



## CHEMICAL UPDATE WORKSHEET

<b>Chemical Name:</b>	<b>Manganese</b>
<b>CAS #:</b>	<b>7439-96-5</b>
<b>Revised By:</b>	RRD Toxicology Unit
<b>Revision Date:</b>	December 4, 2015

### (A) Chemical-Physical Properties

	Part 201 Value	Updated Value	Reference Source	Comments
<b>Molecular Weight (g/mol)</b>	54.938	54.94	EPI	EXP
<b>Physical State at ambient temp</b>	Inorganic	Inorganic	MDEQ	
<b>Melting Point (°C)</b>	---	1246.00	CRC	EXP
<b>Boiling Point (°C)</b>	1962	2061.00	CRC	EXP
<b>Solubility (ug/L)</b>	NA	NA	NA	NA
<b>Vapor Pressure (mmHg at 25°C)</b>	NA	NR	NA	NA
<b>HLC (atm-m<sup>3</sup>/mol at 25°C)</b>	NR	NR	NA	NA
<b>Log Kow (log P; octanol-water)</b>	NR	NR	NA	NA
<b>Koc (organic carbon; L/Kg)</b>	NR	NR	NA	NA
<b>Ionizing Koc (L/kg)</b>		NR	NA	NA
<b>Diffusivity in Air (Di; cm<sup>2</sup>/s)</b>	NR	NR	NA	NA
<b>Diffusivity in Water (Dw; cm<sup>2</sup>/s)</b>	NR	NR	NA	NA
<b>Soil Water Partition Coefficient (Kd; inorganics)</b>	NA	NA	NA	NA

	Part 201 Value	Updated Value	Reference Source	Comments
Flash Point (°C)	NA	NA	NA	NA
Lower Explosivity Level (LEL; unitless)	NA	NA	NA	NA
Critical Temperature (K)		NR	NA	NA
Enthalpy of Vaporization (cal/mol)		NR	NA	NA
Density (g/mL, g/cm <sup>3</sup> )		NR	NA	NA
EMSOFT Flux Residential 2 m (mg/day/cm <sup>2</sup> )	NA	NR	EMSOFT	NA
EMSOFT Flux Residential 5 m (mg/day/cm <sup>2</sup> )	NA	NR	EMSOFT	NA
EMSOFT Flux Nonresidential 2 m (mg/day/cm <sup>2</sup> )	NA	NR	EMSOFT	NA
EMSOFT Flux Nonresidential 5 m (mg/day/cm <sup>2</sup> )	NA	NR	EMSOFT	NA

**(B) Toxicity Values/Benchmarks**

	Part 201 Value	Updated Value	Source/Reference/Date	Comments/Notes/Issues
<b>Reference Dose (RfD) (mg/kg/day)</b>	4.7E-2	4.7E-2	IRIS, 1996/MDEQ 2015	
<b>RfD details</b>	<p>The RfD in IRIS is based on a NOAEL of 10 mg/d for adult humans based on studies by NRC (1989), Freeland-Graves et al. (1987) and WHO (1973). EPA recommends applying a modifying factor of 3 when assessing the risk from drinking water exposure. Thus, two RfDs were calculated, with and without the MF. The unmodified RfD is 0.1429 mg/kg/d and the use of the MF changes the RfD to 0.0476 mg/kg/d. To derive the HNVs, the average consumption of manganese by adult males and females (2.439 mg/d) was subtracted from the NOAEL of 10 mg/d. See risk file for details. RRD calculation date: 11/1/95.</p>	<p><b>Tier 1 Source:</b>  <b>IRIS:</b>  <b>Basis:</b> The IRIS value is selected because it is the only RfD value identified. IRIS is a Tier 1 source. MDEQ applied the IRIS recommended MF = 3 to the IRIS RfD to derive the RfD = 4.7E-2 mg/kg-day.  <b>IRIS</b> RfD = 1.4E-1 mg/kg-day should be divided by a modifying factor of 3 as recommended in IRIS for nondietary exposures.  <b>Note:</b>  <b>Critical Studies:</b>                      1) Freeland-Graves, J.H., C.W. Bales and F. Behmardi. 1987. Manganese requirements of humans. In: Nutritional Bioavailability of Manganese, C. Kies, ed. American Chemical Society, Washington, DC. p. 90-104.                      2) NRC (National Research Council). 1989. Recommended Dietary Allowances, 10th ed. Food and Nutrition Board, National Research Council, National Academy Press, Washington, DC. p. 230-235.                      3) WHO (World Health Organization). 1973. Trace Elements in Human Nutrition: Manganese. Report of a WHO Expert Committee. Technical Report Service, 532, WHO, Geneva, Switzerland. p. 34-36.  <b>Methods:</b> Human Chronic Ingestion Data                      The Food and Nutrition Board of the National Research Council (NRC, 1989) determined an "estimated safe and adequate daily dietary intake" (ESADDI) of manganese to be 2-5 mg/day for adults. The lower end of this range was based on a study by McLeod and Robinson (1972), who reported equilibrium or positive balances at intakes of 2.5 mg Mn/day or higher. The range of the ESADDI also includes an "extra margin of safety" from the level of 10 mg/day, which the NRC considered to be safe for an occasional intake.                      While the NRC determined an ESADDI for manganese of 2-5 mg/day, some</p>		Complete



