is available under Section 742.935(c).

EXHIBIT

1

Instances of Vapor Intrusion Risk at Sites in Illinois

Below are seven case studies detailing remedial efforts at contaminated sites in Illinois. These case studies serve two purposes. First, they are meant to give the reader an overview of the variety of sites and cleanup programs affected by vapor intrusion risks. Second, and more importantly, these case studies illustrate the need for consistent and comprehensive regulations for evaluating and managing the indoor inhalation exposure route. For example, the Peoples Gas site and Bell Fuel site demonstrate how the lack of Tier 1 remediation objectives and a defined sampling protocol for the indoor inhalation exposure route may cause unnecessary work that is costly and intrusive and lead to site evaluation results that may be unreliable.

Without regulations in place, Illinois EPA, site owners, environmental cleanup professionals and future property users experience problems in interpreting site data and uncertainty as to remediation goals.

Acme Solvents/Rockford: Remedial Project Management Section; State Sites Unit

The Acme Solvents Site is located in an industrial area southeast of downtown Rockford, on the southwest corner of the intersection of 15th Street and 20th Avenue. According to Illinois EPA records, Acme Solvents began operation as a solvent reclaimer in 1955. Illinois EPA inspections from 1980 to 1983 noted numerous violations of RCRA storage and disposal regulations, including spills and poor housekeeping. In 1984 a Civil Complaint was filed against Acme for violations of the Hazardous Materials Transporting Act. Acme Solvent Reclaiming, Inc. ceased operation in 1986.

In the late 1980's Illinois EPA conducted an investigation of the Acme Solvent Site and determined that significant concentrations of chlorinated solvents, BETX and other volatile chemicals were present in the soil and groundwater. Further investigation by the Responsible Parties determined that soil impacts extend off-site to one adjacent property and groundwater impacts extend to a number of off-site properties.

Soil and groundwater concentrations exceeded the draft TACO Tier 1 soil and groundwater indoor inhalation remediation objectives. As a result, in 2008 the Responsible Parties collected soil gas samples at three adjacent off-site properties. A number of volatile chemicals were detected in the soil gas samples at concentrations exceeding the draft TACO Tier 1 indoor inhalation objectives. Based on the results of the soil gas samples, the Responsible Parties completed a risk assessment and determined that the indoor inhalation risk at each of the adjacent properties has an incremental lifetime cancer risk less than 1×10^{-6} and a hazard quotient less than 1. To further reduce risks, the Responsible Parties are proposing soil vapor extraction and air sparging at the Acme Solvents Site.

Devon Bank/Wheeling: Remedial Project Management Section, Site Remediation Program

The Devon Bank Site, located in Wheeling, Illinois, is part of a larger remediation site that includes several properties owned by Interstate Brand Corporation. This particular property was formerly occupied by a drycleaner, which contaminated the area with volatile chemicals. Perchlorocthylene (PCE), a chemical commonly used by the dry cleaning industry, was detected at levels exceeding TACO Tier 1 soil remediation objectives. Trichloroethylene (TCE), commonly used as a metal degreaser, was also detected at levels exceeding TACO Tier 1 soil remediation objectives.

During the remedial process, in-situ chemical oxidation was used to lower concentrations of PCE to an acceptable remediation level under TACO. However, concentrations left in the soils at the Devon Bank Site posed a risk of vapor intrusion. To address this concern, in 2008 Devon Bank installed a vapor barrier membrane beneath the foundation slab to exclude the potential for chemicals to migrate into the building.

People Gas/Chicago: Remedial Project Management Section, Site Remediation Program

People's Gas Site, formerly known as 31st Street Gas Distribution Center, served as a storage and distribution facility for manufactured gas between 1887 and 1934. Two gas holders and various gas distribution piping and equipment were on the site. After closure the property was transferred to the Chicago Housing Authority and eventually developed into Bridgeport Homes, which consists of 13 two-story brick buildings, each containing several residential units, and a two-story community building. The buildings are slab on grade with no basements.

Previous soil and soil gas samples showed contamination from benzene, naphthalene, semi-volatiles, and metals. In 2004, indoor and outdoor air samples were taken from the first and second floors of five occupied and eleven unoccupied units in the housing complex. Illinois EPA coordinated with the Illinois Department of Public Health because air samples were taken inside the residences. The results of indoor air sampling found elevated naphthalene in two unoccupied units (A and B). Construction materials were stored in unit A and unit B, which had recently undergone renovation. In both units naphthalene levels were higher on the second floor than on the first; however the Illinois EPA and the Illinois Department of Public Health concluded that contamination levels did not pose a threat to human health, and were probably not due to vapor intrusion.

Chanute Air Force Base/Rantoul: Federal Site Remediation Section, Department of Defense Program

The former Chanute Air Force Base occupies nearly 2100 acres in Rantoul. The base opened in 1917 and conducted military flight operations until 1971. From 1971 until all military operations ceased in 1993, Chanute served as a non-flying training base. During its years of operation, hazardous materials were used at Chanute, such as fuels and chlorinated solvents.

Eighteen structures on the former base were evaluated for vapor intrusion, but two buildings stand out as particularly contaminated. Building 343 served as a laundromat and has a history of trichloroethene (TCE) and PCE spills. Building 995 was a jet engine test cell; TCE and vinyl chloride are the primary contaminants at this location.

Vapor intrusion investigations were performed at the base during remedial investigations conducted under CERCLA. The Air Force conducted sub-slab soil gas sampling at buildings within 100 feet of volatile chemical-impacted groundwater. These measurements exceeded U.S. EPA screening values corresponding to target carcinogenic risk levels of 10^{-6} for indoor air inhalation. The risk assessment model used by the Air Force indicates that remedial action or institutional controls are needed to ensure protection of potential future residents.

Southeast Rockford/Rockford: Federal Sites Remediation Section, Superfund Program

The Rockford Groundwater Contamination Superfund Site contains two contaminated Areas – 4 and 7 – with vapor intrusion potential.

Area 4 is a mixed industrial/commercial and residential use area. The source of the volatile chemical contamination is located across the street from residences to the west and a mobile home park is located to the east (up gradient). The groundwater plume extends down gradient under the houses. Soil gas samples collected during many previous phases of investigation detected volatile chemicals on the western edge of the mobile home park. Initial indoor air samples were collected in 1993. 1,1,1-TCA and TCE were detected but at concentrations below health-based screening levels available at the time. A second round of sampling was done in 2003 using four houses in the affected area and a background house. The houses were sampled indoors and outdoors, and soil gas samples were also taken. A groundwater sample was taken from a well that is down gradient/side gradient and closest to the plume. Risks to residents were estimated from the measured indoor air samples and modeled indoor air concentrations from the soil gas. No data were currently available that adequately characterized shallow groundwater in the vicinity of the residences; risks from groundwater were not assessed. The results of the indoor and outdoor air samples, as well as the soil gas samples, showed signs of vapor intrusion in some areas, in one case due to an improperly sealed well pit which provided a migration pathway for vapors in the groundwater into the home. That well has since been sealed.

Area 7 contains a park owned by the Rockford Park District and is bordered by a subdivision on the east and west. The cause for contamination at the site is a former open dump. The groundwater, which extends under the subdivision, is contaminated with volatile chemicals. Initial air samples taken in 1993 detected volatile chemicals at concentrations below health-based screening levels available at that time. The results of this sampling did not correlate to the groundwater contamination and there were no obvious signs of vapor intrusion. In July and August of 2003, a second round of sampling was conducted. Five houses in the affected area and a background house, used as a control, were air sampled indoors and outdoors; soil gas samples were collected, and groundwater was tested. The results were mixed; chemicals were found but not deemed hazardous to human health.

Premcor/Hartford: RCRA Corrective Action

Premcor Refinery, the largest independent petroleum refiner in North America, is located on 400 acres in the village of Hartford, Madison County, Illinois. Since the 1940's the site has operated under various owners as a petroleum refinery. Bordering Premcor are two other refinery sites. Amoco operated from 1980-81, and ConocoPhillips is currently in operation. In the 1970's and 1980's residents in the Hartford area experienced gas odors in their basements, while some residents experienced fires and explosions. The matter was referred to the Illinois Attorney General who urged all three operators to study gasoline composition. Illinois EPA conducted fingerprinting and geo/hydrology studies which found that Clark (now Premcor) was the predominant source of the gasoline under north Hartford.

Illinois EPA and the Attorney General's Office negotiated with Clark/Premcor in the 1970's and again in the 1990's to install recovery systems to mitigate the effects of the leaks. The first system, recovery wells, captured 1.16 million gallons of gasoline. The second system, vapor recovery, has captured the equivalent of 1.8 million gallons of gasoline, and still operates; however, Premcor no longer operates the recovery wells. Since the implementation of these recovery systems, citizens have continued to complain about gas vapors.

There are several environmental and human health concerns due to contamination. The groundwater under Hartford may contain several million gallons of hydrocarbons, and in May 2002 the Illinois EPA found explosive levels of vapors in homes along a corridor of Hartford. The Illinois EPA also found, in 2002, elevated levels of benzene in many homes, and determined that residential vapor intrusion was a public health hazard.

In May 2003, Illinois EPA requested that U.S. EPA, Region 5 conduct a time critical removal assessment, assess current site conditions, and determine if possible removal actions were warranted at the North Hartford Premcor Site. U.S. EPA has assumed primary responsibility for addressing the problems at the Hartford Site since the summer of 2003. The recent court decision in United States v.Apex No. 05-CV-242-DRH (July 28, 2008) details the court's findings with regards to vapor intrusion issues and the response actions used to address them.

Bell Fuels/Chicago: Leaking Underground Storage Tank Section

Bell Fuels Site is a former fuel distribution center located on a corner lot in Chicago. The site is situated between a residential neighborhood, and a rail yard.

In 2000, a leaking underground storage tank released fuel into the subsurface soil. Groundwater and soil gas samples were collected in May 2007 and analyzed for chemicals of concern. No volatile chemicals were detected above the reporting limit in the groundwater. The soil gas test results were compared to the U.S. EPA Target Shallow Soil Gas Concentrations. Some of the results, as well as some of the reporting limits were greater than the risk level given by the U.S. EPA.

Sub-slab samples were collected at two locations in each of three potentially impacted houses. Only one chemical of concern was detected from each sample, but in concentrations less than the U.S. EPA Target Shallow Soil Gas Concentrations. Indoor air samples were also taken from two locations, the basement and first floor, in each of the three houses. Results from those samples revealed at least one chemical of concern from each sample. However, there may have been problems with the sampling method which could have produced false positives. For example, in a house where elevated levels of benzene were found, the resident had smoked a cigarette just as the samplers arrived. Furthermore, the indoor air sampling protocol was not included with the report.

BEFORE THE ILLINOIS POLLUTION CONTROL BOARD

IN THE MATTER OF:	)	
	)	
PROPOSED AMENDMENTS TO	)	
TIERED APPROACH TO CORRECTIVE	)	R09-9
ACTION OBJECTIVES	)	(Rulemaking-Land)
(35 Ill. Adm. Code 742)	)	

PRE-FILED TESTIMONY OF TRACEY HURLEY

Qualifications

My name is Tracey Hurley. I am an Environmental Toxicologist with the Toxicity Assessment Unit at the Illinois Environmental Protection Agency ("Illinois EPA"). I have been with the Illinois EPA for twenty years. I have been a member of the Illinois EPA's workgroups that developed the original 35 Ill. Adm. Code Part 742 rule, Tiered Approach to Corrective Action Objectives ("TACO", R97-14) and subsequent amendments.

I was a member of the Agency's workgroup that developed the original 35 Ill. Adm. Code Part 620 rule, Groundwater Quality Standards (PCB R89-14).

I have a Bachelor of Science degree in Biology and a Master of Public Health degree.

Testimonial Statement

I will be testifying in support of the proposed amendments to 35 Ill. Adm. Code 742: Tiered Approach to Corrective Action Objectives. I will present an overview of the updates to the tables in Appendices A, B, and C and Errata Sheet 1.

