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GYMPIE GOLD MINE DEWATERING

by

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ABSTRACT

This paper presents a concept-through-completion description of the Gympie Gold Dewatering Project, which entailed the extraction of over 1600 megalitres of mine water from depths up to 600 metres. The system comprised submersible pumps in an in-line configuration, suspended from the surface; making it the deepest suspended mine dewatering system in Australia, possibly the world. Installation of the pumps in the existing small timber-lined shafts required clearing of shaft blockages by manual and remote methods. The mine water was discharged in the nearby Mary River, part of the environmentally sensitive Mary River valley. Permission to discharge the high salinity water was given by the Queensland Government's Water Quality Council after extensive consultations. The successful completion of the dewatering was achieved in just twelve months.

The dewatering has enabled the BHP Gold Mines/Devex Joint Venture to proceed further with underground exploration in an area that historically yielded over one million ounces of gold.

INTRODUCTION

Just two hours drive north of Brisbane, Queensland is the town of Gympie - a quiet rural centre with a population of 10,000 - the town that has been the host to BHP Gold Mine's (BHPGM) high-risk, high-cost gold exploration project since early 1987. But you would hardly notice their presence as you enter Gympie's southern outskirts, travelling along the Bruce Highway. Gympie has an extensive gold mining history with 3.5 million ounces produced, the evidence of which is gone - huge mullock heaps that have since been flattened and grassed for playing fields. The only obvious reminder is the re-built timber headframe atop the old No. 2 South Great Eastern Shaft next to the mining museum, and the nearby restored Scottish Gympie retort house on the eastern side of Tin Can Bay Road. But the history is being revived, with a hive of activity at depths of 750 metres and 900 metres, as BHP Gold Mines progresses tunnelling and drilling to define an ore reserve.

The project centres on the West of Scotland Shaft, situated just two hundred metres off the Bruce Highway. The shaft, sunk between 1895 and 1902 to a depth of 950 metres, now has its third set of hoisting facilities, comprising a 20 metre high steel headframe and electric winder. These components originally served the Davidson Shaft at Mount Isa until relocated to Gympie in 1987.

Just down the road are the Scottish Gympie Shafts, Nos 1, 2 and 3 of depth 450m, 900m and 750m respectively, that combined in the 1800's to yield over 1,000,000 ounces of gold. The shafts and their workings form a small part of the historical Gympie gold field - a labrynth of tunnels and over 100 shafts that are all interconnected. In fact, in the 1890's you could walk underground from the southside of Gympie to the northside. These workings are now inaccessible due to being filled with water. The water is attributable to the Mary River that has periodically flooded over the years to cover low-lying shafts and subsequently flood the underground workings.

HISTORY

Gold was first discovered in 1868 in what is now Gympie's main street, Mary Street. The gold rush was on, with extensive alluvial mining carried out for several years. The miners then progressed to excavating the gold-rich quartz veins exposed at the surface. As the veins were chased deeper and deeper, there developed a gold field of over 100 shafts with such names as Old True Blue, New Caledonian, Phoenix Reborn and Eureka. The deepest shafts were to be found on the southern outskirts where the veins dipped to depths over 700 metres. It was here that the Scottish Gympie Mines were established. Their workings led them to discover a major quartz-bearing structure, the Inglewood Fault, which is a diorite dyke with gold-bearing quartz on its eastern margin. The discovery caused intense speculation and hinted at the promise of extending the gold field further south. It was this find that prompted the sinking of the exploratory West of Scotland Shaft to 950 metres, a daunting task even by today's standards.

The alignment of the southern extension of the Inglewood Fault was unknown and the West of Scotland Shaft was sunk unsure of whether they were on the east side or west side of the Fault. Two tunnels, extended east and west at the 900 metre level in the shaft, failed to find the Fault. One theory of the time was that the shaft was sunk to boost the share price for the British owned mines. The mine was abandoned, never finding the Inglewood Fault, known many years later to be only 200 metres further west.

