CLEANTEQ METAL RECOVERY

ALTA 2022 26 YEARS

20-27 May | Perth, Australia | Online

COMBINING IN SITU RECOVERY AND ION EXCHANGE AT THE KAPUNDA COPPER PROJECT

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ISR AND ION EXCHANGE

- IX is well-suited for recovery of low- to moderate-concentrations of value metals from complex processing liquors. Very-well matched to PLS processing / lixiviant return.
- ISR has a different cost structure to drill-blast-haul-mill-etc. Not reliant on bigger-is-better for payback.
- Ion exchange suits incremental / modular development
- Uranium – 50% global supply
- Copper – Taseko's Florence ISR
- Nickel – KazNickel's Gornostayevskoye
- Future: Rare earths; other battery minerals; gold (paleochannel deposits)

Gornostayevskoye – Nickel ISR IX

South Inkai – Uranium ISR IX

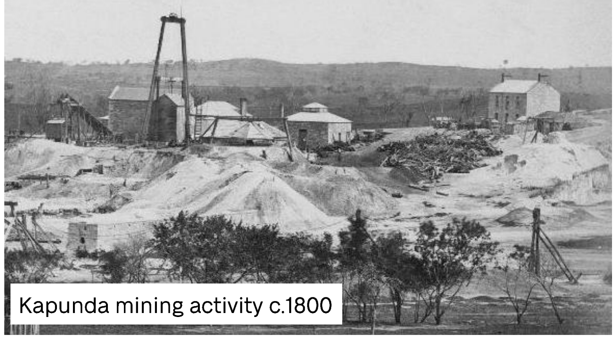
KAPUNDA PROJECT OVERVIEW

CLEANTEQ METAL RECOVERY | ENVIRO COPPER THE INVISIBLE MINE

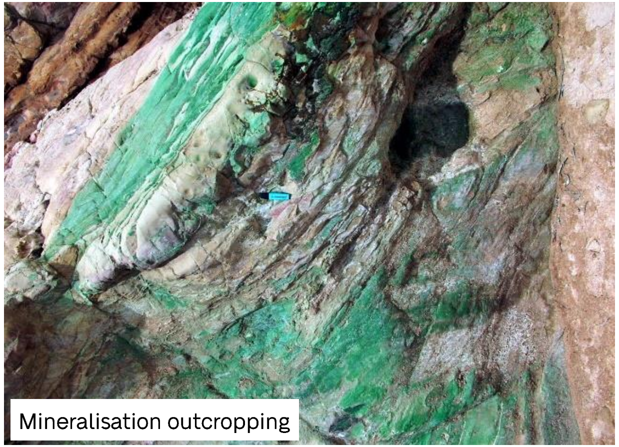
- Desktop review ✓
- Resource definition ✓
- Lab Test work ✓
- Hydro Test work ✓
- Column Leaching ✓
- Scoping Study ✓
- SELT Trials & DFS
- Mining Lease Application
- Production

Interest	**ECL has earned 50% project interest and is earning to 75%**
Location	150 km north of Adelaide, South Australia
Infrastructure	Poximity to power, water and workforce
Resource	JORC resource 102MT @ 0.23% Cu, signif. gold upside potential
Geology	Siltstone, fracture fill mineralisation
Social	Built strong research based community support for project
ISR Characteristics	- Depth of mineralization (40-250m) - Visible core is highly weathered and fractured, likely to be permeable - Mineralisation sits under water table, right hydrogeological environment - Copper already present in water monitoring bores (suggesting readily leachable)

Kapunda is a near term copper/gold ISR project ready for definitive feasibility and mining lease application

