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SUMMARY OF DATA PRESENTED IN THE BACKGROUND DOCUMENT FOR EFFLUENT LIMITATIONS GUIDELINES AND STANDARDS - ORE MINING AND DRESSING POINT SOURCE CATEGORY

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SUMMARY OF DATA PRESENTED IN THE BACKGROUND DOCUMENT FOR EFFLUENT LIMITATIONS GUIDELINES AND STANDARDS - ORE MINING AND DRESSING POINT SOURCE CATEGORY

The Ore Mining and Dressing Category includes extraction and beneficiation operations in the hard rock and mineral mining sectors. These sectors include: Iron, Copper, Lead, Zinc, Gold, Silver, Molybdenum, Aluminum, Tungsten, Nickel, Vanadium, Mercury, Uranium, Antimony, Titanium, and Platinum. In the early 1980's, EPA conducted a study of wastewaters generated at ore mining and dressing sites to support development of national effluent guidelines to be included in NPDES permits issued for these facilities. The results of this study, including wastewater sampling and analysis data, are presented in the "Development Document for Effluent Limitations Guidelines and Standards for the Ore Mining and Dressing Point Source Category," EPA 440/1-82/061, November 1982.

The EPA's Office of Solid Waste has recompiled the data contained in the effluent guideline for possible use in its effort to develop a rational mining program. Data contained in this report is taken from the effluent guideline document and does not represent new research. Further, it should be noted that the data represented has not been reviewed for quality control/quality assurance. The source documents detailing sampling methodolgies and protocols were not consulted for this review.

In 1982, there were over 500 known major active ore mines and over 150 active ore milling operations in the U.S. Approximately two-thirds of these mines and mills were existing point source dischargers, the remainder discharged no process wastewater.

The data presented in the Development Document are divided by sector (or group of sectors) and further subdivided according to type of operation (mining, milling, etc.). The specific types of operations within each sector are listed in Attachment 1 (Table IV-1, page 118 of the Development Document).

Data gathering for the ore mining and dressing category was conducted over several years through the following activities:

(1) Screening and verification sampling and analysis programs
(2) Engineering cost site visits
(3) Supporting data from EPA regional offices
(4) Treatability studies (13 conducted)
(5) Industry self-monitoring sampling
(6) Best Practicable Technology database
(7) Placer study
(8) Titanium sand dredges study
(9) Uranium study
(10) Solid waste study

The parameters analyzed for include:

- Organics, see Attachment 2 (All 114 specific organics as listed in Table V-1 pages 142-146, attached)
  Total Phenolics, see Attachment 3 (4AAP)[1]

- Metals (13 metals listed in Table V-2 page 147 attached)

[1] 4AAp = 4 Amino Anti Pyrine, a reagent designation of use in analysis of total phenolics.

Total and dissolved analyses performed

- Cyanide (Total analyses only)

- Asbestos
  Total Fibers
  Chrysotile

- Conventional Pollutants:
  Total suspended solids (TSS)
  pH

- Non-Conventional Pollutants:
  Temperature
  Volatile Suspended Solids (VSS)
  Chemical Oxygen Demand (COD)
  Total Organic Carbon (TOC)
  Radium - 226 Total and dissolved
  Total Phenolics (4AAP)
  Total Settleable Solids

A narrative description of the results of wastewater characterization for each process is included on pages 155-165 of the Development Document (see Attachment 4). This description provides such information as pollutants found at elevated levels, potential pollutants found at specific types of plants, and impacts of treatment technologies. The raw and treated (see narrative discussion, 155 - 165) wastestream pollutant data are summarized in greater detail for each sector and process category in the attached tables. An index of the Attachment 4 data included in these tables is as follows:

Category	Reference Pages for Sampling and Analysis Data
Ore Mining	166-170
Data Summary for All Subcategories	
Ore Milling	
Summary of Reagent Use in Ore Flotation Mills	187-192
Iron	
Mining - Mine Drainage	171
Milling - Physical and/or Chemical	172
Copper/Lead/Zinc/Gold/Silver/Platinum/Molybdenum	
Mining - Mine Drainage	173
Milling - Cyanidation	174
Milling - Flotation	175
Milling - Heap/Vat/Dump	176
Copper/Lead/Zinc/Gold/Silver/Platinum/Molybdenum	
Milling - Gravity Sep	177
Aluminum	
Mining - Mine Drainage	178

Category	Reference Pages for Sampling and Analysis Data
Ore Mining Data Summary for All Subcategories	166-170
Tungsten Milling	179
Mercury Milling - Flotation	180
Uranium	
Mining - Mine Drainage	181
Milling - Arid Location	182
Titanium	
Mining - Mine Drainage	183
Milling - with Dredge Mining	184
Vanadium	
Mining	185
Milling - Flotation	186

Table 1 provides a list of the applicable standards for many of the contaminants detected in ore processing wastewater. This Table was included to assist the reader in assessing the levels of specific pollutants detected in the wastewaters.

TABLE 1

APPLICABLE STANDARDS FOR CONTAMINANTS DETECTED IN ORE PROCESSING EFFLUENT

Constituent of Concern	Maximum Allowable Level (in mg/l except where noted)	Regulation
pH	6.5 - 8.5 s.u.	NSDWR
Flouride	4	NPDWR
Chloride	250	NSDWR
Sulfate	250	NSDWR
Cadmium	0.010	NPDWR
Barium	1.0	NPDWR
Lead	0.05	NPDWR
Aluminum (pH 6.5 - 9.0 s.u.)	0.05	NSDWR
Asbestos	7 MFL[2]	NPDWR
Turbidity	1 NTU	NPDWR
Nitrate	10	NPDWR
Sulfide	2 ug/l (criterion continuous concentration)	NSDWR
Chromium	0.05	NPDWR
Iron	0.3	NSDWR
Manganese	0.05	NSDWR
Zinc	5	NSDWR
Radium	5 pCi/l	NPDWR

NPDWR = National Primary Drinking Water Regulations
NSDWR = National Secondary Drinking Water Regulations
MFL = Million Fibers per Liter
NTU = National Turbidity Units

ATTACHMENT 1

TABLE IV-1. PROPOSED SUBCATEGORIZATION FOR BAT – ORE MINING AND DRESSING

SUBCATEGORY	SUBDIVISION	PROCESS
Iron Ore	Mine Drainage	
	Mills	Physical and/or Chemical Beneficiation
		Physical Beneficiation Only (Mesabi Range)
Copper, Lead, Zinc, Gold, Silver, Molybdenum Ores	Mine Drainage	
	Mills or Hydro-metallurgical Beneficiation	Cyanidation or Amalgamation
		Heap, Vat, Dump, In-Situ Leaching (Cu)
		Froth Flotation
		Gravity Separation Methods (incl. Dredge, Placer, or other physical separation methods; Mine Drainage or mines and mills)
Aluminum Ore	Mine Drainage	
Tungsten Ore	Mine Drainage	
	Mills	
Nickel Ore	Mine Drainage	
	Mills	(Physical Processes)
Vanadium Ore*	Mine Drainage	
	Mills	Ore Leaching
Mercury Ore	Mine Drainage	
	Mills	Gravity Separation, Froth Flotation, Other Methods
Uranium Ores	Mine Drainage	
	Mills, Mines and Mills or In-Situ Mines	
Antimony Ores	Mine Drainage	
	Mills	Flotation Process
Titanium Ores	Mine Drainage	
	Mills	
	Mills with Dredge Mining	
Platinum Ore	Mine Drainage	
	Mills	

*Vanadium extracted from non-radioactive ores

ATTACHMENT 2

Table V-1

TOXIC ORGANICS

Compound Name

1. *acenaphthene (B)***
2. *acrolein (V)***
3. *acrylonitrile (V)
4. *benzene (V)
5. *benzidene (B)
6. *carbon tetrachloride (tetrachloromethane) (V)

*Chlorinated benzenes (other than dichlorobenzenes)

7. chlorobenzene (V)
8. 1,2,4-trichlorobenzene (B)
9. hexachlorobenzene (B)

*Chlorinated ethanes(including 1,2-dichloroethane, 1,1,1-trichloroethane and hexachloroethane)

10. 1,2-dichloroethane (V)
11. 1,1,1-trichlorethane (V)
12. hexachlorethane (B)
13. 1,1-dichloroethane (V)
14. 1,1,2-trichloroethane (V)
15. 1,1,2,2-tetrachloroethane (V)
16. chloroethane (V)

*Chloroalkyl ethers (chloromethyl, chloroethyl and mixed ethers)

17. bis (chloromethyl) ether (B)
18. bis (2-chloroethyly) ether (B)
19. 2-chloroethyl vinyl ether (mixed) (V)

*Chlorinated naphthalene

20. 2-chloronaphthalene (B)

*Chlorinated phenols (other than those listed elsewhere; includes trichlorophenols and chlorinated cresols)

21. 2,4,6-trichlorophenol (A)***
22. parachlorometa cresol (A)
23. *chloroform (trichloromethane) (V)
24. *2-chlorophenol (A)

Table V-1 (Continued)

TOXIC ORGANICS

*Dichlorobenzenes

25. 1,2-dichlorobenzene (B)
26. 1,3-dichlorobenzene (B)
27. 1,4-dichlorobenzene (B)

*Dichlorobenzidine

28. 3,3'-dichlorobenzidine (B)

*Dichloroethylenes (1,1-dichloroethylene and 1,2-dichloroethylene)

29. 1,1-dichloroethylene (V)
30. 1,2-trans-dischloroethylene (V)
31. *2,4-dichlorophenol (A)

*Dichloropropane and dichloropropene

32. 1,2-dichloropropane (V)
33. 1,2-dichloropropylene (1,3-dichloropropene) (V)
34. *2,4-dimenthylphenol (A)

*Dinitrotoluene

35. 2,4-dinitrotoluene (B)
36. 2,6,-dinitrotoluene (B)
37. *1,2-diphenylhydrazine (B)
38. *ethylbenzene (V)
39. *fluoranthene (B)

*Haloethers (other than those listed elsewhere)

40. 4-chlorophenyl phenyl ether (B)
41. 4-bromophnyl phenyl ether (B)
42. bis(2-chloroisopropyl) ether (B)
43. bis(2-chloroethoxy) methane (B)

*Halomethanes (other than those listed elsewhere)

44. methylene chloride (dichloromethane) (V)
45. methyl chloride (chloromethane) (V)
46. methyl bromide (bromomethane) (V)
47. bromoform (tribromomethane) (V)
48. dichlorobromomethane (V)

Table V-1 (Continued)

TOXIC ORGANICS

49. trichlorofluoromethane (V)
50. dichlorodifluoromethane (V)
51. chlorodibromomethane (V)
52. *hexachlorobutadiene (B)
53. *hexachlorocyclopentadiene (B)
54. *isophorone (B)
55. *naphthalene (B)
56. *nitrobenzene (B)

*Nitrophenols (including 2,4-dinitrophenol and dinitrocesol)

57. 2-nitrophenol (A)
58. 4-nitrophenol (A)
59. *2,4-dinitrophenol (A)
60. 4,6-dinitro-o-cresol (A)

*Nitrosamines

61. N-nitrosodimethylamine (B)
62. N-nitrosodiphenylamine (B)
63. N-nitrosodi-n-propylamine (B)
64. *pentachlorophenol (A)
65. *phenol (A)

*Phthalate esters

66. bis(2-ethylhexyl) phthalate (B)
67. butyl benzyl phthalate (B)
68. di-n-butyl phthalate (B)
69. di-n-octyl phthalate (B)
70. diethyl phthalate (B)
71. dimethyl phthalate (B)

*Polynuclear aromatic hydrocarbons

72. benzo (a)anthracene (1,2-benzanthracene) (B)
73. benzo (a)pyrene (3,4-benzopyrene) (B)
74. 3,4-benzofluoranthene (B)
75. benzo(k)fluoranthane (11,12-benzofluoranthene) (B)
76. chrysene (B)
77. acenaphthylene (B)
78. anthracene (B)
79. benzo(ghi)perylene (1,12-benzoperylene) (B)
80. fluorene (B)
81. phenathrene (B)

Table V-1 (Continued)

TOXIC ORGANICS

82. dibenzo (a,h)anthracene (1,2,5,6-dibenzanthracene) (B)
83. indeno (1,2,3-cd)(2,3,-o-phenylenepyrene) (B)
84. pyrene (B)
85. *tetrachloroethylene (V)
86. *toluene (V)
87. *trichloroethylene (V)
88. *vinyl chloride (chloroethylene) (V)

Pesticides and Metabolites

89. *aldrin (P)
90. *dieldrin (P)
91. *chlordane (technical mixture and metabolites) (P)

*DDT and metabolites

92. 4,4'-DDT (P)
93. 4,4'-DDE(p,p'DDX) (P)
94. 4,4'-DDD(p,p'TDE) (P)

*endosulfan and metabolites

95. a-endosulfan-Alpha (P)
96. b-endosulfan-Beta (P)
97. endosulfan sulfate (P)

*endrin and metabolites

98. endrin (P)
99. endrin aldehyde (P)

*heptachlor and metabolites

100. heptachlor (P)
101. heptachlor epoxide (P)

*hexachlorocyclohexane (all isomers)

102. a-BHC-Alpha (P) (B)
103. b-BHC-Beta (P) (V)
104. r-BHC (lindane)-Gamma (P)
105. g-BHC-Delta (P)

Table V-1 (Continued)

TOXIC ORGANICS

*polychlorinated biphenyls (PCB's)

106. PCB-1242 (Arochlor 1242) (P)
107. PCB-1254 (Arochlor 1254) (P)
108. PCB-1221 (Arochlor 1221) (P)
109. PCB-1232 (Arochlor 1232) (P)
110. PCB-1248 (Arochlor 1248) (P)
111. PCB-1260 (Arochlor 1260) (P)
112. PCB-1016 (Arochlor 1016) (P)

113. *Toxaphene (P)
114. **2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD)

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*Specific compounds and chemical classes as listed in the consent degree.
**This compound was specifically listed in the consent degree.
***B = analyzed in the base-neutral extraction fraction
V = analyzed in the volatile organic fraction
A = analyzed in the acid extraction fraction

ATTACHMENT 3

Table V-2

TOXIC METALS, CYANIDE AND ASBESTOS

1. *Antimony (Total)
2. *Arsenic (Total)
3. *Asbestos (Fibrous)
4. *Beryllium (Total)
5. *Cadmium (Total)
6. *Chromium (Total)
7. *Copper (Total)
8. *Cyanide (Total)
9. *Lead (Total)
10. *Mercury (Total)
11. *Nickel (Total)
12. *Selenium (Total)
13. *Silver (Total)
14. *Thallium (Total)
15. *Zinc (Total)

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*Specific compounds and chemical classes as listed in the consent degree.

