Appendix 2: Capital and Operating Cost Estimate – GR Engineering Services (2016)

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ACH Minerals
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Attention: Paul Bennett

Dear Sir

ACH MINERALS
RAVENSTHORPE COPPER GOLD PROJECT
CAPITAL AND OPERATING COST ESTIMATE

1. INTRODUCTION

ACH Minerals (ACHM) requested that GR Engineering Services Limited (GRES) provide a capital cost and operating cost estimate for a 500,000 t/year conventional CIL plant and a 250,000 t/year sulphide flotation plant.

GRES conducted a definitive feasibility study on the Kundip and Trilogy resources in 2011. These resources comprised 12 metallurgical domains with widely varying metallurgical characteristics. This resulted in a very complex process plant design. The final design had a capital cost of approximately $200M.

The scope of this current estimate was restricted to the Kundip resource and considered just two metallurgical domains – the low copper oxide and the high copper sulphide. This greatly simplifies the process design. In addition, as the processing will be sequenced it allows for a common crushing and grinding circuit followed by separate process plants to treat each ore type.

2. PROCESS DESCRIPTION

The processing plant will be designed with two distinct operating modes. The mode used will depend on the ore being treated. Oxide ore with a low copper content will be treated at a nominal throughput of 500,000 t/year through a hybrid carbon-in-leach (CIL) plant to recover gold as bullion. Sulphide ores will be treated at a nominal throughput of 250,000 t/year through a conventional froth flotation plant to produce a copper-gold concentrate. A block diagram showing the overall flow sheet is shown in Figure 1.

This process design is compatible with the Kundip metallurgical domains but not compatible with the Trilogy metallurgical domains because of the elevated silver to gold ratio in these ores. The present process design can treat the low copper Kundip ore types however the economics will depend on the cyanide consumption and the mill throughput (the design throughput is based on oxide ore for the 500,000 t/year). The recoveries should be in alignment with the 2011 Feasibility study. For the high copper Kundip ore types the recoveries will reflect only the flotation recoveries for copper, gold and silver as there is no CIL circuit treating the flotation tailings and no SART circuit recovering copper and silver. To operate both the flotation and CIL circuits simultaneously will require separate process water circuits to separate cyanide containing water from non-cyanide containing water. This will add considerable capital cost to the project. In addition as the present process design is based on sulphide flotation it makes no allowance for the extra conditioning tanks required for the controlled potential sulphidisation (CPS) necessary for the oxide and transitional high copper ore types and as such the flotation recoveries can be expected to be lower than those in the 2011 feasibility study. The design does make allowance for the sodium hydrosulphide necessary for CPS flotation and it has been included to the process description but to make effective use of this will require approximately six additional conditioning tanks.

2.1 Crushing and Grinding Circuit

Ore will be delivered to a ROM pad and fed into a 50 t ROM bin by a front end loader. The ore will then be crushed to 100% passing 12 mm by a conventional three stage crushing circuit. The circuit will compromise the following:

- 1,000 mm x 760 mm jaw crusher as the primary crusher;
- 940 mm diameter standard head cone crusher as the secondary crusher;
- 940 mm short head cone crusher as the tertiary crusher.

The cone crushers will be closed circuit with a 2.4 m x 6.1 m double deck vibrating screen.

Dust suppression sprays and enclosed transfer chutes will be used through the crushing circuit to minimise dust emissions.

Product from the crushing circuit will be conveyed to the 1,500 t fine ore bin. The fine ore bin will be fitted with an open door rill to provide a means to empty the bin for maintenance purposes. This will also provide a means to feed the grinding circuit during an extended shut down of the crushing circuit.

Ore will be reclaimed from the fine ore bin by a belt feeder and delivered to the single stage 3.4 m diameter (inside shell) x 5.2 long (effective grinding length) overflow ball mill that will be fitted with a 900 kW motor. The ball mill will be in closed circuit with 250 mm diameter cyclones. The ball mill will grind the ore to 80% passing 75 µm. A portion of the cyclone underflow will be directed to a gravity circuit to recover gravity recoverable gold. The gravity circuit concentrate will be treated by intensive cyanidation and electrowinning to produce gold bullion after smelting. Cyclone overflow will be screened by trash screen and the undersize will be directed to either the CIL plant or the flotation plant depending on the ore type.

