Water Consumption at Copper Mines in Arizona

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WATER CONSUMPTION AT COPPER MINES IN ARIZONA

Arizona has the best copper deposits in the United States, and produces more of the red metal than most countries except Chile and Peru. All mining needs water for mining and processing and copper mining is no exception. Arizona is mostly desert and, therefore, short of water. This scarcity has been exacerbated because of the rapid growth of population in the state and the resulting enhanced demands for the resource. This has also attracted the attention of the general public to the use of water for mining.

Most water is used in flotation beneficiation, smelting, and electro-refining. Small amounts are used for domestic purposes (drinking, bathing, and such). It is also used for wetting roads to suppress dust. Factors affecting dust suppression include annual precipitation, natural vegetation, land morphology, and other factors. The amount of water used for wetting may vary between 0% and 15% of the total water used at the mine, depending on conditions. The water source may be from underground aquifers, Central Arizona (CAP), surface streams, precipitation, or a combination.

Copper minerals generally occur as oxides or sulfides. These require different treatments for extraction of the metal. The oxides are exposed to acid in a heap leach; this liberates the copper ions and the resulting solution is then sent to the solvent extraction (SX) process followed by electrowinning (EW) of the copper. The sulfides are subjected to crushing, grinding, and then flotation and the resultant concentrates then transported to smelters, where the sulfur is oxidized to sulfur oxides. The copper is then electro-refined.

Hydrometallurgical (Leaching) Process

Leaching, solvent extraction (SX) and electro-winning (EW) have been used for producing copper from oxide ores since the 1960s and since the 1980s some secondary sulfide ores, such as chalcocite, can also be treated in this manner. Figure 1 shows one possible flowsheet for the leaching process.

The process can involve crushing the ore and then binding it, or the ore can be directly placed on the heap or leach dump, where the lixiviating solution percolates through the ore to release the copper ions into solution. If agglomeration is used the sulfuric acid starts to dissolve the copper from the minerals. At the end of agglomeration, the moisture content is nearly 10%. It is then placed on heaps, 5 to 30 feet high, and irrigated with sulfuric acid. The process can be accelerated with the addition of oxidizing agents such as ferrous ions or bacteria. The heaps, or leach dumps, are built so that the solution can be collected for the next stage, without impact to the surrounding environment. The solution recovered from the heaps contains 0.008 to 0.25 lb of copper/gallon. This concentration is increased during the solvent extraction (SX) process.