Minor work continued in the Gympie gold fields until the 1920's, which saw falling gold grades and periodic flooding halt the mining. Although not connected to the rest of the gold field, ground water seepage eventually filled the West of Scotland Shaft in the intervening years. In the early 1950's, it was dewatered by bailing and explored by a local syndicate. No underground work took place - it is believed the developers ran out of money and soon abandoned the shaft to refill with seepage waters.

It was not until Freeport carried out deep drilling from the surface in the early 1980's that the southern extension of the Inglewood Fault was confirmed by their geologists and its position relative to the West of Scotland Shaft accurately determined. The deep drilling indicated economic grades of gold in the quartz margin of the fault, at a time when world gold prices were on the rise. The plan to explore the resource was to dewater the West of Scotland shaft and tunnel along the Inglewood Fault to enable the ore reserve to be defined. This was by far more cost effective than the "shot in the dark" deep surface drilling. The joint venture between Freeport and Devex was disbanded and Devex, who held the Authorities to Prospect, looked for a substantial partner to undertake the $25 million exploration plan. The newly floated BHP Gold Mines signed the joint venture agreement with Gympie Eldorado Gold Mines (wholly owned by Devex) to earn 55% equity, with BHP Minerals acting as managers. The prize being one million ounces of gold, with an in-situ value at the time in excess of 600 million dollars.

BHPGM, assisted by mining contractors Eltin with engineering assistance from BHP Engineering, began work in early 1987. The first step was to dewater and refurbish the timber-lined West of Scotland Shaft and install a staged pump system as the work progressed down. This was completed in early 1988, at which time driving commenced on the 750 metres and 900 metres levels simultaneously. It was at this stage that detailed assessment of Scottish Gympie Mine plans that were old, incomplete, and considered of dubious accuracy, indicated that further advancement on the 750 metre level would strike the old workings around the No. 2 and No. 3 Scottish Gympie shafts. This would release 1600 megalitres of water into the West of Scotland shaft - enough to fill it 300 times over. Because of the possibility of loss of life and investment, it was decided to dewater the entire old goldfield workings. In March 1988, after producing a feasibility study that indicated it could be done, BHP Engineering were engaged to carry out the complete design and project-management of the forbidding task to dewater the old workings from the surface.

METHODOLOGY

The approach chosen was based on a few premises, being:-

(i) the quantity of water to be removed may reach 2,000 megalitres. This figure was calculated by BHPGM, utilising old mine plans and records of tonnages and gold grades mined. This enabled an assessment of the quantity of water versus depth, which was checked during the dewatering operation by monitoring the depth of water in other shafts. (refer Table 1)

(ii) submersible pumps would be used for dewatering, suspended from the surface by their own rising main. The option of progressing manually down the shaft and progressively dewatering was dismissed as too costly and time consuming, based on work carried out at the West of Scotland Shaft.

(iii) the design was targeted at dewatering to 750 metres depth, dependent on the condition of the existing Scottish Gympie shafts.

(iv) the pumps and associated equipment had to be small enough to fit down one of the compartments of the (usually) three compartment timber-lined shafts. Each compartment was only one metre by one metre.

(v) o pump out of the deepest shafts, as the whole goldfield will drain to the lowest point.

(vi) o progress as quickly as possible. This necessitated not only fast-track design, procurement and construction, but also the use of a staged approach whereby smaller readily-available pumps were to be put in use first, while larger capacity pumps were on order. For each stage there was to be two pumps, with a configuration designed to maximise pumping rates. This entailed a parallel arrangement initially, with pumps hanging side by side, each with its own rising main. Then the pumps were to be configured in a series arrangement, with the two pumps "piggy-backed" off the one rising main.

(vii) to obtain a discharge licence from the Queensland Government Water Quality Council to enable discharge of the water into the nearby Mary River (ironically from whence it came many years ago). Of major concern was the high salinity levels of the mine water.

TABLE 1:ESTIMATED QUANTITY OF WATER CONTAINED IN INTERCONNECTED GYMPIE GOLDFIELD

Although the tonnages will change for the addition of mullock, the percentages will not as mullock produced should be even throughout the mine.