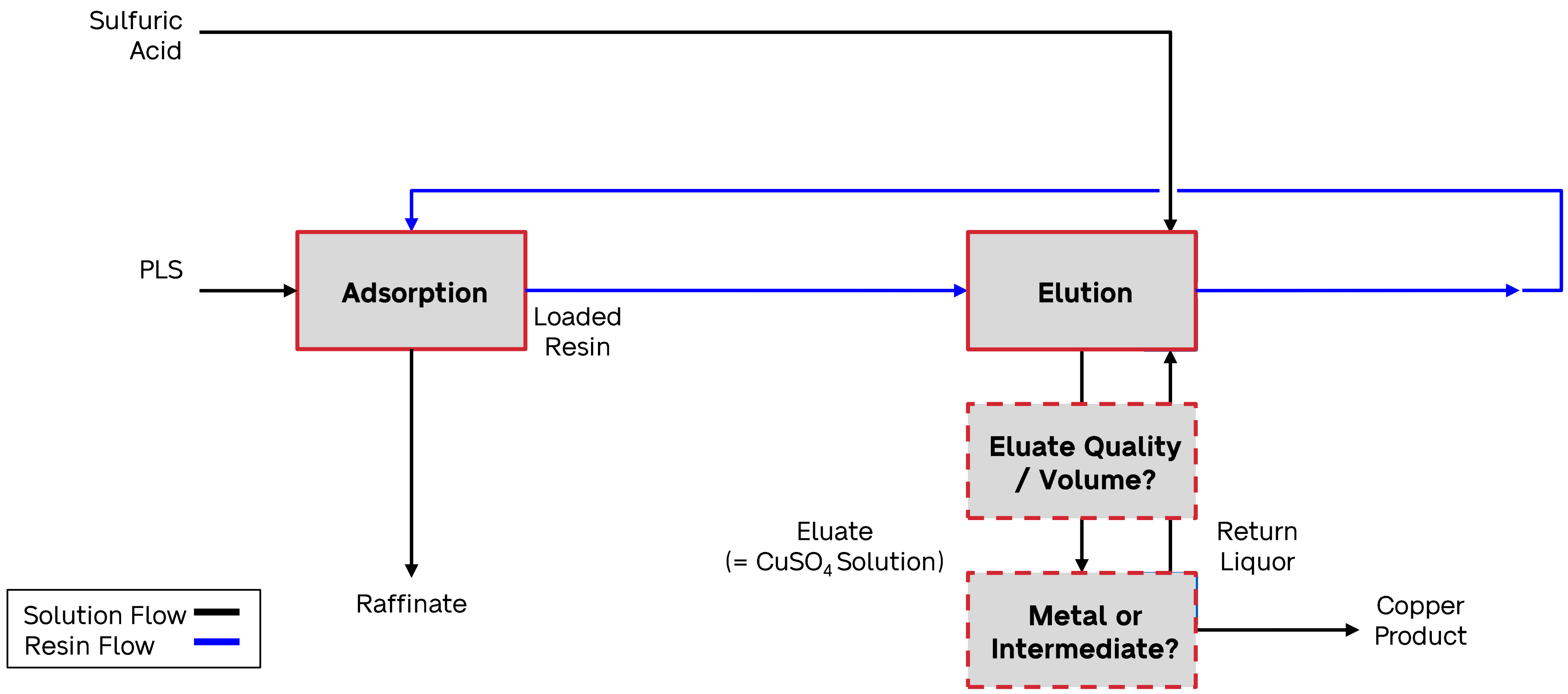


Kapunda mining activity c.1800



Mineralisation outcropping

CONCEPTUAL RECOVERY FLOWSHEET



PLS + COPPER EXTRACTION (ADSORPTION)

- Feed liquor

	Al	Co	**Cu**	Mn	Ni	Zn	**Fe**	ORP (Ag/AgCl)	pH
Feed, mg/L	82	6	**1040**	6	9	54	**1810**	341	2.76

- Preparatory batch testwork
- Fe^{2+} as major impurity, Cu-to-Fe ratio of 0.6
- pH and Fe^{2+} suppressed Cu loading; but Cu^{2+} can displace Fe^{2+}
- Partial oxidation of Fe^{2+} to Fe^{3+} during contact
- Subsequent countercurrent extraction campaign to generate bulk loaded resin


Pilot wellfield control room on-site


Wellfield – piping and control panel

ADSORPTION – MINI-PILOT

- Loaded resin shows upgrade and purification:

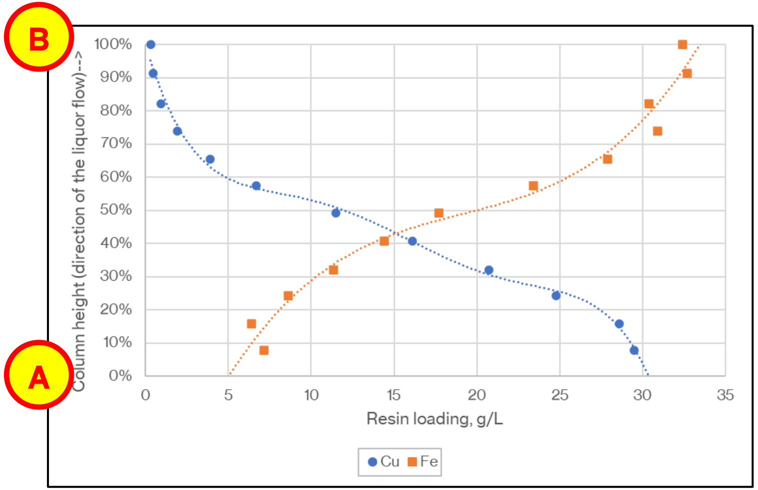
	Al	Co	**Cu**	Mn	Ni	Zn	**Fe**	**pH**
Resin, g/L	1.3	0.1	**29.4**	~0	0.3	1.4	**7.6**	**2.7**