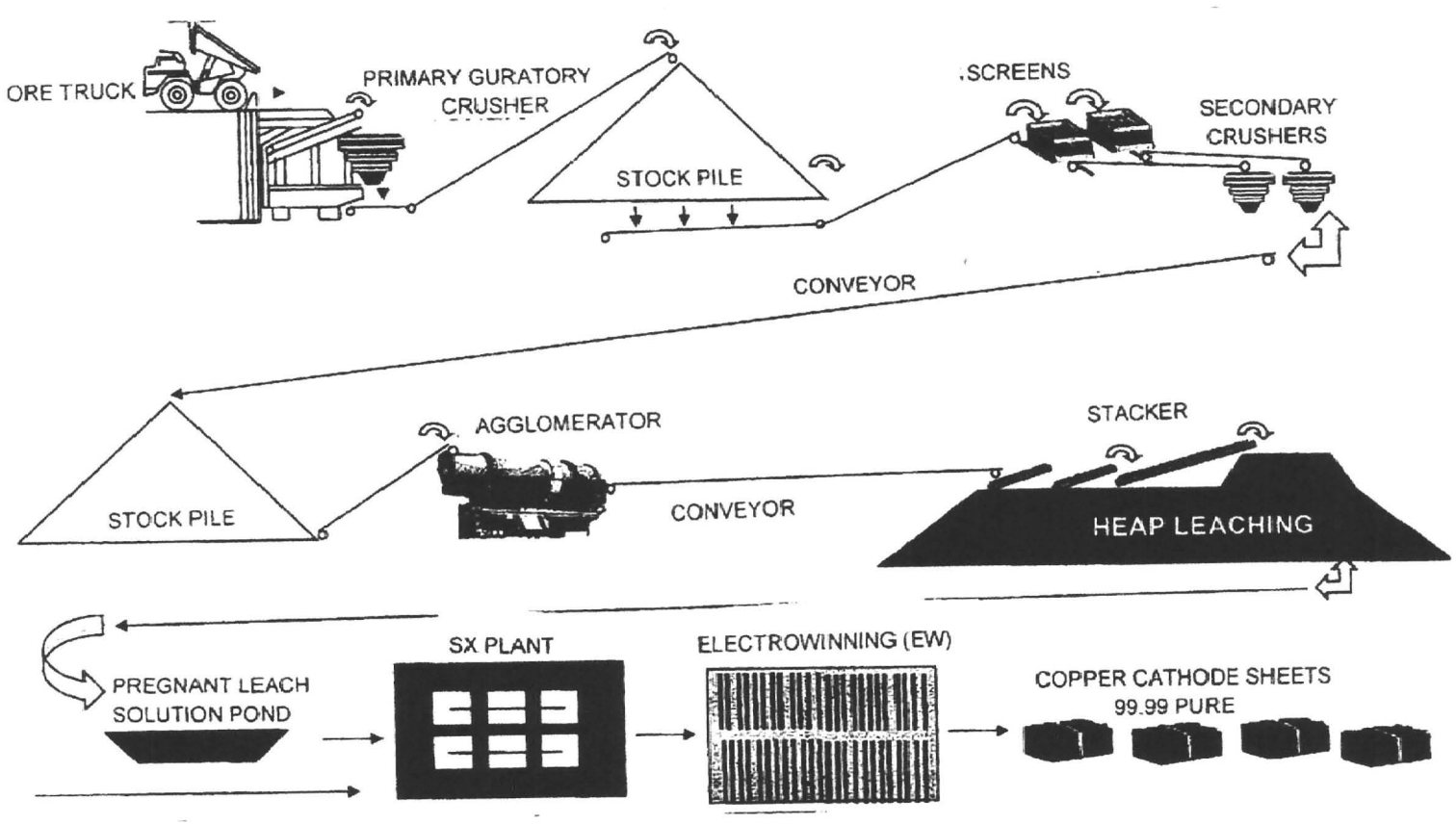

Figure 1 – Typical Flowsheet for the Hydrometallurgical (Leaching) Process

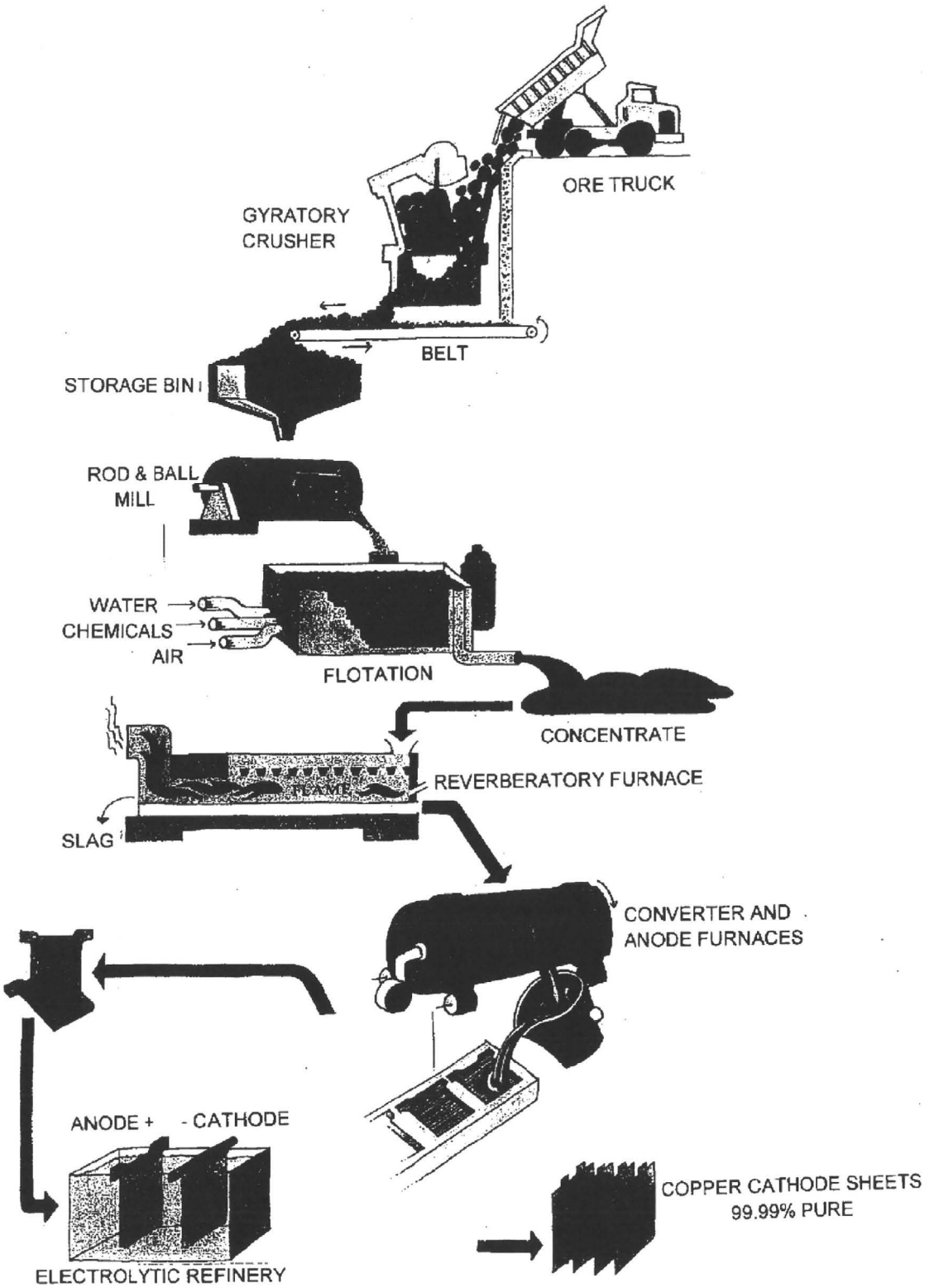

Figure 2 – Typical Flowsheet for the Pyrometallurgical (Smelting) Process

Water Usage in Major Copper Mines in Arizona in Acre-Feet

Mine	Affected GW Basin	Water Type	2004	2005	2006	2007	2008	Average Use
Bagdad[1]	Big Sandy	Groundwater	16,200	14,700	11,900	14,800	16,600	**14,840**
Miami[2]	Salt River	Groundwater	3,850	4,050	3,900	3,800	3,800	**3,880**
Mission[3]	Tucson AMA	Groundwater	4,520	4,270	7,069	7,929	10,130	**6,784**
		Central Arizona Project	0	0	0	1,028	2,460	**1,744**
Morenci[4]	Morenci	Groundwater	6,400	6,000	8,400	14,100	9,900	**8,960**
	Salt River	Surface Water	5,200	5,400	5,000	300	4,900	**4,160**
Ray[2]	Lower San Pedro	Groundwater	13,700	13,000	16,500	13,100	16,000	**14,460**
Sierrita[3]	Tucson AMA	Groundwater	26,480	28,490	26,690	26,710	27,180	**27,110**
Silver Bell[3]	Tucson AMA	Groundwater	1,156	928	1,034	905	820	**969**
Total Use								**55,659**
