GOLDEN REWARD MINING COMPANY

WASTE ROCK AND SPENT ORE CHARACTERIZATION STUDY

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WASTE ROCK AND SPENT ORE CHARACTERIZATION STUDY

1.0 INTRODUCTION

To supplement information in Golden Reward Mining Company's January 1988 Application for Permit, an additional investigation of the chemical characteristics of waste rock and spent ore has been conducted. This work included the following:

1) EP Toxicity tests of representative samples of waste rock.

2) Acid-base balance testing to determine the tendency for waste rock to create acidic or alkaline leachate.

3) Leaching of spent ore with distilled water to simulate natural leaching by rain or snowmelt.

4) Passing spent ore leachate through a column of natural soil to simulate movement through the natural soil that underlies the spent ore disposal area.

These tests were designed to simulate as closely as possible the reactions of spent ore and waste rock to natural processes in the proposed spent ore depositories.

2.0 WASTE ROCK

As described in Golden Reward's January 1988 application for a permit, waste rock will be placed in the Sundance and Stewart depositories on the North Fork of Stewart Gulch and in the upper end of the unnamed ephemeral drainage basin between Stewart Gulch and Fantail Gulch. In addition, waste rock will be used to backfill open pits.

Waste rock will consist primarily of the sedimentary Deadwood Formation and Tertiary igneous intrusive rocks. The Deadwood Formation is the major host for gold mineralization and the dominant sedimentary sequence at the Golden Reward Project. Other rocks which may be removed as waste include Precambrian metamorphic rocks and Ordovician to Mississippian sandstones, shales, siltstones and dolomites.

2.1 ACID-BASE POTENTIAL

Some minerals, particularly pyrite, can decompose and create acidic conditions in water. Similarly, natural bases and some minerals can release alkalinity into water. The relative amounts of acid and base that a rock can release to aqueous solutions determines whether the resultant solution will be basic or acidic and is often termed acid-base accounting or acid-base balance testing.

There are several techniques for determining the acid-base balance. In this study, acid potential was determined by first determining the total sulfur content of waste rock. Acid potential was then calculated

assuming all sulfur was present as pyrite and would weather to produce sulfuric acid and ferric hydroxide. This assumption causes the test to overestimate the acid potential of sulfate-bearing (non-pyrite) rocks because sulfur may be present in non-acid producing forms such as barite and gypsum.

Neutralization potential (potential alkalinity) was measured by treating the rock sample with a known excess of weak acid and then back titrating with base to determine the amount of acid consumed by the carbonate present in the rock.

The acid-base balance is determined by comparison of the tests for acid potential and neutralization potential. These test procedures are described in Smith et al. (1974). Samples representative of waste rock from the proposed Golden Reward open-pits were obtained from drilling cores and were crushed to minus-60 mesh (0.25 mm diameter) as required for the testing procedure. A total of six samples of waste rock types composited from the different pit areas were obtained and tested.

Results of these tests (Table 1) show very low potential acidity in the waste rock and a high neutralization potential. The acid-base potential for all waste rock types shows an overall basic (alkaline) balance indicating Golden Reward waste rock has no potential for generation of acidic drainage.

TABLE 1. ACID BASE POTENTIAL OF WASTE ROCK - GOLDEN REWARD MINING CO.

	Deadwood Quartzite	Deadwood Sandstone	Deadwood Limestone	Deadwood Shale	Precamb. Shist	Tert. Porphyry
Neut. Potential, Tons CaCO3/1000 Tons Material	119	35.2	384	146	4.63	5.64
Potential Acidity, Tons CaCO3/1000 Tons Material	0.03	0.02	0.03	0.03	0.10	0.03
pH of 1/1 Sample/Water Mixture	7.72	7.85	7.99	7.99	7.50	7.57
Acid-Base Potential (1) Tons CaCO3/1000 Tons Material	+119	+35.2	+384	+146	+4.53	+5.61

(1) "+" denotes a net excess of neutralization potential, "-" denotes a net deficiency of neutralization potential.

2.2 EP TOXICITY TESTS

Extraction Procedure (EP) Toxicity tests were performed to evaluate the potential release of metals from waste rock into the environment. The EP Toxicity test was developed by the EPA to simulate conditions occurring in a sanitary landfill. The test method consists of a 24-hour agitated (bottle roll) leach of crushed waste rock in a pH-buffered (pH=5) acetic acid solution. Because of the fine grain size and low pH used in the test, leaching of rock in the test is expected to be much greater than leaching that would occur under natural conditions in Golden Reward's waste rock depository.