	Part 201 Value	Updated Value	Source/Reference/ Date	Comments/Notes /Issues
		<p>nutritionists feel that this level may be too low. Freeland-Graves et al. (1987) have suggested a range of 3.5-7 mg/day for adults based on a review of human studies. It is noted that dietary habits have evolved in recent years to include a larger proportion of meats and refined foods in conjunction with a lower intake of whole grains. The net result of such dietary changes includes a lower intake of manganese such that many individuals may have suboptimal manganese status. This is discussed in more detail in the Additional Studies / Comments Section.</p> <p>The World Health Organization (WHO, 1973) reviewed several investigations of adult diets and reported the average daily consumption of manganese to range from 2.0-8.8 mg Mn/day. Higher manganese intakes are associated with diets high in whole-grain cereals, nuts, green leafy vegetables, and tea. From manganese balance studies, the WHO concluded that 2-3 mg/day is adequate for adults and 8-9 mg/day is "perfectly safe."</p> <p>Evaluations of standard diets from the United States, England, and Holland reveal average daily intakes of 2.3-8.8 mg Mn/day. Depending on individual diets, however, a normal intake may be well over 10 mg Mn/day, especially from a vegetarian diet. While the actual intake is higher, the bioavailability of manganese from a vegetarian diet is lower, thereby decreasing the actual absorbed dose. This is discussed in more detail in the Additional Studies / Comments Section.</p> <p>From this information taken together, EPA concludes that an appropriate reference dose for manganese is 10 mg/day (0.14 mg/kg-day). In applying the reference dose for manganese to a risk assessment, it is important that the assessor consider the ubiquitous nature of manganese, specifically that most individuals will be consuming about 2-5 mg Mn/day in their diet. This is particularly important when one is using the reference dose to determine acceptable concentrations of manganese in water and soils.</p>		



	Part 201 Value	Updated Value	Source/Reference/Date	Comments/Notes/Issues
		<p><b>Critical effect:</b> CNS effects. See above for details.  <b>End point or Point of Departure (POD):</b> NOAEL (food) = 0.14 mg/kg/day  <b>Uncertainty Factors:</b> UF = 1; MF = 1 or 3: When assessing exposure to manganese from food, the modifying factor is 1; however, when assessing exposure to manganese from drinking water or soil, a modifying factor of 3 is recommended. (See IRIS for details)  <b>Source:</b> IRIS, 12/1/1996</p> <p><b>Tier 2 Sources:</b>  <b>PPRTV:</b> No PPRTV record available at this time.  <b>MRL:</b> Per ATSDR (9/2012), no oral MRL is available at this time.</p> <p><b>Tier 3 Source:</b>  <b>MDEQ:</b> Per DEQ-CCD-RRD, RfD = 0.047 mg/kg/day (11/01/1995). See Part 201 value for details.</p>		
Oral Cancer Slope Factor (CSF) (mg/kg-day) <sup>-1</sup>	--	NA	MDEQ, 2015	
CSF details		<p><b>Carcinogen Weight-of-Evidence (WOE) Class:</b> Classification – D; not classifiable as to human carcinogenicity.  <b>IRIS WOE Basis:</b> Existing studies are inadequate to assess the carcinogenicity of Mn.</p> <p><b>Tier 1 and 2 Sources:</b>  <b>IRIS (12/01/1996):</b> No value available.  <b>PPRTV:</b> No PPRTV record available at this time.  <b>MRL:</b> NA; MRLs are for non-cancer effects only</p> <p><b>Tier 3 Source:</b>  <b>MDEQ:</b> Per DEQ-CCD-RRD (3/1/1994) no value available.</p>		Complete
Reference Concentration (RfC) or Initial	5.0E-2	3.0E-1	ATSDR, 2012	