2.2 CIL Circuit

For low copper oxide ores the cyclone overflow will be approximately 40% solids and will be directed to a leaching circuit comprising three 300 m^3 agitated leach tanks in series. The ore will be dosed with sodium cyanide and lime to leach the cyanide soluble gold. To assist the leaching kinetics oxygen will be injected into each leach tank. After leaching the pulp will pass through six 300 m^3 CIL tanks. Each CIL tank will have approximately 10 g/L of carbon. The carbon will be advanced counter-current to the pulp by air lifts. Loaded carbon from the first tank will be recovered over a loaded carbon screen and directed to the elution circuit. The pulp from the last CIL tank will be directed to cyanide detoxification.

The elution circuit will be a split AARL circuit with a 2 t acid wash and elution column. Gold in the pregnant solution from the elution circuit will be recovered by electrowinning and will then be smelted to produce gold bullion. The barren carbon for the elution circuit will be thermally regenerated by a kiln prior returning it to the last tank in the CIL circuit.

Tailings from the CIL circuit will be undergo cyanide detoxification using the air – sulphur dioxide process to target a weak acid dissociable (WAD) cyanide level of less than 50 ppm in the tailings discharge. This will consist of two 150 m^3 agitated tanks in which the slurry will be dosed with sodium metabisulphite and lime to break down the WAD cyanide. After cyanide detoxification the slurry will be directed to a 13 m diameter high rate tailings thickener. Tailings will be thickened to approximately 60% solids prior to pumping to the tailings storage facility (TSF). Water recovered from the tailings thickener will be recycled to the process water pond. Water in the supernatant pond at the TSF will be returned to the process water pond by a pump.

2.3 Flotation Circuit

For copper sulphide ores the cyclone overflow will be approximately 30% solids and will be directed to a rougher flotation circuit consisting of five 20 m^3 tank cells. Flotation reagents will be added to recover the copper minerals to the concentrate. The concentrate from the roughing circuit will be directed to the cleaning circuit. The cleaning circuit will consist of five 1.9 m^3 conventional cells. Both the tailings from the rougher and the cleaner flotation cells will be directed to the tailings thickener for thickening to approximately 60% solids prior to being pumped to the TSF. The concentrate from the copper cleaners will be re-ground in a 132 kW stirred bead mill to further liberate the copper minerals. The regrind mill product will be directed to the copper re-cleaners for a final stage of cleaning. The recleaning circuit will consist of five 1.9 m^3 conventional cells. Concentrate from the recleaners will be directed to the 5 m diameter high rate concentrate thickener. The tailings from the recleaning circuit will be recycled to the copper cleaning circuit.

Copper concentrate will be thickened to approximately 65% solids in the concentrate thickener. The overflow from the concentrate thickener will be recycled to the process water pond. The thickened copper concentrate will be pumped to a 50 m^3 agitated concentrate storage tank. The copper concentrate will then be filtered using a 10 chamber recessed plate filter with 1,500 mm x 1,500 mm plates. The filter cake will be discharged into a concentrate storage shed for shipment off site in bulk. The filtrate from the filter will be returned to the concentrate thickener.

2.4 Reagents

Details of the various reagents required for the process and the equipment required for their delivery, mixing, storage and dosing is as follows:

- *Sodium cyanide* (gold leaching reagent and elution reagent) will be delivered to site in 1,000 kg bulk boxes and will be mixed as a 10% w/v solution in a 20 m^3 agitated mixing tank and transferred to a 40 m^3 storage tank as required for use in the process;
- *Quicklime* (pH modifier and cyanide detoxification reagent) will be delivered to site in bulk (70 t) and will be stored in a 100 t silo. A 20 t/d lime slaking plant will convert this to a hydrated lime slurry at 20% w/w. This slurry will be stored in a 20 m^3 agitated tank for use in the process;
- *Oxygen* (gold leaching agent and cyanide detoxification agent) will be delivered to site in bulk and will be stored in a 42 kL vessel on site for use in the process;
- *Carbon* (gold adsorption agent) will be delivered to site in 500 kg bulk bags. These will be added to the CIL circuit as required;
- *Sodium hydroxide* – 50% w/w (intensive cyanidation and elution reagent) will be delivered to site in bulk (20 t) and stored in a 30 m^3 storage tank for use in the process;
- *Hydrochloric acid* – 30% w/w (carbon acid washing) will be delivered to site in bulk (20 t) and stored in a 30 m^3 storage tank for use in the process;
- *Nitric acid* – 70% w/w (acid washing step in the intensive cyanidation process) will be delivered to site in 1,000 L intermediate bulk containers (IBC). These will be transferred into a 1.5 m^3 storage tank as required for use in the process;
- *LPG* (fuel for the elution heater, carbon regeneration kiln and smelting furnace) will be delivered to site in bulk and will be stored in a 7.5 kL gas bullet for use in the process;
- *Sodium metabisulphite* (cyanide detoxification reagent and flotation reagent) will be delivered in bulk (20 t) as a 35% w/v solution. It will be stored in a 50 m^3 storage for use in the process;

