CHEMICAL UPDATE WORKSHEET

Chemical Name:	**Arsenic, Inorganic**
CAS #:	**7440-38-2**
Revised By:	RRD Toxicology Unit
Revision Date:	November 17, 2015

(A) Chemical-Physical Properties

	Part 201 Value	Updated Value	Reference Source	Comments
Molecular Weight (g/mol)	74.922	77.95	EPI	EXP
Physical State at ambient temp	Inorganic	Inorganic	MDEQ	
Melting Point (˚C)	---	NA	NA	
Boiling Point (˚C)	---	NA	NA	
Solubility (ug/L)	NA	NA	NA	NA
Vapor Pressure (mmHg at 25˚C)	NA	NR	NA	NA
HLC (atm-m^3/mol at 25˚C)	NR	NR	NA	NA
Log Kow (log P; octanol-water)	NR	NR	NA	NA
Koc (organic carbon; L/Kg)	NR	NR	NA	NA
Ionizing Koc (L/kg)		NR	NA	NA
Diffusivity in Air (Di; cm^2/s)	NR	NR	NA	NA
Diffusivity in Water (Dw; cm^2/s)	NR	NR	NA	NA
Soil Water Partition Coefficient	29	2.9E+01	SSG	EST

	Part 201 Value	Updated Value	Reference Source	Comments
(Kd; inorganics)				
Flash Point (˚C)	NA	NA	NA	NA
Lower Explosivity Level (LEL; unit less)	NA	0.051	PC	EXP
Critical Temperature (K)		NR	NA	NA
Enthalpy of Vaporization (cal/mol)		NA	NA	NA
Density (g/mL, g/cm^3)		NR	NA	NA
EMSOFT Flux Residential 2 m (mg/day/cm^2)	NA	NR	EMSOFT	NA
EMSOFT Flux Residential 5 m (mg/day/cm^2)	NA	NR	EMSOFT	NA
EMSOFT Flux Nonresidential 2 m (mg/day/cm^2)	NA	NR	EMSOFT	NA
EMSOFT Flux Nonresidential 5 m (mg/day/cm^2)	NA	NR	EMSOFT	NA

(B) Toxicity Values/Benchmarks

	Part 201 Value	Updated Value	Source*/Reference /Date	Comments/Notes /Issues
Reference Dose (RfD) (mg/kg/day)	2.7E-4	3.0E-4	ATSDR, 2007	
RfD details	Human chronic oral exposure (Tseng, 1977; Tseng et al., 1968). See IRIS printout for adjustments to NOAEL (0.0008 mg/kg/day); UF =3; Critical effect = hyperpigmentation, keratosis & possible vascular problems.	**Tier 2 Source:** **ATSDR:** **Basis:** ATSDR is more recent than the IRIS evaluation. **ATSDR** chronic oral MRL = 0.0003 (3.0E-4) mg/kg-day **Critical Studies:** 1) Tseng, WP, Chu HM, How SW, et al. 1968. Prevalence of skin cancer in an endemic area of chronic arsenicism in Taiwan. J Natl Cancer Inst 40:453-463. 2) Tseng, WP. 1977. Effects and dose-response relationships of cancer and Blackfoot disease with arsenic. Environ Health Perspect 19:109-119. **Methods:** Tseng et al. (1968) and Tseng (1977) investigated the incidence of Blackfoot disease and dermal lesions (hyperkeratosis and hyperpigmentation) in a large number of poor farmers (both male and female) exposed to high levels of arsenic in well water in Taiwan. A control group consisting of 17,000 people was identified. Incidence data were provided based on stratification of the exposed population into low (<300 µg/L), medium (300–600 µg/L), or high (>600 µg/L) exposure levels. Doses were calculated from group mean arsenic concentrations in well water, assuming the intake parameters described by Abernathy et al. (1989). **Critical effect:** dermal lesions **End point or Point of Departure (POD):** NOAEL = 0.0008 mg/kg-day **Uncertainty Factors:** UF = 3 for intraspecies variability **Source and date:** ATSDR, 8/2007. From 12/2014 MRL list. **Tier 1 and 2 Sources**: **IRIS:** Per IRIS (2/01/1993), RfD = 3.0E-4 mg/kg-day **Critical Studies**: Tseng, 1977; Tseng et al., 1968 Tseng, W.P. 1977. Effects and dose-response relationships of skin cancer and blackfoot disease with arsenic. Environ. Health Perspect. 19: 109-119.		Complete