ATTACHMENT 4

SECTION VI

WASTEWATER CHARACTERIZATION

The data base developed during the sampling program described in Section V is presented in Supplement A and summary tables are presented and discussed in this section. Also, a summary of reagent usage at flotation mills, the largest users of mill process chemicals, is presented to evaluate mill reagents as potential sources of toxic pollutants. Special circumstances, such as, the presence of certain toxic pollutants in mine water as a result of backfilling mines with mill tailings, are discussed at the end of this section.

SAMPLING PROGRAM RESULTS

The analytical results of the nine sampling programs discussed in Section V are presented in Supplement A and were entered into a computerized data base. Using this data base, summary data tables were generated for the entire category; and each subcategory, subdivision, and mill process (Tables VI-1 through VI-18, which may be found at the end of this section). These tables include raw and treated wastewater data; and the range of pollutant concentrations observed is indicated by the mean and median values, and the 90 percent and maximum values (defined below).

All Subcategories Combined

Table VI-1 summarizes the BAT data base for all the mines and mills in all subcategories in the ore mining and dressing point source category. As indicated by the table, only 27 of the toxic organics were detected in the category's treated wastewater. Organic compounds are not found naturally with metal ores. Introduction of organics during froth flotation mill processing is discussed later in this section. Otherwise, the discussion of toxic organics is left to Section VII, Selection of Pollutant Parameters.

Toxic metals are naturally associated with metal ores and all of the 13 toxic metals were found in wastewater from the category. The concentrations of each metal varied greatly, as expected for such a diverse category. Cyanide and asbestos, also toxic parameters, were observed in many samples and in varied concentrations.

The conventional parameters observed were primarily those regulated by BPT effluent guidelines, that is TSS and pH. The TSS values are very high in many raw samples because tailings samples which typically run in the tens of thousands of mg TSS/l are included in "raw" samples. Effluent TSS values vary, but are generally low indicating good solids settling characteristics.

Values of pH vary, but are often in the alkaline range (7 to 14). This is because several mill processes operate at elevated pHs. As indicated by discussions in Section III, pH, TSS, and metals values are closely allied. The solubility of many metals varies greatly with pH, and the status of the metals (dissolved v. solubilized) affects the concentration of TSS. This relationship is used by the industry for ore beneficiation and for wastewater treatment.

Nonconventional parameters such as COD, TOC, volatile suspended solids (VSS), and iron were also analyzed for many samples. The concentrations of the organic related parameters, COD, TOC, and VSS, were always low. Any organic compounds added in mill processes are not indicated by these tests which are designed to measure relatively large masses of organics (in the mg/l range at a minimum). Iron is common in metal ores and the summary table reflects this.

The entire BAT data set is discussed below by subcategory, subdivision, and as a mill process or mine drainage, and these discussions more completely characterize mine/mill wastewaters. In general it can be noted from Table VI-1 that organic compounds are not the major concern in this category (a point discussed thoroughly in Section III), metals are prevalent, pH values are generally alkaline, and cyanide and asbestos are often present.

<u>Iron Subcategory, Mine Drainage Subdivision</u>

Table VI-2 summarizes the data for iron mines. Many of the toxic metals were not detected in the one or two available samples; arsenic (.005 mg/l) copper (.090 and 120 mg/l), and zinc (.018 and .030 mg/l) are the exceptions. Asbestos fibers, both total and chrysotile, were detected in relatively small amounts compared to the rest of the category (see Table VI-1). Generally, (comparing Tables VI-1 and VI-2) iron mine water is characterized by low pollutant levels. This is true of most mine water and is the reason for separate mine and mill subdivisions.

<u>Iron Subcategory, Mill Subdivision, Physical and/or Chemical Mill Processes</u>

As indicated in Table VI-3, several of the toxic metals were present in the one or two raw samples taken, but most are removed by existing treatment technologies (sedimentation) and were not detected in discharge samples. Copper is the least affected by current treatment methods. Asbestos was detected in relatively high concentrations in the raw sample (compared to Table VI-1), and in lower concentrations in the discharged sample. This indicates that current treatment methods are removing a portion of the asbestos; a conclusion supported by Table VI-3. The COD, VSS, and TOC (indicators of gross organic pollution) are somewhat higher than the rest of the industry (compared to Table VI-1), but they are effectively removed by current technologies. Iro was detected in one raw sample, as expected for iron mills, but was below detection in the discharge water. Several toxic metals, asbestos, TSS, and some nonconventional parameters were found in the raw wastewater of iron mills, but these parameters were reduced during treatment and many do not appear in the discharge water.

Copper/Lead/Zinc/Gold/Silver/Molybdenum Subcategory, Mine Drainage Subdivision

This subcategory includes more mines than any other subcategory and more samples are available for characterization than for other subcategories. As shown in Table VI-4, all of the toxic metals were detected at least four times in sixteen raw samples. High median concentrations (relative to the other metals detected) of antimony, arsenic, cadmium, chromium, copper, lead, nickel, thallium, and zinc are shown in Table VI-4 for raw mine drainage. In the discharged water, however, the metals concentrations are lower, with the median values ranging from not detected to 280 ug/l (zinc).

Cyanide, asbestos, and phenolics are other toxic parameters detected in this subdivision. Cyanide is used in the froth flotation process and backfilling mines with mill tailings can cause cyanide to pollute the mine water. Asbestos, being a mineral, is found with many metal ores, although the concentrations reported in Table VI-4 are relatively low (compared to Table VI-1) and have a small range for samples taken at many types of mines. Phenolics were detected at low concentrations.

Copper/Lead/Zinc/Silver/Gold/Molybdenum Subcategory, Cyanidation Mill Process

This subdivision was regulated as no discharge of process wastewater in BPT effluent guidelines, therefore, few samples were taken in BAT sampling programs and no discharge samples were taken. It can be seen from Table VI-5 that many toxic parameters, including cyanide, were found in high concentrations in this mill water; thereby supporting the BPT no discharge requirement.

Copper/Lead/Zinc/Silver/Gold/Molybdenum Subcategory, Mill Subdivision, Froth Flotation Mill Process

There were more samples of this mill process than of any others because froth flotation is a widely used process with the potential to generate wastewater polluted with many toxics. As seen in Table VI-6, all of the toxic metals were detected in raw mill water. The number of detections ranged from 7 to 78 out of 78 samples and median concentrations ranged from 1.1 ug/l (mercury) to 63,300 ug/l (copper). These wide ranges are due to the variations in the ore milled at different locations. Generally, the metals concentrations are in the high range of values reported for the category as a whole (Table VI-1). The discharged concentrations of metals are, generally, one or two orders of magnitude lower than the raw values. The number of toxic metals with median concentration over 20 ug/l are reduced from ten in raw samples to five in treated samples and, overall, the concentrations are reduced by existing treatment.

Asbestos, cyanide, and phenolics were also detected in both raw and discharged samples. Median values for all were above the respective medians for the whole category (Table VI-1). All were reduced by the existing treatment systems.

Nonconventional parameters and TSS were generally high (compared to Table VI-1) and the pH range is great.

Generally, mill water and tailings from this mill process contain a wider range and higher concentrations of pollutants, including toxics, than other mill processes or mines in this category. The various process reagents used in flotation are discussed later in this section.

<u>Copper/Lead/Zinc/Gold/Silver/Molybdenum Subcategory, Mill Subdivision, Heap/Vat/Dump/In-Situ Leaching</u>

Very few samples were taken in this mill process because it is regulated as no discharge of process water in BPT effluent guidelines. As can be seen in Table VI-7, the raw wastewater has high concentration of several parameters, the reason for the no discharge requirement. The one discharged sample reported is actually treated recycle water which is not discharged.

<u>Copper/Lead/Zinc/Gold/Silver/Molybdenum Subcategory, Placer Operations Recovering Gold</u>

A study was conducted in 1978 to evaluate current wastewater handling practices at gold placer mines. Eleven operations, all located in Alaska, were sampled to determine performance capabilities of existing settling ponds. Only two of the toxic metals were monitored during the program, arsenic and mercury. Settleable solids were also monitored to provide an indication of treatment pond performance. As can be seen in Table VI-8, the settleable solids concentrations range from not detected to 500 ml/l/hr. However, many of the different samples are discharges that had not been treated in settling ponds.

<u>Aluminum Subcategory, Mine Drainage Subdivision</u>

As shown in Table VI-9, aluminum mine drainage is low in most pollutants. The toxic metals present in the discharge are in relatively low concentrations (compared to Table VI-1) and are chromium, copper, mercury, nickel, and zinc. Asbestos was present in moderate concentrations (compared to Table VI-1) and was not affected by the existing treatment methods. Acid pH levels were noted in the raw, but these increased to the alkaline range (7 pH 14) after pH adjustment.

Tungsten Subcategory, Mill Subdivision

As shown in Table VI-10, 13 of the toxic metals were detected in the raw wastewater. However, these are reduced during treatment leaving only seven above 20 ug/l in the discharge. Of these, copper, lead, and zinc have high concentrations (compared to the other discharge metals concentrations).

Asbestos and phenolics were detected in the raw samples; cyanide was not. The values of asbestos are high relative to the category as a whole (see Table VI-1). The effluent phenolics are low relative to the values in Table VI-1.

Mercury Subcategory, Mill Subdivision

As seen in Table VI-11, the toxic metals are found in high concentrations in the raw wastewater in this subdivision, as are asbestos and phenolics. That is why the applicable BPT regulation is no discharge of process wastewater. The discharged sample in Table VI-11 is actually treated recycle water.

Uranium Subcategory, Mine Drainage Subdivision

Uranium mine drainage, is, relative to mill water less polluted. As seen in Table VI-12, many of the toxic metals were detected, all but zinc in concentrations less than 65 ug/l. Only six were detected in the treated samples, none greater than 50 ug/l.

Cyanide was not detected, and phenolics were detected at a low concentration (10 ug/l). Asbestos was detected in both raw and treated samples at moderate concentrations (as compared to Table VI-1).

Not listed in Table VI-12, but shown in the support data (Supplement A), are radium 226 concentrations. Uranium ore is radioactive and radium 226 is a radionuclide always associated with uranium. It is one of the uranium decay series and has a half life of 1,620 years. Raw mine water may have several hundred to a thousand pico-Curies per liter (p Ci/l) of Ra 226, but existing treatment is capable of reducing this to the BPT guideline of 10 p Ci/l (total, 30-day average).

Uranium Subcategory, Mill Subdivision

As seen in Table VI-13, several of the toxic metals are found in both raw and treated wastewater. Treated wastewater in this table is actually recycle water. The facilities do not discharge. This recycle water is not treated specifically for metals, and, therefore, little reduction occurs.

Asbestos was found in both influent and effluent samples in moderate concentrations (as compared to Table VI-1). Cyanide was not detected and total phenol (4AAP) were detected at a low concentration (10 ug/l). As with mine drainage, mill water may have several hundred to a thousand p Ci/l Ra 226. Current treatment at the single uranium mill discharging is reducing this to 10 p Ci/l, the BPT limitation.

<u>Titanium Subcategory, Mine Subdivision</u>

As can be seen in Table VI-14, the mine water from this subcategory is relatively clean (relative to Table VI-1). Three toxic metals (copper, lead, and zinc) were detected at 20 ug/l. Relative to the category as a whole (Table VI-1), the asbestos values are low. Total phenolics were detected at 30 ug/l.

<u>Titanium Subcategory, Mill Subdivision</u>

As shown in Supplement A (Support Data; Sample Points 1A and 2A, for Mill 9905), seven toxic metals were detected in the raw wastewater; all but selenium and lead at concentrations greater than 200 ug/l. These concentrations were reduced by treatment, leaving only five detected toxic metals ranging in concentration from 20 to 100 ug/l.

Asbestos was detected at moderate concentrations (compared to Table VI-1). Cyanide was not detected and phenolics were detected at 10 ug/l in raw and discharged samples.

