Rule 57 Aquatic Values Work Sheet

Chemical Name: Beryllium

C.A.S #: 7440-41-7

Developed by: William F. Dimond
Approved by: D. Bush
Approval date: 1/9/2014
Literature search date: 12/21/12

FAV: $e^{(1.6839[\ln(H)] - 2.9672)}$ *(Tier:II)*
AMV: $e^{(1.6839[\ln(H)]) - 3.6603)}$ *(Tier:II)*
FCV: $e^{(1.6839[\ln(H)]) - 5.8575)}$ *(Tier:II)*

ACUTE DATA

Species	Duration (hrs)	Test type	Metal Form	Hardness (mg/l $CaCO_3$)	LC 50 (ug/L)	Values normalized to 100 hardness using regression slope SMAV	GMAV	GMAV Rank	Ref.
Cladoceran									
Daphnia magna	48	S,U	n/a	173	1,000	840.01	840.01	1	6
	48	S,U	BeSO4	220	2,410				5
	48	S,U	BeSO4	220	2,450				5
	48	S,M	BeSO4	100	1,190				7
	48	S,M	BeSO4	150	2,090				7
	48	S,M	BeSO4	200	2,910				7
	48	S,M	BeSO4	250	6,220				7
	48	S,M	BeSO4	300	6,320				7
Fathead Minnow	96	FT,M	BeSO4	142	3,250	1800.7	1800.7	2	4
Pimephales promelas	96	S,U	BeSO4	220	17,900 [1]				5
	96	S,U	BeSO4	220	17,500 [1]				5

ACUTE DATA

Species	Duration (hrs)	Test type	Metal Form	Hardness (mg/l $CaCO_3$)	LC 50 (ug/L)	Values normalized to 100 hardness using regression slope SMAV	Values normalized to 100 hardness using regression slope GMAV	GMAV Rank	Ref.
Flagfish									
Jordanella floridae	96	FT,M	BeSO4	142	3,530	2,034	2,034	3	4
	96	FT,M	BeSO4	142	3,530				4
	96	FT,M	BeSO4	142	3,970				4
Guppy									
Lebistes reticulatus	96	S,U	BeSO4	22	160	2475.8	2475.8	4	1
	96	S,U	BeSO4	72	1,330				1
	96	S,U	BeSO4	150	6,100				1
	96	S,U	BeSO4	192	7,100				1
	96	S,U	BeSO4	275	13,700				1
	96	S,U	BeSO4	400	20,000				1
	96	S,U	BeSO4	22.5	450				2
	96	S,U	BeSO4	22.5	130				2
	96	S,U	BeSO4	22.5	200				2
	96	S,U	BeSO4	22.5	160				2
	96	S,U	BeSO4	400	32,000				2
	96	S,U	BeSO4	400	28,000				2
	96	S,U	BeSO4	400	32,000				2
	96	S,U	BeSO4	400	24,000				2
	96	S,U	BeSO4	400	19,000				2
Channel Catfish									
Ictalurus punctatus	96	FT,M	BeSO4	142	>5,090 [2]	2,820	2,820	5/6	4

ACUTE DATA

Species	Duration (hrs)	Test type	Metal Form	Hardness (mg/l $CaCO_3$)	LC 50 (ug/L)	Values normalized to 100 hardness using regression slope SMAV	GMAV	GMAV Rank	Ref.
Brook Trout									
Salvelinus fontinalis	96	FT,M	BeSO4	142	>5,090 [2]	2,820	2,820	5/6	4
Salamander									
Ambyostoma opacum	96	S,U	BeSO4	400	31,500	10,885	11,642	7	3
Ambyostoma opacum	96	S,U	BeSO4	22.5	3,150				3
Salamander									
Ambyostoma maculatum	96	S,U	BeSO4	22.5	3,150	12,451	11,642	7	3
Ambyostoma maculatum	96	S,U	BeSO4	22.5	8,000				3
Ambyostoma maculatum	96	S,U	BeSO4	22.5	8,320				3
Ambyostoma maculatum	96	S,U	BeSO4	400	31,500				3
Ambyostoma maculatum	96	S,U	BeSO4	400	18,200				3
Ambyostoma maculatum	96	S,U	BeSO4	400	18,200				3
Goldfish									
Carassius auratus	96	FT,M	BeSO4	142	55,900	30,972	30,972	8	4

Acute Data Notes

[1]S,U data not used because FT,M data available

[2]Values considered to equal 5,090 for ALV development.

