

### 5.4.3 Relationship between Distance from Tailing Dam and Water Quality

The relationship between distance from tailing dam along Wadi Suq and water quality is presented in Table 5.7 (1)~(4) and Figure 5.8 (1)~(4).

The quality of shallow groundwater indicated uniform attenuation (dispersion) of Hg, Cd, Cr, As, Ni, Mn, Pb, Cu, Fe and Zn with the distance downstream from the tailing dam. The maximum concentrations of these metals were all observed at the tailing dam and decreased with distance downstream until background concentrations were reached at borehole DH-5. Sulfate ( $\text{SO}_4$ ) and chloride (Cl) also indicated uniform attenuation with distance downstream from the tailing dam. However, a secondary peak of relatively high sulfate concentration was observed at borehole DH-7. Chloride concentrations also exhibit a secondary peak at borehole DH-6.

Deep groundwater shows the same tendency as shallow groundwater for uniform attenuation of Hg, As, Ni, and Zn with distance downstream from the tailing dam. Concentrations of these four metals in deep groundwater have their maximum values at the tailings dam that decrease uniformly until reaching background levels at borehole DH-5. However, Cd, Cr, Pb, and Cu concentrations all exhibit secondary peaks at borehole DH-5, and Fe and Mn exhibit secondary peaks at borehole DH-6.

Sulfate and chloride concentrations in deep groundwater also exhibit attenuation with distance downstream from the tailing dam. However, as with the shallow groundwater, deep groundwater sulfate levels exhibit a secondary peak at borehole DH-7. Chloride exhibits a secondary peak at borehole DH-5, instead of at DH-6. The mechanism responsible for the secondary peaks in metal, sulfate, and chloride concentrations observed far downstream from the tailings dam cannot be explained by natural attenuation or dispersion theories. One plausible explanation is that a weakly mineralized zone exists in the vicinity of DH-5 through DH-7 in the basement rock that acts as a secondary source of contamination. For example, the high concentration peak of  $\text{SO}_4$  at DH-7 might indicate the presence of a natural deposit of sulfate minerals, such as gypsum that is acting as a new source of contamination.

The high secondary peak in chloride concentrations detected at DH-5 suggests possible saltwater leakage from the seawater pipeline formerly used as the water supply for the smelter. It is possible leakage occurred near DH-5 but was not observed at the surface, as was the case when leakage occurred near pumping station No. 2 (PS-2).

Table 5.7 Relationship between the Distance from Tailing Dam and Water Quality (1) 浅層地下水  
2000年7月採水

DH No.	Distance from Tailing dam	E.C.	Hg	Cd	Cr	As	Ni	Pb	Cu	Mn	Fe	Zn	SO <sub>4</sub>	Cl
		S/m	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
DH-1A	0.0	7.27	0.0027	0.108	1.090	0.011	0.055	0.52	0.39	5.03	42.50	0.66	1483	31005
DH-2-S	2.0	3.33	0.0006	0.046	0.702	0.007	0.039	0.78	0.11	0.10	0.35	0.13	971	12402
DH-3-S	6.6	1.86	0.0004	0.016	0.272	0.006	0.034	0.33	0.07	0.11	0.20	0.14	653	6536
DH-4S	8.5	1.85	0.0008	0.020	0.212	0.008	0.033	0.30	0.06	0.03	0.27	0.08	584	6388
DH-5-S	12.9	0.23	0.0004	0.006	0.031	0.007	0.030	0.03	0.08	0.01	0.20	0.10	341	287
DH-6S	14.8	1.06	0.0006	0.003	0.032	0.006	0.032	0.17	0.07	<0.01	0.21	0.06	370	3445
DH-7S	20.0	0.59	0.0005	0.011	0.042	0.008	0.030	0.06	0.06	<0.01	0.13	0.05	973	1161
DH-8S	24.8	0.17	0.0004	0.004	0.022	0.005	0.030	0.02	0.01	<0.01	0.33	0.04	114	396
DH-9-S	28.4	0.07	0.0004	0.002	0.006	0.007	0.021	0.02	0.01	<0.01	0.51	0.09	58	112

Red color : Exceeding Omani standard of discharge

Table 5.7 Relationship between the Distance from Tailing Dam and Water Quality (2) 浅層地下水  
2000年11月採水