- *Potassium amyl xanthate* (flotation reagent) will be delivered to site in 850 kg bulk boxes and will be mixed as a 10% w/v solution in a 10 m^3 agitated mixing tank and transferred to a 20 m^3 storage tank as required for use in the process;
- *Cytec 9810* (flotation reagent - dithiophoshate) will be delivered to site in 1,000 L IBC. These will be transferred into a 1.5 m^3 storage tank as required for use in the process;
- *Sodium hydrosulphide* (flotation reagent) will be delivered to site in 1,200 kg bulk bags and will be mixed as a 10% w/v solution in a 12 m^3 agitated mixing tank and transferred to a 24 m^3 storage tank as required for use in the process;
- *Frother* (flotation reagent) will be delivered to site in 1,000 L IBC. These will be transferred into a 1.5 m^3 storage tank as required for use in the process;
- *Flocculant* (settling agent for thickening) will be delivered to site in 25 kg bags. It will be mixed as a 0.25% w/v solution for use in the process.

2.5 Services

High pressure air (HPA) for the site will be supplied by rotary screw compressors. HPA will be stored in air receivers prior to use. Low pressure air (LPA - for flotation) will be supplied by centrifugal blowers.

Raw water will be supplied from bores and pumped to a 2,000 m^3 earthen raw water pond with a HDPE liner. This raw water will be used to generate potable water on site via reverse osmosis (RO) plant. The raw water pond will be used to top up the 5,000 m^3 earthen process water pond with a HDPE liner. Process water recovered from the tailings thickener, concentrate thickener and the TSF will be recycled to the process water pond for re-use.

3. COST ESTIMATES

3.1 Capital Cost Estimates

The capital cost estimate has been estimated using GRES data base equipment costs and quantities from similar work previously undertaken. The costs should be considered accurate to ±30%. The estimated cost forecasts the costs required to design, construct and commission the processing plant infrastructure only. No provision is made for non-process infrastructure such as may be required for site offices, the establishment of power supply or water supply infrastructure to the site, workshop and stores facilities, spare parts, first fills or for the construction of a tailings storage facility. The costs are based on fourth quarter 2016 pricing and include a nominal 7.5% contingency provision (on cost) and 8.0% head contract margin (on sell) that would likely apply should the works be undertaken under a lump sum or EPC contract arrangement.

Estimated capital cost for the processing plant totals $69.4M ±30%. Details of the cost estimate are included as Table 1 and Table 2.

The capital costs represent a conventional fixed plant installation. There are several opportunities to reduce this capital cost (albeit at a higher operating cost and in some cases lower recovery). These are detailed below:

- Replace the crushing circuit with a modular crushing plant (approximately 50% of the capital cost of a fixed plant) or utilise contract crushing (approximately $10/t of ore);
- Utilise second hand equipment or even a second hand plant (approximately 70% of the capital cost of new equipment);
- Eliminate the fine ore bin storage (this will impact on plant utilisation as it will then be driven by the crushing circuit not the rest of the plant and will increase operating costs because it will require additional re-handling);
- Utilise heap leaching instead of a hybrid CIL (lower capital cost but ore this has not been tested to verify suitability of the ore for this option).

There are a number of further cost reduction initiatives that may be possible but these would require further evaluation to properly quantify the overall impact on the project.

3.2 Operating Cost Estimate

The operating cost estimates have been estimated by factoring recent actual operating costs from similar sized operations within the GRES data base. They are considered to be to be ±30%. The costs are direct processing plant costs only and do not include any allowance for corporate overheads or other indirect costs.

For the processing of low copper oxide ore the cost is very dependent on the level of cyanide soluble copper in the ore and so the operating cost is presented as an equation that permits the cost to be derived from a given cyanide soluble copper content in the ore. This relation was derived from a data set that ranged from 0 to 3,255 ppm and is considered to be valid within this range.