Results of the EP Toxicity can be interpreted by comparison with established EPA limits (Table 2). Because the EP Toxicity procedure uses a strong leaching methodology, the EPA has established that concentrations of extracted metals that are 100 times the EPA primary drinking water standards are characteristics of hazardous wastes. All of the waste rock types tested were far below EPA limits for all parameters.

TABLE 2. E. P. TOXICITY TESTS OF WASTE ROCK - GOLDEN REWARD MINING CO.

	Deadwood Quartzite	Deadwood Sandstone	Deadwood Limestone	Deadwood Shale	Precamb. Shist	Tert. Porphyry	Limit Concentration
Arsenic, mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	5.0
Barium, mg/l	5.11	5.01	3.16	4.77	0.60	1.06	100
Cadmium, mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	1.0
Chromium, mg/l	0.12	0.06	0.11	0.09	<0.01	<0.01	5.0
Copper, mg/l	0.23	0.02	0.04	0.04	0.09	0.01	
Lead, mg/l	0.11	0.29	0.41	0.44	<0.01	<0.01	5.0
Mercury, mg/l	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	0.2
Selenium, mg/l	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	1.0
Silver, mg/l	<0.01	<0.01	0.04	0.02	<0.01	<0.01	5.0
Manganese, mg/l	39.8	13.1	26.9	19.6	4.01	3.31	
Zinc, mg/l	0.34	0.58	1.23	0.15	1.10	0.42	
Nickel, mg/l	0.96	0.31	0.67	0.87	0.28	0.16	

3.0 SPENT ORE

In Golden Reward's proposed operating plan, spent ore will be "neutralized" by treatment with hydrogen peroxide to destroy any residual cyanide before placement in the Stewart-Sundance depository. Neutralization of spent ore will be continued until the concentration of weak acid dissociable (WAD) cyanide in water draining from the spent ore (spent ore pore water) is less than 0.5 mg/L. This concentration of WAD cyanide complies with the State of South Dakota's Ground-Water Quality Standard maximum contaminant level of 0.75 mg/L for WAD cyanide in groundwater (ARSD 74:03:15:03) and South Dakota tailings treatment requirements (ARSD 74:29:05:08).

To evaluate characteristics of the spent ore, column tests were run to create leachate from a composite sample of spent ore. The rock used to create the spent ore was derived by compositing different ore types in proportion to the projected amount of each ore type to be mined during the life of the mine. The spent ore leachate was analyzed and the leachate also was passed through a column of natural soil obtained from Golden Reward's proposed spent ore depository. This simulates the process that would occur in the proposed depository where spent ore will be placed on natural soil and then subjected to leaching by natural precipitation.

Spent ore used in the column tests was developed by cyanide leaching of a composite ore sample then rinsing with water and hydrogen peroxide.

The process simulated as closely as possible the proposed leaching and neutralization sequence to be used by Golden Reward. In the column test, when the concentration of WAD cyanide decreased to less than 0.5 mg/L, spent ore neutralization was considered completed. Distilled water was then passed through the spent ore to create pore water. This simulates rainfall percolation through the deposited spent ore. Samples of the pore water were collected and tested in the laboratory.

Results of the analyses of pore water are in Table 3. All parameters tested complied with the South Dakota Ground-Water Quality Standards except for arsenic and pH. The concentration of arsenic in the spent ore pore water was 0.50 mg/L, whereas the standard for this parameter is 0.05 mg/L (Table 3). The pore water pH was 10.4 compared to the standard of 6.5 to 8.5.

Table 3 also shows the average quality of ambient groundwater beneath the Stewart-Sundance Depository area. Ambient groundwater is represented by water quality from two monitoring wells (DM-13 and DM-14) in the proposed depository area. The ambient groundwater water quality exceeds South Dakota Ground-Water Quality Standards for arsenic and iron (DM-13), as well as Federal Drinking Water Standards for manganese (DM-13 and DM-14). Arsenic concentrations in well DM-13 have been measured as high as 0.302 mg/L (Appendix 1). This arsenic concentration is similar to that in the spent ore pore water. Elevated concentrations of arsenic in natural groundwater are commonly

TABLE 3. WATER QUALITY OF SPENT ORE PORE WATER - GOLDEN REWARD MINING CO.

