

Appendix H7a: Input Solution Chemistry for Phreeqc Predictive Model (Mactung)							
Underground Water		Mill Process Water		DSTF Leachate		Surface Water	
SOLUTION 1		SOLUTION 2		SOLUTION 3		SOLUTION 4	
temp	4	temp	4	temp	4	temp	4
pH	9.38	pH	8.38	pH	7.8	pH	7.59
pe	4	pe	4	pe	8	pe	4
redox	N(-3)/N(5)	redox	N(-3)/N(5)	redox	pe	redox	N(3)/N(5)
units	mg/l	units	mg/l	units	mg/l	units	mg/l
density	1	density	1	density	1	density	1
Alkalinity	25	Alkalinity	162	Alkalinity	89.2	Alkalinity	60
Cl	0.1					Cl	0
N(-3)	0.26	N(-3)	2.63			N(3)	0.02
N(5)	0.06	N(5)	3.31			N(5)	0.03
S(6)	69.6	S(6)	123	S(6)	805	S(6)	83.7
Al	0.572	Al	1.37053	Al	0.0795	Al	0.02
As	0.0058	As	0.002889	As	0.0011	As	0.0
Ba	0.012	Ba	0.006648	Ba	0.0101	Ba	0.021
Ca	30.3	Ca	20.221	Ca	264	Ca	44.2
Cd	0.00015	Cd	0.00028	Cd	0.00015	Cd	0.00015
Cu	0.002	Cu	0.065082	Cu	0.0634	Cu	0
Fe	0.31	Fe	5.5026	Fe	0.015	Fe	0.02
K	0.68	K	14	K	16.5	K	0.83
Li	0.003	Li	0.1693	Li	0.142	Li	0.001
Mg	0.51	Mg	9.153	Mg	51.4	Mg	2.56
Mn	0.005	Mn	0.212432	Mn	0.743	Mn	0.0091
Ni	0.001	Ni	0.004775	Ni	0.0052	Ni	0
Na	4.94	Na	239.9	Na	141	Na	0.8
P	0.04	P	1.47	P	0.4	P	0.01
Pb	0.0012	Pb	0.001544	Pb	0.00032	Pb	0.0001
Se	0.002	Se	0	Se	0.0045	Se	0.0
Si	5.5	Si	20.47	Si	6.35	Si	2.4
Sr	0.042	Sr	0.0525	Sr	0.685	Sr	0.096
Zn	0.004	Zn	0.0248	Zn	0.0088	Zn	0.009
-water	1 # kg	-water	1 # kg	-water	1 # kg	-water	1 # kg

Appendix H7b: Reservoir Predictive Chemistry - Saturation Indices (Mactung)			
Phase	Formula	Saturation Index	
		Eq O2+CO2	After Prep
Adularia	KAlSi3O8	2.53	1.42
Al(OH)3(a)	Al(OH)3	-0.21	-0.85
AlAsO4:2H2O	AlAsO4:2H2O	-8.37	-9.01
Albite	NaAlSi3O8	1.11	0
AlumK	KAl(SO4)2:12H2O	-17.26	-17.89
Alunite	KAl3(SO4)2(OH)6	-0.09	-2
Analcime	NaAlSi2O6:H2O	-0.85	-1.81
Anglesite	PbSO4	-5.81	-5.81
Anhydrite	CaSO4	-1.98	-1.98
Anilite	Cu0.25Cu1.5S	-145.8	-145.8
Annite	KFe3AlSi3O10(OH)2	-17.74	-32.68
Anorthite	CaAl2Si2O8	0.26	-1.33
Antlerite	Cu3(OH)4SO4	-5.99	-5.99
Aragonite	CaCO3	-0.09	-0.09
Arsenolite	As2O3	-76.33	-76.33
Artinite	MgCO3:Mg(OH)2:3H2O	-7.24	-7.24
As2O5(cr)	As2O5	-38.59	-38.59
As2S3(am)	As2S3	-519.14	-519.14
As_native	As	-92.63	-92.63
Atacamite	Cu2(OH)3Cl	-9.64	-9.64
Azurite	Cu3(OH)2(CO3)2	-5.72	-5.72
Ba3(AsO4)2	Ba3(AsO4)2	6.12	6.12
Barite	BaSO4	0.03	0.03
Basaluminite	Al4(OH)10SO4	5.85	3.31
BaSeO3	BaSeO3	-23.84	-23.84
Beidellite	(NaKMg0.5)0.11Al2.33Si3.67O10	6.45	4.39
Bianchite	ZnSO4:6H2O	-8.6	-8.6
Birnessite	MnO2	11.88	11.88
Bixbyite	Mn2O3	11.74	11.74
BlaubleI	Cu0.9Cu0.2S	-134.81	-134.81
BlaubleII	Cu0.6Cu0.8S	-141.45	-141.45
Boehmite	AlOOH	1.91	1.28
Brochantite	Cu4(OH)6SO4	-5.71	-5.71
Brucite	Mg(OH)2	-5.52	-5.52
Bunsenite	NiO	-6.11	-6.11
Ca3(AsO4)2:4w	Ca3(AsO4)2:4H2O	-13.53	-13.53
Calcite	CaCO3	0.07	0.07
CaSeO3	CaSeO3	-20.6	-20.6
Cd(gamma)	Cd	-52.07	-52.07
Cd(OH)2	Cd(OH)2	-6.03	-6.03
Cd(OH)2(a)	Cd(OH)2	-7.26	-7.26
Cd3(OH)2(SO4)2	Cd3(OH)2(SO4)2	-23.23	-23.23
Cd3(OH)4SO4	Cd3(OH)4SO4	-19.39	-19.39