Assuming an S.G of 2.6 for the ore the following table can be established:

DEPTH ABOVE	m^3 OF WATER	%
100 m	605,769	40
200 m	769,230	50
300 m	1,065,000	69
400 m	1,271,153	82
500 m	1,414,230	91
500 m - 800 m	1,546,153	100

*With the addition of mullock there is closer to two million cubic metres of water contained in the field.

STAGE 1 - DEWATERING

Being the deepest in the gold field, the only choices for pumping were the Scottish Gympie No. 3 and No. 2 Shafts. The shafts were located and inspected, after a detective hunt through old mine plans and with help from some "old timers". As the Scottish Gympie No. 3 was found to be blocked at 100 metres depth with its concrete collar requiring extension to the surface, it was decided to commence Stage 1 of the dewatering from the interconnected Scottish Gympie No. 2 shaft.

To probe the depths of the Scottish Gympie No. 2 shaft and to ascertain its condition, some novel techniques were implemented. Once its concrete cap was removed, its three compartments were probed with a plumbob to reveal numerous obstacles down to the 210 metres limit of the Stage 1 pumps, and beyond. To ascertain the nature of the blockages, an underwater video camera was lowered, with the image displayed on a TV monitor on the surface. The camera showed lumps of timber and concrete of varying sizes and shapes wedged across the shaft. To try to dislodge the obstacles or possibly raise them to the surface, steel hooks were welded onto the steel tubular casing around the camera. The system was so successful that an old house stump was raised to the surface. Eventually two compartments were cleared to 230 metres depth to allow lowering of the pumps.

The installation system required for the pump rising main and support had to be simple and fast to reduce the substantial cost of on-site cranage, yet strong enough to support 200 metres of rising main together with significant operating dynamic hydraulic forces. The system devised met all these requirements, comprising a chairing beam and scissor support beam arrangement, developed to form the basis for the far more complex Stage 2 arrangement.

Two Pleuger 4 stage 132kW 415V pumps with a capacity of 100 litres per second at 90 metre depth were installed initially in parallel configuration. They quickly dewatered to their limiting depth, extracting approximately 90 megalitres. They were then pulled out and re-lowered in series configuration to 180 metres depth. The $185mm^2$ power cable used was dragline trailing cable purchased from BHP's Moura coal mine, with a special paint applied to give the required waterproofing. The pumps were later lowered a further 30 metres, a depth at which the pumps were at the limit of their operating range. After four months, with minimal operational difficulties, a total of 600 megalitres was removed.

APPROVALS AND ENVIRONMENTAL CONSIDERATIONS

Being in the Mary River valley and on the southern outskirts of the Gympie township, the project had to be environmentally sound. The project team was acutely aware of this and all issues concerning the dewatering were given close attention. The project team worked in conjunction with the Gympie City Council, the Widgee Shire Council, local landowners, the Department of Mines, the Queensland Water Resources Commission, the Main Roads Department and the Water Quality Council. Although several alternative schemes for disposal of the mine water were considered by the project team, because of the vast quantity of water it was found that the only feasible solution was to discharge the water into the nearby Mary River.

The primary task was to agree with the Water Quality Council on acceptable dewatering procedures and controls, and thereby allow issue of a discharge licence. Water quality testing indicated the mine water, while stagnant underground, had leached salts and minerals out of the rock, resulting in a total dissolved solids (TDS) level up to 5000 parts per million (ppm). As the Mary River water was used for irrigation downstream, the possibility of harm to immature crops was identified and the Water Quality Council set a limit for TDS of 500 ppm for river water samples 500 metres downstream of the discharge point. This compared to an ambient TDS level in the river varying from 50 to 400 ppm. Therefore to allow discharge of the mine water, considerable dilution was required by the river so that the river's TDS level did not rise to above the 500 ppm level. Although trace elements such as chromium, lead and molybdenum were present, after dilution their concentration was insignificant.

A discharge control system was devised based on monitoring TDS and flow rate at both the Mary River and the pump site, with the requirement to shut the pumps off if the river TDS level rose above 500 ppm for more than a day. Firstly a real time, reliable measure of TDS was required. This was achieved by the use of an electrical conductivity probe on site. The results could then be directly related to TDS by the use of factor, which was determined from a batch of field samples tested in an independent laboratory. The probe was used for the measurement of mine water salinity, as well as river water salinity.