SITE NAME	SPENT ORE PORE WATER	SPENT ORE PORE WATER	SPENT ORE PORE WATER	SPENT ORE PORE WATER	AMBIENT GRNDWATER	AMBIENT GRNDWATER	S. DAKOTA GRNDWATER
SAMPLE DATE	03/30/88	03/30/88	03/30/88	03/30/88	AVERAGE	AVERAGE	STANDARDS
COLUMN MATERIAL	SPENT	SPENT	SPENT	SPENT			
COLUMN MATERIAL	ORE #2	ORE #2	ORE #2	ORE #2			
LEACHATE	DISTILLED	DISTILLED	DISTILLED	DISTILLED			
LEACHATE	WATER	WATER	WATER	WATER			
PORE VOLUME	1ST 1/3 #1	2ND 1/3 #1	3RD 1/3 #1	PV 2-5			
LAB	EL	EL	EL	EL			
REMARKS					DM-13	DM-14	
PHYSICAL PARAMETERS							
SPEC. COND. (UMHOS/CM) LAB				150	482	875	
PH LAB				10.4	7.25	7.33	6.5-8.5
TDS MEAS. @ 180 DEG. C				72	291	643	1000
SODIUM ADSORPTION RATIO				1.3			
COMMON IONS							
TOTAL HARDNESS AS CACO3				24	260	524	
CALCIUM (CA)	21	17	13	10	67.6	132	
MAGNESIUM (MG)	<1	<1	<1	<1	22	46.8	
SODIUM (NA)	53	44	33	14	8.64	7.6	
POTASSIUM (K)	4	3	3	2	7.14	9.2	
ALKALINITY AS CACO3 (LAB)					224	245	
BICARBONATE (HCO3) (LAB)				18	273	299	
CARBONATE AS CO3 (LAB)				11	0	0	
HYDROXIDE (OH)				0	0	0	
SULFATE (SO4)				19	34.6	252	500
CHLORIDE (CL)				4	11.4	2.76	250.
NUTRIENTS							
NITRATE (NO3-N)					0.048	0.176	10
NITRATE + NITRITE AS N				0.06	0.04	0.2	
AMMONIA (NH3 AS N)				0.3	1.73	0.084	
TRACE ELEMENTS							
ALUMINUM (AL) DISS	0.2	0.2	0.2	0.2	<0.1	<0.1	
ARSENIC (AS) DISS	<0.1	<0.1	<0.1	0.50	0.154	0.0097	0.05
BARIUM (BA) DISS	<0.1	<0.1	<0.1	<0.1	0.397	0.059	1
BERYLLIUM (BE) DISS	<0.005	<0.005	<0.005	<0.005			
BORON (B) DISS	<0.1	<0.1	<0.1	<0.1			
CADMIUM (CD) DISS	0.007	0.009	0.009	0.008	<0.0005	0.0015	0.01
CHROMIUM (CR) DISS	0.04	0.04	0.02	<0.02	0.005	0.0049	0.05
COBALT (CO) DISS	0.02	0.01	0.01	<0.01			
COPPER (CU) DISS	0.08	0.06	0.04	0.01	0.0033	0.0072	1.3
GOLD (AU) DISS	<0.01	0.01	<0.01		<0.005	<0.005	
IRON (FE) DISS	0.07	0.06	0.06	0.05	1.26	0.027	
LEAD (PB) DISS	<0.01	<0.01	<0.01	<0.01	<0.005	<0.005	0.02

* Federal Drinking Water Standard (40 CFR Part 143)

All quantities in milligrams per liter unless otherwise noted. Blank line indicates parameter not tested.

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TABLE 3. WATER QUALITY OF SPENT ORE PORE WATER - GOLDEN REWARD MINING CO.