Projected Water Use								
Rosemont[5]								**5,000**
Safford (Dos Pobres)[5]								**5,500**

1-Data from ADWR estimates
2-Data from USGS Arizona Water Science Center
3-Data from ADWR 2009 Data Files
4-Data from USGS Files/Gila Water Commissioner Annual Reports
5-Data from Environmental Impact Statement (EIS)

The average amount of water used per pound of copper mined varies from mine to mine and from year to year, as mining and processing rates change and as market prices fluctuate, but for the years above these figures were:

Water Use (Gallons) per Pound of Copper

Mine	2004	2005	2006	2007	2008	Average
Bagdad[1]	24.0	23.8	23.4	23.9	23.8	**23.8**
Miami[2]	64.0	53.6	66.9	61.9	65.2	**62.3**
Mission[3]	27.3	36.4	24.1	24.1	26.8	**25.0**
Morenci[4]	4.5	4.6	5.3	5.8	6.5	**5.4**
Ray[2]	18.5	18.8	23.1	18.6	24.0	**20.6**
Sierrita[3]	55.7	58.5	53.8	58.0	47.1	**54.6**
Silver Bell[3]	7.9	6.3	7.2	6.3	5.6	**6.7**
Projected Use						
Rosemont[5]						**7.4**
Safford (Dos Pobres)[5]						**7.5**

Production data for the above are taken from DMMR files.