<u>Titanium Subcategory, Mills with Dredge Mining Subdivision</u>

Table VI-15 summarizes the data for the titanium mills employing dredge mining. Ten toxic metals were detected in the raw water, at concentrations less than or equal to 80 ug/l. In the treated effluent, six toxic metals were detected. Only zinc was detected in concentrations greater than 10 ug/l.

COD and TOC concentrations in the raw water were generally present in higher concentrations than the rest of the category due to the presence of organic material in some of the ores. The treatment processes used substantially reduced the concentrations of both COD and TOC. The TSS concentration of the effluents were less than 10 mg/l.

<u>Vanadium Subcategory, Mine Drainage Subdivision</u>

Table VI-16 illustrates the character of vanadium mine drainage. Several toxic metals were present both in the raw and discharged water. Discharge concentrations greater than 20 ug/l were reported for chromium, copper, lead, nickel, and zinc. Cyanide and total phenolics were not detected. The asbestos values were low relative to the category as a whole.

Vanadium Subcategory, Mill Subdivision

As seen in Table VI-17, many toxic metals were detected in both the raw and discharged waters from this subdivision. Of the metals, only mercury was reduced below the detection limit by the existing treatment system. Cyanide was also reduced below the detection limit, and no total phenolics were detected in raw or discharged water.

Antimony Subcategory, Mill Subdivision

The data for this subcategory are presented in Table VI-18. There is no discharge of treated wastewater from the single mill in this subdivision. Relatively high concentrations of antimony and arsenic are present in the raw and treated wastewater. Phenolics were not detected in the raw or treated wastewater. Asbestos was detected in moderate concentrations compared to Table VI-1. The pH of the impounded water was greater than 12.0.

REAGENT USE IN FLOTATION MILLS

Froth flotation processes use various reagents in the porcess, and these reagents are discharged with the tailings and mill process water. Flotation reagents are a possible source of toxic organics in an industry which, otherwise, has no known source of toxic organics. Therefore, a survey was conducted to determine the availability of toxic organics and other toxics in flotation reagents.

The results of a nationwide survey of sulfide ore flotation mills indicate that over 547,400 metric tons (602,000 short tons) of chemical flotation reagents were consumed in 1975 (Reference 1). Reagent use data supplied by 22 milling operations indicate that 63 different chemical compounds are used directly in sulfide ore flotation circuits. These reagents are categorized as:

1. pH Modifier (Conditioner, Regulator)--Any substance used to regulate or modify the pH of an ore pulp or flotation process stream. Examples of the most commonly used reagents are lime, soda ash (sodium carbonate), caustic soda (sodium hydroxide), and sulfuric acid.

2. Promoter (Collector)--A reagent added to a pulp stream to bring about adherence between solid particles and air bubbles in a flotation cell. Examples of the most common promoters are xanthate and dithiophosphate salts, as well as saturated hydrocarbons (such as fuel oil).

3. Frother--A substance used in flotation processing to stabilizeair bubbles, principally by reducing surface tension. Common frothers are pine oil, cresylic acid, amyl alcohol, MIBC, and polyglycol methyl ethers.

4. Activator--A substance which, when added to a mineral pulp, promotes flotation in the presence of a collecting agent. It may be used to increase the floatability of a mineral in a froth or to refloat a depressed mineral. A good example of an activating agent is copper sulfate, used in the flotation of sphalerite.

5. Depressant--A substance which reacts with the particle surface to render it less prone to stay in the froth, thus causing it to wet down as a tailing product (contrary to activator). Examples of depressing agents most commonly used are cyanide, zinc sulfate, corn starch, sulfur dioxide, and sodium sulfite.

Table VI-19 summarizes reagent use for copper, lead, zinc, silver, and molybdenum flotation mills which discharge process wastewater. Comparing the reagents listed in Table VI-19 to the list of toxic pollutants given in Section V, only the following reagents are considered to be potential sources of one or more toxic pollutants in mill process wastewater: copper, zinc, chromium, and total phenolics (4AAP).

Copper

Copper sulfate addition to a flotation pulp containing sphalerite (ZnS) is a good example of an activating agent. The cupric ions replace zinc in the sphalerite lattice to permit better collector attachment, thus allowing the mineral to be floated with a xanthate (Reference 2). Copper ammonium chloride functions in much the same manner and is used at one operation (Mill 3110) because it is purchased as a waste byproduct from the manufacturer of electronic circuit boards. Copper sulfate is highly soluble in water and is added to the flotation circuit in concentrations as high as 100 mg/l (as Cu). Residual dissolved copper in the tailings pulp stream readily forms copper hydroxide precipitates at the alkaline pH common to most sulfide flotation systems.

Zinc

The function of zinc sulfate is the depression of sphalerite when floating galena and copper sulfides (Reference 3), and the mechanism involved is very similar to that of copper sulfate described above. Typically, dosage rates of 0.1 to 0.4 kilogram of zinc sulfate per metric ton (0.2 to 0.8 pound per short ton) of ore feed are used, often in conjunction with cyanide. These dosage rates translate to dissolved zinc loads in the flotation circuit of 5.2 to 65 mg/l (as Zn). Residual zinc concentrations from excessive zinc sulfate use are small compared to the total zinc content of the tailings.

Chromium

Sodium dichromate is used as a flotation reagent at only one of the 22 flotation mills listed in Table VI-19. It functions as a depressant for galena in copper/lead separations. Dosages of this reagent are relatively small, and long term analyses of treated effluent have not indicated the presence of chromium in detectable concentrations.

Cyanide

Sodium cyanide and, to a lesser extent, calcium cyanide have found widespread application within the industry as strong depressants for iron sulfides and sphalerite. Cyanide also acts as a mild depressant for chalcopyrite, enargite, bornite, and most other sulfide minerals with the exception of galena (Reference 4). A secondary action of cyanide, in some instances, may be the cleaning of tarnished mineral surfaces, thereby allowing a more selective separation of the individual minerals (Reference 5). Typical cyanide reagent dosages range from 0.003 to 0.125 kilogram per metric ton (0.006 to 0.250 pound per short ton) of ore feed and average 0.029 (0.058). Expressed in terms of water use, cyanide dosages range from less than 1.0 to 50.4 milligrams per liter (as sodium cyanide), with an average of about 11.

Sodium cyanide and calcium cyanide flotation reagents are the sole source of cyanide in flotation mill effluents. Four flotation mills (2122, 3121, 6101, and 6102) have effluent discharge concentrations of 0.1 mg/l total cyanide or greater. Mill 6102 is the largest consumer of cyanide in terms of dosage per unit of ore feed and per unit of flotation circuit water feed. As a result, Mill 6102 produces a raw discharge with total cyanide concentrations of 0.2 to 0.4 mg/l. Cyanide dosages used at Mills 2122, 3121, and 6101 are consistent with amounts used throughout the industry, and, for this reason, reagent use alone does not appear to be the cause for high cyanide levels. The treatment of cyanide-bearing wastewater and the chemistry of cyanide in mill wastewater are discussed in Section VIII of this report.

Phenolic Compounds

"Reco" (sodium dicresyldithiophosphate) is used at Mill 2122 to promote the flotation of copper sulfide minerals. Reco is similar to American Cyanamid's AEROFLOAT 31 and 242 promoters, which are used at Mills 3101, 3104, 3115, 4403, and 9202. These reagents contain the cresyl group ($CH_3.C_6H_3.OH$), a very close relative of the toxic substance 2,4-dimethylphenol, which has been detected in raw mill wastewater samples collected during the toxic substance screen sampling program at Mills 2122 and 9202. Mills 3101, 3104, 3115 and 4403 were not selected as sites for screen and/or verification sampling of organic toxic pollutants during this program.

Cresylic acid is used as a flotation reagent at Mills 2117, 2[illegible], and 4403. Xylenols, $C_2H_5.C_6H_4OH$ or $(CH_3)_2.C_6H_3.OH$, are the dominant constituents of commercial cresylic acids and include the toxic pollutant, 2,4-dimethyphenol, which has not been detected in raw or treated wastewater samples at Mills 2117 and 2121. Mill 4403 was not sampled for the organic toxic substances. Nitrobenzenes are present in Aero 633, but nitrobenzene was not detected in wastewater during this program. However, screening and verification sample data strongly implicate these phenol-based flotation reagents as the sources of total phenol (4AAP) in mill process wastewaters. From a practical standpoint, cresylic acid can be considered as 100 percent phenolic with the relative phenolic content of the other phenol-containing reagents being considerably less. Phenolic concentrations of 5.2 mg/l and 5.0 mg/l have been detected in the mill tailing samples at Mill 2117, and treated effluent samples were found to contain 0.30 mg/l and 0.36 mg/l on 2 consecutive days. The large consumption of cresylic acid at Mill 2117 (0.035 kilogram/metric ton equivalent to 0.070 pound per short ton, of ore) and the consistency of data substantiate cresylic acid as being a significant source of phenolic compounds in flotation mill process effluents.

Phenolic compounds were found to be the most prevalent toxic organic species detected in the screen samples, but concentrations did not exceed 0.03 mg/l except at operations which are known to employ one or more of the phenol based flotation reagents previously discussed.

SPECIAL PROBLEM AREAS

Backfilling of Mines With Mill Sand Tailings

A review of sample data and historical monitoring data supplied by the industry indicates the presence of significant concentrations of cyanide in several mine water discharges. Further examination revealed that the facilities with cyanide in mine water backfilled mined-out stopes using mill sand tailings from flotation circuits which use cyanide compounds as process reagents.

A variety of undergound mining techniques are used throughout the mining industry. Typical mining methods include room-and-pillar, vein (or drift) mining, open stoping, pillar stoping, cut-and-fill, and panel-and-fill. The selection of method(s) is dependent on many factors, such as the type and shape of the ore deposit, the depth of excavations, and the ground conditions.

Cut-and-fill, pillar stoping, and panel-and-fill techniques have found common application in lead, zinc, and silver mines located in Colorado, Utah, and the Coeur d'Alene Mining District in Idaho. An inherent feature of these mining methods is the refilling of worked-out and abandoned stopes and other workings to prevent subsidence and cave-ins as mining progresses through the ore body. For many years, waste rock from the mine exploration crosscuts was used as fill material; however, the development of hydraulic sandfill procedures has simplified the backfill operation. In current practice, the coarse (sand) fraction of the flotation-mill tailings is often segregated from the tailings pulp stream by hydro-cyclones and pumped into the mine for backfilling.

Nine mines (Mines 3107, 3113, 3120, 3121, 3130, 4104, 4105, 4401 and 4402) are known to practice hydraulic backfilling with mill sand tailings. Eight of these nine mills use cyanide either as a flotation reagent (Mills 3107, 3113, 3121, 3130 and 4401) or as a leaching agent (Mills 4104, 4105, and 4402). The nature of the mechanism by which cyanide depresses pyrite and sphalerite is such that much of the cyanide added to the flotation circuit associates with the depressed minerals in the tailings and ultimately is leached into mine water during hydraulic backfill.

Mine 3130 is the only facility with a separate mine drainage treatment system that periodically monitors for cyanide. Effluent monitoring data (summarized in Section VIII) include cyanide analyses of five 24-hour composite samples collected during the period of June 1977 through October 1977. The data indicate that cyanide concentrations in the treated mine water did not exceed 0.2 mg/l total cyanide for mills and mine/mills on a daily basis, although the monthly average exceeded 0.1 mg/l on one occasion. Examination of raw (untreated) mine-water data from Mine 3130 indicates that cyanide is not effectively removed by the treatment system, which consists of lime and flocculant addition, followed by a series of two sedimentation ponds. This treatment is not designed for destruction or removal of cyanide and, does not provide sufficient residence time for natural aeration. fore, the poor removals observed are not surprising.

Total cyanide concentrations detected in five mine-water grab samples collected to support BAT at Mine 3130 were found to range from 0.04 to 0.16 mg/l. A 24-hour composite mine-water sample collected at Mine 3107 was found to contain 0.4 mg/l during backfill operations.

Mine 4105, located in South Dakota, was visited during the screening phase of this program. Analysis of mine water for total cyanide indicated that, for the days when the contractor sampled, concentrations were less than detectable. During previous visits to this facility, no cyanide was detected in mine water samples.