	Part 201 Value	Updated Value	Source/Reference/ Date	Comments/Notes /Issues
<b>Threshold Screening Level (ITSL) (<math>\mu\text{g}/\text{m}^3</math>)</b>				
<b>RfC/ITSL details</b>	<p>Per AQD: ITSL is based on EPA's 1993 RfC, from Roels et al 1992, neurobehavioral impairment with occupational exposure to manganese dioxide. 2008 review, AQD decided to maintain the RfC with annual averaging instead of 24-hour. Other agencies have newer and similar values to the RfC, no clear reason to change to another value. FINAL. AQD calculation date: 3/2/09; CAS date is 7/1/2008.</p>	<p><b>Tier 2 Source:</b>  <b>ATSDR:</b>  <b>Basis:</b> The ATSDR MRL accounts for the more recent toxicity data and BMD modeling and is protective of sensitive populations.  <b>MRL:</b> Chronic inhalation MRL = 0.0003 mg respirable manganese/<math>\text{m}^3</math> (0.3 <math>\mu\text{g}/\text{m}^3</math>).  <b>Critical Study:</b> Roels HA, Ghyselen P, Buchet JP, et al. 1992. Assessment of the permissible exposure level to manganese in workers exposed to manganese dioxide dust. Br J Ind Med 49:25-34.  <b>Methods:</b> Neurological effects of manganese exposure were evaluated in 92 male workers in a dry alkaline battery factory. The control group was 101 age- and area-matched workers not occupationally exposed to manganese but with similar work schedules and workloads. Each worker's personal exposure was determined by the measured concentration characteristic for their particular job and the number of years employed. Workers were exposed for an average duration of 5.3 years (range 0.2–17.7 years) to average (geometric mean) concentrations of 0.215 and 0.948 mg manganese/<math>\text{m}^3</math> in respirable and total dust, respectively.  <b>Critical effect:</b> incidence of workers with abnormal scores on an eye-hand coordination test  <b>Source:</b> ATSDR, 9/2012</p> <p><b>Tier 1 Source:</b>  <b>IRIS:</b> RfC = 5E-5 mg/<math>\text{m}^3</math>  <b>Critical Studies:</b>                      1) Roels, H., R. Lauwerys, J.-P. Buchet et al. 1987. Epidemiological survey among workers exposed to manganese: Effects on lung, central nervous system, and some biological indices. Am. J. Ind. Med. 11: 307-327.                      2) Roels H.A., P. Ghyselen, J.P. Buchet, E. Ceulemans, and R.R. Lauwerys. 1992. Assessment of the permissible exposure level to manganese in</p>		Complete