- Operating Cost ($/t of ore) = 34.64 + 9.31 x Cyanide Consumption (kg/t of ore) ±30%;
- Cyanide Consumption (kg/t ore) = 1.076 +0.004 x Cyanide Soluble Copper (ppm).

The above costs relate to a throughput rate of 500,000 t/year and include the cost of cyanide and the cost of detoxification reagents necessary to break down the weak acid dissociable (WAD) cyanide in the tailings stream. The calculation assumes that all cyanide in the ore reports to the tailings as WAD cyanide. This is considered a reasonable assumption in the circumstances.

For processing high copper sulphide ore at 250,000 t/year the operating cost is estimated to be $49.49/t of ore ±30%.

Yours faithfully
GR Engineering Services Limited

WGGosling

Bill Gosling
Principal Process Engineer

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Description	Equipment/ Materials $	Labour $	Transport $	Contingency $	Total $
200 Earthworks	60,870	216,702	0	20,818	298,389
310 Crushing & Screening	5,543,813	1,200,898	250,376	524,632	7,519,719
320 Fine Ore Storage & Handling	1,576,369	699,075	73,198	176,148	2,524,789
330 Grinding & Classification	2,736,197	649,304	290,886	275,729	3,952,116
336 Flotation	4,057,582	895,058	140,243	381,966	5,474,848
338 Concentrate Thickening	276,425	88,705	55,345	31,536	452,011
340 Leaching & Adsorption	2,153,600	905,410	124,131	238,736	3,421,877
342 Concentrate Filtering & Washing	1,657,786	607,811	92,140	176,830	2,534,567
346 Concentrate Storage	1,341,977	650,770	110,828	157,768	2,261,344
350 Gold Recovery	1,255,523	286,479	284,546	136,991	1,963,540
360 Reagent Mixing & Distribution	2,013,899	646,581	107,971	207,634	2,976,085
370 Power Reticulation	4,638,220	2,341,090	46,361	526,925	7,552,596
390 Water Storage & Reticulation	1,278,419	368,422	30,984	125,837	1,803,662
400 Tails Thickening & Disposal	950,281	313,994	130,033	104,573	1,498,881
402 Tailings Return Water	12,500	3,324	2,273	1,357	19,453
420 Air Services	312,738	64,367	4,653	28,632	410,390
430 Administration Buildings	0	0	0	0	0
440 Workshop Stores	0	0	0	0	0
460 Laboratory	0	0	0	0	0
499 Plant Piping	2,340,437	2,336,552	230,033	368,027	5,275,049
500 Project Management	14,130	2,154,810	0	162,671	2,331,611
501 Engineering and Drafting	0	4,755,321	0	356,649	5,111,970
502 Site Construction Costs	0	3,052,510	0	228,938	3,281,448
503 Site Construction Equipment	2,636,597	759,106	0	254,678	3,650,382
504 Site Construction Facilities	2,324,998	182,008	0	188,025	2,695,031
505 Commissioning	99,201	1,048,979	0	86,113	1,234,293
840 Mob / Demob / Indirects	1,034,783	0	0	77,609	1,112,391
TOTAL	**38,316,344**	**24,227,274**	**1,974,002**	**4,838,822**	**69,356,442**

Table 1 Capital Cost Estimate Area Summary

Description	Equipment/ Materials $	Labour $	Transport $	Contingency $	Total $
Earthworks	60,870	216,702	0	20,818	298,389
Civil works	4,907,155	3,038,322	18,394	597,290	8,561,161
Mechanical equipment	10,770,800	1,248,670	940,345	971,986	13,931,802
Platework	4,359,149	1,344,960	338,600	453,203	6,495,912
Structural steel	5,887,164	1,827,366	417,006	609,865	8,741,400
Electrical installations	4,501,605	2,261,880	32,412	509,692	7,305,588
Buildings	0	0	0	0	0
Piping	2,261,873	2,304,988	227,245	359,558	5,153,664
Construction equipment	2,636,597	759,106	0	254,678	3,650,382
Temporary construction facilities	2,817,802	213,661	0	227,360	3,258,823
Construction management	0	3,052,510	0	228,938	3,281,448
Project management	14,130	2,154,810	0	162,671	2,331,611
Engineering design	0	4,755,321	0	356,649	5,111,970
Vendor commissioning	25,272	490,304	0	38,668	554,244
Commissioning	73,929	558,675	0	47,445	680,050
TOTAL	**38,316,344**	**24,227,274**	**1,974,002**	**4,838,822**	**69,356,442**