DH No.	Distance from Tailing dam	E.C.	Hg	Cd	Cr	As	Ni	Pb	Cu	Mn	Fe	Zn	SO <sub>4</sub>	Cl
		S/m	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
DH-1A	0.0	6.88	0.0021	0.097	1.120	0.010	0.049	0.50	0.38	4.99	41.35	0.66	1258	29376
DH-2-S	2.0	3.37	0.0005	0.040	0.693	0.005	0.035	0.75	0.11	0.10	0.36	0.14	990	13209
DH-3-S	6.6	1.82	0.0005	0.018	0.280	0.006	0.032	0.30	0.07	0.10	0.21	0.15	641	6416
DH-4S	8.5	2.05	0.0007	0.018	0.218	0.007	0.037	0.31	0.07	0.03	0.27	0.09	641	7150
DH-5-S	12.9	0.23	0.0004	0.006	0.035	0.008	0.032	0.03	0.08	0.01	0.22	0.11	303	494
DH-6S	14.8	1.08	0.0005	0.004	0.030	0.006	0.035	0.12	0.07	<0.01	0.22	0.07	363	3407
DH-7S	20.0	0.60	0.0004	0.010	0.038	0.007	0.032	0.06	0.06	<0.01	0.14	0.05	949	1153
DH-8S	24.8	0.18	0.0005	0.004	0.029	0.006	0.040	0.02	0.01	<0.01	0.34	0.04	96	361
DH-9-S	28.4	0.07	0.0004	0.003	0.008	0.006	0.024	0.02	0.01	<0.01	0.50	0.09	42	107

Red color : Exceeding Omani standard of discharge

Table 5.7 Relationship between the Distance from Tailing Dam and Water Quality (3)

深層地下水  
2000年7月採水

DH No.	Distance from Tailing dam	E.C.	Hg	Cd	Cr	As	Pb	Cu	Mn	Fe	Ni	Zn	SO <sub>4</sub>	Cl
		S/m	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
DH-1A	0.0	7.27	0.0027	0.108	1.090	0.011	0.520	0.39	5.03	42.50	0.06	0.66	1483	31005
DH-2-D	2.0	3.35	0.0005	0.044	0.663	0.005	0.790	0.10	0.19	0.30	0.04	0.10	953	12944
DH-3-D	6.6	1.90	0.0005	0.012	0.291	0.009	0.470	0.10	0.11	0.88	0.03	0.11	607	6634
DH-4D-2	8.5	0.96	0.0007	0.006	0.042	0.008	0.140	0.06	0.15	2.03	0.03	0.19	477	2973
DH-5D-2	12.9	3.57	0.0004	0.041	0.463	0.008	0.590	0.12	0.05	1.60	0.04	0.11	667	13633
DH-6D-2	14.8	0.81	0.0006	0.012	0.014	0.010	0.140	0.09	0.99	31.67	0.04	0.16	294	2510
DH-7D-2	20.0	0.61	0.0004	0.009	0.011	0.007	0.042	0.06	0.24	0.44	0.03	0.06	1011	1299
DH-8D-3	24.8	0.22	0.0003	0.002	0.008	0.004	0.012	0.01	<0.01	0.17	0.01	0.11	281	394
DH-9-D	28.4	0.07	0.0004	0.005	0.007	0.006	0.016	0.01	<0.01	0.23	0.02	0.03	52	110

Red color : Exceeding Omani standard of discharge

Table 5.7 Relationship between the Distance from Tailing Dam and Water Quality(4)

深層地下水  
2000年11月採水

DH No.	Distance from Tailing dam	E.C.	Hg	Cd	Cr	As	Pb	Cu	Mn	Fe	Ni	Zn	SO <sub>4</sub>	Cl
		S/m	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
DH-1A	0.0	6.88	0.0021	0.097	1.120	0.010	0.500	0.38	4.99	41.35	0.05	0.66	1258	29376
DH-2-D	2.0	3.30	0.0005	0.037	0.654	0.005	0.780	0.11	0.17	0.31	0.03	0.11	960	13260
DH-3-D	6.6	1.93	0.0005	0.013	0.285	0.008	0.450	0.10	0.11	0.92	0.03	0.10	689	6569
DH-4D-2	8.5	0.94	0.0007	0.009	0.038	0.008	0.140	0.06	0.16	2.02	0.03	0.21	419	2917
DH-5D-2	12.9	2.94	0.0004	0.037	0.452	0.008	0.550	0.11	0.06	1.74	0.04	0.10	623	13260
DH-6D-2	14.8	0.73	0.0006	0.010	0.013	0.009	0.130	0.09	0.96	31.35	0.04	0.16	270	2366
DH-7D-2	20.0	0.63	0.0004	0.010	0.009	0.008	0.045	0.06	0.25	0.43	0.03	0.07	948	1306
DH-8D-3	24.8	0.19	0.0004	0.002	0.010	0.005	0.013	0.01	<0.01	0.18	0.01	0.12	156	351
DH-9-D	28.4	0.07	0.0004	0.005	0.010	0.006	0.018	0.01	0.00	0.24	0.03	0.03	43	106

