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BOND GOLD COLOSSEUM INC.
CRUSHING AND GRINDING: AN UPDATE

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INTRODUCTION

The Bond International Gold (BIG) Colosseum Gold Mine was discovered in 1865, but no recorded production occurred until the 1930's, with production approximately 19kg (615 oz) of gold. The mine was closed in 1942 as a non-essential industry during World War II. The property was acquired by Dallhold Resources in mid 1986. Construction of a 1.1 million Mt carbon-in-pulp, cyanide mill started in November, 1986, and was completed in September, 1987. Minable reserves are estimated to be 9,560,831Mt (10,539,000St), with an average grade of 2.1 g/Mt (0.062 oz/st). This paper describes a general view of process flow and plant equipment, as well as a look at the maintenance and operational problems encountered in the fist six months of operation.

SUMMARY DESCRIPTION OF PROCESS

Ore is direct hauled from the open pit mine, 1.5Km (0.95 mi) to the crushing facility and crushed to minus 15.2cm (6") with a single stage 1.52m x 1.22m (60" x 48"), 186.5Kw (250 horsepower) Fuller-Traylor jaw crusher. The oré is then stockpiled in a 31,750 Mt (35,000 st) reclaim ore pile. Lime is added to the crushed product as it is conveyed to a single 6.4m x 4.0m (21' x 13'), Hardinge Semi-Autogenous grinding (SAG) mill, followed by a single 4.3m x 7.3m (14' x 24') Hardinge O.F. ball mill.

After grinding, the slurry is thickened and then preaereated for three hours. Following preaereation the pulp is leached with NaCN at a pH of 11 for 3 hours. The slurry then goes through a 7 stage CIP circuit for 21 hours. Then the tailings slurry is preaereated for 3 hours prior to cyanide destruction using the Inco process.

Loaded carbon is eluted using an Anglo-American strip, followed by electrowinning on stainless steel wire. The stainless steel wire is transferred to refinery cells where the gold and silver is plated on stainless steel plates. Following electro-refining, the gold-silver foil is removed, melted, and poured into dore bars for shipment.

The processes of crushing, milling, refining, and maintenance require 37 personnel.

CRUSHING

The crushing area required changes and modifications following start-up. Several areas are of specific note:

1 - Structural Failures

Rubber support cushion blocks located under the coarse ore bin failed. These were replaced with heavier, more durable blocks and have since appeared to be satisfactory.

A severe structural vibration was encountered in the entire crushing facility. A mechanical engineer was brought in by the contractor. He determined the structure needed more support and cross bracing. This was done and it appeared to alleviate some of the problems. However, after further analysis, it was determined the real problem was that the access bridge and coarse ore bin (ROM) structures around the crusher were anchored to the foundations of the crusher causing a severe vibrational transfer.

This vibration will continue to be a problem until schedules can be coordinated between production and maintenance departments to allow sufficient repair time to revise the structure supports so that they are not tied into the existing crusher base. This will be performed in the spring of 1989. In conjunction with this, we will also replace the jaw liners and toggle seats.

After six months of continuous service the coarse ROM dump hopper required major repair.

Initially the hopper outside web structure was constructed of a 6.3mm (1/4") skin, welded to 9.5mm x 15.2cm (3/8" x 6") flat bar plate for vertical support, and 9.5mm x 10.2cm x 15.2cm (3/8" x 4" x 6") angle iron for horizontal support. The web structure was covered with 1.6cm x 45.7cm x 40.6cm (5/8" x 18" x 16") liner wear plates (360Bn). After a tonnage throughput of less than 508,000 Mt (560,000St), the integrity of the bin failed when excessive flexing and exposure to the ROM material caused 3 sides of the bin to push out. Since this type of hopper is more or less free-standing, the structural integrity of the bin must be addressed and have sufficient safety factors built in. When the bin started to expand the liner wear plates, which were plug welded instead of being drilled and counter-sunk bolted, they started to break away from the web shell.

Permanent repair was made during the 2nd week of June, 1988. The damaged sections on the sides of the bin were removed. Also, the 15.2cm (6") flat bar vertical members were replaced by 20.3cm (8"), 13 lb. angle iron beams. The new web structures were then covered by a 9.5cm (3/8") mild steel plate skin. The lining now consists of fabricated 1.9cm x 10.2cm x 25.4cm (3/4" x 4' x 10') wear plates (360Bn) drilled and counter-sunk bolted using grade 6 tupper head bolts. For extra bin strength, the liners were also bolted through the outer web horizontal support members. Additional modifications will be required to bring this area up to mining environment standards.