	Part 201 Value	Updated Value	Source*/Reference /Date	Comments/Notes /Issues
		Tseng, W.P., H.M. Chu, S.W. How, J.M. Fong, C.S. Lin and S. Yeh. 1968. Prevalence of skin cancer in an endemic area of chronic arsenicism in Taiwan. J. Natl. Cancer Inst. 40: 453-463. **Methods**: chronic human oral exposure studies **Critical effect**: Hyperpigmentation, keratosis & possible vascular complications **End point or Point of Departure (POD):** NOAEL = 8.0E-4 mg/kg/day (converted from 9.0E-3 mg/L **Uncertainty Factors**: UF = 3; The UF of 3 is to account for both the lack of data to preclude reproductive toxicity as a critical effect and to account for some uncertainty in whether the NOAEL of the critical study accounts for all sensitive individuals). **Source and date:** IRIS, Last revision date - 2/01/1993. EPA is currently developing an updated RfD (Toxicological Review External Draft – 2/19/2010) **PPRTV:** No PPRTV record available at this time. **MRL:** Per ATSDR (8/2007), an intermediate oral MRL is available: An MRL of 0.1 mg MMA/kg/day has been derived for intermediate-duration (15–364 days) oral exposure to monomethylarsonic acid (MMA) **Critical Studies**: 1) Arnold LL, Eldan M, van Gemert M, et al. 2003. Chronic studies evaluating the carcinogenicity of monomethylarsonic acid (MMA) in rats and mice. Toxicology 190:197-219. 2) Crown S, Nyska A, Waner T. 1990. Methanearsonic acid: Combined chronic feeding and oncogenicity study in the rat. Conducted by Life Science Research Israel Ltd., Ness Ziona Israel. Submitted to EPA Office of Pesticide Programs (MRID 41669001) **Methods**: Fischer 344 rats (60/sex/group) were exposed to 0, 50, 400, or 1,300 ppm MMA in the diet for 104 weeks. Using the average doses for weeks 1–50 reported in an unpublished version of this study (Crown et al. 1990), doses of 0, 3.5, 30.2, and 106.9 mg MMA/kg/day and 0, 4.2, 35.9, and 123.3 mg MMA/kg/day were calculated for males and females, respectively		

	Part 201 Value	Updated Value	Source*/Reference /Date	Comments/Notes /Issues
		Critical effect: diarrhea in female rats **End point or Point of Departure (POD):** $BMDL_{10}$ = 12.38 mg MMA/kg-day **Uncertainty Factors**: UF = 100 (10 each for intraspecies variability and interspecies extrapolation) **Tier 3 Source:** **MDEQ:** Per DEQ-CCD, RRD adopts IRIS RfD using 2 significant figures. See Part 201 Value RfD details.		
Oral Cancer Slope Factor (CSF) (mg/kg-day)$^{-1}$)	1.5E+0	1.5E+0	IRIS, 1998	
CSF details	EPA has conducted a reassessment of the data presented in Tseng et al, 1968 and Tseng, 1977. A unit risk of 5E-5 ug/L-1 was developed based upon an increased incidence of skin cancer associated with high levels of arsenic in drinking water. Rates of internal cancers (liver, lung, bladder, and kidney) were also increased in exposed	**Tier 1 Source:** **IRIS:** **Basis:** IRIS is a Tier 1 source and the only available value. **IRIS** CSF = 1.5E+0 (mg/kg-day)$^{-1}$). Note: The IRIS final Draft Toxicological Review of Inorganic Arsenic (Cancer) dated 2/19/2010 presents a revised oral cancer slope factor value of 25.7 (mg/kg/day)-1. This value is not used because IRIS indicates "Preliminary Assessment Materials" were released on 04/2015 indicating that the 2010 Tox Review is being updated. Until EPA is further along in the update process, the 1998 IRIS CSF is being used. **Critical Studies**: Tseng, 1977; Tseng et al., 1968 **Methods**: epidemiology studies of arsenic exposure in the Taiwanese population 1) *Dose response data*: *Tumor Type* - skin cancer (and internal cancers (liver, lung, bladder, and kidney); *Test Species* - humans; *Route* - drinking water 2) *Extrapolation method*: Time- and dose-related formulation of the multistage model (U.S. EPA, 1988) **Carcinogen Weight-of-Evidence (WOE) Class**: A; human carcinogen **IRIS WOE Basis**: Increased lung cancer mortality was observed in multiple human populations exposed primarily through inhalation. Also, increased mortality from multiple internal organ cancers (liver, kidney, lung, and bladder) and an increased incidence of skin cancer were observed in populations consuming drinking water high in inorganic arsenic. **Source and date:** IRIS, Last revision date - 4/10/1998**.**		Complete