Red color : Exceeding Omani standard of discharge



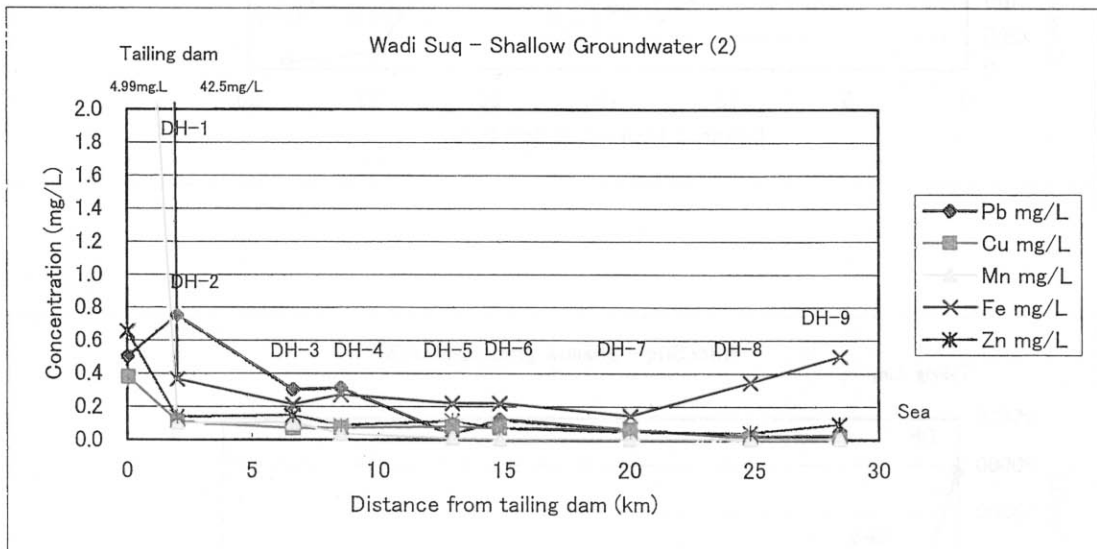
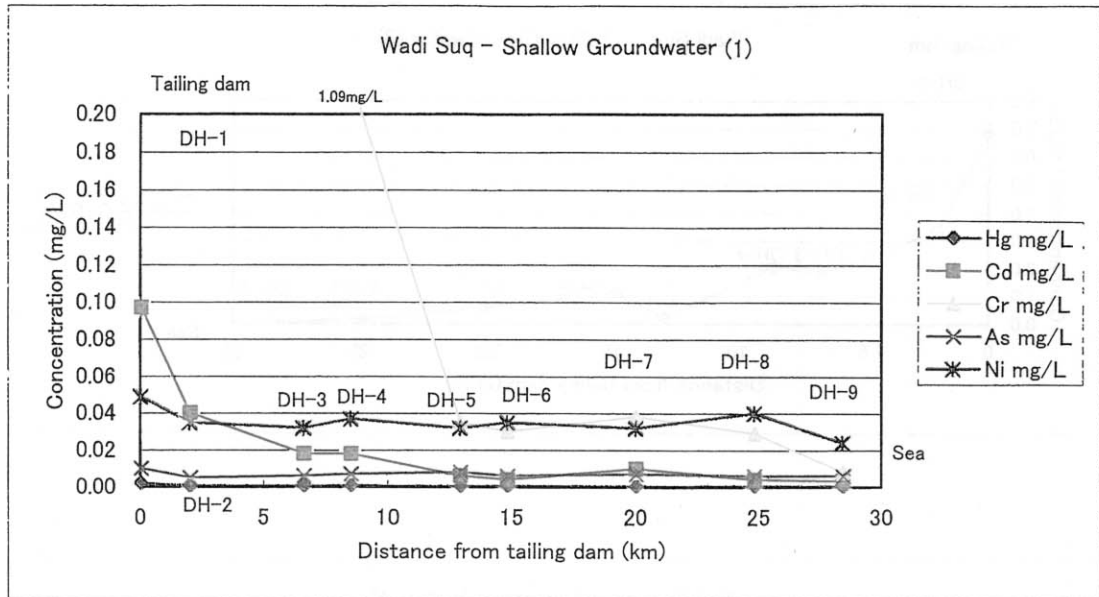


Figure 5.8 Relationship between Distance from Contaminant Source and Water Quality (1)