SITE NAME	SPENT ORE PORE WATER	SPENT ORE PORE WATER	SPENT ORE PORE WATER	SPENT ORE PORE WATER	AMBIENT GRNDWATER	AMBIENT GRNDWATER	S. DAKOTA GRNDWATER
SAMPLE DATE	03/30/88	03/30/88	03/30/88	03/30/88	AVERAGE	AVERAGE	STANDARDS
TRACE ELEMENTS							
LITHIUM (LI) DISS				<0.01			
MANGANESE (MN) DISS	<0.02	<0.02	<0.02	<0.02	2.55	0.142	0.05 *
MERCURY (HG) DISS	<0.1	<0.1	<0.1	<0.001	0.0003	0.0002	0.002
MOLYBDENUM (MO) DISS	0.065	0.052	0.038	0.010			
NICKEL (NI) DISS	<0.03	<0.03	<0.03	<0.03	0.0021	0.0069	
SELENIUM (SE) DISS	<0.1	<0.1	<0.1	<0.005	<0.002	0.0033	0.01
SILICON (SI) DISS	5.6	5.7	5.3	3.8			
SILVER (AG) DISS	0.006	0.006	<0.005	<0.005	0.0002	0.0005	0.05
STRONTIUM (SR) DISS	<0.1	<0.1	<0.1				
TITANIUM (TI) DISS	<0.1	<0.1	<0.1				
VANADIUM (V) DISS	<0.10	<0.10	<0.10	<0.10			
ZINC (ZN) DISS	<0.01	<0.01	<0.01	<0.01	0.019	0.083	
OTHER PARAMETERS							
CYANIDE (CN) TOTAL	0.620	0.530	0.360	0.130	<0.005	<0.005	
CYANIDE (CN) FREE				<0.1			
CYANIDE (CN)					<0.005	<0.005	
CYANIDE (CN) WAD				0.005	<0.005	<0.005	0.75
THIOCYANATE				<1			

* Federal Drinking Water Standard (40 CFR Part 143)
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associated with gold deposits. Geochemical prospecting for gold often centers around areas with high arsenic concentrations in natural water.

4.0 PERCOLATION THROUGH NATURAL SOIL COLUMN

To simulate the effects of naturally occurring soil adsorption mechanisms, spent ore pore water from the column test was passed through a column of natural soil obtained from the spent ore depository. Results of this testing showed all parameters in the effluent were well below South Dakata Ground-Water Quality Standards (Table 4).

There was essentially complete adsorption of arsenic by the soil column reducing the arsenic concentration to less than 0.005 mg/L. This level of arsenic removal is not uncommon. Rose et al (1979) report arsenic attenuation factors in soil of 10 to 1000 depending on the amount of iron oxides present. Hassett and Groenewold (1986) found arsenic to be highly attenuated by overburden sediment in North Dakota. The high pH of the spent ore pore water (10.4) was lowered to 7.9. The pore water has a low alkalinity and the pH rapidly changes in the natural soil which is well buffered.

TABLE 4. WATER QUALITY OF SOIL EFFLUENT - GOLDEN REWARD MINING CO.

SITE NAME	SOIL EFFLUENT	SOIL EFFLUENT	SOIL EFFLUENT	SOIL EFFLUENT	AMBIENT GRNDWATER	AMBIENT GRNDWATER	S. DAKOTA GRNDWATER
SAMPLE DATE	05/11/88	05/11/88	05/11/88	05/11/88	AVERAGE	AVERAGE	STANDARDS
COLUMN MATERIAL	SOIL	SOIL	SOIL	SOIL			
COLUMN MATERIAL	TP-36	TP-36	TP-36	TP-36			
LEACHATE	SPENT ORE	SPENT ORE	SPENT ORE	SPENT ORE			
LEACHATE	PORE WATER	PORE WATER	PORE WATER	PORE WATER			
PORE VOLUME	1ST 1/3 #1	2ND 1/3 #1	3RD 1/3 #1	2 & 3			
LAB	EL	EL	EL	EL			
REMARKS					DM-13	DM-14	
PHYSICAL PARAMETERS							
SPEC. COND. (UMHOS/CM) LAB				393	482	875	
PH LAB				7.9	7.25	7.33	6.5-8.5
TDS MEAS. @ 180 DEG. C				239	291	643	1000
COMMON IONS							
TOTAL HARDNESS AS CACO3				129	260	524	
CALCIUM (CA)				46	67.6	132	
MAGNESIUM (MG)				3	22	46.8	
SODIUM (NA)				16	8.64	7.6	
POTASSIUM (K)				6	7.14	9.2	
ALKALINITY AS CACO3 (LAB)					224	245	
BICARBONATE (HCO3) (LAB)				213	273	299	
CARBONATE AS CO3 (LAB)				0	0	0	
HYDROXIDE (OH)				0	0	0	
SULFATE (SO4)				21	34.6	252	500
CHLORIDE (CL)				2	11.4	2.76	250
NUTRIENTS							
NITRATE (NO3-N)					0.048	0.176	10
NITRATE + NITRITE AS N				<0.05	0.04	0.2	
AMMONIA (NH3 AS N)				<0.1	1.73	0.084	
TRACE ELEMENTS							
ALUMINUM (AL) DISS	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	
ARSENIC (AS) DISS	<0.1	<0.1	<0.1	<0.005	0.154	0.0097	0.05
BARIUM (BA) DISS	0.7	0.2	0.1	0.1	0.397	0.059	1
BERYLLIUM (BE) DISS	<0.005	<0.005	<0.005	<0.005			
BORON (B) DISS	0.4	0.1	0.1	0.1			
CADMIUM (CD) DISS	<0.001	0.001	<0.001	<0.001	<0.0005	0.0015	0.01
CHROMIUM (CR) DISS	<0.02	<0.02	<0.02	<0.01	0.005	0.0049	0.05
COBALT (CO) DISS	0.01	<0.01	<0.01	<0.01			
COPPER (CU) DISS	0.03	<0.01	<0.01	<0.01	0.0033	0.0072	1.3
GOLD (AU) DISS					<0.005	<0.005	
IRON (FE) DISS	<0.03	<0.03	<0.03	<0.03	1.26	0.027	
LEAD (PB) DISS	<0.01	0.01	<0.01	<0.01	<0.005	<0.005	0.02
LITHIUM (LI) DISS				0.01			