Feed Cu-to-Fe = 0.6

Loaded Resin Cu-to-Fe = 3.9

- Some oxidation of Fe^{2+} to Fe^{3+}; some solids formation
- Trade-off exists on resin residence time/ solution contact time / Cu slip to raffinate
- Cu extraction prioritised

Column resin volume	2 L
Solution flowrate	~ 3 BV/h
Solution-to-resin flowrate	~ 33
Cu extraction	~100%
Iron rejection	>90%
Resin loaded	5.7L



Adsorption Mini-Pilot

ELUTION – MINI-PILOT

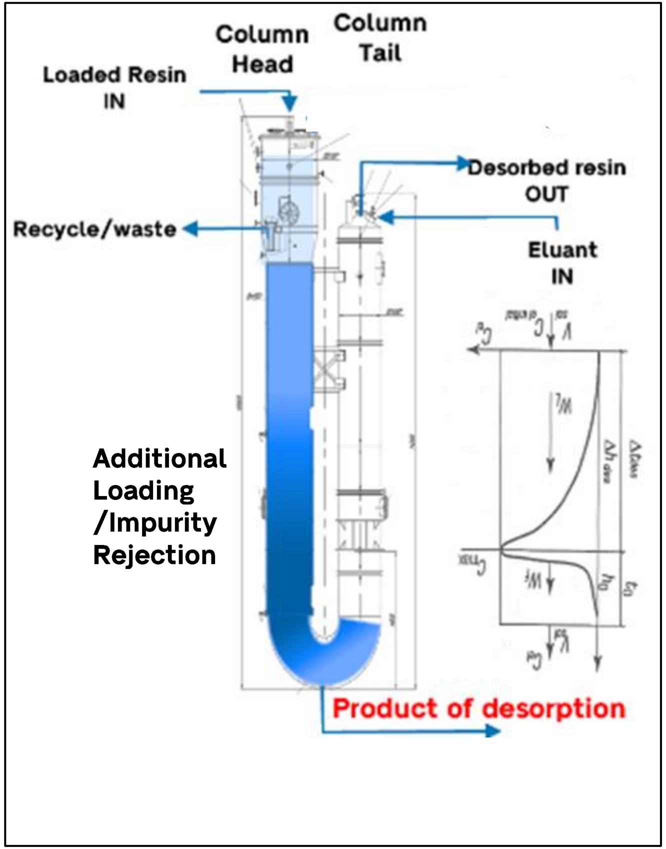
- Counter-current movement of solution and ion exchange resin in U-shaped column
- Further upgrade and purification of Cu

	Al	**Cu**	Mn	Zn	**Fe**
Feed, mg/L	82	**1040**	6	54	**1810**
Resin, g/L	1.3	**29.4**	~0	1.4	**7.6**
Eluate, g/L	<0.1	**87.1**	<0.1	<0.1	**5.6**
Deportment %	0	**100**	0	0	**25**

- Stoichiometric reagent consumption

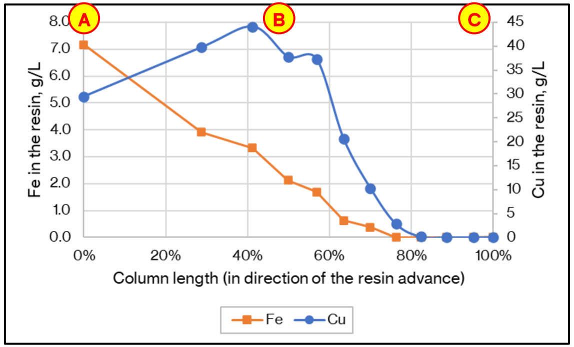
Resin processed	~5.7 L
Eluant H_2SO_4 conc.	~250 g/L
Eluant-to-resin flowrate	0.61
Eluate generated	~1 L
Eluate-to-resin flowrate	0.34