Together with the river flow measurements taken at the Kidd Bridge weir (calibrated by the QWRC) and the discharge control equation, the TDS monitoring enabled regulation of the pumping operation to meet the discharge licence requirements, on a day-to-day basis. Also weekly river water samples were taken both upstream and downstream of the discharge point, which were sent to Brisbane for full analysis of trace elements, as well as TDS. This also provided an on-going check of the field conductivity measurements. Effectively, the dewatering program was at the mercy of the weather in the Mary River Catchment. (refer Tables 2-5)

After six weeks of intense planning and negotiation, the Water Quality Council issued a discharge licence in June 1988 to allow start-up of Stage 1 dewatering pumps on 1st July 1988. The mine water was directed into Halls Gully, a side gully off the Mary River, with extensive erosion control measures in place at the discharge point.

However, concern by the Halls Gully landowner about movement of their stock across the gully and the stock's health due to the possibility of drinking the relatively high-salts water, led to the construction of stock crossings and discussions with the landowner of alternatives. The Stage 1 pumping was temporarily halted in September 1988 while an agreement was reached, resulting in the compromise of allowing the remainder of Stage 1 water to be pumped into Halls Gully, while BHPGM committed itself to construct a pipeline direct to the river, off private land, for Stage 2.

Stage 1 pumping re-commenced, with a further 150 megalitres extracted over the next month, dropping the shaft water level down to 210 metres. The planning and construction of the 1100 metre pipeline direct to the river was not as simple. The preferred route passed through the mining museum parkland (a popular tourist attraction) and other public land including the Bruce Highway. However, the groundwork of good working relations built up previously, resulted in the Gympie City Council allowing construction to proceed (in fact they constructed part of the pipeline) and the Main Roads Department allowing it to pass along the Bruce Highway. The discharge point at the Mary River required extensive erosion control measures, requested by the Queensland Water Resources Commission, as the banks of the Mary River are prone to instability. The galvanised spirally-welded steel pipeline was designed, manufactured and installed in seven weeks.

STAGE 2 - PRELIMINARIES

Due to their four month manufacture period in Germany, the Stage 2 pumps were ordered immediately after purchase of the Stage 1 pumps. They were also Pleuger pumps, supplied by Pacific Pumps, of six stage configuration, 475kW, 3.3kV, capable of 100 litres per second at the depth of 350 metres.

With the Stage 1 dewatering underway, attention focussed on the Stage 2 design and planning. The first decision was which shaft to pump out - wait until Stage 1 dewatering was complete and commence clearing the rest of the blockages out of the No. 2, or set-up at the No. 3 Scottish Gympie Shaft and immediately start to clear the shaft blockages. The decision fell in favour of the No. 3 shaft for a number of reasons:-

(i) allowed substantial works around the No. 3 shaft to be performed unhindered.

(ii) The only interconnection between No. 2 and No. 3 shafts, and the rest of the field, was at 630 metre level. To pump out of the No. 2 would only allow the water level to be dropped to the 630 metre level, still 120 m above the required dewatering depth of 750 metres.

(iii) allowed the possibility of refurbishing the No. 2 shaft, as dewatering progressed at the No, 3, to provide another exit and through-ventilation circuit with the West of Scotland. (This work subsequently did not proceed for a number of reasons.)

(iv) allowed manual clearing of shaft blockages in the top 200 metres of the No. 3 shaft as the Stage 1 dewatering progressed. (Manual clearing provided the only **certain** method of clearing shaft blockages.)