There are four main explanations for the revisions to the tables: changes in the toxicity values, changes in the physical and chemical parameters, addition of chemicals as a result of their inclusion in the proposed Groundwater Quality Standards (35 Ill. Adm. Code 620, R08-18), and addition of the Indoor Inhalation exposure pathway. Rick Cobb, Illinois EPA, provided testimony on the addition of chemicals to the proposed Groundwater Quality Standards during the Part 620 hearings (R08-18). Gary King, Illinois EPA, will provide more detailed testimony on the Indoor Inhalation exposure pathway. I will first describe the reasons for the changes in the toxicity values and physical and chemical parameters in more detail before I discuss the changes to the tables.

In the process of calculating Tier 1 Remediation Objectives for the indoor inhalation route, Illinois EPA realized that physical and chemical parameter values and toxicity values had changed for several of the chemicals. We decided against a partial update to TACO using corrected values to calculate remediation objectives only for the indoor inhalation route because this would have resulted in the volatile chemicals having remediation objectives for the indoor inhalation route calculated with revised values while the ingestion and outdoor inhalation remediation objectives would have been calculated with the old values. Therefore, we decided to revise all of the Tier 1 soil and groundwater remediation objectives in the same rulemaking. The revised physical and chemical parameter values are the result of updates in the sources the Illinois EPA uses for this information. These sources include the following online databases: USEPA's Superfund Chemical Data Matrix ("SCDM"), CHEMFATE, PhysProp, USEPA's Water9 software for diffusivity values, and *Handbook of Environmental Degradation Rates* by P.H. Howard (1991) for first order degradation constant values. The SCDM database and Water software were used by USEPA in developing the Soil Screening Levels ("SSL").

The CHEMFATE and PhysProp databases are the original sources for some of the information in the SCDM database. Howard (1991) also was used by USEPA in developing the Soil Screening Levels.

On December 5, 2003, USEPA issued a memorandum (OSWER Directive 9285.7-53) from Michael B. Cook, Director of the Office of Superfund Remediation and Technology Information, to the Superfund National Policy Managers, Regions 1-10, on Human Health Toxicity Values in Superfund Risk Assessments. As a result, several of the toxicity values changed and some new values were added. As discussed by Tom Hornshaw during the Part 620 hearings (R08-18), this memo revised the hierarchy for selecting human health toxicity values that had been used since the issuance of the original hierarchy in the 1989 Risk Assessment Guidance for Superfund ("RAGS"). The RAGS hierarchy, which has also been used by the Toxicity Assessment Unit in developing human health toxicity values, was to first use values from EPA's Integrated Risk Information System ("IRIS") database, if available, or else values from the most recent Health Effects Assessment Summary Tables ("HEAST"). If no toxicity value was available from these sources, then values could be derived from literature sources or a request could be made to EPA's National Center for Environmental Assessment ("NCEA") for provisional toxicity values.

The revised hierarchy still specifies the IRIS database as the first option for toxicity values, but now includes second and third tiers of data sources. The second tier is a recently introduced database, EPA's Provisional Peer Reviewed Toxicity Values ("PPRTVs"), available from NCEA. The third tier, Other Toxicity Values, includes three named sources but could also include other sources as appropriate. The three named sources are the Agency for Toxic Substances and Disease Registry's ("ATSDR") Minimal Risk Levels ("MRLs"), developed for ATSDR risk assessments; California EPA's toxicity values, developed to support various rules and programs; and EPA's HEAST, which was last updated in 1997.

The Toxicity Assessment Unit has adopted this hierarchy, with some minor revisions, as the basis for determining the toxicity values for its activities. As we began using the new hierarchy, we became aware of some minor issues that ultimately lead to certain revisions of the hierarchy. Three issues that resulted in a minor revision are:

- PPRTVs are retired by EPA after a certain period of time, leading us to question what should be the role of retired values; we ultimately decided to continue using them instead of going to tier three.
- EPA does not provide guidance on which value to use if more than one value is available from the three named sources in tier three; we ultimately decided to use the lowest of the tier three values available in such cases.
- IRIS does not contain values for subchronic exposures, only values for chronic exposures, so there is essentially no first tier for shorter-duration exposures; however, some chronic IRIS values use an Uncertainty Factor to extrapolate to chronic exposures from a study of subchronic duration, and we have used the IRIS value with this Uncertainty Factor removed as the first tier when available.

The Toxicity Assessment Unit has used this new hierarchy to re-evaluate the soil and groundwater objectives for all the chemicals currently included in Part 742 ("TACO"), other than those groundwater objectives that are based on a Maximum Contaminant Level from the Safe Drinking Water Act (which would require a change at the federal level).

The OSWER Directive 9285.7-53 has been added to the Incorporations by Reference, Section 742.210. The reference to IRIS has been removed from Section 742.705(d)(2) and the OSWER Directive 9285.7-53 added in its place.

Appendix A

Table A has an added column for the Soil Saturation Concentration ("C_{sat}") values for the Soil Component of the Groundwater Ingestion Exposure Route. In the process of updating the tables, we realized that each chemical actually has two different C_{sat} values, one for the Outdoor Inhalation Exposure Route and one for the Soil Component of the Groundwater Ingestion Exposure Route. These exposure routes assume different default organic carbon content of soil ("foc") values as listed in Appendix C, Table B. The Soil Component of the Groundwater Ingestion Exposure Route uses an foc value of 0.002 g/g because it is modeling a contaminant that is moving into deeper soils with a lower organic carbon content. The Outdoor Inhalation Exposure Route is modeling a contaminant that is moving through surface soils with a higher organic carbon content of 0.006 g/g. The C_{sat} values listed in Appendix A, Table A of the 2007 version of TACO are actually for the Outdoor Inhalation Exposure Route only. It was an oversight that C_{sat} values for the Soil Component of the Groundwater Ingestion Exposure Route were not included also.

The C_{sat} values listed in Appendix A, Table A have been calculated with the updated Solubility, Organic Carbon Partition Coefficient ("K_{oc}"), and Dimensionless Henry's Law Constant ("H'") properties of the chemicals. The C_{sat} values were calculated using equations S19 and S29 in Appendix C, Table A. The physical and chemical properties used in the equations are listed in Appendix C, Table E. Three footnotes have been added. Footnote "a" specifies that the C_{sat} values were calculated using an foc of 0.006 g/g and a system temperature of 25°C. The values with a "b" footnote were calculated using an foc of 0.002 and a system temperature of 25°C. Footnote "c" specifies that the C_{sat} was calculated at a pH of 6.8. If a site's soil pH is a value other than 6.8, then a site-specific C_{sat} should be calculated using equations S19 and S29 and the pH-specific K_{oc} values listed in Appendix C, Table I. The K_{oc} values for ionizing organic chemicals will vary with pH. The footnotes are new, but the practices are not.

Tables E and F have been updated with fourteen new chemicals. These are the same chemicals that have been added to the proposed Groundwater Quality Standards (35 Ill. Adm. Code 620, R08-18). The target organs have been updated to reflect new toxicity information. Additionally, the tables have been alphabetized by target organ.

Table I contains six new chemicals. Benzo(a)anthracene, benzo(b)fluoranthene, 1,3-dichloropropene, and gamma-HCH should have been included in the previous versions of the table, but were inadvertently omitted. Because of the changes to 35 Ill. Adm. Code 620, we were able to calculate a groundwater remediation objective based on the 10^{-6} risk level for carbazole. However, it does not have an ADL listed in USEPA's SW-846 methods so it appears on this table. The oral slope factor, and, therefore, the 1 in 1,000,000 cancer risk concentration, for 1,2-dichloropropane changed. Bis(2-ethylhexyl)phthalate was deleted from the table because its Class I groundwater remediation objective is actually equal to the 1 in 1,000,000 cancer risk concentration. Vinyl chloride is listed twice, for residential and non-residential, because the slope factor is different for exposures occurring from birth and exposures that occur during adulthood. The ADLs for chlordane and toxaphene have been deleted to reflect changes that USEPA has made to its SW-846 methods. The Class I groundwater remediation objective for arsenic has been changed in accordance with 35 Ill. Adm. Code 620 (R08-18).

Table J is a new table containing a list of volatile chemicals that must be considered for the indoor inhalation route. "Volatile chemical" is defined in 742.200 as a chemical with an H' value greater than 1.9×10^{-2} or a vapor pressure greater than 0.1 Torr (mm Hg) at 25°C and elemental mercury. USEPA, in its "Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils" (November 2002), defines a volatile chemical as having a Henry's Law Constant greater than 10^{-5} atm m^3/mol (equivalent to an H' value of 4.1×10^{-4}). The existing TACO definition for volatile organic compounds is based on SW-846 analytical methods or a boiling point less than 200 °C and a vapor pressure greater than 0.1 Torr (mm Hg) at 25°C. We felt that having two separate definitions for volatile chemicals, one for the indoor inhalation pathway using USEPA's definition and one for the other pathways, would be too confusing. In addition, USEPA's definition includes many polynuclear aromatic hydrocarbons (such as acenaphthene and chrysene) that really do not volatilize in a significant amount. In order to reconcile the two definitions, we looked at some physical-chemical properties of the chemicals and whether these properties determined if the chemical was analyzed by an SW-846 method for volatiles or analyzed as a semi-volatile. The physical-chemical properties we examined included vapor pressure, boiling point, H', molecular weight, and the log of the octanol-water partition coefficient ("logP"). logP is used to calculate K_{oc}. There did not appear to be a relationship between boiling point, molecular weight, and logP to the analytical method for the chemical. It appears that chemicals with a vapor pressure greater than 0.1 Torr (mm Hg) at 25°C are primarily analyzed as volatiles. However, this criterion does not classify naphthalene as a volatile. We wanted to include naphthalene in the definition of a volatile chemical because it can be analyzed either as a volatile chemical (using SW-846 method 8260) or as a semi-volatile (using SW-846 method 8270). Naphthalene generally is considered to exhibit characteristics of both a volatile chemical and a semi-volatile chemical and it does volatilize. Therefore, following USEPA's lead, we decided to include H' in the definition of volatile chemical. We chose a value for H' of 1.9×10^{-2} in order to include naphthalene (H' of 1.98×10^{-2}). Elemental mercury was specifically included in the definition of volatile chemical because it is volatile and there are outdoor inhalation objectives already in TACO.

Table K is another new table. It lists the Soil Vapor Saturation Concentration ("C_v^{sat}") values for the volatile chemicals. The C_v^{sat} values have been calculated using equation J&E6b from Appendix C, Table L, the default parameters listed in Appendix C, Table M, and the physical and chemical parameters listed in Appendix C, Table E.

Table L also is a new table and it lists the C_{sat} values for the volatile chemicals for the indoor inhalation exposure route. These C_{sat} values have been calculated using an foc of 0.002 g/g and a system temperature of 13°C.

Appendix B

Tables A and B contain many revised remediation objectives for the ingestion, outdoor inhalation, and the soil component of the groundwater ingestion routes of exposure. These changes have been made because of revisions to the toxicity values, physical/chemical properties, and the proposed amendments to 35 Ill. Adm. Code 620 (R08-18). Fourteen chemicals have been added to TACO to parallel their addition to 35 Ill. Adm. Code 620. Footnotes d, f, k (Table B only) and r were revised and y and z were added to clarify the basis of the remediation objectives.

Table C has been revised to update the Class I Groundwater Standard for arsenic.

For Tables C and D, the lead soil remediation objective at the pH range of 8.75 to 9.0 may now be used up to a pH of 11.0. These pH specific soil remediation objectives are calculated using k_d values. We have new data with a valid k_d value up to pH range of 11.0. This is applicable only to lead and footnote "b" has been added to denote this.

In Table E the Groundwater Remediation Objectives have been updated to reflect changes in the toxicity values and the proposed Groundwater Quality Standards. Fourteen new chemicals have been added. The 1 in 1,000,000 cancer risk level has been used where it is greater than the ADL for carcinogens. This is in accordance with changes made in 35 Ill. Adm. Code 620.Appendix A. The corresponding changes have been footnoted. Footnote "e" has been added to distinguish between the carcinogens and noncarcinogens.

