Northern Star Paulsens Operations

Fact Sheet

Location and Climate

Paulsens is an operational underground gold mine located 180km west of the mining town of Paraburdoo on the border of the Ashburton and West Pilbara Mineral Fields, Western Australia. The Paulsens underground mine was purchased by Northern Star in July 2010. The mining camp itself is a 160 man camp with modern facilities including pool, gym, sports court and satellite TV with the mining operations working out on either a fly-in fly-out or drive-in drive-out out basis.

Total tenement package in the mineral field is over 7,000km^2. The Paulsens tenement holdings consist of 22 leases for over 290km^2 with 100% ownership. There are a further 8 leases for 162km^2 in joint ventures (Northern Star 80%). The Ashburton tenements consist of holdings of 8 Leases with 930km^2.

The climate is classed as semi- arid with historic rainfall of ~283mm per year. Average monthly rainfall recorded in the region indicates seasonality with the majority of the rainfall occurring in the summer months.

Average maximum temperature in January is 40^{0}C and for July is 24^{0}C.

Average minimum temperature in January is 26^{0}C and for July is 15^{0}C.

History of Ownership

The significant historical events of the Paulsens project can be summarised as follows:

- Underground mining was carried out in the project area in the 1930s in what is known as the Melrose Mine.
- Modern exploration of the area commenced in 1976 with CRA Limited.
- The project was acquired by Taipan in 1997.
- After a takeover by St Barbara Mines in late 2003, a new board and management raised equity, extinguished debt and increased the Mineral Resource by 60% and rebadged Taipan as NuStar Mining Corporation (NuStar).
- After completion of a feasibility study in 2004, construction of the mine commenced in July and the 250,000 tonnes per year mill produced first gold in June 2005.
- In July 2006, NuStar merged with Intrepid Minerals Corporation, creating Intrepid Mines Limited (Intrepid)
- In March 2008, Intrepid merged with Emperor Mines Limited.
- In July 2010, Northern Star Resources Limited (ASX:NST) purchased the mine and surrounding tenements from Intrepid.

History of Exploration

The Paulsens prospect is named after the historic Paulsen Mine (also known as Melrose Mine; Finucane 1939), located at the foot of a prominent quartz hill, which was active during the period 1935 to 1940. According to Seymour, Thorne, and Blight (1988) reported mine production was 2,955t for 28.549kg gold (average recovered grade 9.55gpt). The orebody at the old workings comprised a partially oxidised quartz-carbonate-sulphide vein generally less than 2m thick and dipping roughly 30º to the northeast. Argillaceous sedimentary rocks are exposed in both the hanging and foot-walls. The quartz-carbonate-sulphide vein was worked over a strike length of roughly 50m (140 feet), stoping extended to approx. 17m (57 feet) below surface, and the deepest shaft to 32m (106 feet). It is now recognised that the reef at the old mine represents a small splay at the western edge of a much larger en echelon vein array.

In more recent times, Asarco Australia Ltd carried out reconnaissance surface exploration of the Paulsens area (1982 to 1987).

During the period 1987 to 1989, CRAE conducted a program of 1:40,000 scale aerial photography (enlarged to 1:5,000 over Paulsens), geological mapping, and surface sampling, followed by Rotary Air Blast (RAB), Reverse Circulation (RC), and Diamond Core (DC) drilling. A total of 36 RAB holes (166m), 43 RC holes (3929m), and 2 DC holes (159.7m) were drilled to evaluate the historic Paulsen Mine and test for extensions to known workings.

In 1991, Hallmark Gold NL (Hallmark) took an option on the Paulsens Prospect. In 1992, after drilling a number of RC and DC holes, Hallmark entered into a further agreement with CRAE to acquire 70% of the Mining Lease (M08/99) covering the prospect.

During 1994 Taipan carried out a reconnaissance rock chip sampling program. Soil sampling and RAB drilling by Taipan in 1996 identified a large soil gold anomaly over the Paulsens Prospect, extending well beyond the old mine to the north and northeast. In August 1997, RC drilling of the anomaly commenced and immediately encountered high-grade gold mineralisation. The known mineralisation was quickly extended out from the existing CRAE resource for over 70m to the east, northeast, and north, and a new geometry to the mineralisation was recognised.