CHRONIC DATA

No usable data found.

Acceptable References

1. Slonim, C.B. and A.R. Slonim. 1973. Effect of water hardness on the tolerance of the guppy to beryllium sulfate. Bulletin of Environmental Contamination and Toxicology 10: 295-301.
2. Slonim, A.R. 1973. Acute toxicity of beryllium sulfate to the common guppy. Journal of the Water Pollution Control Federation 45:2110-2122.
3. Slonim, A.R. and E.E. Ray. 1975. Acute toxicity of beryllium sulfate to salamander larvae (*Ambyostoma* spp.) Bulletin of Environmental Contamination and Toxicology 13(3): 307-312.
4. Cardwell et al. 1976. Acute toxicity of selected toxicants to six species of fish. US EPA Ecological Research Series, EPA-600/3-76-008. EPA ERLD, Duluth MN. 118 pp.
5. Kimball, G. 1978. The effects of lesser known metals and one organic to fathead minnows (*Pimphales promelas*) and *Daphnia magna*. Unpublished manuscript.
6. LeBlanc, G.A. 1980. Acute toxicity of priority pollutants to Water Flea (*Daphnia magna*). Bulletin of Environmental Contamination and Toxicology 24: 684-691.
7. Buikema, A.L., Jr. 1986. Toxicity of Beryllium to the Cladoceran, *Daphnia magna* as a Function of Water Hardness. Report, Dep.of Biology, Virginia Polytechnic Institute and State University, Blacksburg, VA:26 p. Note: This study could not be obtained for review. However, study was judged acceptable based on similarity of hardness-LC50 relationship to guppy relationship.

References Reviewed and Rejected

Khangarot, B.S. and P.K. Ray. 1989. Investigation of correlation between physicochemical properties of metals and their toxicity to the Water Flea *Daphnia magna* Straus. Ecotoxicology and Environmental Safety 18: 109-120.
Data not used because *D. magna* age (adult) was outside acceptable range (<24h old). *Daphnia* relesed young during 48 h testing.
Tarzwell,C.M. and C. Henderson. 1960. Toxicity of less common metals. Industrial Wastes, February 1960, page 12.
Methods not described, so cannot be reviewed to assess study acceptability.
Khangarot, B.S. 1991. Toxicity of metals to a freshwater tubificid worm, *Tubifex tubifex* (Muller). Bulletin of Environmental Contamination and Toxicology 46:906-912.
Data not used for two reasons: Accurate species identification by Khangarot 1991 is very unlikely given the more recent divergence of tubificid classification. Also, MDEQ experimental chlorides data indicates *Tubifex* (*T. harmni*) sensitivity to a different chemical (sodium chloride) was much different from the value reported by Khangarot 1991, further decreasing confidence in the reference.

Min. data req. met	Acute Factor
2	13
3	8
4	7
5	6.1
6	5.2
7	4.3

Rule 57 Aquatic Values Work Sheet

*Chemical Name:*__Beryllium_____
*C.A.S. #:*_7440-41-7_____

AQUATIC MAXIMUM VALUE CALCULATIONS

A. Minimum 8 species requirement is **not** met. Minimum requirements met = i, ii, iii, iv
Minimum requirements missing for Tier I = v, vi, vii, viii
Acute factor = __7__