2 - Design Problems

Chute designs did not take into consideration the velocity and trajectory paths of materials. Shortly after start-up, the jaw crusher discharge chute came dislodged from the roof mounting structure when the chute anchors failed. They were epoxy grouted 2.5cm (1") steel bolts used to suspend the chute from the crusher concrete structure. (As previously mentioned, there was severe vibration experienced in this area.) All of the 2.5cm (1") embedded steel studs sheared off at the mounting flange-concrete interface. Since other similar failures had occurred, a decision was made to remount the chute from the floor.

The chute was cribbed from beneath. Using hydraulic jacks, the chute was repositioned. Four 15.2cm (6") vertical "I" beams were placed between the chute and the concrete floor. The beams were welded to a 1.22m x 1.22m (4' x 4') strengthening pad, which was attached to the chute. Four-pass welds were also made where the new vertical supports intersected the conveyor belt structure. The lower vertical support beam pads were drilled through the concrete. Using red head type anchors, the lower support pads were secured to the floor. By supporting the chute in this way, the chute was isolated from the vibrations of the crusher.

Other problems were encountered with this chute when excessive wear developed after 280,000Mt (310,000st) of ore was crushed. The initial dead bed lining of 7.6cm (3") mild steel angle iron backed by a 2" square alloy steel (360Bn) wear bar was inadequate. Due to the size and abrasive nature of the ore, the chute liner failed repeatedly. The solution to the excessive wear consisted of installing an angle support brace, using a 2.5cm (1") removable hardened plate (500Bn) for dead bedding purposes. A removable 7.6cm x 2.5cm (3" x 1") thick steel bar (500Bn) was then installed on top of the outside edge of the bedding plate to dam the crushed material up, creating ore on ore contact. The liners which had previously required repairs on monthly intervals, are now lasting 3 months before the wear bars require change out.

The installation of a Rill Tower (ore distribution tower) as part of the dust suppression system in the crushing area was an integral part of dust control. The device has been used in the coal industry for years. Unfortunately, we experienced some severe wear on the windows or discharge areas of the tower, as well as wear holes in the sides of the tower. To alleviate this problem, we installed large wear plates on the bottoms and sides of the discharge windows. This consisted of 1.9cm (3/4") 500Bn plates bolted and welded to the sides and bottoms of the openings. We are also inserting wear bars vertically within the tower, in high wear areas.

3 - Equipment Selection

The Fuller-Traylor jaw crusher has performed satisfactorily and is adequately sized. Throughput is as high as 590Mtph (650stph).

The crusher is driven by a 186.5 Kw (250 horsepower) wound rotor motor and is step started by automatic switching of the resistor banks in the full run position. A resistor is still in the rotor circuit to prevent damage to the motor in the event of a locked rotor condition.

Very early in the project the crusher developed some excessive vibrations and the large flywheels started to slip off of the shaft. This vibration contributed to the structural vibration. The jaw return bolts failed and it was nearly impossible to keep the lubrication system to the toggle area intact. After a close inspection and communication with the Fuller personnel, it was determined that the pillow block bearings had not been properly aligned or tightened during the initial assembly. In order to repair this condition, the crusher had to be disassembled and the bearings adjusted properly.

When the crusher was disassembled, it was found that there were some areas on the shaft that had very heavy pitting due to improper welding procedures (ground placement) and the bearings were contaminated with dirt. Therefore, the bearings were completely disassembled, cleaned, and inspected for damage before reassembling. Because of the problems with the toggle lube system, the toggle seats had to be replaced and the toggles themselves had to be repaired. Since repairs were completed, and the crusher put back into service, it has operated well.

It should be noted that the general performance of the A.C. ore feeder and feeder grizzly has been excellent. However, installation of multiple 1.9cm (3/4") (360Bn) liners as a direct replacement for Linatex Liners, has resulted in a better operation with increased operational availability. The grizzly bars as supplied, have been very satisfactory and show little wear for the amount of time in service.

CONVEYOR SYSTEM

The conveyor components, impact, and troughing idlers as provided proved unsatisfactory after a short period of time. Most of the problems occurred because of insufficient support in the roller base frame. The solution was to add reinforcement plates to the center brackets between the rolls, and steel plate to the underside of the cross angle support frame.