* Federal Drinking Water Standard (40 CFR Part 143)
All quantities in milligrams per kilogram unless otherwise noted. Blank line indicates parameter not tested. Output Date: 06-16-1988
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TABLE 4. WATER QUALITY OF SOIL EFFLUENT - GOLDEN REWARD MINING CO.

SITE NAME	SOIL EFFLUENT	SOIL EFFLUENT	SOIL EFFLUENT	SOIL EFFLUENT	AMBIENT GRNDWATER	AMBIENT GRNDWATER	S. DAKOTA GRNDWATER
SAMPLE DATE	05/11/88	05/11/88	05/11/88	05/11/88	AVERAGE	AVERAGE	STANDARDS
TRACE ELEMENTS							
MANGANESE (MN) DISS	<0.02	<0.02	<0.02	0.04	2.55	0.142	0.05 *
MERCURY (HG) DISS	<0.1	<0.1	<0.1	<0.001	0.0003	0.0002	0.002
MOLYBDENUM (MO) DISS	0.018	0.008	0.008	0.006			
NICKEL (NI) DISS	0.12	<0.03	<0.03	<0.03	0.0021	0.0069	
SELENIUM (SE) DISS	0.2	<0.1	<0.1	<0.005	<0.002	0.0033	0.01
SILICON (SI) DISS	19	18	25	17			
SILVER (AG) DISS	<0.005	<0.005	<0.005	<0.005	0.0002	0.0005	0.05
VANADIUM (V) DISS	<0.10	<0.10	<0.10	<0.10			
ZINC (ZN) DISS	<0.01	<0.01	<0.01	<0.01	0.019	0.083	
OTHER PARAMETERS							
CYANIDE (CN) TOTAL	0.081	0.059	0.052	0.047	<0.005	<0.005	
CYANIDE (CN) FREE				<0.1			
CYANIDE (CN)					<0.005	<0.005	
CYANIDE (CN) WAD				0.008	<0.005	<0.005	0.75
THIOCYANATE				<1			

* Federal Drinking Water Standard (40 CFR Part 143)
All quantities in milligrams per Kilogram unless otherwise noted. Blank line indicates parameter not tested. Output Date: 06-16-1988
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5.0 CONCLUSIONS

Representative samples of waste rock from the Golden Reward project were tested for acid-base potential and release of toxic metals. Acid-base potential analyses shows the waste rock has no potential for generation of acidic water. EP Toxicity tests on waste rock were conducted to determine the potential for release of metals into the environment. Results of EP toxicity tests show the metals released are far below the EPA established limits.

Column testing was conducted to determine the quality of pore water that will occur in the spent ore. This water (spent ore pore water) was found to meet all South Dakota Ground-Water Quality Standards with the exception of arsenic and pH. Additional tests were conducted to determine the extent of arsenic removal from water and pH change as a result of percolation through natural soil underlying the spent ore depository. Arsenic removal by soil in the test was essentially complete, resulting in arsenic concentrations more than ten times below South Dakota Ground-Water Quality Standards. This shows that arsenic released from spent ore should be completely immobilized in the underlying soil and should not reach groundwater. The high pH of the pore water was lowered in the soil column test by natural soils of the proposed spent ore depository.

