Missouri Department of
Natural Resources

2011 MWCC Conference
Tanks/Remediation Tract

LNAPL and other Miscellaneous Topics

By

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Tanks Section

Evaluating the risk from LNAPL

- **LNAPL present within last 2 years:**

- The representative concentration should be the effective solubility of the product (Section 6.3)

- **Can use MDNR's default values**
- **or site-specific values from product sample**
- **Do not use groundwater sampling data**

Example RC Calculation

Representative Concentration for Groundwater		
	Date	Result
MW-1	1/1/10	8.3
	4/1/10	7.9
	7/1/10	7.5
	10/1/10	6.7
RC for well		7.6
MW-2	1/1/10	FP
	4/1/10	FP
	7/1/10	16
	10/1/10	14
RC for well		44.7
MW-3	1/1/10	2.5
	4/1/10	2.9
	7/1/10	1.7
	10/1/10	2.1
RC for well		2.3
RC for pathway	(7.6+ 44.7+ 2.3) ÷ 3	18.2

LNAPL
(continued)

- Default values assume product is fresh
- To use defaults:

  - You can take the values directly from our tables… See handout

(Table 6-5 for effective solubility & Table 6-6 for effective soil gas saturation)

Table 6-4

Percent Weight of Chemicals of Concern in Various Products

Chemicals of Concern	Gasoline	Diesel/Light Fuel	Product Jet Fuel	Kerosene
Benzene	1.9	0.029	0.47	NA
Toluene	8.1	0.18	1.6	NA
Ethylbenzene	1.7	0.068	0.66	NA
Xylenes (mixed)	9	0.5	1.44	NA
Ethylene Dibromide (EDB)	NA	NA	NA	NA
Ethylene Dichloride (EDC)	NA	NA	NA	NA
Methyl-tert-butyl-ether (MTBE)	NA	NA	NA	NA
Acenaphthene	NA	NA	NA	0.0047
Anthracene	NA	0.0058	NA	0.00012
Benzo(a)anthracene	NA	0.000096	NA	NA
Benzo(a)pyrene	NA	0.00022	NA	NA
Benzo(b)fluoranthene	NA	0.000155	NA	NA
Benzo(k)fluoranthene	NA	0.000155	NA	NA
Chrysene	NA	0.000045	NA	NA
Dibenzo(a,h)anthracene	NA	NA	NA	NA
Fluoranthene	NA	0.0059	NA	0.00086
Fluorene	NA	0.086	NA	NA
Naphthalene	0.25	0.26	0.41	0.31
Pyrene	NA	0.0046	NA	0.00024

Table 6-5

Solubility and Effective Solubility of Chemicals of Concern

Chemicals of Concern	Water Solubility (mg/L)	Molecular Weight (g/mol)	Effective Solubility (mg/L)			
			Gasoline	Diesel/Light Fuel	Product Jet Fuel	Kerosene
Benzene	1.75E+03	7.81E+01	4.47E+01	1.49E+00	1.74E+01	NA
Toluene	5.26E+02	9.20E+01	4.86E+01	2.37E+00	1.51E+01	NA
Ethylbenzene	1.69E+02	1.06E+02	2.84E+00	2.49E-01	1.73E+00	NA
Xylenes (mixed)	1.61E+02	1.06E+02	1.43E+01	1.74E+00	3.60E+00	NA
Ethylene Dibromide (EDB)	4.32E+03	1.88E+02	NA	NA	NA	NA
Ethylene Dichloride (EDC)	8.50E+03	9.90E+01	NA	NA	NA	NA
Methyl-tert-butyl-ether (MTBE)	5.10E+04	8.82E+01	NA	NA	NA	NA
Acenaphthene	4.24E+00	1.54E+02	NA	NA	NA	1.36E-04
Anthracene	4.34E-02	1.78E+02	NA	3.25E-06	NA	3.07E-08
Benzo(a)anthracene	9.40E-03	2.28E+02	NA	9.09E-09	NA	NA
Benzo(a)pyrene	1.62E-03	2.52E+02	NA	3.25E-09	NA	NA
Benzo(b)fluoranthene	1.50E-03	2.52E+02	NA	2.12E-09	NA	NA
Benzo(k)fluoranthene	8.00E-04	2.52E+02	NA	1.13E-09	NA	NA
Chrysene	1.60E-03	2.28E+02	NA	7.25E-10	NA	NA
Dibenzo(a,h)anthracene	2.49E-03	2.78E+02	NA	NA	NA	NA
Fluoranthene	2.06E-01	2.02E+02	NA	1.38E-05	NA	9.20E-07
Fluorene	1.98E+00	1.66E+02	NA	2.36E-03	NA	NA
Naphthalene	3.10E+01	1.28E+02	6.35E-02	1.45E-01	1.64E-01	7.87E-02
Pyrene	1.35E-01	2.02E+02	NA	7.06E-06	NA	1.68E-07

Table 6-6

Saturated Vapor Pressure and Effective Vapor Concentration of Chemicals of Concern