GRINDING

Problems are usually expected in any milling circuit following start-up. This area was no exception.

The initial installation of three variable speed vibrating feeders, located beneath the reclaim ore pile was incorrect. The feeder angle pitch and rotation placed high torque and sheer forces on the associated mounting and stabilization anchor bolts. Several of the feeders dislodged requiring immediate repair. Reinstallation included redrilling, and installation of upgraded roof mounting anchor bolts. The transition chutes between the stockpile hoppers and the feeders were also reinforced. By installing vertical support legs off the floor and on conveyor structures, the feeders were then repositioned to allow the feed to advance to the feeder discharge end more easily.

SAG MILL

In the initial start-up, October-November, 1987, throughput through the SAG mill averaged 83.6Mtph (92stph) with wear rates of 2500 operating hours and 208,878Mt (230,248st) of ore processed to the rubber liners. Change in wear patterns and tonnes/hr throughput was achieved with modification of the discharge grate located in the mill. Due to a washing effect on the last shell lifter bar and the discharge head filler ring liner, we decided to plug the outer two rows of openings on the discharge grate. After several attempts were made to do this in place without success, our spare set of grates was sent out to be modified. A 1.3cm (1/2") retaining pin was installed through the cross sections of the outer two rows of holes, and the open voids were then filled with urethane. This solution solved the majority of the accelerated wear in this area of the mill. Care should be taken in doing this however, because too high of a pulp discharge may result in bridging of feed between the lifters and a reduction in grinding efficiency. Liner wear has now been increased to 3200 Hrs, and 439,622Mt (484,600st) tons per change out. Further modifications to mill linings consisted of going from 6 different lifter bar lengths to 3 for the entire mill, and making all the shell plates the same length. Although no production gains were made from the aforementioned alterations, both maintenance on the mill and warehousing of the materials have been greatly simplified. It should be noted however, that a complete shell lifter replacement changeout can be performed in as little as 8 hours using the rubber liners.

BALL MILL

A change was made in the Ball Mill liner configuration after the first change-out. The lifter bar height was increased from 7.6cm to 12.7cm (3" to 5"), with the leading edge being tapered at a 20 degree angle from vertical to avoid over lifting of grind media. The shell plates were redesigned by transferring 2.5cm (1") of rubber from the leading edge to the trailing edge of the plate. Liner/lifter combinations are now staggered to avoid seam racing wear. Shell changeover can be done in approximately 14 hours.

Two of the cyclone feed pump isolation valves were changed from hand operated Dezurics to one pneumatic New Con valve, and one hydraulic Clarkson valve. The installation of the 35.5cm (14") knife gate slurry valve allows an easier and quicker method of switching over pump line systems.

The Warman 25.4cm x 20.3cm (10" x 8") cyclone feed, 15.2cm x 10.2cm (6" x 4") thickener underflow, and 15.2cm x 10.2cm (6" x 4") final tailings pumps were all converted from mechanical expeller to water gland seal pumps early in the project. Because the pumps were variable speed driven, they would slow down under low flow conditions and allow slurry into the stuffing box chamber, causing failure in this area. Due to inadequate head difference, the pumps were quite often being run at a speed too slow to properly expel slurry from the stuffing boxes. As a result, all of the pumps were converted to water gland seals. Since the modification, they have performed quite satisfactorily.

From the cyclone overflow, the mill slurry passes across a Simplicity 1.8m x 4.9m (6' x 16') trash screen. Pulp flows as high as 252 L/S (4,000 GPM) exceeded the capacity, prompting the addition of six flaps to decrease flow velocity. As a result of high scale buildup and subsequent loss to grinding availability, the addition of a second, Ore Sorters 6m Delkor Linear screen has been completed. This second screen has allowed an increase in mill availability and increased tonnage for the project.

GENERAL

Manning levels for the operations group at Colosseum have expanded from the original design concept. Upon start-up of the crushing and milling portions of the plant, it was observed that additional personnel were required to maintain the plant on a consistent basis. An additional man was also required in the Desorption/Refining section of the plant.

As currently operating, Colosseum's plant expects to continue pursuing a preventative maintenance program, which will provide smooth plant operation and increased dividends for the future.

BOND GOLD COLOSSEUM INC.