Exploration drilling has continued to extend known mineralisation to cover an area roughly 350m by 1000m, including the old Paulsens Mine and CRAE/Hallmark resource in the south-western corner. Up until 1999, Taipan had completed~42,000m of RC drilling and 4,200m DC drilling within the Paulsens Prospect. Mineralisation remains open down plunge to the north-northwest.

Processing History

The original processing facility was designed and commissioned as a 250,000 tonnes per annum carbon in leach (CIL) plant. Subsequent to commissioning, the throughput had been increased to 330,000 tonnes per year and a further upgrade to the circuit and CIL leaching capacity has now enabled the plant to run at 450,000 tonnes per annum. The plant has operated with an average life of mine recovery of 94.5%.

To the end of 2014, the Paulsens Operation has processed over 3.0M tonnes of ore at an average grade of 7.63gpt and poured just under 700,000 fine ounces of gold since operations commenced.

Geology

The Paulsens deposit lies within the west-northwest trending regional Wyloo anticlinal dome. Archaean Fortescue Group metasediments and metavolcanics of the Hamersley Basin are exposed in the core of the dome and form the host rocks of the Paulsens deposit. Paulsens is a mesothermal, orogenic lodestyle gold deposit with mineralisation occurring within a structurally controlled, 40m thick, quartz vein, hosted by a folded, sedimentary sequence. The quartz body is found between the two halves of a large faulted Gabbro dyke. This Gabbro dyke's orientation is somewhat oblique to the regional foliation so the apex of the folded quartz slowly moves out of this corridor.

The main body of mineralisation comprises an Upper (UZ) and Lower (LZ) Zone located on the hanging wall and footwall contacts respectively. Drilling has defined a down-plunge extent in excess of 1,000m to around 550m below surface. The mineralisation is cut in places by a series of steeply dipping dolerite dykes that vary from one to ten metres in thickness.

Mining Operations

The Paulsens underground is accessed via a single decline at the bottom of a 21m deep boxcut developed into the side of the Paulsens Hill which occurs adjacent to the mine office and milling complex. Underground mining takes place from a single decline with level accesses than run south to north with ore drives orientated east to west of the level accesses .

Currently, Paulsens produces around 0.47mtpa. The primary stoping method at Paulsens is up-hole longhole open stoping, with stopes retreating in a top down sequence and towards a central access. Other mechanised ore extraction methods include jumbo stripping and benching. There is also a limited amount of airleg stoping in the Paulsens Upper Zone. Stope sizes vary from ~1,000t to ~7,500t. The centroid of mining is approximately 750m vertically below the surface.

The mine design process at Paulsens commences with a resource model, from which long term mine planning is based on and is refined as infill drilling progresses. Closely spaced definition drilling enables updates to the geological model and the release of final level and stope designs.

The continuous nature of the Paulsens mine down plunge coupled with the single decline with ore drives running off a centralised access for each mine level makes the top down mining sequence employed at Paulsens relatively easy to manage. The shallow plunging nature of the orebody also means that usually only four stoping panels are exposed horizontally which promotes favourable mining induced stress conditions.

The primary mining activities are carried out by Northern Star Mining Services (NSMS) with diamond drilling carried out by Australian Underground Drilling contractors. The current mining fleet consists of:

- 1 x Tamrock DD421 development jumbo
- 1 x Tamrock Solo 5V production drill rig
- 1 x R2900 Caterpillar bogger
- 3 x R1700 Caterpillar boggers
- 1 x Normet charmec 1614B with emulsion hypercharge unit
- 6 x Service vehicles (Integrated tool carriers, store truck, water cart, grader etc)

Process Operations

The Paulsens Gold Mine utilises a Carbon in Leach (CIL) circuit for the extraction of gold.