Appendix H7b: Reservoir Predictive Chemistry - Saturation Indices (Mactung)			
Phase	Formula	Saturation Index	
		Eq O2+CO2	After Prep
Cd3(PO4)2	Cd3(PO4)2	-12.7	-12.7
Cd4(OH)6SO4	Cd4(OH)6SO4	-17.6	-17.6
CdCl2	CdCl2	-23.8	-23.8
CdCl2:2.5H2O	CdCl2:2.5H2O	-22.2	-22.2
CdCl2:H2O	CdCl2:H2O	-22.62	-22.62
CdMetal	Cd	-51.96	-51.96
CdOHCl	CdOHCl	-12.24	-12.24
CdSiO3	CdSiO3	-6.12	-6.28
CdSO4	CdSO4	-12.79	-12.79
CdSO4:2.7H2O	CdSO4:2.67H2O	-10.44	-10.44
CdSO4:H2O	CdSO4:H2O	-10.83	-10.83
Celestite	SrSO4	-2.63	-2.63
Cerrusite	PbCO3	-2.31	-2.31
CH4(g)	CH4	-154.92	-154.92
Chalcanthite	CuSO4:5H2O	-9.64	-9.64
Chalcedony	SiO2	0.05	-0.11
Chalcocite	Cu2S	-150.87	-150.87
Chalcopyrite	CuFeS2	-281.03	-285.63
Chlorite14A	Mg5Al2Si3O10(OH)8	0.17	-1.57
Chlorite7A	Mg5Al2Si3O10(OH)8	-3.41	-5.16
Chrysotile	Mg3Si2O5(OH)4	-4.04	-4.36
Claudetite	As2O3	-76.4	-76.39
Clinoenstatite	MgSiO3	-3.39	-3.55
Clypromorphite	Pb5(PO4)3Cl	-3.87	-3.87
CO2(g)	CO2	-3.42	-3.42
Cotunnite	PbCl2	-20.8	-20.8
Covellite	CuS	-132.12	-132.12
Cristobalite	SiO2	0.13	-0.03
Cu(OH)2	Cu(OH)2	-2.15	-2.15
Cu2(OH)3NO3	Cu2(OH)3NO3	-7.59	-7.59
Cu2SO4	Cu2SO4	-43.17	-43.17
Cu3(AsO4)2:6w	Cu3(AsO4)2:6H2O	-15.43	-15.43
Cu3(PO4)2	Cu3(PO4)2	-9.33	-9.33
Cu3(PO4)2:3H2O	Cu3(PO4)2:3H2O	-11.06	-11.06
CuCO3	CuCO3	-4.73	-4.73
CuMetal	Cu	-25.42	-25.42
CuOCuSO4	CuO:CuSO4	-18.54	-18.54
CupricFerrite	CuFe2O4	18.31	9.09
Cuprite	Cu2O	-23.27	-23.27
CuprousFerrite	CuFeO2	5.63	1.01
CuSO4	CuSO4	-16.38	-16.38
Diaspore	AlOOH	3.81	3.18
Diopside	CaMgSi2O6	-3.02	-3.34