Table 2 Capital Cost Estimate Discipline Summary

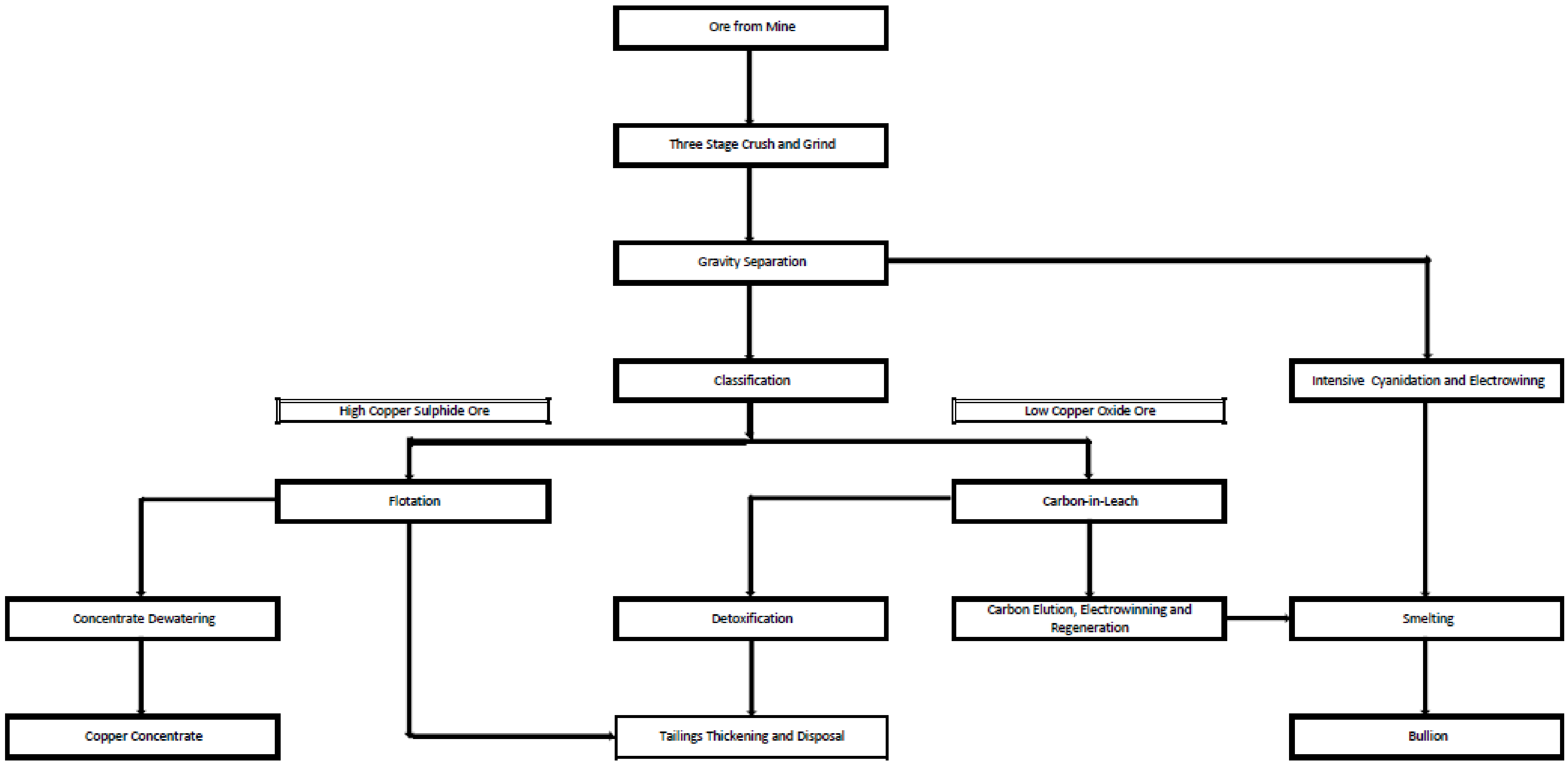

Figure 1 Block Flow Diagram