MILL STATISTICS

CRUSHER

Equipment: Unit Rig M-100S 85 Ton Boxes - Komatsu WA800
Hough 560 Loader
5' x 20' Allis Chalmers Vibrating Grizzley Feeder
48" x 60" Traylor Fuller Jaw Crusher

Approximate throughput = 500 TPH
Product Size Minus = 6.0"

MILL

Equipment: 21' x 13' Hardinge Sag Mill 2500 Hp D.C.
14' x 24' Hardinge O.F. Ball Mill 2500 Hp
8 x 10 Warman Cyclone Feed Pumps
Four D26B Krebs Cyclones

Ore storage capacity = 37,000 ton, 7,000 ton live
Mill throughput = 130 - 170 TPH
3,120 - 4,080 Tpd
Moisture content in ore = 2% - 4%
Typical milled product = 80% minus 120 mesh

THICKENER, LEACH AND CARBON ADSORPTION TANKS

Equipment: One (1) 115' Eimco Thickener with Lift Mechanism
One (1) 6m Delcor Linear Screen
One (1) Upflow Carbon Absorption Column
One (1) PreOxidation Tank with 60 Hp Lightnin Mixer
One (1) Leach Tank with 50 Hp Lightnin Mixer
Seven (7) CIP Tanks with 50 Hp Lightnin Mixer
One (1) Aeration Tank with 60 Hp Lightnin Mixer
All tanks 28'6" x 30'

Thickener Feed 16 - 20% solids
Thickener Underflow 48 - 50% solids at approximately 800 GPM
Leach/CIP retention time = 24 hrs.

Carbon concentration in each CIP = 14 GPL

CN DESTRUCTION

Equipment: One (1) destruction tank with 250 Hp ProChem agitator
Two (2) Centac Air Compressors 200 Hp each
Two (2) SO2 storage vessels with product distribution systems

CARBON STRIPPING CIRCUIT

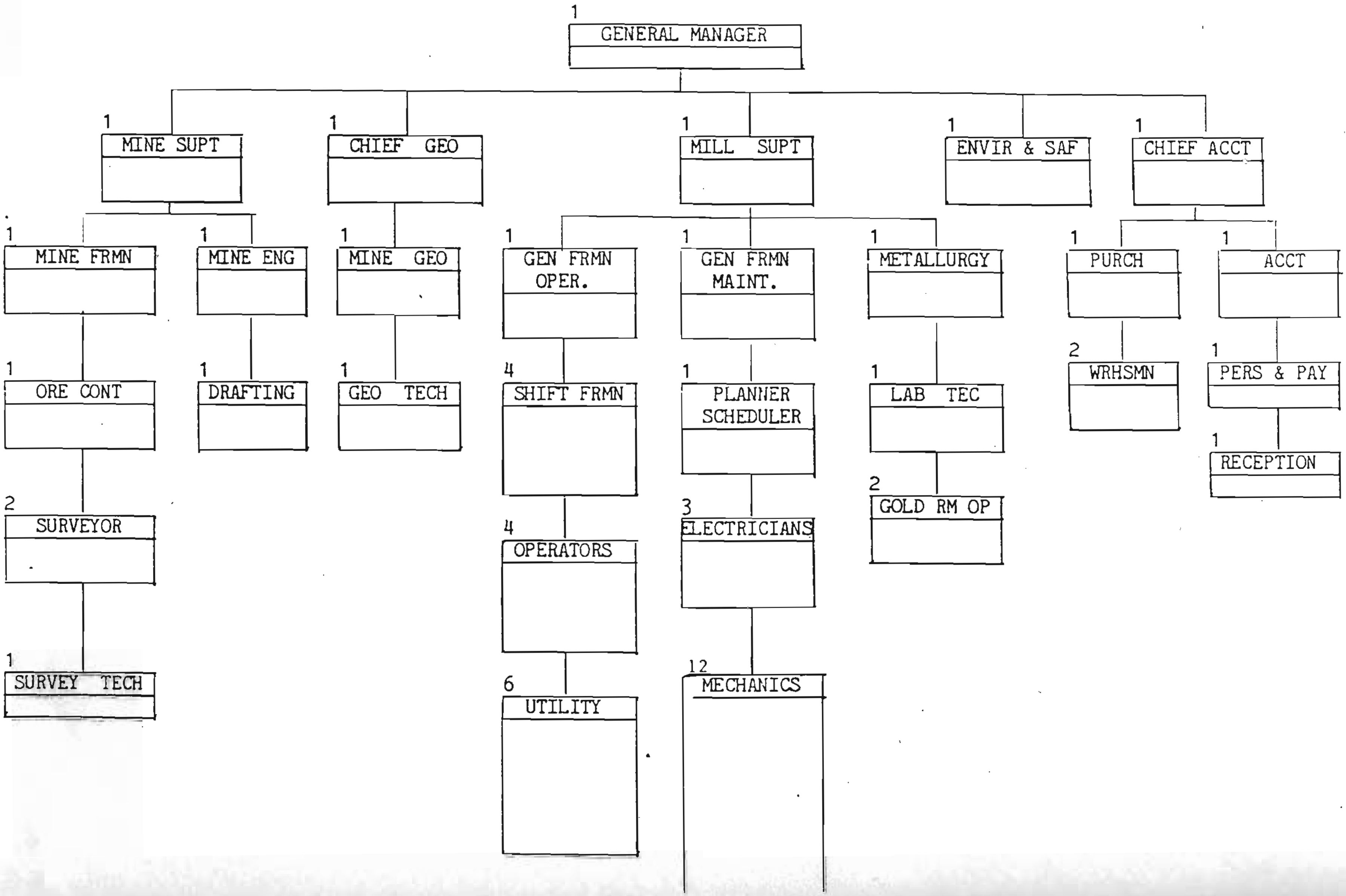
Equipment: One (1) 3' x 6' Simplicity hi-frequency screen
One (1) 7.5 ton load carbon hopper
One (1) 3.7 ton AARL strip column
One (1) 14,500 gallon prep tank
One (1) 100 Hp Bryan shell & tube boiler
Two (2) Tranter frame and plate heat exchangers
Two (2) John Dee electrowinning cells 53 cu. ft.
Two (2) John Dee electrorefining cells 53 cu. ft.