TABLE 2: GYMPIE GOLD DEWATERING TYPICAL MINE WATER ANALYSIS

CATIONS	mg/l	TRACE ELEMENTS
Calcium	400	SiO_2 20
Magnesium	180	Fe 1.50
Sodium	600	Zn 0.02
Potassium	14	Mn 0.25
ANIONS		As <0.03
Hydroxide	-	P 0.2
Carbonate	-	Sr 5.0
Bi-Carbonate	1200	Al 2.0
SULPHATE 1500		Mo <0.01
CHLORIDE 420		Pb <0.02
NITRATE 2.0		Cr <0.01
pH 7.3		Ba <0.02
CONDUCTIVITY (E.C.) 4500 micro-S/cm		La <0.02
TOTAL DISSOLVED SOLIDS 3200 mg/l		Cd <0.01
TOTAL HARDNESS 1900 mg/l		Cu <0.02
		Ni <0.02

TABLE 3 GYMPIE GOLD DEWATERING WATER QUALITY COUNCIL DISCHARGE LICENCE COMPLIANCE CRITERIA

- Mine waters shall be discharged into the Mary River and be diluted.
- Control monitoring point at Normanby Bridge, 1.2 kilometres downstream of discharge point
- TOTAL DISSOLVED SOLIDS — MAX 500ppm
- DISSOLVED OXYGEN — MIN 2mg/litre
- pH shall be in range 6.5 to 8.5
- Aluminium max 0.2mg/litre)
Iron max 0.05mg/litre)
Manganese max 0.1mg/litre) — IMPOSSIBLE TO COMPLY- THESE LEVELS EXCEEDED IN MARY RIVER NORMALLY
- Chromium max 0.05mg/litre)
Arsenic max 0.05mg/litre)
Lead max 0.05mg/litre)
Molybdenum max 0.01mg/ltre) — ABLE TO BE COMPLIED WITH
- Sodium Adsorbtion Ratio — 3meg/litre
- Non-Filtrable Residue — max 100mg/litre

TABLE 4: GYMPIE GOLD DEWATERING WATER QUALITY COUNCIL DISCHARGE LICENCE MONITORING PROCEDURES

Weekly water samples to Amdel Laboratory

Sample points • 3 in Mary River
- 1 in Deep Creek
- 1 of shaft water

Daily river and shaft water conductivity and river flow and pumping rate while pumping.
Water depth in shaft measured daily during pumping.
Water depth in other shafts monitored during Stage 1 of pumping.

TABLE 5: PUMP WATER DISCHARGE CONTROL EQUATION

$$\text{TDS} \times \text{FLOW} + \text{TDS} \times \text{FLOW} = \text{TDS} \times \text{FLOW}$$

Shaft Water		Mary River Upstream of Discharge Point		Mary River Downstream of Discharge Point	
TDS	FLOW	TDS	FLOW	TDS	FLOW
average 3500 ppm	100 litres/second in series (8.6 Megalitres/day) 200 litres/second in parallel (17.2 Megalitres/day)	ambient varies from 50 to 400 ppm normally around 300 ppm		maximum allowable 500 ppm	measured at Kidd Bridge Weir

Mary River
- average flow 80 Megalitres/day
- during pumping operation, flow fluctuated wildly from
  - → just a trickle (<30 Megalitres/day)
  - → to a stream (640 Megalitres/day - at limit of Kidd Bridge Weir - RL 37 metres)
  - → to a flood (thousands of Megalitres/day - RL 58 metres)

To satisfy maximum river TDS of 500 ppm, 100 litres/second pump flow required 130 Megalitres/day river flow.

So began the awesome task of clearing blockages in the Scottish Gympie No. 3 Shaft. At least one compartment was required to be clear to 400 metres and one compartment to be clear to 750 metres for the parallel then series configurations. Firstly, the concrete collar of the shaft was extended six metres to the surface from the base of the excavation needed to find the shaft. Next, in conjunction with BHPGM mining engineers, a hoisting facility, comprising a winch and headframe, was set up to allow men to be lowered into the shaft. The shaft timbers were made safe as the men progressed downwards, using an 800mm diameter kibble for travel and hoisting the timber and rock blockages hung up in the shaft. The speed at which this was achieved was testament to the courage of the men that worked in the cramped and dangerous conditions.