Table VI -1 (Continued)

DATA SUMMARY
ORE MINING DATA
ALL SUBCATEGORIES

	RAW(UG/L)						*	TREATED (UG/L)					
	NUMBER OF SAMPLES	NUMBER DETECTED	DETECTED VALUES ONLY MEAN	MED	90%	MAX	*	NUMBER OF SAMPLES	NUMBER DETECTED	DETECTED VALUES ONLY MEAN	MED	90%	MAX
1,1-DICHLOROETHYLENE	32	2	6.5811	3.1623	8.6326	10	*	28	0				
1,2-TRANS-DICHLOROETHYLE	32	0					*	28	1	270	270	270	270
2,4-DICHLOROPHENOL	32	1	10	10	10	10	*	28	0				
1,2-DICHLOROPROPANE	32	0					*	28	0				
1,3-DICHLOROPROPENE	32	0					*	28	0				
2,4-DIMETHYLPHENOL	32	1	140	140	140	140	*	28	1	270	270	270	270
2,4-DINITROTOLUENE	32	0					*	28	0				
2,6-DINITROTOLUENE	32	0					*	28	0				
1,2-DIPHENYLHYDRAZINE	32	0					*	28	0				
ETHYLBENZENE	32	4	6.7167	1	13.48	17.667	*	28	3	6.6	4.9	9.64	10
FLUORANTHENE	32	0					*	28	0				
METHYL CHLORIDE	33	1	45	45	45	45	*	28	0				
METHYL BROMIDE	33	0					*	28	0				
BROMOFORM	33	0					*	28	0				
DICHLOROBROMOMETHANE	33	0					*	28	2	6.5811	3.1623	8.6325	10
TRICHLOROFLUOROMETHANE	33	5	5.0325	2.0811	10	10	*	28	3	4.7208	2.0811	7.9487	10
DICHLORODIFLUOROMETHANE	33	0					*	28	0				
CHLORODIBROMOMETHANE	33	0					*	28	0				
HEXACHLOROBUTADIENE	33	0					*	28	0				
HEXACHLOROCYCLOPENTADIEN	33	0					*	28	0				
ISOPHORONE	33	0					*	28	0				
NAPHTHALENE	33	1	12.5	12.5	12.5	12.5	*	28	0				
NITROBENZENE	33	0					*	28	0				
2-NITROPHENOL	33	0					*	28	0				
4-NITROPHENOL	33	0					*	28	0				
2,4-DINITROPHENOL	33	0					*	28	0				
4,6-DINITRO-O-CRESOL	33	0					*	28	0				

Table VI -1 (Continued)

DATA SUMMARY
ORE MINING DATA
ALL SUBCATEGORIES

	RAW(UG/L)						*	TREATED (UG/L)					
	NUMBER OF SAMPLES	NUMBER DETECTED	DETECTED VALUES ONLY MEAN	MED	90%	MAX	*	NUMBER OF SAMPLES	NUMBER DETECTED	DETECTED VALUES ONLY MEAN	MED	90%	MAX
N-NITROSODIMETHYLAMINE	33	0					*	28	0				
N-NITROSODIPHENYLAMINE	33	0					*	28	0				
N-NITROSODI-N-PROPYLAMIN	33	0					*	28	0				
PENTACHLOROPHENOL	33	1	10	10	10	10	*	28	0				
PHENOL	33	2	118	78	143.2	160	*	28	3	92.3	33.45	166.8	210
BIS(2-ETHYLHEXYL) PHTHAL	33	15	20.16	13	39.833	100	*	28	18	12.458	10	28	60
BUTYL BENZYL PHTHALATE	33	2	10.75	0.5	18.9	21	*	28	4	27.781	10	52.4	68
DI-N-BUTYL PHTHALATE	33	13	16.489	10	26.1	58	*	28	12	25.884	10	39.2	140
DI-N-OCTYL PHTHALATE	10	3	10	10	10	10	*	7	3	12.167	10	14.65	18.5
DIETHYL PHTHALATE	33	18	24.414	10	59.4	90	*	28	4	7.675	9.8	10	10
DIMETHYL PHTHALATE	33	0					*	28	3	12.2	5.8	20.35	26
BENZO(A)ANTHRACENE	33	0					*	28	0				
BENZO(A)PYRENE	33	0					*	28	0				
BENZO(B)FLUORANTHENE	33	0					*	28	0				
BENZO(K)FLUORANTHENE	33	0					*	28	0				
CHRYSENE	33	0					*	28	0				
ACENAPHTHYLENE	33	0					*	28	0				
ANTHRACENE	33	0					*	28	0				
BENZO(G,H,I)PERYLENE	33	0					*	28	0				
FLUORENE	33	1	10	10	10	10	*	28	1	10	10	10	10
PHENANTHRENE	33	0					*	28	0				
DIBENZO(A,H)ANTHRACENE	33	0					*	28	0				
INDENO(1,2,3-C,D)PYRENE	33	0					*	28	0				
PYRENE	33	0					*	28	0				
TETRACHLOROETHYLENE	33	2	7.75	4.5	9.7	11	*	28	1	1.1	1.1	1.1	1.1
TOLUENE	33	9	399.28	2.0811	368.3	3560	*	28	6	2.5967	1	5.28	10
TRICHLOROETHYLENE	33	0					*	28	0				

Table VI -1 (Continued)

DATA SUMMARY
ORE MINING DATA
ALL SUBCATEGORIES

	RAW(UG/L)						*	TREATED (UG/L)					
	NUMBER OF SAMPLES	NUMBER DETECTED	DETECTED VALUES ONLY MEAN	MED	90%	MAX	*	NUMBER OF SAMPLES	NUMBER DETECTED	DETECTED VALUES ONLY MEAN	MED	90%	MAX
VINYL CHLORIDE	33	0					*	28	0				
ALDRIN	33	4	6.4156	6	9	10	*	28	2	6.5811	3.1623	8.6325	10
DIELDRIN	33	0					*	28	2	6.5811	3.1623	8.6325	10
CHLORDANE	33	0					*	28	0				
4,4-DDT	33	0					*	28	0				
4,4-DDE	33	1	5	5	5	5	*	28	0				
4,4-DDD	33	1	6.6667	6.6667	6.6667	6.6667	*	28	0				
ENDOSULFAN-ALPHA	33	1	10	10	10	10	*	28	0				
ENDOSULFAN-BETA	33	0					*	28	0				
ENDOSULFAN SULFATE	33	0					*	28	0				
ENDRIN	33	0					*	28	1	5	5	5	5
ENDRIN ALDEHYDE	33	0					*	28	0				
HEPTACHLOR	33	1	7.5	7.5	7.5	7.5	*	28	2	6.5811	3.1623	8.6325	10
HEPTACHLOR EPOXIDE	33	0					*	28	0				
BHC-ALPHA	33	6	6.2849	4.0811	7.5	10	*	28	3	5	5	5	5
BHC-BETA	33	6	6.1325	5	8.75	10	*	28	1	5	5	5	5
BHC (LINDANE)-GAMMA	33	4	6.2072	5	8.6667	10	*	28	0				
BHC-DELTA	33	2	5	5	5	5	*	28	2	5	5	5	5
PCB-1242 (AROCHLOR 1242)	33	0					*	28	0				
PCB-1254 (AROCHLOR 1254)	33	0					*	28	0				
PCB-1221 (AROCHLOR 1221)	9	0					*	6	0				
PCB-1232 (AROCHLOR 1232)	9	0					*	6	0				
PCB-1248 (AROCHLOR 1248)	9	0					*	6	0				
PCB-1260 (AROCHLOR 1260)	9	0					*	6	0				
PCB-1016 (AROCHLOR 1016)	9	0					*	6	0				
TOXAPHENE	32	0					*	27	0				
2,3,7,8-TETRACHLORODIBEN	33	0					*	28	0				

Table VI -1 (Continued)

DATA SUMMARY
ORE MINING DATA
ALL SUBCATEGORIES

	RAW(UG/L)						TREATED (UG/L)					
			DETECTED VALUES ONLY						DETECTED VALUES ONLY			
	NUMBER OF SAMPLES	NUMBER DETECTED	MEAN	MED	90%	MAX	NUMBER OF SAMPLES	NUMBER DETECTED	MEAN	MED	90%	MAX
CIS 1-3-DICHLOROPROPYLEN												
TRAN 1,3-DICHLOROPROPYLE												

DATA SUMMARY
ORE MINING DATA
ALL SUBCATEGORIES

	RAW (MG/L)						TREATED (MG/L)					
	NUMBER OF	NUMBER	DETECTED VALUES ONLY				NUMBER OF	NUMBER	DETECTED VALUES ONLY			
	SAMPLES	DETECTED	MEAN	MEDIAN	50%	MAX	SAMPLES	DETECTED	MEAN	MEDIAN	50%	MAX
ANTIMONY*	82	6	.04333	0.028	0.1	0.1	71	3	0.034	100-5	0.1	0.1
ARSENIC*	114	106	2.2219	0.3	8.43	12	100	83	.15349	0.018	0.6	1.5
BERYLIUM*	84	43	.13735	0.1	0.2782	0.82	73	10	0.0051	0.005	0.0109	0.011
CADMIUM*	106	54	0.213	0.0225	0.685	1.2	92	36	.01415	0.005	0.06	0.077
CHROMIUM*	85	70	3.8162	0.81	11	18	75	26	.13623	0.035	0.332	1.8
COPPER*	103	100	80.221	3.8	224.5	464	90	83	.23464	0.06	0.548	4.6
CYANIDE*	68	24	.32042	0.81	0.53	1.24	57	14	.13571	0.08	0.435	0.6
LEAD*	86	70	4.1807	1.35	4.88	130	75	31	.13481	0.05	0.376	0.959
MERCURY*	87	54	.00399	.00145	0.013	0.02	80	37	.01264	800-6	0.0306	0.25
NICKEL*	86	70	3.6166	2.5	9.3	14.2	75	43	.22202	0.07	0.966	1.28
SELENIUM*	84	58	0.2309	0.15	0.615	1.5	73	37	.05957	0.015	0.112	0.9
SILVER*	84	29	.84524	0.21	0.77	1.1	73	9	.01567	0.019	0.04	0.04
THALLIUM*	82	3	.89433	1.17	1.24	1.24	71	3	.52767	0.74	0.84	0.84
ZINC*	106	106	33.885	0.875	202.4	300	92	82	.90209	0.062	2.244	11.1
COD	22	22	303.73	10.85	1761	1900	23	23	11.698	11	20.6	53
TOC	47	47	3150.8	40	836	95430	47	46	24.989	9.5	69.2	157
TSS	6	6	485	560	750	750	9	8	5.1875	5.23	6	6
pH (UNITS)	65	35	6.8934	7	8.44	9.9	36	36	6.9714	7.7	8.16	8.5
PHENOLICS (4AAP)	72	71	.11372	0.04	0.3422	0.75	57	49	.07378	0.032	0.21	0.46
IRON*	22	19	523.7	6.248	1990	2040	25	21	.62619	0.209	2.192	3.87

Table VI-2

DATA SUMMARY
ORE MINING DATA
SUBCATEGORY IRON
SUBDIVISION MINE
MILL PROCESS MINE DRAINAGE

	RAW (MG/L)						TREATED (MG/L)					
	NUMBER OF SAMPLES	NUMBER DETECTED	DETECTED VALUES ONLY MEAN	MEDIAN	90%	MAX	NUMBER OF SAMPLES	NUMBER DETECTED	DETECTED VALUES ONLY MEAN	MEDIAN	90%	MAX
ANTIMONY (TOTAL)	2	0					1	0				
ARSENIC (TOTAL)	1	0					1	1	0.005	0.005	0.005	0.005
BERYLLIUM (TOTAL)	2	0					1	0				
CADMIUM (TOTAL)	2	0					1	0				
CHROMIUM (TOTAL)	1	0					1	0				
COPPER (TOTAL)	2	1	0.09	0.09	0.09	0.09	1	1	0.12	0.12	0.12	0.12
CYANIDE (TOTAL)	1	0					1	0				
LEAD (TOTAL)	2	0					1	0				
MERCURY (TOTAL)	2	0					1	0				
NICKEL (TOTAL)	2	0					1	0				
SELENIUM (TOTAL)	2	0					1	0				
SILVER (TOTAL)	2	0					1	0				
THALLIUM (TOTAL)	2	0					1	0				
ZINC (TOTAL)	2	1	0.018	0.018	0.018	0.018	1	1	0.03	0.03	0.03	0.03
COD	1	1	10	10	10	10	1	1	6	6	6	6
VSS	1	1	2	2	2	2	1	1	3	3	3	3
TSS	2	2	4.65	4.65	5	5	1	1	4	4	4	4
TOC	1	1	25	25	25	25	1	1	19	19	19	19
PH (UNITS)	2	2	8.075	8.075	8.15	8.15	1	1	8	8	8	8
PHENOLICS (4AAP)	1	0					1	0				
IRON (TOTAL)	1	0										
ASBESTOS (CHRYSO) (F/L)	1	1	3500E3	3500E3	3500E3	3500E3	1	1	3800E3	3800E3	3800E3	3800E3
TOTAL FIBERS (F/L)	1	1	1700E4	1700E4	1700E4	1700E4	1	1	4200E4	4200E4	4200E4	4200E4