Table F lists the GW_{obj} Concentrations which have been recalculated to reflect changes in the toxicity values and the proposed Groundwater Quality Standards. Fourteen new chemicals have been added and the changes have been footnoted accordingly.

Table G is a new table. In it are listed the Indoor Inhalation Remediation Objectives for soil, groundwater, and soil gas for the 59 volatile chemicals. The Remediation Objectives have been calculated using the J&E equations listed in Appendix

C, Table L and the parameters listed in Appendix C, Table M. The chemical-specific values for C_{sat} are listed in Appendix A, Table L, and physical/chemical parameters are listed in Appendix C, Table E. If the calculated Tier 1 soil remediation objective exceeds the C_{sat} value of the chemical, the C_{sat} value is shown as the remediation objective. Similarly, the solubility limit was used for the groundwater remediation objective and the C_v^{sat} was used for the soil gas remediation objective. Capping the remediation objectives in this way precludes a two-phase system, or free product. The models used in TACO are invalid if there are two phases.

Inhalation toxicity values were not available for nine volatile chemicals: acetone, bromodichloromethane, butanol, chlorodibromomethane, 2-chlorophenol, dalapon, cis-1,2-dichloroethylene, n-nitrosodi-n-propylamine, and 1,1,2-trichloroethane. Tier 1 soil remediation objectives developed for these chemicals are set at the soil saturation limit calculated using the Tier 1 default values. Tier 1 groundwater remediation objectives for the indoor inhalation pathway have been set at the solubility limit of these chemicals in water. Illinois EPA decided to use this approach rather than using the oral toxicity values because it is not appropriate to do so. The chlorinated solvents are metabolized in the liver when they are ingested but not when they are inhaled. This means that the amount of chemical and/or form, and ultimately, the toxicity, of the chemical that is circulating in the body is going to be different for inhalation and ingestion exposures.

Appendix C

In Tables B and D the source of the toxicity values has been changed from IEPA (IRIS/HEAST) to Illinois EPA. USEPA's latest hierarchy (OSWER Directive 9285.7-53, December 5, 2003) for Human Health Toxicity Values no longer lists only IRIS and

HEAST. There are three tiers of available sources. To simplify the source, we have just listed Illinois EPA.

Table E lists updated Default Physical and Chemical Parameters. The 14 new chemicals from the proposed Groundwater Quality Standards have been added. All values are now expressed in scientific notation for ease of readability. The sources for the physical and chemical parameter values include the online databases USEPA's Superfund Chemical Data Matrix System, CHEMFATE, PhysProp, USEPA's Water9 software for diffusivity values, and *Handbook of Environmental Degradation Rates* by P.H. Howard (1991) for first order degradation constant values.

Table F has been updated to include the J&E equations to the "Method" column for the parameters of total soil porosity, air-filled soil porosity, and water-filled soil porosity.

Table I lists the organic carbon partition coefficient ("K_{oc}") values for the ionizing organic chemicals. MCPP, one of the chemicals added to TACO as a result of changes to the 620 Rules, has been added to the table. 2,4,5-TP (Silvex) has been deleted from the table because its K_{oc} does not change over the pH range of 4.5 of 9.0. The pH-specific K_{oc} values have changed as a result of chemical-specific K_{oc} values and/or pKa (the acid dissociation constant) values.

Table L is a new table that includes all of the equations required for the J&E model. Gary King, Illinois EPA, will provide testimony on the modified J&E equations.

Table M includes the parameters and default values used in the J&E equations.

The equations from Table L and the parameters and default values in Table M were used to generate the Tier 1 Indoor Inhalation Remediation Objectives listed in

Appendix B, Table G.

Errata Sheet Number 1

This part of my testimony concerns the changes made to the appendices in Errata Sheet Number 1.

The solubility for 2-chlorophenol in Appendix E, Table E was incorrectly listed as 2.20E+05 mg/L. It should be 2.20E+04 mg/L. This change in the solubility results in different C_{sat} values in Appendix A, Table A; from 1.00E+05 to 1.00E+04 mg/kg and from 7.00E+04 to 7.10E+03 mg/kg for the outdoor inhalation and the soil component of the groundwater ingestion exposure routes, respectively. The C_{sat} value for the indoor inhalation exposure route listed in Appendix A, Table L has changed from 4.90E+04 to 4.90E+03 mg/kg. The remediation objectives that are C_{sat} based need to be corrected as well. The soil remediation objective for the outdoor inhalation exposure route for residential properties (which is capped at C_{sat}) listed in Appendix B, Table A has changed from 100,000 mg/kg to 10,000 mg/kg. Similarly, in Appendix B, Table B, the soil remediation objectives for the outdoor inhalation exposure route for the industrial/commercial and construction workers have changed to 10,000 mg/kg, capped at C_{sat}. The soil remediation objective for the ingestion exposure route for the construction worker was inadvertently given as 10,000 mg/kg. It should be 1,600 mg/kg. Also affected are the remediation objectives for the indoor inhalation exposure route listed in Appendix B, Table G. The soil remediation objectives for residential and industrial/commercial properties have changed from 49,000 mg/kg to 4,900 mg/kg based on the C_{sat} for indoor inhalation exposure route. The groundwater remediation objectives for residential and industrial/commercial properties have changed from 220,000 mg/L to

22,000 mg/L.

There are a couple of typographical errors on Appendix A, Table A. Dichlorodifluoromethane is misspelled as dichlorofluoromethane. Its C_{sat} value for the outdoor inhalation exposure route should be 8.70E+02 mg/kg not 8.70E+04 mg/kg. The C_{sat} value for vinyl chloride for the outdoor inhalation exposure route should be 2.60E+03 mg/kg not 2.26E+03 mg/kg.

Also in Appendix A, Table A, the C_{sat} value for the soil component of the groundwater ingestion exposure route is not applicable for mercury because the groundwater ingestion remediation objectives are based on the inorganic form of mercury. The C_{sat} value should be replaced with "NA". We do not cap the remediation objectives for the soil component of the groundwater ingestion exposure route at the C_{sat} values for any of the inorganics because these chemicals are analyzed by a different analytical method in soil, the TCLP or SPLP. The C_{sat} values for mercury were re-calculated based on the following information. TACO uses the oral RfD for mercuric chloride (inorganic mercury) as the basis for the soil remediation objectives for the ingestion exposure route. The groundwater remediation objectives are based on mercuric chloride, also. The soil remediation objectives for the indoor and outdoor inhalation exposure routes are based on the inhalation RfC for elemental mercury. Therefore, the C_{sat} values for the outdoor and indoor inhalation exposure routes should be based on elemental mercury using the K_{oc} and other physical and chemical values from Appendix C, Table E. The K_d value listed in Appendix C, Table J is for the divalent form of mercury (Hg+2) from USEPA's Soil Screening Guidance: Technical Background Document and should not be used for calculating the C_{sat} values. The C_{sat} value for the outdoor inhalation exposure route listed in Appendix A, Table A will not change. The C_{sat} value for the indoor inhalation exposure route listed in Appendix A, Table L should be changed from 4.50E-01 mg/kg to 1.05E+00 mg/kg. The soil remediation objectives listed in Appendix B, Table G for the indoor inhalation exposure route for residential and industrial/commercial properties should be changed from 0.45 mg/kg to 1.05 mg/kg because they are capped at the C_{sat} value. The footnote "i" for mercury in Appendix B, Table G should be changed to specify that these remediation objectives are for the elemental form of mercury. This is similar to footnote "s" in Appendix B, Tables A and B. The statement that mercury is measured in mg/L is incorrect and should be removed from footnote "i". The entry for mercury in Appendix C, Table J should have "(+2)" added to specify that the K_d value is specific to this valence state.

An entry was inadvertently omitted from Appendix A, Table F. 1,3-Dichloropropene (cis + trans) (inhalation only) should be included under the category of Respiratory System.

Incorrect air diffusivity and inhalation toxicity values were used in the calculations for 2-butanone (MEK). Consequently, the soil remediation objectives for the outdoor inhalation exposure route listed in Appendix B, Tables A and B for all receptors are incorrect. The residential and industrial/commercial objectives should be 25,000 mg/kg (capped at C_{sat}) and the construction worker objective should be 730 mg/kg based on non-cancer effects. The soil gas remediation objectives for the indoor inhalation exposure route listed in Appendix B, Table G for residential and industrial/commercial properties should be capped at the C_v^{sat} value of 380,000 mg/m^3.

The remediation objectives for 1,4-dichlorobenzene were based on cancer effects.

USEPA and California EPA classify 1,4-dichlorobenzene as a C or possible carcinogen. TACO defines a carcinogen as class A or B carcinogen only. Therefore, the remediation objectives have been recalculated based on non-cancer effects. In Appendix A, Table A, the soil remediation objectives for residential properties for the ingestion exposure route should be changed from 120 mg/kg to 5,500 mg/kg and the outdoor inhalation exposure route should be changed from 3.3 mg/kg to 12,000 mg/kg. In Appendix B, Table B, the soil remediation objectives for industrial/commercial workers for the ingestion exposure route should be changed from 1,100 mg/kg to 140,000 mg/kg and the outdoor inhalation exposure route should be changed from 6.2 mg/kg to 20,000 mg/kg. For construction workers, the outdoor inhalation exposure route should be changed from 8.8 mg/kg to 320 mg/kg. The ingestion exposure route objective for the construction worker remains unchanged because it was based on non-cancer effects. The objectives in Appendix B, Table G for the indoor inhalation exposure route also have changed. The soil objectives for residential properties and industrial/commercial properties should be capped at a C_{sat} value of 130 mg/kg. The groundwater objective for residential properties and industrial/commercial properties should be capped at the water solubility value of 79 mg/L. The soil gas objective for residential properties and industrial/commercial properties should be capped at the C_v^{sat} value of 8,400 mg/m^3.

The Values for the Soil Component of the Groundwater Ingestion Exposure Route for 1,3-dichloropropene in Appendix B, Tables A and B were calculated with the old values for the GW_{obj} (as listed in Appendix B, Table F). The values for Class I groundwater should be changed from 0.003 mg/kg to 0.0052 mg/kg. For Class II groundwater, the values should be changed from 0.015 mg/kg to 0.026 mg/kg.

The Values for the Soil Component of the Groundwater Ingestion Exposure Route listed in Appendix B, Tables A and B for methoxychlor are C_{sat} based and should be 4.5 mg/kg for both Class I and Class II groundwater. This is the value listed in Appendix A, Table A specific to the Soil Component of the Groundwater Ingestion Exposure Route. The value of 14 mg/kg that is currently in listed in Appendix B, Tables A and B is the C_{sat} for the outdoor inhalation exposure route.

The Values for the Soil Component of the Groundwater Ingestion Exposure Route for 2,4-dichlorophenol for Class II groundwater listed in Appendix B, Tables A and B should be 5 times the Class I value or 17 mg/kg.

On August 25, 2008, USEPA issued a revised PPRTV for cobalt. This PPRTV contained updated oral and inhalation toxicity values. As a result, the remediation objectives for cobalt have been recalculated. In Appendix B, Table A the remediation objectives for residential properties for the ingestion exposure route should be changed from 1,600 mg/kg to 23 mg/kg and the inhalation exposure route remediation objectives should be changed from 1,100 mg/kg to 360 mg/kg. In Appendix B, Table B, the remediation objectives for industrial commercial workers for the ingestion route should be changed from 41,000 mg/kg to 610 mg/kg and the inhalation exposure route remediation objectives should be changed from 1,800 mg/kg to 560 mg/kg. Also in Appendix B, Table B, the remediation objectives for construction workers for the ingestion route should be changed from 12,000 mg/kg to 610 mg/kg.