6.0 REFERENCES

Golden Reward Mining Company, 1987. Application for Permit. Submitted to State of South Dakota Board of Minerals and Environment. December, 1987.

Hassett, D.J. and G.H. Groenewold, 1986. Attenuation Capacity of Western North Dakota Overburden Sediments. North Dakota Mining and Mineral Resources Research Institute Bulletin No. 86-04-MMRRI-01.

Rose, A.W., H.E. Hawkes, and J.S. Webb, 1979. Geochemistry in Mineral Exploration, 2nd Edition. Academic Press, Inc., New York, N.Y.

Smith, R.M., W.E. Grube, Jr., T. Arkle, Jr., A. Sobek. 1974. Mine Spoil Potentials for Soil and Water Quality. Environmental Protection Technology Series. EPA-670/2-74-070.

APPENDIX 1.

SUMMARY OF AMBIENT GROUNDWATER QUALITY DATA

SUMMARY OF WATER QUALITY ANALYSES - GOLDEN REWARD MINING CO.

SITE NAME	DM-13	DM-13	DM-13	DM-13	DM-13	DM-14	DM-14	DM-14	DM-14	DM-14
SAMPLE DATE	12/21/87	01/19/88	02/19/88	03/24/88	04/22/88	12/16/87	01/19/88	02/19/88	03/24/88	03/24/88
LAB	TRAVIS	TRAVIS	TRAVIS	TRAVIS	IML	TRAVIS	TRAVIS	TRAVIS	TRAVIS	TRAVIS
REMARKS										REPLICATE
PHYSICAL PARAMETERS										
WATER TEMPERATURE (C)	7.3	6.4	8.1	9.5		4.8	7.5	8.1	9.6	9.6
SPEC. COND. (UMHOS/CM) FIELD	1200 X	820 X	880 X	820 X		1500 X	1650 X	200 X	1800 X	1800 X
SPEC. COND. (UMHOS/CM) LAB	560	525	500	470	353	830	975	1000	960	945
PH FIELD	7.74	7.79	7.14	7.52		7.78	7.60	7.59	7.66	7.66
PH LAB	7.34	7.23	7.25	7.12	7.29	7.56	7.15	7.57	7.22	7.07
TOTAL SUSP. SOLIDS	28	4	7	12	10	136 X	32	<1	4	3
TDS MEAS. @ 180 DEG. C	312	280	282	286	294	568	674	706	720	712
DEPTH TO SWL BELOW MP (FT)	287.10	318.35	316.80	315.20		250.50	250.95	249.1	238.15	238.15
COMMON IONS										
TOTAL HARDNESS AS CACO3	276	280	260	239	245	485	544	581	597	588
CALCIUM (CA)	74	77	69	66	52	133	140	150	161	161
MAGNESIUM (MG)	22	21	21	18	28	37	47	50	47	45
SODIUM (NA)	8	8	9	10	8.2	8	5	5	7	7
POTASSIUM (K)	10	7	4	11	3.7	16	9	5	10	10
ALKALINITY AS CACO3 (LAB)	234	218	224	225	217	260	244	248	262	260
BICARBONATE (HCO3) (LAB)	285	266	273	275	265	317	298	303	320	317
CARBONATE AS CO3 (LAB)	0	0	0	0	0	0	0	0	0	0
HYDROXIDE (OH)					0					
SULFATE (SO4)	39	43	34	32	25	196	251	338	404 X	303
CHLORIDE (CL)	12	11	10	11	13	4	4	2	1	2
FLUORIDE (F)	0.69	0.59	0.30	0.56	0.62	1.20	1.00	0.51	0.99	0.99
NUTRIENTS										
NITRATE (NO3-N)	<0.10	<0.10	<0.10	<0.10	0.04	<0.10	0.53 X	<0.10	<0.10	<0.10
NITRITE (NO2-N)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
NITRATE + NITRITE AS N					0.04					
KJELDAHL NITROGEN AS N	5.90	2.72	1.15	0.71	0.72	4.14 X	0.28	0.27	0.19	0.16
PHOSPHORUS (P) TOTAL	0.070	0.040	0.093	0.155	0.220	0.174	0.081	<0.010	<0.010	0.010
AMMONIA (NH3 AS N)	4.70	2.38	0.75	0.45	0.38	2.05 X	0.25	0.06	<0.03	<0.03
TRACE ELEMENTS										
ALUMINUM (AL) TOTAL	0.12	0.15		0.16	0.1	0.66	0.22		0.50	0.10
ALUMINUM (AL) DISS		<0.10	<0.10	<0.10	<0.1		<0.10	0.10	<0.10	<0.10
ANTIMONY (SB) TOTAL	<0.005	<0.005		<0.005	0.011	0.008	<0.005		0.016	0.017
ANTIMONY (SB) DISS		<0.005	0.017 X	<0.005	0.011		<0.005	0.009	0.007	0.009
ARSENIC (AS) TOTAL	0.034	0.123		0.426	0.375	0.121	0.269		0.024	0.027
ARSENIC (AS) DISS		0.006	0.125	0.183	0.302		0.009	0.018	0.009	0.017
BARIUM (BA) TOTAL	0.292	0.263		1.64	0.455	0.334	<0.100		0.31	<0.10
BARIUM (BA) DISS		0.213	0.65	0.524	0.200		<0.100	<0.10	<0.10	<0.10
CADMIUM (CD) TOTAL	<0.0005	<0.0005		0.0016	<0.0005	0.0019	0.0048		0.0031	0.0022