Table VI-3

DATA SUMMARY
ORE MINING DATA
SUBCATEGORY IRON
SUBDIVISION MILL
MILL PROCESS PHYSICAL AND/OR CHEMICAL

	RAW(MG/L)						*	TREATED (MG/L)					
	NUMBER OF SAMPLES	NUMBER DETECTED	DETECTED VALUES ONLY MEAN	MEDIAN	90%	MAX	*	NUMBER OF SAMPLES	NUMBER DETECTED	DETECTED VALUES ONLY MEAN	MEDIAN	90%	MAX
ANTIMONY (TOTAL)	2	0					*	2	0				
ARSENIC (TOTAL)	2	1	0.89	0.89	0.89	0.89	*	2	1	0.005	0.005	0.005	0.005
BERYLLIUM (TOTAL)	2	1	0.92	0.92	0.92	0.92	*	2	0				
CADMIUM (TOTAL)	2	1	0.031	0.031	0.031	0.031	*	2	0				
CHROMIUM (TOTAL)	2	2	0.276	0.276	0.5	0.5	*	2	2	0.014	0.014	0.018	0.018
COPPER (TOTAL)	2	2	0.225	0.225	0.32	0.32	*	2	1	0.1	0.1	0.1	0.1
CYANIDE (TOTAL)	1	0					*	1	0				
LEAD (TOTAL)	2	2	0.0505	0.0505	0.08	0.08	*	2	0				
MERCURY (TOTAL)	2	0					*	2	0				
NICKEL (TOTAL)	2	2	2.15	2.15	2.7	2.7	*	2	0				
SELENIUM (TOTAL)	2	1	0.02	0.02	0.02	0.02	*	2	0				
SILVER (TOTAL)	2	2	0.017	0.017	0.02	0.02	*	2	0				
THALLIUM (TOTAL)	2	0					*	2	0				
ZINC (TOTAL)	2	2	3.15	3.15	5.8	5.8	*	2	0				
COD	1	1	96	96	96	96	*	2	2	0.019	0.019	0.03	0.03
VSS	1	1	80	80	80	80	*	1	1	4	4	4	4
TSS	2	2	64500	64500	110000	110000	*	1	1	.03162	.03162	.03162	.03162
TOC	1	1	22	22	22	22	*	2	2	2.0158	2.0158	4	4
PH (UNITS)	2	2	7.775	7.775	7.9	7.9	*	1	1	11	11	11	11
PHENOLICS (4AAP)	1	0					*	2	2	7.675	7.675	8.1	8.1
IRON (TOTAL)	1	1	73	73	73	73	*	1	0				
ASBESTOS (CHRYSO) (F/L)	1	1	3800E7	3800E7	3800E7	3800E7	*	1	1	4100E3	4100E3	4100E3	4100E3
TOTAL FIBERS (F/L)	1	1	2300E8	2300E8	2300E8	2300E8	*	1	1	4300E4	4300E4	4300E4	4300E4

Table VI-4

DATA SUMMARY
ORE MINING DATA
SUBCATEGORY COPPER/LEAD/ZINC/GOLD/SILVER/PLATINUM/MOLYBDENUM
SUBDIVISION MINE
MILL PROCESS MINE DRAINAGE

	RAW (MG/L)						TREATED (MG/L)					
			DETECTED VALUES ONLY						DETECTED VALUES ONLY			
	NUMBER OF SAMPLES	NUMBER DETECTED	MEAN	MEDIAN	90%	MAX	NUMBER OF SAMPLES	NUMBER DETECTED	MEAN	MEDIAN	90%	MAX
ANTIMONY (TOTAL)	15	3	.11633	0.121	0.132	0.132	5	0				
ARSENIC (TOTAL)	15	11	.03727	0.018	0.1708	0.196	5	2	0.01	0.01	0.01	0.01
BERYLLIUM (TOTAL)	15	4	.00908	.00715	0.022	0.022	5	1	0.0084	0.0084	0.0084	0.0084
CADMIUM (TOTAL)	15	9	.02819	0.005	0.124	0.124	5	2	.01055	.01055	0.013	0.013
CHROMIUM (TOTAL)	15	7	0.0218	0.017	0.065	0.065	5	0				
COPPER (TOTAL)	15	14	.76418	0.045	4.285	7.3	5	5	0.056	0.04	0.12	0.12
CYANIDE (TOTAL)	11	2	0.0115	0.0115	0.02	0.02	4	1	0.035	0.035	0.035	0.035
LEAD (TOTAL)	15	10	1.0909	0.287	5.498	5.87	5	4	.06275	0.066	0.099	0.099
MERCURY (TOTAL)	15	4	0.0027	0.002	0.0063	0.0063	5	1	0.049	0.049	0.049	0.049
NICKEL (TOTAL)	15	11	.07084	0.059	0.184	0.2	5	2	0.3205	0.3205	0.601	0.601
SELENIUM (TOTAL)	15	1	0.012	0.012	0.012	0.012	5	0				
SILVER (TOTAL)	15	5	.01106	0.012	0.02	0.02	5	1	0.03	0.03	0.03	0.03
THALLIUM (TOTAL)	15	4	0.1045	0.0715	0.269	0.269	5	2	0.309	0.309	0.476	0.476
ZINC (TOTAL)	15	15	5.2516	0.31	23.98	28.15	5	5	3.782	0.53	13.99	13.99
COD	12	12	24.289	7.9	118.15	154	4	4	27.25	14	77	77
VSS	6	5	16.454	3.2	70	70	2	2	2.5	2.5	3	3
TSS	13	13	195.2	20	1094.6	1456	5	5	11	10	20	20
TOC	10	10	7.6507	3.75	22.3	23	2	2	3.5	3.5	6	6
PH (UNITS)	12	12	7.1125	7.1	8.16	8.25	4	4	8.2875	8.225	9	9
PHENOLICS (4AAP)	13	9	.00822	0.008	0.016	0.016	4	2	.00755	.00755	0.0101	0.0101
IRON (TOTAL)	7	7	20.05	1.44	133.4	133.4	3	3	9.4117	0.65	27.36	27.36
ASBESTOS (CHRYSO) (F/L)	6	6	917E13	3063E6	550E14	550E14	2	2	4650E3	4650E3	8200E3	8200E3
TOTAL FIBERS (F/L)	6	5	2424E7	1000E5	1200E8	1200E8	2	2	6450E4	6450E4	7200E4	7200E4

Table VI-5

DATA SUMMARY
ORE MINING DATA
SUBCATEGORY COPPER/LEAD/ZINC/GOLD/SILVER/PLATINUM/MOLYBDENUM
SUBDIVISION MILL
MILL PROCESS CYANIDATION

	RAW(MG/L)						TREATED (MG/L)					
	NUMBER OF SAMPLES	NUMBER DETECTED	DETECTED VALUES ONLY MEAN	MEDIAN	90%	MAX	NUMBER OF SAMPLES	NUMBER DETECTED	DETECTED VALUES ONLY MEAN	MEDIAN	90%	MAX
ANTIMONY (TOTAL)	2	1	0.1	0.1	0.1	0.1						
ARSENIC (TOTAL)	2	2	100	100	200	200						
BERYLLIUM (TOTAL)	2	1	0.03	0.03	0.03	0.03						
CADMIUM (TOTAL)	2	0										
CHROMIUM (TOTAL)	2	2	0.825	0.825	1.6	1.6						
COPPER (TOTAL)	2	2	1.44	1.44	2.6	2.6						
CYANIDE (TOTAL)	2	2	3.85	3.85	6.8	6.8						
LEAD (TOTAL)	2	2	0.195	0.195	0.37	0.37						
MERCURY (TOTAL)	2	2	0.2775	0.2775	0.54	0.54						
NICKEL (TOTAL)	2	0										
SELENIUM (TOTAL)	2	2	0.0775	0.0775	0.15	0.15						
SILVER (TOTAL)	2	1	0.1	0.1	0.1	0.1						
THALLIUM (TOTAL)	2	0										
ZINC (TOTAL)	2	2	2.16	2.16	3.9	3.9						
COD	2	2	354	354	700	700						
VSS	2	2	649	649	1290	1290						
TSS	2	2	30149	30149	60200	60200						
TOC	2	2	11.5	11.5	18	18						
PH (UNITS)	2	2	8.825	8.825	9	9						
PHENOLICS (4AAP)	2	0										
ASBESTOS (CHRYSO) (F/L)	2	2	1372E6	1372E6	2700E6	2700E6						
TOTAL FIBERS (F/L)	2	2	5527E7	5527E7	1100E8	1100E8						

Table VI-6

DATA SUMMARY
ORE MINING DATA

SUBCATEGORY COPPER/LEAD/ZINC/GOLD/SILVER/PLATINUM/MOLYBDENUM
SUBDIVISION MILL
MILL PROCESS FLOTATION (FROTH)

	RAW(UG/L)						*	TREATED (UG/L)					
	NUMBER OF SAMPLES	NUMBER DETECTED	10%	MEAN	MED	90%	*	NUMBER OF SAMPLES	NUMBER DETECTED	10%	MEAN	MED	90%
ANTIMONY (TOTAL)	78	13	44.7	1725	167	1359	*	59	3	100	133.33	100	170
ARSENIC (TOTAL)	78	78	28	2853.4	800	8100	*	59	43	6	75.244	12.5	285
BERYLLIUM (TOTAL)	78	55	0.35	75.401	75	150	*	59	7	1	5.7143	3	12.1
CADMIUM (TOTAL)	78	41	0.81	637.99	170	1178	*	59	6	5	7.3333	5	11.6
CHROMIUM (TOTAL)	78	63	20	4643.1	1850	11000	*	59	20	10	162.05	30	320
COPPER (TOTAL)	78	78	307.2	98854	63300	292000	*	59	55	20	313.64	70	640
CYANIDE (TOTAL)	74	31	40	282.91	180	590	*	51	12	44	165	120	256
LEAD (TOTAL)	78	69	100.7	20192	2750	27300	*	59	27	20	100.19	42.5	233
MERCURY (TOTAL)	72	48	0.2	51.63	1.1	22.2	*	58	16	0.5	27.3	0.8	68
NICKEL (TOTAL)	78	72	72.8	3708.6	2000	9200	*	59	35	25	90.543	60	185
SELENIUM (TOTAL)	77	50	12	242.38	200	526.67	*	58	23	5	23.225	12.083	34
SILVER (TOTAL)	78	43	11.84	410.99	251.67	805	*	59	8	11	31.375	20	46
THALLIUM (TOTAL)	78	7	1.7	89.557	8.1	197.8	*	59	0				
ZINC (TOTAL)	78	78	98	74137	5600	266400	*	59	48	30	258.12	70	562
TOTAL FIBERS	13	13	7.4E+09	1.8E+12	5.4E+11	3.5E+12	*	14	14	3.7E+06	6.1E+08	1.9E+07	1.9E+09
ASBESTOS (CHRYSOTILE)	15	15	1.6E+09	2.3E+11	4.8E+10	4.2E+11	*	14	14	1.5E+05	2.2E+08	1.7E+06	3.2E+08
COD (MG/L)	22	22	22.2	1126.8	530	2988	*	15	14	4.4	15.655	12	26.9
VSS (MG/L)	9	9	345	10244	3750	14794	*	8	7	.03162	1.7211	1.5	3.15
TSS (MG/L)	22	22	38.6	199538	164000	444199	*	21	20	1	11.483	4.6	17.333
TOC (MG/L)	22	22	3.4667	14.864	9.5	28.6	*	15	15	3	11.667	9.5	20.5
PH (UNITS)	22	22	6.52	8.7848	8.35	11.61	*	21	21	6.21	7.8226	7.825	8.8
PHENOLICS (4AAP)	73	65	11.5	214.54	35.5	402.5	*	52	48	9	74.326	19	216
IRON (TOTAL-MG/L)	9	9	1.9	57.733	28.5	159.53	*	6	6	0.095	.56867	0.15	1.288

Table VI-7

DATA SUMMARY
ORE MINING DATA
SUBCATEGORY COPPER/LEAD/ZINC/GOLD/SILVER/PLATINUM/MOLYBDENUM
SUBDIVISION MINE/MILL
MILL PROCESS HEAP/VAT/DUMP LEACHING

	RAW(MG/L)						TREATED (MG/L)					
	NUMBER OF SAMPLES	NUMBER DETECTED	DETECTED VALUES ONLY MEAN	MEDIAN	90%	MAX	NUMBER OF SAMPLES	NUMBER DETECTED	DETECTED VALUES ONLY MEAN	MEDIAN	90%	MAX
ANTIMONY (TOTAL)	1	0					1	0				
ARSENIC (TOTAL)	1	1	0.027	0.027	0.027	0.027	1	1	0.002	0.002	0.002	0.002
BERYLLIUM (TOTAL)	1	1	0.3	0.3	0.3	0.3	1	1	0.002	0.002	0.002	0.002
CADMIUM (TOTAL)	1	1	0.26	0.26	0.26	0.26	1	1	0.003	0.003	0.003	0.003
CHROMIUM (TOTAL)	1	1	1.3	1.3	1.3	1.3	1	0				
COPPER (TOTAL)	1	1	88	88	88	88	1	1	0.023	0.023	0.023	0.023
LEAD (TOTAL)	1	1	0.01	0.01	0.01	0.01	1	1	100E-5	100E-5	100E-5	100E-5
MERCURY (TOTAL)	1	0					1	0				
NICKEL (TOTAL)	1	1	14.2	14.2	14.2	14.2	1	1	0.028	0.028	0.028	0.028
SELENIUM (TOTAL)	1	0					1	0				
SILVER (TOTAL)	1	0					1	0				
THALLIUM (TOTAL)	1	1	0.003	0.003	0.003	0.003	1	1	0.003	0.003	0.003	0.003
ZINC (TOTAL)	1	1	107	107	107	107	1	1	0.013	0.013	0.013	0.013
TSS	1	1	323	323	323	323	1	1	50	50	50	50
PH (UNITS)	1	1	3.04	3.04	3.04	3.04	1	1	7.87	7.87	7.87	7.87
IRON (TOTAL)	1	1	1860	1860	1860	1860	1	0				

DATA SUMMARY
ORE MINING DATA
SUBCATEGORY COPPER/LEAD/Z[illegible]LD/SILVER/PLATINUM/MOLYBDENUM
SUBDIVISION MI[illegible]LL
MILL PROCESS GR[illegible]TY SEPARATION