Now was the dilemma of how to remove blockages submerged in water to depths of 750 metres in cramped shaft compartments by remote methods from the surface. After considerable discussion and investigations, it was decided to use two types of grab suspended off the end of the hoist rope; the first a simple spring-loaded caliper type which achieved limited success. The second type comprising an air-over-oil accumulator operating hydraulic cylinders closing a four prong clamshell grab. On the surface, the accumulator was charged with compressed air and the on-board timer was set. The grab was then lowered till it struck a blockage then lifted up slightly. The timer opened the grab, the grab was then lowered onto the blockage, then the timer closed the grab. The grab with its load was then lifted to the surface. Although problems did occur, which could be expected from its working environment, the grab successfully cleared the three compartments to 210m, 400m and 625m respectively. The blockage at 625 metres was substantial and coincided with the level of workings to the shaft and raised the possibility of a shaft backfilled with rock to this point.

As there was a pump system in place in the West of Scotland Shaft, it was decided to halt attempts to clear blockages to any greater depth. The Stage 2 dewatering design was minimally adjusted to target the 600 metres depth instead of the previously planned 750 metres depth and, as a separate exercise, the West of Scotland pump system was to be used to dewater the remaining 150 metres of head after completion of dewatering out of the No. 3 Scottish Gympie Shaft.

7. STAGE 2 - DETAILS

Although similar to the Stage 1 system, the Stage 2 system's complexity increased exponentially. Notable features included:-

- temperature sensors in the pump motors, connected to the surface switchboards by control cable fixed to the rising main, to prevent overheating of the pumps

- specially designed pump motor starters in the switchboard, with undercurrent and overcurrent protection, and rapid rise time trip for mechanical jamming protection

- a water depth measuring probe, based on a pressure transducer, to measure the head of water above the probe, suspended with control cable from the surface - critical for the safe operation of the $200,000 pumps. Two other methods of depth measuring were used, with limited success. Firstly a pressure tube was strapped to the stage one rising main, with its lower end open and its upper end connected to a compressed air bottle. The intention was for the pressurised compressed air to purge the air out of the tube and an in-line pressure gauge used to measure the back pressure, and hence the head of water above the lower end of the tube. The system did not work however, and a replacement system was required immediately. The new method incorporated contact points similar to a spark plug suspended off calibrated TV aerial wire. A multimeter was connected to the aerial wire and indicated when the points entered the mine water, closing the electrical circuit.

Even the pressure transducer probe experienced trouble, with silt build up on the probe prohibiting a proper reading. The build-up eventually prevented hoisting of the probe through its protective PVC tube.

- o a water sensor, mounted in the booster shroud surrounding the upper pump when in series mode, to detect water around the pump before it is started.

- o use of an 800mm diameter 3mm wall steel liner to extend full length of the rising main and pumps to protect the system against rocks and timber which may fall away from the sides of the shaft during dewatering. The liner was also used to push its way through minor debris hang-ups in the shaft that the grab may have missed. The liner, weighing over 40 tonnes, was suspended off its own chairing beams and collar clamp at the surface.

- o rising main connections using reinforced flanges, highly tensioned bolts and compressible stainless steel gaskets to handle the transient hydraulic bursting pressures of up to 900 metres head and the vertical weight of the rising main and pumps. BHP Engineering's in-house specialist water hammer computer program was used to analyse the system. As a consequence, additional measures such as orifice plates and air valves were placed in the rising main and discharge line to carefully regulate pipe water pressure conditions. Also, as ultimate protection for the pumps against damage by unexpectedly high peak water pressures, a rupture disc was installed off the rising main to vent the pressure if necessary.

- o a 600 metre high rising main, effectively a giant pendulum twice theheight of Sydney's Centrepoint Tower, supported at the surface by its own chairing beams, withstanding a weight up to 100 tonnes. The supports were designed for ease of installation and withdrawal of the 12 metre rising main lengths. Also a special lifting lug was used for lowering by the mobile crane parked next to the shaft.

To minimise costly on-site cranage and facilitate quick and safe installation, special designs were developed.

The liners incorporated sleeves welded to the ends of each liner section. Four rectangular tabs were welded to the sleeves, with holes provided for lifting. The liner sections were carefully lowered into the shaft and supported by two semi-circular clamps, bolted together. The clamps were in turn supported by the framing system over the shaft collar. Subsequent section of liner were lowered sleeve on sleeve, with the tabs site welded. The sequence was then repeated for subsequent liner sections. A cycle of 45 minutes was achieved for each 12 metre long liner section.