Appendix H7b: Reservoir Predictive Chemistry - Saturation Indices (Mactung)			
Phase	Formula	Saturation Index	
		Eq O2+CO2	After Prep
Diopside	CuSiO3:H2O	-3.43	-3.59
Djurleite	Cu0.066Cu1.868S	-149.5	-149.5
Dolomite	CaMg(CO3)2	-0.62	-0.62
Dolomite(d)	CaMg(CO3)2	-1.26	-1.26
Epsomite	MgSO4:7H2O	-4.57	-4.57
Fe(OH)2.7Cl.3	Fe(OH)2.7Cl0.3	7.76	3.15
Fe(OH)3(a)	Fe(OH)3	4.61	0
Fe2(SeO3)3	Fe2(SeO3)3	-64.28	-73.5
Fe3(OH)8	Fe3(OH)8	-0.71	-14.54
FeS(ppt)	FeS	-158.63	-163.24
FeSe2	FeSe2	-200.47	-205.08
Forsterite	Mg2SiO4	-9.11	-9.27
Galena	PbS	-143.22	-143.22
Gibbsite	Al(OH)3	2.69	2.05
Goethite	FeOOH	9.7	5.09
Goslarite	ZnSO4:7H2O	-8.21	-8.21
Greenalite	Fe3Si2O5(OH)4	-26.8	-40.94
Greenockite	CdS	-138.59	-138.59
Greigite	Fe3S4	-587.67	-601.5
Gypsum	CaSO4:2H2O	-1.72	-1.72
H2(g)	H2	-45.09	-45.09
H2O(g)	H2O	-2.09	-2.09
H2S(g)	H2S	-155.04	-155.04
Halite	NaCl	-11.53	-11.53
Halloysite	Al2Si2O5(OH)4	1.88	0.29
Hausmannite	Mn3O4	9.63	9.63
Hematite	Fe2O3	21.3	12.08
Hinsdalite	PbAl3PO4SO4(OH)6	-9.12	-11.03
Huntite	CaMg3(CO3)4	-6.38	-6.38
Hxypyromorphite	Pb5(PO4)3OH	-9.58	-9.58
Hydrocerussite	Pb(OH)2:2PbCO3	-7.99	-7.99
Hydromagnesite	Mg5(CO3)4(OH)2:4H2O	-16.78	-16.78
Hydroxyapatite	Ca5(PO4)3OH	3.63	3.63
Illite	K0.6Mg0.25Al2.3Si3.5O10(OH)2	6.21	4.2
Jarosite(ss)	(K0.77Na0.03H0.2)Fe3(SO4)2(OH)6	2.59	-11.24
Jarosite-K	KFe3(SO4)2(OH)6	1.09	-12.74
Jarosite-Na	NaFe3(SO4)2(OH)6	-1.69	-15.52
JarositeH	(H3O)Fe3(SO4)2(OH)6	-8.56	-22.39
Jurbanite	AlOHSO4	-4.4	-5.04
Kaolinite	Al2Si2O5(OH)4	7.2	5.61
Kmica	KAl3Si3O10(OH)2	13.4	11.02
Langite	Cu4(OH)6SO4:H2O	-9.36	-9.36
Larnakite	PbO:PbSO4	-7.82	-7.82