	RAW(MG/L)						*	TREATED (MG/L)					
	NUMBER OF SAMPLES	NUMBER DETECTED	DETECTED VALUES ONLY MEAN	MEDIAN	90%	MAX	*	NUMBER OF SAMPLES	NUMBER DETECTED	DETECTED VALUES ONLY MEAN	MEDIAN	90%	MAX
ARSENIC (TOTAL)	11	11	1.1738	0.2	4.78	5	*	10	10	0.1729	0.05	1.105	1.2
MERCURY (TOTAL)	11	11	438E-6	100E-6	.00134	0.0014	*	10	10	150E-6	100E-6	470E-6	500E-6
TSS	11	11	18.598	12.4	59.34	64.1	*	10	10	1.4482	0.757	5.45	5.7
PH (UNITS)	6	6	7.2	7.15	7.9	7.9	*	8	8	7.2	7.25	7.9	7.9

Table VI-9

DATA SUMMARY
ORE MINING DATA
SUBCATEGORY ALUMINUM
SUBDIVISION MINE
MILL PROCESS MINE DRAINAGE

	RAW(MG/L)						*	TREATED (MG/L)					
	NUMBER OF SAMPLES	NUMBER DETECTED	DETECTED VALUES ONLY MEAN	MEDIAN	90%	MAX	*	NUMBER OF SAMPLES	NUMBER DETECTED	DETECTED VALUES ONLY MEAN	MEDIAN	90%	MAX
ANTIMONY (TOTAL)	1	0					*	1	0				
ARSENIC (TOTAL)	1	0					*	1	0				
BERYLLIUM (TOTAL)	1	0					*	1	0				
CADMIUM (TOTAL)	1	0					*	1	0				
CHROMIUM (TOTAL)	1	1	0.03	0.03	0.03	0.03	*	1	1	0.025	0.025	0.025	0.025
COPPER (TOTAL)	1	1	0.06	0.06	0.06	0.06	*	1	1	0.05	0.05	0.05	0.05
CYANIDE (TOTAL)	1	0					*	1	0				
LEAD (TOTAL)	1	0					*	1	0				
MERCURY (TOTAL)	1	1	0.037	0.037	0.037	0.037	*	1	1	0.084	0.084	0.084	0.084
NICKEL (TOTAL)	1	1	0.06	0.06	0.06	0.06	*	1	0				
SELENIUM (TOTAL)	1	0					*	1	0				
SILVER (TOTAL)	1	0					*	1	0				
THALLIUM (TOTAL)	1	0					*	1	0				
ZINC (TOTAL)	1	1	0.57	0.57	0.57	0.57	*	1	0				
COD	1	0					*	1	1	2	2	2	2
VSS	1	1	1.6	1.6	1.6	1.6	*	1	1	5	5	5	5
TSS	1	1	2.8	2.8	2.8	2.8	*	1	1	6	6	6	6
TOC	1	1	2	2	2	2	*	1	1	4	4	4	4
PH (UNITS)	1	1	3.05	3.05	3.05	3.05	*	1	1	8.6	8.6	8.6	8.6
PHENOLICS (4AAP)	2	1	0.005	0.005	0.005	0.005	*	3	2	0.0245	0.0245	0.044	0.044
ASBESTOS (CHRYSO) (F/L)	2	2	5500E3	5500E3	5500E3	5500E3	*	2	2	1016E5	1016E5	2000E5	2000E5
TOTAL FIBERS (F/L)	1	1	3500E4	3500E4	3500E4	3500E4	*	2	2	7500E5	7500E5	1400E6	1400E6

Table VI-10

DATA SUMMARY
ORE MINING DATA

SUBCATEGORY TUNGSTEN
SUBDIVISION MILL

	RAW(UG/L)						*	TREATED (UG/L)					
	NUMBER OF SAMPLES	NUMBER DETECTED	10%	MEAN	MED	90%	*	NUMBER OF SAMPLES	NUMBER DETECTED	10%	MEAN	MED	90%
ANTIMONY (TOTAL)	2	1	53	53	53	53	*	1	1	3	3	3	3
ARSENIC (TOTAL)	2	1	370	370	370	370	*	1	1	15	15	15	15
BERYLLIUM (TOTAL)	2	2	90	420	90	618	*	1	1	0.7	0.7	0.7	0.7
CADMIUM (TOTAL)	2	2	160	260	160	320	*	1	1	36	36	36	36
CHROMIUM (TOTAL)	2	2	680	940	680	1096	*	1	1	15	15	15	15
COPPER (TOTAL)	2	2	19000	22000	19000	23800	*	1	1	14000	14000	14000	14000
CYANIDE (TOTAL)	1	0					*						
LEAD (TOTAL)	2	2	1300	3050	1300	4100	*	1	1	220	220	220	220
MERCURY (TOTAL)	2	1	2	2	2	2	*	1	0				
NICKEL (TOTAL)	2	2	890	1345	890	1618	*	1	0				
SELENIUM (TOTAL)	2	2	11	30.5	11	42.2	*	1	0				
SILVER (TOTAL)	2	2	210	295	210	346	*	1	1	35	35	35	35
THALLIUM (TOTAL)	2	0					*	1	0				
ZINC (TOTAL)	2	2	10000	17000	10000	21200	*	1	1	1100	1100	1100	1100
TOTAL FIBERS	1	1	1.3E+12	1.3E+12	1.3E+12	1.3E+12	*						
ASBESTOS (CHRYSOTILE)	1	1	3.7E+11	3.7E+11	3.7E+11	3.7E+11	*						
COD (MG/L)	1	1	300	300	300	300	*						
VSS (MG/L)	1	1	4400	4400	4400	4400	*						
TSS (MG/L)	2	2	29000	257000	29000	393800	*	1	1	160	160	160	160
TOC (MG/L)	1	1	220	220	220	220	*						
PH (UNITS)	2	2	9.9	9.9	9.9	9.9	*	1	1	9.2	9.2	9.2	9.2
PHENOLICS (4AAP)	2	1	63	63	63	63	*						
IRON (TOTAL-MG/L)	1	1	660	660	660	660	*	1	1	15	15	15	15

Table VI-11

DATA SUMMARY
ORE MINING DATA
SUBCATEGORY MERCURY
SUBDIVISION MILL
MILL PROCESS FLOTATION (FROTH)

	RAW(MG/L)						*	TREATED (MG/L)					
	NUMBER OF SAMPLES	NUMBER DETECTED	DETECTED VALUES ONLY MEAN	MEDIAN	90%	MAX	*	NUMBER OF SAMPLES	NUMBER DETECTED	DETECTED VALUES ONLY MEAN	MEDIAN	90%	MAX
ANTIMONY (TOTAL)	1	1	53	53	53	53	*	1	1	0.2	0.2	0.2	0.2
ARSENIC (TOTAL)	1	1	1.1	1.1	1.1	1.1	*	1	1	0.11	0.11	0.11	0.11
BERYLLIUM (TOTAL)	1	1	0.09	0.09	0.09	0.09	*	1	0				
CADMIUM (TOTAL)	1	1	0.56	0.56	0.56	0.56	*	1	1	0.008	0.008	0.008	0.008
CHROMIUM (TOTAL)	1	1	0.46	0.46	0.46	0.46	*	1	1	0.015	0.015	0.015	0.015
COPPER (TOTAL)	1	1	0.85	0.85	0.85	0.85	*	1	1	0.05	0.05	0.05	0.05
CYANIDE (TOTAL)	1	0					*	1	0				
LEAD (TOTAL)	1	1	1	1	1	1	*	1	0				
MERCURY (TOTAL)	1	1	230	230	230	230	*	1	1	0.05	0.05	0.05	0.05
NICKEL (TOTAL)	1	1	1.6	1.6	1.6	1.6	*	1	0				
SELENIUM (TOTAL)	1	0					*	1	0				
SILVER (TOTAL)	1	1	0.01	0.01	0.01	0.01	*	1	0				
THALLIUM (TOTAL)	1	1	0.2	0.2	0.2	0.2	*	1	0				
ZINC (TOTAL)	1	1	2.4	2.4	2.4	2.4	*	1	1	0.04	0.04	0.04	0.04
COD	1	1	60	60	60	60	*	1	1	22	22	22	22
VSS	1	1	4300	4300	4300	4300	*	1	0				
TSS	1	1	139000	139000	139000	139000	*	1	1	16	16	16	16
TOC	1	1	21	21	21	21	*	1	1	13	13	13	13
PH (UNITS)	1	1	8	8	8	8	*	1	1	8.3	8.3	8.3	8.3
PHENOLICS (4AAP)	1	1	0.92	0.92	0.92	0.92	*	1	1	0.22	0.22	0.22	0.22
ASBESTOS (CHRYSO) (F/L)	1	1	1500E8	1500E8	1500E8	1500E8	*	1	1	5700E4	5700E4	5700E4	5700E4
TOTAL FIBERS (F/L)	1	1	1300E9	1300E9	1300E9	1300E9	*	1	1	7700E5	7700E5	7700E5	7700E5

Tab[illegible]I-12

DATA SUMMARY
ORE MINING DATA
SUBCATEGORY URANIUM
SUBDIVISION MINE
MILL PROCESS MINE DRAINAGE

	RAW(MG/L)						TREATED (MG/L)					
	NUMBER OF SAMPLES	NUMBER DETECTED	DETECTED VALUES ONLY MEAN	MEDIAN	90%	MAX	NUMBER OF SAMPLES	NUMBER DETECTED	DETECTED VALUES ONLY MEAN	MEDIAN	90%	MAX
ANTIMONY (TOTAL)	3	1	0.05	0.05	0.05	0.05	3	0				
ARSENIC (TOTAL)	17	16	0.0195	0.007	0.0832	0.17	13	11	.00798	0.008	0.0228	0.024
BERYLLIUM (TOTAL)	3	0					3	0				
CADMIUM (TOTAL)	18	13	.00381	0.003	0.0092	0.01	13	10	0.0038	0.003	0.0069	0.007
CHROMIUM (TOTAL)	4	3	.04333	0.045	0.05	0.05	3	2	0.0425	0.0425	0.06	0.06
COPPER (TOTAL)	14	14	.01673	0.0075	0.075	0.11	11	8	.00575	0.008	0.011	0.011
CYANIDE (TOTAL)	3	0					3	0				
LEAD (TOTAL)	4	3	0.09	0.05	0.18	0.18	3	1	0.05	0.05	0.05	0.05
MERCURY (TOTAL)	3	1	0.0038	0.0038	0.0038	0.0038	3	1	0.0091	0.0091	0.0091	0.0091
NICKEL (TOTAL)	4	1	0.06	0.06	0.06	0.06	3	0				
SELENIUM (TOTAL)	5	3	.02333	0.028	0.037	0.037	5	3	.03833	0.048	0.051	0.051
SILVER (TOTAL)	3	0					3	0				
THALLIUM (TOTAL)	3	0					3	0				
ZINC (TOTAL)	17	17	.04306	0.02	0.158	0.19	13	12	.01983	0.014	0.0666	0.078
COD	15	15	22.504	7	104.2	140.5	12	12	10.169	8.95	33.5	38
VSS	2	2	23.5	23.5	28	28	2	2	1.5	1.5	2	2
TSS	18	18	144.58	21	415.94	1639.5	13	13	33.185	27	75.8	83
TOC	2	2	8.5	8.5	9	9	2	1	10	10	10	10
PH (UNITS)	13	13	7.6519	8.05	8.655	8.825	9	9	7.8833	7.9	8.5	8.5
PHENOLICS (4AAP)	3	1	0.01	0.01	0.01	0.01	3	1	0.01	0.01	0.01	0.01
IRON (TOTAL)	1	1	0.319	0.319	0.319	0.319	1	1	0.054	0.054	0.054	0.054
ASBESTOS (CHRYSO) (F/L)	3	3	1050E5	1100E5	1900E5	1900E5	2	2	4000E4	4000E4	5300E4	5300E4
TOTAL FIBERS (F/L)	2	2	1950E6	1950E6	2300E6	2300E6	2	2	5000E5	5000E5	5700E5	5700E5