The pumps and rising mains, together with the multitude of power and control cables, were suspended off the gusset-reinforced flanges of the rising mains by the scissor beams. These beams were, in turn, supported by the main chairing beams. The whole framework had to be built over the top of the liner support system, and stood 2.4 metres high.

While a rising section was chaired, the crane lowered in place the next section. Each section was bolted together by 12 tensioned high strength M24 bolts, with a compressible stainless steel gasket providing the seal. The special split-tube cable protectors were also bolted on at this stage. Once ready, the crane took the weight of the entire rising main system, the scissor beams were opened, and the system lowered. As the system was lowered, the cables were clamped to the rising main. The upper flange of the upper pipe section was then chaired on the now closed scissor beams and the process was repeated. A cycle of 30 minutes was achieved for each 12 metre long rising main sections.

PUMPING OPERATIONS

The stage 2 pumps were commissioned in parallel configuration in early December 1988. However, due to drought conditions that effectively reduced the Mary River to a trickle, the pumping operations could not commence. Luckily rains came in that month to allow pumping down to 400 metres by mid January, at which stage the pumps were changed over to series operation. The changeover, a three week exercise costing over $200,000, required both pumps and one liner to be pulled out, the liner extended to 625 metres in one compartment, and the pipes and pump lowered inside the liner to their new levels at 620 metres. A total of 52 liner sections and 51 rising main lengths were lowered, along with 1000 metres of power cable, 1400 metres of control cable, and two pumps with their shrouds.

An air of expectation hung over the commissioning of the pumps in series, as the water made its 20 minute journey to the Mary River. Just to raise the water to the surface took five minutes! The pumps continued operation without problems, withstanding two Mary River floods in April 1989 which was estimated to have poured over 140 megalitres into the gold field. The 620 metre mark was reached in mid May 1989. (refer Tables 6 and 7)

The monitoring of water levels in other shafts and the measuring of cumulative pumped-out volumes verified the predicted volumes calculated with surprising accuracy. The lag shown in the attached graph between predicted and actual volumes can be attributed to "leaking" interconnecting tunnels between the shafts. This phenomena showed when the pumps were switched off and the water level recovered, up to several metres in some instances.

CONCLUSION

The successful completion of the dewatering project formed a critical part of the Gympie exploration venture, allowing further progress into the highly prospective zones which may bring this exciting development to fruition. The outcome showed that the dewatering could be done - a task not even considered feasible at the start of the Gympie project.

There were circumstances and elements of the project which played a significant part in the dewatering, and would be recommended for any future jobs of similar scope. However, as with all projects there are lessons to be learnt and elements which can be performed better next time.

The most significant "plus" for the project was the economical and environmentally - acceptable disposal of the water into the Mary River. The use of evaporation ponds was not possible due to Gympie's net precipitation, and discharge direct to the sea was not contemplated because of the distance. The Water Quality Council deserved immense credit for their efforts, not only as a "watchdog", but also as a positive contributor to the final outcome. Another "plus" was the availability of 11kV power off the state grid next to the shafts, which afforded substantial time and cost savings.