The parameters of solubility and dimensionless Henry's law constant were reversed for 2,4,5-trichlorophenol and 2,4,6-trichlorophenol in Appendix C, Table E and in the calculations for the remediation objectives. These two parameters affect the remediation objectives for the outdoor inhalation exposure route for 2,4,6-trichlorophenol. (2,4,5-Trichlorophenol is not affected because there are no remediation objectives for this chemical for this exposure route.) The value listed for 2,4,6-trichlorophenol for residential properties in Appendix B, Table A should be changed from 430 mg/kg to 330 mg/kg. In Appendix B, Table B, the value listed for industrial/commercial workers should be changed from 820 mg/kg to 630 mg/kg and the value for construction workers should be changed from 1,200 mg/kg to 890 mg/kg. Also in Appendix B, Table B, incorrect toxicity values were used to calculate the remediation objectives for construction workers for the ingestion route. The remediation objectives should be changed from 200,000 mg/kg to 61,000 mg/kg for 2,4,5-trichlorophenol and from 11,000 mg/kg to 2,000 mg/kg for 2,4,6-trichlorophenol.

In Appendix B, Table B, the bromoform value for the construction worker for the ingestion route of exposure should have a "b" footnote because it is based on non-cancer effects. It was incorrectly footnoted with "e".

An incorrect value for chloroform's remediation objective for the construction worker for the ingestion route is listed in Appendix B, Table B. It should be changed from 2,000[b] mg/kg to 4,000[e] mg/kg.

Dalapon does not have any toxicity values available for the inhalation exposure route. As a general practice, Illinois EPA uses the C_{sat} value as the remediation objective if the chemical has a melting point less than 30°C. This is the basis of the value that is given in Appendix B, Table B for the construction worker, 120,000 mg/kg. However, for workers, we also need to look at whether the C_{sat} based remediation objective is protective. This practice was incorporated into the 2002 version of TACO for 1,1-

dichloroethylene but was removed in the 2007 version because inhalation toxicity criteria ("Reference Concentration") became available from USEPA. It was an oversight that this practice was not incorporated into these proposed TACO rules. Using the Recommended Exposure Limit ("REL") established by National Institute for Occupational Safety and Health of 6 mg/m^3 to calculate a remediation objective for the inhalation exposure route yields a value of 11,000 mg/kg. The REL based remediation objective is lower than the C_{sat} based remediation objective and should be listed in Appendix B, Table B. We have added a new footnote "aa" to explain the basis of this objective.

The remediation objective for the ingestion exposure route for the construction worker for DDD was incorrectly listed as 360 mg/kg in Appendix B, Table B. It should be changed to 520 mg/kg.

The remediation objective for the outdoor inhalation exposure route for the construction worker for 1,2-dibromo-3-chloropropane in Appendix B, Table B has an incorrect footnote. The footnote should be changed to "e" because the remediation objective is based on cancer effects.

The Values for the Soil Component of the Groundwater Ingestion Exposure Route for di-n-butyl phthalate listed in Appendix B, Table B should be capped at the C_{sat} value of 880 mg/kg, as was done in Appendix B, Table A. The C_{sat} value for this chemical is lower than the value based on the Groundwater Quality Standard.

The remediation objective for the construction worker for the ingestion exposure route for 2,4-dimethylphenol is incorrect in Appendix B, Table B. It should be changed to 10,000 mg/kg.

The Values for the Soil Component of the Groundwater Ingestion Exposure Route for 2,6-dinitrotoluene for Class II groundwater is incorrect in Appendix B, Table B. It should be changed to 0.0018 mg/kg.

The remediation objective for the industrial/commercial worker for the ingestion exposure route for di-n-octyl phthalate in Appendix B, Table B has an incorrect footnote. It should have a "b" footnote because it is based on non-cancer effects.

The Values for the Soil Component of the Groundwater Ingestion Exposure Route for hexachlorocyclopentadiene for Class II groundwater in Appendix B, Table B should be capped at the C_{sat} value of 44 mg/kg for the soil component of the groundwater ingestion exposure route. The value that is listed is the C_{sat} value for the outdoor inhalation exposure route.

There is a typographical error in the remediation objective for the construction worker for the ingestion exposure route for isopropylbenzene in Appendix B, Table B. The value should be changed from 82,00 mg/kg to 82,000 mg/kg.

The footnote was omitted for the remediation objective for the construction worker for the outdoor inhalation exposure route for 2-methylphenol in Appendix B, Table B. The value should have a "b" footnote because it is based on non-cancer effects.

An incorrect footnote is given for the remediation objective for the construction worker for the ingestion exposure route for n-nitrosodiphenylamine in Appendix B, Table B. The footnote should be changed from "e" to "b" because the remediation objective is based on non-cancer effects.

The remediation objectives for the outdoor inhalation exposure route for n-nitrosodi-n-propylamine listed in Appendix B, Table B should be based on cancer effects not C_{sat}. The value for industrial/commercial workers should be changed from 1,900 mg/kg to 0.22 mg/kg. The value for construction workers should be changed from 1,900 mg/kg to 0.31 mg/kg.

An incorrect toxicity value was used to calculate the remediation objective for the construction worker for the ingestion exposure route for 2,4,5-TP. This remediation objective, listed in Appendix B, Table B, should be changed from 160,000 mg/kg to 1,600 mg/kg.

USEPA issued a new PPRTV for antimony establishing a revised subchronic ingestion toxicity value. As a result, the remediation objective for the construction worker for the ingestion exposure route in Appendix B, Table B should be changed from 41 mg/kg to 82 mg/kg.

An incorrect footnote is given for the remediation objective for the construction worker for the ingestion exposure route for chromium, ion, hexavalent in Appendix B, Table B. The footnote should be changed from "b" to "e" because the remediation objective is based on cancer effects.

This concludes my testimony.

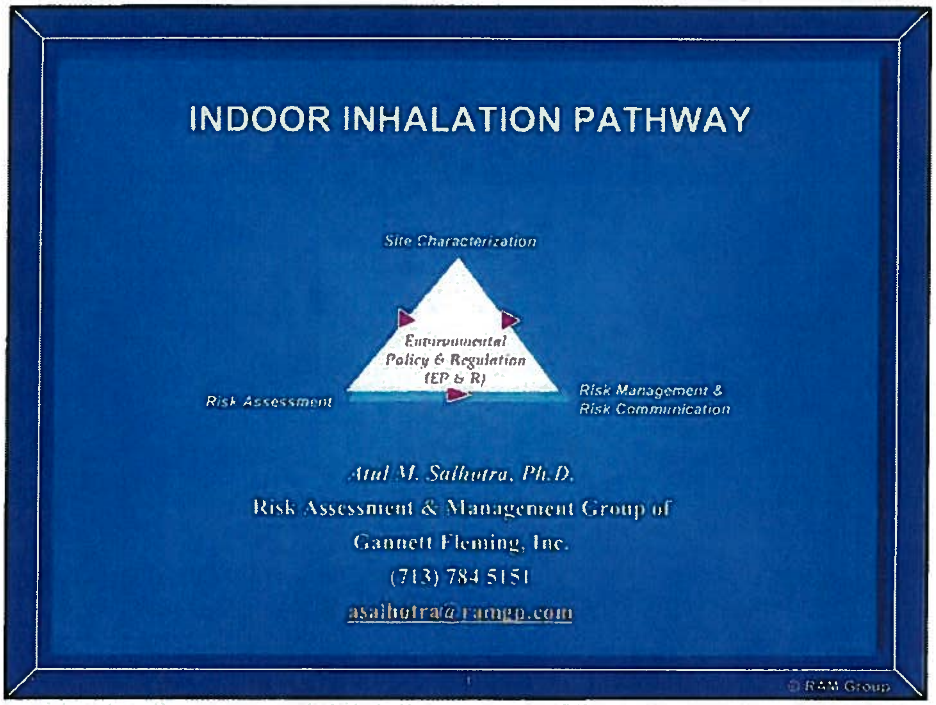
Indoor Inhalation Pathway Slides

Presented by Dr. Atul Salhotra, Ph.D.
Risk Assessment and Management Group of Gannett Fleming, Inc.
Houston, Texas

The purpose of Dr. Salhotra's presentation is to introduce the indoor inhalation pathway and explain the fate and transport of volatile chemicals into buildings. He is not an expert on 35 Ill. Adm. Code Part 742 or on this specific proposed amendment (R09-009), but a professional risk assessor whom Illinois EPA consulted in developing and thinking through various regulatory options.

The testimonies by Gary King and Tracey Hurley from Illinois EPA will address everything contained the proposed rule. Dr. Salhotra's role is to lay the scientific groundwork, defining concepts like attenuation factor and three phase equilibrium.

Dr. Salhotra's information is presented in visual slides because in this case graphic explanations are so much more helpful than written text. Dr. Salhotra is a skilled instructor; the transcript of his oral presentation from the Illinois Pollution Control Board's hearing on this proposed amendment will later serve as an additional and complementary resource for interested parties.



INDOOR INHALATION PATHWAY

Site Characterization

Environmental Policy & Regulation (EP & R)

Risk Assessment

Risk Management & Risk Communication

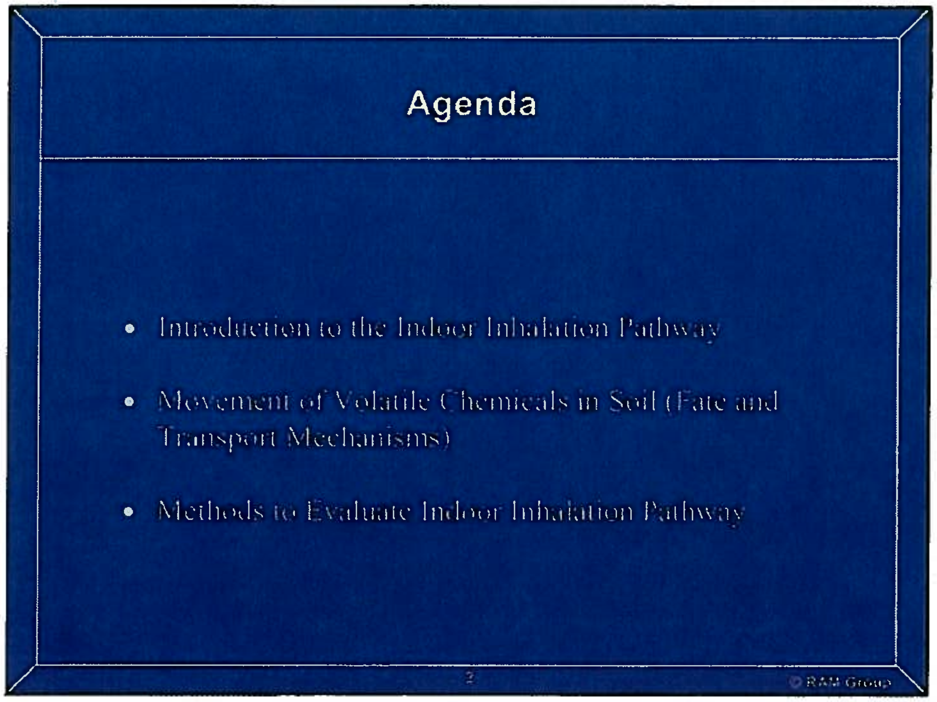
Atul M. Salhotra, Ph.D.

Risk Assessment & Management Group of

Gannett Fleming, Inc.