	Part 201 Value	Updated Value	Source/Reference/ Date	Comments/Notes /Issues
		<p>workers exposed to manganese dioxide dust. Br. J. Ind. Med. 49: 25-34.</p> <p><b>Methods:</b> Occupational exposure to manganese oxides and salts Roels et al. (1992) conducted a cross-sectional study of 92 male workers exposed to manganese dioxide (MnO<sub>2</sub>) dust in a Belgian alkaline battery plant. The manganese (Mn)-exposed group had been exposed to MnO<sub>2</sub> for an average of 5.3 years (range: 0.2-17.7 years). Roels et al. (1992) performed an exposure-response analysis by classifying IRD values into three groups (&lt;0.6, 0.6-1.2, and &gt;1.2 mg Mn/cu.m x years) and comparing the prevalence of abnormal scores for visual reaction time, hand steadiness, and eye-hand coordination with controls. See IRIS for further detail.</p> <p><b>Critical effects:</b> Impairment of neurobehavioral function; occupational exposure to manganese dioxide.</p> <p><b>Point of Departure:</b> NOAEL: none; LOAEL: 0.15 mg/cu.m. LOAEL (ADJ): 0.05 mg/cu.m; LOAEL (HEC): 0.05 mg/cu.m.</p> <p><b>Uncertainty Factor:</b> UF = 1000 (An uncertainty factor of 1000 reflects 10 to protect sensitive individuals, 10 for use of a LOAEL, and 10 for database limitations reflecting both the less-than-chronic periods of exposure and the lack of developmental data, as well as potential but unquantified differences in the toxicity of different forms of Mn.)</p> <p><b>Source and date:</b> IRIS 12/1/1993</p> <p><b>Tier 2 Sources:</b>  <b>PPRTV:</b> No PPRTV record available at this time.  <b>MRL:</b> See ATSDR above.</p> <p><b>Tier 3 Source:</b>  <b>MDEQ, 5/12/2014:</b>  <b>Critical Study:</b> Roels et al. 1992. Assessment of the permissible exposure level to manganese in workers exposed to manganese dioxide dust. Br. J. Ind. Med. 49:25-34.  <b>Methods:</b> Manganese workers were exposed for an average (geometric mean) of 5.3 years (range: 0.2-17.7 years) to a respirable dust concentration</p>		

	Part 201 Value	Updated Value	Source/Reference/Date	Comments/Notes/Issues
		<p>of 215 <math>\mu\text{g Mn/m}^3</math> and a total dust concentration of 948 <math>\mu\text{g Mn/m}^3</math>.</p> <p><b>Critical effect:</b> Neurobehavioral effects i.e., simple reaction time, eye-hand coordination, and head steadiness.</p> <p><b>Point of Departure:</b> <math>\text{BMCL}_{10} = 142 \mu\text{g/m}^3</math> (from logistic model) <b>Uncertainty Factors:</b> <math>\text{UF} = 100</math>. A UF of 10 was used by ATSDR for uncertainty about human variability including possibly enhanced susceptibility of the elderly, infants, and children, individuals with chronic liver disease or diminished hepatobiliary function; and females and individuals with iron deficiency. A UF of 10 was applied by ATSDR for limitations and uncertainties in the database including the lack of epidemiological data for humans chronically exposed to soluble forms of Mn and the concern that the general population may be exposed to more soluble forms of Mn than most of the Mn-exposed workers in the principal and supporting studies. In addition, ATSDR stated that data on developmental toxicity for this route and duration of exposure are lacking. ATSDR (2012) noted that BMD analyses from other studies and analyses, including Health Canada (2010), resulted in <math>\text{BMCL}^{10}</math> values within an approximate 2-4 fold range of the POD (<math>142 \mu\text{g/Mn/m}^3</math>) selected for the MRL derivation.</p> <p><b>Source and date:</b> DEQ-CCD/AQD based on ATSDR (9/2012). AQD footnote #29: The ITSL for manganese and manganese compounds is most appropriately applied to PM10-Mn data rather than TSP-Mn data.</p>		
<b>Inhalation Unit Risk Factor (IURF) (<math>(\mu\text{g/m}^3)^{-1}</math>)</b>	--	NA	MDEQ, 2015	
<b>IURF details</b>	No AQD entry in EPB-CCD.	<p><b>Carcinogen Weight-of-Evidence (WOE) Class:</b> Classification D: not classifiable as to human carcinogenicity. IRIS, 1996.</p> <p><b>Basis:</b> Existing studies are inadequate to assess the carcinogenicity of Mn. Source and date: IRIS 12/1/1996</p> <p><b>Tier 1 and 2 Sources:</b></p> <p><b>IRIS:</b> (12/01/1996) no IURF available at this time.</p> <p><b>PPRTV:</b> No PPRTV record available at this time.</p> <p><b>MRL:</b> NA; MRLs are for non-cancer effects only.</p>		Complete