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SU. .RY OF WATER QUALITY ANALYSES - GOLDEN REWARD MINING CO.

SITE NAME	DM-13	DM-13	DM-13	DM-13	DM-13	DM-14	DM-14	DM-14	DM-14	DM-14
SAMPLE DATE	12/21/87	01/19/88	02/19/88	03/24/88	04/22/88	12/16/87	01/19/88	02/19/88	03/24/88	03/24/88
TRACE ELEMENTS										
CADMIUM (CD) DISS		0.0008 X	<0.0005	<0.0005	<0.0005		0.0020	0.0015	0.0011	0.0011
CHROMIUM (CR) TOTAL	0.100	0.063		0.010	0.018	0.065	0.067		0.052	0.024
CHROMIUM (CR) DISS		<0.005	0.014 X	<0.005	0.005		<0.005	0.014	<0.005	<0.005
COPPER (CU) TOTAL	0.012	0.006		0.020	0.002	0.020	0.012		0.030	0.013
COPPER (CU) DISS		<0.005	0.007	<0.005	0.001		<0.005	0.020	<0.005	<0.005
GOLD (AU) TOTAL	<0.005	<0.005		<0.005	0.006	<0.005	<0.005		<0.005	<0.005
GOLD (AU) DISS		<0.005	<0.005	<0.005	<0.005		<0.005	<0.005	<0.005	<0.005
IRON (FE) TOTAL	1.24	1.02		2.70	3.12	6.28 X	0.74		1.20	0.21
IRON (FE) DISS		0.40	1.87	1.90	0.89		0.02	0.05	<0.05	0.05
LEAD (PB) TOTAL	0.019	0.006		<0.005	<0.005	0.062	0.018		<0.005	<0.005
LEAD (PB) DISS		<0.005	<0.005	<0.005	<0.005		0.005	<0.005	<0.005	<0.005
MANGANESE (MN) TOTAL	0.36	1.91		3.20	2.92	0.49	0.24		0.10	0.10
MANGANESE (MN) DISS		1.51	4.21	3.18	1.28		0.15	0.11	0.05	0.06
MERCURY (HG) TOTAL	0.0002	0.0011		0.0008	0.0002	0.0002	0.0007		0.0004	<0.0002
MERCURY (HG) DISS		0.0002	0.0002	0.0006	<0.0002		0.0002	0.0002	0.0004	<0.0002
NICKEL (NI) TOTAL	0.120	0.049		0.015	0.001	0.072 X	0.005		0.027	0.020
NICKEL (NI) DISS		<0.005	<0.005	<0.006	<0.001		<0.005	<0.005	<0.005	0.005
SELENIUM (SE) TOTAL	<0.002	<0.002		<0.002	0.002	0.007	0.003		0.004	0.005
SELENIUM (SE) DISS		<0.002	<0.002	<0.002	<0.002		0.004	0.004	<0.002	<0.002
SILVER (AG) TOTAL	0.0005	<0.0005		<0.0005	<0.0002	0.0010	<0.0005		0.0010	<0.0005
SILVER (AG) DISS		<0.0005	<0.0005	<0.0005	<0.0002		<0.0005	0.0008	0.0009	<0.0005
ZINC (ZN) TOTAL	0.030	0.06		0.057	0.012	0.200	0.10		0.09	0.09
ZINC (ZN) DISS		0.01	0.025	0.030	0.012		0.11	0.070	0.08	0.08
OTHER PARAMETERS										
CYANIDE (CN) TOTAL	<0.01	<0.01	<0.01	<0.01	<0.005	<0.01	<0.01	<0.01	<0.01	<0.01
CYANIDE (CN)					<0.005					
CYANIDE (CN) WAD					<0.005					

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SUMMARY OF WATER QUALITY ANALYSES - GOLDEN REWARD MINING CO.