(713) 784 5151

asalhotra@ramgp.com

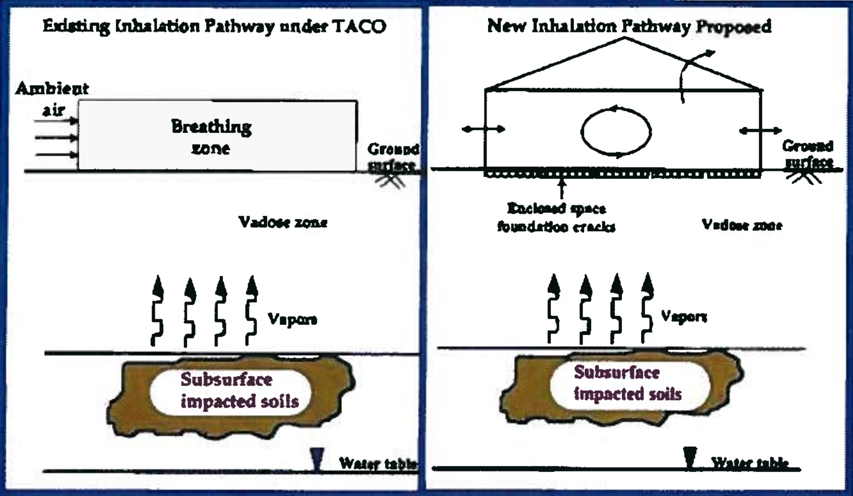


Agenda

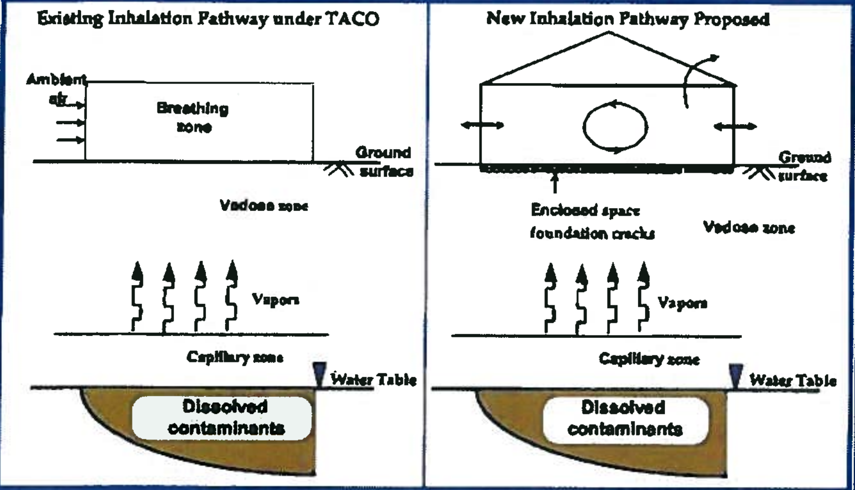
- Introduction to the Indoor Inhalation Pathway
- Movement of Volatile Chemicals in Soil (Fate and Transport Mechanisms)
- Methods to Evaluate Indoor Inhalation Pathway

Introduction to Indoor Inhalation

Subsurface Soil Volatilization Pathways



Groundwater Volatilization Pathways



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Process of Indoor Inhalation
Six Steps

Step 1: Volatilization of chemicals from soil or groundwater

Step 2: Migration of chemicals from the point of volatilization to the building

Step 3: Entry of vapors into the building

Step 4: Mixing of vapors with the air inside the building

Step 5: Inhalation of air by a human being (receptor)

Step 6: Potential health risk to the receptor

These steps are quantitatively evaluated using a model.
We will discuss Step 2 in detail and also the model!

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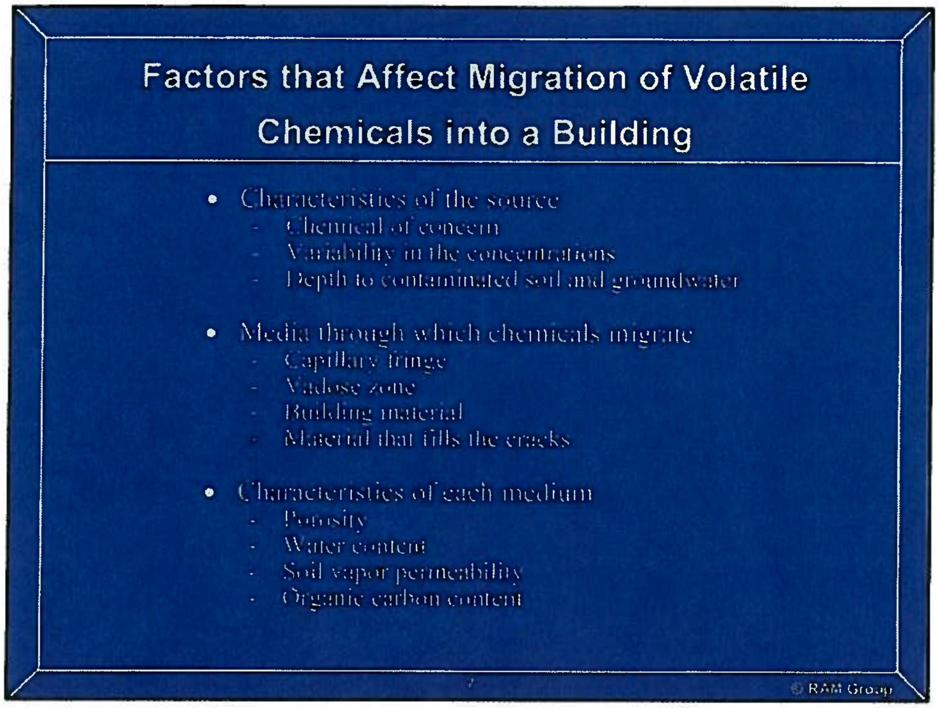
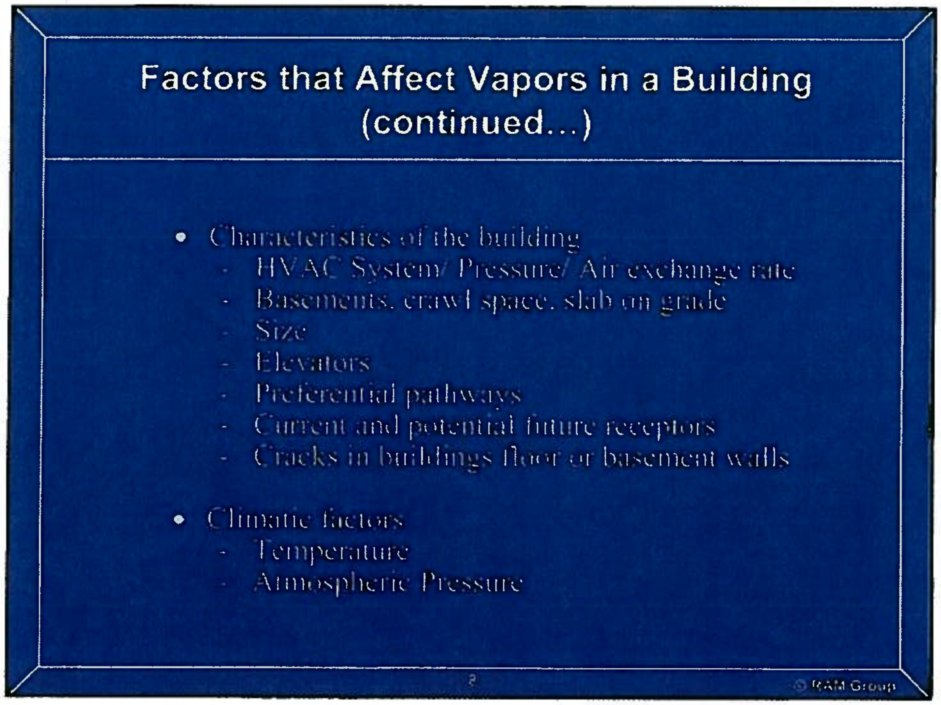


Factors that Affect Migration of Volatile Chemicals into a Building

- Characteristics of the source
  - Chemical of concern
  - Variability in the concentrations
  - Depth to contaminated soil and groundwater

- Media through which chemicals migrate
  - Capillary fringe
  - Vadose zone
  - Building material
  - Material that fills the cracks

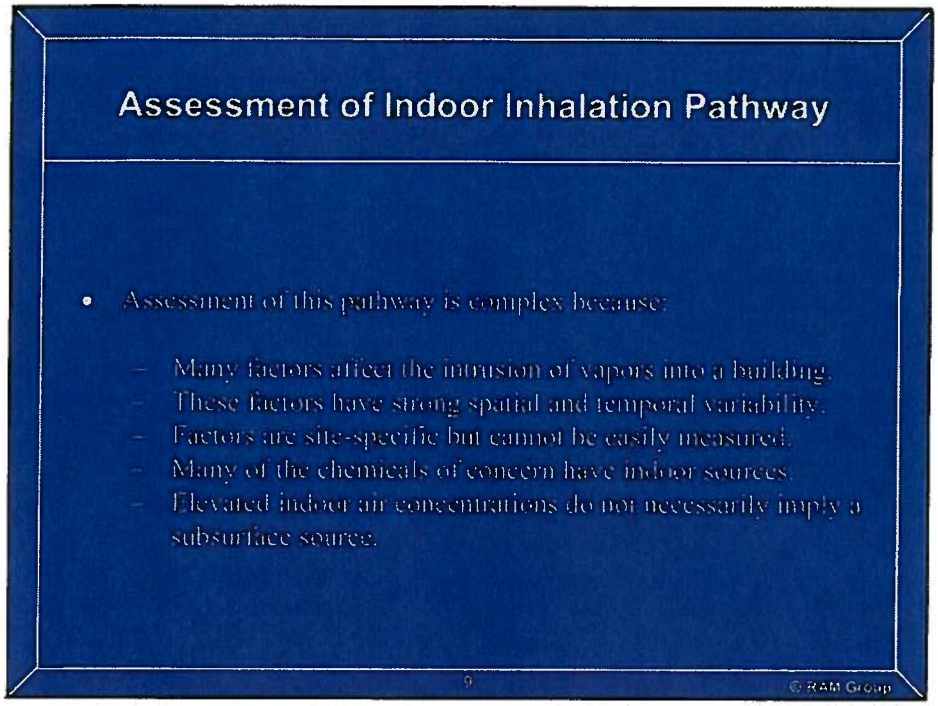
- Characteristics of each medium
  - Porosity
  - Water content
  - Soil vapor permeability
  - Organic carbon content



Factors that Affect Vapors in a Building (continued...)

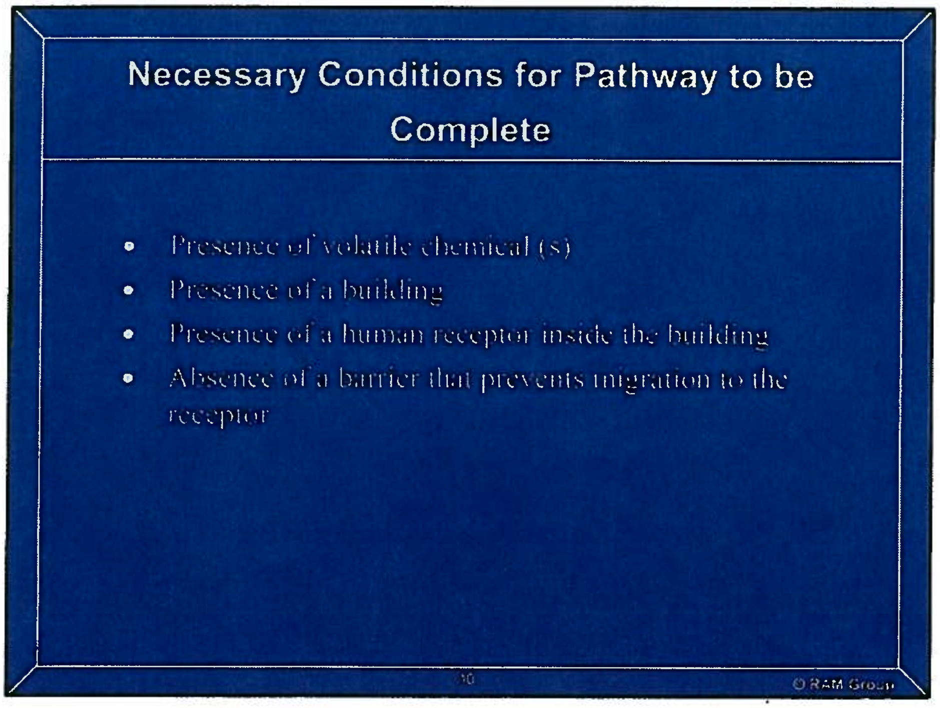
- Characteristics of the building
  - HVAC System/ Pressure/ Air exchange rate
  - Basements, crawl space, slab on grade
  - Size
  - Elevators
  - Preferential pathways
  - Current and potential future receptors
  - Cracks in buildings floor or basement walls

- Climatic factors
  - Temperature
  - Atmospheric Pressure



Assessment of Indoor Inhalation Pathway

- Assessment of this pathway is complex because:
  - Many factors affect the intrusion of vapors into a building.
  - These factors have strong spatial and temporal variability.
  - Factors are site-specific but cannot be easily measured.
  - Many of the chemicals of concern have indoor sources.
  - Elevated indoor air concentrations do not necessarily imply a subsurface source.