	Part 201 Value	Updated Value	Source/Reference/ Date	Comments/Notes /Issues
		<b>Tier 3 Source:</b> <b>MDEQ:</b> Per DEQ-CCD-AQD, no IURF available.		
<b>Mutagenic Mode of Action (MMOA)? (Y/N)</b>	--	NO	USEPA, 2015	
<b>MMOA Details</b>	--	Not listed as a carcinogen with mutagenic MOA in the USEPA OSWER List.		
<b>Developmental or Reproductive Effector? (Y/N)</b>	No	NO	MDEQ, 2015	
<b>Developmental or Reproductive Toxicity Details</b>		--		
<b>State Drinking Water Standard (SDWS) (µg/L)</b>	--	NO	SDWA, 1976	
<b>SDWS details</b>	NA	MI Safe Drinking Water Act (SDWA) 1976 PA 399		
<b>Secondary Maximum Contaminant Level (SMCL) (µg/L)</b>	NA	50	SDWA, 1976 and USEPA SMCL List	
<b>SMCL details</b>		MI Safe Drinking Water Act (SDWA) 1976 PA 399 and USEPA SMCL List, 2015		
<b>Is there an Aesthetic Value? (Y/N)</b>	NO	50	SDWA, 1976 and USEPA SMCL List	
<b>Aesthetic value details</b>		MI Safe Drinking Water Act (SDWA) 1976 PA 399 and USEPA SMCL List, 2015		
<b>Is there a Phytotoxicity Value? (Y/N)</b>	NO	Not evaluated.	NA	
<b>Phytotoxicity details</b>		NA		
<b>Others:</b>				



**(C) Chemical-specific Absorption Factors**

	Part 201 Value	Update	Source/Reference/ Dates	Comments/Notes /Issues
<b>Gastrointestinal absorption efficiency value (ABS<sub>gi</sub>)</b>	---	1.0	MDEQ, 2015/USEPA RAGS-E, 2004	
<b>ABS<sub>gi</sub> details</b>		RAGS E (USEPA, 2004) Default Value		
<b>Skin absorption efficiency value (AE<sub>d</sub>)</b>	---	0.01	MDEQ, 2015	
<b>AE<sub>d</sub> details</b>				
<b>Ingestion Absorption Efficiency (AE<sub>i</sub>)</b>		0.5	MDEQ, 2015	
<b>AE<sub>i</sub> Details</b>				
<b>Relative Source Contribution for Water (RSC<sub>w</sub>)</b>		0.5	MDEQ, 2015	
<b>Relative Source Contribution for Soil (RSC<sub>s</sub>)</b>		1.0	MDEQ, 2015	
<b>Relative Source Contribution for Air (RSC<sub>a</sub>)</b>		1.0	MDEQ, 2015	
<b>Others</b>				



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

<b>Current GSI value (µg/L)</b>	(G,X)
<b>Updated GSI value (µg/L)</b>	(G,X)
<b>Rule 57 Drinking Water Value (µg/L)</b>	1,300

	<b>Rule 57 Value (µg/L)</b>	<b>Verification Date</b>
<b>Human Non-cancer Values- Drinking water source (HNV-drink)</b>	1,300	12/2006
<b>Human Non-Cancer Values- Non-drinking water sources (HNV-Non-drink)</b>	59,000	12/2006
<b>Wildlife Value (WV)</b>	NA	NA
<b>Human Cancer Values for Drinking Water Source (HCV-drink)</b>	NA	NA
<b>Human Cancer values for non-drinking water source (HCV-Non-drink)</b>	NA	NA
<b>Final Chronic Value (FCV)</b>	$EXP(0.8784*(LnH)+3.5385)$	8/2012
<b>Aquatic maximum value (AMV)</b>	$EXP(0.8784*(LnH)+4.3075)$	8/2012
<b>Final Acute Value (FAV)</b>	$EXP(0.8784*(LnH)+5.0006)$	8/2012

Sources:

1. MDEQ Surface Water Assessment Section Rule 57 [website](#)
2. MDEQ Rule 57 [table](#)



**(E) Target Detection Limits (TDL)**

	<b>Value</b>	<b>Source</b>
<b>Target Detection Limit – Soil (<math>\mu\text{g}/\text{kg}</math>)</b>	1,000	MDEQ, 2015
<b>Target Detection Limit – Water (<math>\mu\text{g}/\text{L}</math>)</b>	50	MDEQ, 2015
<b>Target Detection Limit – Air (ppbv)</b>	NA	MDEQ, 2015
<b>Target Detection Limit – Soil Gas (ppbv)</b>	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 OEHHHA	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