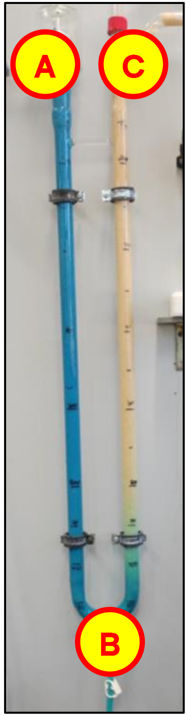
Desorption Mini-Pilot

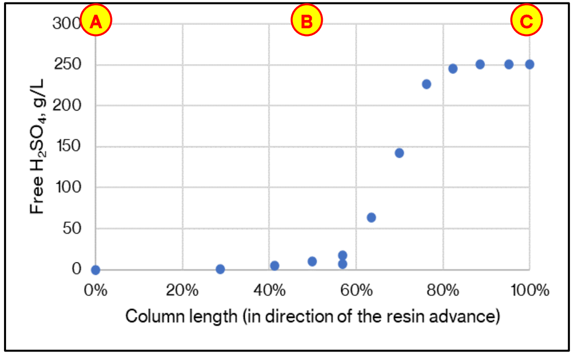


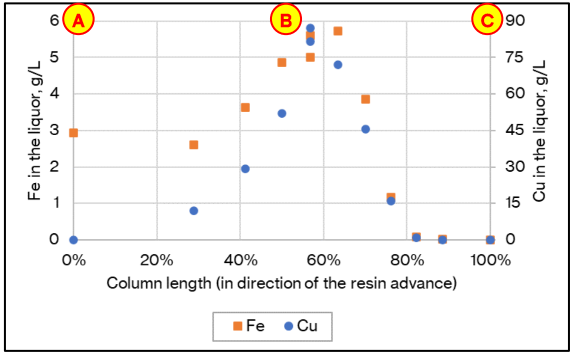
ELUTION – MINI-PILOT

- Fe^{2+} scrubbing (A → B)
- Scrubbing accomplished with 80-90 g/L Cu solution in the presence of ~5 g/L Fe and <10 g/L H_2SO_4
- Cu loading increases 30 to 45 g/L (A →B)
- Fe loading decreases 7.6 to ~2 g/L (A→B)
- Remaining 2 g/L as Fe^{3+}
- Residual Cu and Fe loading <0.05 g/L (at C)





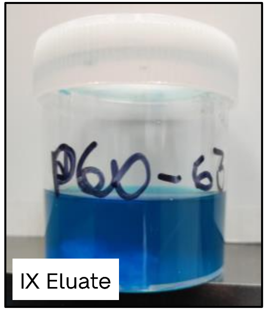




CRYSTALLISATION - BENCHSCALE

- Eluate homogenised and batch processed
- Volume reduction to saturation point at 75°C, targeting controlled crystallisation of $CuSO_4 \cdot 5H_2O$
- Under controlled crystallisation, a difference in Cu- and Fe-sulfate crystalisation leads to further Cu purificaiton
- Technical grade product spec. reached without any eluate pre-treatment (e.g. neutralisation or hydrolysis)