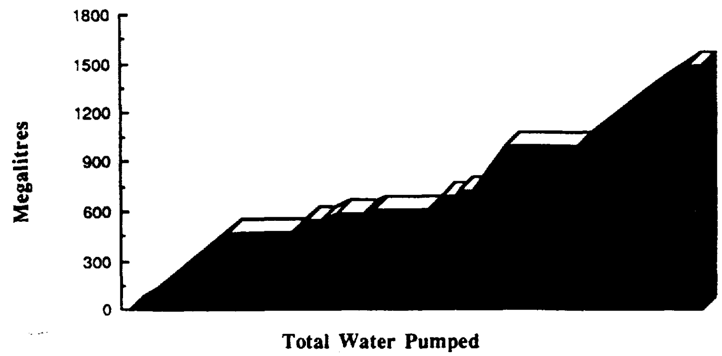

Figure 1. Scottish Gympie No.2 and No.3 Pumping Data

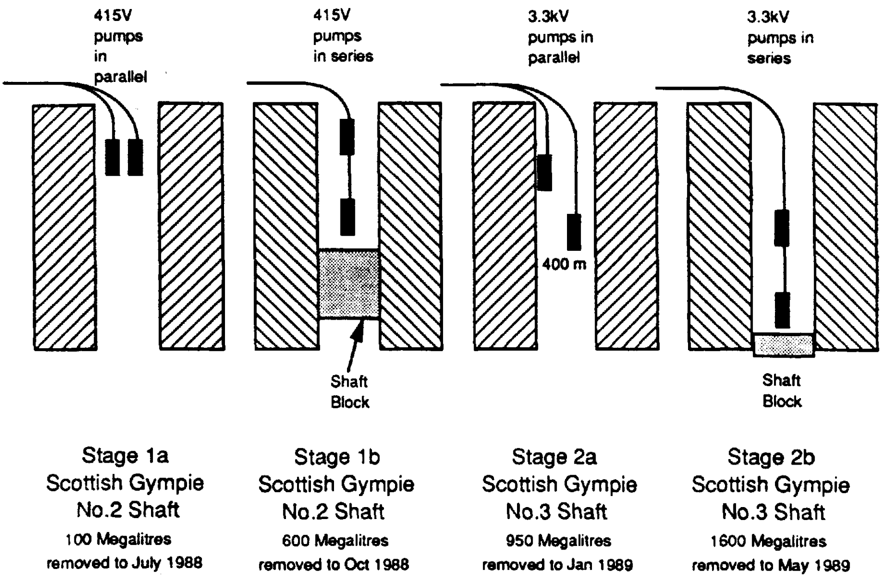

Figure 2. Gympie Gold Dewatering - Schematic Presentation.

One aspect which cannot be forgotten is the input of the project team. With a highly-motivated group of people, supported by an interactive client who minimised the constraints that could hinder the development of such an ill-defined project, there was a good chance of success.

Also of enormous benefit to the project is the information gained on Mary River floods and potential in-flows, and the extent of interconnection to adjacent historical mine workings. In the long run, this information will prove invaluable to the safe operation of what may become Australia's deepest goldmine.

A few lessons were learnt during the project. The first concerns the corrosiveness of the mine water. Although of lesser salinity than other typical mine waters, the water caused noticeable corrosion of the liners and rising main during the relatively short dewatering period. The potential problem was noted in Stage One, and the Stage Two rising main was specified galvanised and the Stage Two pump impellors were to be made of a special alloy. Also, extensive earthing and sacrificial anodes were used to control stray currents, which could promote corrosion. For operations over a longer period, this would be a significant design consideration.

Another lesson learnt is that, although the shaft clearing by remote means was partially successful, there was the need to have a fall back position, being the use of manual shaft clearing and staged pumping arrangements such as that used in the West of Scotland Shaft.

Some of the decision made during the project fall well within the bounds of risk management, and its application could have been more extensive. For example, the savings of not using the liners versus the potential time and cost penalties should the pumps or power cables be damaged. Also, was the use of a rupture disc a sound decision? The cost to raise the pump system, replace the rupture disc and re-lower the system would probably outweigh the cost of the pump it was installed to protect. There are a few other examples which, had there been time for adequate assessment of the risks, may have altered the decisions made.

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APPENDIX A: PROJECT PARTICIPANTS

Owners:	Joint Venture between BHP Gold (55%) and Gympie Eldorado Gold Mines (45%) (100% subsidiary of Devex Ltd)
Managers:	BHP-Utah Minerals International Mr Nigel Rowlands - Exploration Manager Mr Bob Kitch - Project Superintendent
Designers and Project Managers:	BHP Engineering Pty Ltd
Main Contractor:	World Services and Construction
Electrical Subcontractor:	J P Richardsons
Civil Subcontractors:	Gympie Building Company Robertson Bros. Gympie City Council
Pump Supplier:	Pacific Pumps Australia in conjunction with, Pleuger Pumps - West Germany
Environmental Consultants:	Lewis Environmental Consultants
Water Quality Consultants:	Mackie Martin and Associates