	Part 201 Value	Updated Value	Source*/Reference /Date	Comments/Notes /Issues
	populations. The oral slope factor was developed based on drinking water intake rates of 3.5 L/day for males and 2.0 L/day for females. (U.S. EPA, 1994) CCD/RRD date: 11/15/1990	**Note:** The final Draft Toxicological Review of Inorganic Arsenic (Cancer) (2/19/2010) (http://cfpub.epa.gov/ncea/iris_drafts/recordisplay.cfm?deid=219111) contains a **revised oral cancer slope factor value of 25.7 (mg/kg/day)-1. In keeping with EPA policy, the combined oral CSF for women (25.7 per mg/kg-day) is appropriate for use in establishing health criteria, since, based on the available data, women appear to be the more sensitive group.** **Tier 2 Sources**: **PPRTV:** No PPRTV record available at this time **MRL:** NA; MRLs are for non-cancer effects only. **Tier 3 Source:** **MDEQ:** Per DEQ-CCD (6/1/1990), RRD adopted the 1998 IRIS value. See Part 201 Value RfD details.		
Reference Concentration (RfC) or Initial Threshold Screening Level (ITSL) (µg/m³)	--	NA	MDEQ, 2015	
RfC/ITSL details	NA	**Tier 1 and 2 Sources**: **IRIS:** Per IRIS (4/10/1998), no value at this time. **PPRTV:** No PPRTV record available at this time. **MRL:** Per ATSDR List (12/2014), no chronic inhalation MRL at this time. **Tier 3 Source:** **MDEQ:** Per DEQ-CCD, no value at this time.		Complete
Inhalation Unit Risk Factor (IURF) ((µg/m³)$^{-1}$)	4.3E-3	4.3E-3	IRIS, 1998	
IURF details	Potency from EPA IRIS geometric	**Tier 1 Source:** **IRIS:**		Complete

	Part 201 Value	Updated Value	Source*/Reference /Date	Comments/Notes /Issues
	mean of Brown and Chu 1983, Lee-Feldstein 1983, Higgins 1982, Higgins et al 1982, Welch et al 1982, and Enterline and Marsh 1982.	**Basis:** IRIS is a Tier 1 source and the only available value. **IRIS** IURF = 4.3E-3 $(\mu g/m^3)^{-1}$. **Critical Studies**: Brown and Chu 1983, Lee-Feldstein 1983, Higgins 1982, Higgins et al 1982, Welch et al 1982, and Enterline and Marsh 1982 **Methods**: 3) *Dose response data*: *Tumor Type* - lung cancer; *Test Species* – human male; *Route* - inhalation, occupational exposure 4) *Extrapolation method*: absolute-risk linear model **Carcinogen Weight-of-Evidence (WOE) Class**: A; human carcinogen **IRIS WOE Basis**: An increased lung cancer mortality was observed in multiple human populations exposed primarily through inhalation **Source and Date**: IRIS, Last revision date – 4/10/1998. EPA Toxicological Review External Draft (2/19/2010) is being updated based on the release of Preliminary Assessment Materials on 4/2014. The IURF will be updated when the EPA Tox Review is finalized. **Tier 2 Sources:** **PPRTV:** No PPRTV record available at this time **MRL:** NA; MRLs are for non-cancer effects only. **Tier 3 Source:** **MDEQ:** Per DEQ-CCD, AQD adopted IRIS value on 1/13/1988.		
Mutagenic Mode of Action (MMOA)? (Y/N)	--	NO	USEPA, 2015	
MMOA Details	--	NA Not listed as a carcinogen with mutagenic MOA in the USEPA OSWER List.		
Developmental or Reproductive Effector? (Y/N)	No	No, the RfD is not based on a reproductive-developmental effect.	MDEQ, 2015	
Developmental or Reproductive Toxicity Details	NA	NA		