Table VI-13

DATA SUMMARY
ORE MINING DATA
SUBCATEGORY URANIUM
SUBDIVISION MILL
MILL PROCESS ARID LOCATIONS

	RAW(MG/L)						*	TREATED (MG/L)					
	NUMBER OF SAMPLES	NUMBER DETECTED	DETECTED VALUES ONLY MEAN	MEDIAN	90%	MAX	*	NUMBER OF SAMPLES	NUMBER DETECTED	DETECTED VALUES ONLY MEAN	MEDIAN	90%	MAX
ANTIMONY (TOTAL)	4	2	0.516	0.516	1.03	1.03	*	5	3	0.299	100E-5	0.895	0.895
ARSENIC (TOTAL)	10	9	4.2602	0.243	10.6	10.6	*	12	11	.11518	0.029	0.65	0.75
BERYLLIUM (TOTAL)	6	2	0.274	0.274	0.295	0.295	*	7	3	0.0072	0.01	0.011	0.011
CADMIUM (TOTAL)	12	11	14791	0.1	0.4068	0.423	*	13	11	.03545	0.029	0.0746	0.077
CHROMIUM (TOTAL)	8	8	1.738	1.575	3.7	3.7	*	10	5	0.0406	0.028	0.1	0.1
COPPER (TOTAL)	12	10	0.9966	0.485	3.4	3.4	*	14	11	0.192	0.1	0.84	0.9
CYANIDE (TOTAL)	2	1	0.046	0.046	0.046	0.046	*	3	0				
LEAD (TOTAL)	8	5	1.9076	1.3	4.18	4.18	*	10	5	0.3888	0.2	0.959	0.959
MERCURY (TOTAL)	4	1	0.036	0.036	0.036	0.036	*	5	1	0.14	0.14	0.14	0.14
NICKEL (TOTAL)	8	8	2.3422	2.835	3.68	3.68	*	10	8	.82637	0.955	1.28	1.28
SELENIUM (TOTAL)	6	6	0.1705	0.1525	0.49	0.49	*	7	6	.06383	0.0215	0.213	0.213
SILVER (TOTAL)	6	3	0.069	0.056	0.1	0.1	*	7	4	0.016	0.0195	0.023	0.023
THALLIUM (TOTAL)	4	2	1.205	1.205	1.24	1.24	*	5	2	0.79	0.79	0.84	0.84
ZINC (TOTAL)	12	12	26.176	22.365	59.13	60.9	*	14	13	4.729	2.52	11.06	11.1
COD	5	5	95.206	26	386	386	*	7	6	59.505	10.5	279	279
VSS	1	1	20	20	20	20	*	2	2	6	6	10	10
TSS	5	5	19134	64	95450	95450	*	9	9	55.611	26	157	157
TOC	1	1	24	24	24	24	*	2	2	21.5	21.5	27	27
PH (UNITS)	6	6	6.43	7.45	8.3	8.3	*	9	9	6.65	7.7	8.45	8.45
PHENOLICS (4AAP)	2	2	0.0085	0.0085	0.01	0.01	*	3	2	0.01	0.01	0.01	0.01
IRON (TOTAL)	7	5	1462.1	1660	2040	2040	*	7	5	1.4164	0.4	3.87	3.87
ASBESTOS (CHRYSO) (F/L)	1	1	2300E4	2300E4	2300E4	2300E4	*	2	2	1750E5	1750E5	2000E5	2000E5
TOTAL FIBERS (F/L)	1	1	2900E5	2900E5	2900E5	2900E5	*	2	2	1750E6	1750E6	2300E6	2300E6

TABLE VI-14

DATA S[illegible]Y
ORE MIN[illegible]ATA
SUBCATEGORY TI[illegible]UM
SUBDIVISION MINE
MILL PROCESS MINE DRAINAGE

	RAW (MG/L)						TREATED (MG/L)					
	NUMBER OF SAMPLES	NUMBER DETECTED	DETECTED VALUES ONLY MEAN	MEDIAN	90%	MAX	NUMBER OF SAMPLES	NUMBER DETECTED	DETECTED VALUES ONLY MEAN	MEDIAN	90%	MAX
ANTIMONY (TOTAL)							1	0				
ARSENIC (TOTAL)							1	0				
BERYLLIUM (TOTAL)							1	0				
CADMIUM (TOTAL)							1	0				
CHROMIUM (TOTAL)							1	0				
COPPER (TOTAL)							1	1	0.02	0.02	0.02	0.02
CYANIDE (TOTAL)							1	0				
LEAD (TOTAL)							1	1	0.02	0.02	0.02	0.02
MERCURY (TOTAL)							1	0				
NICKEL (TOTAL)							1	0				
SELENIUM (TOTAL)							1	0				
SILVER (TOTAL)							1	0				
THALLIUM (TOTAL)							1	0				
ZINC (TOTAL)							1	1	0.02	0.02	0.02	0.02
COD							1	1	2	2	2	2
VSS							1	0				
TSS							1	0				
TOC							1	1	8	8	8	8
PH (UNITS)							1	1	7.95	7.95	7.95	7.95
PHENOLICS (4AAP)							1	1	0.03	0.03	0.03	0.03
ASBESTOS (CHRYSO) (F/L)							1	1	140000	140000	140000	140000
TOTAL FIBERS (F/L)							1	1	1900E3	1900E3	1900E3	1900E3

Table VI-15

DATA SUMMARY
ORE MINING DATA
SUBCATEGORY TITANIUM
SUBDIVISION MILLS WITH DREDGE MINING
MILL PROCESS PHYSICAL AND/OR CHEMICAL

	RAW(MG/L)						*	TREATED (MG/L)					
	NUMBER OF SAMPLES	NUMBER DETECTED	DETECTED VALUES ONLY MEAN	MEDIAN	90%	MAX	*	NUMBER OF SAMPLES	NUMBER DETECTED	DETECTED VALUES ONLY MEAN	MEDIAN	90%	MAX
ANTIMONY (TOTAL)	9	1	0.002	0.002	0.002	0.002	*	9	0				
ARSENIC (TOTAL)	9	3	.00867	0.009	0.01	0.01	*	9	0				
BERYLLIUM (TOTAL)	9	0					*	9	0				
CADMIUM (TOTAL)	9	0					*	9	1	0.002	0.002	0.002	0.002
CHROMIUM (TOTAL)	9	7	.04743	0.03	0.08	0.08	*	9	0				
COPPER (TOTAL)	9	9	.02733	0.018	0.063	0.063	*	9	5	0.0058	0.008	0.008	0.008
CYANIDE (TOTAL)	6	0					*	9	0				
LEAD (TOTAL)	9	4	0.0375	0.042	0.058	0.058	*	9	1	0.005	0.005	0.005	0.005
MERCURY (TOTAL)	9	2	0.008	0.008	0.011	0.011	*	9	1	100E-5	100E-5	100E-5	100E-5
NICKEL (TOTAL)	9	3	0.023	0.023	0.033	0.033	*	9	0				
SELENIUM (TOTAL)	9	3	0.031	0.029	0.038	0.038	*	9	0				
SILVER (TOTAL)	9	5	0.007	0.009	0.011	0.011	*	9	2	0.003	0.003	0.003	0.003
THALLIUM (TOTAL)	9	0					*	9	0				
ZINC (TOTAL)	9	9	.03122	0.021	0.071	0.071	*	9	8	.02675	0.008	0.071	0.071
COD	6	6	1076.7	1060.5	1900	1900	*	9	9	14	14	17	17
TSS	9	9	341.44	160	1100	1100	*	9	8	3.5625	2.9	9	9
TOC	6	6	485	560	750	750	*	9	8	5.1875	5.25	6	6
PH (UNITS)	9	9	5.9	5.7	6.6	6.6	*	9	9	5.9444	6.8	7.6	7.6
PHENOLICS (4AAP)	6	5	0.0066	0.007	0.007	0.007	*	8	1	0.01	0.01	0.01	0.01
IRON (TOTAL)	9	9	3.1924	1.928	6.287	6.287	*	9	9	.20533	0.171	0.5	0.5
ASBESTOS (CHRYSO) (F/L)							*	1	1	3300E3	3300E3	3300E3	3300E3
TOTAL FIBERS (F/L)							*	1	1	2700E3	2700E3	2700E3	2700E3

Table VI-16

DATA SUMMARY
ORE MINING DATA

SUBCATEGORY VANADIUM
SUBDIVISION MINE
MILL PROCESS NO MILL PROCESS

	RAW (UG/L)						*	TREATED (UG/L)					
	NUMBER OF SAMPLES	NUMBER DETECTED	10%	MEAN	MED	90%	*	NUMBER OF SAMPLES	NUMBER DETECTED	10%	MEAN	MED	90%
ANTIMONY (TOTAL)	1	1	18	18	18	18	*	1	1	2	2	2	2
ARSENIC (TOTAL)	1	1	130	130	130	130	*	1	1	5	5	5	5
BERYLLIUM (TOTAL)	1	1	16.333	16.333	16.333	16.333	*	1	1	1	1	1	1
CADMIUM (TOTAL)	1	1	16.833	16.833	16.833	16.833	*	1	1	8.2	8.2	8.2	8.2
CHROMIUM (TOTAL)	1	1	120	120	120	120	*	1	1	29.333	29.333	29.333	29.333
COPPER (TOTAL)	1	1	41.833	41.833	41.833	41.833	*	1	1	20.5	20.5	20.5	20.5
CYANIDE (TOTAL)	1	0					*	1	0				
LEAD (TOTAL)	1	1	317.5	317.5	317.5	317.5	*	1	1	171.33	171.33	171.33	171.33
MERCURY (TOTAL)	1	1	1	1	1	1	*	1	0				
NICKEL (TOTAL)	1	1	446.67	446.67	446.67	446.67	*	1	1	59.333	59.333	59.333	59.333
SELENIUM (TOTAL)	1	1	6.3333	6.3333	6.3333	6.3333	*	1	1	12	12	12	12
SILVER (TOTAL)	1	1	3	3	3	3	*	1	0				
THALLIUM (TOTAL)	1	1	2	2	2	2	*	1	1	1	1	1	1
ZINC (TOTAL)	1	1	1476.7	1476.7	1476.7	1476.7	*	1	1	159.17	159.17	159.17	159.17
PHENOLICS (4AAP)	1	0					*	1	0				
IRON (TOTAL-MG/L)	1	1	69.133	69.133	69.133	69.133	*	1	1	.86467	.86467	.86467	.86467

Table VI-17

DATA SUMMARY
ORE MINING DATA
SUBCATEGORY VANADIUM
SUBDIVISION MILL
MILL PROCESS FLOTATION (FROTH)

	RAW(MG/L)						*	TREATED (MG/L)					
	NUMBER OF SAMPLES	NUMBER DETECTED	DETECTED VALUES ONLY MEAN	MEDIAN	90%	MAX	*	NUMBER OF SAMPLES	NUMBER DETECTED	DETECTED VALUES ONLY MEAN	MEDIAN	90%	MAX
ANTIMONY (TOTAL)	3	3	.03733	.04167	.05233	.05233	*	3	3	.02067	0.014	0.046	0.046
ARSENIC (TOTAL)	3	3	.29889	.37333	.39333	.39333	*	3	3	0.108	0.014	0.305	0.305
BERYLLIUM (TOTAL)	3	3	0.041	0.038	.06867	.06867	*	3	3	.05317	0.036	0.1225	0.1225
CADMIUM (TOTAL)	3	3	.18456	0.0245	.51233	.51233	*	3	3	.02384	0.025	.03833	.03833
CHROMIUM (TOTAL)	3	3	1.6493	.47117	4.3567	4.3567	*	3	3	.14189	.06133	0.335	0.335
COPPER (TOTAL)	3	3	4.2113	.06533	12.527	12.527	*	3	3	.03668	.04225	.04733	.04733
CYANIDE (TOTAL)	3	1	0.29	0.29	0.29	0.29	*	3	0				
LEAD (TOTAL)	3	3	5.7773	0.3175	16.717	16.717	*	3	3	.55928	0.3265	1.18	1.18
MERCURY (TOTAL)	3	2	0.1425	0.1425	0.284	0.284	*	3	0				
NICKEL (TOTAL)	3	3	.78883	.44667	1.8207	1.8207	*	3	3	.13636	.09475	0.255	0.255
SELENIUM (TOTAL)	3	3	.86767	0.14	2.4567	2.4567	*	3	3	.08367	0.079	0.16	0.16
SILVER (TOTAL)	3	3	.03089	.02667	0.063	0.063	*	3	2	0.009	0.009	0.016	0.016
THALLIUM (TOTAL)	3	3	.28211	0.002	.87333	.87333	*	3	3	.11667	0.0015	0.3475	0.3475
ZINC (TOTAL)	3	3	34.165	1.4767	100.82	100.82	*	3	3	.11664	0.1115	.15917	.15917
PHENOLICS (4AAP)	3	0					*	3	0				
IRON (TOTAL)	3	3	135.24	69.133	334.9	334.9	*	3	3	.55572	0.5505	.86467	.86467

TABLE VI-18 SUMMARY OF REAGENT USE (BY FUNCTION) IN ORE FLOTATION MILLS*

REAGENT	DESCRIPTION	FUNCTION	NUMBER OF MILLS WHERE USED**	USUAL DOSAGE kg/metric ton ore feed
		MODIFIERS		
Lime	CaO or $Ca(OH)_2$	Alkaline pH regulator and depressant for galena, metallic gold, iron sulfides, cobalt, and nickel sulfide. Has flocculating effect on ore slimes.	15	0.054 - 14.2
Caustic soda	Sodium Hydroxide, NaOH	Alkaline pH regulator	3	0.00015 - 0.025
Soda Ash	Sodium Carbonate, Na_2CO_3	Alkaline pH regulator w/slime dispersing action.	3	0.54 - 12.12
Sulfuric Acid	H_2SO_4	Acidic pH regulator.	2	0.018 - 4.3
		ACTIVATORS		
Copper Sulfate	$CuSO_4$ or $CuSO_4 \cdot 5H_2O$	Universal activator for sphalerite. Also used for the reactivation of minerals depressed by cyanide.	13	0.06 - 2.32
Copper Ammonium Chloride	$CuNH_2Cl$	Activator for sphalerite. Purchased as a waste by-product from the manufacture of electric circuit boards.	1	0.13 †
Sodium Sulfhydrate	Sodium Hydrosulfide $NaSH \cdot 2H_2O$	Activator for copper sulfide minerals.	1	0.0094

*Copper, lead, zinc, silver, and molybdenum concentrators which discharge process wastewater (data available).

† Expressed as soluble copper metal.

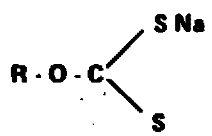
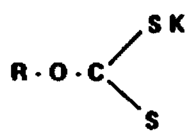
**Reagent usage data supplied by 22 milling operations.