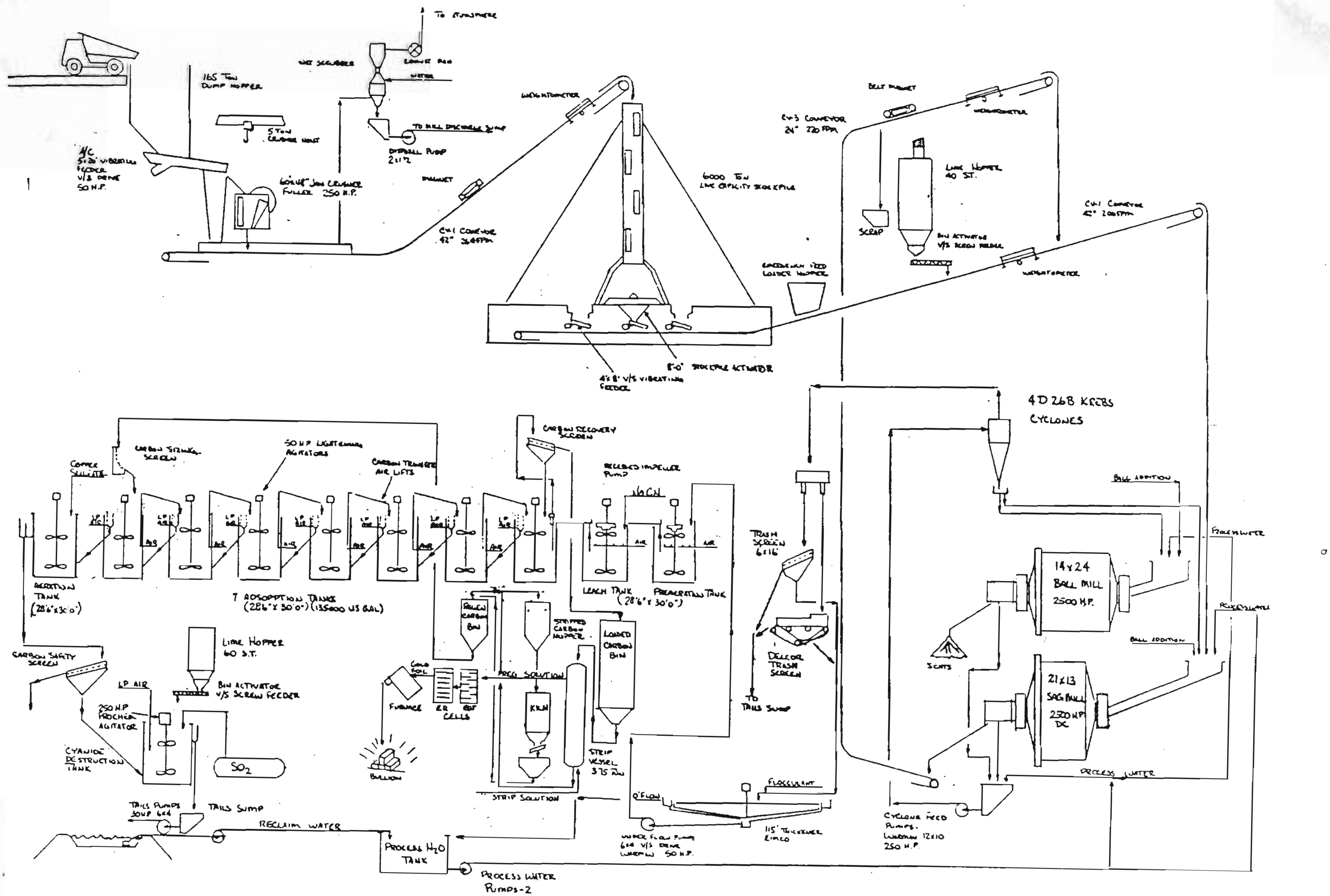
Average depleted gold barren solution = 2 ppm
Average strip time = 8.5 Hrs.
Flow Rate = 55 GPM
Temperature = 240 degrees F.
Electrolite Cyanide = .4%
Electrolite Caustic = .3%