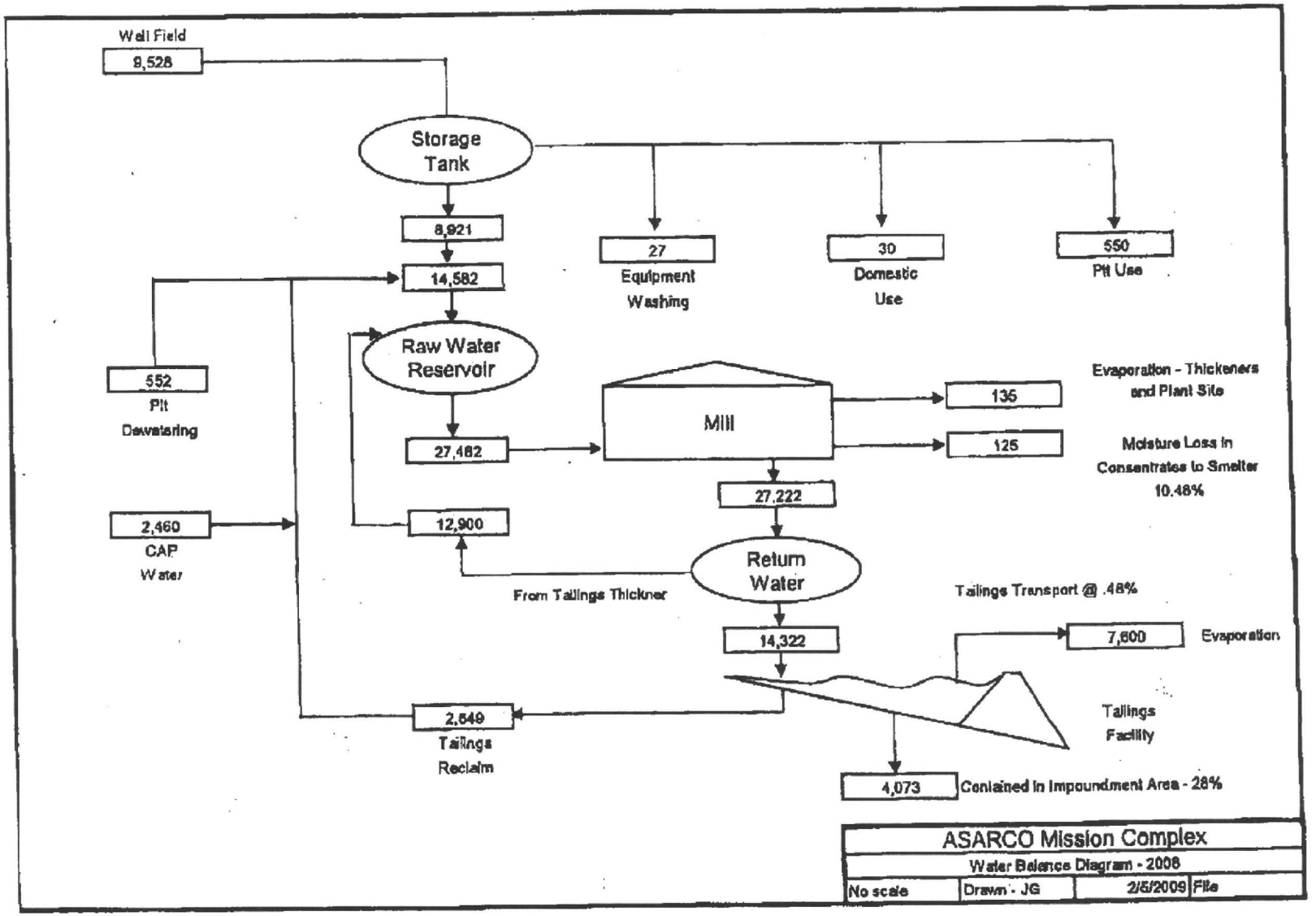

Figure 3 – Water Balance Diagram
(Figures are in acre-feet per annum)

Courtesy ASARCO