TABLE VI-18. SUMMARY OF REAGENT USE (BY FUNCTION) IN ORE FLOTATION MILLS*
(Continued)

REAGENT	DESCRIPTION	FUNCTION	NUMBER OF MILLS WHERE USED**	USUAL DOSAGE kg/metric ton ore feed
DEPRESSANTS				
Cyanide	Sodium Cyanide, NaCN or Calcium Cyanide, $Ca(CN)_2$	Strong depressants for the iron sulfides, arsenopyrite, and sphalerite. Mild depressant for chalcopyrite, enargite, bornite and most other sulfide minerals w/ exception of galena.	13	0.003 - 0.065
Sodium Sulfite	$NaSO_3$	Depressant for pyrite and sphalerite while floating lead and/or copper.	2	0.2 - 7.46
Zinc Sulfate	$ZnSO_4 \cdot H_2O$ or $ZnSO_4 \cdot 7H_2O$	Depressant for sphalerite while floating lead and/or copper minerals. Often used in conjunction w/ cyanide.	7	0.1 - 1.35
Sodium Dichromate	$Na_2Cr_2O_7$	Depressant for galena in copper-lead separations. Excess depresses copper sulfides and iron sulfides.	1	0.022
Dextrin Starch Guar Hodag-31	Corn starch	Depressant for galena and molybdenite while floating copper sulfides	4	0.0005 - 0.071
Sulfur Dioxide	SO_2	Depressant for galena and activator for copper sulfides. Often used in conjunction w/ starch.	2	0.156 - 0.406
Noke's Reagent	Phosphorus Pentasulfide P_2S_5	Depressant for copper and lead while floating molybdenite.	4	0.0001 - 0.47
Hydrogen Peroxide	H_2O_2	Depressant for copper sulfides in copper-molybdenite separations.	1	0.016

*Copper, lead, zinc, silver, and molybdenum concentrators which discharg[illegible]cess wastewater (data available).
**Reagent usage data suplied by 22 milling operations.

TABLE VI-18. SUMMARY OF REAGENT USE (BY FUNCTION) IN ORE FLOTATION MILLS* (Continued)

REAGENT	DESCRIPTION	FUNCTION	NUMBER OF MILLS WHERE USED**	USUAL DOSAGE kg/metric ton ore feed
DEPRESSANTS				
Sodium Silicate	Na_2O: $nSiO_2$	Depressant for quartz and other siliceous gangue minerals. Also acts as slime dispersant.	5	0.031 - 2.08
AERO Depressant 610, 633	Composition unknown – Contains ~ 1.5% phenolics	Depressant for graphitic and talcose gangue. Also acts as gangue dispersants useful in sand-slime separation.	3	0.001 - 0.16
Jaguar Mud	Colloidal material	Depressant for gangue materials	1	0.016
COLLECTORS/PROMOTERS				
Xanthates: AERO 301, 325, 343, 355 Dow Z-3, Z-4, Z-6, Z-11, Z-14.	Sodium or potassium salts of xanthic acid.  or  where R is an alkyl group of 2-6 carbon atoms.	Strong promoters for all sulfide minerals. Essentially non-selective in the absence of modifiers.	17	0.0003 - 0.40

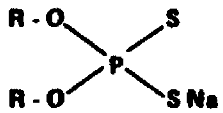
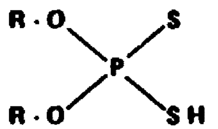
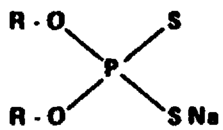
*Copper, lead, zinc, silver, and molybdenum concentrators which discharge process wastewater (data available).
**Reagent usage data supplied by 22 milling operations.

TABLE VI-18. SUMMARY OF REAGENT USE (BY FUNCTION) IN ORE FLOTATION MILLS*
(Continued)

REAGENT	DESCRIPTION	FUNCTION	NUMBER OF MILLS WHERE USED**	USUAL DOSAGE kg/metric ton ore feed
Dow Z-200	Isopropyl Ethyl-Thionocarbamate	Promoter for copper sulfides and activated sphalerite w/ selectivity over iron sulfides.	3	0.004 - 0.10
Fuel Oil Vapor Oil Tar Oil	Saturated Hydrocarbons	Promoters, usually used for readily floatable minerals, such as molybdenite.	4	0.0013 - 0.78
Minerec	Composition Unknown	Promoter.	1	0.01
DRESSENATE TX-65W SOAP	Composition Unknown	Promoter.	1	0.41
FROTHERS				
M.I.B.C. (Methyl Isobutyl Carbinol)	Synonomous with Methyl Amyl Alcohol $(CH_3)_2CHCH_2CHOHCH_3$	Alcohol type frothers are used for the flotation of sulfide minerals where a selective, fine textured froth is desired.	10	0.008 - 0.17
Methanol	CH_3OH	Frother	1	0.00005
Pine Oil	Composed primarily of terpene hydrocarbons, terpene ketones, and terpene alcohols.	Frother, widely used in sulfide flotation. It exhibits some collecting properties, especially for such readily floatable minerals as talc, graphite and molybdenite. Pine oil produces a tough, persistent froth and has a tendency to float gangue.	5	0.015 - 0.175
Cresylic Acid	Higher homologs of phenol, $C_6H_5 \cdot OH$, particularly cresols, $CH_3 \cdot C_6H_4 \cdot OH$, and xylenols, $C_2H_5 \cdot C_6H_4 \cdot OH$, or $(CH_3)_2 \cdot C_6H_4 \cdot OH$	A powerful frother exhibiting some collecting properties. Produces froth of variable texture and persistence, and tends to be non-selective.	3	0.003 - 0.034

*Copper, lead, zinc, silver, and molybedenum concentrators which discharge process wastewater (data available).
**Reagent usage data supplied by 22 milling operations.

TABLE VI-18 SUMMARY OF REAGENT USE (BY FUNCTION) IN ORE FLOTATION MILLS* (Continued)

REAGENT	DESCRIPTION	FUNCTION	NUMBER OF MILLS WHERE USED**	USUAL DOSAGE kg/metric ton ore feed
Aliphatic Dithiophosphates: Sodium AEROFLOAT AEROFLOAT 211, 249, 3477	 where R is an alkyl group of 2-6 carbon atoms.	Promoters of variable selectivity, and strength for the flotation of sulfide materials. Sometimes used in conjunction with xanthates for improved precious metal recoveries.	5	0.015 - 0.043
AEROFLOAT 31 and 242	Aryl Dithiophosphoric Acids  where R is an aryl group (benzene-based).	Promoters for copper, lead, zinc and silver sulfide minerals. Has frothing properties.	4	0.012 - 0.05
"Reco"	Sodium Dicresyl Dithiophosphate  where R is the cresyl group: $CH_3 \cdot C_6H_3 \cdot OH$	Promoter, selective to copper sulfide minerals. Very similar to AEROFLOAT 31 and 242.	1	0.016
ARMAC "C"	Acetate Salt of Aliphatic Amines	Promoter, very selective cationic collector.	1	0.0005

*Copper, lead, zinc, silver, and molybdenum concentrators which discharge process wastewater (data available).
**Reagent usage data supplied by 22 milling operations.

TABLE VI-18 SUMMARY OF REAGENT USE (BY FUNCTION) IN ORE FLOTATION MILLS* (Continued)

REAGENT	DESCRIPTION	FUNCTION	NUMBER OF MILLS WHERE USED**	USUAL DOSAGE kg/metric ton ore feed
Polyglycols: DOWFROTH 200, 250 AEROFROTH 65	Polyglycol Methyl Ethers (i.e. Polypropylene glycol methyl ether) $CH_3 \cdot (OC_3H_6)_x \cdot OH$	Frothers, for metallic flotation, w/ froth persistancy and selectivity against non-metals.	8	0.002 - 0.17
Diphenyl Guanidine	$HN \cdot C\ (NHC_6H_5)_2$	Frother	1	0.00005
UCON-R-23	Composition unknown	Frother	1	0.035
UCON-R-133	Composition unknown	Frother	1	0.015
SYNTEX	Composition unknown	Frother	1	0.017
		FLOCCULANTS		
AEROFLOC AERODRI 100 VALCO 1801 NALCOLYTE 670 SEPARAN NP-10 SUPERFLOC 3302 Flocculants (unspecified)	Anionic, Cationic, or Nonionic Organic Polymers.	Used as dewatering aids or filtration aids for thickening or filtering ore pulps, concentrates, and tailings.	9	0.00015 - 0.051

*Copper, lead, zinc, silver, and molybdenum concentrators which discharge process wastewater (data available).
**Reagent usage data supplied by 22 milling operations.

TABLE VII-2. POLLUTANTS CONSIDERED FOR REGULATION

Subcategory	Sub-Division	Mill Process	Toxic Pollutants																Conventionals		Nonconventionals					
			Sb	As	Chrysotile	Be	Cd	Cr	Cu	CN	Pb	Hg	Ni	Se	Ag	Tl	Zn	Total Phenolics	TSS	pH	COD	Fe - Total or Dis.	Ra 226	Al	U	Settleable Solids
Iron Ore	Mines		E	E	G	E	E	E	E	E	E	E	E	E	E	E	E	E	G	G		G				
	Mills	Phys/Chem	E	E	G	E	E	E	E	E	E	E	E	E	E	E	E	E	G	G		G				
		Phys (Mesabi)	Zero Discharge at BPT																							
Copper, Lead, Zinc, Gold, Silver, Platinum, Molybdenum	Mines		E	E	G	E	G	E	G	G	G	G	G	E	E	E	G	E	G	G						
	Mills	Cyanidation or Amalgamation	Zero Discharge at BPT																							
		Heap, Vat, Dump, In Situ Leach	Zero Discharge at BPT																							
		Froth Flotation	E	G	G	E	G	E	G	G	G	G	G	E	E	E	G	G	G	G						
		Gravity Separation																		G						G
Aluminum	Mines		E	E	G	E	E	E	E	E	E	E	E	E	E	E	E	E	G	G		G		G		
Tungsten	Mines		E	G	G	E	G	E	G	E	E	E	E	E	E	E	G	E	G	G						
	Mills		E	G	G	E	G	E	G	E	G	E	E	E	E	E	G	E	G	G						
Mercury	Mines											G	G						G	G						
	Mills		Zero Discharge at BPT																							
Uranium	Mines		E	E	G	E	E	E	E	E	E	E	E	E	E	E	G	E	G	G	G		G		G	
	Mills, In Situ Leach		E	E	G	E	E	E	E	E	E	E	G	E	E	E	G	E	G	G	G		G			
Antimony	Mines		Reserved																							
	Mills																									
Titanium	Mines		E	E	G	E	E	E	E	E	E	E	E	E	E	E	E	E	G	G		G				
	Mills		E	E	G	E	E	E	E	E	E	E	G	E	E	E	G	E	G	G						
	Mills w/ Dredges		E	E	G	E	E	E	E	E	E	E	E	E	E	E	E	E	G	G		G				
Nickel	Mines		Reserved																							
	Mills																									
Vanadium	Mines		Reserved																							
	Mills																									

E = Excluded from Guideline Development
G = Guidelines to be Considered

TABLE VII-3. PRIORITY METALS EXCLUSION CRITERIA BY SUBCATEGORY, SUBDIVISION, MILL PROCESS

Subcategory	Sub-Division	Mill Process	Toxic Pollutants: Sb	As	Chrysotile	Be	Cd	Cr	Cu	CN	Pb	Hg	Ni	Se	Ag	Tl	Zn	Total Phenolics
Iron Ore	Mines		3	6		3	3	3	6	3	3	3	3	3	3	3	6	3
	Mills	Phys/Chem	3	6		3	3	6	6	3	3	3	3	3	3	3	6	3
		Phys (Mesabi)	Zero Discharge at BPT															
Copper, Lead, Zinc, Gold, Silver, Platinum, Molybdenum	Mines		3	6		6		3						3	6	6		6
	Mills	Cyanidation of Amalgamation	Zero Discharge at BPT															
		Heap, Vat, Dump, In Situ Leach.	Zero Discharge at BPT															
		Froth Flotation	6			6		6						6	6	3		6
		Gravity Separation																
Aluminum	Mines		3	3		3	3	6	6	3	3	6	3	3	3	3	3	6
Tungsten	Mines		3			3				3	3	6	3	3	3	3		3
	Mills		6			6				3		3	3	3	6	3		6
Mercury	Mines																	
	Mills		Zero Discharge at BPT															
Uranium	Mines		3	6		3	3	6	3	3	6	6	3	6	3	3		6
	Mills, In Situ Leach		3			3	3	6	6	3	6	6		6	6	3		6
Antimony	Mines		Reserved															
	Mills																	
Titanium	Mines		3	3		3	3	3	6	3	6	3	3	3	3	3	6	6
	Mills		6	3		3	3	3	6	3	6	3		3	3	3		6
	Mills w/ Dredges		3	3		3	6	3	6	3	6	6	3	3	6	3	6	6
Nickel	Mines		Reserved															
	Mills																	
Vanadium	Mines		Reserved															
	Mills																	

EXCLUSION CRITERIA

1. Equal or more stringent protection is already provided by EPA's guidelines.
2. The pollutant is present as a result of its presence in the intake water.
3. The pollutant is not detected by approved methods.
4. The pollutant is unique to a small number of sources.
5. The pollutant is present in trace, non-toxic amounts.
6. The pollutant is present in amounts too small to treat.
7. The pollutant is effectively controlled by treating other pollutants.