Appendix H7b: Reservoir Predictive Chemistry - Saturation Indices (Mactung)			
Phase	Formula	Saturation Index	
		Eq O2+CO2	After Prep
Laumontite	CaAl2Si4O12:4H2O	5.54	3.63
Laurionite	PbOHCl	-10.57	-10.57
Leonhardite	Ca2Al4Si8O24:7H2O	19.51	15.71
Litharge	PbO	-7.65	-7.65
Mackinawite	FeS	-157.89	-162.5
Magadiite	NaSi7O13(OH)3:3H2O	-6.11	-7.22
Maghemite	Fe2O3	12.62	3.4
Magnesite	MgCO3	-1.18	-1.18
Magnetite	Fe3O4	12.98	-0.85
Malachite	Cu2(OH)2CO3	-2.71	-2.71
Manganite	MnOOH	7.59	7.59
Massicot	PbO	-7.86	-7.86
Melanothallite	CuCl2	-28.94	-28.94
Melanterite	FeSO4:7H2O	-16.68	-21.29
Millerite	NiS	-147.2	-147.2
Minium	Pb3O4	-16.37	-16.37
Mirabilite	Na2SO4:10H2O	-5.67	-5.67
Mn2(SO4)3	Mn2(SO4)3	-43.57	-43.57
Mn3(AsO4)2:8H2O	Mn3(AsO4)2:8H2O	-12.68	-12.68
Mn3(PO4)2	Mn3(PO4)2	-13.07	-13.07
MnCl2:4H2O	MnCl2:4H2O	-23.22	-23.21
MnHPO4	MnHPO4	1.79	1.79
MnS(Green)	MnS	-156.79	-156.79
MnSO4	MnSO4	-12.84	-12.84
Monteponite	CdO	-7.52	-7.52
Montmorillonite-Aberdeen	(HNaK)0.14Mg0.45Fe0.33Al1.47S	6.61	3.56
Montmorillonite-BelleFourche	(HNaK)0.09Mg0.29Fe0.24Al1.57S	6.7	3.97
Montmorillonite-Ca	Ca0.165Al2.33Si3.67O10(OH)2	6.44	4.38
Morenosite	NiSO4:7H2O	-9.5	-9.5
N2(g)	N2	-21.97	-21.97
Nahcolite	NaHCO3	-4.44	-4.44
Nantokite	CuCl	-21.2	-21.2
Natron	Na2CO3:10H2O	-7.65	-7.65
Nesquehonite	MgCO3:3H2O	-3.57	-3.57
NH3(g)	NH3	-75.12	-75.12
Ni(OH)2	Ni(OH)2	-1.44	-1.44
Ni2SiO4	Ni2SiO4	-4.81	-4.97
Ni3(AsO4)2:8H2O	Ni3(AsO4)2:8H2O	-24.02	-24.02
Ni3(PO4)2	Ni3(PO4)2	-13.86	-13.86
Ni4(OH)6SO4	Ni4(OH)6SO4	-21.01	-21.01
NiCO3	NiCO3	-7.73	-7.73
Nsutite	MnO2	12.91	12.91
O2(g)	O2	-0.68	-0.68

Appendix H7b: Reservoir Predictive Chemistry - Saturation Indices (Mactung)			
Phase	Formula	Saturation Index	
		Eq O2+CO2	After Prep
Orpiment	As2S3	-517.49	-517.49
Otavite	CdCO3	-1.97	-1.97
Pb(OH)2	Pb(OH)2	-2.95	-2.95
Pb2(OH)3Cl	Pb2(OH)3Cl	-12.77	-12.77
Pb2O(OH)2	PbO:Pb(OH)2	-14.24	-14.24
Pb2O3	Pb2O3	-3.99	-3.99
Pb2OCO3	PbO:PbCO3	-9.87	-9.87
Pb2SiO4	Pb2SiO4	-13.01	-13.17
Pb3(AsO4)2	Pb3(AsO4)2	-19.21	-19.21
Pb3(PO4)2	Pb3(PO4)2	-5.58	-5.58
Pb3O2CO3	PbCO3:2PbO	-16.25	-16.25
Pb3O2SO4	PbSO4:2PbO	-13.31	-13.31
Pb4(OH)6SO4	Pb4(OH)6SO4	-16.88	-16.88
Pb4O3SO4	PbSO4:3PbO	-19.83	-19.83
PbHPO4	PbHPO4	-3.72	-3.72
PbMetal	Pb	-43.36	-43.36
PbO:0.3H2O	PbO:0.33H2O	-7	-7
PbSiO3	PbSiO3	-5.62	-5.78
Phillipsite	Na0.5K0.5AlSi3O8:H2O	0.83	-0.28
Phlogopite	KMg3AlSi3O10(OH)2	-1.89	-3
Phosgenite	PbCl2:PbCO3	-21.78	-21.78
Plattnerite	PbO2	-2.16	-2.16
Plumbogummite	PbAl3(PO4)2(OH)5:H2O	6.78	4.87
Portlandite	Ca(OH)2	-11.15	-11.15
Prehnite	Ca2Al2Si3O10(OH)2	1.78	0.04
Pyrite	FeS2	-261.4	-266.01
Pyrochroite	Mn(OH)2	-4.81	-4.81
Pyrolusite	MnO2	10.48	10.48
Pyrophyllite	Al2Si4O10(OH)2	7.32	5.42
Quartz	SiO2	0.55	0.39
Realgar	AsS	-203	-203
Retgersite	NiSO4:6H2O	-9.92	-9.92
Rhodochrosite	MnCO3	-0.26	-0.26
Rhodochrosite(d)	MnCO3	-0.92	-0.92
Scorodite	FeAsO4:2H2O	-6.52	-11.13
Se(s)	Se	-69.92	-69.92
SeO2	SeO2	-31.19	-31.19
Sepiolite	Mg2Si3O7.5OH:3H2O	-1.99	-2.46
Sepiolite(d)	Mg2Si3O7.5OH:3H2O	-4.3	-4.77
Siderite	FeCO3	-10.43	-15.04
Siderite(d)(3)	FeCO3	-10.73	-15.34
Silicagel	SiO2	-0.5	-0.66
SiO2(a)	SiO2	-0.87	-1.02