Necessary Conditions for Pathway to be Complete

- Presence of volatile chemical (s)
- Presence of a building
- Presence of a human receptor inside the building
- Absence of a barrier that prevents migration to the receptor

History of Pathway

- Radon accumulation (1980s)
- Methane migration from landfills
- Two solvents plumes in Colorado DOT Materials Testing Laboratory Redfield Rifle Site indicated indoor air impacts (late 1990s)
- Draft vapor intrusion guidance (EPA, 2002)
- ASTM standard (E2600-08) published in 2008

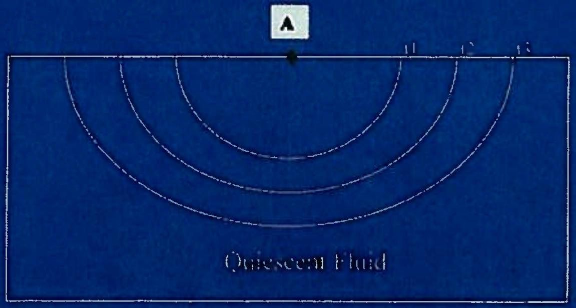
Movement of Vapors in Soil (Fate and Transport Processes)

Two Processes Cause Movement of Vapors

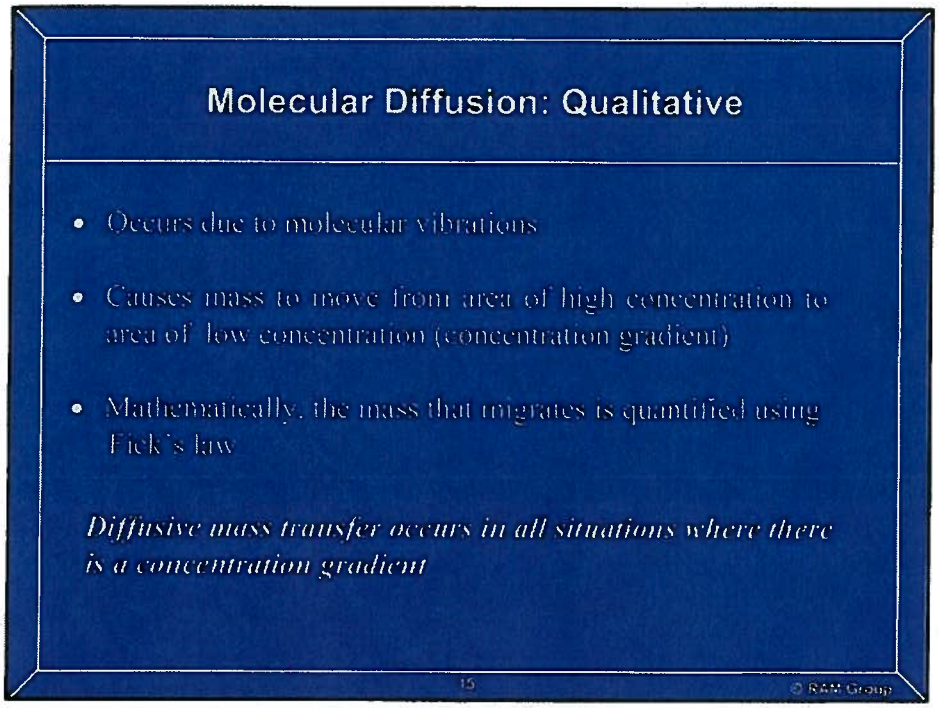
- Diffusion (Primary)
  - Molecular vibrations
- Advection (Variable)
  - Pressure Differences

Of these, advection may or may not occur.
We will briefly review each process.

Molecular Diffusion: Qualitative



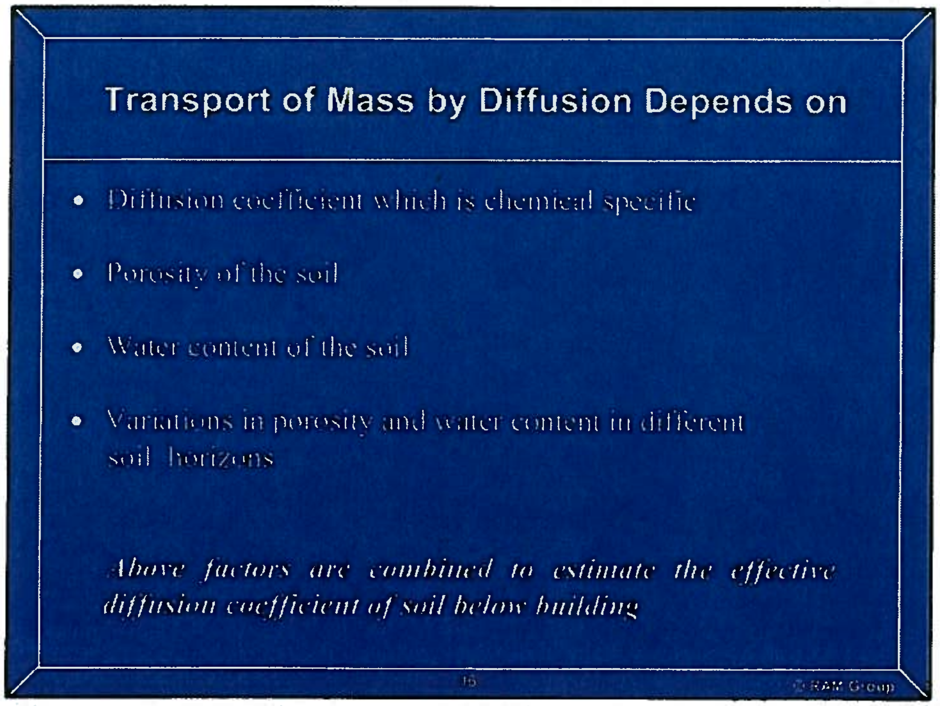
Quiescent Fluid



Molecular Diffusion: Qualitative

- Occurs due to molecular vibrations
- Causes mass to move from area of high concentration to area of low concentration (concentration gradient)
- Mathematically, the mass that migrates is quantified using Fick's law

Diffusive mass transfer occurs in all situations where there is a concentration gradient

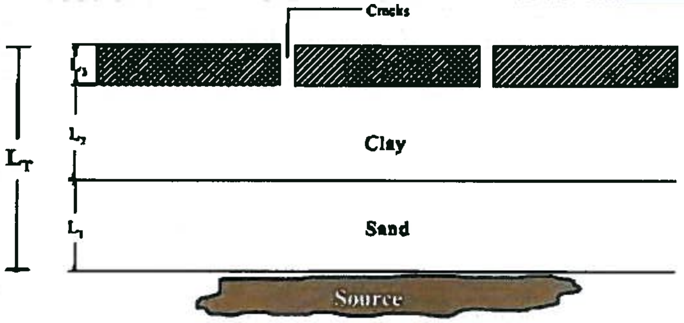


Transport of Mass by Diffusion Depends on

- Diffusion coefficient which is chemical specific
- Porosity of the soil
- Water content of the soil
- Variations in porosity and water content in different soil horizons

Above factors are combined to estimate the effective diffusion coefficient of soil below building

Schematic of Layered System



L_T = Thickness of all layers [cm] (For groundwater, capillary fringe is a separate layer)

L_1 = Sand layer thickness [cm]

L_2 = Clay layer thickness [cm]

L_3 = Slab thickness [cm]

Advection

- Migration of chemicals due to the bulk movement of air
- Bulk movement of air caused by pressure difference
- Vapor flow occurs from high pressure to low pressure areas
- Complicated analytical and numerical models used to estimate migration due to advection

Methods to Evaluate Indoor Inhalation Pathway

Two Methods to Evaluate Risks to Persons for Indoor Inhalation Pathway

1. Collect indoor air samples and compare to acceptable indoor air concentrations.

2. Collect soil and groundwater or soil gas samples and calculate soil and groundwater or soil gas remediation objectives based on acceptable indoor air concentrations.

Evaluation Based on Indoor Air Measurements
Two Step Process

Step 1: Measure **representative** indoor air concentrations

Step 2: Evaluate the measured concentrations

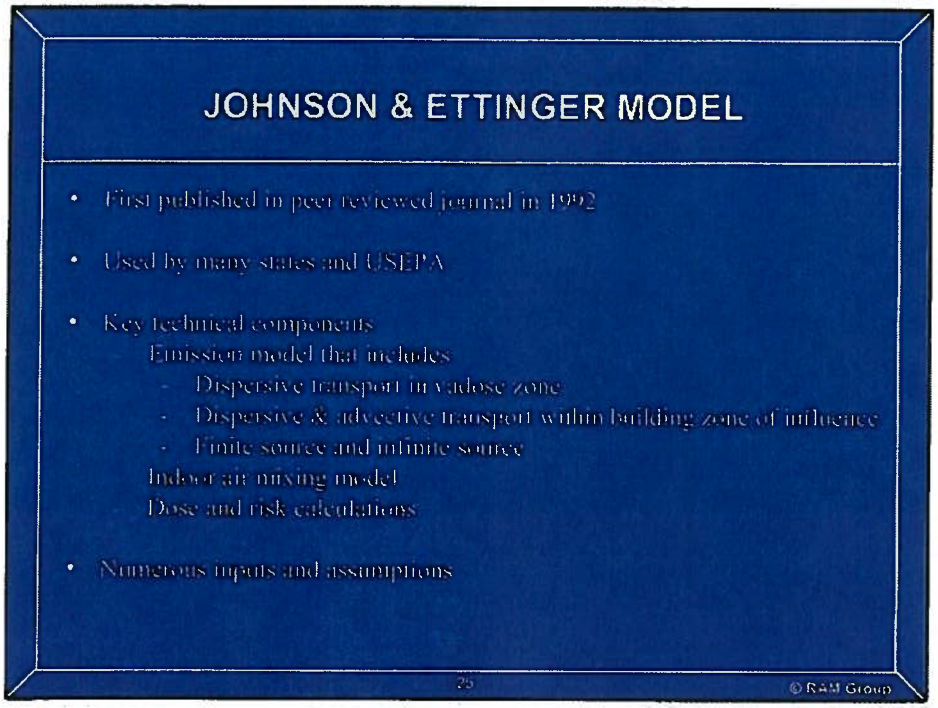
Simple method but has many issues.