SITE NAME	DM-14	DM-14
SAMPLE DATE	03/24/88	04/22/88
LAB	IML	IML
REMARKS	SPLIT	
PHYSICAL PARAMETERS		
WATER TEMPERATURE (C)	9.6	
SPEC. COND. (UMHOS/CM) FIELD	1800 X	
SPEC. COND. (UMHOS/CM) LAB	971	611
PH FIELD	7.66	
PH LAB	7.5	7.17
TOTAL SUSP. SOLIDS	<1.0	1360
TDS - SUM OF DISS. CONST.	703	
TDS @ 105 DEG. C	756	
TDS MEAS. @ 180 DEG. C	732	546
DEPTH TO SWL BELOW MP (FT)	238.15	
COMMON IONS		
TOTAL HARDNESS AS CACO3	580	414
CALCIUM (CA)	159	78
MAGNESIUM (MG)	45	53
SODIUM (NA)	7	13
POTASSIUM (K)	4	6.0
ALKALINITY AS CACO3 (LAB)	246	209
BICARBONATE (HCO3) (LAB)	300	255
CARBONATE AS CO3 (LAB)	0	0
HYDROXIDE (OH)		0
SULFATE (SO4)	340	221
CHLORIDE (CL)	2	218
FLUORIDE (F)	0.86	1.32
NUTRIENTS		
NITRATE (NO3-N)	0.12	0.20
NITRITE (NO2-N)	<0.01	<0.01
NITRATE + NITRITE AS N	0.12	0.20
KJELDAHL NITROGEN AS N	<0.01 X	1.12
PHOSPHORUS (P) TOTAL	0.030	1.479
AMMONIA (NH3 AS N)	<0.01	0.01
TRACE ELEMENTS		
ALUMINUM (AL) TOTAL	<0.10	15.4
ALUMINUM (AL) DISS	<0.10	<0.1
ANTIMONY (SB) TOTAL	<0.005	<0.005
ANTIMONY (SB) DISS	<0.005	<0.005
ARSENIC (AS) TOTAL	0.014	0.385
ARSENIC (AS) DISS	0.010	0.003
BARIUM (BA) TOTAL	0.04	2.088

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SUMMARY OF WATER QUALITY ANALYSES - GOLDEN REWARD MINING CO.

SITE NAME	DM-14		DM-14
SAMPLE DATE	03/24/88		04/22/88
TRACE ELEMENTS			
BARIUM (BA) DISS	0.04		0.059
CADMIUM (CD) TOTAL	0.006		0.0418
CADMIUM (CD) DISS	0.001		0.0012
CHROMIUM (CR) TOTAL	<0.008	X	0.140
CHROMIUM (CR) DISS	<0.008		<0.001
COPPER (CU) TOTAL	<0.01		0.352
COPPER (CU) DISS	<0.01		0.004
GOLD (AU) TOTAL	0.014	X	<0.005
GOLD (AU) DISS	0.014	X	<0.005
IRON (FE) TOTAL	0.08	X	56.12
IRON (FE) DISS	0.03		<0.03
LEAD (PB) TOTAL	<0.005		1.068
LEAD (PB) DISS	<0.005		<0.005
MANGANESE (MN) TOTAL	0.07		8.79
MANGANESE (MN) DISS	0.07		0.26
MERCURY (HG) TOTAL	0.0003		0.0021
MERCURY (HG) DISS	<0.0002		<0.0002
NICKEL (NI) TOTAL	0.039		0.082
NICKEL (NI) DISS	0.022	X	0.020
SELENIUM (SE) TOTAL	0.006		0.005
SELENIUM (SE) DISS	0.004		0.005
SILVER (AG) TOTAL	0.0026		<0.0002
SILVER (AG) DISS	0.0026	X	<0.0002
ZINC (ZN) TOTAL	0.072		1.873
ZINC (ZN) DISS	0.072		0.073
OTHER PARAMETERS			
CYANIDE (CN) TOTAL	<0.005		<0.005
CYANIDE (CN)			<0.005
CYANIDE (CN) WAD			<0.005

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