1. Toxicity **is not** dependent on a water characteristic

   a. FAV calculation

2. Toxicity **is** dependent on a water characteristic

   a. Slope = 1.68390544807541 (Table ___)

   b. FAV @ 100 hardness: 840.007993812353/7 = 120.001141973193

   b. FAV equation: tier I FAV = $e^{(1.6839[\ln(H)] - 2.9672)}$

3. Go to C.

B. Minimum 8 species requirement **is** met (Tier I)

1. Toxicity **is not** dependent on a water characteristic

   a. FAV calculation: Att. ___

2. Toxicity **is** dependent on a water characteristic

C. Aquatic Maximum Value (AMV) calculation:

$\ln(e^{\text{FAV intercept}}/2)$ = AMV intercept

$\ln(e^{-2.96716990633981}/2)$ = -3.66031708689975, round to -3.6603 for equation

AMV = $e^{(1.6839[\ln(H)]) - 3.6603)}$

FINAL CHRONIC VALUE CALCULATIONS

A. Minimum 8 species requirement is **not** met (Tier II). Minimum requirements met = _0_
Minimum requirements missing for Tier I =

1. Acute to chronic ratio

   a. Number ACRs meeting minimum data requirements = 0

   b. Acute to chronic ratio = 18

2. Toxicity **is not** dependent on a water characteristic

   FCV =

3. Toxicity **is** dependent on a water characteristic

   a. Slope = 1.68390544807541 (Acute slope, Table ___)
   round to 1.6839 for reporting

   b. Aquatic chronic intercept = [S-L(ln(Z)] where:

   S = ln(FAV@Z/18) = ln(120.001141973193/18) = 1.89712950128388

   L=chronic slope (Acute slope here) (1.68390544807541)

   Z = selected water quality characteristic value (100)
   Ln(Z) = 4.605170186

   Intercept = [1.89712950128388-1.68390544807541x4.605170186] =
   -5.85754166423597, round to -5.8575 for equation