Issues with Indoor Air Measurements

- Numerous indoor air sources (cooking, washing, smoking)
- Difficult to attribute the portion coming in from subsurface sources vs. indoor or ambient air
- Considerable temporal and spatial variability; difficult to explain
- One snapshot may not be enough; repeat measurements necessary
- May cause unnecessary alarm and inconvenience

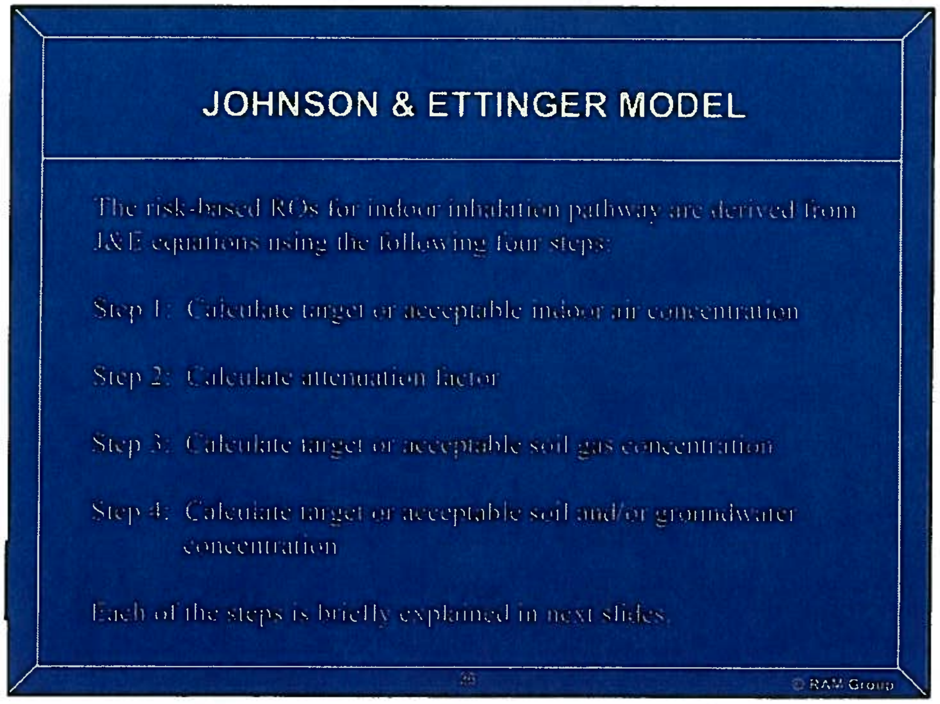
Avoid indoor air concentration measurements unless absolutely Necessary.

JOHNSON & ETTINGER MODEL



JOHNSON & ETTINGER MODEL

- First published in peer reviewed journal in 1992
- Used by many states and USEPA
- Key technical components
  - Emission model that includes
    - Dispersive transport in vadose zone
    - Dispersive & advective transport within building zone of influence
    - Finite source and infinite source
  - Indoor air mixing model
  - Dose and risk calculations
- Numerous inputs and assumptions



JOHNSON & ETTINGER MODEL

The risk-based ROs for indoor inhalation pathway are derived from J&E equations using the following four steps:

Step 1: Calculate target or acceptable indoor air concentration

Step 2: Calculate attenuation factor

Step 3: Calculate target or acceptable soil gas concentration

Step 4: Calculate target or acceptable soil and/or groundwater concentration

Each of the steps is briefly explained in next slides.

Step 1: Calculate Target or Acceptable Indoor Air Concentration

Acceptable indoor air concentrations are calculated to be adequately protects humans who inhale this air (i.e., meets the risk criteria of one-in-a-million individual excess lifetime cancer risk and a hazard quotient of one).

Calculation uses:

- Target risks
- Exposure factors
- Toxicity values

Step 2: Attenuation Factor Definition

The ratio of the concentration in the indoor air (Step 1) to the soil gas concentration is called the attenuation factor.

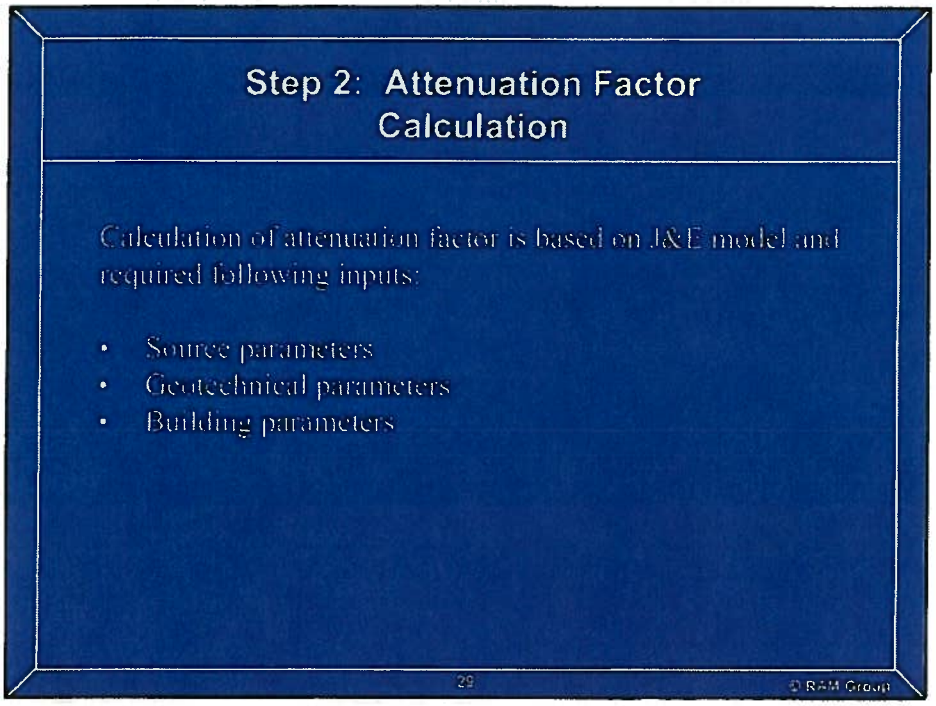
$$\textbf{Attenuation Factor } (\alpha) = \frac{\textbf{Indoor Air Concentration}}{\textbf{Soil Gas Concentration at Source}}$$

(α always ≤ 1)

Higher α → Less attenuation or higher indoor air concentration

$\alpha = 0.5$, implies a factor of 2 reduction in concentration
$\alpha = 0.01$, implies a factor of 100 reduction in concentration

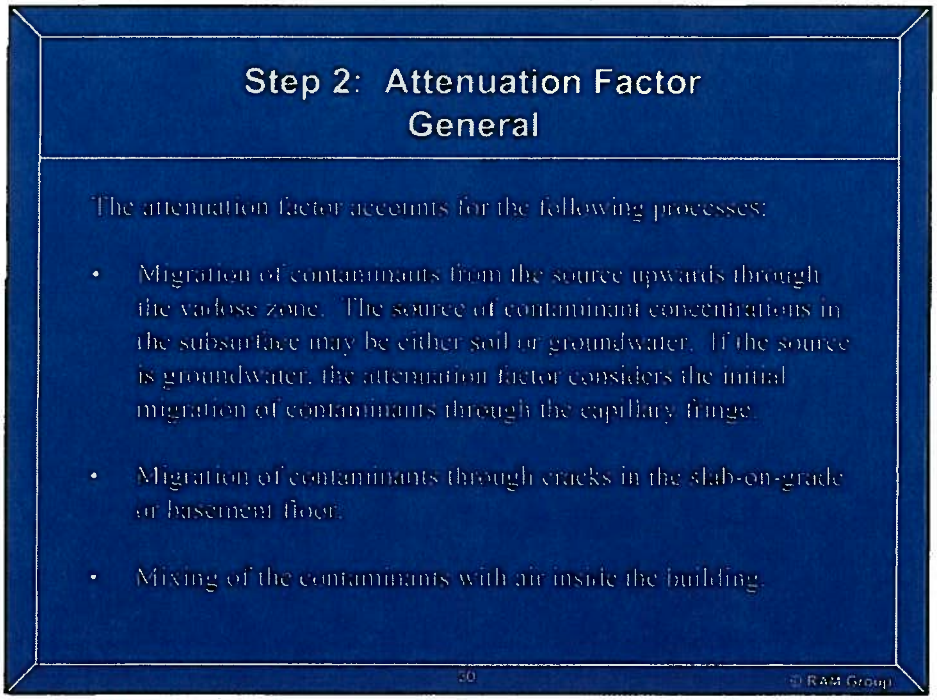
$1/\alpha$ is the concentration reduction factor.



Step 2: Attenuation Factor Calculation

Calculation of attenuation factor is based on J&E model and required following inputs:

- Source parameters
- Geotechnical parameters
- Building parameters



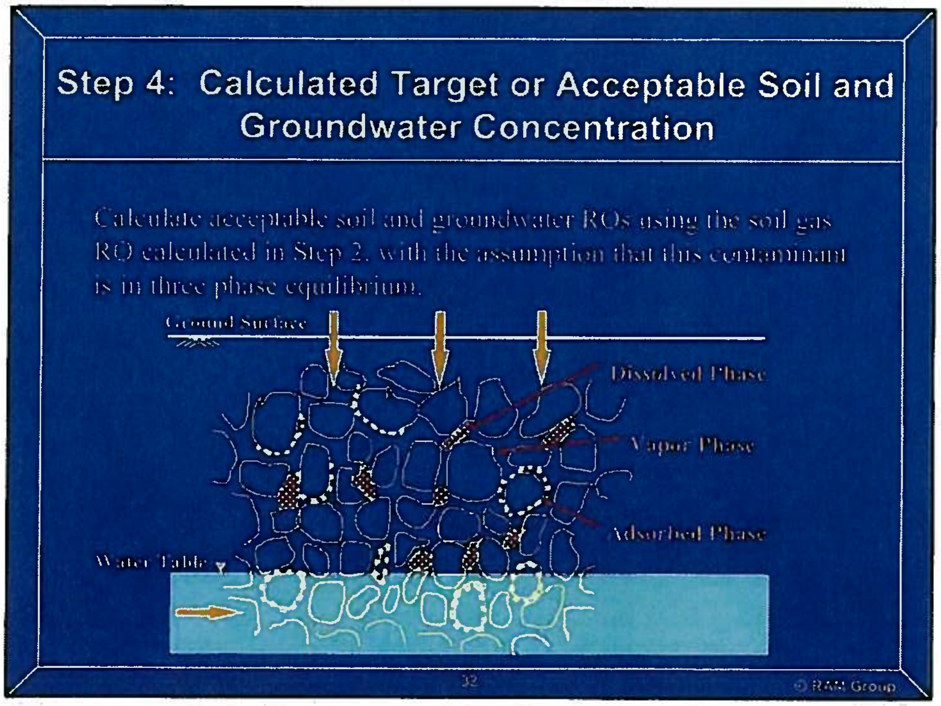
Step 2: Attenuation Factor General

The attenuation factor accounts for the following processes:

- Migration of contaminants from the source upwards through the vadose zone. The source of contaminant concentrations in the subsurface may be either soil or groundwater. If the source is groundwater, the attenuation factor considers the initial migration of contaminants through the capillary fringe.
- Migration of contaminants through cracks in the slab-on-grade or basement floor.
- Mixing of the contaminants with air inside the building.

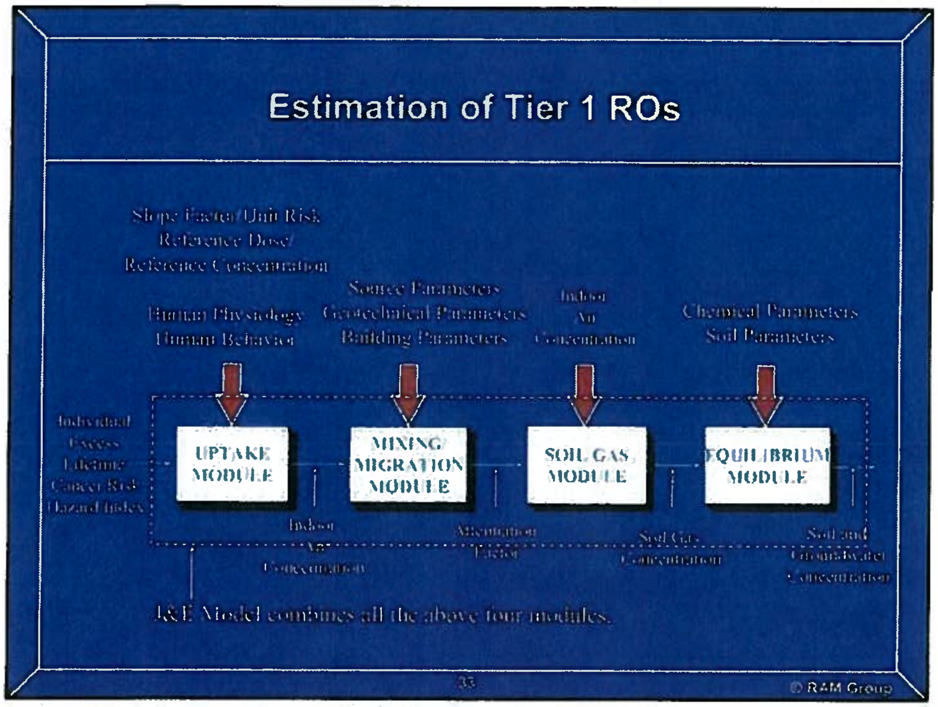
Step 3: Calculate Target or Acceptable Soil Gas Concentration

Calculate an acceptable concentration of the contaminant of concern in the soil gas at the source of contamination. This concentration will not cause the contaminant in indoor air to exceed the concentration calculated in Step 1. This calculation was made using an attenuation factor derived from the modified J&E model.