TYPICAL REAGENT CONSUMPTIONS

Cyanide	1.740	lbs/ton
Lime	5.470	
Carbon	0.115	
Caustic	0.160	
Flocculant	0.021	
Grind Media	3.500	
Hydrochloric Acid	0.025	
SO2	3.920	
Copper Sulfate	0.291	

BOND GOLD COLOSSEUM INC.
ORGANIZATIONAL CHART




165 TON DUMP HOPPER
5 TON CRUSHER HOIST
WET SCRUBBER
TO ATMOSPHERE
WATER
DISCHARGE PUMP
FULLER 250 H.P.
C-1 CONVEYOR 42"
WEIGHTOMETER
6000 TON LIVE CAPACITY STOCKPILE
8'-0" STOCKPILE ACTIVATOR
4'x 8' V/S VIBRATING FEEDER
BELT MAGNET
C-3 CONVEYOR 24" 220 FPM
LIME HOPPER 40 ST.
SCRAP
BIN ACTIVATOR V/S SCREW FEEDER
C-1 CONVEYOR 42"
4 D 26B KREBS CYCLONES
BALL ADDITION
14 x 24 BALL MILL 2500 H.P.
21 x 13 SAG MILL 2500 H.P. DC
SCATS
PROCESS WATER
CYCLONE FEED PUMPS
250 H.P.
TRASH SCREEN 6'x16'
DELCOR TRASH SCREEN
TO TAILS SUMP
FLOCCULANT
115' THICKENER EIMCO
O'FLOW
CARBON RECOVERY SCREEN
RECESSED IMPELLER PUMP
NaCN
LEACH TANK
PREAERATION TANK
(28'6" x 30'0")
COPPER SULFATE
CARBON SIZING SCREEN
50 H.P. LIGHTNIN AGITATORS
CARBON TRANSFER AIR LIFTS
AERATION TANK
(28'6" x 30'0")
7 ADSORPTION TANKS
(28'6" x 30'0") (135000 US GAL)
CARBON SAFETY SCREEN
LIME HOPPER 60 S.T.
LP AIR
BIN ACTIVATOR V/S SCREW FEEDER
250 H.P. PROCHEM AGITATOR
CYANIDE DESTRUCTION TANK
SO_2
TAILS PUMPS
TAILS SUMP
RECLAIM WATER
PROCESS H_2O TANK
PROCESS WATER PUMPS-2
FURNACE
GOLD FOIL
BULLION
E.R. CELLS
PREG SOLUTION
KILN
STRIPPED CARBON HOPPER
LOADED CARBON BIN
STRIP VESSEL
STRIP SOLUTION