	Part 201 Value	Updated Value	Source*/Reference /Date	Comments/Notes /Issues
State Drinking Water Standard (SDWS) (ug/L)	10	10	SDWA, 1976	
SDWS details	MI Safe Drinking Water Act (SDWA) 1976 PA 399	MI Safe Drinking Water Act (SDWA) 1976 PA 399		
Secondary Maximum Contaminant Level (SMCL) (ug/L)	--	NO	SDWA, 1976 and USEPA SMCL List	
SMCL details	NA	MI Safe Drinking Water Act (SDWA) 1976 PA 399 and USEPA SMCL List, 2015		
Is there an aesthetic value for drinking water? (Y/N)	NO	Not evaluated.	NA	
Aesthetic value (ug/L)	--	NA	NA	
Aesthetic Value details		NA		
Phytotoxicity Value? (Y/N)	NO	Not evaluated.	NA	
Phytotoxicity details	NA	NA	NA	
Others	--	--		

(C) Chemical-specific Absorption Factors

	Part 201 Value	Update	Source/Reference/ Dates	Comments/Notes /Issues
Gastrointestinal absorption efficiency value (ABSgi)	---	1.0	MDEQ, 2015/USEPA RAGS-E, 2004	
ABSgi details		MDEQ, 2015/USEPA RAGS-E, 2004		
Skin absorption efficiency value (AEd)	---	0.03	MDEQ, 2015	
AEd details				
Ingestion Absorption Efficiency (AEi)		0.5	MDEQ, 2015	
AEi Details				
Relative Source Contribution for Water (RSC_W)		0.2	MDEQ, 2015	
Relative Source Contribution for Soil (RSC_S)		1.0	MDEQ, 2015	
Relative Source Contribution for Air (RSC_A)		1.0	MDEQ, 2015	
Others				

(D) Rule 57 Water Quality Values and GSI Criteria

Current GSI value (µg/L)	10
Updated GSI value (µg/L)	10
Rule 57 Drinking Water Value (µg/L)	10

	Rule 57 Value (µg/L)	Verification Date
Human Non-cancer Values- Drinking water source (HNV-drink)	10	9/2010
Human Non-Cancer Values- Non-drinking water sources (HNV-Non-drink)	280	9/2010
Wildlife Value (WV)	NA	NA
Human Cancer Values for Drinking Water Source (HCV-drink)	10	9/2010
Human Cancer values for non-drinking water source (HCV-Non-drink)	10	9/2010
Final Chronic Value (FCV)	150	7/1997
Aquatic maximum value (AMV)	340	7/1997
Final Acute Value (FAV)	680	7/1997

Sources:

1. MDEQ Surface Water Assessment Section Rule 57 website
2. MDEQ Rule 57 table

(E) Target Detection Limits (TDL)

	Value	Source
Target Detection Limit – Soil (μg/kg)	2,000	MDEQ, 2015
Target Detection Limit – Water (μg/L)	5	MDEQ, 2015
Target Detection Limit – Air (ppbv)	NA	MDEQ, 2015
Target Detection Limit – Soil Gas (ppbv)	NA	MDEQ, 2015

CHEMICAL UPDATE WORKSHEET ABBREVIATIONS:

CAS # - Chemical Abstract Service Number.