Step 4: Calculated Target or Acceptable Soil and Groundwater Concentration

Calculate acceptable soil and groundwater ROs using the soil gas RO calculated in Step 2, with the assumption that this contaminant is in three phase equilibrium.



Estimation of Tier 1 ROs

Slope Factor/Unit Risk
Reference Dose/
Reference Concentration

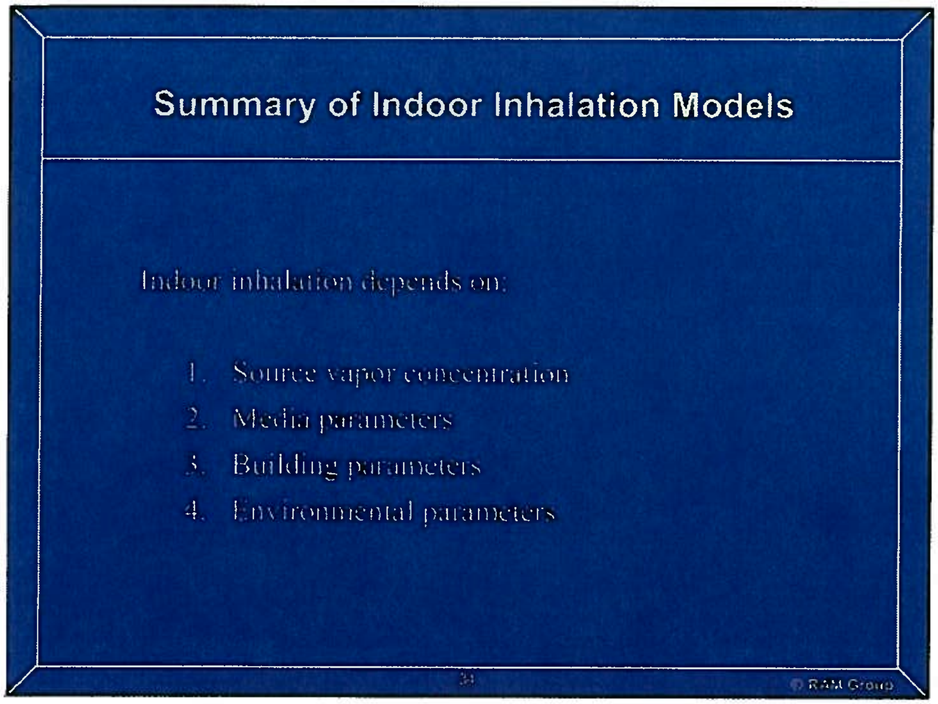
Human Physiology
Human Behavior

Source Parameters
Geotechnical Parameters
Building Parameters

Indoor
Air
Concentration

Chemical Parameters
Soil Parameters

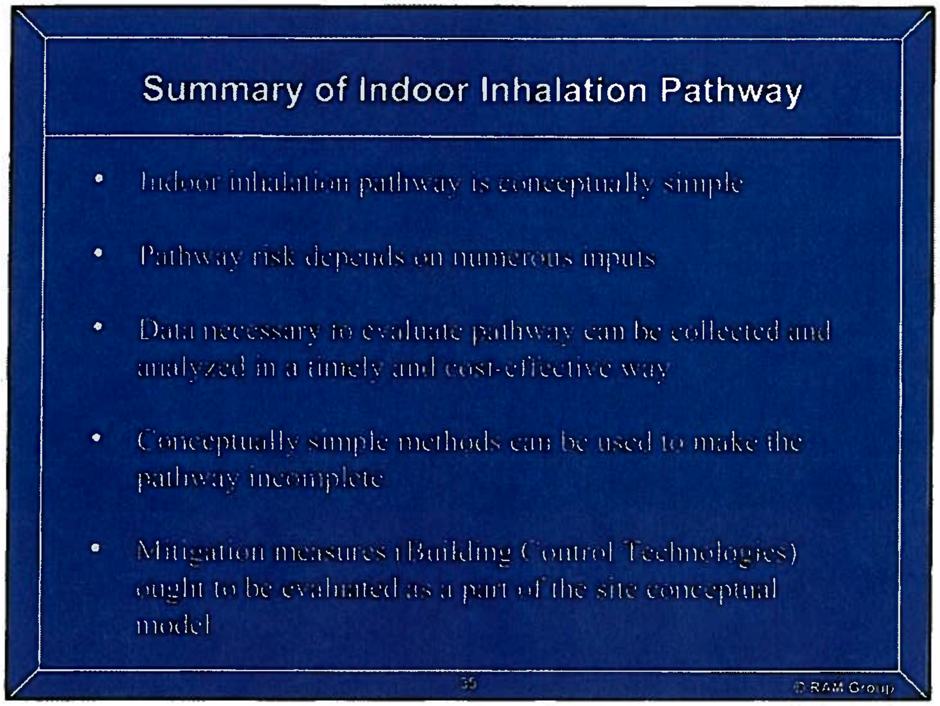
J&E Model combines all the above four modules.



Summary of Indoor Inhalation Models

Indoor inhalation depends on:

1. Source vapor concentration
2. Media parameters
3. Building parameters
4. Environmental parameters



Summary of Indoor Inhalation Pathway

- Indoor inhalation pathway is conceptually simple
- Pathway risk depends on numerous inputs
- Data necessary to evaluate pathway can be collected and analyzed in a timely and cost-effective way
- Conceptually simple methods can be used to make the pathway incomplete
- Mitigation measures (Building Control Technologies) ought to be evaluated as a part of the site conceptual model

STATE OF ILLINOIS)
)
COUNTY OF SANGAMON)

PROOF OF SERVICE

I, the undersigned, on oath state that I have served the attached Errata Sheet Number 1 and the Pre-filed Testimony of Gary King, Thomas C. Hornshaw, Tracey Hurley, and Atul Salhotra upon the persons to whom they are directed, by placing a copy of each in an envelope addressed to:

Dorothy Gunn, Clerk
Illinois Pollution Control Board
James R. Thompson Center
100 W. Randolph, Suite 11-500
Chicago, Illinois 60601

Bill Richardson
Chief Legal Counsel
Illinois Dept. of Natural Resources
One Natural Resources Way
Springfield, Illinois 62702-1271

Matt Dunn
Environmental Bureau Chief
Office of the Attorney General
James R. Thompson Center
100 W. Randolph, 12th Floor
Chicago, Illinois 60601

Richard McGill
Hearing Officer
Illinois Pollution Control Board
James R. Thompson Center
100 W. Randolph, Suite 11-500
Chicago, Illinois 60601

Participants on the Service List

and mailing them (First Class Mail) from Springfield, Illinois on November 12, 2008, with sufficient postage affixed as indicated above.

SUBSCRIBED AND SWORN TO BEFORE ME
This 12th day of November, 2008.

Brenda Boehner
Notary Public

BRENDA BOEHNER
11-3-2009

Party Name	Role	City & State	Phone/Fax
Illinois Environmental Protection Agency Interested Party Kimberly A. Geving, Assistant Counsel Annet Godiksen, Legal Counsel	1021 North Grand Avenue East P.O. Box 19276	Springfield IL 62794-9276	217/782-5544 217/782-9807
IEPA Petitioner Kimberly A.Geving, Assistant Counsel	1021 North Grand Avenue East P.O. Box 19276	Springfield IL 62794-9276	217/782-5544 217/782-9807
Hodge Dwyer Zeman Complainant Katherine D. Hodge Monica T. Rios	3150 Roland Avenue Post Office Box 5776	Springfield IL 62705-5776	217/523-4900 217/523-4948
EPI Interested Party Bob Mankowski	16650 South Canal	South Holland IL 60473	
Chemical Industry Council of Illinois Interested Party Lisa Frede	1400 East Touhy Avenue Suite 100	DesPlaines IL 60019-3338	
Bellande & Sargis Law Group, LLP Interested Party Mark Robert Sargis	19 South LaSalle Street Suite 1203	Chicago IL 60603	312/853-8701 312/853-8702
Hanson Engineers, Inc. Interested Party Tracy Lundein	1525 South Sixth Street	Springfield IL 62703-2886	217/788-2450 217/788-2503
Conestoga-Rovers & Associates Interested Party Douglas G. Soutter	8615 West Bryn Mawr Avenue	Chicago IL 60631	773/380-9933 773/380-6421
Office of the Attorney General Interested Party Matthew J. Dunn, Division Chief	Environmental Bureau 69 W. Washington, 18th Floor	Chicago IL 60602	312/814-0660 312/814-2347
Navy Facilities and Engineering Command Interested Party Mark Schultz, Regional Environmental Coordinator	201 Decatur Avenue Building 1A	Great Lakes IL 60088-2801	847/688-2600 847/688-2319
Illinois Pollution Control Board Interested Party	100 W. Randolph St. Suite 11-500	Chicago IL 60601	312/814-3620 312/814-

Dorothy M. Gunn, Clerk of the Board Richard McGill, Hearing Officer			
Commonwealth Edison Interested Party Diane H. Richardson	10 South Dearborn Street 35FNW	Chicago IL 60603	
Clayton Group Services Interested Party Monte Nienkerk	3140 Finley Road	Downers Grove IL 60515	
Weaver Boos & Gordon Interested Party Elizabeth Steinhour	2021 Timberbrook Lane	Springfield IL 62702	
Andrews Environmental Engineering Interested Party Kenneth W. Liss	3300 Ginger Creek Drive	Springfield IL 62711	
Graef Anhalt Schloemer & Associates, Inc. Interested Party Dr. Douglas C. Hambley, P.E., P.G.	8501 West Higgins Road Suite 280	Chicago IL 60631-2801	
Missman Stanley & Associates Interested Party John W. Hochwarter Jeffrey Larson	333 East State Street	Rockford IL 61110-0827	
Trivedi Associates, Inc. Interested Party Chetan Trivedi	2055 Steeplebrook Court	Naperville IL 60565	
Illinois Department of Natural Resources Interested Party Stan Yonkauski William Richardson, Chief Legal Counsel	One Natural Resources Way	Springfield IL 62702-1271	217/782-1809 217/524-9640
Suburban Laboratories, Inc. Interested Party Jarrett Thomas, V.P.	4140 Litt Drive	Hillside IL 60162	708-544-3260
Illinois Department of Transportation Interested Party Steven Gobelman	2300 S. Dirksen Parkway Room 302	Springfield IL 62764	
McGuire Woods LLP Interested Party David Rieser	77 W. Wacker Suite 4100	Chicago IL 60601	312/849-8100
Reott Law Offices, LLC Interested Party Raymond T. Reott Jorge T. Mihalopoulos	35 East Wacker Drive Suite 650	Chicago IL 60601	312/332-7544
Environmental Management & Technologies, Inc. Interested Party Craig Gocker, President	2012 W. College Avenue Suite 208	Normal IL 61761	309/454-1717

IL Environmental Regulatory Group Interested Party	215 East Adams Street	Springfield IL 62701	217/522-5512 217/522-5518
Alec M. Davis			
Chicago Department of Law Interested Party	30 N. LaSalle Street Suite 900	Chicago IL 60602	312/742-3990 312/744-6798
Charles A. King, Assistant Corporation Counsel			
SRAC Interested Party	2510 Brooks Drive	Decatur IL 62521	
Harry Walton			
Burns & McDonnell Engineering Company, Inc. Interested Party	210 South Clark Street, Suite 2235 The Clark Adams Building	Chicago IL 60603	6306751625
Lawrence L. Fieber, Principal			

Total number of participants: 34