The crushing plant is a three-stage facility that treats up to 150 tph of minus 550mm Run-of-Mine (ROM) ore, to produce a crushed product with P80 of 8mm. The crushing plant consists of a primary jaw crusher and secondary and tertiary cone crushers. Oversize from an inclined double deck vibration screen (apertures 20mm and 8mm) reports to the cone crusher, and undersize reports to the fine ore storage bin (FOB), or the on-ground fine ore stockpile (FOS).

Fine ore product from the crushing plant discharges into the fine ore bin, which provides surge capacity of 24 hours to the milling circuit. The ore is reclaimed from the fine ore bin via a slot feeder and variable speed belt feeder conveyor.

The grinding and classification facility operates 24 hours a day, 365 days a year, to mill 450 000 tpa. Grinding is performed by a 3.51m diameter by 5.63m long (inside shell) rubber lined overflow ball mill, equipped with a 1,000KW motor. A cluster of six hydrocyclones (four operational, two standby) is used to classify the slurry to a P80 of 106µm.

The underflow from the hydrocyclones is split with a stream passing over a gravity screen to scalp the plus 2.4mm material before it reports to two Knelson Centrifugal Concentrators that are installed in parallel. The Knelson Concentrators collect free gold particles and particles with high density by applying a centrifugal force. Concentrate periodically passes to a pair of Acacia Reactors for gold recovery. The Acacia Reactors utilise sodium hydroxide, cyanide, and Leach Aid to leach the gold particles. Gold is recovered from the leach solution via dedicated gravity electrowinning circuits inside the gold room.

Overflow from the cyclones gravitates to a 7.0m diameter high rate thickener fitted with an auto-dilution feed well. Diluted flocculent is added to the feed well through sparges. Thickener overflow flows by gravity back to the process water tank for reuse in the grinding circuit. Thickener underflow, at 55% solids w/w, gravitates into the leach feed pump hopper and is pumped to a conditioning tank where the slurry is pre-oxygenated utilising a Multimix system. The conditioned slurry then gravitates to the first of six 150m^3 CIL tanks operating in series to give a total residence time of 25 hours. Each tank has dual open impellor agitators and an intertank screen.

The elution and gold recovery circuit operates seven days per week/24 hours per day, treating 2.0 tonne batches of carbon, with up to seven strip cycles per week. Carbon, loaded to 4,000 gpt gold, is recovered from CIL tanks, screened and washed to remove the slurry, and directed into the cyanide wash column. The elution circuit comprises of two columns. In the first column a cold cyanide solution wash is carried out to remove copper adsorbed onto the carbon, followed by a hot acid wash to remove nickel and other deleterious elements. The carbon is then transferred pneumatically to the second column, where elutriation takes place. The first column is constructed of mild steel and is butyl rubber lined. The second column is constructed from 304 stainless steel. The total strip cycle will take nine hours, using 36m^3 of water, whilst the elution cycle uses 16.7m^3 of water and takes four hours.

Pregnant solution is discharged from the elution column, via the eluate filters and recovery heat exchanger, to the electrolyte tank. The solution is pumped from this tank via the electrolyte pump to two 600mm by 600mm, electrowinning cells operating in parallel. Cell discharge gravitates back to the electrolyte tank. Electrical current is supplied to the electrowinning cells by two dedicated rectifiers (6V, 1000 A). The mild steel wool cathodes containing the electro-won gold are removed from the electrowinning cells, placed on trays and calcined at 700ºC. The sludge in the cells is removed via the drains in the bottom of the cells, and collected in buckets. Flocculant is added and excess solution is decanted prior to calcining. The calcine is mixed with fluxes, and smelted in the gas fired tilting bullion furnace with A100 crucible capacity. The bullion is stored in the gold room safe.

Slurry from the last CIL tank gravity flows via the screen feed box to the carbon safety screen. The carbon safety screen is fitted with 750µm aperture woven wire mesh. Carbon safety screen oversize reports, via a chute, to a fine carbon waste bin. Screen undersize reports to the tailings pump hopper at 48% solids, and is pumped to the tailings storage facility via the tailings disposal pumps.