Appendix H7b: Reservoir Predictive Chemistry - Saturation Indices (Mactung)			
Phase	Formula	Saturation Index	
		Eq O2+CO2	After Prep
Smithsonite	ZnCO3	-2.59	-2.59
Sphalerite	ZnS	-141.64	-141.63
Strengite	FePO4·2H2O	1.7	-2.91
Strontianite	SrCO3	-1.97	-1.97
Sulfur	S	-116.09	-116.09
Talc	Mg3Si4O10(OH)2	-0.55	-1.18
Tenorite	CuO	-1.13	-1.13
Thenardite	Na2SO4	-7.69	-7.69
Thermonatrite	Na2CO3·H2O	-10.11	-10.12
Tremolite	Ca2Mg5Si8O22(OH)2	-1.18	-2.45
Trona	NaHCO3·Na2CO3·2H2O	-15.23	-15.24
Tsumebite	Pb2CuPO4(OH)3·3H2O	-5.01	-5.01
Vivianite	Fe3(PO4)2·8H2O	-30.63	-44.47
Wairakite	CaAl2Si4O12·2H2O	0.54	-1.37
Willemite	Zn2SiO4	-2.26	-2.42
Witherite	BaCO3	-3.66	-3.66
Wurtzite	ZnS	-143.75	-143.75
Zincite(c)	ZnO	-3.01	-3.01
Zincosite	ZnSO4	-14.43	-14.43
Zn(NO3)2·6H2O	Zn(NO3)2·6H2O	-17.9	-17.9
Zn(OH)2-a	Zn(OH)2	-3.11	-3.11
Zn(OH)2-b	Zn(OH)2	-2.41	-2.41
Zn(OH)2-c	Zn(OH)2	-2.86	-2.86
Zn(OH)2-e	Zn(OH)2	-2.16	-2.16
Zn(OH)2-g	Zn(OH)2	-2.37	-2.37
Zn2(OH)2SO4	Zn2(OH)2SO4	-8.51	-8.51
Zn2(OH)3Cl	Zn2(OH)3Cl	-12.44	-12.44
Zn3(AsO4)2·2.5w	Zn3(AsO4)2·2.5H2O	-16.97	-16.97
Zn3(PO4)2·4w	Zn3(PO4)2·4H2O	-8.1	-8.1
Zn3O(SO4)2	ZnO·2ZnSO4	-33.82	-33.82
Zn4(OH)6SO4	Zn4(OH)6SO4	-10.72	-10.72
Zn5(OH)8Cl2	Zn5(OH)8Cl2	-23.64	-23.63
ZnCl2	ZnCl2	-30.51	-30.51
ZnCO3·H2O	ZnCO3·H2O	-2.09	-2.09
ZnMetal	Zn	-63.55	-63.55
ZnO(a)	ZnO	-1.97	-1.97
ZnS(a)	ZnS	-144.46	-144.46
ZnSiO3	ZnSiO3	1.64	1.48
ZnSO4·H2O	ZnSO4·H2O	-10.37	-10.37

Notes:

1. Kinetics is not considered
2. Assuming fully mixing, no turbidance, enough time for precipitation
3. Water in Equilibrium with O2, CO2, Fe(OH)3(a) and Albite