Section (A) Chemical-Physical Properties

Reference Source(s):

CRC	Chemical Rubber Company Handbook of Chemistry and Physics, 95th edition, 2014-2015
EMSOFT	USEPA Exposure Model for Soil-Organic Fate and Transport (EMSOFT) (EPA, 2002)
EPA2001	USEPA (2001) Fact Sheet, Correcting the Henry's Law Constant for Soil Temperature. Office of Solid Waste and Emergency Response, Washington, D.C.
EPA4	USEPA (2004) User's Guide for Evaluating Subsurface Vapor Intrusion into Buildings. February 22, 2004.
EPI	USEPA's Estimation Programs Interface SUITE 4.1, Copyright 2000-2012
HSDB	Hazardous Substances Data Bank
MDEQ	Michigan Department of Environmental Quality
NPG	National Institute for Occupational Safety and Health Pocket Guide to Chemical Hazards
PC	National Center for Biotechnology Information's PubChem database
PP	Syracuse Research Corporation's PhysProp database
SCDM	USEPA's Superfund Chemical Data Matrix
SSG	USEPA's Soil Screening Guidance: Technical Background Document, Second Edition, 1996
USEPA/EPA	United States environmental protection agency's Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment). July, 2004.
W9	USEPA's User Guide for Water9 Software, Version 2.0.0, 2001

Basis/Comments:

EST	estimated
EXP	experimental
EXT	extrapolated
NA	not available or not applicable
NR	not relevant

Section (B) Toxicity Values/Benchmarks

Sources/References:

ATSDR	Agency for Toxic Substances and Disease Registry
CALEPA	California Environmental Protection Agency
CAL DTSC	California Department of Toxic Substances Control
CAL OEHHA	CAEPA Office of Environmental Health Hazard Assessment
CCD	MDEQ Chemical Criteria Database
ECHA	European Chemicals Agency (REACH)
OECD HPV	Organization for Economic Cooperation and Development HPV Database
HEAST	USEPA's Health Effects Assessment Summary Tables
IRIS	USEPA's Integrated Risk Information System
MADEP	Massachusetts Department of Environmental Protection
MDEQ/DEQ	Michigan Department of Environmental Quality
DEQ-CCD/AQD	MDEQ Air Quality Division
DEQ-CCD/RRD	MDEQ Remediation and Redevelopment Division
DEQ-CCD/WRD	MDEQ Water Resources Division
MNDOH	Minnesota Department of Health

NJDEP	New Jersey Department of Environmental Protection
NYDEC	New York State Department of Environmental Conservation
OPP/OPPT	USEPA's Office of Pesticide Programs
PPRTV	USEPA's Provisional Peer Reviewed Toxicity Values
RIVM	The Netherlands National Institute of Public Health and the Environment
TCEQ	Texas Commission on Environmental Quality
USEPA	United States Environmental Protection Agency
USEPA OSWER	USEPA Office of Solid Waste and Emergency Response
USEPA MCL	USEPA Maximum Contaminant Level
WHO	World Health Organization
WHO IPCS	International Programme on Chemical Safety (IPCS/INCHEM)
WHO IARC	International Agency for Research on Cancers
NA	Not Available.
NR	Not Relevant.

Toxicity terms:

BMC	Benchmark concentration
BMCL	Lower bound confidence limit on the BMC
BMD	benchmark dose
BMDL	Lower bound confidence limit on the BMD
CSF	Cancer slope Factor
CNS	Central nervous system
IURF or IUR	Inhalation unit risk factor
LOAEL	Lowest observed adverse effect level
LOEL	Lowest observed effect level
MRL	Minimal risk level (ATSDR)
NOAEL	No observed adverse effect level
NOEL	No observed effect level
RfC	Reference concentration
RfD	Reference dose
p-RfD	Provisional RfD
aRfD	Acute RfD
UF	Uncertainty factor
WOE	Weight of evidence

Section (C) Chemical-specific Absorption Factors

MDEQ	Michigan Department of Environmental Quality
USEPA RAGS-E	United States Environmental Protection Agency's Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment). July, 2004.

Section (D) Rule 57 Water Quality Values and GSI Criteria

GSI	Groundwater-surface water interface
NA	A value is not available or not applicable.
ID	Insufficient data to derive value
NLS	No literature search has been conducted