Tailings Storage Facilities

The tailings storage facility (TSF) is a single side hill valley impoundment that sits on top of the impermeable Mount Jope Volcanics structure. The TSF impoundment wall has undergone various upstream raises since its initial construction.

Tailings is delivered to the TSF via a 6/4 Warman duty pump in sequence with a Kato 4/3 booster pump along a 100mm diameter line from 650m to 1600m depending on spigot position. Maximum flow to the TSF is 100m^3/hr. The current TSF configuration has no decant for return water due to the small and ever moving pond present on the surface.

Potable water is produced onsite via a reverse osmosis plant. Non-potable water for the processing plant site is sourced from the raw water dam. This dam is fed by a number of bores, underground mine return water and reject water from the reverse osmosis plant. Water for underground mining operations is fed from a series of storage tanks. Water for these tanks is sourced from a number of bores with the option of filling from the raw water dam in the event of high water demand.

Constant operational and environmental monitoring maintains the TSFs within the regulatory conditions at all times.

Support Infrastructure

Paulsens has two operational diesel power stations – one 4.5MW station primarily for processing and administration functions, and one 5.0MW station primary used for underground mining activities. Power is supplied to the processing, mining, camp and administration areas via a high voltage overhead transmission line. The bore fields are supplied with generator sets in the field.

Water supply for the project is pumped from numerous bore fields located surrounding the processing facility. All fields are located within 15km of operations.

The water is of very good quality and is used for both processing and potable supply. It is pumped from bores using submersible pumps.

The airstrip for operations is located 180km away at Paraburdoo with an alternate gravel strip located 20km away at Wyloo station. The Paulsens Accommodation Village has rooms for 160+ employees and boasts some excellent recreation facilities including, a fully equipped gymnasium, tennis court, basketball court, swimming pool and a well-equipped tavern/shop.

The site operates on both a fly-in fly-out and drive-in drive-out basis 24 hours per day/365 days per year with work rosters predominantly either eight days on and six days off or fourteen days on and seven days off – there are however some variations to this.

An emergency response capability is paramount in such a remote location as Paulsens and the operation receives a tremendous service from the many individuals that have volunteered to provide this essential service.

Occupational Health and Safety

Paulsens utilises Northern Star's safety program and management systems, which include detailed standards and procedures. Together, these programs and systems form the cornerstone of safety at Northern Star, ensuring that employees have the tools they need to work safely.

The Company also strives to ensure employees are fit to conduct their work in a safe manner. With this goal in mind, Northern Star offers healthy meal alternatives, fitness equipment and a quality medical service for live-in employees.
Mining is not dangerous but it is hazardous and reducing residual risk to acceptable levels by driving the use of higher order controls from the hierarchy of controls remains a focus.

Summary of Previous Production (FY 2005-2014)

PAULSENS PRODUCTION

FY Year	Tonnes (kt)	Grade (gpt)	Recovery (%)	Ounces Produced
2005	24	10.1	93.8	7,358
2006	301	8.6	94.5	78,848
2007	324	6.6	93.2	64,408
2008	326	8.3	93.8	81,172
2009	335	7.4	94.1	75,368
2010	244	6.8	91.4	48,587
2011	287	10	94.1	86,522
2012	336	6.6	94.0	67,206
2013	412	7.2	91.9	88,603
2014	464	7.4	90.1	100,041

Closure and Reclamation

The site has undergone numerous changes of ownership in its operating history and accordingly has been subjected to various internal reclamation standards. Mining commenced at Paulsens in 2004 and was expected to have a mine life of just four years. In 2014, Paulsens celebrated its tenth anniversary and today continues to operate as an underground mine.

The mining operations have been approved under the Mining Act 1978 and as such the Department of Mines and Petroleum (DMP) require, as per the Tenement Conditions, that the existing Paulsens Mine Closure Plan and Rehabilitation Plans be reviewed in accordance with the DMP (2011) Guidelines for Preparing Mine Closure Plans. Paulsens includes a number of distinct operational areas, these being the underground mine and the associated infrastructure, the original waste rock landform, and the mineral processing facility with associated logistical support infrastructure.`

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