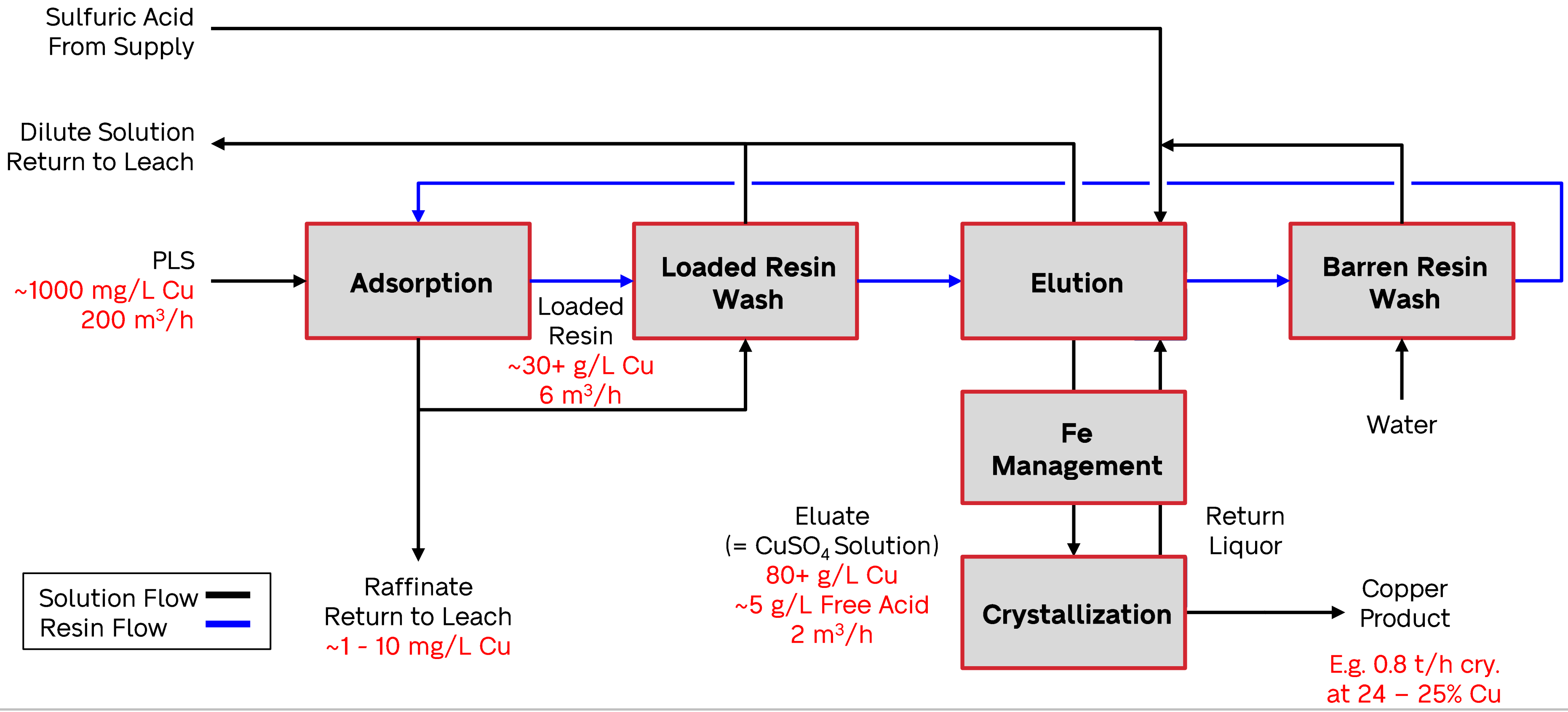
	Al	Co	**Cu**	Mn	Ni	Zn	**Fe**	**Cu/Fe**
Feed, mg/L	82	6	**1040**	6	9	54	**1810**	**0.6**
Resin, g/L	1.3	0.1	**29.4**	~0	0.3	1.4	**7.6**	**4**
Eluate, g/L	<0.1	<0.1	**87.1**	<0.1	0.3	<0.1	**5.6**	**16**
$CuSO_4 \cdot 5H_2O$ crystals, mg/kg	<25	<10	**249000**	<4	26	9	1723	144
Technical grade spec $CuSO_4 \cdot 5H_2O$, mg/kg			**247000**				3000	82



IX Eluate

Batch Rotary Evaporation

COMMERCIAL-SCALE FLOWSHEET



CAPITAL COST ESTIMATE (CLASS 4)

- 3 trains * 200 m^3/h PLS; centralised crystallisation
- 5,000 tpa Cu equivalent ~ 20kt crystal
- Process flow diagram developed to identify key process plant equipment items (from PLS through to raffinate + bagged product)
- Major equipment prices assessed based on material off-take estimates or factored from prior projects
- Parametric method for other components (e.g. factors from in-house database; Lang factors etc.)
- Resulting capital intensity ~$7000/tpa Cu

Direct Costs	US$ M
Purchased equipment cost	12.4
Installation	5.0
Civils	1.9
Utilities / services upgrade, tie-in	0.6
Total direct costs	**19.9**
Indirect Costs	**US$ M**
Engineering and supervision	2.2
Construction common distributables	1.4
Freight (inc. packaging)	0.6
Total indirect costs	**4.2**
First Fill	**US$ M**
Reagents + Resin	**10.6**
TOTAL INSTALLED COST	**34.7**

CONCLUSIONS

- ISR + IX
  - Modular IX configuration for satellite or phased development
  - Further optimisation opportunities exist due to the PLS/Raffinate exchange between ISR and IX
- Impurity Management
  - Pre-treatment of PLS (e.g. pH, Eh adjustment) unnecessary, in this case
  - Solids formation (gypsum, metal hydroxides) manageable with moving bed ion exchange column
  - Given the scrubbing achieved in elution, Fe(III) is the main impurity to manage in eluate
- Product Formation
  - Moving-bed ion exchange provides a path from PLS to technical-grade product at Kapunda
  - Concentrated, (partially) purified liquor creates product formation options inc. technical grade salt, metal precipitates, cathode.
  - Driven by project location, market considerations (volume, payability), infrastructure, etc.

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