Chemicals of Concern	Saturated Vapor Pressure (atm)	Molecular Weight (g/mol)	Effective Vapor Concentration (mg/m^3)			
			Gasoline	Diesel/Light Fuel	Product Jet Fuel	Kerosene
Benzene	1.25E-01	7.81E+01	1.04E+04	3.47E+02	4.03E+03	NA
Toluene	3.71E-02	9.20E+01	1.31E+04	6.39E+02	4.07E+03	NA
Ethylbenzene	1.26E-02	1.06E+02	9.38E+02	8.22E+01	5.72E+02	NA
Xylenes (mixed)	1.06E-02	1.06E+02	4.17E+03	5.07E+02	1.05E+03	NA
Ethylene Dibromide (EDB)	1.45E-02	1.88E+02	NA	NA	NA	NA
Ethylene Dichloride (EDC)	1.07E-01	9.90E+01	NA	NA	NA	NA
Methyl-tert-butyl-ether (MTBE)	3.28E-01	8.82E+01	NA	NA	NA	NA
Acenaphthene	4.93E-06	1.54E+02	NA	NA	NA	1.01E-03
Anthracene	3.36E-08	1.78E+02	NA	1.86E-05	NA	1.76E-07
Benzo(a)anthracene	1.97E-10	2.28E+02	NA	1.81E-09	NA	NA
Benzo(a)pyrene	6.43E-12	2.52E+02	NA	1.35E-10	NA	NA
Benzo(b)fluoranthene	1.06E-10	2.52E+02	NA	1.57E-09	NA	NA
Benzo(k)fluoranthene	1.26E-13	2.52E+02	NA	1.87E-12	NA	NA
Chrysene	1.03E-11	2.28E+02	NA	4.42E-11	NA	NA
Dibenzo(a,h)anthracene	2.76E-14	2.78E+02	NA	NA	NA	NA
Fluoranthene	1.07E-08	2.02E+02	NA	6.04E-06	NA	4.02E-07
Fluorene	4.26E-06	1.66E+02	NA	3.51E-02	NA	NA
Naphthalene	1.17E-04	1.28E+02	1.28E+00	2.91E+00	3.29E+00	1.58E+00
Pyrene	5.59E-09	2.02E+02	NA	2.46E-06	NA	5.86E-08

LNAPL
(continued)

If you want to collect a product sample:

- **Fill VOA vial completely with product**
- **Best to use a product testing lab**
- **Have lab run sample as a solid (mg/kg)**
- **Calculate effective solubility from results**

(See handout for directions & equations)

Calculation of Effective Solubility

$$C_i^l = X_i \times S_i$$

$$X_i = \frac{0.01 \times w_i \times MW_{avg}}{MW_i}$$

S_i = solubility of the constituent i in pure water (mg/L)

X_i = mole fraction of the constituent *i*

w_i = weight percent of the constituent *i* (%)

MW_{avg} = average molecular weight of the mixture (g/mol)

MW_i = molecular weight of the constituent *i* (g/mol).

LNAPL (continued)

- **EPA has an on-line effective solubility calculator http://www.epa.gov/athens/learn2model/part-two/onsite/es.html**

- **Or you can do as I did and create an excel spreadsheet to do the math for you**

Effective Solubility Calculator

Contaminant	LNAPL Results (mg/kg)	Effective Solubility gasoline (mg/L)
Benzene	19000	44.70
Toluene	81000	48.63
Ethylbenzene	17000	2.85
Xylenes	90000	14.35
Naphthalene	250	0.01
Acenapthene	N/A	NA
Anthracene	N/A	NA
Benzo (a) anthracene	N/A	NA
Benzo (a) pyrene	N/A	NA
Benzo (b) fluoranthene	N/A	NA
Benzo (k) fluoranthene	N/A	NA
Chrysene	N/A	NA
Fluoranthene	N/A	NA
Fluorene	N/A	NA
Pyrene	N/A	NA

Backlog Reduction Initiative

- EPA is pushing states to get old sites closed
- Focus on sites with cleanups ongoing > 20 yrs
- Sites are being expedited and re-assigned to Valerie & Laura
- Expedited document reviews (< 2 weeks)
- Tracking deadlines

Off-site Access – Monitoring Wells

- Installation and sampling of off-site monitoring wells is at the approval of off-site property owner
- The property owner can revoke access (change their mind) at any time and ask for the well(s) on their property to be removed for any reason

Neighbor Notification

- By regulation, MDNR must notify affected public when contamination requires clean up
- The RP may notify in lieu of MDNR
- When the risk assessment identifies a current/existing risk, MDNR considers notification a high priority

Tank Rule Revisions - Update

- Formed a Stakeholder Group
- Have held a few Stakeholder meetings
- Shooting for initial draft rule to Hazardous Waste Commission in August 2011
- And final draft rule to commission in December 2011
- Track progress on MDNR's web site http://dnr.mo.gov/env/hwp/tanks/mrbca-pet/rbcarulemaking.htm#document