   c. FCV equation = $e^{(1.6839[\ln(H)]) -5.8575)}$

Rule 57 ALV Worksheet, Beryllium, 2014, Pooled Slopes

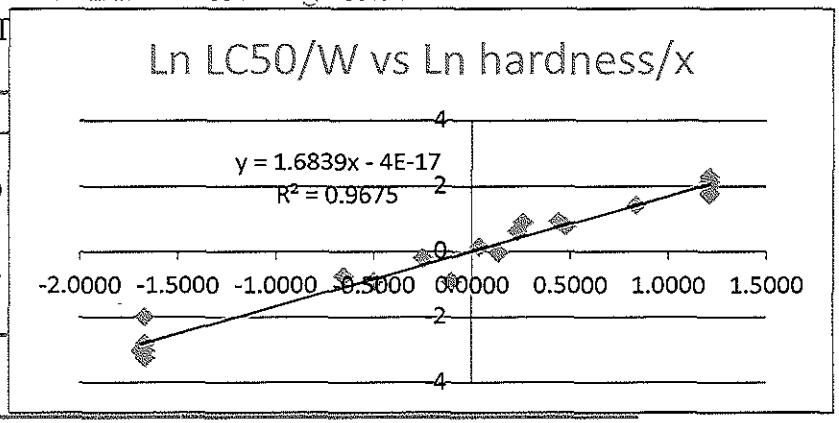
Pooled Slopes

	Hardness	**ln Hardness**	x	hardness/x	ln hardness/x	LC50	**ln LC50**	W	LC50/W	**ln LC50/W**
D. magna	220	**5.3936275**	192.4794	1.1429795	0.1336	2,410	**7.787382**	2530.2277	0.9524835	**-0.0486825**
D. magna	220	**5.3936275**	192.4794	1.1429795	0.1336	2,450	**7.8038433**	2530.2277	0.9682923	**-0.0322213**
D. magna	100	**4.6051702**	192.4794	0.5195361	-0.6548	1190	**7.0817086**	2530.2277	0.4703134	**-0.754356**
D. magna	150	**5.0106353**	192.4794	0.7793042	-0.2491	2090	**7.6449193**	2530.2277	0.8260126	**-0.1911452**
D. magna	200	**5.2983174**	192.4794	1.0390723	0.0383	2910	**7.9759084**	2530.2277	1.1500941	**0.1398438**
D. magna	250	**5.5214609**	192.4794	1.2988403	0.2615	6220	**8.7355252**	2530.2277	2.4582768	**0.8994606**
D. magna	300	**5.7037825**	192.4794	1.5586084	0.4438	6320	**8.7514745**	2530.2277	2.4977989	**0.9154099**
D. magna	173	**5.1532916**	192.4794	0.8987975	-0.1067	1000	**6.9077553**	2530.2277	0.3952213	**-0.9283093**
L. reticulatus	400	**5.9914645**	118.75121	3.3683869	1.2144	20,000	**9.9034876**	3306.7594	6.0482174	**1.7997636**
L. reticulatus	275	**5.6167711**	118.75121	2.315766	0.8397	13,700	**9.5251511**	3306.7594	4.1430289	**1.4214271**
L. reticulatus	192	**5.2574954**	118.75121	1.6168257	0.4805	7,100	**8.8678501**	3306.7594	2.1471172	**0.7641261**
L. reticulatus	150	**5.0106353**	118.75121	1.2631451	0.2336	6,100	**8.7160441**	3306.7594	1.8447063	**0.6123201**
L. reticulatus	72	**4.2766661**	118.75121	0.6063096	-0.5004	1,330	**7.1929342**	3306.7594	0.4022065	**-0.9107897**
L. reticulatus	22	**3.0910425**	118.75121	0.1852613	-1.6860	160	**5.0751738**	3306.7594	0.0483857	**-3.0285502**
L. reticulatus	400	**5.9914645**	118.75121	3.3683869	1.2144	32,000	**10.373491**	3306.7594	9.6771478	**2.2697672**
L. reticulatus	400	**5.9914645**	118.75121	3.3683869	1.2144	28,000	**10.23996**	3306.7594	8.4675043	**2.1362358**
L. reticulatus	400	**5.9914645**	118.75121	3.3683869	1.2144	32,000	**10.373491**	3306.7594	9.6771478	**2.2697672**
L. reticulatus	400	**5.9914645**	118.75121	3.3683869	1.2144	24,000	**10.085809**	3306.7594	7.2578609	**1.9820851**
L. reticulatus	400	**5.9914645**	118.75121	3.3683869	1.2144	19,000	**9.8521943**	3306.7594	5.7458065	**1.7484703**
L. reticulatus	22.5	**3.1135153**	118.75121	0.1894718	-1.6635	450	**6.1092476**	3306.7594	0.1360849	**-1.9944764**
L. reticulatus	22.5	**3.1135153**	118.75121	0.1894718	-1.6635	130	**4.8675345**	3306.7594	0.0393134	**-3.2361895**
L. reticulatus	22.5	**3.1135153**	118.75121	0.1894718	-1.6635	200	**5.2983174**	3306.7594	0.0604822	**-2.8054066**
L. reticulatus	22.5	**3.1135153**	118.75121	0.1894718	-1.6635	160	**5.0751738**	3306.7594	0.0483857	**-3.0285502**

Rule 57 ALV Worksheet, Beryllium, 2014, Pooled Slopes

Normalized Ln LC50/W vs Ln Hardness/x Regression

SUMMARY OUTPUT



Regression Statistics	
Multiple R	0.98361
R Square	0.967489
Adjusted R	0.965941
Standard Er	0.335493
Observation	23

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	70.34002	70.34002	624.9377	4.15439E-17
Residual	21	2.36366	0.112555		
Total	22	72.70368			

	Coefficients	*tandard Err*	*t Stat*	*P-value*	*Lower 95%*	*Jpper 95%*	*ower 95.0%*	*Jpper 95.0%*
Intercept	-4.5E-17	0.069955	-6.4E-16	1	-0.145479456	0.14548	-0.14548	0.145479
X Variable	1.683905	0.06736	24.99875	4.15E-17	1.543823541	1.82399	1.543824	1.823987